BEFORE THE POLLUTION CONTROL BOARD
OF THE STATE OF ILLINOIS

IN THE MATTER OF:	)	
	)	
PROPOSED ADJUSTED STANDARD FOR	)	
AMMONIA NITROGEN DISCHARGE LEVELS	)	AS 08-08
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 August 1, 2008, we filed electronically with the Office of the Clerk of the Illinois Pollution Control Board the attached Pre-filed Testimony of Brigitte Postel, Jim Huff and Bob Stein, and accompanying Exhibits, a copy of which is served upon you.

CITGO PETROLEUM CORPORATION, and
PDV MIDWEST, LLC, Petitioners

By: _____
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TESTIMONY OF BRIGITTE POSTEL

I. BACKGROUND

My name is Brigitte Postel. I have been employed by CITGO Petroleum Corporation ("CITGO") at the Lemont Refinery since October, 2003. At the Lemont Refinery, I have held the position of Environmental Engineer, Water Coordinator. I received a Bachelor of Science in Chemistry from the University of Illinois, Champaign-Urbana, and a Masters of Science in Environmental Engineering from Lamar University, Beaumont, Texas. Prior to my time at the Lemont Refinery, I held various environmental positions in the pharmaceutical, chemical, and power industries.

II. TESTIMONY

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). I want to emphasize that "consistently" meeting the rule is the focus of our Petition. 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 continuously meet the general effluent limit in 35 Ill. Admin. Code 304.122(b). Additional information requested by the Board's hearing officer, Bradley Halloran, may be found in **Exhibit 1** to this testimony.

3. We have attempted to work with the Agency on this matter and initiated meetings with the Agency last November. As suggested by the Agency then, we agreed to separate the Total Dissolved Solids issues from the ammonia nitrogen issues - and further agreed to use the adjusted standard approach rather than the site-specific rule change - in order to meet the requirements of U.S.EPA in reviewing Illinois's water quality standards. We are disappointed that the Agency did not engage in any technical discussions on the content of our proposal and filed the Recommendation it has. We disagree with the Agency's statements in its Recommendation, which we believe mis-characterize the Petition and are not based on facts. One thing we could agree with is to continue to improve our existing biological treatment processes, solids handling processes, and the desalter. Indeed, as will be shown by other presented testimony, the Refinery is currently discharging, on an average basis, less ammonia

nitrogen than is in its raw water supply. Of course, that is because the Refinery is on an "effluent dominated water," the Chicago Sanitary and Ship Canal, as the Agency has testified to in the UAA rulemaking proceeding.

4. The Refinery was constructed during the period 1967 through 1970. It became operational in late fall of 1969. The Refinery employs approximately 530 people.

5. 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.

6. 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.

7. 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.

8. 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 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.

9. 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.

10. 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.

11. 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.

12. 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.

13. 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.

14. 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.

15. 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.

16. 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 and improved its performance in ammonia removal.

17. 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. Jim Huff will explain these calculations in his testimony.

18. 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.

19. 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. While some of that was not done for the specific purpose of improving nitrification, approximately one quarter of that investment had, as a substantial component, improving the ability of the wastewater treatment process to provide nitrification. Even investments that did not primarily target nitrification were done to benefit the nitrification process. For example, the Purge Treatment Unit ("PTU") that was installed as part of the FCC consent decree was required in large part to ensure consistent ammonia nitrogen removal. The testimony of Bob Stein provides more detail on this matter.

20. 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.

21. 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.

22. 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.

23. 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 20-68 times 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.

24. 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.

25. 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.

26. 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.

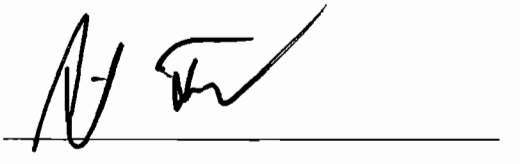
27. At this point in time, the total ammonia discharge from the Refinery, on an average basis over the last 5 years, is less than the allowable discharge of 3 mg/l, even when about 25 percent of that discharge is due to the ammonia nitrogen levels already in the Canal. Nevertheless, the Refinery will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

28. Through the first six months of 2008, the refinery has removed 29 pounds per day from the Ship Canal, while adding only 17 pounds per day. To date, the 2008 annual average ammonia concentration is 0.39 mg/L.

29. This concludes my prepared testimony. Jim Huff and Bob Stein will provide further testimony and exhibits in support of the Petition.

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 Pre-filed Testimony of Brigitte Postel, Jim Huff and Bob Stein, and accompanying Exhibits, via electronic mail, on August 1, 2008



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TESTIMONY OF JAMES E. HUFF

My name is James E. Huff, and I am Vice President and part owner of Huff & Huff, Inc., an environmental consulting firm founded in 1979. I received a Bachelor of Science in Chemical Engineering in 1970 from Purdue University and was awarded a Masters of Science in Engineering from the Environmental Engineering Department at Purdue University in 1971. I am a registered Professional Engineer in Illinois.

My work experience includes two years with Mobil Oil as an Advanced Environmental Engineer during the construction and start-up of the Joliet Refinery. After leaving Mobil in the fall of 1973, I was employed for three years at IIT Research Institute in the Chemical Engineering Department, working on advanced wastewater treatment projects including catalytic oxidation of cyanide in petroleum wastewaters. I then spent four years with the Armak Company, now called Akzo Nobel Chemicals, where I was the Corporate Manager of Environmental Affairs responsible for regulatory compliance and engineering design of environmental systems at nine manufacturing facilities in the United States and Canada. Three of these chemical plants were fatty amines manufacturers, where ammonia was utilized as a raw material and was a major component in the wastewater.

For the last 28 years at Huff & Huff, Inc., I have been involved in over 40 environmental impact studies associated with the impact of wastewater discharges on receiving streams throughout the United States. Many of these studies have involved ammonia nitrogen impacts, including those for the City of Lockport, CITGO Lemont Refinery and its predecessors UNO-

VEN and Union Oil, ExxonMobil Oil Corporation, the Galesburg Sanitary District, and Modine Manufacturing. I was Project Manager on a year long Fox River Ammonia Study on behalf of most of the municipal discharges on the Fox River below the Chain-of-Lakes. I was an active participant in the ammonia water quality proceedings (R94-1b), on behalf of six communities and the Indian Refining Corporation. I am currently working on addressing low dissolved oxygen levels on the East Branch of the Du Page River and Salt Creek on behalf of the Du Page River/Salt Creek Work Group. In addition, I have been actively involved in the current UAA proceedings on the Chicago Waterways on behalf of three industrial clients. I have designed nitrification facilities for both industrial and municipal wastewater treatment plants.

I was retained by CITGO Petroleum Corporation (Lemont Refinery) to evaluate the environmental impact of the ammonia in the Lemont Refinery's discharge to the Chicago Sanitary & Ship Canal. See 2008 report attached as **Exhibit 2**. I have directed previous studies relating to the same issue for previous site-specific requests for the Lemont Refinery. See 1992 report attached as **Exhibit 3**. A copy of my resume is attached as **Exhibit 4**. In addition, effluent limits were derived based upon existing effluent quality, BAT, and current water quality conditions.

