FINAL STAFF REPORT

PROPOSED AMENDMENT OF THE WATER QUALITY CONTROL PLAN – LOS ANGELES REGION – TO REVISE AMMONIA OBJECTIVES FOR INLAND SURFACE WATERS

April 25, 2002

TABLE OF CONTENTS

TABLES

FIGURES

PROPOSED AMENDMENT OF THE WATER QUALITY CONTROL PLAN – LOS ANGELES REGION - TO REVISE AMMONIA OBJECTIVES FOR INLAND SURFACE WATERS

I. INTRODUCTION

Background

Ammonia is a pollutant routinely found in the wastewater effluent of Publicly Owned Treatment Works (POTWs), in landfill-leachate, as well as in run-off from agricultural fields where commercial fertilizers and animal manure are applied.

Because ammonia has a known toxic effect to aquatic life, the United States Environmental Protection Agency (U.S. EPA) Office of Water has found that the control of ammonia discharges is necessary to protect aquatic life uses in surface waters of the United States.

Ammonia exists in two forms – un-ionized ammonia (NH3) and the ammonium ion (NH4+). Both forms are toxic but the un-ionized form (NH3) is much more toxic. Un-ionized ammonia is much more toxic because it is a neutral molecule and able to diffuse across the epithelial membranes of aquatic organisms much more readily than the charged ammonium ion.

The form of ammonia is pH and temperature dependent. Low pH and/or low temperature leads to lower NH3 and lower toxicity.[1]

[1] The two forms are in equilibrium according to the following equation:

$$NH_4^+ \leftrightarrow NH_3 + H^+$$

$$K = \frac{[NH_3][H^+]}{[NH_4^+]}$$

The equilibrium constant K depends significantly on temperature; this relationship has been described by Emerson et al. (1975) with the following equation:

$$pK = 0.09018 + \frac{2729.92}{273.2 + T}$$

where $pK = -\log_{10}K$ and T is temperature in degrees Celsius

The following expressions can be derived for the fraction of total ammonia in each of the two forms:

$$f_{NH3} = \frac{1}{1 + 10^{pK-pH}}$$

$$f_{NH4+} = \frac{1}{1 + 10^{pH-pK}}$$

$$f_{NH3} + f_{NH4+} = 1$$

Proposed Action
The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) has adopted a Water Quality Control Plan for the Los Angeles Region (Basin Plan). The existing Basin Plan establishes water quality objectives for ammonia in inland surface waters that are based on U.S. EPA guidance, data and water quality models available in 1994.

The Regional Board staff proposes an amendment to the Basin Plan to update the inland surface water (including enclosed bays, estuaries and wetlands) quality objectives for ammonia. The proposed amendment would update the current objectives outlined in the Basin Plan for all inland surface waters whose existing beneficial uses include those to protect aquatic life. The goal of this amendment is to reflect the revised criteria developed by U.S. EPA, in the "1999 Update of Ambient Water Quality Criteria for Ammonia," December 1999. The 1999 Update contains U.S. EPA's most recent freshwater aquatic life criteria for ammonia and supersedes all previous freshwater aquatic life criteria for ammonia. For inland waters not characteristic of freshwater, Regional Board staff propose to retain the existing objectives for inland waters designated "WARM" until staff more thoroughly evaluate the most appropriate objectives for these waters. The proposed amendment also includes language for implementing the revised objectives in the Los Angeles Region.

II. RATIONALE FOR BASIN PLAN AMENDMENT

U.S. EPA's 1999 Update criteria constitute the agency's current recommended federal Clean Water Act (CWA) section 304(a) criteria for ammonia, which States, Territories, and authorized Tribes may use as guidance in adopting water quality standards. Water quality standards developed from the section 304(a) criteria are designed to protect the beneficial uses identified for a particular water body. The water quality standards form the basis for establishing enforceable water quality-based effluent limitations in discharge permits.

Section 304(a)(1) of the Clean Water Act (33 U.S.C. 1314(a)(1)) directs U.S. EPA to publish and periodically update ambient water quality criteria. These criteria are to reflect the latest scientific knowledge on the identifiable effects of the pollutants on public health and welfare, aquatic life, and recreation. These criteria serve as guidance to States, Territories and authorized Tribes in adopting water quality standards under section 303(c) of the CWA that protect aquatic life from acute and chronic effects of ammonia. State and Tribal decision-makers retain the discretion to adopt water quality standards on a case-by-case basis that differ from this guidance when appropriate and where supported by local data.

In May of 2001 the Regional Board identified updating the ammonia objective as the second highest priority in its triennial review of the Basin Plan. In the very near term, and in subsequent years, the Regional Board will consider several total maximum daily loads (TMDLs) for nutrients, including ammonia. Adoption of this Basin Plan amendment will update the Region's Ammonia Water Quality Objectives, which serves as a basis for numeric targets in TMDLs and effluent limits in discharge permits. If the Regional Board does not address the 1999 Update for Ammonia, U.S. EPA will establish criteria for the Los Angeles Region by 2004.

III. PROPOSED CHANGES

Existing Ammonia Water Quality Objectives

The Basin Plan objectives for ammonia currently are based on U.S. EPA's "Ambient Water Quality Criteria for Ammonia – 1984," which contains criteria for protection of freshwater aquatic life. In 1992 U.S. EPA revised its recommended values for the Criteria Continuous Concentration (CCC) through a memorandum entitled "Revised Tables for * * * Freshwater Ammonia Concentrations." The chronic criteria were raised slightly because one of the chronic toxicity tests involving white sucker used in the 1984 criteria was no longer considered valid.

The Basin Plan currently addresses ammonia in the following manner:

> The neutral, un-ionized ammonia species (NH_3) is highly toxic to fish and other aquatic life. The ratio of toxic NH_3 to total ammonia ($NH_4^+ + NH_3$) is primarily a function of pH, but is also affected by temperature and other factors. Additional impacts can occur as the oxidation of ammonia lowers the dissolved oxygen content of the water, further stressing aquatic organisms. Ammonia also combines with chlorine (often both are present) to form chloramines – persistent toxic compounds that extend the effects of ammonia and chlorine downstream.
>
> Oxidation of ammonia to nitrate may lead to groundwater impacts in the area of recharge.
>
> *In order to protect aquatic life, ammonia concentrations in receiving waters shall not exceed the values listed for the corresponding in-stream conditions in Tables 3-1 to 3-4 [of the Basin Plan].*
>
> *Timing of compliance with this objective will be determined on a case-by-case basis. Dischargers will have up to 8 years following the adoption of this plan by the Regional Board to (i) make the necessary adjustments/improvements to meet these objectives or (ii) to conduct studies leading to an approved site-specific objective for ammonia. If it is determined that there is an immediate threat or impairment of beneficial uses due to ammonia, the objectives in Tables 3-1 and 3-4 shall apply.*
>
> *In order to protect underlying groundwater basins, ammonia shall not be present at levels that when oxidized to nitrate, pose a threat to groundwater quality.*

Tables 3-1 to 3-4 from the Basin Plan are reproduced in Appendix 1 as Tables 1-1 to 1-4.

Proposed Objectives

The new criteria reflect research and data analyzed since 1985, and represent a revision of several elements in the 1984 guidance, including the relationship between ammonia toxicity, pH and temperature, and the recognition of increased sensitivity of early life stage forms of fish to ammonia toxicity. The 1984 criteria were based on un-ionized ammonia (NH_3), while the 1999 criteria are expressed only as total (un-ionized plus ionized or $NH_3 + NH_4^+$) ammonia. The criteria apply to freshwater and do not impact the Ammonia Water Quality Objectives contained in the California Ocean Plan.

