Rationale for Proposed Revisions to NAC 445A.1236(1)(c) and Water Quality Standards for Beryllium

R114-22

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Bureau of Water Quality Planning
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Acronyms and Abbreviations

BWQP	Bureau of Water Quality Planning
CFR	Code of Federal Regulations
CPP	Continuing Planning Process
EPA	U.S. Environmental Protection Agency
GFAA	Graphite-furnace atomic absorption
ICP/AES	Inductively coupled plasma and atomic emission spectroscopy
ICP/MS	Inductively coupled plasma and mass spectroscopy
IRR	Irrigation (beneficial use)
LT-MDL	Long-term method detection limit
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
MDL	Method detection limit
mg/L	milligrams per liter
µg/L	micrograms per liter
ML	Minimum level
NAC	Nevada Administrative Code
NDEP	Nevada Division of Environmental Protection
NPDES	National Pollutant Discharge Elimination System
NRS	Nevada Revised Statutes
ppb	parts per billion
PQL	Practical quantitation limit
RL	Reporting limit
USGS	U.S. Geological Survey

Rationale for Proposed Revisions to NAC 445A.1236(1)(c) and Water Quality Standards for Beryllium (P2022-13 / R114-22)

1.0 Introduction

Nevada state law (Nevada Revised Statutes [NRS] 445A.520) requires the state to establish water quality standards to protect beneficial uses of surface waters of the state. Additionally, Section 303 of the Clean Water Act and other Federal regulations (40 Code of Federal Regulations [CFR] Part 131) require that States and authorized tribes routinely review and, as appropriate, modify water quality standards that protect the designated uses of surface waters. Such standards also provide a basis for controlling discharges or releases of pollutants into a waterbody.

The U.S. Environmental Protection Agency (EPA) has, through Section 303 of the Clean Water Act, delegated authority to Nevada to establish water quality standards for all waterbodies or segments of waterbodies within the state. Additionally, the Clean Water Act requires that EPA periodically update water quality criteria. Criteria are an important component of the water quality standards, which consist of (1) designated beneficial uses, (2) numeric or narrative criteria that are protective these uses and (3) antidegradation provisions.

This rationale prepared by the Nevada Division of Environmental Protection (NDEP), Bureau of Water Quality Planning (BWQP) reviews and discusses the revisions proposed to update Nevada's water quality standards for beryllium. It is not until EPA approval and adoption of these revisions as part of the State water quality standards, that the criteria values become regulatory.

2.0 Background: History of Criteria Values for Beryllium

Periodically, EPA and its predecessor agencies have issued ambient water quality criteria, beginning in 1968 with the "Green Book" followed by the 1973 publication of the "Blue Book" (Water Quality Criteria 1972). In 1976, the "Red Book" (Quality Criteria for water) was published. on November 28, 1980 (45 FR 79318), and February 15, 1984 (49 FR 5831), EPA announced through Federal Register notices, the publication of 65 individual ambient water quality criteria documents for pollutants listed as toxic under section 307(a)(l) of the Clean Water Act. on July 29, 1985 (50 FR 30784), EPA published additional water quality criteria documents.

2.1 1968 – Federal Water Pollution Control Administration

In **1968**, EPA's predecessor agency, the Federal Water Pollution Control Administration gave beryllium a criterion value of 500 micrograms per liter (µg/L) to protect crops from damage (beneficial use of irrigation, IRR). This value is listed in Table IV-15, "Trace Element Tolerances for Irrigation Waters," on page 152 of the document. Beryllium does not show up under any other beneficial uses in this 1968 document.

2.2 1976 – U.S. Environmental Protection Agency Criteria (“Red Book”)

In **1976**, EPA updated the criteria for beryllium, listing 100 µg/L for irrigation. No criteria values were provided for human health in the 1976 document (“Red Book”).

2.3 1980 – U.S. Environmental Protection Agency Criteria

In October **1980**, EPA published criteria to protect human health from the toxic effects of beryllium. The 1980 document also stated that “*for the maximum protection of human health from the potential carcinogenic effects due to exposure of beryllium through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical.*” However, this neglects the fact that it is not possible to measure “zero” by any analytical method; the best estimate would be less than the method detection limit of the most sensitive analytical method. Zero as a limit is meaningless from an analytical perspective.