Background

The Lemont Refinery is located southwest of Lemont, Illinois, east of Romeoville, along the east side of the Chicago Sanitary & Ship Canal (Ship Canal), at River Mile 296.5. Water is withdrawn from the Ship Canal for refinery use, and the treated wastewater effluent is discharged to the Ship Canal 5.5 miles upstream of the Lockport Lock and Dam and less than one mile upstream of Midwest Generation's Romeoville Power Plant.

The wastewater treatment facilities came on line in 1969, the same time the refinery began processing crude oil. The treatment plant underwent major changes in 1992, including new process water storage tanks, a new aeration basin, a new clarifier, and fine bubble diffusers. Over the past decade, the Lemont Refinery has expended an additional $45 million on capital projects related to ammonia control and reduction. Over the past five years the processing of heavier crude oils has increased. These heavier crude oils contain more inert solids and create

more stable emulsions in the desalter unit. The result has been not only a significant increase in chemical addition to remove oil (break the emulsions) and solids in the process water, but a more variable influent loading on the activated sludge treatment process.

The Ship Canal is classified as Secondary Contact water under Illinois regulations. There is no total ammonia water quality standard applicable to the Ship Canal. Un-ionized ammonia, which is a function of the total ammonia, pH, and temperature, is limited by a not-to-exceed value of 0.1 mg/L. This water quality standard is to be achieved at the edge of the mixing zone. The Agency has proposed to amend the ammonia water quality standard on the Secondary Contact Waterways to be the same standard as in the General Use Standards in R08-09, currently before the Board.

Influent and Effluent Quality

The Lemont Refinery water intake is located approximately 175 feet upstream of the outfall and is routinely analyzed for ammonia by the refinery. Ammonia quality in the Ship Canal has steadily improved over the past two decades, from an annual average of 3.77 mg/L in 1987, to 1.28 mg/L in 1996, to 0.56 mg/L in 2007, as depicted in the attached **Exhibit 5, Figure 1**. This decline is attributed primarily to the reduction in effluent ammonia achieved by the MWRDGC at its upstream treatment plants over this period of time.

Effluent ammonia quality from the Lemont Refinery is presented in **Exhibit 5, Figure 2**. From 1995 until 2005 the annual average ammonia concentration was below 3.0 mg/L. In 2005, with the increase in the processing of the heavier crude oils and resultant higher loading on the treatment facilities, the effluent ammonia increased to an annual average of 3.63 mg/L. As the Lemont Refinery has improved its ability to process these heavier crude oils, the effluent ammonia levels have continued to improve; to 3.50 mg/L in 2006, 2.45 mg/L in 2007, and through the first six months of 2008 to an all time low 0.39 mg/L. Clearly overall, the Lemont Refinery has made progress on consistently nitrifying.

Finally, **Exhibit 5, Figure 3** depicts the mass of ammonia removed from the Ship Canal on an annual average compared to the mass discharged. The net discharge (effluent less influent)

over the past decade has averaged less than 43 pounds per day, and for 2008 to date, the Lemont Refinery has removed 29 pounds per day from the Ship Canal, while only discharging an average 17 pounds per day.

Receiving Water Way Description

As noted previously, the Lemont Refinery discharges into the Ship Canal 5.5 miles upstream of the Lockport Lock and Dam, at River Mile 296.5. The Ship Canal extends 31.1 miles from its confluence with the Des Plaines River to the Damen Avenue Bridge in Chicago (CDM, 2007). The Ship Canal is typically 200 to 300 ft. wide with depths ranging from 27 to 50 ft. (CDM, 2007). The construction of the Ship Canal includes vertical walls and steep embankments. The Ship Canal was erected in approximately 1900, to "transport human waste and industrial pollutants away from Lake Michigan" (CDM, 2007). As part of the Use Attainability Analyses (UAA), CDM conducted a recreation and navigation survey for 28 days. No swimming, skiing, tubing, or wading was observed. A single *canoe, sculling or hand powered boat* was observed within the 28 days. From my own experience in conducting benthic surveys on the Ship Canal for both the Lemont Refinery and the MWRDGC, the Ship Canal is not safe for canoes, sculling or other hand powered boating activities. When barges pass, the wake creates literally a wave machine bouncing off the vertical walls. Where two waves cross, the amplitude doubles, and waves get progressively larger reaching wave heights in excess of five feet before gradually subsiding.

The aquatic habitat of the portion of the Ship Canal where the Lemont Refinery is located was rated as "poor to very poor" (IEPA, 2006). Overall stream use is designated as *non-support* for fish consumption and aquatic life. The identified causes of impairment were polychlorinated biphenyls (PCBs), irons, oil and grease, D.O., total nitrogen, and total phosphorus. Sources included combined sewer overflows, urban runoff/storm sewers, impacts from hydrostructure flow regulation/modification, municipal point source discharges, and other unknown sources. Ammonia concentrations were not identified as a source of impairment, due to the monitored results achieving the water quality standard.

In addition to the unique structure, the Ship Canal is home to three coal fired power plants that provide low cost electricity to the City of Chicago, the remainder of the State of Illinois, and elsewhere through the electrical power grid. The Ship Canal is effluent dominated with over 70 percent of its flow on an annual bases from municipal effluents (IEPA, 2008). This included wastewater effluent from the Stickney treatment plant, one of the largest treatment plants in the world. Essential barge traffic also flows along this critical artery to a wide range of industries located along the Ship Canal.

Another unique factor on the Ship Canal is the electric barrier installed near the Lockport Locks. This barrier was installed to prevent invasive bighead carp from migrating into the Great Lakes. A second electric barrier has been constructed but is yet operational. These electric barriers will not only prevent the invasive fish from migrating, but will also prevent other fish from migrating up or down the Ship Canal at Lockport, normally not a desirable outcome, but certainly necessary in light of the goal to protect the Great Lakes.

The UAA Report (CDM, 2007, page 4-80) notes that habitat ranged from poor to very poor, and identified the following factors as limiting aquatic potential on the Ship Canal:

Silty substrates

Poor substrate material

Little instream cover

Channelization

No sinuosity

There are no backwater areas or tributary mouths along the Ship Canal. The lack of habitat diversity along the Ship Canal clearly limits the diversity of the aquatic biota.

As noted in **Exhibit 5, Figure 1**, the total ammonia concentrations in the Ship Canal are generally low, below 1 mg/L. Un-ionized ammonia levels from 2000 to 2002 at four stations along the Ship Canal and Des Plaines River are presented in **Table 4-1** of the 2008 report, **Exhibit 2**. Average un-ionized ammonia concentrations at all four stations have been

consistently less than 0.010 mg/L. Not only is the un-ionized ammonia levels in the Ship Canal less than the current water quality standard, the levels also attain the proposed changes in the un-ionized ammonia water quality proposed as part of the Use Attainability Analysis (UAA) in R08-09.

