Humboldt River Basin Water Quality Standards Review

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1. Introduction

This technical memorandum is a continuation of the analysis of the water quality standards used by the Nevada Division of Environmental Protection and how they are applied in the Humboldt River Basin. The standards are found in the Nevada Administrative Code Chapter 445A. Currently there are a limited number of narrative standards that apply to all water bodies in the state, some specific physical standards that apply to waters classified as A, B, C or D waters and specific standards that apply to specific reaches and reservoirs in the state called designated waters. All of the class waters and designated waters in the Humboldt basin are listed in a later section of this document. In addition, organic and inorganic compounds that are considered toxic have associated standards that apply on all the designated and class waters in the state.

The NDEP Bureau of Water Quality is preparing to change how the standards are applied by having a table with the applicable standards for each reach. In this way the bureau intends to be able to tailor the standards instead of applying them in a blanket way. The NDEP Total Maximum Daily Load Coordinator Randy Pahl said that this will create some repetition in many of the tables, but will be useful when specific concerns are raised in the watershed. In this way the standards can be analyzed on a reach by reach basis.

The following document explains how the standards for physical and chemical standards were derived and how they are currently applied in the Humboldt watershed. In Section 5 particular emphasis is given to those pollutants that have been exceeded and caused the affected reach to be placed on the Clean Water Act 303(d) list.

A plot for each constituent, including the nutrients, metals and physical characteristics displays the dates and results of water quality analyses for that element. The analyses included in the plots are those for the monitoring stations in the Humboldt River basin. Horizontal lines in each field represent an existing water quality standard listed in the Nevada Administrative Code and referred to in the text of this memorandum. These graphs reveal how often the existing standards are exceeded. For some of the components, like that for ammonia and the toxic compounds that rely on mathematical formulas, a reasonable standard was selected that could represent normal conditions. The number of times that the standard has been exceeded is one of the bases for recommendations to reevaluate the standards in the Humboldt River basin. If a particular standard is frequently exceeded, is more likely that this document recommends that NDEP should reevaluate the standard.

2. Summary

NDEP is currently engaged in activities for the purpose of improving numeric water quality criteria. Specifically, they are addressing standards for nutrients (nitrogen and phosphorus species, including ammonia), total suspended solids, turbidity, temperature, iron, molybdenum, and boron.

In addition to the constituents listed above, it is recommended that the standards be reconsidered for total dissolved solids, chloride, selenium, lead, and mercury.

3. Narrative Standards

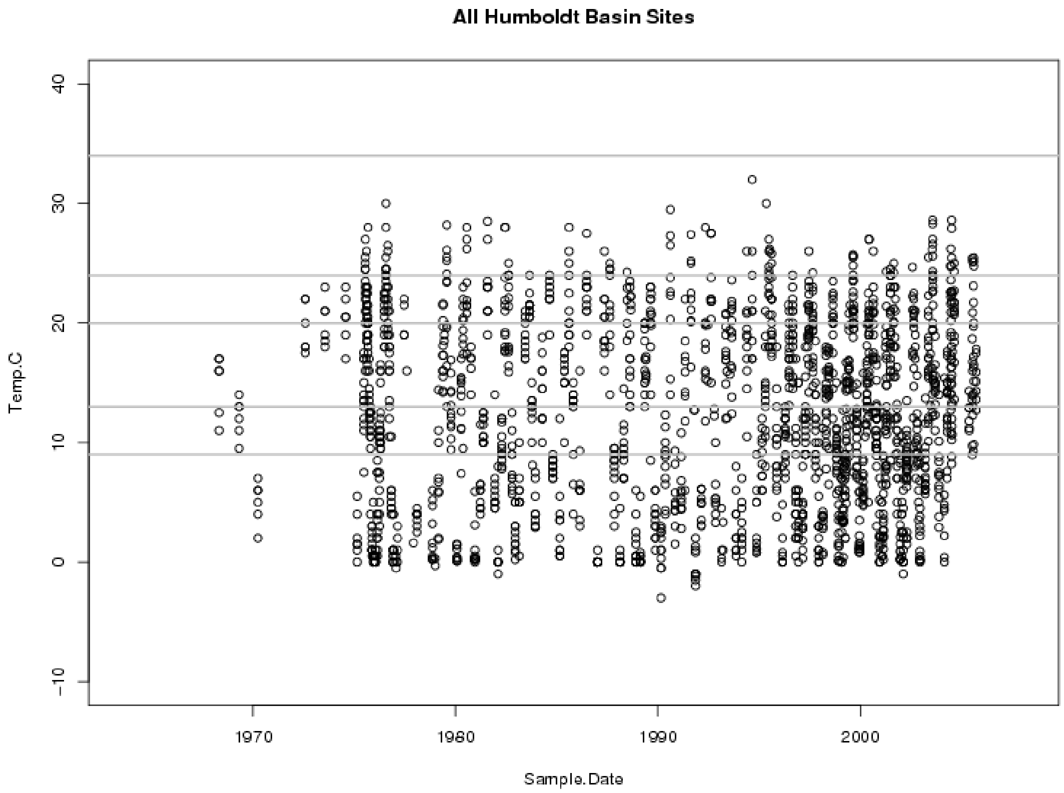
According to NAC 445A.112 (Standards applicable to beneficial uses), the following narrative standards are intended to protect both existing and designated beneficial uses. The following beneficial uses apply to the Humboldt River basin.

a. Watering of livestock. The water must be suitable for the watering of livestock without treatment.
b. Irrigation. The water must be suitable for irrigation without treatment.
c. Aquatic life. The water must be suitable as a habitat for fish and other aquatic life existing in a body of water. This does not preclude the reestablishment of other fish or aquatic life.
d. Recreation involving contact with the water. There must be no evidence of man-made pollution, floating debris, sludge accumulation or similar pollutants.
e. Recreation not involving contact with the water. The water must be free from:
    - Visible floating, suspended or settled solids arising from man’s activities;
    - Sludge banks;
    - Slime infestation;
    - Heavy growth of attached plants, blooms or high concentrations of plankton, discoloration or excessive acidity or alkalinity that leads to corrosion of boats and docks;
    - Surfactants that foam when the water is agitated or aerated; and
    - Excessive water temperatures.
f. Municipal or domestic supply. The water must be capable of being treated by conventional methods of water treatment in order to comply with Nevada’s drinking water standards.
g. Industrial supply. The water must be treatable to provide a quality of water which is suitable for the intended use.
h. Propagation of wildlife. The water must be suitable for the propagation of wildlife and waterfowl without treatment.

Each narrative standard listed above is applicable and reasonable for the Humboldt River and tributaries and are not recommended for reconsideration.

4. Physical and Biological Parameter Standards

4.1. Temperature



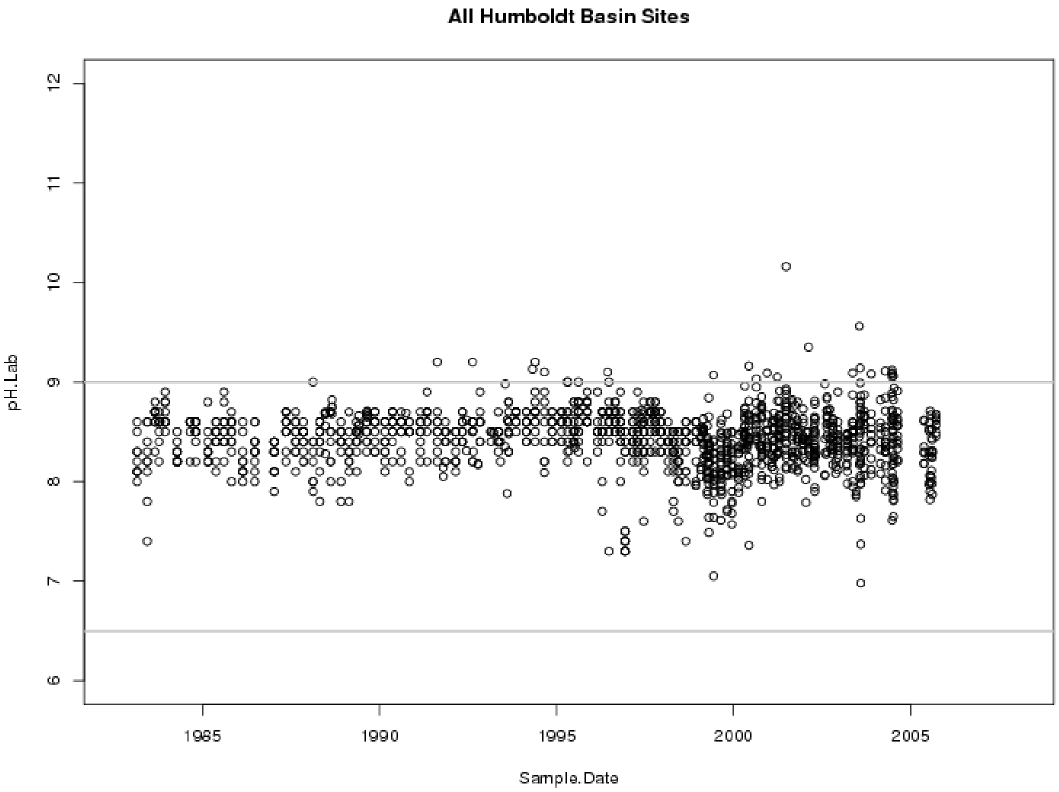
The temperature standards currently set vary by class and designation. Class A, B, and C waters have single-point measurement standards. Class A waters must be less than 20 deg.C, Class B waters must be less than 20 deg.C for trout waters and less than 24 deg.C for non-trout waters, and Class C waters must be less than 20 deg.C for trout waters and less than 34 deg.C for non-trout waters. There is no temperature standard for Class D waters. All designated waters have the same standard: the maximum allowable increase in temperature above the water temperature at the boundary of an approved mixing zone cannot exceed 2 deg.C.

The standards are supposedly based on the temperature criteria outlined in the Gold Book (EPA, 1986), however there appears to be little resemblance between the two. The Gold Book recommendations are directed toward limiting temperatures for the most sensitive species for the time of year. Relevant factors in determining a standard include time of year, length of time of exposure to high temperatures, and weekly average temperatures.

It is likely that the temperature standard will be set to protect the aquatic life for the cold-water fishery beneficial use, even though the most critical beneficial use is listed as warm-water fishery (NAC). Table 11 in the Gold Book shows the recommended temperatures for both the maximum weekly average temperature for growth and short-term maximum temperature for juvenile survival. In that table, several species are listed. For relevance to the Humboldt Basin, brook trout and rainbow trout should be used as the species of reference. The maximum weekly average temperature for growth for these species is 19 deg.C and the maximum short-term temperature for juveniles is 24 deg.C. Table 12 in the Gold Book is a summary of the maximum average weekly temperature for spawning and the short-term maximum temperature for embryo survival during spawning season. The maximum weekly average temperature is 9 deg.C and the maximum short-term temperature is 13 deg.C.

Given the detail outlined in the Gold Book, the Nevada standards appear to be not stringent enough nor detailed enough to account for spawning season or expected seasonal differences in temperature. The State is planning to revisit and revise the temperature standard in the near future. NDEP is currently addressing this issue on two fronts: 1) by contacting local specialists to obtain their input on the suitability of the existing standards, and 2) by tracking the progress of revised temperature criteria in other states such as Colorado.

4.2. pH



The standard for pH for all waters in Nevada is between 6.5 and 9.0 with the exception of Class D waters which have a lower limit of 6.0.