2.4 1986 – U.S. Environmental Protection Agency Criteria (“Gold Book”)

More recently, the **1986** “Gold Book” of criteria repeated the results from the *1980 Ambient Water Quality Criteria for Beryllium*.

2.5 1992 – National Primary Drinking Water Standards

In **1992**, EPA published the current maximum contaminant level (MCL) of 4 µg/L for beryllium (July 17, 1992). However, this 1992 regulation also listed a proposed maximum contaminant level goal (MCLG) of 0 µg/L. By 1994, EPA had adopted 4 µg/L as the value for both the MCL and the MCLG. (Because, again, it is infeasible to measure “zero.”)

2.6 2003 and 2009 – Analytical Feasibility Support Documents

In **2003**, EPA published the “*Analytical Feasibility Support Document for the Six-Year Review of Existing National Primary Drinking Water Regulations*,” with the purpose of evaluating “*whether changes in the practical quantitation level (PQL) were possible in those instances where the Maximum Contaminant Level is limited, or might be limited, by analytical feasibility*.” The 2003 document notes that “*EPA approved multiple analytical methods for determination of beryllium in drinking water, including an atomic absorption–furnace (AAF) method (EPA Method 210.2), an inductively coupled plasma-atomic emission spectroscopy (ICP-AES) method (EPA Method 200.7), ICP-mass spectroscopy method (ICP/MS) (EPA Method 200.8), and atomic absorption-platform (AAP) method (EPA Method 200.9)…*” These are the three main analytical methods used for major and trace metals. The 2003 analysis found that, for beryllium, “*The MDLs of EPA Methods 200.7, 200.8 and 200.9 do not present any improved sensitivity capabilities*.”

In **2009**, EPA published the "Analytical Feasibility Support Document for the Second Six-Year Review of Existing National Primary Drinking Water Regulations." Exhibit 91 on page 109 of the 2009 review indicated that the method detection limits (MDLs) for beryllium ranged from 0.3 µg/L for Method 200.7 (ICP-AES) to 0.02 µg/L for Method 200.9 (GFAA). Method 200.8 (ICP/MS) was shown with MDLs ranging from 0.02 to 0.3 µg/L. For beryllium, this second six-year review concluded that "*No new or revised methods that may be expected to improve analytical performance in the vicinity of the current PQL (and hence suggest possible reduction of the PQL) have been approved from 2000-2007*."

3.0 Geochemistry of Beryllium

Beryllium is a naturally occurring trace metal that is found in largely insoluble minerals. As noted by Foley et al. (2017) in U.S. Geological Survey (USGS) Professional Paper 1802-E, "*The behavior of beryllium in the environment is dominated by its low solubility in water and that it is commonly found in solid form. Natural beryllium in the atmosphere is mostly from dust sources, including windblown dust and volcanic eruptions. The main anthropogenic source of beryllium in the atmosphere is from the combustion of coal and fuel oil, followed by beryllium processing and municipal waste combustion*." Foley et al. (2017) further explain that:

> *The mobility of beryllium in the aqueous environment is limited because of the poor solubility of most beryllium compounds and its affinity to bind with clay minerals and organic compounds; beryllium commonly resides in sediment or soils. Beryllium mobility is enhanced under acidic water conditions and may be found as a dissolved cation (beryllium^{2+}) or may form soluble fluorine and organic complexes (Kabata-Pendias and Mukherjee, 2007). At near-neutral pH, which is typical of most surface and groundwaters, beryllium is controlled by the formation of beryllium hydroxide, which is a low solubility phase. Globally, rivers commonly contain between less than 0.008 and 0.6 ppb* [parts per billion] *beryllium and have an average of 0.009 ppb beryllium (Gaillard et and others, 2003). Surface waters in the United States have a mean concentration of 0.07 ppb beryllium; groundwaters contain comparably low concentrations, and seawater contains even lower concentrations (Eckel and Jacob, 1988; Bruce and Odin, 2001). Beryllium concentrations in industrial effluents are several orders of magnitude higher and range from 30 to 170 ppb (Bruce and Odin, 2001).*

