WATER QUALITY AND MERCURY IN LAKE OWYHEE, SOUTHEASTERN OREGON

by

Douglas Craft, Norbert Cannon, David Zimmer,
Karl Krill, and Louis DiMattia

September 2000

U.S. Department of the Interior
Bureau of Reclamation

WATER QUALITY AND MERCURY IN LAKE OWYHEE, SOUTHEASTERN OREGON

by

Douglas Craft[1], Norbert Cannon[2], David Zimmer[3],
Karl Krill[4], and Louis DiMattia[5]

September 2000

[1] U.S. Department of the Interior - Bureau of Reclamation
Technical Service Center, Fisheries Applications Research Group, D-8290
PO Box 25007, Denver CO 80225-0007, 303-445-2182, dcraft@do.usbr.gov
(Author to whom correspondence should be addressed)
[2] U.S. Department of the Interior - Bureau of Reclamation
Pacific-Northwest Regional Laboratory, Boise ID, PN-3210, 208-334-1540
[3] U.S. Department of the Interior - Bureau of Reclamation
Pacific-Northwest Regional Office, Boise ID, PN-6538, 208-378-5088
[4] U.S. Department of the Interior - Bureau of Reclamation
Technical Service Center, Earth Sciences and Research Laboratory Group, D-8340
[5] U.S. Department of the Interior - Bureau of Reclamation
Technical Service Center, Ecological Research and Investigations Group, D-8220

TABLE OF CONTENTS

Page

Table of Contents - continued

Tables

Table of Contents - continued

Page

Table of Contents - continued

Figures

Table of Contents - continued

Page

Table of Contents - continued

Table of Contents - continued

Table of Contents - continued

Page

Table of Contents - continued

Appendices with Tables and Figures

GLOSSARY

Limnology and General Environmental Science Terms

acute	short-term or immediate, usually applied to toxicity or exposure to toxic compounds.
aerobic	in the presence of oxygen.
AVIRIS	airborne visible and infrared imaging spectrometer.
allochthonous	having an origin or formed outside the system of interest.
anaerobic	in the absence of oxygen.
autochthonous	originating from within the system of interest.
benthic	associated with sediments below the water column, or the bottom of a stream or lake.
bioaccumulation	the process whereby toxic compounds are taken up by living organisms and become concentrated in animal tissue over time, or magnify in organisms feeding at higher levels of the food chain.
bioavailability	a property of chemical compounds that describes how well the compound is taken up by living organisms.
biotic	associated with biological organisms.
chronic	long-term or of extended duration, usually applied to toxicity or exposure to toxic compounds.
delta-T, ΔT	change in temperature.
diatoms	microscopic, single-celled plant plankton that form cell walls of silica, called frustules.
eutrophic	trophic state of a lake having high productivity, generally low water transparency, abundant nutrients for plankton, and elevated concentrations of organic carbon.

epilimnion	the surface layer of a thermally stratified lake.
fugitive dust	wind-blown dust, fine soil, and sediment transported away from its point of origin.
hydrodynamics	the study of water flows and currents.
hydrology	the study of surface and ground water hydrodynamics.
hyperspectral	airborne or satellite imaging where each image pixel contains reflectance data from many wavelengths of light.
hypolimnion	the cold and dense water pool in a thermally stratified lake, next to sediments and below the thermocline.
lacustrine	associated with a lake environment.
lentic	associated with still or calm water.
limnology	the study of the chemistry, biology, and physics of fresh water.
lotic	associated with flowing water.
mesolimnion	the depth region in a thermally stratified lake where temperature drops to a lower limit in the hypolimnion.
microfauna	the collection of microscopic animals in an ecosystem.
microflora	the collection of microscopic plants in an ecosystem.
non-point source	a diffuse source of pollution.
oligotrophic	trophic state of a lake having low productivity, generally higher water transparency, and low concentrations of nutrients and organic carbon.
phytoplankton	microscopic plants suspended in water, usually algae and diatoms.
plankton	microscopic plant and animal organisms suspended in water.
point source	a localized, well defined source of pollution.
productivity	the degree of biological activity in an ecosystem.

profile	the collection of measurements collected in a single location at many depths in a lake.
remote sensing	spectral or photographic imaging from a distance, usually from an aircraft or orbiting satellite.
riverine	associated with a river or flowing stream environment.
Secci depth	the depth below water surface at which a standard flat disk (the Secci disk) becomes invisible, a measure of water transparency.
seston	microscopic debris, sediments, and organisms suspended in a water.
spectrometer	an instrument that measures light intensity at different wavelengths.
spectrum	the collection of light intensity data measured over a continuous range of wavelengths.
thermal stratification	the tendency for deeper lakes to form temperature and density layers in the water column,
thermocline	the temperature transition zone in a thermally stratified lake, associated with the depth of the mesolimnion.
toxicity	the degree to which a compound harms a given organism, usually described using a dosage per unit body weight, or a concentration in water that causes mortality to a percentage of a population.
trophic state	a classification of a lake with respect to biological productivity. High productivity lakes are classified as eutrophic, low productivity lakes as oligotrophic.
turnover	the mixing of a thermally stratified lake, usually occurs in spring and fall.
zooplankton	microscopic animals suspended in water.

Geology Terms

agglomerates	clumps of loosely consolidated solid materials.
albite	a plagioclase feldspar enriched with sodium: $NaAlSi_3O_8$

alteration	change in the mineralogical composition of rock by physical or chemical means, usually applied to hydrothermal solution processes.
amphibole	a group of ferromagnesian silicate minerals, abundant in igneous and metamorphic rock: $(Mg,Fe^{2+},Ca,Na)_{2-3}(Mg,Fe^{2+},Fe^{3+},Al)_5(Si,Al)_8O_{22}(OH)_2$
anatase	a mineral containing titanium usually found with brookite and rutile: TiO_2
anorthite	a plagioclase feldspar enriched with calcium: $CaAl_2Si_2O_8$
apatite	a group of calcium phosphate containing minerals, also containing carbonate, fluoride, chloride, or hydroxide.
basalt	an igneous volcanic rock
breccia	a coarse-grained rock composed of angular broken rock fragments held together with mineral cement.
brookite	a mineral containing titanium usually found with rutile and anatase: TiO_2
calcite	calcium carbonate, $CaCO_3$
chlorite	a group of clay-like minerals of the general formula: $(Mg, Fe^{2+}, Fe^{3+})_6AlSi_3O_{10}(OH)_8$
cinnabar	mercuric sulfide, HgS
clay	a class of finely crystalline or amorphous single and multi-layered aluminosilicate minerals formed from the weathering of feldspars, pyroxenes, and amphiboles; or soil and sediment particles smaller than 0.004 µm containing clay minerals such as illite, smectite, or montmorillonite..
clinoptilolite	a zeolite mineral rich in potassium: $(Na,K,Ca)_{2-3}Al_3(Al,Si)_2Si_{13}O_{36}\cdot 12H_2O$
composite	a single sample composed of many combined individual subsamples, used to represent a larger population or area.

Cretaceous	rocks formed during the final period of the Mesozoic era, covering the span of time from 65 to 135 million years ago.
disaggregation	the process of breaking up soil or sediment solid aggregates.
dolomite	a carbonate mineral containing both calcium and magnesium: $Ca_aMg_b(CO_3)_{a+b}$
epithermal	pertaining to hydrothermal mineral deposits formed in the upper 1 km of the earth's surface at temperatures of 50°-200°C.
feldspar	a class of metamorphic aluminosilicate minerals.
ferrihydrite	an iron hydroxide mineral: $Fe(OH)_3$
ferromagnesian	minerals containing iron and magnesium, such as olivine.
fractional spooning	a procedure for collecting representative subsamples using many small, randomly selected scoops of solid material.
frustules	the siliceous cell walls of diatoms.
geothermal	pertaining to heat from the interior of the earth.
goethite	an iron oxide/hydroxide mineral: α-FeO-OH
granite	a hard plutonic rock, containing mostly quartz and feldspar.
hematite	an iron oxide mineral: α-Fe_2O_3
heterogeneous	non-uniform and poorly mixed..
homogeneous	uniform and well mixed.
hornblende	the most common mineral in the amphibole group, having a general formula: $Ca_2Na(Mg, Fe^{2+})_4(Al, Fe^{3+},Ti)$.
hydrated	a mineral or compound containing water.
hydrothermal	processes in igneous rock involving heated or superheated water.
hydroxyapatite	a variation of the mineral apatite, containing hydroxide: $Ca_5(PO_4)_3OH$

igneous	a rock or mineral formed from cooling of molten or partly molten material, such as magma.
illite	a general name for a group of triple-layer clays commonly found in marine shales.
interbedding	layering of different kinds of sedimentary rock or minerals.
intrusive	a rock different from surrounding rock that formed or forced
loess	small particle-sized wind-blown deposits.
magnesite	a carbonate mineral containing magnesium: $MgCO_3$
metamorphic	previously formed rock that is transformed in structure and mineralogy at higher pressure and temperature.
mica	a group of clay-like, layered aluminosilicate minerals that form elastic sheets and flakes in igneous or metamorphic rock.
mineralization	the processes whereby minerals are introduced into rock, and may involve hydrothermal solution processes, fissure filling, impregnation, or replacement.
minus No. 80 mesh	solid material smaller than 0.007 in. (178 µm), passing through a No. 80 U.S. Standard screen.
minus No. 10 mesh	solid material smaller than 0.079 in. (2,000 µm), passing through a No. 10 U.S. Standard screen.
oligoclase	a plagioclase feldspar mineral enriched with sodium, but containing more calcium than albite.
olivine	a group of ferromagnesian silicate minerals formed from igneous rock: $(Mg,Fe,Mn,Ca)_2SiO_4$
oligoclase	a plagioclase feldspar containing mostly sodium small amounts of calcium.
orthoclase	an alkali feldspar enriched with potassium.
oxyhydrates	hydrated oxide/hydroxide minerals usually containing iron and/or manganese.

Permian	rocks formed during the last period of the Paleozoic era, covering a span of time from 225 to 280 million years ago.
petrography	the branch of geology that determines the mineralogy of rock and soil.
plagioclase	a group of triclinic feldspar minerals of the general formula: $(Na,Ca)Al(Si,Al)Si_2O_8$
Pleistocene	rocks and deposits formed during the Quaternary period, covering a span of time from 2-3 million to 8,000 years ago.
pyroxene	a group of silicate minerals formed in igneous rock, similar to the amphiboles but lacking hydroxyl groups.
Quaternary	rocks formed during the second period of the Cenozoic era, following the Tertiary, covering the span of time from 2-3 million years ago to the present time.
quartz	a crystalline silicon dioxide mineral: SiO_2
rhyolite	an extrusive igneous rock containing quartz and alkali feldspar.
rutile	a mineral containing titanium usually found with brookite and anatase: TiO_2
screen, sieving	the process of separating solid samples into defined size fractions by sifting the sample through a series of mesh screens with known diameter openings.
SEM	scanning electron microscope.
silica	amorphous silicon dioxide mineral: SiO_2
silicate	a mineral containing SiO_4
smectite	a group of multi-layered clay minerals with swelling properties and high cation exchange capacity. Also called *montmorillonite*.
subsample	a portion of a larger sample collected to represent the larger sample or population.

Tertiary	the first period of the Cenozoic era, covering the span of time between 2-3 million and 65 million years ago.
travertine	a carbonate mineral formed by rapid precipitation, usually when groundwater super-saturated with calcium and carbonate contacts a flowing stream.
travertine cones	conical solid deposits of travertine that form in stream beds.
tuff	a general term for consolidated pyroclastic or volcanic rocks.
tuffaceous	containing tuff.
US Standard Mesh	a defined standard for mesh screens used to size solid particles.
weathering	the process whereby one mineral is converted to another.
XRD	X-ray diffraction.
XRF	X-ray fluorescence.

Chemistry Terms

AA	atomic absorption.
AAS	atomic absorption spectrophotometer.
adsorbed	analytes chemically bound or otherwise attached to the surface of a particle.
aliphatic	organic compounds containing only C-C single bonds.
alkalinity	the acid neutralizing capacity of a water or soil, usually associated with the amount of carbonate, bicarbonate, or hydroxide in a sample. In geology, a rock that contains Na or K or other alkali metals.
alkane	a hydrocarbon with no C-C double bonds, and no elements other than C and H, such as butane or propane.
alkene	a hydrocarbon that contains double bonds, and no elements other than C and H, such as ethylene.

alkyl	a functional group comprised of an alkane, such as methyl ($-CH_3$) or ethyl (CH_3-CH_3).
analyte	the chemical compound or element being analyzed in a sample.
anions	negatively charged ions, usually the major anions: HCO_3^-, CO_3^{2-}, SO_4^{2-}, and
aromatic	organic compounds containing heterocyclic rings with alternating C-C double bonds, such as benzene.
atm	atmosphere, SI unit, equal to the atmospheric pressure at mean sea level.
carboxylic acid	an organic acid containing -COOH functional groups, such as acetic acid (CH_3-COOH).
carboxylate	a charged, deprotonated carboxylic acid group, $-COO^-$
cations	positively charged ions, usually Ca, Mg, Na, and K
centrifugate	the denser liquid or solid separated from a liquid during centrifugation.
colloid	very small particles suspended in water that do not settle.
colorimetric	a spectrophotometric analysis technique where the intensity of a colored compound is related to the analyte concentration.
complex	a compound formed between a metal and a ligand, usually called a “trace metal complex.”
coulometric	an analysis technique where analyte is detected based on the amount of electrical current generated in an electrochemical reaction.
CVAA	cold vapor atomic absorption.
CVAFS	cold vapor atomic fluorescence spectrophotometry.
dissolved	an operationally defined term applied to water analysis results, usually meaning that the sample is filtered through a 0.45-µm pore-size membrane filter before analysis.

EC	electron capture detector, on a GC instrument (also electrical conductivity).
electrometric	analysis using measurement of electrical potential (voltage), as with an electrode that measures pH.
equilibrium	the state in a chemical reaction when the forward and reverse reaction rates are equal.
ethylation	a chemical reaction that adds an ethyl group ($-CH_2CH_3$) to an inorganic or organic molecule.
FIA	flow injection analyzer, an automated colorimetric instrument.
FID	flame ionization detector, on a GC instrument.
filtrate	the liquid passed through a filter.
fluorescence	the emission of light caused by incident light, a spectrophotometric analysis method based on fluorescence.
fulvic acid	a class of natural organic matter produced by the chemical breakdown of plant and animal matter, usually dissolved and having a distribution of molecular weights between 600 and 2000 amu.
functional group	a reactive site on a molecule
GC	gas chromatograph.
GC-MS	gas chromatograph - mass spectrometer.
GFAA	graphite furnace atomic absorption.
glycoproteins	proteins that contain polysaccharides.
grab sample	a randomly selected single sample.
heterodisperse	having a distribution of molecular weights, applied to classes of natural compounds such as humic and fulvic acids..
humic acid	a class of natural organic matter produced by the chemical breakdown of plant and animal matter, usually particulate or adsorbed and having a distribution of molecular weights between 2000 and 20,000 amu.

IC	ion chromatograph.
ICP-ES	inductively-coupled plasma - emission spectrograph.
ICP-MS	inductively-coupled plasma - mass spectrometer.
ion, ionic	an element or compound having a positive or negative charge.
ion exchange	the chemical reaction process where one ion will replace another in a reaction with a mineral, such as a clay, or a medium containing ionic binding sites.
K	equilibrium constant.
ligand	a compound or functional group on a molecule, usually negatively charged, that forms a chemical bond with a positively charged trace element.
log(AP/KT)	the base-10 logarithm of the activity product divided by the equilibrium constant times the temperature in °K. Another way to denote the saturation index for a given reaction.
logK	logarithm of the equilibrium constant.
major ions	higher concentration elements dissolved in water, usually: Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, CO_3^{2-}, SO_4^{2-}, and Cl^{-}
media	the type of material associated with a sample: water, wastewater, groundwater, soil, sediments, rock, tissue, etc.
methylation	the chemical process of adding a methyl group(-CH3) to an inorganic or organic compound.
multidendate	a compound having multiple binding sites on the same molecule.
nutrients	a term referring to all nitrogen and phosphorus species, usually includes total-P, ortho-P, TKN, NH_3, NO_2, and NO_3

oversaturated	the temporary condition in a two-phase (solid-solution) system when the reactants in solution that form a chemical compound exceed concentrations required to form the solid compound at equilibrium. Oversaturated solutions tend to form the solid product and precipitate out of solution.
oxidation	chemical combination or reaction with oxygen, or removal of electrons to increase oxidation state.
partial pressure	the proportional pressure exerted by a gas in the presence of other gases, usually expressed in atm.
particulate	analytes bound to, or strongly associated with suspended particles in water.
pH	the degree of acidity or alkalinity of a solution.
phenolic	referring to organic compounds containing phenol groups, $R-C_5H_4-OH$
polysaccharides	biological polymers composed of repeating sugar molecule units.
precipitate	v. to change phase from solution (liquid) to solid or to form an insoluble compound that settles out of solution. n. a solid compound that settles out of solution.
Q	flow.
raw sample	a sample that is untreated, unpreserved, or otherwise processed.
reduction	the chemical removal of oxygen from a compound, or the addition of electrons to lower the oxidation state.
redox	oxidation-reduction.
Ruzic Plot	a graphical method for calculating the equilibrium constant of a chemical reaction based on titration of a ligand solution with a trace element.
saturated	the condition when a chemical compound is in equilibrium with its solid and solution forms.
saturation index	a measure of undersaturation or oversaturation for a mineral or solid compound in aqueous solution.

Scatchard Plot	a graphical method for calculating the equilibrium constant of a chemical reaction based on titration of a ligand solution with a trace element.
Schubert's Method	a method for calculating equilibrium constants for several trace elements at the same time that uses an ion exchange medium.
slurry	a mixture of solid materials in a liquid.
solute	the chemical that is dissolved into the solvent.
solvent	the chemical that dissolves the solute.
speciation	the description of the different compounds formed by an element in a natural water.
species	chemically, the term applied to different compounds that are formed with elements in natural water.
spectrophotometric	an analytical technique that determines analyte concentration by measuring light transmission, emission, or adsorption, at given wavelength.
stability constant	an equilibrium constant, usually for the formation of a metal-ligand complex .
stoichiometry	the set of coefficients for reactants and products in a chemical reaction that produce a balanced algebraic equation and condition of mass balance between reactants and products.
supernate	the liquid separated from a slurry during centrifugation.
suspended	an operationally defined term applied to water analysis results. Analytes associated with suspended particles larger than 0.45-µm, usually calculated by subtracting dissolved from total.
thermal desorption	the process of removing a volatile or semivolatile compound or element from a substrate using heat.
thermodynamic	pertaining to the study of heat transfer and the formation and breaking down of chemical compounds.

titration	the process of adding a standardized reactant chemical solution to a liquid sample, and monitoring completion of a reaction that forms a detectable product.
total	an operationally defined term applied water analysis results, usually meaning an unfiltered sample that is digested or extracted without filtration prior to analysis
trace	low concentrations, generally from mg/L to many µg/L.
trace element	in water chemistry, the general term for transition metals and other elements present in low concentrations.
trace metals	a general term for low concentration trace elements.
turbidity	suspended particles that scatter light in a water sample.
ultra-clean	special precautions taken to minimize sample contamination.
ultra-trace	extremely low concentrations, generally µg/L or lower.
undersaturated	the condition in a two-phase (solid-solution) system when the reactants in solution that form a chemical compound are below concentrations required to form the solid compound. Undersaturated solutions tend to dissolve the solid reaction product.
volatile	a solid or liquid with a tendency to evaporate or sublimate into the gas phase.

Elements and Analytes

Ag	silver
Al	aluminum
As	arsenic
AsO_4^{2-}	arsenate ion
Cl^-.	
B	boron
Ba	barium
BOD	biological oxygen demand
Ca, Ca^{2+}	calcium, or calcium ion
Cd	cadmium
Cl^-	chloride, or chloride ion

Co	cobalt
CO_3^{2-}	carbonate, or carbonate ion
COD	chemical oxygen demand
Cr	chromium
Cu	copper
DO	dissolved oxygen, mg/L
DOC	dissolved organic carbon
EC	electrical conductivity, µS/cm
Eh	redox potential, mV
F^-	fluoride, or fluoride ion
FA	fulvic acid
Fe	iron
HA	humic acid
HCO_3^-	bicarbonate, or bicarbonate ion
Hg	mercury
K, K^+	potassium, or potassium ion
Me-Hg	methylmercury
Mg, Mg^{2+}	magnesium, or magnesium ion
Mn	manganese
Mo	molybdenum
Me-Hg	methylmercury, also CH_3Hg^+, methylmecuric ion
N	nitrogen
NH_3	ammonia
NH_4^+	ammonium ion
NO_3^-	nitrate, or nitrate ion
NO_2^-	nitrite, or nitrite ion
NO_3+NO_2	nitrate plus nitrite
Na, Na^+	sodium, sodium ion
Ni	nickel
OH^-	hydroxide, or hydroxide ion
ON	organic nitrogen
o-P, ortho-P	orthophosphate
P	phosphorus
Pb	lead
PO_4^{3-}	orthophosphate, phosphate, or phosphate ion
Sb	antimony
Se	selenium
SeO_4^{2-}	selenate ion
Si	silicon (element)
SiO_2	silica (mineral)
SiO_4, SiO_3^{2-}	silicate, silicate ion
Sn	tin
SO_4^{2-}	sulfate, or sulfate ion
T	temperature, °C
TDS	total dissolved solids, mg/L, also called “filterable residue”
Tl	thallium
Ti	titanium
TKN	total Kjeldahl nitrogen
TM	trace metals

TOC	total organic carbon
TON	total organic nitrogen
TSS	total suspended solids, mg/L, also called “non-filterable residue”
t-P, total-P	total phosphorus
U	uranium
UO_2^{2+}	uranate ion
V	vanadium
VO_2^+	vanadate ion
Zn	zinc

Measurement Units

amu	atomic mass units.
acre	English unit for land area, (1 acre = 2.471 ha).
acre-ft	acre-foot.
cfs	cubic feet per second, English and engineering unit for flow discharge.
equivalent	a chemical concentration unit based on reactivity, equal to the molar weight divided by the valence of the compound or ion .
eq/L	equivalents per liter.
g	gram, SI mass unit.
ha	hectare, SI area unit (1 Ha = 1.00×10^4 m^2).
Hz	Hertz, SI unit for frequency in cycles per second.
kg	kilogram, SI mass unit, 1 kg = 1000 g.
kW	kilowatt (1000 watts).
L	liter, SI volume unit.
lat/long	latitude/longitude.
M	molarity, moles per liter.
m	meter, SI length unit.
meq/L	milliequivalents per liter, 10^{-3} equivalents per liter
mesh	a size standard unit based on the diameter of space between the wire mesh in a screen, used to separate and quantify size fractions of solid materials.
-80 mesh	minus-80 mesh, material passing through a U.S. Standard No. 80 Screen sieve.
+80 mesh	plus-80 mesh, material retained on a U.S. Standard No. 80 Screen sieve.
-10 mesh	minus-10 mesh, materials passing through a U.S. Standard No. 10 Screen sieve.
+10 mesh	plus-10 mesh, materials retained on a U.S. Standard No. 10 Screen sieve.
mg	milligram, SI mass unit, (1 mg = 10^{-3} g).
mg/kg	milligrams per kilogram (1000 g), SI concentration unit applied to solid samples and liquid samples with high salinity.
mg/L	milligrams per liter, SI concentration unit.

mi^2	square mile.
mL	milliliter, SI volume unit, (1000 mL = 1.000 L).
mm	millimeter (10^{-3} m), SI length unit.
molal	moles per 1000 g of solution.
mole	a chemical concentration unit based on the empirical formula of a chemical compound, equal to the mass of Avogadro's number (6.023 X 10^{23}) of molecules of a chemical compound, or atoms of an element.
mol/L, M/L	moles per liter.
mM/L, mmol/L	millimoles per liter, 10^{-3} moles per liter.
mV	millivolt, (10^{-3} volts) SI voltage unit.
µM/L, µmol/L	micromoles per liter, 10^{-6} moles per liter.
µeq/L	microequivalents per liter, 10^{-6} equivalents per liter.
µg	microgram, SI mass unit, (1 µg = 10^{-6} g).
µg/kg	micrograms per kilogram (1000 g), SI concentration unit applied to solid samples and liquid samples with high salinity.
µg/L	micrograms per liter, SI concentration unit.
µm	micrometer, or micron (10^{-6} m), SI length unit.
µS/cm	microsiemens per square centimeter, SI unit for electrical conductivity.
nm	nanometers, (10^{-9} m), usually applied to spectral wavelengths.
N	normality, expressed in equivalents/liter.
NTU	nephelometric turbidity units.
ng	nanogram, SI mass unit, (1 ng = 10^{-9} g).
ng/kg	nanograms per kilogram (1000 g), SI concentration unit applied to solid samples and liquid samples with high salinity.
ng/L	nanograms per liter, SI concentration unit.
ppb	parts per *billion*, equivalent to µg/kg and properly applied to solid sample concentrations.
ppm	parts per *million*, equivalent to mg/kg and properly applied to solid sample concentrations.
ppt	parts per *trillion*, equivalent to ng/kg and properly applied to solid sample concentrations.
percent H_2O	weight percent water.
SI	Système Internationale d'Unités, the international standard system for metric measurement units.
su or s.u.	standard units, usually applied to pH.
V	volt, SI voltage unit.

Quality Control and Statistics Terms

accuracy	a measurement of closeness to the true or actual value.
α	Greek letter alpha. In statistics, the probability of rejecting the hypothesis being tested (the null hypothesis) when it is true. Also called the Type I error and the level of significance.
alternative hypothesis	H_1 - the statistical testing hypothesis accepted if the null hypothesis, H_0, is rejected.

ANOVA	analysis of variance, a statistical test used to compare means.
blank	a clean check sample used to test for contamination during an instrument run.
blind	a check sample or standard submitted to a lab disguised as a normal sample.
calibration verification	a known concentration certified standard, different from the standards used to calibrate an instrument, that is analyzed after calibration and during the period the instrument is analyzing samples. Used to independently verify initial (ICV) and continuing calibration (CCV).
check sample	a sample analyzed during an instrument run having known concentrations, not necessarily certified or traceable.
certified	as applied to a standard, having documentation attesting to the precision, accuracy, and traceability of a reported concentration.
confidence interval	the interval bounded by confidence limits. An estimate of variability about a mean using the standard deviation adjusted for sample size.
df	degrees of freedom.
distribution	the overall shape of the data set with respect to data values and frequency of occurrence.
DL	detection limit.
estimated	in the data validation process, a term used to indicate that a data value has been qualified because of some degree of QC non-conformance (for example, “J” by EPA protocols). A way of saying that the number may have less certainty.
F	F-statistic, the ratio of two estimates of variance, or the distribution of this ratio.
H_0	null hypothesis.
H_1	alternative hypothesis.
IB	instrument blank - usually pure water or solvent run to check for contamination associated with actual analysis.
ICB	initial calibration blank.
ICV	initial calibration verification.

IDL	instrument detection limit.
Ion Balance	a percentage calculation used to check major ions data that compares cations to anions.
J	EPA data validation code for “estimated.”
LCS	laboratory control sample, a check sample with known, but not necessarily certified, concentration.
linear regression	a statistical method for fitting data to a linear model.
LOD	limit of detection, statistically based. 3 times the standard deviation calculated from repeated same-sample results.
LOQ	limit of quantitation, statistically based. 10 times the standard deviation calculated from repeated same-sample results.
MB	method blank, a clean deionized water sample that is digested or extracted following a given method.
MDL	method detection limit.
mean	arithmetic average, denoted as x-bar, or $\bar{x}$.
MSD	matrix spike duplicate.
matrix	the sum of all chemical components in the sample *besides the analyte* being tested.
matrix spike	a real sample to which a known amount of an analyte is added, sometime denoted MS.
μ	Greek letter mu. In statistics, the population mean.
n	number of data points.
ND	not detected, also U, undetected, or <(number), meaning less than the detection limit.
null hypothesis	H_0 - the hypothesis to be tested by statistical analysis, usually that means are equal or unequal.
%R	percent recovery, in general, (observed value)÷(true= value) X 100.
parameter	a coefficient for a random variable derived from a statistical analysis.
percent RSD	percent relative standard deviation, the ratio of the standard deviation to the mean, expressed as a percentage.

precision	a measure of the variability of repeated measurements.
PQL	practical quantitation limit.
QA	quality assurance, overall efforts, audits, and tests performed to make sure that sample collectors and the analysis lab are following the QC requirements. These could include lab and field sampling audits, or submission of known concentration samples as blind check samples.
QC	quality control, efforts and tests undertaken *in the lab* to check or document analysis data quality.
qualification	a code or commentary describing QA/QC non-conformance and its effect on data usability.
qualitative	detected, but not at a high level of precision and/or accuracy.
quantitative	detected with a higher degree of precision and accuracy.
RPD	relative percent difference, a way to calculate precision from duplicate data.
Recovery	observed concentration divided by theoretical or true concentration, usually expressed as a percentage.
residual	the difference between the statistically predicted value and the actual value, for a mean, $\bar{x} - x_i$.
R-squared, R^2	adjusted correlation coefficient, a measure of linear correlation.
s	sample standard deviation.
SDG	sample delivery group.
σ	Greek letter sigma. In statistics, the population standard deviation.
spike	a known amount of an analyte added to a real sample or blank.
SRM	standard reference material, a known-concentration standard, usually manufactured and tested by a national standards organization (such as NIST.)
standard deviation	an statistical estimate of variability about a mean.
t	t-statistic, used to compare sample means or the distribution of the statistic.

traceable	usually refers to a check sample or verification sample with known values and a certificate indicating comparison to a standard reference material.
TV	true value.
validation	the process of checking and documenting the quality of analysis data.
variable	a measured property that varies.
$\bar{x}$, x-bar	arithmetic average or mean.

Agency, Organizational, and Location Abbreviations

ACS	American Chemical Society.
ANSI	American National Standards Institute.
APHA	American Public Health Association.
ASQC	American Society for Quality Control.
ASTM	American Society for Testing and Materials.
AWWA	American Water Works Association.
BLM	U.S. Department of the Interior, Bureau of Land Management.
DOI	U.S. Department of the Interior.
DOGAMI	State of Oregon, Department of Geology and Mining Industries.
EPA	U.S. Environmental Protection Agency.
FGS	Frontier Geosciences, Inc., Seattle, Washington.
IEC	International Electrotechnical Committee.
ISO	International Organization for Standardization.
JPL	Jet Propulsion Laboratory.
MP	Mid-Pacific Region, Bureau of Reclamation.
NASA	National Aeronautics and Space Administration.
NIST	National Institute for Standards and Technology, formerly NBS, National Bureau of Standards.
ODEQ	State of Oregon, Department of Environmental Quality.
OHD	State of Oregon, Health Division.
NOAA	National Oceanic and Atmospheric Agency.
PN	Pacific Northwest Region, Bureau of Reclamation.
SPSS	Statistical Package for the Social Sciences, SPSS, Inc.
TSC	Technical Service Center, Denver, Colorado.
USBR	U.S. Department of the Interior, Bureau of Reclamation.
USGS	U.S. Department of the Interior, Geological Survey.
WEF	Water Environment Federation.

EXECUTIVE SUMMARY

Lake Owyhee, first filled in 1933, is the largest reservoir in Oregon with a surface area of 12,700 acres (5,160 ha), and is located in Malheur County in the semi-arid southeastern region of the State. The Owyhee River and its tributaries drain a large watershed area (around 10,950 mi^2, 28,360 km^2) that extends into Nevada and southwestern Idaho. The watershed is mostly sagebrush and wheatgrass rangeland, with geology composed primarily of altered igneous volcanic rocks, with intrusive granitic rocks at higher elevations. The volcanic geology of the watershed contains many localized natural sources of mercury (Hg), present as near surface cinnabar, hydrothermal ore bodies, and tuffaceous olivine deposits, and elevated Hg concentrations have been observed in volcanic rock located near Lake Owyhee. Mining and amalgamation recovery of gold and silver around Silver City, Idaho, also released significant quantities of Hg (up to 7.6 lbs/day from 1860 to 1920) into the Jordan Creek sub basin. The specific and diffuse sources of Hg in the watershed have caused public health concern arising from Hg bioaccumulation in watershed fish. The Oregon Health Division has issued fish consumption advisories for Lake Owyhee and several tributaries of the Owyhee River because of high observed concentrations of Hg in fish tissues.

This report presents the results of a preliminary investigation, started in spring 1996 and concluded in spring 1999, that analyzed inflow, reservoir and outflow waters, reservoir sediments, and reservoir suspended sediment samples. The purpose of this study was to characterize very low ambient Hg and methylmercury (Me-Hg) concentrations and background water chemistry to better understand sources and loading of Hg and to identify potential reservoir processes that may affect Hg transport. The following conclusions are suggested by the results of this study:

1. Hydrolab profiles and the major ions data suggest that the deeper reservoir water column stratifies strongly in summer and that time-lagged transport, subsurface density flows, and degrees of mixing are important influences on the chemistry and productivity in Lake Owyhee.

2. Suspended particulates, thought to be the primary external loading vector for Hg and other trace elements, are clearly visible throughout the water bodies of the Lake Owyhee watershed. Several unfiltered chemical constituent concentrations, including total-Hg, total-P, and several trace

elements, show statistically significant correlations with turbidity. Because of small particle sizes and wind mixing in Lake Owyhee surface waters, suspended materials appear to be stable in the upper-depth water column throughout the reservoir. Partial settling of suspended materials on the summer mesolimnion density layer may be causing development of anoxia at these depths.

3. Observed algal blooms and anaerobic conditions in sediments were corroborated by measured dissolved oxygen (DO), redox potential (Eh), nitrogen (N), phosphorus (P), silicon (Si), and carbon (C). Dissolved organic carbon (DOC) is elevated and plentiful for microbial uptake during metabolism and contributes to Lake Owyhee's high biological oxygen demand (BOD) and overall trophic State.

4. Application of ultra-clean sampling, filtration, and analysis procedures produced very high quality data sets for Hg, Me-Hg, and trace elements. Unfiltered total-Hg consistently exceeds the Oregon freshwater chronic water quality criterion; however, Hg dissolved species and Me-Hg are present at very low ng/L concentrations. The low Hg and Me-Hg concentrations are, however, sufficient to result in food chain bioaccumulation in sports fish. Elevated DOC and high productivity combine to produce conditions in the water column and sediments of Lake Owyhee that are conducive to biotic methylation of Hg at lower levels of the food chain. The organic-rich bottom sediments also likely develop anaerobic, chemically reducing conditions that suggest another potential location for biotic methylation and source of internal loading of Hg and Me-Hg to the lake.

5. The water quality data suggest that the suspended fraction is an important aqueous species for many constituents, such as P (40-50 percent), Hg (80-90 percent), and most other trace elements in Lake Owyhee. Nitrogen species are dominated by dissolved organic-N (40-45 percent, likely associated with the DOC), and suspended-N and nitrate (NO_3) account for around 20-30 percent each of molar concentrations.

   Results from the MINTEQA2 chemical equilibrium computer model suggest that the dissolved hydroxide species ($Hg(OH)_2$, from 8-16 percent), with suspended Hg, constitutes the major Hg species in Lake Owyhee waters. Methylmercury, both suspended and dissolved, accounts for only around one percent of total-Hg concentrations, and suspended Me-Hg ranges from 1.3- to 2.9-times dissolved Me-Hg concentrations. In this investigation, measured concentrations of unfiltered total-Hg in Lake Owyhee range from 4.83 to 140 ng/L (a wide range), with mean = 36.9 ng/L, and median = 20.4 ng/L (for n=17). Roughly similar species proportions appear to be present Owyhee River inflow waters; however, unfiltered inflow total-Hg concentrations were much lower, ranging more narrowly from 2.25 to 17.3 ng/L, with a Station OR-2 mean = 8.24 ng/L.

Additional MINTEQA2 results suggest that DOC, thought to be composed largely of fulvic acid, strongly influences trace element speciation. Fulvate (FA^-) forms complexes with most cationic elements and represents an important dissolved trace element species for Cd (22-49 percent), Cu (~49 percent), Ni (25-43 percent), and Zn (14-45 percent). These data suggest that trace elements other than Hg may be bioavailable to the food chain by their association with DOC.

6. A comparison of Owyhee River inflow station data above and below the confluence with Jordan Creek suggests that this inflow is a significant source of Hg, Me-Hg, and several other constituents. Given that the Jordan Creek sub basin accounts for 16 percent of the Rome Gage drainage surface area, the increased Hg concentrations observed below the confluence suggest that Jordan Creek is an important Hg loading source for Lake Owyhee.

7. Reservoir concentrations were elevated relative to inflow waters sampled at Rome, Oregon, for most nutrients, Hg, and trace elements. These data suggest that additional loading occurs in the 85-km reach between Rome and Lake Owyhee, or that the sediments and wind mixing contribute to internal reservoir loading.

Suggested Future Studies

While this study has produced important and previously unavailable information about the chemistry in Lake Owyhee, there are considerable gaps in knowledge concerning this large watershed and complex reservoir. Future investigations could address the following topics:

- Mixing and transport hydrodynamics of Lake Owyhee, and stratification during autumn, winter, and mid-summer.

- Resolution of the internal vs. external loading for Hg, nutrients, and trace elements.

- Current data for Hg and other trace element concentrations in fish tissue and other biological information such as phytoplankton, fish species distributions and numbers, and assessment of overall fishery health.

- Completion of remote-sensing mapping of surface mineral deposits containing Hg in the immediate lake watershed. In 1998, the NASA Jet Propulsion Laboratory funded an overflight and spectral imaging of the near-lake Owyhee watershed using the AVIRIS (airborne visual and infrared imaging spectrometer) instrument. AVIRIS measures a complete visible and infrared spectrum for each pixel, and spectral matching analysis of these data can be used to identify and map occurences of cinnabar and hydrothermal ore bodies associated with Hg. The Owyhee overflight was arranged through the Department of the Interior Hyperspectral Committee to help demonstrate the utility of AVIRIS. Preliminary processing of the Owyhee overflight data has been completed, and final calibration and mapping should be completed with additional funding and resource prioritization.

INTRODUCTION

Mercury (Hg) pollution and bioaccumulation in game fish species has been recognized as a water quality and potential human health problem in Lake Owyhee and its watershed since the early 1970's (Gebhards et.al., 1971). The watershed contains active and historical mining areas, and these watershed sub basins are suspected as past and current Hg sources (Williams et.al., 1974). The volcanic geology of the watershed contains diffuse natural deposits of cinnabar and other geothermal Hg mineral formations (Rytuba and Vander Muelen, 1991), suspected as non-point Hg sources. Finally, atmospheric deposition and wind-blown fugitive dust may also be an unquantified non-point source of Hg to this watershed (Sorensen et.al., 1990).

Table 1 summarizes some of the species and reactions of Hg in the aqueous environment (Jensen and Jernelöv, 1972). The transformation and transport, cycling within lakes, methylation, and food chain bioaccumulation of Hg have been described elsewhere (Bloom, 1990; Jensen and Jernelov, 1969; Zhang and Planas, 1994). With respect to bioaccumulation, the fat-soluble methylmercuric ion (here called methylmercury, or Me-Hg) is thought to be the chemical form of greatest concern and toxicity, and almost all Hg found in fish tissue is in this particular form (Bloom, 1990). Another concern (and contamination prevention problem for sampling and analysis) is that Hg bioaccumulation may occur in aquatic systems containing very low concentrations (on the order of <10 ng/L) of Hg. A detailed review of Hg and its effects on biota are summarized elsewhere (Eisler, 1987).

Several studies performed by State and Federal agencies during the past 25 years have confirmed elevated fish tissue Hg in excess of the U.S. Environmental Protection Agency's (EPA) recommended 0.6 mg/kg screening level (EPA, 1993; and EPA, 1994) and have also observed concentrations of Hg above reported background levels in surface and ground waters, sediments, rocks, soils, aquatic macroinvertebrates, plants, and terrestrial animals (Koerber, 1995). The Oregon Health Division (OHD) issued fish consumption advisories for Lake Owyhee, Antelope Reservoir, and Jordan Creek in response to these data.

Table 1.—Some common chemical forms and reactions for mercury in the environment.
(from Jensen and Jernelöv, 1972)

Major Inorganic Forms:

Hg^0	Elemental	**Hg^{2+}**	Mercuric	**Hg_2^{2+}**	Mercurous
$HgCl^+$		**$HgCl_2$**		chloride formation depends on concentration	
$HgOH^+$		**$Hg(OH)_2$**		hydroxide formation is pH sensitive	

Major Organic Forms:

CH_3Hg^+	Methylmercuric ion	**$(CH_3)_2Hg$**	Dimethylmercury

Common Reactions and Comments:

$Hg^{2+} + 2e^- \rightleftharpoons Hg^0$	Reduction of mercuric ion to elemental mercury is redox sensitive and abiological in anoxic waters at reducing potentials. *Pseudomonas* can reduce Hg^{2+} under aerobic conditions.
$Hg^0 \rightleftharpoons Hg^{2+} + 2e^-$	Oxidation of elemental mercury to mercuric ion is redox and DO sensitive. Aerobic waters will slowly oxidize Hg^0 associated with suspended sediments.
$Hg^{2+} + S^{2-} \rightleftharpoons HgS$	Formation of mercuric sulfide will occur under anaerobic, reducing conditions. Dissolved oxygen will slowly oxidize HgS in reservoirs during overturn and mixing, thus releasing Hg^{2+}.
$Hg^{2+} \Rightarrow CH_3Hg^+$	Methylmercury will form from a large number of biotic reactions in sediments and water - usually when organic carbon, nitrogen and phosphorus are available to stimulate microbiological growth. Under severely reducing conditions in sediments, sulfide formation is favored.
$CH_3Hg^+ \Rightarrow Hg^{2+}$	Oxidation of methylmercury will proceed in aerobic waters. Alkyl mercuries with longer chains will be less stable relative to methylmercury.

Because of the size and remoteness of the Lake Owyhee watershed, knowledge is generally limited regarding Hg concentrations and forms in Lake Owyhee, the extent and significance of watershed Hg source areas, and the chemical processes affecting the fate and transformation of Hg in the reservoir and watershed. The purpose of this reconnaisance study was to describe Hg and Me-Hg concentrations and the general water quality in Lake Owyhee, and to subsequently identify potential Hg source areas and possible transport processes within the reservoir and the watershed.

General Area Description

The Owyhee Project: Owyhee Dam (figure 1a), which for a short period of time was the largest concrete dam in the world, was funded and authorized in 1926 as part of the Owyhee Project and constructed from 1928 to 1932. The dam is a thick-arch concrete structure that was the proving ground for newly developed concrete cooling methods and designs that led to Hoover Dam and later thin-arch concrete structures. Table 2 provides a summary of selected structural dimensions and elevations for Owyhee Dam and figure 1b shows several schematic diagrams of the dam and outlet works (Bureau of Reclamation, 1981).

Table 2.—Some dimensions, elevations, and discharges for Owyhee Dam structural features

Base Length	255 ft (77.7 m)
Structural Height	417 ft (127.1 m)
Hydraulic Height	325 ft (99.1 m)
Crest Length	833 ft (253.9 m)
Crest	Elevation 2,675 ft (815.3 m)
Maximum Water Surface	Elevation 2,670 ft (813.8 m)
Spillway Ring Gate	Elevation 2,658 -2,670 ft (810.2 to 813.8 m), 30,560 cfs discharge
River Outlet Works	Elevation 2,470 ft (752.9 m) - three 40-inch jet flow valves, 2,530 cfs discharge
Tunnel No. 1 Irrigation Outlet	Elevation 2,585.5 ft (788.1 m) - 4.75' X 12' emergency and regulating slide gates, 1,100 cfs discharge
Powerplant Penstock	Elevation 2,570 ft (783.3 m), 240 cfs maximum discharge
Bottom Sluice Gate	Elevation 2,370 ft (722.4 m) - not used since first filling

Lake Owyhee and Owyhee Dam are currently operated by the Owyhee Irrigation District (North Board of Control) as an irrigation water supply. The irrigation districts also own and operate two small powerplants: a 4,340-kw powerplant located at the dam, supplied by two 5' X 6' penstocks at elevation 783 m; and a 7,200-kw powerplant located near the Tunnel No. 1 outlet on the right abutment behind the dam at elevation 788 m. Irrigation deliveries are supplied through the Tunnel No. 1 outlet, while downstream river discharges occur through the river outlet works (elevation 753 m), located within the left portion of the dam, and the smaller powerplant penstocks (elevation 783 m), located on the left abutment behind the dam. During the spring maximum elevation lake surface period, lake water is also discharged through a movable ring-gate “morning glory” spillway (figure 1c). The Owyhee Project provides irrigation water for approximately 75,000 acres (1977 maximum was 112,000 acres) of farmland located in Malheur County, Oregon, and Owyhee County, Idaho.

Figure 1a.—Owyhee dam seen from the right abutment.

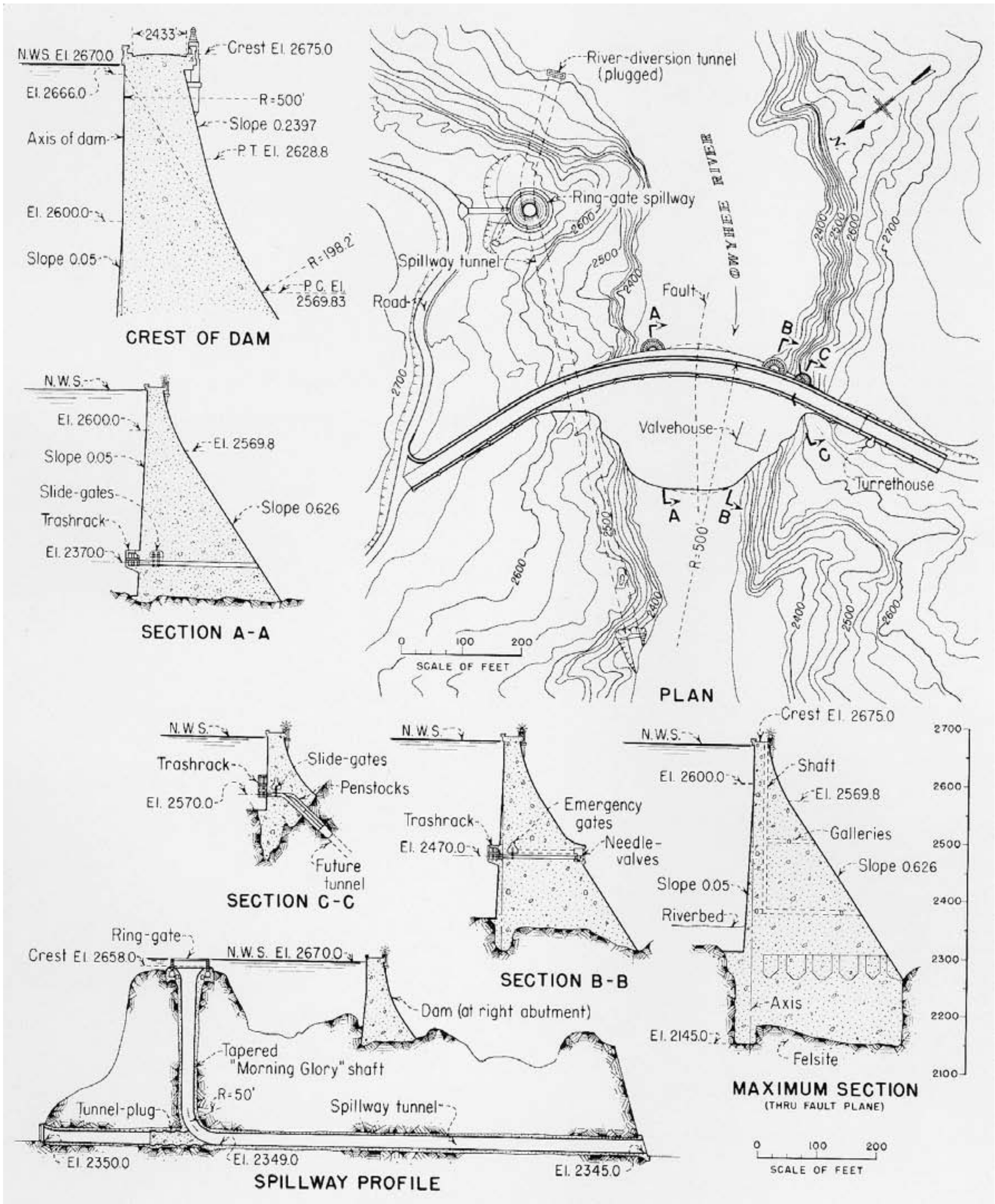


Figure 1b.—Schematic diagrams of Owyhee Dam showing structural features.

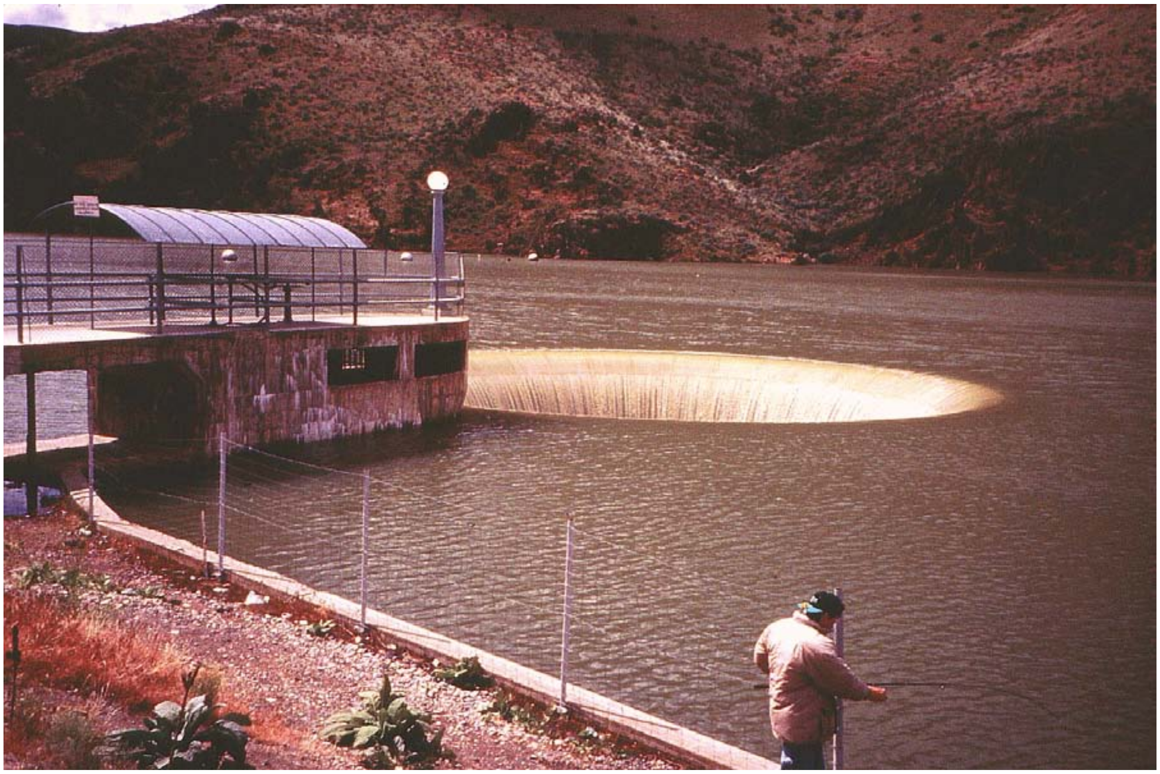


Figure 1c.—The movable ring gate outlet behind the dam on the right abutment seen in Spring 1996.

Lake Owyhee: Lake Owyhee, which formed when the Owyhee River canyon was flooded, is a long and narrow reservoir with a lateral length of approximately 37.3 mi (60 km) from inflow to dam. The lake, seen in the figure 2 map, has an average surface area of 12,700 acres (5,160 ha, 19.9 mi^2) and a maximum reservoir surface elevation of 2670 ft (810 m). Maximum reservoir volume is 1,120,000 acre-ft (1.38×10^9 m^3) at elevation 2,675 ft (815.3 m) and the active volume is 715,000 acre-ft (8.82×10^8 m^3), or approximately 359 billion gallons of storage capacity. Inflows from the Owyhee River, measured from 1963 to 1977 at the U.S. Geological Survey's (USGS) Rome, Oregon, gaging station, ranged from 203,000 acre-ft to 1,328,000 acre-ft, with an average inflow of 760,000 acre-ft. Since 1995, Lake Owyhee surface elevations have fluctuated between 2,640 ft. (805 m) during September and October and up to 2,670 ft (814 m) during April and May. At its deepest point behind the dam, Lake Owyhee fluctuates in depth between 290 and 310 ft (88 to 94 m).

Lake Owyhee is classified as a eutrophic system (Johnson et al., 1985) that often experiences nuisance algal blooms in the upper reaches during summer months. It is rare for Lake Owyhee to freeze over, and no samples were collected during the fall or winter during this study. The lake does appear to mix during spring turnover, but the nature of stratification and turnover during the autumn and winter is not

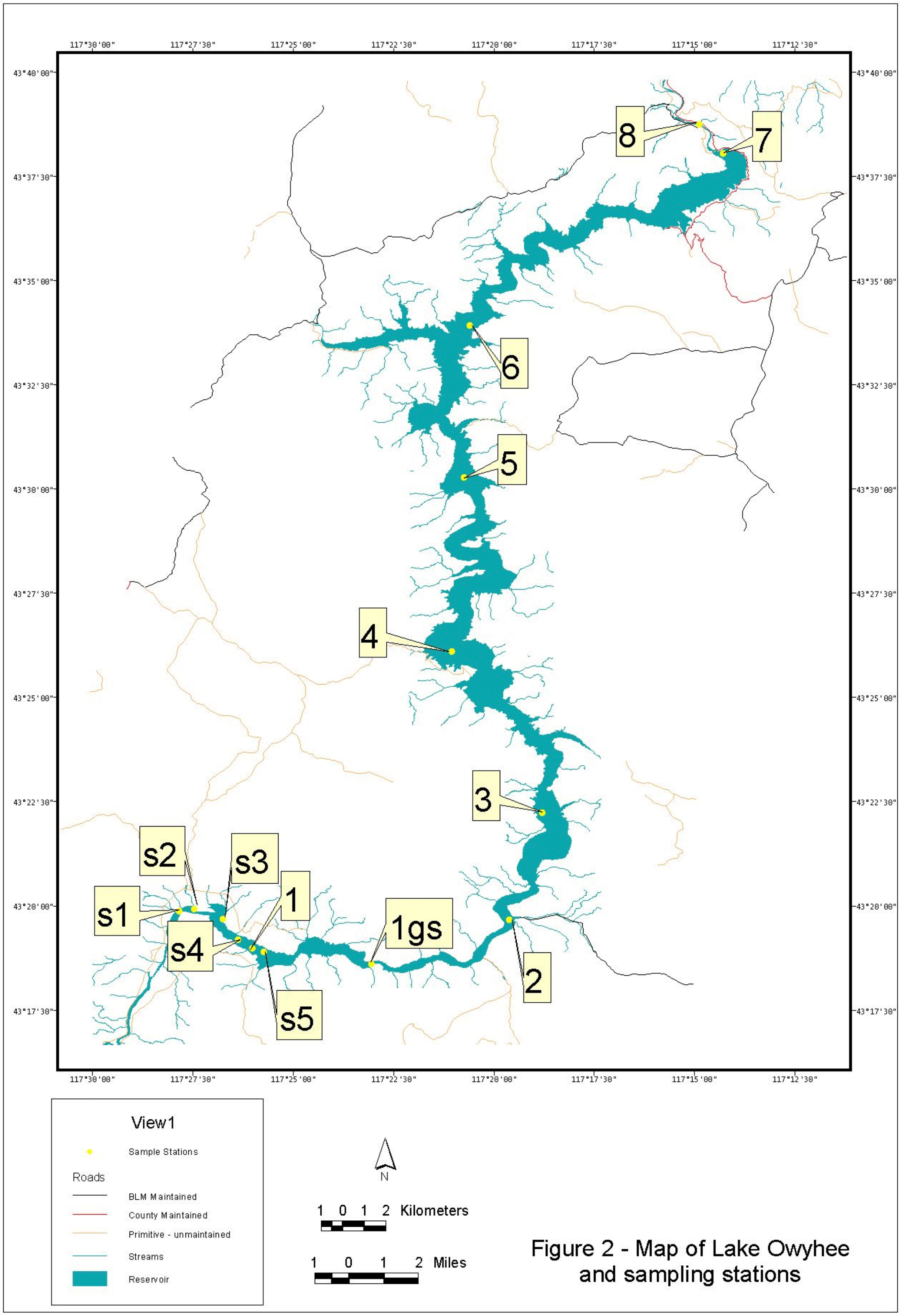


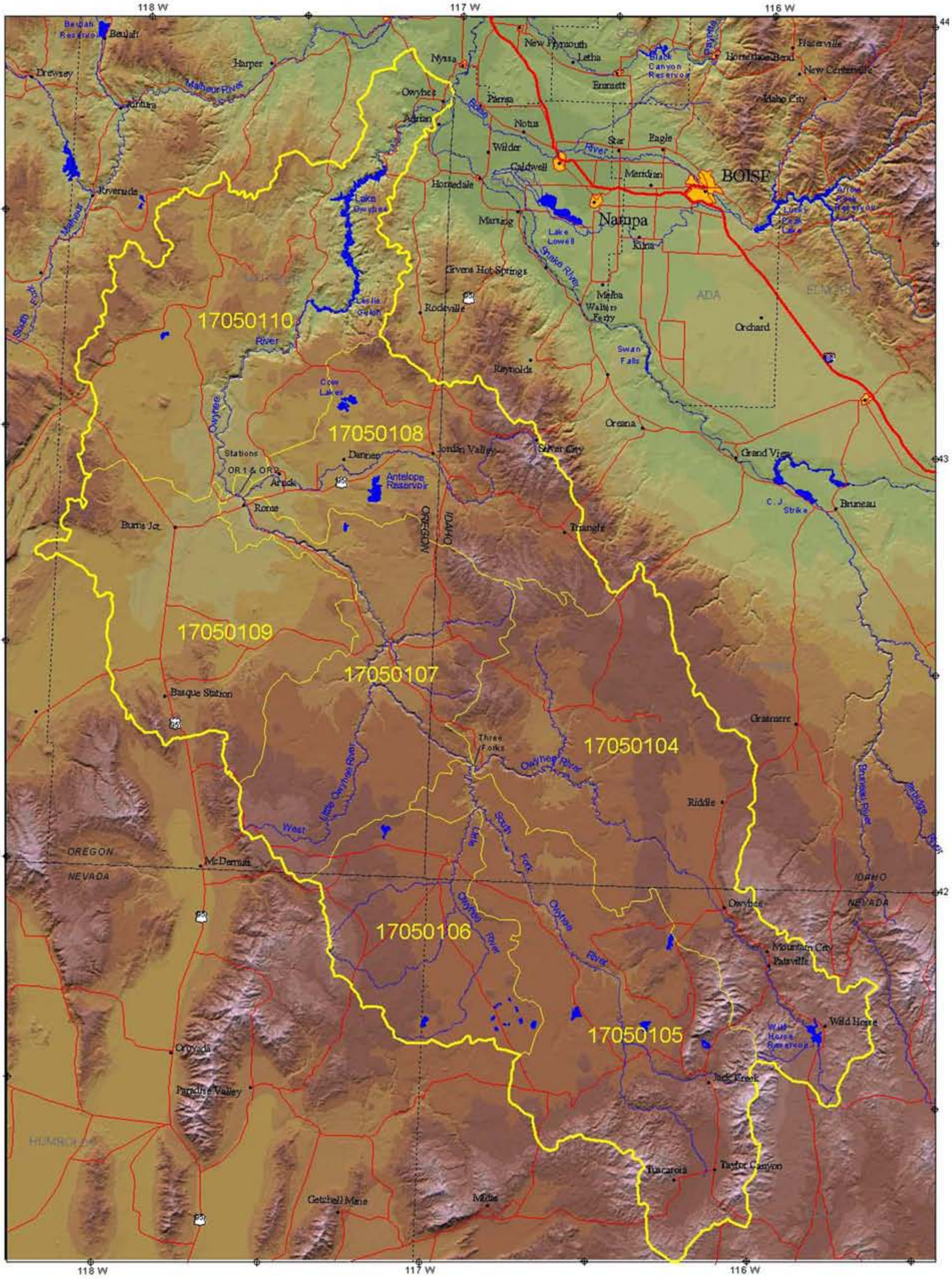
Figure 2 - Map of Lake Owyhee and sampling stations

known. The deeper reaches of the lake are strongly stratified during summer; however, epilimnetic waters are generally well mixed from frequent sustained winds.

Finely-divided suspended solids produce a milky appearance in waters throughout the watershed and the reservoir, and these suspended materials appear to settle only partially during water transit from inflow to the dam. Total dissolved solids (TDS) in the lake water range from 100-200 mg/L, and the major ions are dominated by sodium (Na), calcium (Ca), and magnesium (Mg) cations, and bicarbonate (HCO_3-) anions. The major source of water is from the Owyhee River and its upland tributaries, with minor point sources from localized storm runoff and geothermal springs. One geothermal spring discharging above the lake surface was sampled in this study (Station 1gs); however, it is possible that other springs discharge underwater directly into the reservoir. Depending on the localized subsurface geology and mineralization along flow paths, these geothermal waters may contain elevated concentrations of Hg (Rytuba and Vander Muelen, 1991; Rytuba, 1995).

Lake Owyhee Watershed: The watershed for Lake Owyhee (map in figure 3) is drained by the Owyhee River and its tributaries and covers an area of approximately 10,950 mi^2 (28,360 km^2). This is a large, rugged, and remote area that extends into Idaho and Nevada and is comparable in size to the State of Maryland (10,577 mi^2). The elevation of the watershed ranges from around 9,000 ft (2,800 m) in the Bull Run Mountains, Nevada, to 2,500 ft (762 m) at Lake Owyhee, a gradient of approximately 6,500 ft (2,000 m). The Lake Owyhee watershed lies in the U.S. Geological Survey's (USGS) Subregion 1705, which is part of the Middle Snake River watershed, and contains the following USGS sub basin watershed cataloging units:

Figure 3 - Map of the Lake Owyhee watershed.



USGS Unit Number	Sub-basin Surface Area	Percent of Watershed Area	USGS Unit Name	Features
17050104	2,110 mi^2 (5,465 km^2)	19.3 percent	Upper Owyhee	Eastern Uplands in NV, midlands in ID. Contains East Branch Owyhee River, Wildhorse Reservoir, towns of Riddle, ID, Owyhee, NV, Mountain City, NV, Patsville, NV, and WIld Horse, NV.
17050105	1,860 mi^2 (4,718 km^2)	17.0 percent	South Fork Owyhee	Central Uplands in NV, ID. Contains South Fork Owyhee River, towns of Kack Creek, NV, Taylor Canyon, NV, and Tuscarora, NV.
17050106	910 mi^2 (2,357 km^2)	8.31 percent	East Little Owyhee	Western uplands in NV, ID, and OR.
17050107	1,460 mi^2 (3,781 km^2)	13.3 percent	Middle Owyhee	West Little Owyhee River in OR and ID.
17050109	1,3 40 mi^2 (3,471 km^2)	12.2 percent	Crooked-Rattlesnake	Western midlands in OR. Contains Crooked and Rattlesnake Creeks, towns of Basque Station, OR, and Burns Junction, OR.
17050108	1,270 mi^2 (3,289 km^2)	11.6 percent	Jordan	Eastern uplands in ID and OR. Contains Jordan Creek, Cow Lakes, Antelope Reservoir, and towns of Silver City, ID, Jordan Valley, OR, Danner, OR, and Rome, OR.
17050110	2,000 mi^2 (5,180 km^2)	18.3 percent	Lower Owyhee	Lowlands in OR. Contains Lake Owyhee and main stem of the Owyhee River.

The semi-arid climate of the watershed experiences an average annual precipitation of approximately 25 cm (9.8 in), primarily in the form of snow, and has an average growing season of 188 days (Bureau of Reclamation, 1981). The vegetative cover is primarily sagebrush, wheatgrass, saltbush, and greasewood, with greater than 90 percent of the watershed used for rangeland and grazing. Other land use includes mining in the upper Jordan Creek sub basin and agriculture in the lower Jordan Valley.

The Lake Owyhee watershed is located within a 10-15 million year old continental volcanic province and the surface geology is composed of primarily igneous volcanic rock with numerous geothermal sources. The uplands are characterized by intrusive Tertiary and Cretaceous granitics (Silver City, Idaho), and rhyolites and welded tuffs in northern Nevada. Middle elevations, including Jordan Valley and upper portions of the Owyhee River, contain Quaternary and Tertiary volcanics, rhyolite, basalt, and welded tuffs. Lower elevations in the vicinity of Lake Owyhee are characterized by tuffaceous sedimentary deposits with interbedded rhyolites and basalts. There are numerous localized geologic sources of Hg, present as near surface cinnabar or hydrothermal alteration zones (Rytuba and Vander Muelen, 1991), and elevated Hg concentrations have been observed in volcanic rock located near Lake Owyhee (Ferns and Huber, 1984). Historical mining and amalgamation recovery of gold and silver around the Delamar-Silver City, Idaho, area also released significant quantities of elemental mercury (up to 7.6 lbs/day) into the Jordan Creek sub basin from 1860 to 1920 (Koerber, 1995). This region was extensively investigated by geologists during gold mining exploration activity the 1980s when a large number of epithermal/hot spring mineralization systems were discovered. See appendix 8 for a bibliography of recent geology reports published by investigators from U.S. Department of the Interior (DOI) agencies and the Oregon Department of Geology and Mining Industries (DOGAMI).

Besides runoff from the Jordan Creek sub basin and the large percentage of the watershed drained by the main branch and tributaries of the Owyhee River, there may be other more localized, nearby Hg sources for Lake Owyhee. In the reach of the Owyhee River downstream from the Jordan Creek confluence (approximately 85 km upstream from the reservoir inflow zone), there are several intermittantly flowing creeks and gulches intersecting the Owyhee River that may be potential sources of Hg during storm runoff events. For example, sub basin 17050109, associated with Crooked Creek and its tributary drainage and comprising 12.2 percent of the Lake Owyhee watershed surface area, enters the Owyhee River approximately 6 km downstream of the USGS Gage Station on the Owyhee River near Rome, Oregon (Station OR-2). Table 3 lists several intermittant drainage inflows upstream from the reservoir that may be contributing sources of Hg for Lake Owyhee.

Table 3.—Intermittantly flowing drainages that may be local Hg loading sources upstream from Lake Owyhee.

Feature	River Distance Upstream from Lake Owyhee, km	Surface Features Drained
Crooked Creek	79	Flattop Mountain, Scott Butte drained by Palomino Creek, Iron Mountain. Additional tributary drains and gulches to the SW
Unnamed Gluches	65	Lava fields to the west of the Owyhee River and north of Iron Mountain.
Ryegrass Creek	48	Northern border extent of lava fields west of the Owyhee River.
Bogus Creek	43	Bogus Bench and lava fields to the east of the Owyhee River.
Bull Creek	42	Saddle Butte on the west side of the Owyhee River.
Jackson Creek	27	Cedar Mountain, NW of the Owyhee River.

Numerous small gulches also drain directly into Lake Owyhee all along the length of the reservoir, the largest being Dry Creek. This sub basin drains an area that extends approximately 45 km to the west and southwest of the Dry Creek arm of the reservoir (see figure 2, map of Lake Owyhee) and includes the areas around Grassy Mountain, Sourdough Mountain, and Freezout Mountain.

Historical Data and Previous Studies

A summary of existing studies and available Hg data in a variety of media has been prepared by Koerber. This report provides an overview of watershed Hg issues, as well as a data base summarizing 444 samples analyzed for Hg in fish tissue and 925 additional samples analyzed for Hg in a variety of other media, including 256 samples analyzed for Hg in surface waters. Some of the Hg data that Koerber summarized represent averages based on values reported by different investigators. Koerber noted the following general observations regarding the available data:

1. ***Areal and Temporal Distribution of Available Data is Limited***.—The Hg data are limited geographically and come primarily from two areas within the watershed: 1) the Jordan Creek sub basin in the Silver City, Idaho vicinity (refer to figure 3, sub basin 17050108) and 2) lands adjacent to Lake Owyhee. These areas account for approximately 68 percent of available Hg data, and rightfully so; they are the obvious choices as suspected Hg sources because of historical mining activity around Silver City, and observed elevated Hg concentrations observed in rock samples collected near Lake Owyhee (Ferns and Huber, 1984).

   There are no data from large areas in the regions west and southwest of the main branch of the Owyhee River, the South Fork Owyhee River area, or the region south of the Jordan Creek watershed divide and north of the East Fork of the Owyhee River. Notably, the terrain in these areas is very rugged and access by road is limited. Data are minimal (no fish tissue and only a few water samples) from the southern upland regions of the watershed, an area containing mining activity and potential Hg source areas. Finally, the available data do not appear to have been obtained from long-term investigations, but rather one-time sample collections for screening or regulatory purposes.

2. ***Analytical Data Quality Varies***.—The available Hg data are reliable to varying degrees. It is probably safe to conclude that data for Hg samples analyzed prior to 1980 are of questionable applicability because of higher

> detection limits and undocumented data quality. While the more recent data benefit from improvement in analytical methods, instrumentation, and awareness of sampling problems, quality control (QC) information needed to assess data quality is generally unavailable. These factors limit the ability to statistically compare or interpret data. In general, Hg data from biological tissues, sediments, and soils are more reliable than water sample data because solid samples contain much larger amounts of Hg.

Summary of Existing Data: In the Jordan Creek drainage, Hg is less than reported detection limits in most waters; however, detection limits for older samples are high relative to probable existing concentrations. The Oregon Department of Environmental Quality (ODEQ), DOGAMI, U.S. Department of the Interior, Bureau of Land Management (BLM), and the Delamar Mine provided Hg data for 294 fish; 143 groundwater; 43 surface water; 139 soil, rock and sediment; and 298 plant and animal samples. Most of these data are from Silver City and the Delamar Mine vicinities. All Jordan Creek sub basin fish, except Crappie, showed tissue Hg > 0.6 mg/kg (the EPA advisory level for issuing fish consumption advisories) (EPA, 1993, EPA, 1994), which prompted State health agencies to issue consumption advisories for streams and lakes in this sub basin.

Seronko (Seronko, 1995) performed a study that analyzed Hg in surface samples from old tailings and milling piles located in the general area of Silver City and observed that concentrations were not notably elevated in old exposed mining surface deposits relative to nearby control samples. In disturbed deposits, higher concentrations were observed, but these concentrations fell to background levels a short lateral distance from the disturbed piles. These results suggest that surface erosion of weathered and undisturbed historical mining and milling deposits is probably not a significant current source of Hg contamination to Lake Owyhee.

ODEQ collected and analyzed 111 fish tissue samples, 38 sediment samples, and two water samples for Hg from Lake Owyhee. Fish tissue from all species exceeded the EPA 0.6 mg/kg advisory level. Some of the sediments showed elevated Hg, and Hg was detected in local rock near Lake Owyhee (Ferns and Huber, 1984). ODEQ also analyzed Jordan Creek and Owyhee River sediments above and below the confluence of Jordan Creek and the Owyhee River, near Rome, Oregon (located approximately 85 km upstream from Lake Owyhee). Their results (0.16 mg/kg below the confluence, 0.08 mg/kg above the confluence, and 0.6 mg/kg in Jordan Creek sediments) suggest that the Jordan Creek sub basin is source of Hg for Lake Owyhee.

METHODOLOGY

Field Sampling Methods

Sampling for this study was performed by Reclamation personnel from the Pacific Northwest Region Soil and Water Laboratory, Boise, Idaho (the Boise Lab) and the first author using established procedures (EPA, 1982). Seven reservoir sampling stations were chosen at approximately equal distance intervals from the inflow to the dam. The outflow station was located in the Owyhee River downstream of the dam, and the inflow stations were located in the Owyhee River near Rome, Oregon, above and below the Jordan Creek confluence. All seven reservoir stations were not consistently sampled during this study, and samples were collected only during spring and late summer. Additional samples were collected from a geothermal spring inflow in the upper reaches of the reservoir, and sediment samples were collected in the river-lake inflow zone.

Sampling station names, locations, and descriptions are listed in table 4. Latitude and longitude were measured at each sampling site with a Rockwell Model HNV-560B PLGR Unit (Precision Lightweight Global Positioning System Receiver), using the WGS-84 Datum. The PLGR was used to confirm station position on subsequent return sampling events.

Water samples were collected from the reservoir during August 1996, May and August 1997, and May 1998. Except for at-depth samples collected in August 1997, all samples were collected from the reservoir surface. Reservoir sediment and suspended sediment samples were collected only during May 1998, and Owyhee River water above and below the confluence of Jordan Creek was sampled in September of 1998 and April 1999. Suspended sediments were obtained from water collected during the May 1998 sampling event.

Water column data profiles for temperature (T), pH, dissolved oxygen (DO), conductivity (EC), and redox potential (Eh) were measured at each station where samples were collected, using a Hydrolab Model H-20 multi-probe with the Surveyor 3 data logger. Turbidity was also measured intermittantly. The Hydrolab probes

Table 4.—Lake Owyhee Sampling Stations

Station	Lateral Distance From Inflow, kilometers	North Latitude	West Longitude	Description
Station OR-1	-88.5	42°50'26"	117°37'23"	Water: Owyhee River at Rome, OR, off Hwy 95 Bridge
Station OR-2	-84.1	42°51'58"	117°38'52"	Water: Owyhee River at USGS Gage Station off local bridge
Station 1	2.60	43°18'33"	117°26'01"	Water: reservoir inflow mixing zone
Station s1	0	43°19'28"	117°27'50"	Sediment: Owyhee River inflow
Station s2	0.8	43°19'32"	117°27'27"	Sediment: reservoir inflow mixing zone
Station s3	1.8	43°19'17"	117°26'45"	Sediment: reservoir inflow mixing zone
Station s4	2.5	43°18'46"	117°26'22"	Sediment: reservoir inflow mixing zone
Station s5	4.0	43°18'27"	117°25'43"	Sediment: reservoir inflow mixing zone
Station 1gs	6.72	43°18'09"	117°23'03"	Water: geothermal spring outflow
Station 2	13.1	43°19'15"	117°19'37"	Water: reservoir at Leslie Gulch
Station 3	19.9	43°21'56"	117°18'47"	Water: reservoir one mile upstream from Three-Fingers Gulch
Station 4	28.1	43°25'59"	117°21'02"	Water: reservoir at Pelican Point
Station 5	37.3	43°30'21"	117°20'44"	Water: reservoir at Fisherman's Cove
Station 6	45.3	43°34'09"	117°20'36"	Water: reservoir near Wildhorse Basin
Station 7	60.4	43°38'28"	117°14'17"	Water: reservoir behind dam
Station 8	61.4	43°39'12"	117°14'52"	Water: Owyhee River below dam

were all calibrated the evening prior to sampling. EC was calibrated using a certified standard reference solution (ERA), pH was calibrated using a 2-buffer (VWR Scientific) calibration, and Eh was calibrated using Zobell's solution (VWR Scientific) or pH buffer. DO was calibrated using saturated air at a measured barometric pressure, and turbidity was calibrated using a 40 mg/L formazin standard (Hach 4000 mg/L stock solution). Calibration for each probe was verified during the middle of the day, and at the end of the day using a reference calibration verification solution or a calibration stock solution. The Hydrolab was recalibrated if calibration verification failed (greater than ±5 percent of true value) during the day. Hydrolab profile data, Secci disk depth, and sample notes were recorded on field forms archived by the authors.

Raw water samples for major ions, nutrients (N, P, silica - SiO_2), and total organic carbon (TOC, DOC = dissolved organic carbon) were collected as surface grab samples from the boat or with a van Dorn sampler (Wildco Supply) for deeper samples. Water samples were then transferred to labeled, pre-cleaned polyethylene cubitainers which were then placed on ice in coolers. These samples were hand delivered to the Boise Lab at the end of each sampling day, and 0.45-µm membrane filtration of samples was performed within 24 hours of receipt. Field quality assurance (QA) for these samples included collection of duplicate samples and field blanks submitted as blinds to the Boise Lab.

Ultra-clean sampling procedures and equipment were provided by Frontier Geosciences, Inc., Seattle, Washington (FGS), for all Hg and low-concentration trace element analyses. This equipment included certified pre-cleaned, double-bagged Teflon sample bottles; clean room gloves; and a pre-cleaned and bagged Go-Flo™ at-depth sampler with Teflon line. Surface samples were collected as grab samples from a slowly moving boat, and at-depth samples for Hg were collected using the Go-Flo™ sampler. Ultra-clean samples were collected following a procedure from FGS contained in EPA Method 1669 (EPA, 1996c). This sampling method requires two people following the “clean hands/dirty hands” protocol to avoid contamination. Water samples were shipped to FGS by overnight delivery on ice (sediment samples were packed in dry ice) using standard chain of custody forms and procedures. Ultra-clean filtration of samples was performed by FGS within 24 hours of receipt. Chain of custody forms were returned to the author with data delivery packages from FGS. Field QA for these samples included collection of duplicate samples and field blanks submitted as blinds to the analytical lab.

Reservoir sediment samples were collected using a Mini-Ponar dredge (Wildco Supply) and dredge contents were transferred into labeled, pre-cleaned, air-tight polyethylene containers (Rubbermaid). Composite samples were collected at each site by collecting five separate dredge subsamples within an approximately 20-m radius (called a five-dredge composite sample). Each individual dredge subsample was transferred to separate plastic containers and labeled, by site, as “number *n* of 5." At each station, field composite subsamples for Hg and Me-Hg analyses were prepared using a random shoveling method (Pitard, 1993; Ramsey, 1998) with 10 random 0.5- to 1-g scoops collected from each of the five-dredge subsamples. Field QA for reservoir sediment samples involved collecting two different types of duplicates at two stations. A *station duplicate,* which consisted of two sets of five-dredge subsamples, was collected at Station s1. At Station s1 and s2, *fractional shovelling duplicates* were collected from the five-dredge station composite subsamples for Hg and Me-Hg. These duplicates were submitted as blinds to the analytical labs.

Water samples for suspended sediment analyses were collected in 1-gal. polyethylene cubitainers, 10 cubitainers collected at each of three sites. Both suspended and reservoir bottom sediments were shipped overnight on ice in coolers to the Denver Reclamation Chemistry Laboratory (Denver Lab) for preparation, compositing, and analysis. Both reservoir and suspended sediment samples were shipped under standard chain of custody forms and procedures.

Solid Sample Preparation

On receipt by the Denver Lab, sediment composite subsamples were drained of excess standing water, large visible twigs, seeds, and rocks were removed, and samples were then weighed prior to air drying. After drying, samples were re-weighed to determine the sediment solid fraction. Clods and agglomerates were gently disaggregated and then sieved through a U.S. Standard No. 10-mesh screen. Both +10-mesh and -10-mesh material from each subsample was then weighed. The -10-mesh subsamples were then sieved through a U.S. Standard No. 80-mesh screen and material passing and remaining on the screen was weighed.

A 150- to 350-g composite subsample was then prepared from each of the five dried, -80-mesh field subsample fractions using the random fractional shoveling method. This -80-mesh composite was then used to prepare subsequent individual analytical and physical test subsamples. For each station, the number of ~1-g random scoops taken from each of the five -80-mesh station subsamples was adjusted to account for weight differences relative to the smallest station subsamples, with a minimum of 30 scoops being collected from the smallest subsample. Appropriately-sized subsamples for testing were then prepared from the preparation composite using smaller volume scoops (~0.5 g) for particle size determination, petrographic examination, total organic and inorganic carbon, and trace elements analyses. The digestion duplicate for trace element sediment analysis was prepared using random shoveling. Simple grab subsamples were used to prepare total carbon and phosphorus analysis duplicates.

Suspended Sediment Preparation

The 10-gal water samples from Stations 1, 5 and 8, were also sent to the Denver Lab for preparation and analysis. Raw water was centrifuged at 15,000 rpm for 10 minutes in an IEC Model B-20A refrigerated centrifuge. After 6 L from Station 1 were centrifuged, the lack of solid separated mass prompted pre-concentration of the remaining 31 L of Station 1 water using evaporation. The subsequent 5X preconcentrated water was then centrifuged and combined with the raw water centrifugate. Centrifugate was combined into a single centrifuge tube and the final concentrated supernate was decanted from the separated solids. The combined solids were then shaken with 40-mL of previously centrifuged lake water (from the initial 6 L centrifuged) in the centrifuge tube. The slurry was transferred to a 100-mL beaker, placed in an ultrasonic bath and mixed for 4 min. A 5-mL subsample for particle size analysis was removed from the slurry with an Oxford pipettor while the slurry was still in the ultrasonic bath. The remaining slurry was then transferred to a 50-mL crucible and placed in a 104°C drying oven for 16 hours. This process managed to separate approximately 1.5-g of suspended material which was submitted for petrographic identification (suggesting suspended solids of around 40 mg/L). Suspended sediments were not prepared from Stations 5 and 8 water because of the slow and tedious difficulty of this process.

Chemical Analyses

The Boise Lab analyzed water samples for major ions, nutrients, and TOC using EPA methods (EPA 1983, EPA 1986) or APHA-AWWA-WEF *Standard Methods* (American Public Heath Association, 1995) consensus methods. Ca, Mg, Na, and potassium (K) were analyzed using flame atomic absorption (AA) spectrophotometry with a Perkin-Elmer Model 5100 AA spectrophotometer. Ammonia (NH_3), was analyzed using a specific ion electrode. Nitrate+nitrite (NO_2+NO_3), and total Kjeldahl nitrogen (TKN), total-phosphorus (total-P), ortho-phosphorus (ortho-P, or PO_4^{3-}), and chloride (Cl^-) were analyzed using automated colorimetric methods on a Lachat Quikchem 4200 automated flow-injection analyzer. Sulfate ($S0_4^{2-}$), was analyzed using a turbidimetric method, fluoride (F^-) by specific ion electrode (Orion), and carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) alkalinity using electrometric titration.

FGS analyzed for total-Hg using EPA Method 1631 (EPA, 1996a). This method involves bromine monochloride (BrCl) oxidation of the sample, followed by stannous chloride ($SnCl_2$) reduction, purging volatile Hg onto a gold trap, and then thermal desorption before detection using cold vapor atomic fluorescence spectrophotometry (CVAFS). Me-Hg was analyzed using FGS methods (Bloom, 1989; and Bloom and Horvat, 1993) which involved distillation extraction and aqueous phase ethylation followed by gas chromatographic (GC) separation before detection using CVAFS. Low concentration trace elements were analyzed using inductively-coupled plasma mass spectrometry (ICP-MS), following EPA Method 1638 (EPA, 1996b) using an Elan-Perkin Elmer Model 6000 ICP-MS. All analyses by FGS used statistical blank correction. Ultra-clean filtration was performed under clean-room conditions and 0.45-µm filtration was used for total suspended solids (TSS) analyses performed by FGS.

The Denver Lab analyzed sediments for trace elements using EPA Methods 3051B (EPA, 1986) and 200.6 (EPA, 1983): microwave assisted nitric acid digestion with a CEM Model MDS-2100, followed by analysis using ICP emission spectrometer with a Thermo-Jarrel Ash model ICP-61E. Particle size analysis was performed using a Coulter Model LS 100 laser size analyzer.

TOC, total inorganic carbon (TIC), and total-P were analyzed by Huffman Laboratories, Golden, Colorado. TOC was determined using ASTM method D5373, involving sample combustion and infrared detection with a Leco Model CR 12 Carbon Analyzer. Carbonate (CO_3^{2-}) C was determined using ASTM method D513, involving acidic conversion of CO_3^{2-} to CO_2 and coulometric detection using a UIC-Coulometrics System 140 Carbonate Carbon Analyzer. Total-P was determined by ICP-ES analysis of samples digested using nitric and perchloric acids.

All analytical service labs used in this study had formal quality assurance plans in place which included provisions for standard operating procedures, instrument calibration verification, duplicates, spikes, laboratory control samples, and defined corrective actions for each instrument run. All data deliverable packages included QC reports that allowed evaluation and validation of data quality. No chemical data from this study required special qualification.

Mineralogy and SEM Methods

Petrographic examination used x-ray diffraction (XRD) on a Scintag 2000 x-ray spectrometer, optical examination (megascopic and microscopic) to identify minerals, and a Jeol 5400-LV scanning electron microscope (SEM) for electron micrograph imaging. Trace elements on sediment grain surfaces were identified using the SEM x-ray energy dispersive spectrometer accessory . For SEM analysis, an as-received -80-mesh representative portion of the suspended and reservoir sediment samples were examined. The work was performed on uncoated samples under low vacuum conditions using backscattered electron imaging. The samples were prepared by affixing the sample grains to double stick carbon tape adhered to brass specimen holders. SEM spectral analyses were performed at 15 KV accelerating voltage in order to detect elements of atomic number 26 (Fe) and lower.

Statistical Summaries and Calculated Data

Statistical summaries for data in this study were performed using SPSS™ (Statistical Package for the Social Sciences, version 8.0). Chemical data were generally grouped and analyzed by source, where source corresponded to samples from the reservoir (Lake Owyhee Stations 1-7), inflow (Owyhee River Stations OR-1 and OR-2 near Rome, Oregon), outflow (Station 8, Owyhee River below the dam), or the single geothermal spring sampled in this study (Station 1gs). The samples grouped by source were also grouped and evaluated by spring and summer sampling dates. When reservoir comparison summaries were prepared as plotted output, only surface data were compared between spring and summer. Median and standard deviation were only calculated for sample groups with n>2, and means for sample groups with n>1. In cases where only one sample was analyzed in a group, only the measured data are presented, or the inappropriate statistic was deleted from output tables. All analytical data are valid to 3-significant figures.

Non-detected (ND) data were coded in the SPSS data file as the inverse of the reported detection limit (for example <0.005 would be coded as -0.005). This was done as a computational convenience (all numeric data in a numeric variable) and to preserve information about detection limits. When statistical summaries were calculated, however, these data were exported to Excel spreadsheets and temporarily re-coded as half the detection limit for statistical calculations (Nehls and Akland, 1973). None of the inverse coded ND data was changed in the original SPSS data file.

When both 0.45-µm filtered (or dissolved) and unfiltered (or total) samples were analyzed, suspended (or particulate-associated) concentration was calculated by subtracting filtered concentrations from unfiltered concentrations. Suspended and dissolved organic nitrogen (org-N, or ON) data were calculated by subtracting filtered and/or unfiltered ammonia (NH_3) concentrations from filtered and unfiltered total Kjeldahl nitrogen (TKN) concentrations. Dissolved non-ortho-P was calculated by subtracting filtered ortho-P from filtered total-P. The suspended:dissolved ratio (S:D; susp:diss in tables) was calculated by dividing suspended concentration by dissolved concentration. S:D ratios < 1 indicate that dissolved > suspended, and ratios > 1 imply that suspended > dissolved. The S:D ratio was not calculated for samples where filtered concentration was greater than unfiltered (indicated by “NC” in data tables). When the filtered concentration was ND, the S:D ratio was calculated by substituting half the reported detection limit for the ND filtered values. Statistical summaries for suspended concentrations and S:D ratios were similarly edited for loss of data from ND values, either by deletion from summary tables or by manual recalculation and substitution using recoded data (Nehls and Akland, 1973; Keith et.al., 1983; Gilliom et.al., 1984; Gilbert, 1987).