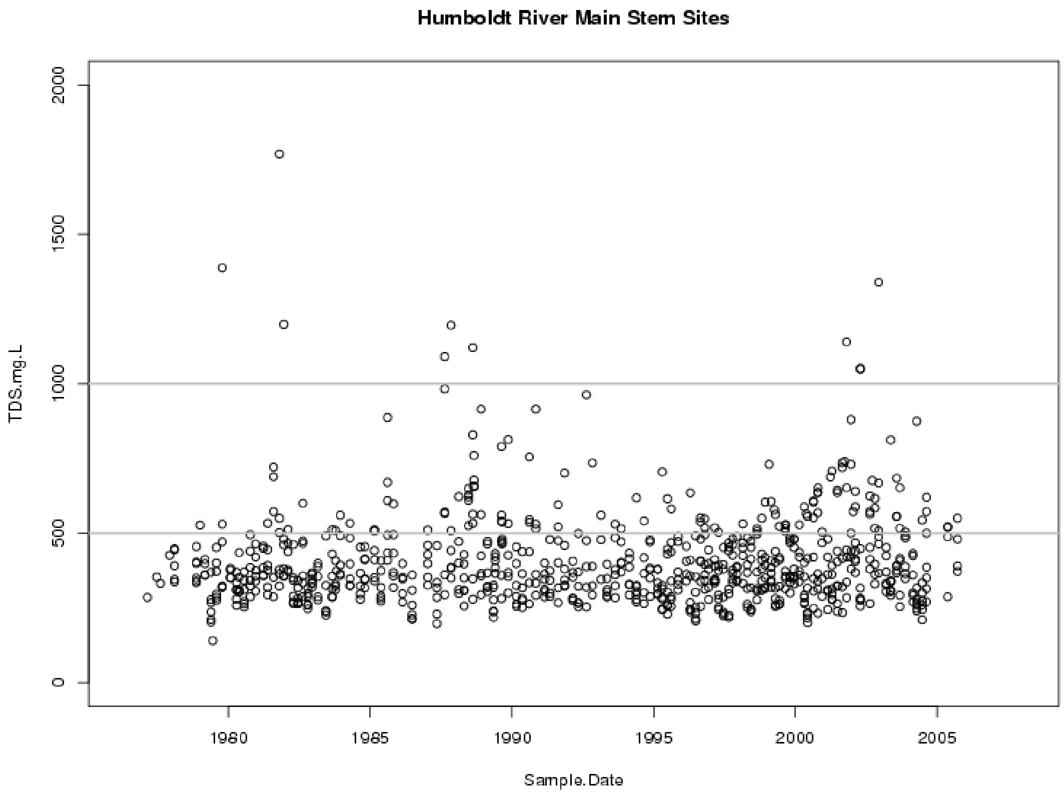
There are a few historic samples with pH greater than 9.0. However, there are two water bodies on EPA's 303(d) list for pH: the South Fork Humboldt Reservoir, and the lower reaches of Maggie Creek.

The standard was developed for the EPA's Red Book (1976) and is directed toward freshwater aquatic life. References for determination of this range include the European Inland Fisheries Advisory Council (EIFAC, 1969) and a study of the effect of low pH on fathead minnows (Mount, 1973) which concluded a pH range of 6.5 to 9.0 is harmless to fish. The range of pH for which irrigation is unaffected is larger than that for aquatic life. Because of the high buffering capacity of soils, the acceptable range is approximately 4.5 to 9.0, though the greatest danger to acid soils is that metallic ions may be dissolved in concentrations that are toxic to plants.

Though the standard for pH is rarely exceeded, it is still an important parameter for the ammonia standard and should continue to be monitored. In fact, ammonia has been shown to be 10 times as toxic at pH 8.0 as at pH 7.0 (EIFAC, 1969). It should also be noted that pH value also has affects the speciation of metals. The form metals take greatly influence their toxicity, deposition rate and environmental impact.

Nevertheless few reaches are likely to exceed the established pH range, and this range has been shown to provide adequate protection for freshwater fish and invertebrates, revisiting this standard should not be a high priority.

4.3. Total Dissolved Solids

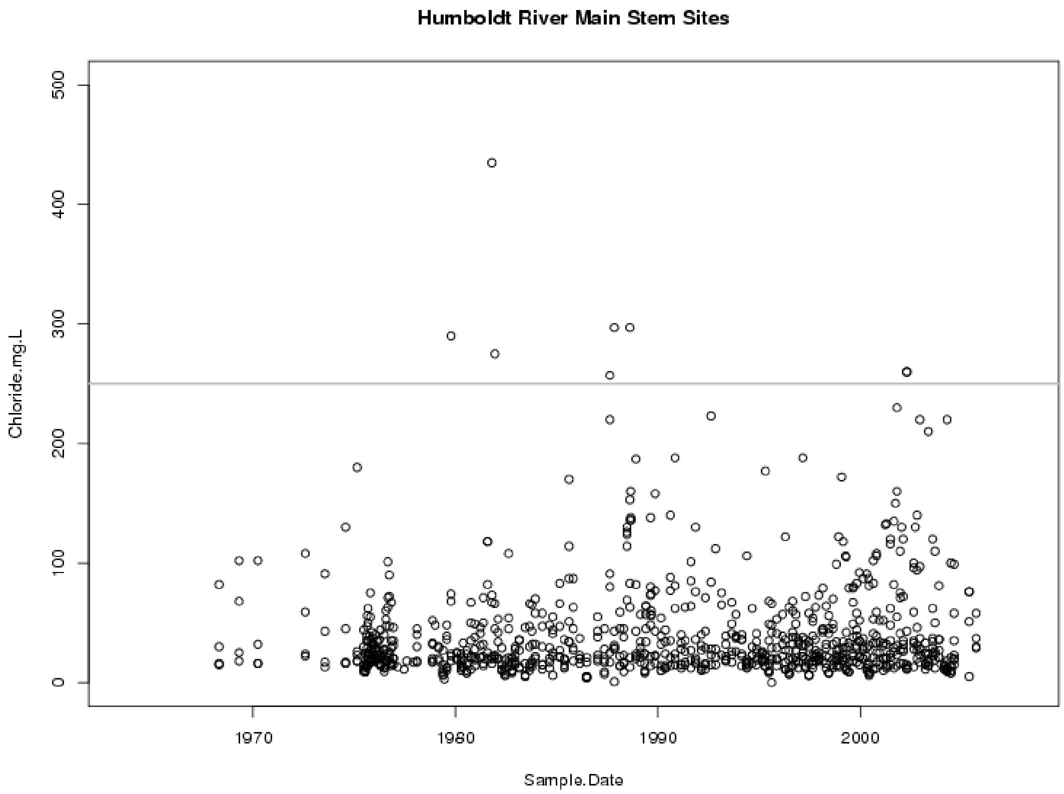


The standard for total dissolved solids (TDS) for class A, B and C waters is less than 500 mg/l or one-third above that characteristic of natural conditions, whichever is less. The standard for designated waters is less than 500 mg/l except at Woolsey, where the standard is less than 1000 mg/l. The most restrictive beneficial use for designated waters is municipal or domestic supply, with other beneficial uses of irrigation and watering of livestock.

The TDS standard is taken from the EPA's Red Book (1976), which refers to the Public Health Service's drinking water standards of 1962 and recommends a maximum TDS concentration of 500 mg/l. However, many species of freshwater aquatic life can tolerate concentrations as high as 10,000 mg/l, though no specific studies on coldwater fish were found.

For a beneficial use of municipal or domestic supply, the TDS standard is often exceeded and is a common parameter of concern on the EPA's 303(d) list. Therefore, it is necessary to determine if this standard is indeed appropriate for the reaches of the Humboldt River. If these reaches are not used as municipal or domestic supply, it may be possible to use the higher standard and still protect the actual uses of these reaches.

4.4. Chloride



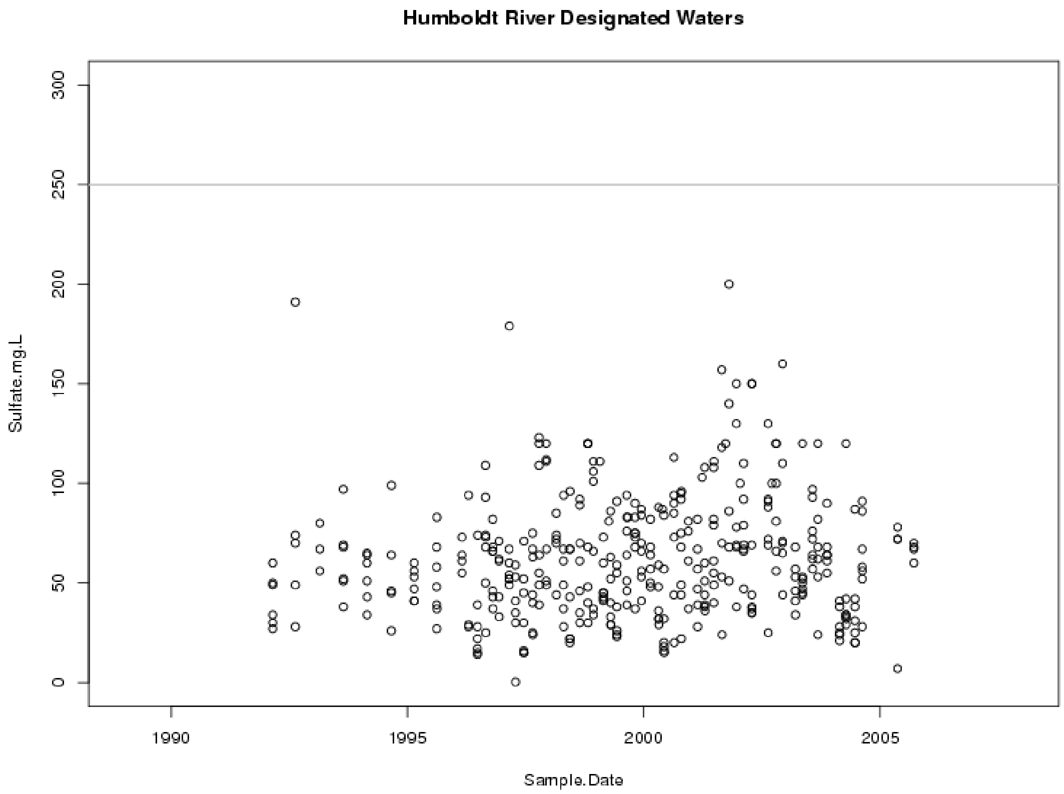
The chloride standard is not defined for class waters and is less than 250 mg/l for designated waters. The source of the standard is from EPA's Ambient Water Quality Criteria for Chloride (1988). The major anthropogenic sources of chloride are urban and agricultural runoff, discharges from municipal wastewater plants, and industrial plants (Birge, et al, 1985; Dickman and Gochnauer, 1978; Sonzogni et al, 1983). The EPA chloride standard borrows heavily EPA (1985d) and the response to public comment (EPA, 1985). This document focuses on freshwater species of macroinvertebrates and vertebrates.

In the aforementioned studies it was found that invertebrates are generally more sensitive to chloride than vertebrates. The concentration of acute toxicity is 1720 mg/l for the genus Daphnia. Chronic toxic concentrations are much lower; Daphnia pulex can survive chronic concentrations up to 625 mg/l and reproduction was unaffected at 314 mg/l. Early life-stage rainbow trout could not survive concentrations of 2740 mg/l, but half survived 1324 mg/l. 97% of the trout survived a concentration of 643 mg/l. Also, fathead minnows were minimally-affected by a concentration of 533 mg/l.

However, chronic values are not determined solely by the chronic value experiments. Rather, the acute-chronic ratios are considered as well as the final (or most restrictive) acute values. Therefore, division of the final acute value by the final acute-chronic ratio results in a final chronic value of 226.5 mg/l. It appears Nevada's standard of 250 mg/l is based on this final chronic value, even though the most restricted beneficial use for designated waters is municipal or domestic use.

It is recommended that more site- and species-specific data be collected to develop a more appropriate standard for the Humboldt River basin and native species.

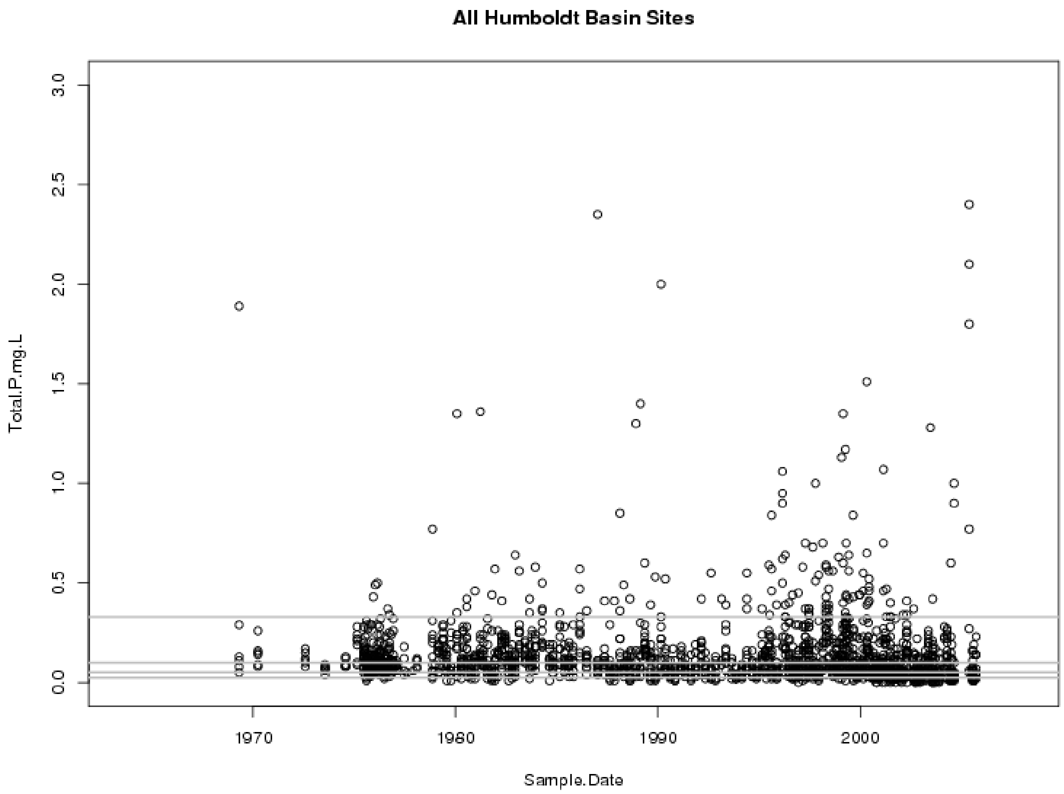
4.5. Sulfate



The standard for sulfate is a single value of 250 mg/l. This standard matches the current drinking water standard for taste given in the EPA's website (http://www.epa.gov/waterscience/criteria/drinking/dwstandards.html#advisory). The source of this value is unclear. The only beneficial use affected by the sulfate standard is municipal or domestic use.