Hem (1992) reported that the solubility of beryllium hydroxide reaches a minimum of about 0.9 µg/L around pH 8.5; dissolved concentrations may be higher in acidic waters, such as acid mine drainage or industrial waste streams, however. The low-level detections of beryllium (total) reported in samples collected from waterbodies throughout Nevada ranged from 0.03 to 4 µg/L, except for three samples from one waterbody: NV04-HR-153_00, Rodeo Creek, which has a jurisdictional determination as "not a water of the U.S." Additionally, these elevated values for Rodeo Creek reflect one moment in time. Newmont mining collected three samples on March 14 to 16, 2011, that showed concentrations of total beryllium of 15.1, 28.2, and 30.9 µg/L. All other samples (N=23) collected before and after those dates from this waterbody were reported as nondetects of <1 and <2 µg/L. The cause of the three anomalous detections is unknown, but samples collected in May, 2011 (N=5) were all reported as nondetections at <2 µg/L (quantitation limit as censoring limit).

Between October 1, 2000 and September 30, 2020, BWQP's database showed 7,490 records for total and dissolved beryllium. Of these 7,490 records, 6,944 were designated as "nondetects" (i.e., censored values). There were 546 records shown as detected concentrations; of these, 17 records were for dissolved beryllium (0.006 to 5.19 µg/L) and 529 records were for total beryllium (0.03 to 30.9 µg/L). The anomalously high value of 5.19 µg/L was from Walker Lake, a saline terminal lake in which evaporative concentrations of metals and other ions has occurred. The next highest detected value for dissolved beryllium was 2 µg/L. The three anomalously high values for total beryllium were described in the preceding paragraph. Table 1 provides summary statistics for all detected values of total beryllium.

Table 1. Statistical summary of 2000-2020 data for total beryllium detected, as available in the BWQP database as of October 1, 2020.

Statistic	Be, µg/L	Percentile	Be	Units
Mean =	0.36	10%	0.07	µg/L
SD =	1.94	20%	0.09	µg/L
Median =	0.15	30%	0.11	µg/L
Min =	0.03	40%	0.13	µg/L
Max =	30.9	50%	0.15	µg/L
		60%	0.18	µg/L
		70%	0.22	µg/L
		80%	0.27	µg/L
		90%	0.38	µg/L
		95%	0.49	µg/L
		96%	0.60	µg/L
		97%	0.71	µg/L
		98%	1.03	µg/L
		99%	2.72	µg/L
		100%	30.90	µg/L

There are statistical methods of handling nondetect values in a population with a high percentage of nondetects; however, when dealing with high-value nondetects, one can exclude these for plotting purposes and plot the values of detected concentrations to obtain a sense of the population distribution undistorted by replacement values. In the data set for total beryllium evaluated here, out of 6,130 records, only 529 (8.6%) were detections, with 97% of the detected values being less than the average detection limit of 2.5 µg/L. This illustrates why use of the MDL for censoring trace metals is a better option for understanding low levels of beryllium and other metals in natural waters, but is not recommended for permit limits.

Data detected above the MDL but less than a quantitation limit represent "estimated" values. In contrast, a laboratory "reporting limit" is typically the "minimum level" (ML) or "practical quantitation limit" (PQL). Estimated results are qualified in the data report using a "J" qualification code; this means that the parameter is likely present in the sample, but cannot be accurately quantified. EPA typically recommends using a quantification limit for regulatory purposes, such as setting permit limits (see EPA 2007, EPA 2005, EPA 1994)

4.0 Nevada's Current and Proposed Water Quality Standards for Beryllium

At some point, 0 µg/L beryllium (total) was adopted into Nevada's water quality standards for surface waters under NAC 445A.1236 to protect the beneficial use of "municipal and domestic supply" (MDS). Nevada also adopted 100 µg/L beryllium (total) to protect the beneficial use of irrigation (IRR). The footnotes to NAC 445A.1236 (the "toxics table") indicate that Nevada adopted a water quality standard of zero for MDS from EPA's 1986 criteria document ("Gold Book"), and a value of 100 µg/L for IRR from EPA's 1976 criteria document.

