TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

TN - BIOLOGY NO. 18

Boise, Idaho
March, 1984

ASSESSING WATER QUALITY FOR AGRICULTURE, FISHERIES, AND DOMESTIC USES

This note is a guide for determining the suitability of water supplies for their intended use. This includes ground water developed by wells or obtained from springs as well as surface flows. Uses include domestic, livestock, irrigation, and aquaculture.

The significance of water quality parameters is explained; recommended and permissible limits for the intended uses are given; and sources for water analysis are provided.

For further information on agricultural nonpoint source pollutants (sediment, nutrients, animal waste, pesticides, salts) and their effects on water of the United States, see the Water Quality Field Guide, Soil Conservation Service, 1983.

The idea and some of the data gathered for this tech note is credited to Dave Jones, Environmental Engineer, SCS, Bozeman, Montana.

INDEX

Subject	Sheet Color
Water quality Parameters and Their Significance	Blue
Water for Human Consumption and Use	Yellow
Water for Livestock and Poultry	Beige
Water for Irrigation	White
Water for Aquaculture and Fisheries	Pink
Labs for Analysis	Green

TABLE 1 - WATER QUALITY PARAMETERS AND THEIR SIGNIFICANCE

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Alkalinity (as ($CaCO_3$)	Formed by the presence of certain anions in solution. Certain organic materials may also produce alkalinity.	Alkalinity is an indicator of the relative amounts of carbonate, bicarbonate, phosphates, and hydroxide. Alkalinity is a measure of the buffering capacity of water to pH changes and to the toxicity of some heavy metals. Relationships between bicarbonate and carbonate is pH related.	50 to 400 mg/L		Objectionable taste.		
Bicarbonate (HCO_3) and Carbonate (CO_3) (alkalinity)	Action of carbon dioxide in water on carbonate rocks such as limestone and dolomite, oxidation of organic carbon.	Bicarbonate and carbonate produce alkalinity. Bicarbonates of calcium and magnesium in steam boilers and some geothermal water facilities form scale and release carbon dioxide gas. Low salt water that is high in bicarbonates may present a permeability hazard even at low sodium adsorption ratios.					
Boron (B)	Dissolved from rocks and soils. Present in municipal sludges.	Boron is essential to plant growth, but is exceedingly toxic at concentrations only slightly above optimum. The optimum concentration varies with each plant type and ranges from approximately 0.3 mg/1 to 0.4 mg/1. What is optimum for one plant type may be toxic to another.		750 ug/L for long term irrigation.	Toxic effect on sensitive crops.	Weathering of boron-bearing rocks.	

TABLE 1 - WATER QUALITY PARAMETERS AND THEIR SIGNIFICANCE (Continued)

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Calcium (Ca) and Magnesium (Mg)	Dissolved from almost all soils and rocks, but especially from limestone, dolomite, and gypsum. Calcium and magnesium are found in large quantities in some brines. Magnesium is present in large quantities in sea water.	Causes most of the hardness and scale-forming properties of water; soap-consuming. (See hardness.) Calcium reduces the toxicity of many chemical compounds to fish and other aquatic fana and may be necessary in their excretory process. Usually has no effect on suitability of water for irrigation or stockwater.	10 to several hundred mg/L		Buildup of scale within plumbing.		Contributes to the hardness of water. May buffer the impact of sodium ion on soil permeability.
Chloride (Cl)	Dissolved from rocks and soils. Present in sewage and found in large amounts in ancient brines, sea water, and industrial brines.	Chloride salts in excess of 100 mg/l give salty taste to water. When combined with calcium and magnesium may increase the corrosive activity of water. It is recommended that chloride content should not exceed 250 mg/l. Most tree crops and other woody perennial plants are sensitive to low concentrations of chloride. Most annual crops are not so sensitive; however, they may be affected by higher concentrations.	100 mg/L	250 mg/L[1]	Salty taste in concentrations greater than 100 mg/L.	Pollution by organic wastes.	Chloride is not removed by soils; good indicator of possible pollution.

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Total Dissolved Solids (TDS) (filterable residue):	Chiefly mineral constituents dissolved from rocks and soils. Includes all materials that is in solution in the water.	Water with dissolved solids exceeding 1000 mg/l is generally unacceptable for most uses. However, water with concentrations exceeding 1000 mg/l have been used for drinking and livestock water when no other supply was available. "Dissolved solids" and "salinity" sometimes are used interchangeably, but incorrectly. The total dissolved solids in water are represented by the weight of residue left when a water sample has been evaporated to dryness, the sample having already been filtered to remove suspended solids. This value is not the same as salinity, which is the concentration of only certain cations and anions in water.	500 mg/L			Excess salinity	
Fecal coliform	All warm-blooded animal (including human) excrement.	Fecal coliform bacteria serve as an indicator organism to show that pathogenic organisms may also be present. Limits are recommended to minimize transmission of communicable diseases.			Limits water use for primary water contact recreation.	Contamination from humans and/or animal wastes.	

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Fluoride (F)	Dissolved in small to minute quantities from most rocks and soils. Most hot and warm springs contain more than the recommended concentration of fluoride.	Fluoride in drinking water reduces the incidence of tooth decay in children when the water is consumed during the period of enamel calcification, but it may cause mottling of the teeth, depending on the concentration of fluoride, the age of the child, the amount of drinking water consumed, and the susceptibility of the individual. 0.8 to 1.7 mg/l is optimum, depending upon the air temperature. Fluoride on plant surfaces can be harmful to plants and grazing animals. Fluoride in the soil is generally not harmful.	0.10 to 10 mg/L	1.8 mg/L[2] at average maximum daily temperature of 69.1° F.	Dental fluorosis.	Thermal waters.	
Hardness as $CaCO_3$	In most water nearly all the hardness is due to calcium and magnesium. All the metallic cations besides the alkali metals also cause hardness.	Hard water consumes soap before a lather will form, deposits soap curd on bathtubs, and forms scale in boilers, water heaters, and pipes. (For fish, the threshold of resistance to several toxins increases considerably as water becomes harder). Hardness equivalent to the bicarbonate and carbonate is called carbonate hardness. Any hardness in excess of this is called noncarbonate hardness.	50 to 500 mg/L		Soap will not produce duce lather; forms scale when heated.		