Historic values of sulfate approach 200 mg/l, though the vast majority are below 150 mg/l. Therefore, the sulfate standard is not recommended for reconsideration.

4.6. Total Phosphorus

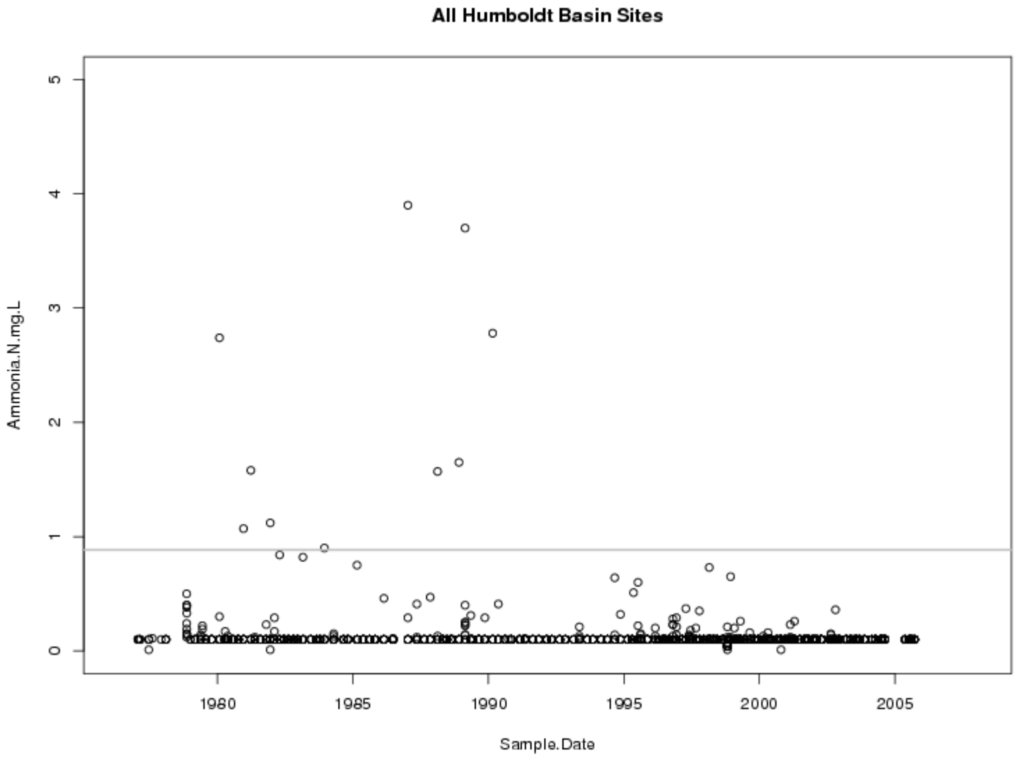


The state standards for class A waters are less than 0.10 mg/l in a stream, 0.05 mg/l in a stream where it enters a lake or reservoir, and 0.025 mg/l for any lake or reservoir. Standards for class B waters are less than 0.01 mg/l and less than 0.33 mg/l for class C waters. Designated waters all have the same standard of less than 0.10 mg/l as a seasonal average between April and November. The most critical beneficial use in designated waters is aquatic life (warm-water fishery).

As shown in the figure above, the numeric criteria for total phosphorus is often exceeded. However, discussions with NDEP revealed that in 1998, the EPA formed a technical assistance group to develop more appropriate numeric criteria for region IX. A preliminary conclusion is that nutrient concentrations alone are poor predictors of the likelihood of impairment and that there are other factors, such as substrate conditions, turbidity and flow that could affect algal dynamics.

NDEP plans to continue working with the Regional Technical Assistance Group to develop more appropriate numeric criteria for all nutrients.

4.7. Ammonia



The ammonia standards are found in NAC445A. 118. The ammonia standard is complex because the amount of ammonia that is safe in water is dependent on the pH, temperature, dissolved oxygen algae and amounts of other nutrients present.

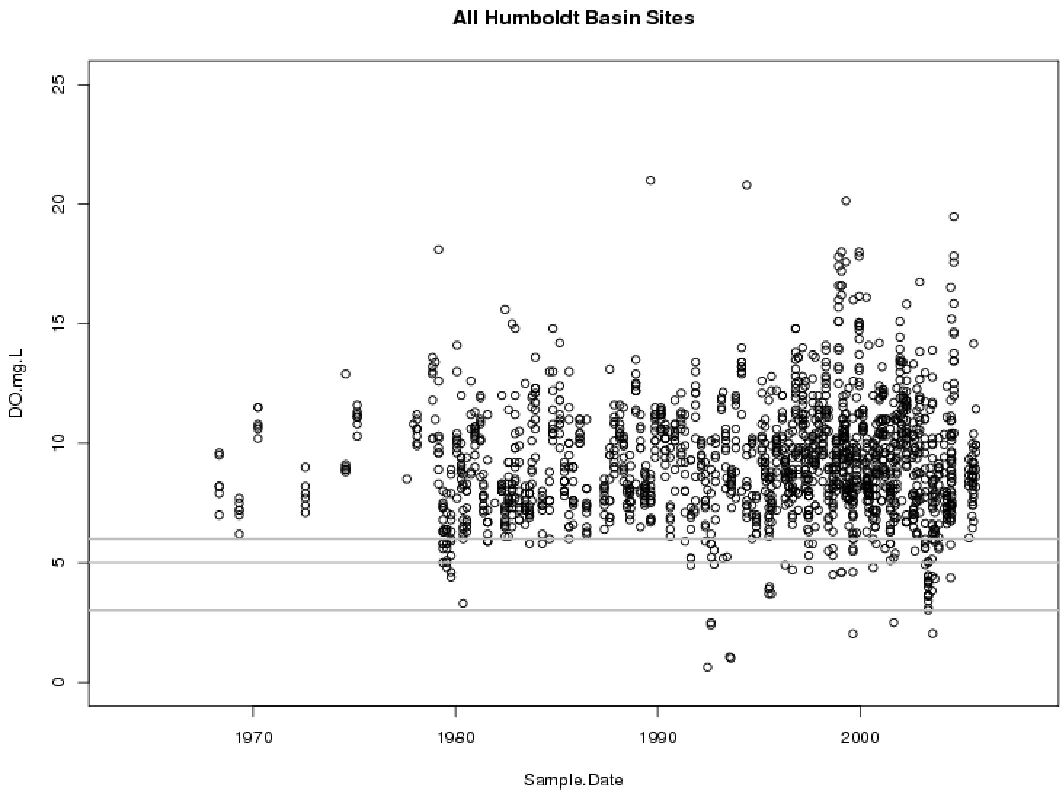
The NDEP is aware of this complexity and is attempting through a collaborative Region IX EPA Technical Assistance Group to create standards that incorporate all of the nutrient criteria together.

The EPA on the national level is also considering a reevaluation of the ammonia standard. Recent studies have shown that some freshwater mussel species are more sensitive to the ammonia exposure than the ones originally used to derive the recommendations.

At this point ammonia is considered on its own in the NAC. The NAC uses several mathematical expressions derived from the EPA recommendations given in the 1999 Update of Ambient Water Quality Criteria for Ammonia (EPA, 1999). The expressions relate pH and temperature with the appropriate level of Ammonia, given in milligrams of Nitrogen per liter. The allowed amount of ammonia decreases with increasing pH and increasing temperature.

Given the complexity of the relationships of Nitrogen, pH and temperature the NDEP should continue the work of updating the ammonia standards for different water bodies in the state.

4.8. Dissolved Oxygen

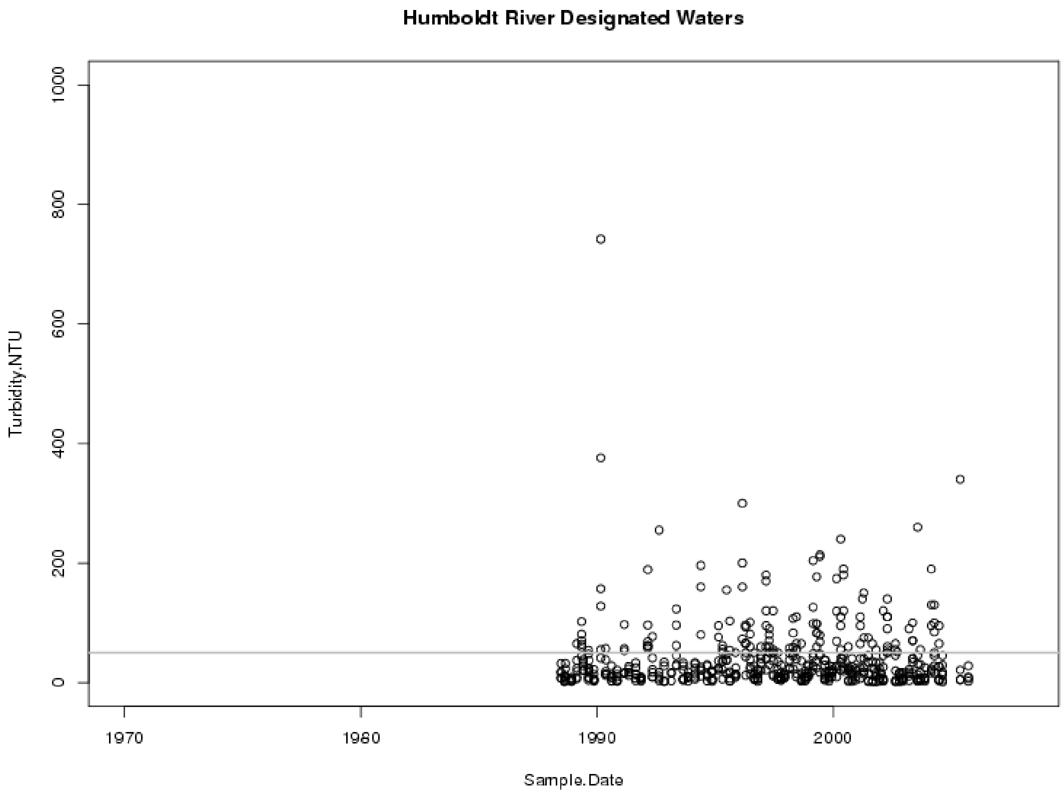


The state standard for dissolved oxygen varies with class or designation, as well as classification of trout waters. Class A waters single value concentrations must be greater than 6.0 mg/l, class B and C waters must have concentrations greater than 5.0 mg/l for non-trout streams and greater than 6.0 mg/l for trout streams. Class D waters concentrations must be greater than 3.0 mg/l. Designated waters must be greater than 5.0 mg/l.

The most restrictive beneficial use with respect to dissolved oxygen is aquatic life (warm-water fishery). Therefore, it is important to consider the critical time of year for these species. The standard was first described in the EPA's Gold Book (1986). The recommended standards account for the life stage of the species, where early life stages require higher mean and minimum dissolved oxygen concentrations than other life stages. Also, the recommended dissolved oxygen concentrations account for the minimum and maximum daily concentrations. For example, the seven-day mean is the mean of each day's minimum and maximum temperature. Therefore, near-continuous monitoring is required to determine the average temperature.

The Nevada standard for dissolved oxygen is not specific enough. Monitoring at each site needs to be more frequent (at least hourly) and the time of year must be considered to account for the life stage of the species in question. Therefore, it is recommended that the state reconsider its standard for dissolved oxygen.