The Gold Book (EPA 1986) states:

> *For the maximum protection of human health from the potential carcinogenic effects of exposure to beryllium through ingestion through of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero, based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 68 ng/L, 6.8 ng/L, and 0.68 ng/L, respectively.*

The current value of 0 µg/L for MDS in NAC 445A.1236 is outdated and fails to account for the analytical detection and quantitation limits. In 2003, and again in 2009, EPA published the *Analytical Feasibility of Drinking Water Standards*. Beryllium was evaluated in both documents; EPA found that the MDL ranged from 0.02 µg/L (Method 200.9) to 0.3 µg/L (Methods 200.7 and 200.8) in 2003; these values remained the same in EPA's 2009 evaluation. The PQL was reported as 1.0 µg/L. EPA (2009) concluded that "*No new or revised methods that may be expected to improve analytical performance in the vicinity of the current PQL.*"

Consistent with Nevada's Continuing Planning Process (CPP) document (2002), NDEP proposes to adopt the current drinking water standard of 4 µg/L for beryllium, to replace the value of 0 µg/L as the criterion value for MDS in NAC 445A.1236. MDS would remain as the most sensitive beneficial use, with a water quality standard of 4 µg/L.

5.0 Revision of Language in NAC 445A.1236(1)(c)

The current language in NAC 445A.1236 (1)(c) refers to "…*the detection limit of a method that is acceptable to the Division…*" BWQP acknowledges that the current language in NAC 445A.1236 may cause confusion for regulatory uses of the data (e.g., permitting); seeming to require censoring at the MDL for toxic constituents listed under NAC 445A.1236. In fact, EPA recommends that quantitation limits are the values to use in regulatory applications (e.g., permitting). Unless otherwise stated, the laboratory reporting limits (RLs) provided in laboratory reports to clients are quantitation limits. Because EPA recommends that permit limits be written at a quantitation limit, the RL is the appropriate choice for use in permits (EPA 1994, 2005, 2007).

EPA recently (2014) finalized minor amendments to its Clean Water Act regulations to codify that "…*permit applicants must use "sufficiently sensitive" analytical test methods when completing an NPDES permit application*." (NPDES = National Pollutant Discharge Elimination System). The purpose of this rule was to "*clarify that NPDES applicants and permittees must use EPA-approved analytical methods that are capable of detecting and measuring the pollutants at, or below, the applicable water quality criteria or permit limits*" (EPA 2014). It is assumed here that "measuring" means "quantifying" the concentrations detected. Detections between the MDL and RL are "estimated," with low confidence in the accuracy of the result, which is why use of the RL or other quantitation limit is recommended for permitting and other regulatory applications.

A client can request that the laboratory report data censored at the MDL, with appropriate qualifiers for results detected above the MDL, but below the RL. Because beryllium and other trace metals—especially in the dissolved phase—are found at extremely low levels in most waters, use of the MDL as a censoring level is a reasonable option to obtain concentration data for the trace amounts of such metals in natural waters. Such low-level concentrations may otherwise be censored and limit the understanding of natural background. For this reason, the BWQP requests that laboratories report ***both*** the MDL and the RL, along with the appropriate qualification codes (e.g., J, U, etc.) for each analytical result.

In conclusion, NDEP proposes a minor change in language under NAC 445A.1236(1)(c), changing "*detection limit of a method*" to "*reporting limit of a method*," and "…*substance was not detected shall be deemed to show compliance*…" to "*substance was not detected at quantifiable levels shall be deemed to show compliance…*" This change will align the regulatory language with how laboratories typically report data.

6.0 References

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Appendix A

Proposed Regulation R114-22

PROPOSED REGULATION OF THE

STATE ENVIRONMENTAL COMMISSION

LCB File No. R114-22

July 25, 2022

EXPLANATION – Matter in ***italics*** is new; matter in brackets ~~[omitted material]~~ is material to be omitted.

AUTHORITY: § 1, NRS 445A.425 and 445A.520.

A REGULATION relating to water quality; revising certain requirements relating to compliance with water quality standards; revising the standards for beryllium that are applicable to certain designated waters in this State; and providing other matters properly relating thereto.