Mixing Zone

In 1992, Huff & Huff, Inc. conducted a mixing zone study on the Lemont Refinery outfall (see **Exhbit 3**). The outfall design is unique in that it is a 15-inch diameter pipe, extending vertically downward 15 feet below the surface into the Ship Canal. The result is a turbulent discharge that is strongly buoyant due to the entrained air from the effluent flowing over the weir from the Treated Water Basin. The Zone of Initial Dilution (ZID) was measured at 10:1 and only occupies 100 square feet of the Ship Canal. There are only 300 gallons of effluent within the ZID at any one time, with a mean retention time under 7 seconds.

In 1992 the mixing zone achieved a 40:1 dilution within 60 ft. downstream, occupying only 0.05 acres, compared to the allowable 26 acres. With the lower 7-day, 10-year low flow due to the MWRDGC's loss of discretionary diversion from Lake Michigan and the slightly higher effluent flow today than in 1992, the mixing zone today achieves a 36.7:1 dilution within the same 0.05 acres.

Historical Relief Sought

In 1987, the Board granted site-specific relief to the Lemont Refinery, allowing the Agency to establish limits based on a reasonable measure of actual production at the Refinery. From that order, the Agency set limits of 749 lb/day ammonia (monthly average) and 1,648 lb/day (daily maximum). No concentration limits were imposed in 1987 but at the refinery's design average flow of 5.79 MGD, these mass limits equate to:

Monthly Average: 15.5 mg/L
Daily Maximum: 34.1 mg/L

The next two rule changes contained the following concentration limits:

Monthly Average: 9.4 mg/L
Daily Maximum: 26.0 mg/L

The current petition is requesting the following concentration limits:

Monthly Average[1]: 6.9 mg/L
Daily Average[2]: 10.6 mg/L

Clearly, the Lemont Refinery has made progress in reducing its effluent ammonia discharged, and the requested relief continues to make commitments to future progress. It is important to remember that this requested relief is for a reduction in pollutant loading from the current permitted level.

Receiving Water Impacts

Exhibit 5, Figure 1 and **Tables 4-1** and **4-2** of **Exhibit 2** present the historical concentrations of total ammonia and un-ionized ammonia in the Ship Canal. The total ammonia can be described as relatively low on an annual basis, and the requested relief will further lower the Lemont Refinery's contribution to the downstream stations. The permitted monthly average limit will decline by 27 percent, while the permitted daily maximum will decline by 59 percent.

The un-ionized ammonia in the Ship Canal on an annual basis is less than 10 percent of the un-ionized water quality standard, and is consistently in compliance with the water quality standard. This adjusted standard request will further reduce both the total and un-ionized ammonia levels downstream over the existing conditions.

[1] Concentration limits would apply whenever average discharge exceeds 100 lbs/day.
[2] Daily maximum would apply only when the daily discharge exceeds 200 lbs/day.

As ammonia is oxidized in the receiving stream, oxygen is consumed. To the extent the Lemont Refinery's ammonia is contributing to lower dissolved oxygen (D.O.) levels, the requested relief will only improve D.O. from the existing levels, with the more restrictive ammonia effluent limits proposed. According to the UAA Study (CDM, 2007), the MWRDGC has recorded D.O. levels below the 4.0 mg/L minimum water quality standard at all seven stations on the Ship Canal. At Romeoville and Lockport, both downstream of the Lemont Refinery, 19 percent of the time D.O. levels below 4.0 mg/L were recorded, the same percentage of time as at the upstream location at Cicero Avenue.

The Agency's proposal is to change the minimum D.O. to 3.5 mg/L in the Ship Canal. It is my understanding the Ship Canal does not currently achieve this 3.5 mg/L D.O. level during wet weather combined sewer overflow events.

In 1992, in support of an earlier petition, Huff & Huff used the MWRDGC's QUAL 2E model to predict changes in D.O. from the Lemont Refinery's contribution. At a discharge rate of 744 pounds per day of ammonia from the Lemont Refinery, the maximum D.O. decline was 0.03 mg/L (maximum loading at low flow conditions.) With the current requested relief, the maximum reduction in D.O. will be closer to 0.02 mg/L at maximum loading and low flow. The minor level of change in D.O. is less than can be accuracy of the D.O. test method for streams (0.1 mg/L). In essence, no change in D.O. could be measured attributed to the Lemont Refinery.

Illinois EPA Recommendations

The Agency has recommended that the Board deny CITGO's requested Adjusted Standard relief. Some responses to the Agency's technical basis are appropriate.

- *The Agency cites the Board's 1972 conclusion that a reduction in ammonia is necessary if the Illinois River is to achieve the D.O. Standard.*

While the 36 year old opinion held significant meaning at the time, more recent water quality data present different stream conditions. The attached **Exhibit 5, Figure 1** shows that since just 1986, ammonia levels in the Ship Canal have declined from over 3.6 mg/L to between

0.47 and 0.81 mg/L. There is no longer an ammonia issue on the Illinois River. The Agency also overlooks the fact that the requested relief will further reduce ammonia concentrations over existing levels in the Ship Canal.

- *At this point, CITGO is the only refinery discharging to the Ship Canal that has yet to meet the ammonia nitrogen standard at 35 III. Adm. Code 304.122(b).*

This statement is misleading as the Lemont Refinery is the sole refinery on the Ship Canal. However, the waterway receives effluent from one of the largest municipal wastewater treatment plants in the world, which contributes significantly more ammonia on a pounds per day basis than the Lemont Refinery contributes. Over the past four years, the ship canal upstream of the Lemont Refinery has contained an average 0.66 mg/L total ammonia. Even at the 7-day, 10-year low flow, this translates into 4,640 pounds per day of ammonia passing by the Lemont Refinery. The Lemont Refinery over the past decade has contributed an average 43 pounds per day of ammonia on a net basis, or less than one percent of the overall ammonia loading under low flow conditions. (The contribution from the Lemont Refinery would be even less at higher Ship Canal flows.)

- *CITGO further claims that the discharge from the refinery doesn't 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. Since Section 304.122(b) is a technology based standard, not a water quality standard, CITGO's assertion is irrelevant to the issue at hand as there exist removal technologies that are economically reasonable and technically feasible.*

The economically reasonable and technically feasible determination by the Board was based on treating municipal wastewater. The Agency has supported since the late 1980s, for both the Lemont Refinery and Mobil Oil relief from this rule, in part based on the absence of environmental impact. The Agency's current response addresses environmental impact, including citing the Board's 1972 opinion on the D.O. concern, yet claims such concerns are

"irrelevant". The Lemont Refinery continues to make progress in reducing its ammonia discharge. The requested relief will reduce the permitted daily maximum by 59 percent.