Streamflow at Station OR-1 was estimated by multiplying the discharge at the OR-2 gage station by the proportion of the watershed area not drained by the Jordan Creek sub basin (USGS Cataloging Unit 17050108). The Rome gage station measures discharge for a drainage area of 7,610 mi^2 , and the Jordan Creek sub basin drains 1270 mi^2, producing an OR-1 discharge correction factor of 0.833.

MINTEQA2 Modeling

The MINTEQA2 chemical equilibrium computer model (Allison et.al., 1991) was used to calculate the concentrations of the different chemical species associated with each of the dissolved chemical components. For example, while Ca is measured as the element Ca, it normally exists in natural waters chemically bound (or complexed) with other dissolved anionic components (or ligands), such as SO_4^{2-} (as $CaSO_{4\,(aq)}$), HCO_3^- (as the charged complex $CaHCO_3^+$), or fulvic acid (as Ca-FA^+). Ca also competes with other cations and cationic trace elements for the available dissolved ligands. Many trace metals form complexes with dissolved ligands and the speciation of metals is thought to be related to their toxicity (Stumm and Morgan, 1996). The MINTEQA2 model calculates the chemical speciation of a water by using numerical methods to solve the many possible balanced chemical reaction expressions associated with all the chemical component concentrations entered into the model.

This model also calculates mineral saturation indices (SI) for all possible minerals that could have dissolved to produce the observed chemistry in the water. Combined with knowledge of the watershed geology, SI data provide information regarding the geochemical processes that may influence the water chemistry. An SI equal to or very near zero indicates that the water and mineral are in equilibrium. SI values > 0 suggest that the mineral is over-saturated, and will tend to precipitate out of solution (perhaps suggesting a mechanism for removing toxic metals). SI values < 0 suggest that the water is under-saturated with respect to the particular mineral and will tend to dissolve that mineral. For example, an SI of

-1.60 for calcite suggests that the water will dissolve additional calcite if it is introduced into the water.

The MINTEQA2 model was run using several averaged reservoir (Stations 1-7) analytical data sets. Average spring and summer data sets were modeled along with the all-reservoir average data set for Lake Owyhee. The averaged data sets were assumed to represent waters in equilibrium with atmospheric O_2 and CO_2. The following general conditions and gas partial pressures were assumed (NOAA, 1976):

	Reservoir Elevation ft.	**pO_2 atm**	**pCO_2 atm**	**T, °C**	**pH**
Spring Average	2672.5	0.190366	2.999×10^{-4}	13.48	7.16
Summer Average	2660.3	0.190442	3.001×10^{-4}	14.54	7.61
All Data Average	2666.4	0.190405	3.000×10^{-4}	14.01	7.39

Refer to appendix 3 for details regarding the assumptions and reference materials associated with the MINTEQA2 model runs. Besides the calculated aqueous inorganic speciation table in table A3-1, appendix 3 also contains component names used for data entry (table a3-2) and their associated gravimetric conversion factors, and an annotated bibliography of references for humic and fulvic log*K* equilibrium constant values (Martel and Smith, 1976; Morel and Hering, 1993) entered into the MINTEQA2 data bases. Literature values for the molecular weight and binding capacity of fulvic acid (Aiken and Malcolm, 1987; Aiken et al., 1989; Averett et al., 1987) were used to modify MINTEQA2 thermodynamic data files. Example MINTEQA2 input data files, thermodynamic data base files for metal-fulvic acid reactions, files are also provided in appendix 3.

RESULTS AND DISCUSSION

Interpretative Considerations

Lake Owyhee is a complex system located in a very large watershed. The long lateral reach of the reservoir creates several different lake environments and significant system complexity that introduces uncertainty for any simple summary or description. Large-scale hydrologic complexity is caused by the variability in timing and quantity of the spring snowmelt runoff and the variable timing and quantity of releases at Owyhee Dam (see tables 5a and 5b). The large inactive reservoir storage volume (table 2) suggests a reservoir volume turnover period on the order of many months or years, meaning that time-lagged transport effects or density currents may account for observed changes in water chemistry. At the localized scale, storm events may interact in a random way with specific geologic deposits of Hg or land use patterns to produce unpredictable contaminant inputs to the reservoir.

It is important to note that this study was intended to be an initial reconnaisance of limited scope and 3-year duration. While this is the first study to investigate ambient, low-level concentrations of Hg and Me-Hg and the water and sediment chemistry in Lake Owyhee, samples were collected only during spring and summer, and all seven reservoir stations were sampled only during the summer 1996 event. At-depth samples were limited to summer 1996 and 1997 events, and inflow samples at Rome, Oregon, were collected only during summer 1998 and spring 1999 (after reservoir sampling was completed).

While the inflow conditions detailed in table 5a (for this study's sampling events) are in the general range of the table 5b USGS gage station (Station 13181000: Owyhee River at Rome, Oregon) monthly average flows based on water years 1950-1998, runoff flows vary considerably from year to year. Daily average flow for April is 2,938 cfs (the average maximum runoff month) and May is 2,050 cfs. However, minimum flows for these months may be as low as 145 cfs and 87 cfs (during April and May 1992), and maximum flows may be as high as 16,960 cfs and 10,470 cfs (during April 1952 and May 1984).

Table 5a.—Comparison of hydrologic condititons for spring and summer sampling events for inflow, reservoir, and outflow samples collected during this study

Season	Source - # of sampling events	Sampling Dates		Inflow at Rome, cfs	Outflow at Dam, cfs	Reservoir Surface Elevation, m
SPRING	inflow - 1	04/14/99		3708	833	
	outflow and reservoir -2	05/05/97	**Minimum**	2251	1980	813.8
		05/07/98	**Maximum**	3080	4793	815.3
			Mean	2666	3387	814.6 (2,672 ft.)
			Range	829	2813	1.47
Summer	inflow -1	09/08/98		170	1963	
	outflow and reservoir -2	08/14/97	**Minimum**	135	1928	808.2
		08/21/96	**Maximum**	161	1995	812.2
			Mean	152	1973	810.9 (2,660 ft.)
			Range	26	67	3.98

Table 5b.—1950-1998 monthly statistics from the USGS gage station at Rome, Oregon. WY refers to water year, a term from hydrology measured from October to September. Thus, November 1995 would be included in WY 1996

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	163	216	394	706	1,283	2,519	2,938	2,050	915	262	155	140
MAX	442	593	2,898	4,461	8,820	9,404	16,960	10,470	4,870	1,035	452	361
MIN	85.3	107	104	114	129	233	145	86.5	89.6	61.2	56	62.5
WYof MAX	1976	1971	1965	1971	1986	1972	1952	1984	1984	1984	1984	1984
WY of MIN	1955	1955	1955	1955	1955	1977	1992	1992	1992	1968	1992	1955

Seasonal comparisons of chemistry mentioned in this report should therefore be considered in light of possible variable hydrologic conditions, and conclusions offered here should be considered initial hypotheses subject to confirmation by future investigations. For reference, appendix 7 contains data files and graphs that summarize inflow, reservoir surface elevations, and outflows from the dam during the period of this study.

General Observations

One of the most obvious observations about Lake Owyhee and the streams and rivers in the watershed is the ubiquitous presence of finely-divided suspended material in the water. These visible particulates lend the lake and stream water a slightly milky appearance and were the initial indication that suspended sediments may represent a transport vector for Hg, trace elements, and nutrients in this watershed. Despite the long lateral length of Lake Owyhee, suspended particulates only partially settle during reservoir transit and are clearly visible in the Owyhee River downstream from the dam. This observation suggests that particulates are small in size (or form stable charged colloidal suspensions) and are readily re-suspended by wind mixing of surface waters. Typical Secci disk depths during this study ranged from 0.1 to 0.4 m in the upper reach inflow zone (Station 1) to 1.4 to 1.6 m behind the dam at Station 7 (except during periods of high wind agitation).

Several late summer algal blooms and biotic-rich seston were observed in the upper reaches of Lake Owyhee during this study. Mat-like algal blooms were observed as far down the reservoir as Leslie Gulch (~13 km from the river inflow) and in other locations in and around the upper reach sampling stations. Higher amounts of suspended organic materials, organic matter, and nutrients were typically observed in the upper reaches during both spring and summer sampling events.

Water Column Profile Data

Depth profile plots for the all-station sampling event on August 21, 1996, are provided in appendix 1, figures A1-1 though A1-4, and a statistical summary of all profile data by station and sampling date is provided in table A1-1. Figures 4 and 5 show Hydrolab profiles observed at mid-lake (Station 5, figure 4) and behind the dam (Station 7, figure 5) comparing summer and spring water column conditions observed during four sampling events covering a 2-year period. Summer profiles are found in the left-hand plots, while spring profiles are found in the right-hand plots. Figures 4a and 5a show profiles for T (top four plots) and EC (bottom four plots), and figures 4b and 5b show profiles for pH (top four plots) and DO (bottom four plots). Note that the same-row profiles for summer and spring are from different hydrologic water years.

As expected, Lake Owyhee indicates strong thermoclines in deeper waters during late summer; however, the spring T-profile for May 7, 1998, shows that the thermocline is already beginning to form by early May at both mid-lake (Station 5) and the dam (Station 7). These data suggest that more complete overturn and mixing probably occurs earlier during the spring. The T-profile data suggests that the summer epilimnion extends from 8 -10 m below the surface, with the mesolimnion extending from 10 - 20 m down to 30 m, and the stable hypolimnion below 30 m. Appendix 1, figure A1-1, plotting August 20, 1996 T-profiles for Stations 2 through 7, shows that thermal stratification intensifies with lateral distance from inflow (where ΔT ≅ 7° at Station 2, and ΔT ≅ 16° by Station 4) and with increasing depth of the water column. Observed Station 7 summer ΔT of 17° - 18°C compares to spring ΔT of 6° to 13°C.

EC profiles can be found in appendix 1, figure A1-3, and the lower four plots in figures 4a and 5a. While the T-profiles are relatively straightforward, the EC profiles are not and show large differences for summer year to year and between Station 5 and Station 7 during the same sampling event. The general pattern for both summer and spring EC-profiles is for lower EC in the epilimnion and higher EC in the hypolimnion. However, an interesting departure from this trend may be seen for Station 5 on August 14, 1997 (bottom left profile in figure 4a). Here we see a higher epilimnetic EC (≅ 325 µS/cm) with a lower EC in the hypolimnion (≅ 210 µS/cm). Perhaps the higher concentration surface waters are not dense enough to overcome the summer temperature density gradient at the thermocline.

Comparing figures 4a and 5a reveals that the August 14, 1997 Station 5 surface EC (≅ 325 µS/cm) is more than double the surface EC at Station 7 (≅ 150 µS/cm) on the same date. In fact, there appears to be a linear correlation ($R^2 = 0.96$, $F_{\text{linear model}} = 143$, $n = 7$) between summer 1997 surface EC data and lateral distance from the inflow. A similar trend of high inflow surface EC trending towards lower surface EC at Station 7 ($R^2 = 0.91$, $F_{\text{linear model}} = 117$, $n = 12$) was also observed for the 1996 summer data. These trends suggest that inflow waters move through the reservoir in a time-lagged manner without significant mixing during summer.

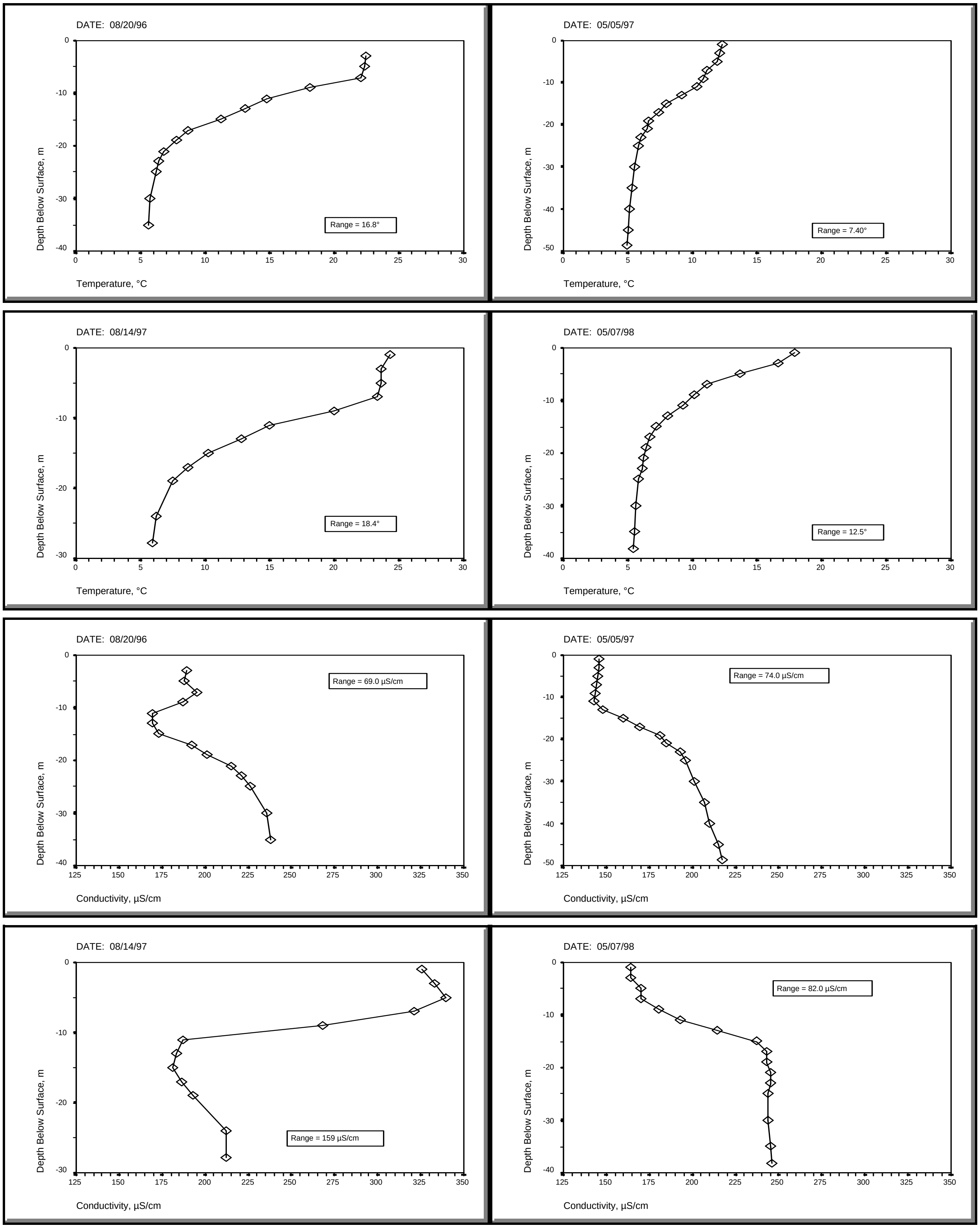


Figure 4a.—Comparison of Summer (left) and Spring (right) profiles for temperature (top 4 plots) and conductivity (bottom 4 plots) measured at Station 5. Profiles were measured on August 20 1996, May 5, 1997, August 14, 1997, and May 7, 1998.

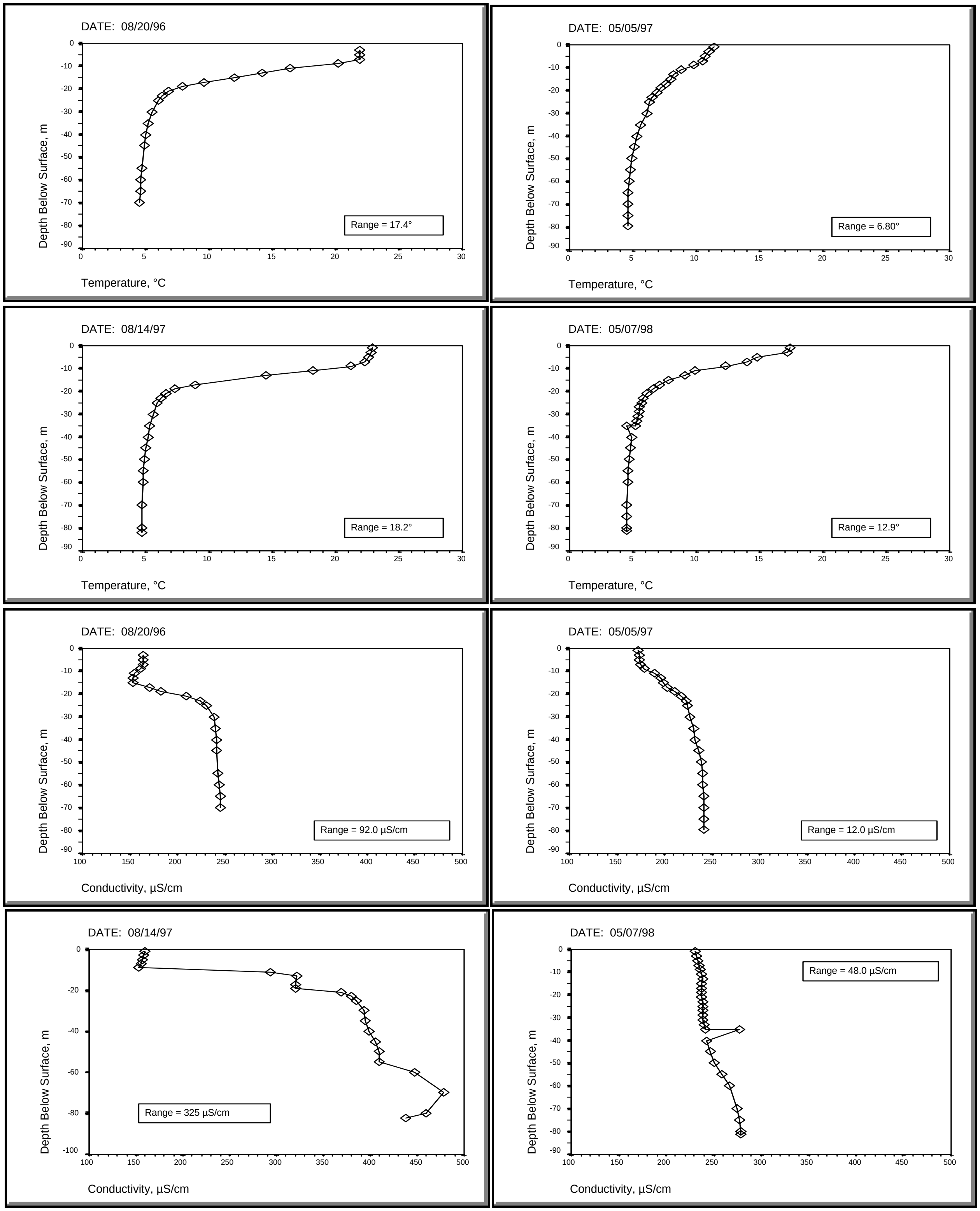


Figure 4b.—Comparison of Summer (left) and Spring (right) profiles for temperature (top 4 plots) and conductivity (bottom 4 plots) measured at Station 7. Profiles were measured on August 20, 1996, May 5, 1997, August 14, 1997, and May 7, 1998.

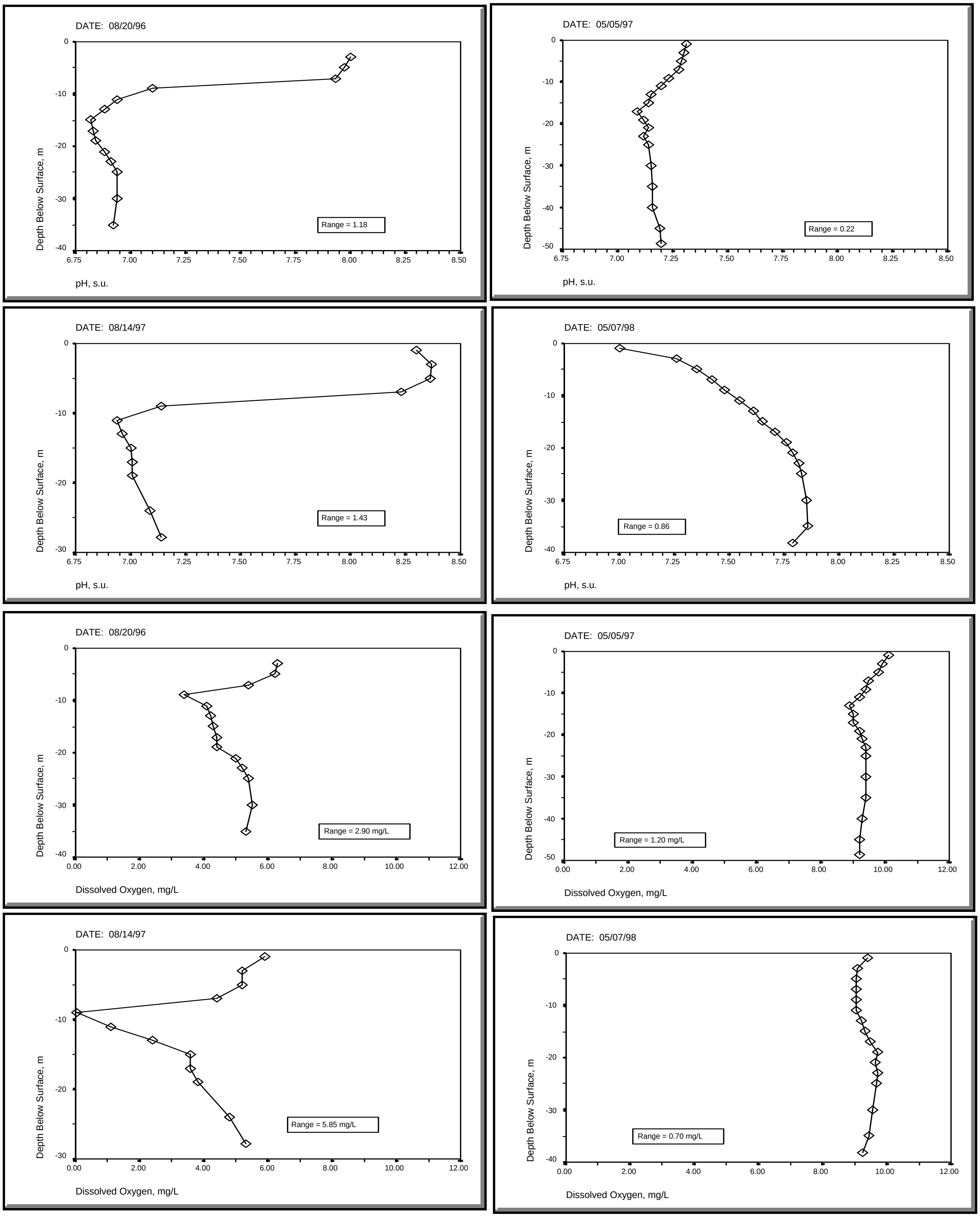


Figure 5a.—Comparison of Summer (left) and Spring (right) profiles for pH (top 4 plots) and dissolved oxygen (bottom 4 plots) measured at Station 5. Profiles were measured on August 20, 1996, May 5, 1997, August 14, 1997, and May 5, 1998.

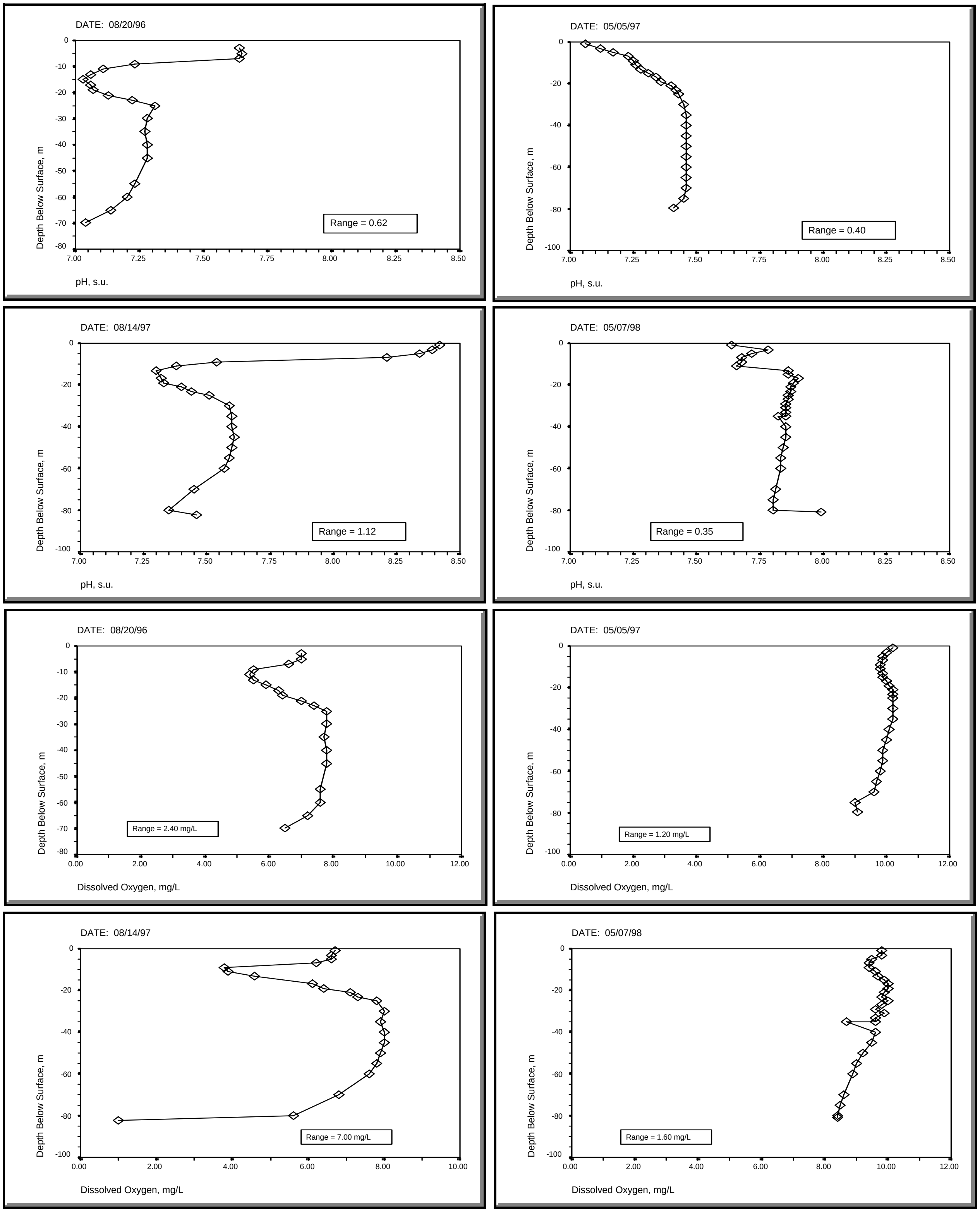


Figure 5b.—Comparison of Summer (left) and Spring (right) profiles for pH (top 4 plots) and dissolved oxygen (bottom 4 plots) measured at Station 7. Profiles were measured on August 20, 1996, May 5, 1997, August 14, 1997, and May 7, 1998.

Considering the maximum EC (242 µS/cm) observed for the spring 1997 profile at Station 7, the August 1997 EC profile maximum of 478 µS/cm (at -75 m) is notable. These hypolimnion values are comparable with same date inflow EC of 467 µS/cm, commonly observed for late summer watershed inflows. These EC profile observations may suggest the presence of higher salinity density currents flowing at depth (and perhaps not intersected at Station 5). Clearly, the available EC profiles suggest that mixing and transport at Lake Owyhee is a very complex process during periods of thermal stratification.

Figures 4b (Station 5) and 5b (Station 7) show summer (left hand plots) and spring (right hand plots) Hydrolab profiles for pH (top four plots) and DO (bottom four plots). Both Stations 5 and 7 show summer DO and pH minima at the top of the mesolimnion, with the DO minima for both stations around -10 m and the pH minima around -15 m.

DO at the thermocline was low (<2 mg/L) at several stations past mid-lake during the both summer sampling events . At Station 5 (Fisherman's Cove) on August 14, 1997, 0.0 mg/L DO was observed at -10 m depth. The DO depletion observed at Station 5 may be exacerbated by local raw sewage inflows from cabins located on the reservoir shoreline.

These summer mesolimnion minima are likely caused by bacterial activity and oxygen demand associated with particulate matter and seston settling on the mesolimnion density layer. While turbidity profiles are only available for spring sampling events, the data seen in figure 6 show evidence of turbidity maxima at depths of -10 to -30 m, even with the weaker spring thermal stratification.

While the DO and Eh profiles (not presented) suggest that anaerobic, chemically reducing conditions are not common in the water column (only one negative Eh value of -31 mV was observed near the bottom at Station 7 on August 14, 1997), sediments at Station s3 (located within two km from the Owyhee River inflow) are organic-rich muds that exhibit H_2S (hydrogen sulfide gas) odors indicative of prolonged anaerobic reducing conditions associated with SO_4^{2-} reduction to sulfide (S^{2-}). It would be reasonable to expect that DO depletion and negative redox potentials would be more common in the hypolimnion under conditions of prolonged stratification.

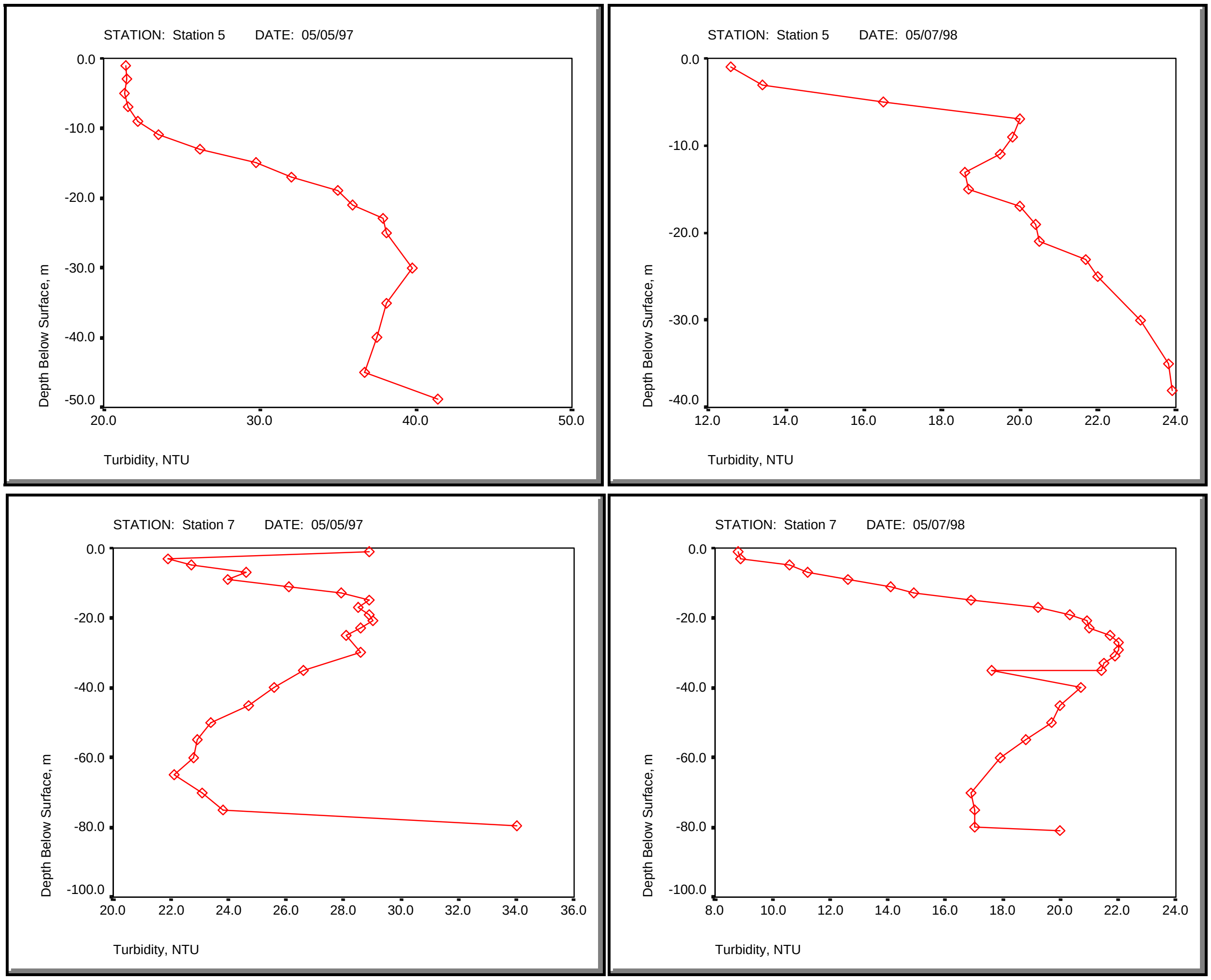


Figure 6.—Available turbidity profiles for spring samples at Stations 5 and 7.

Appendix 2 Analysis Data Summaries

Chemical analysis data for samples collected during this study are summarized in appendix 2 tables. The tables for each of these analysis classes are organized such that reservoir stations (Stations 1 through 7) are presented first in the "a" tables, followed by the "b" tables listing data for the inflow stations (Owyhee River Stations OR-1 and OR-2 near Rome, Oregon), the outflow (Station 8, below the dam), and the single geothermal spring (Station 1gs, sampled on August 14, 1997). Each of the appendix 2 tables presents observed analysis data along with simple statistical summaries for samples grouped by spring and summer. Keep in mind that spring samples were limited to surface grab samples, and at-depth samples were collected only during summer 1996 and 1997 events.

Field water quality data associated with collected water samples (T, pH, DO, EC, Eh, Turbidity) and Secci depth, may be found in Tables A2-1a and A2-1b. These data were obtained from Hydrolab profile data corresponding to the depth of the sample, or from turbidity measured in the Boise Lab. Major ions data including Ca, Mg, Na, K, HCO_3^-, CO_3^{2-}, SO_4^{2-}, Cl^-, and F^-, are summarized in tables A2-2a and A2-2b. Nutrient data (the aqueous nitrogen, phosphorus, and carbon species) are presented in tables A2-3a and 3b and provide summaries for TOC, Total-P, PO_4^{3-}, NO_3+NO_2, NH_3, TKN, and organic-N (calculated by subtracting NH_3 from TKN).

Hg and Me-Hg data are summarized in tables A2-4a and 4b. Mineral- or particulate-associated trace elements, including silicon (Si) measured as silica (SiO_2), aluminum (Al), Ca, Mg, and K when analyzed by ICP-MS, iron (Fe), and manganese (Mn), may be found in tables A2-5a and 5b. Toxic trace element data, including silver (Ag), arsenic (As), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), uranium (U), vanadium (V), and zinc (Zn), are arranged alphabetically by element symbol in tables A2-6a and A2-6b. The results of MINTEQA2 modeling of the speciation of dissolved elements in Lake Owyhee water, as grouped by spring, summer, and combined data averages, may be found in appendix 3.

Appendix 4 summarizes data for reservoir sediment sample preparation, particle size analysis, and sediment chemical data. SEM micrographs and x-ray diffraction patterns for bottom and suspended sediments are collected in appendix 5. A summary of the sampling and analytical error associated with the composite sediment sampling and fractional spooning subsampling is provided in appendix 6. Appendix 7 provides graphs summarizing the hydrologic variables for the Owyhee system, including a graph of 50-year average monthly flow at the Rome, Oregon, USGS Gage Station, daily 1995-1999 Owyhee River inflow at Rome, reservoir surface elevation, and outflow releases at the dam. Finally, appendix 8 provides a bibliography of Lake Owyhee watershed geology reports prepared by the USGS, BLM, and DOGAMI.

General Chemistry and Major Ions

Observed pH in Lake Owyhee ranged from 6.68 to 8.66, with maximum pH values observed on August 21, 1996, in the upper Lake Owyhee surface sample stations. Generally lower pH and elevated bicarbonate at depth for lake stations suggests prolonged biotic activity in the hypolimnion (Stumm and Morgan, 1996; Drever, 1988). However, time-lagged reservoir mixing and density currents introduce exceptions to expected behavior at mid-lake and lower stations. Inflow samples showed a much narrower range of pH, from 7.60 to 7.84, and only slightly higher pH was observed for spring inflow samples.

The alkaline pH observed at Station 1 on August 21, 1996, could suggest that higher alkalinity inflows may exist along the 89-km river reach between Rome, Oregon, and Lake Owyhee. Alkaline pH = 9.00 was observed in the Station 1gs geothermal spring sample, suggesting that similar springs may provide a source of higher alkalinity water to Lake Owyhee inflows. In the absence of direct observation of riverine geothermal inflows, however, it is also possible that the inflow sampling dates are simply not representative of the actual inflow pH variation. Outflow pH varied between 7.20 and 7.68, with lower pH associated with spring samples.

Sum of ions concentrations (calculated from individual ion data, an approximation of TDS) in Lake Owyhee ranged from 103 to 243 mg/L, with lower concentrations associated with spring snowmelt runoff inflows. Inflow samples showed spring sums of 85 to 86 mg/L and summer values from 195 to 204 mg/L. Station 8 outflow samples showed total ions from 119 to 156 mg/L; however, both minimum and maximum outflow values are from spring samples.

Figure 7a shows Stiff diagrams (Stiff, 1951) that compare average major ions concentrations for spring (left plots) and summer (right plots). The Stiff diagrams have a zero-axis in the middle and plot meq/L cations (positively charged ions) to the left and meq/L anions (negatively charged ions) to the right. Figure 7a compares Lake Owyhee surface samples, arranged from inflow (top) to outflow (bottom) stations. Spring waters contained roughly equal meq/L concentrations of Na and Ca, while the summer inflow stations show a water with Na as the dominant cation. Anions for both spring and summer waters are dominated by

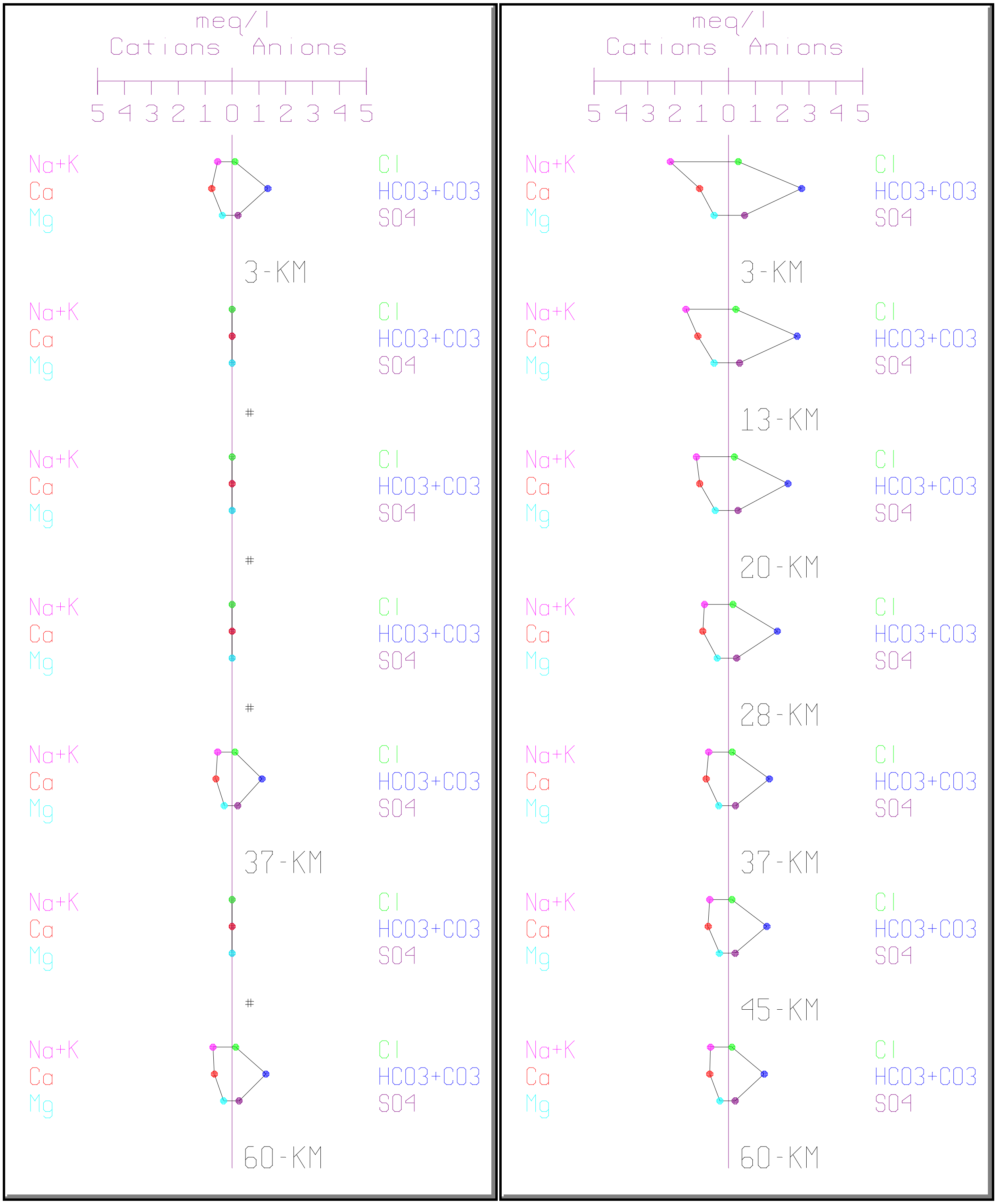


Figure 7a.—Stiff diagrams comparing spring 1997 (left) and summer 1996 (right) major ion concentrations for surface samples vs. lateral distance from inflow zone in km.

HCO_3^-, with higher SO_4^{2-} observed in summer inflow waters. The decreasing concentrations from inflow to dam observed in summer Stiff diagrams are corroborated by the EC profiles seen in figures 4a and 5a.

Figure 7b compares averaged ions data for spring (SPR) and summer (SUM) samples from inflow (INF, top two plots), reservoir (RES, middle two plots), and outflow (OUT, bottom two plots) stations. Outflow Station 8 ions data showed concentrations similar to Station 7 (behind the dam) at mid-depth, suggesting that the dam releases water associated with the outlet work's intake depth during summer when the reservoir surface elevation is below the ring gate outlet. For example, during summer 1997, when reservoir surface elevation was 2,651.8 ft (808.2 m), the outlets were releasing lake water from depths of 181.6 ft (from the river outlet works), 66.1ft (from Tunnel No. 1 Outlet), and 81.6 ft (from the powerplant penstock). The August 1997 thermocline at Station 7 (behind the dam) started at a depth of around 33 ft (-10 m), and extended to a depth of around 66 ft (-20m), so the shallowest lake outlet was near the top of the hypolimnion, with the river outlet works discharging lake water from the lower half of the hypolimnion.

A comparison of summer 1996 major ions samples from surface (SURF), middle (MID), and bottom (BOT) depths may be seen in figure 7c. Here we see increasing ions concentrations from surface to bottom for the deeper reservoir locations at Station 4 (left column, 37 km from inflow), Station 5 (middle column, 45 km from inflow), and Station 7 (right column, behind dam at 60 km from inflow). These data corroborate the EC profiles seen in figures 4a and 5a.

The geothermal spring water (Station 1gs) is an alkaline water with pH = 9.00 and total ions = 407 mg/L. Na, at almost 6 meq/L, is the dominant (and almost the only) cation. Anions are dominated by carbonate species, with CO_3^{2-} (2.4 meq/L) approximately twice HCO_3^- (1.2 meq/L). Station 1gs contains 50.7 mg/L SO_4^{2-}, approximately 1.75-times the observed maximum reservoir concentration, probably indicative of the oxidation of sulfide minerals common to the watershed geology. Notably, this water also contains significant F-, observed at 23.0 mg/L. Fluoride is commonly associated with geothermal waters, and water supply wells in the Jordan Valley are also known to contain elevated F^-. Inflow volumes from this geothermal spring were low (on the order of a few L/min), so the effects of this source on local water chemistry is probably inconsequential. However, the potential presence of other geothermal sources, located below water surfaces or present in riverine travertine cones, should not be overlooked.

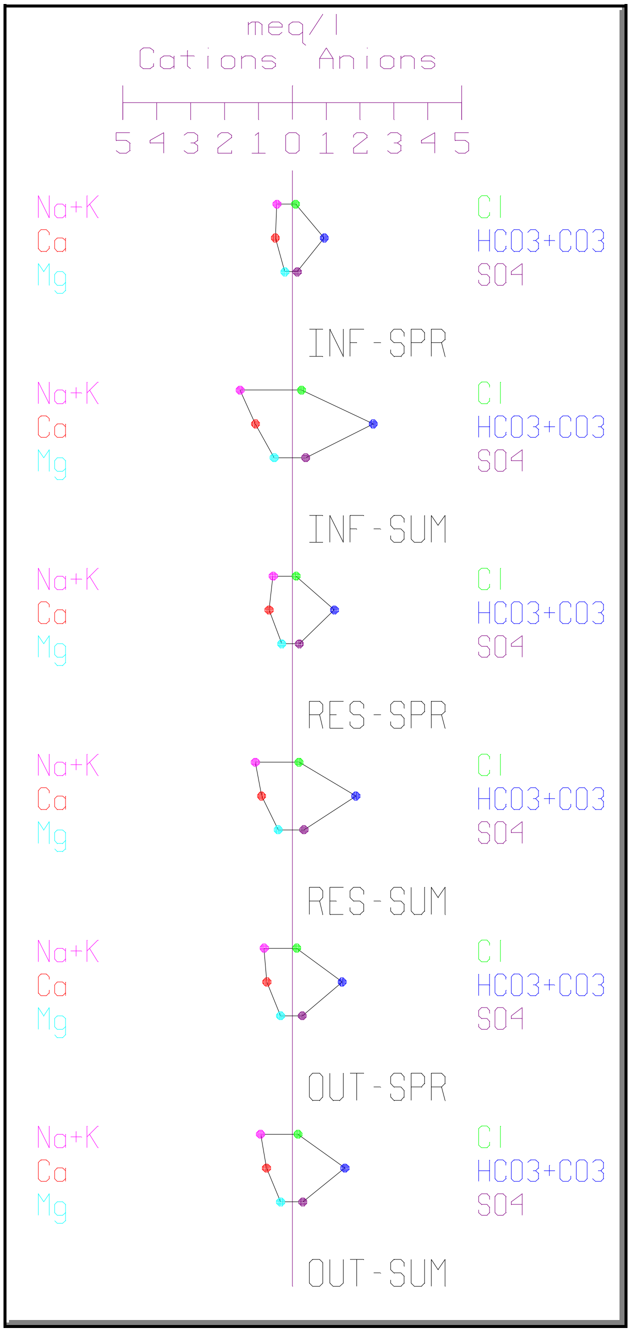


Figure 7b.—Stiff diagrams comparing major ions for spring (SPR) and summer (SUM) inflow (INF - stations OR-1 and OR-2), reservoir (RES - all data averages), and outflow (OUT - Station 8) samples.

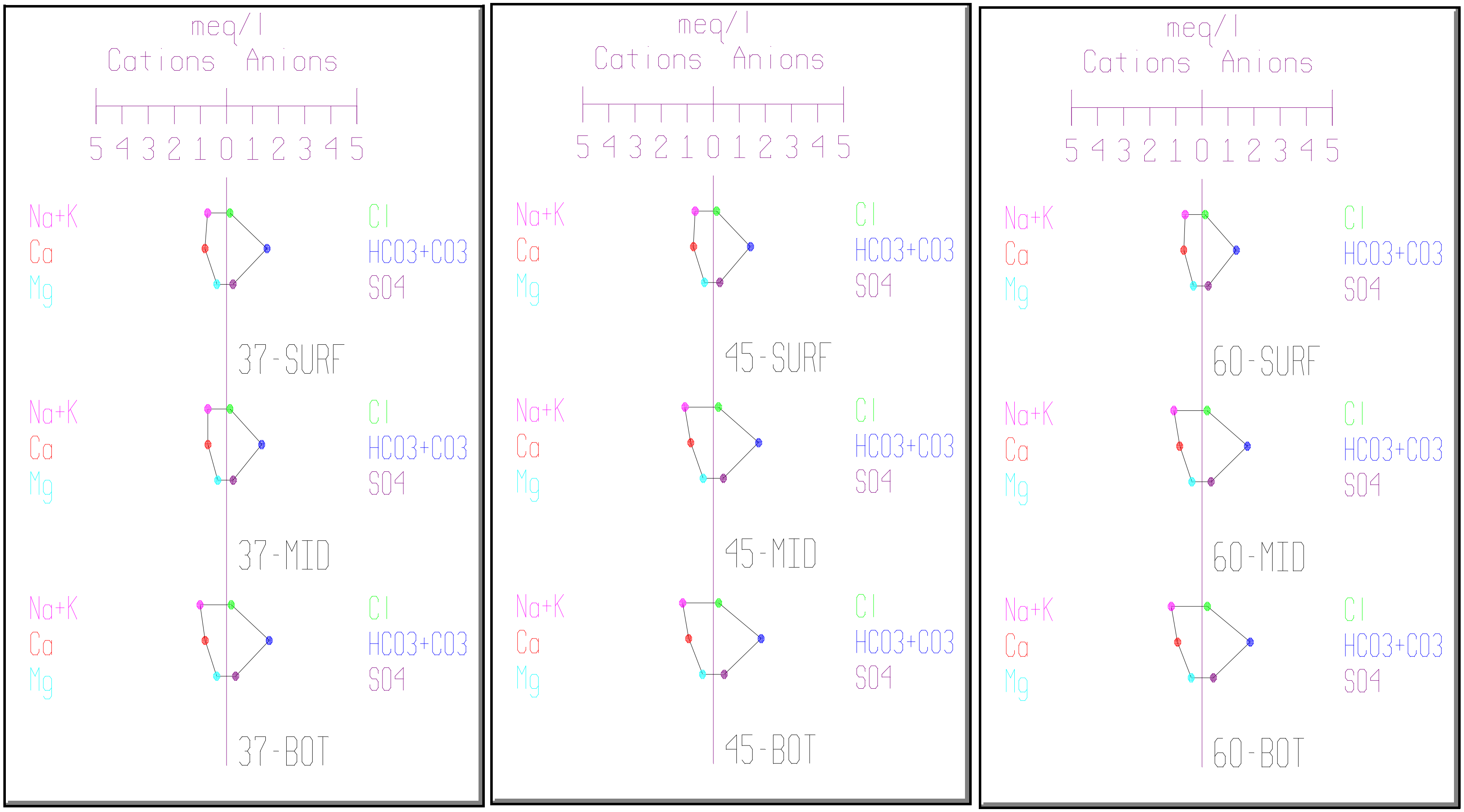


Figure 7c.—Comparing major ions for summer samples from surface (SURF), mid-depth (MID), and bottom (BOT). Samples are from the deeper reservoir stations, and numbers refer to lateral distance from inflow in km.

Suspended Particulate Matter

The suspended particulates that lend Lake Owyhee and its watershed waters an opaque, milky appearance appear to be the chemical loading vector for several nutrient species and trace elements. The particle size distribution for the separated suspended material, seen in figure 8a, shows very low concentrations of particles > 50 µm and a mode around 8 µm. Particle sizes < 0.45 µm (the lower size range of the Coulter instrument) account for less than 0.5 percent of materials; however, approximately 35 percent of the suspended material is clay-sized (< 4.0 µm), and around 59 percent is silt-sized (from 4 µm to 62 µm) (Hem, 1985; Horowitz, 1985). The abundance of small particle sizes may account for the observed lack of settling during reservoir transit and the difficulty performing filtrations of raw Lake Owyhee water samples.

Petrographic results suggest that the suspended material contains > 50 percent calcite; however, this observation is thought to be caused by precipitation of calcite during separation from Lake Owyhee water (despite precautions taken to avoid this problem). Observed suspended concentrations in water samples show very low proportions of Ca, and analyses of reservoir bottom sediments showed very little inorganic carbon (see discussion in section below). While some coated calcite grains probably exist in the suspended materials, the mineralogy is probably dominated by quartz, feldspar (insufficient sample to identify feldspar type), coated diatom fragments, and volcanic glass particles, a hypothesis supported by the data seen in figures 8b, 8c, and 8d. These minerals are also present in abundance in the watershed geology. Hg was detected spectroscopically on the SEM grain mounts; however, these data are qualitative, and efforts to map mercury and its specific occurrence and/or mineralogical association proved inconclusive. Refer to the filtered and unfiltered Hg and Me-Hg data in appendix 2 for information regarding the likely Hg species concentrations present in the suspended materials.

Figures 8b, 8c, 8d and 8e show pie charts of elemental proportions (based on molar concentrations) derived from filtered and unfiltered water sample data. Figure 8b provides an all-data average pie chart and figure 8c show averages calculated for spring and summer samples. Figure 8d compares molar proportions for reservoir suspended materials (all samples, Stations 1-7), and figure 8e compares inflow (Stations OR-1 and OR-2) and outflow (Station 8) average elemental proportions.

All averaged proportion data charts show that Si is the dominant element measured in suspended matter, with mole percentages ranging from 67 percent (summer average, figure 8c) to 80 percent (inflow average, figure 8e), with an all-data average of 70 percent. Si is a component of quartz (crystalline SiO_2), volcanic glass

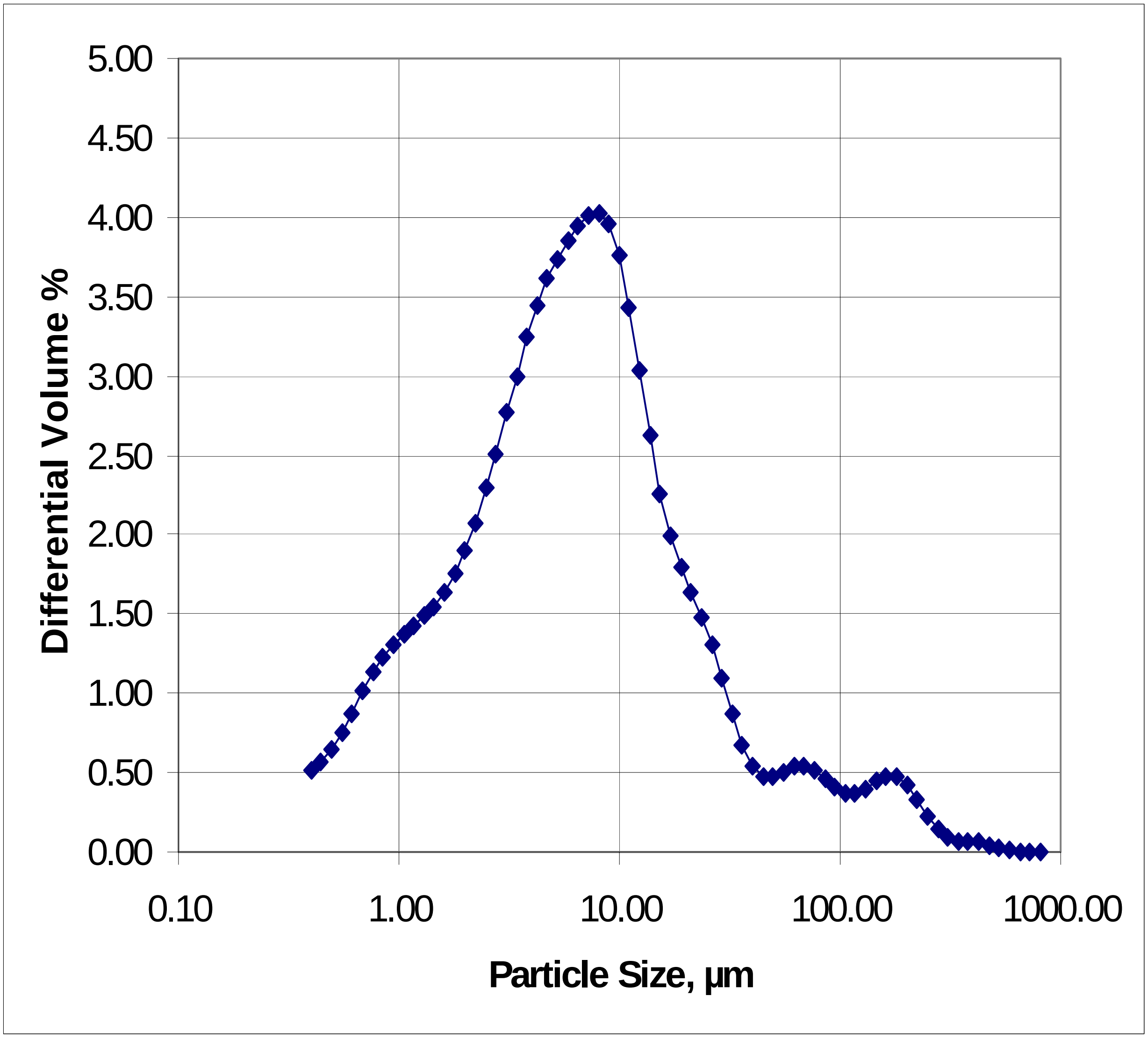


Figure 8a.—Particle size distribution for suspended material separated from water at Station 1.

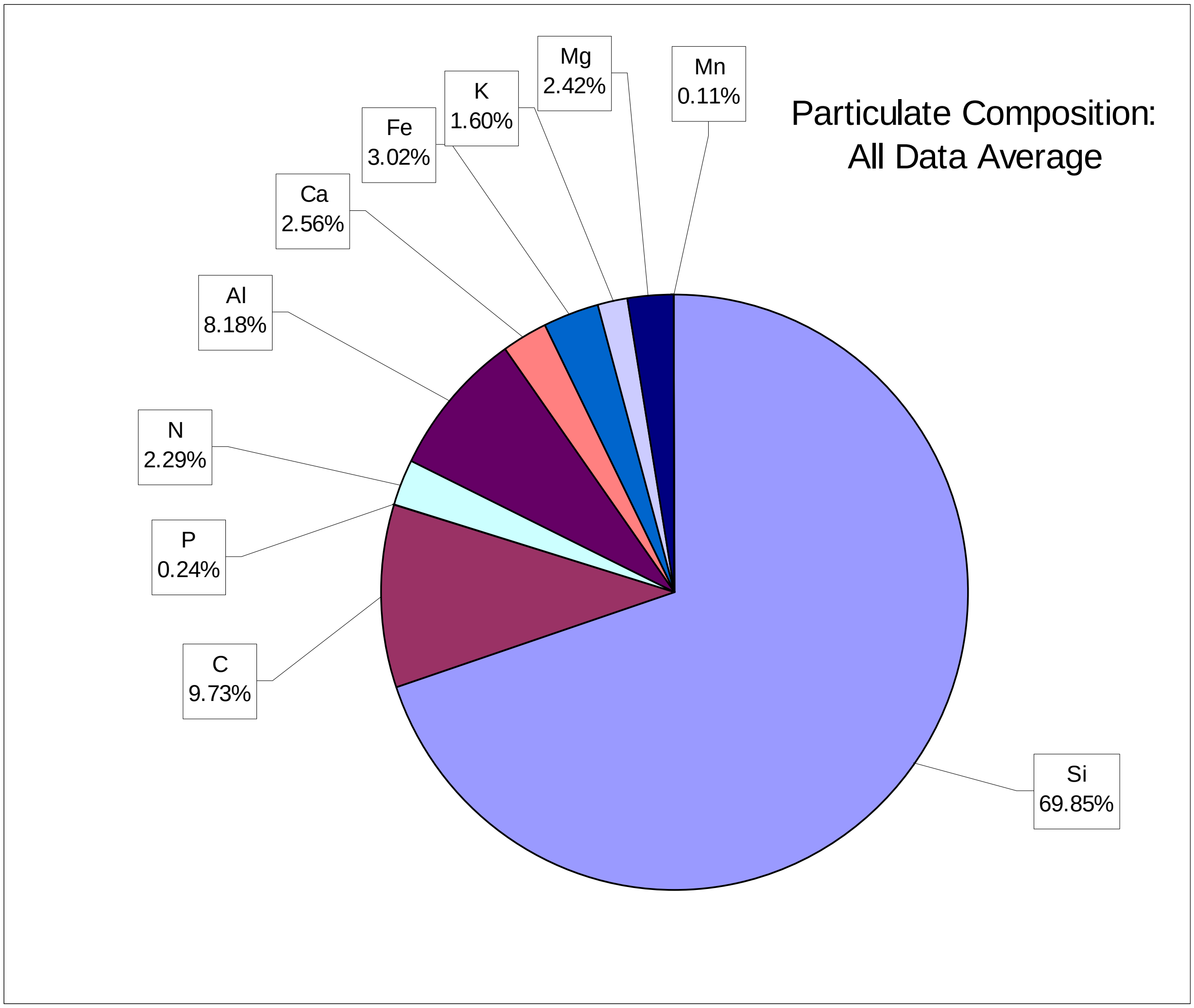
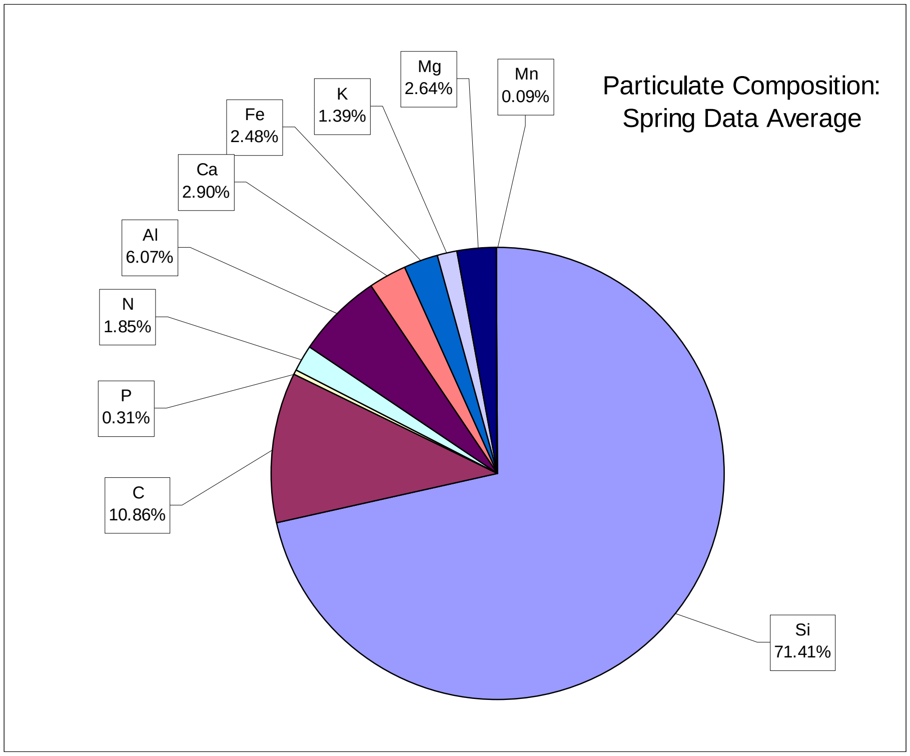


Figure 8b.—Elemental proportions in suspended particulates > 0.45 µm. Proportions are based on molar amounts of individual components. Si was determined as SiO2. Average for all study samples.



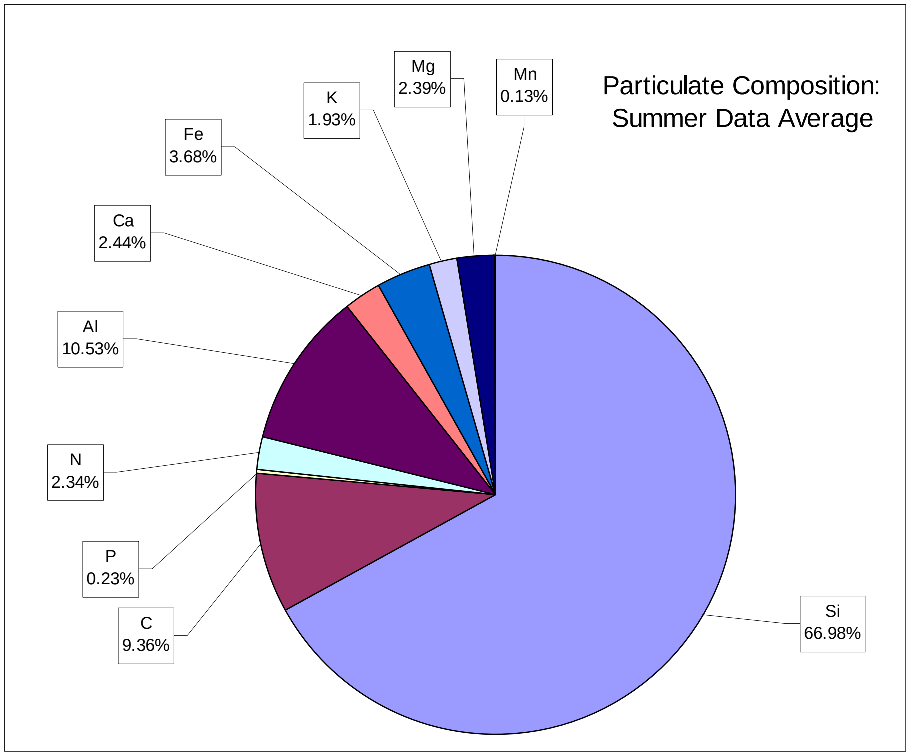


Figure 8c.—Averages for all spring (top) and summer samples (bottom).

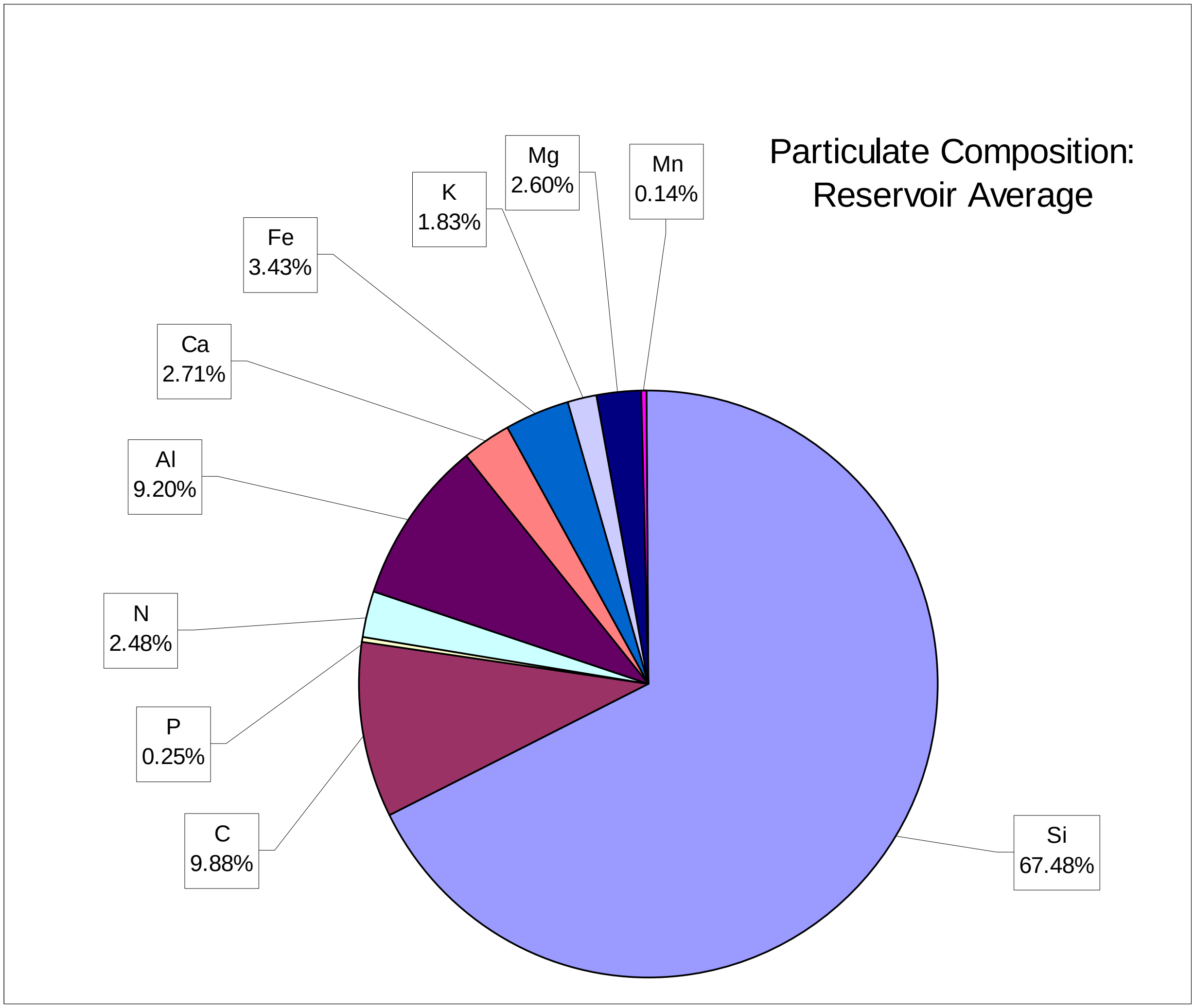


Figure 8d.—Elemental proportions in suspended particulates > 0.45 µm. Proportions are based on molar amounts of individual components. Si was determined as SiO_2. Average for all reservoir samples. Suspended Si calculated for samples with unfiltered, but no filtered SiO_2 data based on average suspended:dissolved ratio.

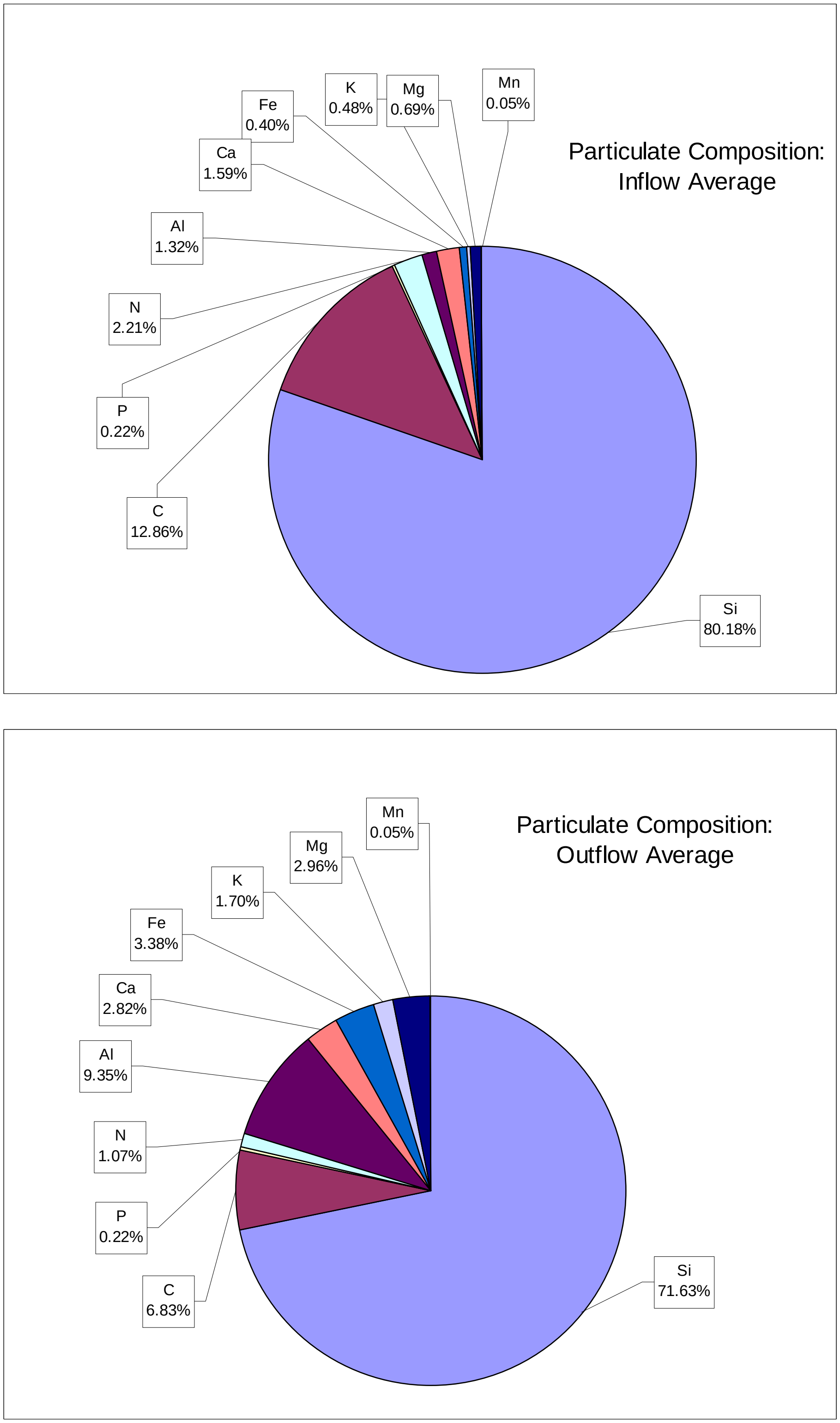


Figure 8e.—Averages for inflow samples (top) and outflow samples (bottom).

(amorphous SiO_2), feldspars (simple aluminosilicates containing K, Na, and Ca), clays, and other aluminosilicate minerals. Organic carbon ranges from 6.8 percent (outflow average, figure 8e) to 13 percent (inflow average, figure 8e), with an all-data average of 9.7 percent. Organic carbon is probably present as adsorbed humic and fulvic materials on surfaces of particles (Thurman, 1985). Al, probably associated with aluminosilicate minerals such as feldspars and clays, ranges from 1.3 percent (inflow, figure 8e) to 11 percent (summer average, figure 8c), with an all-data average of 8.2 percent.

The all-data average proportions suggest that the remaining 10 percent of suspended elements are roughly composed of Fe (3.0 percent), Ca (2.6 percent), Mg (2.4 percent), N (2.3 percent), and K (1.6 percent), followed by the minor components, P (0.24 percent) and Mn (0.11 percent). Fe and Mn are probably present as adsorbed oxyhydrates on particle surfaces (Schindler and Stumm, 1987; Stone and Morgan, 1987; Dzombak and Morel, 1990). N is probably also associated with adsorbed organic matter, and P is probably partitioned between adsorbed organic forms and phosphate-containing minerals such as apatite (a calcium phosphate). The elemental proportions observed for Ca and Mg suggest that the likely upper limit for calcite in suspended materials is around 1 percent (weight basis). Both Ca and Mg may also be associated with simple silicate and aluminosilicate minerals. The observed K proportions suggest that the feldspar is an orthoclase ($KAlSi_3O_8$), and that K concentrations in the water column are probably regulated by the weathering of orthoclase feldspar (Deer et.al., 1977, Drever, 1988).

Figure 8e pie charts show only slight differences between spring and summer suspended compositions, and the reservoir averages seen in figure 8d are very similar to the all-data average pie chart (caused by the high proportion of reservoir samples collected). However, more obvious differences are seen when inflow average proportions are compared with outflow data in figure 8e. The available data suggest that inflows contain higher proportions of Si and organic C compared to outflows. The observed changes in elemental proportions are probably the result of the combined effects of reservoir productivity (algal and bacterial), adsorption, and weathering reactions, coupled with particle settling and mixing.

Nutrients in Water

The high observed algal productivity of Lake Owyhee, especially in the upper reaches during summer, is indicative of the presence of nitrogen and phosphorus and the observed DO depletion in Hydrolab profiles suggests adequate organic carbon for bacterial metabolism. While most Si was associated with particulate matter (approximately 95 percent suspended), average dissolved SiO_2 in the reservoir was 1.25 mg/L (n=19), suggesting Si availability for uptake by diatoms (frustules were also observed in the reservoir sediments, see section below). TOC-, N-, and P-species data summaries from this study may be found in appendix 2, pages 11-22, in tables A2-3a through A2-3c.

Organic C was observed to be primarily dissolved (averaging 88.6 percent in the reservoir), with average DOC concentrations of 4.25 mg/L in inflow samples (n=4), 4.54 mg/L in the reservoir (n=31, s = 0.366 mg/L), 0.80 mg/L in the geothermal sample (n=1), and 4.32 mg/L in outflow samples (n=6). These data suggest that most of the DOC is allochthonus and derived from watershed sources. DOC concentrations range from 5.7- to 9.4- times suspended organic C, with observed suspended:dissolved (S:D) ratios of 0.163 for reservoir samples (n = 31, s = 0.133), 0.175 for inflow samples (n = 4, s = 0.121), 0.125 for the geothermal sample, and 0.106 for outflow samples (n = 6, s = 0.042).

Figure 9a shows organic C concentrations vs. lateral distance for data from the summer 1996 sampling event. Suspended and DOC data from surface, mid-depth, and bottom samples are plotted from top to bottom. Note that both DOC and suspended OC concentrations appear to decrease with distance from the inflow, and that the log-scale exaggerates the absolute decrease seen in the suspended data. The observed changes may be caused by some combination of time-lagged transport effects, settling of particulates, and microbial activity.

Most of the DOC is thought to be present as fulvic acid, a highly charged, heterodisperse, heterogeneous mixture of organic carbon, containing aromatic carboxylate and phenolic functional groups with molecular weights ranging from 600 - 2000 amu (atomic mass units) (Thurman, 1985). Fulvic acid exists in neutral pH waters as a charged, multidendate collection of primarily carboxylate anions known to form complexes with many cationic trace elements (Leenheer et.al., 1995a, 1995b, 1998). With an average reservoir concentration of 5.13×10^{-5} M, MINTEQA2 modeling (see appendix 3) suggests that organic-C in Lake Owyhee is composed of 66 percent dissolved free fulvate (heterodisperse carboxylate) anion (FA-), 23 percent as dissolved calcium fulvate ($CaFA^+$), 8.1 percent as suspended organic matter, 1.4 percent as dissolved sodium fulvate (NaFA), and 1.3 percent as dissolved magnesium fulvate ($MgFA^+$). While the mole percentage of total carbon as fulvate complexes (around 0.21 percent) metal-fulvate complexes are important species for ultra-trace concentration trace elements Cd, Cu, Ni, Pb, and Zn.

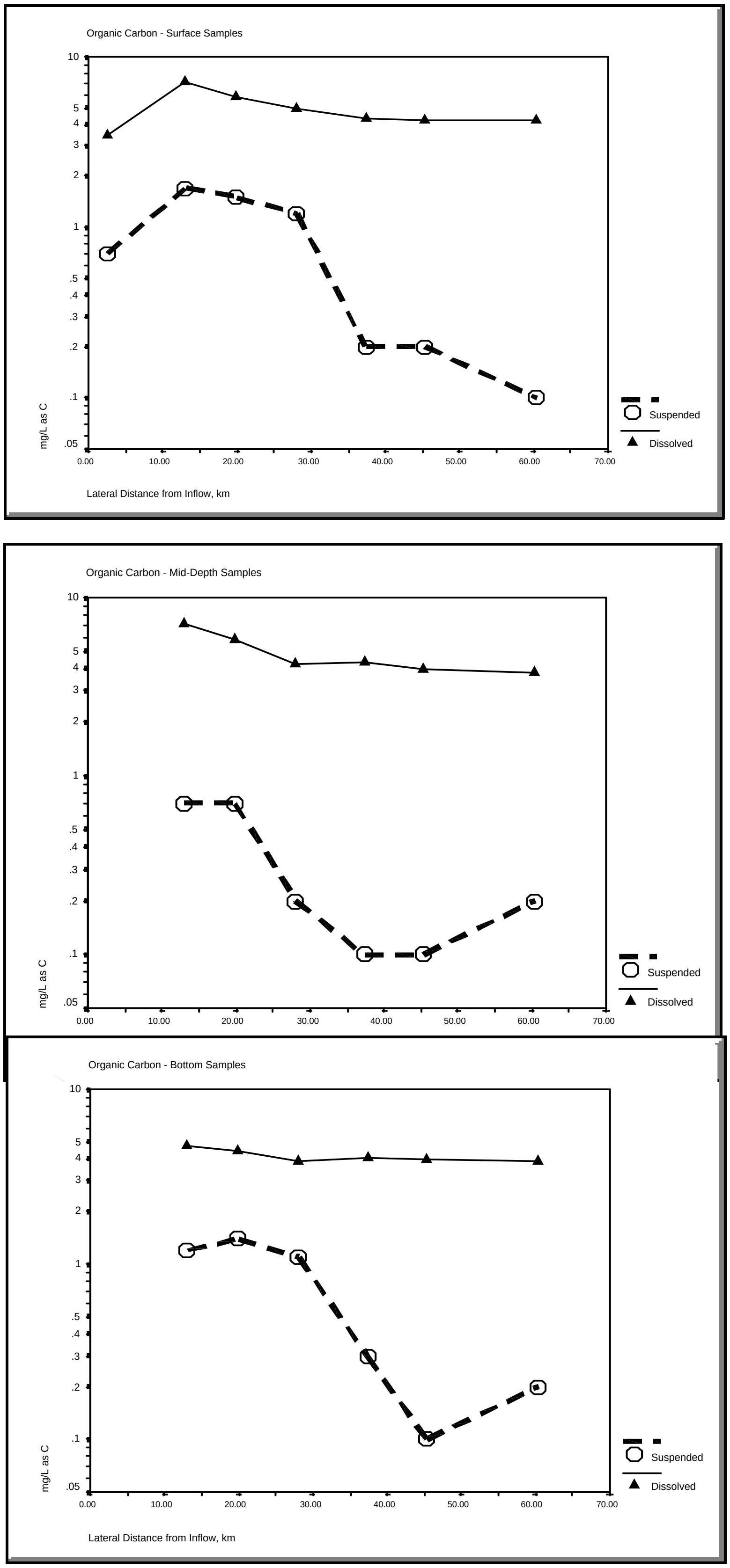


Figure 9a.—Dissolved and suspended organic carbon vs. lateral distance from inflow for surface (top), mid-depth (middle), and bottom (bottom) samples. Data are from summer 1996.

Tables 6a and 6b provide an overview of average total-P and the percentages for the operationally-defined P-species. Data in table 6a are based on all available data, while table 6b data represent averages from the August 1996 sampling event. Summer inflow total-P appears to be lower than spring, but the distribution among the P-species is very similar across seasons. Note that the spring Owyhee River flow is over 20-times the summer flow (3,708 vs. 170 cfs), but the spring total-P concentration is greater by around 3-times, compared to the summer concentration. This is somewhat counter-intuitive and suggests P association with runoff-suspended materials and that P concentration in inflows are not related to runoff flow dilution in a simple manner. A regression of total-P vs. turbidity for reservoir surface samples suggests a linear correlation with $R^2 = 0.81$ and $F_{\text{linear model}} = 50$.

Table 6a.—Average spring and summer phosphorus concentration and P-species percentages for all available inflow, reservoir, and outflow samples. Dominant species percentages are boldfaced

		Average Total-P mg/L	Suspended Total-P percent	Dissolved Ortho-P percent	Dissolved non-Ortho-P percent
Inflow	Spring	0.0950	**57**	25	18
	Summer	0.0325	**53**	25	22
Reservoir	Spring	0.118	**52**	34	14
	Summer	0.118	41	**50**	9
Outflow	Spring	0.116	36	**49**	15
	Summer	0.110	30	**62**	8

Very little seasonal difference was observed between reservoir and outflow average total-P; however, the P-species distribution does appear to show a seasonal effect for reservoir samples. The available reservoir total-P data are also greater than the observed inflow concentrations, suggesting that either the inflow sampling dates are not representative for the observed reservoir data, or additional nutrient loadings occur between Stations OR-1 and OR-2 and the reservoir inflow zone. Summer reservoir suspended P percentages are lower by 11 percent and dissolved ortho-P shows a 16 percent increase compared to spring. The percentage of dissolved non-ortho-P, which is probably associated with dissolved organic matter (DOM), also appears to be lower in the summer, perhaps suggesting uptake by microfauna.

Table 6b shows average summer 1996 reservoir P-species distributions for samples collected at different depths. Here we see much more dramatic differences with depth class, with hypolimnetic total-P 2.6-times surface concentrations. Surface samples are dominated by suspended-P, but deeper samples show higher dissolved ortho-P and lower non-ortho-P percentages. Also note the similarity between the summer 1996 mid-depth averages and the summer averages for all outflow samples collected downstream of the reservoir. As mentioned earlier, reservoir releases are from the mid-depth outlets after reservoir surface elevations drop below the maximum water surface ring-gate outlet. These data are plotted for sample depth class vs. lateral distance from the inflow in figure 9b.

Table 6b.—Comparing summer 1996 reservoir phosphorus concentration and species percentages grouped by sample depth class. These data are based on samples from all seven Lake Owyhee stations

	Average Total-P mg/L	Suspended Total-P percent	Dissolved Ortho-P percent	Dissolved non-Ortho-P percent
Surface	0.0753	65	19	16
Mid-Depth	0.0898	35	53	12
Bottom	0.197	32	64	4

A similar summary for N-species may be found in tables 7a and 7b. All table 7a averages suggest that NH_3 is a minor N-species component and that organic-N is a significant N-species component throughout the system. On a molar basis, average inflow total-N concentrations were observed to be from 11- to 40-times total-P concentrations. Unlike the inflow total-P data, inflow total-N is higher in summer compared to spring, suggesting a simpler relationship with runoff flow dilution and seasonal agricultural activity. Spring inflow N-species appear to be dominated by organic-N and suspended-N, while summer samples show a clear increase in NO_3+NO_2 percentage.