Legislative Counsel's Digest:

Existing law requires the State Environmental Commission to adopt regulations establishing standards of water quality and amounts of waste which may be discharged into the waters of this State. (NRS 445A.425) Each standard adopted by the Commission must ensure a continuation of the designated beneficial use or uses applicable to the body of water to which the standard applies. (NRS 445A.520)

Existing regulations: (1) provide that a laboratory result is deemed to show compliance with a water quality standard if the results show that a substance was not detected and the criterion was less than the detection limit, unless other information indicates the substance is present; and (2) set forth the standards for toxic materials, including beryllium, that are applicable to certain designated waters in this State. (NAC 445A.1236) This regulation: (1) provides instead that the laboratory results show compliance if the substance was not detected at a quantifiable level and the criterion is less than the reporting limit, unless other information indicates the substance is present; and (2) revises the standard for beryllium that is applicable to certain designated waters in this State.

Section 1. NAC 445A.1236 is hereby amended to read as follows:

445A.1236 1. Except for waters which have site-specific standards for toxic materials or as otherwise provided in this section, the standards for toxic materials prescribed in subsection 2 are applicable to the waters specified in NAC 445A.123 to 445A.2234, inclusive. The following criteria apply to this section:

(a) If the standards are exceeded at a site and are not economically controllable, the Commission will review and may adjust the standards for the site.

(b) If a standard does not exist for each designated beneficial use, a person who plans to discharge waste must demonstrate that no adverse effect will occur to a designated beneficial use. If the discharge of a substance will lower the quality of the water, a person who plans to discharge waste must meet the requirements of NRS 445A.565.

(c) If a criterion is less than the ~~[detection]~~ ***reporting*** limit of a method that is acceptable to the Division, laboratory results which show that the substance was not detected ***at a quantifiable level*** shall be deemed to show compliance with the standard unless other information indicates that the substance may be present.

2. The standards for toxic materials are:

Chemical	Municipal or Domestic Supply (µg/L)	Aquatic Life[1,2] (µg/L)	Irrigation (µg/L)	Watering of Livestock (µg/L)
INORGANIC CHEMICALS[3]				
Antimony	146[a]	-	-	-
Arsenic	50[b]	-	100[c]	200[d]
1-hour average	-	340[f,(4)]	-	-
96-hour average	-	150[f,(4)]	-	-
Barium	2,000[b]	-	-	-
Beryllium	~~[0[a]]~~ ***4[i]***	-	100[c]	-
Boron	-	-	750[a]	5,000[d]
Cadmium	5[b]	-	10[d]	50[d]
1-hour average	-	$(1.136672-\{\ln(hardness)(0.041838)\})* e^{(0.9789\{\ln(hardness)\} - 3.866)}$ [h,(4)]	-	-
96-hour average	-	$(1.101672-\{\ln(hardness)(0.041838)\})* e^{(0.7977\{\ln(hardness)\} - 3.909)}$ [h,(4)]	-	-
Chromium (total)	100[b]	-	100[d]	1,000[d]
Chromium (VI)	-	-	-	-
1-hour average	-	16[f,(4)]	-	-
96-hour average	-	11[f,(4)]	-	-
Chromium (III)	-	-	-	-
1-hour average	-	$(0.316) * e^{(0.8190\{\ln(hardness)\} + 3.7256)}$ [f,(4)]	-	-
96-hour average	-	$(0.860) * e^{(0.8190\{\ln(hardness)\} + 0.6848)}$ [f,(4)]	-	-
Copper	-	-	200[d]	500[d]
1-hour average	-	$(0.960) * e^{(0.9422\{\ln(hardness)\} - 1.700)}$ [f,(4)]	-	-
96-hour average	-	$(0.960) * e^{(0.8545\{\ln(hardness)\} - 1.702)}$ [f,(4)]	-	-
Cyanide	200[a]	-	-	-
1-hour average	-	22[f,(5)]	-	-