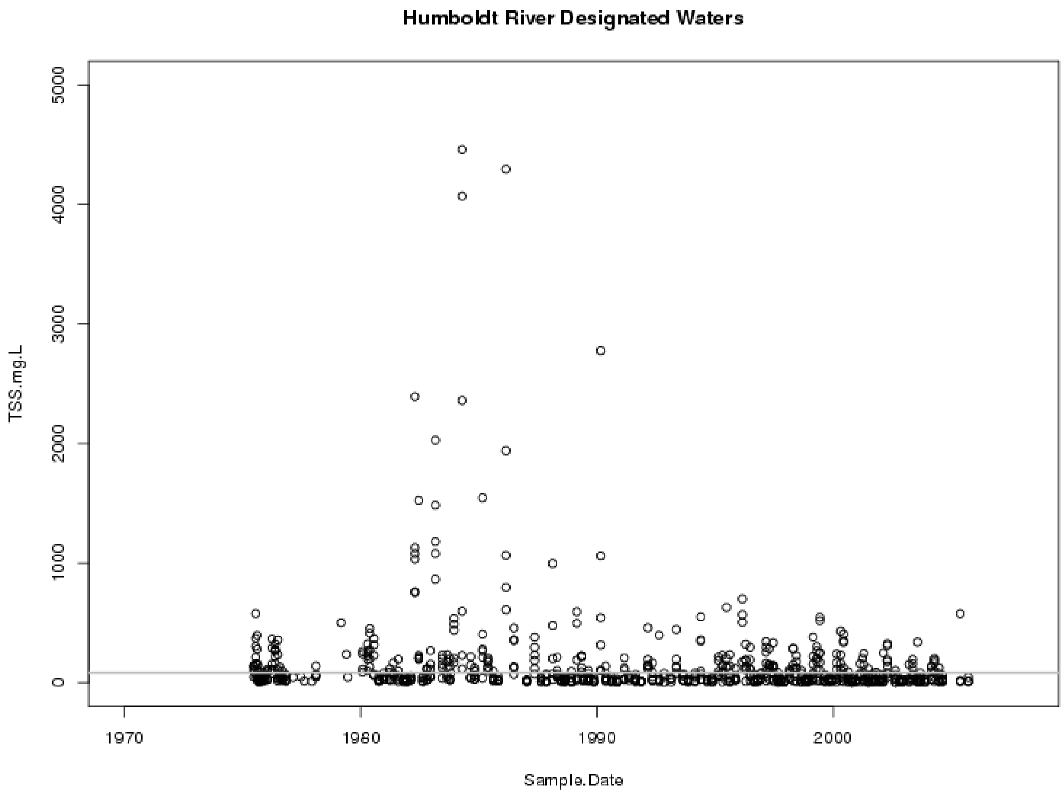
4.9. Turbidity



The state standard for turbidity applies only to designated waters in the Humboldt basin. The most restrictive beneficial use is municipal or domestic supply. All designated waters must have turbidity less than 50 Nephelometric Turbidity Units (NTU). The primary concern with turbidity for domestic use is it interferes with chlorine disinfection. The effect of turbidity on fish was studied by the European Inland Fisheries Advisory Commission (EIFAC, 1965). The primary effect on fish is that turbidity reduces the available oxygen in spawning gravels and inhibits development of eggs and larvae.

The turbidity standard for Nevada comes from the EPA's Gold Book (1986), though the Gold Book does not specifically recommend a standard of 50 NTU. Through conversations with NDEP, it was revealed that the EPA is re-evaluating TSS and turbidity thresholds. NDEP plans to revisit their own standard, but only after the EPA concludes their study. Until then, the standard of 50 NTU applies.

4.10. Total Suspended Solids



The state standard for total suspended solids (TSS) applies only to designated waters in the Humboldt basin. The most restrictive beneficial use aquatic life (warm-water fishery). Annual median values must be below 80 mg/l. Also, the maximum allowable point source discharge is a single value of less than 80 mg/l.

The standard comes from the EPA's Gold Book (1986). The effect of turbidity on fish was studied by the European Inland Fisheries Advisory Commission (EIFAC, 1965). Suspended solids affect fish and fish food populations by:

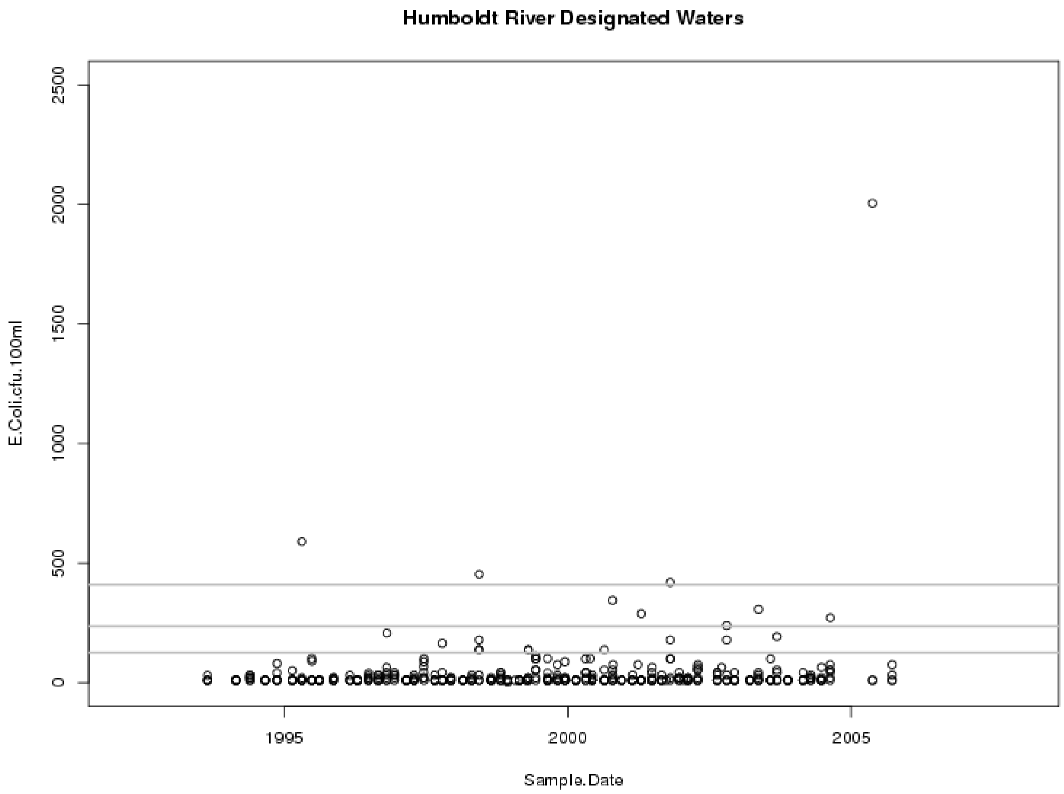
1) acting directly on the fish swimming in water and either killing them or reducing their growth rate, resistance to disease, etc.;
2) preventing the successful development of fish eggs and larvae;
3) modifying natural movements and migrations of fish; and
4) reducing the abundance of food available to the fish.

The standard of 80 mg/l appears to come from a study where suspended solids downstream of a rock quarry reached 80 mg/l and the density of macroinvertebrates decreased by 60 percent. Also, this criterion for freshwater fish and other aquatic life was developed by the National Academy of Sciences and the Great Lakes Water Quality Board.

Through conversations with NDEP, it was revealed that the EPA is re-evaluating TSS and turbidity thresholds to better manage suspended and bedded sediments. NDEP plans to revisit their own standard, but only after the EPA concludes their study. Until then, the standard of 80 mg/l applies. A modified standard should account for the species of fish found in the Humboldt basin, which would then determine the most critical time of year for spawning.

As shown in the plot above, this standard is often exceeded with values often reaching 600 mg/l and sometimes as high as 4000 mg/l.

4.11. E. Coli



The standard for E. Coli was set to protect designated waters for recreation involving contact with water. The standard for most reaches is an annual geometric mean cannot exceed 126 cfu/100ml and no single value can exceed 410 cfu/100ml. The most downstream reach of the Humboldt River, represented by the Humboldt River at Woolsey, has the same annual geometric mean standard of 126 cfu/100ml, and no single value can exceed 235 cfu/100ml.

The standard came from the Ambient Water Quality Criteria for Bacteria (EPA, 1986) as it applies to bathing waters. Studies were conducted in the 1940s and 1950s at bathing beaches on Lake Michigan, the Ohio River, and Long Island Sound. All studies were similar. A statistical analysis was performed to determine differences in illness rates between those who swam in water with high coliform counts and the general population. The acceptable gastroenteritis rate per 1000 swimmers was 8, which was achieved with a steady state indicator density with a geometric mean of 126 cfu/100ml. Single sample maximum allowable densities were determined by evaluating the confidence levels (C.L.) of the geometric mean. Designated beach areas were assigned to an Upper C.L. of 75%, resulting in a single value of 235 cfu/100ml. Areas with lightly used full body contact recreation were assigned to the 90% Upper C.L., resulting in a single value of 410 cfu/100ml.

As shown in the plot above, there are a few samples that exceed the single value limit of 410 cfu/100ml. Geometric means were not computed for this study. At this time, the E.Coli standard is not a priority for reconsideration, unless the beneficial use designations were to change. In the new table format that the NDEP is planning to display water quality standards for all water bodies in the state, an E.Coli standard is proposed to be listed for each reach. Currently these E.Coli standards only apply to designated waters.

5. Pollutants of Concern

The standards used by the Nevada Department of Environmental Protection for toxic materials inorganic and organic compounds are found in the Nevada Administrative Code chapter 445. 144 A. The standards apply to the class waters of the state and to the designated water of the state. These two categories do not include all water bodies of the state. The included water bodies for the Humboldt River Basin are listed in a later section of this document. The table includes standards for 125 compounds. For the purposes of this document we have analyzed the criteria used by the NDEP for selecting the standards for those elements that have been identified as pollutants of concern or have required the Bureau of Water Quality to list the water body in the Clean Water Act 303(d) list.

Many of the compounds listed in the table have no monitoring associated with them currently and would only be used if there was a suspected problem in a particular reach. The table is divided into four columns to reflect different standards that are used based on the use of the water: domestic supply, protection of aquatic life, irrigation and livestock watering. For most of the compounds evaluated in this review, the NAC 445A.144 has standard for aquatic life protection and sometimes for irrigation, but not for all four criteria.

The current standards for zinc, lead, and copper are based on mathematical formulas that take into account the hardness of the water sample. These formulas have recently been updated by Paul Comba at the NDEP. The new formulas are in the process of being approved by the US Environmental Protection Agency (EPA) but are already incorporated into the Nevada statute. Comba expects official approval within 60 days.

Other than the elements mentioned in the previous paragraph, iron, boron and molybdenum the NDEP is not currently investigating revision of any of the other compounds in the table found in NAC445.144A.

Standards for toxic materials applicable to designated waters (after NAC 445A.144)

Chemical	Domestic Supply[1]	Aquatic Life[1,2]	Irrigation[1]	Livestock[1]
	(μg/l)	(μg/l)	(μg/l)	(μg/l)
INORGANIC CHEMICALS[3]				
Antimony	146[a]	-	-	-
Arsenic	50[b]	-	100[c]	200[d]
1-hour average	-	340[g,h]	-	-
96-hour average	-	150[g,h]	-	-
Barium	2,000[b]	-	-	-
Beryllium	0[a]	-	100[c]	-
hardness <75 mg/l	-	-	-	-
hardness >= 75 mg/l	-	-	-	-
Boron	-	-	750[a]	5,000[d]
Cadmium	5[b]	-	10[d]	50[d]
1-hour average	-	$(1.136672-\{\ln(hardness)(0.041838)\})*e^{(1.0166\{\ln(hardness)\} - 3.924)}$ [g,h]	-	-
96-hour average	-	$(1.101672-\{\ln(hardness)(0.041838)\})* e^{(0.7409\{\ln(hardness)\} - 4.719)}$ [g,h]	-	-
Chromium (total)	100[b]	-	100[d]	1,000[d]
Chromium (VI)	-	-	-	-
1-hour average	-	16[g,h]	-	-
96-hour average	-	11[g,h]	-	-
Chromium (III)	-	-	-	-
1-hour average	-	$(0.316) * e^{(0.8190\{\ln(hardness)\} + 3.7256)}$ [g,h]	-	-
96-hour average	-	$(0.860) * e^{(0.8190\{\ln(hardness)\} + 0.6848)}$ [g,h]	-	-
Copper	-	-	200[d]	500[d]
1-hour average	-	$(0.960) * e^{(0.9422\{\ln(hardness)\} - 1.700)}$ [g,h]	-	-
96-hour average	-	$(0.960) * e^{(0.8545\{\ln(hardness)\} - 1.702)}$ [g,h]	-	-
Cyanide	200[a]	-	-	-
1-hour average	-	22[h]	-	-