Table 7a.—Average spring and summer total-N concentrations and N-species percentages for all available inflow, reservoir, and outflow samples. Total-N was calculated by adding unfiltered TKN and filtered NO_3+NO_2 data. Suspended N was calculated from filtered and unfiltered TKN data

		Average Total-N mg/L	Suspended Total-N percent	Dissolved NH_3 percent	Dissolved NO3+NO2 percent	Dissolved Organic-N percent
Inflow	Spring	0.455	36	2	8	**54**
	Summer	0.600	25	3	33	**39**
Reservoir	Spring	0.624	23	2	30	**45**
	Summer	0.786	30	5	25	**40**
Outflow	Spring	0.661	11	2	**45**	42
	Summer	0.710	13	1	**51**	35

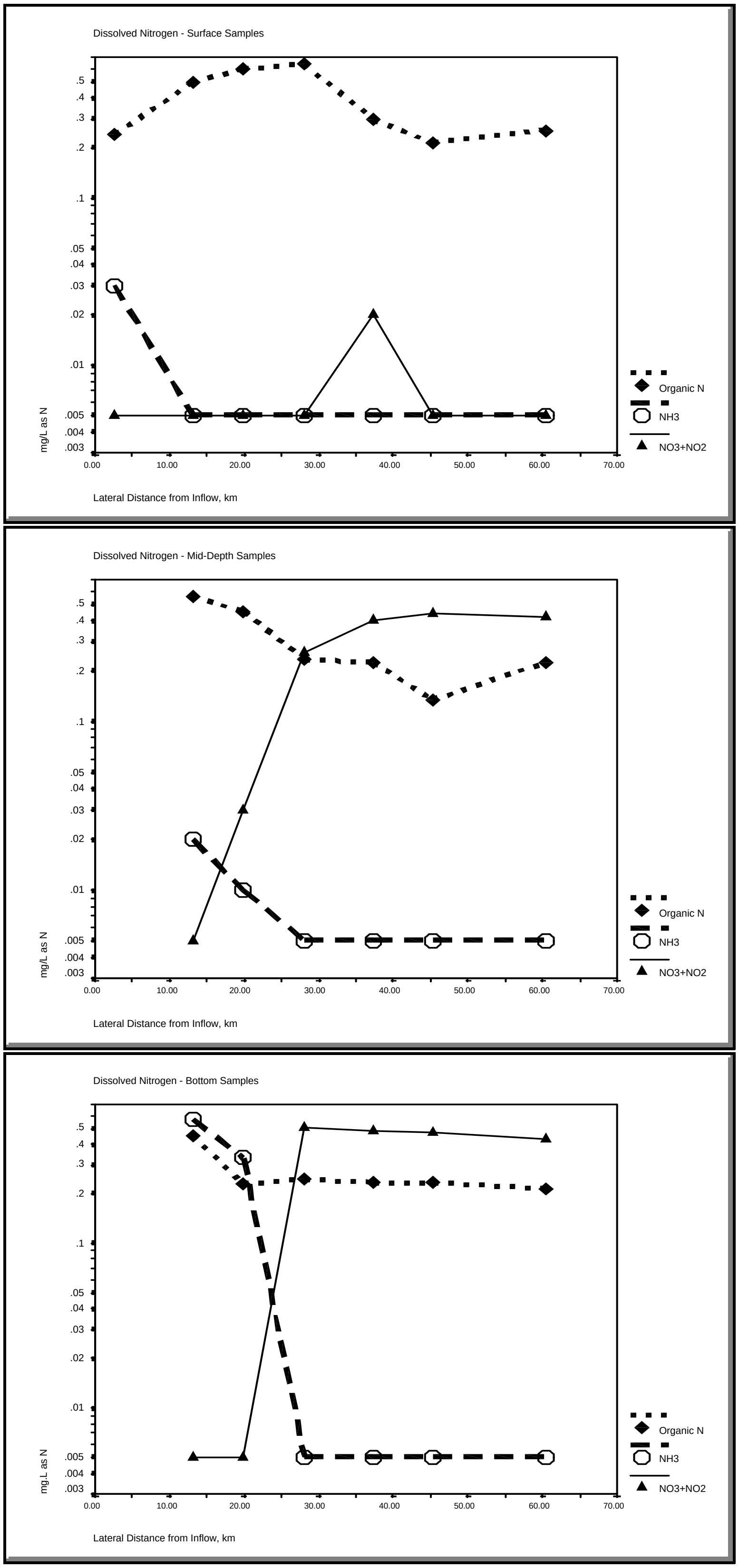


Figure 9b.—Dissolved nitrogen species vs. lateral distance from inflow for surface (top), mid-depth (middle), and bottom (bottom) samples. Data are from summer 1996 sampling event.

Table 7b.—Summer 1996 reservoir nitrogen concentrations and species percentages grouped by sample depth class. These data are based on samples from all seven Lake Owyhee stations

	Average Total-N mg/L	Suspended N percent	Dissolved NH_3 percent	Dissolved NO_3+NO_2 percent	Dissolved Organic-N percent
Surface	0.806	50	<1	1	48
Mid-Depth	0.823	30	1	32	37
Bottom	0.798	8	19	39	34

Reservoir total-N molar concentrations are from 12- to 15-times P concentrations. Reservoir total-N averages 27 percent higher in spring and 24 percent higher in summer compared to inflow averages. Table 7b shows the summer 1996 reservoir averages by sample depth class. As with P, note the similarity between the table 7b, mid-depth average values, and the summer reservoir averages in table 7a. While average total-N is relatively constant with depth, dissolved NO_3+NO_2 and NH_3 show clear increases in proportion, while suspended-N and dissolved organic-N percentages decrease with depth. The notable observation is that bottom samples show much lower proportions of suspended-N and much higher proportions of NH_3. These results suggest higher bacterial activity and less mixing in the hypolimnion during summer stratification.

Outflow N data are comparable to the reservoir, with the exception of NO_3+NO_2, which shows elevated proportions in summer averages. These data probably are indicative of the chemistry at the mid-depth elevation of the reservoir outlet works.

Nitrogen data from the summer 1996 sampling event are presented in figure 9c, which plots dissolved N species (NH_3, organic-N, and NO_3+NO_2) concentrations in mg/L (on a log-scale) vs. lateral distance from inflow for surface, mid-depth, and bottom reservoir samples. These plots provide some comparison to the table 7 averages and demonstrate the complexity of the Lake Owyhee water column. Note that figure 9c surface NO_3+NO_2 concentrations are near the detection limit, except for Station 5 (0.02 mg/L). Given that the 1998 summer inflow samples showed 0.14 and 0.16 mg/L NO_3+NO_2, and the reservoir at Station 1 in summer 1997 showed 0.02 mg/L, the lack of NO_3+NO_2 in the summer 1996 surface data is preplexing. Perhaps nitrate inputs to Lake Owyhee are episodic and of short duration, or there may be unobserved inputs (and/or stream denitrification processes) in the 85-km reach of the Owyhee River between the reservoir and the sampled inflow stations. The available data do not resolve this apparent anomaly.

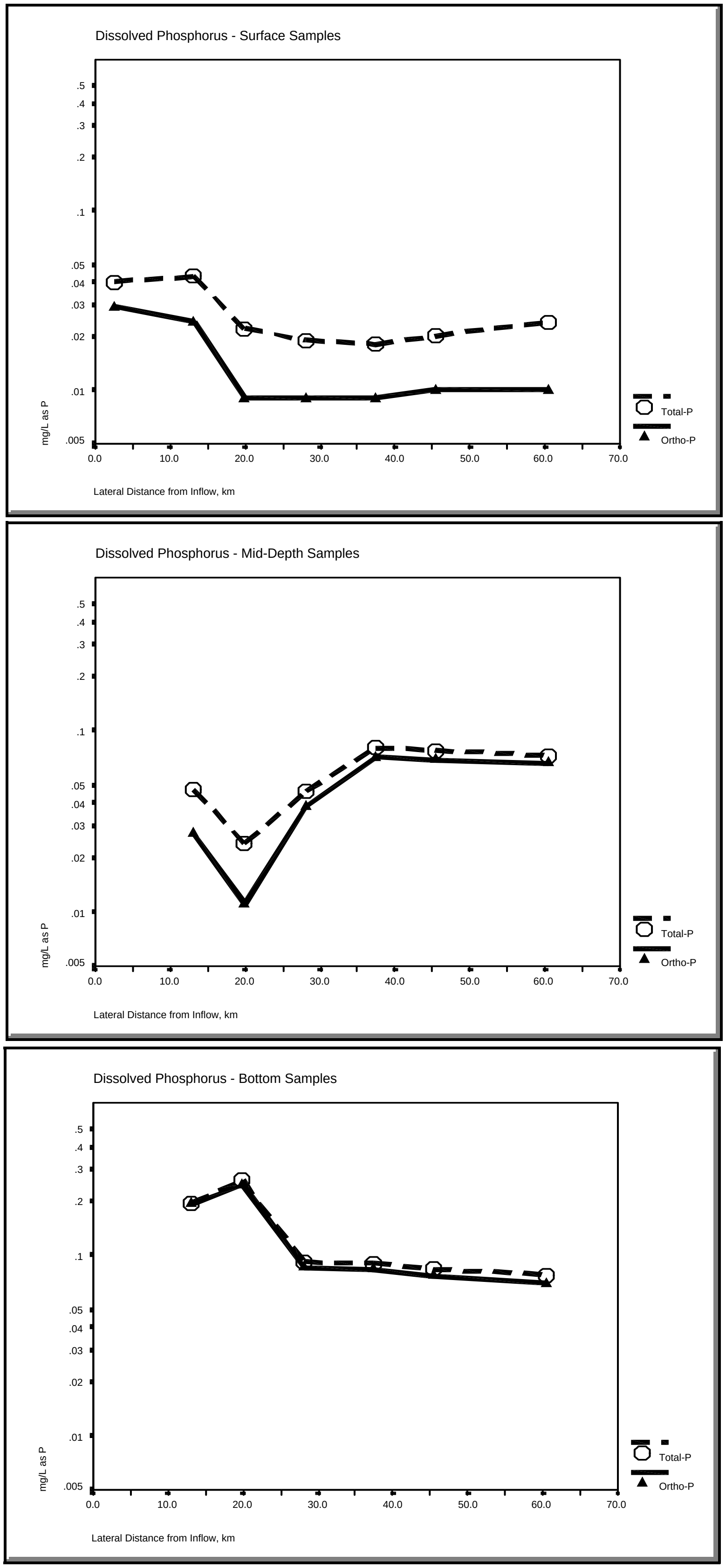


Figure 9c.—Dissolved phosphorus species vs. lateral distance from inflow for surface (top), mid-depth (middle), and bottom (bottom) samples. Data are from summer 1996 samples.

At depth, NO_3+NO_2 shows progressive increases with lateral distance that are accompanied by coincident drops in organic-N and NH_3. NH_3 is elevated in the upper reaches of the reservoir, but appears to permanently fall to detection limit levels by Station 3, near Three-Fingers Gulch. These data are probably indicative of both time-lagged mixing of inflow waters and reservoir biotic processes in the upper, shallower reaches of Lake Owyhee. Given the low observed NH_3 in the summer 1996 reservoir data, higher NH_3 concentrations observed at the outflow (Station 8) may be caused by localized bacterial activity at the mesolimnion depth of the reservoir outlets.

Figures 10a through 10c show radar diagrams for averaged and grouped nutrient data. Radar diagrams are similar to the Stiff diagrams used for major ions, in that several analytes are plotted along multiple axes to provide a polygon shape depiction of multivariate data sets. All the radar diagrams in figures 10a through 10c plot N and P species concentrations in mg/L on radially-arranged log-scales that show, clockwise: suspended total-P (calculated), dissolved ortho-P, dissolved non-ortho-P (calculated), suspended TKN (calculated), dissolved NH_3, dissolved organic-N (calculated), and dissolved NO_3+NO_2.

Figure 10a data were grouped by reservoir reach (left to right columns, based on lateral distance from the inflow) and by sample depth (top to bottom rows). Surface samples (top row diagrams) show similarly shaped polygons with decreasing concentrations with lateral distance. The dominant surface species are suspended-P, suspended N (as TKN) and dissolved organic-N. Suspended-P and -N both show decreases with downstream distance, while dissolved surface species show a less obvious decrease. Suspended concentration decreases, especially in surface samples, are probably caused by particulate settling. Upper reach mid-depth plots are similar to surface samples, but show a shift in radar diagram shape with downstream distance caused by lower suspended-P and suspended-TKN and increased dissolved NO_3+NO_2. Bottom sample averages show more pronounced dissolved NH_3 vertices in middle and upper reservoir reach polygons but the lower reach diagram shows $NH_3 < 0.01$ mg/L and is very similar to the lower reach mid-depth diagram.

Figure 10b uses radar diagrams to compare surface sample N and P averages for spring (top row plots) and summer (bottom row), grouped by reservoir reach from left to right, from inflow mixng zone to the dam. Here, a difference is visible in diagram shape between spring and summer, with spring reservoir samples containing higher proportions of NO_3+NO_2. As seen for major ions data and with the figure 10a surface samples there is a summer trend towards lower overall N and P concentrations with increasing lateral distance from the inflow.

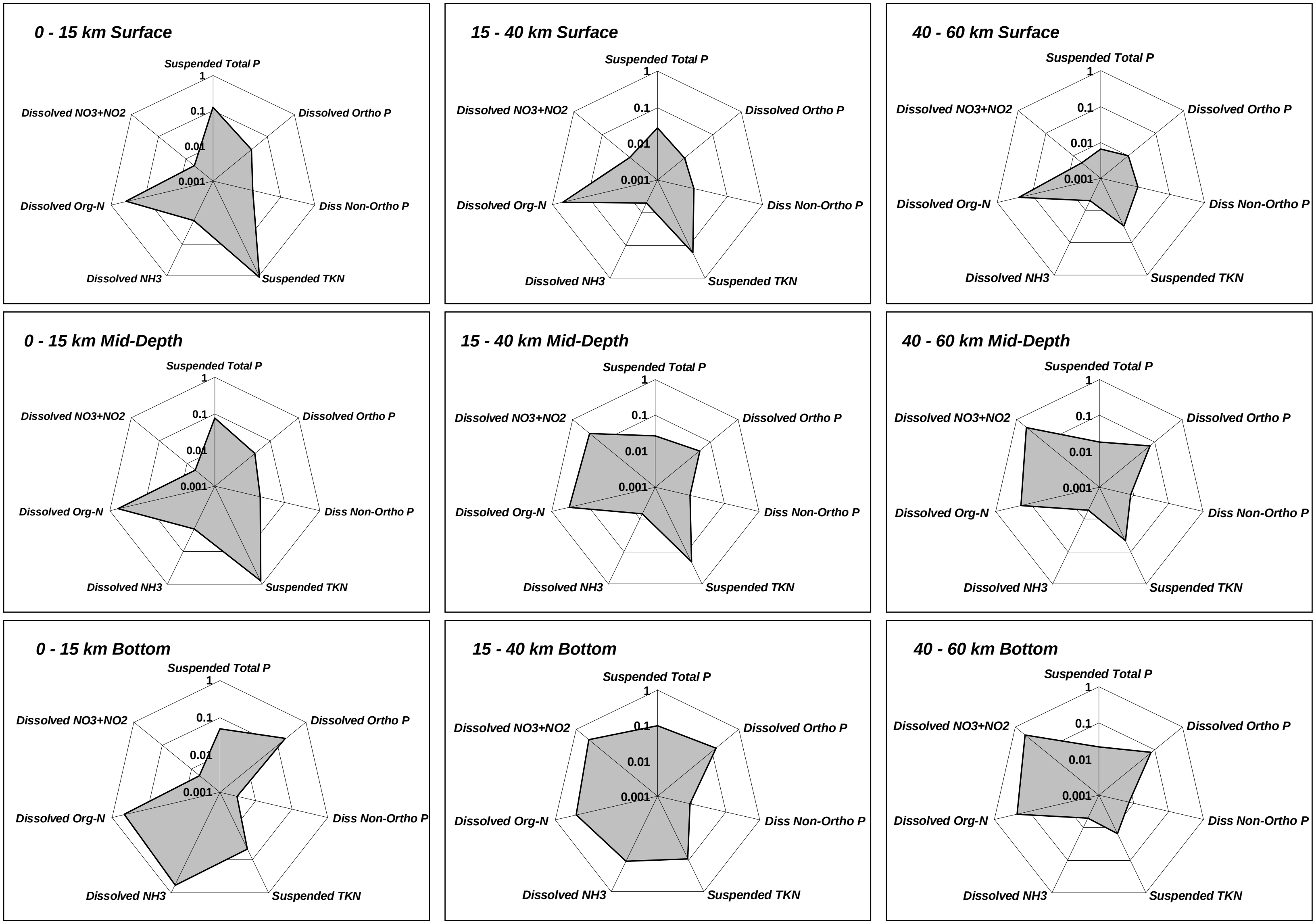
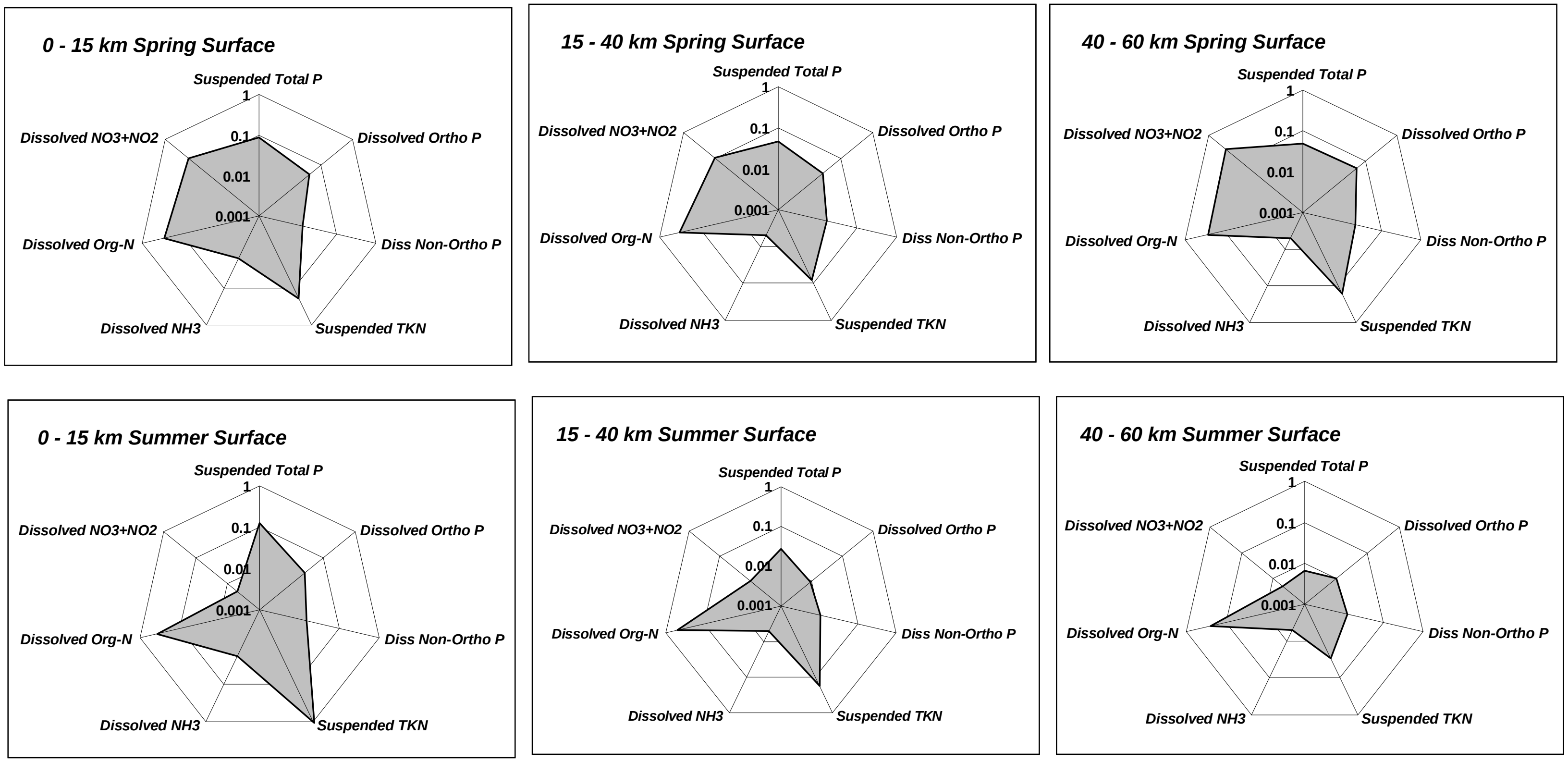

0 - 15 km Surface
15 - 40 km Surface
40 - 60 km Surface
0 - 15 km Mid-Depth
15 - 40 km Mid-Depth
40 - 60 km Mid-Depth
0 - 15 km Bottom
15 - 40 km Bottom
40 - 60 km Bottom

Figure 10a.—Radar diagram comparison of summer 1996 phosphorus and nitrogen species concentrations in different reaches (lateral segments) and depths in Lake Owyhee. Upper Reach includes stations within 15 km of the inflow zone, Middle reach stations are 15-40 km from inflow, and Lower Reach stations are 40-61 km from inflow. Reaches are displayed from left to right columns, and depth classes are displayed from top (surface) to bottom rows. Note log scale in mg/L.



0 - 15 km Spring Surface

15 - 40 km Spring Surface

40 - 60 km Spring Surface

0 - 15 km Summer Surface

15 - 40 km Summer Surface

40 - 60 km Summer Surface

Figure 10b.—Comparison of average spring and summer reservoir nutrient concentrations by reach. Radar diagrams show Upper Reach (left column), Middle Reach (middle column), and Lower Reach (right column) concentrations for spring (top row) and summer (bottom row) surface water samples. Note log scale for mg/L on different analyte axes.

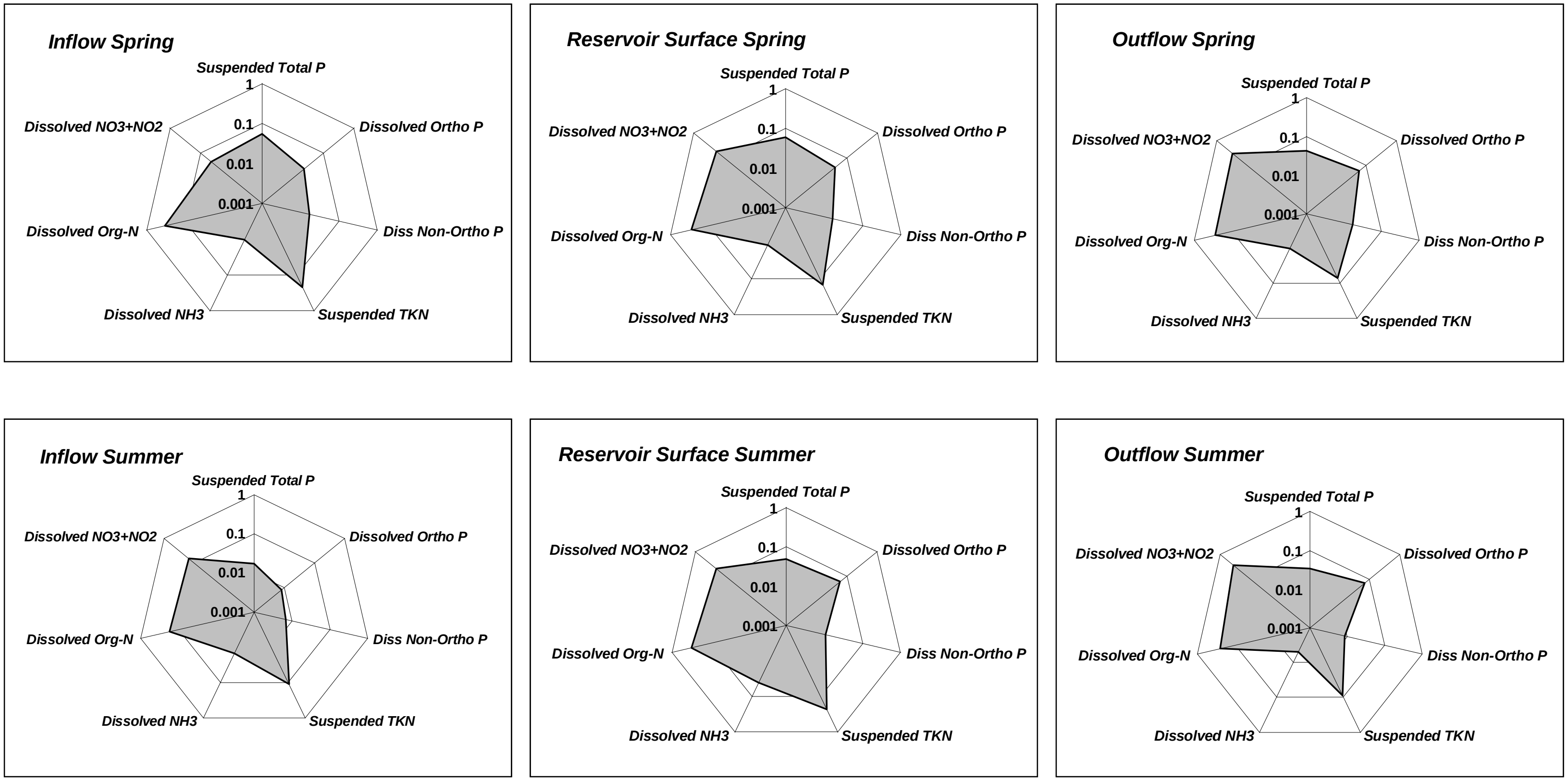


Figure 10c.—Comparison of nutrient concentrations in inflow (left column), reservoir surface samples (middle column) and outflow (right column) for spring (top row) and summer (bottom row) samples. Note log scale for mg/L on different analyte axes.

A comparison of average N and P for inflow (left column diagrams), reservoir surface samples (middle), and outflow samples (right), also grouped by spring (top row diagrams) and summer (bottom), may be seen in figure 10c. In general, there are not dramatic differences in diagram shape. During spring, little change is seen between inflow, reservoir, and outflow for suspended-P, dissolved ortho-P, dissolved NH_3, or dissolved organic-N. Spring suspended TKN, however, shows a decreasing trend, while NO_3+NO_2 increases through the system. The summer diagrams suggest that reservoir surface averages are higher for all species compared to inflow, and except for lower dissolved NH_3 and suspended-P, the summer reservoir average is also similar to the outflow. Unfortunately, the existing data set is not large enough to assess the significance of the observed increase from inflow to the reservoir. The increased reservoir surface average may be due to seasonal non-representativeness, or may suggest either additional N and P inputs in the 85-km Owyhee River reach below the inflow stations, or autocthonus sources for nutrients within the reservoir.

A preliminary summary of N and P mass loading for Lake Owyhee inflow and outflow is summarized in table 8. These data clearly show that while differences in water concentrations may be subtle (figure 10c), when flow-weighted mass loadings are calculated, clear differences between spring and summer are seen in inflows. The table 8 data show that spring P-loading is around 60-times summer loading and that spring N-loading is 25-times summer loading. For comparison, spring flow at Rome, Oregon, was around 22-times summer stream flow. Much less dramatic seasonal differences are seen in outflow loading (or emptying, as the case may be), suggesting that the reservoir acts to “buffer” or regulate seasonal inflow nutrient loadings. Interestingly, outflow loadings are consistently higher compared to inflow, suggesting that Lake Owyhee may be a net nutrient source; however, these observations have to be considered speculative until longer-term and more data-rich evaluations of inflow/outflow hydrologic comparisons can be made.

Table 8.—P and N loading, expressed in kg/d, for inflow and outflow samples collected during this study.

					PHOSPHORUS		NITROGEN	
Source	Season	Summary	Inflow at Rome, cfs	Outflow at Dam, cfs	TOTAL P kg/d	DISSOLVED P kg/d	TOTAL N kg/d	DISSOLVED N kg/d
INFLOW	Summer	Mean	170		13.5	6.24	189	141
	Spring	Mean	3,708		862	367	5,440	3,490
OUTFLOW	Summer	Mean		1,962	528	368	3,410	2,980
		Minimum		1,928	443	344	2,920	2,450
		Maximum		1,995	581	386	3,810	3,470
	Spring	Mean		3,387	920	617	5,330	4,930
		Minimum		1,980	484	344	2,910	2,710
		Maximum		4,793	1370	915	7,860	7,390

Mercury and Methylmercury in Water

Observed concentrations and MINTEQA2 results suggest that aqueous Hg exists in Lake Owyhee primarily as suspended fractions for both total-Hg and Me-Hg. Dissolved (filtered) total-Hg ranged from approximately 5 percent to 50 percent of unfiltered total-Hg, suggesting that the higher unfiltered total-Hg concentrations were associated with suspended materials. Unfiltered Me-Hg ranged from 0.022 ng/L to 2.45 ng/L (~1 percent to 5 percent of unfiltered total-Hg), and dissolved Me-Hg ranged from <0.009 ng/L to 0.308 ng/L (~0.1 percent to 0.5 percent of unfiltered total-Hg)

Figure 11 shows reservoir average percentages for both measured and MINTEQA2 model-calculated Hg-species. In Lake Owyhee, most Hg is suspended (86 percent), with the next largest species being dissolved $Hg(OH)_2$ (12 percent), suspended Me-Hg (0.66 percent), and dissolved HgCl(OH) (0.65 percent), followed by the most toxic and bioavailable form, dissolved Me-Hg (0.35 percent). Appendix 2, tables A2-4a and A2-4b, provide summaries of the analytical data for filtered and unfiltered total-Hg and Me-Hg.

Lake Owyhee Hg: In general, lake samples exhibit a large variation in observed Hg concentrations for the same stations and seasons from year to year. For example, Station 1 (Lake inflow mixing zone) on August 21, 1996, (inflow Q = 135 cfs) showed 19.1 ng/L total-Hg, but 100 ng/L total-Hg was observed on August 8, 1997 (inflow Q = 161 cfs). The summer 1997 Station 1 sample was submitted as a blind

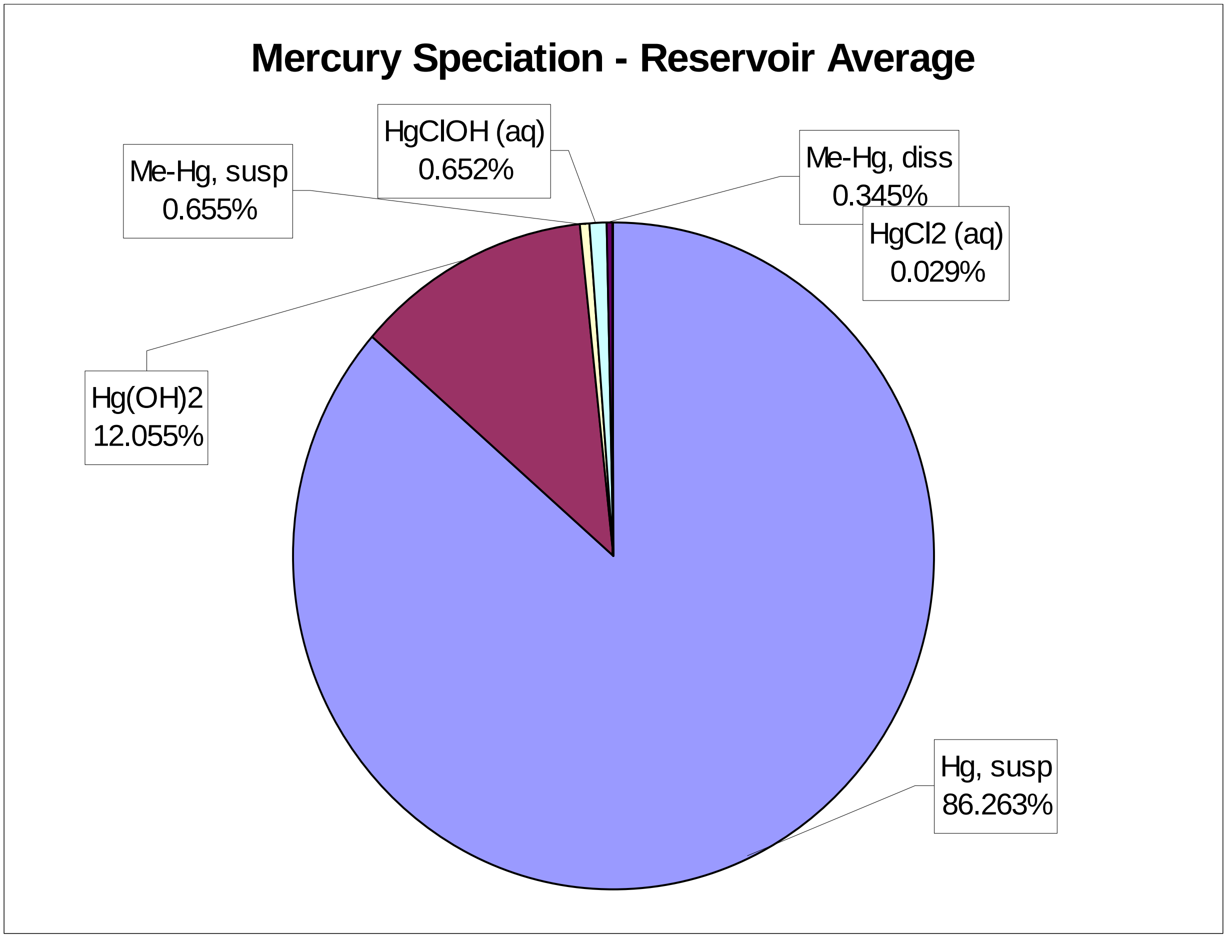


Figure 11.—Reservoir average Hg species distribution based on analysis data and MINTEQA2 calculations.

duplicate (with nearly identical results) and the trip blank for this sampling event was acceptable, so these differences are likely valid observations. The highest total-Hg (140 ng/L) was observed at Station 1 during spring 1997 (flow at Rome = 3,080 cfs), while the following spring, Station 1 showed only 36.9 ng/L (blind duplicate = 36.3 ng/L), with Q = 2,251 cfs. These differences appear to be real year to year variability, suggesting that episodic events may account for varying observed Hg concentrations.

Figure 12 shows summer 1996 Hg concentrations for Lake Owyhee surface samples vs. lateral distance from the lake inflow zone. Note the log scale needed to display the very low Me-Hg concentrations along with the total-Hg. This graph shows a trend with lateral reservoir distance of gradual reduction in concentration by mid-lake (30-40 km downstream from the inflow zone), with an apparent increase by Station 7 to concentrations 0.1- to 0.3-times upper reach unfiltered total-Hg concentrations. The available Hg data may reflect a combination of factors, perhaps including particulate settling, time-lagged transport of earlier inflow waters, internal reservoir processes that release Hg, or isolated inflows from surface runoff or underwater geothermal sources. Notably, the Station 1gs geothermal spring water showed negligible amounts of Hg (unfiltered total-Hg = 2.24 ng/L). This observation does not preclude other submerged or obscured geothermal springs which may well contribute additional Hg to Lake Owyhee.

A mid-depth sample for Hg was collected only at Station 5 during summer 1997, and showed unfiltered total-Hg to be 45.2 ng/L compared to 9.54 ng/L for the surface sample. Additionally, the Station 8 (river downstream of dam) sample collected on August 14, 1997, with unfiltered total-Hg at 29.7 ng/L, is almost three times higher than the Station 7 surface sample (12.1 ng/L). By contrast, the May 5, 1997 spring samples (when stratification was minimal and mixing enhanced) show that unfiltered total-Hg from Stations 7 (33.1 ng/L) and 8 (30.9 ng/L) are very similar. A linear regression of unfiltered total-Hg vs. turbidity showed $R^2 = 0.72$ and $F_{linear\ model} = 33$. These data, along with the overall trends observed for suspended sediments, suggest that Hg is higher in concentration at depth during summer stratification, especially at the summer mesolimnion density change layer, and is primarily adsorbed on and transported by suspended materials.

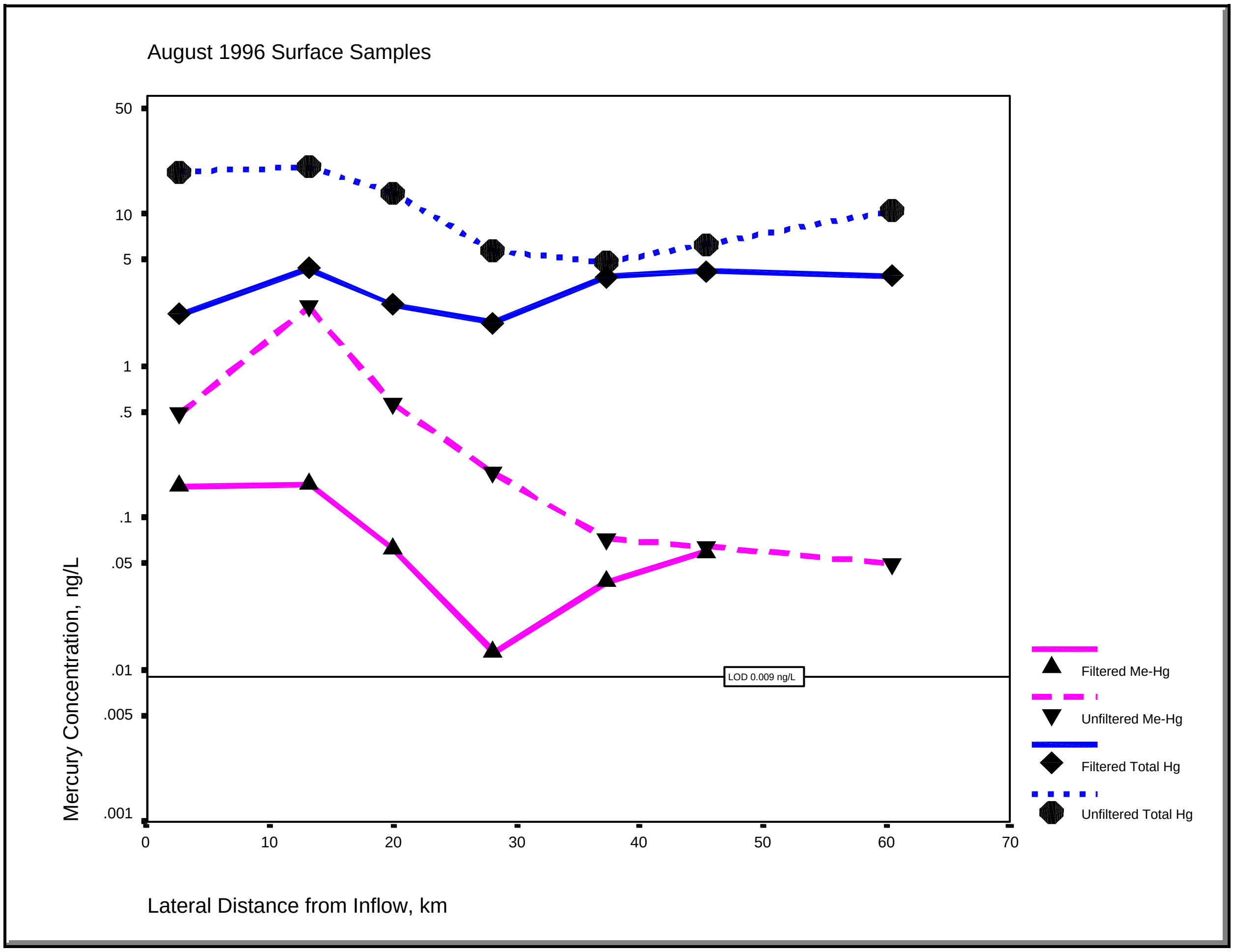


Figure 12.—Total and methylmercury vs. lateral distance from inflow for filtered and unfiltered surface reservoir samples collected in August 1996.

Comparative Hg Data: A comparison of average suspended and dissolved Hg and Me-Hg data, grouped by water source, is presented for all sampling dates (and depths for reservoir samples) in figure 13a. These data are grouped by the single geothermal sample (Station 1gs), inflow samples (Stations OR-1 and OR-2), Lake Owyhee samples (Stations 1-7), and the Owyhee River outflow below the dam at Station 8.

Figure 13b shows a similar set of grouped bar graphs, with the upper plot showing spring and the lower plot showing summer suspended and dissolved Hg concentrations. All plots in figures 13a and 13b show that suspended total-Hg increases from the geothermal water, to the inflow, then the outflow, followed by the highest concentration average in the reservoir. Similar relative concentrations are seen for dissolved total-Hg. Me-Hg appears to be fairly equally distributed between suspended and dissolved fractions, with only slight differences between grouped water source averages. Note that the log scale visually exaggerates the Me-Hg data relative to total-Hg.

Inflow Station Hg: Inflow Stations OR-1 (above Jordan Creek confluence) and OR-2 (below Jordan Creek confluence) showed lower Hg concentrations in a narrower range compared to same-season reservoir samples from the lake inflow mixing zone (Station 1). Spring inflow total-Hg ranged from 9.22 to 17.3 ng/L (04/14/99), while spring total-Hg at reservoir Station 1 ranged from 36.6 ng/L (May 7, 1998, inflow Q = 2,250 cfs) to the maximum value of 140 ng/L (May 5, 1997, inflow Q = 3,080 cfs), suggesting that observed Hg concentrations do not appear clearly related to runoff flow. Because inflow stations were sampled after reservoir sampling was completed, differences observed here may be caused by random year to year variability. However, it may also be that there are additional Hg sources along the 85 km river reach between Rome and the Lake Owyhee inflow zone.

Table 9a shows the Hg concentration data for the multiple independent samples collected from inflow Stations OR-1 and OR-2. Five samples were collected from each inflow station at five equally-spaced locations across the Owyhee River during summer 1998, and from three locations for the spring 1999 sampling event (with a blind field duplicate collected mid-stream for OR-1). Note that both the spring and summer OR-1 samples show fairly uniform results across the Owyhee River cross-section, while the OR-2 samples show higher Hg concentrations for east bank samples. These results suggest that Hg is fairly homogeneous above the Jordan Creek confluence, but is not fully mixed below the confluence, as evidenced by higher standard deviations for the OR-2 sampling events. The table 9a results suggest a consistent Hg mixing plume for all measured Hg species that extends to the middle of the OR-2 river channel during both spring and summer.

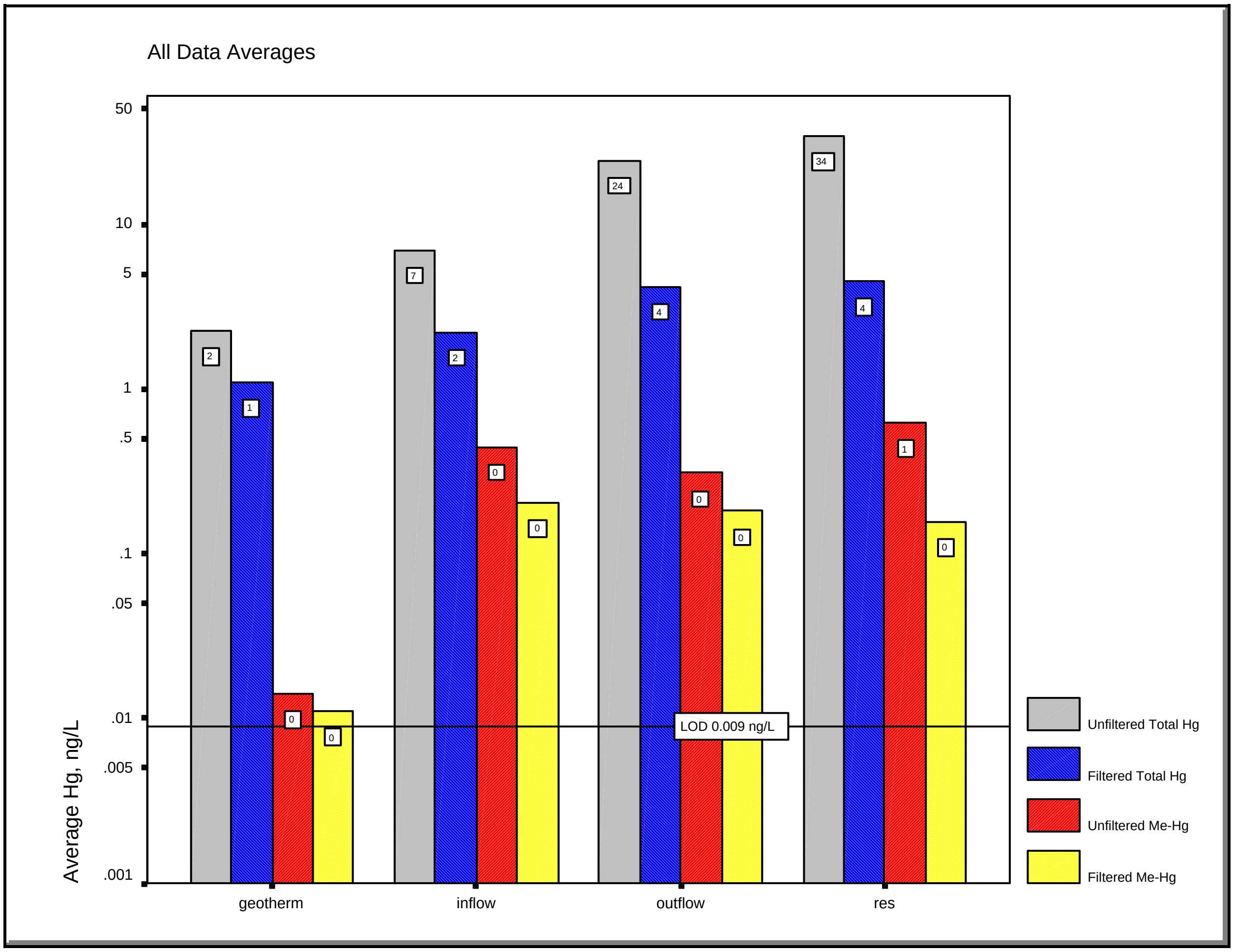


Figure 13a.—All data averages for mercury concentrations grouped by water source: Geothermal (one sample, Station 1gs), Inflow (Stations OR-1 and OR-2), Outflow (Station 8), and Reservoir samples. Reservoir averages presented here include bottom samples.

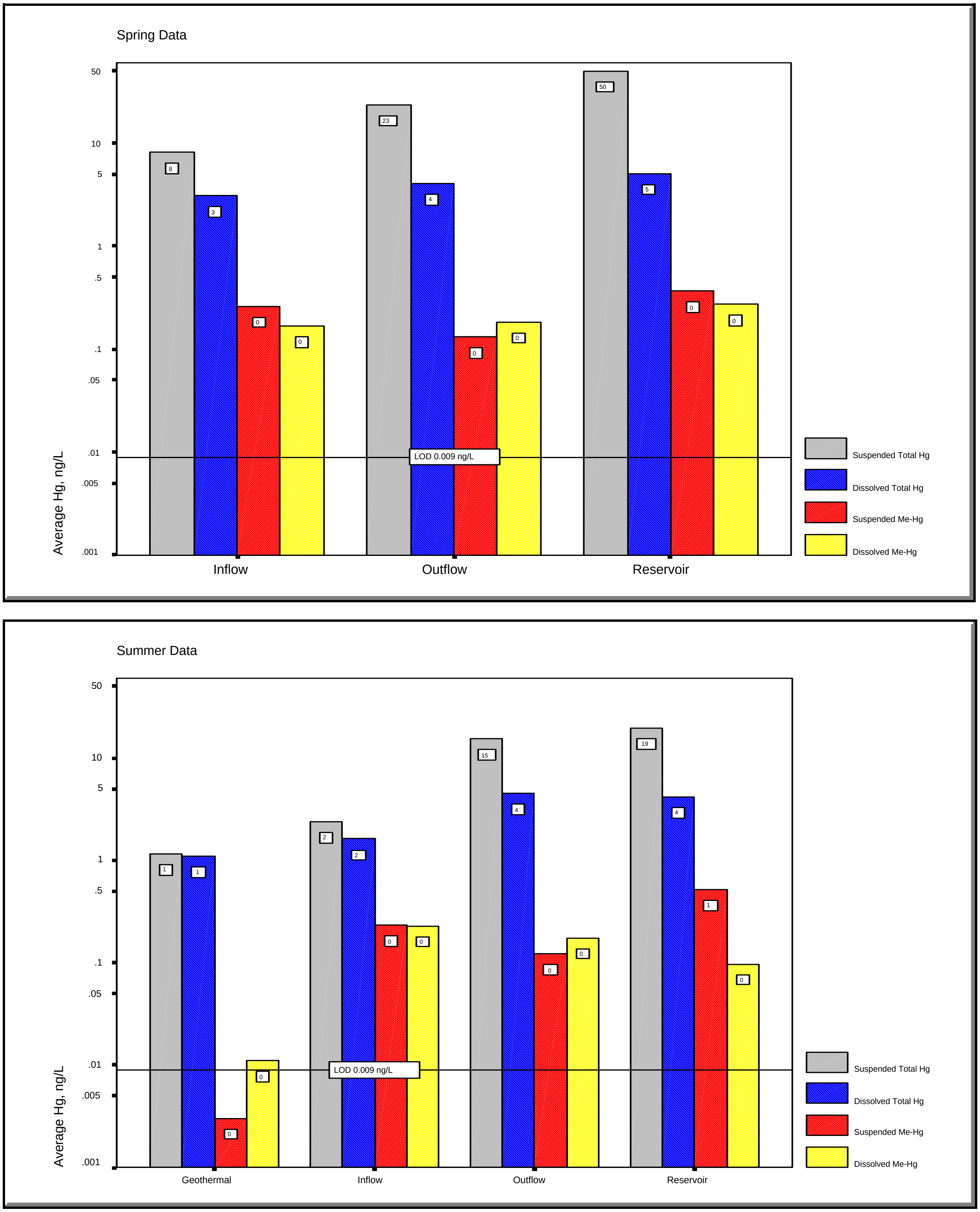


Figure 13b.—A comparison of average spring (top) and summer (bottom) mercury concentrations for Geothermal(one sample, Station 1gs), Inflow (Stations OR-1 and OR-2), Outflow (Station 8), and Reservoir samples. Reservoir average includes bottom samples.

Table 9a.—Spring and summer inflow Hg concentrations for Station OR-1 (above the Jordan Creek confluence) and Station OR-2 (below the confluence)

Station	location note	inflow gage cfs	Total Hg unfiltered ng/L	Total Hg filtered ng/L	Me-Hg unfiltered ng/L	Me-Hg filtered ng/L	Total Hg susp:diss ratio	Me-Hg susp:diss ratio
SUMMER 1998								
Station OR-1	east side channel	170.0	2.25	1.15	.310	.214	.96	.45
	east side - 20m center		3.10	1.02	.313	.155	2.04	1.02
	mid-channel		2.28	1.07	.315	.129	1.13	1.44
	west side + 20m center		2.78	.97	.369	.142	1.87	1.60
	west side channel		2.38	1.09	.300	.138	1.18	1.17
	n		5	5	5	5	5	5
	Minimum		2.25	.97	.300	.129	.96	.45
	Maximum		3.10	1.15	.369	.214	2.04	1.60
	Mean		2.56	1.06	0.321	0.156	1.44	1.14
	Median		2.38	1.07	0.313	0.142	1.18	1.17
	Range		.850	.18	.069	.085	1.08	1.15
	s		.370	0.0686	0.0273	0.0340	0.484	0.446
Station OR-2	east side channel	170.0	9.32	4.00	1.058	.531	1.33	.99
	east side - 20m center		7.21	2.67	.701	.417	1.70	.68
	mid-channel		4.83	1.66	.537	.251	1.91	1.14
	west side + 20m center		2.88	1.32	.343	.160	1.18	1.14
	west side channel		2.79	1.15	.325	.140	1.43	1.32
	n		5	5	5	5	5	5
	Minimum		2.79	1.15	.325	.140	1.18	.68
	Maximum		9.32	4.00	1.058	.531	1.91	1.32
	Mean		5.41	2.16	0.593	0.300	1.51	1.06
	Median		4.83	1.66	0.537	0.251	1.43	1.14
	Range		6.53	2.85	0.733	0.391	0.730	0.640
	s		2.83	1.19	0.302	0.169	0.293	0.240

Table 9a.—Spring and summer inflow Hg concentrations for Station OR-1 (above the Jordan Creek confluence) and Station OR-2 (below the confluence) - continued

Station	location note	inflow gage cfs	Total Hg unfiltered ng/L	Total Hg filtered ng/L	Me-Hg unfiltered ng/L	Me-Hg filtered ng/L	Total Hg susp:diss ratio	Me-Hg susp:diss ratio
SPRING 1999								
Station OR-1	mid + 30m east	3708.0	9.93	2.95	.473	.161	2.37	1.94
	mid-channel		10.1	2.97	.312	.165	2.40	.89
	mid-channel dup		9.74	2.91	.441	.150	2.35	1.94
	mid - 30m west		9.22	3.06	.329	.147	2.01	1.24
	n		4	4	4	4	4	4
	Minimum		9.22	2.91	.312	.147	2.01	.89
	Maximum		10.1	3.06	.473	.165	2.40	1.94
	Mean		9.75	2.97	0.389	0.156	2.28	1.50
	Median		9.84	2.96	0.385	0.156	2.36	1.59
	Range		0.880	0.150	0.161	0.0180	0.390	1.05
	s		0.3812	0.0634	0.0802	0.00862	0.181	0.524
Station OR-2	mid + 30m east	3708.00	17.3	3.40	.371	.207	4.09	.79
	mid-channel		11.3	3.15	.560	.168	2.59	2.33
	mid - 30m west		10.3	2.97	.502	.173	2.47	1.90
	n		3	3	3	3	3	3
	Minimum		10.3	2.97	.371	.168	2.47	.79
	Maximum		17.3	3.40	.560	.207	4.09	2.33
	Mean		13.0	3.17	0.478	0.183	3.05	1.68
	Median		11.3	3.15	0.502	0.173	2.59	1.90
	Range		7.00	0.430	0.189	0.0390	1.62	1.54
	s		3.79	0.216	0.0968	0.0212	0.903	0.795
All Inflow	n		17	17	17	17	17	17
	Minimum		2.25	0.970	0.300	0.129	0.960	0.450
	Maximum		17.3	4.00	1.06	0.531	4.09	2.33
	Mean		6.92	2.21	0.445	0.203	1.94	1.29
	Median		7.21	2.67	0.369	0.161	1.91	1.17
	Range		15.1	3.03	0.758	0.402	3.13	1.88
	s		4.40	1.05	0.195	0.109	0.765	0.508

Table 9b shows a statistical summary of Hg-loading calculated at OR-2 for the four measured Hg species. Note that the standard deviations and standard errors reflect a heterogeneous plume, which further downstream, would likely be more fully mixed.

Table 9b.—Descriptive statistics for total-Hg and Me-Hg loading for inflow Station OR-2

	n	Mean, g/d	Standard Deviation	Std. Error
SUMMER 1998				
Total Mercury				
Unfiltered Total-Hg Loading, g/d	5	2.25	1.18	0.527
Dissolved Total-Hg Loading, g/d	5	0.898	0.493	0.221
Methylmercury				
Unfiltered Me-Hg Loading, g/d	5	0.247	0.126	0.0562
Filtered Me-Hg Loading, g/d	5	0.125	0.0704	0.0315
SPRING 1999				
Total Mercury				
Unfiltered Total-Hg Loading, g/d	3	97.7	28.5	16.5
Dissolved Total-Hg Loading, g/d	3	23.9	1.63	0.939
Methylmercury				
Unfiltered Me-Hg Loading, g/d	3	3.60	.729	0.421
Filtered Me-Hg Loading, g/d	3	1.38	0.160	0.0923

Table 9c shows percentage increases in Hg concentrations observed between Stations OR-1 and OR-2. The left two data columns present percentage increases observed in the measured Hg concentrations from OR-1 to OR-2. These data show a clear increase in all total-Hg and Me-Hg concentrations for both summer and spring samples, all of which were detected well above the blank-corrected limit of quantitation (LOQ = 0.027 ng/L, limit of detection = 0.009 ng/L).

Table 9c.— Average percentage increases in Hg concentrations seen between Stations OR-1 and OR-2 (above and below the Jordan Creek inflow, respectively - left two data columns). Right three data columns compare summer vs. spring Hg loading in g/d at OR-2 below Jordan Creek confluence

	Increase in Average Hg Species Concentrations and OR-2 Loading				
	Percent Concentration Increase, OR-1 to OR-2		Actual LOADING at OR-2, g/d		
Species	Summer	Spring	Summer	Spring	Spr>Sum
Unfiltered Total-Hg	111	33.2	2.25	97.6	43.4x
Filtered Total-Hg	104	37.6	0.898	23.9	24.2x
Unfiltered Me-Hg	59.3	22.9	0.247	3.60	14.6x
Filtered Me-Hg	92.7	17.3	0.125	1.38	11.0x

The lower summer Hg concentrations at OR-1 and OR-2, where spring concentrations are more than twice summer, also suggest that higher spring runoff flows mobilize and transport more Hg. The right three data columns in table 9c clearly show that while spring concentrations are elevated compared to summer, loading is significantly higher during the spring runoff, with spring loading showing order of magnitude greater values compared to summer Hg loading.

So, do the enhanced concentrations seen at OR-2 suggest that Jordan Creek represents a statistically significant Hg increase to the Owyhee River? Table 9d shows the results of t-tests on the Hg species concentration means at OR-1 and OR-2 for summer 1998 and spring 1999 data. As expected, Levene's F (a test for homogeneity of variance) suggests what is already known: that the variances for OR-1 and OR-2 are different, because of the heterogeneous plume observed at OR-2. The 1-tailed t statistics, however, show that the OR-1 and OR-2 means for summer ($n = 5$) are different for almost all variables and variance assumptions, at significance levels > 0.065. The only summer differences with significance level $\alpha > 0.05$ (and only slightly so) were observed for unequal variance assumptions for filtered total Hg and both filtered and unfiltered Me-Hg. Spring means ($n = 3$) are also different, but with a lesser level of significance, around $\alpha = 0.100$. Spring filtered Me-Hg, however, shows a significant difference at $\alpha = 0.0325$, assuming equal variances.

Table 9d.—Comparison of inflow station means between stations OR-1 and OR-2 for measured Hg species, grouped by sampling date

Hg Variable	Equal Variance Assumption	Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (1-tailed)	Mean Difference	Std. Error Difference
SUMMER 1998								
Unfiltered Total-Hg, ng/L	assumed	13.0	.007	2.23	8	.0280	2.85	1.28
	not assumed			2.23	4.14	.0440		1.28
Filtered Total-Hg, ng/L	assumed	13.0	.007	2.07	8	.0360	1.1	0.531
	not assumed			2.07	4.03	.0540		0.531
Unfiltered Me-Hg, ng/L	assumed	8.55	.019	2.00	8	.0410	0.271	0.136
	not assumed			2.00	4.07	.0575		0.136
Filtered Me-Hg, ng/L	assumed	13.9	.006	1.87	8	.0495	0.144	0.0772
	not assumed			1.87	4.32	.0650		0.0772
SPRING 1999								
Unfiltered Total-Hg, ng/L	assumed	15.6	.011	1.75	5	.0705	3.22	1.84
	not assumed			1.47	2.03	.139		2.19
Filtered Total-Hg, ng/L	assumed	3.39	.125	1.81	5	.0650	0.201	0.111
	not assumed			1.56	2.26	.123		0.129
Unfiltered Me-Hg, ng/L	assumed	.0170	.903	1.34	5	.120	0.0889	0.0666
	not assumed			1.29	3.90	.1335		0.0688
Filtered Me-Hg, ng/L	assumed	5.58	.065	2.35	5	.0325	0.0269	0.0114
	not assumed			2.07	2.50	.0740		0.013

Given the likelihood that river mixing would make the Hg concentrations more uniform across the width of the Owyhee RIver farther downstream from OR-2, it is probably valid to assume equal variances for the above- and below-confluence means. When this assumption was tested by simulating fully mixed OR-2 data by applying the residuals, $(x_i - \bar{x})$, from OR-1 to the mean from OR-2, highly significant differences were observed for summer samples (t = 16, df = 8). Therefore, it seems safe to conclude that Jordan Creek represents an important inflow source of Hg to Lake Owyhee, and that observed Hg concentration differences are real and statistically significant. Since the Jordan Creek sub basin (1,270 mi^2) accounts for approximately 16 percent of the drainage area at the Rome, Oregon, gage (7,610 mi^2), it seems likely that Hg loading is also significantly different between OR-1 and OR-2.

Other Trace Elements

Trace elements (and major cations) besides Hg were analyzed using ICP-MS, and because of field sampling using ultra-clean collection procedures and statistical blank correction used by the analysis lab (FGS), very low, sub-µg/L detection limits were realized. This methodology provided a fairly complete picture of naturally occuring trace (µg/L to low mg/L concentrations) and ultra-trace (low µg/L to ng/L concentrations) elements in the Owyhee system and allowed more detailed speciation modeling (see appendix 3) using the MINTEQA2 model. When speciation issues are discussed, they are based on MINTEQA2 modeling of Lake Owyhee averaged data from filtered samples.

Measured trace element concentrations are summarized in appendix 2, tables A2-5 and A2-6. Tables A2-5a (Lake Owyhee) and A2-5b (Inflow, Outflow, and Geothermal waters) present data for trace elements usually associated with suspended particulates (Si, Al, Ca, Mg, K, Fe, and Mn). Tables A2-6a (Lake) and A2-6b (Inflow, Outflow, and Geothermal) provide data for toxic elements Ag, As, Be, Cd, Co, Cr, Cu, Ni, Pb, Sb, Se, Tl, U, V, and Zn. Minor cations and anions, Sr, Ba, and B are not summarized in appendix 2, but were modeled using MINTEQA2 and these results are found in appendix 3. The MINTEQA2 trace element speciation results are summarized table A3-1, which presents calculations for Lake Owyhee samples grouped by spring, summer, and all-data averages. Inflow and outflow samples were not modeled. Suspended elemental species were calculated from measured filtered and unfiltered data, and these data were combined with the dissolved species calculated by MINTEQA2 to obtain the summary "total" element molar amounts and percentages.

Major and Minor Ions Speciation: Average Lake Owyhee data suggests that Ca and Mg both exist mostly (> 90 percent) as free divalent ions (Ca^{2+} and Mg^{2+}), with Mg showing a greater percentage as suspended (7.7 percent) than Ca shows (3.9 percent). Calcium fulvate ($Ca\text{-}FA^-$, 2.5 percent) is around 8-times $Mg\text{-}FA^-$ (at around 0.31 percent), so the divalent cations are competing with trace and ultra-trace elements that also bind with fulvate. Each of these cations also forms sulfate complexes. The monovalent cations Na and K are also dominantly present as the free ion, with suspended Na at 2 percent and suspended K at 10-17 percent. The higher suspended fraction for K is probably related to its association with suspended feldspars and clays. The free ion is also the dominant species for the minor cations Sr (97.7 percent as Sr^{2+}) and Ba (65.4 percent as Ba^{2+}), with Ba showing a much greater association with suspended particulates (34.6 percent suspended Ba compared to 2.2 percent suspended Sr) . Both minor divalent cations also form small amounts of fulvate and hydroxide complexes.

Trace and Ultra-trace Element Speciation: The ICP-MS analytical data suggest that the suspended fraction represents the dominant species for almost all trace (10^{-4} to 10^{-6} molar) and ultra-trace (10^{-7} to 10^{-10} molar) elements in Lake Owyhee. Besides clay minerals with negative surface charges, the suspended particulates likely contain surface coatings composed of hydrous Fe- and Mn-oxides (Lion et al. 1982; Schindler and Stumm, 1987), adsorbed humic and fulvic materials (Stumm and Morgan, 1996; Thurman, 1985), along with glycoproteins and polysaccharides from adsorbed bacteria and periphyton. The suspended materials observed in Lake Owyhee and watershed waters probably provide large adsorptive surface areas in the range of hundreds of cm^2/L (Horowitz 1985; Jackson, 1979; Forstner and Whitmann, 1979). All these factors combine to provide suspended materials with very effective adsorptive and binding capacity for trace elements in the Owyhee system.

As mentioned above, Si (4.4×10^{-4} molar) is primarily suspended, with the remainder of species composed of various hydro-silicic acids (H_4SiO_4 = 4.6 percent, others < 0.10 percent). Observed concentrations of suspended Si are corroborative of the general level of observed opacity in Lake Owyhee and watershed waters. Al and Fe show similar suspended-dominant speciation, with approximately 80 percent suspended and the remainder of species dominated by variously-substituted hydroxide complexes ($Al(OH)_3$ (*aq*) from 12- to 29 percent, $Fe(OH)_2+$ from 11- to 21 percent). Manganese also shows strong association with particulates, with suspended Mn around 93 percent, $Mn\text{-}FA^-$ complexes ranging from 4.5 - 5.6 percent, and the free ion, Mn^{3+}, around 1 percent.

Several ultra-trace concentration elements show suspended element as the dominant species class, including Cd (50-78 percent), Co (69-83 percent), Cr (29-67 percent), Cu (~50 percent), Hg (81-90 percent), Ni (44-67 percent), Pb (79-89 percent), and Zn (50-84 percent). The relative proportions of trace elements in suspended fractions are also discussed in the section on suspended particulates above. Of the ultra-trace elements observed in this study, only As (7.7-11 percent), Sb (5.7-12 percent), and U (9.9-11 percent) indicate suspended fractions as minor proportion species (< 20 percent).

The MINTEQA2 results suggest that fulvate complexes are another important dissolved species for several cationic trace elements, including Cd (22-50 percent), Co (15-27 percent), Cu (~50 percent), Ni (25-43 percent), Pb (6.8-13 percent), and Zn (15-46 percent). Trace and ultra-trace element-fulvate complexes account for only a modest molar percentage of total fulvic acid (around 0.2 percent), suggesting that Lake Owyhee waters have around 66 percent of the DOC available in reserve as complexing capacity for additional trace element inputs. At a DOC concentration of

5.0 mg/L, fulvic materials may account for effective metal binding surface areas in the range of many m^2/L (Horowitz, 1985). Since these dissolved species are associated with organic carbon, they also represent a bioavailable source of toxic metals to the microorganisms at the base of the Owyhee system fishery food web.

Several trace and ultra-trace elements probably exist as dissolved anions, including B (not measured by ICP-MS or modeled, but observed in sediments, and probably present as the **+V** borate ion, BO_3^{2-}), As (dominant forms as H-substituted arsenate anions, $HAsO_4^{2-}$, with As in the **+V** redox State), Cr (dominant forms as free-, H- and Na-substituted chromates, CrO_4^{2-}, with MINTEQA2 suggesting the hexavalent **+VI** redox state), Sb (with predicted large proportions of **+III** forms, $Sb(OH)_3$, $HSbO_2$, and minor amounts of free SbO_2^- anion), Se (largely present as selenate ion, SeO_4^{2-}, with Se in the **+VI** State), and V (present as substituted vanadates, VO_4^{3-}, V in the **+V** State). The MINTEQA2 speciation of hexavalent Cr is a good example of an equilibrium assumption that is often violated in the environment, where trivalent Cr^{3+} is often measured under oxidizing redox conditions.

Another form predicted by MINTEQA2 for several ultra-trace elements is the complex cation, as observed for Sb (in the **+III** state which complexes with OH^-), and U (present in the **+VI** state as the UO_2^{2+} cation, bound to phosphate, PO_4^{3-}, and carbonate, CO_3^{2-}, ligands).

Comparative Trace Elements: A comparison of average suspended and dissolved trace element concentrations may be found in figures 14a and 14b. These figures show radar diagrams grouped by inflow (Stations OR-1 and OR-2), reservoir (all Lake Owyhee stations, all depths), geothermal (Station 1gs), and outflow (Station 8) for average observed concentrations. Despite the interpretative caveats mentioned above, both figures 14a and 14b show that there are visually apparent differences in trace element diagram shapes for the different waters. While outflow and reservoir diagrams are similar, the inflow and geothermal diagrams (the geothermal diagram is based on a single sample) are notably smaller and lower in almost all average concentrations compared to the reservoir and outflow. The geothermal water from Station 1gs contains greater amounts of dissolved concentration compared to suspended concentration, probably caused by the lack of suspended particulates in this particular geothermal source water.

Figure 14a shows radar diagrams for suspended and dissolved As, Cd, Cu, Ni, and Pb. Except for Cd, the inflow and geothermal waters show similar shapes, but with the geothermal water having lower average concentrations, except for As. All grouped averages indicate that dissolved As is similar in all waters, with a suggestion that some of the dissolved As has been adsorbed onto particulates relative to the inflow.

The figure 14b radar diagrams show suspended and dissolved Se, Tl, U, V, and Zn. Here, there is less similarity in shape between the geothermal and inflow averages, with inflows containing greater concentrations of Se, U and dissolved V. Interestingly, Zn is higher in the geothermal water, perhaps suggesting that geothermal sources may contribute to reservoir Zn. Again, reservoir and outflow are very similar and generally higher in concentration than inflow. The higher concentrations of suspended ultra-trace elements in the lake and outflow suggest possible adsorption conversions of dissolved Se, U, V, and Zn within the reservoir.

With respect to the trace element data, the more obvious differences between inflow and reservoir seen in the figure 14 radar diagrams suggest that additional elemental inputs may be occurring in the 85-km reach from Station OR-2 to the Lake Owyhee inflow zone, along the near-lake watershed itself, or within the lake. Table 10 compares average summer concentrations at inflow Stations OR-1 and OR-2, Station 1 in Lake Owyhee, and the outflow at Station 8, for suspended trace elements that were also detected in the summer lake sediment samples. These data show suspended concentration increases between Rome and Lake Owyhee for Co (10x), Fe (14x), total-Hg (13x), Me-Hg (3.5x), Mn (5.5x), Ni (15x), and Se (7.0x). Increased average dissolved trace elements are also observed between inflow stations and the lake for Cd, Cu, Ni. Pb, Se, V, and Zn.

Because the time of travel between Rome and Lake Owyhee is relatively short (stream velocities of 3- to 15 km/hr will yield travel times from Rome of 6 to 29-hours), the summer suspended concentration differences observed here are probably significant. Comparison of summer Station 1 with outflow at Station 8 suggests a net *decrease* in almost all trace elements; however, these differences may be the result of time-lagged, (on the order of months) lower concentration, earlier season inflow waters rather than removal by reservoir processes.

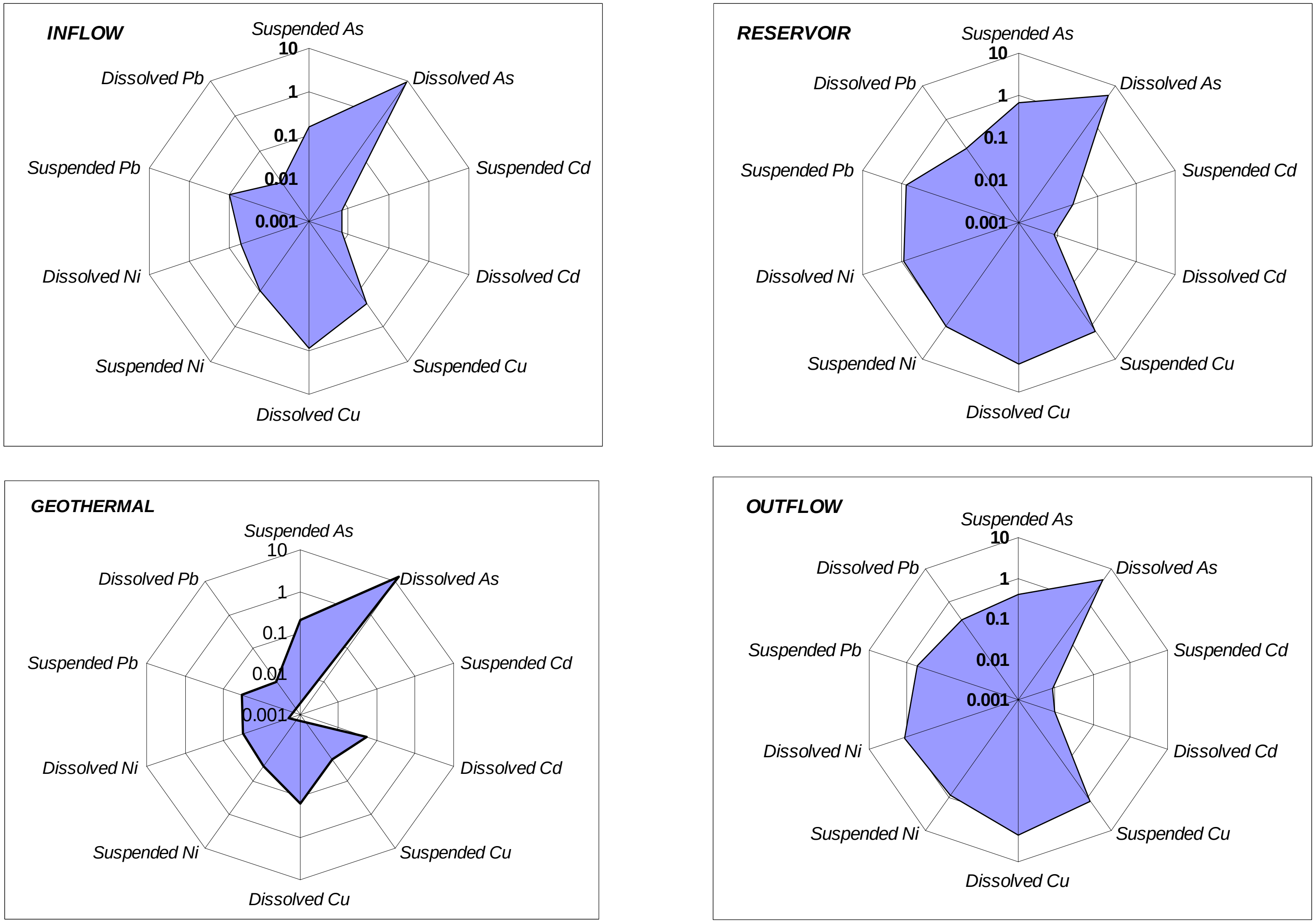


Figure 14a.—Radar diagrams comparing average suspended and dissolved concentrations for toxic trace metals arsenic, cadmium, copper, nickel, and lead, as grouped by source: Inflow (Stations OR-1 and OR-2), Reservoir (all stations, all depths), Geothermal (Station 1gs), and Ouflow (Station 8). Note log scale for concentrations in µg/L. Low detection limits from ICP-MS.

Figure 14b Radar diagrams comparing average suspended and dissolved concentrations for toxic trace metals selenium, thallium, uranium, vanadium, and zinc, as grouped by source: Inflow (Stations OR-1 and OR-2), Reservoir (all stations, all depths), Geothermal (Station 1gs), and Ouflow (Station 8). Note log scale for concentrations in µg/L. Low detection limits from ICP-MS.

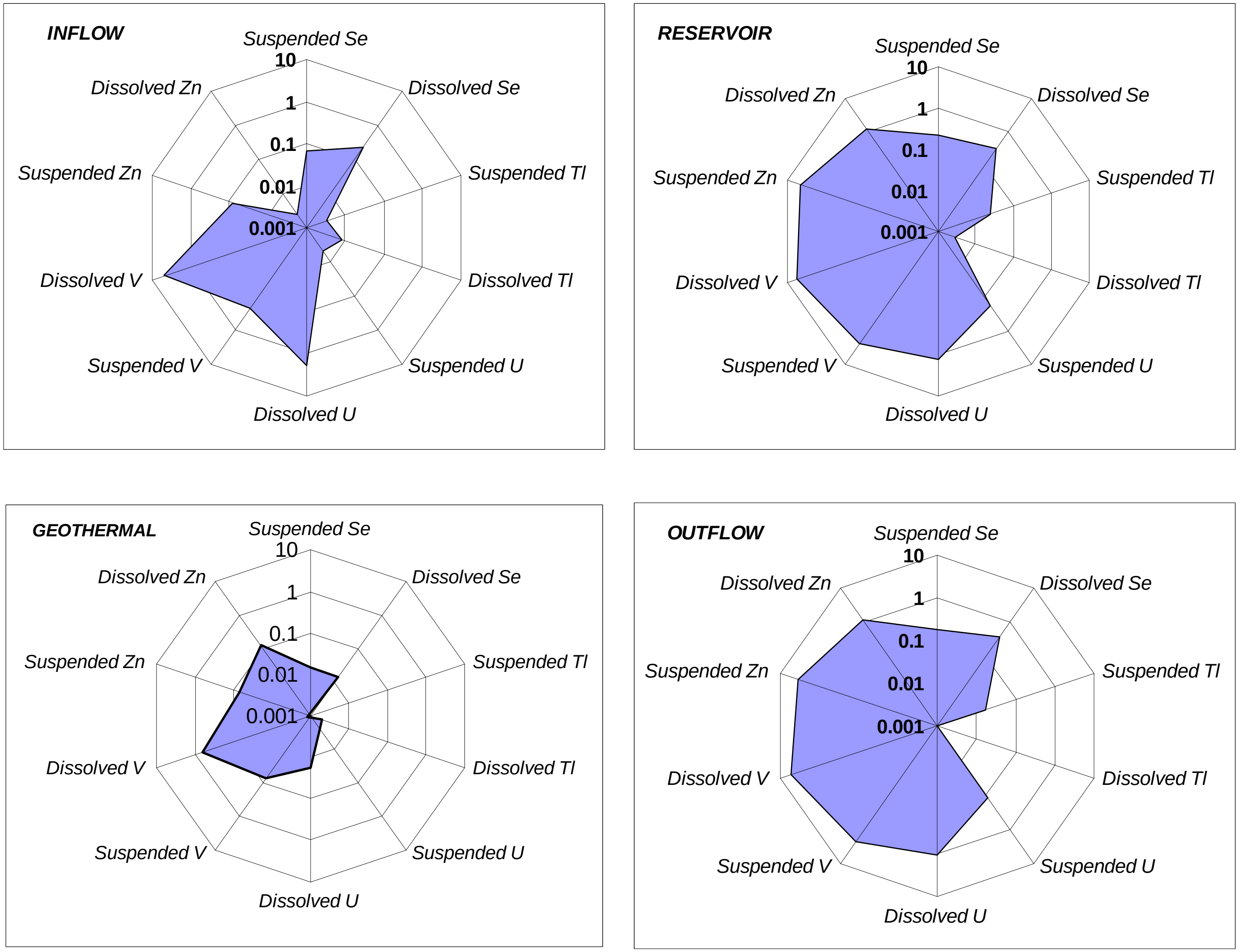


Table 10.—Average summer suspended trace element concentrations and observed changes in concentrations for elements also detected in sediments

	Average Summer Concentrations			Increase from Inflow to Reservoir Station 1		Decrease from Station 1 to Outflow Station 8	
Element	INFLOW Stations OR-1+OR-2	LAKE Station 1	OUTFLOW Station 8	Conc increase + decrease -	**Sta 1 ÷ inflow**	Conc increase + decrease -	**Sta 8 ÷ Sta 1**
Co, µg/L	0.0756	0.789	0.319	+0.714	**10.4**	-0.470	**0.404**
Cr, µg/L	2.19	2.04	1.67	-0.147	**0.933**	-0.371	**0.819**
Cu, µg/L	1.36	2.07	1.45	+0.711	**1.52**	-0.622	**0.700**
Fe, µg/L	119	1660	1710	+1540	**13.9**	+53.1	**1.03**
Total Hg, **ng/L**	4.72	61.5	15.2	+56.8	**13.0**	-46.3	**0.247**
Me-Hg, **ng/L**	0.242	0.839	0.122	+0.598	**3.47**	-0.718	**0.145**
Mn, µg/L	16.1	88.2	12.0	+72.1	**5.48**	-76.2	**0.136**
Ni, µg/L	0.0948	1.45	1.044	+1.35	**15.2**	-0.401	**0.722**
Pb, µg/L	0.800	1.10	0.569	+0.295	**1.37**	-0.526	**0.520**
Se, µg/L	0.0688	0.479	0.0310	+0.410	**6.96**	-0.448	**0.0647**
V, µg/L	1.62	3.13	3.03	+1.52	**1.94**	-0.101	**0.968**
Zn, µg/L	5.36	5.98	5.23	+0.616	**1.11**	-0.747	**0.875**

Reservoir Sediments

Reservoir sediments were collected during May 1998 at five locations within 4 km of the river inflow and analyzed for particle size distribution, mineralogy, and chemical constituents. These data may be found in appendix 4. Tables A4-1a and A4-1b summarize sample preparation and gross particle size fractions. Coulter particle size plots for minus-80 materials from the prepared samples are found in figures A4-1 through A4-5, and adjusted size fraction plots including all size fractions may be found in figures A4-7 to A4-10. Chemical analysis data are summarized in Tables A4-2 through A4-3. Appendix 5 provides x-ray diffraction and SEM micrographs for the sediment samples, and appendix 6 provides data and information regarding sampling and chemical analysis repeatibility and error associated with the sampling design and fractional spooning subsampling and preparation used in this study.

Sediment Size Distributions: Station s1 (lateral distance = 0 km, depth = 2.80 m) was very near the river inlow point, behind a small mid-channel island which allowed local particle settling. These sediments are probably similar to river sediments, and downstream flow was fairly rapid compared to sites farther downstream. This station was where the duplicate five-dredge composite sample was collected. Hg field duplicates were also collected at Station s1, with fractional spooning duplicates collected from the first five-dredge composite (to determine variability associated with fractional spooning subsampling in the field), and another fractional spooning subsample was collected from the second five-dredge composite (to check variability for duplicate five-dredge composite samples). These fractional spooning subsamples were collected from each of the five wet dredge composite subsamples.

Station s2 (lateral distance = 0.8 km, depth = 5.70 m) showed size and chemical data different from all other sediment sampling stations and was located just beyond the first major eastward bend in the river/reservoir channel, approximately 0.8 km downstream from Station s1. This composite was difficult to collect because of higher amounts of larger debris, cobbles, and sandy consistency; however, this station is thought to be representative of this particular location in the reservoir inflow-mixing zone. Similar sediment consistency and materials were found across a fairly wide cross section of the lake before the actual dredge composite was collected. This sampling site was probably located over a sand deposition delta subject to seasonal inflow scouring and may be the zone where larger river-transported materials settle first. Duplicate field fractional spooning subsamples were also collected for Hg analyses at this location, and they have an order of magnitude higher RPD (54.5 percent vs. 5.3 percent at s1) when compared to the Station s1 five-dredge composite field subsample duplicates.

Sediments were subsequently collected at Station s3 (lateral distance = 1.8 km, depth = 5.90 m), Station s4 (lateral distance = 3.3 km, depth = 7.80 m), and Station s5 (lateral distance = 4.8 km, depth = 8.80 m), locations farther downstream of the river/lake inflow zone.

Past Station s2, sediments were clearly lacustrine muds with a sticky clayey-consistency, obvious sulfide odor, and consistent presence of woody fragments and plant materials (Sweetgum seed pods) in all dredges. These observations are supported by the gross size classes and pore water fractions (reported as percent water, or percent H_2O) for each of the five-dredge composite subsamples within each sampling station, shown in appendix 4, tables A4-1 and A4-2. Generally, much better repeatability between dredge subsamples is seen for samples past Station s2, probably the extent of the more dynamic river/lake inflow mixing zone. The higher variability seen for Station s2 is thought to be caused by the actual heterogeneity of the lake bottom materials at this location. Beyond Station s2, the lake bottom sediments appear to be more uniform and less hererogeneous. Station s2 is the only location to show plus-No. 10 mesh (> 2,000 µm) materials. Similarly, percent H_2O data shows standard deviations (*s*, n=5) ranging from 1.6 percent at Station s3, to 12.6 percent at Station s2.

Figure 15 shows the average percentages associated with different sediment size fractions, and the dominant average size fraction is the 178 - 2000 µm (fine to coarse sand) at 48.4percent, followed by the 20 - 60µm fraction (fine silt, coarse clay) at 18.7 percent. Station s2 showed the lowest average size fraction less than 178 µm (minus No. 80 mesh, at 8.40 percent, s = 6.94 percent). Appendix 4, figures A4-1 to A4-5 show Coulter PSA distributions for the minus-80 mesh prepared samples. Note the similarity between the distributions plotted in figures A4-1a and A4-1b, which were from field duplicate five-dredge composite samples. Adjusted size distributions that include all fractions are found in figures A4-5 through A4-10.

Figures 16a (fractions < 60 µm) and 16b (fractions > 60 µm) plot average size fractions vs. lateral distance from river/lake inflow, and all plots show a drop in all small-size fractions associated with Station s2 - the only sample to have plus-10 mesh materials. If the dip at Station s2 is overlooked, there is a general trend for smaller size fractions (< 100-150 µm) to increase in percentage from the river inflow to Station s3, where fraction percentages plateau. A clear downward trend is seen only in figure 16b for the 200-300 µm size fraction, associated with coarse- to fine sands and silts.

Mineralogy of Sediments: Petrographic examination suggests that the reservoir sediments collected in May 1998 at Stations s1 through s5 are composed primarily of feldspar (>50 percent), with moderate quantities (10-50 percent) of quartz and organic materials (chiefly diatom fragments with trace to minor woody fragments), minor (<10 percent) to moderate amounts of mixed-layer chlorite/smectite, and trace (<0.5 percent) amounts of miscellaneous minerals including volcanic glass, hornblende, iron oxides, illite/mica, apatite, and rutile/brookite, with possible presence of chlorite, and clinoptilolite (a zeolite). These observations are consistent with the general volcanic geology of the watershed. Diatoms, specifically their frustules (walls of silica), may account for as much as 25 to 30 percent of the sediment samples, and these data corroborate the observed higher concentration of suspended material and frequent summer productivity observed in the inflow zone. The diatom frustules may also constitute a portion of the suspended Si observed in water samples.

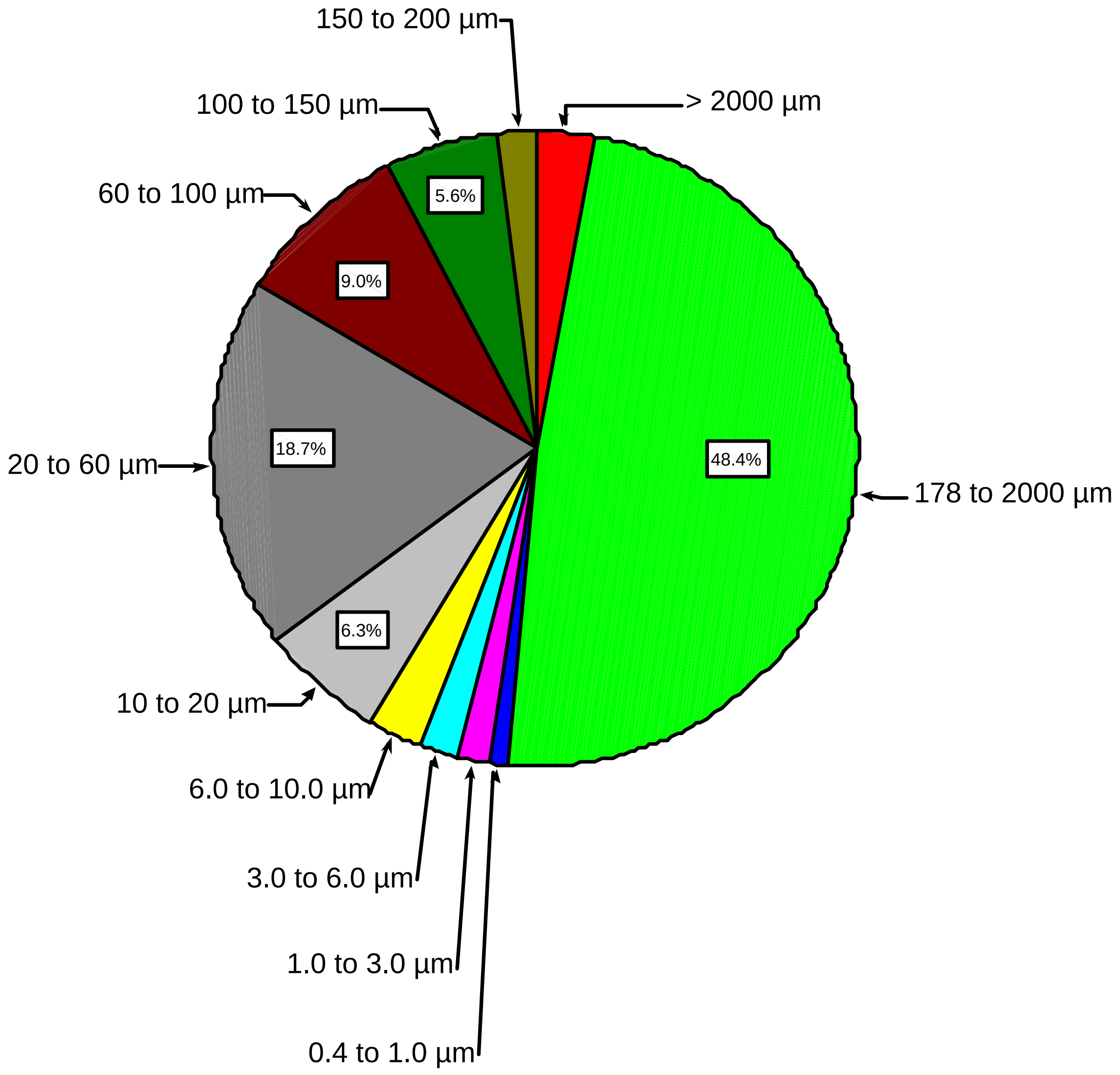


Figure 15.—Average percentages for Lake Owyhee sediment size fractions for samples within 5 km of the inflow mixing zone.