TABLE 1 - WATER QUALITY PARAMETERS AND THEIR SIGNIFICANCE (Continued)

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Hydrogen sulfide (H_2S)	Natural decomposition of organic material under anaerobic conditions and from the reduction of sulfates.	Causes objectionable odor when in concentration above 1 mg/l and taste when in excess of .05 mg/l. Can be a long-term hazard to most fish and other aquatic wildlife. Accumulates at the bottom of ponds and is a common cause of partial and total winterkills. Also present in some geothermal wells and springs, but will readily escape during aeration.			Aesthetics		
Hydrogen-ion activity (pH)	Acids, acid-generating salts, and free carbon dioxide lower pH. Carbonates, bicarbonates, hydroxides, and phosphates, silicates, and borates raise the pH.	The pH is a measure of the activity of the hydrogen ions. A pH of 7.0 indicates neutrality of a solution. Values lower than 7.0 denote increasing acidity. Corrosiveness of water generally increases with decreasing pH, but high alkaline waters may also attack metals. Waters of low or high can be detrimental to fish and other aquatic life as well as for animal drinking water. A pH range between 6.0 and 8.5 is acceptable and is normal for most waters in Idaho.	5 to 9 pH units	6.5-8.5 units.[1]	Water corrosive if too high or too low.	pH values below 4 units indicate acid mineral wastes.	pH units 0 — 14 Acid — Alkaline

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Iron (Fe)	Dissolved from almost all rocks and soils. May also be derived from iron pipes. pumps, and other equipment. Mine drainage.	On exposure to air, iron in ground water oxidizes to reddish-brown sediment. More than about 0.3 mg/l stains laundry and utensils reddish brown. Objectionable for food processing, beverages, dyeing, bleaching, ice manufacture, and other processes. Iron and manganese together should not exceed 0.3 mg/l. Larger quantities cause unpleasant taste and favor growth of iron bacteria, but do not endanger health. Excessive iron may also interfere with the efficient operation of exchange-silicate water softeners. Iron may be removed from water by aeration of the water, followed by settling of filtration. High concentrations cannot be econmically removed from water supply. Toxic to fresh-water aquatic life above 1 mg/l. Will cause problems with uptake of oxygen through fish gills at concentrations more than 0.3 mg/l.	0.01 to 10 mg/L	0.3 mg/L[1]	Objectionable taste and staining.	Iron-bearing minerals.	

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Adjusted Sodium Absorption Ratio (SAR)	The adjusted SAR is defined by the equation: $SAR = NA/\sqrt{(Ca+Mg)/2}$ $[1+(8.4-pHc)]$ where the concentrations are expressed in milliequivalents per liter (Meq/l).	High sodium concentration combined with low alkaline earth element concentrations (lime) usually reduces soil tilth and affects plant growth. It is a prediction of the cation exchange of water and soil ions.			High values indicate loss of soil permeability.		Sodium replaces calcium and magnesium on soil particles.
Specific conductance (Sp. Cond.) Sometimes reported as E.C., Sp. Cond. = E.C. X 10^3 @ 25°C. or mhos X 10-6 @ 25°C. or umhos @ 25°C.	Dissolved minerals in the water.	Specific conductance is a measurement of the water's capacity to conduct an electric current and is an indirect approximation of the total dissolved solids. This varies with temperature and the degree of ionization of the constituents. When measured in micromhos per centimeter, it is generally 1.0 to 1.5 times the total dissolved solids content. The relationship between conductivity and TDS is usually a constant for a given water body.	50 to 1,000 Umhos/cm				Easily measured in the field.

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Usually present in industrial wastes.	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfate in combination with other ions gives bitter taste to water. Concentrations above 250 mg/l may have a laxative effect, but is considered safe up to 500 mg/l. Domestic waters containing as much as 1,000 mg/l sulfate are used for drinking in the absence of a less mineralized water supply. High sulfate concentrations may limit use of water for irrigation on some soils. High concentrations are tolerated by livestock.	1 to 100 mg/L	250mg/L[1]	Cathartic effect on humans.	Association with sedimentary rocks.	500 mg/l. Domestic waters
Manganese (Mn)	Dissolved from some rocks and soils. Not as common as iron. Large quantities often associated with high iron content and with acid waters.	Same objectionable features as iron. Causes dark-brown or black stain. Iron and manganese together should not exceed 0.3 mg/l for taste and aesthetic reasons. Higher concentrations do not endanger health and can be used if objectionable features are tolerated.		0.05 mg/L[1]	Stains laundry; objectionable taste.		

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Nitrate (NO_3), reported as N, may also be written NO_3-N). Often includes nitrite (NO_2) then reported as NO_3+NO_2 as N.	Decaying organic matter, sewage, nitrates in soil, and chemical fertilizers.	Concentrations much greater than the local average may suggest pollution. High concentrations are generally a characteristic of individual wells and not of whole aquifers. Nitrate concentrations in unpolluted water seldom exceed 10 mg/l as N. Nitrate encourages growth of algae and other organisms, which produce undesirable tastes and odors. There is evidence that more than about 10 mg/l as N may cause a type of methemoglobinemia ("blue babies") in infants which may be fatal.	0.10 to 10 mg/L	10 mg/L[3] for domestic use.	Infants may develop temporary blood disorders; may cause excessive algae growth.	Organic wastes or excessive fertilization.	Excessive concentrations may indicate possible organic pollution.

