BEFORE THE POLLUTION CONTROL BOARD
OF THE STATE OF ILLINOIS

IN THE MATTER OF:	)
	)
PROPOSED ADJUSTED STANDARD FOR	)
AMMONIA NITROGEN DISCHARGE LEVELS	) AS 08 -_______
APPLICABLE TO CITGO PETROLEUM	) (Adjusted Standard - Water)
CORPORATION AND PDV MIDWEST	)
REFINING, L.L.C., PETITIONERS	)

NOTICE OF FILING

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Please take notice that on March 18, 2008, we filed electronically with the Office of the Clerk of the Illinois Pollution Control Board the attached Petition for an Adjusted Standard, a copy of which is served upon you.

CITGO PETROLEUM CORPORATION, and
PDV MIDWEST, LLC, Petitioners

By: ______________________
One of Its Attorneys

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PETITION FOR AN ADJUSTED STANDARD

CITGO Petroleum Corporation and PDV Midwest Refining, LLC ("CITGO" or "Petitioner") petition the Illinois Pollution Control Board ("Board") for an Adjusted Standard applicable to its Lemont Refinery. This rule change would reduce the allowable levels of ammonia nitrogen in the wastewater discharges from a refinery located in Lemont, Will County, Illinois. ("Refinery") CITGO is the operator of the Refinery and PDV Midwest Refining, LLC is the owner of the Refinery. For the reasons stated below, Petitioner requests an Adjusted Standard from Section 304.122(b) of Subpart B of Part 304 of Title 35 of the Illinois Administrative Code. Petitioner's existing site-specific regulation pertaining to ammonia nitrogen, 35 Ill. Admin. Code § 304.213, will expire on December 31, 2008. This Petition for an Adjusted Standard ("Petition") is brought pursuant to Section 28.1 of the Act, 415 ILCS 5/28.1, and Part 104 of Chapter 35 of the Illinois Administrative Code, 35 Ill. Admin. Code § 104.400 et seq. In support of this Petition, CITGO states as follows:

STATEMENT OF REASONS

1. PDV Midwest Refining, L.L.C. ("The Refinery") owns a petroleum refinery located on an 860-acre tract in Will County near Lemont, Illinois. The Refinery was formerly owned and operated by the Union Oil Company of California ("Union") and then operated by the

UNO-VEN Company. On May 1, 1997, PDV became the owner of the Refinery and CITGO was contracted to operate the Refinery.

2. Despite extensive improvements and other efforts, the Refinery is not able to consistently meet the ammonia nitrogen effluent limits contained in Section 304.122(b) of Subpart B of Part 304 of Title 35 of the Illinois Administrative Code (ammonia nitrogen rule). The general ammonia nitrogen discharge rule would apply to the Refinery, but for site specific rule changes granted in 1987, 1993 and 1998. Despite steady improvements during the last twenty years, Petitioner and its predecessors have been unable to consistently achieve the effluent limits of the ammonia nitrogen rule. The Refinery has been successful in lowering the ammonia nitrogen concentration in its effluent and has achieved this success even though the plant throughput has increased and wastewater usage has decreased. The Refinery is prepared to continue efforts to reduce its ammonia nitrogen discharge, but it cannot commit to meet the general effluent limit in 35 Ill. Admin. Code 304.122(b).

3. The Refinery currently discharges to the Chicago Sanitary and Ship Canal ("Canal") which is a tributary of the Illinois River. The discharge is quickly dispersed in the Canal and assimilated by the receiving stream. The dilution pattern of the effluent is rapid and immediate under the criteria of 35 Ill. Admin. Code Subtitle C, Chapter I, Section 302.102.

4. Petitioner proposes the following adjusted standard be adopted by the Board:

> a) This standard applies to discharges from PDV Midwest Refining, L.L.C. Refinery ("The Refinery"), located in Lemont into the Chicago Sanitary and Ship Canal;
>
> b) The requirements of Section 304.122(b) shall not apply to the discharge. The Refinery shall meet applicable Best Available Technology Economically Achievable (BAT) limitations pursuant to 40 CFR 419.23 (2003), incorporated by reference in subsection (d);

c) The Refinery shall also meet a monthly average limitation for ammonia nitrogen of 6.93 mg/l whenever the monthly average discharge exceeds 100 lbs per day and 10.61 mg/l whenever the daily discharge exceeds 200 pounds of ammonia;

d) The Board incorporates by reference 40 CFR 419.23 (2003) only as it relates to ammonia nitrogen as N. This incorporation includes no subsequent amendments or editions;

e) The Refinery shall continue its efforts to reduce the concentration of ammonia nitrogen in its wastewaters;

f) The Refinery shall monitor the nitrogen concentration of its oil feedstocks and report on an annual basis such concentrations to the Agency;

g) The Refinery shall continue its efforts to control and manage solids from its crude oil supply with respect to its wastewater treatment system;

h) The Refinery shall submit the reports described in subsection "f" no later than 60 days after the end of a calendar year; and

i) The provisions of this Section with respect to Ammonia Nitrogen shall terminate on December 31, 2013.

5. The limits for ammonia nitrogen proposed here are based on a statistical analysis using the 95th percentile of the standard deviation over historical and representative time periods to calculate the effluent limits. The daily and monthly limit is based on the 95th percentile based on the last five years of effluent data. The limits proposed demonstrate the commitment to improvement in nitrification, a reduction in the daily limit of 59 percent and in the monthly limit of 27 percent.

6. Over the last several years, Lemont Refinery has been processing an increased percentage of heavy crudes and can expect the trend in feedstocks over the course of this petition to continue. The uncertainty associated with this issue justifies the Board choosing to set daily and monthly limits that take into account this uncertainty. Moreover, this analysis indicates that the proposed limits represent a continued emphasis on improvement in wastewater controls and achieving nitrification in the wastewater treatment plant even with more difficult wastewater

streams to be treated. Over the last 5 years, on a net basis, the Refinery has exceeded 100 pounds on a monthly daily average for ammonia only 33 percent of the time, and exceeded 200 pounds per day for ammonia only 17 percent of the time.

GENERAL INFORMATION

7. The water quality conditions in the receiving stream do not require further treatment of the Refinery discharge to meet applicable water quality standards. The un-ionized ammonia levels in the receiving streams currently meet the applicable water quality standard (0.1 mg/l). Further reductions in the ammonia discharged are expected during the course of this proposed adjusted standard

8. At this point, Petitioner and its predecessors have expended significant resources in improving the wastewater treatment system at the Refinery. Petitioner and its predecessors have spent nearly $75,000,000 to upgrade and improve the wastewater treatment facilities at the Refinery; approximately $45,000,000 of that was spent just in the last 10 years.

9. While there has been success in reducing the effluent ammonia nitrogen concentration, the Refinery is unaware of proven means to comply with the ammonia nitrogen rule on a continuous basis. The options available to Lemont are two orders of magnitude more expensive, on a unit cost basis, than other available alternatives for ammonia removal. Therefore, it is possible to spend millions of dollars in an attempt to implement unproven strategies for potential ammonia nitrogen reduction even though: (a) the present level of wastewater treatment at the Refinery is better than the United States Environmental Protection Agency's ("U.S. EPA") effluent guideline of best available technology ("BAT") economically

achievable; and (b) the ammonia nitrogen discharge for the Refinery has no discernable water quality impact on the receiving stream.

10. The requested amendment will allow Lemont Refinery to continue to operate without spending millions of dollars on unproven technology in an attempt to accomplish further ammonia nitrogen reductions with little or no environmental benefit. The Refinery will continue to optimize its treatment facilities, regardless of the outcome of this Petition. Indeed, the daily limit requested here represents a 59 percent reduction, substantially below the level authorized in 1998.

11. The following paragraphs and exhibits address the remaining requirements of 35 Ill. Admin. Code § 104.406 with respect to adjusted standards. With respect to ammonia nitrogen, the other major sources are the same as in the previous proceedings: the three major plants of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC).

12. Petitioner has consulted with the Agency regarding this petition for an adjusted standard; the Agency, however, has not yet determined its position on this request.

REFINERY INFORMATION

13. The Refinery was constructed during the period 1967 through 1970. It became operational in late fall of 1969. Currently, the maximum daily production is approximately 168,000 barrels per day. The Refinery employs approximately 530 people.

14. Approximately twenty-five different products are produced at the Refinery, including gasolines, turbine fuels, diesel fuels, furnace oils, petroleum coke and various specialty naphthas which can be manufactured into many intermediate products, including antifreeze,

dacron, detergent, industrial alcohols, plastics and synthetic rubber. Ninety percent of the Refinery's output goes into making gasolines, diesel fuels, home heating oils and turbine fuels for use in Illinois and throughout the Midwest.

15. The Refinery draws from and discharges to the Canal. The Refinery takes approximately 5.0 million gallons of water daily from the Canal, and discharges approximately 4.5 million gallons to the Canal, the difference being cooling tower evaporation and steam losses. The wastewater effluent contains ammonia as nitrogen derived from compounds present in crude oil that are removed from the crude by various Refinery operations, as well as the ammonia already present in the intake water from the Canal.

16. The Refinery operates under a National Pollutant Discharge Elimination System ("NPDES") permit (No. IL 0001589), issued by the Illinois Environmental Protection Agency ("IEPA," or "the Agency"). The most recent NPDES permit was issued as modified June 22, 2007 and expires July 31, 2011. The NPDES permit includes outfall 001 at the Refinery at river mile 296.5 on the Canal (Latitude 41°38'58", Longitude 88°03'31"). The current NPDES permit includes ammonia nitrogen limits in the existing 35 IAC 304.213.

EXISTING WATER QUALITY

17. The requested adjusted standard will not result in environmental or health effects substantially and significantly more adverse than the effects considered by the Board in adopting the rules of general applicability for ammonia nitrogen. No adverse environmental impact, including harm to aquatic life, will result from the granting of the requested adjusted standard. At 3 mg/l, the allowable discharge of ammonia nitrogen from the Refinery is 145 pounds at the design average flow. The annual average discharge loading to the Canal over the last 5 years

has been an average of 102.4 pounds per day, with a net ammonia discharge of 76.2 pounds per day; 26.2 pounds per day are estimated to be in the intake water from the Canal, on an average day. Thus, about 25 percent of the ammonia nitrogen currently discharged is due to background conditions in the Canal.

18. The Refinery discharges into the Canal, upstream of the Lockport Lock & Dam. Below the dam, the Canal merges with the Des Plaines River, passes through Joliet and 11 miles downstream of Joliet passes beneath the I-55 Bridge. Until the I-55 Bridge, the receiving waters are designated as Secondary Contact waters; below the I-55 Bridge, the Des Plaines River is designated as General Use Water. The General Use Waters begin 18.5 miles below the Refinery's outfall.

AMMONIA NITROGEN WATER QUALITY

19. In 1992, UNO-VEN engaged Huff & Huff, Inc. to investigate and report on the environmental effects of its ammonia nitrogen discharge on the Canal. The consequent report, entitled "Environmental Assessment of Ammonia Concentration in the Wastewater Discharge of the UNO-VEN Refinery, Lemont, Illinois" (the 1992 Huff & Huff report), contained a detailed assessment of the discharge on the receiving waters. The 1992 Huff & Huff report was included in UNO-VEN's 1993 Petition for a site specific rule change.

20. The 1992 Huff & Huff report concluded that the Refinery's discharge results in a 10:1 dilution plume in an area 15 feet long by 8 feet wide. The effluent is dispersed to a 10:1 dilution in approximately 7 seconds which is considered "rapid" and "immediate" under Board regulations. Effluent conditions and low flow conditions in the Ship Canal have not changed materially, so this Zone of Initial Dilution analysis remains valid today. The overall mixing zone

was determined to provide a dilution ratio of 40:1 during this same 1992 study. Again, conditions are similar today, except that the 7-day 10-year low flow in the Ship Canal has been reduced from 1,100 MGD to 850 MGD due to the loss of discretionary diversion of Lake Michigan water. The result is a current mixing zone dilution ratio of 36.1:1 at the design average flow for the Lemont Refinery.

21. In order to further evaluate the water quality and the effect of the Refinery's discharge, Huff & Huff conducted benthic macroinvertebrate sampling of the Canal. The sampling retrieved 1,967 specimens representing 14 different species. A comparison of samples taken upstream and downstream of the Refinery outfall showed no significant variation in the type and number of species retrieved. No measurable impact from the Refinery's discharge on the benthic organisms in the Canal was discerned. Furthermore, the 1992 Huff & Huff study showed a dramatic improvement in the benthic community between 1983 and 1992. These results were corroborated by a June 1991 study conducted by the MWRDGC.

22. In 1997, the Refinery contracted Huff & Huff for another assessment of the environmental impact of the ammonia in the Refinery's wastewater effluent on the receiving stream. Huff & Huff produced another report, entitled "Environmental Assessment & Effluent Limit Derivation Report of The Lemont Refinery Wastewater Discharge" (the 1997 Huff & Huff report).

23. The 1997 Huff & Huff report reviews the water quality data for the Canal. For each year from 1992 to 1997 (except 1993), the total ammonia levels downstream of the Refinery were less than the upstream values. This reduction in ammonia suggests that active nitrification is being achieved in this portion of the Canal. The 1997 Huff & Huff report notes a

5 percent reduction in total ammonia in the 5.3 miles of Canal upstream of the Refinery and a 56 percent reduction in the 5.5 miles downstream of the Refinery. This ammonia reduction downstream indicates that the Refinery effluent does not have a negative impact on nitrification in the Canal.

24. The Refinery has again requested Huff and Huff to summarize more recent water quality information. That report, entitled "Environmental Assessment & Effluent Limit Derivation Report for the Ammonia Discharge from the CITGO Lemont Refinery" ("2007 Huff & Huff Report,") is attached as Exhibit A. This report analyzes the existing water quality data in the Ship Canal and projects the impact of the proposed monthly limitation: among the conclusions are that the ammonia levels in the Ship Canal, at the edge of the mixing zone, would be 0.805 mg/l. Since the Refinery usually is able to nitrify the typical levels in the Canal after mixing would be lower. Moreover, the maximum unionized ammonia level recently collected in the Canal [downstream at Lockport] was 0.079 mg/l - which includes the discharge of the Refinery. Thus, the ammonia levels in the Canal today are well within established water quality standards.

<u>THERE ARE NO REGULATORY CONSTRAINTS THAT PROHIBIT THIS RELIEF</u>

25. Section 303(d) of the Clean Water Act requires states to identify impaired waterways and the causes of impairment and then develop what is essentially a waste load allocation for addressing the impairment. Illinois prepared its list of impaired waterways in 1998; 738 segments were identified. Illinois also developed a priority list for addressing these 738 segments. According to the Agency's *Illinois Water Quality Report 2006*, the Chicago

Sanitary and Ship Canal is listed as an impaired waterway, for a variety of reasons. However, none of the reasons listed are for Ammonia Nitrogen.

26. Effluent Limits - With respect to Ammonia Nitrogen, the applicable effluent limits for the Refinery have been those set in the site specific rules for the Refinery, as adjusted over time.

27. Mixing Zone - Under Illinois regulations, the maximum allowable mixing zone is 25 percent of the stream flow. Water quality standards must be achieved at the edge of the mixing zone. Using the requested monthly average concentration of 6.9 mg/l as the projected discharge and only 25 percent of the Canal's low flow yields an incremental change of 0.17 mg/l at the edge of the mixing zone.

28. Categorical Limits - U.S. EPA has promulgated categorical limits on various industries, including the petroleum refining industry. While these regulations, found in 40 CFR 419, do specify limits for ammonia nitrogen, these are less stringent than the limits in the existing site-specific rule. The Board has previously found that the wastewater treatment system goes beyond Best Available Technology ("BAT") requirements.

29. The U.S. EPA has established effluent guidelines for wastewater discharges by industry category. The petroleum refining industry is divided into five subcategories based on the processes utilized and the products produced. The Refinery is classified as a Subcategory-B cracking refinery under the federal regulations. Effluent limits under the federal regulations are based on production, and are computed on a pounds per day basis.

30. The Board has adopted Title 35, Section 304.122 to control ammonia discharges to the Illinois River System, originally Rule 406, adopted Jan 6,1972. Rule 304.122(b) limits

larger industrial discharges (greater than 100 lbs/day ammonia) to an effluent discharge concentration of 3.0 mg/l NH_3-N. Historically, the refinery has achieved compliance with the federal effluent regulations; however, the 3.0 mg/l effluent limit has not been attainable on a consistent basis.

31. From 1977 through 1984, Union operated the Refinery under several variances from the Board for the ammonia nitrogen discharge. In 1982, the Board granted Union a variance, contingent that by May of 1984, Union would submit a program to ensure compliance with Rule 304.122 or prepare a proposal for a site specific rule change. In December of 1984, Union petitioned the Board for a site specific rule change. The Board granted Union site specific effluent limits set at the U.S. EPA's best available technology (BAT) pursuant to 40 CFR 419.23 (1985). This site specific rule change terminated on December 31, 1993. In 1993, UNO-VEN petitioned the Board for a site specific rule change. The Board granted UNO-VEN's request and set effluent limits for ammonia nitrogen of 9.4 mg/l monthly average and 26.0 mg/l daily maximum. By final order dated December 17, 1998, the Board made only two changes to the rule as adopted in 1993: a change of the name to reflect the sale to PDV Midwest Refining, LLC, and an extension of the termination date by 9 years to December 31, 2008.

32. Based on the foregoing, the Lemont Refinery submits that the relief here requested is not inconsistent with the effluent standards and area-wide planning criteria under the Clean Water Act.

OTHER FACTORS JUSTIFYING THE SITE-SPECIFIC STANDARD

33. The Refinery utilizes a physical/chemical and biological wastewater treatment plant. The treatment plant performs primary, secondary and tertiary treatment on the generated

wastewater before it is discharged into the Canal. The original wastewater treatment plant, which began operation in 1969, included two oil/water separators, a flow equalization tank, a primary clarifier, an activated sludge system and a polishing pond. Several wastewater treatment plant modifications have been made since the original installation. Major changes to the system include new oil/water separators, process water storage tanks, a new aeration basin, a high efficiency aeration system, a second final clarifier, an induced gas flotation system, additional strippers in the sour water system, upgrades to the diffused aerators, and addition of a purge treatment unit, associated with operating the WGS.

34. The primary treatment portion of the current plant consists of four sour water strippers for ammonia and sulfide removal, oil/water separators for free oil removal, stormwater impoundment, equalization, and emulsified oil removal using organic polymers.

35. The effluent from the primary clarifier flows to the Induced Gas Flotation ("IGF") vessel and then to the secondary treatment portion of the wastewater plant which consists of a single stage activated sludge treatment system. The system includes three aeration basins operated in parallel with a total aeration basin volume of a 1.92 million gallons. Aeration is provided by a fine-bubble diffused aeration system. Activated sludge is settled in two 100-ft. diameter secondary clarifiers. Within the aeration basin, phosphorous is added as a nutrient for biological organisms. During the winter, steam is injected to the equalization tank to maintain operating temperatures at a minimum of 70°F in the aeration basin effluent.

36. The tertiary system consists of a 16 million gallon polishing lagoon. The purpose of the lagoon is to remove any carryover solids from the secondary clarifier. The lagoon also serves as a water supply for fire protection.

37. Under the site specific rule change granted in 1987, the Refinery was required to continue its efforts to reduce the concentration of ammonia nitrogen in its wastewaters. The Refinery met this requirement through continuous upgrades to the wastewater treatment plant. After petitioning for the 1987 site specific rule change, the Refinery:

- Added a third aeration basin, increasing the total aeration volume from 1.38 million gallons to 1.92 million gallons;
- Upgraded the aeration system by replacing the existing mechanical surface aerators with a fine-bubble diffused aeration system; and
- Added the second 100-ft. diameter secondary clarifier, doubling the secondary clarifier capacity.

These improvements were designed to increase ammonia oxidation, increase available dissolved oxygen and increase hydraulic throughput.

38. While the site specific rule change was granted in 1993, the Refinery continued its efforts to reduce the concentration of ammonia nitrogen in its wastewaters. From 1992 until 1998, the Refinery:

- Installed a new chemical feed facility at the WWTP;
- Eliminated discharge of process wastewater to the stormwater basin and provided tankage for equalization/oil separation of process wastewater;
- Converted the WWTP control system to new DCS control;
- Modified the sour water stripper charge tanks inlet line for better oil/water separation;
- Performed a clean closure of the stormwater basin; and
- Utilized Nalco dried bacteria and conducted nitrifier inhibition testing.

39. Since 1998, the Refinery has continued to make improvements to its wastewater treatment system. Those measures have included:

- In 2000, installed induced gas flotation system with polymer addition;
- In 2003, added additional strippers in the sour water system for ammonia removal;
- Also in 2003, upgraded diffused aerators to improve oxygen transfer;
- In 2006, upgraded phosphoric acid feed system and the aerators to improve oxygen transfer;
- In 2007, installed purge treatment unit to treat the discharge from the FCC scrubber; and
- Also in 2007, upgraded diffused aerators to improve oxygen transfer.

The total cost of these improvements was approximately $45,000,000.

40. Despite the improvements in its treatment plant, the Refinery has been unable to continuously meet the Illinois standard for ammonia concentration in treated wastewater effluent. As a result, the Refinery contracted with AWARE Environmental, Inc. ("AWARE") to evaluate current conditions at the Refinery. AWARE was also asked to evaluate the treatment system operations and to evaluate alternative ammonia removal technologies. AWARE reported its findings in "<u>Technical Review of Ammonia Treatment At The Wastewater Treatment Plant - CITGO Petroleum Corporation, Lemont Refinery</u>" (the 2007 AWARE report). The 2007 AWARE report is attached hereto as Exhibit B.

41. The 2007 AWARE report concludes that the Refinery is a BAT plant that employs the best available treatment technology currently required of refineries in the U.S. The report also concludes that the current plant is unable to continuously attain the limits set by the State of Illinois for effluent ammonia nitrogen. While the Refinery and its predecessors have made progress toward meeting the Illinois limits, the Refinery is still unable to meet these limits on a continuous basis.

42. The Refinery has improved its performance of ammonia removal despite higher crude throughput and a decrease in wastewater volume. Wastewater volumes have decreased since 1984 through the exercise of sound water management practices. Despite these factors that would tend to increase ammonia concentration, the Refinery has maintained/improved its performance in ammonia removal.

43. At this point in time, the total ammonia discharge from the Refinery, on an average basis over the last 5 years, is less than the allowable discharge of 3 mg/l, even when about 25 percent of that discharge is due to the ammonia nitrogen levels already in the Canal. [See paragraph 17 above.] Nevertheless, the Refinery will continue to look to improve its treatment for ammonia nitrogen.

44. The 2007 AWARE report reviewed the continued improvements made by the Refinery in its wastewater treatment. Since 1997, the average removal of ammonia from the strippers has increased to 96.8 percent. The report also demonstrates that the Refinery has excellent control over the key parameters which control nitrification: the food-to-microorganism [F/M] ratio show lower BOD levels than in prior years; sludge age indicates good wastewater treatment plant operation and does not appear to be a limiting factor; the aeration system is operated to provide adequate D.O. levels; the alkalinity pH is maintained in an adequate range; and the system is operated at an appropriate temperature to provide for nitrification. Yet the Refinery cannot continuously meet the 3 mg/l limitation.

45. The 2007 AWARE report evaluated several alternatives to the current treatment process. AWARE qualifies its analysis of these alternatives with the assumptions that each alternative will be effective and reliable. The report stated that the choices are design

alternatives and that there are no data to show that even with these alternatives the Refinery can continuously comply with the 3.0 mg/l ammonia nitrogen limit. The report concluded that of the technologies available, the following have the greatest potential for meeting the Illinois standard:

- Activated sludge with powdered activated carbon treatment,
- Activated sludge with a fixed media system;
- Membrane bioreactor activated sludge; and
- Activated sludge with breakpoint chlorination and dechlorination.

Even with the uncertainty associated with these technologies, the costs of implementing the alternatives ranged from a low capital cost of $1,400,000 for activated sludge with breakpoint chlorination/dechlorination to a high of $54,700,000 for the membrane bioreactor activated sludge process. Operation and Maintenance (O&M) costs ranged from a low of $220,000 per year for activated sludge with a fixed media system to a high of $3,280,000 per year for activated sludge with membrane bioreactor. The lowest equivalent annual cost ($3,220,000) was for the activated sludge plant with a fixed media system.

46. The 2007 AWARE report does not recommend that the Refinery pursue any of these alternatives and concludes that implementing the alternative technologies is not justified. None of these technologies have been demonstrated as technically feasible or as able to provide better control of the ammonia nitrogen discharge than currently achieved by the Refinery. Continued optimization of the treatment system and continued efforts to improve handling of the solids from the heavy crude oil supply is the most appropriate approach to the Refinery's ongoing efforts to control the ammonia nitrogen in its wastewater.

47. The least expensive option available to the Refinery which might meet the ammonia nitrogen rule is activated sludge with the fixed media system. This option, and the others studied by AWARE, should not be considered only in terms of overall cost. Rather, with respect to cost, they should be evaluated in terms of a unit cost of dollars-per-pound of ammonia removed from the Canal. The results of that analysis should be compared with other measures available to improve the water quality in the Canal.

48. The fixed media option costs $13.5 million in capital and $1.2 million in annual O&M. These figures translate into a total annual cost of $3.2 million.[1] Using effluent data available from June 2002 through July 2007, and assuming the fixed media system would yield an effluent of 0.5 mg/l, an additional 28,250 pounds of ammonia would be removed from the Canal per year. The unit cost for this removal would be $113.30 per pound of ammonia removed. By comparison, a 1983 analysis showed that the Calumet Water Reclamation Plant removes ammonia at a cost of $1.40 per pound. See "Environmental Assessment of Ammonia Concentrations in the Wastewater Discharge of Union Oil Company, Chicago Refinery" (by L.L. Huff and J.E. Huff, 1983). Allowing for inflation, the latter figure is currently closer to $3.00 per pound. But even when adjusted for inflation, the Calumet Water Reclamation Plant unit cost is 37 times smaller than the cost facing the Refinery to meet the ammonia nitrogen rule.

49. The costs of reducing ammonia in the Refinery effluent are similarly prohibitive when compared with other programs for addressing water quality in the Canal. The MWRDGC has installed five side-stream aeration facilities on the Chicago Waterway. These facilities address the same problem as limits on ammonia concentration in effluent -- they increase the

[1] Capital cost annualized over 10 years at 9% interest.

dissolved oxygen ("DO") concentration in the Chicago Waterway. The MWRDGC spent $39 million for these side-stream aerations which have the potential for adding enough DO to compensate for 720,000 pounds of ammonia per year. These figures translate into a unit cost of $6.94 per pound of ammonia oxidized. Again, this unit cost is nearly twenty fold smaller than the least expensive alternative available to the Refinery.

50. The Lemont Refinery has investigated the available information on the performance of other refineries in Illinois to provide nitrification. The conclusions of that investigation are in the 2007 Aware report, but can be summarized as follows: (a) the other refineries were using similar technological approaches as used by the Lemont refinery design, and none of them were using the technologies investigated by Aware as possible additions to the Lemont Refinery; (b) there are site specific variations in how the wastewater treatment systems are designed and operated, as well as some differences in the crude supply; and (c) there are some differences in these design specifics which may be worth exploring for potential use and modifications at the Lemont Refinery to further enhance its nitrification capabilities.

51. Based on evaluations and reports that accompany this Petition, the Refinery will continue to investigate improvements to its existing wastewater treatment system. It is believed that focusing on better solids handling from the desalter holds the greatest promise for achieving improved wastewater treatment performance on a consistent basis. The options that will be investigated include: an in situ solid removal system, increased tankage to allow brine segregation; amine management; and adjusting chemical usage to reduce emulsification in the primary treatment units.

<u>DIFFERENT FACTORS EXIST HERE THAN THOSE CONSIDERED BY THE BOARD IN ADOPTING THE EXISTING AMMONIA NITROGEN EFFLUENT LIMITATION</u>

52. Several factors relating to this matter are substantially and significantly different from the factors relied on by the Board in adopting the water quality standards cited here.

a) The Board has already found the situation for ammonia nitrogen treatment at the Refinery to be unique and site specific relief justified. *See e.g., In the Matter of Petition of PDV Midwest Refining, L.L.C., R98-14 , Opinion and Order of the Board (December 17, 1998)*; *In the Matter of Petition of Uno-ven, R93-8, Opinion and Order of the Board (December 16, 1993)*

b) In 1972, the Lemont Refinery was just coming on line and was clearly not known as a source of discharge into the Des Plaines River of ammonia. The Board did not then consider the costs of treatment for ammonia in a refinery wastewater discharge and certainly did not anticipate that treatment would require the kind of massive investment that would be required to meet the ammonia nitrogen rule.

c) The discharge from the Refinery that will occur does not pose any threat to human health or the environment and is not significantly greater than the environmental impact that the Board was trying to control when it adopted the ammonia nitrogen rule. Indeed, the recent discharge, in terms of mass, is less than the "allowable" discharge were the Refinery discharging at its design flow.

d) It appears that there are no treatment technology differences between the Refinery and other refineries in Illinois, but there are differences in specific design details. While CITGO is able to achieve nitrification, it cannot do so on a consistent basis. However, the Refinery continues to undertake investigations and studies to determine how to be able to consistently provide nitrification.

For each and all of the preceding reasons, the situation relating to the Lemont Refinery is fundamentally different than those considered by the Board in adopting the ammonia nitrogen rule.

CONCLUSION

This Petition satisfies the requirements of the Act and of the Board's Procedural Rules for Adjusted Standards as shown in the Appendix. The situation here represents conditions which are substantially and significantly different from the factors relied on by the Board in adopting the ammonia nitrogen effluent rule. Those factors necessitate the relief here sought. The requested standard will not result in environmental and health effects more adverse than the effects considered by the Board (see ¶¶ 17-24); and the requested standard is consistent with applicable federal law (see ¶¶ 7, 25, 28-29). The regulation of general applicability from which Petitioners seek an adjusted standard does not specify a level of justification or other requirements. As such, 415 ILCS 5/28.1(c) applies. For proof satisfying that section, please see ¶¶9, 17-30, 32, and 52.

53. Pursuant to 35 Ill. Admin. Code §104.406(j), Petitioners request a hearing on this Petition. The Petitioner has discussed this request with the Agency; the Agency has stated that it does not have a position on the Petition at this time.

WHEREFORE, Petitioner requests that the Board grant this adjusted standard.