Chemical	Municipal or Domestic Supply (µg/L)	Aquatic Life[(1,2)] (µg/L)	Irrigation (µg/L)	Watering of Livestock (µg/L)
96-hour average	-	5.2[f,(5)]	-	-
Fluoride	-	-	1,000[d]	2,000[d]
Iron	-	-	5,000[d]	-
96-hour average	-	1,000[f]	-	-
Lead	50[a,b]	-	5,000[d]	100[d]
1-hour average	-	$(1.46203-\{\ln(hardness)(0.145712)\})* e^{(1.273\{\ln(hardness)\} - 1.460)}$ [f,(4)]	-	-
96-hour average	-	$(1.46203-\{\ln(hardness)(0.145712)\})* e^{(1.273\{\ln(hardness)\} - 4.705)}$ [f,(4)]	-	-
Manganese	-	-	200[d]	-
Mercury	2[b]	-	-	10[d]
1-hour average	-	1.4[f,(4)]	-	-
96-hour average	-	0.77[f,(4)]	-	-
Molybdenum	-	-	-	-
1-hour average	-	6,160[g]	-	-
96-hour average	-	1,650[g]	-	-
Nickel	13.4[a]	-	200[d]	-
1-hour average	-	$(0.998) * e^{(0.8460\{\ln(hardness)\} + 2.255)}$ [f,(4)]	-	-
96-hour average	-	$(0.997) * e^{(0.8460\{\ln(hardness)\} + 0.0584)}$ [f,(4)]	-	-
Selenium	50[b]	See NAC 445A.1237	20[d]	50[d]
Silver	-	-	-	-
1-hour average	-	$(0.85) * e^{(1.72\{\ln(hardness)\} - 6.59)}$ [f,(4)]	-	-
Sulfide (undissociated hydrogen sulfide)	-	-	-	-
96-hour average	-	2.0[f]	-	-
Thallium	13[a]	-	-	-
Zinc	-	-	2,000[d]	25,000[d]
1-hour average	-	$(0.978) * e^{(0.8473\{\ln(hardness)\} + 0.884)}$ [f,(4)]	-	-
96-hour average	-	$(0.986) * e^{(0.8473\{\ln(hardness)\} + 0.884)}$ [f,(4)]	-	-
ORGANIC CHEMICALS				
Acrolein	320[a]	-	-	-
1-hour average	-	3[f]	-	-
96-hour average	-	3[f]	-	-
Aldrin	0[a]	-	-	-
1-hour average	-	3.0[f]	-	-
alpha-Endosulfan	-	-	-	-
1-hour average	-	0.22[f]	-	-
96-hour average	-	0.056[f]	-	-
beta-Endosulfan	-	-	-	-
1-hour average	-	0.22[f]	-	-
96-hour average	-	0.056[f]	-	-
Benzene	5[b]	-	-	-
Bis (2-chloroisopropyl) ether	34.7[a]	-	-	-
Chlordane	0[a]	-	-	-
1-hour average	-	2.4[f]	-	-
96-hour average	-	0.0043[f]	-	-
Chloroethylene (vinyl chloride)	2[b]	-	-	-
Chlorpyrifos	-	-	-	-
1-hour average	-	0.083[f]	-	-
96-hour average	-	0.041[f]	-	-
2,4-D	100[a,b]	-	-	-
DDT & metabolites	0[a]	-	-	-
4,4'-DDT	-	-	-	-
1-hour average	-	1.1[f,(6)]	-	-
96-hour average	-	0.001[f,(6)]	-	-
Demeton	-	-	-	-