TABLE 1 - WATER QUALITY PARAMETERS AND THEIR SIGNIFICANCE (Continued)

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Sodium Na) and Potassium (K)	Dissolved from almost all rocks and soils. Found also in ancient brines, some industrial brines, sea water, and sewage.	Large amounts give a salty taste when combined with chloride. Moderate quantities have little effect on the usefulness of water for most purposes. Sodium salts may cause foaming in steam boilers, and a high sodium adsorption ratio may limit the use of water for irrigation. Most tree crops and other woody perennial plants are sensitive to low concentrations of sodium. Most annual crops are not so sensitive; however, they may be affected by higher concentrations. Sodium concentrations greater than 270 mg/l may be harmful to persons on sodium-restricted diets.	Sodium 0.01 to 10 mg/l Potassium 1-200 mg/l	20 mg/l 250 mg/l	 Loss of permeability.	Industrial wastes.	Dissolved from practically all rocks and soils. Found in industrial wastes and sewage and commercial fertilizers.

TABLE 1 - WATER QUALITY PARAMETERS AND THEIR SIGNIFICANCE (Continued)

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Dissolved Oxygen (DO)	Photosynthesis or contact with the atmosphere.	Required to sustain aquatic life.		5 mg/L	Loss of aquatic growth and reproduction.	Low concentrations may indicate pollution.	Needed to avoid septic conditions in streams. Subject to diurnal fluctuations.
Total Phosphorus as Phosphate (P)	Decaying organic matter, sewage, and chemical fertilizers.	Plant nutrient.		25 ug/L^3 in lake water.	Excessive algae growth.	Organic pollution.	
Arsenic (An)	Dissolved from rocks and soils.	Used in the manufacture of herbicides and pesticides.	0.005 to 0.3 mg/L	0.05 mg/L	Poisoning.	Source other than natural conditions.	0.10 mg/L limit of use for irrigation of crops.
Chromium (Cr)	Dissolved from rocks and soils.	Rarely found in natural waters.	Greater than 0.01 mg/L	0.05 mg/L^3	Detrimental to health.	Pollution by industrial wastes.	0.10 mg/L limit of use to sustain fresh-water aquatic life.
Cobalt (Co)	Dissolved from rocks and soils.	Rarely found in natural waters.	0.001 mg/L	1.0 mg/L		Weathering of rock.	

TABLE 1 - WATER QUALITY PARAMETERS AND THEIR SIGNIFICANCE (Continued)

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Copper (Cu)	Dissolved from rocks and soils.	Found in natural waters but usually not at levels high enough for adverse effect on humans.	0.015 mg/L[3]	1.0 mg/L[1]	Inhibits growth of invertebrate organisms.	Mining of sulfides and oxides of copper.	Mined by man since pre-historic times.
Silica (SiO_2)	Dissolved from rocks and soils.	Present in most waters in varying concentrations.	10 to 60 mg/L	None.	Forms scale in steam boilers.	Thermal waters.	Dissolved from practically all rocks and soils.
Lead (Pb)	Dissolved from rocks and soils.	Accumulation in animal tissue.	Greater than 0.05 mg/L	0.05 mg/L[3]	Toxic to humans and animals.	Source other than natural conditions.	0.10 mg/L limit of use for livestock.
Mercury (Hg)	Dissolved from rocks and soils, industrial pollution.	Accumulates in animal tissue.	Greater than 0.1 mg/L	0.002 mg/L[3]	Poisoning.		
Nickel (Ni)	Dissolved from rocks and soils.	Relatively nontoxic to man.		100 mg/L for irrigation.	Toxic to irrigated plants and aquatic organisms.	Weathering of rock.	Nickel salts may leach from nickel bearing area.

TABLE 1 - WATER QUALITY PARAMETERS AND THEIR SIGNIFICANCE (Continued)

CONSTITUENT OR PHYSICAL PROPERTY	SOURCE OF CAUSE	SIGNIFICANCE	CONCENTRATION OF NORMAL OCCURRENCE	LIMITS OF USE	ADVERSE EFFECTS	UNUSUAL CONCENTRATIONS MAY INDICATE	REMARKS
Zinc (Zn)	Industrial waste. Dissolved from rocks and soils.	Found in nature as a sulfide.	0.64 mg/L[3]	5 mg/L[1]	Unpleasing aesthetic effects.	Found in leachates from dump and mill tailings.	

1 U.S. Environmental Protection Agency, 1977 (National Secondary Drinking Regulations)
2 U.S. Environmental Protection Agency, 1977 (National Interim Primary Drinking Water Regulations)
3 U.S. Environmental Protection Agency, 1976

WATER FOR HUMAN CONSUMPTION AND USE

TABLE 2: Recommended limits and maximum levels of constituents in drinking and domestic water

(in mg/l unless otherwise noted)

Parameter	Maximum Contaminate Levels	USPHS Recommended Limits, 1962	Notes
Arsenic (As)	0.05	0.01	
Barium (Ba)	1.0	--	
Cadmium (Cd)	0.01	--	
Chromium (Cr)	0.05	--	
Fluoride (F)	2.4	0.8 -1.7	See Table 3
Nitrate (NO_3as N)	10	10	
Lead (Pb)	0.05	--	
Mercury (Hg)	0.002	--	
Selenium (Se)	0.01	--	
Silver (Ag)	0.05	--	
Chloride (Cl)		250	
Copper (Cu)		1.0	
Cyanide (CN)		0.2	
Iron (Fe)		0.3	
Manganese (Mn)		0.05	
Sulfate (SO_4)		250	
Zinc (Zn)		5.0	
Total Dissolved Solids (TDS)		500	
Phenolic Compounds (as phenols)		0.001	
Endrin	0.0002		
Lindane	0.004		
Methoxychlor	0.1		
Toxaphene	0.005		
2,4-D	0.1		
2,4,5-TP Silvex	0.01		
Combined radium-226 and radium-228	5		pCi/liter
Gross alpha particle activity (including radium-226 but excluding radon and uranium)	15		pCi/liter
Tritium	20,000		pCi/liter
Strontium-90	8		pCi/liter
Gross beta radioactivity	50		pCi/liter

Source: Column 2--National Primary Drinking Water Regulations from Safe Drinking Water Act (Public Law 93-523); Column 3--U.S. Public Health Service (1962).

Fluoride

Optimum fluoride levels will reduce dental cares by 60 to 65 percent. Excessive fluoride in drinking water will mottle teeth. The optimum fluoride level for a given location depends on climatic conditions because the amount of water (and consequently the amount of fluoride) ingested is primarily influenced by air temperture.