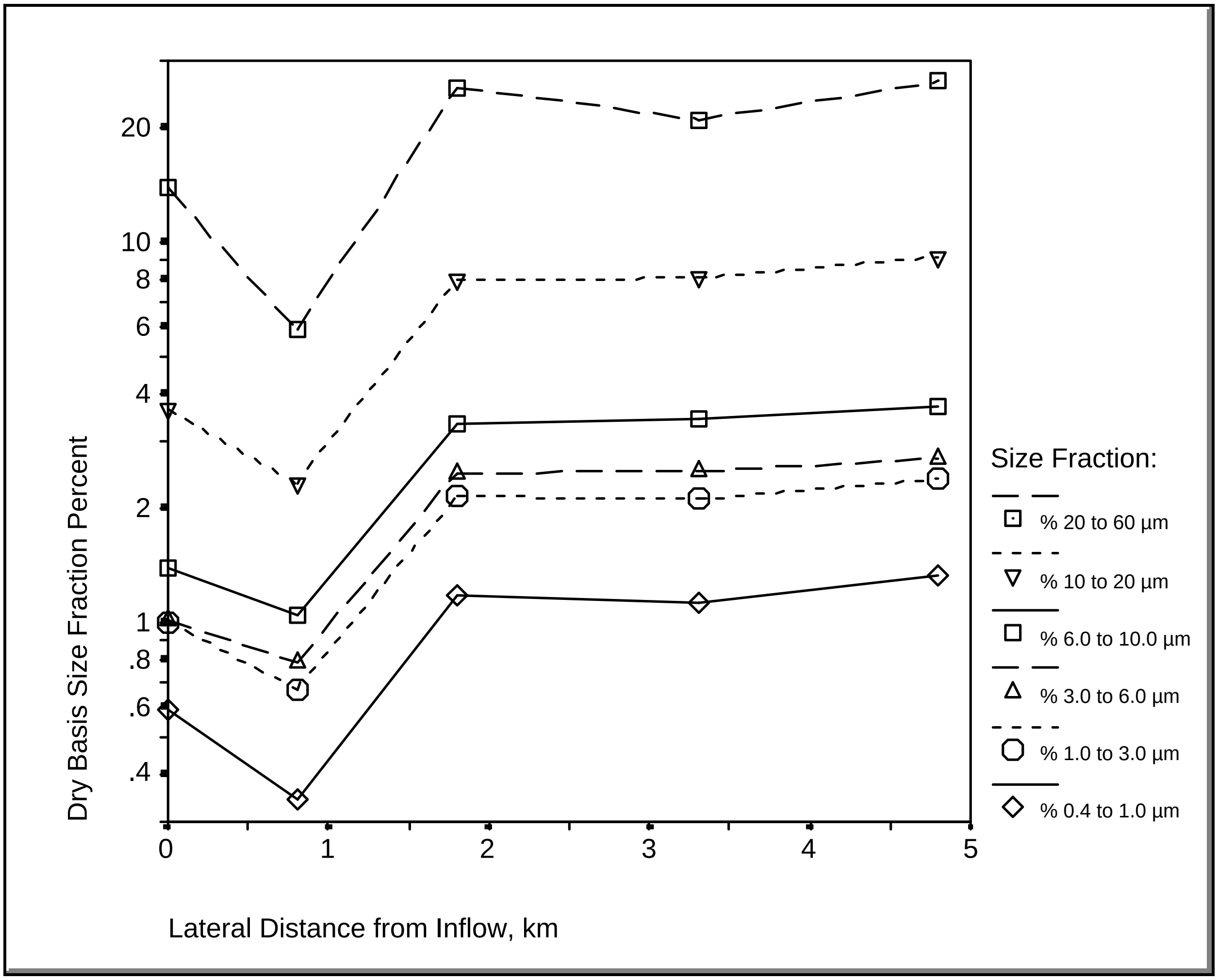


Figure 16a.—Plot of reservoir sediment size fractions < 60 µm vs. lateral distance from inflow.

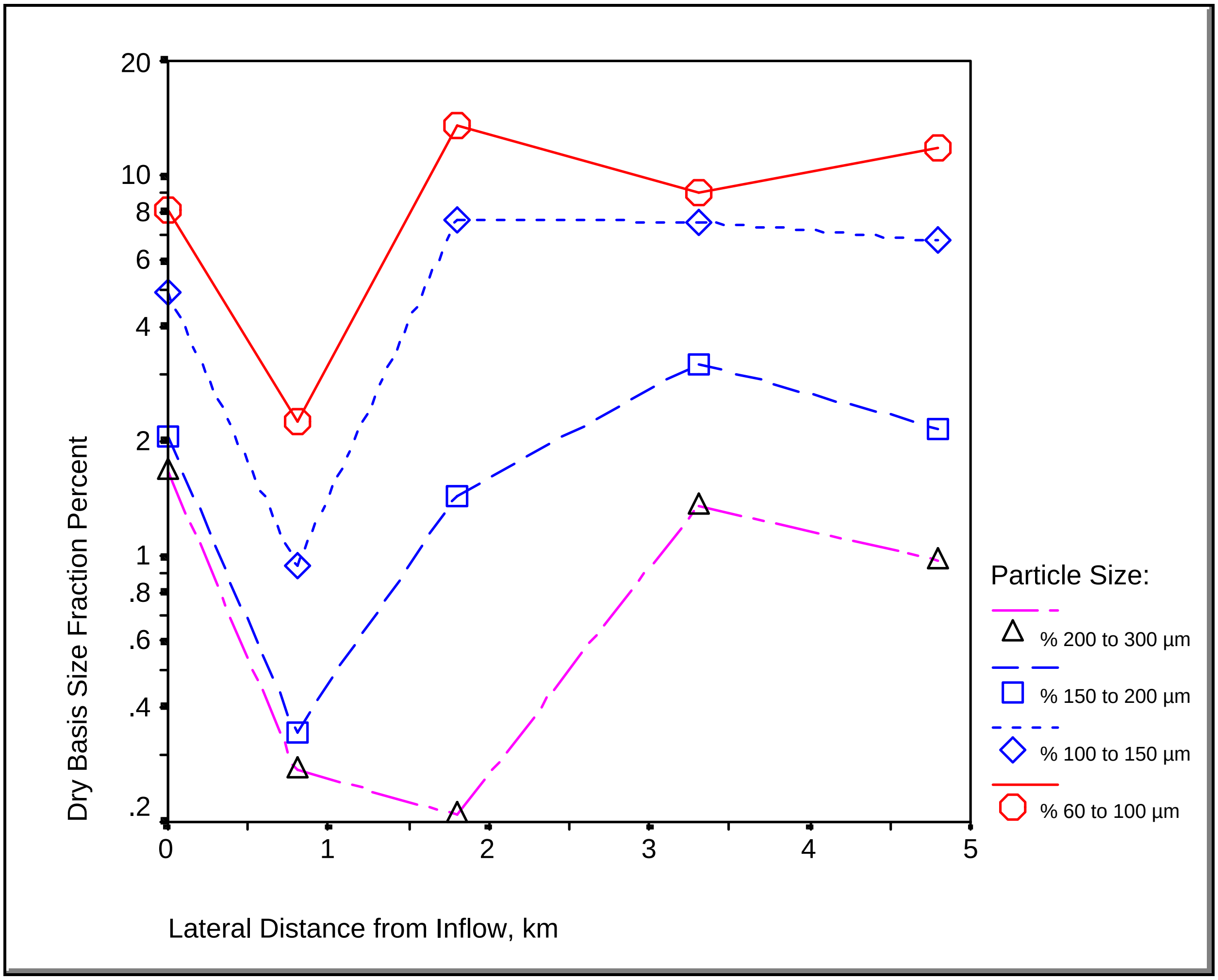


Figure 16b.—Plot of reservoir sediment size fractions > 60 µm vs. lateral distance from inflow.

Some grain coatings were recognizable in SEM micrographs, which are compiled with x-ray and other ancillary data in appendix 5. Mercury was detected spectroscopically on the SEM grain mounts; however, efforts to map Hg proved inconclusive as to its specific occurrence and/or mineralogical association (maps obtained at different magnifications appeared contradictory, probably due to the low concentrations of Hg). The grain coatings were not petrographically characterized, but are probably composed of ferric and manganese oxyhydrates, along with adsorbed organic materials.

Sediment Chemical Analysis Data: Table A4-2a shows that organic C ranged from 0.174 to 0.541 mg/kg, with a mean = 0.418 mg/kg (wet-weight, or whole sediment basis). Despite the low TOC concentrations in sediments, most of the organic C will probably be present as adsorbed humic and fulvic materials, contributing a very large amount of surface area, on the order of 1.9 m^2/mg (Horowitz, 1985). This is an example where the percentage of an element is not necessarily indicative of its influence on trace element chemistry. Inorganic carbon was not detected in the sediments, so calcite observed petrographically on suspended particles was likely a preparation artifact. Additionally, all lake water data averages modeled by MINTEQA2 suggest that calcite, dolomite, and other carbonate minerals are undersaturated in these waters. Ca and Mg carbonate mineral SI values (abbreviated “Sat. Index” in appendix 3, table A3-2) were all below zero for calcite, dolomite, and magnesite, suggesting that Owyhee system waters are aggressive to these minerals and will tend to dissolve any cabonate minerals that might precipitate out of solution onto solid particles. Ca, observed at a mean = 5.82 g/kg, suggests that calcite, if present at all, could not be more than about 0.5 percent on a wet-weight basis.

P is present in lake sediments ranging from 52.6 to 252 mg/kg, with a mean = 163 mg/kg (wet weight basis). The MINTEQA2 saturation indices (spring SI = -1.23, summer SI = -0.262) for hydroxyapatite ($Ca_5(PO_4)_3OH$), one the most common P-class apatite minerals (Deer et al., 1977), suggest that these forms are potentially soluble and P may be bioavailable when lake sediments are disturbed and resuspended. Given the lower inflow P concentrations compared to reservoir concentrations (mentioned in the nutrient section above), the available sediment P data suggest that internal loading from reservoir sediment resuspension by inflow turbulence and wind mixing may be operative at Lake Owyhee.

Iron is the dominant trace element present in Lake Owyhee sediments. Observed concentrations range from 16.4 to 22.2 g/kg (dry-weight basis), 1.87 to 7.99 g/kg (wet- weight basis). The MINTEQA2 SIs for Fe-containing oxide/hydroxide minerals goethite (α-FeO-OH, SI = +6.52), hematite (α-Fe_2O_3, SI = +18.0), and ferrihydrite (FeOH)3, SI = +2.51), suggest that these minerals are oversaturated in oxygenated Owyhee waters and that conditions in the water column are favorable for precipitation enrichment of Fe in sediments. Like adsorbed humic and fulvic carbon, the ferric and manganese oxyhydrates adsorbed on mineral particle surfaces are important mediators of trace element partioning between solid and aqueous phases. Under oxidizing conditions, these coatings will tend to adsorb most trace elements and release these same elements under reducing conditions.

Total-Hg and Me-Hg (wet-weight) sediment data are plotted vs. distance from the inflow in figures 17a and 17b. plot other trace elements detected in sediments, and here the Station s2 dip is more pronounced and similar to the particle size fraction plots in figures 16a and 16b, and show only a slight dip in concentration associated with the larger particle size fractions at Station s2. Trace elements analyzed in sediments are summarized in appendix 4 tables A4-3a through A4-3d. Detected sediment trace elements are summarized in table 11.

Table 11.—Summary of wet-weight and dry-weight basis average concentrations for lower concentration trace elements in Lake Owyhee sediments. Hg concentrations are in µg/kg

Element	dry-weight mg/kg	wet-weight mg/kg
Co	12.4	3.39
Cr	20.9	5.68
Cu	49.1	12.0
Total Hg	370 µg/kg)	136 µg/kg
Me-Hg	3.63 µg/kg)	1.90 µg/kg
Ni	20.0	5.42
Pb	11.9	3.16
Se	34.2	9.42
V	29.5	8.04
Zn	63.8	17.1

So, how do sediment trace elements compare to observed suspended concentrations?

Comparing Suspended and Reservoir Sediments: Because 0.45-µm filtration total suspended solids (TSS) analyses were run on water samples collected with sediments for the May 1998 sampling, a comparison between aqueous particulate Hg and sediment Hg can be made. By dividing suspended Hg concentrations (in ng/L) by TSS (in mg/L), µg/kg suspended concentrations can be compared to sediment data.

Table 12 summarizes the results for suspended total-Hg and Me-Hg and shows that suspended particulates have total-Hg concentrations from 3.2 times (at Station 8 outflow) to 5.2 times greater than observed sediment concentrations. Me-Hg shows

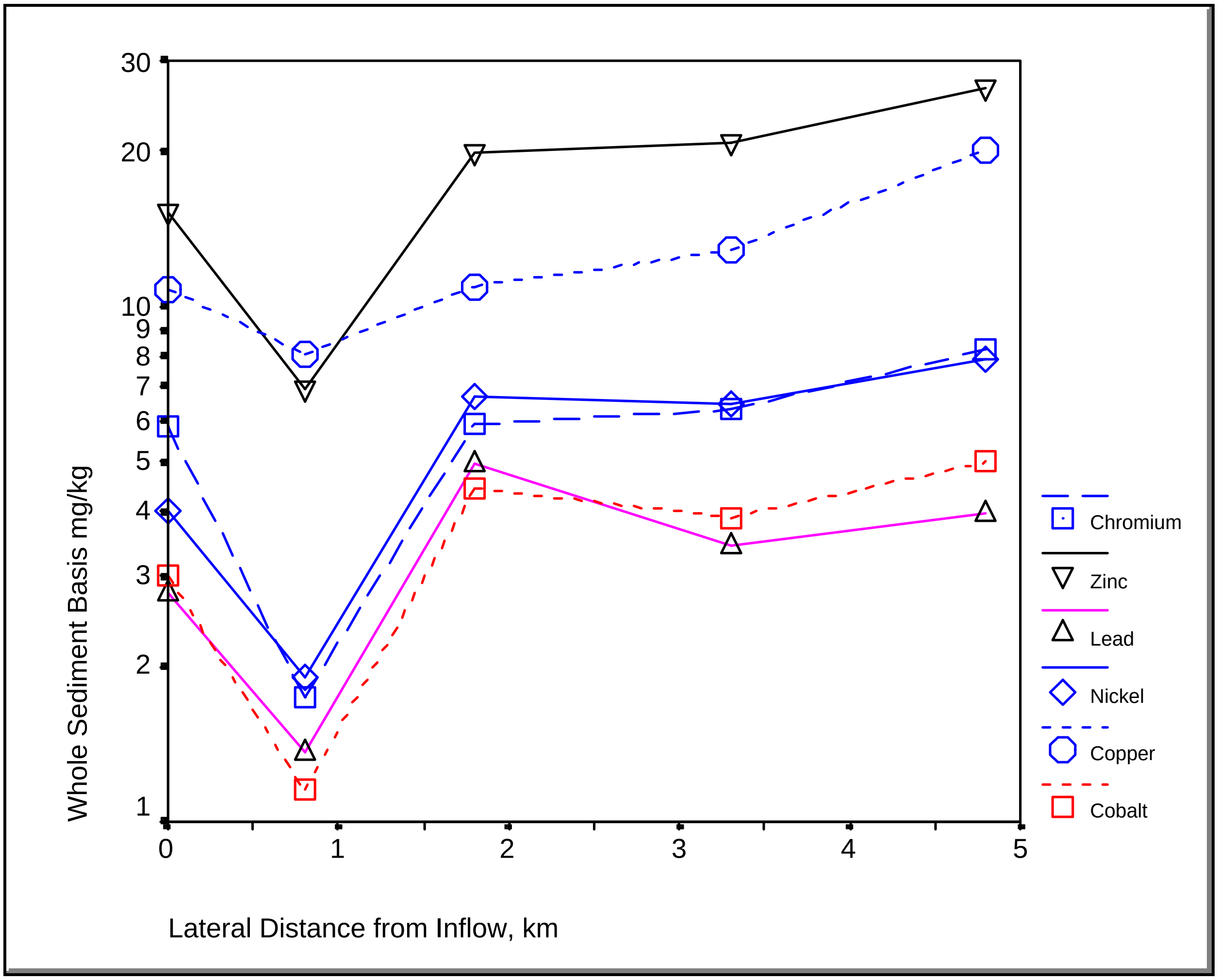


Figure 17a.—Whole weight basis concentrations of particulate trace elements observed in reservoir sediments within 5 km of the inflow vs. lateral distance from the Owyhee River inflow.

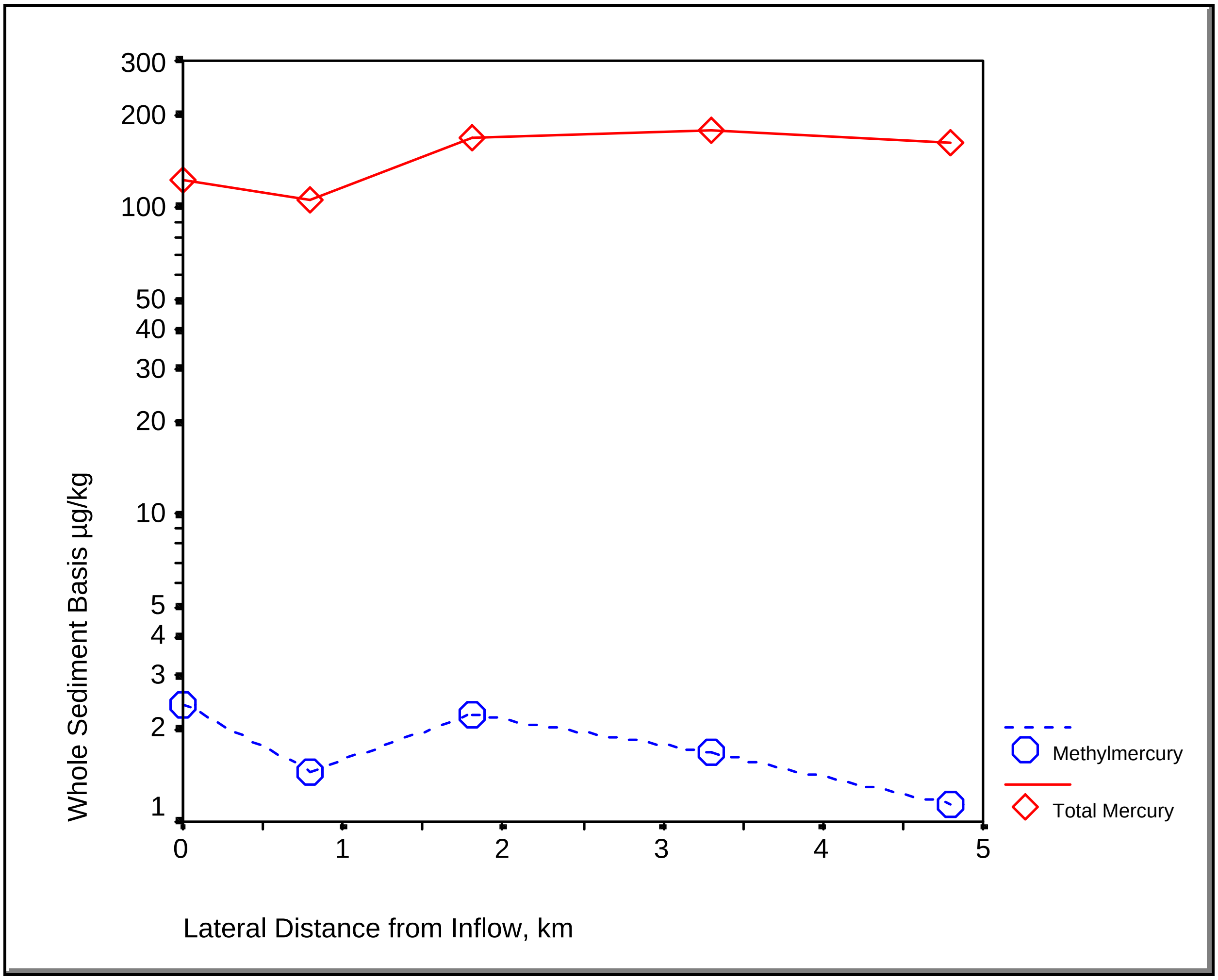


Figure 17b.—Whole weight basis concentrations for mercury and methylmercury observed in reservoir sediments within 5 km of the inflow vs. lateral distance from the Owyhee River inflow.

Station 1 suspended:settled ratios of 3.0 to 3.7, while Station 8 (same date) outlfow water suspended materials have a Me-Hg suspended:settled ratio of less than 1. These data suggest that incoming spring suspended particulates are enriched with Hg relative to in-place sediments in the river/lake inflow mixing zone. The Station 8 data, where both total-Hg and Me-Hg suspended concentrations are lower compared to Station 1, suggest that internal reservoir processes may be removing some of the Hg. However, no lake bottom sediment data from behind the dam or the Owyhee River at Station 8 are available for comparisons similar to table 12. Also, because reservoir turnover rates and transport hydrodynamics are not known, suspended sediment concentrations behind the dam may represent time-lagged lower concentration inflows from earlier in the season.

Table 12.—A comparison of Lake Owyhee spring 1998 suspended Hg data and average dry-weight Hg concentrations observed in sediments from Station s1. Measurement of 0.45-µm filtration TSS, in mg/L, provided the means to convert unfiltered and filtered total-Hg and Me-Hg in ng/L to µg/kg

Sample	TSS 0.45-µm mg/L	Suspended Aqueous Total-Hg µg/kg	Total-Hg Sediment Total-Hg µg/kg	Total-Hg suspended: settled RATIO	Suspended Aqueous Me-Hg µg/kg	Me-Hg Sediment Me-Hg µg/kg	Me-Hg suspended: settled RATIO
Station 1	30.3	993	190	5.23	13.6	3.72	3.66
	32.0	919	190	4.84	11.3	3.72	3.04
Station 8	29.5	603	190	3.17	3.22	3.72	0.866

A visual comparison of the relative proportions of trace elements in suspended particulates and reservoir sediments may be see in figures 18a and 18b. Here, summer inflow suspended sediment data at Rome, spring reservoir suspended sediment data at Station 1, and spring reservoir outflow suspended sediment data at Station 8 are compared to the spring lake sediment averages. All trace element proportion data in figures 18a and 18b were based on scaling each element's average data relative to the maximum trace element concentration, which was Fe for all water and sediment samples. For these gravimetric (not molar) comparisons, all Hg concentrations, measured in ng/L for waters and in µg/kg for sediments, were multiplied by 1,000. Note that Fe = 1.0 in every radial diagram.

The summer inflow water - which contains lower trace element concentrations compared to the reservoir (see table 10 above) - does not have the same relative proportions of trace elements compared to the other diagrams. The relative

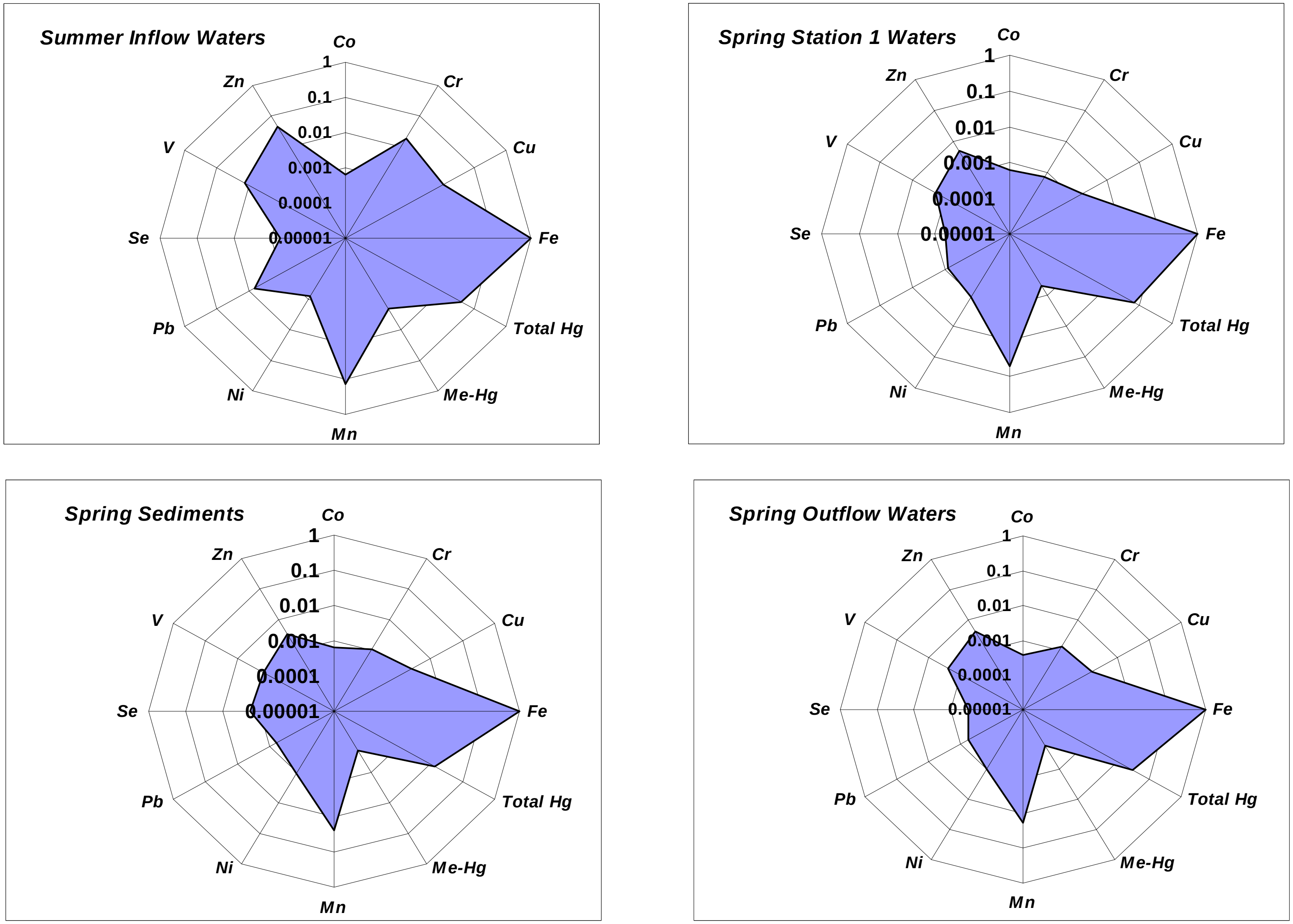


Figure 18a.—Summer inflow and spring average reservoir and outflow suspended trace element relative proportions, compared with Lake Owyhee sediment proportions. Data are proportionally scaled to the maximum concentration value to allow visual comparison of multivariate shapes (Hg = 1000x).

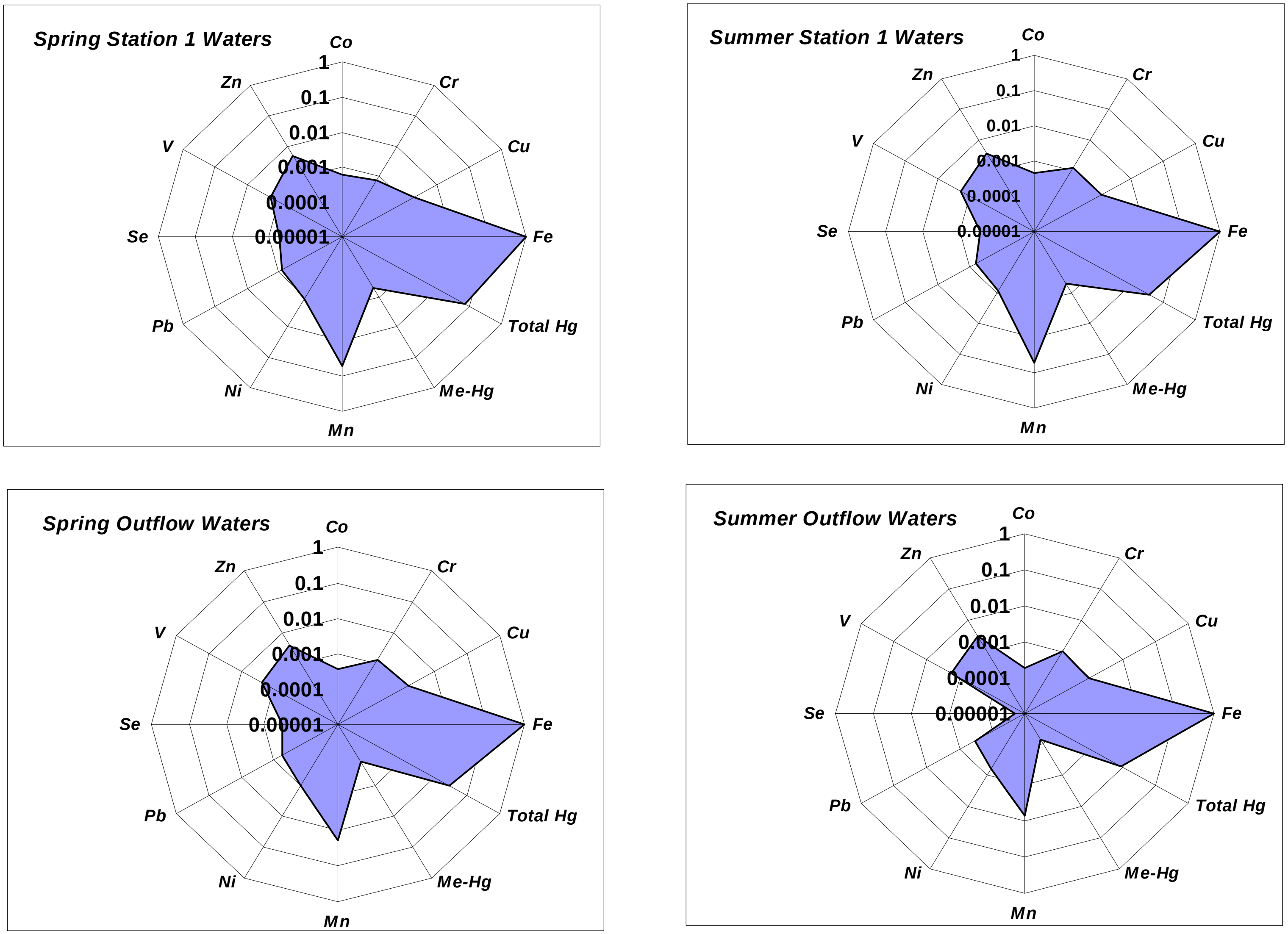


Figure 18b.—Comparing Spring and Summer suspended trace element proportions.

proportions of Cr, Cu, Pb, V, and Zn in suspended sediments are higher relative to Station 1 and Station 8 suspended proportions, as well as the spring lake sediment proportions. By contrast, note that the Station 1 and Station 8 suspended proportions more closely resemble lake sediment proportions. The similarity in trace element proportions seen in Lake Owyhee suspended data and the reservoir sediments suggests that the higher observed Lake concentrations relative to the Rome inflow data may be caused by internal reservoir processes. The current data, however, are not definitive or conclusive - they may just as well indicate that the lake sediments are similar to the suspended materials. There may, indeed, be additional loading between Rome and Lake Owyhee, or internal reservoir processes (such as anaerobic reduction in sediments) and mixing and resuspension of sediments by inflow turbulence and wind may be producing higher lake concentrations. Additional sampling in the Owyhee River reach between Rome and the Lake may help resolve these questions.

Comparison to Oregon Water Quality Criteria

The State of Oregon Department of Environmental Quality (ODEQ) has classified the Owyhee River downstream of Owyhee Dam as having “good” water quality (state of Oregon, 1998), with an average Oregon Water Quality Index of 87 out of 100, with a slight trend towards deteriorating water quality for the years 1986-1995 (Cude, 1995). ODEQ noted that Lake Owyhee was classified as eutrophic (Johnson, 1985), which was thought to account for “moderately high levels” of total-P, NH_3, and NO_3 observed during the 1986-1995 period. In accordance with the Clean Water Act, Section 303(d), Oregon regulates water quality in water bodies by applying total maximum daily load (TMDL) calculations, which represent concentrations times daily flow volumes, to waterbodies identified as *water quality limited* (State of Oregon, 1997). While the Owyhee River (both downstream from the dam and upstream from the reservoir) and Lake Owyhee have been identified on Oregon’s 1998 303(d) list of water quality limited waterbodies for one or more parameters, TMDLs have not yet been determined or implemented. Table 13 provides a conservative comparison of Lake Owyhee unfiltered maximum observed concentrations for measured constituents that are regulated by concentration criteria for all Oregon waterbodies.

Note that dissolved oxygen, not included in table 13, was observed near zero at the top of the Station 5 mesolimnion, and percent saturation levels are often below 50 percent in deeper samples during warm months. Freshwater aquatic life criteria were violated only by maximum unfiltered observed concentrations for Fe (chronic criteria = 1,000 µg/L) and Hg (chronic criteria = 0.012 µg/L). In fact, unfiltered total-Hg was often observed above the chronic aquatic life level (> 0.012 µg/L) during this study. No drinking water criteria were exceeded; however, maximum unfiltered As and Be exceeded LOEL (lower observed effect levels) criteria relating to water and fish injestion and fish consumption categories. The LOEL criteria are very low and may be conservative given the very low dissolved Lake Owyhee As and Be concentrations observed in this study. Maximum unfiltered Mn (158 µg/L at Station one on 8/14/97) exceeded the water and fish injestion criteria of 50 µg/L; however, overall average reservoir Mn was 54.2 µg/L, with overall median Mn = 32.2 µg/L, and spring average Mn = 37.3 µg/L.

Table 13.—Maximum observed Lake Owyhee unfiltered concentrations with State of Oregon water quality criteria summary (State of Oregon, 1997). Boldface Lake Owyhee data exceed one of the Freshwater Aquatic Life Criteria levels, and italicized data exceed one of the human health protection criteria levels

					Protection of Human Health Criteria, µg/L		
Compound µg/L (unfilt.)	Lake Owyhee Maximum Pollutant	Freshwater Priority Acute	Aquatic Life Criteria, µg/L Chronic		Water and Fish Injestion (and/or)	Fish Consumption Only	Drinking Water MCL
NH_3	0.570	N					
Sb	0.431	Y	9,000	1,600	146	45,000	
As	*13.8*	Y			0.0022 [R]	0.0175 [R]	50
Be	*0.203*	Y	130 [LL]	5.3 [LL]	0.0068 [R]	0.117 [R]	
Cd	0.0705	Y	3.9 *	1.1 *	10		10
Cr VI	5.40	Y	16	11	50		50
Cr III	5.40	N	1,700 *	210 *	170,000	3,433,000	50
Cu	5.35	Y	18 *	12 *			
Fe	**2920**	N		1,000	300		
Pb	1.67	Y	82 *	3.2 *	50		50
Mn	*158*	N			50	100	
Hg	**0.140**	Y	2.4	0.012	0.144	0.146	2.0
Ni	2.91	Y	1,400 *	160 *	13.4	100	
NO_3	0.510	N			10,000		10,000
Se	0.389	Y	260	35	10		10
Ag	0.0530	Y	4.1 *	0.12	50		50
Tl	0.0425	Y	1,400 [LL]	40 [LL]	13	48	
Zn	9.31	Y	120 *	110 *			

[R] = human health criteria for carcinogens at 10^{-6} risk level.
* = hardness-based value (assuming TH = 100 mg/L)
[LL] = criteria value not developed, value is lower observed effect level (LOEL)

SUMMARY AND RECOMMENDATIONS

The following conclusions are suggested by the results of this study:

1. The timing of sampling in this study appears to be reasonably representative of average minimum and maximum flow conditions related to the local hydrologic cycle; however, Lake Owyhee is a long and complex water body with poorly investigated water exchange rate, mixing hydrodynamics, and density stratification. The available Hydrolab profiles and the major ions data suggest that the deeper reservoir water column stratifies readily and that time-lagged transport, subsurface density flows, and degrees of mixing may strongly influence the chemistry and productivity.

2. Suspended particulates are clearly visible throughout the water bodies of the Lake Owyhee watershed. The suspended particulate matter appears to be stable in the reservoir water column and does not appreciably settle out during lake residence, as evidenced by the consistently milky appearance of the Owyhee River below the dam. Statistically significant linear correlations were observed between unfiltered Hg, P, and other trace elements, vs. turbidity, showing a direct relationship between loading and suspended materials. Strong summer reservoir temperature-density stratification and wind mixing of the epilimnion further prevent settling and results in the collection of particulates and the development of anoxia at the mesolimnion density layer mid-lake and farther downstream.

3. Algal blooms and anaerobic conditions in sediments are corroborated by measured nutrient concentrations of N, P, Si, and C. DOC is elevated and plentiful for microbial uptake during metabolism, and no doubt contributes to Lake Owyhee's overall trophic state, and probably exacerbates food chain bioaccumulation of Hg and other organic-bound compounds.

4. Application of ultra-clean sampling, filtration, and analysis procedures produced very high quality data sets for Hg, Me-Hg, and trace elements. Unfiltered total-Hg consistently exceeds the Oregon freshwater chronic water quality criterion; however, Hg dissolved species and Me-Hg are present at very low ng/L concentrations. The low Hg and Me-Hg concentrations are, however, sufficient to result in food chain bioaccumulation leading to fish consumption advisories by Idaho and Oregon

State public heath agencies. Elevated DOC and high primary and secondary productivity combine to produce conditions in the water column and sediments of Lake Owyhee that are conducive to biotic methylation of Hg at the lower levels of the food chain. The organic-rich bottom sediments also probably develop anaerobic, chemically reducing conditions that suggest another potential source of internal loading of adsorbed inorganic Hg and Me-Hg available to biota.

5. The filtered and unfiltered water quality data suggest that the suspended fraction (adsorbed on particulates) is an important aqueous species for many constituents, and likely the dominant vector for transport of P (40-50 percent), Hg (80-90 percent), and most other trace elements into Lake Owyhee. Reasonably strong correlations are observed between turbidity and suspended data. Among trace elements, the adsorbed fraction is a minor species (< 20 percent) for only As, Sb, and U. Silicon (~95percent) and Al (66-85percent), important mineral elements, are also dominantly suspended. Nitrogen species are dominated by dissolved organic-N (40-45 percent, likely associated with the DOC), and suspended-N and NO_3 account for around 20-30 percent each of molar concentrations.

   Results from the MINTEQA2 model, run with average Lake Owyhee dissolved (filtered) concentrations, suggest that inorganic Hg is dominantly suspended (81-90 percent), and with the dissolved hydroxide species ($Hg(OH)_2$, from 8-16 percent) represent the major Hg species in Lake Owyhee waters. Methylmercury, both suspended and dissolved, accounts only for around 1 percent of total-Hg, and suspended forms range from 1.3 to 2.9 times dissolved forms. Actual measured concentrations of unfiltered total-Hg in Lake Owyhee range from 4.83 to 140 ng/L (a wide range), with mean = 36.9 ng/L and median = 20.4 ng/L (for n=17). Roughly similar distributions of species probably apply to Owyhee River inflow waters; however, unfiltered total-Hg concentrations were much lower and more narrowly range from 2.25 to 17.3 ng/L, with an OR-2 mean = 8.24 ng/L.

   Additional MINTEQA2 results suggest that DOC, largely composed of fulvic acid, is an important arbiter of trace element speciation. Fulvate complexes with most cationic elements and represents an important dissolved trace element species. Fulvate complexes are important for Cd (22-49 percent), Cu (~49 percent), Ni (25-43 percent), and Zn (14-45 percent), suggesting that other trace elements besides Hg may be bioaccumulating through the food chain by their association with DOC.

6. A comparison of Owyhee River inflow station data above and below the confluence with Jordan Creek suggests that this inflow is a significant source of Hg, Me-Hg, and several other constituents. Samples collected at Station OR-2, below the confluence, show evidence of a Hg-concentration mixing plume, with higher concentrations observed on the Jordan Creek inflow side of the Owyhee River. Because Jordan Creek is not flow gaged, the contributions from this sub basin relative to the rest of the Rome Gage drainage basin cannot be determined with high accuracy. Given that the Jordan Creek sub basin accounts for only 16 percent of the Rome Gage drainage surface area, the increased Hg observed below the confluence suggests that Jordan Creek is an important Hg source.

7. Reservoir concentrations were elevated relative to inflow water sampled at Rome, Oregon, for most nutrients, Hg, and trace elements. These data suggest that either that additional loading occurs in the 85-km reach between Rome and Lake Owyhee, or that the reservoir sediments and wind mixing contribute to internal loading. The elevated Zn observed at Station 1gs, along with literature reports of Hg in volcanic groundwater, suggest that geothermal inputs may have contributed to some of the observed increases between Rome and Lake Owyhee. Also, given that the surface geology immediately downstream from Station OR-2 contains exposed lava flows and there are numerous surface runoff sources between Rome and Lake Owyhee, contributions from surface runoff cannot be dismissed.

   On the other hand, reservoir bottom sediments within five km of the river inflow contain anaerobic muds, suggesting potential internal loading of trace elements adsorbed to hydrous iron and manganese oxides on particle surfaces during periods of thermal stratification. While lake sediments and reservoir suspended particulates show similar proportional distributions of trace elements, (suggesting internal loading), additional study is needed to resolve this anomaly and to better partition loading between internal and external sources.

Suggested Future Studies

While this study has produced important and previously unavailable information about the chemistry in Lake Owyhee, there are considerable gaps in knowledge concerning this large watershed and complex reservoir. Very little is known about the overall mixing and transport hydrodynamics of Lake Owyhee, and this very basic information would be valuable for any future chemistry investigations. The status of lake stratification during winter is unknown. Additional Hydrolab profiles collected on a more regular schedule throughout the water year would provide a much better understanding of how seasonal temperature, inflows, and releases at the dam interact with seasonal air temperatures near the lake and in other watershed locations.

Important information resolving the internal-external loading question could be obtained from a limited study collecting spring samples from the Owyhee River immediately upstream from the lake (and at Station 1 in the lake). Ultra-clean sampling ahould be used and very low ng/L level Hg, Me-Hg, and ICP-MS trace elements should be determined on filtered and unfiltered samples. Similar concentrations in the river and the lake would suggest external loading occuring somewhere between Rome and the lake, while lower river concentrations would suggest internal loading. If external loading is imdicated, then further river sampling between Rome and Lake Owyhee would be justified to better quantify localized sources. If lake concentrations are clearly higher than the river, then internal loading is indicated and further sampling and testing of inflow zone sediments and water would be justified to better understand anaerobic conditions in sediments and possible resuspension scenarios.

More complete followup investigations should address knowledge gaps regarding several biological components in the Owyhee system. These ecological components were not included in this study. Confirmation of fish tissue Hg and other trace element concentrations would be a valuable followup to previous analyses performed by the State health departments. Biological surveys of phytoplankton and fish species distributions and assessment of overall fishery health would be valuable information to relate to existing water and sediment chemistry data. Bioavailability of all trace elements could be investigated using bryophytes as as time-integrative, pre-concentrating sampling medium (Nelson and Campbell, 1995). Bryophytes can be installed in specific locations and depths in the lake or river for extended periods of exposure time, and then digested and analyzed using routine analytical methodology.

Finally, another important tool that may be applied to help unravel the loading source mystery is hyperspectral remote sensing. In 1998, the NASA Jet Propulsion Laboratory funded an overflight and spectral imaging of the near-lake Owyhee watershed using the AVIRIS (airborne visual and infrared imaging spectrometer) instrument. AVIRIS measures a complete visible and infrared spectrum for each pixel, and spectral matching analysis of these data can be used to identify and map occurences of cinnabar and hydrothermal ore bodies associated with Hg. AVIRIS was applied to an EPA Superfund remediation study at Leadville, Colorado, and successfully identified surface deposits of jarosite, a weathering product of the oxidation of pyrite, that were associated with tailings piles. The Owyhee overflight was arranged through the Department of Interior Hyperspectral Committee to help demonstrate the utility of AVIRIS. Preliminary processing of the Owyhee overflight data has been completed, and final calibration and mapping may be completed with additional funding and prioritization. Mapping of possible Hg sources between Rome and Lake Owyhee would be a valuable tool for planning future studies or monitoring, and the AVIRIS data could be combined with already existing digital land use map data of Lake Owyhee.

ACKNOWLEDGMENTS

This study was funded by Reclamation Research and Technology Transfer Program projects ER.99.21, *Environmental Chemistry of Reservoirs and Watersheds*, and ER.99.27, *Fate and Transformation of Environmental Contaminants,* and by funding from the Reclamation Pacific Northwest Region water quality program. Contributions from the following people helped make this study a success:

Cooperative Funding Support and Coordination

David Zimmer, Pacific Northwest Region, Bureau of Reclamation, Boise, Idaho.
Paul Seronko, field coordination, Bureau of Land Management, Boise Idaho.

Field and Lab Support

Norbert Cannon: boat captain, field coordination, analytical support; Bill Stroud and Jenny Smout: analytical laboratory support, Reclamation Pacific Northwest Regional Soil and Water Laboratory, Boise, Idaho. Lou DiMattia: sediment prep planning and supervision; Juli Fahy, Mike Simonavice, and Barb Frost: analytical laboratory support, Reclamation Denver Environmental Research Chemistry Laboratory, Denver, Colorado. Karl Krill: petrography, mineralogy, and SEM support, Reclamation Technical Service Center, Denver Colorado. Bruce Whitesell: digital mapping, Reclamation remote Sensing and Gegraphic Information Stystem Group, Denver, Colorado. Dr. Ralph Turner: analytical and field support, Michelle Gauthier: ICP-MS analyses, Frontier Geosciences, Inc., Seattle, Washington. Dr. Chris Holdren: peer review, Reclamation Ecological Research and Investigations Group, Denver, Colorado. Dr. James Rytuba: peer review, U.S. Geological Survey, Menlo Park, California. Dr. Mark Ferns: peer review, regional geologist, DOGAMI, Baker City, Oregon.

REFERENCES

Aiken, G.R, and R.L. Malcolm, 1987, *Molecular Weight of Aquatic Fulvic Acids by Vapor Pressure Osmometry,* Geochem. Cosmochim. Acta, 51, pp. 2177-2184.

Aiken, G.R., P.A. Brown, T.I. Noyes, and D.J. Pinckney, 1989, *Molecular size and weight of fulvic and humic acids from the Suwannee River,* in “Humic Substances in the Suwannee River, Georgia: Interactions, Properties, and Proposed Structures,” edited by R.C. Averett, et al., U.S. Geological Survey Open File Report 87-557, Denver, Colorado.

Allison, J.D., D.S. Brown, K.J. Novo-Gradac, 1991, *MINTEQA2/PRODEFA2, A Geochemical Assessment Model for Environmental Systems: Version 3.0 User's Manual*, EPA/600/3-91/021, U.S. Environmental Protection Agency, Environmental Research Laboratory, Office of Research and Development, Athens, Georgia.

American Public Health Association, 1995, *Standard Methods for the Examination of Water and Wastewater,* 19th Edition, Edited by M.A.H. Franson, A.D. Eaton, L.S. Clesceri, and A.E. Greenburg, APHA-AWWA-WEF, American Public Health Association, Washington, DC.

Averett, R.C., J.A. Leenheer, D.M. McKnight, and K.A. Thorn, editors, 1987, *Humic Substances in the Suwannee River, Georgia: Interactions, Properties, and Proposed Structures*, U.S. Geological Survey Open File Report 87-557, Denver, Colorado.

Bloom, N., 1989, *Determination of Picogram Levels of Methylmercury by Aqueous Phase Ethylation, Followed by Cryogenic Gas Chromatography with Cold Vapour Atomic Fluorescence Detection*, Can. J. Fish. Aquat. Sci., Vol. 46, pp. 1131-1140.

Bloom, N.S., 1990, *On the chemical form of mercury in edible fish and marine invertebrate tissue,* Can. J. Aquat. Sci., Vol. 49, pp. 1010-1017.

Bloom, N.S. and M. Horvat, 1995, *Results of the International Aqueous Mercury Speciation Exercise*, Wat. Air, Soil. Pollut., Vol. 80, p. 1257.

Bloom, N.S., 1996, *Method 1631: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry,* US EPA Report Number 821-R-95-027, Environmental Protection Agency, Office of Water, Washington, DC.

Bowles, E.C., R.C. Antweiler, and P. MacCarthy, 1989, *Acid-base titration and hydrolysis of fulvic acid from the Suwannee River,* in "Humic Substances in the Suwannee River, Georgia: Interactions, Properties, and Proposed Structures," edited by R.C. Averett, et al., U.S. Geological Survey Open File Report 87-557, Denver, Colorado.

Bureau of Reclamation, 1981, *Project Data*, U.S. Department of the Interior, Water and Power Resources Service (Bureau of Reclamation), pp. 733-738, US Government Printing Office, Washington, DC.

Craft, D., 1994, *unpublished research reseults.*

Cude, C., 1995, *Oregon Water Quality Index Report for the Malheur and Owyhee Basins: Water years 1986-1995,* State of Oregon, Department of Environmental Quality, Corvallis, Oregon.

Deer, W.A., R.A. Howie, and J. Zussman, 1977, *An Introduction to the Rock-Forming Minerals,* Longman Group, Ltd., London.

Drever, J.I., 1988, *The Geochemistry of Natural Waters,* Second Edition, Prentice Hall, Englewood Cliffs, NJ, p 310.

Dzombak, D.A., and F.M.M. Morel, 1990, *Surface Complexation Modeling: Hydrous Ferric Oxide*, John Wiley and Sons, New York, pp. 103-109.

Eisler, R., 1987, *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Department of the Interior, Fish and Wildlife Service, Biological Report 85(1.10), Laurel, Maryland.

Environmental Protection Agency, 1982, *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA-600/4-82-029, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati OH, 1982.

Environmental Protection Agency, 1983, *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, U.S. Environmental Protection Agency, Cincinnati OH.

Environmental Protection Agency, 1986, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, 3rd Edition: Proposed Update I and II, U.S. Environmental Protection Agency, Washington DC.

Environmental Protection Agency, 1993, *Guidance for assessing chemical contaminant data for use in fish advisories, Volume 1: Fish Sampling and Analysis*, EPA/823/B-93/002.

Environmental Protection Agency, 1994, *Guidance for assessing chemical contaminant data for use in fish advisories, Volume 2: Risk Assessment and fish consumption limits*, EPA/823/B-94/004.

Environmental Protection Agency, 1996a, *Mercury in Water by Oxidation, Purge and Traps, and Cold Vapor Atomic Fluorescence Spectrometry*, EPA Method 1631, USEPA Office of Water, Engineering and Analysis Division, Washington, DC.

Environmental Protection Agency, 1996b, *Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma - Mass Spectrometry*, EPA Method 1638, EPA/821/R-96-005, Office of Water, Engineering and Analysis Division, Washington, DC.

Environmental Protection Agency, 1996c, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels*, EPA Method 1669, EPA 821-R-96-011, Office of Water, Engineering and Analysis Division, Washington, DC.

Ferns, M.L., and D.F. Huber, 1984, *Mineral Resources Map of Oregon*. GMS-36, 1:500,000 scale map, Oregon Department of Geology and and Mineral Industries, Portland, Oregon.

Forstner, U. and G. Whitmann, 1979, *Metal Pollution in the Aquatic Environment*, Springer-Verlag, New York.

Gebhards, S., et al., 1971, *Mercury Residues in Idaho Fishes -1970*, in “Mercury in the Western Environment”, edited by Buhler, workshop proceedings, Portland, Oregon.

Gilbert, R.O., 1987, *Statistical Methods for Environmental Pollution Monitoring,* Van Nostrand Reinhold, New York, pp 177-179.

Gilliom, R.J., R.M. Hirsch, and E.J. Gilroy, 1984, *Effect of censoring trace-level water-quality data on trend-detection capability*, Environ. Sci. Technol., Vol. 5, pp 530-535.

Hays, M.H.B., P. MacCarthy, R.L. Malcolm, and R.S. Swift, editors, 1989, *Humic Substances II: In Search of Structure,* John Wiley and Sons, Chichester, United Kingdom.

Hem, J.D., 1985, *Study and Interpretation of the Chemical Characteristics of Natural Waters,* 3rd Edition, USGS Water Supply Paper 2254, U.S. Government Printing Office, Washington, DC.

Hill, S. et al., 1973, *Study of mercury and heavy metals pollutants in the Jordan Creek Drainage*, unpublished report, College of Mines, University of Idaho, Moscow, Idaho.

Horowitz, A.J., 1985, *A Primer on Trace Metal-Sediment Chemistry,* U.S. Geological Survey Water-Supply Paper 2277.

Jackson, M., 1979, *Soil Chemical Analysis - Advanced Course,* 2nd Edition, published by the author.

Jensen, S., and A. Jernelov, 1969, *Biological methylation of mercury in aquatic organisms,* Nature, Vol. 23, pp. 753-754.

Jensen, S., and A. Jernelov, 1972, *Behavior of Mercury in the Environment,* Chapter 4 in “Mercury Contamination in Man and the Environment”, United Nations World Health Organization, International Atomic Energy Agency, Vienna, Austria, Technical Report 9.

Johnson, D.M., R.R. Petersen, et al., 1985, *Atlas of Oregon Lakes*, Oregon State University Press, Corvallis, Oregon.

Keith, L.H., W. Crummett, J. Deegan, Jr., R.A. Libby, J.K. Taylor, and G. Wentler, 1983, *Principles of Environmental Analysis*, Analytical Chemistry, Vol. 55, pp. 2210-2218.

Koerber, S., 1995, *Mercury in the Owyhee River Basin Oregon, Idaho, and Nevada,* Oregon Department of Environmental Quality, Mercury Working Group, Portland, Oregon.

Leenheer, J.A., D.M. McKnight, E.M. Thurman, and P. MacCarthy, 1989, *Structural Components and proposed structural models of fulvic acid from the Suwannee River,* in "Humic Substances in the Suwannee River, Georgia: Interactions, Properties, and Proposed Structures," edited by R.C. Averett, et al., U.S. Geological Survey Open File Report 87-557, Denver, Colorado.

Leenheer, J.A., R.L. Wershaw, and M.M. Reddy, 1995a, *Strong Acid, Carboxyl-Group Structures in Fulvic Acid from the Suwannee River, Georgia. 1. Minor Structures,* Environ. Sci. Technol., Vol. 29, pp. 393-398.

Leenheer, J.A., R.L. Wershaw, and M.M. Reddy, 1995b, *Strong Acid, Carboxyl-Group Structures in Fulvic Acid from the Suwannee River, Georgia. 1. Major Structures,* Environ. Sci. Technol., Vol. 29, pp. 399-405.

Leenheer, J.A., G.K. Brown, P. MacCarthy, and S.E. Cabaniss, 1998, *Models of Metal Binding Structures in Fulvic Acid from the Suwannee River, Georgia,* Environ. Sci. Technol. Vol. 32, pp. 2410-2416.

Lion, L.W., R.S. Altmann, and J.O. Leckie, 1982, *Trace metal adsorption characteristics of estuarine particulate matter: evaluation of contributions of Fe/Mn oxide and organic surface coatings,* Environ. Sci. Technol., Vol. 16 pp. 660-666.

Martel, A.E., and R.M. Smith, 1976, *Critical Stability Constants, Volume 3: Other Organic Ligands,* Plenum, New York.

Morel, F.M.M., and J.G. Hering, 1993, *Principles and Applications of aquatic Chemistry,* John WIley and Sons, New York, 1993, pp. 338-343.

National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration, and United States Air Force, 1976, *U.S Standard Atmosphere,* Superintendant of Documents, U.S. Government Printing Office, Washington DC.

Nehls, G.J. and G.G. Akland, 1973, *Procedures for Handling Aerometric Data,* Journal of the Air Pollution Control Association, , Vol. 23, pp 180-184.

Nelson, S.M., and S.G. Campbell, 1995, *Integrated Assessment of Metals Contamination in a Lotic System Using Water Chemistry, Transplanted Bryophytes, and Macroinvertebrates*, J. Freshwater Ecology, vol. 10, no. 4, pp. 409-420.

Pitard, F.E., 1993, *Pierre Gy's Sampling Theory and Sampling Practice: Heterogeneity, Sampling Correctness, and Statistical Process Control*, Second Edition, CRC Press, Boca Raton, Florida.

Ramsey, Charles, 1998, *Defensible Environmental Decisions*, classroom materials for couse, EnviroStat, Inc, Eugene, Washington.

Rinella, F.A., W.H. Mullins, and C.A. Schuler, 1994, *Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Owyhee and Vale Projects, Oregon and Idaho, 1990-1991*, U.S. Geological Survey, Water Resources Investigations Report 93-4156.

Rogers, R.D., 1977, *Abiological Methylation of Mercury in Soils,* J. Environ. Qual., Vol. 6, No. 4, pp.463-467.

Rytuba, J.J., and D.B. Vander Muelen, 1991, *Hot-Spring Precious-Metal Systems in the Lake Owyhee Volcanic Field, Oregon-Idaho*, Symposium Proceedings: Geology and Ore Deposits of the Great Basin, April 1990, ed. By Raines, et al., Geological Society of Nevada and U.S Geological Survey, Reno, Nevada.

Rytuba, J.J., 1995, *Geo-environmental Mercury Problems in the Context of the Global Mercury Cycle,* CEGG Short Course Notes, U.S. Geological Survey, Menlo Park, California.

Schindler, P.W. and W. Stumm, 1987, *The Surface Chemistry of Oxides, Hydroxides, and Oxide Minerals*, Chapter 4 in "Aquatic Surface Chemistry: Chemical Processes at the Particle-Water Interface," edited by Werner Stumm, John Wiley and Sons, New York, pp.83-110..

Seronko, Paul, 1995, *Studies Related to Mercury in the Owyhee River Drainage Area,* U.S. Bureau of Land Management, Boise, Idaho, unpublished internal report.

Sorenson, J.A. *et.al.*, 1990, *Airborne mercury deposition and watershed characteristics in relation to mercury concentrations in water, sediments, plankton, and fish of eighty Northern Minnesota lakes,* Environ. Sci. Technol. Vol. 24, pp. 1716-1727.

State of Oregon, 1997, Water Quality Standards and Beneficial Uses - Division 41, Oregon Administrative Rules (OAR) Chapter 340, OAR 340-041-0001 to 340-041-0975, Table 16 (Owyhee Basin 340-41-842), Table 20, *Water Quality Criteria Summary,* 340-041-845(p).

State of Oregon, 1998, *Oregon's 1998 Water Quality Status Assessment Report: Section 305(b) Report*, Oregon Department of Environmental Quality, 811 SW Sixth Avenue, Portland, Oregon 97204.

Stiff, H.A.,Jr., 1951, *The Interpretation of Chemical Water Analysis by Means of Patterns*, Journal of Petroleum Technology, Vol. 3, pp. 15-17.

Stone, A.T. and J.J. Morgan, 1987, *Reductive Dissolution of Metal Oxides,* Chapter 9 in “Aquatic Surface Chemistry: Chemical Processes at the Particle-Water Interface,” edited by Werner Stumm, John Wiley and Sons, New York, pp.221-254.

Stumm, W. (editor), 1987, *Aquatic Surface Chemistry: Chemical Processes at the Particle-Water Interface*, John Wiley and Sons, New York.

Stumm, W. and J.J. Morgan, 1996, *Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters,* Third Edition, Wiley-Interscience, John Wiley and Sons, Inc, New York.

Thurman, E.M., 1985, *Organic Geochemistry of Natural Waters,* Martinus Nijhoff/Dr W. Junk Publishers, Dordrecht, The Netherlands, 1985.

Williams, G.A., L.L. Mink, et al., 1974., *Mercury and Heavy Metal Contamination in the Jordan Creek Drainage near Silver City, Owyhee County, Idaho,* in “Proceedings of the 12th Annual Engineering Geology and Soils Engineering Symposium”, pp.253-272, Idaho Transportation Department, Boise, Idaho.

Zhang, L. and D. Planas, 1994, *Biotic and Abiotic Mercury Methylation and Demethylation in Sediments,* Bull. Environ. Contam. Toxicol., Vol. 52, pp. 691-698.

Appendix 1

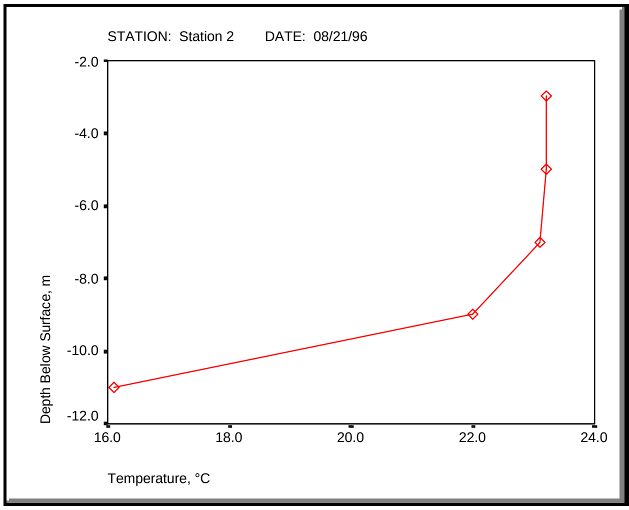
Hydrolab Profile Data, 1996-1998

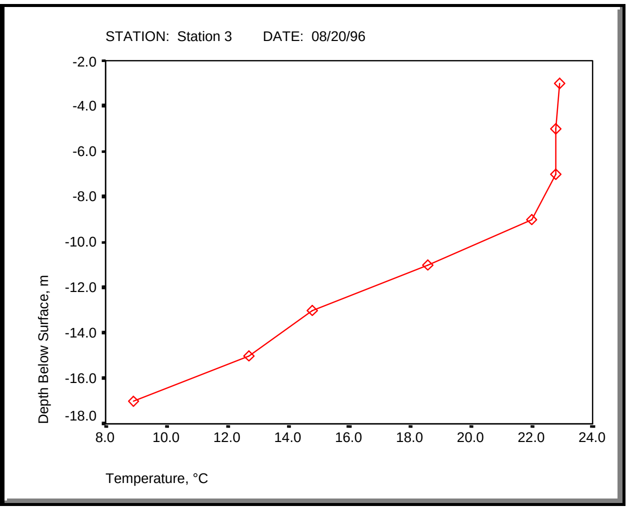
APPENDIX 1

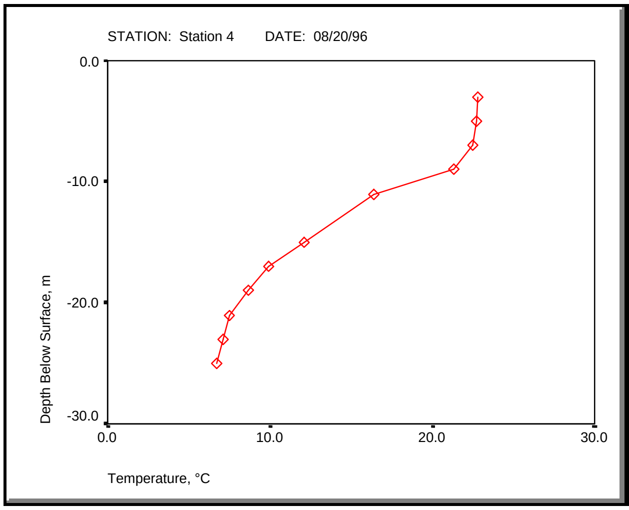
Lake Owyhee Hydrolab Profile Data: 1996-1998

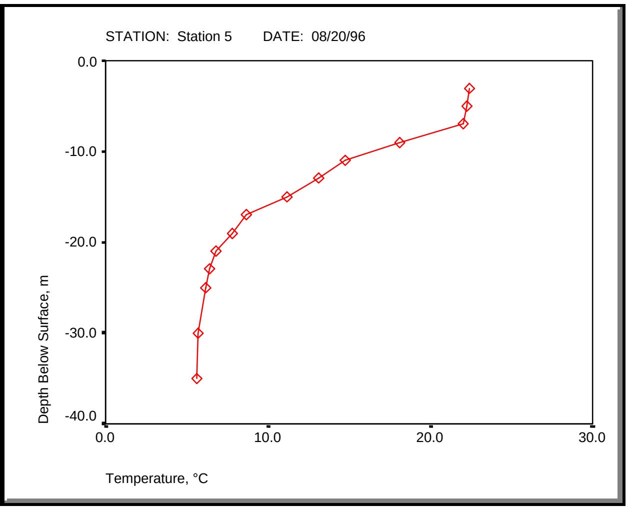
Figure A1-1 Temperature profiles for August 1996. Note varying scales.

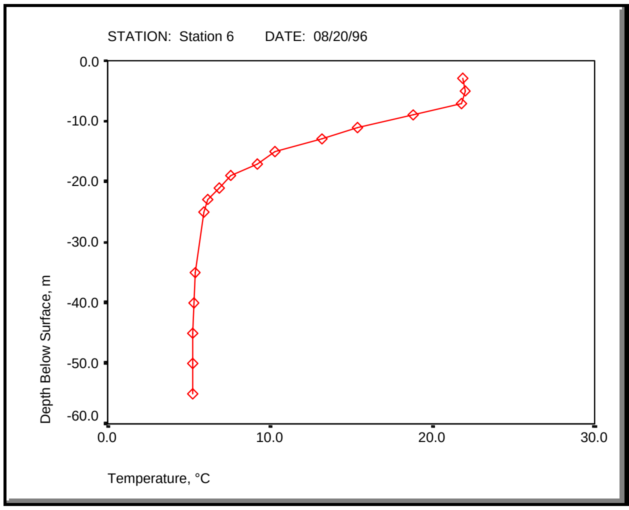
Figure A1-2 Dissolved Oxygen profiles for August 1996. Note varying scales.











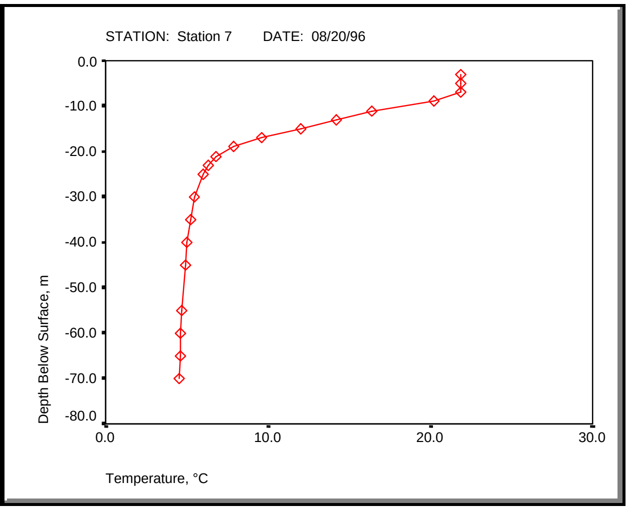


Figure A1-3 Conductivity profiles for August 1996. Note varying scales.

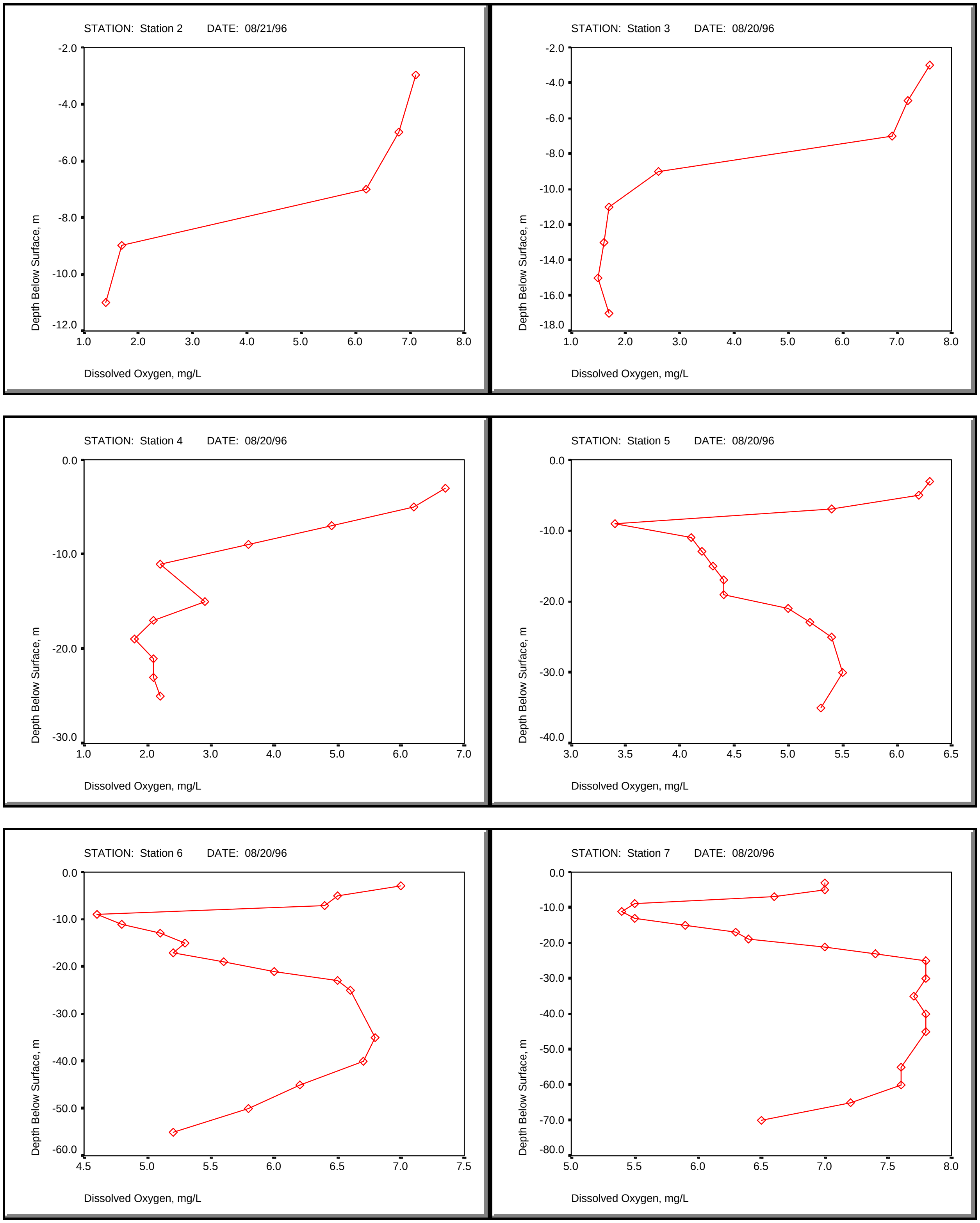


Figure A1-4 pH profiles for August 1996. Note varying scales.

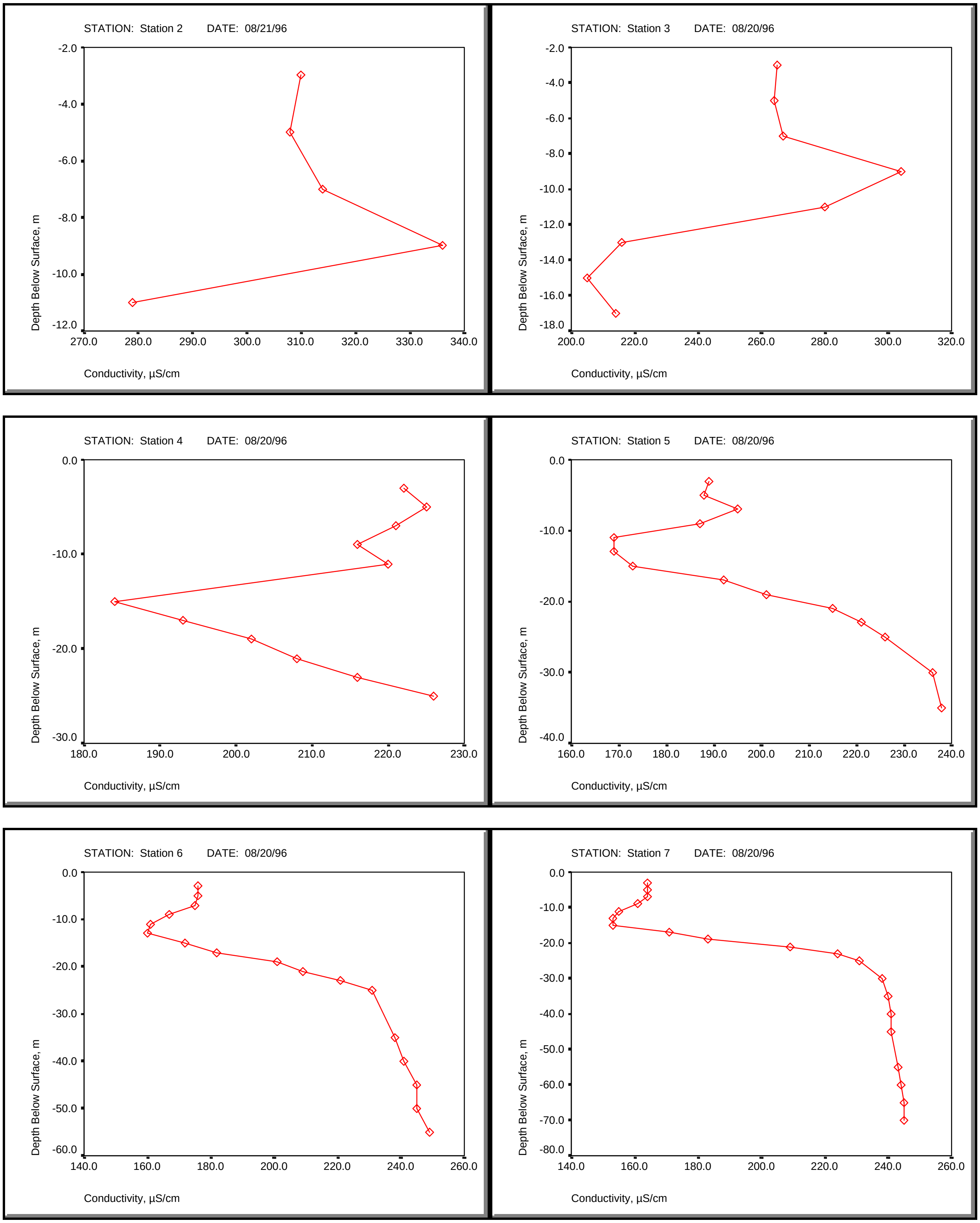
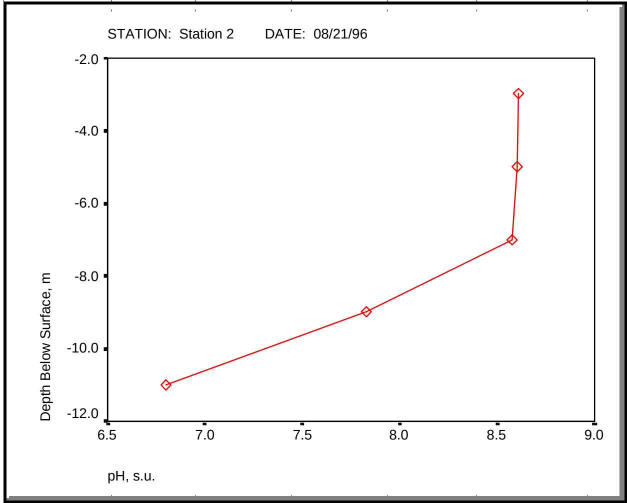
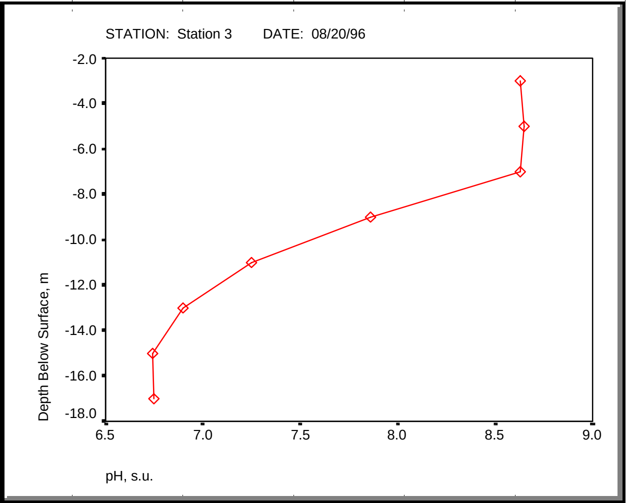
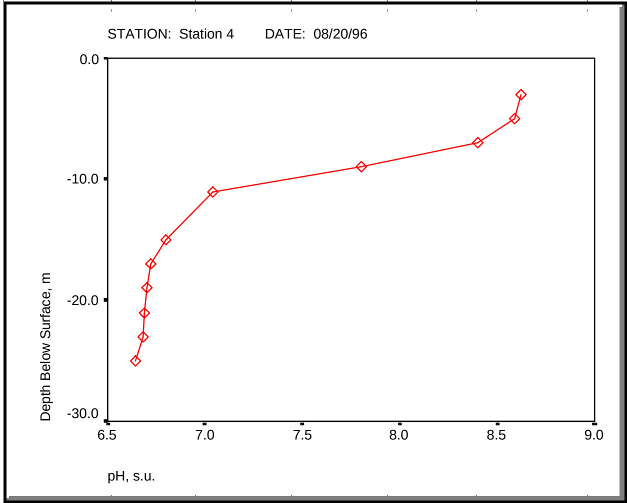


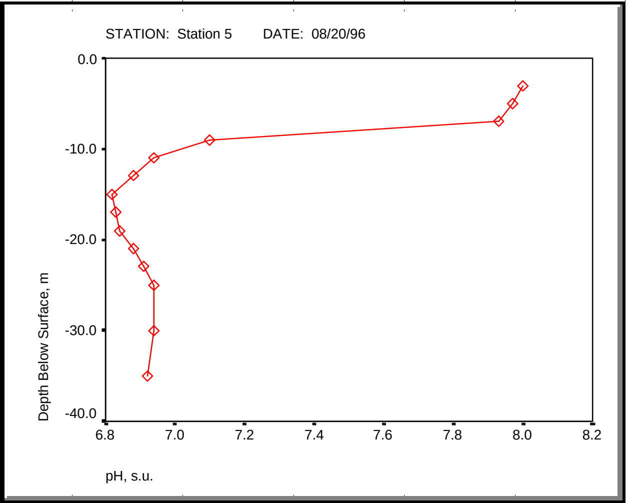
Table A1-1 Summary of Hydrolab probe measurements grouped by station.

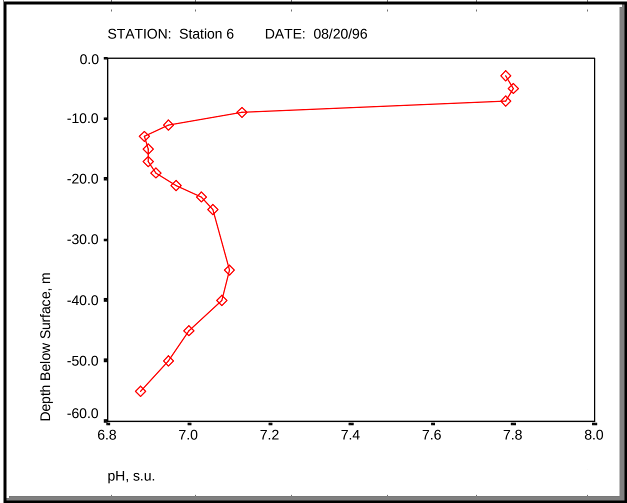
		Lateral	*Max*		*Secci*						*Turbidity,*
Station	*Date*	*Dist, km*	*Depth, m*		*Depth, m*	*T, °C*	*pH, s.u.*	*DO, mg/L*	*EC, µS/cm*	*Eh, mV*	*NTU*

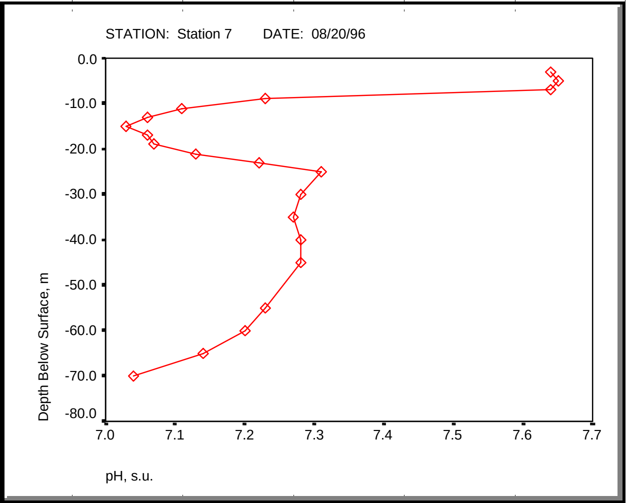












Station 1	08/21/96	2.60	-5.00	***n***		2	2	2	2		
				Min		20.9	8.35	7.50	360		
				Max		21.3	8.41	8.10	360		
				Range		0.40	0.06	0.600	.00		
				Mean		21.1	8.38	7.80	360		
	05/05/97	2.60	-3.60	***n***	2.0	2	2	2	2	2	2
				Min	0.3	12.8	7.26	9.60	169	228	46.0
				Max	0.3	12.9	7.42	9.60	169	230	47.3
				Range	0.0	0.10	0.16	0.00	0.00	2.00	1.30
				Mean	0.3	12.9	7.34	9.60	169	229	46.7
	08/14/97	2.60	-1.60	***n***	2.0	2	2	2	2	2	
				Min	0.2	24.9	8.40	4.10	467	52.0	
				Max	0.2	25.6	8.64	6.50	472	68.0	
				Range	0.0	0.70	0.24	2.40	5.00	16.0	
				Mean	0.2	25.3	8.52	5.30	470	60.0	
		Station 1 Summary		***n***	4.0	6	6	6	6	4	2
				Min	0.2	12.8	7.26	4.10	169	52.0	46.0
				Max	0.3	25.6	8.64	9.60	472	230	47.3
				Range	0.1	12.8	1.38	5.50	303	178	1.30
				Mean	0.2	19.7	8.08	7.57	333	145	46.7
Station 2	08/21/96	13.1	-11.0	***n***		5	5	5	5		
				Min		16.1	6.80	1.40	279		
				Max		23.2	8.61	7.10	336		
				Range		7.10	1.81	5.70	57.0		
				Mean		21.5	8.08	4.64	309		
Station 3	08/20/96	19.9	-17.0	***n***		8	8	8	8		
				Min		8.90	6.74	1.50	205		
				Max		22.9	8.65	7.60	304		
				Range		14.0	1.91	6.10	99.0		
				Mean		18.2	7.68	3.85	252		
Station 4	05/23/96	28.1	-29.0	***n***	11.0	11	11	11	11	11	
				Min	1.1	5.94	7.35	8.10	143	62.0	
				Max	1.1	15.4	7.76	9.70	210	86.0	
				Range	0.0	9.46	0.410	1.60	66.8	24.0	
				Mean	1.1	10.8	7.51	8.59	166	75.2	
	08/20/96	28.1	-25.0	***n***		11	11	11	11	11	
				Min		6.70	6.64	1.80	184	52.0	
				Max		22.8	8.62	6.70	226	111	
				Range		16.1	1.98	4.90	42.0	59.0	
				Mean		14.3	7.33	3.35	212	88.0	
		Station 4 Summary		***n***	11.0	22	22	22	22	22	
				Min	1.1	5.94	6.64	1.80	143	52.0	
				Max	1.1	22.8	8.62	9.70	226	111	
				Range	0.0	16.9	1.98	7.90	82.8	59.0	
				Mean	1.1	12.6	7.42	5.97	189	81.6	

Station	Date	Lateral Dist, km	Max Depth, m		Secci Depth, m	T, °C	pH, s.u.	DO, mg/L	EC, µS/cm	Eh, mV	Turbidity, NTU
Station 5	08/20/96	37.3	-35.1	***n***		14	14	14	14	14	
				Min		5.60	6.82	3.40	169	66.0	
				Max		22.4	8.00	6.30	238	111	
				Range		16.8	1.18	2.90	69.0	45.0	
				Mean		12.2	7.14	4.94	200	97.2	
	05/05/97	37.3	-48.7	***n***	18	18	18	18	18	18	18
				Min	0.5	4.90	7.09	8.90	143	217	21.3
				Max	0.5	12.3	7.31	10.1	217	225	41.4
				Range	0.0	7.40	0.22	1.20	74.0	8.00	20.1
				Mean	0.5	7.98	7.19	9.37	175	221	31.1
	08/14/97	37.3	-27.8	***n***	12	12	12	12	12	12	
				Min	1.6	5.90	6.94	0.05	181	68.0	
				Max	1.6	24.3	8.37	5.90	340	117	
				Range	0.0	18.4	1.43	5.85	159	49.0	
				Mean	1.6	15.1	7.46	3.78	245	80.0	
	05/07/98	37.3	-38.1	***n***	16	16	16	16	16	16	16
				Min	0.8	5.45	7.00	9.03	164	127	12.6
				Max	0.8	17.9	7.86	9.73	246	133	23.9
				Range	0.0	12.5	0.86	0.70	82.0	6.00	11.3
				Mean	0.8	8.86	7.61	9.36	215	130	19.7
		Station 5 Summary		***n***	46	60	60	60	60	60	34
				Min	0.5	4.90	6.82	0.050	143	66.0	12.6
				Max	1.6	24.3	8.37	10.1	340	225	41.4
				Range	1.1	19.4	1.55	10.1	197	159	28.8
				Mean	0.9	10.6	7.34	7.21	206	140	25.7
Station 6	08/20/96	45.3	-55.0	***n***		17	17	17	17	17	
				Min		5.20	6.88	4.60	160	71.0	
				Max		22.0	7.80	7.00	249	104	
				Range		16.8	0.92	2.40	89.0	33.0	
				Mean		10.9	7.12	5.90	203	91.0	
Station 7	08/20/96	60.4	-70.0	***n***		20	20	20	20	20	
				Min		4.50	7.03	5.40	153	70.0	
				Max		21.9	7.65	7.80	245	103	
				Range		17.4	0.62	2.40	92.0	33.0	
				Mean		10.2	7.24	6.89	203	89.4	
	05/05/97	60.4	-79.4	***n***	24	24	24	24	24	24	24
				Min	0.4	4.60	7.06	9.00	172	211	21.9
				Max	0.4	11.4	7.46	10.2	242	223	34.0
				Range	0.0	6.80	0.40	1.20	69.4	12.0	12.1
				Mean	0.4	6.99	7.36	9.90	214	220	26.1
	08/14/97	60.4	-82.2	***n***		22	22	22	22	22	
				Min		4.70	7.30	1.00	153	-31.0	
				Max		22.9	8.42	8.00	478	141	
				Range		18.2	1.12	7.00	325	172	
				Mean		10.4	7.64	6.44	337	118	
	05/07/98	60.4	-81.0	***n***	28.0	28	28	28	28	28	28
				Min	1.6	4.50	7.64	8.40	231	121	8.80
				Max	1.6	17.40	7.99	10.0	279	132	22.0
				Range	0.0	12.9	0.35	1.60	48.0	11.0	13.2
				Mean	1.6	7.39	7.82	9.43	247	127	17.7
		Station 7 Summary		***n***	52.0	94	94	94	94	94	52
				Min	0.4	4.50	7.03	1.00	153	-31.0	8.80
				Max	1.6	22.9	8.42	10.2	478	223	34.0
				Range	1.2	18.4	1.39	9.20	325	254	25.2
				Mean	1.0	8.59	7.54	8.31	250	141	21.6

Station	Date	Lateral Dist, km	Max Depth, m		Secci Depth, m	T, °C	pH, s.u.	DO, mg/L	EC, µS/cm	Eh, mV	Turbidity, NTU
Station 8	05/05/97	61.4	0.0	***n***		1	1	1	1	1	1
				Min		10.3	7.32	11.2	181	185	26.1
				Max		10.3	7.32	11.2	181	185	26.1
				Range		0.00	0.00	0.00	0.00	0.00	0.00
				Mean		10.3	7.32	11.2	181	185	26.1
	08/14/97	61.4	0.0	***n***		1	1	1	1	1	
				Min		7.45	7.68	9.33	367	107	
				Max		7.45	7.68	9.33	367	107	
				Range		0.00	0.00	0.00	0.00	0.00	
				Mean		7.45	7.68	9.33	367	107	
	05/07/98	61.4	0.0	***n***		1	1	1	1	1	1
				Min		6.87	7.20	12.0	238	124	23.6
				Max		6.87	7.20	12.0	238	124	23.6
				Range		0.00	0.00	0.00	0.00	0.00	0.00
				Mean		6.87	7.20	12.0	238	124	23.6
		Station 8 Summary		***n***		3	3	3	3	3	2
				Min		6.87	7.20	9.33	181	107	23.6
				Max		10.3	7.68	12.0	367	185	26.1
				Range		3.43	0.48	2.64	186	78.0	2.50
				Mean		8.21	7.40	10.8	262	139	24.9
Station s1	05/07/98	0.00	-2.80	***n***		3	3	3	3	3	3
				Min		17.1	7.00	8.40	157	128	29.4
				Max		17.3	7.23	8.50	159	128	32.0
				Range		0.20	0.23	0.10	2.00	0.00	2.60
				Mean		17.2	7.13	8.43	158	128	31.1
	05/08/98	0.0	-1.70	***n***	2	2	2	2	2	2	
				Min	0.4	17.6	6.99	8.00	161	142	
				Max	0.4	17.6	7.14	8.00	161	145	
				Range	0.0	0.00	0.15	0.00	0.00	3.00	
				Mean	0.4	17.6	7.07	8.00	161	143	
Station s2	05/08/98	.80	-5.70	***n***	6	6	6	6	6	6	
				Min	0.5	17.6	7.01	7.90	160	127	
					0.5	17.8	7.43	8.30	161	130	
				Range	0.0	0.20	0.42	0.40	1.00	3.00	
				Mean	0.5	17.6	7.27	8.03	161	130	
Station s3	05/08/98	1.80	-6.00	***n***	6	6	6	6	6	6	
				Min	0.5	17.9	7.13	7.40	159	128	
				Max	0.5	19.1	7.42	8.50	162	132	
				Range	0.0	1.20	0.29	1.10	3.00	4.00	
				Mean	0.5	18.3	7.33	7.83	161	130	
Station s4	05/08/98	3.30	-7.80	***n***	5	5	5	5	5	5	
				Min	0.6	14.4	7.24	3.50	159	125	
				Max	0.6	19.1	7.41	8.40	183	135	
				Range	0.0	4.70	0.17	4.90	24.0	10.0	
				Mean	0.6	17.3	7.35	6.82	165	128	
Station s5	05/08/98	4.80	-8.80	***n***	5	5	5	5	5	5	
				Min	0.4	11.9	7.29	1.50	160	119	
				Max	0.4	20.0	7.45	9.50	198	134	
				Range	0.0	8.10	0.16	8.00	38.0	15.0	
				Mean	0.4	16.9	7.36	6.70	169	125	
ALL STATIONS/ ALL DATE SUMMARY				***n***	137	242	242	242	242	227	93
				Min	0.2	4.50	6.64	0.05	143	-31.0	8.80
				Max	1.6	25.6	8.65	12.0	478	230	47.3
				Range	1.5	21.1	2.01	11.9	335	261	38.5
				Mean	0.9	11.5	7.45	7.36	224	130	24.0

Appendix 2

Chemical Data Summaries from Lake Owyhee

APPENDIX 2

Chemical Data Summaries from Lake Owyhee Reservoir, Inflow, and Ouflow Water Samples 1996-1999

Data arranged by field data, major ions, nutrients, mercury, suspended particulate trace elements, then toxic trace elements grouped by reservoir, and inflow - outflow samples

Table A2-1a Summary of field data associated with reservoir water samples collected during this study.