- *Conoco-Phillips Refinery does not have water quality based limits due to its location on the Mississippi River, however nitrification is known to occur on a regular basis given the ammonia levels measured in the effluent and the results of whole effluent toxicity testing.*

This statement is also misleading. The Lemont Refinery nitrifies a high percentage of the time and its effluent also passes the whole effluent toxicity testing. From information in the Agency files, the following could have been provided to the Board by the Agency:

CONOCOPHILLIPS WOOD RIVER AMMONIA EFFLUENT LEVELS

Year	Maximum Monthly Average, mg/L	Daily Maximum, mg/L
2003	2.0	15.2
2004	7.6	7.6
2005	5.8	10.6
2006	2.3	3.0
2007	4.2	4.2

From 2002 to 2007, the ConocoPhillips Wood River Refinery has discharged an average 67 pounds of ammonia per day. As the intake water is groundwater, this 67 pounds per day can be considered a net discharge, as compared to the Lemont Refinery net 43 pounds per day ammonia discharged. It would seem that the Agency's use of this other refinery as an example is totally consistent with the Lemont Refinery's performance.

It is clear Conoco-Phillips does not meet a 3.0 mg/L monthly average or a 6.0 mg/L daily maximum all the time. In fact, the results look very similar to the Lemont Refinery's performance. Simply comparing concentrations discharged from petroleum refineries can be misleading, as water conservation practices vary. The more modern refineries like the Lemont Refinery discharge less water per barrel of crude processed than older refineries.

- *By seeking relief from Section 304.122 ammonia standard, CITGO is subjecting a portion of the Ship Canal to experience much higher ammonia concentrations, 6.9 mg/L as a monthly average and 10.61 mg/L as a daily maximum.*

This statement does not offer an accurate representation of the relief sought. The requested relief will result in lower ammonia concentrations in the Ship Canal than result from the existed permitted levels, which the Agency supported in the previous site specific rule change. The Agency also seems to imply that ZIDs and mixing zones are inappropriate. Within the ZID, where a 10:1 dilution occurs within 7 seconds. Assuming the Lemont Refinery is discharging at the requested **daily maximum** limit of 10.61 mg/L, the ammonia concentration at the edge of the ZID will be 1.63 mg/L, and at the edge of the mixing zone, the ammonia concentration will be 0.91 mg/L. At the 7-day, 10-year low flow, the increase in ammonia will be from 0.634 mg/L upstream to 0.701 mg/L once complete mixing has occurred when the refinery is discharging at its proposed daily maximum 10.61 mg/L and its design average flow. Again, all of these values are reductions from the current permitted levels.

The Lemont Refinery is seeking an adjusted standard from ammonia effluent limits that were adopted by the Board solely because of the elevated ammonia/low dissolved oxygen in the Illinois River over 36 years ago. No other large water body in Illinois has effluent ammonia standards. The conditions that lead to these unique Illinois River Basin effluent standards no longer exist today.

- *The Ship Canal will thus have an area that is effectively unavailable as habitat for sensitive forms of aquatic life.*

The Agency should identify which "sensitive forms of aquatic life" it is referring to. The Agency in its pre-filed testimony in R08-09, described the Qualitative Habitat Evaluation Index on the Ship Canal as "generally below 22, which are to be expected in waters with **very poor to poor habitual attributions**" (R. Sulski, 2007, page 17, emphasis added). If the habitat is controlling the aquatic potential, it is misleading to state sensitive forms would enter into the turbulent ZID and mixing zone. In Adjusted Standard AS96-10, the Board's opinion noted that

the Agency's opinion was that the costs of installing additional cooling "may not be economically reasonable **when compared to the likelihood of no improvement in the aquatic community of the UIW."**[3] (AS96-10, Opinion and Order at page 7). The Agency's position in this ammonia proceeding is inconsistent with the position it has taken historically along the waterway as well as its current position on the limitations of habitat in the UAA proceedings.

- *Adding higher ammonia discharge levels would only further prevent attainment of dissolved oxygen standard (emphasis added).*

Again, the Agency is confusing the Lemont Refinery's request, which is a reduction in ammonia levels over the current permitted levels. Attainment of the dissolved oxygen standard on the Ship Canal will depend on the elimination of CSO events, not on the Lemont Refinery's minor ammonia contribution.

Cost Effectiveness

As presented in **Exhibit 5, Figure 3**, the Lemont Refinery has achieved an average annual total ammonia effluent level of 75 pounds per day over the past decade while the existing Site Specific Rule Change was in effect. The ammonia removed from the Ship Canal by the Lemont Refinery over this same period has averaged 32 pounds per day, so the net contribution has been 43 pounds per day. Assuming that the lowest cost upgrade identified in the Aware Report (February 2008) will remove the 43 pounds per day contributed (the refinery becomes *ammonia neutral* to the Ship Canal), the annualized cost would be $3,220,000, or a cost of $205 per additional pound removed.

The Lemont Refinery would also increase its carbon footprint from the additional energy consumed with the add-on equipment, should the adjusted standard be denied. The operating horsepower for the added equipment will be 144 HP. Assuming the additional energy consumed is derived from coal, the additional pounds per year of carbon dioxide emitted will be 1,976,000.

[3] UIW-Upper Illinois Waterway

Or for every additional pound of ammonia oxidized, 126 pounds of carbon dioxide will be emitted. Remember, that ammonia oxidation occurs naturally within the receiving stream, without carbon dioxide generation.

The $205 per pound of ammonia removal for the incremental 43 pounds per day can be compared to the cost for ammonia removal at the Calumet Water Reclamation Plant of approximately $3.00 per pound, and the addition of five side-stream aeration systems that provide sufficient oxygen to remove a pound of ammonia at approximately $10.00 per pound.[4] The above unit cost is 68-times higher for the Lemont Refinery than the ammonia removal costs required for the Calumet Water Reclamation Plant, and is clearly not cost effective.

Derivation of Effluent Limits

The Lemont Refinery is currently operating under a site-specific rule change that expires on December 31, 2008. The existing limits include both load limits based on Best Available Treatment under the federal categorical limits and concentration limits. The existing limits are as follows:

	Ammonia Concentration
Monthly Average	9.4 mg/L
Daily Maximum	26.0 mg/L

Using five years of effluent data from June 2002 to May 2007, and the U.S. EPA Technical Support Document for Water Quality-based Toxics Control (1985) procedure, at the 95th percentile the calculated ammonia limits are 6.9 mg/L monthly average and 10.6 mg/L daily maximum. As noted previously, these are significant reductions from the current limits, 27 percent on the monthly and 59 percent on the daily maximum. However, Section 304.122(b) only applies to dischargers that discharge more than an average 100 pounds per day on a monthly average, and 200 pounds per day on a daily basis, and the Lemont Refinery is asking that the

[4] 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, updated to 2008 dollars and testimony of J. E. Huff in the Matter of Petition of Uno-Ven to Amend Regulations Pertaining to Water Pollution, R93-8.

above concentration limits only apply when these mass limits are exceeded. This is particularly important from a compliance perspective. If nitrification is lost or inhibited, ammonia concentrations increase, and there is minimal corrective action that can be accomplished in the short term to lower concentrations. However, the Lemont Refinery does have the ability to limit the volume of discharge for a period of time, and could reduce its discharge rate during periods when the nitrification process is upset to stay under the mass limits. From an environmental perspective, this is a good approach to minimizing any increase in ammonia in the Ship Canal, and allows for a proactive method for refinery personnel to respond to upsets without violating an effluent limit.