TABLE 3: Recommended fluoride limits

Annual Average of Maximum Daily Air Temperatures, °F.	Fluoride Concentrations in mg/l. Lower	Optimum	Upper	Maximum [1] Limit mg/l
50.0 - 53.7	1.1	1.2	1.3	2.4
53.8 - 58.3	1.0	1.1	1.2	2.2
58.4 - 63.8	0.9	1.0	1.1	2.0
63.9 - 70.6	0.8	0.9	1.0	1.8
70.7 - 79.2	0.7	0.8	0.9	1.6
79.3 - 90.5	0.6	0.7	0.8	1.4

[1] Where fluorides are native to the water supply, these concentrations will not mottle teeth. Source: Public Health Service, DHEW.

TABLE 4: Classification of water by hardness content

Hardness mg/l $CaCO^3$	Class	Description
0-75	soft	minimum soap required
75-150	moderately hard	moderate soap consumption
150-300	hard	high soap consumption; scum forms; mineral deposits
300 up	very hard	excessive soap consumption; scum and curds form; mineral deposits

WATER FOR LIVESTOCK AND POULTRY

TABLE 5: Recommendations for maximum levels of toxic substances in drinking water for livestock

Constituent	Upper Limit
Aluminum (Al)	5 mg/l
Arsenic (As)	0.2 mg/l
Beryllium (Be)	no data
Boron (B)	5.0 mg/l
Cadmium (Cd)	.05 mg/l
Chromium (Cr)	1.0 mg/l
Cobalt (Co)	1.0 mg/l
Copper (Cu)	0.5 mg/l
Fluoride (F)	2.0 mg/l
Iron (Fe)	no data
Lead (Pb)	0.1 mg/l[1]
Manganese (Mn)	no data
Mercury (Hg)	.01 mg/l
Molybdenum (Mo)	no data
Nitrate + Nitrite (NO_3-N+NO_2-N)	100 mg/l
Nitrite (NO_2-N)	10 mg/l[3]
Selenium (Se)	0.05 mg/l
Vanadium (V)	0.10 mg/l
Zinc (Zn)	24 mg/l
Total Dissolved Solids (TDS)	10,000 mg/l[2]

[1] Lead is accumulative and problems may begin at threshold value = 0.05 mg/l.
[2] See Table 6
[3] See Table 7
Source: Environmental Studies Board. Nat. Acad. of Sci., Nat. Acad. of Eng. Water Quality Criteria 1972.

TABLE 6: Guide to the use of saline waters for livestock and poultry

Total Dissolved Solids in mg/l (Sp. Cond. in umhos/cm)	
Less than 1,000 mg/l (Sp. Cond. <1500)	Relatively low level of salinity. Excellent for all classes of livestock and poultry.
1,000 - 3,000 mg/l (Sp. Cond. = 1500-5000)	Very satisfactory for all classes of livestock and poultry. May cause temporary and mild diarrhea in livestock not accustomed to them or watery droppings in poultry.
3,000 - 5,000 mg/l (Sp. Cond. = 5000-8000)	Satisfactory for livestock, but may cause temporary diarrhea or be refused at first by animals not accustomed to them. Poor waters for poultry, often causing water feces, increased mortality, and decreased growth, especially in turkeys.
5,000 - 7,000 mg/l (Sp. Cond. = 8,000-11,000)	Can be used with reasonable safety for dairy and beef cattle, sheep, swine, and horses. Avoid use for pregnant or lactating animals. Not acceptable for poultry.
7,000 - 10,000 mg/l (Sp. Cond. = 11,000-16,000)	Unfit for poultry and probably for swine. Considerable risk in using for pregnant or lactating cows, horses, or sheep, or for the young of these species. In general, use should be avoided although older ruminants, horses, poultry, and swine may subsist on them under certain conditions.
Over 10,000 mg/l (Sp. Cond. > 16,000)	Risks with these highly saline waters are so great that they cannot be recommended for use under any condition.

Source: Environmental Studies Board, Nat. Acad. of Sci., Nat. Acad. of Eng. Water Quality Criteria 1972.

TABLE 7: Effects of nitrate on livestock

Nitrate concentration (mg/l NO_3 as N)	Effect
0-10	Not harmful
10-30	Slight possibility of harm
30-50	Risky, especially over a long period of time
50-100	Interference syndrome likely (trembling, weakness, discolored urine)
100-145	More serious; possible acute losses of livestock.
145-195	Increased acute losses, secondary diseases
195 up	Acute losses

Source: "Professional Topics." Bulletin No. 14, University of Illinois. July-August 1964.

WATER FOR IRRIGATION

It is not feasible to set rigid quality standards for irrigation waters because of such varied and complex factors as soil porosity, soil chemistry, climatic conditions, the ratio of rainwater to irrigation water, artificial and natural drainage, relative tolerance of different plants, and interferences between and among constituents in the water.

Some general guidelines have been established that indicate the relative usability of a water for irrigation and generally indicates the waters for which more detailed study would be necessary. The most important quality parameters to consider are the adjusted Sodium Adsorption Ratio, the salinity, and several specific ions or trace elements.

Permeability Hazard

Irrigation water with high sodium levels and low calcium and magnesium levels can cause a severe soil permeability problem. The most commonly used method to evaluate the potential has been the adjusted sodium adsorption ratio (adjusted SAR). For adjusted SAR values greater than 6 to 9, the water could be expected to cause a permeability problem on shrink-swell types of soil. Thus, the permeability can be related to the clay type.

TABLE 8: adjusted SAR guidelines

Dominant clay type	No Problem	Increasing Problem	Severe Problem
Montmorillonite	<6	6-9	>9
Illite-Vermiculite	<8	8-16	>16
Kaolinite	<16	16-24	>24

Source: Water quality for Agriculture, UN-FAO, Rome, 1976.