Chemical	Domestic Supply[(1)]	Aquatic Life[(1,2)]	Irrigation[(1)]	Livestock[(1)]
96-hour average	-	5.2[h]	-	-
Fluoride	-	-	1,000[d]	2,000[d]
Iron				
96-hour average	-	1,000[h]	5,000[d]	-
Lead	50[a,b]	-	5,000[d]	100[d]
1-hour average	-	$(1.46203-\{\ln(hardness)(0.145712)\})*e^{(1.273\{\ln(hardness)\} - 1.460)}$ [g,h]	-	-
96-hour average	-	$(1.46203-\{\ln(hardness)(0.145712)\})*e^{(1.273\{\ln(hardness)\} - 4.705)}$ [g,h]	-	-
Manganese	-	-	200[d]	-
Mercury	2[b]	-	-	10[d]
1-hour average	-	1.4[g,h]	-	-
96-hour average	-	0.77[g,h]	-	-
Molybdenum	-	19[e]	-	-
Nickel	13.4[a]	-	200[d]	-
1-hour average	-	$(0.998) * e^{(0.8460\{\ln(hardness)\} + 2.255)}$ [g,h]	-	-
96-hour average	-	$(0.997) * e^{(0.8460\{\ln(hardness)\} + 0.0584)}$ [g,h]	-	-
Selenium	50[b]	-	20[d]	50[d]
1-hour average	-	20[a]	-	-
96-hour average	-	5.0[h]	-	-
Silver				
1-hour average	-	$(0.85) * e^{(1.72\{\ln(hardness)\} - 6.59)}$ [g,h]	-	-
96-hour average	-	2.0[h]	-	-
Thallium	13[a]	-	-	-
Zinc	-	-	2,000[d]	25,000[d]
1-hour average	-	$(0.978) * e^{(0.8473\{\ln(hardness)\} + 0.884)}$ [g,h]	-	-
96-hour average	-	$(0.986) * e^{(0.8473\{\ln(hardness)\} + 0.884)}$ [g,h]	-	-
ORGANIC CHEMICALS				

Chemical	Domestic Supply[(1)]	Aquatic Life[(1,2)]	Irrigation[(1)]	Livestock[(1)]
Acrolein	320[a]	-	-	-
Aldrin	0[a]	3[a]	-	-
Chlordane	0[a]	2.4[a]	-	-
24-hour average	-	0.0043[a]	-	-
2,4-D	100[a,b]	-	-	-
DDT & metabolites	0[a]	1.1[a]	-	-
24-hour average	-	0.0010[a]	-	-
Demeton	-	0.1[a]	-	-
Dieldrin	0[a]	2.5[a]	-	-
24-hour average	-	0.0019[a]	-	-
Endosulfan	75[a]	0.22[a]	-	-
24-hour average	-	0.056[a]	-	-
Endrin	0.2[b]	0.18[a]	-	-
24-hour average	-	0.0023[a]	-	-
Guthion	-	0.01[a]	-	-
Heptachlor	-	0.52[a]	-	-
24-hour average	-	0.0038[a]	-	-
Lindane	4[b]	2.0[a]	-	-
24-hour average	-	0.080[a]	-	-
Malathion	-	0.1[a]	-	-
Methoxychlor	100[a,b]	0.03[a]	-	-
Mirex	0[a]	0.001[a]	-	-
Parathion	-	-	-	-
1-hour average	-	0.065[a]	-	-
96-hour average	-	0.013[a]	-	-
Silvex (2,4,5-TP)	10[a,b]	-	-	-
Toxaphene	5[b]	-	-	-

Chemical	Domestic Supply[(1)]	Aquatic Life[(1,2)]	Irrigation[(1)]	Livestock[(1)]
1-hour average	-	0.73[a]	-	-
96-hour average	-	0.0002[a]	-	-
Benzene	5[b]	-	-	-
Monochlorobenzene	488[a]	-	-	-
m-dichlorobenzene	400[a]	-	-	-
o-dichlorobenzene	400[a]	-	-	-
p-dichlorobenzene	75[b]	-	-	-
Ethylbenzene	1,400[a]	-	-	-
Nitrobenzene	19,800[a]	-	-	-
1,2-dichloroethane	5[b]	-	-	-
1,1,1-trichloroethane (TCA)	200[b]	-	-	-
Bis (2-chloroisopropyl) ether	34.7[a]	-	-	-
Chloroethylene	2[b]	-	-	-
(vinyl chloride)				
1,1-dichloroethylene	7[b]	-	-	-
Trichloroethylene (TCE)	5[b]	-	-	-
Hexachlorocyclopentadiene	206[a]	-	-	-
Isophorone	5,200[a]	-	-	-
Trihalomethanes (total)[f]	100[b]	-	-	-
Tetrachloromethane	5[b]	-	-	-
(carbon tetrachloride)				
Phenol	3,500[a]	-	-	-
2,4-dichlorophenol	3,090[a]	-	-	-
Pentachlorophenol	1,010[a]	-	-	-
1-hour average	-	exp{1.005 (pH)-4.830}[a]	-	-
96-hour average	-	exp{1.005 (pH)-5.290}[a]	-	-
Dinitrophenols	70[a]	-	-	-

Chemical	Domestic Supply[1]	Aquatic Life[1,2]	Irrigation[1]	Livestock[1]
4,6-dinitro-2-methylphenol	13.4[a]	-	-	-
Dibutyl phthalate	34,000[a]	-	-	-
Diethyl phthalate	350,000[a]	-	-	-
Dimethyl phthalate	313,000[a]	-	-	-
Di-2-ethylhexyl phthalate	15,000[a]	-	-	-
Polychlorinated biphenyls				
(PCBs)	0[a]	-	-	-
24-hour average	-	0.014[a]	-	-
Fluoranthene	42[a]	-	-	-
(polynuclear aromatic				
hydrocarbon)				
Dichloropropenes	87[a]	-	-	-
Toluene	14,300[a]	-	-	-

Footnotes:

(1) Single concentration limits and 24-hour average concentration limits must not be exceeded. One-hour average and 96-hour average concentration limits may be exceeded only once every 3 years. See reference a.

(2) Aquatic life standards apply to surface waters only; “hardness” is expressed as mg/L CaCO3; and “e” refers to the base of the natural logarithm whose value is 2.718.

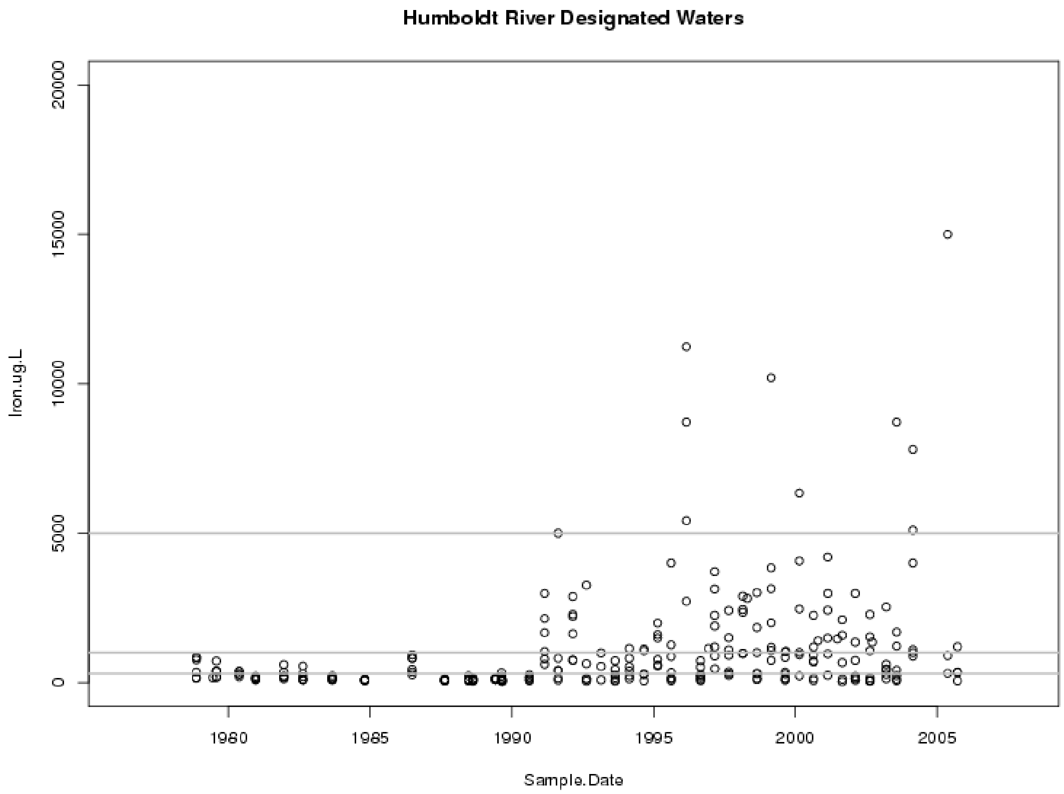
(3) The standards for metals are expressed as total recoverable, unless otherwise noted.

References:

a. U.S. Environmental Protection Agency, Pub. No. EPA 440/5-86-001, Quality Criteria for Water (Gold Book) (1986).
b. Federal Maximum Contaminant Level (MCL), 40 C.F.R. §§ 141.11, 141.12, 141.61 and 141.62 (1992).
c. U.S. Environmental Protection Agency, Pub. No. EPA 440/9-76-023, Quality Criteria for Water (Red Book) (1976).
d. National Academy of Sciences, Water Quality Criteria (Blue Book) (1972).

e. California State Water Resources Control Board, Regulation of Agricultural Drainage to the San Joaquin River: Appendix D, Water Quality Criteria (March 1988 revision).
f. The criteria for trihalomethanes (total) is the sum of the concentrations of bromodichloromethane, dibromochloromethane, tribromomethane (bromoform) and trichloromethane (chloroform). See reference b.
g. This standard applies to the dissolved fraction.
h. U.S. Environmental Protection Agency, National Recommended Water Quality Criteria, May 2005

5.1. Iron



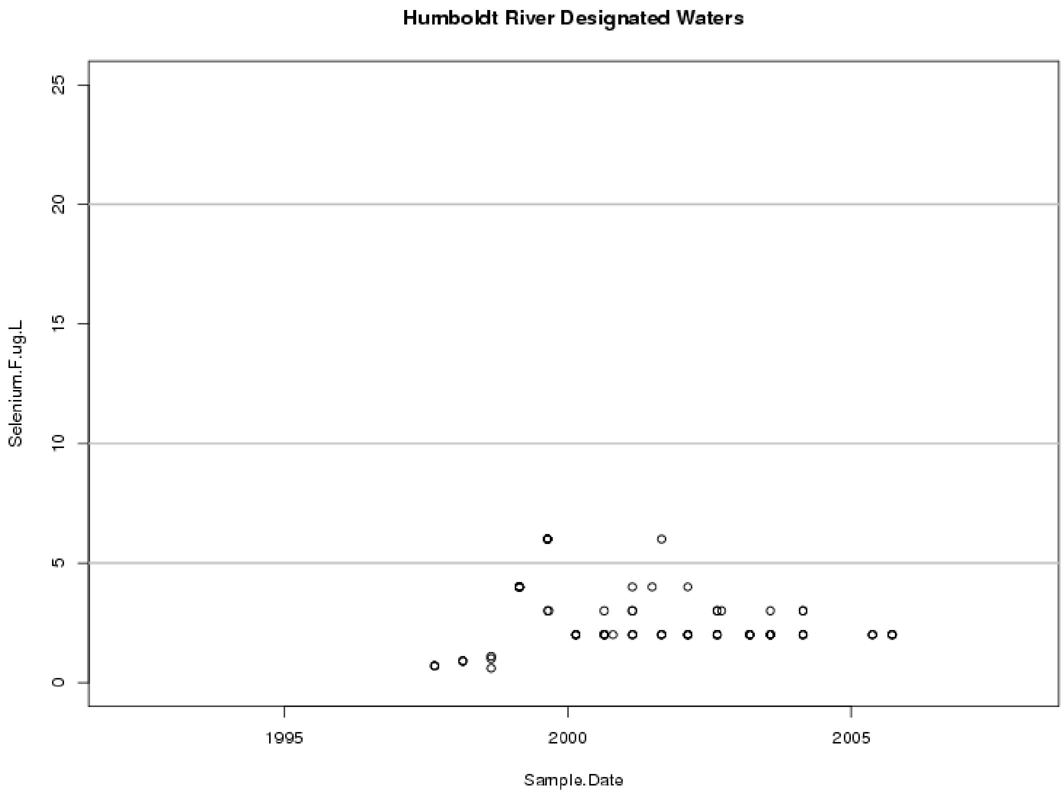
The Iron water column standard currently set for designated and class waters of Nevada is measured in a 96-hour standard to be 1000 micrograms per liter in all waters that have aquatic life and 5000 micrograms per liter in irrigation water as listed in the NAC 445A.144. There are no additional standards for municipal/domestic supply. This standard was used in the NAC following the recommendation given in the US EPA publication National Recommended Water Quality Criteria 2005 and from the Gold Book (US EPA, 1986). Iron is listed as a "non-priority" pollutant because the ill-effect of the pollutant is in color, taste and staining of pipes and laundry, not to human health. The EPA recommendation for water used for human consumption is 300 micrograms per liter.