		Lat Dist.	***Depth***	***T***	***pH***	***DO***	***EC***	***Eh***	***Secci***	***Turbidity***
Station	***Date***	***km***	***m***	***°C***	***s.u.***	***mg/L***	***µS/cm***	***mV***	***m***	***NTU***
	SPRING DATA									
Station 1	05/05/97	2.60	-1.00	12.9	7.26	9.60	170	230	0.3	47.0
	05/07/98	2.60	0.00	17.3	7.00	8.50	157	128	0.4	29.4
	05/07/98	2.60	0.00							
	05/07/98	0.00	0.00							
	05/07/98	0.00	0.00							
		Station 1	***n***	2	2	2	2	2	2	2
			Min	12.9	7	8.50	157	128	0.3	29.4
			Max	17.3	7.26	9.60	170	230	0.4	47.0
			Mean	15.1	7.13	9.05	164	179	0.325	38.2
			Range	4.40	0.260	1.10	13.0	102	0.150	17.6
Station 5	05/05/97	37.30	-1.00	12.3	7.31	10.1	146	218	0.5	21.4
Station 7	05/05/97	60.40	-1.00	11.4	7.06	10.2	172	222	0.4	28.9
	SPRING SUMMARY		***n***	*4*	*4*	*4*	*4*	*4*	*4*	*4*
			Min	*11.4*	*7*	*8.50*	*146*	*128*	*0.3*	*21.4*
			Max	*17.3*	*7.31*	*10.20*	*172*	*230*	*0.5*	*47.0*
			Mean	***13.5***	***7.16***	***9.60***	***161***	***200***	***0.388***	***31.7***
			Median	*12.6*	*7.160*	*9.85*	*163*	*220*	*0.400*	*29.2*
			Range	*5.90*	*0.310*	*1.70*	*26.0*	*102*	*0.250*	*25.6*
			s	*2.62*	*0.151*	*0.779*	*12.1*	*47.9*	*0.103*	*10.9*
	SUMMER DATA									
Station 1	08/21/96	2.60	-2.99	21.3	8.41	8.10	360		0.3	12.0
	08/14/97	2.60	0.00	25.6	8.64	6.50	467	68.0	0.2	52.0
	08/14/97	2.60	0.00							
		Station 1	***n***	2	2	2	2		2	2
			Min	21.3	8.41	6.50	360		0.2	12.0
			Max	25.6	8.64	8.10	467		0.3	52.0
			Mean	23.45	8.525	7.30	413	68.0	0.225	32.0
			Median	23.45	8.525	7.30	413		0.225	32.0
			Range	4.30	0.230	1.60	107		0.150	40.0
			s	3.04	0.163	1.13	75.7		0.106	28.3
Station 2	08/21/96	13.1	-1.00	23.3	8.62	7.40	308		0.3	35.0
	08/21/96	13.1	-5.00	23.2	8.6	6.80	308		0.3	16.0
	08/21/96	13.1	-12.1	16.0	6.74	1.20	280		0.3	11.0
		Station 2	***n***	3	3	3	3		3	3
			Min	16.0	6.74	1.20	280		0.3	11.0
			Max	23.3	8.62	7.40	308		0.3	35.0
			Mean	20.8	7.99	5.13	298		0.300	20.7
			Median	23.2	8.60	6.80	308			16.0
			Range	7.30	1.88	6.20	28.0		0.00	24.0
			s	4.19	1.08	3.42	16.2		0.00	12.7

		Lat Dist.	***Depth***	***T***	***pH***	***DO***	***EC***	***Eh***	***Secci***	***Turbidity***
Station	***Date***	***km***	***m***	***°C***	***s.u.***	***mg/L***	***µS/cm***	***mV***	***m***	***NTU***
Station 3	08/21/96	19.9	-1.00	22.9	8.58	8.10	263		0.5	13.0
	08/21/96	19.9	-9.00	22.0	7.86	2.60	304		0.5	10.0
	08/21/96	19.9	-19.5	8.70	6.74	1.40	215		0.5	18.0
		Station 3	***n***	3	3	3	3		3	3
			Min	8.70	6.74	1.40	215		0.5	10.0
			Max	22.9	8.58	8.10	304		0.5	18.0
			Mean	17.9	7.73	4.03	261		0.5	13.7
			Median	22.0	7.86	2.60	263			13.0
			Range	14.2	1.84	6.70	89.0		0.00	8.00
			s	7.95	0.927	3.57	44.5		0.00	4.04
Station 4	08/20/96	28.1	-1.00	23.3	8.66	7.50	220	52.0	0.8	10.0
	08/20/96	28.1	-13.0	14.1	6.89	3.00	185	97.0	0.8	7.00
	08/20/96	28.1	-26.6	6.70	6.68	2.10	225	112	0.8	29.0
		Station 4	***n***	3	3	3	3	3	3	3
			Min	6.70	6.68	2.10	185	52	0.8	7.00
			Max	23.3	8.66	7.50	225	112	0.8	29.0
			Mean	14.7	7.41	4.20	210	87.0	0.800	15.3
			Median	14.1	6.89	3.00	220	97.0	0.800	10.0
			Range	16.6	1.98	5.40	40.0	60.0	0.00	22.0
			s	8.32	1.09	2.89	21.79	31.2	0.00	11.9
Station 5	08/20/96	37.3	-1.00	22.8	8.02	6.50	189	65.0	1.5	5.00
	08/20/96	37.3	-21.0	6.80	6.88	5.00	215	108	1.5	14.0
	08/20/96	37.3	-40.0	5.60	6.99	5.00	240	106	1.5	16.0
	08/14/97	37.3	-1.00	24.3	8.30	5.90	191	117	1.6	5.00
	08/14/97	37.3	-17.0	8.70	7.01	3.60	163	71.0	1.6	28.0
	08/14/97	37.3	-32.0	5.90	7.14	5.30	199	78.0	1.6	34.0
		Station 5	***n***	6	6	6	6	6	6	6
			Min	5.6	6.88	3.60	163	65.0	1.5	5.00
			Max	24.3	8.30	6.50	240	117	1.6	34.0
			Mean	12.4	7.39	5.22	199	90.8	1.55	17.0
			Median	7.75	7.08	5.15	195	92.0	1.55	15.0
			Range	18.7	1.42	2.90	77.0	52.0	0.100	29.0
			s	8.76	0.609	0.983	26.1	22.1	0.0548	11.9
Station 6	08/20/96	45.3	-1.00	22.0	7.78	7.40	176	73.0	1.6	6.00
	08/20/96	45.3	-30.0	5.60	7.10	6.80	235	96.0	1.6	12.0
	08/20/96	45.3	-58.0	5.20	6.79	3.40	260	74.0	1.6	15.0
		Station 6	***n***	3	3	3	3	3	3	3
			Min	5.20	6.79	3.40	176	73.0	1.6	6.00
			Max	22.0	7.78	7.40	260	96.0	1.6	15.0
			Mean	10.9	7.22	5.87	224	81.0	1.60	11.0
			Median	5.60	7.10	6.80	235	74.0	1.60	12.0
			Range	16.8	0.990	4.00	84.0	23.0	0.00	9.00
			s	9.59	0.506	2.16	43.1	13.0	0.00	4.58
Station 7	08/20/96	60.4	-1.00	21.9	7.62	7.20	164	75.0		6.00
	08/20/96	60.4	-50.0	4.70	7.25	7.80	242	96.0		11.0
	08/20/96	60.4	-72.0	4.50	6.98	6.00	246	104		12.0
	08/14/97	60.4	-1.00	22.9	8.42	6.70	161	113	1.8	7.00

		Lat Dist.	***Depth***	***T***	***pH***	***DO***	***EC***	***Eh***	***Secci***	***Turbidity***
Station	***Date***	***km***	***m***	***°C***	***s.u.***	***mg/L***	***µS/cm***	***mV***	***m***	***NTU***
	08/14/97	60.4	-39.9	5.20	7.60	8.00	220	129	1.8	19.0
	08/14/97	60.4	-49.8	4.90	7.60	7.90	229	132	1.8	16.0
		Station 7	***n***	6	6	6	6	6	3	6
			Min	4.50	6.98	6.00	161	75	1.8	6.00
			Max	22.9	8.42	8.00	246	132	1.8	19.0
			Mean	10.7	7.58	7.27	210	108	1.80	11.8
			Median	5.05	7.60	7.50	224	109		11.5
			Range	18.4	1.44	2.00	85.0	57.0	0.00	13.0
			s	9.08	0.485	0.794	38.2	21.4	0.00	5.04
SUMMER SUMMARY			***n***	*26*	*26*	*26*	*26*	*19*	*23*	*26*
			Min	*4.50*	*6.68*	*1.20*	*161*	*52.0*	*0.2*	*5.00*
			Max	*25.6*	*8.66*	*8.10*	*467*	*132*	*1.8*	*52.0*
			Mean	***14.5***	***7.61***	***5.66***	***241***	***92.9***	***1.08***	***16.1***
			Median	*15.1*	*7.60*	*6.50*	*227*	*96.0*	*1.50*	*12.5*
			Range	*21.1*	*1.98*	*6.90*	*306*	*80.0*	*1.65*	*47.0*
			s	*8.38*	*0.721*	*2.21*	*68.1*	*23.1*	*0.612*	*11.1*
RESERVOIR SUMMARY			***n***	*30*	*30*	*30*	*30*	*23*	*27*	*30*
			Min	*4.5*	*6.68*	*1.20*	*146*	*52.0*	*0.2*	*5.00*
			Max	*25.6*	*8.66*	*10.2*	*467*	*230*	*1.8*	*52.0*
			Mean	***14.4***	***7.55***	***6.19***	***230***	***111***	***0.974***	***18.2***
			Median	*13.5*	*7.29*	*6.75*	*220*	*104*	*0.800*	*14.5*
			Range	*21.1*	*1.98*	*9.00*	*321*	*178*	*1.65*	*47.0*
			s	*7.84*	*0.689*	*2.47*	*69.1*	*49.5*	*0.617*	*12.2*

Table A2-1b Summary of field data associated with Owyhee River inflow, reservoir outflow, and the single geothermal source sampled in this study.

		Lateral Distance	*T*	*pH*	*DO*	*EC*	*Eh*	*Turbidity*
Station	***Date***	***km***	***°C***	***s.u.***	***mg/L***	***µS/cm***	***mV***	***NTU***
INFLOW DATA								
Station OR-1	09/08/98	-88.5	22.6	7.74	7.4	303	164	4.00
	04/14/99		9.30	7.84	10.5	109	224	46.0
All OR-1		n	2	2	2	2	2	2
		Min	9.30	7.74	7.4	109	164	4.00
		Max	22.6	7.84	10.5	303	221	46.0
		Range	11.9	0.1	2.9	194	57	42.0
Station OR-2	09/08/98	-84.1	22.5	7.60	7.70	318	157	6.90
	04/14/99		9.20	7.81	10.5	109	250	42.0
All OR-2		n	2	2	2	2	2	2
		Min	9.20	7.60	7.70	109	157	6.90
		Max	22.5	7.81	10.5	318	250	42.0
		Range	11.7	0.210	2.80	209	97.0	35.1
INFLOW SUMMARY		***n***	4	4	4	4	4	4
		Min	9.2	7.6	7.4	109	157	4.00
		Max	22.6	7.84	10.5	318	250	46.0
		Range	13.4	0.240	3.10	209	93.0	42.0
OUTFLOW DATA								
Station 8	08/21/96	61.4	8.30	7.58	11.2	216	.	11.0
	08/14/97		7.40	7.68	9.30	195	107	27.0
Summer Station 8		n	2	2	2	2	1	2
		Min	7.40	7.58	9.30	194	107	11.0
		Max	8.30	7.68	11.2	216	107	27.0
		Range	0.900	0.100	1.90	22.0	0.00	16.0
	05/05/97	61.4	10.3	7.32	11.2	181	185	26.1
	05/05/97							
	05/07/98		6.87	7.20	12.0	238	124	23.6
Spring Station 8		n	2	2	2	2	2	2
		Min	6.87	7.20	11.2	181	124	23.6
		Max	10.3	7.32	12.0	238	185	26.1
		Range	3.43	0.120	0.770	57.0	61.0	2.50
OUTFLOW SUMMARY		***n***	*4*	*4*	*4*	*4*	*4*	*4*
		Min	*6.87*	*7.20*	*9.30*	*181*	*107*	*11.0*
		Max	*10.3*	*7.68*	*12.0*	*238*	*185*	*27.0*
		Range	*3.43*	*0.48*	*2.67*	*57.0*	*78.0*	*16.0*
GEOTHERMAL SAMPLE								
Station 1gs	08/14/97	6.70	35.0	9.00	.	605	.	2.00

Table A2-2a Summary of major ions data associated with reservoir water samples collected during this study.

		Lat Dist.	***Depth***	***pH***	***Ca***	***Mg***	***Na***	***K***	***CO3***	***HCO3***	***SO4***	***Cl***	***Sum***
Station	***Date***	***km***	***m***	***s.u.***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
	SPRING DATA												
Station 1	05/05/97	2.60	-1.00	7.26	15.2	4.40	10.9	2.40	0.00	81.0	10.50	3.80	115
	05/07/98	2.60	0.00	7.00	14.3	3.70	10.8	2.30	0.00	76.0	8.20	3.50	113
	05/07/98	2.60	0.00		14.2	3.70	10.9	2.40	0.00	76.0	8.10	3.50	115
	05/07/98	0.00	0.00										
	05/07/98	0.00	0.00										
		Station 1	***n***	2	3	3	3	3	3	3	3	3	3
			Min	7.00	14.2	3.70	10.8	2.30	0.00	76.0	8.10	3.50	113
			Max	7.26	15.2	4.40	10.9	2.40	0.00	81.0	10.5	3.80	115
			Mean	7.13	14.6	3.93	10.9	2.44	0.00	77.7	8.93	3.60	114
			Median	7.13	14.3	3.70	10.9	2.40		76.0	8.20	3.50	115
			Range	0.260	1.00	0.700	0.100	0.100	0.00	5.00	2.40	0.300	2.00
			s	0.184	0.551	0.404	0.0577	0.0577	0.00	2.89	1.36	0.173	1.15
Station 5	05/05/97	37.3	-1.00	7.31	12.0	3.50	10.8	2.50	0.00	68.0	10.2	3.80	103
Station 7	05/05/97	60.4	-1.00	7.06	13.1	3.80	14.8	2.70	0.00	77.0	12.6	4.80	117
		SPRING	***n***	*4*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*7.00*	*12.0*	*3.50*	*10.8*	*2.30*	*0.00*	*68.0*	*8.10*	*3.50*	*103*
			Max	*7.31*	*15.2*	*4.40*	*14.8*	*2.70*	*0.00*	*81.0*	*12.6*	*4.80*	*117*
			Mean	***7.16***	***13.8***	***3.82***	***11.6***	***2.46***	***0.00***	***75.6***	***9.92***	***3.88***	***112***
			Median	*7.16*	*14.2*	*3.70*	*10.9*	*2.40*		*76.0*	*10.2*	*3.80*	*115*
			Range	*0.310*	*3.20*	*0.900*	*4.00*	*0.400*	*0.00*	*13.0*	*4.50*	*1.30*	*14.0*
			s	*0.151*	*1.23*	*0.342*	*1.77*	*0.152*	*0.00*	*4.72*	*1.86*	*0.536*	*5.55*

		Lat Dist.	***Depth***	***pH***	***Ca***	***Mg***	***Na***	***K***	***CO3***	***HCO3***	***SO4***	***Cl***	***Sum***
Station	***Date***	***km***	***m***	***s.u.***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
	SUMMER DATA												
Station 1	08/21/96	2.60	-3.00	8.41	21.5	6.50	46.9	4.90	7.38	151	28.8	13.0	243
	08/14/97	2.60	0.00	8.64	23.6	6.90	39.5	5.00	12.8	147	19.7	11.3	227
	08/14/97	2.60	0.00										
		Station 1	***n***	2	2	2	2	2	2	2	2	2	2
			Min	8.41	21.5	6.50	39.5	4.90	7.38	147	19.7	11.3	227
			Max	8.64	23.6	6.90	46.9	5.00	12.8	151	28.8	13.0	243
			Mean	8.53	22.6	6.70	43.2	4.95	10.1	149	24.3	12.2	235
			Median	8.53	22.6	6.70	43.2	4.95	10.1	149	24.3	12.2	235
			Range	0.230	2.10	0.400	7.40	0.100	5.42	4.00	9.10	1.70	16.0
			s	0.163	1.48	0.283	5.23	0.0707	3.83	2.83	6.43	1.20	11.3
Station 2	08/21/96	13.1	-1.00	8.62	22.9	6.50	33.7	4.60	15.7	124	19.7	9.60	208
	08/21/96	13.1	-5.00	8.60	23.0	6.60	33.9	4.70	11.8	134	19.7	9.80	209
	08/21/96	13.1	-12.1	6.74	23.3	6.80	36.0	4.70	0.00	167	19.2	10.3	219
		Station 2	***n***	3	3	3	3	3	3	3	3	3	3
			Min	6.74	22.9	6.50	33.7	4.60	0.00	124	19.2	9.60	208
			Max	8.62	23.3	6.80	36.0	4.70	15.7	167	19.7	10.3	219
			Mean	7.99	23.1	6.63	34.5	4.67	9.17	142	19.5	9.90	212
			Median	8.60	23.0	6.60	33.9	4.70	11.8	134	19.7	9.80	209
			Range	1.88	0.400	0.300	2.30	0.100	15.7	43.0	0.500	0.700	11.0
			s	1.08	0.208	0.153	1.27	0.0577	8.17	22.5	0.289	0.361	6.08
Station 3	08/21/96	19.9	-1.00	8.58	21.4	6.00	25.2	3.90	10.8	113	16.8	7.70	178
	08/21/96	19.9	-9.00	7.86	21.8	6.10	26.0	3.90	0.00	138	17.3	7.90	182
	08/21/96	19.9	-19.5	6.74	17.6	4.80	18.6	3.00	0.00	112	12.0	5.80	147
		Station 3	***n***	3	3	3	3	3	3	3	3	3	3
			Min	6.74	17.6	4.80	18.6	3.00	0.00	112	12.0	5.80	147
			Max	8.58	21.8	6.10	26.0	3.90	10.8	138	17.3	7.90	182
			Mean	7.73	20.3	5.63	23.3	3.60	3.60	121	15.4	7.13	169
			Median	7.86	21.4	6.00	25.2	3.90	0.00	113	16.8	7.70	178
			Range	1.84	4.20	1.30	7.40	0.900	10.8	26.0	5.30	2.10	35.0
			s	0.927	2.32	0.723	4.06	0.520	6.24	14.7	2.93	1.19	19.2

		Lat Dist.	*Depth*	*pH*	*Ca*	*Mg*	*Na*	*K*	*CO3*	*HCO3*	*SO4*	*Cl*	*Sum*
Station	***Date***	***km***	***m***	***s.u.***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
Station 4	08/20/96	28.1	-1.00	8.66	19.2	5.10	18.7	3.10	7.87	95.0	14.4	5.80	150
	08/20/96	28.1	-13.0	6.89	19.1	5.00	17.2	3.00	0.00	106	13.9	5.10	144
	08/20/96	28.1	-26.6	6.68	17.2	4.70	21.1	3.00	0.00	100	17.3	6.60	147
		Station 4	***n***	3	3	3	3	3	3	3	3	3	3
			Min	6.68	17.2	4.70	17.2	3.00	0.00	95.0	13.9	5.10	144
			Max	8.66	19.2	5.10	21.1	3.10	7.87	106	17.3	6.60	150
			Mean	7.41	18.5	4.93	19.0	3.03	2.62	100	15.2	5.83	147
			Median	6.89	19.1	5.00	18.7	3.00	0.00	100	14.4	5.80	147
			Range	1.98	2.00	0.400	3.90	0.100	7.87	11.0	3.40	1.50	6.00
			s	1.09	1.13	0.208	1.97	0.0577	4.54	5.51	1.84	0.751	3.00
Station 5	08/20/96	37.3	-1.00	8.02	16.7	4.40	15.3	2.80	0.00	93.0	12.5	4.80	129
	08/20/96	37.3	-21.0	6.88	15.4	4.20	16.7	2.80	0.00	87.0	13.9	5.20	128
	08/20/96	37.3	-40.0	6.99	18.2	4.90	24.0	3.30	0.00	108	19.7	7.30	158
	08/14/97	37.3	-1.00	8.30	16.4	4.60	14.5	2.90	0.00	97.0	11.5	4.60	128
	08/14/97	37.3	-16.9	7.01	13.2	3.90	13.0	2.60	0.00	78.0	10.8	4.50	112
	08/14/97	37.3	-32.0	7.14	14.6	4.20	18.8	3.00	0.00	92.0	13.8	5.80	132
		Station 5	***n***	6	6	6	6	6	6	6	6	6	6
			Min	6.88	13.2	3.90	13.0	2.60	0.00	78.0	10.8	4.50	112
			Max	8.30	18.2	4.90	24.0	3.30	0.00	108	19.7	7.30	158
			Mean	7.39	15.8	4.37	17.1	2.90	0.00	92.5	13.7	5.37	131
			Median	7.08	15.9	4.30	16.0	2.85		92.5	13.2	5.00	128
			Range	1.42	5.00	1.00	11.0	0.700	0.00	30.0	8.90	2.80	46.0
			s	0.609	1.75	0.350	3.94	0.237	0.00	10.0	3.19	1.06	14.9
Station 6	08/20/96	45.3	-1.00	7.78	15.2	4.10	14.4	2.70	0.00	87.0	12.0	4.50	122
	08/20/96	45.3	-30.0	7.10	17.3	4.70	23.1	3.20	0.00	106	18.7	7.00	153
	08/20/96	45.3	-57.9	6.79	18.9	5.00	25.0	3.30	0.00	112	20.2	7.30	161
		Station 6	***n***	3	3	3	3	3	3	3	3	3	3
			Min	6.79	15.2	4.10	14.4	2.70	0.00	87.0	12.0	4.50	122
			Max	7.78	18.9	5.00	25.0	3.30	0.00	112	20.2	7.30	161
			Mean	7.22	17.1	4.60	20.8	3.07	0.00	102	17.0	6.27	145
			Median	7.10	17.3	4.70	23.1	3.20		106	18.7	7.00	153
			Range	0.990	3.70	0.900	10.6	0.600	0.00	25.0	8.20	2.80	39.0
			s	0.506	1.86	0.458	5.65	0.322	0.00	13.1	4.37	1.54	20.6

		Lat Dist.	*Depth*	*pH*	*Ca*	*Mg*	*Na*	*K*	*CO3*	*HCO3*	*SO4*	*Cl*	*Sum*
Station	***Date***	***km***	***m***	***s.u.***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
Station 7	08/20/96	60.4	-1.00	7.62	14	3.90	13.8	2.70	0.00	81.0	12.00	4.50	117
	08/20/96	60.4	-50.0	7.25	18.4	4.80	24.8	3.30	0.00	110.0	21.10	7.30	159
	08/20/96	60.4	-72.0	6.98	18.7	5.00	25.0	3.40	0.00	113.0	21.10	7.40	162
	08/14/97	60.4	-1.00	8.42	13.9	4.00	12.5	2.70	1.42	77.0	11.20	4.20	113
	08/14/97	60.4	-39.9	7.60	16.2	4.60	21.4	3.10	0.00	102.0	14.40	7.30	145
	08/14/97	60.4	-49.8	7.60	16.7	4.70	22.4	3.20	0.00	107.0	14.90	6.60	149
		Station 7	***n***	6	6	6	6	6	6	6	6	6	6
			Min	6.98	13.9	3.90	12.5	2.70	0.00	77.0	11.2	4.20	113
			Max	8.42	18.7	5.00	25.0	3.40	1.42	113	21.1	7.40	162
			Mean	7.58	16.3	4.50	20.0	3.07	0.237	98.3	15.8	6.22	140
			Median	7.60	16.5	4.65	21.9	3.15	0.000	104	14.6	6.95	147
			Range	1.44	4.80	1.10	12.5	0.700	1.420	36.0	9.90	3.20	49.0
			s	0.485	2.07	0.447	5.49	0.301	0.580	15.4	4.35	1.48	21.0
	SUMMER SUMMARY		***n***	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*
			Min	*6.68*	*13.2*	*3.90*	*12.5*	*2.60*	*0.00*	*77.0*	*10.8*	*4.20*	*112*
			Max	*8.66*	*23.6*	*6.90*	*46.9*	*5.00*	*15.7*	*167*	*28.8*	*13.0*	*243*
			Mean	***7.61***	***18.2***	***5.08***	***23.1***	***3.42***	***2.61***	***109***	***16.4***	***6.97***	***159***
			Median	*7.60*	*17.9*	*4.80*	*21.9*	*3.15*	*0.00*	*106*	*15.9*	*6.80*	*150*
			Range	*1.98*	*10.4*	*3.000*	*34.4*	*2.40*	*15.7*	*90.0*	*18.0*	*8.80*	*131*
			s	*0.721*	*3.11*	*0.949*	*8.73*	*0.752*	*4.93*	*22.9*	*4.27*	*2.28*	*36.3*
ALL RESERVOIR SUMMARY			***n***	*30*	*31*	*31*	*31*	*31*	*31*	*31*	*31*	*31*	*31*
			Min	*6.68*	*12.0*	*3.50*	*10.8*	*2.30*	*0.00*	*68.0*	*8.10*	*3.50*	*103*
			Max	*8.66*	*23.6*	*6.90*	*46.9*	*5.00*	*15.7*	*167*	*28.8*	*13.0*	*243*
			Mean	***7.55***	***17.5***	***4.87***	***21.3***	***3.26***	***2.19***	***104***	***15.4***	***6.47***	***151***
			Median	*7.29*	*17.2*	*4.70*	*18.8*	*3.00*	*0.00*	*102*	*14.4*	*5.80*	*147*
			Range	*1.98*	*11.6*	*3.40*	*36.1*	*2.70*	*15.7*	*99.0*	*20.7*	*9.50*	*140*
			s	*0.689*	*3.33*	*0.994*	*9.08*	*0.776*	*4.61*	*24.4*	*4.64*	*2.39*	*37.4*

Table A2-2b Summary of major ions data associated with Owyhee River inflow, reservoir outflow, and the single geothermal source sampled in this study.

		Lat. Dist.	***pH***	***Ca***	***Mg***	***Na***	***K***	***CO3***	***HCO3***	***SO4***	***Cl***	***F***	***Ion Sum***
Station	***Date***	***km***	***s.u.***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
INFLOW DATA		***SUMMER***											
Station OR-1	09/08/98	-88.5	7.74	21.4	6.30	32.0	3.60	3.78	134	18.3	9.50		195
		SPRING											
	04/14/99	-88.5	7.84	10.2	2.80	9.00	2.50	0.00	58.0	6.70	3.50		86.4
	Station OR-1	***n***	2	2	2	2	2	2	2	2	2		2
		Min	7.74	10.2	2.80	9.00	2.50	0.00	58.0	6.70	3.50		86.4
		Max	7.84	21.4	6.30	32.0	3.60	3.78	134	18.3	9.50		195
		Mean		15.8	4.55	20.5	3.05	1.89	96.0	12.5	6.50		141
		Range	0.10	11.2	3.50	23.0	1.10	3.78	76.0	11.6	6.00		109
		SUMMER											
Station OR-2	09/08/98	-84.1	7.60	22.2	6.70	34.7	3.80	3.78	142	19.6	9.50		204
		SPRING											
	04/14/99	-84.1	7.81	9.90	2.60	9.10	2.50	0.00	57.0	7.00	3.20		85.3
	Station OR-2	***n***	2	2	2	2	2	2	2	2	2		2
		Min	7.60	9.9	2.60	9.10	2.50	0.00	57.0	7.00	3.20		85.3
		Max	7.81	22.2	6.70	34.7	3.80	3.78	142	19.6	9.50		204
		Mean		16.1	4.65	21.9	3.15	1.89	99.5	13.3	6.35		145
		Median		16.1	4.65	21.9	3.15	1.89	99.5	13.3	6.35		145
		Range	0.210	12.3	4.10	25.6	1.30	3.78	85.0	12.6	6.30		119
		s		8.70	2.90	18.1	0.919	2.67	60.1	8.91	4.45		83.9
INFLOW SUMMARY		***n***	4	4	4	4	4	4	4	4	4		4
		Min	7.60	9.90	2.60	9.00	2.50	0.00	57.0	6.70	3.20		85.3
		Max	7.84	22.2	6.70	34.7	3.80	3.78	142	19.6	9.50		204
		Mean	7.75	15.9	4.60	21.2	3.10	1.89	97.7	12.9	6.43		143
		Median	7.78	15.8	4.55	20.6	3.05	1.89	96.0	12.7	6.50		141
		Range	0.240	12.3	4.10	25.7	1.30	3.78	85.0	12.9	6.30		119
		s	0.107	6.79	2.20	14.1	0.698	2.18	46.6	7.01	3.55		65.7

		Lat. Dist.	***pH***	***Ca***	***Mg***	***Na***	***K***	***CO3***	***HCO3***	***SO4***	***Cl***	***F***	***Ion Sum***
Station	***Date***	***km***	***s.u.***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***	***mg/L***
OUTFLOW DATA													
		SUMMER											
Station 8	08/21/96	61.4	7.58	17.0	4.50	22.4	3.10	0.00	102	18.3	6.70		149
	08/14/97		7.68	14.6	4.10	18.4	2.90	0.00	91.0	13.2	4.80		130
	08/14/97			14.4	4.10	18.7	3.00	0.00	91.0	13.2	5.70		130
Summer Outflow		***n***	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*		*3*
		Min	*7.58*	*14.4*	*4.10*	*18.4*	*2.90*	*0.00*	*91.0*	*13.2*	*4.80*		*130*
		Max	*7.68*	*17.0*	*4.50*	*22.4*	*3.10*	*0.00*	*102*	*18.3*	*6.70*		*149*
		Mean		***15.3***	***4.23***	***19.8***	***3.00***	***0.00***	***94.7***	***14.9***	***5.73***		***136***
		Median		*14.6*	*4.10*	*18.7*	*3.00*	*.*	*91.0*	*13.2*	*5.70*		*130*
		Range	*0.100*	*2.60*	*0.400*	*4.00*	*0.200*	*0.00*	*11.0*	*5.10*	*1.90*		*19.0*
		s		*1.45*	*0.231*	*2.23*	*0.100*	*0.00*	*6.35*	*2.94*	*0.950*		*11.0*
		SPRING											
	05/05/97	61.4	7.32	13.4	3.90	15.6	2.70	0.00	81.0	13.3	5.00		119
	05/05/97			13.4	3.90	15.7	2.70	0.00	81.0	13.3	5.00		120
	05/07/98		*7.20*	*18.6*	*5.00*	*21.2*	*3.20*	*0.00*	*107*	*15.4*	*3.70*		*156*
Spring Outflow		***n***	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*		*3*
		Min	*7.20*	*13.4*	*3.90*	*15.6*	*2.70*	*0.00*	*81.0*	*13.3*	*3.70*		*119*
		Max	*7.32*	*18.6*	*5.00*	*21.2*	*3.20*	*0.00*	*107*	*15.4*	*5.00*		*156*
		Mean		***15.1***	***4.27***	***17.5***	***2.87***	***0.00***	***89.7***	***14.0***	***4.57***		***132***
		Median		*13.4*	*3.90*	*15.7*	*2.70*	*.*	*81.0*	*13.3*	*5.00*		*120*
		Range	*0.120*	*5.20*	*1.10*	*5.60*	*0.500*	*0.00*	*26.0*	*2.10*	*1.30*		*37.0*
		s		*3.00*	*0.635*	*3.20*	*0.289*	*0.00*	*15.0*	*1.21*	*0.751*		*21.1*
OUTFLOW		***n***	*4*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*		*6*
		Min	*7.20*	*13.4*	*3.90*	*15.6*	*2.70*	*0*	*81.0*	*13.2*	*3.70*		*119*
		Max	*7.68*	*18.6*	*5.00*	*22.4*	*3.20*	*0*	*107*	*18.3*	*6.70*		*156*
		Mean		***15.2***	***4.25***	***18.7***	***2.93***	***0.00***	***92.2***	***14.5***	***5.15***		***134***
		Median		*14.5*	*4.10*	*18.6*	*2.95*	*.*	*91.0*	*13.3*	*5.00*		*130*
		Range	*0.480*	*5.20*	*1.10*	*6.80*	*0.500*	*0.00*	*26.0*	*5.10*	*3.00*		*37.0*
		s		*2.11*	*0.428*	*2.78*	*0.207*	*0.00*	*10.7*	*2.07*	*0.998*		*15.2*
GEOTHERMAL WATER DATA													
Station 1gs	08/14/97	6.70	9.00	0.90	0.20	135	1.10	71.1	71.0	50.7	13.3	23.0	407

Table A2-3a Summary of total organic carbon (TOC), total phosphorus (Total-P), ortho-phosphorus (Ortho-P), and nitrate+nitrite (NO3NO2) for reservoir samples.

				TOC				***Total P***				***Ortho-P***	***NO3+NO2***
		Lat Dist.	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***filtered***	***filtered***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***
SPRING DATA													
Station 1	05/05/97	2.60	-1.00	5.40	4.20	1.20	0.286	0.142	0.055	0.087	1.5818	0.042	0.200
	05/07/98	2.60	0.00	4.60	4.00			0.100				0.040	0.180
	05/07/98	2.60	0.00	4.60	3.90			0.093				0.041	0.180
	05/07/98	0.00	0.00			0.60	0.150						
	05/07/98	0.00	0.00			0.70	0.180						
		Station 1	***n***	3	3	3	3	3				3	3
			Min	4.60	3.90	0.60	0.150	0.093				0.040	0.180
			Max	5.40	4.20	1.20	0.286	0.142				0.042	0.200
			Mean	4.8667	4.03	0.833	0.205	0.112				0.0410	0.187
			Median	4.6000	4.00	0.700	0.180	0.100				0.0410	0.180
			Range	0.8000	0.300	0.600	0.136	0.0490				0.00200	0.0200
			s	0.4619	0.153	0.322	0.0714	0.0265				0.00100	0.0115
Station 5	05/05/97	37.3	-1.00	5.00	4.60	0.400	0.0870	0.089	0.043	0.046	1.0698	0.026	0.100
Station 7	05/05/97	60.4	-1.00	5.30	4.80	0.500	0.1042	0.121	0.073	0.048	0.6575	0.052	0.280
		SPRING	***n***	*5*	*5*	*5*	*5*	*5*	*3*	*3*	*3*	*5*	*5*
			Min	*4.60*	*3.90*	*0.40*	*0.0870*	*0.0890*	*0.0430*	*0.0460*	*0.658*	*0.0260*	*0.100*
			Max	*5.40*	*4.80*	*1.20*	*0.286*	*0.142*	*0.0730*	*0.0870*	*1.58*	*0.0520*	*0.280*
			Mean	***4.98***	***4.30***	***0.680***	***0.161***	***0.109***	***0.0570***	***0.0603***	***1.10***	***0.0402***	***0.188***
			Median	*5.00*	*4.20*	*0.600*	*0.150*	*0.100*	*0.0550*	*0.0480*	*1.07*	*0.0410*	*0.180*
			Range	*0.800*	*0.900*	*0.800*	*0.199*	*0.0530*	*0.0300*	*0.0410*	*0.924*	*0.0260*	*0.180*
			s	*0.377*	*0.387*	*0.311*	*0.0786*	*0.0222*	*0.0151*	*0.0231*	*0.463*	*0.00930*	*0.0642*

				TOC				***Total P***				***Ortho-P***	***NO3+NO2***
		Lat Dist.	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***filtered***	***filtered***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***
SUMMER DATA													
Station 1	08/21/96	2.60	-3.00	4.20	3.50	0.70	0.200	0.091	0.040	0.051	1.28	0.0290	0.00500
	08/14/97	2.60	0.00	9.10	5.60	3.50	0.625	0.260	0.091	0.169	1.86	0.0730	0.0200
		Station 1	***n***	2	2	2	2	2	2	2	2	2	2
			Min	4.20	3.50	0.700	0.200	0.0910	0.0400	0.0510	1.28	0.0290	0.00500
			Max	9.10	5.60	3.50	0.625	0.260	0.0910	0.169	1.86	0.0730	0.0200
			Mean	6.65	4.55	2.10	0.413	0.176	0.0655	0.110	1.57	0.0510	0.0125
			Median	6.65	4.55	2.10	0.413	0.176	0.0655	0.110	1.57	0.0510	0.0125
			Range	4.90	2.10	2.80	0.425	0.169	0.0510	0.118	0.582	0.0440	0.0150
			s	3.46	1.48	1.98	0.301	0.120	0.0361	0.0834	0.412	0.0311	0.0106
Station 2	08/21/96	13.1	-1.00	8.80	7.10	1.70	0.239	0.238	0.0430	0.195	4.53	0.0240	0.00500
	08/21/96	13.1	-5.00	7.90	7.20	0.70	0.0972	0.122	0.047	0.075	1.5957	0.0270	0.00500
	08/21/96	13.1	-12.10	5.90	4.70	1.20	0.2553	0.246	0.196	0.050	0.2551	0.193	0.00500
		Station 2	***n***	3	3	3	3	3	3	3	3	3	3
			Min	5.90	4.70	0.70	0.0972	0.122	0.0430	0.0500	0.255	0.0240	0.00500
			Max	8.80	7.20	1.70	0.255	0.246	0.196	0.195	4.53	0.193	0.00500
			Mean	7.53	6.33	1.20	0.197	0.202	0.0953	0.107	2.13	0.0813	0.00500
			Median	7.90	7.10	1.20	0.239	0.238	0.0470	0.0750	1.60	0.0270	
			Range	2.90	2.50	1.00	0.158	0.124	0.153	0.145	4.28	0.169	0.00
			s	1.48	1.42	0.500	0.0871	0.0694	0.0872	0.0775	2.19	0.0967	0.00
Station 3	08/21/96	19.9	-1.00	7.30	5.80	1.50	0.259	0.0720	0.0220	0.0500	2.27	0.00900	0.00500
	08/21/96	19.9	-9.00	6.50	5.80	0.70	0.121	0.0670	0.0240	0.0430	1.79	0.0110	0.0300
	08/21/96	19.9	-19.5	5.80	4.40	1.40	0.318	0.443	0.261	0.182	0.697	0.246	0.00500
		Station 3	***n***	3	3	3	3	3	3	3	3	3	3
			Min	5.80	4.40	0.700	0.121	0.0670	0.0220	0.043	0.697	0.00900	0.00500
			Max	7.30	5.80	1.50	0.318	0.443	0.261	0.182	2.27	0.246	0.0300
			Mean	6.53	5.33	1.20	0.233	0.194	0.102	0.0917	1.59	0.0887	0.0133
			Median	6.50	5.80	1.40	0.259	0.0720	0.0240	0.0500	1.79	0.0110	0.00500
			Range	1.50	1.40	0.800	0.198	0.376	0.239	0.1390	1.58	0.237	0.0250
			s	0.751	0.808	0.436	0.101	0.216	0.137	0.0783	0.807	0.136	0.0144

				TOC				***Total P***				***Ortho-P***	***NO3+NO2***
		Lat Dist.	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***filtered***	***filtered***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***
Station 4	08/20/96	28.1	-1.00	6.20	5.00	1.20	0.240	0.0370	0.0190	0.0180	0.947	0.00900	0.00500
	08/20/96	28.1	-13.0	4.40	4.20	0.200	0.0476	0.0600	0.0460	0.0140	0.304	0.0380	0.260
	08/20/96	28.1	-26.6	5.00	3.90	1.10	0.282	0.167	0.0920	0.0750	0.815	0.0860	0.510
		Station 4	***n***	3	3	3	3	3	3	3	3	3	3
			Min	4.40	3.90	0.20	0.0476	0.0370	0.0190	0.0140	0.304	0.00900	0.00500
			Max	6.20	5.00	1.20	0.282	0.167	0.0920	0.0750	0.947	0.0860	0.510
			Mean	5.20	4.37	0.833	0.190	0.0880	0.0523	0.0357	0.689	0.0443	0.258
			Median	5.00	4.20	1.10	0.240	0.0600	0.0460	0.0180	0.815	0.0380	0.260
			Range	1.80	1.10	1.00	0.234	0.130	0.0730	0.0610	0.643	0.0770	0.505
			s	0.917	0.569	0.551	0.125	0.0694	0.0369	0.0341	0.340	0.0389	0.253
Station 5	08/20/96	37.3	-1.01	4.50	4.30	0.200	0.0465	0.0320	0.0180	0.0140	0.778	0.00900	0.0200
	08/20/96	37.3	-21.0	4.40	4.30	0.100	0.0233	0.103	0.0800	0.0230	0.288	0.0710	0.400
	08/20/96	37.3	-40.0	4.40	4.10	0.300	0.0732	0.120	0.0900	0.0300	0.333	0.0840	0.480
	08/14/97	37.3	-1.00	5.80	4.30	1.50	0.349	0.0340	0.0200	0.0140	0.700	0.00600	0.0100
	08/14/97	37.3	-17.0	5.60	4.30	1.30	0.302	0.124	0.0720	0.0520	0.722	0.0640	0.340
	08/14/97	37.3	-32.0	5.40	4.50	0.900	0.200	0.151	0.0930	0.0580	0.624	0.0840	0.430
		Station 5	***n***	6	6	6	6	6	6	6	6	6	6
			Min	4.40	4.10	0.100	0.0233	0.0320	0.0180	0.0140	0.288	0.00600	0.0100
			Max	5.80	4.50	1.50	0.349	0.151	0.0930	0.0580	0.778	0.0840	0.480
			Mean	5.02	4.30	0.717	0.166	0.0940	0.0622	0.0318	0.574	0.0530	0.280
			Median	4.95	4.30	0.600	0.137	0.112	0.0760	0.0265	0.662	0.0675	0.370
			Range	1.40	0.400	1.40	0.326	0.119	0.0750	0.0440	0.490	0.0780	0.470
			s	0.652	0.127	0.601	0.139	0.0497	0.0343	0.0190	0.211	0.0361	0.210
Station 6	08/20/96	45.3	-1.00	4.40	4.20	0.200	0.0476	0.0300	0.0200	0.0100	0.500	0.0100	0.00500
	08/20/96	45.3	-30.0	4.10	4.00	0.100	0.0250	0.0960	0.0780	0.0180	0.231	0.0690	0.440
	08/20/96	45.3	-58.0	4.10	4.00	0.100	0.0250	0.110	0.0840	0.0260	0.310	0.0770	0.470
		Station 6	***n***	3	3	3	3	3	3	3	3	3	3
			Min	4.10	4.00	0.100	0.0250	0.0300	0.0200	0.0100	0.231	0.0100	0.00500
			Max	4.40	4.20	0.200	0.0476	0.110	0.0840	0.0260	0.500	0.0770	0.470
			Mean	4.20	4.07	0.133	0.0325	0.0787	0.0607	0.0180	0.347	0.0520	0.305
			Median	4.10	4.00	0.100	0.0250	0.0960	0.0780	0.0180	0.310	0.0690	0.440
			Range	0.300	0.200	0.100	0.0226	0.0800	0.0640	0.0160	0.269	0.0670	0.465
			s	0.173	0.116	0.0577	0.0131	0.0427	0.0353	0.00800	0.138	0.0366	0.260

				TOC				*Total P*				*Ortho-P*	*NO3+NO2*
		Lat Dist.	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***filtered***	***filtered***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***
Station 7	08/20/96	60.4	-1.00	4.30	4.20	0.100	0.0238	0.027	0.024	0.003	0.125	0.0100	0.00500
	08/20/96	60.4	-50.0	4.00	3.80	0.200	0.0526	0.091	0.073	0.018	0.247	0.066	0.420
	08/20/96	60.4	-72.0	4.10	3.90	0.200	0.0513	0.096	0.078	0.018	0.231	0.070	0.430
	08/14/97	60.4	-1.00	4.70	4.40	0.300	0.0682	0.034	0.024	0.0100	0.417	0.008	0.00500
	08/14/97	60.4	-39.9	4.50	3.90	0.600	0.1538	0.113	0.081	0.032	0.395	0.071	0.400
	08/14/97	60.4	-49.8	4.20	3.80	0.400	0.1053	0.107	0.083	0.024	0.289	0.072	0.390
		Station 7	***n***	6	6	6	6	6	6	6	6	6	6
			Min	4.00	3.80	0.100	0.0238	0.0270	0.0240	0.003	0.125	0.00800	0.00500
			Max	4.70	4.40	0.600	0.154	0.113	0.0830	0.032	0.417	0.0720	0.430
			Mean	4.30	4.00	0.300	0.0758	0.0780	0.0605	0.0175	0.284	0.0495	0.275
			Median	4.25	3.90	0.250	0.0604	0.0935	0.0755	0.0180	0.268	0.0680	0.395
			Range	0.700	0.600	0.500	0.130	0.0860	0.0590	0.0290	0.292	0.0640	0.425
			s	0.261	0.245	0.179	0.0466	0.0377	0.0285	0.0100	0.109	0.0314	0.210
	SUMMER SUMMARY		***n***	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*
			Min	*4.00*	*3.50*	*0.100*	*0.0233*	*0.0270*	*0.0180*	*0.00300*	*0.125*	*0.00600*	*0.00500*
			Max	*9.10*	*7.20*	*3.50*	*0.625*	*0.443*	*0.261*	*0.195*	*4.54*	*0.246*	*0.510*
			Mean	***5.37***	***4.58***	***0.785***	***0.163***	***0.118***	***0.0690***	***0.049***	***0.867***	***0.0580***	***0.196***
			Median	*4.60*	*4.30*	*0.650*	*0.113*	*0.100*	*0.0730*	*0.0280*	*0.562*	*0.0650*	*0.0250*
			Range	*5.10*	*3.70*	*3.40*	*0.602*	*0.416*	*0.243*	*0.192*	*4.41*	*0.240*	*0.505*
			s	*1.48*	*0.957*	*0.764*	*0.142*	*0.0930*	*0.0550*	*0.0530*	*0.946*	*0.0560*	*0.211*
ALL RESERVOIR SUMMARY			***n***	*31*	*31*	*31*	*31*	*31*	*29*	*29*	*29*	*31*	*31*
			Min	*4.00*	*3.50*	*0.100*	*0.0233*	*0.0270*	*0.0180*	*0.00300*	*0.125*	*0.00600*	*0.00500*
			Max	*9.10*	*7.20*	*3.50*	*0.625*	*0.443*	*0.261*	*0.195*	*4.54*	*0.246*	*0.510*
			Mean	***5.31***	***4.54***	***0.768***	***0.163***	***0.117***	***0.0679***	***0.0501***	***0.891***	***0.0554***	***0.195***
			Median	*4.70*	*4.30*	*0.600*	*0.121*	*0.100*	*0.0720*	*0.0320*	*0.658*	*0.0420*	*0.180*
			Range	*5.10*	*3.70*	*3.40*	*0.602*	*0.416*	*0.243*	*0.192*	*4.41*	*0.240*	*0.505*
			s	*1.37*	*0.892*	*0.708*	*0.133*	*0.0851*	*0.0526*	*0.0505*	*0.906*	*0.0521*	*0.194*

Table A2-3a (Continued) Summary of ammonia, total Kjeldahl nitrogen, and organic nitrogen data for reservoir samples.

				NH3				***TKN***				***Organic***			
		Lat	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:dis***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***
SPRING DATA															
Station 1	05/05/97	2.60	-1.00	0.00500	0.00500	0.000	0.00	0.470	0.280	0.190	0.679	0.465	0.275	0.190	0.691
	05/07/98	2.60	0.00		0.0200			0.360				0.340			
	05/07/98	2.60	0.00		0.0200			0.390				0.370			
	05/07/98	0.00	0.00												
	05/07/98	0.00	0.00												
		Station 1	***n***		3			3				3			
			Min		0.00500			0.360				0.340			
			Max		0.0200			0.470				0.465			
			Mean		0.0150			0.407				0.392			
			Median		0.0200			0.390				0.370			
			Range		0.0150			0.110				0.125			
			s		0.00870			0.0569				0.0653			
Station 5	05/05/97	37.3	-1.00	0.00500	0.00500	0.00	0.00	0.400	0.320	0.080	0.2500	0.395	0.315	0.080	0.2540
Station 7	05/05/97	60.4	-1.00	0.00500	0.00500	0.00	0.00	0.420	0.260	0.160	0.6154	0.415	0.255	0.160	0.6275
	SPRING SUMMARY		***n***	*3*	*5*	*3*	*3*	*5*	*3*	*3*	*3*	*5*	*3*	*3*	*3*
			Min	*0.00500*	*0.00500*	*0.00*	*0.00*	*0.360*	*0.260*	*0.080*	*0.250*	*0.340*	*0.255*	*0.080*	*0.2540*
			Max	*0.00500*	*0.0200*	*0.00*	*0.00*	*0.470*	*0.320*	*0.190*	*0.679*	*0.465*	*0.315*	*0.190*	*0.6909*
			Mean	***0.005000***	***0.011***	***0.00***	***0.00***	***0.408***	***0.287***	***0.143***	***0.515***	***0.397***	***0.282***	***0.143***	***0.5241***
			Median		*0.00500*			*0.400*	*0.280*	*0.160*	*0.615*	*0.395*	*0.275*	*0.160*	*0.6275*
			Range	*0.00*	*0.0150*	*0.00*	*0.00*	*0.110*	*0.0600*	*0.110*	*0.429*	*0.125*	*0.0600*	*0.110*	*0.4369*
			s	*0.00*	*0.00820*	*0.00*	*0.00*	*0.0409*	*0.0306*	*0.0569*	*0.231*	*0.0472*	*0.0306*	*0.0569*	*0.2361*

				NH3				***TKN***				***Organic***			
		Lat	***depth***	***unfiltered***	***filtered***	***suspended***	***susp:dis***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***
SUMMER DATA															
Station 1	08/21/96	2.60	-3.00	0.0400	0.0300	0.0100	0.333	0.500	0.270	0.230	0.852	0.470	0.240	0.230	0.958
	08/14/97	2.60	0.00	0.0200	0.00500	0.0150	3.00	1.62	0.630	0.990	1.57	1.62	0.625	0.990	1.58
		Station 1	***n***	2	2	2	2	2	2	2	2	2	2	2	2
			Min	0.0200	0.00500	0.0100	0.333	0.500	0.270	0.230	0.852	0.470	0.240	0.230	0.958
			Max	0.0400	0.0300	0.0150	3.00	1.62	0.630	0.990	1.57	1.62	0.625	0.990	1.58
			Mean	0.0300	0.0175	0.0125	1.67	1.06	0.450	0.610	1.21	1.04	0.433	0.610	1.27
			Median	0.0300	0.0175	0.0125	1.67	1.06	0.450	0.610	1.21	1.04	0.433	0.610	1.27
			Range	0.0200	0.0250	0.00500	2.67	1.12	0.360	0.760	0.720	1.15	0.385	0.760	0.626
			s	0.0141	0.0177	0.00350	1.89	0.792	0.255	0.537	0.509	0.810	0.272	0.537	0.442
Station 2	08/21/96	13.1	-1.00	0.00500	0.00500	0.00	0.00	2.49	0.500	1.99	3.98	2.49	0.495	1.99	4.02
	08/21/96	13.1	-5.00	0.0300	0.0200	0.0100	0.5000	1.38	0.580	0.800	1.38	1.36	0.560	0.800	1.43
	08/21/96	13.1	-12.1	0.570	0.570	0.00	0.00	1.07	1.020	0.050	0.0490	0.500	0.450	0.0500	0.111
		Station 2	***n***	3	3	3	3	3	3	3	3	3	3	3	3
			Min	0.00500	0.00500	0.000	0.00	1.07	0.500	0.0500	0.0490	0.500	0.450	0.0500	0.111
			Max	0.570	0.570	0.0100	0.500	2.49	1.02	1.99	3.98	2.49	0.560	1.99	4.02
			Mean	0.202	0.198	0.00330	0.167	1.65	0.700	0.947	1.80	1.45	0.502	0.947	1.85
			Median	0.0300	0.0200	0.00	0.00	1.38	0.580	0.800	1.38	1.36	0.495	0.800	1.43
			Range	0.565	0.565	0.0100	0.500	1.42	0.520	1.94	3.93	1.99	0.110	1.94	3.91
			s	0.319	0.322	0.00501	0.289	0.747	0.280	0.978	2.00	0.995	0.0553	0.978	1.99
Station 3	08/21/96	19.9	-1.00	0.00500	0.00500	0.00	0.00	1.010	0.600	0.410	0.683	1.01	0.595	0.410	0.689
	08/21/96	19.9	-9.00	0.0100	0.0100	0.00	0.00	0.980	0.460	0.520	1.13	0.970	0.450	0.520	1.16
	08/21/96	19.9	-19.5	0.340	0.330	0.0100	0.0303	0.720	0.560	0.160	0.2857	0.390	0.230	0.160	0.696
		Station 3	***n***	3	3	3	3	3	3	3	3	3	3	3	3
			Min	0.00500	0.00500	0.00	0.00	0.720	0.460	0.160	0.286	0.390	0.230	0.160	0.689
			Max	0.340	0.330	0.0100	0.0303	1.01	0.600	0.520	1.13	1.01	0.595	0.520	1.16
			Mean	0.118	0.115	0.00330	0.0100	0.903	0.540	0.363	0.700	0.788	0.425	0.363	0.847
			Median	0.0100	0.0100	0.00	0.00	0.980	0.560	0.410	0.683	0.970	0.450	0.410	0.696
			Range	0.335	0.325	0.0100	0.0303	0.290	0.140	0.360	0.845	0.615	0.365	0.360	0.467
			s	0.1920	0.1862	0.00501	0.0175	0.160	0.0721	0.185	0.423	0.345	0.185	0.185	0.267

				NH3				***TKN***				***Organic***			
		Lat	***depth***	***unfiltered***	***filtered***	***suspended***	***susp:dis***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***
Station 4	08/20/96	28.1	-1.00	0.00500	0.00500	0.00	0.00	0.740	0.640	0.100	0.156	0.735	0.635	0.100	0.158
	08/20/96	28.1	-13.0	0.00500	0.00500	0.00	0.00	0.280	0.240	0.040	0.167	0.275	0.235	0.040	0.170
	08/20/96	28.1	-26.6	0.00500	0.00500	0.00	0.00	0.370	0.250	0.120	0.480	0.365	0.245	0.120	0.490
		Station 4	***n***	3	3	3	3	3	3	3	3	3	3	3	3
			Min	0.00500	0.00500	0.00	0.00	0.280	0.240	0.0400	0.156	0.275	0.235	0.0400	0.158
			Max	0.00500	0.00500	0.00	0.00	0.740	0.640	0.1200	0.480	0.735	0.635	0.120	0.490
			Mean	0.00500	0.00500	0.00	0.00	0.463	0.377	0.0867	0.268	0.458	0.372	0.0867	0.273
			Median					0.370	0.250	0.100	0.167	0.365	0.245	0.100	0.170
			Range	0.00	0.00 0	0.00	0.00	0.460	0.400	0.0800	0.324	0.460	0.400	0.0800	0.332
			s	0.00	0.00 0	0.00	0.00	0.244	0.228	0.0416	0.184	0.244	0.228	0.0416	0.188
Station 5	08/20/96	37.3	-1.00	0.00500	0.00500	0.00	0.00	0.310	0.300	0.0100	0.0333	0.305	0.295	0.0100	0.0339
	08/20/96	37.3	-21.00	0.00500	0.00500	0.00	0.00	0.280	0.230	0.050	0.217	0.275	0.225	0.050	0.2222
	08/20/96	37.3	-40.0	0.00500	0.00500	0.00	0.00	0.240	0.240	0.00	0.00	0.235	0.235	0.00	0.00
	08/14/97	37.3	-1.00	0.00500	0.00500	0.00	0.00	0.280	0.250	0.030	0.120	0.275	0.245	0.030	0.122
	08/14/97	37.3	-17.0	0.00500	0.00500	0.00	0.00	0.280	0.240	0.040	0.167	0.275	0.235	0.040	0.170
	08/14/97	37.3	-32.0	0.00500	0.00500	0.00	0.00	0.380	0.220	0.160	0.727	0.375	0.215	0.160	0.744
		Station 5	***n***	6	6	6	6	6	6	6	6	6	6	6	6
			Min	0.00500	0.00500	0.00	0.00	0.240	0.220	0.00	0.00	0.235	0.215	0.00	0.00
			Max	0.00500	0.00500	0.00	0.00	0.380	0.300	0.160	0.727	0.375	0.295	0.160	0.744
			Mean	0.00500	0.00500	0.00	0.00	0.295	0.247	0.0483	0.211	0.290	0.242	0.0483	0.216
			Median					0.280	0.240	0.0350	0.143	0.275	0.235	0.0350	0.146
			Range	0.00	0.00	0.00	0.00	0.140	0.0800	0.160	0.727	0.140	0.0800	0.160	0.744
			s	0.00	0.00	0.00	0.00	0.0472	0.0280	0.0578	0.266	0.0472	0.0280	0.0578	0.272
Station 6	08/20/96	45.3	-1.00	0.00500	0.00500	0.00	0.00	0.280	0.220	0.060	0.2727	0.275	0.215	0.060	0.2791
	08/20/96	45.3	-30.0	0.00500	0.00500	0.00	0.00	0.220	0.140	0.080	0.5714	0.215	0.135	0.080	0.5926
	08/20/96	45.3	-58.0	0.00500	0.00500	0.00	0.00	0.260	0.240	0.020	0.0833	0.255	0.235	0.020	0.0851
		Station 6	***n***	3	3	3	3	3	3	3	3	3	3	3	3
			Min	0.00500	0.00500	0.00	0.00	0.220	0.140	0.020	0.0833	0.215	0.135	0.020	0.0851
			Max	0.00500	0.00500	0.00	0.00	0.280	0.240	0.080	0.5714	0.275	0.235	0.080	0.5926
			Mean	0.00500	0.00500	0.00 0	0.00 0	0.2533	0.2000	0.0533	0.3092	0.2483	0.1950	0.0533	0.3189
			Median					0.2600	0.2200	0.0600	0.2727	0.2550	0.2150	0.0600	0.2791
			Range	0.00	0.00	0.00	0.00	0.0600	0.1000	0.0600	0.4881	0.0600	0.1000	0.0600	0.5075
			s	0.00	0.00	0.00	0.00	0.0306	0.0529	0.0306	0.2461	0.0306	0.0529	0.0306	0.2561

				NH3				TKN				Organic			
		Lat	depth	unfiltered	filtered	suspended	susp:dis	unfiltered	filtered	suspended	susp:diss	unfiltered	filtered	suspended	susp:diss
Station	Date	km	m	mg/L	mg/L	mg/L	RATIO	mg/L	mg/L	mg/L	RATIO	mg/L	mg/L	mg/L	RATIO
Station 7	08/20/96	60.40	-1.00	0.00500	0.00500	0.00	0.00	0.260	0.260	0.00	0.00	0.255	0.255	0.00	0.00
	08/20/96	60.40	-49.99	0.00500	0.00500	0.00	0.00	0.240	0.230	0.0100	0.0435	0.235	0.225	0.0100	0.0444
	08/20/96	60.40	-71.99	0.00500	0.00500	0.00	0.00	0.230	0.220	0.0100	0.0455	0.225	0.215	0.0100	0.0465
	08/14/97	60.40	-1.00	0.00500	0.00500	0.00	0.00	0.350	0.260	0.090	0.3462	0.345	0.255	0.090	0.3529
	08/14/97	60.40	-39.86	0.00500	0.00500	0.00	0.00	0.270	0.220	0.050	0.2273	0.265	0.215	0.050	0.2326
	08/14/97	60.40	-49.83	0.00500	0.00500	0.00	0.00	0.290	0.220	0.070	0.3182	0.285	0.215	0.070	0.3256
		Station 7	**n**	6	6	6	6	6	6	6	6	6	6	6	6
			Min	0.00500	0.00500	0.00	0.00	0.230	0.220	0.00	0.00	0.225	0.215	0.00	0.00
			Max	0.00500	0.00500	0.00	0.00	0.350	0.260	0.090	0.3462	0.345	0.255	0.090	0.3529
			Mean	0.005000	0.00500	0.00	0.00	0.2733	0.2350	0.0383	0.1634	0.2683	0.2300	0.0383	0.1670
			Median					0.2650	0.2250	0.0300	0.1364	0.2600	0.2200	0.0300	0.1395
			Range	0.00	0.00	0.00	0.00	0.1200	0.0400	0.0900	0.3462	0.1200	0.0400	0.0900	0.3529
			s	0.00	0.00	0.00	0.00	0.0432	0.0197	0.0371	0.1526	0.0432	0.0197	0.0371	0.1559
SUMMER SUMMARY			**n**	26	26	26	26	26	26	26	26	26	26	26	26
			Min	0.00500	0.00500	0.00	0.00	0.220	0.140	0.00	0.00	0.215	0.135	0.00	0.00
			Max	0.570	0.570	0.0150	3.00	2.49	1.020	1.990	3.98	2.485	0.635	1.99	4.02
			Mean	**0.043**	**0.0410**	**0.00200**	**0.149**	**0.590**	**0.355**	**0.234**	**0.535**	**0.549**	**0.314**	**0.234**	**0.5658**
			Median	0.00500	0.00500	0.00	0.00	0.300	0.250	0.065	0.250	0.295	0.238	0.0650	0.256
			Range	0.565	0.565	0.0150	3.00	2.27	0.880	1.990	3.98	2.270	0.500	1.99	4.02
			s	0.126	0.125	0.00400	0.594	0.549	0.205	0.436	0.823	0.539	0.150	0.436	0.831
ALL RESERVOIR			**n**	29	31	29	29	31	29	29	29	31	29	29	29
			Min	0.00500	0.0050	0.00	0.00	0.220	0.140	0.00	0.00	0.215	0.135	0.00	0.00
			Max	0.570	0.570	0.015	3.00	2.49	1.02	1.99	3.98	2.49	0.635	1.990	4.02
			Mean	**0.0388**	**0.0361**	**0.0016**	**0.133**	**0.5603**	**0.348**	**0.225**	**0.533**	**0.524**	**0.311**	**0.225**	**0.562**
			Media	0.00500	0.0050	0.00	0.00	0.360	0.260	0.0800	0.273	0.345	0.245	0.0800	0.279
			Range	0.565	0.565	0.0150	3.0000	2.27	0.880	1.99	3.98	2.27	0.500	1.99	4.02
			s	0.1196	0.115	0.00400	0.5621	0.506	0.196	0.413	0.780	0.496	0.142	0.413	0.788

Table A2-3b Summary of total organic carbon (TOC), total phosphorus (Total-P), ortho-phosphorus (Ortho-P), and nitrate+nitrite (NO3+NO2) for inflow, outflow, and geothermal spring samples.

			TOC				*Total-P*				*Ortho-P*	*NO3+NO2*
		Latdist	*unfiltered*	*filtered*	*suspended*	*susp:diss*	*unfiltered*	*filtered*	*suspended*	*susp:diss*	*filtered*	*filtered*
Station	*Date*	*km*	*mg/L*	*mg/L*	*mg/L*	*RATIO*	*mg/L*	*mg/L*	*mg/L*	*RATIO*	*mg/L*	*mg/L*
INFLOW SAMPLES												
Station OR-1	04/14/99	-88.5	6.50	5.30	1.20	0.2264	0.097	0.040	0.057	1.4250	0.023	0.040
Station OR-2	04/14/99	-84.1	6.60	5.00	1.60	0.3200	0.093	0.041	0.052	1.2683	0.024	0.050
Spring Inflow		***n***	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
		Min	*6.50*	*5.00*	*1.20*	*0.226*	*0.0930*	*0.0400*	*0.0520*	*1.2683*	*0.023*	*0.040*
		Max	*6.60*	*5.30*	*1.60*	*0.320*	*0.0970*	*0.0410*	*0.0570*	*1.4250*	*0.024*	*0.050*
		Mean	***6.55***	***5.15***	***1.40***	***0.273***	***0.0950***	***0.0405***	***0.0545***	***1.35***	***0.0235***	***0.0450***
Station OR-1	09/08/98	-88.5	3.40	3.10	0.300	0.0968	0.0250	0.0120	0.0130	1.08	0.00500	0.160
Station OR-2	09/08/98	-84.1	3.80	3.60	0.200	0.0556	0.040	0.0180	0.0220	1.22	0.0110	0.140
Summer Inflow		***n***	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
		Min	*3.40*	*3.10*	*0.200*	*0.0556*	*0.025*	*0.0120*	*0.0130*	*1.08*	*0.00500*	*0.140*
		Max	*3.80*	*3.60*	*0.300*	*0.0968*	*0.040*	*0.0180*	*0.0220*	*1.22*	*0.0110*	*0.160*
		Mean	***3.60***	***3.35***	***0.250***	***0.0762***	***0.0325***	***0.0150***	***0.0175***	***1.15***	***0.00800***	***0.1500***
ALL INFLOW		***n***	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
		Min	*3.40*	*3.10*	*0.200*	*0.0556*	*0.0250*	*0.0120*	*0.0130*	*1.08*	*0.00500*	*0.0400*
		Max	*6.60*	*5.30*	*1.60*	*0.320*	*0.0970*	*0.0410*	*0.0570*	*1.43*	*0.0240*	*0.160*
		Mean	*5.08*	*4.25*	*0.825*	*0.175*	*0.0638*	*0.0278*	*0.0360*	*1.25*	*0.0158*	*0.0975*
		Median	*5.15*	*4.30*	*0.750*	*0.162*	*0.0665*	*0.0290*	*0.0370*	*1.25*	*0.0170*	*0.0950*
		s	*1.71*	*1.07*	*0.685*	*0.121*	*0.0366*	*0.0149*	*0.0218*	*0.141*	*0.00900*	*0.0613*

			TOC				***Total-P***				***Ortho-P***	***NO3+NO2***
		Latdist	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***filtered***	***filtered***
Station	***Date***	***km***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***
OUTFLOW SAMPLES												
Station 8	05/05/97	61.4	5.10	4.90	0.200	0.0408	0.117	0.0780	0.0390	0.500	0.0580	0.320
Station 8	05/05/97	61.4	5.10	4.70	0.400	0.0851	0.116	0.0710	0.0450	0.634	0.0570	0.310
Station 8	05/07/98	61.4	4.30	3.90	.	.	0.100	.	.	.	0.0570	0.290
Station 8	05/07/98	61.4	.	.	0.400	0.103	.	.	.	.	.	.
Spring Outflow		***n***	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*3*	*3*
		Min	*4.30*	*3.90*	*0.400*	*0.0408*	*0.100*	*0.0710*	*0.0390*	*0.500*	*0.0570*	*0.290*
		Max	*5.10*	*4.90*	*0.400*	*0.103*	*0.117*	*0.0780*	*0.0450*	*0.634*	*0.0580*	*0.320*
		Mean	***4.83***	***4.50***	***0.333***	***0.0762***	***0.111***	***0.0745***	***0.0420***	***0.567***	***0.0573***	***0.307***
		Median	*5.10*	*4.70*	*0.400*	*0.0851*	*0.116*				*0.0570*	*0.310*
		s	*0.462*	*0.529*	*0.116*	*0.0318*	*0.00901*				*0.00600*	*0.0153*
Station 8	08/21/96	61.4	4.40	3.90	0.500	0.128	0.0940	0.0730	0.0210	0.288	0.0660	0.380
Station 8	08/14/97	61.4	4.80	4.30	0.500	0.116	0.117	0.0780	0.0390	0.500	0.0690	0.360
Station 8	08/14/97	61.4	4.90	4.20	0.700	0.167	0.119	0.0790	0.0400	0.506	0.0690	0.360
Summer Outflow		***n***	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
		Min	*4.40*	*3.90*	*0.500*	*0.116*	*0.0940*	*0.0730*	*0.0210*	*0.288*	*0.0660*	*0.360*
		Max	*4.90*	*4.30*	*0.700*	*0.167*	*0.119*	*0.0790*	*0.0400*	*0.506*	*0.0690*	*0.380*
		Mean	***4.70***	***4.13***	***0.567***	***0.137***	***0.110***	***0.0767***	***0.0333***	***0.431***	***0.0680***	***0.367***
		Median	*4.80*	*4.20*	*0.500*	*0.128*	*0.117*	*0.0780*	*0.0390*	*0.500*	*0.0690*	*0.360*
		s	*0.265*	*0.208*	*0.116*	*0.0260*	*0.0139*	*0.00320*	*0.0101*	*0.124*	*0.00170*	*0.0115*
ALL OUTFLOW		***n***	*6*	*6*	*6*	*6*	*6*	*5*	*5*	*5*	*6*	*6*
		Min	*4.30*	*3.90*	*0.200*	*0.0408*	*0.0940*	*0.0710*	*0.0210*	*0.288*	*0.0570*	*0.290*
		Max	*5.10*	*4.90*	*0.700*	*0.167*	*0.119*	*0.0790*	*0.0450*	*0.634*	*0.0690*	*0.380*
		Mean	***4.77***	***4.32***	***0.450***	***0.107***	***0.111***	***0.0758***	***0.0368***	***0.486***	***0.0627***	***0.337***
		Median	*4.85*	*4.25*	*0.450*	*0.109*	*0.117*	*0.0780*	*0.0390*	*0.500*	*0.0620*	*0.340*
		s	*0.344*	*0.412*	*0.164*	*0.0424*	*0.0101*	*0.00360*	*0.00900*	*0.125*	*0.00600*	*0.0350*
GEOTHERMAL SPRING SAMPLE												
Station 1gs	08/14/97	6.70	0.900	0.800	0.100	0.125	0.0290	0.0180	0.0110	0.611	0.0160	0.130

Table A2-3b (Continued) Summary of ammonia, total Kjeldahl nitrogen, and organic nitrogen data for inflow, outflow, and geothermal spring samples.

			NH3				***TKN***				***Organic-N***			
		Latdist	***unfiltered***	***filtered***	***suspende***	***susp:diss***	***unfiltered***	***filtered***	***suspende***	***susp:diss***	***unfiltered***	***filtered***	***suspende***	***susp:diss***
Station	***Date***	***km***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***
INFLOW SAMPLES														
Station OR-1	04/14/99	-88.5	0.0100	0.0100	0.00	0.00	0.560	0.32	0.24	0.7500	0.55	0.31	0.24	0.7742
Station OR-2	04/14/99	-84.1	0.0100	0.0100	0.00	0.00	0.550	0.36	0.19	0.5278	0.54	0.35	0.19	0.5429
Spring Inflow		***n***	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
		Min	*0.0100*	*0.0100*	*0.00*	*0.00*	*0.550*	*0.320*	*0.190*	*0.528*	*0.540*	*0.310*	*0.190*	*0.543*
		Max	*0.0100*	*0.0100*	*0.00*	*0.00*	*0.560*	*0.360*	*0.240*	*0.750*	*0.550*	*0.350*	*0.240*	*0.774*
		Mean	***0.01000***	***0.0100***	***0.00***	***0.00***	***0.555***	***0.340***	***0.215***	***0.639***	***0.545***	***0.330***	***0.2150***	***0.659***
Station OR-1	09/08/98	-88.5	0.020	0.0200	0.00	0.00	0.280	0.170	0.110	0.647	0.260	0.150	0.110	0.733
Station OR-2	09/08/98	-84.1	0.0200	0.0100	0.0100	1.00	0.330	0.210	0.12	0.5714	0.32	0.2	0.12	0.6000
Summer Inflow		***n***	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
		Min	*0.0200*	*0.0100*	*0.00*	*0.00*	*0.280*	*0.170*	*0.110*	*0.571*	*0.260*	*0.150*	*0.110*	*0.600*
		Max	*0.0200*	*0.0200*	*0.00*	*0.00*	*0.330*	*0.210*	*0.120*	*0.647*	*0.320*	*0.200*	*0.120*	*0.733*
		Mean	***0.0200***	***0.0150***	***0.00***	***0.00***	***0.305***	***0.190***	***0.115***	***0.609***	***0.290***	***0.175***	***0.115***	***0.667***
ALL INFLOW		***n***	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
		Min	*0.0100*	*0.0100*	*0.00*	*0.00*	*0.280*	*0.170*	*0.110*	*0.528*	*0.260*	*0.150*	*0.11*	*0.5429*
		Max	*0.0200*	*0.0200*	*0.0100*	*1.00*	*0.560*	*0.360*	*0.240*	*0.750*	*0.550*	*0.350*	*0.24*	*0.7742*
		Mean	*0.0150*	*0.0125*	*0.00250*	*0.250*	*0.430*	*0.265*	*0.165*	*0.624*	*0.418*	*0.253*	*0.1650*	*0.6626*
		Media	*0.0150*	*0.0100*	*0.00*	*0.00*	*0.440*	*0.265*	*0.155*	*0.609*	*0.430*	*0.255*	*0.1550*	*0.6667*
		s	*0.00501*	*0.00500*	*0.00500*	*0.500*	*0.146*	*0.0896*	*0.0614*	*0.0973*	*0.149*	*0.0932*	*0.0614*	*0.1091*

			NH3				***TKN***				***Organic-N***			
		Latdist	***unfiltered***	***filtered***	***suspende***	***susp:diss***	***unfiltered***	***filtered***	***suspende***	***susp:diss***	***unfiltered***	***filtered***	***suspende***	***susp:diss***
Station	***Date***	***km***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***
OUTFLOW SAMPLES														
Station 8	05/05/97	61.4	0.00500	0.00500	0.00	0.00	0.340	0.310	0.0300	0.0968	0.335	0.305	0.03	0.0984
Station 8	05/05/97	61.4	0.00500	0.00500	0.00	0.00	0.360	0.250	0.110	0.440	0.355	0.245	0.11	0.4490
Station 8	05/07/98	61.4	.	0.0200	.	.	0.310	.	.	.	0.29	.	.	.
Station 8	05/07/98	61.4	.	.	.	.	.	.	.	.	.	.	.	.
Spring Outflow		***n***	*2*	*3*	*2*	*2*	*3*	*2*	*2*	*2*	*3*	*2*	*2*	*2*
		Min	*0.00500*	*0.00500*	*0.00*	*0.00*	*0.310*	*0.250*	*0.0300*	*0.0968*	*0.290*	*0.245*	*0.0300*	*0.0984*
		Max	*0.00500*	*0.0200*	*0.00*	*0.00*	*0.360*	*0.310*	*0.110*	*0.440*	*0.355*	*0.305*	*0.110*	*0.449*
		Mean	***0.00500***	***0.0100***	***0.00***	***0.00***	***0.337***	***0.280***	***0.0700***	***0.268***	***0.327***	***0.275***	***0.0700***	***0.274***
		Median		*0.00500*			*0.340*				*0.335*			
		s		*0.00870*			*0.0252*				*0.0333*			
Station 8	08/21/96	61.4	0.00500	0.00500	0.00	0.00	0.240	0.140	0.100	0.714	0.235	0.135	0.100	0.741
Station 8	08/14/97	61.4	0.00500	0.00500	0.00	0.00	0.420	0.350	0.0700	0.200	0.415	0.345	0.0700	0.203
Station 8	08/14/97	61.4	0.00500	0.00500	0.00	0.00	0.370	0.270	0.100	0.370	0.365	0.265	0.100	0.377
Summer Outflow		***n***	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
		Min	*0.00500*	*0.00500*	*0.00*	*0.00*	*0.240*	*0.140*	*0.0700*	*0.200*	*0.235*	*0.135*	*0.0700*	*0.203*
		Max	*0.00500*	*0.00500*	*0.00*	*0.00*	*0.420*	*0.350*	*0.100*	*0.714*	*0.415*	*0.345*	*0.100*	*0.741*
		Mean	***0.00500***	***0.00500***	***0.00***	***0.00***	***0.343***	***0.253***	***0.0900***	***0.428***	***0.338***	***0.248***	***0.0900***	***0.440***
		Median	*.*	*.*	*.*	*.*	*0.370*	*0.270*	*0.100*	*0.370*	*0.365*	*0.265*	*0.100*	*0.377*
		s	*0.00*	*0.00*	*0.00*	*0.00*	*0.0929*	*0.106*	*0.0173*	*0.262*	*0.0929*	*0.106*	*0.0173*	*0.274*
ALL OUTFLOW		***n***	*5*	*6*	*5*	*5*	*6*	*5*	*5*	*5*	*6*	*5*	*5*	*5*
		Min	*0.00500*	*0.00500*	*0.00*	*0.00*	*0.240*	*0.140*	*0.0300*	*0.0968*	*0.235*	*0.135*	*0.0300*	*0.0984*
		Max	*0.00500*	*0.0200*	*0.00*	*0.00*	*0.420*	*0.350*	*0.110*	*0.714*	*0.415*	*0.345*	*0.110*	*0.741*
		Mean	***0.00500***	***0.00750***	***0.00***	***0.00***	***0.340***	***0.264***	***0.0820***	***0.364***	***0.333***	***0.259***	***0.0820***	***0.374***
		Media	*.*	*0.00500*	*.*	*.*	*0.350*	*0.270*	*0.100*	*0.370*	*0.345*	*0.265*	*0.100*	*0.377*
		s	*0.00*	*0.00610*	*0.00*	*0.00*	*0.0610*	*0.0792*	*0.0327*	*0.238*	*0.0627*	*0.0792*	*0.0327*	*0.248*
GEOTHERMAL SPRING SAMPLE														
Station 1gs	08/14/97	6.70	0.00500	0.00500	0.00	0.00	0.0500	0.0700	.	.	0.0450	0.0650	.	.

Table A2-4a Total Mercury and methylmercury in Lake Owyhee. Negative numbers represent non-detect data at absolute value detection limits. Half the detection limit was substituted for calculations.

					Total Mercury				***Methylmercury***			
		Lat Dist	***Depth***	***Turbidity***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***NTU***	***ng/L***	***ng/L***	***ng/L***	***RATIO***	***ng/L***	***ng/L***	***ng/L***	***RATIO***
SPRING RESERVOIR SAMPLES												
Station 1	05/07/98	2.60	0.00	29.4	36.9	6.81	30.1	4.42	0.840	0.429	0.411	0.958
	05/07/98				36.3	6.88	29.4	4.28	0.792	0.431	0.361	0.838
			Spring Station 1	***n***	2	2	2	2	2	2	2	2
				Min	36.3	6.81	29.4	4.28	0.792	0.429	0.361	0.838
				Max	36.9	6.88	30.1	4.42	0.840	0.431	0.411	0.958
				Mean	36.6	6.85	29.8	4.35	0.816	0.430	0.386	0.898
				Median	36.6	6.85	29.8	4.35	0.816	0.430	0.386	0.898
				Range	0.600	0.0700	0.700	0.142	0.0480	0.002	0.0500	0.121
				s	0.424	0.0495	0.474	0.101	0.0339	0.00140	0.0354	0.0852
Station 5	05/05/97	37.3	-1.00	21.4	30.1	3.27	26.9	8.21	0.311	0.119	0.192	1.61
Station 7	05/05/97	60.4	-1.00	28.9	33.1	3.79	29.3	7.73	0.339	0.117	0.222	1.90
			Spring Reservoir Summary	***n***	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
				Min	*30.1*	*3.27*	*26.9*	*4.28*	*0.311*	*0.117*	*0.192*	*0.838*
				Max	*36.9*	*6.88*	*30.1*	*8.21*	*0.840*	*0.431*	*0.411*	*1.90*
				Mean	***34.1***	***5.19***	***28.9***	***6.16***	***0.571***	***0.274***	***0.297***	***1.33***
				Median	*34.7*	*5.30*	*29.4*	*6.07*	*0.566*	*0.274*	*0.292*	*1.29*
				Range	*6.77*	*3.61*	*3.23*	*3.94*	*0.529*	*0.314*	*0.219*	*1.06*
				s	*3.13*	*1.93*	*1.42*	*2.10*	*0.284*	*0.180*	*0.106*	*0.511*
SUMMER RESERVOIR SAMPLES												
Station 1	08/21/96	2.60	-3.00	12.0	19.1	2.20	16.9	7.66	0.484	0.161	0.323	2.01
	05/05/97		-1.00	47.0	140	4.67	136	29.0	0.890	0.258	0.632	2.45
	08/14/97		0.00	52.0	101	5.77	95.3	16.5	1.70	0.114	1.59	13.9
	08/14/97		0.00	.	103	.	.	.	1.85	0.131	1.72	13.2
		Station 1	***n***	3	4	3	3	3	4	4	4	4
			Min	12.0	19.1	2.2	16.9	7.66	0.484	0.114	0.323	2.01
			Max	52.0	140	5.77	136	29.0	1.85	0.258	1.72	13.9
			Mean	37.0	90.8	4.21	82.6	17.7	1.23	0.166	1.066	7.88
			Median	47.0	102	4.67	95.3	16.5	1.30	0.146	1.109	7.80
			Range	40.0	121	3.57	119	21.4	1.37	0.144	1.40	11.9
			s	21.8	51.1	1.83	60.4	10.7	0.654	0.0643	0.693	6.54

					Total Mercury				***Methylmercury***			
		Lat Dist	***Depth***	***Turbidity***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***NTU***	***ng/L***	***ng/L***	***ng/L***	***RATIO***	***ng/L***	***ng/L***	***ng/L***	***RATIO***
Station 2	08/21/96	13.1	-1.00	35.0	20.4	4.38	16.0	3.65	2.45	0.167	2.28	13.7
Station 3	08/21/96	19.9	-1.00	13.0	13.9	2.55	11.3	4.44	0.566	0.0630	0.503	7.98
Station 4	08/20/96	28.1	-1.00	10.0	5.72	1.94	3.78	1.95	0.198	0.0130	0.185	14.2
Station 5	08/20/96	37.3	-1.00	5.00	4.83	3.85	0.980	0.255	0.0730	0.0380	0.0350	0.921
	08/14/97		-1.00	5.00	9.54	5.74	3.80	0.662	0.0560	0.0530	0.00300	0.0566
	08/14/97		-32	34.0	45.2	6.93	38.2	5.52	0.479	0.308	0.171	0.555
		Station 5	***n***	6	3	3	3	3	3	3	3	3
			Min	5.0	4.83	3.85	0.98	0.255	0.0560	0.0380	0.00300	0.0566
			Max	34.0	45.2	6.93	38.2	5.52	0.479	0.308	0.171	0.921
			Mean	17.0	19.8	5.51	14.3	2.14	0.203	0.133	0.0697	0.511
			Median	15.0	9.54	5.74	3.80	0.662	0.0730	0.0530	0.0350	0.555
			Range	29.0	40.3	3.08	37.3	5.264	0.423	0.270	0.168	0.864
			s	11.9	22.1	1.55	20.7	2.928	0.240	0.152	0.0892	0.434
Station 6	08/20/96	45.3	-1.00	6.00	6.34	4.20	2.14	0.510	0.0650	0.0600	0.00500	0.0833
Station 7	08/20/96	60.4	-1.00	6.00	10.5	3.93	6.52	1.66	0.0500	-0.00900	0.0490	6.56
	08/14/97		-1.00	7.00	12.1	.	.	.	0.0220	0.0110	0.0110	1.00
		Station 7	***n***	2	2				2	2	2	2
			Min	6.0	10.5				0.0220	0.00450	0.0175	3.89
			Max	7.0	12.1				0.0500	0.0110	0.0590	6.56
			Mean	6.5000	11.3				0.0360	.00775	0.0383	5.23
			Range	1.0	1.60				0.0280	0.00650	0.0415	2.67

					Total Mercury				***Methylmercury***			
		Lat Dist	***Depth***	***Turbidity***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***NTU***	***ng/L***	***ng/L***	***ng/L***	***RATIO***	***ng/L***	***ng/L***	***ng/L***	***RATIO***
Summer Reservoir Summary				***n***	*13*	*11*	*11*	*11*	*13*	*13*	*13*	*13*
				Min	*4.83*	*1.94*	*0.980*	*0.255*	*0.0220*	*0.00450*	*0.00300*	*0.0566*
				Max	*140*	*6.93*	*136*	*29.0*	*2.45*	*0.308*	*2.28*	*14.2*
				Mean	***37.8***	***4.20***	***30.0545***	***6.53***	***0.684***	***0.106***	***0.578***	***5.89***
				Median	*13.9*	*4.20*	*11.3*	*3.65*	*0.479*	*0.0630*	*0.185*	*2.45*
				Range	*135*	*4.99*	*135*	*28.8*	*2.43*	*0.304*	*2.28*	*14.2*
				s	*46.0*	*1.57*	*44.5*	*8.81*	*0.811*	*0.0961*	*0.774*	*5.94*
ALL RESERVOIR DATA			***n***	*33*	*17*	*15*	*15*	*15*	*17*	*17*	*17*	*17*
			Min	*5.0*	*4.83*	*1.94*	*0.980*	*0.255*	*0.0220*	*0.00500*	*0.00300*	*0.0570*
			Max	*52.0*	*140*	*6.93*	*136*	*29.0*	*2.45*	*0.431*	*2.28*	*14.2*
			Mean	***19.2***	***36.9***	***4.46***	***29.8***	***6.43***	***0.657***	***0.146***	***0.512***	***4.82***
			Median	*16.0*	*20.4*	*4.20*	*16.9*	*4.42*	*0.479*	*0.117*	*0.222*	*1.90*
			Range	*47.0*	*135*	*4.99*	*135*	*28.8*	*2.43*	*0.427*	*2.28*	*14.2*
			s	*12.0*	*39.9*	*1.66*	*37.6*	*7.51*	*0.715*	*0.136*	*0.683*	*5.53*

Table A2-4b Total Mercury and methylmercury in Owyhee River inflow, reservoir outflow, and the sampled geothermal spring.