Salinity-Sodium Hazard

Irrigation water is essential for crop production in the arid and semiarid regions of the United States. Unfortunately, irrigation water in many of these regions contains a natural load of dissolved salts. As the water is consumed by plants or lost by evaporation, the salts remain and are concentrated in the soil profile. To maintain the productivity of irrigated lands, the accumulation of soluble salts must be moved (leached) below the root zone. Thus, the amount of irrigation water and the timing of its application (irrigation water management) become critical in salinity control.

Irrigation water management is a management measure to effectively use available irrigation water to minimize soil and nutrient loss and to protect water quality. It is the process of determining and controlling

Table 9 – Crop salt tolerance[1] [Expected decrease in crop yield based on conductivity of soil water extract when common surface irrigation methods are used]

Crop	Yield decrease			
	0%	10%	25%	50%
	- - - - *Conductivity* $(\sigma_e)^2$ - - - -			
Field crops				
Barley (Hordeum vulgare)[3]	8.0	10	13	18
Cotton (Gossypium hirsutum)	7.7	9.6	13	17
Sugarbeet (Beta vulgaris)[4]	7.0	8.7	11	15
Wheat (Triticum aestivum)[3 5]	6.0	7.4	9.5	13
Safflower (Carthamus tinctorius)	5.3	6.2	7.6	9.9
Soybean (Glycine max)	5.0	5.5	6.2	7.5
Sorghum (Sorghum bicolor)	4.0	5.1	7.2	11
Groundnut (Arachis hypogaea)	3.2	3.5	4.1	4.9
Rice (Ozyza sativa)	3.0	3.8	5.1	7.2
Sesbania (Sesbania macrocarpa)	2.3	3.7	5.9	9.4
Corn (Zea mays)	1.7	2.5	3.8	5.9
Flax (Linum usitatissimum)	1.7	2.5	3.8	5.9
Broadbean (Vicia faba)	1.6	2.6	4.2	6.8
Cowpea (Vigna sinensis)	1.3	2.0	3.1	4.9
Beans (Phaseolus vulgaris)	1.0	1.5	2.3	3.6
Fruit crops				
Date palm (Phoenix dactylifera)	4.0	6.8	10.9	17.9
Fig (Ficus carica)	2.7	3.8	5.5	8.4
Olive (Olea europaea)				
Pomegranate (Pucia granatum)				
Grapefruit (Citrus paradisi)	1.8	2.4	3.4	4.9
Orange (Citrus sinensis)	1.7	2.3	3.2	4.8
Lemon (Citrus limon)	1.7	2.3	3.3	4.8
Apple (Malus sylvestris)	1.7	2.3	3.3	4.8
Pear (Pyrus communis)				
Walnut (Juglans regia)	1.7	2.3	3.3	4.8
Peach (Prunus persica)	1.7	2.2	2.9	4.1
Apricot (Prunus armeniaca)	1.6	2.0	2.6	3.7
Grape (Vitis spp.)	1.5	2.5	4.1	6.7
Almond (Prunus dulcis)	1.5	2.0	2.8	4.1
Plum (Prunus domestica)	1.5	2.1	2.9	4.3
Blackberry (Rubus spp.)	1.5	2.0	2.6	3.8
Boysenberry (Rubus ursinus)	1.5	2.0	2.6	3.8
Avocado (Persea americana)	1.5	1.8	2.5	3.7
Raspberry (Rubus idaeus)	1.0	1.4	2.1	3.2
Strawberry (Fragaria spp.)	1.0	1.3	1.8	2.5

Crop	Yield decrease			
	0%	10%	25%	50%
	- - - *Conductivity* $(\sigma_e)^2$ - - -			
Vegetable crops				
Beets (Beta vulgaris)[4]	4.0	5.1	6.8	9.6
Broccoli (Brassica oleracea italica)	2.8	3.9	5.5	8.2
Tomato (Lycopersicon esculentum)	2.5	3.5	5.0	7.6
Cucumber (Cucumis sativus)	2.5	3.3	4.4	6.3
Cantalope (Cucumis melo)	2.2	3.6	5.7	9.1
Spinach (Spinacia oleracea)	2.0	3.3	5.3	8.6
Cabbage (Brassica oleraoea capitata)	1.8	2.8	4.4	7.0
Potato (Solanum tuberosum)	1.7	2.5	3.8	5.9
Sweet corn (Zea mays)	1.7	2.5	3.8	5.9
Sweet potato (Ipomoea batatas)	1.5	2.4	3.8	6.0
Pepper (Capsicum frutescens)	1.5	2.2	3.3	5.1
Lettuce (Lactuca sativa)	1.3	2.1	3.2	3.6
Radish (Raphanus sativus)	1.2	2.0	3.1	5.0
Onion (Allium cepa)	1.2	1.8	2.8	4.3
Carrot (Daucus carota)	1.0	1.7	2.8	4.6
Beans (Phaseolus vulgaris)	1.0	1.5	2.3	3.6
Forage crops				
Tall wheatgrass (Apropyron elongatum)	7.5	9.9	13.3	19.4
Bermuda grass (Cynodon dactylon)[6]	6.9	8.5	10.8	14.7
Barley (hay) (Hordeum vulgare)[3]	6.0	7.4	9.5	13.0
Perennial ryegrass (Lolium perenne)	5.6	6.9	8.9	12.2
Trefoil, birdsfoot narrowleaf (Lotus tenuis)	5.0	6.0	7.5	10
Harding grass (Phalaris stenoptera)	4.6	5.9	7.9	11.1
Tall fescue (Festuca arundinacea)	3.9	5.8	8.6	13.3
Crested wheatgrass (Agropyron desertorum)	3.5	6.0	9.8	16
Vetch (Vicia sativa)	3.0	3.9	5.3	7.6
Sudangrass (Sorgum sudanense)	2.8	5.1	8.6	14.4
Wildrye, beardless (Elymus triticoides)	2.7	4.4	6.9	11
Trefoil, big (lotus uliginosus)[7]	2.3	2.8	3.6	4.9
Alfalfa (Medicago sativa)	2.0	3.4	5.4	8.8
Lovegrass (Eragrostis spp.)[8]	2.0	3.2	5.0	8.0
Corn (forage) (Zea mays)	1.8	3.2	5.2	8.6
Clover, berseem (Trifolium alexandrinum)	1.5	3.2	5.9	10.3
Orchardgrass (Dactylis glomerata)	1.5	3.1	5.5	9.6
Meadow foxtail (Alopecurus pratensis)	1.5	2.5	4.1	6.7
Clover, alsike, ladino, red, strawberry (Trifolium spp.)	1.5	2.3	3.6	5.7

[1]Adapted from Ayers and Westcot (1).