The existing Basin Plan chronic objectives, from the 1984 EPA Ammonia Criteria and addendum, are based on Acute to Chronic Ratios (ACRs). The chronic toxicity data available in 1984 was not sufficient to develop pH and temperature dependent chronic criteria, so an estimated ACR was used to convert the acute criteria to chronic criteria. In the 1999 update, sufficient studies had been conducted to develop a chronic criterion directly, independent of the acute criterion. This method is preferable because it is based on observed relationships to pH and temperature in chronic toxicity testing rather than being based on a ratio to the acute criteria estimated from a small number of available chronic studies.

The most significant differences in the 1999 U.S. EPA guidance for ammonia are:

1. Acute criteria are no longer temperature-dependent but remain dependent on pH and fish species present.
2. A greater recognition of the temperature dependence of the chronic criteria, especially at low temperatures.
3. An Early Life Stage (ELS) chronic criteria was introduced.
4. Chronic criteria are no longer dependent on the presence or absence of specified fish species, but remain dependent on pH and temperature.
5. A 30-day averaging period for the ammonia chronic criteria replaced the 4-day averaging period.

Under the 1984 guidance, the acute criteria were dependent on pH, temperature, and the presence or absence of salmonids. Under the updated guidance, the acute criteria are dependent on pH and fish species, but not temperature.

The 1984 chronic criteria were dependent mainly on pH and there was no temperature dependency below 20 degrees. The updated chronic criteria are dependent on pH and temperature. At lower temperatures, the chronic criteria also are dependent on the presence or absence of early life stages of fish (ELS), regardless of species. Another significant revision in the 1999 Update is U.S. EPA's recommendation of 30 days as the averaging period for the chronic criteria instead of 4 days. The averaging period has been extended because the most sensitive test species used, *fathead minnow* (*Pimephales promelas*) and fingernail clam (*Muscullum transversum)* show their sensitivity after long periods of exposure.

Calculation of Proposed Objectives

1. The one-hour average concentration of total ammonia as nitrogen (in mg N/L) shall not exceed the acute objective (CMC) calculated using the following equations.[2]

   Where salmonid fish are present:

$$CMC = \frac{0.275}{1+10^{7.204-pH}} + \frac{39.0}{1+10^{pH-7.204}}$$

[2] U.S. EPA has not provided official guidance on what level to set the pH in these equations.

Or where salmonid fish are not present:

$$CMC = \frac{0.411}{1+10^{7.204-pH}} + \frac{58.4}{1+10^{pH-7.204}}$$

2. The thirty-day average concentration of total ammonia as nitrogen (in mg N/L) shall not exceed the chronic objective (CCC) calculated using the following equations.

   Where early life stage fish are present:

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) * MIN\left(2.85, 1.45 * 10^{0.028*(25-T)}\right)$$

   Where T = temperature expressed in ºC.

   Or where early life stage fish are not present:

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) * 1.45 * 10^{0.028*(25-MAX(T,7))}$$

   Where T = temperature expressed in ºC.

3. In addition, the highest four-day average within the 30-day period shall not exceed 2.5 times the chronic objective (CCC).

The 1999 Criteria can be seen in three tables in Appendix 2.

For inland surface waters not characteristic of freshwater (as determined by the procedures in paragraph 2 of Section V, Implementation of Ammonia Objectives), concentrations of ammonia shall not exceed the values listed for the corresponding instream conditions in Tables 1-2 and 1-4 in Appendix 1.

For water bodies where Ammonia Water Effects Ratios (WERs) have been fully approved through the Basin Plan Amendment process, the objective will be multiplied by the WER to determine the site-specific objective.

IV. COMPARISON OF CURRENT BASIN PLAN OBJECTIVES AND 1999 UPDATE RECOMMENDED CRITERIA FOR AMMONIA

Criteria Maximum Concentration (acute criteria)

The CMC (criteria maximum concentration) is a function of pH and the presence/absence of salmonids. The CMC is not a function of temperature. The criteria are designed to protect the most sensitive taxa; in the case of acute ammonia toxicity, fish are more sensitive than invertebrates. During acute ammonia toxicity testing, fish survival was not seen to be dependent on temperature. Therefore, the acute criteria are not temperature dependent. Different CMC values are derived for waters where salmonids[3] are present versus not present.

[3] Salmonids are a type of fish that include chinook salmon, coho salmon, steelhead trout and coastal cutthroat trout.

For the salmonids present, acute criteria, the 1999 U.S. EPA recommended ammonia criteria are higher (less stringent) than the current Basin Plan criteria for cold water, except in the pH range of 7.25-8.25 where the temperature is between 0 and 15 degrees Celsius (32 to 59 degrees Fahrenheit) (See Figure 1). The maximum difference between the current Basin Plan objectives and U.S. EPA recommended criteria is approximately 21 mg/L as nitrogen (mg N/L) for the salmonids present, acute condition. This difference occurs at 30 degrees Celsius and a pH value of 6.5 (See Table 1a). The minimum difference between the current Basin Plan objectives and U.S. EPA recommended criteria is approximately -0.12 mg N/L for the salmonids present, acute condition. This difference occurs at 5 degrees Celsius and a pH value of 7.5 (See Table 1a).

For the salmonids absent, acute criteria, the 1999 U.S. EPA recommended ammonia criteria are higher (less stringent) at all temperature and pH values than the current Basin Plan criteria (See Figure 2). The maximum difference between the current Basin Plan and U.S. EPA recommended criteria is approximately 32 mg N/L. This difference occurs at 30 degrees Celsius and a pH of 6.5. The minimum difference between the current Basin Plan objectives and U.S. EPA recommended criteria is approximately 0.49 mg N/L for the salmonids absent, acute condition. This difference occurs at 25 degrees Celsius and a pH value of 9 (See Table 1a).

The differences between the current Basin Plan objectives and the U.S. EPA recommended criteria are greatest where the pH is equal to or less than 7.5. On average, the U.S. EPA recommended acute criteria are 1.56 times greater than the current Basin Plan objectives for ammonia (See Table 1b). [4]

Table 1a: Range of Differences between the Current Acute Basin Plan Objectives and the U.S. EPA Recommended Acute Criteria

ACUTE CRITERIA TYPE	mg N/L (pH range < or = 7.5)	mg N/L (pH range > 7.5)
Salmonids present, Acute	0.12 – 20.85	0.14 – 2.74
Salmonids absent, Acute	5.59 – 32.39	0.49 – 7.25
Min / Max	**-0.12 – 32.39**	**0.14 – 7.25**

[4] The 1999 EPA recommended acute criterion for the salmonids absent condition was divided by the Basin Plan acute objectives for warm waters for each pH and temperature scenario described in Table 3-2 of the Basin Plan. The average of these ratios was then calculated. The same calculation was conducted for the salmonids present condition. The average of these ratios was then calculated. Finally the average was taken of the two calculated averages to derive the summary ratio given above for the difference between the acute objectives under the Basin Plan and the 1999 recommended criteria.