CITGO PETROLEUM CORPORATION, and
PDV MIDWEST REFINING, L.L.C., Petitioners

By: ______________________________

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CERTIFICATE OF SERVICE

The undersigned, an attorney, certifies that I have served upon the individuals named on the attached Notice of Filing true and correct copies of the Petition for an Adjusted Standard by First Class Mail, postage prepaid, on March 18, 2008

____

APPENDIX

The table below sets out those paragraphs that correspond to the subsections of 35 Ill. Admin. Code §104.406:

a) A statement describing the standard from which an adjusted standard is sought. This must include the Illinois Administrative Code citation to the regulation of general applicability imposing the standard as well as the effective date of that regulation;	Preamble paragraph and ¶2.
b) A statement that indicates whether the regulation of general applicability was promulgated to implement, in whole or in part, the requirements of the CWA (), Safe Drinking Water Act ((f) et seq.), Comprehensive Environmental Response, Compensation and Liability Act (42 USC 9601 et seq.), CAA (42 USC 7401 et seq.), or the State programs concerning RCRA, UIC, or NPDES [415 ILCS 5/28.1];	¶¶25, 28-30, and 32
c) The level of justification as well as other information or requirements necessary for an adjusted standard as specified by the regulation of general applicability or a statement that the regulation of general applicability does not specify a level of justification or other requirements [415 ILCS 5/28.1] (See Section 104.426);	¶¶9, 17-30, 32, and 52
d) A description of the nature of the petitioner's activity that is the subject of the proposed adjusted standard. The description must include the location of, and area affected by, the petitioner's activity. This description must also include the number of persons employed by the petitioner's facility at issue, age of that facility, relevant pollution control equipment already in use, and the qualitative and quantitative description of the nature of emissions, discharges or releases currently generated by the petitioner's activity;	¶¶7-10, 13-16, 18-24, and 33-45
e) A description of the efforts that would be necessary if the petitioner was to comply with the regulation of general applicability. All compliance alternatives, with the corresponding costs for each alternative, must be discussed. The discussion of costs must include the overall capital costs as well as the annualized capital and operating costs;	¶¶45-50
f) A narrative description of the proposed adjusted standard as well as proposed language for a Board order that would impose the standard. Efforts necessary to achieve this proposed standard and the corresponding costs must also be presented;	¶¶4-6
g) The quantitative and qualitative description of the impact of the petitioner's activity on the environment if the petitioner were to comply with the regulation of general applicability as compared to the quantitative and qualitative impact on the environment if the petitioner were to comply only with the proposed adjusted standard. To the extent applicable, cross-media impacts must be discussed. Also, the petitioner must compare the	¶¶17-24, 30

qualitative and quantitative nature of emissions, discharges or releases that would be expected from compliance with the regulation of general applicability as opposed to that which would be expected from compliance with the proposed adjusted standard;	
h) A statement which explains how the petitioner seeks to justify, pursuant to the applicable level of justification, the proposed adjusted standard;	¶¶9, 17-30, 32, and 52
i) A statement with supporting reasons that the Board may grant the proposed adjusted standard consistent with federal law. The petitioner must also inform the Board of all procedural requirements applicable to the Board's decision on the petition that are imposed by federal law and not required by this Subpart. Relevant regulatory and statutory authorities must be cited;	¶¶25, 28-30, and 32
j) A statement requesting or waiving a hearing on the petition (pursuant to Section 104.422(a)(4) of this Part a hearing will be held on all petitions for adjusted standards filed pursuant to 35 Ill. Adm. Code 212.126 (CAA));	¶¶53
k) The petition must cite to supporting documents or legal authorities whenever they are used as a basis for the petitioner's proof. Relevant portions of the documents and legal authorities other than Board decisions, State regulations, statutes, and reported cases must be appended to the petition;	The Petition cites to such support throughout its text. See, e.g., ¶¶2, 3, 19, 25, 49, and 52.
l) Any additional information which may be required in the regulation of general applicability.	Nothing required.

TECHNICAL REVIEW OF AMMONIA TREATMENT AT THE WASTEWATER TREATMENT PLANT – CITGO PETROLEUM CORPORATION, LEMONT REFINERY

Prepared for:

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Lemont Refinery
Lemont, Illinois

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AEI Job No. N356-06
AEI Document No. 35606r004

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EXECUTIVE SUMMARY

CITGO Petroleum Corporation operates a petroleum refinery (Lemont Refinery) in Lemont, Illinois. The process wastewater and stormwater from the refinery are treated in the refinery's wastewater treatment facility and are discharged into the Chicago Sanitary and Ship Canal under a National Pollutant Discharge Elimination System (NPDES) permit issued by the State of Illinois. The wastewater treatment facility utilized by Lemont Refinery surpasses the criteria for Best Available Technology Economically Achievable (BAT) for treatment of refinery wastewaters as define by the U.S. EPA. Specifically, the refinery treatment system includes sour water strippers which provide greater than 95 percent ammonia removal, oil and solids removal, flow equalization, clarification, single-stage activated sludge treatment and final polishing.

The U.S. EPA effluent limitations guidelines provide mass based limits for ammonia nitrogen (and other parameters) based on refinery production, with the use of BAT treatment technology. The Illinois regulations contain ammonia discharge standards which are much more stringent than the U.S. EPA limitations. The Illinois standards would require Lemont Refinery to meet a 3.0 mg/l ammonia nitrogen discharge standard. Lemont Refinery has been unable to consistently comply with the 3.0 mg/l limit. The Illinois Pollution Control Board granted the refinery a site specific rule change effective through December 31, 2008. The refinery has consistently achieved compliance with these regulations and typically provides an effluent quality significantly better than the regulatory criteria.

Lemont Refinery is in the process of preparing a request for an adjusted standard for its discharge of ammonia. AWARE Environmental Inc. (AEI) was retained to conduct a technical review of the ammonia removal capacities of the wastewater treatment system. The primary objectives of this review are to:

1. Determine if the present wastewater treatment system is consistent with the U.S. EPA BAT criteria;

2. Determine if the wastewater treatment system operating conditions are conducive to biological nitrification; and

3. Evaluate alternative ammonia removal technologies and the cost of those technologies to determine if changes in the present wastewater treatment system are warranted as part of a program to achieve compliance with the 3 mg/l ammonia nitrogen criteria.

The results of this evaluation indicate that Lemont Refinery has a wastewater treatment system which exceeds BAT criteria and which allows the facility to comply with U.S. EPA refinery discharge regulations. The long term performance data has demonstrated that the refinery wastewater treatment facility has achieved compliance with the current mass based limitations for ammonia nitrogen contained in the NPDES permit, but that the refinery has not been able to consistently meet a 3.0 mg/l ammonia nitrogen limit as per the Illinois regulations.

A review of the wastewater treatment technologies employed at the other Illinois Refineries was conducted. These refineries were Conoco-Phillips, Roxana, IL; Exxon-Mobil, Joliet, IL; and Marathon, Robinson, IL. The wastewater treatment processes employed by these Refineries are very similar to those utilized at the Lemont Refinery.

A review of the activated sludge treatment plant was performed with regard to factors which control the ability of a biological treatment facility to achieve nitrification. These factors include food to microorganism ratio (F/M), sludge age, dissolved oxygen concentration, temperature, pH, and alkalinity. The review indicates that these parameters have been maintained in the ranges favorable to nitrification. However, in spite of this, the refinery treatment facility has been unable to meet the 3.0 mg/l ammonia nitrogen standard on a consistent basis.

Lemont Refinery has maintained an ongoing optimization program which has resulted in improved ammonia nitrogen removal. The program has been expanded to address changes in the petroleum refinery industry. The refinery has spent over $45,000,000 over the last ten years on capital projects related to ammonia control and reduction.

As a result of changes in crude quality, Lemont refinery has experienced a five-fold increase in wastewater treatment chemical addition costs over the last 4 years. Lemont refinery has and is continuing to conduct research which addresses the environmental impacts caused by crude quality fluctuations. Crude quality fluctuations confirm AEI's previous analysis which indicated that the capability of the wastewater treatment system is limited, in large part, due to the inherent variability of refinery wastewater.

Potential alternative technologies were evaluated for upgrading the wastewater treatment facility with additional nitrogen removal technologies which would increase the likelihood of consistently meeting the 3.0 mg/l ammonia nitrogen standard. Several alternatives were screened and preliminary process designs and budget cost estimates were developed for the four most viable alternatives. These four alternatives include powdered activated carbon addition (PACT), fixed media biological treatment, membrane bioreactors, and breakpoint chlorination. Addition of a fixed media biological reactor would be the most cost-effective alternative. The fixed media system would utilize a rotating biological contractor (RBC) and would have an estimated capital cost of $13,500,000 and an estimated annual operating cost of $1,220,000. The estimated total annualized cost for the addition of the fixed media reactor system over a ten (10) year period at 8 percent interest is $3,220,000/year.

Even with the ammonia removal upgrades, the ability of the treatment system to consistently meet the 3.0 mg/l ammonia nitrogen standard is uncertain. Based on the significant cost of upgrading the system, and the uncertainty that the upgraded system would achieve consistent compliance with the 3.0 mg/l ammonia nitrogen standard, upgrading the treatment system with additional treatment technologies for ammonia removal is not justified.

We recommend that Lemont Refinery continue its ongoing research studies and projects designed to optimize the existing wastewater treatment system. These efforts should be directed toward obtaining the maximum possible ammonia removal on a consistent basis. Continued development of operational data under the varying conditions inherent with refinery wastes will help to improve the performance of the system, and will allow the maximum ammonia removal capability of the system to be achieved.

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SECTION 1.0
INTRODUCTION

CITGO Petroleum Corporation (CITGO) operates a petroleum refinery (Lemont Refinery) in Lemont, Illinois. The refinery produces gasoline, a variety of other fuels, coke, and solvents from crude oil. Lemont Refinery was formerly owned and operated by the UNO-VEN Company, and had previously been operated as the Union Oil Refinery. On May 1, 1997 PDV Midwest Refining, L.L.C. purchased the Lemont Refinery and contracted with CITGO to operate the refinery.

The process wastewater generated by the refinery and the contaminated stormwater runoff from the facility are treated in a single stage activated sludge wastewater treatment plant. The treated wastewater is discharged to the Chicago Sanitary and Ship Canal under a National Pollutant Discharge Elimination System (NPDES) permit. The current permit (No. IL0001589) was issued by the Illinois Environmental Protection Agency (IEPA) on July 28, 2006, became effective August 1, 2006 and was modified on June 22, 2007. The permit expires on July 31, 2011.

The State of Illinois has ammonia nitrogen discharge standards for sources which discharge greater than 100 lb/day of ammonia nitrogen, such as the Lemont Refinery. These criteria are contained in the State of Illinois Rules and Regulations under Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board. Section 304.122 (b) of this regulation sets monthly average discharge standards at 3.0 mg/l of ammonia nitrogen.

Lemont Refinery has been unable to consistently meet the 3.0 mg/l ammonia concentration standard. As a result, the Illinois Pollution Control Board (IPCB) granted the refinery a site specific rule change for ammonia under Section 304.213 of the Illinois regulations. The current site specific rule was adopted in 1998, as an extension of a previous rule change, and is effective through December 31, 2008. This site specific rule change exempts the facility from the ammonia limits under Section 304.122(b) of the Illinois regulations and requires that the facility meet the U.S. EPA Best Available Technology Economically Achievable (BAT) limitations for ammonia pursuant to 40 CFR 419.23 (1992). Under the site specific rule, the facility is required to meet a monthly average ammonia limit of 9.4 mg/l, a daily maximum ammonia limit of 26.0 mg/l, to continue its efforts to reduce ammonia discharges and to monitor and report nitrogen concentrations of its oil feedstocks.

Lemont Refinery has retained AWARE Environmental Inc. (AEI) of Charlotte, North Carolina to evaluate current conditions, to evaluate potential alternatives for upgrading the treatment system to meet a 3.0 mg/l limit, and to evaluate the need to re-apply for a site specific rule change. AEI conducted a conceptual evaluation of Lemont Refinery wastewater treatment system, and the available alternatives to achieve ammonia removal from a refinery wastewater. The primary objectives of this program were to:

1. Determine if the present wastewater treatment system is consistent with the U.S. EPA BAT criteria;
2. Determine if the wastewater treatment system operating conditions are conducive to biological nitrification; and
3. Evaluate alternative ammonia removal technologies, and the cost of those technologies to determine if changes in the present wastewater treatment system are warranted as part of a program to achieve compliance with the 3.0 mg/l ammonia nitrogen criteria.

This report presents the AEI findings.

SECTION 2.0
REGULATORY REVIEW

There are a wide range of regulations which control the wastewater discharges from petroleum refineries. The primary regulatory drivers for determining the ammonia discharge limitations from Lemont Refinery are the U.S. EPA effluent limitations guidelines and the State of Illinois water pollution regulations. As a part of the development of this report, current regulations and potential pending changes in regulations which may impact Lemont Refinery wastewater treatment operations and/or ammonia discharge were reviewed.

2.1 U.S. EPA EFFLUENT LIMITATIONS GUIDELINES

The U.S. EPA has developed effluent limitations guidelines for the petroleum refining industry which are included in 40 CFR 419. The basis for these guidelines are included in the 1982 *Development Document for Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Petroleum Refining Industry* (EPA 440/1-82/014). These guidelines provide effluent load-based limitations for conventional pollutants based on the Best Practicable Control Technology Currently Available (BPT) (40 CFR 419.22) and for non-conventional pollutants based on Best Available Technology Economically Achievable (BAT) (40 CFR 419.23). Conventional pollutants include BOD_5, TSS, oil and grease, and pH. Non-conventional pollutants include COD, ammonia nitrogen, sulfide, phenolic compounds, total chromium, and hexavalent chromium. The effluent limitations guidelines are based on actual effluent flows and pollutant concentrations obtained by refineries employing BAT and BPT treatment technologies.

EPA guidelines define five (5) general subcategories of refineries based on the production processes employed. These categories are summarized in Table 2-1. Lemont Refinery is classified as Subcategory B – Cracking Refinery. Under the guidelines, effluent limitations are calculated for each individual facility based on the refining subcategory, the maximum feedstock processing rate and the process configuration.

TABLE 2-1

U.S. EPA REFINERY SUBCATEGORIES

Subcategory	Basic Refinery Operations Included
A - Topping	Topping and catalytic reforming whether or not the facility includes any other process in addition to topping and catalytic reforming. This subcategory is not applicable to facilities which include thermal processes (coking, visbreaking, etc.) or catalytic cracking.
B – Cracking	Topping and cracking, whether or not the facility includes any processes in addition to topping and cracking, unless specified in one of the subcategories listed below.
C – Petrochemical	Topping, cracking and petrochemical operations whether or not the facility includes any process in addition to topping, cracking and petrochemical operations’, except lube oil manufacturing operations.
D – Lube	Topping, cracking and lube oil manufacturing processes, whether or not the facility include any process in addition to topping, cracking and lube oil manufacturing processes, except petrochemical operations’.
E – Integrated	Topping, cracking, lube oil manufacturing processes and petrochemical operations, whether or not the facility includes any processes in addition to topping, cracking and lube oil manufacturing processes and petrochemical operations’.

The term “petrochemical operations” shall mean the production of second generation petrochemicals (i.e. alcohols, ketones, cumene, styrene, etc.) or first generation petrochemicals and isomerization products (i.e. BTX, olefins, cyclohexane, etc.) when 15% or more of the refinery production is as first generation petrochemicals and isomerization products.

Source: Development Document for Effluent Limitations Guidelines and Standards for the Petroleum Refining Point Source Category, EPA 440/1-82-014, October 1982, 64-65.

The U.S. EPA BAT guidelines are based on the implementation of in-plant water reuse/conservation measures to minimize the volume of wastewater discharge, and the use of sour water strippers to reduce ammonia and sulfide loads in the process wastewater. These in-refinery controls should be followed by end-of-pipe treatment technologies. The U.S. EPA BAT model, as found in the 1982 "Development Document", is based on a wastewater treatment plant (WWTP) that includes the following treatment processes:

1. Flow equalization;
2. Initial oil and solids removal (API separator or baffle plate separator);
3. Additional oil/solids removal (clarifiers or dissolved air flotation);
4. Biological treatment; and
5. Filtration or other final polishing steps.

As a part of this report preparation, contacts were made with the U.S. EPA personnel responsible for developing guidelines for the Petroleum Refinery subcategory to determine if modifications to the effluent guidelines for petroleum refinery are anticipated. According to U.S. EPA personnel, U.S. EPA has no immediate plans to revise the effluent guidelines. The 304 (m) process involves substantial public input and generally, leads to lengthy studies before any type of rule making is identified. Presently, petroleum refineries are not being considered for updated guidelines.

2.2 ILLINOIS WATER POLLUTION REGULATIONS

Under the current Illinois water pollution regulations, as amended through November 21, 2005, the State of Illinois has established ammonia nitrogen limitations for discharges into the Illinois River system. Under Section 304.122 (b) of the regulations, ammonia nitrogen discharges of greater than 100 lb/day are required to meet a 3.0 mg/l monthly average effluent ammonia nitrogen limit. This limitation is significantly more stringent than the ammonia nitrogen standards in the U.S. EPA effluent limitations guidelines.

Lemont Refinery discharges treated wastewater into the Chicago Sanitary and Ship Canal, a secondary contact waterway, and periodically discharges more than 100 lb/day of ammonia nitrogen. Therefore, Lemont Refinery discharge is regulated by the 3.0 mg/l ammonia nitrogen discharge rule.

The refinery has not been able to consistently meet the 3.0 mg/l ammonia limit under the Illinois regulations. Based on the results of previous evaluations performed in conjunction with the petitions for the site specific rule changes, no economically feasible treatment methods were identified which could ensure consistent compliance with a 3.0 mg/l ammonia nitrogen limit. As discussed above, site specific rule changes were granted by the IPCB to the refinery under Section 304.213 of the Illinois water pollution regulations. The site specific rule change exempts the refinery from the ammonia limits under Section 304.122 of the Illinois regulations and requires the refinery to meet the U.S. EPA BAT limitations for ammonia nitrogen pursuant to 40 CFR 419.23 (1992). The facility is also required to comply with a monthly average ammonia nitrogen limit of 9.4 mg/l and a daily maximum ammonia nitrogen limit of 26.0 mg/l. In addition, as part of the site specific rule change, the refinery is required to continue its efforts to reduce ammonia discharge and to monitor and report nitrogen concentrations of its oil feedstocks.

SECTION 3.0
ANALYSIS OF EXISTING FACILITY
WITH RESPECT TO BAT AND NITRIFICATION

A detailed analysis of the wastewater treatment program was conducted in order to determine if the refinery continues to be a BAT facility. Included in this analysis were evaluations of the refinery wasteloads and the current wastewater treatment program. These were conducted with regard to the ability of the system to provide consistent biological nitrification. The objects of this analysis were to:

1. Determine if the waste loadings, and the hydraulic and ammonia loads in particular, are consistent with BAT criteria;
2. Determine if the BAT effluent limitations guidelines and discharge permit criteria are being met;
3. Determine if the physical facility is consistent with the EPA BAT technology model; and
4. Evaluate the present treatment program to determine if it is consistent with the refinery's objective of improving ammonia removal, and if additional changes in the program are warranted.

The results of this analysis are presented in this section.

Currently, the refinery does not have long term crude supply agreements or super tanker unloading facilities which could provide a fairly consistent grade of crude to the refinery. Therefore, crude quality will vary significantly. In addition, the refinery is processing heavier crudes. These factors affect the feed stock. There are frequent feed stock fluctuations which result in chemical and operating changes throughout the day. These fluctuations affect the water quality discharged to the wastewater treatment plant.

The maximum monthly production rate for Lemont refinery observed during the period of 1997 to present was 170,341 barrels per day which occurred in September 2005. The maximum production of each individual process is presented in Table 3-1. The United States Environmental Protection Agency uses these process capacities as the basis for defining effluent

TABLE 3-1

OBSERVED MAXIMUM MONTHLY PRODUCTION RATES[1]

Process	Max Production Rate (bbl/day)
Crude Processes	
Desalting	168,626
Atmospheric Distillation	168,626
Vacuum Distillation	82,807
Cracking Processes	
Fluid Catalytic Cracking	69,098
Delay Coking	40,326
Needle Coking	6,413
Asphalt Production	
Asphalt Production	4,329
Asphalt Oxidation	10,935

(1) This is based on the monthly average production rates for the period used to develop the current NPDES permit. Note that the maximum monthly production rate reached 170,341 in September 2005. (This was after the time period utilized for NPDES development).

criteria. The specific calculations to define the present design criteria are presented in Appendix A.

The waste load to the refinery treatment system has become more variable. Several of the factors which affect the waste loads are:

1. Operate consistently at design thru put rates;
2. Changes in the quality of crude; and
3. Feedstocks with a higher percentage of heavy crude.

Specifically, these problems are as follows:

1. Because of increased gasoline demand, refineries are operating at design capacities and there is very little production variability on a month to month basis. This provides less time for turnarounds and the potentials for malfunctions or upsets to occur is increased at higher production levels.
2. Crude oil is delivered by pipelines and the nature of the pipeline sources means that there can be significant variability on a batch to batch basis. Lemont has to continually review the quality of the crude and make adjustments in chemicals and processing factors especially in the crude desalting units. This variability can result in increased wasteloads to the wastewater treatment plant.
3. Heavy crude is of a poorer quality than sweet crude. Heavy crude is most readily available in the Midwest US because it is directly piped to this area. Heavy crude results in more solid materials and asphaltenes. Therefore, the wasteloads in terms of COD, oil and grease and TSS are greater than with other types of crude processed at the refinery. This places a much greater emphasis on the wastewater treatment program to maintain compliance with effluent criteria.

3.1 ANALYSIS OF REFINERY WASTELOADS

The U.S. EPA effluent guidelines for the petroleum refinery category are based on the use of sour water strippers. Sour water generally results from water brought into direct contact with a hydrocarbon stream, such as when steam is used for stripping or mixing, or when water is used as a washing medium, as in desalting. The U.S. EPA development document reported maximum sour water stripper ammonia removal efficiencies of 95 percent or greater. In an analysis of Lemont Refinery which was conducted in conjunction with the 1992 site specific rule change, the combined average ammonia removal observed in the sour water strippers was 95 percent.

Lemont Refinery has maintained an ongoing program to optimize the performance of the sour water strippers. This can be seen based on the data from the last fifteen years. During this time period, the sour water stripper operation has been very effective. The data presented in the 1997 rule change request showed that ammonia removal efficiencies averaged in excess of 96.4 percent, and monthly average efficiencies have been observed in excess of 99 percent. The data for the past ten years is presented in Table 3-2 and shows an average removal of 96.8 percent with a number of monthly average removal efficiencies exceeding 99 percent. This type of performance is indicative of the facility's diligent program of improving performance. This represents performance well exceeding the U.S. EPA model refinery objective and continues to show improved removals since our analysis of the data as part of previous site specific rule change applications.

A review of the characteristics of the primary effluent was performed in order to evaluate the influent conditions to the activated sludge system. Design parameters were also evaluated for potential additional treatment technologies to improve ammonia removal. The monthly average secondary influent characteristics for the period August 1997 to March 2007 are presented in Table 3-3.

Sour Water Stripper - Ammonia Removal

	non-CN service			CN service		
Date	Inf.-mg/l	Eff.-mg/l	% Removal	Inf.-mg/l	Eff.-mg/l	% Removal
Jan '97	3369	12	99.6	4517	64	98.6
Feb '97	4043	7	99.8	4141	42	99.0
March '97	1909	4	99.8	2783	65	97.7
Apr '97	944	4	99.6	4037	50	98.8
May '97	992	4	99.6	3900	43	98.9
June '97	1013	5	99.5	3840	2	99.9
July '97	596	32	94.6	2732	42	98.5
Aug '97	1204	4	99.7	3816	61	98.4
Sept '97	1118	9	99.2	3949	74	98.1
Oct '97	1520	3	99.8	4120	64	98.4
Nov '97	1799	7	99.6	3317	79	97.6
Dec '97	1399	5	99.6	4134	131	96.8
Average	1659	8	99.5	3774	60	98.4
Jan '98	1594	7	99.6	3686	105	97.2
Feb '98	1086	8	99.3	3383	86	97.5
Mar '98	1128	42	96.3	3204	69	97.8
Apr '98	986	14	98.6	2705	50	98.2
May '98	963	24	97.5	1564	13	99.2
June '98	1288	303	76.5	2569	77	97.0
July '98	1216	16	98.7	2944	123	95.8
Aug '98	1434	34	97.6	2867	80	97.2
Sept '98	1401	27	98.1	2956	132	95.5
Oct '98	1095	22	98.0	2871	85	97.0
Nov '98	887	17	98.1	3097	79	97.4
Dec '98	877	16	98.2	2964	94	96.8
Average	1163	44	96.2	2901	83	97.1
Jan '99	1162	9	99.2	2896	48	98.3
Feb '99	1132	46	95.9	3360	100	97.0
Mar '99	610	11	98.2	2397	76	96.8
Apr '99	1134	27	97.6	2877	120	95.8
May '99	3974	38	99.0	3163	77	97.6
June '99	4332	15	99.7	3579	74	97.9
July '99	5153	19	99.6	3575	84	97.7
Aug '99	2550	18	99.3	3016	77	97.4
Sept '99	1495	13	99.1	2641	122	95.4
Oct '99	870	13	98.5	2724	89	96.7
Nov '99	851	14	98.4	2807	94	96.7
Dec '99	800	8	99.0	2676	72	97.3
Average	2005	19	99.0	2976	86	97.1
Jan '00	1099	17	98.5	3080	90	97.1
Feb '00	1184	6	99.5	3157	99	96.9
Mar '00	1058	6	99.4	3039	143	95.3
Apr '00	1437	14	99.0	2739	110	96.0
May '00	1342	10	99.3	3040	101	96.7
June '00	1198	19	98.4	2912	122	95.8
July '00	1296	18	98.6	3017	118	96.1
Aug '00	1206	10	99.2	2813	103	96.3

Stripper-NH3N

Sept ' 00	627	7	98.9	2708	156	94.2
Oct ' 00	924	20	97.8	3028	123	95.9
Nov ' 00	1967	20	99.0	3056	107	96.5
Dec ' 00	1489	28	98.1	4055	126	96.9
	1236	15	98.8	3054	117	96.2
Jan ' 01	1269	32	97.5	2999	166	94.5
Feb ' 01	726	16	97.8	3130	109	96.5
Mar ' 01	886	27	97.0	2669	130	95.1
Apr ' 01	1506	3	99.8	3250	72	97.8
May ' 01	1988	3	99.8	3486	102	97.1
June ' 01	2056	4	99.8	3499	111	96.8
July ' 01	1246	9	99.3	3111	106	96.6
Aug ' 01	933	7	99.2	2854	66	97.7
Sept ' 01	7060	294	95.8	10178	411	96.0
Oct ' 01	2505	145	94.2	3602	180	95.0
Nov ' 01	1361	26	98.1	1562	142	90.9
Dec ' 01	1217	27	97.8	1567	121	92.3
	1896	49	98.0	3492	143	95.5
Jan ' 02	1665	17	99.0	1755	97	94.5
Feb ' 02	1880	13	99.3	1902	97	94.9
Mar ' 02	1147	14	98.8	1763	79	95.5
Apr ' 02	769	39	94.9	1920	116	94.0
May ' 02	477	21	95.6	1724	18	99.0
June ' 02	737	13	98.2	2877	79	97.3
July ' 02	654	14	97.9	3020	80	97.4
Aug ' 02	961	9	99.1	3937	173	95.6
Sept ' 02	989	7.0	99.3	3621	117	96.8
Oct ' 02	1632	39	97.6	1769	63	96.4
Nov ' 02						
Dec ' 02	1259	123	90.2	1630	292	82.1
	1106	28	97.3	2356	110	94.8
Jan-03	590	29	95.1	2824	29	99.0
Feb-03	760	54	92.9	3141	42	98.7
Mar-03	739	23	96.9	2263	69	97.0
Apr-03	922	84	90.9	2755	148	94.6
May-03	993	62	93.8	2667	170	93.6
Jun-03	789	2	99.7	2286	106	95.4
Jul-03	1362	8	99.4	2585	94	96.4
Aug-03	1341	15	98.9	2253	86	96.2
Sep-03	1256	12.0	99.0	2024	66	96.7
Oct-03	1109	51	95.4	2149	62	97.1
Nov-03	834	65	92.2	2384	112	95.3
Dec-03	1062	104	90.2	2537	71	97.2
	980	42	95	2489	88	96.4
Jan-04	838	11	98.7	2741	109	96.0
Feb-04	689	13	98	2938	80	97.3
Mar-04	558	7	99	2065	42	98.0
Apr-04	738	4	99	2460	35	98.6
May-04	832	3	100	2725	24	99.1
Jun-04	922	20	98	2802	99	96.5
Jul-04	805	26	97	1833	51	97.2
Aug-04	980	17	98.3	3208	73	97.7

Sep-04	628	16	97.5	2405	58	97.6
Oct-04	531	5	99.1	2005	97	95.2
Nov-04	662	5	99.2	2333	61	97.4
Dec-05	698	46	93.4	2338	64	97.3
	740	14	98	2488	66	97
Jan-05	716	8	99.0	1844	42	97.7
Feb-05	876	12	98.7	2762	64	97.7
Mar-05	554	11	98.0	1800	54	97.0
Apr-05	1080	7	99.3	2310	54	97.7
May-05	1223	40	96.7	2242	61	97.3
Jun-05	989	19	98.0	2563	63	97.5
Jul-05	894	20	97.7	2853	82	97.1
Aug-05	1218.00	42.10	96.54	2880.00	125.00	95.66
Sep-05	1460.00	17.00	98.84	3218.00	77.00	97.61
Oct-05	1174.00	10.00	99.15	2705.00	57.00	97.89
Nov-05	962.00	6.00	99.38	2025.00	55.00	97.28
Dec-05	967.00	6.00	99.38	1586.00	71.00	95.52
	1009.42	16.51	98.40	2399.00	67.02	97.17
Jan-06	1150.00	5.40	99.53	2620.00	159.00	93.93
Feb-06	1305.00	5.00	99.62	2443.00	184.00	92.47
Mar-06	1035.00	25.00	97.58	2763.00	96.00	96.53
Apr-06	1111.00	14.00	98.74	2355.00	121.00	94.86
May-06	856.00	30.00	96.50	2219.00	68.00	96.94
Jun-06	869.00	10.00	98.85	21730.00	123.00	99.43
Jul-0-6	762.00	7.00	99.08	2453.00	102.00	95.84
Aug-06	872.00	6.60	99.24	14962.00	107.00	99.28
Sep-06	756.00	13.00	98.28	2362.00	94.00	96.02
Oct-06	337.00	16.00	95.25	1063.00	64.00	93.98
Nov-06	557.00	17.00	96.95	946.00	66.00	93.02
Dec-06	858.00	81.00	90.56	1665.00	92.00	94.47
	872.33	19.17	97.52	4798.42	106.33	95.57
Jan-07	1185.00	113.00	90.46	3095.00	213.00	93.12
Feb-07	2072.00	57.00	97.25	8033.00	89.00	98.89
Mar-07	858.00	48.00	94.41	2443.00	109.00	95.54
AVG.						
OVER	1284.46	25.32	97.88	3152.29	90.61	96.76
PERIOD						

g:nh398-Stripper Data

35606t001

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Table 3-3
Secondary System
Influent Waste Loads