Although the Gold Book is sited by the NAC as the source of the standard, the methodology of choosing that standard came from the Red Book (US EPA, 1976). In the Red Book it states that iron is found naturally in aquatic environments but high iron water is attributed to mine drainage. In particular the book mentions "yellow boy" deposits near coal mines. The form that iron takes in aqueous environments is dependent on the temperature of the water. In some aqueous forms iron is not dangerous to wildlife because it is biologically inactive. When it forms hydroxide compounds and precipitates on stream bottoms though, it can form into cement that makes fish spawning impossible. The iron compounds that form a gel-like substance and settle on stream bottoms can coat fish gills and destroy bottom-dwelling invertebrates, plants and fish eggs. Several studies are cited in the Red Book show the toxicity of iron to some insects and freshwater fish but the chosen standard of 1000 micrograms per liter is thought to be adequately protective. The protection of freshwater aquatic life is the basis for the iron standard of 1000 μg/L.

According to the Red Book (1976) the domestic and municipal use standard in the book was chosen to avoid objectionable taste and staining, but iron is a nutritional requirement for humans and the average intake is around 16 milligrams. The 300 microgram per liter recommendation is not related to the toxicity of iron for human consumption. Iron is not known to have a detrimental effect on recreational uses of water, except perhaps aesthetically when iron oxides are present. In livestock very high iron concentrations can interfere with the metabolism of phosphorus. Excess iron in soil may also result in a nutrient deficiency disease in plants because of the way it complexes with phosphorus. There is one study cited that revealed a reduction in the quality of tobacco when it was spray irrigated with water containing 5 milligrams per liter of soluble iron.

In a draft NDEP Bureau of Water Quality 5-year plan (2006) the bureau states that the iron standard should be revised. The plan acknowledges that there is no new national guidance the process of revising the standard. Though, other states are beginning to explore changes to the standard. Ohio recently deleted its 1000 μg/L standard following evidence that healthy aquatic populations were present in waters that had higher iron concentrations. The bureau has no direct plan to pursue the changes until there is more data and new assessment tools are developed. There is broad agreement in several states and within the NDEP that the iron standard should be reconsidered, though it may not have the highest priority, given that the toxicity to humans is not of great concern.

5.2. Selenium



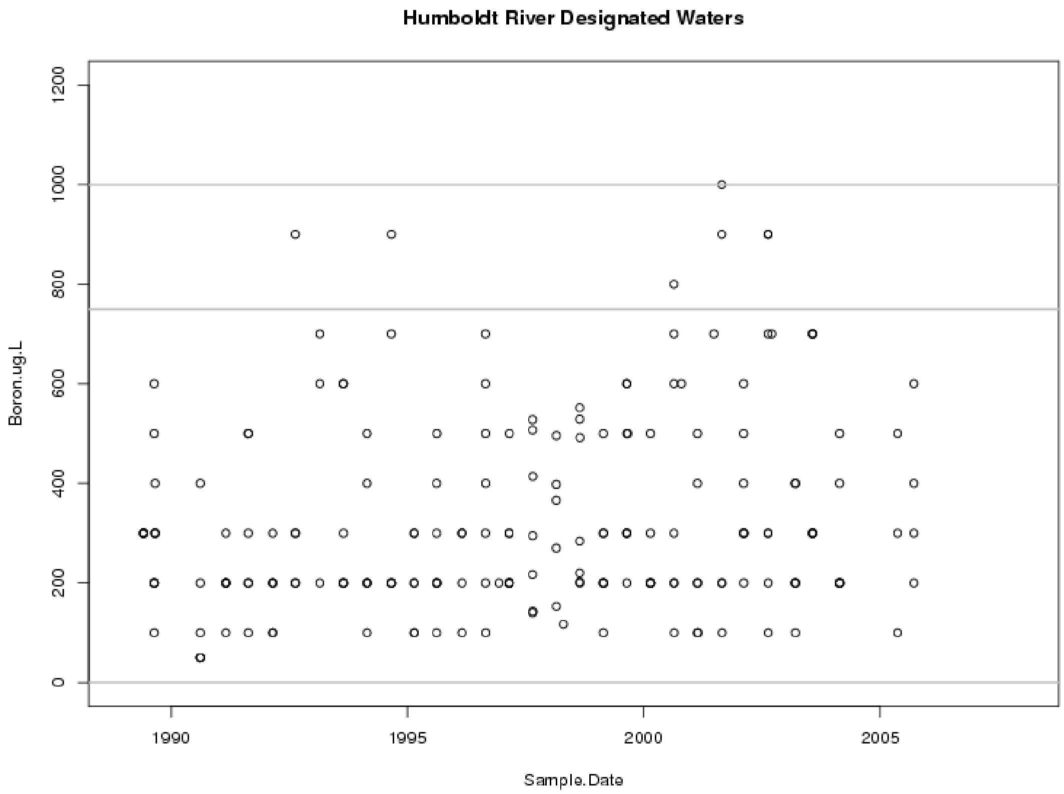
The Selenium water quality standard set in the NAC 445A.144 is µg/L for a one-hour average and 5 micrograms per liter in a 96-hour average both as protection for aquatic life. The first standard is taken from US EPA recommendations given in the Gold Book and the second is based on the recommendation given in National Recommended Water Quality Criteria (EPA, 2005). The one-hour average adopted by Nevada is stricter than the US EPA recommendation. The standard in the 2005 publication was created in 1987 in a separate document, Water Quality Guidance for the Great Lakes System (EPA, 1987).

The recommendation given in the Gold Book is for total recoverable inorganic selenite to protect freshwater aquatic life is 35 micrograms per liter, in a 24-hour average, not to exceed 260 micrograms per liter at any time. The recommendation is based on cited data in which toxicity in freshwater wildlife occurred at 760 micrograms per liter and lower depending on the species. To protect human consumption the EPA recommends that levels not exceed 10 micrograms per liter. Toxic effects are observed in humans after ingesting the water directly and eating fish that have lived in high selenium waters. Nevada has not adopted this human consumption standard.

The EPA is currently reassessing the recommendation given for selenium. The EPA criteria for selenium will be revised based on the final reassessment to be found in document (EPA website). The agency recommends continuing with the existing criteria until the assessment is made. The new study acknowledges that there are two prevalent oxidation states of selenium. The ratios of each of the two states in the water column can create an additive effect, which is why the EPA would like to conduct more studies to set a new standard for the water column.

The selenium standard is already in revision at the national level and reevaluation by the NDEP should wait until the US EPA has completed its studies.

5.3. Boron

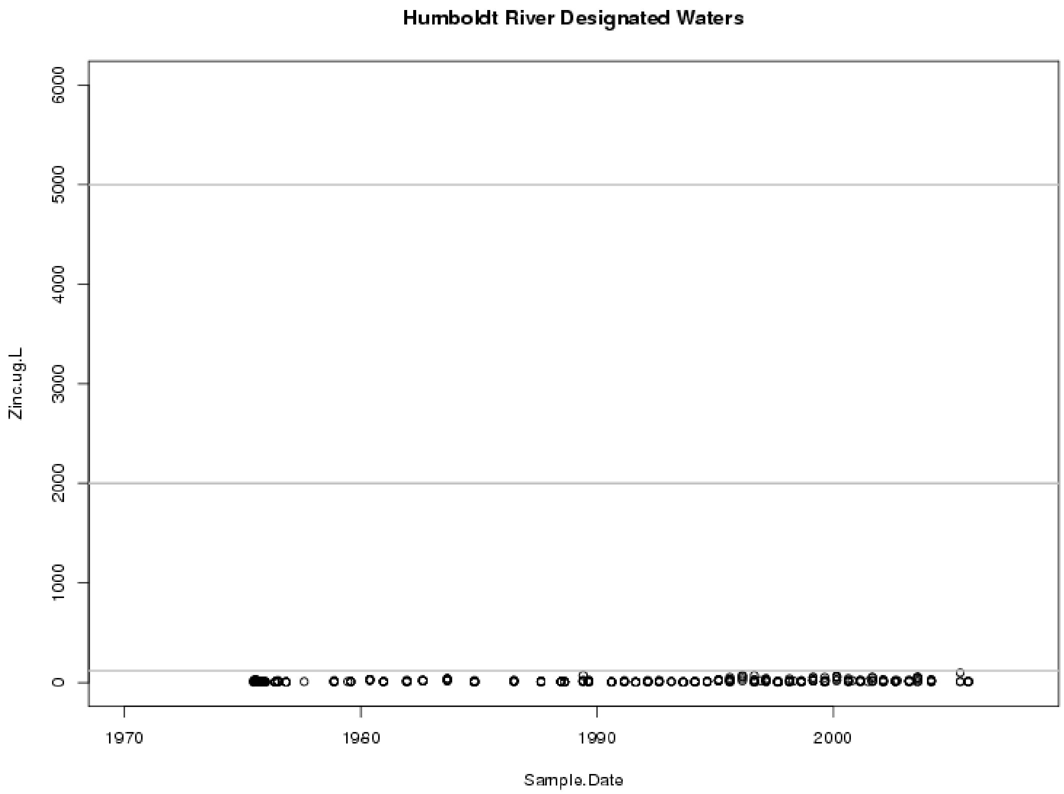


The Boron water column standard currently set for designated and class waters of Nevada is 750 micrograms per liter for water used for irrigation as listed in the Nevada Administrative Code 445A.144. The standard was added to the NAC following the recommendation given in the US Environmental Protection Agency publication referred to as the Gold Book. According to the Gold Book, sensitive crops, such as citrus, show the toxic effects of boron at less than 1000 micrograms per liter of boron in the water column. One study cited revealed that citrus began to show injury with as little as .75 micrograms per liter in irrigation water depending on the acidity of the soil. The recommendation of no more than 750 micrograms per liter was chosen because it is thought to “protect sensitive crops during long-term irrigation.” (EPA, 1986)

In a discussion with current staff at the NDEP (Pahl, 2007) this standard is an example that should be reconsidered. It applies to all of the class waters in the watershed and the main stem of the Humboldt River, without regard to the fact that irrigation of identified Boron sensitive crops does not occur in the region.

In monitoring done by the NDEP between August of 1996 and March 2003 boron levels frequently exceed the 750 µg/L standard at several of the monitoring stations.

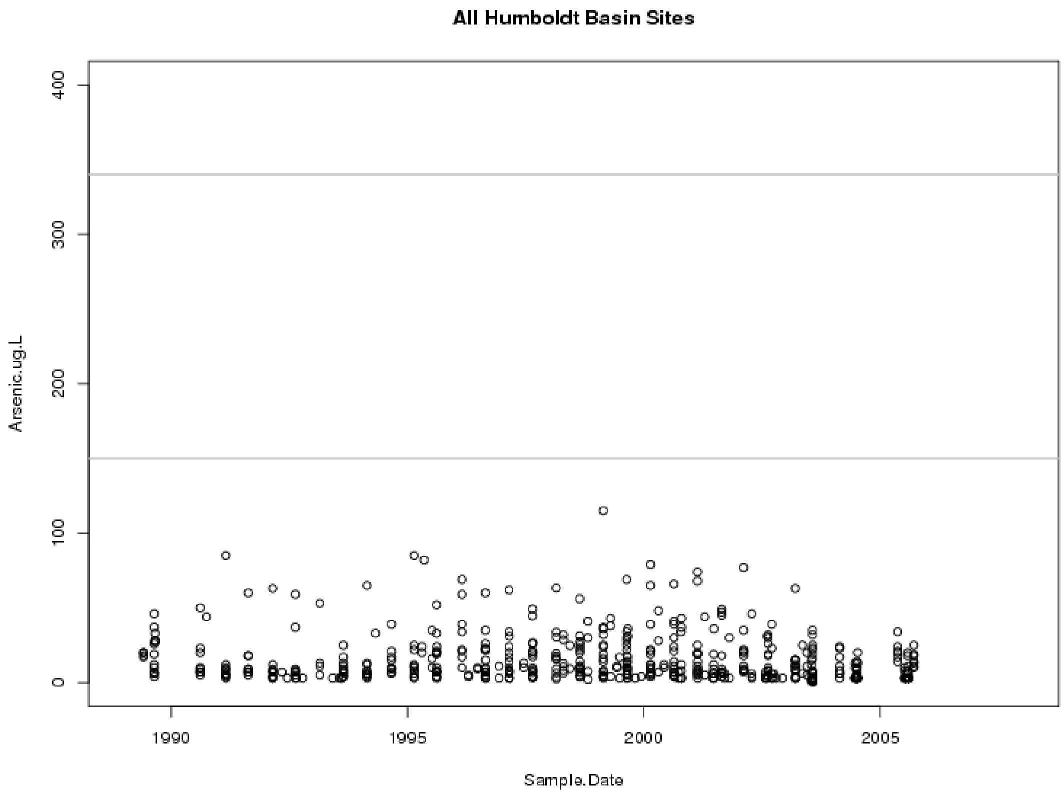
5.4. Zinc



The zinc standard given in the NAC 445A.144 protection of aquatic life is expressed in a formula that takes into account the hardness of the water sample. The standard was adopted from the recommendations in Recommended Water Quality Criteria 2005, published by the EPA. The zinc standard in this originated from EPA studies of specific elements that are performed periodically (EPA website). In Recommended Water Quality Criteria (EPA, 2005), the number 120 micrograms per liter is given based on a hardness of 100 milligrams per liter. The expression is 0.978*e(0.8473{ln(hardness)}+0.884). This recommended criterion is based on a formula that is published in the National Recommended Water Quality Criteria (EPA, 2006). Although the above document is based on data gathered in the Great Lakes region, the Recommended Water Quality Criteria (EPA, 2005) states that the derivation of the expressions are not affected by any considerations specific to the Great Lakes.