Table 1b: Ratio Between 1999 U.S. EPA Recommended Acute Criteria and Current Acute Basin Plan Objectives

ACUTE CRITERIA TYPE	mg N/L
Salmonids present, Acute	1.35
Salmonids absent, Acute	1.77
Average	**1.56**

Figure 1

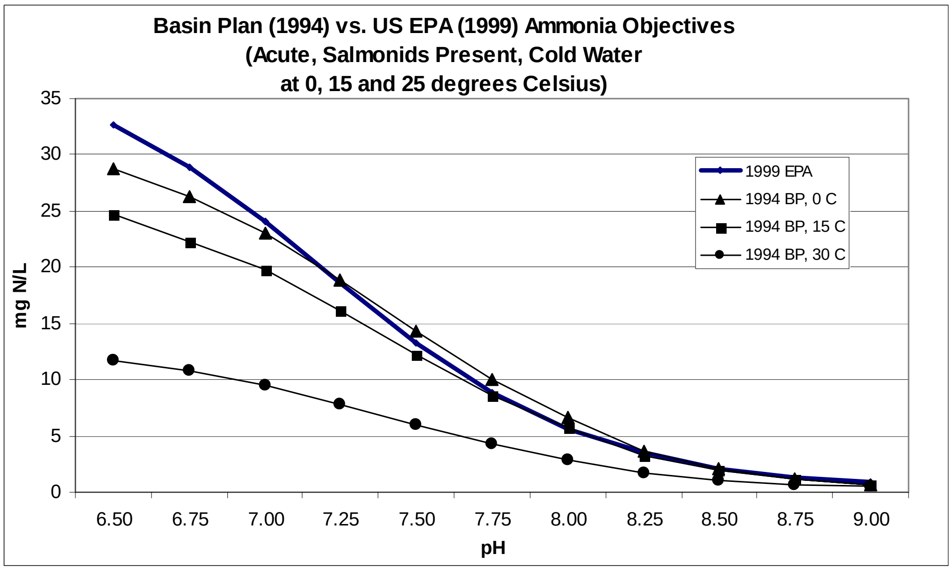
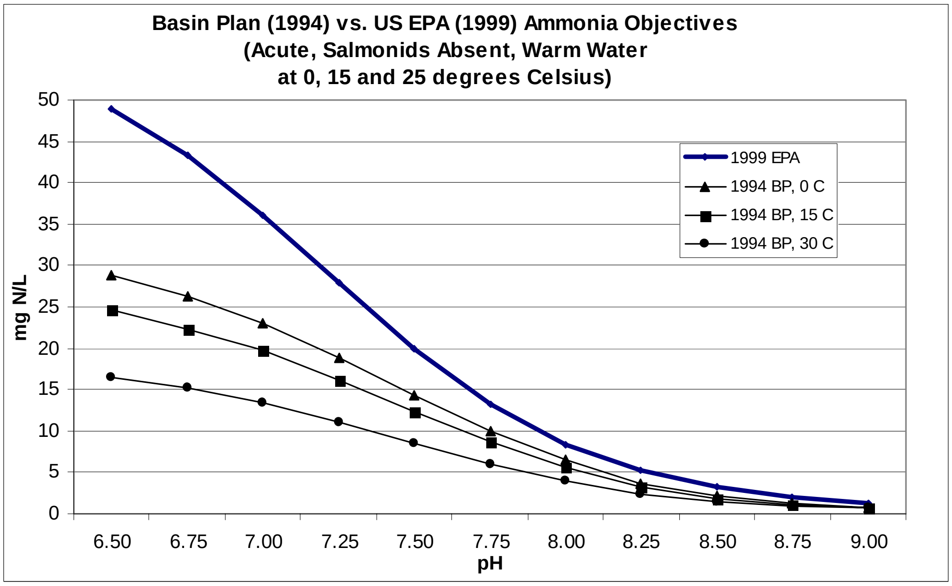


Figure 2

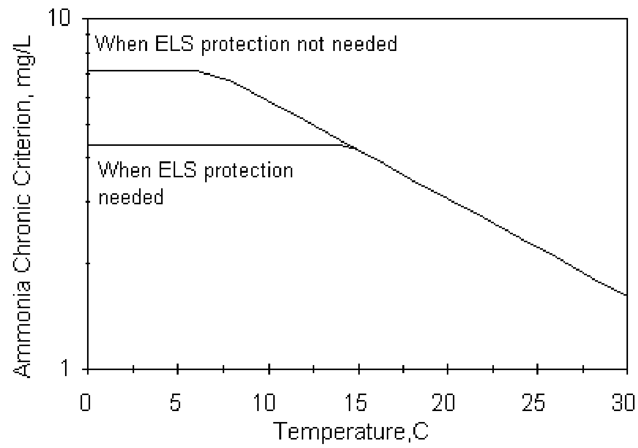


Criteria Continuous Concentration (chronic criteria)

The CCC (criteria continuous concentration) is a function of pH, temperature and presence/absence of "early life stages" (ELS) of fish. The 1999 CCC criteria are based on a revised relationship to temperature. Above 15 degrees Celsius, invertebrates are the most sensitive chronic test species. The higher the temperature or pH the less ammonia invertebrates can tolerate. At low temperatures (below 15 degrees Celsius), the CCC depends instead on whether early life stages of fish are present. At temperatures below 15 degrees Celsius, where ELS are present, the chronic criterion for ammonia is 4.36 mg/L as nitrogen (mg N/L). However, ELS have the same sensitivity to ammonia irrespective of how low the temperature is below 15 degrees Celsius, therefore the curve flattens beginning at 15 degrees Celsius in Figure 3. At temperatures below approximately 7 degrees Celsius, when ELS are not present, fish are more sensitive to ammonia than are invertebrates. Again, fish sensitivity to ammonia does not depend on temperature changes below 7 degrees Celsius, so the curve flattens out where the ammonia criterion is 7.09 mg N/L.

The CCC is not species specific but is based on the most sensitive test species. In addition, the criteria include a sub-chronic (4-day) criteria which is higher than the 30-day chronic criteria. Specifically the sub-chronic (4-day) is 2.5 times higher than the chronic (30-day) criteria. Prior to the 1999 Update, the factor was 2.0.

Figure 3. Chronic criterion values in the 1999 Update; pH=7.5.



As can be seen in Figures 4 through 11, the 1999 Update contains chronic criteria for ammonia that are higher (less stringent) in all cases than the criteria (objectives)[5] currently in the Basin Plan. Note that the 4-day objectives (called "chronic") in the current Basin Plan were compared to the 4-day criteria (called "sub-chronic") in the 1999 Update. The greatest differences between the present and recommended criteria are at low pH values (equal to or less than 7.5), where the maximum difference is 24.76 mg N/L. This difference occurs in warm waters where ELS are absent. At pH values greater than 7.5, the maximum difference is 11.58 mg N/L. This difference also occurs for warm-water habitat where ELS is absent. See Table 2a below for the range of differences between U.S. EPA criteria and Basin Plan objectives for each chronic criteria type at various pH levels. On average, the U.S. EPA recommended criterion is 6.35 times greater than the current Basin Plan objective for ammonia (See Table 2b).[6]

[5] The allowable limits or levels of water quality constituents or characteristics, which are established for the reasonable protection of beneficial uses of water or the prevention of a nuisance within a specific area are referred to as "criteria" in the federal Clean Water Act. By contrast these limits or levels are called "objectives" in the State of California Porter-Cologne Water Quality Control Act.

[6] The 1999 EPA recommended chronic criterion for the warm water/ELS present condition was divided by the Basin Plan chronic objective for warm waters for each pH and temperature scenario. The average of these ratios was then calculated. This calculation was repeated for three other scenarios: warm water/ELS absent, cold water/ELS present and cold water/ELS absent. Finally, the average was taken of all of the calculated averages to derive the summary ratio given above.

Table 2a: Range of Differences between the Current Chronic Basin Plan Objectives and 1999 U.S. EPA Recommended Chronic Criteria

CHRONIC CRITERIA TYPE	mg N/L (pH range < or = 7.5)	mg N/L (pH range > 7.5)
Cold, ELS Absent	3.29-24.76	0.37-11.58
Cold, ELS Present	3.29-14.45	0.37-6.39
Warm, ELS Absent	2.99-24.76	0.34-11.58
Warm, ELS Present	2.99-14.45	0.34-6.39
Min / Max	**2.99 - 24.76**	**0.34 – 11.58**

Table 2b: Ratio Between 1999 U.S. EPA Recommended Chronic Criteria and Current Chronic Basin Plan Objectives

CHRONIC CRITERIA TYPE	mg N/L
Cold, ELS Absent	7.4
Cold, ELS Present	6.08
Warm, ELS Absent	6.62
Warm, ELS Present	5.3
Average	**6.35**

Criteria Continuous Concentration – Early Life Stage Provision

U.S. EPA has established a provision in its ammonia criteria that allows for a relaxation of the CCC when early life stages (ELS) of fish are not present, since, at low ambient water temperatures, adult and juvenile fish are less sensitive to ammonia toxicity than are ELS fish. U.S. EPA has concluded that it would be appropriate to relax the ammonia CCC, as ambient water temperature decreases, in water bodies at certain times of the year where early life stages are not present. The magnitude of the ELS-absent adjustment is dependent on temperature. There are two tables in the 1999 Update, one for periods when early life stages are present and one when absent (see Appendix 2, Tables 2-2 and 2-3).