Date	Al Flow (MGD)	Al pH (SU)	Al Alk (mg/l)	Al TSS (mg/l)	Al TSS (lb/day)	Al COD (mg/l)	Al COD (lb/day)	Al BOD (mg/l)	Al BOD (lb/day)	Al Tot. Cr (mg/l)	Al Tot. Cr (lb/day)	Al O&G (mg/l)	Al O&G (lb/day)	Al NH_3-N (mg/l)	Al NH_3-N (lb/day)	Al Fluor. (mg/l)	Al Fluor (lb/day)	Al Phenol (mg/l)	Al Phenol (lb/day)	Al Sulfide (mg/l)	Al Sulfide (lb/day)	Al CN (mg/l)	Al CN (lb/day)
Aug-97	3.86	8.3	220	75	2414	495	15935	183	5891	0.020	0.6	32.8	1056	16.9	544	1.59	51	12.8	412	0.6	19	0.081	2.61
Sep-97	3.59	8.1	277	161	4820	881	26378	239	7156	0.020	0.6	43.6	1305	19.6	587	2.51	75	16.3	488	0.8	24	0.099	2.96
Oct-97	3.42	8.3	244	105	2995	1027	29293	266	7587	0.040	1.1	147.9	4219	18.5	528	2.43	69	12.7	362	0.1	3	0.100	2.85
Nov-97	3.30	8.8	272	357	9825	858	23614	213	5862	0.070	1.9	63.0	1734	21.2	583	2.21	61	11.7	322	1.9	52	0.080	2.20
Dec-97	3.78	8.9	247	118	3720	718	22635	200	6305	0.070	2.2	65.2	2055	17.4	549	2.01	63	14.2	448	0.8	25	0.093	2.93
Average	3.59	8.5	252	163	4755	796	23571	220	6560	0.04	1.3	70.50	2074	18.7	558	2.2	64	13.5	406	0.8	25	0.091	2.71
Minimum	3.30	8.1	220	75	2414	495	15935	183	5862	0.02	0.6	32.80	1056	16.9	528	1.6	51	11.7	322	0.1	3	0.080	2.20
Maximum	3.86	8.9	277	357	9825	1027	29293	266	7587	0.07	2.2	147.90	4219	21.2	587	2.5	75	16.3	488	1.9	52	0.100	2.96
Jan-98	5.18	8.4	212	67	2894	435	18793	139	6005	·0.04	1.7	29.6	1279	17.0	734	1.5	66	9.0	389	0.1	4	0.054	2.33
Feb-98	4.45	8.6	243	62	2301	744	27612	205	7608	0.04	1.5	62.8	2331	14.9	553	1.8	67	9.4	350	0.2	7	0.056	2.08
Mar-98	5.35	8.3	224	93	4150	695	31010	194	8656	0.07	3.1	37.8	1687	12.5	558	2.9	130	10.1	451	0.1	4	0.042	1.87
Apr-98	4.50	8.2	226	61	2289	984	36930	182	6830	0.03	1.1	23.7	889	9.6	360	2.3	85	12.8	480	0.1	4	0.033	1.24
May-98	4.98	9.4	311	51	2118	533	22137	245	10176	0.02	0.8	29.3	1217	19.0	789	12.6	523	9.5	393	4.2	174	0.017	0.71
Jun-98	4.65	9.8	415	191	7407	664	25751	336	13030	0.03	1.2	34.1	1322	39.8	1543	10.1	392	12.2	473	30.0	1163	0.067	2.60
Jul-98	5.20	8.9	238	69	2992	438	18995	193	8370	0.03	1.3	22.2	963	17.8	772	3.0	130	16.1	698	0.1	4	0.057	2.47
Aug-98	4.31	8.7	321	64	2301	610	21927	245	8807	0.03	1.1	29.9	1075	24.0	863	4.5	160	26.1	938	1.1	40	0.055	1.98
Sep-98	4.50	8.6	215	64	2402	431	16175	136	5104	0.05	1.9	31.2	1171	16.8	631	2.8	107	12.9	484	0.4	15	0.065	2.44
Oct-98	4.50	8.6	230	44	1651	470	17639	169	6343	0.06	2.3	27.9	1047	16.7	627	2.7	101	14.0	525	0.8	30	0.065	2.44
Nov-98	4.24	8.5	282	38	1344	544	19237	199	7037	0.04	1.4	27.8	983	21.7	767	2.9	102	16.6	587	8.5	301	0.058	2.05
Dec-98	3.59	8.3	292	38	1138	814	24372	213	6377	0.04	1.2	42.3	1266	26.8	802	2.4	73	18.2	545	7.1	213	0.146	4.37
Average	4.62	8.7	267	70	2749	614	23381	205	7862	0.04	1.5	33.2	1269	19.7	750	4.1	161	13.9	526	4.4	163	0.060	2.2
Minimum	3.59	8.2	212	38	1138	431	16175	136	5104	0.02	0.8	22.2	889	9.6	360	1.5	66	9.0	350	0.1	4	0.017	0.7
Maximum	5.35	9.8	415	191	7407	984	36930	336	13030	0.07	3.1	62.8	2331	39.8	1543	12.6	523	26.1	938	30.0	1163	0.146	4.4
Jan-99	4.78	9.1	381	43	1714	833	33208	296	11800	0.04	1.6	49.2	1961	34.8	1387	1.92	77	8.0	318	17.8	710	0.051	2.03
Feb-99	4.96	8.8	348	26	1076	534	22090	223	9225	0.05	2.1	12.5	517	28.8	1191	4.38	181	11.7	484	7.5	310	0.049	2.03
Mar-99	4.58	9.4	351	87	3323	561	21429	262	10008	0.04	1.5	17.7	676	39.2	1497	3.61	138	17.0	649	9.1	348	0.082	3.13
Apr-99	4.23	9.2	313	23	811	405	14288	186	6562	0.04	1.4	7.9	279	22.3	787	3.75	132	10.6	374	5.1	180	0.055	1.94
May-99	5.72	10	414	63	3005	449	21419	212	10113	0.05	2.4	8.5	405	16.9	806	3.98	190	9.0	429	6.0	286	0.043	2.05
Jun-99	5.04	8.9	245	29	1219	311	13072	123	5170	0.04	1.7	8.1	340	12.6	530	4.06	171	7.1	300	1.2	50	0.052	2.19
Jul-99	4.27	9.4	293	29	1033	364	12963	161	5733	0.04	1.4	9.5	338	17.2	613	3.65	130	14.8	527	4.2	150	0.059	2.10
Aug-99	3.89	9.5	338	42	1363	486	15767	242	7851	0.03	1.0	30.4	986	24.6	798	2.68	87	18.7	607	3.8	123	0.055	1.78
Sep-99	3.56	9.2	315	24	713	516	15320	220	6532	0.05	1.5	18.1	537	23.4	695	4.77	142	16.1	478	8.1	240	0.33	9.80
Oct-99	4.25	9.5	346	58	2056	624	22118	201	7124	0.05	1.8	74.8	2651	14.6	517	3.85	136	16.0	567	1.9	67	0.142	5.03
Nov-99	3.93	8.7	290	65	2130	761	24943	219	7178	0.05	1.6	105.2	3448	14.0	459	7.10	233	12.5	410	0.1	3	0.078	2.56
Dec-99	4.19	8.8	279	81	2831	758	26488	196	6849	0.09	3.1	80.9	2827	19.8	692	2.70	94	12.2	426	1.7	59	0.111	3.88
Average	4.45	9.21	326	48	1773	550	20259	212	7845	0.05	1.8	35.2	1247	22.4	831	3.87	143	12.8	464	5.5	211	0.09	3.2
Minimum	3.56	8.70	245	23	713	311	12963	123	5170	0.03	1.0	7.9	279	12.6	459	1.92	77	7.1	300	0.1	3	0.04	1.8
Maximum	5.72	10.00	414	87	3323	833	33208	296	11800	0.09	3.1	105.2	3448	39.2	1497	7.10	233	18.7	649	17.8	710	0.33	9.8
Jan-00	4.35	8.8	290	48	1741	478	17341	150	5442	0.10	3.6	43.4	1575	27.6	1001	2.98	108	16.8	609	0.1	4	0.071	2.58
Feb-00	4.54	8.7	256	40	1515	425	16092	155	5869	0.09	3.4	58.2	2204	15.9	602	3.33	126	12.4	470	0.1	4	0.056	2.12
Mar-00	4.26	8.7	358	109	3873	536	19043	265	9415	0.07	2.5	63.3	2249	30.8	1094	4.22	150	6.9	246	2.2	78	0.134	4.76
Apr-00	5.14	8.5	254	94	4030	529	22677	262	11231	0.08	3.4	50.8	2178	13.1	562	3.14	135	8.6	369	0.1	4	0.063	2.70
May-00	5.64	8.5	240	41	1929	222	10442	82	3857	0.07	3.3	11.6	546	11.8	555	3.38	159	7.9	373	0.1	5	0.047	2.21
Jun-00	6.56	9	254	86	4705	254	13896	127	6948	0.06	3.3	19.2	1050	13.4	733	4.55	249	6.5	357	0.1	5	0.091	4.98
Jul-00	4.98	8.8	258	131	5441	350	14537	179	7434	0.09	3.7	36.7	1524	16.8	698	6.39	265	13.0	540	0.1	4	0.05	2.08
Aug-00	4.46	9.2	322	110	4092	577	21462	201	7476	0.12	4.5	28.4	1056	25.0	930	4.64	173	17.0	632	0.3	11	0.087	3.24
Sep-00	4.65	9.2	334	71	2753	433	16792	166	6438	0.07	2.7	38.0	1474	16.5	640	4.51	175	8.8	343	0.15	6	0.055	2.13
Oct-00	3.58	9.5	413	71	2120	559	16690	141	4210	0.07	2.1	40.0	1194	23.6	705	4.91	147	14.6	436	1.0	30	0.074	2.21
Nov-00	4.05	9.1	300	69	2331	496	16753	153	5168	0.06	2.0	45.6	1540	16.9	571	3.46	117	10.8	365	0.9	30	0.057	1.93
Dec-00	4.04	9.6	467	50	1685	532	17925	242	8154	0.07	2.4	8.6	290	23.0	775	5.81	196	12.2	411	5.5	185	0.055	1.85
Average	4.69	8.97	312	77	3018	449	16971	177	6804	0.08	3.1	37.0	1407	19.5	739	4.3	167	11.3	429	0.9	31	0.07	2.7
Minimum	3.58	8.50	240	40	1515	222	10442	82	3857	0.06	2.0	8.6	290	11.8	555	3.0	108	6.5	246	0.1	4	0.05	1.9

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Table 3-3
Secondary System
Influent Waste Loads

Date	AI Flow (MGD)	AI pH (SU)	AI Alk (mg/l)	AI TSS (mg/l)	AI TSS (lb/day)	AI COD (mg/l)	AI COD (lb/day)	AI BOD (mg/l)	AI BOD (lb/day)	AI Tot. Cr (mg/l)	AI Tot. Cr (lb/day)	AI O&G (mg/l)	AI O&G (lb/day)	AI NH_3-N (mg/l)	AI NH_3-N (lb/day)	AI Fluor. (mg/l)	AI Fluor. (lb/day)	AI Phenol (mg/l)	AI Phenol (lb/day)	AI Sulfide (mg/l)	AI Sulfide (lb/day)	AI CN (mg/l)	AI CN (lb/day)
Maximum	6.56	9.60	467	131	5441	577	22677	265	11231	0.12	4.5	63.3	2249	30.8	1094	6.4	265	17.0	632	5.5	185	0.13	5.0
Jan-01	6.04	9.75	367	81	4080	462	23273	180	9067	0.06	3.0	30.2	1521	19.7	992	5.10	257	10.35	521	0.5	25	0.054	2.72
Feb-01	6.19	9.4	316	60	3097	441	22766	192	9912	0.05	2.6	30.9	1595	16.5	852	1.74	90	7.78	402	0.9	46	0.103	5.32
Mar-01	5.33	9.6	351	112	4979	609	27071	255	11335	0.05	2.2	57.4	2552	18.1	805	2.86	127	6.62	294	0.3	13	0.059	2.62
Apr-01	5.32	9.4	397	92	4082	446	19788	175	7765	0.05	2.2	21.8	967	11.1	492	2.69	119	10.6	470	0.8	35	0.202	8.96
May-01	4.30	8.8	270	56	2008	580	20800	173	6204	0.05	1.8	33.1	1187	15.9	570	4.93	177	11.3	405	0.6	22	0.204	7.32
Jun-01	5.11	9.1	277	72	3068	467	19902	201	8566	0.03	1.3	23.7	1010	17.7	754	4.04	172	13.0	554	2.2	94	0.331	14.11
Jul-01	4.01	8.6	250	64	2140	540	18059	212	7090	0.04	1.3	39.8	1331	22.0	736	3.00	100	13.8	462	1.5	50	0.093	3.11
Aug-01	5.07	8.9	233	31	1311	311	13150	120	5074	0.04	1.7	15.9	672	9.67	409	2.08	88	5.36	227	0.5	21	0.039	1.65
Sep-01	3.73	9.0	255	39	1213	322	10017	104	3235	0.06	1.9	13.1	408	8.37	260	2.51	78	9.39	292	0.6	19	0.046	1.43
Oct-01	4.67	9.2	208	34	1324	258	10049	152	5920	0.03	1.2	14.7	573	12.9	502	1.11	43	17.6	685	0.1	4	0.063	2.45
Nov-01	3.32	9.15	234	71	1966	382	10577	205	5676	0.01	0.3	37.7	1044	20.6	570	1.77	49	12.0	332	0.1	3	0.062	1.72
Dec-01	3.54	8.7	256	77	2273	444	13108	144	4263	0.01	0.3	57.9	1709	15.1	446	3.23	95	17.3	511	0.1	3	0.063	1.86
Average	4.72	9.13	285	66	2629	439	17380	176	7009	0.04	1.6	31.4	1214	15.6	616	3	116	11.3	430	0.7	28	0.11	4.4
Minimum	3.32	8.60	208	31	1213	258	10017	104	3235	0.01	0.3	13.1	408	8.4	260	1	43	5.4	227	0.1	3	0.04	1.4
Maximum	6.19	9.75	397	112	4979	609	27071	255	11335	0.06	3.0	57.9	2552	22.0	992	5	257	17.6	685	2.2	94	0.33	14.1
Jan-02	3.44	9.45	278	43	1234	292	8377	138	3959	0.01	0.3	22.3	640	12.2	350	2.50	72	11.4	327	0.1	3	0.047	1.35
Feb-02	4.34	9.3	297	38	1375	461	16686	153	5538	0.01	0.4	26.7	966	16.5	597	1.65	60	7.6	275	2.1	76	0.071	2.57
Mar-02	5.01	8.6	283	29	1212	380	15878	183	7646	0.01	0.4	11.6	485	14.5	606	1.55	65	7.13	298	0.1	4	0.075	3.13
Apr-02	5.29	8.9	216	43	1897	392	17294	180	7941	0.01	0.4	14.2	626	9.2	406	2.25	99	4.67	206	0.1	4	0.030	1.32
May-02	4.96	8.7	292	236	9762	493	20394	128	5295	0.01	0.4	19.6	811	7.61	315	2.57	106	12.3	509	0.1	4	0.039	1.61
Jun-02	4.60	8.9	298	124	4757	770	29540	194	7443	0.02	0.8	77.1	2958	10.9	418	2.70	104	12.3	472	0.13	5	0.063	2.42
Jul-02	4.80	8.4	262	91	3643	631	25260	179	7166	0.03	1.2	68.3	2734	10.3	412	2.50	100	12.1	484	0.1	4	0.056	2.24
Aug-02	4.72	8.8	278	64	2519	394	15510	119	4684	0.01	0.4	35.3	1390	10.8	425	3.38	133	13.4	527	0.1	4	0.13	5.12
Sep-02	4.16	8.4	334	422	14641	954	33098	213	7390	0.01	0.3	54.1	1877	14.4	500	2.77	96	15.0	520	0.1	3	0.182	6.31
Oct-02	3.92	8.7	402	86	2812	858	28050	246	8042	0.03	1.0	81.4	2661	11.7	383	9.94	325	16.1	526	0.26	9	0.172	5.62
Nov-02	3.17	8.5	408	133	3516	834	22049	173	4574	0.13	3.4	76.5	2022	16.2	428	13.70	362	2.72	72	0.5	13	0.065	1.72
Dec-02	3.68	9.4	660	76	2333	719	22067	273	8379	0.02	0.6	51.0	1565	25.1	770	6.22	191	8.78	269	16.7	513	0.634	19.46
Average	4.34	8.8	334	115	4142	598	21184	182	6505	0.03	0.8	44.8	1561	13	468	4.31	143	10.3	374	1.7	54	0.130	4
Minimum	3.17	8.4	216	29	1212	292	8377	119	3959	0.01	0.3	11.6	485	8	315	1.55	60	2.7	72	0.1	3	0.030	1
Maximum	5.29	9.5	660	422	14641	954	33098	273	8379	0.13	3.4	81.4	2958	25	770	13.70	362	16.1	527	16.7	513	0.634	19
Jan-03	4.51	9.1	483	535	20123	2069	77822	229	8613	0.11	4.1	86.1	3239	24.4	918	5.53	208	10.8	406	3.0	113	0.243	9.14
Feb-03	4.40	9.3	339	194	7119	1144	41980	237	8697	0.02	0.7	121.8	4470	16.8	616	4.72	173	12.7	466	3.9	143	0.443	16.26
Mar-03	5.03	8.8	345	93	3901	722	30288	145	6083	0.02	0.8	53.9	2261	11.7	491	2.53	106	7.63	320	4.0	168	0.605	25.38
Apr-03	4.95	9.2	259	526	21715	556	22953	166	6853	0.01	0.4	44.4	1833	16.5	681	1.82	75	7.93	327	3.1	128	0.371	15.32
May-03	5.79	8.9	260	285	13762	819	39548	172	8306	0.03	1.4	54.4	2627	14.4	695	1.80	87	8.07	390	1.1	53	0.242	11.69
Jun-03	4.62	9.0	237	52	2004	462	17801	186	7167	0.01	0.4	24.7	952	16.0	616	2.18	84	8.46	326	2.3	89	0.551	21.23
Jul-03	5.64	9.4	253	90	4233	282	13265	103	4845	0.01	0.5	6.1	287	10.1	475	2.88	135	6.59	310	2.1	99	0.440	20.70
Aug-03	5.61	9.7	351	142	6644	378	17686	158	7392	0.01	0.5	20.3	950	10.5	491	1.57	73	7.95	372	0.7	33	0.220	10.29
Sep-03	4.16	9.29	304	200	6939	605	20990	180	6245	0.01	0.3	49.7	1724	8.55	297	1.25	43	9.1	315	1.6	56	0.492	17.07
Oct-03	4.18	9.26	297	200	6972	606	21126	183	6380	0.01	0.3	52.3	1823	8.36	291	1.25	44	9.37	327	1.71	60	0.538	18.76
Nov-03	4.19	9.66	315	163.4	5710	457.9	16001	229.6	8023	0.011	0.4	42.6	1489	15.3	535	2.72	95	8.95	313	1.65	58	0.324	11.32
Dec-03	4.79	8.4	310	908	36273	1067	42625	238.8	9540	0.02	0.8	137.3	5485	20.73	828	4.02	161	9.8	391	1.47	59	0.357	14.26
Average	4.82	9.2	313	282	11283	764	30174	186	7345	0.02	0.9	57.8	2262	14	578	2.69	107	8.9	355	2.2	88	0.402	16
Minimum	4.16	8.4	237	52	2004	282	13265	103	4845	0.01	0.3	6.1	287	8	291	1.25	43	6.6	310	0.7	33	0.220	9
Maximum	5.79	9.7	483	908	36273	2069	77822	239	9540	0.11	4.1	137.3	5485	24	918	5.53	208	12.7	466	4.0	168	0.605	25
Jan-04	4.51	8.8	265	47.7	1794	363	13639	154	5792.464	0.01	0.4	13.3	500	14.4	542	3.7	139	8.03	302	1.18	44	0.286	10.8
Feb-04	5.86	9.5	269	46.3	2263	414	20233	155	7575.222	0.01	0.5	34.9	1706	12.04	588	2.2	108	8.5	415	3.3	161	0.319	15.6
Mar-04	5.72	9	218	53	2528	354	16887	138	6583.262	0.02	1.0	8.42	402	10.5	501	1.6	76	8.1	386	1.07	51	0.245	11.7
Apr-04	5.69	9.6	304	65.7	3118	441	20927	215	10202.74	0.012	0.6	13.6	645	8.8	418	2.4	114	8.4	399	6.2	294	0.476	22.6
May-04	5.42	9	277	30.9	1396.8	393	17765	168	7594.07	0.014	0.6	6.61	299	5.98	270	2.4	108	7.87	356	8.7	393	0.622	28.1
Jun-04	5.99	9.1	208	111	5545.2	291	14537	127.9	6389.449	0.01	0.5	20.1	1004	13.3	664	1.24	62	5.4	270	1.01	50	0.331	16.5
Jul-04	5.18	8.9	196	87	3758.5	285	12312	132	5702.558	0.019	0.8	11	475	8.24	356	1.33	57	6.83	295	0.1	4	0.062	2.7

356061001 Table 3-3 12/4/2007

Secondary System
Influent Waste Loads

Date	AI Flow (MGD)	AI pH (SU)	AI Alk (mg/l)	AI TSS (mg/l)	AI TSS (lb/day)	AI COD (mg/l)	AI COD (lb/day)	AI BOD (mg/l)	AI BOD (lb/day)	AI Tot Cr (mg/l)	AI Tot. Cr (lb/day)	AI O&G (mg/l)	AI O&G (lb/day)	AI NH_3-N (mg/l)	AI NH_3-N (lb/day)	AI Fluor (mg/l)	AI Fluor. (lb/day)	AI Phenol (mg/l)	AI Phenol (lb/day)	AI Sulfide (mg/l)	AI Sulfide (lb/day)	AI CN (mg/l)	AI CN (lb/day)
Aug-04	4 56	8.5	248	30	1140.9	261	9925.9	101	3841.07	0.014	0.5	6.8	259	8.9	338	1.57	60	10.8	411	0.12	5	0.072	2.7
Sep-04	4.09	8.8	202	40	1364.4	347	11836	144	4911.926	0.01	0.3	12.1	413	14.2	484	5.29	180	8.4	287	0.32	11	0.177	6.0
Oct-04	3.95	8.4	209	95	3129.6	724	23851	164	5402.652	0.03	1.0	52	1713	11.7	385	5.09	168	7.07	233	0.1	3	0.093	3.1
Nov-04	4.44	8.6	221	174	6443.2	491	18182	184	6813.446	0.016	0.6	60.2	2229	19 3	715	2.01	74	8.3	307	2.6	96	0.488	18.1
Dec-04	5.98	8.5	183	65	3241.8	410	20448	143	7131.868	0.021	1.0	62	3092	19.8	987	1 77	88	8.53	425	0.45	22	0.53	26.4
Average	5.1	8.892	233.3	70.467	2976.9	397.8	16712	152	6495	0.0155	0.7	25	1061	12	521	3	103	8	340	2	95	0.308	14
Minimum	3.95	8.4	183	30	1140.9	261	9925.9	101	3841	0.01	0.3	7	259	6	270	1	57	5	233	0	3	0.062	3
Maximum	5.99	9.6	304	174	6443.2	724	23851	215	10203	0.03	1.0	62	3092	20	987	5	180	11	425	9	393	0.622	28
Jan-05	6.4	8.8	248	38.4	2049.6	350	18682	152	8113.152	0.019	1.0	12.2	651	7.96	425	1.05	56	8.6	459	0.22	12	0.303	16.2
Feb-05	5.83	9.4	260	61.2	2975.7	422	20519	188	9140.974	0.02	1.0	10.9	530	9 68	471	1.91	93	8.4	408	1.30	63	0.2	9.7
Mar-05	5.47	9	245	70	3193.4	388	17700	171	7800.986	0.03	1.4	16.2	739	12.18	556	1.76	80	7.8	356	0.42	19	0.223	10.2
Apr-05	6.31	9 3	224	87	4578.4	479	25208	148	7788 559	0.026	1.4	42 9	2258	7 64	402	2.08	109	8.6	453	0.20	11	0.217	11.4
May-05	4.26	9.8	219	127	4512.1	445	15810	199	7070.152	0 019	0,68	19.6	696	14.3	508	1.78	63	13.2	469	0.80	28	0.329	11.7
Jun-05	4.90	9.5	229	64	2615.4	508	20760	182	7437.612	0.014	0.6	37	1512	12.87	526	2.09	85	8.8	360	0 63	26	0.399	16.3
Jul-05	5 50	9.00	225	357	16376	812	37246	185	8485.95	0.015	0.7	48	2201.8	13	596	1.64	75	9.12	418	0.097	4	0.14	6.4
Aug-05	4.67	8.5	208	498	19396	1032	40194	187	7283.239	0.014	0.5	57.4	2235.6	12.15	473	1.6	62	9.48	369	0.1	4	0.185	7.2
Sep-05	4.15	9	210	393	13602	984	34057	188	6506.868	0.02	0.7	76.7	2654.7	15.04	521	1.96	68	11.02	381	0.1	3	0.13	4.5
Oct-05	4.01	9.1	192	201	6722.1	793	26521	154	5150.284	0.022	0.7	65.1	2177.2	13.01	435	1.7	57	10.2	341	0.195	7	0.18	6.0
Nov-05	2.67	8.7	184	98	2182.2	460	10243	164	3651.919	0.013	0.3	20	445.36	13.91	310	1.49	33	12.22	272	0.111	2	0.207	4.6
Dec-05	5.24	8.4	197	148	6467.8	850	37146	173	7560.377	0.014	0.6	53.2	2324.9	12.84	561	1.52	66	11.05	483	0.204	9	0.242	10.6
Average	4.95	9	220	179	7056	627	25341	174	7166	0.019	1	38	1535	12 05	482	2	71	9.87	397	0	16	0.230	10
Minimum	2 67	8	184	38	2050	350	10243	148	3652	0.013	0	11	445	7.64	310	1	33	7.80	272	0	2	0.130	4
Maximum	6.40	10	260	498	19396	1032	40194	199	9141	0.030	1	77	2655	15.04	596	2	109	13.20	483	1	63	0.399	16
Jan-06	5.67	9 4	263	86	4066.8	535	25299	179	8464.5	0.011	0.5	38.5	1820.6	16.2	766.1	1.3	61	9.8	463.4	0.181	8.6	0.216	10.2
Feb-06	5 45	9.5	229	141	6408.9	804	36544	169	7681.6	0.02	0.9	75	3409	12.7	577.3	1.31	60	10.6	481.8	0.37	16.8	0.277	12.6
Mar-06	5.68	8.6	195	71	3363.4	979	46376	121	5731.9	0.012	0.6	38	1800.1	16	757.9	1.87	89	7.4	350.5	0.1	4.7	0.145	6.9
Apr-06	5.63	8.3	204	105	4930.2	708	33244	126	5916.2	0.022	1.0	40	1878.2	15.15	711.4	3.1	146	7.43	348.9	0.149	7.0	0.311	14.6
May-06	4 94	9 1	301	129	5314.7	698	28757	212	8734.3	0.015	0.6	135	5561.9	24.4	1005.3	4.3	177	7.81	321.8	0.877	36.1	0.34	14.01
Jun-06	4.91	8.9	396	484	19820	1344	55036	173	7084.2	0.02	0.8	103	4217.8	14.64	599.5	2.58	106	9.19	376.3	0.13	5.3	0.27	11.1
Jul-06	4.73	9	281	352	13886	1096	43235	188	7416.3	0.02	0.8	135	5325.5	17.4	686 4	3.24	128	8.09	319.1	0.15	5.9	0.3	11.8
Aug-06	5.38	8.2	226	305	13685	734	32934	151	6775.2	0.013	0.6	103	4621.5	19.86	891 1	2.13	96	8.74	392.2	0.111	5.0	0.272	12.2
Sep-06	6.11	8.6	208	108	5503.4	644	32817	166	8458.9	0.011	0.6	77	3923.7	17.29	881.1	2.47	126	9.28	472.9	0.464	23.6	0.225	11.5
Oct-06	5.22	8.3	184	56	2437.9	455	19808	136	5920.7	0.019	0.8	17	740.09	12.2	531.1	4.52	197	2.77	120.6	0.1	4.4	0.119	5.2
Nov-06	4.48	9.5	272	690	25781	795	29704	232	8668.262	0.01125	0.42	56	2092.3	11.91	445.0	5.28	197	2.944	110.0	0.1	3.7	0.093	3.5
Dec-06	6.7	9.25	285	84.5	4721.7	532	29727	182	10169.8	0.015	0.84	45	2514.5	22.14	1237.14	1.69	94.4338	9.17	512.4	0.99	55.31922	0.273	15.255
Average	5.41	9	254	218	9160	777	34457	170	7585	0.016	0.71	72	3159	16 7	757	3	123	8	356	0	15	0.237	11
Minimum	4.48	8	184	56	2438	455	19808	121	5732	0.011	0.42	17	740	11.9	445	1	60	3	110	0	4	0.093	3
Maximum	6.7	10	396	690	25781	1344	55036	232	10170	0.022	1.03	135	5562	24.4	1237	5	197	11	512	1	55	0.34	15
Jan-07	5 7	9.3	329	129	6132.4	656	31185	256	12169.7	0.01	0.475	54	2567.1	36.3	1725.63	1.98	94	9.8	465.9	4.57	217.2	0.527	25.053
Feb-07	5.1	9.2	297	46.5	1977.8	931	39599	186	7911.3	0.011	0.468	30.9	1314.3	40.12	1706.46	1.86	79	10.3	438.1	5.48	233.1	0.367	15.61
Mar-07	6.52	9.2	243	138	7504	783	42577	82	4458.898	0.016	0.870029	124	6742.7	23	1250.67	1.25	67.971	7.93	431.208	2.75	149.5362	0.242	13.159
							0		0		0		0		0		0		0		0		0
							0		0												0		0
																							0

This data was analyzed statistically to determine the occurrence probability for flow and pollutants based on the crude production rate of the refinery. The statistical analysis utilized the data from August 1997 to March 2007. However, the data for the period August 2001 through December 2002 were not included in this analysis because the crude unit was out of service. Therefore, the waste loads were not typical during this period.