Summary

The Lemont Refinery has consistently achieved the Best Available Treatment ammonia limits since 1987. The average net ammonia discharged by the refinery to the Ship Canal since 1999 has been 43 lbs/day, and in 2008 through June the refinery has removed 29 pounds per day from the Ship Canal, while adding only 17 pounds per day.

The site-specific relief is not required to achieve the calculated BAT limits, but rather for the unique Illinois River Basin regulations that were based on river conditions that existed in the early 1970s, but no longer exist today. The Lemont Refinery has been unable to consistently achieve the ammonia effluent limits due to the complex nature of petroleum refining as well as the sensitive nature of the nitrification process itself. The Lemont Refinery has expended over $45,000,000 since 1998, to attempt to further reduce effluent ammonia levels. The increase in the processing of heavier crude oils in 2005 clearly set back the refinery's progress. However, the steady improvement since 2006 and the record low effluent ammonia levels through the first six months of 2008 suggest that the Lemont Refinery is close to achieving the 3/6 mg/L limits, and a five year period to fine tune and demonstrate performance is reasonable. The environment will benefit from the significant reductions in ammonia permitted to be discharge while consumers may benefit from less expensive petroleum products in Illinois and a reduced carbon footprint associated with add-on nitrification equipment at the Lemont Refinery.

Given that the proposed effluent limits are lower than the limits determined from the water quality-based derivation, the requested effluent limits will be protective of the Ship Canal's water quality. The overall declining ammonia loading on the Illinois River System and the onset of nitrification within the Ship Canal itself (due to higher dissolved oxygen levels) have virtually eliminated un-ioinized ammonia exceedances downstream of the Lemont Refinery. Dramatic improvements in the dissolved oxygen level within the Ship Canal have also occurred over the past twenty years. These factors support the Lemont Refinery's request for site-specific relief, as no environmental impacts from the requested relief have been identified.

REFERENCES

CDM, *Chicago Area Waterway System Use Attainability Analysis,* August 2007.

Huff, J. E. and M. A. Panatera, *Environmental Assessment & Effluent Limit Derivation Report for the Ammonia Discharge from the CITGO Lemont Refinery,* February 2008.

Illinois EPA, Statement of Reason, R08-09, 2008.

R. Sulski, *Pre-filed Testimony in the Matter of R08-09,* December 21, 2007, page 17.

U. S. EPA, *Technical Support Document for Water Quality-based Toxics Control,* EPA-440/4-85-032, September 1985.

TESTIMONY OF ROBERT M. STEIN

My name is Robert M. Stein and I am affiliated with AWARE Environmental Inc. (AEI). I have been evaluating the Citgo Lemont Refinery's (Lemont Refinery) wastewater treatment plant with regard to achieving the State of Illinois ammonia nitrogen discharge limitations for over 30 years. A summary of the AWARE Environmental Inc. professional capabilities, as well as the vitae for those persons participating in this evaluation are attached and are designated as follows:

Description of AWARE Environmental Inc.	**Exhibit 6**
Robert M. Stein Vitae	**Exhibit 7**
George Tyrian Vitae	**Exhibit 8**

I have specialized in the area of industrial water pollution control and I have worked with numerous industries with regard to biological nitrification and nitrogen control. I have consulted on over 10 refinery and 30 nitrogen control projects. A detailed list of projects is included in the attached vitae.

I have been a contributing author to one of the standard texts in the environmental engineering field, have been an adjunct professor at the University of North Carolina-Charlotte, I was appointed by the North Carolina Environmental Management Commission to serve on the Champion/Pigeon River Water Quality Variance Review Committee and I was awarded the TAPPI Roy F. Weston award for outstanding contributions in environmental technology. I have authored numerous articles on industrial environmental control. A list of publications is included with my vitae. Several of these were in the area of nitrogen control.

AEI, in addition to extensive experience in refinery and nitrogen removal systems in general, has a detailed understanding of the Lemont Refinery. The refinery produces gasoline, a variety of other fuels, coke, and solvents from crude oil. AEI personnel have been working with the Lemont Refinery treatment system for approximately thirty (30) years.

Process wastewater and stormwater from the refinery are treated in the refinery's wastewater treatment facility. The wastewater facility includes oil and solids removal, flow equalization, clarification, single-stage activated sludge treatment and final polishing.

The Lemont Refinery has been unable to consistently and reliably meet the State of Illinois effluent ammonia nitrogen concentration standard of 3.0 mg/L. The Illinois Pollution Control Board granted the refinery a site specific rule change, effective through December 31, 2008, which allows the refinery to meet the U.S. EPA Best Available Technology Economically Achievable (BAT) effluent limitations. The refinery has consistently achieved compliance with the U.S. EPA BAT effluent limitations.

AWARE Environmental Inc. (AEI) of Charlotte, North Carolina was retained by the Lemont Refinery to evaluate current conditions and potential alternatives for upgrading the treatment system to meet a 3 mg/l ammonia nitrogen limit. AEI conducted a conceptual evaluation of the Lemont Refinery wastewater treatment system, and the available alternatives to achieve ammonia removal for a refinery wastewater. The details of this evaluation are presented in our report entitled "Technical Review of Ammonia Treatment at the Wastewater Treatment Plant – Citgo Petroleum Corporation, Lemont Refinery," attached to this testimony as **Exhibit 9**. The primary objectives of this evaluation were to:

1. Determine if the present wastewater treatment system is consistent with 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 refinery 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 microorganisms 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.

We found that Lemont Refinery has maintained an ongoing optimization program and this program 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 the 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.

There are a large number of treatment technologies which can be utilized for ammonia removal. These include biological treatment technologies, land treatment, wetlands polishing, and physical/chemical treatment. As part of my review of treatment alternatives for upgrade of the Lemont Refinery wastewater treatment plant to achieve increased ammonia removal I considered our experience in design and operation of nitrogen technologies along with a detailed review of published data on technologies for ammonia removal. The most commonly used approach for ammonia nitrogen removal is biological nitrification.

Biological nitrification is typically a two step process as follows:

Nitrosomonas

$$2\ NH_4 + 3O_2 \longrightarrow 2\ NO_{2-} + 4H^+ + 2\ H_2O$$

Nitrobacter

$$2\ NO_{2-} + O_2 \longrightarrow 2NO_3^-$$

Total Reaction

$$NH_4^+ + 2O_2 \longrightarrow NO_3^- + 2H^+ + H_2O$$

It is in the biological nitrification process where refineries have experienced problems in providing consistent ammonia nitrogen removal. This is because biological nitrification is a very sensitive process. The cell growth rate is much lower for the ammonia nitrogen organisms (nitrifers) than for carbonaceous degradation (COD) organisms. In a typical activated sludge aeration basin, nitrifies represent only 2-5% of the aeration tank biomass. The nitrification growth rate is more sensitive to temperature changes than carbonaceous organism and nitrifers are more susceptible to chemicals discharges. This can occur in a number of ways:

1. Inhibition – Nitrifers continue to grow but at a slower rate
2. Toxicity – Loss of nitrifers

EPA has published a listing of organics and metals which inhibit the organic activated sludge process and which affect nitrification (EPA-430/9-76-017a). This document indicates there are significantly more compounds which affect nitrification than carbonaceous organisms and where a compound affects both it typically affects nitrifers at a much lower dosage (I.E. phenol affects carbonaceous organisms at 200 mg/l and nitrifers at 4-10 mg/l).