The early life stages include the pre-hatch embryonic period, the post-hatch free embryo or yolk-sac fry, and the larval period, during which the organism feeds. The ELS does not include the juvenile stage. The duration of ELS lasts from the beginning of spawning until the end of the ELS. The end of ELS varies per fish species. The duration of ELS of selected fish can be seen in Table 3 below.

Table 3: Duration of ELS for Selected Species

TAXON	End of ELS Development (in days after spawning)
Fathead minnow	34 days
Channel catfish	34 days
Bluegill	34 days
White sucker	34 days
Northern pike	34 days
Striped bass	46 days
Trout, salmon, char	30 days after swim-up (swim-up is the stage when fry leave the nest and swim up to the surface to catch food.

Chronic Criteria (ELS Absent, Cold Water)

Figure 4

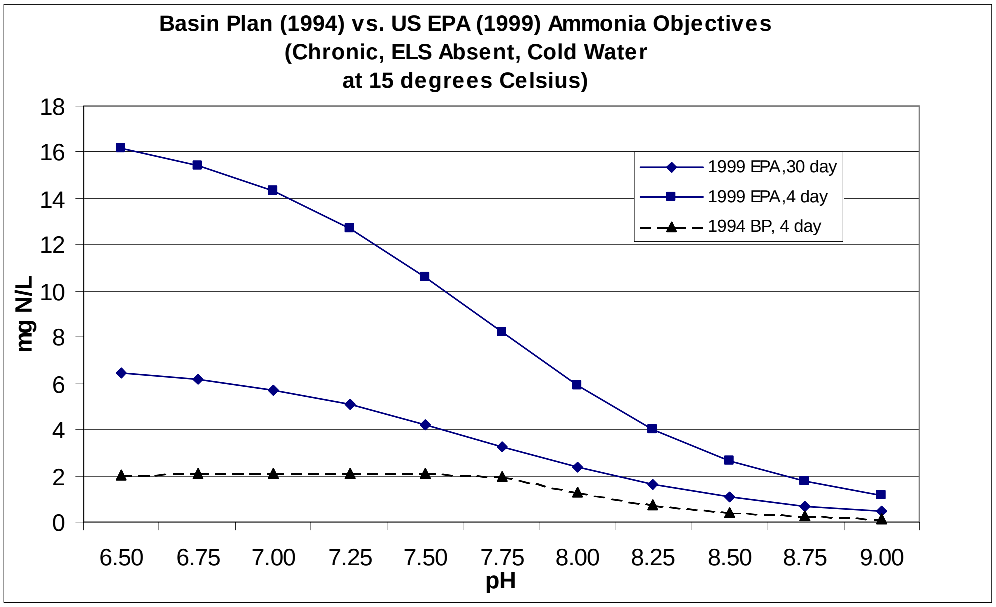
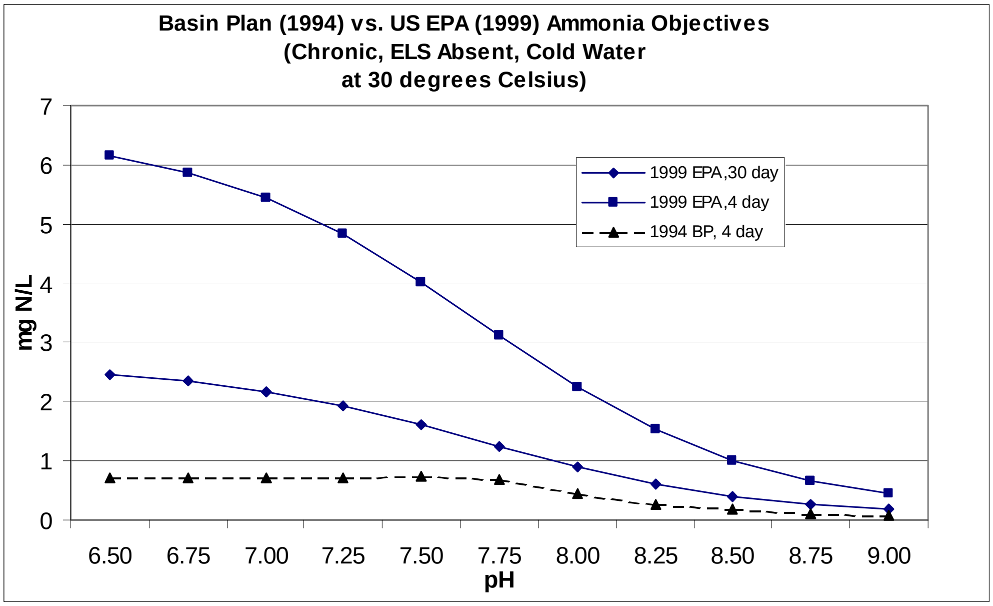


Figure 5



Chronic Criteria (ELS Present, Cold Water)

Figure 6

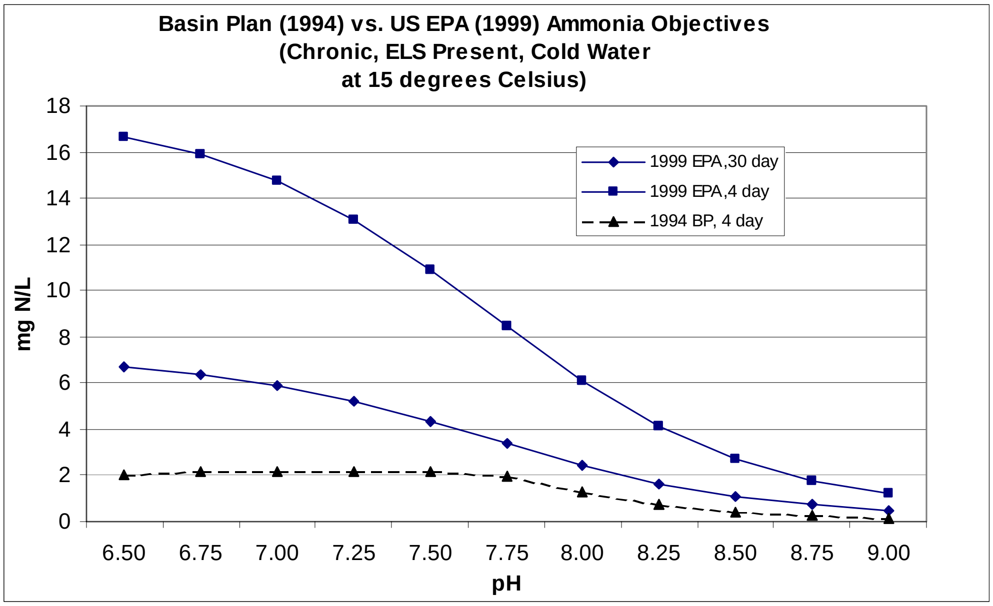
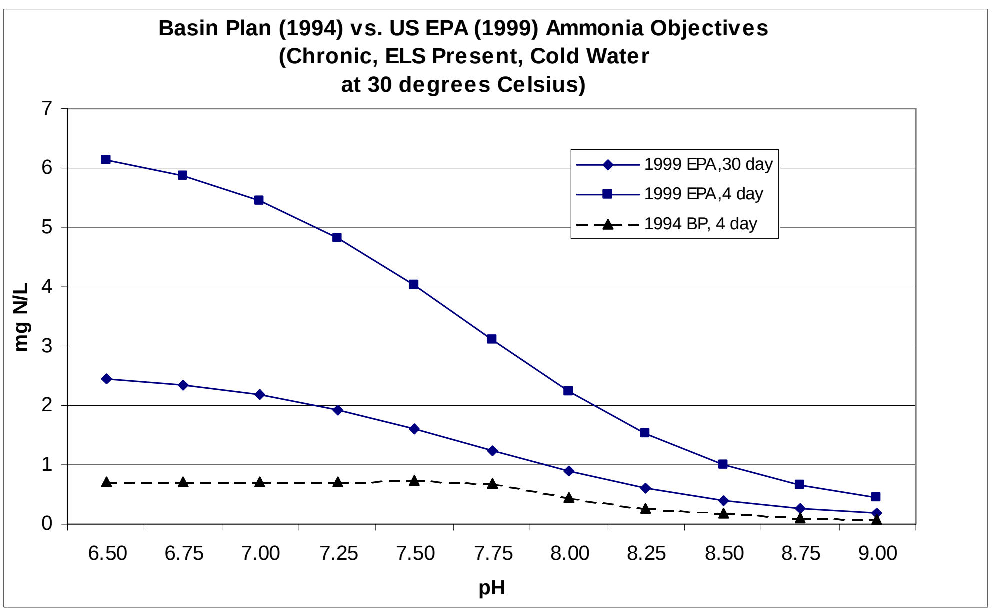