The toxicity of zinc in aquatic life and in humans is not well understood, but in the Gold Book (EPA, 1986) it states that to avoid objectionable taste and odor the amount should be less than 5 milligrams per liter. In the draft Nevada Bureau of Water Quality Planning's 5-Year Plan (2006) the bureau states that the level given in the NAC has been exceeded in several water bodies in the state. But the NDEP water quality office believes that this may be related to the type filters used in the Zinc analysis. The bureau is waiting to make a decision on next steps until the results come back from new filters. The zinc standard may be at an acceptable level. Before recommending that NDEP revisit this standard the results from the new filters should be analyzed.

5.5. Arsenic



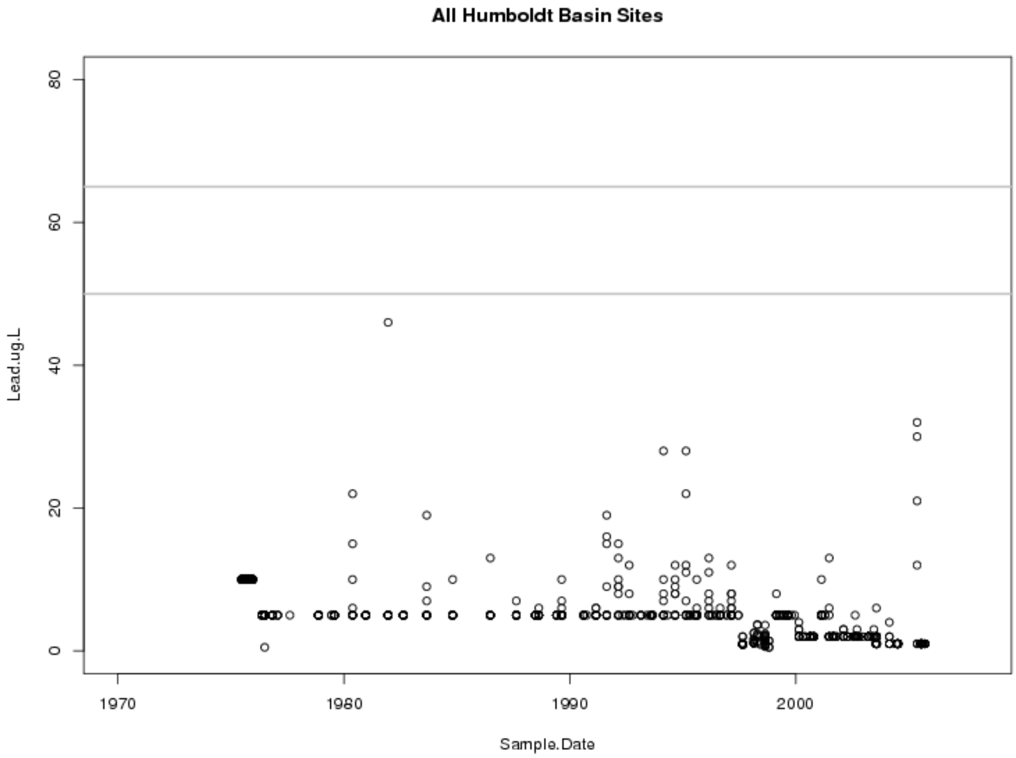
Arsenic is not to exceed 340 micrograms per liter in a 1-hour average or 150 micrograms per liter in a 96-hour average according to NAC 445 A.144 to protect fresh water aquatic environments. This standard is based on the most recent recommendations of the US EPA found in National Recommended Water Quality Criteria (2005). Arsenic takes several forms in the aquatic environment and each may have different toxicity in different species or be additive in the environment. The recommendation is based on arsenic (III) and taken from studies given to five different species (EPA 1984, EPA 1985).

The standard for drinking water is 50 micrograms per liter and is based on the Federal Maximum Contaminant level adopted into law in 1992 (40 C.F.R 141.11 and 141.62). The new EPA regulation for drinking water is 10 micrograms per liter. The regulation went into effect in January 2006 and is enforceable at the level of municipal supplies. Arsenic is known to cause skin damage, problems with circulatory systems, and may have increase the risk of getting cancer

Arsenic speciation in aquatic environments is complex. The document Ambient Water Quality Criteria for Arsenic (EPA, 1984) states that the toxicity of the different species and their interactions are not well understood which causes difficulty in setting an overall arsenic standard. But arsenic is certainly a toxic substance that has ill affects in humans and wildlife. Therefore the standard should be conservative based on all available studies. The EPA is conscious of this and has documentation for the methods used to achieve the given standard.

It should be kept in mind that in Nevada there are areas with naturally high arsenic levels and the Nevada standard may have to be adjusted on specific reaches to account for this. Also, it should be noted that much recent research is available about arsenic speciation, which could inform the NDEP in setting more specific standards in the Humboldt Basin.

5.6. *Lead*



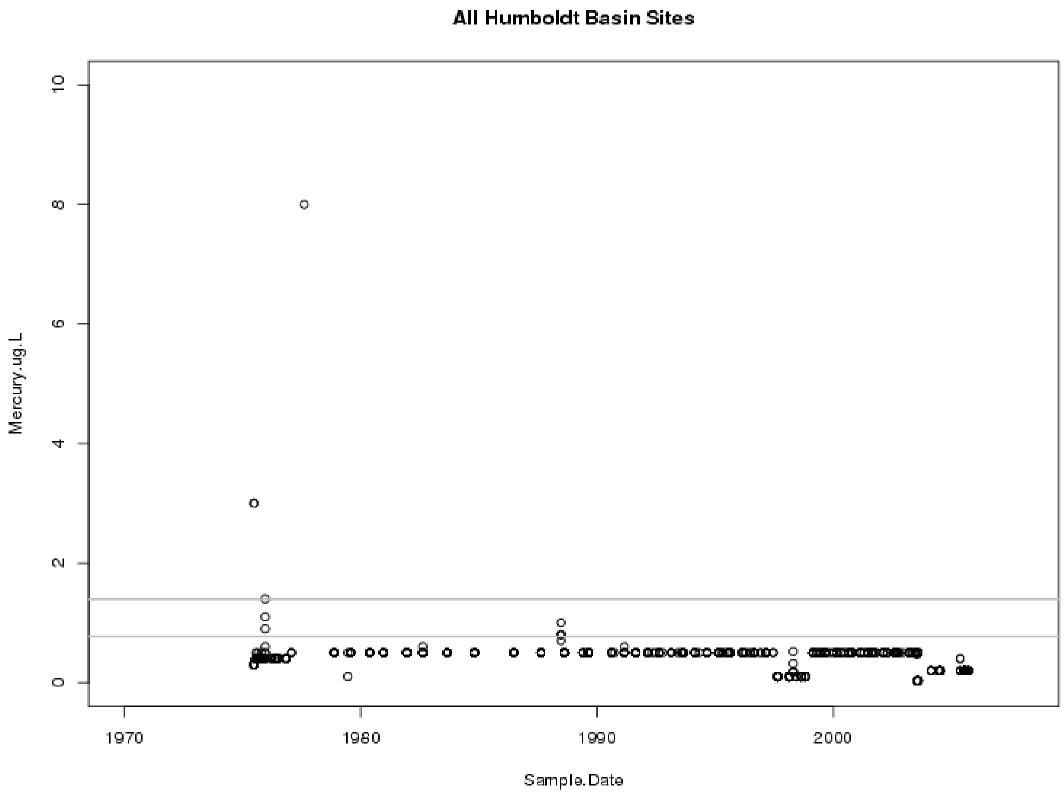
The lead standard for protection of aquatic species in NAC 445A.144 is based on a formula that takes into account the hardness of the water. Nevada has adopted the standard for the protection of aquatic life. The formula comes from the EPA's National Recommended Water Quality Criteria (2005). The EPA recommendation originated from another EPA publication: Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, (EPA, 1985c) and the associated criteria document (EPA, 1985d). The EPA periodically studies particular elements to better evaluate the standard associated with each. The toxicity of lead to several species of freshwater animals decreases as the hardness increases (EPA, 1986). The standard was developed through data derived in toxicity studies of about 240 species of fish, insects, worms, crustaceans and toads found in North America (EPA, 1985d).

The formula is (1.46203-{ln(hardness)(0.145712)})*e (1.273{ln(hardness)} - 1.460). For a given hardness of 100 mg/L the standard is 65 μg/L to protect freshwater aquatic life.

For drinking water the standard is 50 micrograms per liter which originally came from the Gold. In 1992 it was set into law as a Maximum Federal Contaminant Level (40 C.F.R 141.11 and 141.62). The EPA goal is to have drinking water that is lead free. Lead is linked to delays in physical or mental development in children; kidney problems and high blood pressure in adults.

Lead is studied intensively at the national level especially in the case of water for human consumption. The formula recently updated by the NDEP and in the process of being approved by the US EPA may be enough of an update of the Nevada lead standard. After the new standard takes effect the NDEP should closely monitor how the new standard differs from the old in terms of the number of water bodies that exceed the standard and by how much. The NDEP has little power to adjust the federal regulations.

5.7. Mercury



The NAC 445A.144 sets a standard of 1.4 micrograms per liter mercury in a one-hour average and .77 micrograms per liter in an 96-hour average to protect aquatic life. The standard follows the recommendation of the US EPA (2005) found in the most recent National Recommended Water Quality Criteria. The drinking water standard is 2 micrograms per liter, a number set by the Federal Maximum Contaminant Level regulation (40 C.F.R 141.11 and 141.62).

Mercury speciation is complex and has an effect on the toxicity of the element. Methylated mercury, as opposed to inorganic mercury in the environment is mobile and toxic. The standard adopted by the Nevada statute is derived from data for inorganic mercury (II). The National Recommended Water Quality Criteria (EPA, 2005) states that if a good portion of the mercury in the water column is methylmercury that the standard is likely under protective.

Inorganic mercury is converted to methylmercury in natural systems. Methylmercury bioaccumulates to a great extent but the standard does not account for uptake via the food chain because sufficient data were not available when the criterion was derived. The standard found in the EPA recommendations was derived from the final acute and final chronic toxicity values found in Ambient Water Quality Criteria for Mercury (EPA, 1985b).

Because of the methylation process the mercury that is in the water column is not a reliable tool to determine the amount of mercury that exists in the aquatic environment. In a discussion with current staff at the NDEP (Pahl, 2007), he noted that a fish tissue standard could be adopted that would be a more reliable indicator. Currently the NDEP obtains fish tissue data from other organizations that do research, but the office does not have the resources to create a fish tissue standard for the element. He stated that the EPA is in the process of refining fish tissue criteria recommendations for mercury.

Mercury has become a relevant topic in Nevada politics. The NDEP has a mercury program being implemented in the state for mercury "control, containment and reduction" in air and water systems. With all of this awareness, the NDEP may want to take the initiative to determine the appropriateness of the current water column standard for inorganic mercury.