Because of the sensitivity of the nitrifying organisms in the degradation of refinery wastewaters and the long term variability which has occurred in achieving ammonia removal at the Lemont

Refinery, process technologies considerations were based on approaches which could minimize potential upsets and provide the best mechanism for biological nitrogen removal. This included single stage activated sludge (an increase in the activated sludge aeration basin size or addition of a media to the existing aeration basin to obtain additional biomass). Some of the media applications include Kaldnes, Linpor, Hydroxyl or Agar or the addition of supplemental specialized bacteria to a single stage basin. However, these alternatives were rejected because of the sensitivity of nitrifers to the refinery wastewater. Since the existing treatment plant has been experiencing problems with loss of nitrification and the fixed media type organisms are subject to sluffing, the addition of fixed media or increased retention time does not provide the best alternative to minimize potential upsets.

An alternative approach could be providing a fixed bed type system ahead of the activated sludge system as a pretreatment. However, this still presents a problem since the fixed bed bacteria would be more sensitive to upsets and would not do as good as job of removing the carboneous materials. There is a very high probability of sluffing of the organisms which could upset the activated sludge process.

In reviewing alternatives for upgrading a single activated sludge system, we felt that the two most promising alternatives were a single stage activated sludge with a powered activated carbon supplement or a single stage activated sludge membrane bioreactor. The powered activated carbon supplement includes the advantage of the plastic type media in that it provides a location where additional bacteria can grow however the powdered activated carbon also adsorbs materials that may be toxic or inhibitory to the nitrifying organisms. This process allows concentration of trace nutrients at the carbon surface and provides bulk addition to improve sludge settling properties.

The membrane bioreactor technology is one of the newest approaches for improving biological nitrification. With the membrane there can be improved solids liquids separation and the treatment plant is able to operate at significantly higher MLSS levels than in a conventional treatment plant (typically twice the normal MLSS levels). Specifically this allows:

1) the retention time of the biomass can be increased to create favorable conditions for normal growth of the nitrifying organisms;

2) better and more reliable effluent quality as compared to a conventional processes; and
3) easier control and operation of the system since the system would not longer need a secondary clarifier.

In addition to considering a single stage system we also considered two stage biological treatment. In a two stage process, carbonaceous removal is achieved in the first stage. This is normally an activated sludge process. The first stage reduces the concentration of toxic and inhibitory materials. There are two basic second stage alternatives. One is to have a 2^{nd} stage activated sludge system and the other is use of a fixed media system for the 2^{nd} stage. The reason for selecting a fixed media system for the 2^{nd} stage is that the nitrifying organisms tend to grow slower than carboneous organisms, they do not settle as well and therefore, if the inhibitory or toxic materials can be reduced in the 1^{st} stage than a 2^{nd} stage fixed film system provides a very good mechanism for biological treatment. The poor settling organisms will attach to the media.

Based on the analysis of all alternatives, four of the most viable alternatives were selected for preliminary process design and budgetary cost estimates. The four alternatives selected include powdered activated carbon addition (PACT), a two stage activated sludge 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.

Our findings indicate that the Lemont refinery has an approach which is properly directed to improving treatment plant performance, particularly as it relates to ammonia removal. 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.

In conjunction with the preparation of testimony I received and reviewed a copy of the June 20, 2008 document entitled "Recommendation of the Illinois Environmental Protection Agency" related to the Lemont Refinery ammonia standard request. I offer the following comments to information contained in that document:

1. Item #13 on Page 5. In this section it is indicated that many expenditures which were credited as improvements to the treatment plant were not directly related to ammonia nitrogen. I feel that this is not true since many of the items noted were implemented to improve the overall treatment plant performance and the overall treatment plant performance improvements allowed the treatment plant to provide increased biological nitrification. For example, gas floatation pretreats and removes oils and solids prior to the activated sludge system. Oils can inhibit nitrification and the lower levels of these materials improves biological nitrification. In addition, the cost of the Purge treatment unit "PTU", installed as part of the FCC consent decree, were largely caused by the need to consistently provide ammonia nitrogen removal. Before installation of the FCC unit, the Refinery was far below BAT treatment standards. The PTU wastewater treatment processes would likely not have been needed had the ammonia rule - or the ammonia site specific rule - not been in effect.

2. Item #15 on Page 7. There is a discussion that when the board adopted the provisions of the ammonia nitrogen standard there was extensive testimony as to the availability of methods for reducing ammonia in the effluent and it was determined that nitrification can be satisfactory accomplished for a reasonable price by a second stage of biological

treatment. It indicated that the evidence is clear that for too long, oxygen demand exerted by ammonia in **DOMESTIC** waste has been overlooked.

We feel that there is adequate demonstration that domestic wastewater treatment plants can achieve biological nitrification but this is not the case for the treatment of refinery wastewaters. Two documents which justify this finding are the "Development Document for Effluent Limitation Guidelines in New Source Performance Standards for the Petroleum Refinery Point Source Category", April 1974, developed by the US Environmental Protection Agency and the "Develop Document for Effluent Guidelines New Source Performance Standards and Pretreatment Standards for the Petroleum Refinery Point Source Category", October 1982, developed by the effluent guidelines division of the US Environmental Protection Agency. In both of these documents, there is clear indication that the petroleum refinery industry does not have the technology for economically achieving a 3 mg/l effluent standard on a consistent basis. In 1974, the EPA data showed that an activated sludge system for an petroleum refinery can expect to produce an effluent ammonia of 1 to 100 mg/l and in the 1982 development document the EPA indicated that for direct dischargers in the petroleum refinery industry (Table 6-1) that the current BPT for ammonia nitrogen is 6.8 mg/l.

These data indicate that although the board may have had extensive testimony on methods of removing ammonia nitrogen in domestic effluents the technology was fundamentally different for ammonia nitrogen in the refining industry.

3. Item #15 on Page 7. It is noted that Citgo is the only refinery discharging to the Ship Canal that has yet to meet the ammonia nitrogen standard in the Illinois administrative code. I am not aware of any other refineries that discharge to the ship canal.