Figure 7



Chronic Criteria (ELS Absent, Warm Water)

Figure 8

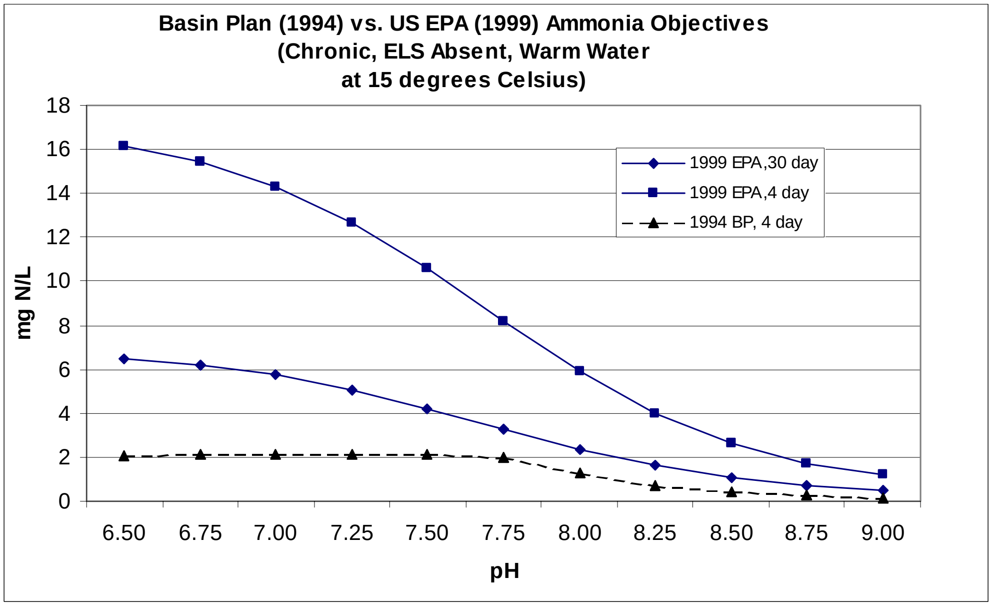
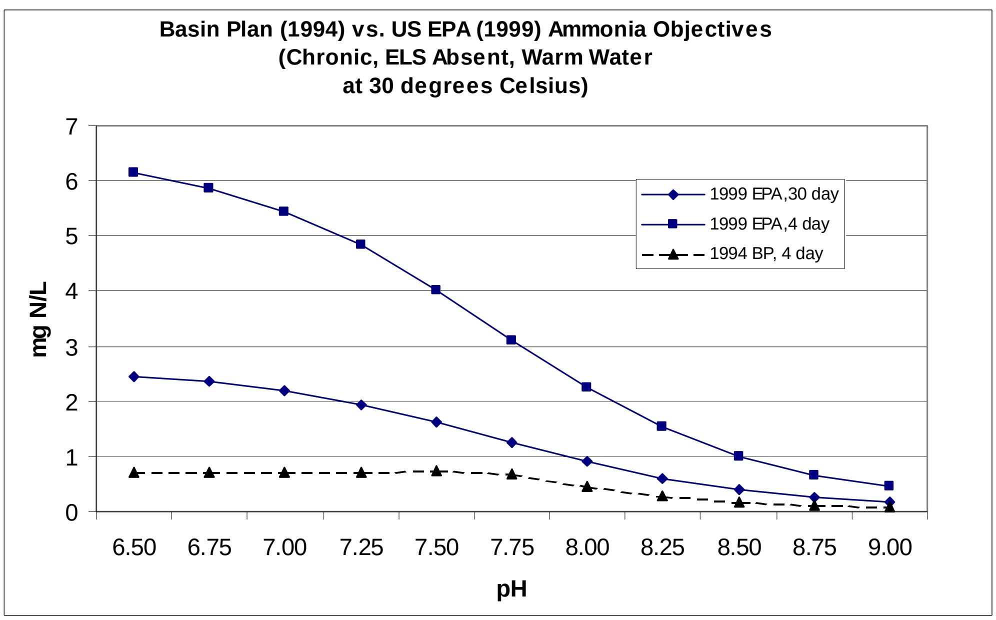


Figure 9



Chronic Criteria (ELS Present, Warm Water)

Figure 10

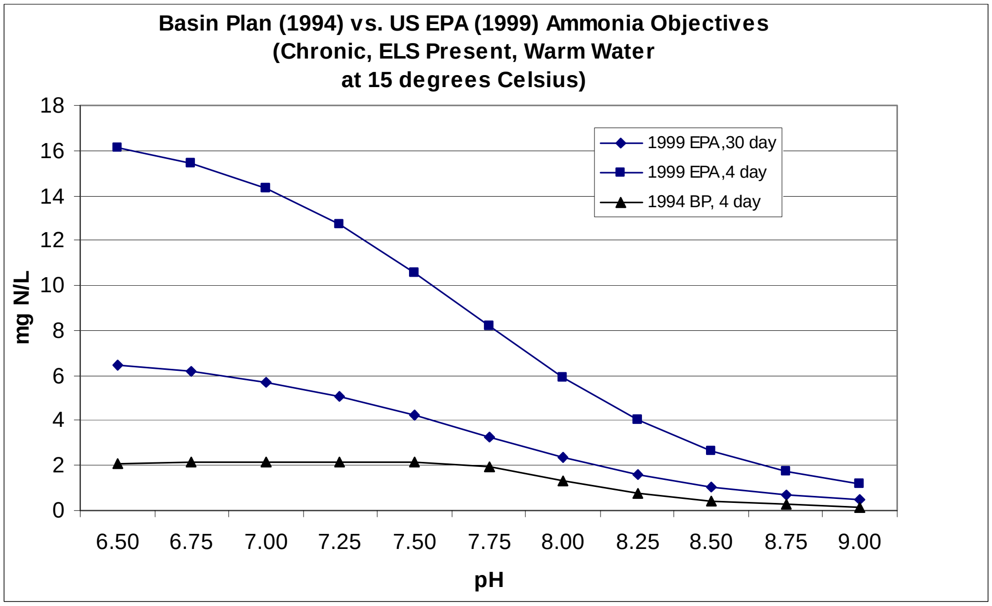
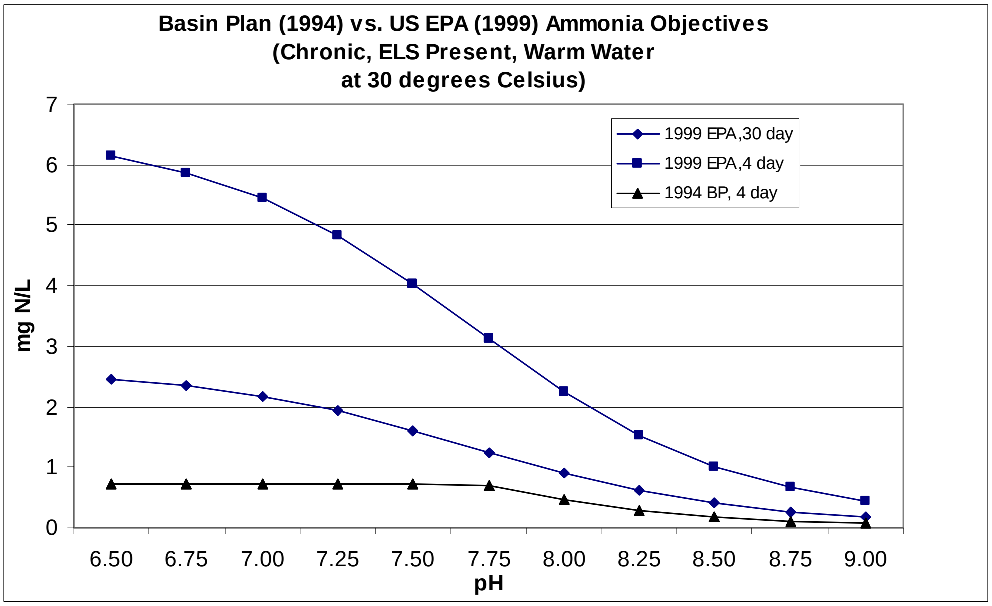