The statistically determined 90 percentile occurrences were utilized to estimate average monthly conditions, and the 95 percentile occurrences were utilized to develop maximum daily conditions. The production based flow values (in gal/bbl) and pollutant loads (in lb/1000 bbl) were multiplied by 170,341 bbl/day, the maximum monthly crude charge observed during this period, to determine design conditions for the refinery WWTP. The statistical analysis of this data is included in Appendix B. A summary of the data is presented in Table 3-4.

Based on our analyses of the production based flow data, the refinery had reduced water usage and even with the changes in production and crude quality, the refinery has maintained the reduced water usage.

These data show that TSS, oil and grease and COD wasteloads have increased by greater than 60% as compared to historical data. These results are consistent with the increased usage of heavy crudes. The increased COD and TSS loads place an increased stress on the wastewater treatment plant and require more extensive operation in order to maintain effluent quality and comply with the effluent regulations. The BOD is lower; however, the higher COD is expected to result in a much slower to degrade organic component and requirements for tighter wastewater treatment plant operation in order to achieve effluent quality criteria is needed.

TABLE 3-4

SUMMARY OF DESIGN WASTEWATER LOADINGS

	Design Monthly Average Loading		Design Monthly Average Loading	
Parameter	**lb/1,000 bbl[(1)]**	**lb/day**	**lb/1,000 bbl[(2)]**	**lb/day**
Flow	39[(3)]	6.64[(4)]	42[(3)]	7.15[(4)]
BOD_5	59	10,050	63	10,731
TSS	41	6,984	46	7,835
O&G	19	3,236	22	3,748
COD	232	39,519	255	43,437
NH_3	6.25	1,065	7	1,192
Phenol	3.45	588	3.7	630
Sulfide	0.6	102	0.71	121
Fluoride	1.2	204	1.34	228

NOTE: Crude Charge = 170,341 bbl/day

(1) 90 percentile occurrence

(2) 95 percentile occurrence

(3) gal/bbl

(4) MGD

3.2 CURRENT WASTEWATER COLLECTION AND TREATMENT SYSTEM

The refinery has an extensive wastewater collection and treatment system. This system has continued to be upgraded and improved. Figure 3-1 shows the Process Flow Diagram for Lemont Refinery wastewater treatment system. A process design summary of the system is presented in Table 3-5. This section presents a review of the specific components of the facility.

Separate collection systems for the process and non-process wastewaters have been developed. The process wastewaters from the north plant and south plant areas of the refinery are collected separately and can be pretreated in separate corrugated plate interceptors (CPI) for removal of free oils and settleable solids. Cyanide and non-cyanide sour waters are stripped separately and then combined with the south plant area process wastewaters upstream of the south plant CPI separators. Stormwater and non-process wastewater from the refinery are collected and directed into a 52 million gallon (MG) stormwater basin. This stormwater basin provides in excess of 14 days equalization capacity.

The discharge from the north plant and the south plant areas is pumped to two (2) 4.6 MG process wastewater storage tanks (TK485 and TK486). These tanks, which replaced a single 2 MG tank (Tank 114), were put in service in early 1993. These tanks provide approximately five (5) days of equalization capacity. The tanks are equipped with floating roofs with oil skimmers and provide removal of free oils and settleable solids. The tanks are operated in parallel and provide adequate capacity to allow shutdown and servicing of either of the tanks without disruption of the treatment process. In 2000, the refinery installed an induced gas floatation (IGF) system to treat the discharge from tanks 485 and 486. The induced gas floatation system induces gas bubbles into the chemically treated process stream. This allows floatation and skimming of the oil and suspended solids. The objective of the IGF is to remove insoluble oil/organics and suspended solids. This allows this stream to go directly to the activated sludge system.

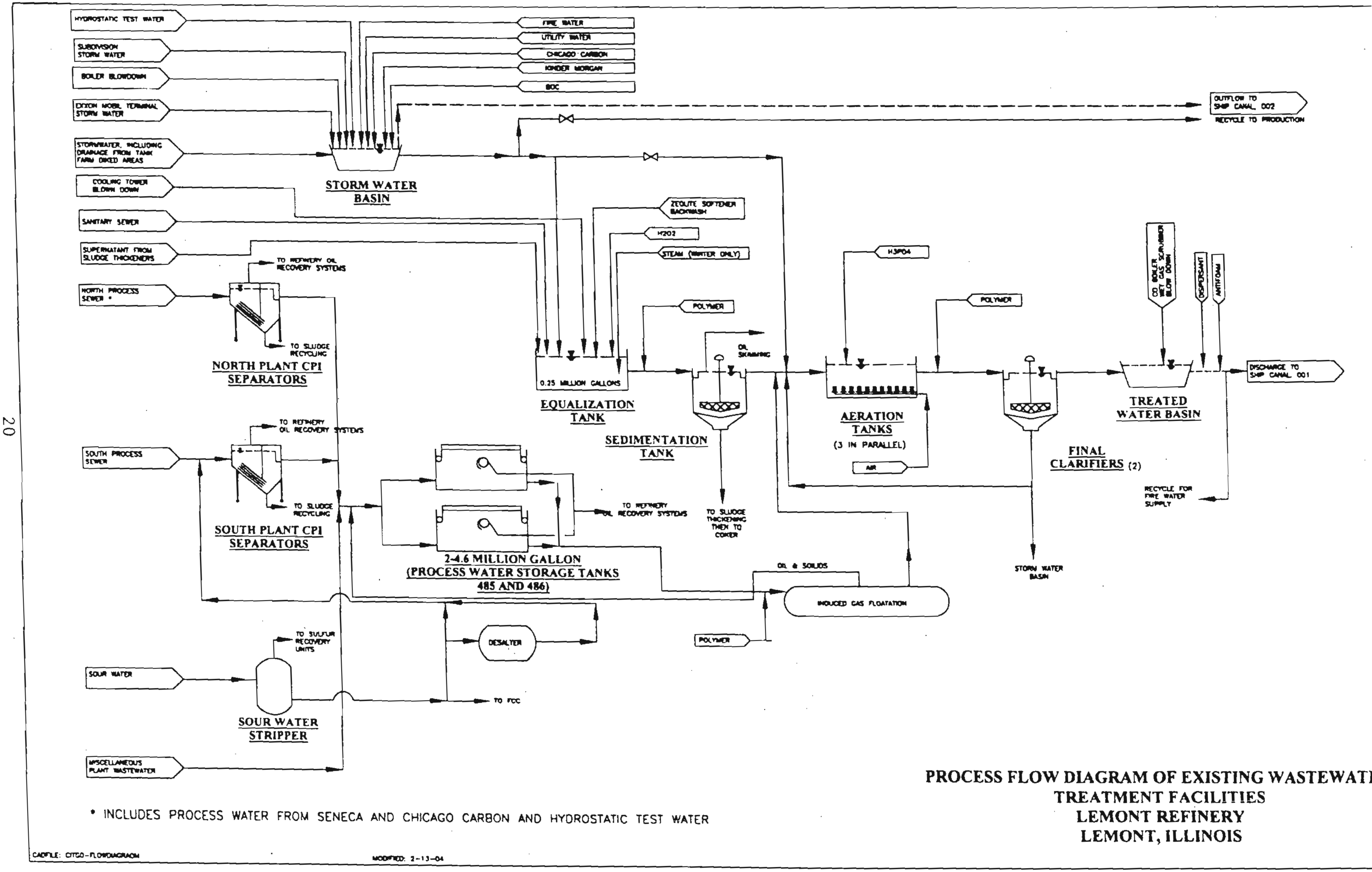
HYDROSTATIC TEST WATER
SUBDIVISION STORM WATER
BOILER BLOWDOWN
EXXON MOBIL TERMINAL STORM WATER
STORMWATER, INCLUDING DRAINAGE FROM TANK FARM DIKED AREAS
COOLING TOWER BLOWN DOWN
SANITARY SEWER
SUPERNATANT FROM SLUDGE THICKENERS
NORTH PROCESS SEWER *
SOUTH PROCESS SEWER
SOUR WATER
MISCELLANEOUS PLANT WASTEWATER
FIRE WATER
UTILITY WATER
CHICAGO CARBON
KINDER MORGAN
BOC
OUTFLOW TO SHIP CANAL 002
RECYCLE TO PRODUCTION
STORM WATER BASIN
ZEOLITE SOFTENER BACKWASH
H2O2
STEAM (WATER ONLY)
TO REFINERY OIL RECOVERY SYSTEMS
TO SLUDGE RECYCLING
NORTH PLANT CPI SEPARATORS
POLYMER
OIL SKIMMING
0.25 MILLION GALLONS
EQUALIZATION TANK
SEDIMENTATION TANK
H3PO4
AERATION TANKS
(3 IN PARALLEL)
AIR
CO BOILER WET GAS SCRUBBER BLOW DOWN
DISPERSANT
ANTIFOAM
TREATED WATER BASIN
DISCHARGE TO SHIP CANAL 001
FINAL CLARIFIERS (2)
RECYCLE FOR FIRE WATER SUPPLY
TO REFINERY OIL RECOVERY SYSTEMS
TO SLUDGE RECYCLING
SOUTH PLANT CPI SEPARATORS
TO REFINERY OIL RECOVERY SYSTEMS
TO SLUDGE THICKENING THEN TO COKER
STORM WATER BASIN
2-4.6 MILLION GALLON (PROCESS WATER STORAGE TANKS 485 AND 486)
OIL & SOLIDS
INDUCED GAS FLOATATION
DESALTER
POLYMER
TO SULFUR RECOVERY UNITS
TO FCC
SOUR WATER STRIPPER
PROCESS FLOW DIAGRAM OF EXISTING WASTEWAT
TREATMENT FACILITIES
LEMONT REFINERY
LEMONT, ILLINOIS
* INCLUDES PROCESS WATER FROM SENECA AND CHICAGO CARBON AND HYDROSTATIC TEST WATER
CADFILE: CITGO-FLOWDIAGRAM
MODIFIED: 2-13-04

Figure 3-1

TABLE 3-5

PROCESS DESIGN SUMMARY EXISTING WASTEWATER TREATMENT PLANT

Unit	Plant Configuration
Stormwater Basin	
Capacity, MG	52.0
Process Wastewater Storage Tank (TK485 & TK486)	
No. Units	2
Capacity (each), MG	4.6
Total Detention Time, days	4.2
Induced Gas Flotation	
Vessels	1
Outside Diameter (ft)	10
Length (ft)	30
Operating Pressure (psig)	12
Temperature (°F)	85-130
Equalization Tank	
Capacity, gal	250,000
Depth, ft	16
Detention Time, @ 6.0 MGD, hrs	1.0
Sedimentation Tank	
Diameters, ft	100
Side Water Depth, ft	16
Surface Area, sq ft	7,850
Overflow Rate, @ 6.0 MGD, gpd/sq ft	764
Aeration Tanks	
No. of Tanks	3
Total Volume, MG	1.92
Depth, ft	12
Detention Time, @ 6.0 MGD, hrs	7.7
Aeration	
Number of Blowers (2 on-line, 1 spare)	3
Horsepower, each	300
Total Horsepower Applied	600
Air Flow Rate, each, scfm	5,500
Discharge Pressure, psig	7.0
Total Operating Capacity, scfm	10,000
Final Clarifier(s)	
Total Number	2
Diameter, ft	100
Side Water Depth, ft	14
Surface Area, sq ft (each unit)	7,854
Overflow Rate, @ 6.0 MGD, gpd/sq ft	382
Treated Water Basin	
Capacity, MG	16

This modification has reduced the wasteload to the equalization basin and the sedimentation tank. The 0.25 MG equalization tank still receives the cooling tower blow down, sanitary sewer discharge, supernatant from sludge thickeners and the Zeolite softener backwash.

Stormwater is pumped from the stormwater basin into the equalization tank where it is mixed with these streams, or it can be by-passed around the equalization tank and added directly to the aeration basins. The combined equalization provided by the 9.2 MG in process wastewater storage tanks, the 52 MG stormwater basin and the 0.25 MG equalization tank allows the process wastewater and stormwater additions to the treatment plant to be controlled and regulated to obtain the best performance through the WWTP.

To provide optimum conditions for ammonia nitrogen removal in the winter, stream is injected into the equalization tank. The stream addition is provided to maintain aeration basin operating temperatures of greater than 70°F. Since 1997, the minimum monthly average aeration basin temperature has been over 73°F.

The combined wastewaters flow to a single stage activated sludge treatment system which includes three (3) aeration basins operated in parallel with a total aeration basin volume of 1.92 MG. Aeration is provided by a fine-bubble diffused aeration system. Phosphorus is added to the aeration basins as a nutrient for the biological organisms. The activated sludge is settled in one of the two 100 ft diameter secondary clarifiers.

Because of air pollution regulations, the refinery has installed a scrubber on the carbon monoxide boiler associated with the Fluid Catalytic Cracker (FCC) unit. This unit began operation in October 2007. The purge stream from this unit is treated in a new physical-chemical treatment system as shown in Figure 3-2. This purge treatment unit (PTU) is designed to handle 300 gpm and this stream can contain an elevated ammonia nitrogen discharge. Therefore, a breakpoint chlorination-dechlorination system has been

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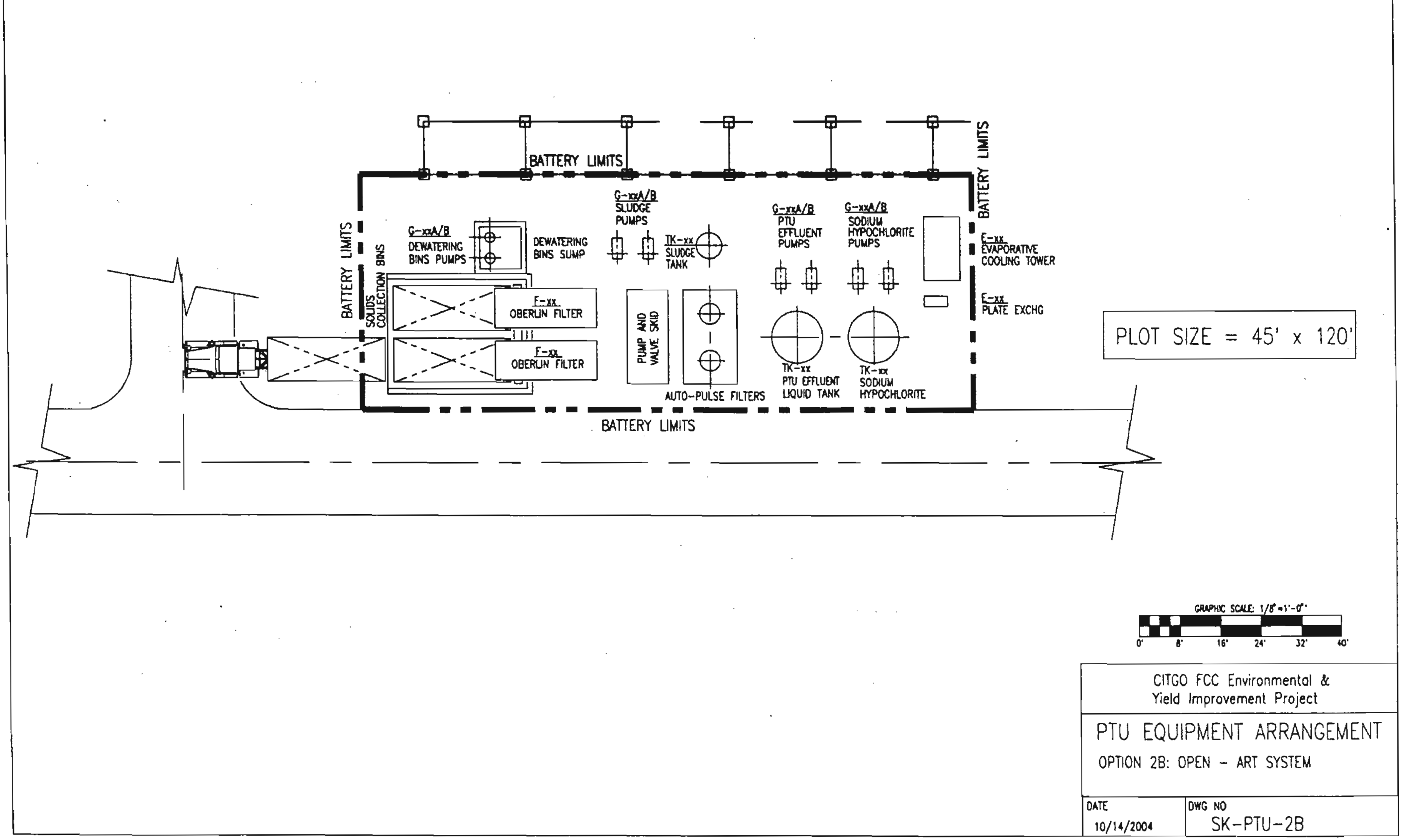

Figure 3-2
PTU Treatment System

installed to treat the ammonia nitrogen in this discharge. As shown in Figure 3-1, this stream discharges to the treated water basin where it is combined with the discharge from the activated sludge system. The purge stream is inorganic and high in total dissolved solids and is not compatible with a biological treatment system.

The tertiary treatment system consists of a 16 million gallon polishing lagoon known as the Treated Water Basin (TWB). The purpose of the TWB is to provide additional settling of any carryover solids from the secondary clarifier and provide further BOD_5 reduction. The TWB serves as a holding/polishing pond. This water can be recycled to the refinery for fire protection. The treated effluent from the TWB is discharged to the Chicago Sanitary and Ship Canal.

Our analysis of Lemont Refinery's wastewater treatment system indicates that it exceeds the BAT technology for wastewater treatment as presented in the 1982 U.S. EPA "Development Document". The BAT criteria used as the basis for the U.S. EPA effluent limitations guidelines are compared with the refinery wastewater treatment system in Table 3-6. As shown in Table 3-6 the refinery treatment system contains all of the BAT components outlined by U.S. EPA. In addition to complying with the U.S. EPA model technology, the facility has continually made improvements and upgrades to its wastewater management program to reduce effluent ammonia and improve the overall performance of the treatment system. A summary of the improvements and upgrades from 1997 to present is presented in Table 3-7. This program represents a total expenditure in excess of $45,000,000. Based on the continued compliance with the effluent criteria and improvements in effluent quality, it appears that these improvements and upgrades have been successful.

3.3 COMPARISON OF LEMONT REFINERY'S WASTEWATER TREATMENT PERFORMANCE WITH BAT

To determine if the performance of the treatment system is consistent with BAT, an analysis of the treatment plant data was conducted. A detailed review of the WWTP performance data for the period August 1997 to March 2007 was conducted. The secondary system operations data and final effluent data are presented in Table 3-8.

TABLE 3-6

COMPARISON OF BAT GUIDELINES WITH LEMONT REFINERY'S WASTEWATER TREATMENT SYSTEM

BAT Guidelines	Lemont Refinery System
• Sour water strippers	• Sour water strippers provide in excess 96.5% average ammonia removal efficiency
• Flow equalization	• Two (2) 4.6 MG process wastewater storage tanks providing approximately 4.2 day equalization capacity in addition to a 52 MG stormwater capacity which provide 14 days equalization and a 0.25 MG equalization tank
• Initial oil and solids removal	• CPI separators • Additional oil and solids removal in the two 4.6 MG process wastewater storage tanks
• Additional oil and solids removal	• 100 ft diameter primary clarifier with polymer addition • Induced gas flotation
• Biological treatment	• Single-stage activated sludge system
• Filtration or other final polishing	• 16 MG final polishing pond

TABLE 3-7

SUMMARY OF WASTE TREATMENT MODIFICATIONS/UPGRADES

1997-2007(1)

Year	Project
2000	Installed induced gas flotation system with polymer addition to remove insoluble oil/organics and suspended solids from the process water storage tank discharge.
2003	Added additional strippers in the sour water system for ammonia removal.
2003	Upgrade of Sanitare diffused aerators to improve oxygen transfer – Cell B.
2006	Upgrade phosphoric acid feed system to optimize the performance of nitrifying organisms.
2006	Upgrade of Sanitare diffused aerators to improve oxygen transfer – Cell A.
2007	Installing purge treatment unit (PTU) to treat the discharge from the FCC wet gas scrubber air pollution control project. The treatment unit includes wastewater filtration, solids dewatering, breakpoint chlorination/dechlorination, heat exchanger, and evaporative cooling tower.
2007	Upgrade of Sanitare diffused aerators to improve oxygen transfer – Cell C.

Table 3-8
Secondary System
Operating History

Date	Al Flow (MGD)	Aer Basin TSS mg/l	Aeration Volatile Fraction	Aer Tk Temp °F	R Sludge TSS mg/l	Ave Sludge Wasted MGD	Sludge Wasted gpm	Ave Sludge Wasted lb/day	Basin DO (AE)	Detention Time days	Aer Inf BOD	F/M 1/day	Sludge Age Days	Clar pH (SU)	Clar Alk mg/l	Clar TSS mg/l	Clar TSS #/day	Clar COD mg/l	Clar COD #/day	Clar BOD mg/l	Clar BOD #/day	Clar NH_3-N mg/l	Clar NH_3-N #/day	Clar Tot CN mg/l	Clar Tot CN #/day	Clar Phenol mg/l	Clar Phenol #/day	Final BOD #/day	Final TSS #/day
Aug-97	3.86	5958	0.73	91	15213	4.41E-02	30.6	5591	4.0	0.50	183	0.06	14	7.4	105	34	1095	85	2736	6.7	216	0.50	16.1	0.020	0.6	0.03	1.0	186	371
Sep-97	3.59	6803	0.77	85	16612	4.59E-03	3.19	636	3.7	0.53	239	0.07	75	7.4	132	27	808.4	76	2275	8.5	254	5.01	150.0	0.021	0.6	0.035	1.0	215	343
Oct-97	3.42	8560	0.80	85	25756	5.04E-03	3.50	1083	2.7	0.56	266	0.06	51	7.4	128	56	1597	108	3080	7.2	205	5.00	142.6	0.028	0.8	0.078	2.2	186	336
Nov-97	3.30	7942	0.79	87	21962	8.21E-04	0.57	150	3.0	0.58	213	0.05	162	7.5	109	23	633	103	2835	13.3	366	0.52	14.3	0.027	0.7	0.076	2.1	174	349
Dec-97	3.78	8165	0.79	86	21076	1.15E-04	0.08	20	3.6	0.51	200	0.05	222	7.4	149	18	567.5	78	2459	6.0	189	0.48	15.1	0.025	0.8	0.05	1.6	125	377
Average	3.59	7486	0.78	87	20124	1.09E-02	7.59	1496	3	0.54	220	0.06	84	7.42	125	32	940	90	2677	8	246	2.3	67.6	0.024	0.7	0.054	1.6	177	355
Minimum	3.30	5958	0.73	85	15213	1.15E-04	0.08	20	3	0.50	183	0.05	14	7.40	105	18	567	76	2275	6	189	0.5	14.3	0.020	0.6	0.030	1.0	125	336
Maximum	3.86	8560	0.80	91	25756	4.41E-02	30.6	5591	4	0.58182	266	0.066	222	7.5	149	56	1597	108	3080	13	366	5.0	150.0	0.028	0.8	0.078	2.2	215	377
Jan-98	5.18	7883	0.78	85	28677	1.32E-03	0.92	317	3.7	0.37	139	0.05	107	7.3	122	20	864	82	3542	4.8	207	0.39	16.8	0.019	0.8	0.083	3.6	180	294
Feb-98	4.45	10244	0.78	82	28704	1.41E-03	0.98	338	3.9	0.43	205	0.05	116	7.4	153	29	1076	89	3303	7.4	275	0.68	25.2	0.018	0.7	0.057	2.1	168	439
Mar-98	5.35	10060	0.77	83	24161	7.20E-05	0.05	15	3.6	0.36	194	0.05	132	7.3	147	27	1205	81	3614	12.7	567	0.3	13.4	0.011	0.5	0.053	2.4	245	231
Apr-98	4.50	10782	0.77	84	33338	8.06E-05	0.056	22	2.6	0.43	182	0.04	113	7.4	139	40	1501	140	5254	12.2	458	1.09	40.9	0.023	0.9	0.112	4.2	443	653
May-98	4.98	8706	0.77	85	21455	3.30E-03	2.29	590	2.8	0.39	245	0.07	71	7.5	114	33	1371	119	4942	10.7	444	3.94	163.6	0.013	0.5	0.067	2.8	326	696
Jun-98	4.65	7974	0.8	89	22549	4.55E-03	3.16	856	2.1	0.41	336	0.10	47	7.5	111	48	1861	107	4150	21.4	830	2.47	95.8	0.019	0.7	0.061	2.4	522	485
Jul-98	5.20	8836	0.78	95	27605	1.09E-04	0.076	25	3.9	0.37	193	0.06	107	7.6	115	30	1301	88	3816	8.1	351	0.24	10.4	0.012	0.5	0.071	3.1	322	629
Aug-98	4.31	7994	0.79	95	21044	1.02E-04	0.071	18	2.6	0.45	245	0.07	95	7.5	119	37	1330	120	4313	7.8	280	0.67	24.1	0.011	0.4	0.057	2.0	185	527
Sep-98	4.50	8842	0.78	91	20766	1.21E-04	0.084	21	3.9	0.43	136	0.04	148	7.4	103	25	938.3	101	3791	6.9	259	0.63	23.6	0.009	0.3	0.04	1.5	139	410
Oct-98	4.50	7411	0.78	84	20416	1.28E-04	0.089	22	4.0	0.43	169	0.05	161	7.4	109	19	713.1	81	3040	3.0	113	0.38	14.3	0.011	0.4	0.045	1.7	107	382
Nov-98	4.24	7122	0.8	76	19118	9.79E-05	0.068	16	3.1	0.45	199	0.06	96	7.2	107	33	1167	103	3642	11.0	389	1.11	39.3	0.016	0.6	0.062	2.2	243	418
Dec-98	3.59	10325	0.82	77	23113	8.52E-04	0.592	164	2.8	0.53	213	0.04	133	7.1	97	36	1078	105	3144	9.1	272	0.62	18.6	0.039	1.2	0.049	1.5	204	287
Average	4.62	8848	0.79	86	24246	1.01E-03	0.70	200	3.3	0.42	205	0.06	111	7.38	120	31	1200	101	3879	9.59	370	1.0	40.5	0.017	0.6	0.063	2.4	257	454
Minimum	3.59	7122	0.77	76	19118	7.20E-05	0.05	15	2.1	0.36	136	0.04	47	7.10	97	19	713	81	3040	3.00	113	0.2	10.4	0.009	0.3	0.040	1.5	107	231
Maximum	5.35	10782	0.82	95	33338	4.55E-03	3.16	856	4.0	0.53	336	0.10	161	7.6	153	48	1861	140	5254	21.4	830	3.9	163.6	0.039	1.2	0.112	4.2	522	696
Jan-99	4.78	8586	0.85	76	23693	5.77E-03	4.01	1141	2.1	0.40	296	0.09	44	7.3	142	50	1993	176	7016	38.2	1523	26.8	1068	0.056	2.2	0.182	7.3	230	282
Feb-99	4.96	5786	0.85	81	16227	9.07E-05	0.06	12	6.1	0.39	223	0.10	48	7.2	100	46	1903	136	5626	16.8	695	3.52	145.6	0.017	0.7	0.063	2.6	271	529
Mar-99	4.58	4702	0.88	84	13396	4.81E-03	3.34	537	5.4	0.42	262	0.13	21	7.2	116	79	3018	113	4316	14.8	565	0.88	33.6	0.022	0.8	0.024	0.9	299	438
Apr-99	4.23	4146	0.84	85	11296	1.96E-03	1.36	184	7.6	0.45	186	0.10	34	7.2	104	50	1764	154	5433	10.7	377	0.64	22.6	0.017	0.6	0.016	0.6	349	321
May-99	5.72	4900	0.84	88	12848	7.92E-05	0.06	8	6.3	0.34	212	0.13	125	7.5	118	13	620	66	3149	6.5	310	0.76	36.3	0.012	0.6	0.023	1.1	409	461
Jun-99	5.04	5099	0.79	91	13757	9.99E-04	0.69	115	6.3	0.38	123	0.06	76	7.4	133	23	967	61	2564	6.4	269	0.76	31.9	0.009	0.4	0.015	0.6	333	442
Jul-99	4.27	5315	0.78	98	15292	1.08E-04	0.08	14	5.3	0.45	161	0.07	130	7.5	121	18	641	77	2742	5.9	210	0.85	30.3	0.011	0.4	0.021	0.7	243	511
Aug-99	3.89	5279	0.79	97	13970	8.58E-04	0.60	100	5.4	0.49	242	0.09	104	7.7	122	22	714	64	2076	12.5	406	0.87	28.2	0.012	0.4	0.027	0.9	305	431
Sep-99	3.56	5698	0.82	93	15092	1.05E-03	0.73	132	4.3	0.54	220	0.07	176	7.6	110	13	386	62	1841	9.6	285	2.55	75.7	0.010	0.3	0.023	0.7	392	494
Oct-99	4.25	6684	0.82	82	16139	7.57E-04	0.53	102	5.9	0.45	201	0.07	169	7.8	150	15	532	88	3119	11.1	393	2.33	82.6	0.027	1.0	0.056	2.0	238	420
Nov-99	3.93	8665	0.80	80	28688	2.00E-03	1.39	479	3.8	0.49	219	0.05	67	7.4	161	49	1606	189	6195	26.4	865	2.17	71.1	0.012	0.4	0.132	4.3	371	597
Dec-99	4.19	10993	0.85	74	28704	6.00E-04	0.42	144	3.2	0.46	196	0.04	68	7.4	180	70	2446	204	7129	22.5	786	24.6	859.6	0.021	0.7	0.119	4.2	191	684
Average	4.45	6321	0.83	86	17425	1.59E-03	1.10	247	5.1	0.44	212	0.08	88	7.4	130	37	1382	116	4267	15.1	557	5.6	207	0.019	0.7	0.058	2.2	303	468
Minimum	3.56	4146	0.78	74	11296	7.92E-05	0.06	8	2.1	0.34	123	0.04	21	7.2	100	13	386	61	1841	5.9	210	0.6	23	0.009	0.3	0.015	0.6	191	282
Maximum	5.72	10993	0.88	98	28704	5.77E-03	4.01	1141	7.6	0.54	296	0.133	176	7.8	180	79	3018	204	7129	38.2	1523	26.8	1068	0.056	2.2	0.182	7.3	409	684
Jan-00	4.35	7048	0.87	83	24334	6.52E-04	0.45	132	4.8	0.44	150	0.05	65	7.2	148	44	1596	120	4353	13.6	493	3.79	137.5	0.016	0.6	0.058	2.1	251	578
Feb-00	4.54	8077	0.87	85	22700	2.15E-03	1.50	408	5.5	0.42	155	0.05	84	7.2	135	30	1136	90	3408	18.8	712	1.9	71.9	0.010	0.4	0.097	3.7	441	789
Mar-00	4.26	8091	0.84	86	23299	5.31E-04	0.37	103	4.2	0.45	265	0.07	104	7.4	162	32	1137	96	3411	12.5	444	4.39	156.0	0.039	1.4	0.071	2.5	362	724
Apr-00	5.14	9914	0.79	82	23853	1.80E-02	12.48	3575	5.0	0.37	262	0.07	33	7.2	177	28	1200	122	5230	12.6	540	1.17	50.2	0.010	0.4	0.055	2.4	444	703
May-00	5.64	6382	0.77	85	22947	1.60E-02	11.11	3062	6.0	0.34	82	0.04	26	7.2	129	20	941	94	4422	7.8	367	0.32	15.1	0.009	0.4	0.057	2.7	332	591
Jun-00	6.56	6325	0.70	85	19925	1.48E-02	10.29	2462	6.5	0.29	127	0.07	26	7.3	129	26	1422	98	5362	7.6	416	5.49	300.4	0.103	5.6	0.033	1.8	652	883
Jul-00	4.98	8126	0.70	92	17820	2.76E-02	19.14	4096	6.5	0.39	179	0.06	26	7.5	144	23	955	80	3323	5.6	233	0.81	33.6	0.008	0.3	0.044	1.8	413	1047
Aug-00	4.46	6660	0.70	93	23469	2.65E-02	18.41	5189	6.3	0.43	201	0.07	18	7.5	148	22	818	85	3162	10.5	391	1.2	44.6	0.009	0.3	0.050	1.9	277	491
Sep-00	4.65	4284	0.77	88	27835	1.26E-02	8.76	2928	7.7	0.41	166	0.09	19	7.4	129	20	776	75	2909	7.3	283	0.93	36.1	0.006	0.2	0.029	1.1	255	425
Oct-00	3.58	3877	0.78	88	21347	1.45E-02	10.09	2587	7.8	0.54	141	0.07	20	7.4	145	19	567	66	1971	6.5	194	0.65	19.4	0.005	0.1	0.036	1.1	174	189
Nov-00	4.05	4528	0.80	86	17499	1.63E-02	11.35	2385	6.3	0.47	153	0.07	15	7.2	164	73	2466	72	2432	7.7	260	0.66	22.3	0.006	0.2	0.035	1.2	240	285
Dec-00	4.04	4845	0.84	85	19577	9.57E-03	6.65	1562	6.9	0.48	242	0.11	31	7.2	167	29	977	113	3807	11.7	394	7.26	244.6	0.012	0.4	0.040	1.3	346	456
Average	4.69	6513	0.79	87	22050	1.33E-02	9.22	2374	6.1	0.42	177	0.07	39	7.3	148	31	1166	93	3649	10.2	394	2.4	94.3	0.019	0.9	0.050	2.0	349	597
Minimum	3.58	3877	0.70	82	17499	5.31E-04	0.37	103	4.2	0.29	82	0.04	15	7.2	129	19	567	66	1971	5.6	194	0.3	15.1	0.005	0.1	0.029	1.1	174	189
Maximum	6.56	9914	0.87	93	27835	2.76E-02	19.14	5189	7.8	0.54	265	0.11	104	7.5	177	73	2466	122	5362	18.8	712	7.3	300.4	0.103	5.6	0.097	3.7	652	1047
Jan-01	6.04	4030	0.84	81	21461	2.79E-03	1.94	500	5.8	0.32	180	0.14	43	7.7	192	20	1007	60	3022	6.7	338	1.41	71.0	0.007	0.4	0.021	1.1	256	468