[2]These values are the electrical conductivity (σ_e) of the soil-water extract in deciseimens per meter (dS/m - formerly millimhos per centimeter) at 25 degrees C. For example, if barley is to be grown, and the σ_e is 13 dS/m, a 25% decrease in yield can be expected.

[3]Barley and wheat are less tolerant during germination and seedling stage. σ_e should not exceed 4 or 5 dS/m.

[4]Sensitive during germination; σ_e should not exceed 3 dS/m for garden beets and sugar beets.

[5]Tolerance data may not apply to new semi-dwarf varieties of wheat.

[6]An average for Bermuda grass varieties. Suwannee and Coastal are about 20% more tolerant; common and Greenfield are about 20% less tolerant.

[7]Broadleaf birdsfoot trefoil appears to be less tolerant than narrowleaf.

[8]Average for Boer, Wilman, sand, and weeping varieties. Lehman appears about 50% more tolerant.

Source: Water Quality Field Guide, USDA-SCS 1983.

(1) the time to irrigate, (2) the rate of water application, and (3) the quantity of water to be applied.

Crop selection can provide a solution to salinity-sodium hazards in some instances. By selecting a salt tolerant crop, the leaching requirement is reduced. Salt tolerance of crops varies with climatic conditions and with crop varieties. Table 9 gives the expected decrease in yield of various crops based on their salt tolerance. The values given in the table are the electrical conductivity (σ_e) of the soil saturation extract in decisiemens per meter (dS/m) at the point where a 50 percent reduction in yield would occur as compared to yields on nonsaline soils under comparable growing conditions.

Trace Element Hazard

Trace element concentrations greater than those shown in Tables 10 and 11 can hinder plant growth.

TABLE 10: Recommended Maximum concentrations of trace elements in irrigation waters

Element (symbol)	For waters used continuously on all soils (mg/l)	For use up to 20 years on fine-textured soils of pH 6.0 to 8.5 (mg/l)
Aluminum (Al)	5.0	20.0
Arsenic (As)	0.1	2.0
Beryllium (Be)	0.1	0.5
Boron (B)	1	2.0
Cadmium (Cd)	0.01	0.05
Chromium (Cr)	0.1	1.0
Cobalt (Co)	0.05	5.0
Copper (Cu)	0.2	5.0
Fluoride (F)	1.0	15.0
Iron (Fe)	5.0	20.0
Lead (Pb)	5.0	10.0
Lithium (Li)	2.5	2.5
Manganese (Mn)	0.2	10.0
Molybdenum (Mo)	0.01	0.05[2]
Nickel (Ni)	0.2	2.0
Selenium (Se)	0.02	0.02
Vanadium (V)	0.1	1.0
Zinc (Zn)	2.0	10.0

These levels will normally not adversely affect plants or soils. No data available for Mercury (Hg), Silver (Ag), Tin (Sn), Titanium (Ti), Tungsten (W).

[1] See Table 10.
[2] For only acid fine-textured soils or acid soils with relatively high iron oxide contents.

Source: Environmental Studies Board. Nat. Acad. of Sci., Nat. Acad. of Eng. Water Quality Criteria 1972.

TABLE 11 - Relative tolerance of crops and ornamentals to boron[1]

Tolerance decreases in descending order in each column
(Wilcox, 1960)

Tolerant	Semitolerant	Sensitive
(4.0 mg/l of boron)	(2.0 mg/l of boron)	(1.0 mg/l of boron)
Asparagus	Sunflower, native	Walnut, black
		Persian or English
Sugarbeet	Potato	Jerusalem artichoke
Garden beet	Tomato	Navy bean
Alfalfa	Sweetpea	American elm
Gladiolus	Radish	Plum
Broadbean	Field pea	Pear
Onion	Ragged-robin rose	Apple
Turnip	Barley	Persimmon
Cabbage	Wheat	Cherry
Lettuce	Corn	Peach
Carrot	Milo	Apricot
	Oat	Thornless
	Zinnia	blackberry
	Pumpkin	
	Bell pepper	
	Lima bean	
2.0 mg/l of boron	1.0 mg/l of boron	0.3 mg/l of boron

[1]Relative tolerance is based on boron in irrigation water at which boron toxicity symptoms were observed when plants were grown in sand culture. Does not necessarily indicate a reduction in yield.

WATER FOR AQUACULTURE AND RECREATIONAL FISHERIES

The quality of water is very important for successful fish farming (aquaculture) and for maintaining a recreational fishpond. The following parameters must be considered in making a preliminary assessment of a water source for aquaculture.

FLOW: A dependable flow of 1 cfs minimum is needed for an economic commercial operation. Very small home or hobby operations require a minimum of 100-300 gpm. A water source that requires pumping is not dependable or economical.

SOURCE: Springs and artesian wells offer the most satisfactory water sources for commercially rearing fishes. These water sources most generally provide uniform water quality and temperature necessry for successful fish production. Surface waters and stream waters should be avoided whenever possible because they are highly variable relative to water quality attributes and seasonal temperature changes. Stream waters often carry fish diseases, parasites, sediments, and other pollutants harmful to fishes. Wells that require pumping often contain harmful atmospheric gases.

TEMPERATURE: The temperature of most surface and ground water sources varies with the season and precipitation. Temperatures should be monitored weekly to ensure fluctuations do not occur outside the recommended ranges for the species being grown.

Optimum temperature for trout growth is 56°F. The desirable range is 55-64°F. with 45/70°F., the minimum/maximum temperatures for growth. Temperatures of 45-52°F. are needed for egg production.