4. Items #17 and 18 on Page 8. The board specifically states that nitrification can be satisfactory accomplished at a reasonable price. We question the use of reasonable price in light of the specific nitrogen reduction which is proposed to be achieved. Table 3-10 of the AWARE report (**Exhibit 9)** shows that the average effluent ammonia from January 2006 through October 2007 was 122 lbs NH_3-N/day. At an average flow of 7.13 MGD

and at a 3 mg/l ammonia nitrogen limit, the refinery would be allowed to discharge 178 lbs NH_3-N/day. Therefore, the long term ammonia discharge is less than the projected limit. The technical and economic justification to spend an annual cost in excess of 3,000,000 to achieve very little addition nitrogen removal and a level that is not expected to consistently achieve the 3 mg/l standard is questionable.

5. Item #19 on Page 9. This notes that Citgo is the only Illinois refinery not meeting the ammonia limit. Based on a review of the available NPDES data, the Conoco Philips Refinery is only in compliance with the 3 mg/l limit approximately 90% of the time and the Exxon Mobil Refinery has been in compliance only since 2005.

6. Item #20 on Page 9. The report questions if the refinery has adequate retention time to comply with the effluent standards. It should be noted that the retention time at the Conoco Philips is 1.31 days and that refinery, as previously noted, has only been in compliance approximately 90% of the time. The F/M as noted in the AEI report at the Citgo Refinery is adequate for biological nitrification and on a long term basis achieves a very low effluent ammonia concentration. One item noted in the EPA development document related to refineries are "the effluent from a properly designed and operated treatment plant changes continually due to the variety of factors. Changes in production mix, production rate, and reaction chemistry influence the composition of raw wasteload and therefore, its treatability. Changes in biological factors influence the efficiency of the treatment process". Therefore, we feel that there are a number of factors which effect the performance of a refinery treatment plant to achieve nitrification and that these have a direct effect on the ability of the treatment plant to consistently achieve nitrification.

7. Item #20 on Page 10. It was noted that Citgo did not consider additional aeration basin or additional clarifier to provide longer detention time. It should be noted in the AEI report (in Table 4-6 of **Exhibit 9**) that the overflow rate in the clarification system is lower than in the Exxon Mobil and Conoco Philips refineries. Therefore additional clarification would not necessarily make any significant improvement. We looked at additional detention time in that one of the processes selected (2-stage biological system where we used a fixed film system as the second stage). This provides additional detention time

and also provides what we feel is one of the best cases for providing good treatment in that a 2-stage system provides reduction of toxic and inhibitory materials in the 1st stage and a 2nd stage a fixed film type process provides a very good media for growth of nitrifying organisms.

8. Item #24 on Page 11. The ammonia concentrations in the permit should not affect the long term average ammonia discharge. As previously noted the long term ammonia discharge from the refinery in 2006-2007 was 122 lbs/day. This is actually significantly less on a long term basis than the proposed permitting levels. Therefore, we do not feel that there is any significant additional effect on aquatic life. This also applies to Item 25 on Page 12 which questions the additional ammonia effecting DO in the ship canal since on a long term average the ammonia discharge is less than would be permitted under the 3 mg/l regulation.

9. Item #37 on Page 16. The other refineries have not been able to consistently achieve the 3 mg/l level. We disagreed, as previously stated, that the additional ammonia removal will be cost effective.

I will now summarize our findings which have resulted in these conclusions:

1. COMPARISON OF LEMONT REFINERY WITH U.S. EPA BAT TECHNOLOGY

a) The U.S. EPA has developed a model plant for sour water strippers. The Lemont Refinery has maintained an on-going program with the objective of improving stripper performance. The sour water stripper data from the last ten years shows that ammonia removal efficiencies have been observed in excess of 96.8 percent, and monthly average efficiencies have been observed in excess of 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 ongoing improvement.

b) The U.S. EPA developed a BAT model for a refinery wastewater treatment system. Our analysis of the Lemont Refinery wastewater treatment system indicates that it exceeds the BAT technology for refinery 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 1. As shown in Table 1 the refinery treatment system contains all of the BAT components outlined in the 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. Based on the continued improvement in effluent quality it appears that these improvements and upgrades have been successful.

c) We have found that the Refinery wastewater treatment system performance is compliant with the U.S. EPA BAT effluent limits for ammonia. The current NPDES ammonia limits are 1005.73 lbs/day average and 2212.65 lbs/day maximum based upon updated production data. An evaluation of the data from January 2006 through October 2007 shows that the effluent ammonia has consistently been less than BAT levels with an average ammonia nitrogen discharge over this period of 122 lbs/day. The refinery produces a better quality effluent ammonia and the U.S. EPA BAT ammonia effluent limits are achieved 100 percent of the time, even under extreme and adverse conditions.

2) ANALYSIS OF TREATMENT PROGRAM

A number of parameters have been identified which affect biological nitrification. These parameters are: F/M (food to mass ratio); sludge age, aeration basin pH, aeration basin temperature; and aeration basin dissolved oxygen concentration.

Table 2 presents an analysis of normal requirements for nitrification and the operating levels at the Lemont Refinery. As can be noted, the Lemont Refinery has consistently provided equal or better capabilities.

TABLE 1

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% 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 2

TYPICAL OPERATING RANGES FOR NITRIFICATION

Parameter	Optimum Range	Lemont Refinery Operation[2]
F/M, lb BOD5/lb MLVSS-day	Less than 0.3	0.056 – 0.287[3]
Sludge Age, days	$\geq$ 10	13.1 - > 100
D.O., mg/L	2.0[1]	3.3 – 7.0
pH	7.2 – 9.0	7.0 – 8.2
Temperature, ºF	68 – 100	76 - 97

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) F/M exceeded this range in June and July 1994. Overall average F/M over operating period is approximately 0.150 lb/lb-day.

3) 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 3.

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-Phillips and Marathon refineries have a longer retention time than the Lemont Refinery. The Exxon-Mobil and Lemont Refinery have similar activated sludge retention times. A review of the effluent data shows that the Conoco-Phillips Refinery has not been in consistent compliance with the 3 mg/l ammonia standard. The Exxon-Mobil Refinery exceeded the 3 mg/l limit prior to 2005.

TABLE 3

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 mg	Polishing pond 4.9 mg	Polishing in treated water basin (polishing pond) 16 mg	Final filtration

4) ADDITIONAL TECHNOLOGIES FOR THE REMOVAL OF AMMONIA

The AEI analysis of the Lemont Refinery treatment facility indicated that the refinery has been unable to provide consistent biological nitrification. Consequently alternative treatment technologies or variations of the biological treatment technology were examined to determine the feasibility of achieving the State of Illinois ammonia limitations of 3 mg/L. The alternative technologies which were evaluated included:

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.

Each technology was subjected to a rigorous and thorough evaluation to evaluate its potential for achieving the objective mentioned above.

Our analysis indicated that the least expensive approach for compliance was a second stage fixed media biological treatment unit. The annualized cost for the fixed media system over 10 years at percent interest is $3,220,000.

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 mg/L ammonia nitrogen standard. Therefore, upgrading the treatment system with additional treatment technologies for ammonia removal is not justified at this time.