Table 3-8
Secondary System
Operating History

Date	Al Flow (MGD)	Aer Basin TSS mg/l	Aeration Volatile Fraction	Aer Tk Temp °F	R Sludge TSS mg/l	Ave Sludge Wasted MGD	Sludge Wasted gpm	Ave Sludge Wasted lb/day	Basin DO (AE)	Detention Time days	Aer Inf BOD	F/M 1 day	Sludge Age Days	Clar pH (SU)	Clar Alk mg/l	Clar TSS mg/l	Clar TSS #/day	Clar COD mg/l	Clar COD #/day	Clar BOD mg/l	Clar BOD #/day	Clar NH_3-N mg/l	Clar NH_3-N #/day	Clar Tot. CN mg/l	Clar Tot CN #/day	Clar Phenol mg/l	Clar Phenol #/day	Final BOD #/day	Final TSS #/day
Feb-01	6.19	4325	0.82	80	23067	2.45E-02	16.99	4707	7.1	0.31	192	0.14	12	7.4	161	22	1136	59	3046	5.0	258	0.29	15.0	0.007	0.4	0.020	1.0	316	523
Mar-01	5.33	5341	0.82	83	24203	2.58E-02	17.92	5209	5.3	0.36	255	0.13	13	7.2	178	27	1200	64	2845	7.3	325	1.05	46.7	0.012	0.5	0.029	1.3	359	374
Apr-01	5.32	4430	0.80	85	18972	2.34E-02	16.24	3700	4.4	0.36	175	0.11	13	7.6	200	36	1597	114	5058	9.2	408	0.24	10.6	0.012	0.5	0.041	1.8	308	536
May-01	4.30	4227	0.81	90	11400	2.45E-02	17.03	2332	4.7	0.45	173	0.09	19	7.5	155	36	1291	106	3801	6.3	226	3.09	110.8	0.017	0.6	0.037	1.3	174	336
Jun-01	5.11	3697	0.87	92	9241	1.58E-02	10.96	1216	4.7	0.38	201	0.14	22	7.6	149	34	1449	82	3495	8.0	341	0.70	29.8	0.015	0.6	0.039	1.7	168	285
Jul-01	4.01	3872	0.86	96	6478	1.87E-03	1.301	101	4.9	0.48	212	0.11	32	8.0	150	55	1839	103	3445	7.4	247	0.88	29.4	0.015	0.5	0.025	0.8	130	325
Aug-01	5.07	3674	0.83	87	10658	7.65E-03	5.31	680	5.1	0.38	120	0.09	42	8.0	176	17	718.8	56	2368	5.8	245	0.29	12.3	0.008	0.3	0.014	0.6	282	355
Sep-01	3.73	2892	0.88	83	8879	7.44E-03	5.17	551	5.2	0.51	104	0.07	42	7.8	144	18	559.9	47	1462	6.7	208	0.80	24.9	0.021	0.7	0.016	0.5	194	232
Oct-01	4.67	2841	0.82	83	8423	2.29E-02	15.87	1605	7.1	0.36	152	0.15	20	7.8	116	16	623.2	31	1207	5.6	218	0.30	11.7	0.011	0.4	0.007	0.3	144	261
Nov-01	3.32	4722	0.74	84	15205	1.79E-02	12.42	2268	4.9	0.42	205	0.10	27	7.6	128	20	553.8	44	1218	6.4	177	0.80	22.2	0.009	0.2	0.030	0.8	120	222
Dec-01	3.54	4456	0.84	82	12755	2.60E-02	18.09	2771	4.6	0.39	144	0.08	22	7.6	161	18	531.4	59	1742	4.9	145	1.96	57.9	0.016	0.5	0.041	1.2	69	181
Average	4.72	4042	0.83	86	14229	1.67E-02	11.60	2137	5.3	0.39	176	0.11	26	7.6	159	27	1042	69	2726	6.6	261	0.98	36.9	0.013	0.5	0.027	1.0	210	342
Minimum	3.32	2841	0.74	80	6478	1.87E-03	1.30	101	4.4	0.31	104	0.07	12	7.2	116	16	531	31	1207	4.9	145	0.24	10.6	0.007	0.2	0.007	0.3	69	181
Maximum	6.19	5341	0.88	96	24203	2.60E-02	18.09	5209	7.1	0.51	255	0.15	43	8.0	200	55	1839	114	5058	9.2	408	3.09	110.8	0.021	0.7	0.041	1.8	359	536
Jan-02	3.44	3012	0.85	85	10908	1.12E-02	7.8	1022	4.9	0.40	138	0.11	29	7.6	154	22	631.2	53	1521	4.8	138	0.43	12.3	0.015	0.4	0.034	1.0	83	187
Feb-02	4.34	4290	0.83	84	10941	5.04E-03	3.5	460	4.9	0.40	153	0.09	48	7.5	183	27	977.3	109	3945	13.3	481	1.13	40.9	0.022	0.8	0.053	1.9	11.4	1317
Mar-02	5.01	5702	0.84	83	13195	1.67E-02	11.6	1838	5.4	0.35	183	0.09	33	7.45	106	22	919.2	70	2925	9.5	397	0.16	6.7	0.019	0.8	0.034	1.4	5.5	1132
Apr-02	5.29	4389	0.78	82	13906	1.08E-03	0.75	125	5.0	0.33	180	0.12	76	7.6	194	18	794.1	92	4059	6.0	265	1.27	56.0	0.010	0.4	0.022	1.0	5.1	540
May-02	4.96	6330	0.71	84	15574	1.68E-02	11.65	2179	3.0	0.35	128	0.06	34	7.6	153	19	786	65	2689	4.4	182	0.14	5.8	0.009	0.4	0.022	0.9	4.8	413
Jun-02	4.60	4773	0.76	89.5	14147	3.38E-02	23.44	3982	5.4	0.38	194	0.11	16	7.7	229	19	728.9	90	3453	5.8	223	4.25	163.0	0.021	0.8	0.045	1.7	183	961
Jul-02	4.80	5303	0.81	95.2	14888	2.16E-02	15	2682	3.9	0.36	179	0.09	26	7.4	140	15	600.5	75	3002	4.9	196	0.28	11.2	0.007	0.3	0.036	1.4	155	260
Aug-02	4.72	6577	0.79	94	14117	2.16E-02	15	2543	5.0	0.37	119	0.05	33	7.5	155	16	629.8	75	2952	3.1	122	0.15	5.9	0.009	0.4	0.028	1.1	108	468
Sep-02	4.16	6687	0.81	91	14838	1.06E-02	7.34	1308	3.7	0.42	213	0.08	31	7.5	207	63	2186	189	6557	15.1	524	1.44	50.0	0.018	0.6	0.024	0.8	184	365
Oct-02	3.92	6455	0.86	77	14705	1.32E-02	9.18	1621	4.4	0.45	246	0.09	41	7.4	253	28	915.4	129	4217	9.9	324	1.16	37.9	0.024	0.8	0.043	1.4	209	240
Nov-02	3.17	7626	0.78	73	24374	1.73E-02	11.98	3507	5.0	0.55	173	0.04	25	7.5	257	52	1375	133	3516	16.5	436	1.32	34.9	0.014	0.4	0.063	1.7	148	126
Dec-02	3.68	6489	0.73	81	26206	6.67E-03	4.63	1457	3.7	0.48	273	0.09	49	7.6	321	21	644.5	85	2609	13.0	399	17	521.8	0.031	1.0	0.092	2.8	119	44
Average	4.34	5636	0.80	85	15650	1.46E-02	10.16	1894	4.5	0.40	182	0.08	37	7.5	196	27	932	97	3454	8.9	307	2.39	78.9	0.017	0.6	0.041	1.4	101	504
Minimum	3.17	3012	0.71	73	10908	1.08E-03	0.75	125	3.0	0.33	119	0.04	16	7.4	106	15	600	53	1521	3.1	122	0.14	5.8	0.007	0.3	0.022	0.8	5	44
Maximum	5.29	7626	0.86	95	26206	3.38E-02	23.44	3982	5.4	0.55	273	0.124	76	7.7	321	63	2186	189	6557	16.5	524	17	521.8	0.031	1.0	0.092	2.8	209	1317
Jan-03	4.51	8026	0.80	82	21444	2.96E-02	20.53	5287	2.9	0.31	229	0.09	20	7.3	183	32	1204	108	4062	10.8	406	1.99	74.9	0.026	1.0	0.049	1.8	213	548
Feb-03	4.40	4587	0.87	83	10274	1.58E-02	10.96	1352	2.4	0.40	237	0.13	8	7.8	186	200	7339	462	16954	61.7	2264	1.36	49.9	0.024	0.9	0.067	2.5	348	792
Mar-03	5.03	4446	0.85	85	7482	3.61E-03	2.51	226	3.6	0.35	145	0.09	30	7.6	140	52	2181	133	5579	12.9	541	0.62	26.0	0.027	1.1	0.046	1.9	367	816
Apr-03	4.95	5147	0.82	85	11955	9.81E-03	6.81	978	2.9	0.35	166	0.09	25	7.6	131	56	2312	112	4624	14.3	590	0.74	30.5	0.012	0.5	0.052	2.1	269	525
May-03	5.79	5882	0.82	85	16577	1.24E-02	8.62	1716	1.0	0.30	172	0.10	26	7.75	177	39	1883	108	5215	11.6	560	5.15	248.7	0.009	0.4	0.035	1.7	316	657
Jun-03	4.62	4297	0.84	87	21025	6.08E-03	4.22	1066	4.9	0.38	186	0.11	32	7.5	115	28	1079	84	3237	6.0	231	2.72	104.8	0.021	0.8	0.033	1.3	209	477
Jul-03	5.64	3600	0.78	89	14868	2.16E-02	15	2678	4.7	0.31	108	0.10	18	7.5	98	10	470	57	2681	9.7	456	0.27	12.7	0.020	0.9	0.011	0.5	238	492
Aug-03	5.61	6191	0.62	91	20576	2.16E-02	15	3707	4.3	0.31	158	0.08	24	7.6	118	9	421	44	2059	3.7	173	0.18	8.4	0.009	0.4	0.013	0.6	227	242
Sep-03	4.16	6980	0.78	88.4	13846	2.37E-02	16.47	2739	3.7	0.42	180	0.06	21	7.5	149	78	2699	143	4961	8.2	286	0.32	11.1	0.012	0.4	0.036	1.2	231	199
Oct-03	4.18	6995	0.77	91	14023	2.81E-02	19.53	3289	3.5	0.42	183	0.06	19	7.5	144	79	2751	146	5078	7.6	264	0.34	11.9	0.015	0.5	0.037	1.3	208	363
Nov-03	4.19	6624	0.77	81.8	14116	7.56E-03	5.25	890	3.5	0.42	230	0.08	48	7.32	98	38	1314	97.2	3397	6.0	210	5.1	178.2	0.031	1.1	0.049	1.7	225	509
Dec-03	4.79	8889	0.77	82.2	9212	8.63E-03	5.99	663	2.6	0.37	239	0.07	28	7.5	169	111	4434	184	7351	22.7	907	16.24	648.8	0.010	0.4	0.146	5.8	259	487
Average	4.82	5972	0.79	86	14617	1.57E-02	10.91	2049	3.3	0.36	186	0.09	25	7.5	142	61	2341	140	5433	14.6	574	2.92	117.2	0.018	0.7	0.048	1.9	259	509
Minimum	4.16	3600	0.62	82	7482	3.61E-03	2.51	226	1.0	0.30	108	0.06	8	7.3	98	9	421	44	2059	3.7	173	0.18	8.4	0.009	0.4	0.011	0.5	208	199
Maximum	5.79	8889	0.87	91	21444	2.96E-02	20.53	5287	4.9	0.42	239	0.13	48	7.8	186	200	7339	462	16954	61.7	2264	16.24	648.8	0.031	1.1	0.146	5.8	367	816
Jan-04	4.51	6019	0.79	83.2	18502	4.41E-03	3.06	680	2.9	0.38803	154	0.07	41	7.6	149	45	1693	92	3460	8.11	305	4.93	185.4	0.02	0.6	0.056	2.1	165	523
Feb-04	5.86	5267	0.83	82.4	11211	1.02E-03	0.71	96	5.7	0.29863	154	0.10	43	7.5	129	38	1857	97	4741	7.6	371	0.14	6.842	0.01	0.5	0.023	1.1	221	530
Mar-04	5.72	5585	0.78	82.8	16681	1.04E-02	7.24	1450	5.1	0.30594	138	0.08	36	7.6	185	21	1002	63	3005	3.65	174	0.12	5.725	0.01	0.5	0.024	1.1	214	548
Apr-04	5.69	4390	0.82	85.6	11885	1.54E-02	10.7	1527	4.8	0.30756	215	0.16	28	7.6	166	21	996.5	68	3227	4.1	195	0.072	3.417	0.01	0.5	0.029	1.4	217	448
May-04	5.42	5629	0.82	84.7	16214	1.59E-02	11.01	2144	4.4	0.32288	167	0.09	28	7.6	153	25	1130	67	3029	3.88	175	0.134	6.057	0.017	0.8	0.034	1.5	219	467
Jun 04	5.99	4801	0.84	84	21148	3.24E-03	2.25	571	4.5	0.29215	128	0.09	59	7.7	148	15	739.4	49	2448	2.5	125	0.113	5.645	0.011	0.5	0.02	1.0	210	657
Jul-04	5.18	3559	0.79	90.7	14657	1.41E-02	9.8	1725	4.7	0.33784	132	0.11	22	7.6	140	19	820.8	54.4	2350	2.8	121	0.069	2.981	0.005	0.2	0.024	1.0	212	426
Aug-04	4.56	5764	0.71	88	14870	1.13E-02	7.86	1404	5.1	0.38377	101	0.05	41	7.6	120	22	836.7	53	2016	3.6	137	0.099	3.765	0.007	0.3	0.033	1.3	237	507
Sep-04	4.09	5837	0.72	88	14678	2.58E-02	17.92	3159	5.1	0.42787	144	0.06	23	7.6	114	28	955.1	64	2183	5.2	177	0.372	12.69	0.005	0.2	0.037	1.3	176	410
Oct-04	3.95	5683	0.78	83	16327	2.09E-02	14.51	2845	3.9	0.44304	164	0.07	13	7.5	158	126	4151	143	4711	8.1	267	8.62	284	0.014	0.5	0.09	3.0	144	362
Nov-04	4.44	5754	0.78	74	20892	1.60E-02	11.1	2785	5	0.39414	184	0.08	24	7.6	181	28	1037	108	3999	3	111	26	962.8	0.006	0.2	0.054	2.0	221	660
Dec-04	5.98	7807	0.72	80.8	20920	3.40E-02	23.6	5929	5.9	0.29264	143	0.06	17	7.6	144	25	1247	74	3691	4.7	234	6.84	341.1	0.0067	0.3	0.047	2.3	248	627

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Secondary System
Operating History

Date	Al Flow (MGD)	Aer Basin TSS mg/l	Aeration Volatile Fraction	Aer Tk Temp °F	R Sludge TSS mg/l	Ave Sludge Wasted MGD	Sludge Wasted gpm	Ave Sludge Wasted lb/day	Basin DO (AE)	Detention Time days	Aer Inf BOD	F/M 1 day	Sludge Age Days	Clar pH (SU)	Clar Alk mg/l	Clar TSS mg/l	Clar TSS #/day	Clar COD mg/l	Clar COD #/day	Clar BOD mg/l	Clar BOD #/day	Clar NH_3-N mg/l	Clar NH_3-N #/day	Clar Tot. CN mg/l	Clar Tot CN #/day	Clar Phenol mg/l	Clar Phenol #/day	Final BOD #/day	Final TSS #/day
Average	5 116	5508	0 78	84	16499	0 0143712	9 98	2026	4 8	0.35	152	0 084	31	7.59	149	34	1372	77 7	3238	4 77	199	3 959	151 7	0 01	0 42	0 039	1 596	207	514
Minimum	3 95	3559	0 71	74	11211	0.0010224	0 71	96	2 9	0 29	101	0 046	13	7 5	114	15	739 4	49	2016	2 5	111	0 069	2 981	0 01	0 17	0 02	0 999	144	362
Maximum	5 99	7807	0 84	91	21148	0 033984	23 6	5929	5 9	0 44	215	0 159	59	7 7	185	126	4151	143	4741	8.11	371	26	962 8	0 02	0 77	0 09	2 965	248	660
Jan-05	6 4	6446	0 63	80 3	22088	3 40E-02	23 6	6260	4 5	0 27	152	0 086	14	7 2	117	22	1153	69	3683	4.5	240	2 53	135	0 007	0 4	0 043	2 3	225	391
Feb-05	5.83	3170	0 79	77 2	19996	4.54E-03	3 15	756	3 5	0 30	188	0 198	29	7 3	87	21	1021	69	3355	6 6	321	0 361	18	0 007	0 3	0 034	1 7	245	391
Mar-05	5 47	4715	0 78	78 2	15129	1 56E-02	10 8	1962	4 7	0 32	171	0 113	22	7 5	101	32	1460	75	3421	7 34	335	0 358	16	0 007	0 3	0 031	1 4	214	341
Apr-05	6.31	5704	0 79	82 1	15352	1 64E-02	11 4	2102	5 0	0.28	148	0.094	19	7 6	114	50	2631	105	5526	5 35	282	0 211	11	0 0032	0 2	0 047	2 5	179	357
May-05	4 26	6620	0 76	88 4	17692	1 11E-02	7 68	1632	4 1	0.41	199	0 073	53	7 7	124	11	373	64	2274	3.28	117	0 242	9	0 0045	0.2	0 031	1 1	186	516
Jun-05	4 9	6518	0 76	92 9	16301	3 93E-03	2.73	534	3 6	0.36	182	0 078	28	7.7	118	77	3147	116	4740	3 5	143	0 27	11	0.016	0 7	0.04	1 6	164	472
Jul-05	5 5	9652	0 71	92 3	20796	2 48E-02	17.2	4296	3 4	0.32	185	0.06	31	7 7	163	14	651 4	81	3715	2 6	119	6.48	297	0.0045	0 2	0.03	1 4	157	243
Aug-05	4.67	7284	0.78	92 9	19952	1 77E-02	12 29	2945	3 9	0.37	187	0 069	31	7 5	106	22	856 9	92	3583	3.53	137	3 98	155	0 0039	0 2	0 051	2 0	117	288
Sep-05	4 15	7370	0.78	88 2	23445	1 77E-02	12 29	3460	4 3	0.42	188	0.06	28	7 5	113	21	726.8	157	5434	3.53	122	5.52	191	0 0068	0.2	0.062	2.1	124	310 0
Oct-05	4 01	7101	0 77	82 8	22032	1.27E-02	8 81	2331	5 9	0.44	158	0 051	10	7.7	167	257	8595	313	10468	7	234	10 4	348	0.067	2 2	1 75	58 5	143	317.0
Nov-05	2 67	7400	0 59	84 7	31055	2 36E-02	16.4	6117	6 1	0 66	164	0.034	17	7 8	174	30	668	98	2182	3	66 8	10.39	231	0 007	0 2	0 046	1 0	106	230 0
Dec-05	5 24	6548	0 73	83	20351	1 70E-02	11 8	2884	3.67	0.33397	173	0 079	26	7 4	94	25	1093	109	4763	4.53	198	2 75	120	0 009	0 4	0 072	3 1	110	319 0
Average	4.95	6544	0.74	85 3	20349	1 66E-02	11 5	2940	4 4	0.37	175	0 083	26	7 6	123	48	1865	112	4429	4 56	193	3 624	128.5	0.0119	0 4499	0 186	6 566	164	348
Minimum	2.67	3170	0.59	77.2	15129	3 93E-03	2 7	534	3 4	0.27	148	0.034	10	7 2	87	11	373	64	2182	2.6	66.8	0 211	8.598	0 0032	0 1519	0 03	1.024	106	230
Maximum	6.40	9652	0 79	92 9	31055	3 40E-02	23 6	6260	6.1	0.66	199	0.198	53	7 8	174	257	8595	313	10468	7.34	335	10.4	347.8	0.067	2 2407	1 75	58 53	245	516
Jan-06	5 67	6512	0 79	84 6	18272	1.77E-02	12 3	2,699.1	5 2	0.31	179	0.089	27	7.4	108	26	1229	98	4634	4 6	218	5 3	250 6	0.025	1 1822	0.05	2 364	162	329
Feb-06	5 45	6760	0.75	83 8	22045	3 01E-02	20 9	5,533 3	4 9	0 32	169	0 078	14	7 7	151	45	2045	116	5273	4 3	195	9.7	440.9	0.041	1 8636	0 088	4 0	220	378
Mar-06	5 68	6364	0 71	80 3	22652	1.63E-02	11 3	3,074.1	4 7	0.31	121	0.062	19	7 6	133	49	2321	205	9711	4	189	12.28	581.7	0.006	0.2842	0.1	4.7	131	310
Apr-05	5 63	5963	0.79	85 9	20813	1.92E-02	13 3	3,324 4	4 5	0 31	126	0.068	21	7 5	125	25	1174	90	4226	4.4	207	6 24	293	0.004	0 1878	0.054	2 5	141	400
May-06	4 94	5719	0 80	86 9	19387	2.48E-02	17 2	4,004.7	4	0 35	212	0 105	19	7.4	136	20	824	92	3790	11 4	470	7.5	309	0.003	0.1236	0 053	2 2	147	423
Jun-06	4.91	7597	0 70	89 8	25322	3 21E-02	22 3	6,781 6	4 6	0 36	173	0 064	17	7 5	123	11	450 4	79	3235	4 4	180	0 31	12.69	0 003	0 1228	0 03	1.2	194	357
Jul-06	4 73	8282	0.77	94 1	24102	5.16E-02	35 8	10,362 5	3.3	0.37	188	0 061	12	7.7	163	14	552 3	81	3195	2.6	103	6 49	256	0 005	0.1972	0 03	1.2	141	219
Aug-06	5 38	9373	0 76	92.7	21490	2.84E-02	19 7	5,084.3	4 5	0 33	165	0 054	25	7 48	106	22	964.7	93	4173	3 5	157	3 98	178.6	0.004	0 1795	0.051	2 3	122	245
Sep-06	6 11	7650	0 78	83.7	17907	5 34E-02	37 1	7,978 6	3 9	0 29	166	0 076	14	7 5	118	19	968 2	78	3975	4.7	239	0.46	23.44	0 004	0 2038	0 038	1 9	161	356
Oct-06	5 22	6117	0.76	81 4	22660	3.79E-02	26 3	7,157 2	3 7	0 34	136	0 066	12	7 7	173	16	687 8	74 5	3243	8 5	370	0 405	17.63	0.002	0.0871	0 023	1.0	217	309
Nov-06	4 48	6232	0 68	81 1	30574	2.74E-02	19 05	6,994 8	4	0 39	232	0.095	13	7 8	226	12	429 7	76.5	2858	8 1	303	0.337	12.59	0.0089	0 3325	0.02	0 8	197	109
Dec-07	6 7	5728	0.70	78 2	21826	7.78E-03	5 4	1,415.5	4 8	0.26	182	0.122	41	7 9	149	15	842 1	49 2	2749	3.19	178	0 181	10.11	0 01	0 5588	0 022	1.2	114	259
Average	5 41	6858	0 75	85.2	22254	2 89E-02	20.1	5368	4 3	0 33	171	0.078	19	7 6	143	23	1041	94.4	4255	5 31	234	4 432	198 9	0.0097	0 4436	0 047	2 12	162	308
Minimum	4.48	5719	0 68	78 2	17907	7 78E-03	5 4	1415	3.3	0.26	121	0 054	12	7 4	106	11	429.7	49 2	2749	2 6	103	0.181	10.11	0 002	0 0871	0.02	0 751	114	109
Maximum	6 70	9373	0.80	94.1	30574	5.34E-02	37.1	10363	5 2	0.39	232	0.122	41	7 9	226	49	2321	205	9711	11.4	470	12.28	581.7	0 041	1.8636	0.1	4.737	220	423
Jan-07	5.7	6972	0.7	81 2	18653	0 021888	15.2	3405.029	3 5	0 30702	256	0 12	23	7 6	212	31	1450	77	3660	7 04	335	0 65	30 9	0 007	0 3328	0 051	2 424	172	319
Feb-07	5 1	6885	0.74	83 6	18451	0 027792	19 3	4276 6702	5 5	0.34314	186	0 079	17	7 6	144	56	2382	140	5955	6 37	271	0 6	25 52	0 066	2 8072	0 028	1 191	126	478
Mar-07	6 52	6569	0 79	84 2	17289	0 020736	14 4	2989.9292	3 7	0.2684	82	0.047	13	7 6	153	92	5003	229	12452	9 4	511	1 41	76 67	0 007	0 3806	0 21	11.42	169	468

As a first step in evaluating the performance of the treatment plant, the secondary treatment plant data was compared to the discharge criteria. Table 3-9 summarizes the calculated BPT and BAT limits, the IEPA general effluent standards (contained in Section 304 of the Illinois regulations) and the current NPDES limits for the refinery. These calculated BPT/BAT limits were used in the recent July 2006 renewal of the NPDES permit.

A comparison of the regulatory limits (Table 3-10) with the treatment plant performance and final effluent quality indicates that the treatment system has consistently achieved an effluent quality which is significantly better than the applicable limits. The system has performed excellently in terms of effluent quality and pollutant removal. The final effluent has consistently complied with the mass based final effluent ammonia limitations contained in the NPDES permit and is achieving significantly better performance than that required by the BAT/BPT guidelines.

3.4 REVIEW OF LONG TERM AMMONIA REMOVAL PERFORMANCE

The Refinery has continued to maintain an excellent long term ammonia nitrogen removal program. This has been achieved in spite of an increasingly more difficult environment for operating a petroleum refinery.

Changes in environmental regulations have required CITGO to undergo a major expenditure to add a FCCU wet gas scrubber/selective catalytic reduction unit which has resulted in an additional ammonia source. The refinery has added a new physical-chemical wastewater treatment system to process this waste stream.