Figure 11



V. IMPLEMENTATION OF AMMONIA OBJECTIVES

Application of Ammonia Objectives to Inland Surface Waters in the Los Angeles Region

Compliance with Proposed Objectives

The Regional Board recognizes that the existing Basin Plan includes a provision that required compliance with existing Basin Plan ammonia objectives by June 13, 2002. While the amendment removes the 8-year compliance provision, it does so in recognition that the revised objectives are not more stringent, and in fact generally are less stringent, than the existing objectives. The removal of the 8-year compliance language will not result in an impact to dischargers because the Basin Plan amendment will not take effect, given the need for State Board, Office of Administrative Law, and US EPA review and approval, until after the expiration of the 8-year compliance schedule.

Selection of Freshwater vs. Saltwater Objectives[7]

According to the Basin Plan, inland surface waters include enclosed bays and estuaries. Enclosed bays and estuaries are often characterized by a brackish environment (i.e. an environment with salinity levels in between those of freshwater and saltwater). U.S. EPA's "1999 Update of Ambient Water Quality Criteria for Ammonia" addresses freshwater, while the California Ocean Plan addresses saltwater. Neither set of criteria/objectives address waters with salinity levels in between freshwater and saltwater, and specifically enclosed bays and estuaries. To address this gap, Regional Board staff proposes the following solution. (1) For inland surface waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the applicable objectives are the freshwater objectives, based on the US EPA "1999 Update of Ambient Water Quality Criteria for Ammonia." (2) For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, the applicable objectives are the inland surface water objectives in Tables 3-2 and 3-4 of the current Basin Plan or in Tables 1-2 and 1-4 of Appendix 1. (3) For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent between the freshwater objectives, based on the US EPA "1999 Update of Ambient Water Quality Criteria for Ammonia and the objectives in the Basin Plan as amended in 1994. Under scenario three above the Regional Board may, by adoption of a resolution at a publicly noticed Board meeting, approve the use of freshwater or saltwater objectives for an enclosed bay or estuary that are not the more stringent of the two. The resolution must be based on scientifically defensible information. This information must demonstrate (on a site-specific basis) that the biology of the water body is dominated by freshwater aquatic life and that freshwater objectives are more appropriate; or conversely, that the biology of the water body is dominated by saltwater aquatic life and that saltwater objectives are more appropriate.

---

[7] The procedure described in this section to determine whether freshwater or saltwater objectives should be applied is the same method employed in the National Toxics Rule and California Toxics Rule.

Selection of Acute Objective – Salmonids Present vs. Salmonides Absent
To implement the acute objectives it is necessary to determine whether salmonids are present or absent to determine which of the objectives applies. In the absence of this information, the designated beneficial use "COLD" specifies an environment at which temperatures are appropriate for various life stages of salmonids. In light of the beneficial use designations and in the absence of additional information to the contrary, it will be assumed that salmonids may be present in waters designated in the Basin Plan as "COLD" and absent in waters not designated "COLD" in the absence of additional information to the contrary. In addition, the beneficial use "MIGR" will be used to indicate the salmonid present condition. The Basin Plan says "MIGR" (migration of aquatic organisms) supports uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

Chronic Objectives – ELS Provision
It is necessary to determine the time of the year when ELS are not present in numbers that, if chronic toxicity did occur, would affect the long-term success of the fish population. Water bodies with a Basin Plan designation "SPWN" support high quality aquatic habitats suitable for reproduction and early development of fish and therefore will be designated as ELS present waters.

Early Life Stages are assumed present year-round unless a site-specific study is conducted which justifies a seasonal provision. The Basin Plan Amendment process must be followed to develop a seasonal beneficial use designation.

To conduct a site-specific study as to when the ELS-absent provision should be applied, all readily available information regarding the fish species distributions, spawning periods, nursery periods and the duration of sensitive life stages should be considered for that water body. Information on water body temperature may also be useful. Expert opinions from fisheries biologists and other scientists should be relied upon. The record of information to determine the ELS absent condition must hold up to public and U.S. EPA's scrutiny.

Applicable Temperature and pH Ranges
Not all pH and temperature ranges in Figures 1-11 are applicable to inland surface water conditions in the Los Angeles Region. For example, looking at water quality data used to conduct a regional water quality assessment per section 305(b) of the CWA, the average pH in all water bodies is 8.03, with a standard deviation of 0.39. This means that 68% of all pH data falls between 7.64 and 8.42 and that 95% of all data falls between 7.25 and 8.80. Only portions of the curves graphed in Figures 1-11 are relevant to the majority of pH conditions exhibited in water bodies in the Los Angeles Region. The portion of the curve that is most relevant to the Los Angeles Region is where the differences between the existing and proposed objectives are moderate. Therefore, the maximum differences between the existing and proposed objectives on the left of these graphs are not applicable to the Los Angeles Region.

The average temperature in all water bodies is 19.14 degrees Celsius, with a standard deviation of 4.11 degrees Celsius. This means that 68% of all temperature data falls between 15.03 and 23.25 degrees Celsius and 95% of all data falls between 10.92 and 27.35 degrees Celsius. Therefore both the 15 and 30 degree Celsius figures among

Figures 1-11 are important to look at, as in Los Angeles, the water bodies fall within both of these categories.

Existence of Threatened or Endangered Species
States are required to protect all beneficial uses, and therefore should protect for the most sensitive uses in a given water. Because ambient criteria are generally designed to protect 95% of all fish and aquatic invertebrate taxa, there remains a small possibility that the criteria will not protect all listed or threatened species. Where endangered or threatened species may be more sensitive to a pollutant than the species upon which the criteria are based, more stringent, site-specific modifications of the objectives shall be necessary. Modifications must include the adjustment of pH and temperature to match the conditions used to develop the objectives. One of two methods can be used to modify the objectives to protect threatened and endangered species.[8] Tests to determine site-specific objectives for threatened and endangered species can be conducted in site water or laboratory water.