SUMMARY

In 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. There have been significant changes in crude supply and the refinery is processing heavier crudes, the wastewater treatment program has been diligent and has continued to provide excellent performance. 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 mg/L ammonia nitrogen standard as required in the Illinois regulations.

The Lemont Refinery has continued its program to optimize its treatment system. This appears to be the proper direction for improving wastewater treatment performance.

Alternative add-on, end-of-pipe treatment technology has been evaluated and will have an annualized cost of $3,220,000. There is no guarantee that installing this technology will result in compliance with the 3 mg/L ammonia nitrogen limitation.

Therefore, 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.

35606003

EXHIBIT 1 TO PRE-FILED TESTIMONY IN SUPPORT OF
CITGO'S PETITION FOR AN ADJUSTED STANDARD (AS 2008-008)

ADDITIONAL INFORMATION REQUESTED BY THE HEARING OFFICER

1a. *What is the Design Average Flow for the Refinery's discharge?*

5.79 MGD (H&H Report, page 9).

1b. *Is the far edge of the mixing zone located in the Chicago Sanitary & Ship Canal?*

Citgo discharges into the S&S Canal at River Mile 296.5 (H&H Report page 16). The maximum permitted mixing zone would carry to River Mile 291.5, which is still in the Chicago Sanitary & Ship Canal 0.5 miles above the Lockport Lock & Dam (H&H report page 16).

1c. *What is the projected incremental change in the ammonia concentration at the edge of the mixing zone when the refinery is discharging 10.61 mg/L? Also, please describe the incremental changes in terms of un-ionized ammonia.*

The 7Q10 for the S&S Canal at Romeoville is 1,315 cfs, or 850 million gallons per day (MGD) (H&H Report, page 9). The mixing zone would encompass 212.5 MGD at low flow, so the available dilution would be 212.5 MGD/5.79 MGD or 36.7 to 1. Using a background of 0.65 mg/L for the average ammonia upstream of the refinery, then when the refinery is discharging 10.61 mg/L at 5.79 MGD, the incremental increase in ammonia concentration at the edge of the mixing zone will be 0.27 mg/L. This value assumes no reduction in concentration due to nitrification or volatilization within the mixing zone, essentially treating ammonia as a conservative pollutant. It should be noted that Citgo's already exists, and so the downstream water quality data presented in the Huff & Huff Report already reflect this contribution.

With respect to the question on the un-ionized ammonia, the average ammonia at Lockport was 0.65 mg/L from 2001 to 2002, while the un-ionized ammonia averaged 0.005 mg/L (Tables 4-1 and 4-2 from the H&H Report). Therefore on average, the un-ionized ammonia represents 0.76% of the total ammonia. So when the Refinery is discharging at 10.61 mg/L, at the edge of the mixing zone the total ammonia will be 0.27 mg/L higher, and the un-ionized ammonia will increase over the upstream by 0.002 mg/L, assuming again no biological degradation or volatilization. Table 4-2 from the H&H Report clearly indicates un-ionized ammonia water quality consistently achieves the standards.

1d. *The 2008 AWARE Report states that "[t]he annual average ammonia discharge to the Canal over the last 5 years has averaged 102.4 pounds per day…" Pet., Exh. B at 30. Please elaborate on the data used to calculate the average of 102.4 pounds per day for the last five years.*

Aware used the effluent data from 2003 through 2007, inclusive, to compute this average mass discharge. The specific data was:

Year	Ammonia(lb/day)
2003	99
2004	62
2005	116
2006	139
2007	96

1e *Does Citgo anticipate an increase in production during the requested 5-year adjusted standard period?*

Citgo continues to carry out projects that make the refinery process more efficient, and this will continue over the five year period. None of these projects will result in an increase in the ammonia loading to the wastewater treatment plant. There are currently no plans to increase the crude oil throughput from the current rated capacity. Citgo does anticipate it will identify additional projects that will reduce effluent ammonia loadings to the wastewater treatment plant over the five year period.

2a. *Did the petitioners intend to propose that 6.93 mg/L be the monthly average limitation and 10.61 mg/L be the daily maximum limitation? Also, please explain the rationale for proposing effluent limits based upon ammonia loading rates on a monthly and daily basis.*

Citgo did indeed intend to propose the 6.93 mg/L as a monthly average limit and the 10.61 mg/L as the daily maximum limit.

The proposed concentration limits when the mass loadings exceed 100 lbs/day (monthly) or 200 lbs/day (daily) is based upon Title 35, Section 304.122. The refinery is located on part of the Illinois River System, which has unique effluent ammonia limits that are applicable only to dischargers exceeding the above mass limits. Dischargers below these mass limits currently have no concentration limits. As noted in the next question, Citgo has not consistently achieved the requested concentration limits. Citgo believes it is important to continue to show progress toward meeting the Illinois effluent limits, and therefore committed to the more restrictive concentration limits, when the mass loadings exceed the regulatory thresholds. This threshold is important in the Refinery's ability to comply with the proposed limits. While the Refinery has limited control over ammonia concentrations on a day-to-day basis, it has significant control on the volume discharged to the Ship Canal. Therefore, during upsets, Citgo plans to reduce the volume discharge in the short run in its Treated Water Basin, and if necessary reprocess part of this water until the concentration limits are achieved. This will require a change in the operational practices at the wastewater treatment facilities, which Citgo is prepared to make.

2b *Please clarify that the limits of 6.93 mg/L and 10.61 mg/L in the proposed adjusted standard are attainable as expected by petitioners. Also, please elaborate on reliance upon the 95th percentile and whether exceedences above the limits based on the 95th percentile are expected.*

Anytime one relies on a statistical approach, exceedences can be expected based on the confidence level chosen. Again, Citgo is committed to making reasonable progress toward compliance with the Illinois effluent limits, and believes it can achieve the requested levels on a consistent basis, assuming the mass limit applicability is also adopted. As explained in the response to question 2a, Citgo's operational strategy will be to hold back effluent water to stay under the mass thresholds during upset conditions.

3. *Please demonstrate that the unionized ammonia water quality standard of 0.1 mg/L will be met at the edge of the mixing zone.*

The monitoring data presented in the Huff & Huff Report already includes the ammonia contribution from the Citgo Refinery. This request is not for a new or increased discharge of ammonia. As described in response to question 1c, the un-ionized ammonia averages 0.76% of the total ammonia. At a discharge of 10.61 mg/L, as derived in response to question 1c, the incremental increase in ammonia at the edge of the mixing zone will be 0.27 mg/L. Assuming the un-ionized ammonia is 0.76% of this 0.27 mg/L, that yields 0.002 mg/L increase in un-ionized ammonia. Using the highest un-ionized ammonia recorded at the Lockport Forebay on the Ship Canal (Table 4-2 from H&H Report) of 0.070 mg/L and assuming that Citgo's existing effluent did not somehow contribute to this value, then the predicted maximum un-ionized ammonia will be 0.072 mg/L at the edge of the mixing zone, compared to the water quality standard of 0.100 mg/L. Again, it is important to note that ammonia is not a conservative pollutant, it will both degrade and volatilize as it travels downstream.