				Total Mercury				***Methylmercury***			
		Latdist	***Turbidity***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***NTU***	***ng/L***	***ng/L***	***ng/L***	***RATIO***	***ng/L***	***ng/L***	***ng/L***	***RATIO***
INFLOW DATA											
Station OR-1	09/08/98	-88.5	4.00	2.25	1.15	1.10	0.957	0.310	0.214	0.096	0.449
	09/08/98			3.10	1.02	2.08	2.04	0.313	0.155	0.158	1.019
	09/08/98			2.28	1.07	1.21	1.13	0.315	0.129	0.186	1.442
	09/08/98			2.78	0.970	1.81	1.87	0.369	0.142	0.227	1.599
	09/08/98			2.38	1.09	1.29	1.18	0.300	0.138	0.162	1.174
		Summer OR-1	***n***	5	5	5	5	5	5	5	5
			Min	2.25	0.970	1.10	0.957	0.300	0.129	0.096	0.449
			Max	3.10	1.15	2.08	2.04	0.369	0.214	0.227	1.599
			Mean	2.56	1.06	1.50	1.43	0.321	0.155	0.166	1.136
			Median	2.38	1.07	1.29	1.18	0.313	0.142	0.162	1.174
			Range	0.850	0.180	0.980	1.08	0.069	0.0850	0.131	1.150
			s	0.370	0.0686	0.424	0.484	0.0272	0.0340	0.0477	0.446
Station OR-1	04/14/99	-88.5	46.0	9.93	2.95	6.98	2.37	0.473	0.161	0.312	1.94
	04/14/99			10.1	2.97	7.13	2.40	0.312	0.165	0.147	0.891
	04/14/99			9.74	2.91	6.83	2.35	0.441	0.150	0.291	1.94
	04/14/99			9.22	3.06	6.16	2.01	0.329	0.147	0.182	1.24
		Spring OR-1	***n***	4	4	4	4	4	4	4	4
			Min	9.22	2.91	6.16	2.01	0.312	0.147	0.147	0.891
			Max	10.1	3.06	7.13	2.40	0.473	0.165	0.312	1.94
			Mean	9.75	2.97	6.78	2.28	0.389	0.156	0.233	1.50
			Median	9.84	2.96	6.905	2.36	0.385	0.156	0.237	1.59
			Range	0.880	0.150	0.970	0.388	0.161	0.0180	0.165	1.05
			s	0.381	0.0634	0.428	0.181	0.0802	0.00860	0.0808	0.524
	All Station OR-1 Summary		***n***	*9*	*9*	*9*	*9*	*9*	*9*	*9*	*9*
			Min	*2.25*	*0.970*	*1.10*	*0.957*	*0.300*	*0.129*	*0.0960*	*0.449*
			Max	*10.1*	*3.06*	*7.13*	*2.40*	*0.473*	*0.214*	*0.312*	*1.94*
			Mean	***5.75***	***1.91***	***3.84***	***1.81***	***0.351***	***0.156***	***0.196***	***1.30***
			Median	*3.10*	*1.15*	*2.08*	*2.01*	*0.315*	*0.150*	*0.182*	*1.24*
			Range	*7.85*	*2.09*	*6.03*	*1.44*	*0.173*	*0.0850*	*0.216*	*1.49*
			s	*3.81*	*1.01*	*2.81*	*0.573*	*0.0636*	*0.0246*	*0.0696*	*0.490*

				Total Mercury				***Methylmercury***			
		Latdist	***Turbidity***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***NTU***	***ng/L***	***ng/L***	***ng/L***	***RATIO***	***ng/L***	***ng/L***	***ng/L***	***RATIO***
Station OR-2	09/08/98	-84.1	6.9	9.32	4.00	5.32	1.33	1.06	0.531	0.527	0.992
	09/08/98			7.21	2.67	4.54	1.70	0.701	0.417	0.284	0.681
	09/08/98			4.83	1.66	3.17	1.91	0.537	0.251	0.286	1.14
	09/08/98			2.88	1.32	1.56	1.18	0.343	0.160	0.183	1.14
	09/08/98			2.79	1.15	1.64	1.43	0.325	0.140	0.185	1.32
	Summer Station OR-2		***n***	5	5	5	5	5	5	5	5
			Min	2.79	1.15	1.56	1.18	0.325	0.14	0.183	0.681
			Max	9.32	4.00	5.32	1.91	1.06	0.531	0.527	1.32
			Mean	5.41	2.16	3.25	1.51	0.593	0.300	0.293	1.06
			Median	4.83	1.66	3.17	1.43	0.537	0.251	0.284	1.14
			Range	6.53	2.85	3.76	0.728	0.733	0.391	0.344	0.640
			s	2.83	1.19	1.69	0.293	0.302	0.169	0.140	0.240
Station OR-2	04/14/99	-84.1	42	17.3	3.40	13.9	4.09	0.371	0.207	0.164	0.792
	04/14/99			11.3	3.15	8.15	2.59	0.560	0.168	0.392	2.33
	04/14/99			10.3	2.97	7.33	2.47	0.502	0.173	0.329	1.90
	Spring Station OR-2		***n***	3	3	3	3	3	3	3	3
			Min	10.3	2.97	7.33	2.47	0.371	0.168	0.164	0.792
			Max	17.3	3.40	13.9	4.09	0.560	0.207	0.392	2.33
			Mean	13.0	3.17	9.79	3.05	0.478	0.183	0.295	1.68
			Median	11.3	3.15	8.15	2.59	0.502	0.173	0.329	1.90
			Range	7.00	0.430	6.57	1.62	0.189	0.0390	0.228	1.54
			s	3.79	0.216	3.58	0.903	0.0968	0.0212	0.118	0.795
	ALL Station OR-2		***n***	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*
			Min	*2.79*	*1.15*	*1.56*	*1.18*	*0.325*	*0.140*	*0.164*	*0.681*
			Max	*17.3*	*4.00*	*13.9*	*4.09*	*1.06*	*0.531*	*0.527*	*2.33*
			Mean	***8.24***	***2.54***	***5.70***	***2.09***	***0.550***	***0.256***	***0.294***	***1.29***
			Median	*8.27*	*2.82*	*4.93*	*1.81*	*0.520*	*0.190*	*0.285*	*1.14*
			Range	*14.5*	*2.85*	*12.3*	*2.91*	*0.733*	*0.391*	*0.363*	*1.65*
			s	*4.90*	*1.04*	*4.10*	*0.957*	*0.242*	*0.142*	*0.123*	*0.563*

				Total Mercury				*Methylmercury*			
		Latdist	***Turbidity***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***Unfiltered***	***Dissolved***	***Suspended***	***Susp:Diss***
Station	***Date***	***km***	***NTU***	***ng/L***	***ng/L***	***ng/L***	***RATIO***	***ng/L***	***ng/L***	***ng/L***	***RATIO***
ALL INFLOW SUMMARY			***n***	*17*	*17*	*17*	*17*	*17*	*17*	*17*	*17*
			Min	*2.25*	*0.970*	*1.10*	*0.957*	*0.300*	*0.129*	*0.0960*	*0.449*
			Max	*17.3*	*4.00*	*13.9*	*4.09*	*1.06*	*0.531*	*0.527*	*2.33*
			Mean	***6.92***	***2.21***	***4.72***	***1.94***	***0.445***	***0.203***	***0.242***	***1.29***
			Median	*7.21*	*2.67*	*4.54*	*1.91*	*0.369*	*0.161*	*0.186*	*1.17*
			Range	*15.1*	*3.03*	*12.8*	*3.13*	*0.758*	*0.402*	*0.431*	*1.89*
			s	*4.40*	*1.05*	*3.49*	*0.765*	*0.195*	*0.109*	*0.108*	*0.508*
OUTFLOW DATA											
Station 8	08/21/96	61.4	11.0	9.56	3.63	5.93	1.63	0.321	0.201	0.120	0.597
	08/14/97		27.0	29.7	5.29	24.4	4.62	0.270	0.147	0.123	0.837
	Summer Station 8		***n***	2	2	2	2	2	2	2	2
			Min	9.56	3.63	5.93	1.63	0.270	0.147	0.120	0.597
			Max	29.7	5.29	24.4	4.62	0.321	0.201	0.123	0.837
			Mean	19.6	4.46	15.2	3.12	0.296	0.174	0.122	0.717
			Median								
			Range	20.2	1.66	18.5	2.98	0.0510	0.0540	0.00300	0.240
			s								
	05/05/97	61.4	26.1	30.8	2.90	27.9	9.62	0.391	0.199	0.192	0.965
	05/05/97			31.0	6.19	24.8	4.00	0.34	0.234	0.106	0.453
	05/07/98		23.6	.	.	.	.	.	.	.	.
	05/07/98			20.8	3.02	17.8	5.89	0.215	0.120	0.0950	0.792
	Spring Station 8		***n***	3	3	3	3	3	3	3	3
			Min	20.8	2.90	17.8	4.00	0.215	0.120	0.0950	0.453
			Max	31.0	6.19	27.9	9.62	0.391	0.234	0.192	0.965
			Mean	27.5	4.04	23.5	6.50	0.315	0.184	0.131	0.737
			Median	30.8	3.02	24.8	5.89	0.340	0.199	0.106	0.792
			Range	10.2	3.29	10.1	5.62	0.176	0.114	0.097	0.512
			s	5.83	1.87	5.19	2.86	0.0906	0.0584	0.0531	0.260

				Total Mercury				*Methylmercury*			
		Latdist	***Turbidity***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***Unfiltered***	***Dissolved***	***Suspended***	***Susp:Diss***
Station	***Date***	***km***	***NTU***	***ng/L***	***ng/L***	***ng/L***	***RATIO***	***ng/L***	***ng/L***	***ng/L***	***RATIO***
ALL OUTFLOW SUMMARY			***n***	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*9.56*	*2.90*	*5.93*	*1.63*	*0.215*	*0.120*	*0.0950*	*0.453*
			Max	*31.0*	*6.19*	*27.9*	*9.62*	*0.391*	*0.234*	*0.192*	*0.965*
			Mean	***24.4***	***4.21***	***20.2***	***5.15***	***0.307***	***0.180***	***0.127***	***0.729***
			Median	*29.7*	*3.63*	*24.4*	*4.62*	*0.321*	*0.199*	*0.120*	*0.792*
			Range	*21.4*	*3.29*	*22.0*	*7.99*	*0.176*	*0.114*	*0.0970*	*0.512*
			s	*9.30*	*1.46*	*8.77*	*2.94*	*0.0674*	*0.0458*	*0.0379*	*0.203*
GEOTHERMAL WATER DATA											
Station 1gs	08/14/97	6.70	2.00	2.24	1.09	1.15	1.06	0.0140	0.0110	0.00300	0.273

Table A2-5a Trace elements associated with suspended particulates in Lake Owyhee waters.

		Lat		***Silica - SiO_2***				***Aluminum - Al***				***Calcium - Ca***			
		Dist.	***Depth***	***unfilt***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***
SPRING RESERVOIR DATA															
Station 1	05/05/97	2.60	-1.00	26.2				1430	349	1080	3.11	18.0	17.0	1.00	0.0590
	05/07/98	0.00	0.00					1290	219	1070	4.89	13.7	13.4	0.300	0.0220
	05/07/98	0.00	0.00					1310	269	1040	3.87	14.3	13.8	0.500	0.0360
		Station 1	***n***					3	3	3	3	3	3	3	3
			Min					1290	219	1040	3.11	13.7	13.4	0.300	0.0220
			Max					1430	349	1080	4.89	18.0	17.0	1.00	0.0590
			Mean					1340	279	1070	3.96	15.3	14.7	0.601	0.0392
			Median					1310	269	1070	3.87	14.3	13.8	0.500	0.0362
			Range					143	130	43.0	1.79	4.33	3.63	0.700	0.0370
			s					77.5	65.6	22.1	0.896	2.35	1.99	0.362	0.0184
Station 5	05/05/97	37.3	-1.00	25.7				1350	687	659	0.959	14.1	13.5	0.600	0.0440
Station 7	05/05/97	60.4	-1.00	25.7				1190	710	484	0.682	15.4	14.8	0.640	0.0430
SPRING SUMMARY			***n***	*3*				*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*25.7*				*1190*	*219*	*484*	*0.682*	*13.7*	*13.4*	*0.300*	*0.0220*
			Max	*26.2*				*1430*	*710*	*1080*	*4.89*	*18.0*	*17.0*	*1.00*	*0.0590*
			Mean	***26.0***				***1310***	***447***	***868***	***2.70***	***15.1***	***14.5***	***0.608***	***0.0410***
			Median	*25.7*				*1310*	*349*	*1040*	*3.11*	*14.3*	*13.8*	*0.597*	*0.0433*
			Range	*0.500*				*239*	*491*	*600*	*4.21*	*4.33*	*3.63*	*0.700*	*0.0370*
			s	*0.289*				*86.8*	*235*	*278*	*1.83*	*1.76*	*1.52*	*0.257*	*0.0133*
SUMMER RESERVOIR DATA															
Station 1	08/21/96	2.60	-2.99	37.0	2.30	34.7	15.1								
	08/14/97	2.60	0.00	33.2				3560	146	3410	23.4	24.5	22.3	2.20	0.0990
	08/14/97	2.60	0.00					3360	118	3240	27.5	25.3	23.0	2.30	0.100
		Station 1	***n***	2				2	2	2	2	2	2	2	2
			Min	33.2				3360	118	3240	23.4	24.5	22.3	2.20	0.0990
			Max	37.0				3560	146	3410	27.5	25.3	23.0	2.30	0.100
			Mean	35.1				3460	132	3330	25.4	24.9	22.7	2.25	0.0993
			Median	35.1				3460	132	3320	25.4	24.9	22.7	2.25	0.0993
			Range	3.80				200	28.0	172	4.09	0.800	0.700	0.100	0.00100
			s	2.69				141	19.8	122	2.89	0.566	0.495	0.0707	0.00100

		Lat		***Silica - SiO_2***				***Aluminum - Al***				***Calcium - Ca***			
		Dist.	***Depth***	***unfilt***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***
Station 2	08/21/96	13.1	-1.00	31.3	1.60	29.7	18.6								
	08/21/96	13.1	-5.00	31.2	1.60	29.6	18.5								
	08/21/96	13.1	-12.1	33.5	1.70	31.8	18.7								
		Station 2	***n***	3	3	3	3								
			Min	31.2	1.60	29.6	18.5								
			Max	33.5	1.70	31.8	18.7								
			Mean	32.0	1.63	30.4	18.6								
			Median	31.3	1.60	29.7	18.6								
			Range	2.30	0.10	2.20	0.206								
			s	1.30	0.0577	1.24	0.106								
Station 3	08/21/96	19.9	-1.00	28.4	1.20	27.2	22.7								
	08/21/96	19.90	-8.99	28.8	1.30	27.5	21.2								
	08/21/96	19.90	-19.5	28.3	1.00	27.3	27.3								
		Station 3	***n***	3	3	3	3								
			Min	28.3	1.00	27.2	21.2								
			Max	28.8	1.30	27.5	27.3								
			Mean	28.5	1.17	27.3	23.7								
			Median	28.4	1.20	27.3	22.7								
			Range	0.500	0.300	0.300	6.15								
			s	0.266	0.153	0.153	3.20								
Station 4	08/20/96	28.10	-1.00	26.9	1.00	25.9	25.9								
	08/20/96	28.10	-12.9	26.4	0.90	25.5	28.3								
	08/20/96	28.10	-26.6	26.0	1.20	24.8	21								
		Station 4	***n***	3	3	3	3.00								
			Min	26.0	0.90	24.8	20.7								
			Max	26.9	1.20	25.9	28.3								
			Mean	26.4	1.03	25.4	25.0								
			Median	26.4	1.00	25.5	25.9								
			Range	0.900	0.300	1.10	7.67								
			s	0.451	0.153	0.557	3.92								

		Lat		***Silica - SiO_2***				***Aluminum - Al***				***Calcium - Ca***			
		Dist.	***Depth***	***unfilt***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***
Station 5	08/20/96	37.3	-1.00	25.6	0.90	24.7	27.4								
	08/20/96	37.3	-21.0	25.4	1.00	24.4	24.4								
	08/20/96	37.3	-40.0	25.5	1.30	24.2	18.6								
	08/14/97	37.3	-1.00	24.2				827	257	570	2.22	16.4	17.3	NC	NC
	08/14/97	37.3	-32.0	25.0				4460	393	4070	10.3	14.2	13.9	0.300	0.0220
		Station 5	***n***	6	3	3	3	2	2	2	2	2	2		
			Min	24.2	0.900	24.2	18.6	827	257	570	2.22	14.2	13.9		
			Max	25.6	1.30	24.7	27.4	4460	393	4070	10.4	16.4	17.3		0.0220
			Mean	25.1	1.07	24.4	23.5	2640	325	2320	6.28	15.3	15.6		
			Median	25.2	1.00	24.4	24.4	2640	325	2320	6.28	15.3	15.6		
			Range	1.40	0.400	0.500	8.83	3630	136	3500	8.13	2.20	3.40		
			s	0.531	0.208	0.252	4.48	2570	96.2	2470	5.75	1.56	2.40		
Station 6	08/20/96	45.3	-1.00	25.2	0.800	24.4	30.5								
	08/20/96	45.3	-30.0	25.2	1.30	23.9	18.4								
	08/20/96	45.3	-58.0	24.8	1.30	23.5	18.1								
		Station	***n***	3	3	3	3								
			Min	24.8	0.800	23.5	18.1								
			Max	25.2	1.30	24.4	30.5								
			Mean	25.1	1.13	23.9	22.3								
			Median	25.2	1.30	23.9	18.4								
			Range	0.400	0.500	0.900	12.4								
			s	0.231	0.289	0.451	7.09								
Station 7	08/20/96	60.4	-1.00	24.8	0.800	24.0	30.0								
	08/20/96	60.4	-50.0	23.7	1.30	22.4	17.2								
	08/20/96	60.4	-72.0	24.2	1.30	22.9	17.6								
	08/14/97	60.4	-1.00	24.4				1530	1100	430	0.391	14.2	14.1	0.100	0.00700
		Station 7	***n***	6	3	3	3								
			Min	23.7	0.800	22.4	17.2								
			Max	26.1	1.30	24.0	30.00								
			Mean	24.9	1.13	23.1	21.6								
			Median	24.6	1.30	22.9	17.6								
			Range	2.40	0.500	1.60	12.8								
			s	0.983	0.289	0.819	7.26								

		Lat		Silica - SiO_2				Aluminum - Al				Calcium - Ca			
		Dist.	Depth	unfilt	filtered	suspended	susp:diss	unfiltered	filtered	suspended	susp:diss	unfiltered	filtered	suspended	susp:diss
Station	Date	km	m	mg/L	mg/L	mg/L	RATIO	µg/L	µg/L	µg/L	RATIO	mg/L	mg/L	mg/L	RATIO
SUMMER RESERVOIR			n	26	19	19	19	5	5	5	5	5	5	5	
			Min	23.7	0.800	22.4	15.1	827	118	430	0.391	14.2	13.9		
			Max	37.0	2.30	34.7	30.5	4460	1100	4067	27.5	25.3	23.0	2.30	
			Mean	27.2	1.25	26.2	22.1	2750	403	2340	12.8	18.9	18.1	0.800	
			Median	25.8	1.30	24.8	20.7	3360	257	3240	10.3	16.4	17.3	0.300	
			Range	13.3	1.50	12.3	15.4	3630	982	3640	27.1	11.1	9.10	3.20	
			s	3.41	0.366	3.24	4.85	1510	405	1712	12.2	5.54	4.36	1.40	
ALL RESERVOIR			n	29	19	19	19	10	10	10	10	10	10	10	10
			Min	23.7	0.800	22.4	15.1	827	118	430	0.391	13.7	13.4	0	NC
			Max	37.0	2.30	34.7	30.5	4460	1100	4067	27.5	25.3	23.0	2.30	0.100
			Mean	**27.0**	**1.25**	**26.2**	**22.1**	**2030**	**425**	**1610**	**7.73**	**17.0**	**16.3**	**0.704**	**0.0380**
			Media	25.7	1.30	24.8	20.7	1390	309	1060	3.49	14.9	14.5	0.548	0.0398
			Range	13.3	1.50	12.3	15.4	3630	982	3640	27.1	11.6	9.60	3.20	0.152
			s	3.25	0.365	3.24	4.85	1260	313	1390	9.81	4.36	3.62	0.954	0.0442

Table A2-5a (Continued) Trace elements associated with suspended particulates in Lake Owyhee waters.

		Magnesium - Mg				***Potassium - K***				***Iron - Fe***				***Manganese - Mn***			
		unfilt	***filt***	***susp***	***susp:diss***	***unfilt***	***filt***	***susp***	***susp:diss***	***unfilt***	***filt***	***susp***	***susp:diss***	***unfilt***	***filt***	***susp***	***susp:diss***
Station	***Date***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
SPRING RESERVOIR DATA																	
Station 1	05/05/97	4.62	4.09	0.530	0.129	2.76	2.41	0.35	0.146	1050	198	855	4.32	78.3	1.99	76.3	38.4
	05/07/98																
	05/07/98																
	05/07/98	3.40	3.27	0.130	0.0400	2.33	2.10	0.230	0.110	1120	153	967	6.32	33.7	1.82	31.9	17.5
	05/07/98	3.42	3.25	0.170	0.052	2.42	2.16	0.260	0.120	1200	185	1020	5.49	36.8	2.00	34.8	17.4
	n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Min	3.40	3.25	0.13	0.0400	2.33	2.10	0.230	0.110	1050	153	855	4.32	33.7	1.82	31.9	17.4
	Max	4.62	4.09	0.53	0.129	2.76	2.41	0.350	0.146	1200	198	1020	6.32	78.3	2.00	76.3	38.5
	Mean	3.81	3.54	0.275	0.0736	2.50	2.22	0.281	0.125	1120	179	946	5.37	49.6	1.94	47.7	24.5
	Median	3.42	3.27	0.170	0.0523	2.42	2.16	0.260	0.120	1120	185	967	5.49	36.8	1.99	34.8	17.5
	Range	1.22	0.840	0.400	0.0890	0.430	0.310	0.120	0.0360	147	45	160	2.01	44.6	0.180	44.4	21.1
	s	0.696	0.479	0.218	0.0482	0.229	0.166	0.0633	0.0185	73.4	23.2	82.0	1.01	24.9	0.0999	24.9	12.1
Station 5	05/05/97	3.54	3.26	0.29	0.088	2.78	2.50	0.280	0.111	739	339	399	1.18	17.8	3.27	14.5	4.44
Station 7	05/05/97	4.04	3.55	0.49	0.139	3.11	2.84	0.270	0.0960	805	365	440	1.20	19.8	3.25	16.6	5.11
	SPRING RESERVOIR SUMMARY																
	n	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
	Min	*3.40*	*3.25*	*0.130*	*0.0400*	*2.33*	*2.10*	*0.230*	*0.0960*	*739*	*153*	*399*	*1.18*	*17.8*	*1.82*	*14.5*	*4.44*
	Max	*4.62*	*4.09*	*0.530*	*0.139*	*3.11*	*2.84*	*0.350*	*0.146*	*1200*	*365*	*1020*	*6.32*	*78.3*	*3.27*	*76.3*	*38.4*
	Mean	*3.80*	*3.48*	*0.321*	*0.0895*	*2.68*	*2.40*	*0.278*	*0.1160*	*983*	*248*	*735*	*3.70*	*37.3*	*2.46*	*34.8*	*16.6*
	Median	*3.54*	*3.27*	*0.286*	*0.0878*	*2.76*	*2.413*	*0.271*	*0.111*	*1050*	*198*	*855*	*4.32*	*33.7*	*2.00*	*31.9*	*17.4*
	Range	*1.22*	*0.840*	*0.400*	*0.0990*	*0.780*	*0.740*	*0.120*	*0.0500*	*461*	*212*	*616*	*5.14*	*60.5*	*1.45*	*61.8*	*34.0*
	s	*0.523*	*0.361*	*0.182*	*0.0442*	*0.311*	*0.295*	*0.0450*	*0.0186*	*201*	*96.9*	*294*	*2.40*	*24.4*	*0.728*	*24.9*	*13.8*

		Magnesium - Mg				***Potassium - K***				***Iron - Fe***				***Manganese - Mn***			
		unfilt	***filt***	***susp***	***susp:diss***	***unfilt***	***filt***	***susp***	***susp:diss***	***unfilt***	***filt***	***susp***	***susp:diss***	***unfilt***	***filt***	***susp***	***susp:diss***
Station	***Date***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***mg/L***	***mg/L***	***mg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
SUMMER RESERVOIR DATA																	
Station 1	08/14/97	6.75	5.83	0.920	0.158	5.51	4.49	1.02	0.227	2900	124	2776	22.4	155	8.00	147	18.4
	08/14/97	6.84	5.85	0.990	0.169	5.54	4.50	1.04	0.231	2780	98.9	2681	27.1	158	6.79	151	22.3
	n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Min	6.75	5.83	0.920	0.158	5.51	4.49	1.02	0.227	2780	98.9	2681	22.4	155	6.79	147	18.4
	Max	6.84	5.85	0.990	0.169	5.54	4.50	1.04	0.231	2900	124	2776	27.1	158	8.00	151	22.3
	Mean	6.80	5.84	0.955	0.164	5.53	4.50	1.03	0.229	2840	111	2730	24.7	156	7.40	149	20.3
	Range	0.0900	0.0200	0.0700	0.0110	0.0300	0.0100	0.0200	0.00400	120	25.1	94.9	4.72	3.00	1.21	4.21	3.90
Station 5	08/14/97	4.10	4.05	0.05	0.012	2.67	2.69			508	187	321	1.72	6.33	2.77	3.56	1.29
	08/14/97	3.78	3.35	0.43	0.128	3.17	2.54	0.630	0.248	2920	249	2671	10.7	30.6	3.19	27.4	8.59
	n	2	2	2	2	2	2			2	2	2	2	2	2	2	2
	Min	3.78	3.35	0.05	0.012	2.67	2.54			508	187	321	1.72	6.33	2.77	3.56	1.29
	Max	4.10	4.05	0.43	0.128	3.17	2.69			2920	249	2670	10.7	30.6	3.19	27.4	8.59
	Mean	3.9400	3.7000	0.2400	0.0704	2.9200	2.62			1710	218	1500	6.22	18.5	2.98	15.5	4.94
	Range	0.32	0.70	0.38	0.116	0.50	0.150			2410	62.1	2350	9.01	24.3	0.420	23.9	7.31
Station 7	08/14/97	3.53	3.44	0.09	0.026	2.63	2.54			901	648	253	0.390	6.07	3.81	2.26	0.593
	SUMMER RESERVOIR SUMMARY																
	n	*5*	*5*	*5*	*5*	*5*	*5*	*4*	*4*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
	Min	*3.53*	*3.35*	*0.0500*	*0.0120*	*2.63*	*2.54*	*0.0900*	*0.0350*	*508*	*99.0*	*253*	*0.390*	*6.07*	*2.77*	*2.26*	*0.593*
	Max	*6.84*	*5.85*	*0.990*	*0.169*	*5.54*	*4.50*	*1.04*	*0.248*	*2920*	*648*	*2780*	*27.1*	*158*	*8.00*	*151*	*22.3*
	Mean	*5.00*	*4.50*	*0.496*	*0.0988*	*3.90*	*3.35*	*0.695*	*0.185*	*2000*	*261*	*1740*	*12.5*	*71.2*	*4.91*	*66.3*	*10.2*
	Median	*4.10*	*4.05*	*0.430*	*0.128*	*3.17*	*2.69*	*0.825*	*0.229*	*2780*	*187*	*2670*	*10.7*	*30.6*	*3.81*	*27.4*	*8.59*
	Range	*3.31*	*2.50*	*0.940*	*0.157*	*2.91*	*1.96*	*0.950*	*0.213*	*2410*	*549*	*2520*	*26.7*	*152*	*5.23*	*149*	*21.7*
	s	*1.65*	*1.25*	*0.445*	*0.0743*	*1.50*	*1.05*	*0.445*	*0.100*	*1190*	*224*	*1330*	*12.0*	*78.5*	*2.34*	*76.3*	*9.83*
ALL RESERVOIR SAMPLES SUMMARY																	
	n	*10*	*10*	*10*	*10*	*10*	*10*	*9*	*9*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
	Min	*3.40*	*3.25*	*0.0500*	*0.0120*	*2.33*	*2.10*	*0.0900*	*0.0350*	*508*	*98.9*	*253*	*0.390*	*6.07*	*1.82*	*2.26*	*0.593*
	Max	*6.84*	*5.85*	*0.990*	*0.169*	*5.54*	*4.50*	*1.04*	*0.248*	*2920*	*648*	*2780*	*27.1*	*158*	*8.00*	*151*	*38.4*
	Mean	***4.40***	***3.99***	***0.409***	***0.0941***	***3.29***	***2.88***	***0.463***	***0.147***	***1490***	***255***	***1240***	***8.08***	***54.2***	***3.69***	***50.6***	***13.4***
	Median	*3.91*	*3.49*	*0.358*	*0.108*	*2.77*	*2.54*	*0.277*	*0.120*	*1090*	*193*	*911*	*4.90*	*32.2*	*3.22*	*29.6*	*13.0*
	Range	*3.44*	*2.60*	*0.940*	*0.157*	*3.21*	*2.40*	*0.950*	*0.213*	*2410*	*549*	*2520*	*26.7*	*152*	*6.18*	*149*	*37.9*
	s	*1.32*	*1.02*	*0.333*	*0.0578*	*1.21*	*0.880*	*0.352*	*0.0727*	*969*	*163*	*1050*	*9.38*	*57.6*	*2.08*	*56.0*	*11.8*

Table A2-5b Trace elements associated with suspended particulates in Owyhee River inflows, reservoir outflow, and the sampled geothermal spring.

			Silica - SiO_2				*Aluminum - Al*				*Calcium - Ca*				*Magnesium - Mg*			
Station	*Date*	*Latdist km*	*unfilt mg/L*	*filt mg/L*	*susp mg/L*	*Susp: Diss RATIO*	*unfilt µg/L*	*filt µg/L*	*susp µg/L*	*Susp: Diss RATIO*	*unfilt mg/L*	*filt mg/L*	*susp mg/L*	*Susp: Diss RATIO*	*unfilt mg/L*	*filt mg/L*	*susp mg/L*	*Susp: Diss RATIO*
INFLOW DATA																		
Station OR-1	09/08/98	-88.5	31.7	.	.	.	159	3.54	155	43.915	20.1	20.0	0.18	0.00900	5.52	5.48	0.04	0.007
	04/14/99	-88.5	22.2															
Station OR-2	09/08/98	-84.1	31.7	.	.	.	248	23.5	225	9.553	22.1	21.6	0.50	0.023	6.46	6.32	0.14	0.022
	04/14/99	-84.1	.	22.0														
ALL INFLOW		***n***	*2*	*2*			*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
		Min	*22.2*	*22.0*			*159*	*3.54*	*155*	*9.55*	*20.1*	*20.0*	*0.180*	*0.00900*	*5.52*	*5.48*	*0.040*	*0.007*
		Max	*31.7*	*31.7*			*248*	*23.5*	*225*	*43.9*	*22.1*	*21.6*	*0.500*	*0.0230*	*6.46*	*6.32*	*0.140*	*0.022*
		Mean	***27.0***	***26.9***			***204***	***13.5***	***190***	***26.7***	***21.1***	***20.8***	***0.340***	***0.0164***	***5.99***	***5.90***	***0.0900***	***0.0147***
		Range	*9.50*	*9.70*			*89.0*	*20.0*	*69.0*	*34.4*	*1.96*	*1.64*	*0.320*	*0.00700*	*0.94*	*0.84*	*0.100*	*0.015*
OUTFLOW DATA																		
Station 8	08/21/96	61.4	24.8	1.20	23.6	19.700	3200	560	2640	4.71	14.4	14.0	0.400	0.0290	3.87	3.52	0.350	0.099
	05/05/97	61.4	24.3				1160	155	1010	6.48	15.9	15.0	0.900	0.0600	4.19	3.72	0.470	0.126
	05/05/97		24.7				1190	686	500	0.728	16.0	15.1	0.900	0.0580	4.17	3.69	0.480	0.130
	05/07/98		.				1520	136	1380	10.2	17.5	17.2	0.300	0.0170	4.52	4.24	0.280	0.0660
Spring Station 8		***n***	2				3	3	3	3	3	3	3	3	3	3	3	3
		Min	24.3				1160	136	500	0.728	15.9	15.0	0.300	0.0200	4.17	3.69	0.280	0.0660
		Max	24.7				1520	686	1380	10.2	17.5	17.2	0.900	0.0520	4.52	4.24	0.480	0.130
		Mean	24.5000				1290	326	964	5.80	16.5	15.8	0.6939	0.0440	4.29	3.88	0.410	0.107
		Median					1190	155	1010	6.48	16.0	15.1	0.8800	0.0581	4.19	3.72	0.469	0.126
		Range	0.40				358	550	884	9.45	1.60	2.20	0.600	0.0430	0.350	0.550	0.200	0.0640
		s					200	312	444	4.76	0.882	1.22	0.341		0.199	0.311	0.112	0.0359
ALL OUTFLOW		***n***	*5*				*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
		Min	*24.3*				*1160*	*136*	*500*	*0.728*	*14.4*	*14.0*	*0.300*	*0.0210*	*3.87*	*3.52*	*0.280*	*0.0660*
		Max	*25.0*				*3200*	*686*	*2640*	*10.2*	*17.5*	*17.2*	*0.900*	*0.0520*	*4.52*	*4.24*	*0.480*	*0.130*
		Mean	***24.70***				***1770***	***384***	***1380***	***5.53***	***16.0***	***15.3***	***0.621***	***0.0404***	***4.19***	***3.79***	***0.395***	***0.105***
		Median	*24.7*				*1350*	*358*	*1200*	*5.60*	*16.0*	*15.1*	*0.640*	*0.0424*	*4.18*	*3.70*	*0.410*	*0.113*
		Range	*0.700*				*2040*	*550*	*2140*	*9.45*	*3.10*	*3.20*	*0.600*	*0.031*	*0.650*	*0.72*	*0.200*	*0.064*
		s	*0.259*				*969*	*281*	*913*	*3.93*	*1.27*	*1.34*	*0.315*		*0.266*	*0.312*	*0.0965*	*0.0296*
GEOTHERMAL WATER DATA																		
Station 1gs	08/14/97	6.7	73.5	.	.	.	125	57.7	67.3	1.17	1.00	0.960	0.0400	0.0420	0.0200	0.0100	0.0100	2.00

Table A2-5b (Continued) Trace elements associated with suspended particulates in Owyhee River inflows, reservoir outflow, and the sampled geothermal spring.

			Potassium - K				*Iron - Fe*				*Manganese - Mn*			
		Latdist	*unfiltered*	*filtered*	*suspended*	*susp:diss*	*unfiltered*	*filtered*	*suspended*	*susp:diss*	*unfiltered*	*filtered*	*suspended*	*susp:diss*
Station	*Date*	*km*	*mg/L*	*mg/L*	*mg/L*	*RATIO*	*µg/L*	*µg/L*	*µg/L*	*RATIO*	*µg/L*	*µg/L*	*µg/L*	*RATIO*
INFLOW DATA														
Station OR-1	09/08/98	-88.5	3.19	3.11	0.0800	0.0260	89.2	-4.00	89.2	>22.3	14.3	0.80	13.5	16.875
	04/14/99	-88.5												
Station OR-2	09/08/98	-84.1	3.77	3.65	0.120	0.0330	149	-4.00	149	>37.3	19.8	1.07	18.7	17.505
	04/14/99	-84.1												
ALL INFLOW		***n***	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
		Min	*3.19*	*3.11*	*0.0800*	*0.0260*	*89.2*	*-4.00*	*89.2*	*>22.3*	*14.3*	*0.800*	*13.5*	*16.9*
		Max	*3.77*	*3.65*	*0.120*	*0.0330*	*149*	*-4.00*	*149*	*>37.3*	*19.8*	*1.07*	*18.7*	*17.5*
		Mean	***3.48***	***3.38***	***0.100***	***0.0293***	***119***	***-4.00***	***119***	***>29.8***	***17.1***	***0.935***	***16.1***	***17.2***
		Range	*0.580*	*0.540*	*0.0400*	*0.00700*	*60.0*	*0*	*60.0*	*NC*	*5.50*	*0.27*	*5.23*	*0.630*
OUTFLOW DATA														
Station 8	08/21/96	61.4	3.03	2.59	0.440	0.170	2060	348	1710	4.92	14.6	2.56	12.0	4.703
	05/05/97	61.4	3.20	2.80	0.400	0.143	803	124	679	5.48	20.6	1.88	18.7	9.92
	05/05/97		3.17	2.85	0.320	0.114	811	356	455	1.28	20.3	3.35	16.9	5.05
	05/07/98		3.13	2.84	0.290	0.102	1400	108	1290	12.0	10.7	0.850	9.85	11.6
Spring Station 8		***n***	3	3	3	3	3	3	3	3	3	3	3	3
		Min	3.13	2.80	0.290	0.102	803	108	455	1.28	10.7	0.850	9.85	5.05
		Max	3.20	2.85	0.400	0.143	1400	356	1290	12.0	20.6	3.35	18.7	11.6
		Mean	3.17	2.83	0.338	0.120	100	196	809	6.24	17.2	2.03	15.1	8.86
		Median	3.17	2.84	0.3240	0.114	811	124	679	5.48	20.3	1.88	16.9	9.92
		Range	0.0700	0.0500	0.110	0.0410	597	248	837	10.7	9.86	2.50	8.82	6.56
		s	0.0339	0.0266	0.0564	0.0211	342	139	433	5.38	5.61	1.26	4.67	3.41
ALL OUTFLOW		***n***	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
		Min	*3.03*	*2.59*	*0.290*	*0.102*	*803*	*108*	*455*	*1.28*	*10.7*	*0.850*	*9.85*	*4.70*
		Max	*3.20*	*2.85*	*0.440*	*0.170*	*2060*	*356*	*1710*	*12.0*	*20.6*	*3.35*	*18.7*	*11.6*
		Mean	***3.13***	***2.77***	***0.364***	***0.132***	***1270***	***234***	***1030***	***5.91***	***16.5***	***2.16***	***14.4***	***7.82***
		Median	*3.15*	*2.82*	*0.362*	*0.129*	*1110*	*236*	*986*	*5.20*	*17.4*	*2.22*	*14.5*	*7.49*
		Range	*0.170*	*0.260*	*0.150*	*0.0680*	*1260*	*248*	*1260*	*10.7*	*9.86*	*2.50*	*8.82*	*6.92*
		s	*0.0734*	*0.121*	*0.0687*	*0.0304*	*597*	*136*	*574*	*4.44*	*4.76*	*1.06*	*4.12*	*3.47*
GEOTHERMAL WATER DATA														
Station 1gs	08/14/97	6.70	0.960	0.910	0.0600	0.0630	56.8	10.5	46.4	4.44	1.07	0.230	0.840	3.61

Table A2-6a *RESERVOIR* **Silver, Arsenic, and Beryllium:** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Lake Owyhee. Negative values represent below detection limit (ND) results with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated (NC) if both unfiltered and filtered were non-detect or if dissolved was greater than total (diss>tot). Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

		Lat		***Silver - Ag***				***Arsenic - As***				***Beryllium - Be***			
		dist	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
SPRING RESERVOIR DATA															
Station 1	05/05/97	2.60	-1.00	0.0355	-0.00200	0.0345	35.0	3.92	3.75	0.168	0.0450	0.175	0.0202	0.154	7.64
	05/07/98	0.00	0.00	0.0261	0.00730	0.0188	2.58	3.67	3.31	0.360	0.109	0.0877	0.0114	0.0763	6.69
	05/07/98	0.00	0.00	0.0251	0.00790	0.0172	2.18	3.68	3.28	0.400	0.122	0.0887	0.0144	0.0743	5.16
	Spring Station 1		***n***	3	3	3	3	3	3	3	3	3	3	3	3
			Min	0.0251	ND	0.0172	2.18	3.67	3.28	0.168	0.0450	0.0877	0.0114	0.0743	5.16
			Max	0.0355	0.00790	0.0188	35.0	3.92	3.75	0.400	0.122	0.175	0.0202	0.154	7.64
			Mean	0.0289	0.00500	0.0180	13.1	3.76	3.45	0.309	0.0918	0.117	0.0153	0.102	6.50
			Median	0.0261	0.00730	0.0188	2.58	3.68	3.31	0.360	0.109	0.0887	0.0144	0.0763	6.69
			Range	0.0100	0.00690	0.00160	32.3	0.250	0.470	0.232	0.0770	0.0868	0.00880	0.0800	2.48
			s	0.00501	0.00380	0.00901	18.8	0.142	0.265	0.124	0.0413	0.0498	0.00450	0.0456	1.25
Station 5	05/05/97	37.3	-1.00	0.0034	-0.0030	NC	NC	3.27	3.57	diss>tot	diss>tot	0.131	0.0249	0.106	4.25
Station 7	05/05/97	60.4	-1.00	-0.0070	-0.005000	NC	NC	4.08	4.46	diss>tot	diss>tot	0.116	0.0332	0.0824	2.48
	SPRING RESERVOIR SUMMARY														
			n	*5*	*5*	*3*	*3*	*5*	*5*	*3*	*3*	*5*	*5*	*5*	*5*
			Min	*0.00340*	*ND*	*0.0170*	*2.18*	*3.27*	*3.28*	*0.168*	*0.0450*	*0.0877*	*0.0114*	*0.0743*	*2.48*
			Max	*0.0355*	*0.00790*	*0.0350*	*35.0*	*4.08*	*4.46*	*0.400*	*0.122*	*0.175*	*0.0332*	*0.154*	*7.64*
			Mean	***0.0187***	***0.00400***	***0.0237***	***13.3***	***3.72***	***3.67***	***0.309***	***0.0918***	***0.120***	***0.0208***	***0.0986***	***5.25***
			Median	*0.0251*	*0.00250*	*0.0190*	*2.58*	*3.68*	*3.57*	*0.360*	*0.109*	*0.116*	*0.0202*	*0.0824*	*5.16*
			Range	*0.0321*	*0.00690*	*0.0180*	*32.8*	*0.810*	*1.18*	*0.232*	*0.0770*	*0.0868*	*0.0218*	*0.0800*	*5.16*
			s	*0.0145*	*0.00330*	*0.00901*	*18.8*	*0.308*	*0.479*	*0.124*	*0.0413*	*0.0358*	*0.00870*	*0.0336*	*2.03*
SUMMER RESERVOIR DATA															
Station 1	08/14/97	2.60	0.00	-0.0120	-0.0120	NC	NC	13.8	11.5	2.30	0.200	0.203	0.00300	0.200	66.7
	08/14/97	2.60	0.00	-0.0120	-0.0120	NC	NC	12.7	11.7	1.00	0.0850	0.175	0.00700	0.168	24.0
	Summer Station 1		***n***	2	2			2	2	2	2	2	2	2	2
			Min	ND	ND			12.7	11.5	1.00	0.0850	0.175	0.00300	0.168	24.0
			Max	ND	ND			13.8	11.7	2.30	0.200	0.203	0.00700	0.200	66.7
			Mean	ND	ND			13.3	11.6	1.65	0.143	0.189	0.00500	0.184	45.3
			Range					1.10	0.200	1.30	0.115	0.0280	0.00400	0.032	42.7

		Lat		***Silver - Ag***				***Arsenic - As***				***Beryllium - Be***			
		dist	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
Station 5	08/14/97	37.3	-1.00	-0.0120	-0.0120	NC	NC	3.88	3.75	0.130	0.0350	0.0296	0.0185	0.0111	0.600
	08/14/97	37.3	-32.0	0.0530	-0.0120	0.0470	7.83	4.45	3.60	0.850	0.236	0.162	0.0173	0.145	8.36
Summer Station 5			n	2	2			2	2	2	2	2	2	2	2
			Mean	0.0205	ND			4.17	3.68	0.490	0.135	0.0958	0.0179	0.0779	4.48
			Range	0.0650				0.570	0.15	0.720	0.201	0.132	0.00120	0.134	7.76
Station 7	08/14/97	60.4	-1.00	-0.0120	-0.0120			3.24	3.11	0.130	0.0420	0.0595	0.0401	0.0194	0.484
	SUMMER RESERVOIR SUMMARY														
			n	*5*	*5*			*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*ND*	*ND*	*NC*	*NC*	*3.24*	*3.11*	*0.130*	*0.0350*	*0.0296*	*0.003*	*0.0111*	*0.484*
			Max	*0.0530*	*ND*	*0.0470*	*7.83*	*13.8*	*11.7*	*2.300*	*0.236*	*0.203*	*0.0401*	*0.200*	*66.7*
			Mean	***0.0154***	***ND***	***NC***	***NC***	***7.61***	***6.73***	***0.882***	***0.120***	***0.126***	***0.0172***	***0.109***	***20.0***
			Median					*4.45*	*3.75*	*0.850*	*0.0855*	*0.162*	*0.0173*	*0.145*	*8.36*
			Range					*10.6*	*8.59*	*2.17*	*0.201*	*0.173*	*0.0371*	*0.189*	*66.2*
			s					*5.18*	*4.45*	*0.888*	*0.0928*	*0.0764*	*0.0144*	*0.0875*	*27.8*
ALL RESERVOIR DATA SUMMARY															
			n	*10*	*10*	*4*	*4*	*10*	*10*	*8*	*8*	*10*	*10*	*10*	*10*
			Min	*0.00340*	*0.00100*	*0.0170*	*2.18*	*3.24*	*3.11*	*0.130*	*0.0350*	*0.0296*	*0.00300*	*0.0111*	*0.484*
			Max	*0.0530*	*0.00790*	*0.0470*	*35.0*	*13.8*	*11.7*	*2.30*	*0.236*	*0.203*	*0.0401*	*0.200*	*66.7*
			Mean	***0.0171***	***0.00500***	***0.0295***	***11.9***	***5.67***	***5.20***	***0.667***	***0.109***	***0.123***	***0.0190***	***0.104***	***12.6***
			Median	*0.0060*	*0.00600*	*0.0270*	*5.20*	*3.90*	*3.68*	*0.380*	*0.0971*	*0.123*	*0.0179*	*0.0942*	*5.93*
			Range	*0.0496*	*0.00690*	*0.0300*	*32.8*	*10.6*	*8.59*	*2.17*	*0.201*	*0.173*	*0.0371*	*0.189*	*66.1*
			s	*0.0171*	*0.00240*	*0.0142*	*15.6*	*4.02*	*3.39*	*0.737*	*0.0750*	*0.0563*	*0.0114*	*0.0627*	*20.1*

Table A2-6a (Continued) *RESERVOIR* **Cadmium, Cobalt, and Chromium:** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Lake Owyhee. Negative values represent below detection limit (ND) results with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated (NC) if both unfiltered and filtered were non-detect or if dissolved was greater than total (diss>tot). Half the detection limit was substituted to calculate statistical summaries and susp:diss ratios with only dissolved non-detect values.

		Lat		***Cadmium - Cd***				***Cobalt - Co***				***Chromium - Cr***			
		Dist.	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
SPRING RESERVOIR DATA															
Station 1	05/05/97	2.60	-1.00	0.0505	0.00380	0.0467	12.3	1.11	0.0860	1.03	12.0	2.13	2.55	diss>tot	diss>tot
	05/07/98	0.00	0.00	0.0160	0.00200	0.0140	7.00	0.422	0.0860	0.336	3.91	0.882	0.251	0.631	2.51
	05/07/98	0.00	0.00	0.0171	0.00500	0.0119	2.29	0.454	0.0940	0.360	3.84	0.972	0.295	0.677	2.30
	Spring Station 1		***n***	3	3	3	3	3	3	3	3	3	3	2	2
			Min	0.0160	0.00200	0.0119	2.29	0.422	0.0860	0.336	3.84	0.882	0.251	0.631	2.30
			Max	0.0505	0.00500	0.0467	12.3	1.11	0.0940	1.03	12.0	2.13	2.55	0.677	2.51
			Mean	0.0279	0.00370	0.0242	7.19	0.663	0.0885	0.574	6.58	1.33	1.03	0.654	2.40
			Median	0.0171	0.00380	0.0140	7.00	0.454	0.0860	0.360	3.91	0.972	0.295		
			Range	0.0345	0.00320	0.0348	10.0	0.690	0.00800	0.690	8.15	1.24	2.30	0.0460	0.219
			s	0.0196	0.00160	0.0195	5.00	0.390	0.00460	0.392	4.67	0.694	1.32		
Station 5	05/05/97	37.3	-1.00	0.0276	0.00790	0.0197	2.49	0.372	0.104	0.267	2.56	1.66	2.34	diss>tot	diss>tot
Station 7	05/05/97	60.4	-1.00	0.0177	0.00901	0.00780	0.788	0.424	0.115	0.309	2.69	1.65	2.55	diss>tot	diss>tot
	SPRING RESERVOIR														
			n	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*2*	*2*
			Min	*0.0160*	*0.00200*	*0.00780*	*0.788*	*0.372*	*0.0860*	*0.267*	*2.56*	*0.882*	*0.251*	*0.631*	*2.30*
			Max	*0.0505*	*0.00901*	*0.0467*	*12.3*	*1.11*	*0.115*	*1.03*	*12.0*	*2.13*	*2.55*	*0.677*	*2.51*
			Mean	***0.0258***	***0.00501***	***0.0200***	***4.97***	***0.557***	***0.0969***	***0.460***	***5.00***	***1.45***	***1.60***	***0.654***	***2.40***
			Median	*0.0177*	*0.00500*	*0.0140*	*2.49*	*0.424*	*0.0938*	*0.336*	*3.84*	*1.65*	*2.34*		
			Range	*0.0345*	*0.00790*	*0.0389*	*11.5*	*0.740*	*0.0290*	*0.759*	*9.43*	*1.24*	*2.30*	*0.0460*	*0.219*
			s	*0.0146*	*0.00320*	*0.0155*	*4.70*	*0.312*	*0.0126*	*0.319*	*3.96*	*0.523*	*1.21*		
SUMMER RESERVOIR DATA															
Station 1	08/14/97	2.6	0.00	0.0693	0.0138	0.0555	4.02	1.56	0.451	1.11	2.46	5.40	0.876	4.52	5.16
	08/14/97	2.6	0.00	0.0705	0.0174	0.0531	3.05	1.55	0.436	1.11	2.56	3.07	0.736	2.33	3.17
	Summer Station 1		***n***	2	2	2	2	2	2	2	2	2	2	2	2
			Min	0.0693	0.0138	0.0531	3.05	1.55	0.436	1.11	2.46	3.07	0.736	2.33	3.17
			Max	0.0705	0.0174	0.0555	4.02	1.56	0.451	1.14	2.56	5.40	0.876	4.52	5.16
			Mean	0.0699	0.0156	0.0543	3.54	1.55	0.444	1.11	2.51	4.24	0.806	3.43	4.17
			Range	0.00120	0.00360	0.00240	0.970	0.0100	0.0150	0.00500	0.096	2.33	0.140	2.19	1.99

		Lat		***Cadmium - Cd***				***Cobalt - Co***				***Chromium - Cr***			
		Dist.	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
Station 5	08/14/97	37.3	-1.00	0.00900	0.00500	0.0040	0.7692	0.178	0.117	0.061	0.521	2.02	1.46	0.560	0.384
	08/14/97	37.3	-32.0	0.0294	0.00790	0.0215	2.7215	0.610	0.095	0.515	5.428	3.75	0.758	2.99	3.94
	Summer Station 5		***n***	2	2	2	2	2	2	2	2	2	2	2	2
			Mean	0.0193	0.00660	0.0128	1.7454	0.3940	0.1060	0.2881	2.9746	2.8850	1.1090	1.7760	2.1654
			Range	0.0202	0.00270	0.0175	1.9523	0.432	0.022	0.454	4.906	1.73	0.702	2.43	3.564
Station 7	08/14/97	60.4	-1.00	0.00900	0.00830	0.00 7	0.0843	0.202	0.152	0.050	0.329	1.94	1.52	0.420	0.276
	SUMMER RESERVOIR SUMMARY														
			n	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*0.00900*	*0.00500*	*0.00700*	*0.0843*	*0.178*	*0.0950*	*0.0500*	*0.329*	*1.94*	*0.736*	*0.420*	*0.276*
			Max	*0.0705*	*0.0174*	*0.0555*	*4.02*	*1.56*	*0.451*	*1.11*	*5.43*	*5.40*	*1.52*	*4.52*	*5.16*
			Mean	***0.0375***	***0.0101***	***0.0270***	***2.13***	***0.820***	***0.250***	***0.570***	***2.26***	***3.24***	***1.07***	***2.17***	***2.59***
			Median	*0.0294*	*0.00830*	*0.0215*	*2.72*	*0.610*	*0.152*	*0.515*	*2.46*	*3.07*	*0.876*	*2.33*	*3.17*
			Range	*0.0615*	*0.0122*	*0.0548*	*3.94*	*1.38*	*0.356*	*1.06*	*5.10*	*3.46*	*0.784*	*4.10*	*4.89*
			s	*0.0307*	*0.00500*	*0.0262*	*1.64*	*0.693*	*0.178*	*0.529*	*2.06*	*1.43*	*0.388*	*1.72*	*2.18*
ALL RESERVOIR DATA SUMMARY															
			n	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*7*	*7*
			Min	*0.00900*	*0.00200*	*0.00700*	*0.0843*	*0.178*	*0.0860*	*0.0500*	*0.329*	*0.882*	*0.251*	*0.420*	*0.276*
			Max	*0.0705*	*0.0174*	*0.0555*	*12.3*	*1.56*	*0.451*	*1.11*	*12.0*	*5.40*	*2.55*	*4.52*	*5.16*
			Mean	***0.0316***	***0.00810***	***0.0235***	***3.55***	***0.688***	***0.174***	***0.515***	***3.63***	***2.35***	***1.33***	***1.73***	***2.54***
			Median	*0.0227*	*0.00790*	*0.0169*	*2.61*	*0.439*	*0.110*	*0.348*	*2.63*	*1.98*	*1.17*	*0.677*	*2.51*
			Range	*0.0615*	*0.0154*	*0.0548*	*12.2*	*1.38*	*0.365*	*1.06*	*11.7*	*4.52*	*2.30*	*4.10*	*4.89*
			s	*0.0235*	*0.00470*	*0.0206*	*3.64*	*0.525*	*0.144*	*0.416*	*3.31*	*1.38*	*0.893*	*1.59*	*1.78*

Table A2-6a (Continued) *RESERVOIR* **Copper, Nickel, and Lead:** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Lake Owyhee. Negative values represent below detection limit (ND) results with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated (NC) if both unfiltered and filtered were non-detect or if dissolved was greater than total (diss>tot). Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

				Copper - Cu				***Nickel -Ni***				***Lead - Pb***			
		Lat	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
SPRING RESERVOIR DATA															
Station 1	05/05/97	2.60	-1.00	5.35	2.50	2.85	1.141	2.91	1.56	1.34	0.858	1.46	0.216	1.25	5.78
	05/07/98	0.00	0.00	2.43	1.44	0.990	0.688	1.43	0.315	1.12	3.540	0.571	0.0584	0.513	8.78
	05/07/98	0.00	0.00	2.59	1.55	1.04	0.671	0.989	0.374	0.615	1.644	0.597	0.0678	0.529	7.81
	Spring Station 1		***n***	3	3	3	3	3	3	3	3	3	3	3	3
			Min	2.43	1.44	0.990	0.671	0.989	0.315	0.615	0.858	0.571	0.0584	0.513	5.78
			Max	5.35	2.50	2.85	1.14	2.91	1.56	1.34	3.54	1.46	0.216	1.25	8.78
			Mean	3.46	1.83	1.63	0.833	1.77	0.751	1.02	2.01	0.877	0.114	0.763	7.45
			Median	2.59	1.55	1.04	0.688	1.43	0.374	1.12	1.64	0.597	0.0678	0.529	7.81
			Range	2.92	1.06	1.86	0.470	1.92	1.25	0.726	2.68	0.892	0.158	0.734	3.00
			s	1.64	0.582	1.06	0.267	1.00	0.705	0.372	1.38	0.508	0.0884	0.419	1.53
Station 5	05/05/97	37.3	-1.00	3.70	2.79	0.905	0.324	2.11	1.52	0.590	0.388	0.753	0.310	0.444	1.43
Station 7	05/05/97	60.4	-1.00	4.16	3.04	1.12	0.370	2.41	1.76	0.653	0.372	1.11	0.294	0.818	2.79
	SPRING RESERVOIR SUMMARY														
			n	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*2.43*	*1.44*	*0.905*	*0.324*	*0.989*	*0.315*	*0.590*	*0.372*	*0.571*	*0.0580*	*0.444*	*1.43*
			Max	*5.35*	*3.04*	*2.85*	*1.14*	*2.91*	*1.76*	*1.34*	*3.54*	*1.46*	*0.310*	*1.25*	*8.78*
			Mean	***3.65***	***2.26***	***1.38***	***0.639***	***1.97***	***1.11***	***0.863***	***1.36***	***0.899***	***0.189***	***0.710***	***5.31***
			Median	*3.70*	*2.50*	*1.04*	*0.671*	*2.11*	*1.52*	*0.653*	*0.858*	*0.753*	*0.216*	*0.529*	*5.77*
			Range	*2.92*	*1.60*	*1.95*	*0.817*	*1.92*	*1.44*	*0.751*	*3.17*	*0.892*	*0.251*	*0.803*	*7.35*
			s	*1.20*	*0.727*	*0.826*	*0.327*	*0.765*	*0.701*	*0.344*	*1.32*	*0.382*	*0.120*	*0.333*	*3.16*
SUMMER RESERVOIR DATA															
Station 1	08/14/97	2.6	0.00	4.85	2.10	2.75	1.31	2.68	0.564	2.12	3.75	1.67	0.0713	1.60	22.4
	08/14/97	2.6	0.00	4.80	2.07	2.73	1.32	2.57	0.532	2.04	3.83	1.66	0.0712	1.59	22.3
	Summer Station 1		***n***	2	2	2	2	2	2	2	2	2	2	2	2
			Min	4.80	2.07	2.73	1.31	2.57	0.532	2.04	3.75	1.66	0.0712	1.59	22.3
			Max	4.85	2.10	2.75	1.32	2.68	0.564	2.12	3.83	1.67	0.0713	1.60	22.4
			Mean	4.83	2.09	2.74	1.31	2.63	0.548	2.08	3.79	1.67	0.0713	1.59	22.4
			Range	0.0500	0.0300	0.0200	0.00900	0.100	0.0320	0.0780	0.0790	0.0100	0.00 100	0.0100	0.108

				Copper - Cu				***Nickel -Ni***				***Lead - Pb***			
		Lat	***depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
Station 5	08/14/97	37.3	-1.00	2.05	1.76	0.290	0.165	0.682	0.452	0.230	0.509	0.185	0.103	0.0820	0.796
	08/14/97	37.3	-32.0	4.08	1.91	2.17	1.14	2.34	0.744	1.60	2.15	0.989	0.0810	0.909	11.3
Summer Station 5			***n***	2	2	2	2	2	2	2	2	2	2	2	2
			Mean	3.07	1.84	1.23	0.650					0.587	0.0918	0.495	6.04
			Range	2.03	0.150	1.88	0.971					0.804	0.0230	0.827	10.5
Station 7	08/14/97	60.4	-1.00	2.45	2.18	0.270	0.124	0.898	0.709	0.189	0.267	0.265	0.187	0.0780	0.417
	SUMMER RESERVOIR SUMMARY														
			n	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*2.05*	*1.76*	*0.270*	*0.124*	*0.682*	*0.452*	*0.189*	*0.267*	*0.185*	*0.071*	*0.078*	*0.417*
			Max	*4.85*	*2.18*	*2.75*	*1.32*	*2.68*	*0.744*	*2.12*	*3.83*	*1.67*	*0.187*	*1.60*	*22.4*
			Mean	***3.65***	***2.00***	***1.64***	***0.811***	***1.83***	***0.600***	***1.23***	***2.10***	***0.954***	***0.103***	***0.851***	***11.4***
			Media	*4.08*	*2.07*	*2.17*	*1.14*	*2.34*	*0.564*	*1.60*	*2.15*	*0.989*	*0.0805*	*0.909*	*11.3*
			Range	*2.80*	*0.420*	*2.48*	*1.20*	*2.00*	*0.292*	*1.93*	*3.56*	*1.49*	*0.116*	*1.52*	*22.0*
			s	*1.32*	*0.168*	*1.27*	*0.613*	*0.964*	*0.123*	*0.956*	*1.70*	*0.721*	*0.0489*	*0.758*	*10.9*
ALL RESERVOIR DATA SUMMARY															
			n	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
			Min	*2.05*	*1.44*	*0.270*	*0.124*	*0.680*	*0.320*	*0.190*	*0.267*	*0.185*	*0.0580*	*0.0780*	*0.417*
			Max	*5.35*	*3.04*	*2.85*	*1.32*	*2.91*	*1.76*	*2.12*	*3.83*	*1.67*	*0.310*	*1.60*	*22.4*
			Mean	***3.65***	***2.13***	***1.51***	***0.725***	***1.90***	***0.853***	***1.05***	***1.73***	***0.927***	***0.146***	***0.781***	***8.38***
			Media	*3.89*	*2.09*	*1.08*	*0.679*	*2.23*	*0.637*	*0.884*	*1.25*	*0.871*	*0.0918*	*0.674*	*6.79*
			Range	*3.30*	*1.60*	*2.58*	*1.20*	*2.22*	*1.44*	*1.93*	*3.56*	*1.49*	*0.251*	*1.52*	*22.0*
			s	*1.19*	*0.516*	*1.02*	*0.472*	*0.824*	*0.544*	*0.705*	*1.49*	*0.545*	*0.0979*	*0.557*	*8.22*

Table A2-6a (Continued) *RESERVOIR* **Antimony, Selenium, and Thallium:** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Lake Owyhee. Negative values represent below detection limit (ND) results with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated (NC) if both unfiltered and filtered were non-detect or if dissolved was greater than total (diss>tot). Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

				Antimony - Sb				***Selenium - Se***				***Thallium - Tl***			
		Lat	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
SPRING RESERVOIR DATA															
Station 1	05/05/97	2.60	-1.00	0.218	0.216	0.00200	0.00930	0.888	0.409	0.479	1.17	0.0353	-0.006		
	05/07/98	0.00	0.00	0.219	0.197	0.0220	0.111	0.101	0.184	diss>tot	diss>tot	0.0206	0.00760	0.0130	1.71
	05/07/98	0.00	0.00	0.217	0.204	0.0130	0.0637	0.0660	0.263	diss>tot	diss>tot	0.0224	0.00870	0.0137	1.57
	Spring Station 1		***n***	3	3	3	3	3	3	1	1	3	3	2	2
			Min	0.217	0.197	0.00200	0.00930	0.066	0.184			0.0206	-0.006	0.0130	1.57
			Max	0.219	0.216	0.0220	0.111	0.888	0.409	0.479	1.17	0.0353	0.00870	0.0137	1.71
			Mean	0.218	0.206	0.0123	0.0614	0.352	0.285			0.0261	0.00340	0.0134	1.64
			Median	0.218	0.204	0.0130	0.0637	0.101	0.263			0.0224	0.00760	0.0134	1.64
			Range	0.00200	0.0190	0.0200	0.102	0.822	0.225			0.0147	0.0147	0.00700	0.136
			s	0.00100	0.00960	0.0100	0.0510	0.465	0.114			0.00800	0.00820	0.00500	0.0960
Station 5	05/05/97	37.3	-1.00	0.187	0.198			0.599	0.331	0.268	0.8109	0.0390	-0.006		
Station 7	05/05/97	60.4	-1.00	0.172	0.203			0.714	0.438	0.276	0.6291	0.0205	-0.006		
	SPRING RESERVOIR SUMMARY														
			n	*5*	*5*	*3*	*3*	*5*	*5*	*3*	*3*	*5*	*5*	*2*	*2*
			Min	*0.172*	*0.197*	*0.002*	*0.00930*	*0.0660*	*0.184*	*0.268*	*0.629*	*0.0205*	*-0.00600*	*0.0130*	*1.57*
			Max	*0.219*	*0.216*	*0.022*	*0.111*	*0.888*	*0.438*	*0.479*	*1.17*	*0.0390*	*0.00870*	*0.0137*	*1.71*
			Mean	***0.203***	***0.204***	***0.0123***	***0.0614***	***0.474***	***0.325***	***0.341***	***0.870***	***0.0276***	***-0.00300***	***0.0134***	***1.64***
			Median	*0.217*	*0.203*	*0.0130*	*0.0637*	*0.599*	*0.331*	*0.276*	*0.811*	*0.0224*	*-0.00600*	*0.0134*	*1.64*
			Range	*0.0470*	*0.0190*	*0.0200*	*0.102*	*0.822*	*0.254*	*0.211*	*0.542*	*0.0185*	*0.0147*	*0.00700*	*0.136*
			s	*0.0218*	*0.00750*	*0.0100*	*0.0510*	*0.371*	*0.105*	*0.120*	*0.276*	*0.00890*	*0.00780*	*0.00500*	*0.0960*
SUMMER RESERVOIR DATA															
Station 1	08/14/97	2.6	0.00	0.431	0.354	0.0770	0.218	0.441	0.446	diss>tot	diss>tot	0.0425	0.00400	0.0385	9.63
	08/14/97	2.6	0.00	0.410	0.357	0.0530	0.148	0.442	0.488	diss>tot	diss>tot	0.0400	0.00400	0.0360	9.00
	Summer Station 1		***n***	2	2	2	2	2	2			2	2	2	2
			Min	0.410	0.354	0.0530	0.148	0.441	0.446			0.0400	0.00400	0.0360	9.00
			Max	0.431	0.357	0.0770	0.218	0.442	0.488			0.0425	0.00400	0.0385	9.63
			Mean	0.421	0.356	0.0650	0.183	0.442	0.467			0.0413	0.00400	0.0373	9.31
			Range	0.0210	0.00300	0.0240	0.0693	0.00100	0.0420			0.00250	0.00	0.00250	0.625

				Antimony - Sb				**Selenium - Se**				**Thallium - Tl**			
		Lat	**depth**	**unfiltered**	**filtered**	**suspended**	**susp:diss**	**unfiltered**	**filtered**	**suspended**	**susp:diss**	**unfiltered**	**filtered**	**suspended**	**susp:diss**
Station	**Date**	**km**	**m**	**µg/L**	**µg/L**	**µg/L**	**RATIO**	**µg/L**	**µg/L**	**µg/L**	**RATIO**	**µg/L**	**µg/L**	**µg/L**	**RATIO**
Station 5	08/14/97	37.3	-1.00	0.219	0.214	0.00500	0.0225	0.255	0.227	0.0280	0.123	0.0100	0.00620	0.00410	0.661
	08/14/97	37.3	-32.0	0.255	0.170	0.0850		0.143	0.213	diss>tot	diss>tot	0.0411	0.00500	0.03570	6.61
Summer Station 5			***n***	2	2	2	0	2	2	1	1	2	2	2	2
			Mean	0.237	0.192	0.0448	2.00	0.199	0.220			0.0257	0.00501	0.0199	3.64
			Range	0.0370	0.0430	0.0800	0.0225	0.112	0.014			0.0308	0.00800	0.0316	5.95
							0.498								
Station 7	08/14/97	60.4	-1.00	0.215	0.214	0.00100	0.00500	0.235	0.168	0.0670	0.399	0.0140	0.0101	0.00340	0.321
	SUMMER RESERVOIR SUMMARY														
			n	*5*	*5*	*5*	*5*	*5*	*5*	*2*	*2*	*5*	*5*	*5*	*5*
			Min	*0.215*	*0.170*	*0.00100*	*0.00500*	*0.143*	*0.168*	*0.0280*	*0.123*	*0.0100*	*0.00400*	*0.00340*	*0.321*
			Max	*0.431*	*0.357*	*0.0850*	*0.498*	*0.442*	*0.488*	*0.0670*	*0.399*	*0.0425*	*0.0101*	*0.0385*	*9.63*
			Mean	***0.306***	***0.262***	***0.0441***	***0.178***	***0.303***	***0.308***	***0.0475***	***0.261***	***0.0296***	***0.00600***	***0.0235***	***5.24***
			Media	*0.255*	*0.214*	*0.0529*	*0.148*	*0.255*	*0.227*			*0.0400*	*0.00500*	*0.0357*	*6.61*
			Range	*0.216*	*0.187*	*0.0840*	*0.493*	*0.299*	*0.320*	*0.0390*	*0.276*	*0.0322*	*0.00660*	*0.0351*	*9.30*
			s	*0.106*	*0.0873*	*0.0394*	*0.199*	*0.133*	*0.147*			*0.0160*	*0.00270*	*0.0181*	*4.48*
ALL RESERVOIR DATA SUMMARY															
			n	*10*	*10*	*8*	*8*	*10*	*10*	*5*	*5*	*10*	*10*	*7*	*7*
			Min	*0.172*	*0.170*	*0.00100*	*0.00500*	*0.0663*	*0.168*	*0.0280*	*0.123*	*0.0100*	*-0.00600*	*0.00340*	*0.321*
			Max	*0.431*	*0.357*	*0.0850*	*0.498*	*0.888*	*0.488*	*0.479*	*1.17*	*0.0425*	*0.0101*	*0.0385*	*9.63*
			Mean	***0.254***	***0.233***	***0.0322***	***0.13***	***0.389***	***0.317***	***0.224***	***0.627***	***0.0286***	***0.00290***	***0.0206***	***4.21***
			Media	*0.218*	*0.209*	*0.0175*	*0.0874*	*0.348*	*0.297*	*0.268*	*0.629*	*0.0289*	*0.0047*	*0.0137*	*1.71*
			Range	*0.259*	*0.187*	*0.0840*	*0.493*	*0.822*	*0.320*	*0.451*	*1.05*	*0.0322*	*0.0166*	*0.0351*	*9.30*
			s	*0.0904*	*0.0660*	*0.0344*	*0.165*	*0.278*	*0.121*	*0.182*	*0.399*	*0.0122*	*0.00640*	*0.0156*	*4.06*

Table A2-6a (Continued) *RESERVOIR* **Uranium, Vanadium, and Zinc:** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Lake Owyhee. Negative values represent below detection limit (ND) results with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated (NC) if both unfiltered and filtered were non-detect or if dissolved was greater than total (diss>tot). Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

		Lat		***Uranium - U***				***Vanadium - V***				***Zinc - Zn***			
		dist.	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
SPRING RESERVOIR DATA															
Station 1	05/05/97	2.60	-1.00					6.70	4.23	2.47	0.582	7.52	1.23	6.29	5.13
	05/07/98	0.00	0.00	0.699	0.626	0.0730	0.117	4.86	3.51	1.35	0.385	4.17	0.668	3.50	5.24
	05/07/98	0.00	0.00	0.720	0.652	0.068	0.104	5.09	3.65	1.44	0.395	4.29	0.834	3.46	4.14
	Spring Station 1		***n***	2	2	2	2	3	3	3	3	3	3	3	3
			Min	0.699	0.626	0.0680	0.104	4.86	3.51	1.35	0.385	4.17	0.668	3.46	4.14
			Max	0.720	0.652	0.0730	0.117	6.70	4.23	2.47	0.582	7.52	1.23	6.29	5.24
			Mean	0.710	0.639	0.0705	0.111	5.55	3.80	1.75	0.454	5.33	0.910	4.42	4.84
			Median					5.09	3.65	1.44	0.395	4.29	0.834	3.50	5.12
			Range	0.0210	0.0260	0.00500	0.0123	1.84	0.724	1.11	0.198	3.35	0.560	2.84	1.10
			s					1.00	0.384	0.619	0.111	1.90	0.288	1.62	0.6031
Station 5	05/05/97	37.3	-1.00					5.87	4.67	1.20	0.257	4.19	2.51	1.68	0.670
Station 7	05/05/97	60.4	-1.00					6.94	5.58	1.36	0.244	4.42	2.14	2.27	1.061
	SPRING RESERVOIR SUMMARY														
			n	*2*	*2*	*2*	*2*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*0.699*	*0.626*	*0.0680*	*0.104*	*4.86*	*3.51*	*1.20*	*0.244*	*4.17*	*0.668*	*1.68*	*0.670*
			Max	*0.720*	*0.652*	*0.0730*	*0.117*	*6.94*	*5.58*	*2.47*	*0.582*	*7.52*	*2.51*	*6.29*	*5.24*
			Mean	***0.710***	***0.639***	***0.0705***	***0.111***	***5.89***	***4.33***	***1.56***	***0.372***	***4.92***	***1.48***	***3.44***	***3.25***
			Median						*4.23*	*1.36*	*0.385*	*4.29*	*1.23*	*3.46*	*4.14*
			Range	*0.0210*	*0.0260*	*0.00500*	*0.0123*	*2.08*	*2.07*	*1.27*	*0.339*	*3.35*	*1.84*	*4.61*	*4.57*
			s						*0.841*	*0.512*	*0.137*	*1.46*	*0.812*	*1.77*	*2.22*
SUMMER RESERVOIR DATA															
Station 1	08/14/97	2.6	0.00	3.15	2.79	0.362	0.123	15.7	10.1	5.60	0.555	8.99	0.508	8.48	16.7
	08/14/97	2.6	0.00	3.11	2.81	0.300	0.107	14.9	10.1	4.80	0.475	8.65	0.499	8.15	16.3
	Summer Station 1		***n***	2	2	2	2	2	2	2	2	2	2	2	2
			Min	3.11	2.79	0.300	0.107	14.9	10.1	4.8	0.475	8.65	0.499	8.15	16.3
			Max	3.15	2.81	0.362	0.130	15.7	10.1	5.6	0.555	8.99	0.508	8.48	16.7
			Mean	3.13	2.80	0.331	0.118	15.3	10.1	5.20	0.515	8.82	0.504	8.32	16.5
			Range	0.0400	0.0221	0.0621	0.0231	0.800	0.00	0.800	0.0792	0.340	0.00900	0.331	0.362

		Lat		***Uranium - U***				***Vanadium - V***				***Zinc - Zn***			
		dist.	***Depth***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***m***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
Station 5	08/14/97	37.3	-1.00	0.886	0.867	0.0190	0.0219	5.56	5.05	0.510	0.101	1.69	0.706	0.989	1.40
	08/14/97	37.3	-32.0	0.918	0.608	0.310	0.510	8.42	3.67	4.75	1.29	9.31	1.15	8.16	7.10
	Summer Station 5		***n***	2	2	2	2	2	2	2	2	2	2	2	2
			Mean	0.902	0.738	0.165	0.266	6.99	4.36	2.63	0.698	5.50	0.928	4.57	4.25
			Range	0.0320	0.259	0.291	0.488	2.86	1.38	4.24	1.19	7.62	0.444	7.17	5.70
Station 7	08/14/97	60.4	-1.00	0.695	0.681	0.0140	0.0206	5.75	5.19	0.560	0.108	2.95	2.18	0.770	0.353
	SUMMER RESERVOIR SUMMARY														
			n	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
			Min	*0.695*	*0.608*	*0.0140*	*0.0206*	*5.56*	*3.67*	*0.510*	*0.101*	*1.69*	*0.499*	*0.770*	*0.353*
			Max	*3.15*	*2.81*	*0.362*	*0.510*	*15.7*	*10.1*	*5.60*	*1.2943*	*9.31*	*2.18*	*8.48*	*16.7*
			Mean	***1.75***	***1.55***	***0.201***	***0.158***	***10.1***	***6.82***	***3.24***	***0.507***	***6.32***	***1.01***	***5.31***	***8.38***
			Median	*0.918*	*0.867*	*0.300*	*0.107*	*8.42*	*5.19*	*4.75*	*0.475*	*8.65*	*0.706*	*8.15*	*7.10*
			Range	*2.46*	*2.20*	*0.348*	*0.489*	*10.1*	*6.43*	*5.09*	*1.19*	*7.62*	*1.68*	*7.71*	*16.3*
			s	*1.26*	*1.14*	*0.170*	*0.203*	*4.92*	*3.05*	*2.50*	*0.487*	*3.68*	*0.706*	*4.05*	*7.86*
ALL RESERVOIR DATA SUMMARY															
			n	*7*	*7*	*7*	*7*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
			Min	*0.695*	*0.608*	*0.0140*	*0.0206*	*4.86*	*3.51*	*0.510*	*0.101*	*1.69*	*0.499*	*0.770*	*0.353*
			Max	*3.15*	*2.81*	*0.362*	*0.510*	*15.7*	*10.1*	*5.60*	*1.29*	*9.31*	*2.51*	*8.48*	*16.7*
			Mean	***1.45***	***1.290***	***0.164***	***0.144***	***7.98***	***5.58***	***2.40***	***0.440***	***5.61***	***1.24***	***4.38***	***5.81***
			Median	*0.886*	*0.681*	*0.0730*	*0.107*	*6.29*	*4.86*	*1.40*	*0.390*	*4.35*	*0.992*	*3.48*	*4.63*
			Range	*2.46*	*2.20*	*0.348*	*0.489*	*10.8*	*6.59*	*5.09*	*1.19*	*7.62*	*2.01*	*7.71*	*16.3*
			s	*1.15*	*1.03*	*0.153*	*0.167*	*4.00*	*2.49*	*1.92*	*0.344*	*2.74*	*0.758*	*3.11*	*6.08*

Table A2-6b *INFLOW-OUTFLOW* **Silver, Arsenic, and Beryllium:** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Owyhee River inflows, reservoir outflow, and the single geothermal spring sampled in this study. Negative values represent below detection limit results (ND) with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated (NC) if both unfiltered and filtered were non-detect or if dissolved was greater than total (diss>tot). Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

			Silver - Ag				***Arsenic - As***				***Beryllium - Be***			
	Sampling	***Latdist***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
INFLOW DATA														
Station OR-1	09/08/98	-88.5	.	.			9.29	9.12	0.170	0.0186	0.0049	-0.00150	0.00490	>3.27
	04/14/99		.	.			2.00	2.00	NC	NC-low				
	Station OR-1	***n***	.	.			2	2	1	1				
		Min	.	.			2.00	2.00						
		Max					9.29	9.12						
		Mean					5.65	5.56						
		Range					7.29	7.12						
Station OR-2	09/08/98	-84.1					9.63	9.50	0.130	0.0137	0.00360	-0.00100	0.00360	>3.60
	04/14/99		.	.			2.00	2.00	NC	NC-low	.	.		
	Station OR-	***n***	.	.			2	2						
		Min	.	.			2.00	2.00						
		Max					9.63	9.50	0.130	0.0137				
		Mean					5.82	5.75	0.0650	0.00680				
		Range					7.63	7.50	0.130	0.0137				
INFLOW SUMMARY														
		n					*4*	*4*						
		Min					*2.00*	*2.00*						
		Max					*9.63*	*9.50*						
		Mean					***5.73***	***5.66***						
		Media					*5.65*	*5.56*						
		Range					*7.63*	*7.50*						
		s					*4.31*	*4.22*						

			Silver - Ag				***Arsenic - As***				***Beryllium - Be***			
	Sampling	***Latdist***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
OUTFLOW DATA														
Station 8	08/14/97	61.4	0.0440	-0.00300	0.0290	1.93	4.51	3.85	0.660	0.171	0.125	0.0214	0.104	4.84
	05/05/97		-0.00700	-0.00500	NC	NC	4.30	4.17	0.140	0.0325	0.110	0.0270	0.0826	3.06
	05/05/97		-0.00700	-0.00500	NC	NC	4.37	4.61			0.0935	0.0431	0.0504	1.17
	05/07/98		0.0169	0.00320	0.0137	4.28	4.82	4.45	0.370	0.0831	0.0749	0.0101	0.0640	5.87
Spring Station 8		***n***	*3*	*3*	*1*	*1*	*3*	*3*	*2*	*2*	*3*	*3*	*3*	*3*
		Min	*ND*	*ND*			*4.30*	*4.17*	*0.140*	*0.0325*	*0.0749*	*0.0101*	*0.0504*	*1.17*
		Max	*0.0169*	*0.00320*	*0.0137*	*4.28*	*4.82*	*4.61*	*0.370*	*0.0831*	*0.110*	*0.0431*	*0.104*	*5.87*
		Mean	***0.00800***	***0.00270***			***4.50***	***4.41***		***0.0578***	***0.0927***	***0.0270***	***0.0657***	***3.37***
		Media	*ND*	*ND*			*4.37*	*4.45*			*0.0935*	*0.0270*	*0.0640*	*3.06*
		Range					*0.520*	*0.450*		*0.0507*	*0.0347*	*0.0322*	*0.0322*	*4.70*
		s	*0.00770*	*0.00400*				*0.225*			*0.0174*	*0.0161*	*0.0162*	*2.37*
OUTFLOW SUMMARY														
		n	*4*	*4*	*2*	*2*	*4*	*4*	*4*	*3*	*4*	*4*	*4*	*4*
		Min	*ND*	*ND*	*0.0137*	*1.93*	*4.30*	*3.85*	*-0.240*	*0.0325*	*0.0749*	*0.0101*	*0.0504*	*1.17*
		Max	*0.0440*	*0.0150*	*0.0290*	*4.28*	*4.82*	*4.61*	*0.660*	*0.171*	*0.125*	*0.0431*	*0.104*	*5.87*
		Mean	***0.0170***	***0.00501***	***0.0214***	***3.11***	***4.50***	***4.27***	***0.231***	***0.0957***	***0.101***	***0.0256***	***0.0752***	***3.74***
		Media	*0.0101*	*0.00290*			*4.44*	*4.31*	*0.253*	*0.0831*	*0.102*	*0.0242*	*0.0733*	*3.95*
		Range			*0.0153*	*2.35*	*0.520*	*0.760*	*0.900*	*0.139*	*0.0501*	*0.0322*	*0.0532*	*4.70*
		s	*0.0191*	*0.00610*			*0.230*	*0.334*	*0.381*	*0.0703*	*0.0215*	*0.0134*	*0.0231*	*2.07*
GEOTHERMAL WATER DATA														
Station 1gs	08/14/97	6.70	0.00600	0.00600	NC	NC-low	14.0	13.8	0.200	0.0145	0.0200	0.0182	0.00180	0.0990

Table A2-6b (Continued) *INFLOW-OUTFLOW* **Cadmium, Cobalt, and Chromium:** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Owyhee River inflows, reservoir outflow, and the single geothermal spring sampled in this study. Negative values represent below detection limit results (ND) with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated (NC) if both unfiltered and filtered were non-detect or if dissolved was greater than total (diss>tot). Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