Translation of Objectives into Effluent Limits[9, 10]

If the Regional Board determines that water quality based effluent limitations are necessary to control ammonia in a discharge, and a Total Maximum Daily Load (TMDL) for ammonia is not in effect, the permit shall contain effluent limitations for ammonia using one of the following methods:

1. *Use the following procedure based on a steady-state model:*

   Step 1: Identify the applicable water quality objectives for ammonia.

---

[8] 1) If the CMC is greater than 0.5 times the Species Mean Acute Value (SMAC) for a threatened or endangered species, or a surrogate (see glossary for definition) for such species, then the CMC should be reset to 0.5 times the SMAC. If the CCC is greater than the Species Mean Chronic Value (SMCV) of a threatened or endangered species, or surrogate, then the CCC should be reset to that SMCV. If the SMCV is not available, then the CCC can be reset by dividing the SMAC by the Acute to Chronic Ration (ACR) in accord with EPA's "Guidance for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses" (1985). 2) More stringent, site-specific modifications may be calculated to protect a listed endangered of threatened species by using the recalculation procedure described in Chapter 3 of the "U.S. EPA Water Quality Standards Handbook, Second Edition – Revised" (1994).

[9] Mixing zones may be authorized on a discharge-by-discharge basis per the mixing zone provision in Chapter 4 of the Basin Plan.

[10] The method whereby objectives are translated to effluent limits is similar to the method contained in the "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California" (2000). The method is also consistent with that outlined in the U.S. EPA "Technical Support Document for Water Quality-based Toxics Control (1991).

Step 2: For each water quality objective, calculate the effluent concentration allowance (ECA) using the following steady-state mass balance model:

If a mixing zone has not been authorized by the Regional Board:

ECA = WQO

If a mixing zone has been authorized by the Regional Board.[11]

$$ECA = \frac{WQO(Qd + Qs) - (CsQs)}{Qd}$$

Where WQO = water quality objective
Cs = Pollutant Concentration of Upstream (mg/L)
Qd = Flow Discharge (mgd or cfs)
Qs = Flow Upstream (mgd or cfs)

For the acute objective (CMC), one of the following shall be used for the Qs term:

3. *the lowest one-day flow based on a three-year return interval (1B3) when flow records are analyzed using EPA's 1986 DFLOW procedure.*[12]
4. *the lowest one-day flow based on a ten-year return interval (1Q10) when flow records are analyzed using extreme-value statistics.*[13]
5. *Other appropriate critical flow condition.*

For the chronic objective (CCC), one of the following shall be used for the Qs term:

1. *the lowest 30-day flow based on a three-year return interval (30B3) when flow records are analyzed using EPA's 1986 DFLOW procedure or*
2. *the 30Q10 or the 30Q5 (lowest 30-day flow based on a ten or five-year return interval) when flow records are analyzed using extreme-value statistics.*
3. *Other appropriate critical flow condition.*

Effluent concentration allowances based on a critical condition of 30Q10 are protective of both the 30-day average and the 4-day average. If a 30Q5 is used, it must be demonstrated that the 7Q10 (seven-day low flow which recurs once every ten years on the average) is protective of 2.5

---

[12] U.S. EPA procedure that counts each low flow value during the year and treats it as a separate event.

[13] U.S.G.S. procedure that counts only one value per year, the lowest daily flow in that year, and therefore does not consider the duration of such low flows that may occur in each year.

times the CCC, to ensure that short-term (4-day) chronic toxicity does not occur. The more stringent (i.e. lower) of the 30Q5 or the 7Q10 shall be used.

Step 3: For each ECA calculated in Step 2, determine the long-term average discharge condition (LTA) by multiplying the ECA with a factor (multiplier) that adjusts for effluent variability. The multiplier shall be calculated as described below, or shall be found in Table 3-1. To use Table 3-1 of Appendix 3, the coefficient of variation (CV)[14] for the effluent ammonia concentration must first be calculated. If (a) the number of effluent data points is less than 10, or (b) at least 80 percent of the effluent data are reported as not detected, then the CV shall be set equal to 0.6. When calculating the CV in this procedure, if a data point is below the detection limit in an effluent sample, one-half the detection limit shall be used as the value in the calculation. Multipliers for acute, sub-chronic, and chronic objectives for ammonia that correspond to the CV can be found in Table 3-2 of Appendix 3..

ECA Multipliers:

ECA multiplier$_{acute99} = e^{\left(0.5\sigma^2 - z\sigma\right)}$

ECA multiplier$_{sub\text{-}chronic99} = e^{\left(0.5\sigma_4^2 - z\sigma_4\right)}$

ECA multiplier$_{chronic99} = e^{\left(0.5\sigma_{30}^2 - z\sigma_{30}\right)}$

Where σ *= standard deviation*

$$\sigma = \left[\ln\left(CV^2 + 1\right)\right]^{0.5}$$
$$\sigma^2 = \ln\left(CV^2 + 1\right)$$
$$\sigma_4 = \left[\ln\left(CV^2/4 + 1\right)\right]^{0.5}$$
$$\sigma_4^2 = \ln\left(CV^2/4 + 1\right)$$
$$\sigma_{30} = \left[\ln\left(CV^2/30 + 1\right)\right]^{0.5}$$
$$\sigma_{30}^2 = \ln\left(CV^2/30 + 1\right)$$

z = 2.326 for 99th percentile probability basis

[14] The coefficient of variation (CV) is a measure of the data variability and is calculated as the estimated standard deviation divided by the arithmetic mean of the observed values.

LTA Equations:

$LTA_{acute99} = ECA_{acute} * ECA\ multiplier_{acute99}$

$LTA_{sub\text{-}chronic99} = ECA_{sub\text{-}chronic} * ECA\ multiplier_{sub\text{-}chronic99}$

$LTA_{chronic99} = ECA_{chronic} * ECA\ multiplier_{chronic99}$

Step 4: Select the lowest (most limiting) of the LTAs derived in Step 3 (LTA_{min}).

Step 5: Calculate water quality based effluent limitations (a maximum daily effluent limitation, MDEL, and an average monthly effluent limitation, AMEL) by multiplying LTA_{min} (as selected in Step 4) with a factor (multiplier) that adjusts the averaging period and exceedance frequency of the objective, and the effluent monitoring frequency, as follows:

MDEL and AMEL Equations:

$MDEL = LTA_{min} * MDEL\ multiplier_{99}$

$AMEL = LTA_{min} * AMEL\ multiplier_{95}$

The MDEL and AMEL multipliers shall be calculated as described below, or shall be found in Table 3-2 using the previously calculated CV and monthly sampling frequency (n) of ammonia in the effluent. If the LTA_{min} selected in Step 4 is $LTA_{sub\text{-}chronic99}$ and the sampling frequency is four times per month or less, then n shall be set equal to 4. If the LTA_{min} selected in Step 4 is $LTA_{chronic99}$ and the sampling frequency is 30 times per month or less, then n shall be set equal to 30.

MDEL and AMEL Mulitipliers:

$MDEL\ multiplier_{99} = e^{\left(z\sigma - 0.5\sigma^2\right)}$

Where $z = 2.326$ *for 99th percentile probability basis*

$$\sigma = \left[\ln\left(CV^2 + 1\right)\right]^{0.5}$$

$$\sigma^2 = \ln\left(CV^2 + 1\right)$$

$AMEL\ multiplier_{95} = e^{\left(z\sigma_n - 0.5\sigma_n^2\right)}$

Where $z = 1.645$ *for 95th percentile probability basis*

$$\sigma_n = \left[\ln\left(CV^2/n+1\right)\right]^{0.5}$$
$$\sigma_n^2 = \ln\left(CV^2/n+1\right)$$
n = number of samples per month

2. *Apply a dynamic model approved by the Regional Board.*

3. *If a Total Maximum Daily Load (TMDL) for ammonia is in effect, the permit shall contain effluent limitations for ammonia that are based on the waste load allocation for ammonia in the TMDL.*

IV. OTHER CONSIDERATIONS

The California Water Code (CWC), section 13241, specifies that Regional Boards shall establish water quality objectives that in its judgement will ensure the reasonable protection of beneficial uses and the prevention of nuisances. Factors to be considered by a Regional Board when establishing water quality objectives shall include, but not necessarily be limited to all of the following:

1. Past, present and probable future beneficial uses of water.

2. Environmental characteristics of the hydrographic unit under consideration including the quality of the water available thereto.