Optimum growth of warm water fish, takes place in 83°F. water. Growth is slow between 60 to 70° F.; very little growth occurs below 60 degrees. Disease and stress occur more frequently in water over 85° F.

Water temperature may be the single most important factor for the welfare of a fish during its life. As temperatures increase fish require more dissolved oxygen. Temperature influences activity, feeding, growth, and reproduction of all fish. In raceway culture there is generally no significant temperature variations with depth, time of day, or season. This feature illustrates the benefits of raceway culture over pond culture.

DISSOLVED OXYGEN (D.O): A minimum dissolved oxygen concentration of 7 mg/l for trout and 5 mg/l for warm water fish. A good source of oxygenated water is needed to assure that as depletion occurs, adequate oxygen is available throughout the raceways or ponds. Oxygen concentrations for productive aquatic life should be over 7 mg/l. Concentrations of 3-5 mg/l are deleterious to fish and levels below 3 mg/l are lethal to most fish.

HARDNESS: Water hardness of 50 mg/l minimum, with 100 mg/l or greater preferably, is required to buffer the effect of toxic substances on fish--both those in the water unintentionally and those added for disease control. Alkalinity of 50 mg/l or greater will generally ensure adequate buffering against sudden changes in pH.

pH	best fish production	6.5-8.6
	deleterious to fish	5.0-6.5; 8.6-9.5
	may be lethal to fish	4.0-5.0; 9.5-11.0
	lethal to most fish	below 4.0; over 11.0

AMMONIA: Unionized ammonia is very toxic to fish and should never exceed 0.125 mg/l.

PHENOLIC COMPOUNDS: Such as from oils cause bad tastes in fish flesh.

ZINC: Galvanized metal contaminates water with small concentrations of zinc which are toxic to trout. For this reason, galvanized pipe should be avoided in hatcheries and galvanized tanks should be treated to remove this hazard. Zinc concentrations should be limited to less than 0.5 mg/l at pH 7.6.

DEPENDABILITY OF QUALITY AND QUANTITY: While a water source may be of suitable quality and quantity when tested, the source of water in conveyance to point of use may be subject to degradation. For example, a ditch or stream conveying spring water to a fish farm may allow entrance of runoff contaminated by herbicides from weed spraying. Herbicide concentrations below those lethal to fish may still create decaying water plants that lower the water's dissolved oxygen content. The chemical quality of a spring recharged by a shallow perched ground water can be significantly affected by man's activities on the surface. The physical qualities such as temperature and the flow rate can be altered by the season and precipitation.

Before extensive planning or investments are made in commercial ventures, an on-site assessment by a fishery biologist is strongly recommended. Weekly temperature measurements for a year or as long as possible before an on-site visit would accelerate and improve the assessment.

NOTE - Research is obsolete on many aspects of aquatic life requirements. Then in doubt test the waters with caged fish.

TABLE 12: Suggested water quality criteria for optimum health of salmonid fishes, concentrations are in parts per million (ppm) (Source: Wedemeyer 1977).

Chemical	Upper Limits for Continuous Exposure
Ammonia (NH_3	0.0125 ppm (un-ionized form)
Cadmium [a]	0.0004 ppm (in soft water < 100 ppm alkalinity)
Cadmium [b]	0.003 ppm (in hard water > 100 ppm alkalinity)
Chlorine	0.03 ppm
Copper [c]	0.006 ppm in soft water
Hydrogen sulfide	0.002 ppm
Lead	0.03 ppm
Mercury (organic or inorganic)	0.002 ppm maximum, 0.00005 ppm average
Nitrogen	Maximum total gas pressure 110% of saturation
Nitrite (NO^{2-})	0.1 ppm in soft water, 0.2 ppm in hard water (0.03 and 0.06 ppm nitrite-nitrogen)
Ozone	0.005 ppm
Polychlorinated biphenyls (PCB's)	0.002 ppm
Total suspended and settleable solids	80 ppm or less
Zinc	0.03 ppm

[a] To protect salmonid eggs and fry. For non-salmonids, 0.004 ppm is acceptable.
[b] To protect salmonid eggs and fry. For non-salmonids, 0.03 ppm is acceptable.
[c] Copper at 0.005 ppm may suppress gill adenosine triphosphatase and compromise smoltification in anadromous salmonids.

TABLE 19: Suggested chemical values for hatchery water supplies concentration are in parts per million (PPM). (Source: Howard N. Larsen; Unpublished.)

Variable	Trout	Warm Water
Dissolved oxygen	7-saturation	5-saturation
Carbon dioxide	0-0-15	0-15
Total alkalinity (as $CaCO_3$)	10-400	50-400
% as phenolphthalein	0-25	0,40
% as methyl orange	75-100	60-100
% as ppm hydroxide	0	0
% as ppm carbonate	0-25	0-40
% as ppm bicarbonate	75-100	75-100
pH	6.5-8.0	6.5-9.0
Total hardness (as $CaCO_3$)	10-400	50-400
Calcium	4-160	10-160
Magnesium	Needed for buffer system	
Manganese	0-0.01	0-0.01
Iron (total)	0-0.15	0-0.5
Ferrous ion	0	0
Ferric ion	0.5	0-0.5
Phosphorous	0.01-3.0	0.01-3.0
Nitrate	0-3.0	0-3.0
Zinc	0-0.05	0-3.0
Hydrogen sulfide	0	0

TABLE 14: Conversion of degrees fahrenheit (°F) to degrees centigrade (°C)

°F	°C	°F	°C	°F	°C	°F	°C
32	0.0	52	11.1	72	22.2	92	33.3
33	0.6	53	11.7	73	22.8	93	33.9
34	1.1	54	12.2	74	23.3	94	34.4
35	1.7	55	12.8	75	23.9	95	35.0
36	2.2	56	13.3	76	24.4	96	35.6
37	2.8	57	13.9	77	25.0	97	36.1
38	3.3	58	14.4	78	25.6	98	36.7
39	3.9	59	15.0	79	26.1	99	37.2
40	4.4	60	15.6	80	26.7	100	37.8
41	5.0	61	16.1	81	27.2	101	38.3
42	5.6	62	16.7	82	27.8	102	38.9
43	6.1	63	17.2	83	28.3	103	39.4
44	6.7	64	17.8	84	28.9	104	40.0
45	7.2	65	18.3	85	29.4	105	40.6
46	7.8	66	18.9	86	30.0	106	41.1
47	8.3	67	19.4	87	30.6	107	41.7
48	8.9	68	20.0	88	31.1	108	42.2
49	9.4	69	20.6	89	31.7	109	42.8
50	10.0	70	21.1	90	32.2	110	43.3
51	10.6	71	21.7	91	32.8		

TABLE 15: Sources of water analysis

Note: Before sampling, contact lab for collecting and shipping instructions and for current prices.