The demand for refined material has resulted in production near design capacities and use of heavier crudes. These factors have resulted in increased loadings to the wastewater treatment plant. The data shows that the refinery has made exceptional strides under difficult circumstances. The annual average ammonia discharge to the Canal over the last 5 years has averaged 102.4 pounds per day, with a net ammonia discharge of 76.2 pounds per day.

TABLE 3-9

BPT & BAT LIMITATIONS AND IEPA/NPDES LIMITATIONS

	BPT/BAT Limits[1]		Illinois Regs[2]		NPDES Permit Limits			
Parameter	**Monthly Avg. lb/day**	**Daily Max lb/day**	**Monthly Avg. lb/day**	**Daily Max lb/day**	**Monthly Avg. lb/day**	**Daily Max lb/day**	**Monthly Avg. mg/l**	**Daily Max mg/l**
BPT (40CFR419.22)								
BOD	1,843.8	3,318.9	1,189	4,996	1,008.8	2,472.32		
CBOD							20	40
TSS	1,475.1	2,313.2	1,489	6,247	1,475.10	2,313.23	25	50
O&G	536.4	1,005.7	891.7	3,747	536.40	1,005.75	15	20
BAT (40CFR4192.23)								
COD	12,873.4	24,808.2			12,873.6	24,808.50		
NH3-N	1,005.7	2,212.6	559.8	3,247	1,005.75	2,212.65	9.4	26.0
Sulfide	9.72	21.79			9.72	21.79		
BAT Settlement Agreement (40CFR419.23)								
Phenol	12.07	24.81	17.8	74.9	10.28	42.37	0.3	0.4
Chromium, Tot.	29.5	50.29	59.5	249.8	11.99	34.51	--	1.0
Chromium, Hex.	1.88	4.02	5.94	37.47	.99	2.2	0.1	0.3
Fluoride			2,288.7	3,747	756.6	2,161.7	15	28.6
Cyanide			5.94	25	5.04	14.41	0.1	0.2

(1) Calculated based on July 2006 renewal of NPDES permit.

(2) Calculated from concentration based effluent standards and an average flow of 7.13 MGD and a daily maximum flow of 14.98 MGD.

TABLE 3-10

SUMMARY OF MONTHLY AVERAGE EFFLUENT BOD, TSS AND AMMONIA

JANUARY 2006 – OCTOBER 2007

Month	Effluent BOD (lb/day)	Effluent TSS (lb/day)	Effluent Ammonia (lbs/day
January 2006	162	329	250
February	220	378	403
March	131	310	287
April	141	400	284
May	147	423	241
June	194	357	26
July	141	219	75
August	122	245	15
September	161	356	26
October	217	309	16
November	197	109	18
December	114	259	21
January 2007	172	319	61
February	126	478	68
March	169	468	76
April	429	723	148
May	466	645	95
June	359	335	138
July	558	578	140
August	463	620	202
September	200	466	57
October	212	384	43
NPDES Permit (lbs/day) Monthly Average	1008.8	1475.1	1005.75

Approximately, 25 percent of the ammonia nitrogen discharge is due to background conditions in the Canal.

The refinery has continued to maintain an excellent long term ammonia nitrogen removal program. This has been achieved in spite of an increasingly more difficult environment for operating a petroleum refinery.

The Lemont refinery has processed heavier crudes over the last 3 to 4 years. The use of heavier crudes has resulted in higher solids and COD loading to the wastewater treatment plant. This has made it exceedingly more difficult to maintain biological nitrification and nitrogen removal. Since the year 2002, the chemical cost for pretreatment (TSS and oil and grease removal) has risen by 500% and has become a significant expenditure of the treatment plant operating budget. Also, because of the changes in the crude quality, a daily regiment to optimize chemical addition to maintain the optimum performance of the treatment plant is required.

The higher solids loadings to the biological treatment plants have compounded and complicated the maintenance of an adequate sludge age for biological nitrification. In spite of considerable difficulties, the refinery treatment program has maintained consistent compliance with effluent criteria and has maintained a very high quality effluent. A review of the data shows that changes in crude quality have resulted in an increase in the effluent nitrogen discharge. A summary of these data is presented in Figure 3-3. In spite of these difficulties, the refinery wastewater treatment plant operating program has maintained compliance with the effluent criteria and has consistently produced a BAT quality effluent.

The refinery has expanded its optimization program to handle problems related to changes in production. This has included projects to optimize the induced gas floatation system, to further improve solids removal, and to conduct pilot studies to evaluate alternatives for additional solids removal.

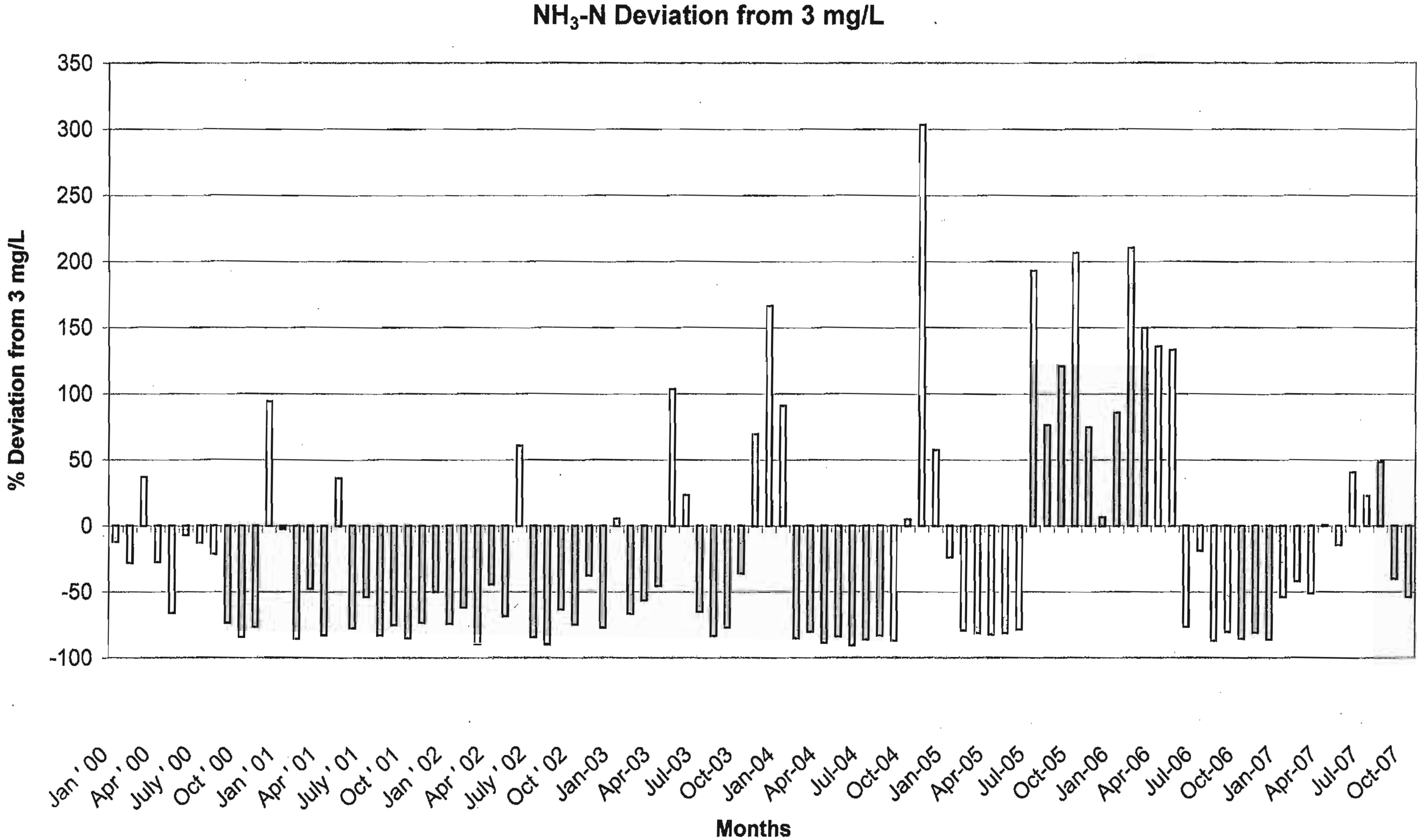


Figure 3-3
Variability of Effluent Ammonia Nitrogen as compared to Proposed 3 mg/L Limitation

In addition, the refinery is a sponsor of a research effort being conducted by the Petroleum Environmental Research Forum. Lemont in combination with BP, Conoco Phillips, Marathon Ashland, ExxonMobil, Shell Global, Repsol and Total are conducting research studies to access the performance of solid removal systems when processing heavy crude oils. This technology evaluation is designed to analyze treatment options which could be used to pretreat or handle crude solids. Revealing a viable solid removal technology would benefit the ammonia removal optimization program as it would reduce the COD, oil and grease and TSS loads which have increased with processing heavier crudes.

In light of the problem created because of changes in crude supply and processing heavier crudes, the wastewater treatment program has been diligent and has continued to provide excellent wastewater treatment plant operations. However, consistently meeting the 3.0 mg/l ammonia nitrogen standard has not been achieved. This inconsistency is attributed in large part to the inherent variability in refinery wastes. To determine other potential causes of the higher effluent ammonia concentrations, the factors which affect ammonia removal were reviewed and are discussed in the following section.

3.5 PARAMETERS WHICH CONTROL NITRIFICATION

In order to review the ability of the wastewater treatment system to provide biological nitrification it is necessary to evaluate the plant operation with regard to those parameters which control biological nitrification. The primary factors which affect nitrification in a biological treatment system include F/M (food-to-microorganism ratio), sludge age, aeration basin pH, aeration basin temperature, availability of alkalinity, and the aeration basin dissolved oxygen (D.O.) concentration. The facility operating data for these parameters are included in Table 3-8. The operating ranges for these parameters which have generally been found to provide optimum nitrification performance in activated sludge systems are summarized in Table 3-11. This table includes a comparison with the operation of Lemont Refinery treatment system. This shows that the facility has operated the system under the conditions which are conducive to biological nitrification. The specific parameters are discussed below.

TABLE 3-11

TYPICAL OPERATING RANGES FOR NITRIFICATION

Parameter	Optimum Range	Lemont Refinery Operation[(2)]
F/M, lb BOD_5/lb MLVSS-day	Less than 0.3	0.034 – 0.159
Sludge Age, days	$\geq$ 10	10 - >100
D.O., mg/l	2.0[(1)]	2.1 – 7.8[(3)]
pH	7.2 – 9.0	7.1 – 8.0
Temperature, ºF	68 – 100	73 – 98

NOTES:

(1) Average D.O. should be $\geq$ 2.0 mg/l.
Minimum D.O. should be $\geq$ 1.5 mg/l.

(2) Based on monthly average data.

(3) In May 2003, the D.O. averaged 1 mg/l; however, the effluent ammonia averaged 5.15 mg/l. This is thought to have been a probe problem with actual D.O. levels being higher.

The F/M level, expressed as lb of BOD applied per day per lb mixed liquor volatile suspended solids (MLVSS), is an important indicator of conditions suitable for nitrification to occur. The lower F/M ratios normally provide an improved environment for nitrification to occur. The F/M has been maintained at less than 0.16 lb BOD_5/lb MLVSS-day over the last ten years. The BOD loading over the last ten years has been lower than in previous years and provides an improved condition to achieve biological nitrification.

These F/M ratios should provide an excellent opportunity for the system to achieve nitrification. However, there still is periodic variability of the effluent ammonia concentrations. This data indicates that F/M ratios do not appear to be a factor limiting nitrification.

Sludge age represents the average length of time the biomass remains in the treatment system. The greater the sludge age the better the chance for nitrifying organisms to grow and for biological nitrification to occur. Sludge ages of 10 days or more are generally adequate for nitrification. During this period of operation, the increase in influent TSS levels due to heavier crudes has made the control of sludge age difficult. However, the sludge age has consistently been maintained at greater than 10 days and has typically been maintained at 20 to 100 days. This is an indication of good wastewater treatment plant operation. The data indicates the occurrence of elevated effluent ammonia concentrations, even at long sludge ages. Therefore, sludge age does not appear to be a factor which limits nitrification.

The desired minimum dissolved oxygen concentration for biological nitrification is an average D.O. of 2 mg/l with a minimum D.O. of 1.5 mg/l. Nitrifying bacteria are extremely sensitive to D.O. concentrations. Adequate aeration is extremely important to ensure that D.O. levels are adequate at all times throughout the aeration basins. The average aeration basin dissolved oxygen concentration has been excellent over the 1997 through 2007 time period. The D.O. has averaged in excess of 4.5 mg/l over the last three (3) years. The aeration system includes ceramic fine bubble diffusers which are distributed uniformly over the entire aeration basin floor. The aeration system provides consistently adequately D.O. levels throughout the basins and provides a very uniform mixing pattern. Based on this, D.O. does not appear to be a factor limiting nitrification.

Optimal nitrification performance occurs in the pH range between 7.2 and 9.0 and in the temperature range between 68 and 100ºF. Aeration basin pH and temperature have remained within acceptable ranges throughout the period under review. The refinery has provisions to add steam to maintain the aeration basin temperature above 70ºF. This is a very desirable feature for maintaining optimum treatment and nitrification performance. The lowest monthly average temperature over the period evaluated was 73ºF in November 2002 and over the last two (2) winters the average aeration basin temperatures has been 80ºF or above. This data indicates that the pH and temperature have been maintained well within the optimum range for nitrification.

The nitrification reaction consumes 7.1 mg/l of alkalinity (as calcium carbonate) per 1 mg/l of ammonia nitrogen removed. Inadequate alkalinity can result in sharp decreases in pH which can upset the treatment system. The system has had adequate alkalinity available based upon residual alkalinities and pH in the effluent. Alkalinity has consistently been available in the influent, and supplementary alkalinity is added when needed to maintain an effluent residual. Therefore, alkalinity is not a factor limiting nitrification.

In summary, the Lemont Refinery wastewater treatment system has consistently operated at F/M, sludge age, DO, alkalinity, pH and temperature levels normally found to be satisfactory for single-stage biological nitrification.

3.6 SUMMARY

An analysis of the Lemont Refinery wastewater collection and treatment system was conducted to determine if the system continues to be a BAT facility. The results of this analysis indicate that the refinery has a state-of-the art wastewater treatment system which exceeds BAT criteria and allows compliance with all U.S. EPA refinery discharge regulations and with the current NPDES permit for the facility. The wastewater treatment system has been operated under conditions which are optimum to achieve biological nitrification. However, the system has been unable to consistently achieve biological nitrification. The data has demonstrated that the wastewater treatment system is not able to consistently provide biological nitrification to meet the 3.0 mg/l ammonia nitrogen standard as required in the Illinois regulations.

Lemont Refinery has an ongoing program to optimize the wastewater treatment system and to address problems caused by use of heavier crudes. This appears to be the proper direction for improving wastewater treatment plant performance.

SECTION 4.0
ANALYSIS OF ALTERNATIVES

An alternative procedure for Lemont Refinery to assure sufficient ammonia removal is the utilization of additional treatment technologies. The additional treatment technologies would have to comply with an effluent ammonia nitrogen level of 3 mg/l or less on a consistent basis. AEI conducted an analysis of these treatment technologies for application at the refinery based on technical and economic feasibility. AEI also reviewed the treatment technologies employed at the other Illinois refineries to determine if they were employing treatment approaches which differed from the Lemont system.

4.1 SELECTED TECHNOLOGIES FOR EVALUATION

There are a number of technologies which have been reported to be applicable for providing ammonia removal. A large number of technologies were considered and the following technologies and variations were deemed appropriate for evaluation at Lemont Refinery:

1. Biological Treatment Technologies/Adaptations
    a. Single-stage activated sludge.
    b. Single-stage activated sludge with the supplement of specialized bacteria.
    c. Single-stage activated sludge with a powdered activated carbon supplement.
    d. Single-stage activated sludge membrane bioreactor.
    e. Two-stage activated sludge.
    f. Two-stage biological treatment using activated sludge for the first stage and a fixed media system for the second stage.

2. Land Treatment

3. Wetlands Polishing

4. Physical – Chemical Technologies
    a. Ion exchange.
    b. Air stripping.

c. Steam stripping.

d. Breakpoint chlorination.

Based on a review of available literature, previous studies on Lemont Refinery wastewater, and our personal experience with similar wastewaters, this list of technologies was reduced to the four with the greatest potential for achieving the Illinois 3.0 mg/l ammonia nitrogen standard on a consistent basis. The four technologies selected for consideration at Lemont Refinery are:

1. Activated sludge with powdered activated carbon addition (PACT);
2. Activated sludge with a fixed media system;
3. Activated sludge with membrane bioreactor; and
4. Activated sludge with breakpoint chlorination and dechlorination.

Process designs were developed for each of the four selected ammonia nitrogen removal technologies. The process designs presented in this chapter were developed to treat the design waste loadings presented in Table 3-4. The advantages and disadvantages for each alternative are summarized in Table 4-1.

This section will focus primarily on a presentation of the actual design parameters, the required modifications to the treatment system to implement these technologies, and a comparative cost estimate for each design alternative. The assumption in this discussion is that the selected alternatives will work and be reliable. However, it is not certain that the refinery can consistently comply with the 3.0 mg/l ammonia nitrogen standard even with implementation of one of these technologies.

The alternatives presented in this report utilize end-of-pipe processes. Each design has been developed as a complement to the existing WWTP. Each addition to the existing WWTP is designed to improve the existing WWTP's nitrification capabilities, and add reliability and dependability to the system.

TABLE 4-1

SUMMARY OF POTENTIAL TECHNOLOGIES

Method	Advantages	Disadvantages
Powdered Activated Carbon System	Removes toxic compounds; Enhances nitrification; Aids solids settling; Removes color.	Increased quantity of sludge produced; High operating cost; Abrasion to mechanical equipment; May require expensive sludge disposal and carbon regeneration facilities; No proven process reliability for this type of application.
Fixed Media System	Media provides a good growth mechanism for nitrifying organisms; Easier and less costly to operate than PAC or membrane bioreactor; Low heat loss.	Chemical incompatibility with the refinery wastewater may limit media life; No proven process reliability for this type of application; Based on a biological process.
Membrane Bioreactor	Allows operation at longer sludge ages; Potential for water reuse.	Relatively new technology application; Fouling of membrane; Potentially short membrane life; Increased extracellular polymeric substance generation; No long term experience of this application (fouling and foam).
Breakpoint Chlorination and Dechlorination	Low capital cost; Easy process control.	High operating cost; Potential for formation of toxic chlorinated hydrocarbons; Handling large quantities of chlorine; Requires dechlorination; State of Illinois (IEPA) is against use of chlorination for organic wastewaters; creates by-products in the treated water which have greater water quality concern than the ammonia being treated.

4.2 ACTIVATED SLUDGE WITH POWDERED ACTIVATED CARBON ADDITION

The activated sludge process with the addition of powdered activated carbon provides an enhancement of the treatment system by providing removal of biologically resistant organics. The mechanism for powdered activated carbon to enhance biological nitrification appears to be through removal of inhibitory compounds rather than enhanced nitrifier growth on the surface of suspended solids. In this process, powdered activated carbon is added to the aeration basin mixed liquor. The system includes a wet air oxidation process which allows for recovery of the powdered activated carbon (PAC).

Design information for the single-stage activated sludge system incorporating powdered activated carbon addition is shown in Table 4-2. A simplified process flow diagram is presented in Figure 4-1, utilizing the existing WWTP. The system will require the construction of a third secondary clarifier to handle both the additional solids loading from the powdered carbon and the slower settling nitrifying bacteria, and addition of a wet air regeneration system.

An average F/M ratio of 0.1 lb BOD_5 applied/lb MLVSS-day is assumed for this design, with an average MLVSS concentration of 6,750 mg/l. The design sludge age is 12 days based on the average flow rate of 6.64 MGD. PAC will be added at a rate of 100 mg/l. These conditions should enable the system to nitrify, and the PAC could provide adsorption of any inhibitory substances to the biological nitrification process which may be present.

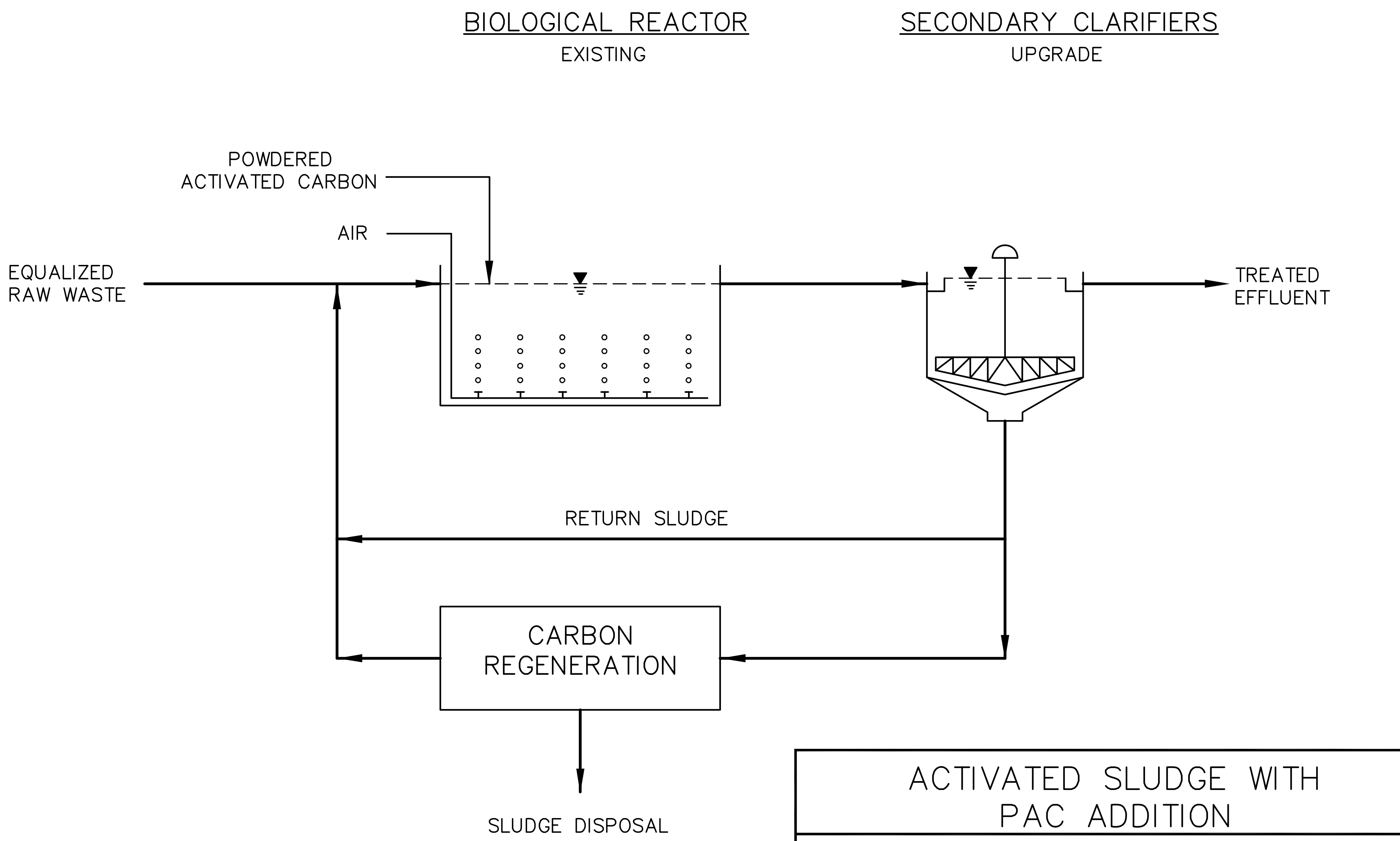
The carbon will be mixed in slurry form and pumped into the WWTP. The PAC would be regenerated on-site in a wet air regeneration system. This will provide a ninety (90) percent PAC recovery. The remaining portions of the system would remain intact, with the addition of a third secondary clarifier and a gravity thickener for thickening spent PAC prior to wet air regeneration. Some upgrading of the existing system may be necessary to handle the increased abrasion due to the presence of the PAC, but no costs are included in our estimate for this upgrade.

The cost estimate for this option includes facilities for carbon regeneration and sludge disposal. It is assumed that continuation of the present sludge disposal practices will not be possible

TABLE 4-2

PROCESS DESIGN SUMMARY FOR ACTIVATED SLUDGE WITH PAC

Parameter		Units	Design Value
BOD Load		lb/day	10,050
NH3 Load		lb/day	1,065
Flow		MGD	6.64
Aeration Basin			
Average F/M (BOD)		lb/lb-day	0.1
Average MLSS		mg/l	6,750
Total Hydraulic Retention Time		days	0.29
Total Required Volume		MG	1.92
Number of Aeration Basins			3
Average Waste Sludge		lb/day	9,000
Oxygen Requirements		lb/day	16,400
Carbon Addition		mg/l	100
		lb/day	5,540
Secondary Clarifier			
Overflow Rate		gpd/sq ft	300
Total Clarification Area		sq ft	22,100
Number of Clarifiers			3
Selected Clarifier Diameter	(existing)	ft	2@ 100
	(new)	ft	1 @ 100
Average Underflow Concentration		mg/l	10,000
Average Recycle Flow		MGD	3.32
Average Recycle Rate		%	50



ACTIVATED SLUDGE WITH PAC ADDITION		
LEMONT REFINERY LEMONT, ILLINOIS		
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PROJECT NUMBER N356-06	AWARE ENVIRONMENTAL INC	DRAWING NO. FIGURE 4-1

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because of the presence of the PAC in the waste sludge. Construction of the new facilities will cost approximately $14,800,000, with an annual operating cost of $1,424,000. The annualized cost for this alternative is $3,630,000 per year, assuming a capital recovery factor for 10 years at 8 percent interest.

Although it is anticipated that powdered activated carbon process can improve biological nitrification, there is no assurance that it will provide compliance with the 3 mg/l ammonia nitrogen criteria. The powdered activated carbon may not be able to adsorb the compounds which limit nitrification at Lemont Refinery, and there is the possibility that compounds adsorbed onto the activated carbon can deadsorb, under certain conditions. This could increase inhibition of the nitrifying organisms.

Additional concerns include increased sludge production and higher operating costs. The addition of the carbon can be abrasive to the mechanical components of the treatment plant. Overall, there is no proven process reliability that the technology will achieve continuous compliance with the 3.0 mg/l ammonia nitrogen effluent criteria.

4.3 ACTIVATED SLUDGE WITH A FIXED MEDIA SYSTEM

The operation of an activated sludge system with a fixed media system can provide a mechanism for improving biological nitrification. In this process the activated sludge system provides a suspended growth biological system for removal of the organic components in the wastewater. This is then followed by a fixed media rotating biological contactor (RBC). The RBC consists of large diameter closely spaced circular discs, with corrugated plastic media mounted on a horizontal shaft placed in a concrete tank. The discs are submerged in the wastewater and slowly rotate through the wastewater. The surface of the discs provide an ideal mechanism for nitrifying organisms to grow. Since the activated sludge process provides organic removal, this limits competition on the disc surface between the organisms which remove carbon and the nitrifying organisms.

The design parameters and process flow diagram for the fixed media attached-growth rector system are presented in Table 4-3 and Figure 4-2, respectively. This would be operated as an aerobic process. A tertiary clarifier would be required following the reactors, since there will be some sludge sloughing and additional solids discharging into the RBC system.

The current activated sludge system with the addition of a third secondary clarifier would provide the first stage of the process. The RBCs utilized for the nitrification stage contain a total of 6.64 million sq ft of media area. This would be split into three or four stages to achieve low effluent ammonia nitrogen concentrations. Twelve foot diameter, high-density media is specified to minimize the total number of shafts and cost. The use of this media is possible due to the low organic removals which will take place in this treatment step. The hydraulic loading rate used for this design is 1.0 gpd/sq ft. This corresponds to 6235 sq ft/lb of influent ammonia nitrogen. The design overflow rate of the third clarifier is 600 gpd/ft^2.

The total capital cost of installing an RBC system following the existing treatment plant is estimated to be approximately $13,500,000. Operation and maintenance costs were estimated to be approximately $1,220,000 per annum. The total annual cost is $3,220,000/year.

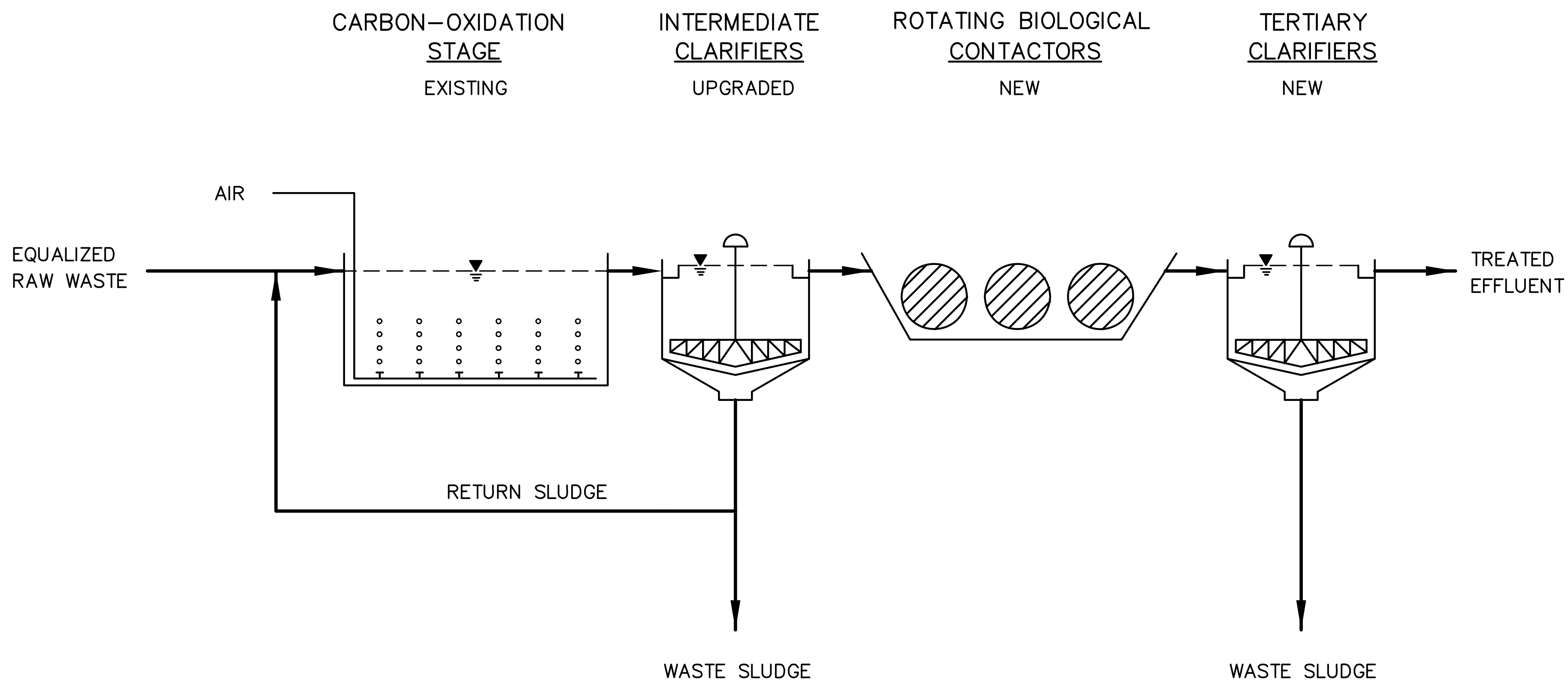
There are potential problems associated with a fixed film nitrification process. The nitrifiers are sensitive to a number of compounds and this can inhibit biological nitrification. There is a potential of chemical incompatibility with the refinery wastewater. This can result in premature failure of the RBC media. RBC units have been plagued with shaft failure problems caused by structural design problems, metal fatigue and excessive biomass accumulation. Because of these problems there is no assurance that this technology can consistently comply with the 3.0 mg/l ammonia nitrogen criteria.