3. Water quality conditions that could reasonably be achieved through coordinated control of all factors, which affect water quality in the area.
   The "Beneficial Uses" and "Water Quality Objectives" chapters of the Basin Plan (Water Quality Control Plan for the Los Angeles Region) are incorporated by reference to address the above three factors.

4. Economic considerations.
   The Regional Board has considered the costs of implementing the amendment, and other factors, as required by the California Water Code, section 13241. This Basin Plan Amendment will result in ammonia objectives that will be less stringent than the existing objectives in most cases. Therefore the economic burden on the regulated community will be less than the burden resulting from the existing objectives.

5. The need for developing housing within the region.
   These criteria should not affect the housing market, as the criteria are less stringent than those that they replace.

6. The need to develop and use recycled water.
   Increasing the levels of ammonia should not alter the development or use of recycled water because this amendment only applies to surface water discharges.

V. ALTERNATIVES

1. **No action**. To maintain the existing objectives would be to ignore the latest, peer-reviewed scientific data.
2. **Adopt U.S. EPA recommended criteria and associated implementation provisions**. By adopting the proposed revisions to the ammonia objectives for fresh water, the Regional Board will make the region's ammonia objectives consistent with U.S. EPA guidance, which is based on the latest research. Finally, by acting proactively, we will be able to more efficiently carry out other activities such as developing the region's 303(d) list, developing TMDLs, and specifying effluent limits in discharge permits.
3. **Adopt U.S. EPA recommended criteria and associated implementation provisions with modifications arising as a logical outgrowth of the proposed amendment.** The Regional Board staff hereby solicits comments on possible alternative criteria that may be used for the ammonia water quality objective for inland surface waters.
4. **Adopt U.S. EPA recommended criteria, 2) incorporate saltwater ammonia objectives from the California Ocean Plan to address inland surface water bodies with salinity levels more characteristic of saltwater than freshwater, and 3) adopt associated implementation provisions.**

VI. RECOMMENDED ALTERNATIVE

Alternative #3: Adopt U.S. EPA recommended criteria and associated implementation provisions with modifications arising as a logical outgrowth of the proposed amendment.

References

Emerson, K., R.C. Russo, R.E. Lund, and R.V. Thurston. 1975. Aqueous Ammonia Equilibrium Calculations: Effect of pH and Temperature. J. Fish. Res. Bd. Can. 32:2379-2383. (As referenced in U.S. EPA. August 1994.)

Federal Register. December 22, 1999. Environmental Protection Agency, Water Quality Criteria; Notice of Availability; 1999 Update of Ambient Water Quality Criteria for Ammonia; Notice. FRL-6513-6. Volume 64, No. 245.

Los Angeles Regional Water Quality Control Board. 1994. Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties.

State Water Resources Control Board. California Environmental Protection Agency. 2000. Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays and Estuaries of California.

State Water Resources Control Board. California Environmental Protection Agency. 2001. Water Quality Control Plan, Ocean Waters of California. California Ocean Plan.

U.S. EPA. 1984. Ambient Water Quality Criteria for Ammonia. EPA 440/5-85-001. Office of Water, Regulations and Standards, Criteria and Standards Division, Washington DC.

U.S. EPA. 1991. Technical Support Document for Water Quality-based Toxics Control. EPA/505/2-90-001. Office of Water, Washington D.C.

U.S. EPA. 1992. National Toxics Rule. 56 FR 58420; codified at 40 CFR 131.36.

U.S. EPA. July 30, 1992. Revised Tables for *** Freshwater Ammonia Concentrations. Office of Water, Washington D.C.

U.S. EPA. August 1994. Water Quality Criteria: *Water Quality Standards Handbook: 2nd Edition* EPA 823-B-94-005a. U.S. Environmental Protection Agency, Office of Water

U.S. EPA. 1999. 1999 Update of Ambient Water Quality Criteria for Ammonia. EPA 882-R-99-014. Office of Water, Washington DC.

U.S. EPA. May 18, 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California. Federal Register, Vol. 65, No. 97.

Glossary

AMEL	Average monthly effluent limit
Ammonia	NH_3, un-ionized ammonia, more toxic than ammonium (NH_4^+)
Ammonium	NH_4^+, ionized ammonia, less toxic than ammonia (NH_3)
CCC	Criteria continuous concentration
CMC	Criteria maximum concentration
ECA	Effluent concentration allowance
ELS	Early Life Stages
Extreme-value Statistics	U.S.G.S. procedure that is commonly used and counts only one value per year, the lowest daily flow in that year, and therefore does not consider the duration (in days) of such low flows may occur in each year
LOEC	Lowest observed effect level
LTA	Long term average
MDEL	Maximum daily effluent limit
NOEC	No observed effect level
Salmonids	Salmonids include chinook salmon, coho salmon, steelhead trout and coastal cutthroat trout
Surrogate Species	A surrogate species is one that is toxicologically and taxonomically representative of the species in question. The highest appropriate taxonomic level is generally the family, where both the surrogate species and species in question reside. However, certain standard test organisms (e.g., rainbow trout) are toxicologically representative of species from other taxonomic families and many times, even phyla.
1986 DFLOW Procedure	A U.S. EPA procedure that is infrequently used and treats flow in each successive day as a separate event
TSD	Technical Support Document for Water-Quality-Based Toxics Control

APPENDIX 1

Insert Tables 1-1 to 1-4

APPENDIX 2

APPENDIX 2

Table 2-1. 1999 Acute Criteria: Selected Values for One-hour Average Concentration for Ammonia

CMC, mg N/L		
pH	**Salmonids Present**	**Salmonids Absent**
6.5	32.60	48.80
6.6	31.30	46.80
6.7	29.80	44.60
6.8	28.10	42.00
6.9	26.20	39.10
7.0	24.10	36.10
7.1	22.00	32.80
7.2	19.70	29.50
7.3	17.50	26.20
7.4	15.40	23.00
7.5	13.30	19.90
7.6	11.40	17.00
7.7	9.65	14.40
7.8	8.11	12.10
7.9	6.77	10.10
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

APPENDIX 2

Table 2-2. Chronic Criteria (ELS Present): Selected Values for 30-day Average Concentration for Ammonia

CCC for Fish Early Life Stages Present, mg N/L										
	Temperature, C									
PH	0	14	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

APPENDIX 2

Table 2-3. Chronic Criteria (ELS Absent): Selected Values for 30-day Average Concentration for Ammonia

CCC for Fish Early Life Stages Absent, mg N/L										
	Temperature, C									
PH	0-7	8	9	10	11	12	13	14	15*	16*
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46	6.06
6.6	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36	5.97
6.7	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25	5.86
6.8	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10	5.72
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93	5.56
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73	5.37
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49	5.15
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22	4.90
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92	4.61
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59	4.30
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23	3.97
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85	3.61
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47	3.25
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71	2.54
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36	2.21
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03	1.91
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74	1.63
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48	1.39
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25	1.17
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06	0.990
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892	0.836
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754	0.707
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684	0.641	0.601
8.9	0.917	0.86	0.806	0.756	0.709	0.664	0.623	0.584	0.548	0.513
9.0	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471	0.442

* At 15 C and above, the criterion for fish ELS absent is the same as the criterion for fish ELS present

APPENDIX 3

APPENDIX 3

Insert Tables 3-1 and 3-2