		Lat	***Cadmium - Cd***				***Cobalt - Co***				***Chromium - Cr***			
	Samplin	***dist***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
INFLOW														
Station OR-1	09/08/98	-88.5	0.0114	0.00501	0.00501	0.932	0.165	0.102	0.0631	0.617	0.187	0.0890	0.0980	1.11
	04/14/99		-0.100	-0.100	NC	NC					4.00	-0.100	3.50	7.00
Station OR-1		***n***	2	2	1	1	1	1	1	1	2	2	2	2
		Min	ND	ND	NC	NC					0.187	ND	0.0980	0.00
		Max	0.0114	0.00501	0.00501	0.932	0.165	0.102	0.0631	0.617	4.00	0.0890	4.00	1.11
		Mean									2.09		2.05	0.553
		Range									3.81	0.0890	3.90	1.11
Station OR-2	09/08/98	-84.1	0.0145	0.00730	0.00720	0.986					1.67	-0.0300	1.66	110
	04/14/99		-0.100	-0.100	NC	NC					4.00	-1.00	3.50	7.00
Station OR-2		***n***	2	2	1	1	1	1	1	1	2	2	2	
		Min	ND	ND	NC	NC	0.195	0.107	0.0880	0.822	1.67	ND	1.67	
		Max	0.0145	0.00730	0.00720	0.986	0.195	0.107	0.0880	0.822	4.00	ND	4.00	
		Mean					0.195	0.107	0.0880	0.822	2.84	ND	2.84	
		Range					0	0	0	0	2.33	0.970	2.33	
INFLOW SUMMARY														
		n	*4*	*4*	*2*	*2*	*2*	*2*	*2*	*2*	*4*	*4*	*4*	*4*
		Min	*ND*	*ND*	*0.00501*	*0.932*	*0.165*	*0.102*	*0.0631*	*0.617*	*0.187*	*ND*	*0.0980*	*1.11*
		Max	*0.0145*	*0.00730*	*0.00720*	*0.986*	*0.195*	*0.107*	*0.0880*	*0.822*	*4.00*	*0.500*	*3.50*	*110*
		Mean					***0.180***	***0.105***	***0.0756***	***0.720***	***2.46***	***0.276***	***2.19***	***31.4***
		Median					*0.180*	*0.105*	*0.0756*	*0.720*	*2.84*	*0.294*	*2.58*	*7.00*
		Range					*0.0297*	*0.00480*	*0.0249*	*0.205*	*3.81*	*0.485*	*3.40*	*109*
		s					*0.0210*	*0.00340*	*0.0176*	*0.145*	*1.87*	*0.261*	*1.64*	*52.7*

		Lat	***Cadmium - Cd***				***Cobalt - Co***				***Chromium - Cr***			
	Samplin	***Dist***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
OUTFLOW DATA														
Station 8	08/14/97	61.4	0.0234	0.00950	0.0139	1.46	0.429	0.110	0.319	2.9	2.64	0.969	1.67	1.72
	05/05/97		0.0191	0.0101	0.00820	0.752	0.402	0.0618	0.340	5.51	1.70	2.27	diss>tot	diss>tot
	05/05/97		0.0165	0.0142	0.00230	0.162	0.410	0.110	0.300	2.72	1.95	2.70	diss>tot	diss>tot
	05/07/98		0.0100	0.00330	0.00680	2.06	0.336	0.0779	0.258	3.31	1.11	0.0970	1.01	10.4
Spring Station 8		***n***	3	3	3	3	3	3	3	3	3	3	1	1
		Min	0.0100	0.00330	0.00230	0.162	0.336	0.0618	0.258	2.72	1.11	0.0970		
		Max	0.0191	0.0142	0.00820	2.06	0.410	0.110	0.340	5.51	1.95	2.70	1.01	10.4
		Mean	0.0152	0.00950	0.00501	0.992	0.383	0.0833	0.300	3.85	1.59	1.69		
		Median	0.0165	0.0101	0.00680	0.752	0.402	0.0779	0.300	3.31	1.70	2.27		
		Range	0.00900	0.0101	0.00501	1.90	0.0740	0.0484	0.0822	2.79	0.840	2.60		
		s	0.00460	0.00501	0.00310	0.972	0.0406	0.0246	0.0411	1.47	0.431	1.40		
OUTFLOW SUMMARY														
		n	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*2*	*2*
		Min	*0.0100*	*0.00330*	*0.00230*	*0.162*	*0.336*	*0.0618*	*0.258*	*2.72*	*1.11*	*0.0971*	*1.01*	*1.72*
		Max	*0.0234*	*0.0142*	*0.0139*	*2.06*	*0.429*	*0.110*	*0.340*	*5.51*	*2.64*	*2.70*	*1.67*	*10.4*
		Mean	***0.0173***	***0.00950***	***0.00780***	***1.11***	***0.394***	***0.0900***	***0.304***	***3.61***	***1.85***	***1.51***	***1.34***	***6.08***
		Median	*0.0178*	*0.0100*	*0.00750*	*1.11*	*0.406*	*0.0940*	*0.309*	*3.11*	*1.82*	*1.62*		
		Range	*0.0133*	*0.0101*	*0.0116*	*1.90*	*0.0930*	*0.0484*	*0.0822*	*2.79*	*1.53*	*2.60*	*0.658*	*8.71*
		s	*0.00501*	*0.00460*	*0.00480*	*0.828*	*0.0405*	*0.0242*	*0.0350*	*1.29*	*0.634*	*1.19*		
GEOTHERMAL WATER DATA														
Station 1gs	08/14/97	6.70	0.0532	0.0527	0.00500	0.00901	0.0295	0.00630	0.0232	3.68	1.73	1.70	0.0300	0.0180

Table A2-6b (Continued) *INFLOW-OUTFLOW* **Copper, Nickel, and Lead.** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Owyhee River inflows, reservoir outflow, and the single geothermal spring sampled in this study. Negative values represent below detection limit results with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated if both unfiltered and filtered were non-detect or if dissolved was greater than total. Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

			Copper - Cu				***Nickel - Ni***				***Lead - Pb***			
	Sampling	***Latdis***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
INFLOW DATA														
Station OR-	09/08/98	-88.5	1.09	0.882	0.211	0.240	0.0420	-0.0280	0.0280	1.96	0.100	0.0120	0.0880	7.65
	04/14/99		5.00	2.00	3.00	1.50	-5.00	-5.00	NC	NC	1.00	-1.00	NC	NC
Station OR-1		***n***	2	2	2	2	2	2	1	1	2			
		Min	1.09	0.882	0.211	0.240	ND	ND	NC	NC	0.100			
		Max	5.00	2.00	3.000	1.50	0.0420	ND	0.0280	1.96	1.00			
		Mean	3.05	1.44	1.61	0.870		ND			0.550			
		Range	3.91	1.12	2.79	1.26					0.901			
Station OR-	09/08/98	-84.1	1.09	0.854	0.236	0.276	0.288	0.127	0.161	1.27	0.127	0.0150	0.112	7.30
	04/14/99		4.00	2.00	2.00	1.00	-5.00	-5.00	NC	NC	1.00	-1.00	NC	NC
Station OR-2		***n***	2	2	2	2	2	2	1	1	2			
		Min	1.09	0.854	0.236	0.276	ND	ND	NC	NC	0.127	ND		
		Max	4.00	2.00	2.00	1.00	0.288	0.127	0.161	1.27	1.00	0.0150		
		Mean	2.55	1.43	1.12	0.638								
		Range	2.91	1.15	1.76	0.724								
INFLOW SUMMARY														
		n	*4*	*4*	*4*	*4*	*4*	*4*	*2*	*2*	*4*	*4*	*4*	*2*
		Min	*1.09*	*0.854*	*0.211*	*0.240*	*ND*	*ND*	*0.0290*	*1.27*	*0.100*	*-1.00*	*0.0880*	*7.30*
		Max	*5.00*	*2.00*	*3.00*	*1.50*	*0.288*	*0.127*	*0.161*	*1.96*	*1.00*	*0.0150*	*2.00*	*7.65*
		Mean	***2.80***	***1.43***	***1.36***	***0.754***			***0.0948***	***1.61***	***0.566***			***7.48***
		Median	*2.55*	*1.44*	*1.12*	*0.638*					*0.564*			
		Range	*3.91*	*1.15*	*2.79*	*1.26*			*0.123*	*0.690*	*0.901*			*0.352*
		s	*2.01*	*0.654*	*1.38*	*0.608*					*0.512*			

			Copper - Cu				*Nickel - Ni*				*Lead - Pb*			
		Latdis	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
OUTFLOW DATA														
Station 8	08/14/97	61.4	3.32	1.87	1.45	0.775	1.78	0.736	1.04	1.42	0.679	0.110	0.569	5.17
	05/05/97		4.06	2.58	1.48	0.574	2.40	1.53	0.870	0.570	0.967	0.580	0.387	0.668
	05/05/97		4.09	2.92	1.17	0.402	2.40	1.69	0.702	0.415	0.812	0.296	0.516	1.74
	05/07/98		2.34	1.38	0.960	0.696	1.08	0.338	0.742	2.20	0.454	0.0260	0.428	16.3
	Spring	***n***	3	3	3	3	3	3	3	3	3	3	3	3
		Min	2.34	1.38	0.960	0.402	1.08	0.338	0.702	0.415	0.454	0.0260	0.387	0.668
		Max	4.09	2.92	1.48	0.696	2.40	1.69	0.870	2.20	0.967	0.580	0.516	16.3
		Mean	3.50	2.29	1.20	0.557	1.96	1.19	0.771	1.06	0.744	0.301	0.444	6.22
		Median	4.06	2.58	1.17	0.574	2.40	1.53	0.742	0.570	0.812	0.296	0.428	1.74
		Range	1.75	1.54	0.521	0.294	1.32	1.36	0.168	1.78	0.513	0.554	0.129	15.6
		s	1.00	0.808	0.262	0.148	0.760	0.739	0.0876	0.986	0.263	0.277	0.0657	8.71
OUTFLOW SUMMARY														
		n	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
		Min	*2.34*	*1.38*	*0.960*	*0.402*	*1.08*	*0.338*	*0.702*	*0.415*	*0.454*	*0.0260*	*0.387*	*0.668*
		Max	*4.09*	*2.92*	*1.48*	*0.775*	*2.40*	*1.69*	*1.04*	*2.20*	*0.967*	*0.580*	*0.569*	*16.3*
		Mean	***3.45***	***2.19***	***1.27***	***0.612***	***1.91***	***1.07***	***0.840***	***1.15***	***0.728***	***0.253***	***0.475***	***5.96***
		Median	*3.69*	*2.22*	*1.31*	*0.635*	*2.09*	*1.13*	*0.806*	*0.994*	*0.745*	*0.203*	*0.472*	*3.46*
		Range	*1.75*	*1.54*	*0.521*	*0.373*	*1.32*	*1.36*	*0.342*	*1.78*	*0.513*	*0.554*	*0.182*	*15.6*
		s	*0.823*	*0.692*	*0.246*	*0.163*	*0.627*	*0.644*	*0.154*	*0.825*	*0.217*	*0.245*	*0.0825*	*7.13*
GEOTHERMAL WATER DATA														
Station 1gs	08/14/97	6.70	0.168	0.146	0.0220	0.151	0.0670	0.0320	0.0350	1.078	0.0440	0.0100	0.0340	3.49

Table A2-6b (Continued) *INFLOW - OUTFLOW* **Antimony, Selenium, and Thallium.** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Owyhee River inflows, reservoir outflow, and the single geothermal spring sampled in this study. Negative values represent below detection limit results with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated if both unfiltered and filtered were non-detect or if dissolved was greater than total. Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

			Antimony - Sb				***Selenium - Se***				***Thallium - Tl***			
	Sampling	***Latdist***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
INFLOW DATA														
Station OR-1	09/08/98	-88.5	0.230	0.226	0.00400	0.0170	0.220	0.151	0.0690	0.455	0.0115	0.00870	0.00280	0.322
	04/14/99		.	.			-5.00	-5.00	NC	NC				
	Station OR-1	***n***					2	2	1	1				
		Min					ND	ND	NC	NC				
		Max					0.220	0.151	0.0690	0.455				
		Mean												
		Range												
Station OR-2	09/08/98	-84.1	0.216	0.203	0.0130	0.0640	0.175	0.322	diss>tot	diss>tot	0.0128	0.00880	0.00400	0.455
	04/14/99						-5.00	-5.00	NC	NC				
	Station OR-2	***n***					2	2						
		Min					ND	ND						
		Max					0.175	0.322						
		Mean												
		Range												
	INFLOW SUMMARY													
		n	*2*	*2*	*2*	*2*	*4*	*4*	*1*	*1*	*2*	*2*	*2*	*2*
		Min	*0.216*	*0.203*	*0.00400*	*0.0170*	*ND*	*ND*	*NC*	*NC*	*0.0115*	*0.00870*	*0.00280*	*0.322*
		Max	*0.230*	*0.226*	*0.0130*	*0.0640*	*0.220*	*0.322*	*0.0690*	*0.455*	*0.0128*	*0.00880*	*0.00400*	*0.455*
		Mean	***0.223***	***0.215***	***0.00850***	***0.0407***					***0.0122***	***0.00880***	***0.00340***	***0.389***
		Range	*0.0140*	*0.0230*	*0.00900*	*0.0470*					*0.00130*	*0.000100*	*0.00120*	*0.133*

			Antimony - Sb				*Selenium - Se*				*Thallium - Tl*			
	Sampling	***Latdist***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
OUTFLOW DATA														
Station 8	08/14/97	61.4	0.245	0.222	0.023	0.104	0.254	0.223	0.0310	0.139	0.0315	0.00780	0.0237	3.04
	05/05/97		0.208	0.176	0.032	0.182	0.758	0.553	0.205	0.370	0.0182	-0.0060	0.0152	5.07
	05/05/97		0.184	0.205	diss>tot	diss>tot	0.833	0.535	0.298	0.557	0.0174	-0.0060	0.0144	4.80
	05/07/98		0.200	0.196	0.00400	0.0200	0.156	0.171	diss>tot	diss>tot	0.0196	0.00470	0.0149	3.17
	Spring Station 8	***n***	3	3	2	2	3	3	2	2	3	3	3	3
		Min	0.184	0.176	0.00400	0.0200	0.156	0.171	0.205	0.370	0.0174	ND	0.0144	3.17
		Max	0.208	0.205	0.0320	0.182	0.833	0.553	0.298	0.557	0.0196	0.00470	0.0152	5.07
		Mean	0.197	0.192	0.0180	0.101	0.582	0.420	0.251	0.464	0.0184	0.00360	0.0148	4.35
		Median	0.200	0.196			0.758	0.535	0.251	0.464	0.0182	ND	0.0149	4.80
		Range	0.0240	0.0290	0.0280	0.161	0.677	0.382	0.0930	0.186	0.0022	0.000200	0.000800	1.90
		s	0.0122	0.0147			0.371	0.216	0.0657	0.132	0.00110		0.000400	1.02
OUTFLOW SUMMARY														
		n	*4*	*4*	*3*	*3*	*4*	*4*	*3*	*3*	*4*	*4*	*4*	*4*
		Min	*0.184*	*0.176*	*0.00400*	*0.0200*	*0.156*	*0.171*	*0.0310*	*0.139*	*0.0174*	*ND*	*0.0144*	*3.04*
		Max	*0.245*	*0.222*	*0.0320*	*0.182*	*0.833*	*0.553*	*0.298*	*0.557*	*0.0315*	*0.00780*	*0.0237*	*5.07*
		Mean	***0.209***	***0.200***	***0.0197***	***0.102***	***0.500***	***0.371***	***0.178***	***0.355***	***0.0217***	***0.00460***	***0.0171***	***4.02***
		Median	*0.204*	*0.200*	*0.0231*	*0.104*	*0.506*	*0.379*	*0.205*	*0.370*	*0.0256*	*0.00390*	*0.0152*	*3.99*
		Range	*0.0610*	*0.0460*	*0.0280*	*0.161*	*0.677*	*0.382*	*0.267*	*0.418*	*0.01410*	*0.00480*	*0.00930*	*2.03*
		s	*0.0259*	*0.0191*	*0.0143*	*0.0807*	*0.345*	*0.202*	*0.135*	*0.209*	*0.00660*	*0.00230*	*0.00440*	*1.06*
GEOTHERMAL WATER DATA														
Station 1gs	08/14/97	6.70	0.251	0.266	diss>tot	diss>tot	-0.030	-0.03	NC	NC	0.0029	0.0021	0.000800	0.381

Table A2-6b (Continued) *INFLOW - OUTFLOW* **Uranium, Vanadium, and Zinc.** Total (unfiltered), dissolved (filtered), and suspended (total - dissolved) toxic trace elements in Owyhee River inflows, reservoir outflow, and the single geothermal spring sampled in this study. Negative values represent below detection limit results with a detection limit equal to the absolute value of negative number. Suspended:dissolved ratios were not calculated if both unfiltered and filtered were non-detect or if dissolved was greater than total. Half the detection limit was substituted to calculate statistical summaries and ratios with only dissolved non-detect values.

			Uranium - U				***Vanadium - V***				***Zinc - Zn***			
	Sampling	***Latdist***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
INFLOW DATA														
Station OR-1	09/08/98	-88.5	1.73	1.75	diss>tot	diss>tot	4.96	4.85	0.110	0.0227	0.0840	-0.00500	0.0815	32.6
	04/14/99						6.00	-5.00	NC	NC	11.0	-5.00	8.50	3.40
Station OR-1		***n***					2	2	1	1	2	2	2	2
		Min					4.96	ND	NC	NC	0.0840	ND	0.0815	3.40
		Max					6.00	4.85	0.110	0.0227	11.0	ND	8.50	32.6
		Mean					5.48				5.54	ND	5.5420	18.0
		Range					1.04				10.9		8.42	29.2
Station OR-2	09/08/98	-84.1	2.08	2.07	0.0100	0.00480	5.40	5.05	0.350	0.0693	-0.00500	-0.00500	NC	NC
	04/14/99						5.00	-5.00	NC	NC	10.000	-5.00	7.50	3.000
	Station	***n***					2	2	2	1	2	2	1	1
		Min					5.00	-5.00	NC	NC	ND	ND	NC	NC
		Max					5.40	5.05	0.350	0.0693	10.0	ND	`7.50	3.00
		Mean					5.20							
		Range					0.400							
INFLOW SUMMARY														
		n	*2*	*2*	*1*	*1*	*4*	*4*	*2*	*2*	*4*	*4*	*3*	*3*
		Min	*1.73*	*1.75*			*4.96*	*ND*	*0.110*	*0.0227*	*ND*	*ND*	*0.0815*	*3.00*
		Max	*2.08*	*2.07*	*0.0100*	*0.00480*	*6.00*	*5.05*	*0.350*	*0.0693*	*11.0*	*ND*	*8.50*	*32.6*
		Mean	***1.91***	***1.91***			***5.34***		***0.230***	***0.0460***	***5.27***	***ND***	***5.36***	***13.0***
		Median					*5.20*				*5.04*		*7.50*	*3.40*
		Range	*0.346*	*0.318*			*1.04*		*0.240*	*0.0466*	*11.0*		*8.42*	*29.6*
		s					*0.483*				*6.05*		*4.60*	*17.0*

			Uranium - U				***Vanadium - V***				***Zinc - Zn***			
	Sampling	***Latdist***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***	***unfiltered***	***filtered***	***suspended***	***susp:diss***
Station	***Date***	***km***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***	***µg/L***	***µg/L***	***µg/L***	***RATIO***
OUTFLOW DATA														
Station 8	08/14/97	61.4	1.07	0.894	0.176	0.197	7.65	4.62	3.03	0.656	6.48	1.25	5.23	4.18
	05/05/97						7.30	5.24	2.06	0.393	4.47	1.10	3.37	3.06
	05/05/97						7.33	5.71	1.61	0.283	4.34	2.12	2.22	1.05
	05/07/98		1.36	1.29	0.07	0.0543	6.41	4.58	1.83	0.400	3.96	0.471	3.49	7.41
Spring Station 8		***n***	1	1	1	1	3	3	3	3	3	3	3	3
		Min					6.41	4.58	1.61	0.283	3.96	0.471	2.22	1.045
		Max	1.36	1.29	0.07	0.0543	7.33	5.71	2.06	0.400	4.47	2.12	3.49	7.41
		Mean					7.01	5.18	1.84	0.359	4.26	1.23	3.02	3.84
		Median					7.30	5.24	1.83	0.393	4.34	1.10	3.37	3.06
		Range					0.916	1.13	0.447	0.117	0.506	1.65	1.27	6.36
		s					0.522	0.569	0.224	0.0658	0.264	0.834	0.700	3.25
OUTFLOW SUMMARY														
		n	*2*	*2*	*2*	*2*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
		Min	*1.07*	*0.894*	*0.0700*	*0.0543*	*6.41*	*4.58*	*1.61*	*0.283*	*3.96*	*0.471*	*2.22*	*1.05*
		Max	*1.36*	*1.29*	*0.176*	*0.197*	*7.65*	*5.71*	*3.03*	*0.656*	*6.48*	*2.12*	*5.23*	*7.41*
		Mean	***1.22***	***1.09***	***0.123***	***0.126***	***7.17***	***5.04***	***2.13***	***0.433***	***4.81***	***1.24***	***3.58***	***3.92***
		Median					*7.31*	*4.93*	*1.95*	*0.397*	*4.40*	*1.18*	*3.43*	*3.62*
		Range	*0.290*	*0.396*	*0.106*	*0.143*	*1.24*	*1.13*	*1.42*	*0.373*	*2.52*	*1.65*	*3.01*	*6.36*
		s					*0.532*	*0.542*	*0.625*	*0.158*	*1.13*	*0.681*	*1.24*	*2.66*
GEOTHERMAL WATER DATA														
Station 1gs	08/14/97	6.70	0.0196	0.0172	0.00240	0.140	0.723	0.649	0.0740	0.114	0.196	0.128	0.0680	0.531

APPENDIX 3:

Lake Owyhee MINTEQA2 Speciation Results and Modeling Assumptions

Table A3-1 Speciation results obtained from the MINTEQA2 modeling runs along with calculation of suspended fractions for each element. Refer to the following Appendix 3 sections for assumptions and interpretative considerations.

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Hydrogen - H									
330	**H+1**	7.23e-08		**H+1**	7.29e-08		**H+1**	7.28e-08	
Calcium - Ca									
150	**Ca+2**	3.30e-04	91.9	**Ca+2**	4.35e-04	91.4	**Ca+2**	4.18e-04	91.8
40.078	**Ca, susp**	1.52e-05	4.23	**Ca, susp**	2.00e-05	4.2	**Ca, susp**	1.76e-05	3.86
1501450	**CaFA+**	9.44e-06	2.63	**CaFA+**	1.20e-05	2.52	**CaFA+**	1.16e-05	2.54
1507320	**CaSO4 aq**	4.16e-06	1.16	**CaSO4 aq**	8.41e-06	1.77	**CaSO4 aq**	7.65e-06	1.68
1501400	**CaHCO3 +**	1.70e-07	0.0480	**CaHCO3 +**	2.21e-07	0.046	**CaHCO3 +**	2.13e-07	0.047
1505800	**CaHPO4 aq**	5.91e-08	0.0160	**CaHPO4 aq**	1.06e-07	0.022	**CaHPO4 aq**	9.83e-08	0.022
1501401	**CaCO3 aq**	1.33e-08	0.004	**CaCO3 aq**	1.72e-08	0.004	**CaCO3 aq**	1.66e-08	0.004
1505802	**CaH2PO4 +**	3.40e-09	0.001	**CaH2PO4 +**	6.13e-09	0.001	**CaH2PO4 +**	5.68e-09	0.001
1505801	**CaPO4 -**	1.69e-09	0.000	**CaPO4 -**	3.12e-09	0.001	**CaPO4 -**	2.88e-09	0.001
1503300	**CaOH +**	3.94e-10	0.000	**CaOH +**	5.55e-10	0.000	**CaOH +**	5.29e-10	0.000
Total Ca		***3.59e-04***			***4.75e-04***			***4.55e-04***	
Magnesium - Mg									
460	**Mg+2**	1.55e-04	90.8	**Mg+2**	2.05e-04	89.2	**Mg+2**	1.97e-04	90.4
24.305	**Mg, susp**	1.32e-05	7.75	**Mg, susp**	2.04e-05	8.90	**Mg, susp**	1.68e-05	7.73
4607320	**MgSO4 aq**	1.71e-06	1.01	**MgSO4 aq**	3.47e-06	1.51	**MgSO4 aq**	3.16e-06	1.45
4601450	**MgFA+**	5.45e-07	0.320	**MgFA+**	6.93e-07	0.302	**MgFA+**	6.70e-07	0.308
4601401	**MgHCO3 +**	1.20e-07	0.0700	**MgHCO3 +**	1.51e-07	0.066	**MgHCO3 +**	1.46e-07	0.067
4605802	**MgHPO4 aq**	3.79e-08	0.0220	**MgHPO4 aq**	6.81e-08	0.030	**MgHPO4 aq**	6.31e-08	0.029
4601400	**MgCO3 aq**	4.34e-09	0.003	**MgCO3 aq**	5.65e-09	0.002	**MgCO3 aq**	5.44e-09	0.003
4605801	**MgH2PO4 +**	2.04e-09	0.001	**MgH2PO4 +**	3.68e-09	0.002	**MgH2PO4 +**	3.41e-09	0.002
4605800	**MgPO4 -**	1.07e-09	0.000	**MgPO4 -**	1.98e-09	0.001	**MgPO4 -**	1.83e-09	0.001
4603300	**MgOH +**	1.14e-09	0.000	**MgOH +**	1.62e-09	0.001	**MgOH +**	1.54e-09	0.001
Total Mg		***1.70e-04***			***2.29e-04***			***2.17e-04***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	*Calculated mol/L*	*Mole Percent*	*Species Name*	*Calculated mol/L*	*Mole Percent*	*Species Name*	*Calculated mol/L*	*Mole Percent*
Sodium - Na									
500	**Na+1**	5.06e-04	97.5	**Na+1**	1.01e-03	96.8	**Na+1**	9.25e-04	97.5
22.9898	**Na, susp**	1.25e-05	2.42	**Na, susp**	3.16e-05	3.04	**Na, susp**	2.22e-05	2.34
5001450	**NaFA**	3.97e-07	0.0770	**NaFA**	7.72e-07	0.074	**NaFA**	7.13e-07	0.075
5007320	**NaSO4 -**	1.92e-07	0.0370	**NaSO4 -**	6.03e-07	0.058	**NaSO4 -**	5.23e-07	0.055
5001401	**NaHCO3 aq**	1.68e-08	0.003	**NaHCO3 aq**	3.33e-08	0.003	**NaHCO3 aq**	3.06e-08	0.003
5005800	**NaHPO4 -**	3.79e-10	0.000	**NaHPO4 -**	1.06e-09	0.000	**NaHPO4 -**	9.37e-10	0.000
5001400	**NaCO3 -**	2.14e-10	0.000	**NaCO3 -**	4.52e-10	0.000	**NaCO3 -**	4.13e-10	0.000
5002120	**NaCrO4-**	5.46e-11	0.000	**NaCrO4-**	7.03e-11	0.000	**NaCrO4-**	8.10e-11	0.000
5002120	**NaCrO4-**	5.46e-11	0.000	**NaCrO4-**	7.03e-11	0.000	**NaCrO4-**	8.10e-11	0.000
Total Na		***5.19e-04***			***1.04e-03***			***9.48e-04***	
Potassium - K									
410	**K+1**	6.29e-05	89.8	**K+1**	8.72e-05	83.0	**K+1**	8.33e-05	87.4
39.0983	**K, susp**	7.11e-06	10.1	**K, susp**	1.78e-05	16.9	**K, susp**	1.19e-05	12.4
4107320	**KSO4 -**	2.93e-08	0.0420	**KSO4 -**	6.51e-08	0.062	**KSO4 -**	5.85e-08	0.061
4101450	**KFA**	3.92e-08	0.0560	**KFA**	5.32e-08	0.051	**KFA**	5.10e-08	0.054
4105800	**KHPO4 -**	4.75e-11	0.000	**KHPO4 -**	9.30e-11	0.000	**KHPO4 -**	8.52e-11	0.000
4102120	**KCrO4-**	8.60e-12	0.000	**KCrO4-**	7.73e-12	0.000	**KCrO4-**	9.25e-12	0.000
4102120	**KCrO4-**	8.60e-12	0.000	**KCrO4-**	7.73e-12	0.000	**KCrO4-**	9.25e-12	0.000
Total K		***7.00e-05***			***1.05e-04***			***9.53e-05***	
Chlorine - Cl, as Chloride Species									
180	**Cl-1**	1.10e-04	100	**Cl-1**	1.97e-04	100	**Cl-1**	1.83e-04	100
5401800	**NiCl +**	7.45e-13	0.000	**NiCl +**	7.23e-13	0.000	**NiCl +**	9.55e-13	0.000
3611805	**HgClOH (aq)**	8.11e-13	0.000	**Me-Hg, diss**	3.07e-13	0.000	**Me-Hg, diss**	5.83e-13	0.000
6001800	**PbCl +**	4.54e-13	0.000	**PbCl +**	4.51e-13	0.000	**PbCl +**	4.18e-13	0.000
9501800	**ZnCl +**	2.82e-13	0.000	**ZnCl +**	3.64e-13	0.000	**ZnCl +**	4.13e-13	0.000
3611801	**HgCl2 (aq)**	2.02e-14	0.000	**HgCl2 (aq)**	5.28e-14	0.000	**HgCl2 (aq)**	4.87e-14	0.000
1601800	**CdCl +**	2.75e-15	0.000	**CdCl +**	2.31e-14	0.000	**CdCl +**	1.87e-14	0.000
2311800	**CuCl +**	1.66e-16	0.000	**CuCl +**	3.75e-16	0.000	**CuCl +**	3.18e-16	0.000
2811800	**FeCl +2**	2.07e-17	0.000	**FeCl +2**	4.13e-17	0.000	**FeCl +2**	3.71e-17	0.000
1601801	**CdCl2 aq**	1.10e-18	0.000	**CdCl2 aq**	1.64e-17	0.000	**CdCl2 aq**	1.23e-17	0.000
Total Cl		***1.10e-04***			***1.97e-04***			***1.83e-04***	

MINTEQ ID	Spring Reservoir Average			Summer Reservoir Average			Pooled Reservoir Average		
	Species Name	Calculated mol/L	Mole Percent	Species Name	Calculated mol/L	Mole Percent	Species Name	Calculated mol/L	Mole Percent
Inorganic Carbon and Alkalinity Species									
3301400	**HCO3 -**	8.45e-05	75.0	**HCO3 -**	8.32e-05	75.9	**HCO3 -**	8.34e-05	75.3
303303	**Al(OH)3 aq**	1.46e-05	13.0	**Al(OH)3 aq**	1.29e-05	11.7	**Al(OH)3 aq**	1.36e-05	12.3
3301401	**H2CO3 aq**	1.12e-05	9.92	**H2CO3 aq**	1.11e-05	10.1	**H2CO3 aq**	1.11e-05	10.0
303302	**Al(OH)4 -**	1.12e-06	0.991	**Al(OH)4 -**	1.31e-06	1.20	**Al(OH)4 -**	1.34e-06	1.21
303301	**Al(OH)2 +**	8.39e-07	0.744	**Al(OH)2 +**	7.46e-07	0.680	**Al(OH)2 +**	7.88e-07	0.712
1501400	**CaHCO3 +**	1.70e-07	0.151	**CaHCO3 +**	2.21e-07	0.201	**CaHCO3 +**	2.13e-07	0.192
4601401	**MgHCO3 +**	1.20e-07	0.106	**MgHCO3 +**	1.51e-07	0.138	**MgHCO3 +**	1.46e-07	0.132
3300020	**OH-**	6.15e-08	0.055	**OH-**	6.75e-08	0.061	**OH-**	6.66e-08	0.060
140	**CO3-2**	4.98e-08	0.044	**CO3-2**	5.18e-08	0.047	**CO3-2**	5.15e-08	0.046
1501401	**CaCO3 aq**	1.33e-08	0.012	**CaCO3 aq**	1.72e-08	0.016	**CaCO3 aq**	1.66e-08	0.015
4601400	**MgCO3 aq**	4.34e-09	0.004	**MgCO3 aq**	5.65e-09	0.005	**MgCO3 aq**	5.44e-09	0.005
4603300	**MgOH +**	1.14e-09	0.001	**MgOH +**	1.62e-09	0.001	**MgOH +**	1.54e-09	0.001
5401401	**NiCO3 aq**	8.42e-10	0.001	**NiCO3 aq**	4.56e-10	0.000	**NiCO3 aq**	6.49e-10	0.001
1503300	**CaOH +**	3.94e-10	0.000	**CaOH +**	5.55e-10	0.001	**CaOH +**	5.29e-10	0.000
5401400	**NiHCO3 +**	2.42e-11	0.000	**NiHCO3 +**	1.33e-11	0.000	**NiHCO3 +**	1.88e-11	0.000
303300	**AlOH +2**	3.81e-09	0.003	**AlOH +2**	3.75e-09	0.003	**AlOH +2**	3.91e-09	0.004
Total Alk		***1.13e-04***			***1.10e-04***			***1.11e-04***	
Sulfur - S, as Sulfate Species (SO_4^{2-})									
732	**SO4-2**	9.72e-05	94.1	**SO4-2**	1.58e-04	92.7	**SO4-2**	1.49e-04	92.9
1507320	**CaSO4 aq**	4.16e-06	4.03	**CaSO4 aq**	8.41e-06	4.92	**CaSO4 aq**	7.65e-06	4.78
4607320	**MgSO4 aq**	1.71e-06	1.66	**MgSO4 aq**	3.47e-06	2.03	**MgSO4 aq**	3.16e-06	1.97
5007320	**NaSO4 -**	1.92e-07	0.186	**NaSO4 -**	6.03e-07	0.353	**NaSO4 -**	5.23e-07	0.327
4107320	**KSO4 -**	2.93e-08	0.0280	**KSO4 -**	6.51e-08	0.038	**KSO4 -**	5.85e-08	0.037
4907320	**NH4SO4 -**	8.22e-10	0.001	**NH4SO4 -**	4.81e-09	0.003	**NH4SO4 -**	4.00e-09	0.002
3307320	**HSO4 -**	4.19e-10	0.000	**HSO4 -**	6.83e-10	0.000	**HSO4 -**	6.41e-10	0.000
5407320	**NiSO4 aq**	3.90e-11	0.000	**NiSO4 aq**	3.34e-11	0.000	**NiSO4 aq**	4.48e-11	0.000
307320	**AlSO4 +**	3.73e-12	0.000	**AlSO4 +**	5.29e-12	0.000	**AlSO4 +**	5.26e-12	0.000
307321	**Al(SO4)2 -**	2.31e-14	0.000	**Al(SO4)2 -**	5.17e-14	0.000	**Al(SO4)2 -**	4.85e-14	0.000
2317320	**CuSO4 aq**	1.55e-14	0.000	**CuSO4 aq**	2.93e-14	0.000	**CuSO4 aq**	2.54e-14	0.000
1607321	**Cd(SO4)2-2**	6.86e-18	0.000	**Cd(SO4)2-2**	8.20e-17	0.000	**Cd(SO4)2-2**	6.32e-17	0.000
Total SO4		***1.03e-04***			***1.71e-04***			***1.60e-04***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Nitrogen - N									
14.00674	**N-org, diss**	2.01e-05	45.1	**N-org, diss**	2.24e-05	40.0	**N-org, diss**	2.22e-05	40.6
14.00674	**N-org, susp**	1.02e-05	23.0	**N-org, susp**	1.67e-05	29.8	**N-org, susp**	1.61e-05	29.3
492	**NO3-1**	1.34e-05	30.1	**NO3-1**	1.40e-05	24.9	**NO3-1**	1.39e-05	25.4
490	**NH4+1**	7.82e-07	1.76	**NH4+1**	2.91e-06	5.19	**NH4+1**	2.56e-06	4.68
3304900	**NH3 aq**	2.65e-09	0.006	**NH3 aq**	1.06e-08	0.019	**NH3 aq**	9.22e-09	0.017
4907320	**NH4SO4 -**	8.22e-10	0.002	**NH4SO4 -**	4.81e-09	0.009	**NH4SO4 -**	4.00e-09	0.007
Total N		***4.46e-05***			***5.60e-05***			***5.47e-05***	
Phosphorus - P									
30.9738	**P, susp**	1.95e-06	51.5	**P, susp**	1.58e-06	41.7	**P, susp**	1.62e-06	42.6
3305801	**H2PO4 -**	6.07e-07	16.0	**H2PO4 -**	8.39e-07	22.1	**H2PO4 -**	8.08e-07	21.3
3305800	**HPO4 -2**	5.81e-07	15.4	**HPO4 -2**	8.30e-07	21.9	**HPO4 -2**	7.95e-07	20.9
30.9738	**P, org**	5.42e-07	14.3	**P, org**	3.52e-07	9.28	**P, org**	4.04e-07	10.6
1505800	**CaHPO4 aq**	5.91e-08	1.56	**CaHPO4 aq**	1.06e-07	2.80	**CaHPO4 aq**	9.83e-08	2.59
4605802	**MgHPO4 aq**	3.79e-08	1.00	**MgHPO4 aq**	6.81e-08	1.80	**MgHPO4 aq**	6.31e-08	1.66
1505802	**CaH2PO4 +**	3.40e-09	0.090	**CaH2PO4 +**	6.13e-09	0.162	**CaH2PO4 +**	5.68e-09	0.149
4605801	**MgH2PO4 +**	2.04e-09	0.054	**MgH2PO4 +**	3.68e-09	0.097	**MgH2PO4 +**	3.41e-09	0.090
1505801	**CaPO4 -**	1.69e-09	0.045	**CaPO4 -**	3.12e-09	0.082	**CaPO4 -**	2.88e-09	0.076
4605800	**MgPO4 -**	1.07e-09	0.028	**MgPO4 -**	1.98e-09	0.052	**MgPO4 -**	1.83e-09	0.048
5005800	**NaHPO4 -**	3.79e-10	0.010	**NaHPO4 -**	1.06e-09	0.028	**NaHPO4 -**	9.37e-10	0.025
4105800	**KHPO4 -**	4.75e-11	0.001	**KHPO4 -**	9.30e-11	0.002	**KHPO4 -**	8.52e-11	0.002
3305802	**H3PO4**	4.15e-12	0.000	**H3PO4**	5.85e-12	0.000	**H3PO4**	5.62e-12	0.000
580	**PO4-3**	3.71e-12	0.000	**PO4-3**	5.66e-12	0.000	**PO4-3**	5.37e-12	0.000
Total P		***3.78e-06***			***3.79e-06***			***3.80e-06***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Organic Carbon as Fulvate, FA^{-1}									
145	**FA-1**	3.41e-05	70.6	**FA-1**	3.40e-05	65.6	**FA-1**	3.40e-05	66.3
1501450	**CaFA+**	9.44e-06	19.5	**CaFA+**	1.20e-05	23.1	**CaFA+**	1.16e-05	22.6
185.185	**FA, susp**	3.67e-06	7.60	**FA, susp**	4.24e-06	8.17	**FA, susp**	4.15e-06	8.09
5001450	**NaFA**	3.97e-07	0.822	**NaFA**	7.72e-07	1.49	**NaFA**	7.13e-07	1.39
4601450	**MgFA+**	5.45e-07	1.13	**MgFA+**	6.93e-07	1.34	**MgFA+**	6.70e-07	1.31
4711450	**MnFA+2**	3.71e-08	0.077	**MnFA+2**	5.68e-08	0.110	**MnFA+2**	5.50e-08	0.107
4101450	**KFA**	3.92e-08	0.081	**KFA**	5.32e-08	0.103	**KFA**	5.10e-08	0.099
2311450	**CuFA+**	2.17e-08	0.045	**CuFA+**	2.58e-08	0.050	**CuFA+**	2.38e-08	0.046
9501450	**ZnFA+**	2.06e-08	0.043	**ZnFA+**	1.40e-08	0.027	**ZnFA+**	1.73e-08	0.034
5401450	**NiFA+**	1.47e-08	0.030	**NiFA+**	7.91e-09	0.015	**NiFA+**	1.13e-08	0.022
3301450	**H-FA**	8.99e-09	0.019	**H-FA**	8.88e-09	0.017	**H-FA**	8.89e-09	0.017
8001450	**SrFA+**	3.21e-10	0.001	**SrFA+**	4.17e-10	0.001	**SrFA+**	3.88e-10	0.001
2201450	**CoFA+**	2.02e-10	0.000	**CoFA+**	5.05e-10	0.001	**CoFA+**	3.52e-10	0.001
6001450	**PbFA+**	5.89e-10	0.001	**PbFA+**	3.15e-10	0.001	**PbFA+**	3.16e-10	0.001
1601450	**CdFA+**	5.13e-11	0.000	**CdFA+**	2.39e-10	0.000	**CdFA+**	2.08e-10	0.000
1001450	**BaFA+**	8.04e-11	0.000	**BaFA+**	7.90e-11	0.000	**BaFA+**	7.86e-11	0.000
2811450	**FeFA+2**	1.84e-13	0.000	**FeFA+2**	1.97e-13	0.000	**FeFA+2**	1.91e-13	0.000
Total FA-		***4.83e-05***			***5.19e-05***			***5.13e-05***	
Silicon - Si									
60.0843	**SiO2, susp**	4.11e-04	95.4	**SiO2, susp**	4.37e-04	95.4	**SiO2, susp**	4.24e-04	95.4
770	**H4SiO4**	1.98e-05	4.60	**H4SiO4**	2.09e-05	4.56	**H4SiO4**	2.03e-05	4.58
3307700	**H3SiO4 -**	1.99e-08	0.005	**H3SiO4 -**	2.13e-08	0.005	**H3SiO4 -**	2.11e-08	0.005
3307701	**H2SiO4 -2**	1.56e-13	0.000	**H2SiO4 -2**	1.98e-13	0.000	**H2SiO4 -2**	1.92e-13	0.000
Total Si		***4.31e-04***			***4.58e-04***			***4.44e-04***	
Aluminum - Al									
26.9815	**Al, susp**	3.22e-05	66.0	**Al, susp**	8.69e-05	85.3	**Al, susp**	5.95e-05	79.1
303303	**Al(OH)3 aq**	1.46e-05	30.0	**Al(OH)3 aq**	1.29e-05	12.6	**Al(OH)3 aq**	1.36e-05	18.1
303302	**Al(OH)4 -**	1.12e-06	2.29	**Al(OH)4 -**	1.31e-06	1.29	**Al(OH)4 -**	1.34e-06	1.78
303301	**Al(OH)2 +**	8.39e-07	1.72	**Al(OH)2 +**	7.46e-07	0.732	**Al(OH)2 +**	7.88e-07	1.05
303300	**AlOH +2**	3.81e-09	0.008	**AlOH +2**	3.75e-09	0.004	**AlOH +2**	3.91e-09	0.005
30	**Al+3**	7.17e-11	0.000	**Al+3**	6.84e-11	0.000	**Al+3**	7.15e-11	0.000
Total Al		***4.87e-05***			***1.02e-04***			***7.53e-05***	

MINTEQ ID	*Spring Reservoir Average*			*Summer Reservoir Average*			*Pooled Reservoir Average*		
	Species Name	*Calculated mol/L*	*Mole Percent*	*Species Name*	*Calculated mol/L*	*Mole Percent*	*Species Name*	*Calculated mol/L*	*Mole Percent*
Arsenic - As									
3300612	**HAsO4 -2**	3.59e-08	67.5	**HAsO4 -2**	6.63e-08	65.3	**HAsO4 -2**	5.12e-08	65.3
3300611	**H2AsO4 -**	1.31e-08	24.7	**H2AsO4 -**	2.35e-08	23.2	**H2AsO4 -**	1.83e-08	23.3
74.92159	**As, susp**	4.13e-09	7.77	**As, susp**	1.18e-08	11.6	**As, susp**	8.91e-09	11.4
3300613	**AsO4 -3**	1.22e-12	0.002	**AsO4 -3**	2.42e-12	0.002	**AsO4 -3**	1.85e-12	0.002
61	**H3AsO4**	1.36e-13	0.000	**H3AsO4**	2.44e-13	0.000	**H3AsO4**	1.89e-13	0.000
Total As		***5.32e-08***			***1.02e-07***			***7.84e-08***	
Barium - Ba									
100	**Ba+2**	2.23e-07	69.3	**Ba+2**	2.28e-07	61.9	**Ba+2**	2.25e-07	65.4
137.327	**Ba, susp**	9.85e-08	30.6	**Ba, susp**	1.40e-07	38.1	**Ba, susp**	1.19e-07	34.6
1001450	**BaFA+**	8.04e-11	0.025	**BaFA+**	7.90e-11	0.021	**BaFA+**	7.86e-11	0.023
1003300	**BaOH +**	4.46e-14	0.000	**BaOH +**	4.89e-14	0.000	**BaOH +**	4.79e-14	0.000
Total Ba		***3.22e-07***			***3.68e-07***			***3.45e-07***	
Cadmium - Cd									
112.411	**Cd, susp**	1.78e-10	77.5	**Cd, susp**	2.40e-10	49.9	**Cd, susp**	2.09e-10	49.9
1601450	**CdFA+**	5.13e-11	22.3	**CdFA+**	2.39e-10	49.6	**CdFA+**	2.08e-10	49.6
160	**Cd+2**	3.26e-13	0.142	**Cd+2**	1.58e-12	0.328	**Cd+2**	1.36e-12	0.326
1607320	**CdSO4 aq**	5.98e-15	0.003	**CdSO4 aq**	4.42e-14	0.009	**CdSO4 aq**	3.62e-14	0.009
1601800	**CdCl +**	2.75e-15	0.001	**CdCl +**	2.31e-14	0.005	**CdCl +**	1.87e-14	0.004
1601401	**CdCO3 aq**	2.86e-15	0.001	**CdCO3 aq**	1.34e-14	0.003	**CdCO3 aq**	1.17e-14	0.003
1601400	**CdHCO3 +**	2.08e-15	0.001	**CdHCO3 +**	9.81e-15	0.002	**CdHCO3 +**	8.53e-15	0.002
1603300	**CdOH +**	1.41e-16	0.000	**CdOH +**	7.24e-16	0.000	**CdOH +**	6.22e-16	0.000
1601803	**CdOHCl aq**	1.22e-17	0.000	**CdOHCl aq**	1.04e-16	0.000	**CdOHCl aq**	8.38e-17	0.000
1607321	**Cd(SO4)2-2**	6.86e-18	0.000	**Cd(SO4)2-2**	8.20e-17	0.000	**Cd(SO4)2-2**	6.32e-17	0.000
1604920	**CdNO3 +**	1.31e-17	0.000	**CdNO3 +**	6.16e-17	0.000	**CdNO3 +**	5.35e-17	0.000
1601801	**CdCl2 aq**	1.10e-18	0.000	**CdCl2 aq**	1.64e-17	0.000	**CdCl2 aq**	1.23e-17	0.000
1603301	**Cd(OH)2 aq**	2.55e-19	0.000	**Cd(OH)2 aq**	1.19e-18	0.000	**Cd(OH)2 aq**	1.04e-18	0.000
1607620	**CdSeO4**	1.65e-19	0.000	**CdSeO4**	7.43e-19	0.000	**CdSeO4**	6.33e-19	0.000
1601802	**CdCl3 -**	6.32e-23	0.000	**CdCl3 -**	1.72e-21	0.000	**CdCl3 -**	1.20e-21	0.000
1603302	**Cd(OH)3 -**	4.32e-25	0.000	**Cd(OH)3 -**	2.04e-24	0.000	**Cd(OH)3 -**	1.77e-24	0.000
1603304	**Cd2OH +3**	3.12e-28	0.000	**Cd2OH +3**	7.89e-27	0.000	**Cd2OH +3**	5.85e-27	0.000
Total Cd		***2.30e-10***			***4.81e-10***			***4.18e-10***	

MINTEQ ID	Spring Reservoir Average			Summer Reservoir Average			Pooled Reservoir Average		
	Species Name	Calculated mol/L	Mole Percent	Species Name	Calculated mol/L	Mole Percent	Species Name	Calculated mol/L	Mole Percent
Cobalt - Co									
58.9332	**Co, susp**	7.80e-09	82.6	**Co, susp**	9.67e-09	69.5	**Co, susp**	8.74e-09	74.8
220	**Co+2**	1.44e-09	15.3	**Co+2**	3.74e-09	26.9	**Co+2**	2.59e-09	22.2
2201450	**CoFA+**	2.02e-10	2.14	**CoFA+**	5.05e-10	3.63	**CoFA+**	3.52e-10	3.01
Total Co		***9.45e-09***			***1.39e-08***			***1.17e-08***	
Chromium - Cr									
51.9961	**Cr, susp**	1.26e-08	29.0	**Cr, susp**	4.17e-08	66.9	**Cr, susp**	4.88e-08	65.5
212	**CrO4-2**	2.59e-08	59.8	**CrO4-2**	1.74e-08	27.9	**CrO4-2**	2.16e-08	29.1
2123300	**HCrO4 -**	4.77e-09	11.0	**HCrO4 -**	3.14e-09	5.04	**HCrO4 -**	3.92e-09	5.27
5002120	**NaCrO4-**	5.46e-11	0.126	**NaCrO4-**	7.03e-11	0.113	**NaCrO4-**	8.10e-11	0.109
4102120	**KCrO4-**	8.60e-12	0.020	**KCrO4-**	7.73e-12	0.012	**KCrO4-**	9.25e-12	0.012
2125801	**CrO3HPO4-2**	1.03e-14	0.000	**CrO3HPO4-2**	9.73e-15	0.000	**CrO3HPO4-2**	1.16e-14	0.000
2123302	**Cr2O7 -2**	1.19e-15	0.000	**Cr2O7 -2**	5.07e-16	0.000	**Cr2O7 -2**	7.94e-16	0.000
2123301	**H2CrO4 aq**	4.66e-17	0.000	**H2CrO4 aq**	3.02e-17	0.000	**H2CrO4 aq**	3.78e-17	0.000
2127320	**CrO3SO4-2**	9.96e-18	0.000	**CrO3SO4-2**	1.05e-17	0.000	**CrO3SO4-2**	1.24e-17	0.000
2125800	**Cr03H2PO4-**	3.00e-19	0.000	**Cr03H2PO4-**	2.77e-19	0.000	**Cr03H2PO4-**	3.33e-19	0.000
Total Cr		***4.33e-08***			***6.22e-08***			***7.44e-08***	
Copper - Cu									
63.546	**Cu, susp**	2.18e-08	49.9	**Cu, susp**	2.58e-08	49.9	**Cu, susp**	2.38e-08	49.9
2311450	**CuFA+**	2.17e-08	49.9	**CuFA+**	2.58e-08	49.9	**CuFA+**	2.38e-08	49.9
2313301	**Cu(OH)2 aq**	4.41e-12	0.010	**Cu(OH)2 aq**	5.25e-12	0.010	**Cu(OH)2 aq**	4.84e-12	0.010
231	**Cu+2**	1.20e-12	0.003	**Cu+2**	1.49e-12	0.003	**Cu+2**	1.36e-12	0.003
2311400	**CuCO3 aq**	2.27e-13	0.001	**CuCO3 aq**	2.71e-13	0.001	**CuCO3 aq**	2.50e-13	0.001
2313300	**CuOH +**	1.53e-13	0.000	**CuOH +**	1.84e-13	0.000	**CuOH +**	1.69e-13	0.000
2311402	**CuHCO3 +**	3.05e-14	0.000	**CuHCO3 +**	3.69e-14	0.000	**CuHCO3 +**	3.39e-14	0.000
2317320	**CuSO4 aq**	1.55e-14	0.000	**CuSO4 aq**	2.93e-14	0.000	**CuSO4 aq**	2.54e-14	0.000
2311800	**CuCl +**	1.66e-16	0.000	**CuCl +**	3.75e-16	0.000	**CuCl +**	3.18e-16	0.000
2311401	**Cu(CO3)2-2**	1.42e-17	0.000	**Cu(CO3)2-2**	1.77e-17	0.000	**Cu(CO3)2-2**	1.62e-17	0.000
2313302	**Cu(OH)3 -**	4.02e-18	0.000	**Cu(OH)3 -**	4.84e-18	0.000	**Cu(OH)3 -**	4.45e-18	0.000
2311801	**CuCl2 aq**	7.84e-21	0.000	**CuCl2 aq**	3.17e-20	0.000	**CuCl2 aq**	2.50e-20	0.000
2313304	**Cu2(OH)2+2**	3.39e-21	0.000	**Cu2(OH)2+2**	5.58e-21	0.000	**Cu2(OH)2+2**	4.64e-21	0.000
Total Cu		***4.35e-08***			***5.17e-08***			***4.76e-08***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Iron - Fe									
55.847	**Fe, susp**	1.32e-05	74.8	**Fe, susp**	3.12e-05	86.9	**Fe, susp**	2.22e-05	82.9
2813301	**FeOH2 +**	3.74e-06	21.3	**FeOH2 +**	3.95e-06	11.0	**FeOH2 +**	3.85e-06	14.4
2813302	**FeOH3 aq**	6.08e-07	3.46	**FeOH3 aq**	6.36e-07	1.77	**FeOH3 aq**	6.21e-07	2.32
2813303	**FeOH4 -**	9.19e-08	0.522	**FeOH4 -**	9.69e-08	0.270	**FeOH4 -**	9.44e-08	0.353
2813300	**FeOH +2**	4.41e-10	0.003	**FeOH +2**	5.10e-10	0.001	**FeOH +2**	4.91e-10	0.002
2811450	**FeFA+2**	1.84e-13	0.000	**FeFA+2**	1.97e-13	0.000	**FeFA+2**	1.91e-13	0.000
281	**Fe+3**	1.19e-14	0.000	**Fe+3**	1.35e-14	0.000	**Fe+3**	1.30e-14	0.000
2817320	**FeSO4 +**	4.37e-15	0.000	**FeSO4 +**	7.42e-15	0.000	**FeSO4 +**	6.80e-15	0.000
2815800	**FeHPO4 +**	1.43e-15	0.000	**FeHPO4 +**	2.04e-15	0.000	**FeHPO4 +**	1.92e-15	0.000
2815801	**FeH2PO4 +2**	1.09e-15	0.000	**FeH2PO4 +2**	1.67e-15	0.000	**FeH2PO4 +2**	1.56e-15	0.000
2811800	**FeCl +2**	2.07e-17	0.000	**FeCl +2**	4.13e-17	0.000	**FeCl +2**	3.71e-17	0.000
2817321	**Fe(SO4)2 -**	1.08e-17	0.000	**Fe(SO4)2 -**	2.89e-17	0.000	**Fe(SO4)2 -**	2.49e-17	0.000
2813304	**Fe2(OH)2+4**	1.22e-17	0.000	**Fe2(OH)2+4**	1.67e-17	0.000	**Fe2(OH)2+4**	1.54e-17	0.000
2811801	**FeCl2 +**	1.24e-20	0.000	**FeCl2 +**	4.15e-20	0.000	**FeCl2 +**	3.50e-20	0.000
2813305	**Fe3(OH)4+5**	1.28e-20	0.000	**Fe3(OH)4+5**	2.00e-20	0.000	**Fe3(OH)4+5**	1.77e-20	0.000
2811802	**FeCl3 aq**	1.24e-25	0.000	**FeCl3 aq**	7.34e-25	0.000	**FeCl3 aq**	5.76e-25	0.000
Total Fe		***1.76e-05***			***3.58e-05***			***2.67e-05***	
Manganese - Mn									
54.93805	**Mn, susp**	6.34e-07	93.4	**Mn, susp**	1.21e-06	94.6	**Mn, susp**	9.20e-07	93.2
4711450	**MnFA+2**	3.71e-08	5.47	**MnFA+2**	5.68e-08	4.45	**MnFA+2**	5.50e-08	5.58
471	**Mn+3**	7.76e-09	1.14	**Mn+3**	1.26e-08	0.986	**Mn+3**	1.21e-08	1.23
Total Mn		***6.79e-07***			***1.28e-06***			***9.87e-07***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Mercury - Hg									
200.59	**Hg, susp**	2.49e-10	90.2	**Hg, susp**	9.43e-11	81.5	**Hg, susp**	1.46e-10	86.3
361	**Hg(OH)2**	2.32e-11	8.41	**Hg(OH)2**	1.91e-11	16.5	**Hg(OH)2**	2.04e-11	12.1
200.59	**Me-Hg, susp**	1.80e-12	0.652	**HgClOH (aq)**	1.10e-12	0.950	**Me-Hg, susp**	1.11e-12	0.655
200.59	**Me-Hg, diss**	1.29e-12	0.466	**Me-Hg, susp**	8.87e-13	0.767	**HgClOH (aq)**	1.10e-12	0.652
3611805	**HgClOH (aq)**	8.11e-13	0.294	**Me-Hg, diss**	3.07e-13	0.265	**Me-Hg, diss**	5.83e-13	0.345
3611801	**HgCl2 (aq)**	2.02e-14	0.007	**HgCl2 (aq)**	5.28e-14	0.046	**HgCl2 (aq)**	4.87e-14	0.029
3613302	**HgOH+1**	8.34e-16	0.000	**HgOH+1**	6.93e-16	0.001	**HgOH+1**	7.39e-16	0.000
3611800	**HgCl+1**	8.59e-17	0.000	**HgCl+1**	1.27e-16	0.000	**HgCl+1**	1.26e-16	0.000
3811802	**HgCl3-1**	1.77e-17	0.000	**HgCl3-1**	8.29e-17	0.000	**HgCl3-1**	7.10e-17	0.000
3614901	**Hg(NH3)2+2**	1.67e-18	0.000	**Hg(NH3)2+2**	1.94e-17	0.000	**Hg(NH3)2+2**	1.61e-17	0.000
3614900	**HgNH3+2**	5.87e-19	0.000	**HgNH3+2**	1.85e-18	0.000	**HgNH3+2**	1.73e-18	0.000
3613300	**Hg+2**	3.49e-19	0.000	**Hg(OH)3-1**	2.88e-19	0.000	**Hg(OH)3-1**	3.07e-19	0.000
3613303	**Hg(OH)3-1**	3.47e-19	0.000	**Hg+2**	2.78e-19	0.000	**Hg+2**	2.98e-19	0.000
3611803	**HgCl4-2**	5.44e-21	0.000	**HgCl4-2**	4.66e-20	0.000	**HgCl4-2**	3.70e-20	0.000
3617320	**HgSO4 (aq)**	2.80e-22	0.000	**HgSO4 (aq)**	3.63e-22	0.000	**HgSO4 (aq)**	3.66e-22	0.000
3611450	**HgFA+**	4.77e-24	0.000	**Hg(NH3)3+2**	4.04e-24	0.000	**HgFA+**	4.18e-24	0.000
3614920	**HgNO3+1**	4.20e-24	0.000	**HgFA+**	3.91e-24	0.000	**HgNO3+1**	3.83e-24	0.000
3614902	**Hg(NH3)3+2**	9.41e-26	0.000	**HgNO3+1**	3.60e-24	0.000	**Hg(NH3)3+2**	2.94e-24	0.000
3614921	**Hg(NO3)2 (a**	1.10e-30	0.000	**Hg(NO3)2 (a**	9.67e-31	0.000	**Hg(NO3)2 (a**	1.02e-30	0.000
3614903	**Hg(NH3)4+2**	3.36e-33	0.000	**Hg(NH3)4+2**	5.32e-31	0.000	**Hg(NH3)4+2**	3.42e-31	0.000
Total Hg		***2.76e-10***			***1.16e-10***			***1.69e-10***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Lead - Pb									
207.2	**Pb, susp**	3.43e-09	78.9	**Pb, susp**	4.11e-09	89.2	**Pb, susp**	3.77e-09	88.40
6001450	**PbFA+**	5.89e-10	13.6	**PbFA+**	3.15e-10	6.85	**PbFA+**	3.16e-10	7.41
600	**Pb+2**	1.67e-10	3.85	**Pb+2**	9.30e-11	2.02	**Pb+2**	9.27e-11	2.17
6001401	**PbCO3 aq**	1.02e-10	2.35	**PbCO3 aq**	5.49e-11	1.19	**PbCO3 aq**	5.50e-11	1.29
6003300	**PbOH +**	4.13e-11	0.952	**PbOH +**	2.24e-11	0.486	**PbOH +**	2.24e-11	0.525
6007320	**PbSO4 aq**	6.43e-12	0.148	**PbSO4 aq**	5.44e-12	0.118	**PbSO4 aq**	5.14e-12	0.120
6001402	**PbHCO3 +**	6.72e-12	0.155	**PbHCO3 +**	3.66e-12	0.079	**PbHCO3 +**	3.65e-12	0.086
6001800	**PbCl +**	4.54e-13	0.010	**PbCl +**	4.51e-13	0.010	**PbCl +**	4.18e-13	0.010
6003301	**Pb(OH)2 aq**	2.22e-13	0.005	**Pb(OH)2 aq**	1.19e-13	0.003	**Pb(OH)2 aq**	1.20e-13	0.003
6004920	**PbNO3 +**	2.78e-14	0.001	**PbNO3 +**	1.56e-14	0.000	**PbNO3 +**	1.55e-14	0.000
6001400	**Pb(CO3)2-2**	1.28e-14	0.000	**Pb(CO3)2-2**	7.15e-15	0.000	**Pb(CO3)2-2**	7.12e-15	0.000
6007321	**Pb(SO4)2-2**	3.28e-15	0.000	**Pb(SO4)2-2**	4.52e-15	0.000	**Pb(SO4)2-2**	4.00e-15	0.000
6001801	**PbCl2 aq**	9.02e-17	0.000	**PbCl2 aq**	1.55e-16	0.000	**PbCl2 aq**	1.34e-16	0.000
6003302	**Pb(OH)3 -**	3.85e-17	0.000	**Pb(OH)3 -**	2.09e-17	0.000	**Pb(OH)3 -**	2.09e-17	0.000
6003303	**Pb2OH +3**	1.84e-19	0.000	**Pb2OH +3**	5.75e-20	0.000	**Pb2OH +3**	5.70e-20	0.000
6001802	**PbCl3 -**	7.27e-21	0.000	**PbCl3 -**	2.26e-20	0.000	**PbCl3 -**	1.81e-20	0.000
6003305	**Pb(OH)4 -2**	1.46e-21	0.000	**Pb(OH)4 -2**	8.12e-22	0.000	**Pb(OH)4 -2**	8.09e-22	0.000
6001803	**PbCl4 -2**	3.80e-25	0.000	**PbCl4 -2**	2.18e-24	0.000	**PbCl4 -2**	1.61e-24	0.000
6003304	**Pb3(OH)4+2**	3.14e-26	0.000	**Pb3(OH)4+2**	5.98e-27	0.000	**Pb3(OH)4+2**	5.84e-27	0.000
Total Pb		***4.34e-09***			***4.60e-09***			***4.26e-09***	
Nickel - Ni									
58.69	**Ni, susp**	1.47e-08	43.8	**Ni, susp**	2.10e-08	67.3	**Ni, susp**	1.79e-08	55.1
5401450	**NiFA+**	1.47e-08	43.8	**NiFA+**	7.91e-09	25.3	**NiFA+**	1.13e-08	34.7
540	**Ni+2**	3.24e-09	9.65	**Ni+2**	1.81e-09	5.79	**Ni+2**	2.56e-09	7.91
5401401	**NiCO3 aq**	8.42e-10	2.51	**NiCO3 aq**	4.56e-10	1.46	**NiCO3 aq**	6.49e-10	2.00
5407320	**NiSO4 aq**	3.90e-11	0.116	**NiSO4 aq**	3.34e-11	0.107	**NiSO4 aq**	4.48e-11	0.138
5401400	**NiHCO3 +**	2.42e-11	0.072	**NiHCO3 +**	1.33e-11	0.042	**NiHCO3 +**	1.88e-11	0.058
5403300	**NiOH +**	2.44e-12	0.007	**NiOH +**	1.44e-12	0.005	**NiOH +**	2.03e-12	0.006
5401800	**NiCl +**	7.45e-13	0.002	**NiCl +**	7.23e-13	0.002	**NiCl +**	9.55e-13	0.003
5401402	**Ni(CO3)2-2**	7.29e-14	0.000	**Ni(CO3)2-2**	4.11e-14	0.000	**Ni(CO3)2-2**	5.81e-14	0.000
5403301	**Ni(OH)2 aq**	5.67e-14	0.000	**Ni(OH)2 aq**	3.06e-14	0.000	**Ni(OH)2 aq**	4.36e-14	0.000
5407620	**NiSeO4**	3.22e-15	0.000	**NiSeO4**	1.72e-15	0.000	**NiSeO4**	2.39e-15	0.000
5401801	**NiCl2 aq**	2.72e-16	0.000	**NiCl2 aq**	4.66e-16	0.000	**NiCl2 aq**	5.73e-16	0.000
5407321	**Ni(SO4)2-2**	2.26e-16	0.000	**Ni(SO4)2-2**	3.12e-16	0.000	**Ni(SO4)2-2**	3.93e-16	0.000
5403302	**Ni(OH)3 -**	8.57e-18	0.000	**Ni(OH)3 -**	4.67e-18	0.000	**Ni(OH)3 -**	6.64e-18	0.000
Total Ni		***3.36e-08***			***2.04e-08***			***2.89e-08***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Antimony - Sb									
740	**Sb(OH)3**	8.43e-10	47.5	**Sb(OH)3**	1.08e-09	43.1	**Sb(OH)3**	9.63e-10	44.3
7400021	**HSbO2**	8.30e-10	46.8	**HSbO2**	1.07e-09	42.5	**HSbO2**	9.48e-10	43.6
121.75	**Sb, susp**	1.01e-10	5.70	**Sb, susp**	3.62e-10	14.4	**Sb, susp**	2.65e-10	12.2
7403301	**SbO2-**	6.46e-15	0.000	**SbO2-**	9.33e-15	0.000	**SbO2-**	8.16e-15	0.000
7400020	**Sb(OH)4-1**	3.72e-15	0.000	**Sb(OH)4-1**	5.37e-15	0.000	**Sb(OH)4-1**	4.70e-15	0.000
7403302	**Sb(OH)2+**	1.48e-15	0.000	**Sb(OH)2+**	1.92e-15	0.000	**Sb(OH)2+**	1.70e-15	0.000
7403300	**SbO+**	4.46e-16	0.000	**SbO+**	5.87e-16	0.000	**SbO+**	5.20e-16	0.000
Total Sb		***1.77e-09***			***2.51e-09***			***2.18e-09***	
Selenium - Se									
762	**SeO4-2**	4.12e-09	48.8	**SeO4-2**	4.12e-09	87.3	**SeO4-2**	4.01e-09	58.6
78.96	**Se, susp**	4.32e-09	51.2	**Se, susp**	6.02e-10	12.7	**Se, susp**	2.83e-09	41.4
3307620	**HSeO4-1**	1.51e-14	0.000	**HSeO4-1**	1.51e-14	0.000	**HSeO4-1**	1.48e-14	0.000
5407620	**NiSeO4**	3.22e-15	0.000	**NiSeO4**	1.72e-15	0.000	**NiSeO4**	2.39e-15	0.000
9507620	**ZnSeO4**	8.93e-16	0.000	**ZnSeO4**	5.89e-16	0.000	**ZnSeO4**	7.10e-16	0.000
1607620	**CdSeO4**	1.65e-19	0.000	**CdSeO4**	7.43e-19	0.000	**CdSeO4**	6.33e-19	0.000
Total Se		***8.44e-09***			***4.72e-09***			***6.85e-09***	
Strontium - Sr									
800	**Sr+2**	8.89e-07	96.7	**Sr+2**	1.20e-06	98.0	**Sr+2**	1.11e-06	97.7
87.62	**Sr, susp**	2.97e-08	3.23	**Sr, susp**	2.37e-08	1.94	**Sr, susp**	2.55e-08	2.24
8001450	**SrFA+**	3.21e-10	0.035	**SrFA+**	4.17e-10	0.034	**SrFA+**	3.88e-10	0.034
8003300	**SrOH +**	2.80e-13	0.000	**SrOH +**	4.05e-13	0.000	**SrOH +**	3.71e-13	0.000
Total Sr		***9.19e-07***			***1.23e-06***			***1.14e-06***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Uranium - U									
8935801	**UO2HPO4)2**	2.68e-09	89.9	**UO2HPO4)2**	6.51e-09	88.5	**UO2HPO4)2**	5.42e-09	88.7
238.0289	**U, susp**	2.96e-10	9.94	**U, susp**	8.44e-10	11.5	**U, susp**	6.88e-10	11.3
8931400	**UO2CO3 aq**	1.81e-12	0.061	**UO2CO3 aq**	2.30e-12	0.031	**UO2CO3 aq**	2.07e-12	0.034
8935800	**UO2HPO4 aq**	4.64e-13	0.016	**UO2HPO4 aq**	8.18e-13	0.011	**UO2HPO4 aq**	7.07e-13	0.012
8931401	**UO2CO3)2-2**	5.80e-13	0.019	**UO2CO3)2-2**	7.84e-13	0.011	**UO2CO3)2-2**	6.99e-13	0.011
8933300	**UO2OH +1**	2.20e-13	0.007	**UO2OH +1**	2.99e-13	0.004	**UO2OH +1**	2.66e-13	0.004
8937700	**UO2H3SIO4**	4.48e-15	0.000	**UO2H3SIO4**	5.72e-15	0.000	**UO2H3SIO4**	5.14e-15	0.000
893	**UO2+2**	4.26e-15	0.000	**UO2+2**	5.58e-15	0.000	**UO2+2**	4.99e-15	0.000
8931402	**UO2CO3)3-4**	2.31e-15	0.000	**UO2CO3)3-4**	3.21e-15	0.000	**UO2CO3)3-4**	2.85e-15	0.000
8937320	**UO2SO4 aq**	1.14e-16	0.000	**UO2SO4 aq**	2.32e-16	0.000	**UO2SO4 aq**	1.97e-16	0.000
8935802	**UO2H2PO4+1**	2.52e-18	0.000	**UO2H2PO4+1**	4.44e-18	0.000	**UO2H2PO4+1**	3.84e-18	0.000
8931800	**UO2Cl +1**	5.97e-19	0.000	**UO2Cl +1**	1.37e-18	0.000	**UO2Cl +1**	1.14e-18	0.000
8937321	**UO2SO4)2-2**	3.15e-19	0.000	**UO2SO4)2-2**	1.05e-18	0.000	**UO2SO4)2-2**	8.33e-19	0.000
8933301	**UO2)2OH2+2**	3.60e-21	0.000	**UO2)2OH2+2**	6.37e-21	0.000	**UO2)2OH2+2**	5.08e-21	0.000
8935803	**UO2H2PO4)2**	7.84e-22	0.000	**UO2H2PO4)2**	1.78e-21	0.000	**UO2H2PO4)2**	1.50e-21	0.000
8933302	**UO2)3OH5+1**	1.40e-24	0.000	**UO2)3OH5+1**	3.37e-24	0.000	**UO2)3OH5+1**	2.40e-24	0.000
Total U		***2.98e-09***			***7.36e-09***			***6.11e-09***	

MINTEQ ID	***Spring Reservoir Average***			***Summer Reservoir Average***			***Pooled Reservoir Average***		
	Species Name	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***	***Species Name***	***Calculated mol/L***	***Mole Percent***
Vanadium - V									
9033301	**H2VO4 -1**	7.04e-08	62.7	**H2VO4 -1**	1.07e-07	56.2	**H2VO4 -1**	8.91e-08	58.7
50.9415	**V, susp**	3.07e-08	27.3	**V, susp**	6.37e-08	33.4	**V, susp**	4.72e-08	31.1
9033302	**HVO4 -2**	7.92e-09	7.05	**HVO4 -2**	1.27e-08	6.64	**HVO4 -2**	1.05e-08	6.89
9030021	**HV2O7 -3**	3.27e-09	2.91	**HV2O7 -3**	6.98e-09	3.66	**HV2O7 -3**	4.88e-09	3.21
9030022	**H3V2O7 -1**	3.74e-11	0.033	**H3V2O7 -1**	7.43e-11	0.039	**H3V2O7 -1**	5.25e-11	0.035
9033300	**H3VO4 aq**	3.02e-11	0.027	**H3VO4 aq**	4.53e-11	0.024	**H3VO4 aq**	3.77e-11	0.025
9030020	**V2O7 -4**	1.12e-14	0.000	**V2O7 -4**	2.53e-14	0.000	**V2O7 -4**	1.75e-14	0.000
903	**VO2+1**	8.93e-15	0.000	**VO2+1**	1.27e-14	0.000	**VO2+1**	1.06e-14	0.000
9033303	**VO4 -3**	5.87e-15	0.000	**VO4 -3**	1.01e-14	0.000	**VO4 -3**	8.25e-15	0.000
9030023	**V3O9 -3**	1.11e-15	0.000	**V3O9 -3**	3.33e-15	0.000	**V3O9 -3**	1.96e-15	0.000
9037320	**VO2SO4 -1**	3.74e-17	0.000	**VO2SO4 -1**	8.32e-17	0.000	**VO2SO4 -1**	6.59e-17	0.000
9030024	**V4O12 -4**	3.33e-20	0.000	**V4O12 -4**	1.49e-19	0.000	**V4O12 -4**	7.27e-20	0.000
9034920	**VO2NO3 aq**	4.08e-20	0.000	**VO2NO3 aq**	5.92e-20	0.000	**VO2NO3 aq**	4.95e-20	0.000
Total V		***1.12e-07***			***1.91e-07***			***1.52e-07***	
Zinc - Zn									
65.39	**Zn, susp**	2.26e-08	49.9	**Zn, susp**	8.12e-08	84.0	**Zn, susp**	6.69e-08	77.9
9501450	**ZnFA+**	2.06e-08	45.6	**ZnFA+**	1.40e-08	14.5	**ZnFA+**	1.73e-08	20.1
950	**Zn+2**	1.93e-09	4.28	**Zn+2**	1.37e-09	1.42	**Zn+2**	1.68e-09	1.95
9507320	**ZnSO4 aq**	2.83e-11	0.063	**ZnSO4 aq**	3.07e-11	0.032	**ZnSO4 aq**	3.56e-11	0.041
9501401	**ZnCO3 aq**	1.35e-11	0.030	**ZnCO3 aq**	9.28e-12	0.010	**ZnCO3 aq**	1.14e-11	0.013
9501400	**ZnHCO3 +**	1.23e-11	0.027	**ZnHCO3 +**	8.52e-12	0.009	**ZnHCO3 +**	1.05e-11	0.012
9503300	**ZnOH +**	1.09e-11	0.024	**ZnOH +**	8.14e-12	0.008	**ZnOH +**	9.90e-12	0.012
9503301	**Zn(OH)2 aq**	4.28e-12	0.009	**Zn(OH)2 aq**	2.92e-12	0.003	**Zn(OH)2 aq**	3.60e-12	0.004
9501800	**ZnCl +**	2.82e-13	0.001	**ZnCl +**	3.64e-13	0.000	**ZnCl +**	4.13e-13	0.000
9501804	**ZnOHCl aq**	8.14e-14	0.000	**ZnOHCl aq**	9.90e-14	0.000	**ZnOHCl aq**	1.13e-13	0.000
9507321	**Zn(SO4)2-2**	2.45e-14	0.000	**Zn(SO4)2-2**	4.29e-14	0.000	**Zn(SO4)2-2**	4.68e-14	0.000
9501402	**Zn(CO3)2-2**	1.44e-14	0.000	**Zn(CO3)2-2**	1.03e-14	0.000	**Zn(CO3)2-2**	1.26e-14	0.000
9507620	**ZnSeO4**	8.93e-16	0.000	**ZnSeO4**	5.89e-16	0.000	**ZnSeO4**	7.10e-16	0.000
9503302	**Zn(OH)3 -**	2.04e-16	0.000	**Zn(OH)3 -**	1.41e-16	0.000	**Zn(OH)3 -**	1.73e-16	0.000
9501801	**ZnCl2 aq**	2.82e-17	0.000	**ZnCl2 aq**	6.45e-17	0.000	**ZnCl2 aq**	6.82e-17	0.000
Total Zn		***4.52e-08***			***9.67e-08***			***8.59e-08***	

Lake Owyhee MINTEQA2 Modeling Assumptions

Trace Metal - Fulvic Acid Complexation Reactions

Lake Owyhee averaged data sets were modeled by MINTEQA2 using modified thermodynamic data base files (*complig.dbs*, seen in table A3-5, and *comp.dbs*, seen in table A3-6). These data bases were amended to include reactions between cationic dissolved trace elements and fulvic acid (FA). It was assumed that the DOC in Lake Owyhee waters was primarily FA, a heterodisperse and heterogeneous mixture of aromatic and aliphatic carbon molecules produced by decomposition of biotic matter. FA has molecular weights ranging from 600 amu to 2,000 amu and contains 4-6 µeq/g of trace metal binding capacity. The functional groups associated with trace metal binding are carboxylic acids (R-COOH) that are deprotonated ($R\text{-}COO^-$) in natural water with pH above 7 (Thurman, 1985; Purdue et al., 1984; Leenheer et al., 1989). The electrostatic repulsion associated with negatively-charged carboxylate sites also makes the fulvate (FA^-) molecules assume an open, hydrophyllic, stearically unhindered configuration conducive to trace metal approach and complexation.

Molecular weight and elemental compositional data reported for Suwannee River FA (SFA) (Thurman, 1985; Aiken and Malcolm, 1987; Aiken et al., 1989), were used to enter molecular weights into the MINTEQA2 data bases. SFA is a well-characterized reference material available from the International Humic Substances Society. Average SFA carboxylate binding capacity of 5.38 meq/L was determined experimentally (Craft, 1994) using a NaOH titration and this binding capacity compares to previously reported values of 5.5 to 6.2 meq/g (Thurman, 1985). The FA molecular weight (per molecule) of 829 g/M as determined by vapor pressure osmometry (Aiken and Malcolm, 1989) corresponds to a binding concentration of 4.46 eq/mol and an effective carboxylate molecular weight of 186.00 g/mol. Subsequent molecular weights for the various trace metal-FA complexes were based on 186.00 g/mol.

Trace metal complexation with FA^- in natural waters is a complicated process. There are several available ligand binding sites (carboxylic, dicarboxylic, phenolic) (Leenheer, 1998). These ligand sites are competing with the major ions (Ca and Mg, which are generally 10^3 times as concentrated as most trace elements) and all other trace element cations present in the water. Trace element binding with FA- also may require displacement of already bound Ca and Mg before trace metal complexation can occur.

An additional complicating factor is suggested by reported *log(K)* values based on titrations of FA with metal ion solutions, with determination of *log(K)* using graphical methods as suggested by Scatchard (Scatchard, 1949, Ruzic, 1982, Ruzic and Nicolic, 1982), and methods involving ion exchange (Schubert, 1948; Ardakani and Stevenson, 1972; Brown et al., 1999). Many of these studies report two apparent *log(K)* values associated with curvature of the titration-derived Scatchard plots. Reported results suggest a higher $log(K)_1$, associated with higher FA^-/M^{n+} ratios for intital titrant additions, followed by a lower $log(K)_2$ where more FA- binding sites are occupied during later titrant additions. Some investigators report a single, overall $log(K)_0$. Several researchers have suggested that metal binding constants for natural FA- depend on the ratio of FA to metal ions (Sposito et al., 1981; Brown et al., 1999).

For the Lake Owyhee modeling exercise, a simplifying assumption for M-FA binding was employed. *log(K)* for the different metals and aquatic FA were entered into the MINTEQ data base file *complig.dbs* (table A3-5, assuming the following simple reaction stoichiometry:

$$M^{m+} + FA^{n-} \rightleftharpoons M\text{-}FA^{(m+n)}$$

where M represents the particular cationic trace element, and the metal-fulvate complex equilibrium constant, K, is defined by:

$$K = [M\text{-}FA]^{(m+n)}/([M^{m+}]^m \times [FA^{n-}]^n$$

log(K) values were obtained from a variety of literature sources reporting conditional stability constant values for various M-FA complexes (table A3-2, with references to the annotated bibliography in this appendix). The *log(K)* data provided in the MINTEQA2 distribution files for binding of H+ with FA- was retained. The literature *log(K)* values represent a variety of FA source materials, including humic acid

(HA, with molecular weights ranging from 2,000 amu up to 20,000 amu) and FA extracted from river water, lake water, ocean water, soil, and sediments. The determinations for *log(K)* were reported for a variety of cationic trace elements, measured at different concentrations, pH, and calculated using several computational methods. Selection of *log(K)* values for the amended MINTEQA2 file, complig.dbs, was prioritized as follows:

1. $log(K)_1$ values reported for SFA, at higher pH values
2. $log(K)_1$ values reported for freshwater lakes, or river waters at higher pH values
3. $log(K)_0$ for SFA, at higher pH, based on multiple element ion exchange
4. $log(K)_1$ values meeting priorities 1-3 above at pH <= 7
5. $log(K)_1$ from soil- derived FA, first at higher pH, then at pH < 7
6. soil FA $log(K)_1$ values at higher pH, then soil FA at lower pH
7. $log(K)_0$ or $log(K)_1$ from humic materials.

The *log(K)* for Na, K, Sr, Ba, Co, Hg, and Cr, were entered into *complig.dbs* (table A3-5) as complexes of these trace elements with acetate (acetic acid as an anion) or citrate (a aliphatic tri-carboxylate) as the carboxylate ligand (Martel and Smith, 1976). The MINTEQA2 component data file, *comp.dbs* (table A3-7), includes Co added as component number 220 and the molecular weight for component 145, FA-, as 186.00 g/mol.

Data Conversions and Calculations

Measured mg/L as DOC was converted to mol/L as FA^- assuming the average elemental compositions for lake FA summarized by Thurman (Thurman, 1985), the SFA molecular weight as determined by vapor pressure osmometry (Aiken and Malcolm, 1987), and unpublished measurements of SFA carboxylate concentration for SFA (Craft, 1994):

C = 52.0% O = 39.0% H = 5.2% Ash = 5.0% S = 1.0% P = 0.10%
molecular weight of SFA = 829 g/mol
SFA-carboxylate groups = 5.38 meq/g
Effective FA^- mole = 829 g/mol ÷ 4.457 eq/mol = 186.000 g/mol
(with respect to metal binding with fulvate COO-)

DOC to FA- Calculation:

FA- (component 145), mol/L = mg/L DOC X 1.03392 X 10^{-5} mol/mg

Reservoir average data and seasonal averages were entered into the MINTEQA2 model assuming that the average water concentrations were in equilibrium with partial pressures of atmospheric O_2 and CO_2 associated with average reservoir surface elevations for spring (814.67 m - 2,762.80 ft.), summer = (809.43 m - 2,655.61 ft), and the all reservoir average (810.51 m - 2,659.15). The partial pressures (in atmospheres) of CO_2 and O_2, (pCO_2 and pO_2) were calculated using the following formulas derived from atmospheric density vs. elevation above sea level data (National Oceanic and Atmospheric Administration, et al., 1976).

$$pO_2 \text{ (atm)} = 0.20704 - (6.239E\text{-}06)*(\text{elevation in feet})$$
$$pCO_2 \text{ (atm)} = 3.262E\text{-}04 - (9.8297E\text{-}09)*(\text{elevation in feet})$$

Table A3-3 lists the partial pressures of O_2 and CO_2 entered for these modeling problems. Table A3-4 lists all the MINTEQA2 component numbers and names for chemical element data entry and the gravimetric conversions used to convert the measured concentratons to mg/L or mol/L for modeling. Table A3-7 provides example saturation index (SI, or Sat.Index) output the MINTEQA2 results, and table A3-8 shows the actual input files for the Lake Owyhee MINTEQA2 simulations.

Table A3-2 Summary of *log(K)* references for MINTEQA2 file *complig.dbs* .

MINTEQ Number	Complex	*log(K)*	Reference	Ionic Strength pH	*i, mol/L*	note
3301450	H-FA	3.60	Allison, et al., 1991	various	various	salicylate *log(K)*
3301460	H2(FA)2	5.60	Allison, et al., 1991	various	various	higher for H-FA
3301461	H(FA)2-1	4.60	Allison, et al., 1991	various	various	complexes
1501450	CaFA+	3.00	Brown, et al., 1999	6.0	0.10	SFA - ion xch
4601450	MgFA+	2.09	Schnitzer and Skinner, 1967	5.0	0.10	Soil FA Schnitzer ionxch
5001450	NaFA	1.40	Martel and Smith, 1976	unkn	0	as citrate
4101450	KFA	1.30	Martel and Smith, 1976	unkn	0	as citrate (only citation)
1001450	BaFA+	1.10	Martel and Smith, 1976	unkn	0	as acetate
8001450	SrFA+	1.10	Martel and Smith, 1976	unkn	0	as acetate
2811450	FeFA+2	5.77	Schnitzer and Skinner, 1966	5.0	0.10	gel filt Scatchard, *log(K)*$_1$, sediment FA
4711450	MnFA+2	5.26	Hirata,	8.0	0.10	sediment FA, *log(K)*$_1$
1601450	CdFA+	6.74	Craft. p30 book 5	8.0	0.001	*log(K)*$_1$- Scatchard - Serial
1601462	Cd(FA)2	7.20	Martel and Smith, 1976	unkn	0	as citrate Cd-L$_2$
1601470	Cd(FA2)+	4.60	Craft. p30 book 5	8.0	0.001	*log(K)*$_2$ Scatchard - Serial
1601480	Cd(FA3)+	3.75	Craft. p30 book 5	8.0	0.001	*log(K)*$_0$- Scatchard - Serial + Ca
5401450	NiFA+	5.20	Brown, et al., 1999	6.0	0.10	SFA ion xch, *log(K)*$_0$
3611450	HgFA+	6.10	Martel and Smith, 1976	unkn	0	as acetate
2101450	CrFA+	5.40	Martel and Smith, 1976	unkn	0	as acetate
2201450	CoFA+	3.69	Schnitzer and Skinner, 1967	5.0	0.10	soil FA Schnitzer ion xch
6001450	PbFA+	5.09	Alberts and Giesy, 1983	5.0	0.10	SFA, ISE Scatchard, *log(K)*$_1$
9501450	ZnFA+	5.57	Hirata, 1981	8.0	0.10	gel filt Scatchard, *log(K)*$_1$, sediment FA
2311450	CuFA+	8.80	Mantoura and Riley, 1975	8.0	0.10	gel perm, Scatchard, *log(K)*$_1$, Lake FA

Table A3-3 Partial pressures entered into the Lake Owyhee MINTEQA2 model runs.