4.4 ACTIVATED SLUDGE WITH MEMBRANE BIOREACTOR

A membrane bioreactor (MBR) is a system which couples the activated sludge process with membrane separation of the treated effluent from the mixed liquor. This separator eliminates the

TABLE 4-3
PROCESS DESIGN SUMMARY FOR ACTIVATED SLUDGE WITH A FIXED MEDIA SYSTEM

Parameter	Units	Design Values
Fixed Media System		
Type		Rotating biological contractor (RBC)
Diameter	ft	12
Hydraulic Loading Rate	gpd/sq ft	1
Area Requirement	sq ft/lb NH_3-N	6235
Total Media Surface Area	10^6 sq ft	6.64
Media Type		High Density
No. of Stages		3-4
Additional Secondary Clarifier		
Type		Circular
Number		1
Diameter	ft	100
Side Water Depth	ft	16
Tertiary Clarifier		
Type		Circular
Number		1
Diameter	ft	120
Side Water Depth	ft	16



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ACTIVATED SLUDGE WITH A FIXED MEDIA SYSTEM

LEMONT REFINERY
LEMONT, ILLINOIS

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need of a separate secondary clarifier since the membrane section can be added directly to the aeration basins. The advantage of the MBR process is mainly due to the fact that high MLVSS levels and sludge ages can be maintained in the aeration basin. This is a relatively new technology and there is limited experience in applying this technology to the petroleum refining industry for nitrogen removal.

There are several advantages associated with the MBR which makes this an alternative for consideration. The MBR process allows retention of suspended matter and most soluble compounds within the bioreactor thus leading to a good quality effluent and provides very good control with regard to sludge age since the system can be operated with a higher biomass concentration.

The design of the system is based on a minimum sludge age of 20 days with a minimum MLSS of 5,800 mg/l. In this alternative, the existing secondary clarifiers would be converted to sludge thickeners. Each basin would be equipped with 320 membrane modules of Siemens (or equivalent) B2OR, poly vinylidinedifluoride (PVDF). These modules would incorporate filtrate and air supply header integrally.

Table 4-4 presents the design information for the membrane bioreactor system. Figure 4-3 presents the process flow diagram for the membrane bioreactor activated sludge system.

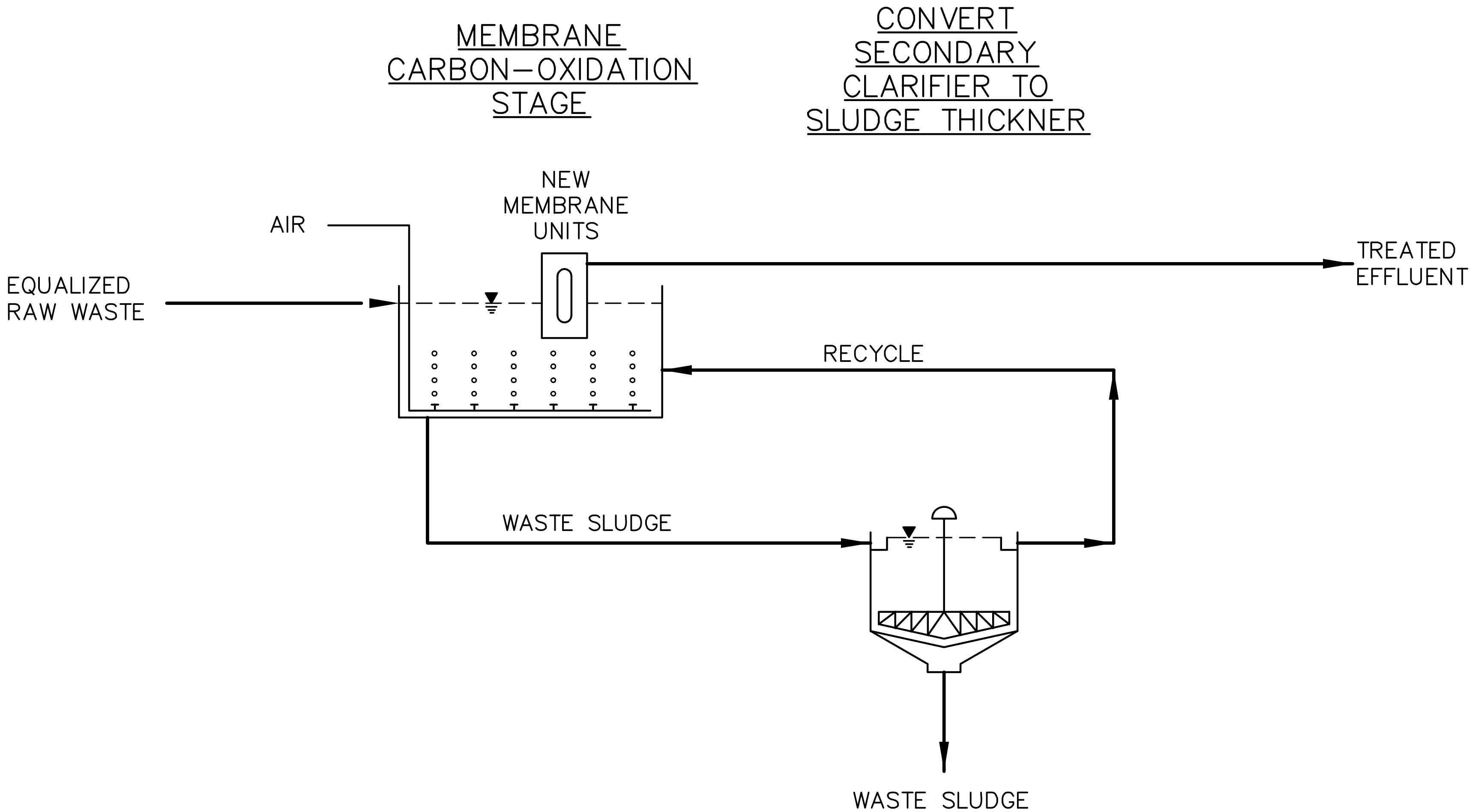
The total capital cost including aeration tank equipment, membrane modules, air scouring and filtrate water distribution equipment is estimated to be $54,700,000. The annual operating cost for this system is $3,280,000. The total annualized cost for the membrane bioreactor alternative is $11,400,000.

There is limited data on the utilization of MBR systems for biological nitrification applications in the refining industry. The membrane process allows operation at high MLVSS levels; however, since the membrane retains low molecular weigh compounds it may be possible to build up a concentration of inhibitory compounds. Full scale MBR systems have experienced problems

TABLE 4-4

PROCESS DESIGN FOR MEMBRANE BIOREACTOR ACTIVATED SLUDGE

Parameter	Design Value
Aeration Basins	
Number	3
Volume (MG per basin)	1.92
MLSS (mg/l)	5800
Membrane Units	One per basin
Number of Modules per unit	320 per basin
Module Type	Siemens or equivalent - B3OR poly vinylidinediflouride
Related Equipment	Filtrate and air supply header
Membrane Cleaning	Air souring



MEMBRANE BIOREACTOR
ACTIVATED SLUDGE

LEMONT REFINERY
LEMONT, ILLINOIS

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DATE SEPTEMBER 2007	DESIGNED BY :	REVISED
PROJECT NUMBER N356-06	AWARE ENVIRONMENTAL INC	DRAWING NO. FIGURE 4-3

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with foaming and fouling of membranes. This necessitates expensive cleaning and replacement operations. This process has a very high capital cost and if the membranes need to be replaced, the operating costs would increase significantly. In addition, the process may not be able to provide consistent compliance with the 3.0 mg/l ammonia nitrogen criteria.

4.5 ACTIVATED SLUDGE WITH BREAKPOINT CHLORINATION/ DECHLORINATION

Activated sludge with breakpoint chlorination/dechlorination utilizes a physical chemical process for nitrogen removal following the activated sludge system. Specifically, the wastewater with nitrogenous compounds is chlorinated with a sufficient dosages of chlorine to produce a free chlorine residual. The hypothetical breakpoint curve is based on a 9:1 $Cl:NH_3$ ratio. The end products of the breakpoint reaction are primarily nitrogen gas (N_2) and secondarily, nitrate-nitrogen (NO_3^-). Any residual chlorine is removed using a dechlorination agent (usually a reduced sulfur compound).

Breakpoint chlorination provides chemical destruction of the ammonia nitrogen. This alternative is the simplest of the proposed alternatives in terms of operation and equipment requirements. Table 4-5 and Figure 4-4 present the design parameters and the flow diagram for this process alternative.

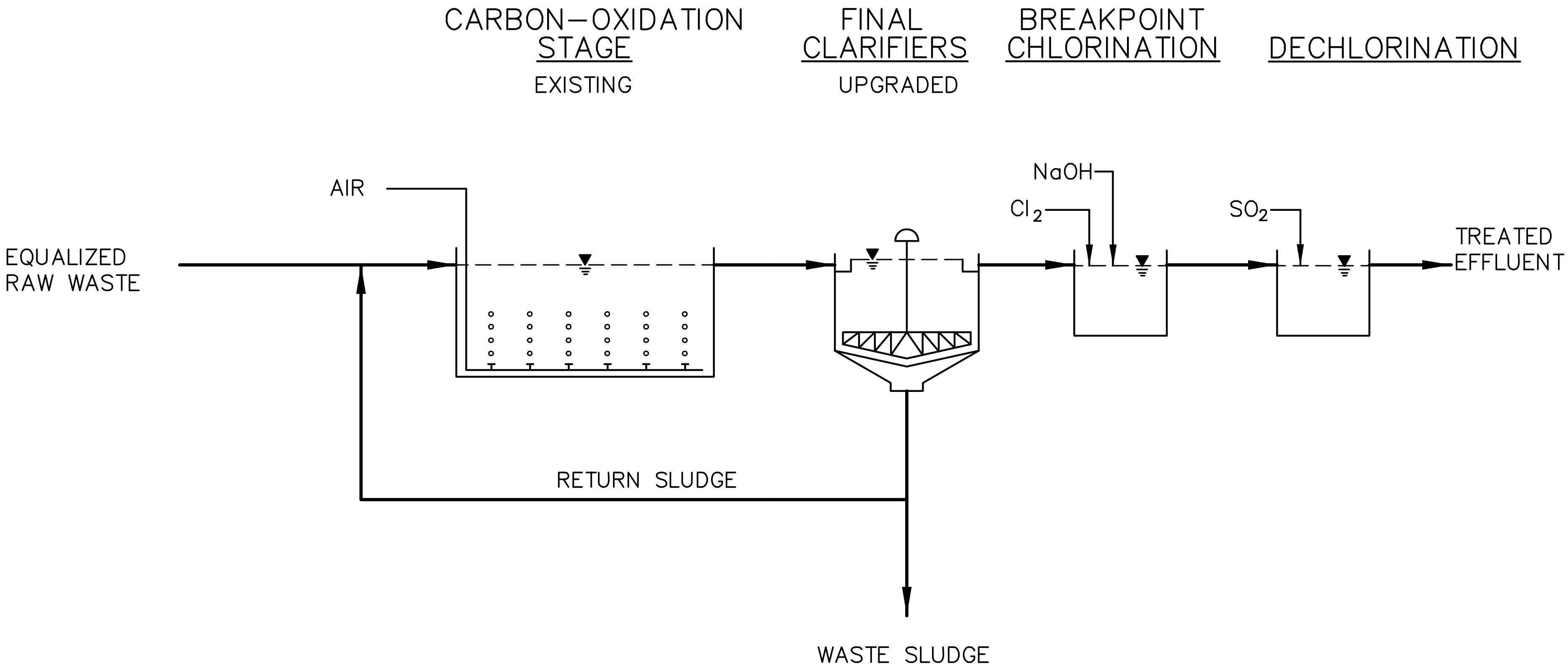
A chlorine contact chamber with a 20 minute detention time, and facilities to add a maximum of 10,710 lb/day of chlorine are included. Chlorine is fed at a 8:1 to 10:1 chlorine-ammonia nitrogen ratio. Caustic is added to offset the pH reduction which occurs when the reaction converts ammonia to hydrochloric acid and nitrogen gas. The caustic requirement is estimated at 10,850 lb/day.

Dechlorination is accomplished by adding sulfur dioxide after the chlorine reaction is completed. A reaction tank volume of approximately 9,700 gallons would be required to provide the 2 minute retention time necessary to complete this second

TABLE 4-5

PROCESS DESIGN SUMMARY FOR ACTIVATED SLUDGE WITH BREAKPOINT CHLORINATION AND DECHLORINATION

Parameter	Units	Design Values
Breakpoint Chlorination		
Max Influent Ammonia Load	lb/day	1,190
$C1_2/NH_3$-N Ratio	lb/lb	9
Max Chlorine Requirements	lb/day	10,710
Caustic Requirements	mg/l	196
	lb/day	10,850
Detention Time	min	20
Reactor Volume	gal	92,000
Dechlorination		
$C1_2$ Residual	mg/l	5
	lb/day	277
$SO_2/C1_2$ Ratio	lb/lb	1
SO_2 Requirement	lb/day	277
Dechlorination Time	min	2
Reactor Volume	gal	9,700



October 10, 2007 2:41:56 p.m.
Drawing: 35606P04.DWG.DWG

ACTIVATED SLUDGE WITH BREAKPOINT CHLORINATION–DECLORINATION		
LEMONT REFINERY LEMONT, ILLINOIS		
SCALE NOT TO SCALE	APPROVED BY :	DRAWN BY: JKS
DATE OCTOBER 2007	DESIGNED BY :	REVISED
PROJECT NUMBER N356–06	AWARE ENVIRONMENTAL INC	DRAWING NO. FIGURE 4–4

reaction. This reaction is fast enough that in-line dechlorination can be considered, but for estimating purposes, a reaction tank is included. Assuming a 5 mg/l chlorine residual, approximately 280 lb/day of sulfur dioxide will be required.

Capital construction costs for the feed equipment, the reaction tanks, and the third secondary clarifier are estimated at $1,400,000. The annul operating cost is estimated to be $3,332,000. The estimated total annualized cost is $3,640,000 for the chlorination/dechlorination system.

The chlorination/dechlorination process can remove ammonia. However, there are potential downside risks of this option. Chlorine as well as chlorinated organic by-products are generally toxic to fish as well as harmful to aquatic biota even at low concentrations. The use of dechlorination removes residual chlorine but does not remove chlorinated organics which are byproducts of the chlorination process.

The use of chlorine for water and wastewater disinfection is of concern for regulatory authorities in the treatment of organic wastewaters. In the wastewater treatment field, chlorine is known to react with organic matter to form disinfection byproducts such as trihalomethanes. These are carcinogens and can be toxic to aquatic species. Due to the higher organic content of wastewaters as compared to drinking water, wastewater chlorination can result in the production of a much greater quantity and a much wider range of organic compounds. These chlorinated organic compounds exhibit acute toxicity, bioaccumulation and/or sublethal affects and have come under increasing scrutiny and regulation around the world.

Numerous organizations have proposed the prohibition of the use of chlorine and chlorine containing compounds for treatment of organic wastewaters because of the toxicity of chlorinated organic by-products. The Illinois Pollution Control Board has eliminated chlorination as a requirement for disinfection in many municipal wastewater treatment plant discharges, where it had previously been required. The trend is away from the use of chlorine for treatment of organic wastewaters. Because of these concerns, the use of breakpoint chlorination/dechlorination is not a justifiable treatment technology on organic containing wastestreams for Lemont Refinery.

Breakpoint chlorination/dechlorination is being used to remove ammonia in the PTU. However, this is an inorganic wastewater and will not produce chlorinated organic by-products. The dechlorination process will remove the residual chlorine.

4.6 ANALYSIS OF TECHNOLOGIES UTILIZED AT ILLINOIS REFINERIES

In conjunction with the review of alternative technologies to upgrade the Lemont Refinery, a review of the treatment technologies in place at other Illinois refineries was conducted. The refineries included:

Conoco-Phillips	Roxana, IL
Exxon-Mobil	Joliet, IL
Marathon	Robinson, IL

A summary of this analysis is presented in Table 4-6.

This analysis indicated that the treatment technologies at all the Illinois refineries are very similar. All have preliminary oil separation followed by an additional oil-water separator using a gas flotation process. The biological treatment process is activated sludge. The overflow rates on the secondary clarifiers are similar. The only difference in the treatment systems appears to be the activated sludge retention time. The Conoco-Phllips and Marathon refineries have a longer retention time than the Lemont Refinery. The Exxon-Mobil and Lemont Refinery have similar activated sludge retention times. The activated sludge is followed by polishing ponds at all refineries except Marathon which has final filters.

4.7 CONCLUSIONS

The treatment process at the Lemont Refinery is similar to that at the other Illinois refineries. All of the refineries employ the activated sludge process for nitrogen removal.

TABLE 4-6

COMPARISON OF WASTEWATER TREATMENT AT ILLINOIS REFINERIES
AEI JOB NO. N356-01

System	Refinery			
	Conoco Phillips	**Exxon Mobil**	**Lemont**	**Marathon**
Initial Oil and Solids Removal	Oil/Water Separator	API Separator	Two-4.6 MG Process Separation Tanks	API Separator
Additional Oil and Solids Removal	Dissolved Nitrogen Flotation	Air Flotation	Induced Gas Flotation	Dissolved Nitrogen Flotation
Biological Treatment	Activated sludge with 1.31 days detention time and 450 gpd/ft^2 clarifier overflow	Activated sludge with 10.9 hrs detention time (upgrading to 19.4 hrs). Clarifier overflow 392 gpd/ft^2	Activated sludge with 7.7 hrs detention time and 382 gpd/ft^2 clarifier overflow	Activated sludge with 1.54 days detention time and 227 gpd/ft^2 clarifier overflow
Tertiary Treatment	Polishing ponds 5.4 MMgal	Polishing pond 4.9 MMgal	Polishing in treated water basin (polishing pond) 16 MMgal	Final filtration

Estimated costs for the four most viable alternatives to upgrade the Lemont wastewater treatment system are presented in Table 4-7. The least expensive of these technologies is the fixed media biological treatment unit. Additional ammonia removal may be achievable by upgrading the treatment plant with additional treatment steps such as a fixed media biological treatment unit. However, this would be at significant cost, and it is uncertain that the upgraded system would achieve consistent compliance with the 3.0 mg/l ammonia nitrogen standard. Therefore, upgrading the treatment system with additional treatment technologies for ammonia removal is not justified.

The ongoing optimization program at Lemont Refinery has resulted in improved ammonia nitrogen removal. The Refinery has participated in pilot studies and research programs to address problems because of higher solid loadings. It is anticipated that the refinery will be able to improve treatment plant performance based on research through the Petroleum Environmental Research Forum. In addition, improved performance is anticipated in conjunction with continued optimization. However, the capability of any system is limited in large part due to the inherent variability in refinery wastes.

We recommend that Lemont Refinery continue its ongoing wastewater treatment improvement programs. These efforts should be directed toward obtaining the maximum possible ammonia removal on a consistent basis. Continued development of operational data under the varying conditions inherent with refinery wastes will help to improve the performance of the system, and will allow the maximum ammonia removal capability of the system to be achieved.

35606r003

TABLE 4-7

SUMMARY OF PROJECT COST ESTIMATE
AEI JOB NO. N356-01

CASE	CASE 1	CASE 2	CASE 3	CASE 4
CASE DESCRIPTION	**ACTIVATED SLUDGE & POWDERED ACTIVATED CARBON**	**ACTIVATED SLUDGE WITH A FIXED MEDIA SYSTEM**	**MEMBRANE BIOREACTOR ACTIVATED SLUDGE**	**ACTIVATED SLUDGE, BREAKPOINT CHLORINATION/ DECHLORINATION**
Major Processes Cost	$9,264,600	$8,487,000	$35,710,000	$468,000
Site Work, Pumps and Piping	$592,400	$492,000	$492,000	$248,000
Electrical	$1,000,000	$945,000	$4,016,000	$127,000
Engineering	$1,480,000	$1,341,000	$5,432,000	$209,000
Contingency	$2,463,000	$2,235,000	$9,050,000	$348,000
Total Project Cost	$14,800,000	$13,500,000	$54,700,000	$1,400,000
Major O&M Cost (annual)	$1,424,000	$1,220,000	$3,280,000	$3,332,000
Equivalent Annual Cost (a)	$3,630,000	3,220,000	$11,400,000	$3,640,000

(a) Based on a Capital Recovery Factor for 10 years @ 8% interest.

APPENDIX A

CALCULATION OF EFFLUENT CRITERIA

Load Limit Calculations
Based on Federal Regulations - 40 CFR419
168,626 barrels of crude oil processed per day

Process	Capacity M bbl's	Capacity Relative to Throughput	Weighting Factor	Processing Configuration
Crude: Design	168.626			
Desalt	168.626	1.000		
Atmos Dist.	168.626	1.000		
Vac. Dist.	82.807	0.491		
		2.491	1	2.491

Process	Capacity M bbl's	Capacity Relative to Throughput	Weighting Factor	Processing Configuration
Cracking:				
FCC	69.098	0.410		
Delayed Coker	40.326	0.239		
Needle Coker	6.413	0.038		
		0.687	6	4.122

Process	Capacity M bbl's	Capacity Relative to Throughput	Weighting Factor	Processing Configuration
Asphalt				
Prod.	4.329	0.026		
Emul	10.935	0.065		
		0.091	12	1.092
			TL	7.705

Refinery Processing Configuration 7.705

Size Factor	1.41	Paragraph 419.22 (b) (1)
Process Factor	1.41	Paragraph 419.22 (b) (2)
# of 1000 Bbl's of Feed	168.626	
Multiplication Factor C	335.25	

Go to BPT Parameters Tab

C:\Documents and Settings\bob.a\Local Settings\Temporary Internet Files\OLKA1\[NPDES Permit Calcs IEPA - 2

BPT Parameters [419.22a]

Parameter	Average			Maximum		
	419.22a factor	Proc Config factor	#'s		Proc Config factor	#'s
BOD	5.5	335.25	1843.8	9.9	335.25	3318.9
TSS	4.4	335.25	1475.1	6.9	335.25	2313.2
COD	38.4	335.25	12873.4	74	335.25	24808.2
O & G	1.6	335.25	536.4	3	335.25	1005.7
Phenol	0.036	335.25	12.07	0.074	335.25	24.81
NH3-N	3.0	335.25	1005.7	6.6	335.25	2212.6
Sulfide	0.029	335.25	9.72	0.065	335.25	21.79
Cr Tl	0.088	335.25	29.50	0.15	335.25	50.29
Cr +6	0.0056	335.25	1.88	0.012	335.25	4.02

BAT Parameters [419.23 (a)]

Parameter	Average			Maximum		
	419.22a factor	Proc Config factor	#'s		Proc Config factor	#'s
COD	38.4	335.25	12873.42	74	335.25	24808.2
NH3-N	3.0	335.25	1005.7	6.6	335.25	2212.6
Sulfide	0.029	335.25	9.72	0.065	335.25	21.79

167.139

BAT Effluent Calcs (419.23(c)(1)(I) (Phenol, CrTl, Cr+6)

Refinery Processes

Crude	M Bbls	**Cracking, Coking, Product Hydrotreating**	M Bbls	**Asphalt**	M Bbls	**Reforming**	M Bbls
Distillation	168.626	FCC	69.098	Prod	4.329	U-16	25.182
Desalting	168.626	Delayed Coking	40.326	Emul	10.935	U-23	14.545
Vac Dist	82.807	Needle coking	6.413				
		U-25 Hyd Trt	35.32				
		U-15 Hyd Trt	14.34				
		U-102 Hyd Trt	41.7				
Group Totals	420.059		207.232		15.264		39.727

Phenol

		Average		Maximum	
	Totals	419(c)(1)(I) factor	#'s	419(c)(1)(I) factor	#'s
Crude	420.059	0.003	1.260177	0.013	5.460767
Cracking, etc	207.232	0.036	7.460352	0.147	30.463104
Asphalt	15.264	0.019	0.290016	0.079	1.205856
Reforming	39.727	0.032	1.271264	0.132	5.243964
Totals			**10.28**		**42.4**

Total Cr

		Average		Maximum	
	Totals	419(c)(1)(I) factor	#'s	419(c)(1)(I) factor	#'s
Crude	420.059	0.004	1.680236	0.011	4.620649
Cracking, etc	207.232	0.041	8.496512	0.119	24.660608
Asphalt	15.264	0.022	0.335808	0.064	0.976896
Reforming	39.727	0.037	1.469899	0.107	4.250789
Totals			**11.98**		**34.5**

Hex Cr

		Average		Maximum	
	Totals	419(c)(1)(I) factor	#'s	419(c)(1)(I) factor	#'s
Crude	420.059	0.0003	0.126018	0.0007	0.2940413
Cracking, etc	207.232	0.0034	0.704589	0.0076	1.5749632
Asphalt	15.264	0.0019	0.029002	0.0041	0.0625824
Reforming	39.727	0.0031	0.123154	0.0069	0.2741163
Totals			**0.983**		**2.21**

Stormwater Credit 419.23(f)(2) and 419.24 (e)(2)

Parameter	Average	Maximum
Phenols	0.0014	0.0029
CrTl	0.0018	0.005
Cr+6	0.00023	0.00052
COD	1.5	3
BOD	0.22	0.4
TSS	0.18	0.28
O & G	167.139	0.13

Multiply the above factor times the number of 1000 gallons of stormwater flow

e.g.) Dry weather flow = 2400 gpm Wet weather flow = 4000 gpm

COD 1600 gpm : # of 1000's gal = 2304

38.50 = 2304 (1.5) = 3456 #'s
Maximum = 2304 (3.0) = 6912 #'s

Concentration Limits - Section 304.124 Title 35 - Subtitle C - Chapter I

Title 35 - Subtitle C - Chapter I Regulations
Average Flow = 4950gpm (6-93) Maximum Flow = 10400gpm (7-96)

	GPM	MGD
Ave flow	4950	7.128
Max Flow	10400	14.98

	167.139		#'s	
	Average	Max	Average	Max
TSS	25	50	1486.2	6245.0
BOD	20	40	1189.0	4996.0
Cr+6	0.1	0.3	5.94	37.47
CrTl	1.0	2.0	59.45	249.8
O & G	15	30	891.7	3747.0
NH3-N	9.4	26.0	558.8	3247.4
Fluoride	38.50	30	2288.7	3747.0
Phenol	0.3	0.6	17.8	74.9
Cyanide	0.1	0.2	5.94	25.0
CBOD	20	40		

Load Limits Comparison

	BAT & BPT		Chapter I Regulations	
Parameter	Average	Maximum	Average	Maximum
TSS	1475.1	2313.2	1486.2	6245.0
COD	12873.4	24808.2	-----	-----
BOD	1843.8	3318.9	1189.0	4996.0
Cr+6	0.983	2.21	5.94	37.5
CrTl	11.98	34.5	59.4	249.8
O & G	536.4	1005.7	891.7	3747.0
NH3-N	1005.7	2212.6	558.8	3247.4
Fluoride	----	----	2288.7	3747.0
Phenol	10.28	42.4	17.8	74.9
CN	----	----	5.94	25.0
Sulfide	9.72	21.8	----	----