Chemical	Municipal or Domestic Supply (μg/L)	Aquatic Life[(1,2)] (μg/L)	Irrigation (μg/L)	Watering of Livestock (μg/L)
96-hour average	-	0.1[f]	-	-
Diazinon	-	-	-	-
1-hour average	-	0.17[f]	-	-
96-hour average	-	0.17[f]	-	-
Dibutyl phthalate	34,000[a]	-	-	-
m-dichlorobenzene	400[a]	-	-	-
o-dichlorobenzene	400[a]	-	-	-
p-dichlorobenzene	75[b]	-	-	-
1,2-dichloroethane	5[b]	-	-	-
1,1-dichloroethylene	7[b]	-	-	-
2,4-dichlorophenol	3,090[a]	-	-	-
Dichloropropenes	87[a]	-	-	-
Dieldrin	0[a]	-	-	-
1-hour average	-	0.24[f]	-	-
96-hour average	-	0.056[f]	-	-
Di-2-ethylhexyl phthalate	15,000[a]	-	-	-
Diethyl phthalate	350,000[a]	-	-	-
Dimethyl phthalate	313,000[a]	-	-	-
4,6-dinitro-2-methylphenol	13.4[a]	-	-	-
Dinitrophenols	70[a]	-	-	-
Endosulfan	75[a]	-	-	-
Endrin	0.2[b]	-	-	-
1-hour average	-	0.086[f]	-	-
96-hour average	-	0.036[f]	-	-
Ethylbenzene	1,400[a]	-	-	-
Fluoranthene (polynuclear aromatic hydrocarbon)	42[a]	-	-	-
Guthion	-	-	-	-
96-hour average	-	0.01[f]	-	-
Heptachlor	-	-	-	-
1-hour average	-	0.52[f]	-	-
96-hour average	-	0.0038[f]	-	-
Heptacholor Epoxide	-	-	-	-
1-hour average	-	0.52[f]	-	-
96-hour average	-	0.0038[f]	-	-
Hexachlorocyclopentadiene	206[a]	-	-	-
Isophorone	5,200[a]	-	-	-
Lindane	4[b]	-	-	-
1-hour average	-	0.95[f]	-	-
Malathion	-	-	-	-
96-hour average	-	0.1[f]	-	-
Methoxychlor	100[a,b]	-	-	-
96-hour average	-	0.03[f]	-	-
Mirex	0[a]	-	-	-
96-hour average	-	0.001[f]	-	-
Monochlorobenzene	488[a]	-	-	-
Nitrobenzene	19,800[a]	-	-	-
Nonylphenol	-	-	-	-
1-hour average	-	28[f]	-	-
96-hour average	-	6.6[f]	-	-
Parathion	-	-	-	-
1-hour average	-	0.065[a]	-	-
96-hour average	-	0.013[a]	-	-
Pentachlorophenol	1,010[a]	-	-	-
1-hour average	-	$e^{1.005(pH) - 4.869}$[f]	-	-
96-hour average	-	$e^{1.005(pH) - 5.134}$[f]	-	-
Phenol	3,500[a]	-	-	-
Polychlorinated biphenyls (PCBs)	0[a]	-	-	-

Chemical	Municipal or Domestic Supply (µg/L)	Aquatic Life[(1,2)] (µg/L)	Irrigation (µg/L)	Watering of Livestock (µg/L)
96-hour average	-	0.014[f]	-	-
Silvex (2,4,5-TP)	10[a,b]	-	-	-
Tetrachloromethane (carbon tetrachloride)	5[b]	-	-	-
Toluene	14,300[a]	-	-	-
Toxaphene	5[b]	-	-	-
1-hour average	-	0.73[a]	-	-
96-hour average	-	0.0002[a]	-	-
Tributyltin (TBT)	-	-	-	-
1-hour average	-	0.46[f]	-	-
96-hour average	-	0.072[f]	-	-
1,1,1-trichloroethane (TCA)	200[b]	-	-	-
Trichloroethylene (TCE)	5[b]	-	-	-
Trihalomethanes (total)[(7)]	100[b]	-	-	-

Footnotes:

(1) One-hour average and 96-hour average concentration limits may be exceeded only once every 3 years. See reference a.

(2) "Hardness" is expressed as mg/L $CaCO_3$; 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.

(4) This standard applies to the dissolved fraction.

(5) This standard is expressed as free cyanide.

(6) This standard applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

(7) The standard for trihalomethanes (TTHMs) is the sum of the concentration of bromodicholoromethane, dibromocholoromethane, tribromomethane (bromoform) and trichloromethane (chloroform). See reference b.

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, 141.61 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. Not used to avoid confusion with "e" as a natural logarithm.

f. U.S. Environmental Protection Agency, *National Recommended Water Quality Criteria*, May 2009.

g. Nevada Division of Environmental Protection, *Aquatic Life Water Quality Criteria for Molybdenum,* Tetra Tech, Inc., (June 2008).

h. U.S. Environmental Protection Agency, Pub. No. EPA-820-R-16-002, *Aquatic Life Ambient Water Quality Criteria Cadmium - 2016*, March 2016.

i. U.S. Environmental Protection Agency, Pub. No. EPA 811-Z-92-002, 40 CFR Parts 141 and 142, National Primary Drinking Water Regulations; Synthetic Organic Chemicals and Inorganic Chemicals; Final Rule (Table 1-MCLGs and MCLs for Inorganic Contaminants) (July 1992).