5.8. Cyanide

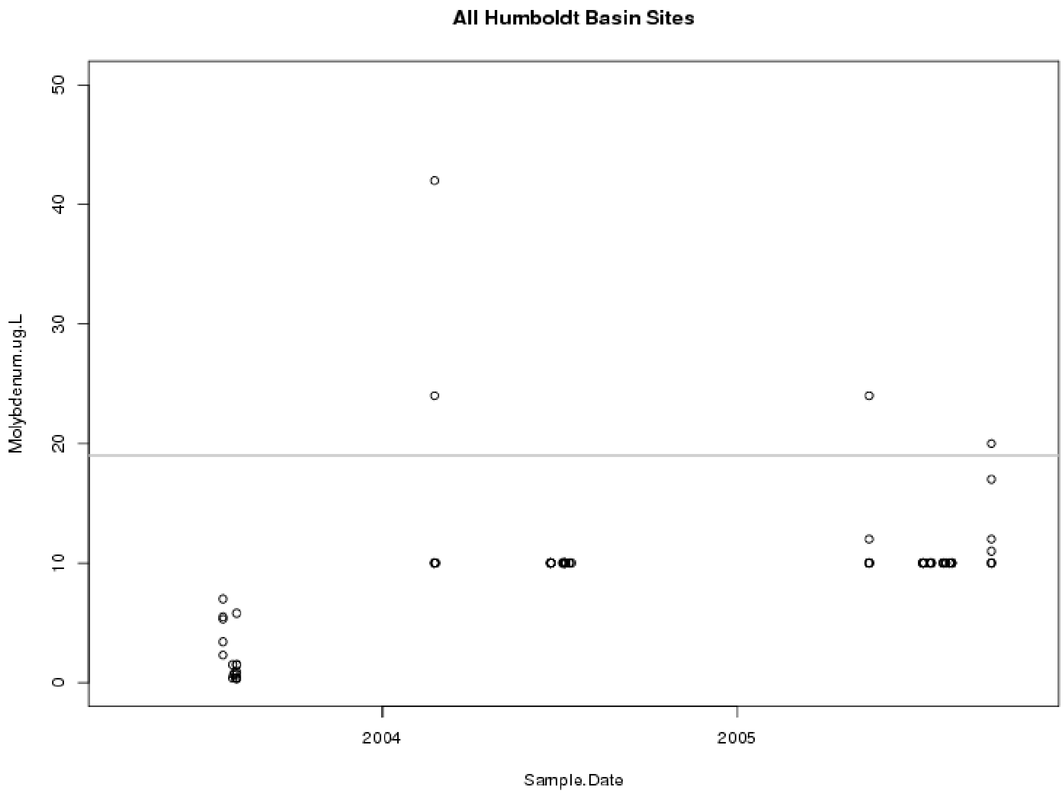
The cyanide regulation for Nevada found in NAC 445A.144 for protection of aquatic life is 16 micrograms per liter in the one-hour average and 5.2 micrograms per liter for the 96 hour average. These standards are derived from the EPA National Recommended Water Quality Criteria (2005). This recommended criterion is based on the aquatic life criterion that was issued in the 1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water, (EPA, 1996). These values were derived using the latest guidelines issued as a result of the Great Lakes Initiative (EPA, 1995). The recommendations are not affected by any criterion specific to the Great Lakes, according to the 2005 document.

Nevada has also adopted the domestic supply standard of 200 micrograms per liter recommended in the EPA Gold Book (1986). At this level human health is thought to be protected both from toxicity of drinking the water and bioaccumulation from ingestion of animals that live in the water.

Cyanide has detrimental effects on human health: shortness of breath, tremors and neurological dysfunction in the short term. In the long term cyanide can cause neurological problems and effect the thyroid functioning. Once released into a water system, cyanide does not persist in the water column; it is be broken down by microbes. In this way it has the potential for bioaccumulation in the environment. Sources of cyanide are discharges from metal finishing industries, iron and steel mills and organic chemical industries. In soils the sources of cyanide are from disposal of cyanide wastes in landfills and the use of cyanide-containing road salts.

The NDEP does not have plans to reevaluate the cyanide standard at this time. The cyanide standard has been recently updated by the EPA and therefore should not be a priority for reevaluation at this time. It should be noted though that the toxicity values vary widely among different species and it may be worthwhile to adapt the Nevada standard to the specific species found in the Humboldt River system.

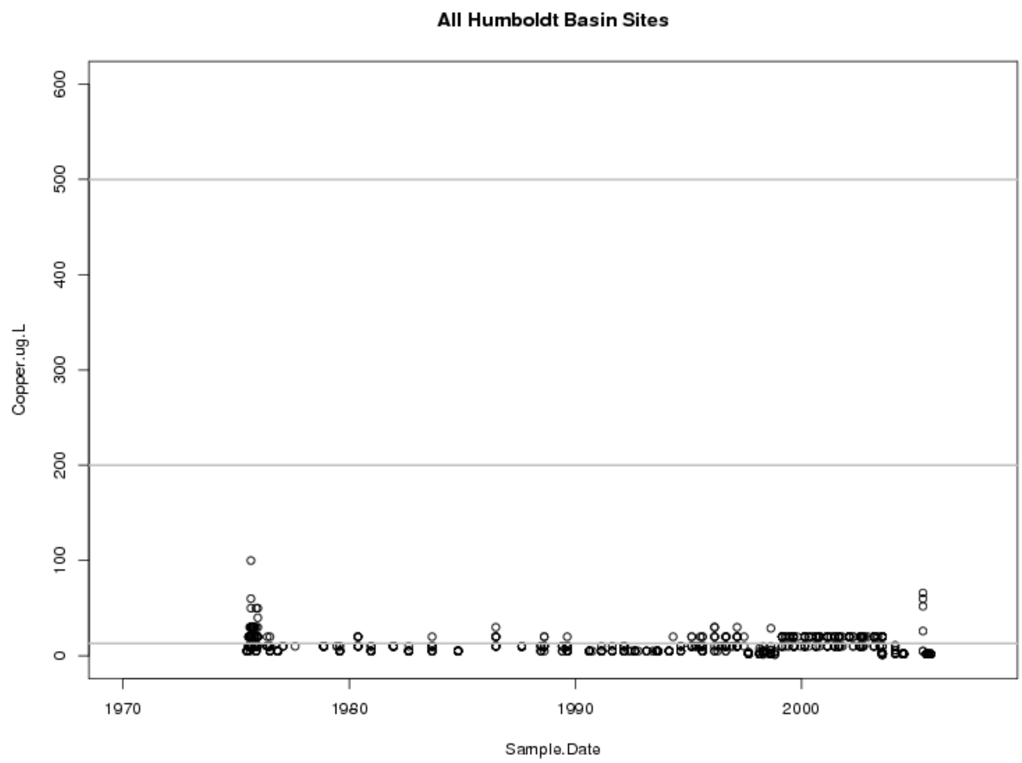
5.9. Molybdenum



The current standard for molybdenum is 19 micrograms per liter for protection of aquatic life listed in the NAC 445A. 144. This standard follows guidelines given in the California State Resources Control Board, regulation of Agricultural Drainage to the San Joaquin River (California State Resources Control Board, 1988) The NDEP has struggled with setting a standard for molybdenum. The number recommended by the EPA is not appropriate for Nevada waters and in general the national standard should be evaluated according to current NDEP staff (Pahl, 2007). The current draft of the NDEP's Bureau of Water Quality Planning's 5-year Plan (2006) indicates that the office will pursue revision of the existing standard. The toxicity test data used in setting the standard for the San Joaquin Delta was limited. The main species used for the California studies is not a common species in Humboldt streams.

The NDEP currently is seeking a contractor to perform studies to improve the toxicity data and make recommendations for a new molybdenum standard. The office should be supported in this effort to and recommend a standard for the Humboldt watershed either in hiring a consultant to gather and analyze the data or providing resources within the office to gather the needed data.

5.10. Copper



The standard for copper listed in the NAC 445A.144 is based on a formula taking into account the hardness of the water. The formulas are those recommended in the EPA National Recommended Water Quality Criteria (2005): (0.960) * e (0.9422{ln(hardness)} - 1.700) for the one-hour average and (0.960) * e (0.8545{ln(hardness)} - 1.702) as the 96-hour average. Based on a hardness of 100 milligrams per liter the numbers come out to 13 micrograms per liter and 9 micrograms per liter respectively. Nevada also has adopted the EPA standard of 200 micrograms per liter for water used in irrigation and 500 micrograms per liter for water used in livestock watering. These standards were recommended in the Blue Book (National Academy of Sciences, 1972).

In humans excess copper can cause gastrointestinal distress, and long term liver and kidney damage. Copper is a minor nutrient for organisms but in larger quantities has toxic effects.

The NDEP copper standard may be readjusted. Until recently the State Health Laboratory was using analysis equipment that required rounding to the nearest 10 microgram per liter (NDEP, 2006). Many of the values were near the standard and therefore it was unclear that the standard is being met. With a lower detection limit now implemented by the State Health Laboratory it may be easier to tell that the standards are being met. If there are still problems with meeting it, the NDEP should revisit the standard.

6. Reaches of the Humboldt

6.1. 445A Designated waters

- Humboldt River near Osino
- Humboldt River at Palisade Gage
- Humboldt River at Battle Mountain Gage
- Humboldt River at crossing of State Highway 789
- Humboldt River at Imlay
- Humboldt River at Woolsey

6.2. Class A waters

- Green Mountain Creek from origin to the national forest boundary (Elko)
- North Fork Humboldt River and tributaries in Independence Mountain Range from its origin to the national forest boundary (Elko)
- South Fork Humboldt River and Tributaries from its origin to Lee (Elko)
- Lamoille Creek from its origin to gaging station number 10-316500 (Elko)
- Maggie Creek tributaries from their origin to the point where they become/or reach Maggie Creek (Elko)
- Mary's River from its origin to the point where the river crosses the east line of T. 42 N., R.59 E. M.D. B & M. (Elko)
- Secret Creek from its origin to the national forest boundary (Elko)
- Starr Creek from its origin to the national forest boundary (Elko)
- Tabor Creek from its origin to the east line of T.40 N. R. 60 E. M.D. B & M. (Elko)
- Toyn Creek from its origin to the national forest boundary (Elko)
- Willow Creek from its origin to the Willow Creek Reservoir (Elko)
- Denay Creek from its origin to Tonkin Reservoir (Eureka)
- Tonkin Reservoir, the entire reservoir (Eureka)
- North Fork Little Humboldt River from its origin to the national forest boundary (Eureka)
- South Fork Little Humboldt River from its origin to Elko-Humboldt county line (Eureka)
- Martin Creek from its origin to the national forest boundary (Eureka)
- Pole Creek from its origin to the point of diversion of Golconda water supply (Eureka)
- Water Canyon Creek from its origin to the point of diversion of the Winnemucca municipal water supply (Eureka)
- Big Creek from its origin to the east boundary of USFS Big Creek Campground (Lander)
- Lewis Creek from its origin to the first point of diversion (Lander)
- Mill Creek From its origin to the first point of diversion (Lander)
- Reese Creek from its origin to its confluence with Indian Creek (Nye)
- San Juan Creek from its origin to the national forest boundary (Nye)

- Huntington Creek from its origin to the White Pine-Elko county line (White Pine)

6.3. Class B waters

- Green Mountain Creek from the national forest boundary to its confluence with Corral Creek (Elko)
- North Fork Humboldt River from the national forest boundary to its confluence with the Humboldt River (Elko)
- South Fork Humboldt River from Lee to its confluence with the Humboldt River (Elko)
- Huntington Creek from White Pine County line to confluence with South Fork Humboldt River (Elko)
- Lamoille Creek from gauging station number 10-316500 to its confluence with the Humboldt River (Elko)
- Maggie Creek from where it is formed by tributaries to its confluence with Jack Creek (Elko)
- Mary's River from the east line of T. 42 N. R. 59 E., M. D. B. & M to its confluence with the Humboldt River (Elko)
- Secret Creek from the national forest boundary to the Humboldt River (Elko)
- Starr Creek from the National Forest Boundary to the Humboldt River (Elko)
- Willow Creek Reservoir, the entire reservoir (Elko)
- Denay Creek below Tonkin Reservoir (Eureka)
- North Fork Little Humboldt River from the national forest boundary to its confluence with the south fork of the Little Humboldt River (Eureka)
- South Fork Little Humboldt River from the Elko-Humboldt county line to its confluence with the north fork of the Little Humboldt River (Eureka)
- Martin Creek from the national forest boundary downstream to the first diversion in T.42 N., R 40 E., M.D. B. & M. (Eureka)
- Big Creek from the east boundary of the USFS Big Creek campground to the first diversion dam (Lander)
- Iowa Canyon Reservoir, the entire reservoir (Lander)
- Reese River from its confluence with Indian Creek to old US Highway 50 (Lander)
- Franktown Creek from the first irrigation diversion to Washoe Lake (Lander)

6.4. Class C waters

- Maggie Creek from its confluence with Jack Creek to the Humboldt River (Elko)
- J.D. Ponds, the entire area (Eureka)
- Little Humboldt River, its entire length (Humboldt)
- Reese River North of Old US Highway 50 (Lander)
- Rock Creek below Squaw Valley Ranch (Lander)
- Humboldt River from Woolsey to Rodger's Dam (Pershing)

6.5. Class D waters

- Humboldt River Rodgers Dam to and including Humboldt Sink (Pershing)

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