Outfall 001 Effluent Limits

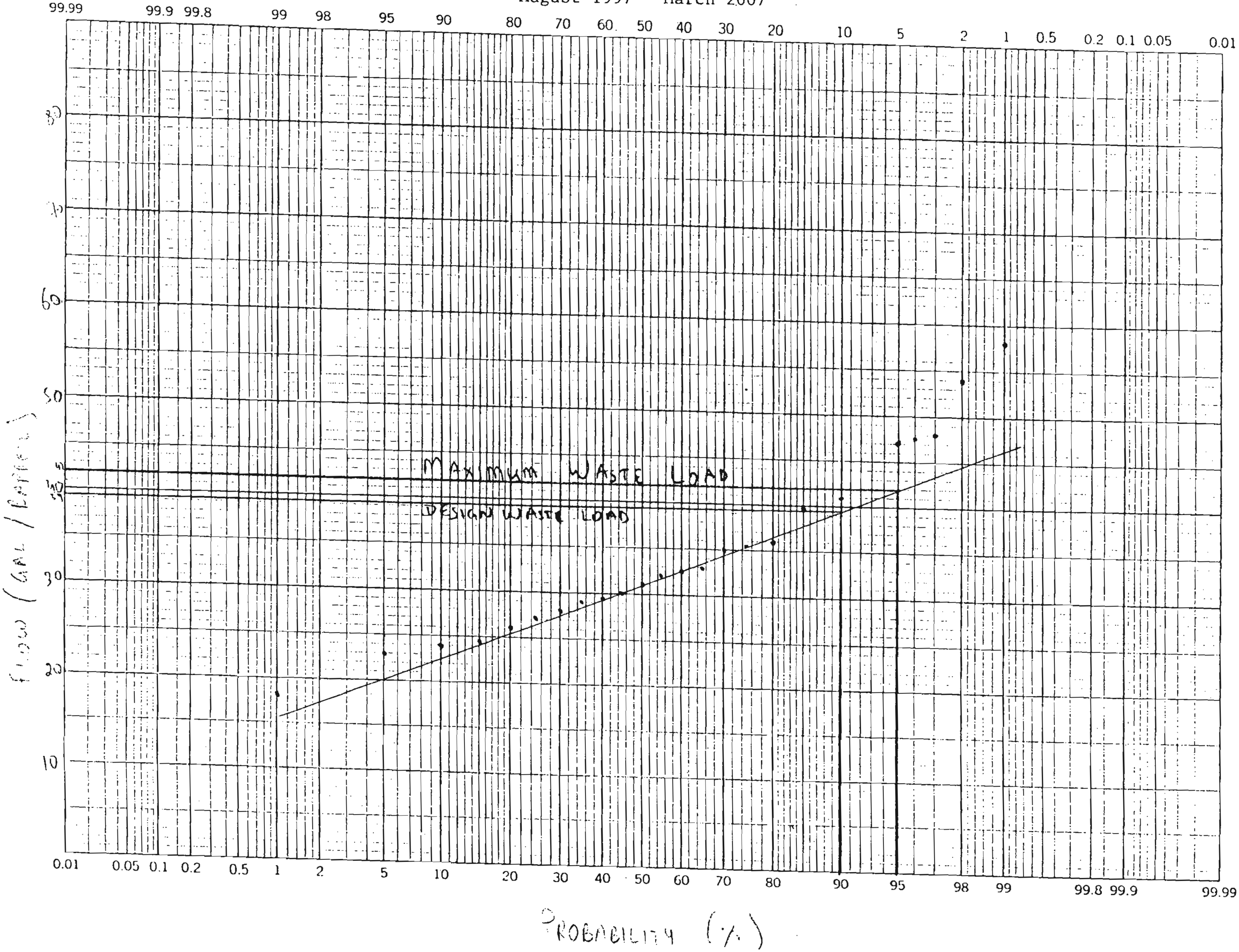
	Concentration Limits (mg/l)		Load Limits (#'s/day)		Site Specific		
Parameter	Average	Maximum	Average	Maximum	Average	Maximum	
BOD	----	----	1189.0	3318.9			
TSS	25	50	1486.2	2313.2			
COD	----	----	12873.4	24808.2			
O & G	15	30	536.4	1005.7			
Phenol	0.3	0.6	10.28	42.4			
NH3-N	9.4	26	~~967.5~~	~~2212.6~~	749.19	1648.21	USEPA supported from 1994 issued permit
Sulfide	----	----	9.72	21.8			
CrTl	1	2	11.98	34.5			
Cr+6	0.1	0.3	0.983	2.21			
CN	0.1	0.2	5.94	25.0			
Fluoride	38.5	30	2288.7	3747.0			
CBOD	20	40	----	----			

APPENDIX B

STATISTICAL DATA ANALYSIS

MAX = 42
DESIGN = 39

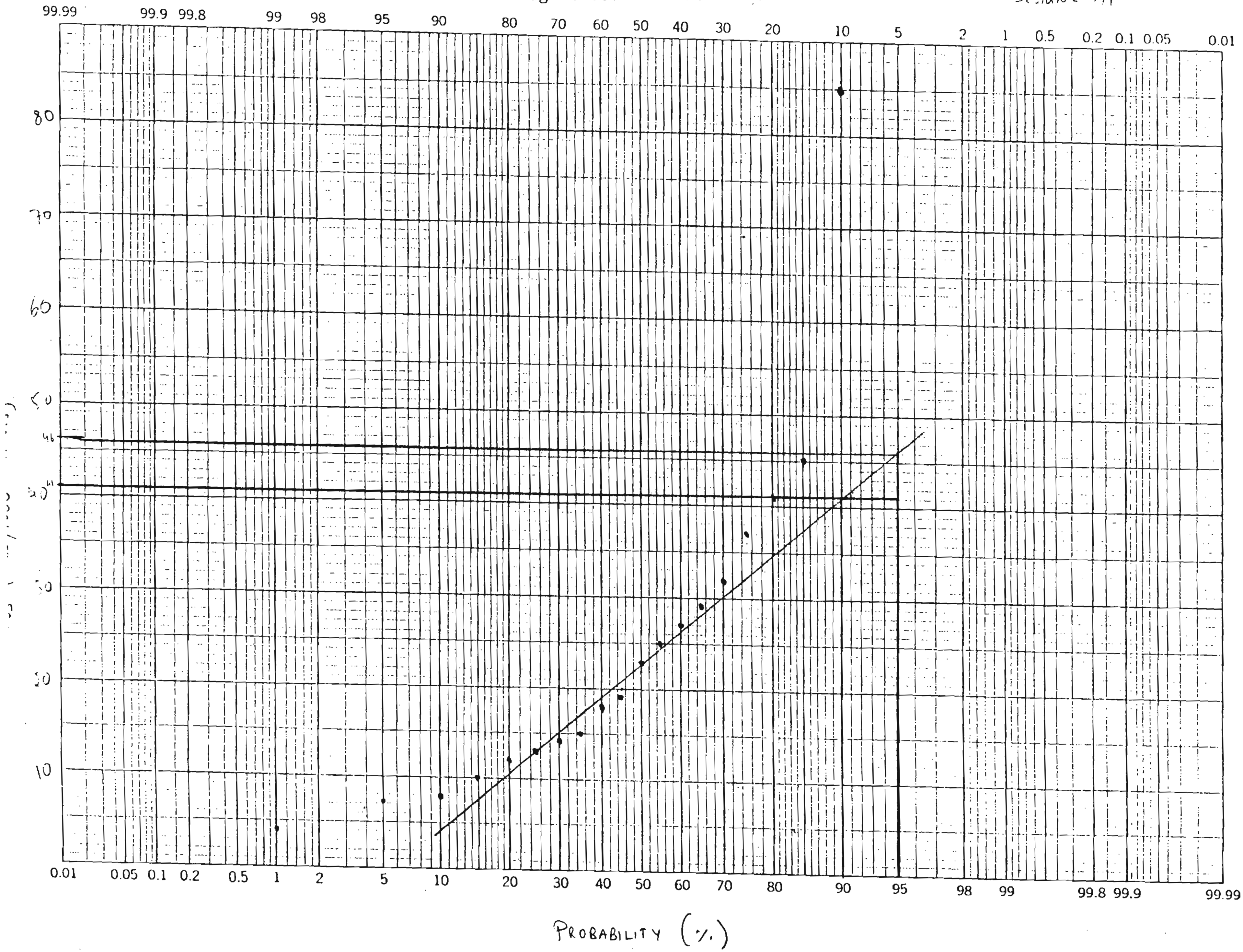
Average Monthly Aeration Influent Flow
August 1997 - March 2007



Electronic Filing - Received, Clerk's Office, March 18, 2008
* * * * * AS 2008-008 * * * * *

Average Monthly Aeration Influent TSS
August 1997 - March 2007

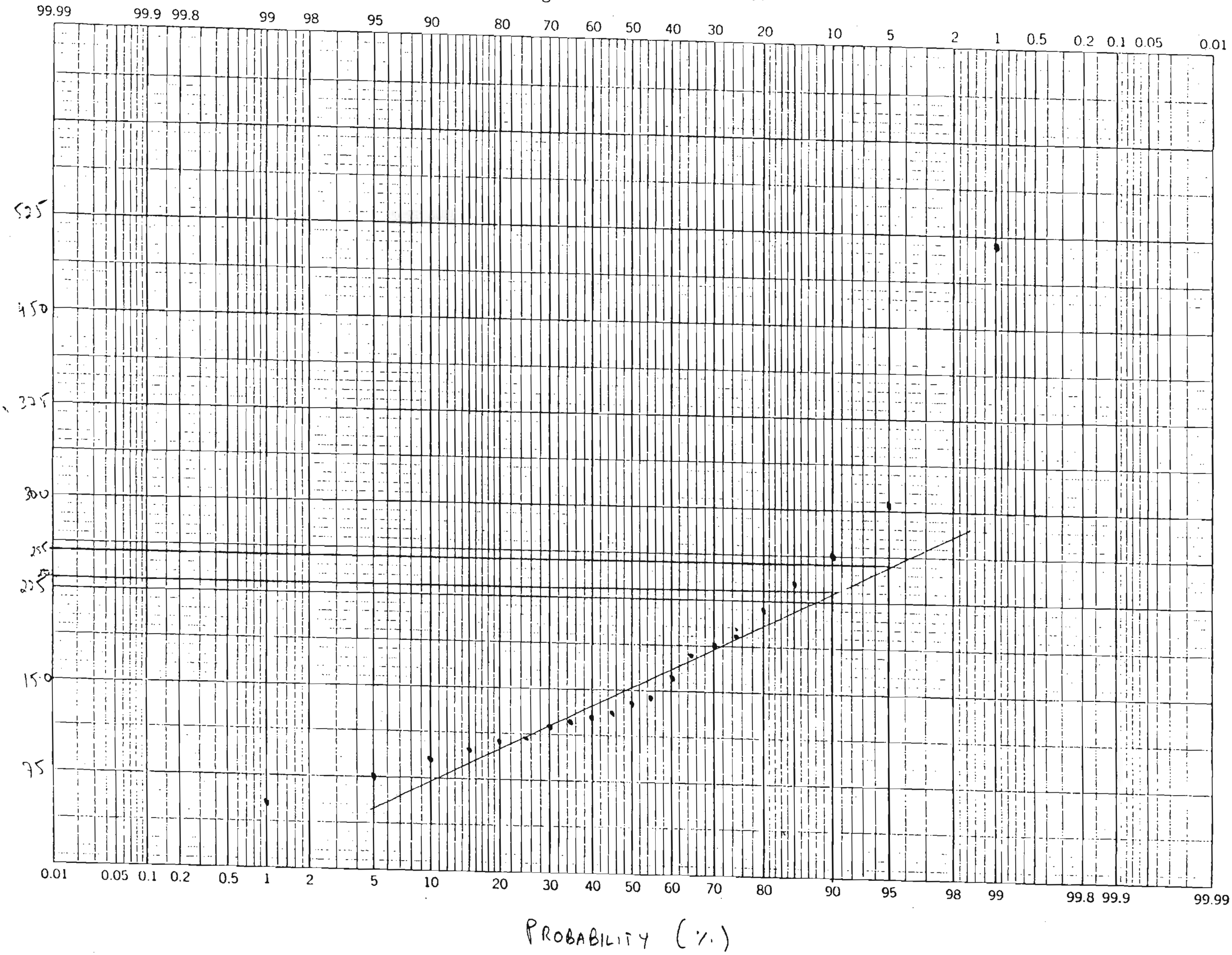
MAX = 46
DESIGN = 41



K+E PROBABILITY X ... KEUFFEL & ESSER CO. MADE IN U.S.A. 46 8000

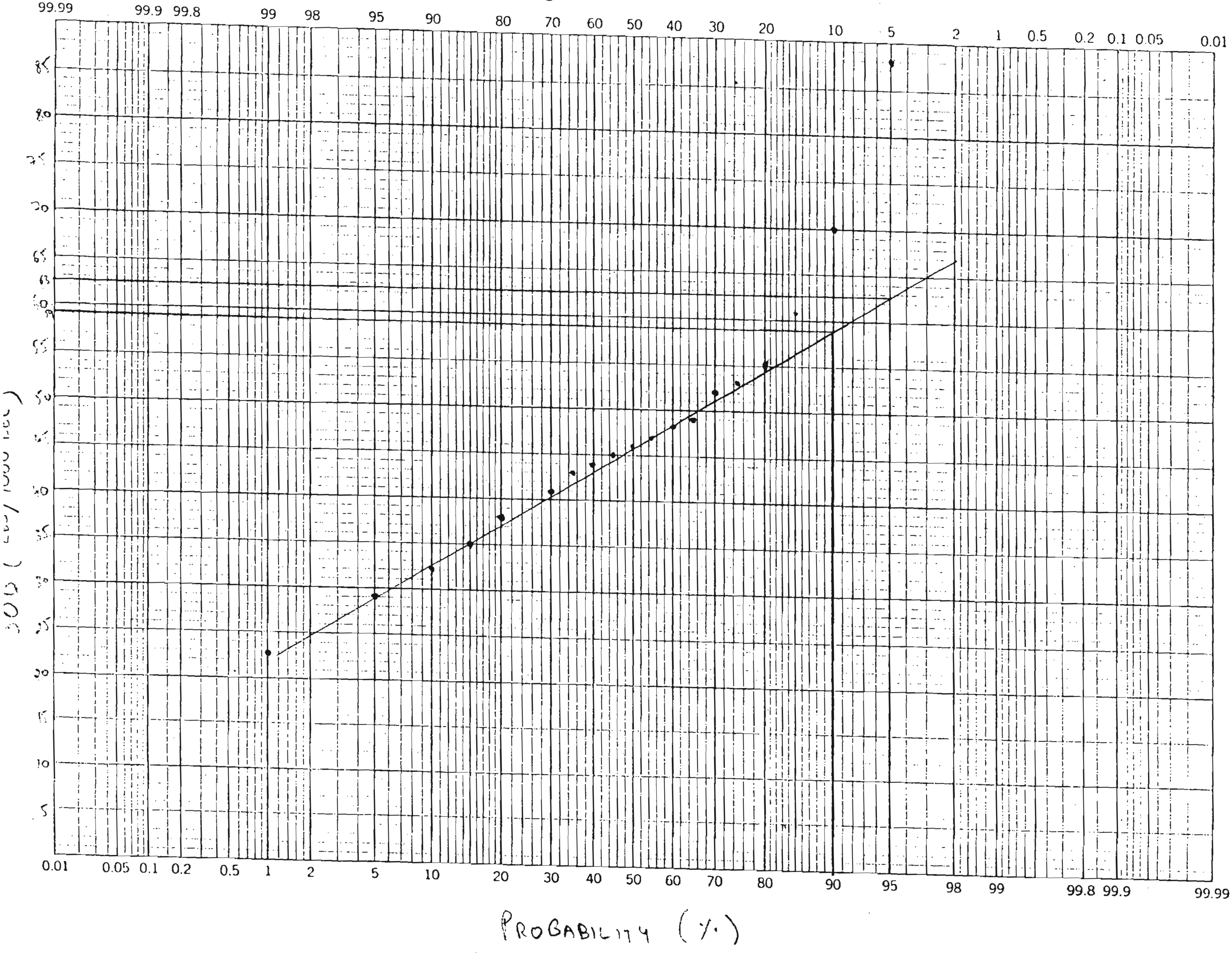
MAX = 255
DESIGN = 232

Average Monthly Aeration Influent COD
August 1997 - March 2007



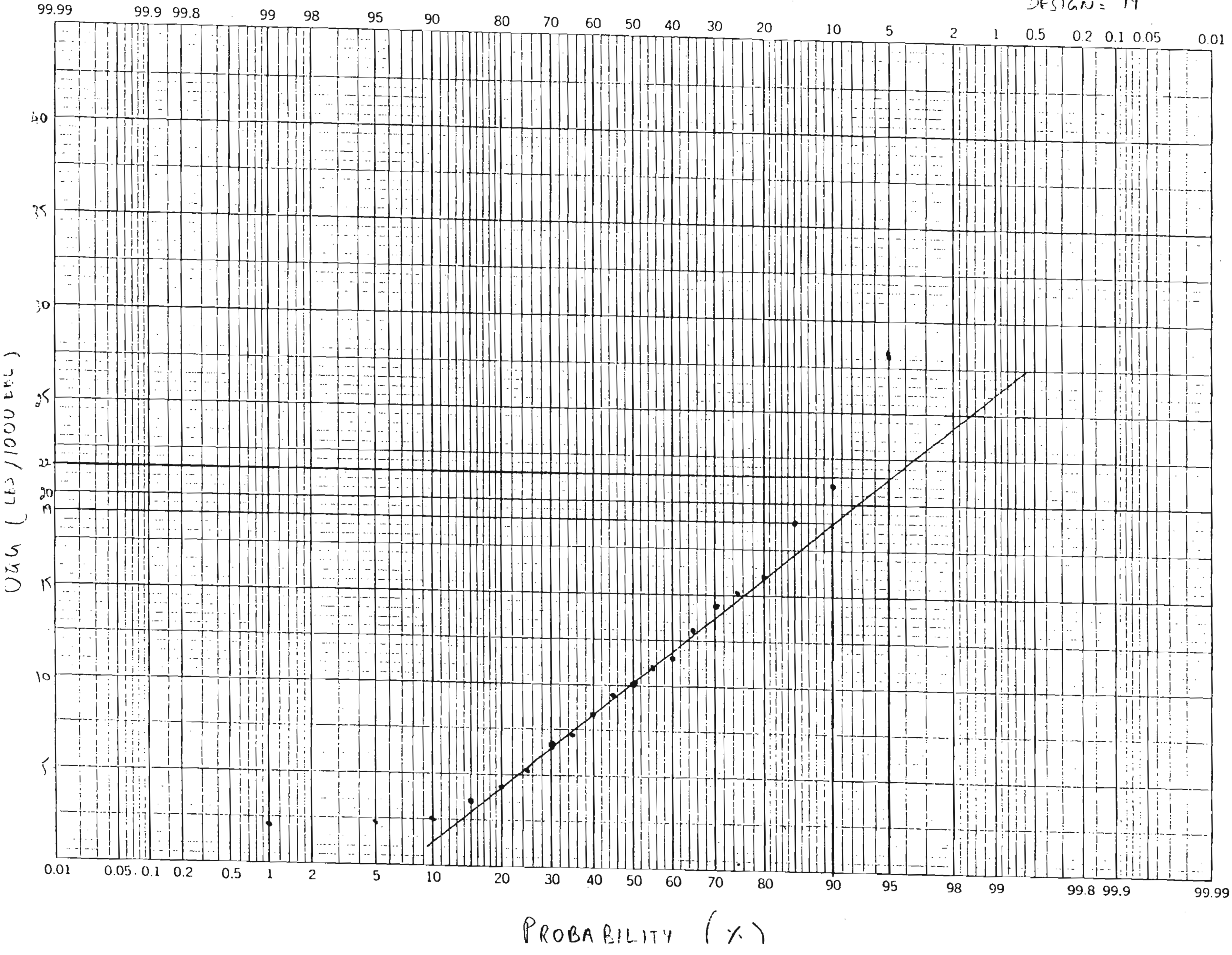
Average Monthly Aeration Influent BOD
August 1997 - March 2007

MAX = 63
DESIGN = 59



Average Monthly Influent Oil and Grease
August 1997 - March 2007

MAX = 22
DESIGN = 19



Electronic Filing - Received, Clerk's Office, March 18, 2008
* * * * * AS 2008-008 * * * * *

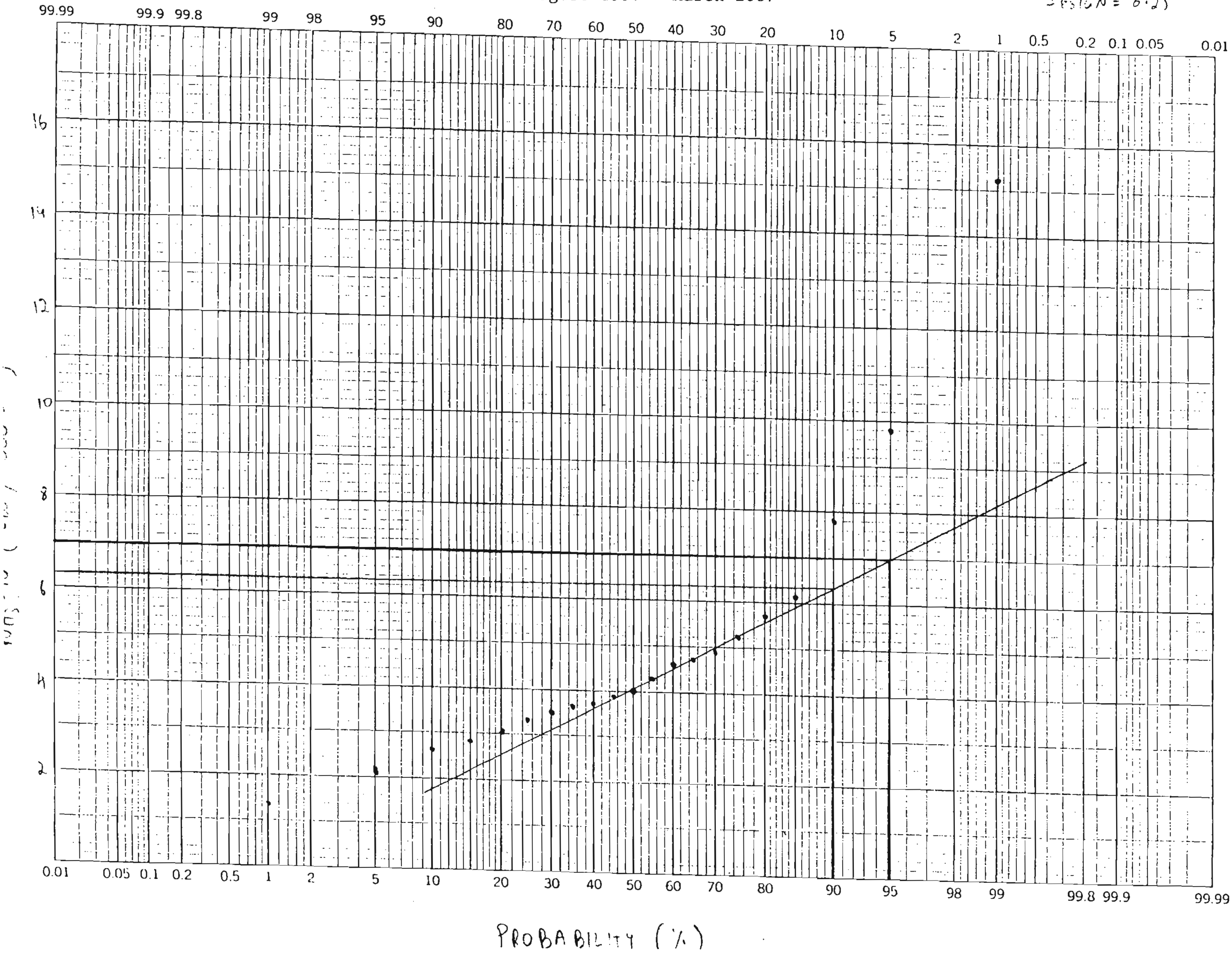
46 8000

Average Monthly Aeration Influent Ammonia

August 1997 - March 2007

MAX = 7.0

DESIGN = 6.25

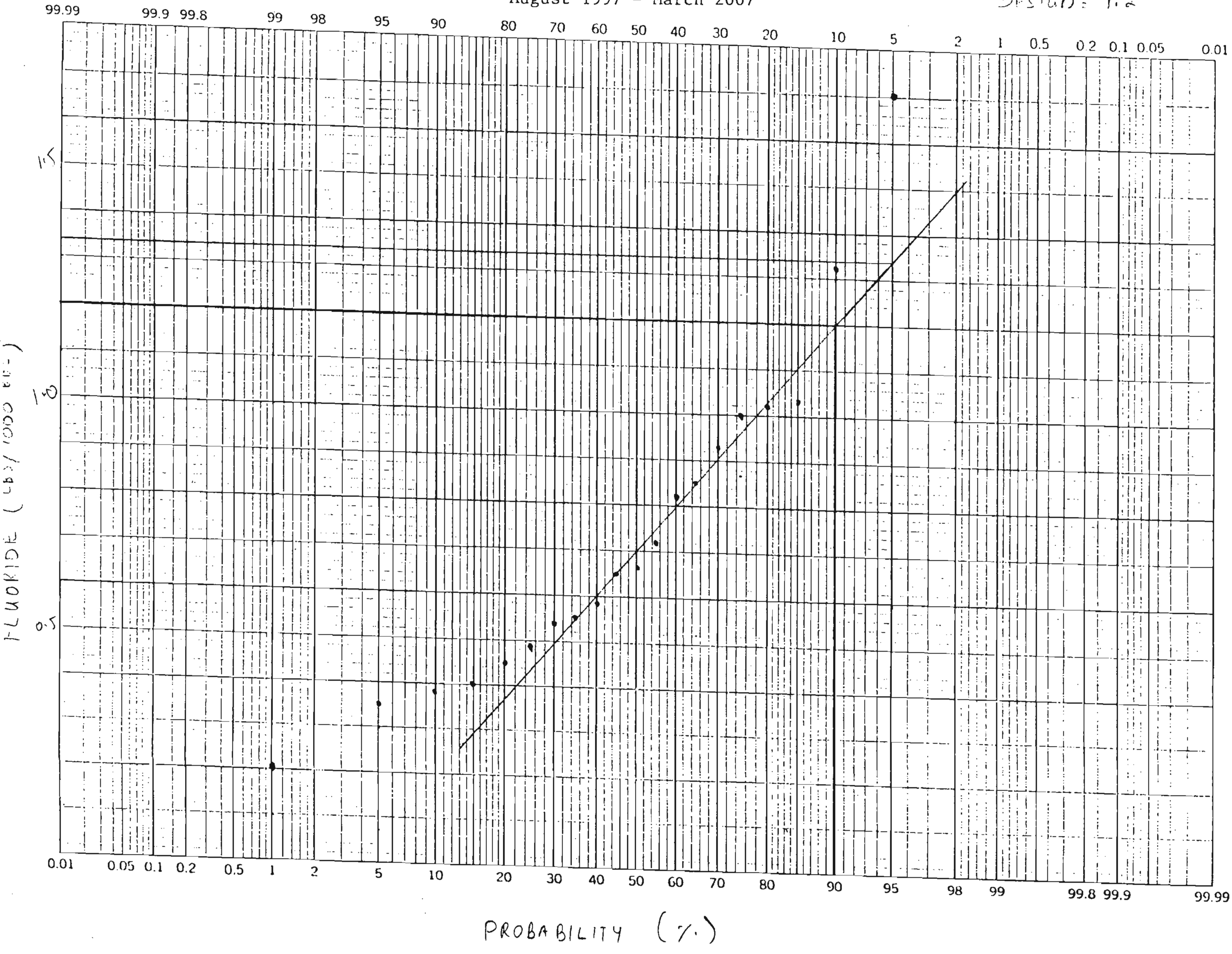


Electronic Filing - Received, Clerk's Office, March 18, 2008
* * * * * AS 2008-008 * * * * *

46 8000

Average Monthly Aeration Influent Fluoride
August 1997 - March 2007

MAX: 1.34
DESIGN: 1.2



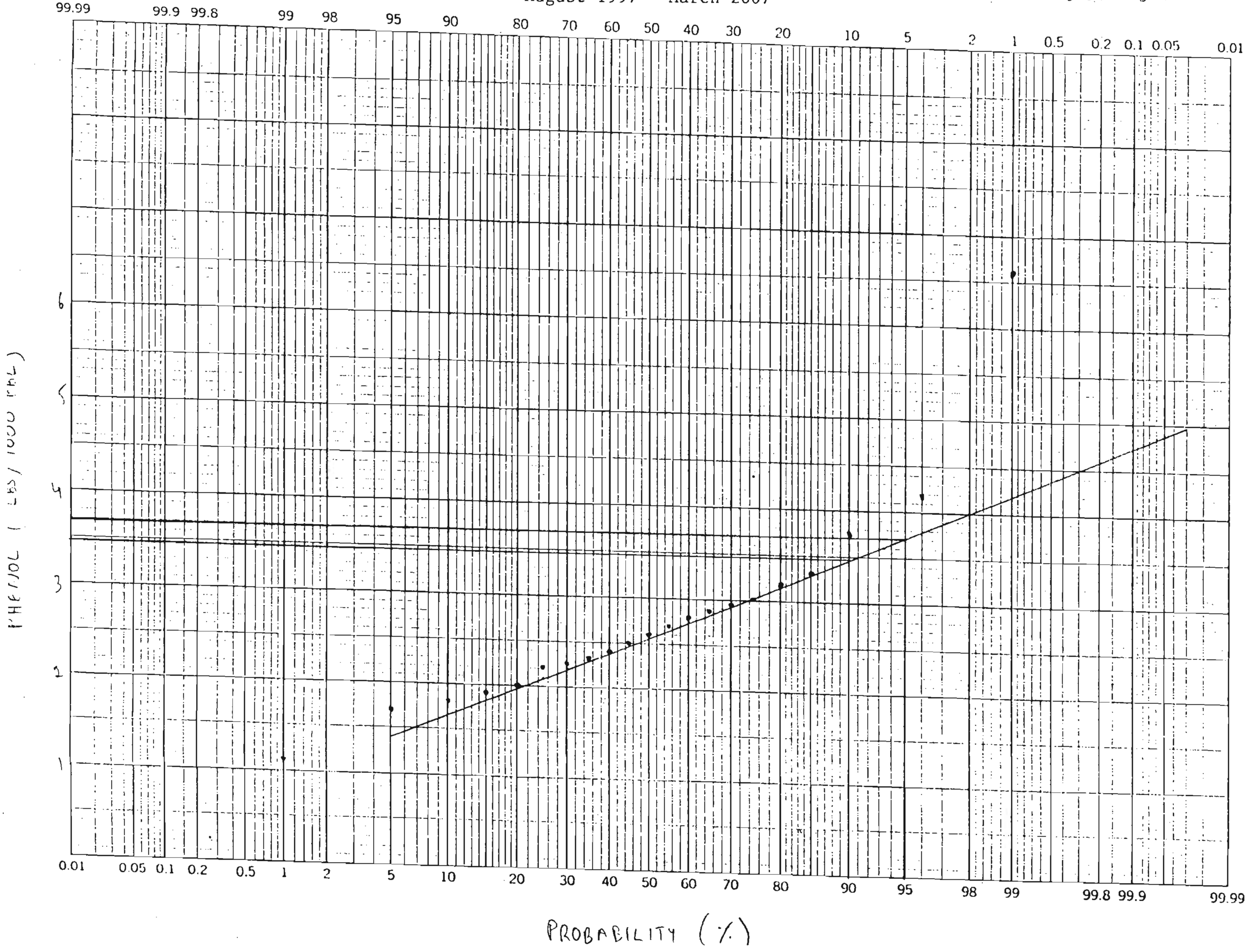
K+E KEUFFEL & ESSER CO. 46 8000

MAX = 3.7

DESIGN = 3.45

Average Monthly Aeration Influent Phenol

August 1997 - March 2007



46 8000

Average Monthly Aeration Influent Sulfide
August 1997 - March 2007

MAX: 0.71
DESIGN: 0.6