INTERIM CERTIFIED LABORATORIES
APPROVED FOR PERFORMANCE OF MICROBIOLOGICAL TESTS
ON PUBLIC DRINKING WATER SUPPLIES

Phone #	Laboratory & Address	Method*
362-1300	Boise Water Corporation 8248 Victory, West Boise, ID 83709	303 305
334-2235	Central Laboratory 2220 Old Penitentiary Rd. Boise, ID 83702	303 305
459-2392	Caldwell Wastewater Treatment Plant 504 Johnson Lane Caldwell, ID 83605	303 305
376-2257	Century Laboratory 250 South Beechwood Ave. Boise, ID 83705	303 305
879-2285	Challis National Forest P.O. Box 247 Challis, ID 83226	303 305
667-3481	Coeur d'Alene Branch Lab 2195 Ironwood Court Coeur d'Alene, ID 83814	303 305
667-9533	City of Coeur d'Alene Wastewater Plant Hubbard Ave. Coeur d'Alene, ID 83814	303 305
342-5511	Environmental Engineering Lab 1802 N. 33rd Boise, ID 83703	303 305
356-9201	Forsgren, Perkins, and Associates 350 North 2nd East Rexburg, ID 83440	303 305

* 303 = Membrane Filter Procedure 305 = Most Probable Number Procedure

APPROVED LABS FOR MICROBIOLOGICAL TESTING CONT'D

Phone #	Laboratory & Address	Method *
522-0310	Idaho Falls Branch Lab 254 E. Street Idaho Falls, ID 83401	303 305
529-1476	Idaho Falls Wastewater Treatment Lower Plant Rd. Idaho Falls, ID 83401	303 305
459-0071	J.R. Simplot Lab, Caldwell P.O. Box 1059 Caldwell, ID 83605	303 305
799-3000	Lewiston Branch Laboratory 1221 F. Street Lewiston, ID 83501	303 305
743-7461	City of Lewiston Water Filtration Plant 29th and Railroad Lewiston, ID 83501	305
743-4627	Lewiston Orchards Irrigation District 2901 Powers Lewiston, ID 83501	303 305
828-2359	Mountain Home Laboratory Mt. Home AFB Mt. Home, ID 83648	303 305
233-9080	Pocatello Branch Laboratory 465 Memorial Drive Pocatello, ID 83201	303 305
232-4311	Pocatello Wastewater Treatment Plant 209 East Lewis St. Pocatello, ID 83201	303 305
799-0123	Potlatch - Paul Hart P.O. Box 1016 Lewiston, ID 83501	303 305
756-4291	Steele Memorial Hospital Lab Main & Daisy, Box 700 Salmon, ID 83467	303 305
734-5900	Twin Falls Branch Laboratory 324 2nd Street Twin Falls, ID 83301	303 305

* 303 = Membrane Filter Procedure 305 = Most Probable Number Procedure

TABLE 16: IDAHO WATER QUALITY LABORATORIES - INORGANIC CHEMICAL CONTAMINANTS GRANTED INTERIM CERTIFICATION - EFFECTIVE MARCH 5, 1982

LAB NUMBER	NAME AND ADDRESS OF LABORATORY	1005 Arsenic	1010 Barium	1015 Cadmium	1020 Chromium	1025 Fluoride	1030 Lead	1035 Mercury	1040 Nitrate	1045 Selenium	1050 Silver	1024 Cyanide
00001	Central Laboratory *	125	101	125	125	115	125	103	109	125	125	111
	ID. Dept. of Health & Welfare	X	X	X	X	X	X	X	X	X	X	X
	2220 Old Penitentiary Rd.											
	Boise, Idaho 83702											
	Supv. Jim Dodds											
00102	Century Laboratories	125	101	125	125	111	125	103	109	125	101	111
	250 S. Beechwood, Suite 11	X	X	X	X	X	X	X	X	X	X	X
	Boise, Idaho 83705											
	Supv. David Bennett											
00003	Coeur d'Alene Branch Lab.	125	101	125	125	107	125	103	109	125	125	
	Idaho Dept. of Health & Welfare	X	X	X	X	X	X	X	X	X	X	
	2195 Ironwood court											
	Coeur d'Alene, Idaho 83814											
	Analyst: Mike Meyer											
00103	Energy Incorporated	123	125	125	125	107	125	103		123	125	
	Energy Plaza, P.O. Box 736	X	X	X	X	X	X	X		X	X	
	Idaho Falls, Idaho 83401											
	Supv. Craig Young											
00104	Environmental Engineering	125	101	125	125	107	125		105		101	
	1802 N. 33rd Street	X	X	X	X	X	X		X		X	
	Boise, Idaho 83703											
	Supv. Mike Moore											
00106	Hibbs Laboratories	125	101	125	125	107	125	103	109	125	125	111
	2808 Cassia	X	X	X	X	X	X	X	X		X	X
	Boise, Idaho 83705											
	Supv. Robert A. Hibbs											
00006	Pocatello Branch Lab	125	101	125	125	107	125	103	109	125	125	
	Idaho Dept. of Health & Welfare	X	X	X	X	X	X	X	X	X	X	
	465 Memorial Drive											
	Pocatello, Idaho 83201											
	Analyst: Charles Schwartz											

* Central Laboratory, of the Bureau of Laboratories, has been granted interim approval by Region X of EPA for the determination of these contaminants with the exception of cyanide. Three digit numbers are analytical method codes.