	Average Surface Elevation, ft	**pO_2, atm**	**pCO_2, atm**
Spring	2762.80	0.18980	0.000299
Summer	2655.61	0.19047	0.000300
All Reservoir	2659.15	0.19045	0.000300

Table A3-4 MINTEQA2 component data input conversions assuming oxidizing redox conditions (Stumm and Morgan, 1994)

Analyte and usual conc unit		mw	Enter as MINTEQ Component	MINTEQ name	mw/**eq wt**	mg/L Gravimetric Conversion
	NOTE: *These components are entered as complex anions or uncharged compounds.*					
As	µg/L	74.92459	061	H3AsO4	141.9431	1.89456E-03
Se	µg/L	78.96	762	SeO4-2	142.96	1.81054E-03
Hg	ng/L	200.59	361	Hg(OH)2	230.6047	1.14963E-06
Sb	µg/L	121.75	740	Sb(OH)3	172.77202	1.41907E-03
V	µg/L	50.9415	903	VO2+1	82.9403	1.62815E-03
U	µg/L	238.0289	893	UO2+2	270.0277	1.13443E-03
Cr	µg/L	51.9961	212	CrO4-2	115.9937	2.23082E-03
B	µg/L	10.811	090	H3BO3	61.8331	5.71946E-03
NOTE:	*These components are entered without conversion except for µg/L to mg/L. See note below concerning fulvate complexes with these elements.*					
Ag	µg/L	107.868	020	Ag+		0.001
Al	µg/L	26.98154	030	Al+3		0.001
Ba	µg/L	137.3400	100	Ba+2		0.001
Be	µg/L	9.0122	110	Be+2		0.001
Cd	µg/L	112.411	160	Cd+2		0.001
Co	µg/L	58.93320	220**	Co+2		0.001
Cu	µg/L	63.546	230	Cu+2		0.001
Ni	µg/L	58.69	540	Ni+2		0.001
Pb	µg/L	207.1899	600	Pb+2		0.001
Sr	µg/L	87.62	800	Sr+2		0.001
Zn	µg/L	65.39	950	Zn+2		0.001
NOTE:	*Enter Fe+3 and Mn+3 for oxidizing conditions. Enter both Fe and Mn components for reducing redox problems, convert µg/L to mg/L:*					
Fe	µg/L	55.847	280	Fe+2		0.001
			281	Fe+3		0.001
Mn	µg/L	54.93805	470	Mn+2		0.001
			471	Mn+3		0.001
P	mg/L	30.97376	580	PO4-3	94.97136	3.06619
N	mg/L	14.00674	492	NO3-1	62.00494	4.42679
			490	NH4+	18.0385	1.28784
NOTE:	*FA- must be entered in mol/L regardless of units used for other component entry. Adjust mg/L as C to mg/L as FA based on 52.0 C in fulvic acid, then divide by 186.00 g/mol for Suwannee River FA, or 193.498 g/mol for Nordic FA.*					
DOC	mg/L	12.011	145 (SFA)	FA-	186.000	1.0339E-05
			145 (NFA)	FA-	193.498	9.9386E-06
Si	mg/L	28.0855	770	H4SiO4	96.1155	3.42225
SiO_2	mg/L	60.0843	770	H4SiO4	96.1155	1.59968
NOTE: Convert bicarbonate and hydroxide alkalinity on an ***equivalent*** *weight basis.*						
CO_3^{2-}	mg/L	60.0094	140	CO3-2	30.0047	1.00000
HCO_3^-	mg/L	61.0171	140	CO3-2	61.0171	0.49174
OH^-	mg/L	17.00734	140	CO3-2	17.00834	1.76412
$CaCO_3$	mg/L	100.0874	140	CO3-2	50.0437	0.59957
H_2CO_3	mg/L	62.0250	140	CO3-2	31.0125	0.96750

** Cobalt, Co, is not in the standard MINTEQ data bases and must be entered into MINTEQ file **comp.dbs**

Table A3-5 Contents of MINTEQA2 thermodynamic data base files for metal-fulvate reactions, *complig.dbs*.

```
3301450 H-FA            0.0000    3.6000   0.000   0.000 0.00 0.00 0.00 187.0079
 0.00 2     1.000 145     1.000 330
3301460 H2(FA)2         0.0000    5.6000   0.000   0.000 0.00 0.00 0.00 374.0159
 0.00 2     1.000 146     2.000 330
3301461 H(FA)2-1        0.0000    4.6000   0.000   0.000-1.00 0.00 0.00 373.0079
 0.00 2     1.000 146     1.000 330
1501450 CaFA+           0.0000    3.0000   0.000   0.000 1.00 0.00 0.00 226.0780
 0.00 2     1.000 145     1.000 150
4601450 MgFA+           0.0000    2.0900   0.000   0.000 1.00 0.00 0.00 210.3050
 0.00 2     1.000 145     1.000 460
5001450 NaFA            0.0000    1.4000   0.000   0.000 0.00 0.00 0.00 208.9898
 0.00 2     1.000 145     1.000 500
4101450 KFA             0.0000    1.3000   0.000   0.000 0.00 0.00 0.00 225.0983
 0.00 2     1.000 145     1.000 410
1001450 BaFA+           0.0000    1.1000   0.000   0.000 1.00 0.00 0.00 323.3400
 0.00 2     1.000 145     1.000 100
8001450 SrFA+           0.0000    1.1000   0.000   0.000 1.00 0.00 0.00 273.6200
 0.00 2     1.000 145     1.000 800
2811450 FeFA+2          0.0000    5.7700   0.000   0.000 2.00 0.00 0.00 241.8847
 0.00 2     1.000 145     1.000 281
4711450 MnFA+2          0.0000    5.2600   0.000   0.000 2.00 0.00 0.00 241.8847
 0.00 2     1.000 145     1.000 471
1601450 CdFA+           0.0000    6.7400   0.000   0.000 1.00 0.00 0.00 298.4110
 0.00 2     1.000 145     1.000 160
1601462 Cd(FA)2         0.0000    7.2000   0.000   0.000 0.00 0.00 0.00 484.4110
 0.00 2     1.000 146     1.000 160
1601470 Cd(FA2)+        0.0000    4.6000   0.000   0.000 1.00 0.00 0.00 298.4110
 0.00 2     1.000 147     1.000 160
1601480 Cd(FA3)+        0.0000    3.7500   0.000   0.000 1.00 0.00 0.00 298.4110
 0.00 2     1.000 148     1.000 160
5401450 NiFA+           0.0000    5.2000   0.000   0.000 1.00 0.00 0.00 244.6900
 0.00 2     1.000 145     1.000 540
3611450 HgFA+           0.0000    6.1000   0.000   0.000 1.00 0.00 0.00 386.5900
 0.00 4     1.000 145     1.000 361     2.000 330    -2.000   2
2101450 CrFA+           0.0000    5.4000   0.000   0.000 1.00 0.00 0.00 237.9961
 0.00 2     1.000 145     1.000 210
2201450 CoFA+           0.0000    3.6900   0.000   0.000 1.00 0.00 0.00 244.9332
 0.00 2     1.000 145     1.000 220
6001450 PbFA+           0.0000    5.0900   0.000   0.000 1.00 0.00 0.00 393.1899
 0.00 2     1.000 145     1.000 600
9501450 ZnFA+           0.0000    5.5700   0.000   0.000 1.00 0.00 0.00 251.3900
 0.00 2     1.000 145     1.000 950
2311450 CuFA+           0.0000    8.8000   0.000   0.000 1.00 0.00 0.00 249.5460
 0.00 2     1.000 145     1.000 231
3301490 H-TRIS          0.0000    8.1000   0.000   0.000 0.00 0.00 0.00 121.1000
 0.00 2     1.000 149     1.000 330
3301510 H-TRIS2-        0.0000    9.1000   0.000   0.000-1.00 0.00 0.00 241.10
 0.00 2     1.000 151     1.000 330
3301511 H2-TRIS2        0.0000    10.100   0.000   0.000 0.00 0.00 0.00 242.10
 0.00 2     1.000 151     2.000 330
1601490 CdTRIS+         0.0000    2.3900   0.000   0.000 1.00 0.00 0.00 233.5110
 0.00 2     1.000 149     1.000 160
1601510 CdTRIS2         0.0000    6.4700   0.000   0.000 0.00 0.00 0.00 352.6110
 0.00 2     1.000 151     1.000 160
      0
      0
```

Table A3-6 MINTEQ data base file: *comp.dbs*

```
001 E-1     -1.0    0.0  0.0          0.0000
002 H2O      0.0    0.0  0.0          18.0153
020 Ag+1     1.0    0.0  0.0          107.868
030 Al+3     3.0    9.0  0.0          26.9815
060 H3AsO3   0.0    0.0  0.0          125.9437
061 H3AsO4   0.0    0.0  0.0          141.9431
090 H3BO3    0.0    0.0  0.0          61.8331
100 Ba+2     2.0    5.0  0.0          137.3400
110 Be+2     2.0    0.0  0.0          9.0122
130 Br-1    -1.0    4.0  0.0          79.9040
140 CO3-2   -2.0    5.4  0.0          60.0094
143 CN-     -1.0    0.0  0.0          26.018
144 OCN-    -1.0    0.0  0.0          42.017
145 FA-1    -1.0    0.0  0.0          186.000
146 (FA)2-2 -2.0    0.0  0.0          372.000
147 FA2-1   -1.0    0.0  0.0          186.000
148 FA3-1   -1.0    0.0  0.0          186.000
149 TRIS-1  -1.0    0.0  0.0          120.1
150 Ca+2     2.0    6.0  .165         40.0800
151 TRIS2-2 -2.0    0.0  0.0          240.2
160 Cd+2     2.0    0.0  0.0          112.3994
180 Cl-1    -1.0    3.0  .015         35.4530
210 Cr+2     2.0    0.0  0.0          51.996
211 Cr(OH)2+ 1.0    0.0  0.0          86.011
212 CrO4-2  -2.0    4.0  0.0          115.994
220 Co+2     2.0    0.0  0.0          58.9332
230 Cu+1     1.0    2.5  0.0          63.5460
231 Cu+2     2.0    6.0  0.0          63.5460
270 F-1     -1.0    3.5  0.0          18.9984
280 Fe+2     2.0    6.0  0.0          55.8470
281 Fe+3     3.0    9.0  0.0          55.8470
330 H+1      1.0    9.0  0.0          1.0080
360 Hg2+2    2.0    4.0  0.0          401.18
361 Hg(OH)2  0.0    0.0  0.0          234.61
380 I-1     -1.0    0.0  0.0          126.9044
410 K+1      1.0    3.0  .015         39.1020
440 Li+1     1.0    6.0  0.0          6.9390
460 Mg+2     2.0    6.5  .20          24.3120
470 Mn+2     2.0    6.0  0.0          54.9380
471 Mn+3     3.0    9.0  0.0          54.9380
490 NH4+1    1.0    2.5  0.0          18.0386
491 NO2-1   -1.0    0.0  0.0          46.0055
492 NO3-1   -1.0    3.0  0.0          62.0049
500 Na+1     1.0    4.0  .075         22.9898
540 Ni+2     2.0    0.0  0.0          58.7100
580 PO4-3   -3.0    5.0  0.0          94.9714
600 Pb+2     2.0    0.0  0.0          207.1899
730 HS-1    -1.0    3.5  0.0          33.0720
731 S        0.0    0.0  0.0          32.0640
732 SO4-2   -2.0    4.0  -.04         96.0616
740 Sb(OH)3  0.0    0.0  0.0          172.7719
741 Sb(OH)6--1.0    0.0  0.0          223.7938
760 HSe-1   -1.0    0.0  0.0          79.97
761 HSeO3-1 -1.0    0.0  0.0          127.97
762 SeO4-2  -2.0    4.0  0.0          142.96
770 H4SiO4   0.0    0.0  0.0          96.1155
800 Sr+2     2.0    5.0  0.0          87.6200
811 ADS1TYP1 0.0    0.0  0.0           0.0000
812 ADS1TYP2 0.0    0.0  0.0           0.0000
813 ADS1PSIo 0.0    0.0  0.0           0.0000
814 ADS1PSIb 0.0    0.0  0.0           0.0000
815 ADS1PSId 0.0    0.0  0.0           0.0000
821 ADS2TYP1 0.0    0.0  0.0           0.0000
822 ADS2TYP2 0.0    0.0  0.0           0.0000
823 ADS2PSIo 0.0    0.0  0.0           0.0000
824 ADS2PSIb 0.0    0.0  0.0           0.0000
825 ADS2PSId 0.0    0.0  0.0           0.0000
831 ADS3TYP1 0.0    0.0  0.0           0.0000
832 ADS3TYP2 0.0    0.0  0.0           0.0000
833 ADS3PSIo 0.0    0.0  0.0           0.0000
834 ADS3PSIb 0.0    0.0  0.0           0.0000
835 ADS3PSId 0.0    0.0  0.0           0.0000
841 ADS4TYP1 0.0    0.0  0.0           0.0000
842 ADS4TYP2 0.0    0.0  0.0           0.0000
843 ADS4PSIo 0.0    0.0  0.0           0.0000
844 ADS4PSIb 0.0    0.0  0.0           0.0000
845 ADS4PSId 0.0    0.0  0.0           0.0000
851 ADS5TYP1 0.0    0.0  0.0           0.0000
852 ADS5TYP2 0.0    0.0  0.0           0.0000
853 ADS5PSIo 0.0    0.0  0.0           0.0000
854 ADS5PSIb 0.0    0.0  0.0           0.0000
855 ADS5PSId 0.0    0.0  0.0           0.000
870 Tl+1     1.0    0.0  0.0          204.37
871 Tl(OH)3  0.0    0.0  0.0          255.39
890 U+3      3.0    0.0  0.0          238.0290
891 U+4      4.0    0.0  0.0          238.0290
892 UO2+1    1.0    0.0  0.0          270.0278
893 UO2+2    2.0    0.0  0.0          270.0278
900 V+2      2.0    0.0  0.0          50.94
901 V+3      3.0    0.0  0.0          50.94
902 VO+2     2.0    0.0  0.0          66.939
903 VO2+1    1.0    0.0  0.0          82.939
917 Benzoat -1.0    0.0  0.0          121.12
918 PAcetat -1.0    0.0  0.0          134.14
920 IPhthal -1.0    0.0  0.0          164.12
950 Zn+2     2.0    6.0  0.0          65.3699
955 Dietham  0.0    0.0  0.0          73.000
956 Nbutyam  0.0    0.0  0.0          73.000
958 Metham   0.0    0.0  0.0          31.018
959 Dimetham 0.0    0.0  0.0          45.028
960 Trbutph  0.0    0.0  0.0          265.97
961 Hexam    0.0    0.0  0.0          101.00
963 EN       0.0    0.0  0.0          60.12
964 Npropam  0.0    0.0  0.0          59.04
965 Ipropam  0.0    0.0  0.0          59.04
966 Tmetham  0.0    0.0  0.0          59.04
967 Citrate -3.0    0.0  0.0          189.06
968 NTA-3   -3.0    0.0  0.0          188.06
969 EDTA-4  -4.0    0.0  0.0          276.00
971 Prpanot -1.0    0.0  0.0          73.032
972 Butanot -1.0    0.0  0.0          87.043
973 Isobuty -1.0    0.0  0.0          87.043
980 2Metpyr  0.0    0.0  0.0          94.0
981 3Metpyr  0.0    0.0  0.0          94.0
982 4Metpyr  0.0    0.0  0.0          94.0
983 Formate -1.0    0.0  0.0          45.02
984 Isvaler -1.0    0.0  0.0          101.13
985 Valerat -1.0    0.0  0.0          101.13
992 Acetate -1.0    0.0  0.0          59.05
993 Tartrat -2.0    0.0  0.0          148.09
994 Glycine -1.0    0.0  0.0          74.07
995 Salicyl -2.0    0.0  0.0          136.12
996 Glutama -2.0    0.0  0.0          145.13
997 Phthala -2.0    0.0  0.0          164.13
```

Table A3-7 Selected mineral saturation indices for Lake Owyhee all-data average, and spring and summer averaged data sets.

```
AVERAGE RES
    ID #     NAME      Sat. Index        Stoichiometry in [brackets]
  5015002 DOLOMITE       -5.243    [  1.000] 150  [  1.000] 460  [  2.000] 140
  6046000 EPSOMITE       -5.497    [  1.000] 460  [  1.000] 732  [  7.000]   2
  8646003 SEPIOLITE(C)   -9.644    [ -0.500]   2  [  2.000] 460  [  3.000] 770
                                   [ -4.000] 330
  2028100 FERRIHYDRITE    2.502    [ -3.000] 330  [  1.000] 281  [  3.000]   2
  4128100 FEOH)2.7CL.3    7.157    [ -2.700] 330  [  1.000] 281  [  2.700]   2
                                   [  0.300] 180
  6028100 FE2(SO4)3     -45.103    [  2.000] 281  [  3.000] 732
  7015003 HYDRAPATITE    -0.393    [  5.000] 150  [  3.000] 580  [  1.000]   2
                                   [ -1.000] 330
  8046000 FORSTERITE    -13.241    [ -4.000] 330  [  2.000] 460  [  1.000] 770
  2003003 GIBBSITE (C)    1.748    [ -3.000] 330  [  1.000]  30  [  3.000]   2
  3003000 Al2O3          -0.711    [  2.000]  30  [  3.000]   2  [ -6.000] 330
  2028102 GOETHITE        6.502    [ -3.000] 330  [  1.000] 281  [  2.000]   2
  6015001 GYPSUM         -2.530    [  1.000] 150  [  1.000] 732  [  2.000]   2
  4150000 HALITE         -8.374    [  1.000] 500  [  1.000] 180
  3028100 HEMATITE       17.961    [ -6.000] 330  [  2.000] 281  [  3.000]   2
  5015003 HUNTITE       -15.093    [  3.000] 460  [  1.000] 150  [  4.000] 140
  5046001 HYDRMAGNESIT  -26.813    [  5.000] 460  [  4.000] 140  [ -2.000] 330
                                   [  6.000]   2
  6050000 JAROSITE NA     0.031    [ -6.000] 330  [  1.000] 500  [  3.000] 281
                                   [  2.000] 732  [  6.000]   2
  6041002 JAROSITE K      2.718    [ -6.000] 330  [  1.000] 410  [  3.000] 281
                                   [  2.000] 732  [  6.000]   2
  6028101 JAROSITE H     -3.686    [ -5.000] 330  [  3.000] 281  [  2.000] 732
                                   [  7.000]   2
  8450000 MAGADIITE     -14.364    [ -1.000] 330  [ -9.000]   2  [  1.000] 500
                                   [  7.000] 770
  3028101 MAGHEMITE       8.400    [ -6.000] 330  [  2.000] 281  [  3.000]   2
  5046002 MAGNESITE      -3.311    [  1.000] 460  [  1.000] 140
  6050001 MIRABILITE     -8.403    [  2.000] 500  [  1.000] 732  [ 10.000]   2
  3050000 NATRON        -11.754    [  2.000] 500  [  1.000] 140  [ 10.000]   2
  5046003 NESQUEHONITE   -5.709    [  1.000] 460  [  1.000] 140  [  3.000]   2
  8646001 PHLOGOPITE    -36.911    [-10.000] 330  [  1.000] 410  [  3.000] 460
                                   [  1.000]  30  [  3.000] 770
  2077002 QUARTZ         -0.507    [ -2.000]   2  [  1.000] 770
  8646004 SEPIOLITE(A)  -11.775    [ -0.500]   2  [  2.000] 460  [  3.000] 770
                                   [ -4.000] 330
  2077003 SIO2(A,GL)     -1.543    [ -2.000]   2  [  1.000] 770
  2077004 SIO2(A,PT)     -1.865    [ -2.000]   2  [  1.000] 770
  7028100 STRENGITE       0.788    [  1.000] 281  [  1.000] 580  [  2.000]   2
  5080000 STRONTIANITE   -4.189    [  1.000] 800  [  1.000] 140
  8646002 TALC          -11.152    [ -4.000]   2  [  3.000] 460  [  4.000] 770
                                   [ -6.000] 330
  6050002 THENARDITE     -9.866    [  2.000] 500  [  1.000] 732  ts]
  5050001 THERMONATR    -13.691    [  2.000] 500  [  1.000] 140  [  1.000]   2
  8215001 TREMOLITE     -22.280    [ -8.000]   2  [  2.000] 150  [  5.000] 460
                                   [  8.000] 770  [-14.000] 330
  5010000 WITHERITE      -5.519    [  1.000] 100  [  1.000] 140
  2047000 PYROLUSITE     18.217    [ -4.000] 330  [ -1.000]   1  [  1.000] 471
                                   [  2.000]   2
  2047001 BIRNESSITE     16.775    [ -4.000] 330  [ -1.000]   1  [  1.000] 471
                                   [  2.000]   2
  2047002 NSUTITE        17.362    [ -4.000] 330  [ -1.000]   1  [  1.000] 471
                                   [  2.000]   2
```

```
SPRING AVG
    ID #     NAME      Sat. Index        Stoichiometry in [brackets]
  2003000 ALOH3(A)       -0.011    [  1.000]  30  [  3.000]   2  [ -3.000] 330
  6003000 ALOHSO4        -4.014    [ -1.000] 330  [  1.000]  30  [  1.000] 732
                                   [  1.000]   2
  6003001 AL4(OH)10SO4    3.550    [-10.000] 330  [  4.000]  30  [  1.000] 732
                                   [ 10.000]   2
  6041000 ALUM K        -17.331    [  1.000] 410  [  1.000]  30  [  2.000] 732
                                   [ 12.000]   2
  6041001 ALUNITE         1.078    [  1.000] 410  [  3.000]  30  [  2.000] 732
                                   [  6.000]   2  [ -6.000] 330
  6015000 ANHYDRITE      -3.120    [  1.000] 150  [  1.000] 732
  5015000 ARAGONITE      -2.699    [  1.000] 150  [  1.000] 140
  5046000 ARTINITE      -11.277    [ -2.000] 330  [  2.000] 460  [  1.000] 140
                                   [  5.000]   2
  6010000 BARITE         -0.655    [  1.000] 100  [  1.000] 732
  2003001 BOEHMITE        1.759    [ -3.000] 330  [  1.000]  30  [  2.000]   2
  2046000 BRUCITE        -7.118    [  1.000] 460  [  2.000]   2  [ -2.000] 330
  5015001 CALCITE        -2.519    [  1.000] 150  [  1.000] 140
  6080000 CELESTITE      -3.764    [  1.000] 800  [  1.000] 732
  2077000 CHALCEDONY     -1.022    [ -2.000]   2  [  1.000] 770
  8646000 CHRYSOTILE    -11.793    [ -6.000] 330  [  3.000] 460  [  2.000] 770
                                   [  1.000]   2
  8246000 CLINOENSTITE   -6.174    [ -1.000]   2  [  1.000] 460  [  1.000] 770
                                   [ -2.000] 330
  2077001 CRISTOBALITE   -0.932    [ -2.000]   2  [  1.000] 770
  2003002 DIASPORE        3.567    [ -3.000] 330  [  1.000]  30  [  2.000]   2
  8215000 DIOPSIDE       -9.002    [ -2.000]   2  [  1.000] 150  [  1.000] 460
                                   [  2.000] 770  [ -4.000] 330
  5015002 DOLOMITE       -5.445    [  1.000] 150  [  1.000] 460  [  2.000] 140
  6046000 EPSOMITE       -5.752    [  1.000] 460  [  1.000] 732  [  7.000]   2
  8646003 SEPIOLITE(C)   -9.891    [ -0.500]   2  [  2.000] 460  [  3.000] 770
                                   [ -4.000] 330
  2028100 FERRIHYDRITE    2.493    [ -3.000] 330  [  1.000] 281  [  3.000]   2
  4128100 FEOH)2.7CL.3    7.082    [ -2.700] 330  [  1.000] 281  [  2.700]   2
                                   [  0.300] 180
  6028100 FE2(SO4)3     -45.775    [  2.000] 281  [  3.000] 732
  7015003 HYDRAPATITE    -1.237    [  5.000] 150  [  3.000] 580  [  1.000]   2
                                   [ -1.000] 330
  8046000 FORSTERITE    -13.538    [ -4.000] 330  [  2.000] 460  [  1.000] 770
  2003003 GIBBSITE (C)    1.724    [ -3.000] 330  [  1.000]  30  [  3.000]   2
  3003000 Al2O3          -0.651    [  2.000]  30  [  3.000]   2  [ -6.000] 330
  2028102 GOETHITE        6.459    [ -3.000] 330  [  1.000] 281  [  2.000]   2
  6015001 GYPSUM         -2.791    [  1.000] 150  [  1.000] 732  [  2.000]   2
  4150000 HALITE         -8.850    [  1.000] 500  [  1.000] 180
  3028100 HEMATITE       17.870    [ -6.000] 330  [  2.000] 281  [  3.000]   2
  5015003 HUNTITE       -15.521    [  3.000] 460  [  1.000] 150  [  4.000] 140
  5046001 HYDRMAGNESIT  -27.396    [  5.000] 460  [  4.000] 140  [ -2.000] 330
                                   [  6.000]   2
  6050000 JAROSITE NA    -0.683    [ -6.000] 330  [  1.000] 500  [  3.000] 281
                                   [  2.000] 732  [  6.000]   2
  6041002 JAROSITE K      2.156    [ -6.000] 330  [  1.000] 410  [  3.000] 281
                                   [  2.000] 732  [  6.000]   2
  6028101 JAROSITE H     -4.185    [ -5.000] 330  [  3.000] 281  [  2.000] 732
                                   [  7.000]   2
  8450000 MAGADIITE     -14.623    [ -1.000] 330  [ -9.000]   2  [  1.000] 500
                                   [  7.000] 770
  3028101 MAGHEMITE       8.383    [ -6.000] 330  [  2.000] 281  [  3.000]   2
  5046002 MAGNESITE      -3.417    [  1.000] 460  [  1.000] 140
  6050001 MIRABILITE     -9.046    [  2.000] 500  [  1.000] 732  [ 10.000]   2
  3050000 NATRON        -12.235    [  2.000] 500  [  1.000] 140  [ 10.000]   2
  5046003 NESQUEHONITE   -5.814    [  1.000] 460  [  1.000] 140  [  3.000]   2
  8646001 PHLOGOPITE    -37.478    [-10.000] 330  [  1.000] 410  [  3.000] 460
                                   [  1.000]  30  [  3.000] 770
  2077002 QUARTZ         -0.492    [ -2.000]   2  [  1.000] 770
```

```
SPRING AVG (CONTINUED)
    ID #     NAME      Sat. Index        Stoichiometry in [brackets]
  8646004 SEPIOLITE(A)  -11.956    [ -0.500]   2  [  2.000] 460  [  3.000] 770
                                   [ -4.000] 330
  2077003 SIO2(A,GL)     -1.533    [ -2.000]   2  [  1.000] 770
  2077004 SIO2(A,PT)     -1.856    [ -2.000]   2  [  1.000] 770
  7028100 STRENGITE       0.643    [  1.000] 281  [  1.000] 580  [  2.000]   2
  5080000 STRONTIANITE   -4.276    [  1.000] 800  [  1.000] 140
  8646002 TALC          -11.508    [ -4.000]   2  [  3.000] 460  [  4.000] 770
                                   [ -6.000] 330
  6050002 THENARDITE    -10.556    [  2.000] 500  [  1.000] 732  ts]
  5050001 THERMONATR    -14.216    [  2.000] 500  [  1.000] 140  [  1.000]   2
  8215001 TREMOLITE     -23.144    [ -8.000]   2  [  2.000] 150  [  5.000] 460
                                   [  8.000] 770  [-14.000] 330
  5010000 WITHERITE      -5.511    [  1.000] 100  [  1.000] 140
  2047000 PYROLUSITE     18.064    [ -4.000] 330  [ -1.000]   1  [  1.000] 471
                                   [  2.000]   2
  2047001 BIRNESSITE     16.692    [ -4.000] 330  [ -1.000]   1  [  1.000] 471
                                   [  2.000]   2
  2047002 NSUTITE        17.279    [ -4.000] 330  [ -1.000]   1  [  1.000] 471
                                   [  2.000]   2
  3047100 BIXBYITE       26.561    [ -6.000] 330  [  2.000] 471  [  3.000]   2
  2047100 MANGANITE      13.437    [ -3.000] 330  [  1.000] 471  [  2.000]   2
  6047100 MN2(SO4)3     -24.264    [  2.000] 471  [  3.000] 732
  4123100 MELANOTHALLI  -24.048    [  1.000] 231  [  2.000] 180
  5023100 CUCO3          -9.744    [  1.000] 231  [  1.000] 140
  2023100 CU(OH)2        -6.764    [ -2.000] 330  [  1.000] 231  [  2.000]   2
  4123101 ATACAMITE     -14.381    [ -3.000] 330  [  2.000] 231  [  3.000]   2
                                   [  1.000] 180
  5123100 CU2(OH)3NO3   -17.153    [ -3.000] 330  [  2.000] 231  [  3.000]   2
                                   [  1.000] 492
  6023100 ANTLERITE     -19.726    [ -4.000] 330  [  3.000] 231  [  4.000]   2
                                   [  1.000] 732
  6023101 BROCHANTITE   -24.451    [ -6.000] 330  [  4.000] 231  [  6.000]   2
                                   [  1.000] 732
  6023102 LANGITE       -27.066    [ -6.000] 330  [  4.000] 231  [  7.000]   2
                                   [  1.000] 732

SUMMER AVG
    ID #     NAME      Sat. Index        Stoichiometry in [brackets]
  2003000 ALOH3(A)        0.009    [  1.000]  30  [  3.000]   2  [ -3.000] 330
  6003000 ALOHSO4        -3.872    [ -1.000] 330  [  1.000]  30  [  1.000] 732
                                   [  1.000]   2
  6003001 AL4(OH)10SO4    3.527    [-10.000] 330  [  4.000]  30  [  1.000] 732
                                   [ 10.000]   2
  6041000 ALUM K        -16.874    [  1.000] 410  [  1.000]  30  [  2.000] 732
                                   [ 12.000]   2
  6041001 ALUNITE         1.434    [  1.000] 410  [  3.000]  30  [  2.000] 732
                                   [  6.000]   2  [ -6.000] 330
  6015000 ANHYDRITE      -2.808    [  1.000] 150  [  1.000] 732
  5015000 ARAGONITE      -2.584    [  1.000] 150  [  1.000] 140
  5046000 ARTINITE      -10.984    [ -2.000] 330  [  2.000] 460  [  1.000] 140
                                   [  5.000]   2
  6010000 BARITE         -0.482    [  1.000] 100  [  1.000] 732
  2003001 BOEHMITE        1.782    [ -3.000] 330  [  1.000]  30  [  2.000]   2
  2046000 BRUCITE        -6.941    [  1.000] 460  [  2.000]   2  [ -2.000] 330
  5015001 CALCITE        -2.409    [  1.000] 150  [  1.000] 140
  6080000 CELESTITE      -3.451    [  1.000] 800  [  1.000] 732
  2077000 CHALCEDONY     -1.035    [ -2.000]   2  [  1.000] 770
  8646000 CHRYSOTILE    -11.331    [ -6.000] 330  [  3.000] 460  [  2.000] 770
                                   [  1.000]   2
  8246000 CLINOENSTITE   -6.013    [ -1.000]   2  [  1.000] 460  [  1.000] 770
                                   [ -2.000] 330
  2077001 CRISTOBALITE   -0.947    [ -2.000]   2  [  1.000] 770
  2003002 DIASPORE        3.580    [ -3.000] 330  [  1.000]  30  [  2.000]   2
```

```
SUMMER AVG CONT.
    ID #     NAME      Sat. Index        Stoichiometry in [brackets]
  8215000 DIOPSIDE       -8.702    [ -2.000]   2  [  1.000] 150  [  1.000] 460
         [  2.000] 770  [ -4.000] 330
  5015002 DOLOMITE       -5.209    [  1.000] 150  [  1.000] 460  [  2.000] 140
  6046000 EPSOMITE       -5.457    [  1.000] 460  [  1.000] 732  [  7.000]   2
  8646003 SEPIOLITE(C)   -9.604    [ -0.500]   2  [  2.000] 460  [  3.000] 770
                                   [ -4.000] 330
  2028100 FERRIHYDRITE    2.513    [ -3.000] 330  [  1.000] 281  [  3.000]   2
  4128100 FEOH)2.7CL.3    7.177    [ -2.700] 330  [  1.000] 281  [  2.700]   2
                                   [  0.300] 180
  6028100 FE2(SO4)3     -44.984    [  2.000] 281  [  3.000] 732
  7015003 HYDRAPATITE    -0.263    [  5.000] 150  [  3.000] 580  [  1.000]   2
                                   [ -1.000] 330
  8046000 FORSTERITE    -13.193    [ -4.000] 330  [  2.000] 460  [  1.000] 770
  2003003 GIBBSITE (C)    1.732    [ -3.000] 330  [  1.000]  30  [  3.000]   2
  3003000 Al2O3          -0.760    [  2.000]  30  [  3.000]   2  [ -6.000] 330
  2028102 GOETHITE        6.518    [ -3.000] 330  [  1.000] 281  [  2.000]   2
  6015001 GYPSUM         -2.490    [  1.000] 150  [  1.000] 732  [  2.000]   2
  4150000 HALITE         -8.307    [  1.000] 500  [  1.000] 180
  3028100 HEMATITE       17.993    [ -6.000] 330  [  2.000] 281  [  3.000]   2
  5015003 HUNTITE       -15.022    [  3.000] 460  [  1.000] 150  [  4.000] 140
  5046001 HYDRMAGNESIT  -26.717    [  5.000] 460  [  4.000] 140  [ -2.000] 330
                                   [  6.000]   2
  6050000 JAROSITE NA     0.162    [ -6.000] 330  [  1.000] 500  [  3.000] 281
                                   [  2.000] 732  [  6.000]   2
  6041002 JAROSITE K      2.831    [ -6.000] 330  [  1.000] 410  [  3.000] 281
                                   [  2.000] 732  [  6.000]   2
  6028101 JAROSITE H     -3.583    [ -5.000] 330  [  3.000] 281  [  2.000] 732
                                   [  7.000]   2
  8450000 MAGADIITE     -14.328    [ -1.000] 330  [ -9.000]   2  [  1.000] 500
                                   [  7.000] 770
  3028101 MAGHEMITE       8.421    [ -6.000] 330  [  2.000] 281  [  3.000]   2
  5046002 MAGNESITE      -3.293    [  1.000] 460  [  1.000] 140
  6050001 MIRABILITE     -8.313    [  2.000] 500  [  1.000] 732  [ 10.000]   2
  3050000 NATRON        -11.688    [  2.000] 500  [  1.000] 140  [ 10.000]   2
  5046003 NESQUEHONITE   -5.691    [  1.000] 460  [  1.000] 140  [  3.000]   2
  8646001 PHLOGOPITE    -36.839    [-10.000] 330  [  1.000] 410  [  3.000] 460
                                   [  1.000]  30  [  3.000] 770
  2077002 QUARTZ         -0.509    [ -2.000]   2  [  1.000] 770
  8646004 SEPIOLITE(A)  -11.744    [ -0.500]   2  [  2.000] 460  [  3.000] 770
                                   [ -4.000] 330
  2077003 SIO2(A,GL)     -1.545    [ -2.000]   2  [  1.000] 770
  2077004 SIO2(A,PT)     -1.867    [ -2.000]   2  [  1.000] 770
  7028100 STRENGITE       0.817    [  1.000] 281  [  1.000] 580  [  2.000]   2
  5080000 STRONTIANITE   -4.157    [  1.000] 800  [  1.000] 140
  8646002 TALC          -11.094    [ -4.000]   2  [  3.000] 460  [  4.000] 770
                                   [ -6.000] 330
  6050002 THENARDITE     -9.769    [  2.000] 500  [  1.000] 732
  5050001 THERMONATR    -13.618    [  2.000] 500  [  1.000] 140  [  1.000]   2
  8215001 TREMOLITE     -22.138    [ -8.000]   2  [  2.000] 150  [  5.000] 460
                                   [  8.000] 770  [-14.000] 330
```

Table A3-8 Data input files for Lake Owyhee MINTEQA2 modeling.

FILE *OWY_RES.DAT*

```
Lake Owyhee - Reservoir Average Data

14.40 MG/L   0.000  0.00000E-01
0 0 1 0 2 0 0 0 1 1 0 0 0
0   0   0
    330  0.000E-01   -7.55 y                    /H+1
      1  0.000E-01   -8.79 y                    /E- (ENTERED AS EH)
    140  5.537E+01   -3.21 y                    /CO3-2
    150  1.752E+01   -3.46 y                    /Ca+2
    460  4.874E+00   -3.80 y                    /Mg+2
    500  2.128E+01   -3.30 y                    /Na+1
    410  3.261E+00   -4.20 y                    /K+1
    732  1.536E+01   -3.99 y                    /SO4-2
    180  6.471E+00   -3.96 y                    /Cl-1
    145  4.713E-05   -4.35 y                    /FA-1
    580  1.699E-01   -5.89 y                    /PO4-3
    492  8.620E-01   -4.87 y                    /NO3-1
    490  4.647E-02   -6.10 y                    /NH4+1
    770  2.004E+00   -4.68 y                    /H4SiO4
     30  4.248E-01   -4.75 y                    /Al+3
    281  2.548E-01   -5.35 y                    /Fe+3
    471  3.688E-03   -7.35 y                    /Mn+3
     61  9.856E-03   -7.84 y                    /H3AsO4
    160  2.350E-05  -10.29 y                    /Cd+2
    212  2.975E-03   -7.51 y                    /CrO4-2
    231  1.512E-03   -7.38 y                    /Cu+2
    540  8.531E-04   -7.72 y                    /Ni+2
    600  1.026E-04   -9.04 y                    /Pb+2
    740  3.302E-04   -8.78 y                    /Sb(OH)3
    762  5.736E-04   -8.39 y                    /SeO4-2
    893  1.464E-03   -8.57 y                    /UO2+2
    903  9.079E-03   -8.07 y                    /VO2+1
    950  1.242E-03   -7.65 y                    /Zn+2
    361  5.048E-06   -7.59 y                    /Hg(OH)2
    220  1.736E-04   -8.78 y                    /Co+2
    800  9.746E-02   -6.05 y                    /Sr+2
    100  3.097E-02   -6.65 y                    /Ba+2

  3   3
3301403    21.6830    -0.5300                   /CO2 (g)
3300021   -82.3996   133.8300                   /O2 (g)
    330     7.1600     0.0000                   /H+1
  6   1
      1     0.0000     0.0000                   /E-1
```

FILE *OWY_SPR.DAT*

```
Lake Owyhee - Spring Average Data

13.50 MG/L   0.000  0.00000E-01
0 0 1 0 2 0 0 0 1 1 0 0 0
0   0   0
    330  0.000E-01   -7.16 y                    /H+1
      1  0.000E-01   -8.79 y                    /E- (ENTERED AS EH)
    140  3.718E+01   -3.21 y                    /CO3-2
    150  1.376E+01   -3.46 y                    /Ca+2
    460  3.820E+00   -3.80 y                    /Mg+2
    500  1.164E+01   -3.30 y                    /Na+1
    410  2.460E+00   -4.20 y                    /K+1
    732  9.920E+00   -3.99 y                    /SO4-2
    180  3.880E+00   -3.96 y                    /Cl-1
    145  4.465E-05   -4.35 y                    /FA-1
    580  1.233E-01   -5.89 y                    /PO4-3
    492  8.319E-01   -4.87 y                    /NO3-1
    490  1.416E-02   -6.10 y                    /NH4+1
    770  2.004E+00   -4.68 y                    /H4SiO4
     30  4.468E-01   -4.75 y                    /Al+3
    281  2.482E-01   -5.35 y                    /Fe+3
    471  2.464E-03   -7.35 y                    /Mn+3
     61  6.959E-03   -7.84 y                    /H3AsO4
    160  5.800E-06  -10.29 y                    /Cd+2
    212  3.563E-03   -7.51 y                    /CrO4-2
    231  1.382E-03   -7.38 y                    /Cu+2
    540  1.106E-03   -7.72 y                    /Ni+2
    600  1.891E-04   -9.04 y                    /Pb+2
    740  2.889E-04   -8.78 y                    /Sb(OH)3
    762  5.886E-04   -8.39 y                    /SeO4-2
    893  7.249E-04   -8.57 y                    /UO2+2
    903  7.050E-03   -8.07 y                    /VO2+1
    950  1.476E-03   -7.65 y                    /Zn+2
    361  5.629E-06   -7.59 y                    /Hg(OH)2
    220  9.690E-05   -8.78 y                    /Co+2
    800  7.790E-02   -6.05 y                    /Sr+2
    100  3.064E-02   -6.65 y                    /Ba+2

  3   3
3301403    21.6830    -0.5300                   /CO2 (g)
3300021   -82.3996   133.8300                   /O2 (g)
    330     7.1600     0.0000                   /H+1
  6   1
      1     0.0000     0.0000                   /E-1
```

FILE *OWY_SUM.DAT*

```
Lake Owyhee - Summer Average Data

14.54 MG/L   0.000  0.00000E-01
0 0 1 0 2 0 0 0 1 1 0 0 0
0   0   0
    330  0.000E-01   -7.61 y                    /H+1
      1  0.000E-01   -8.79 y                    /E- (ENTERED AS EH)
    140  5.887E+01   -3.21 y                    /CO3-2
    150  1.825E+01   -3.46 y                    /Ca+2
    460  5.077E+00   -3.80 y                    /Mg+2
    500  2.313E+01   -3.30 y                    /Na+1
    410  3.415E+00   -4.20 y                    /K+1
    732  1.641E+01   -3.99 y                    /SO4-2
    180  6.969E+00   -3.96 y                    /Cl-1
    145  4.761E-05   -4.35 y                    /FA-1
    580  1.778E-01   -5.89 y                    /PO4-3
    492  8.673E-01   -4.87 y                    /NO3-1
    490  5.278E-02   -6.10 y                    /NH4+1
    770  2.004E+00   -4.68 y                    /H4SiO4
     30  4.028E-01   -4.75 y                    /Al+3
    281  2.614E-01   -5.35 y                    /Fe+3
    471  3.810E-03   -7.35 y                    /Mn+3
     61  1.275E-02   -7.84 y                    /H3AsO4
    160  2.700E-05  -10.29 y                    /Cd+2
    212  2.387E-03   -7.51 y                    /CrO4-2
    231  1.642E-03   -7.38 y                    /Cu+2
    540  6.002E-04   -7.72 y                    /Ni+2
    600  1.026E-04   -9.04 y                    /Pb+2
    740  3.715E-04   -8.78 y                    /Sb(OH)3
    762  5.886E-04   -8.39 y                    /SeO4-2
    893  1.759E-03   -8.57 y                    /UO2+2
    903  1.111E-02   -8.07 y                    /VO2+1
    950  1.009E-03   -7.65 y                    /Zn+2
    361  4.744E-06   -7.59 y                    /Hg(OH)2
    220  2.502E-04   -8.78 y                    /Co+2
    800  1.053E-01   -6.05 y                    /Sr+2
    100  3.130E-02   -6.65 y                    /Ba+2
  3   3
3301403    21.6830    -0.5300                   /CO2 (g)
3300021   -82.3996   133.8300                   /O2 (g)
    330     7.1600     0.0000                   /H+1
  6   1
      1     0.0000     0.0000                   /E-1
```

Annotated Bibliography for Metal- FA Stability Constants

The following citations provide information for various *log(K)* determinations on humic and fulvic materials.

Alberts, J.J., and J.P. Giesy, 1983, *Conditional Stability Constants of Trace metals and Naturally Occurring Humic Materials: Application in Equilibriium Models and Verification with Field Data*, Chapter 16 in *aquatic and Terrestrial Humic Materials*, edited by Christman and Gjessing, Ann Arbor Science Publishers, Ann Arbor MI, pp. 333-348.

Suwannee River FA @ pH = 5.0
Ion Selective Electrodes + Scatchard Plots
log(K) = Cd_1 = 5.83 Cu_1 = 6.52 Pb_1 = 5.09
Cd_2 = 3.13 Cu_2 = 4.89 Pb_2 = 2.00

Bresnahan, W.T, C.L. Grant, and J.H. Weber, 1978, *Stability Constants for the Complexation of Copper (II) Ions with Water and Soil Fulvic Acids measured by an Ion Selective Electrode*, Analytical Chemistry, Vol. 50, pp. 1675-1679.

Water and Soil Fulvic Acid + Cu - ISE + Scatchard Plots
(log K_0 = calc average of *log(K)*$_1$ and *log(K)*$_2$)

	pH	***log(K)***$_0$		***log(K)***$_1$	***log(K)***$_2$
WaterFA	4.0	4.74	5.48	4.00	
	4.7	4.93	6.00	3.85	
	5.0	4.83	5.95	3.70	
	6.0	4.98	6.11	3.85	
SoilFA	4.0	4.78	5.60	3.95	
	5.0	5.04	6.00	4.08	
	6.0	5.04	6.30	3.78	

Brown, G.K., P. MacCarthy, and J.A. Leenheer, 1999, *Simultaneous determination of Ca, Cu, Ni, Zn, and Cd binding strengths with fulvic acid fractions by Schubert's method*, Analytica Chimica Acta, 402, pp. 169-181.

Suwannee River FA, pH = 6.0
Ion Exchange, distribution coefficient isotherms (Schubert, 1948)
log(K):Ca = 3.00 Ni = 5.20 Cu = 5.70 Zn = 4.78 Cd = 3.56

Giesy, Jr., J.P., 1980, *Cadmium Interactions with Naturally Occurring Organic Ligands*, Chapter 7 in "Cadmium in the Environment", edited by Nriagu, J.O., John Wiley and Sons, New York.

ISE with **Aldrich Humic Acid** 7.14 mg/L @ pH = 5.5

log(K):Cd_1 = 5.70 Cd_2 = 4.42

Giesy, J.P., J.J. Alberts, and D.W. Evans, 1986, *Conditional Stability Constants and Binding Capacities for Copper (II) by Dissolved Organic Carbon Isolated fro Surface Waters of the Southeastern United States*, Environ. Sci. Technol., vol. 5, pp.139-154.

Cu - Suwannee River FA, pH = 4.0, ISE + Scatchard
avg *log(K)* = 5.72 fraction I
avg *log(K)* = 4.77 fraction II

Hirata, S., 1981, *Stability Constants for the Complexes of Transition-Metal Ions with Fulvic and Humic Acids in Sediments measured by Gel Filtration*, Talanta, Vol. 28, pp. 809-815

Sediment FA$^-$ pH = 8.0 in TRIS
gel filtration + Scatchard Plots - average *log(K)*

log(K): $Cu_0 = 6.76$ $Zn_0 = 5.57$ $Mn_0 = 4.56$ ($log(K)_0$ calculated avg of K_1 and K_2)
$Cu_1 = 7.36$ $Zn_1 = 6.32$ $Mn_1 = 5.26$
$Cu_2 = 6.15$ $Zn_2 = 4.82$ $Mn_2 = 3.86$

Mantoura, R.F.C., and J.P. Riley, 1975, *The Use of Gel Filtration in the Study of Metal Binding to Humic Acids and Related Compounds*, Analytica Chimica Acta, 78, pp. 193-200.

Lake Fulvic Acid (Lake Celyn, North Wales) pH = 8.0
gel permeation chromatography + Scatchard Plots

log(K): $Cu_0 = 8.42$ $Ni_0 = 5.14$ $Zn_0 = 5.14$
$Cu_1 = 8.80$
$Cu_2 = 8.05$

Mantoura, R.F.C., A. Dickson, and J.P. Riley, 1978, *The Complexation of Humic Materials in Natural Waters*, Estuarine Coastal Marine Science, Vol. 6, pp. 387-408.

Lake, Loch and Seawater Fulvic Acid (Lake Celyn, North Wales) @ pH = 8.0
gel permeation chromatography + Scatchard Plots

log(K): Lake $Cd_0 = 4.64$ Loch $Cd_0 = 4.91$ Sea $Cd_0 = 5.08$
$Cd_1 = 4.70$ $Cd_1 = 4.95$
$Cd_2 = 4.57$ $Cd_2 = 4.87$

Martell, E.A., and M. Calvin, 1952, *Chemistry of Metal Chelate Compounds*, Prentice-Hall Inc, New York.

Graphical method to estimate *log(K)* from ion exchange data by Schnitzer et al.

Martel, A.E., and R.M. Smith, 1976, *Critical Stability Constants*, *Volume 3: Other Organic Ligands,* Plenum, New York.

Morel, F.M.M., and J.G. Hering, 1993, *Principles and Applications of aquatic Chemistry*, John WIley and Sons, New York, 1993, pp. 338-343.

General table of *log(K)* for organo-metal complexes, with source data from Martel and Smith, 1976.

Pitluck, M.R., B.D. Pollard, and D.T. Haworth, 1987, *Conditional Stability Constant Determination of Metal-Fulvic Acid Complexes*, Journal of Liquid Chromatography, 10(10), pp. 2081-2103.

Soil Fulvic Acid - ion exchange method - Scatchard Plots @ pH = 3

log(K):Cd = 4.90 Cu = 4.51 Ni = 4.66 Pb = 2.20 Zn = 5.29

Ryan, D.K. and J.H. Weber, 1982, *Fluoresence Quenching Titration for Determination of Complexing Capacities and Stability Constants for Fulvic Acid*, Anal. Chem., vol 54, pp 986-990.

This method criticized by Shuman and MacCarthy

Saar, R.A., and J.H. Weber, 1980, *Lead (II)-Fulvic Acid Complexes. Conditional Stability Constants, Solubility, and Implications for Lead (II) Mobility*, Environmental Science and Technology, Vol. 14 (7), pp. 877-880.

Water FA - ISE, *log(K)* by method of Buffle, et.al, 1977, Anal. Chem., vol. 49, pp. 216-222.

pH	**Pb-FA** $log(K)_0$	**Pb-**$(FA)_2$ $log(K)_0$
4.5	3.7	8.8
5.0	4.7	9.3
6.0	5.1	10.1

Schnitzer, M., and S.I.M. Skinner, 1966, *Organo-Metallic Interactions in Soils: 5. Stability Constants of* Cu^{++}*-,* Fe^{++}*-, and* Zn^{++}*-Fulvic Acid Complexes*, Soil Science, 102(6), pp. 361-365.

Soil FA @ pH = 5

ion exchange (Schubert, 1948) + graphical *log(K)* method (Martel and Calvin, 1952)

average *log(K)*: Cu = 8.69 Fe = 5.77 Zn = 2.34

Schnitzer, M., and S.I.M. Skinner, 1967, *Organo-Metallic Interactions in Soils: 7. Stability Constants of* Pb^{++}*-,* Ni^{++}*-,* Mn^{++}*-,* Co^{++}*-,* Ca^{++}*-, and* Mg^{++}*-Fulvic Acid Complexes*, Soil Science, 103(4), pp. 247-252.

Soil FA @ pH = 5
ion exchange (Schubert, 1948) + method of (Martel and Calvin, 1952)

average *log(K)*:	Pb = 6.13	Ni = 4.14	Mn = 3.78	Co = 3.69
	Ca = 2.92	Mg = 2.09		

Sposito, G., K.W. Holtzclaw, and C.S. LaVesque-Madore, 1981, *Trace metal Complexation by Fulvic Acid Extracted from Sewage Sludge: I. Determinations of Stability Constants and Linear Correlation Analysis*, Soil Sci. Soc. Am. J., vol. 45, pp. 465-468.

Sludge FA @ pH 5.0 - ISE

	log(K)$_1$	*log(K)*$_2$	
Ca	3.12	---	(@pH = 7.0)
Cu	3.88`	2.11	
Cd	3.04	2.27	
Pb	4.22	2.62	

log(K) References for MINTEQA2 Problems

The following citations were used for the *log(K)* values included with the MINTEQA2 distribution disk in the thermodynamic data file, complig.dbs.

Dobbs, J.C., W. Susetyo, F.E. Knight, M.A. Castles, L.A. Carreira, and L.V. Azarraga, 1989a, Anal. Chem., vol. 61, pp. 483-488.

Dobbs, J.C., W. Susetyo, L.A. Carreira, and L.V.Azarraga, 1989b, Anal. Chem., vol. 61, pp. 1519-1524.

Grimm, D.M., L.V. Azarraga, L.A. Carreira, and W. Susetyo, 1991, *Continuous Multiligand Distribution Model to Predict the Stability Constant of Cu(II) Metal Complexation with Humic Material from Fluorescence Quenching Data*, Environ. Sci. Tech., vol. 25, pp.1427-1431.

Perdue, E.M., J.H. Reuter, and R.S. Parrish, 1984. Geochim. Cosmochim. Acta, vol. 48, pp. 1257-1263.

Susetyo, W., J.C. Dobbs, L.A. Carreira, L.V. Azarraga, and D.M. Grimm, 1990, *Development of a Statistical Model for Metal-Humic Interactions,* Anal. Chem., vol. 62, pp. 1215-1221.

Susetyo, W., L.A. Carreira, L.V. Azarraga, and D.M. Grimm, 1991, Fresenius J. Anal. Chem., vol. 339, pp. 624-635.

General Humic and Fulvic Materials References

The following citations are good general references for humic and fulvic materials:

Allard, B, H. Borén, and A. Grimvall, editors, 1991, *Humic Substances in the Aquatic and Terrestrial Environment*, Lecture Notes in Earth Sciences 33, Springer-Verlag, Germany.

Ardakani, M.S., and F.J. Stevenson, 1972, *A Modified Ion-Exchange Technique for Determination of Stability Constants of Metal-Soil Organic Matter Complexes* Soil Sci. Soc. Amer. Proc., Vol. 36, pp. 884-890.

Averett, R.C., J.A. Leenheer, D.M. McKnight, and K.A. Thorn, editors, 1989, *Humic Substances in the Suwannee River, Georgia: Interactions, Properties, and Proposed Structures*, U.S. Geological Survey Open File Report 87-557, Denver, Colorado.

Brown, G.K., P. MacCarthy, and J.A. Leenheer, 1999, *Simultaneous determination of Ca, Cu, Ni, Zn, and Cd binding strength with fulvic acid fractions by Schubert's method, Anal. Chim. Acta,* Vol. 402, pp. 169-181.

Clark, J.S. and R.C. Turner, 1969, *An examination of the resin exchange method for the determination of stability constants of metal-soil organic matter complexes*, Soil Sci., Vol. 107, pp. 8-11.

Christman, R.F., and E.T. Gjessing, editors, 1983, *Aquatic and Terrestrial Humic Acids*, Ann Arbor Science, Ann Arbor, Michigan.

Hayes, M.H.B., P. MacCarthy, R.L. Malcolm, and R.S. Swift, editors, 1989, *Humic Substances II: The Search for Structure*, John Wiley and Sons, New York, New York, New York.

Hessen, D.O. and L.J. Tranvik, editors, *Aquatic Humic Substances: Ecology and Biogeochemistry*, Ecological Studies 133, Springer-Verlag, Berlin, Germany.

Leenheer, J.A., Wershaw, R.L., and Reddy, M.M., 1995a, *Strong Acid, Carboxyl-Group Structures in Fulvic Acid from the Suwannee River, Georgia. 1. Minor Structures*, Environ. Sci. Technol., Vol. 29, pp. 393-398.

Leenheer, J.A., Wershaw, R.L., and Reddy, M.M., 1995b, *Strong Acid, Carboxyl-Group Structures in Fulvic Acid from the Suwannee River, Georgia. 1. Major Structures*, Environ. Sci. Technol., Vol. 29, pp. 399-405.

Leenheer, J.A., Brown, G.K., MacCarthy, P., and Cabaniss, S.E., 1998, *Models of Metal Binding Structures in Fulvic Acid from the Suwannee River, Georgia*, Environ. Sci. Technol. Vol. 32, pp. 2410-2416.

Sinesi, N. and T.M. Milano, editors, 1994, *Humic Substances in the Global Environment and Implications on Human Health*, Elsevier, Amsterdam, The Netherlands.

Suffet, I.H., and P. MacCarthy, editors, 1989, *Aquatic Humic Substances: Influence on Fate and Treatment of Pollutants*, Advances in Chemistry Series 219, American Chemical Society, Washington, DC.

Thurman, E.M., 1985, *Organic Geochemistry of Natural Waters*, Martinus Nijhoff/Dr W. Junk Publishers, Dordrecht, The Netherlands, 1985.

References for log(K) Computational Methods

The following citations describe computational methods for calculating conditional stability constants:

Ruzic, I., 1982, *Theoretical aspects by the direct titration of natural waters and its information yield for trace metal speciation*, Anal. Chim. Acta, Vol. 140, pp. 99-113.

Ruzic, I and S. Nikolic, 1982, *The influence of kinetics on the direct titration curves of natural water systems - theoretical considerations*, Anal. Chim. Acta, Vol. 140, pp. .31-334.

Scatchard, G., 1949, *The attraction of proteins for small moleculesand ions*, Ann. New York Acad. Sci., Vol 51, pp. 660-672.

Scheinberg, I.H., 1982, *Scatchard plots*, Science, Vol. 215, pp. 312-313.

Schubert, J., 1948, *The use of ion exchangers for the determination of physical-chemical properties of substances, particularly radiotracers in soultion: I. Theoretical*, J. Phys. Colloid Chem., Vol. 52, pp. 340-350.

APPENDIX 4

Sample Preparation Data, and Physical and Chemical Data Results from Sediment Samples Collected on May 8, 1998

Table A4-1a Composite sediment sample preparation details. Five separate dredge subsamples were collected at each site. After drying and sieving to obtain the minus-80 mesh fraction of each subsample, composite samples for testing were obtained using the fractional shovelling method. All weights are in grams.

Station	*Wet Gross Wt*	*Dry Gross Wt*	*Tare Wt*	*Wet Net Wt*	*H2O Wt*	*Wt% H2O*	*Dry:Wet Fraction*	*Dry Net Wt*	*>10 Mesh Wt*	*<10 Mesh Wt*	*10 to 80 Mesh Wt*	*<80 Mesh Wt*	*Fraction <80 Mesh Dry*	*Fraction <80 Mesh Wet*
Station s1	776.68	643.18	224.91	551.77	133.50	24.19%	0.7581	418.27	0	418.27	294.11	124.16	0.2968	0.2250
(comp 1)	916.64	686.4	229.71	686.93	230.24	33.52%	0.6648	456.69	0	456.69	219.91	236.78	0.5185	0.3447
	859.48	692.93	345.6	513.88	166.55	32.41%	0.6759	347.33	0	347.33	224.75	122.58	0.3529	0.2385
	933.02	761.41	354.44	578.58	171.61	29.66%	0.7034	406.97	0	406.97	228.71	178.26	0.4380	0.3081
	1394.84	1098.95	230.19	1164.65	295.89	25.41%	0.7459	868.76	0	868.76	661.62	207.14	0.2384	0.1779
Station s1	598.24	504.07	217.3	380.94	94.17	24.72%	0.7528	286.77	0	286.77	223.98	62.79	0.2190	0.1648
(comp 2)	624.53	525.25	341.87	282.66	99.28	35.12%	0.6488	183.38	0	183.38	99.89	83.49	0.4553	0.2954
	882.28	729.56	340.69	541.59	152.72	28.20%	0.7180	388.87	0	388.87	255.49	133.38	0.3430	0.2463
	1432.97	1046.78	229.26	1203.71	386.19	32.08%	0.6792	817.52	0	817.52	422.86	394.66	0.4828	0.3279
	1158.03	829.5	221.91	936.12	328.53	35.09%	0.6491	607.59	0	607.59	316.94	290.65	0.4784	0.3105
Station s2	799.01	627.76	230.12	568.89	171.25	30.10%	0.6990	397.64	87	310.64	277.91	32.73	0.0823	0.0575
	1507.99	1261.29	225.38	1282.61	246.70	19.23%	0.8077	1035.91	128.45	907.46	863.75	43.71	0.0422	0.0341
	1877.95	1431	225.49	1652.46	446.95	27.05%	0.7295	1205.51	175.94	1029.57	949.72	79.85	0.0662	0.0483
	1324.91	959.76	352.59	972.32	365.15	37.55%	0.6245	607.17	132.19	474.98	402.02	72.96	0.1202	0.0750
	562.94	443.21	335.38	227.56	119.73	52.61%	0.4739	107.83	4.79	103.04	56.32	46.72	0.4333	0.2053
Station s3	2191.61	1262.94	226.35	1965.26	928.67	47.25%	0.5275	1036.59	0	1036.59	392.17	644.42	0.6217	0.3279
	1187.38	729.02	232.52	954.86	458.36	48.00%	0.5200	496.5	0	496.5	166.09	330.41	0.6655	0.3460
	2475.98	1418.34	232.98	2243.00	1057.64	47.15%	0.5285	1185.36	0	1185.36	390.13	795.23	0.6709	0.3545
	2195.5	1347.64	353.83	1841.67	847.86	46.04%	0.5396	993.81	0	993.81	339.13	654.68	0.6588	0.3555
	2440.93	1387.83	348.04	2092.89	1053.10	50.32%	0.4968	1039.79	0	1039.79	361.72	678.07	0.6521	0.3240
Station s4	2602.74	1530.63	223.5	2379.24	1072.11	45.06%	0.5494	1307.13	0	1307.13	626.63	680.5	0.5206	0.2860
	2568.3	1526.48	345.53	2222.77	1041.82	46.87%	0.5313	1180.95	0	1180.95	464.32	716.63	0.6068	0.3224
	2794.97	1518.49	224.29	2570.68	1276.48	49.66%	0.5034	1294.2	0	1294.2	543.9	750.3	0.5797	0.2919
	1750.91	1204	350.05	1400.86	546.91	39.04%	0.6096	853.95	0	853.95	282.09	571.86	0.6697	0.4082
	2303.48	1283.35	229.67	2073.81	1020.13	49.19%	0.5081	1053.68	0	1053.68	429.7	623.98	0.5922	0.3009
Station s5	1388.9	929.44	335.57	1053.33	459.46	43.62%	0.5638	593.87	0	593.87	174.83	419.04	0.7056	0.3978
	1641.06	1028.74	224.47	1416.59	612.32	43.22%	0.5678	804.27	0	804.27	298.38	505.89	0.6290	0.3571
	1483.51	919.88	216.62	1266.89	563.63	44.49%	0.5551	703.26	0	703.26	216.95	486.31	0.6915	0.3839
	780.35	564.58	237.54	542.81	215.77	39.75%	0.6025	327.04	0	327.04	103.4	223.64	0.6838	0.4120
	1994.76	1332.97	339.81	1654.95	661.79	39.99%	0.6001	993.16	0	993.16	336.53	656.63	0.6612	0.3968

Table A4-1b Summary statistics for water content and gross size fractions from composite sediment sample processing.

Station	***Summary***	***Mean***	***Standard Deviation***	***Subsample Number***	***Percent >10 mesh***	***Percent 10 to 80 mesh***	***Percent <80 mesh***	***Dry Weight Fraction***	***Mean, Percent***	***Standard Deviation, percent***
Station s1	***Percent H2O***	*29.04*	4.14 percent	1	0.00	70.32	29.68	***Plus 10***	*0.00*	0.00
(comp 1)	***dry:wet fraction***	*0.7096*	0.0414	2	0.00	48.15	51.85	***10 to 80***	*63.1*	11.1
	dry <80 fraction	*0.3689*	0.1114	3	0.00	64.71	35.29	***Minus 80***	*36.9*	11.1
	wet <80 fraction	*0.2588*	0.0669	4	0.00	56.20	43.80			
				5	0.00	76.16	23.84			
Station s1	***Percent H2O***	*31.04*	4.53 percent	1	0.00	78.10	21.90	***Plus 10***	*0.00*	0.00
(comp 2)	***dry:wet fraction***	*0.6896*	0.0453	2	0.00	54.47	45.53	***10 to 80***	*60.4*	11.4
	dry <80 fraction	*0.3957*	0.1140	3	0.00	65.70	34.30	***Minus 80***	*39.6*	11.4
	wet <80 fraction	*0.2690*	0.0657	4	0.00	51.72	48.28			
				5	0.00	52.16	47.84			
Station s2	***Percent H2O***	*33.31*	12.63 percent	1	21.88	69.89	8.23	***Plus 10***	*15.0*	7.27
	dry:wet fraction	*0.6669*	0.1263	2	12.40	83.38	4.22	***10 to 80***	*70.1*	12.1
	dry <80 fraction	*0.1488*	0.1615	3	14.59	78.78	6.62	***Minus 80***	*14.9*	16.2
	wet <80 fraction	*0.0841*	0.0694	4	21.77	66.21	12.02			
				5	4.44	52.23	43.33			
Station s3	***Percent H2O***	*47.75*	1.60 percent	1	0.00	37.83	62.17	***Plus 10***	*0.00*	0.00
	dry:wet fraction	*0.5225*	0.0160	2	0.00	33.45	66.55	***10 to 80***	*34.6*	1.90
	dry <80 fraction	*0.6538*	0.0193	3	0.00	32.91	67.09	***Minus 80***	*65.4*	1.90
	wet <80 fraction	*0.3416*	0.0148	4	0.00	34.12	65.88			
				5	0.00	34.79	65.21			
Station s4	***Percent H2O***	*45.96*	4.29 percent	1	0.00	47.94	52.06	***Plus 10***	*0.00*	0.00
	dry:wet fraction	*0.5404*	0.0429	2	0.00	39.32	60.68	***10 to 80***	*40.6*	5.40
	dry <80 fraction	*0.5938*	0.0536	3	0.00	42.03	57.97	***Minus 80***	*59.4*	5.40
	wet <80 fraction	*0.3219*	0.0502	4	0.00	33.03	66.97			
				5	0.00	40.78	59.22			
Station s5	***Percent H2O***	*42.21*	2.19 percent	1	0.00	29.44	70.56	***Plus 10***	*0.00*	0.00
	dry:wet fraction	*0.5779*	0.0219	2	0.00	37.10	62.90	***10 to 80***	*32.6*	3.00
	dry <80 fraction	*0.6742*	0.0300	3	0.00	30.85	69.15	***Minus 80***	*67.4*	3.00
	wet <80 fraction	*0.3895*	0.0207	4	0.00	31.62	68.38			
				5	0.00	33.88	66.12			

Table A4-2a May 8, 1998 sediment analytes related to mineral and nutrient composition. Results are summarized in mg/kg on a minus-80 mesh dry weight basis and on a whole sediment weight basis. Note that Si and Al are not presented because the 3051 microwave digestion used here may not dissolve all silica or aluminosilicate mineral particles.

			Total Inorganic Carbon		**Total Organic Carbon**		**Total Phosphorus**		**Calcium**	
Station	***Lateral Distance from Inflow, km***	***Sample Depth, m***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***
Station s1	0.00	-2.80	.	.	.	.	.	.	5300	1370
			.	.	.	.	.	.	5560	1440
			.	.	.	.	.	.	5360	1440
			-0.020	-0.005	1.40	.362	498	129	.	.
			-0.020	-0.005	1.40	.362	576	149	.	.
			-0.020	-0.005	1.53	.412	533	143	.	.
			-0.020	-0.005	1.53	.412	591	159	.	.
N @ s1			4	4	4	4	4	4	3	3
Minimum			-0.020	-0.005	1.40	.362	498	129	5300	1370
Maximum			-0.020	-0.005	1.53	.412	591	159	5560	1440
Mean					1.47	.387	550	145	5410	1420
Median					1.47	.387	555	146	5360	1440
Station s2	0.80	-5.70	.	.	.	.	.	.	6590	554
			-0.020	-0.002	2.08	.175	626	52.6	.	.
			-0.020	-0.002	2.07	.174	636	53.5	.	.
Station s3	1.80	-5.90	.	.	.	.	.	.	5670	1940
			-0.020	-0.007	1.57	.536	607	207	.	.
			-0.020	-0.007	1.57	.536	609	208	.	.
Station s4	3.30	-7.80	.	.	.	.	.	.	6220	2000
			-0.020	-0.006	1.50	.483	571	184	.	.
			-0.020	-0.006	1.50	.483	554	178	.	.
Station s5	4.80	-8.80	.	.	.	.	.	.	6070	2360
			-0.020	-0.008	1.39	.541	648	252	.	.
			-0.020	-0.008	1.39	.541	612	238	.	.
ALL N			12	12	12	12	12	12	7	7
Minimum			-0.020	-0.008	1.39	.174	498	52.6	5300	554
Maximum			-0.020	-0.002	2.08	.541	648	252	6590	2360
Mean			-0.020	-0.0053	1.58	.418	588	163	5820	1590
Median					1.52	.447	599	169	5670	1440

Table A4-2b May 8, 1998 sediment analytes related to mineral and nutrient composition. Results are summarized in mg/kg on a minus-80 mesh dry weight basis (for all elements as analyzed) and on a whole sediment weight basis. Note Si and Al are not presented because the 3051 microwave digestion used here may not dissolve all silica or aluminosilicate mineral particles.

			Magnesium		***Iron***		***Manganese***	
	Lateral Distance from Inflow, km	***Sample Depth, m***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***
Station s1	0.00	-2.80	4640	1200	17100	4430	382	99
			4800	1240	18400	4760	390	101
			4470	1200	16400	4410	373	100
N			3	3	3	3	3	3
Minimum			4470	1200	16400	4410	373	99
Maximum			4800	1240	18400	4760	390	101
Mean			4640	1220	17300	4530	382	100
Median	.	.	4640	1200	17100	4430	382	100
Station s2	0.80	-5.70	5260	442	22200	1870	752	63.2
Station s3	1.80	-5.90	4700	1610	18700	6390	481	164
Station s4	3.30	-7.80	5000	1610	20200	6500	441	142
Station s5	4.80	-8.80	5050	1970	20500	7990	435	169
ALL N			7	7	7	7	7	7
Minimum			4470	442	16400	1870	373	63.2
Maximum			5260	1970	22200	7990	752	169
Mean			4850	1320	19100	5190	465	120
Median			4800	1240	18700	4760	435	101

Table A4-3a Toxic trace elements in Lake Owyhee sediments. Results are summarized in mg/kg on a minus-80 mesh dry basis and on a whole sediment wet weight basis. Negative values were not detected with detection limit equal to absolute value of the listed number.

			Silver, Ag		***Arsenic, As***		***Cadmium, Cd***		***Cobalt, Co***	
	Lateral Distance from Inflow, km	***Sample Depth, m***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***
Station s1	.00	-2.80	-0.800	-0.207	-14.0	-3.62	-0.800	-0.207	11.6	3.00
			-0.800	-0.207	-14.0	-3.62	-0.800	-0.207	12.1	3.13
			-0.800	-0.215	-14.0	-3.77	-0.800	-0.215	11.7	3.15
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
		s1 N	3	3	3	3	3	3	3	3
		Mean	-0.800	-0.210	-14.0	-3.67	-0.800	-0.210	11.8	3.09
		Minimum	-0.800	-0.215	-14.0	-3.77	-0.800	-0.215	11.6	3.00
		Maximum	-0.800	-0.207	-14.0	-3.62	-0.800	-0.207	12.1	3.15
Station s2	0.80	-5.70	-0.800	-0.067	-14.0	-1.18	-0.800	-0.0673	13.7	1.15
Station s3	1.80	-5.90	-0.800	-0.273	-14.0	-4.78	-0.800	-0.273	13.0	4.44
Station s4	3.30	-7.80	-0.800	-0.258	-14.0	-4.51	-0.800	-0.258	12.1	3.90
Station s5	4.80	-8.80	-0.800	-0.312	-14.0	-5.45	-0.800	-0.312	12.8	4.99
		All N	7	7	7	7	7	7	7	7
		Mean	-0.800	-0.210	-14.0	-3.85	-0.800	-0.210	12.4	3.39
		Minimum	-0.800	-0.312	-14.0	-5.45	-0.800	-0.312	11.6	1.15
		Maximum	-0.800	-0.067	-14.0	-1.18	-0.800	-0.0673	13.7	4.99

Table A4-3b Toxic trace elements in Lake Owyhee sediments. Results are summarized in mg/kg on a minus-80 mesh dry basis and on a whole sediment wet weight basis, except for Hg, expressed as µg/kg on dry and wet whole sediment basis. Negative number were not detected with detection limit equal to absolute value.

			Chromium, Cr		***Copper, Cu***		***Total Mercury, Hg***		***Methylmercury, MeHg***	
	Lateral Distance from Inflow, km	***Sample Depth, m***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***
Station s1	0	-2.80	34.2	8.85	37.2	9.63	.	.	.	.
			17.9	4.63	36.5	9.45	.	.	.	.
			15.1	4.06	49.8	13.4	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	.	.	.	.
			.	.	.	.	203	123	3.91	2.37
			.	.	.	.	214	130	3.94	2.39
			.	.	.	.	152	114	3.3	2.48
		s1 N	3	3	3	3	3	3	3	3
		Mean	22.4	5.85	41.2	10.8	190	122	3.76	2.41
		Minimum	15.1	4.06	36.5	9.45	152	114	3.3	2.37
		Maximum	34.2	8.85	49.8	13.4	214	130	3.94	2.48
Station s2	0.8	-5.70	20.7	1.74	96.4	8.17	.	.	.	.
			.	.	.	.	280	141	2.88	1.45
			.	.	.	.	160	69.3	3.39	1.47
						s2 N	2	2	2	2
						Mean	220	105	3.135	1.46
						Minimum	160	69.3	2.88	1.45
						Maximum	280	141	3.39	1.47
Station s3	1.80	-5.90	17.3	5.91	32.1	11	401	168	5.35	2.24
			.	.	.	.				
Station s4	3.30	-7.80	19.6	6.31	39.9	12.8	410	178	3.87	1.68
			.	.	.	.				
Station s5	4.80	-8.80	21.2	8.26	51.9	20.2	340	162	2.39	1.14
		All N	7	7	7	7	8	8	8	8
		Mean	20.9	5.68	49.1	12	270	136	3.63	1.90
		Minimum	15.1	1.74	32.1	8.11	152	69.3	2.39	1.14
		Maximum	34.2	8.85	96.4	20.2	410	178	5.35	2.48

Table A4-3c Toxic trace elements in Lake Owyhee sediments. Results are summarized in mg/kg on a minus-80 mesh dry basis and on a whole sediment wet weight basis. Negative values were not detected with detection limit equal to absolute value of the listed number.

			Molybdenum, Mo		***Nickel, Ni***		***Lead, Pb***		***Selenium, Se***	
	Lateral Distance from Inflow, km	***Sample Depth, m***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***
Station s1	0.00	-2.80	-2.00	-.518	19.3	4.99	8.87	2.30	30.0	7.76
			-2.00	-.518	20.7	5.36	13.3	3.44	27.6	7.14
			-2.00	-.538	17.5	4.71	9.82	2.64	35.1	9.44
		S1 N	3	3	3	3	3	3	3	3
		Mean	-2.00	-.524	19.2	5.02	10.7	2.79	30.9	8.11
		Minimum	-2.00	-.538	17.5	4.71	8.87	2.29	27.6	7.14
		Maximum	-2.00	-.518	20.7	5.36	13.3	3.44	35.1	9.44
Station s2	0.80	-5.70	-2.00	-.168	22.7	1.91	16.2	1.36	36.9	3.10
Station s3	1.80	-5.90	-2.00	-.683	19.5	6.66	14.5	4.95	28.7	9.80
Station s4	3.30	-7.80	-2.00	-.644	20.1	6.47	10.7	3.44	43.2	13.9
Station s5	4.80	-8.80	-2.00	-.779	20.2	7.87	10.2	3.97	38.0	14.8
		All N	7	7	7	7	7	7	7	7
		Mean	-2.00	-.550	20.0	5.42	11.9	3.16	34.2	9.42
		Minimum	-2.00	-.779	17.5	1.91	8.87	1.36	27.6	3.10
		Maximum	-2.00	-.168	22.7	7.87	16.2	4.95	43.2	14.8

Table A4-3d Toxic trace elements in Lake Owyhee sediments. Results are summarized in mg/kg on a minus-80 mesh dry basis and on a whole sediment wet weight basis. Negative values were not detected with detection limit equal to absolute value of the listed number.

			Antimony, Sb		***Vanadium, V***		***Zinc, Zn***	
	Lateral Distance from Inflow, km	***Sample Depth, m***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***	***-80 Mesh Dry mg/kg***	***W hole Sediment mg/kg***
Station s1	.00	-2.80	-4.00	-1.04	25.8	6.68	56.7	14.7
			.	.	28.2	7.30	59.4	15.4
			-4.00	-1.08	24.5	6.59	57.3	15.4
		s1 N	2	2	3	3	3	3
		Mean	-4.00	-1.06	26.2	6.86	57.8	15.2
		Minimum	-4.00	-1.08	24.5	6.59	56.7	14.7
		Maximum	-4.00	-1.04	28.2	7.30	59.4	15.4
Station s2	.80	-5.70	-4.00	-.336	35.0	2.94	82.6	6.95
Station s3	1.80	-5.90	-4.00	-1.37	28.9	9.87	58.4	19.9
Station s4	3.30	-7.80	-4.00	-1.29	31.6	10.2	64.4	20.7
Station s5	4.80	-8.80	-4.00	-1.56	32.7	12.7	68.1	26.5
		N	6	6	7	7	7	7
		Mean	-4.00	-1.11	29.5	8.04	63.8	17.1
		Minimum	-4.00	-1.56	24.5	2.94	56.7	6.95
		Maximum	-4.00	-0.336	35.0	12.7	82.6	26.5

Figure A4-1a Small particle size distribution (minus 80-mesh sample) for reservoir sediment at Station s1: k5186-1.

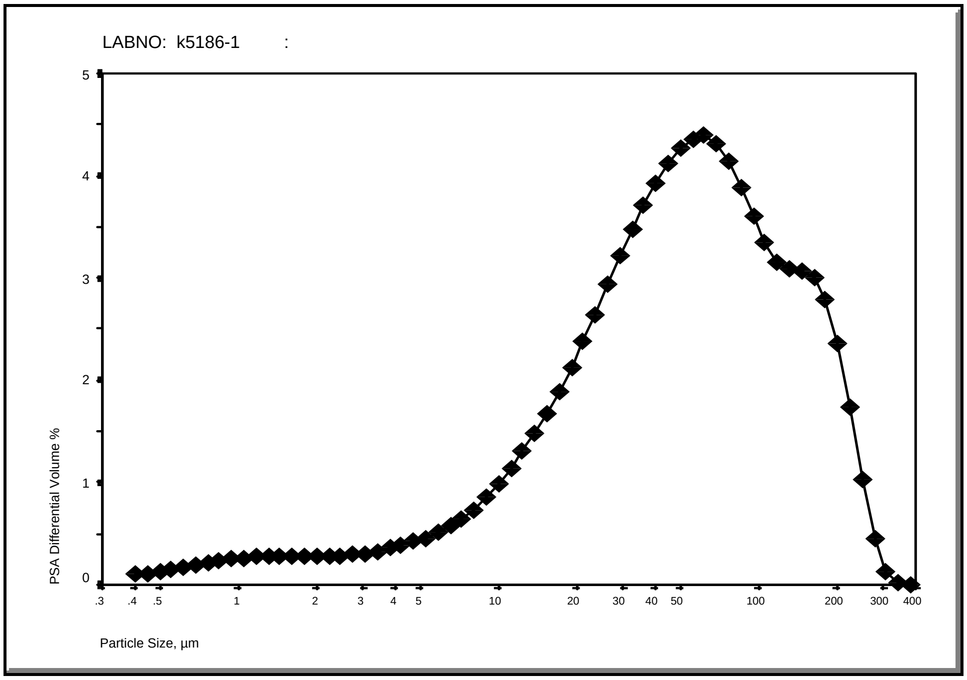


Figure A4-1b Small particle size distribution (minus 80-mesh sample) for reservoir duplicate composite sediment at Station s1: k5186-5.

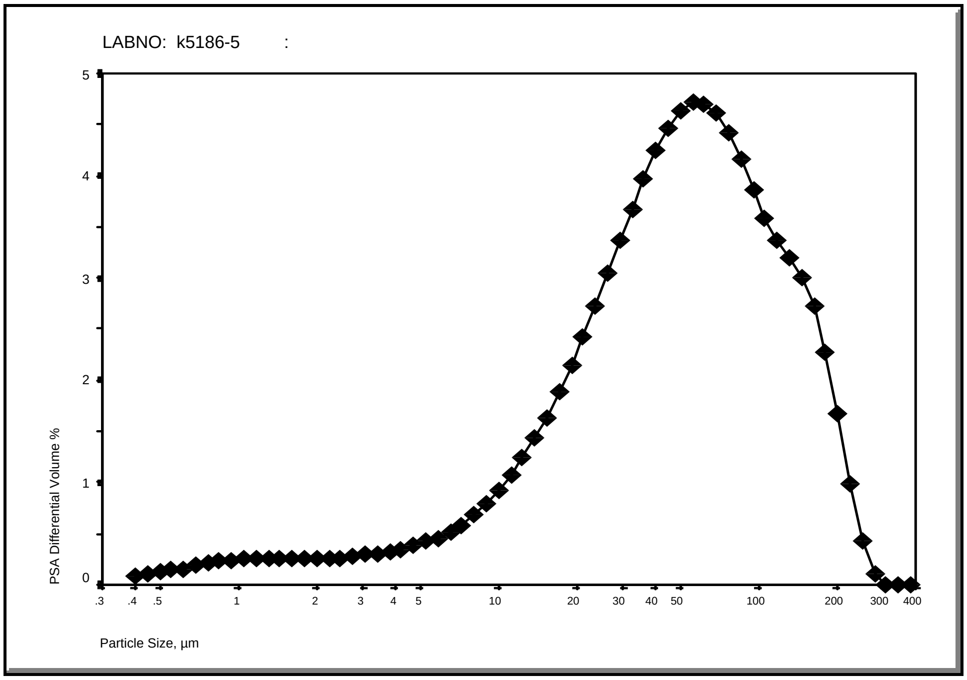


Figure A4-2 Small particle size distribution (minus 80-mesh sample) for reservoir sediment at Station s2: k5186-2.

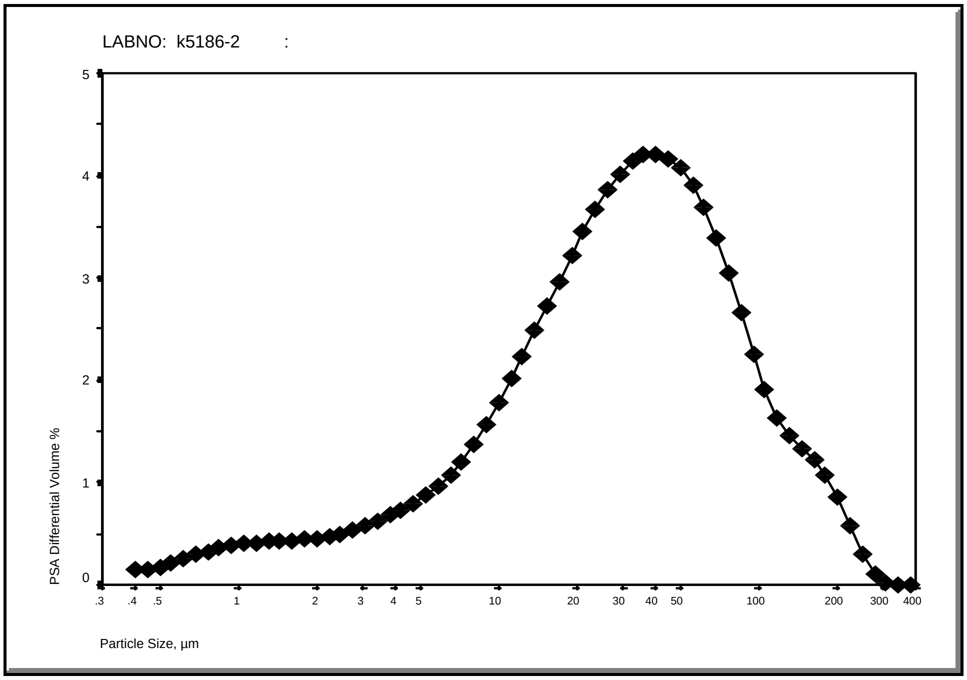


Figure A4-3 Small particle size distribution (minus 80-mesh sample) for reservoir sediment at Station s3: k5186-3.

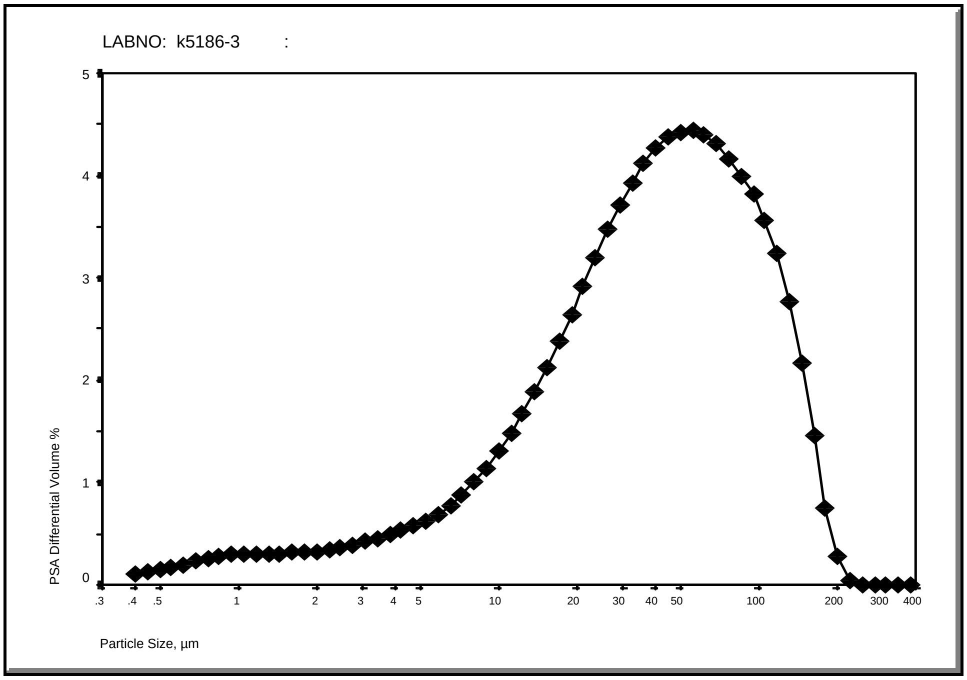


Figure A4-4 Small particle size distribution (minus 80-mesh sample) for reservoir sediment at Station s4: k5186-4.

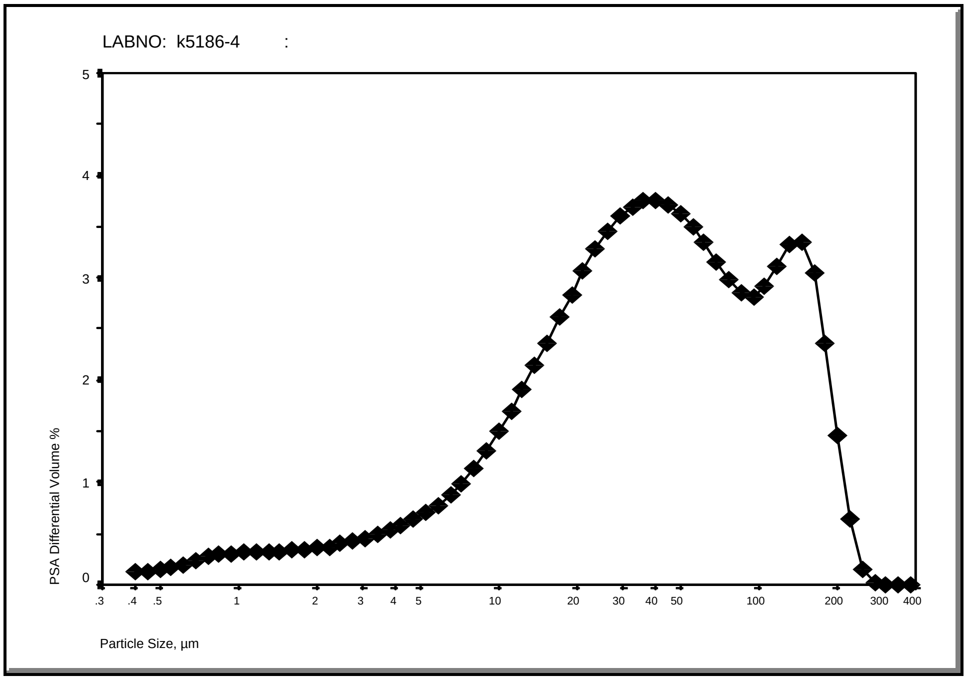


Figure A4-5 Small particle size distribution (minus 80-mesh sample) for reservoir sediment at Station s5: k5186-6.

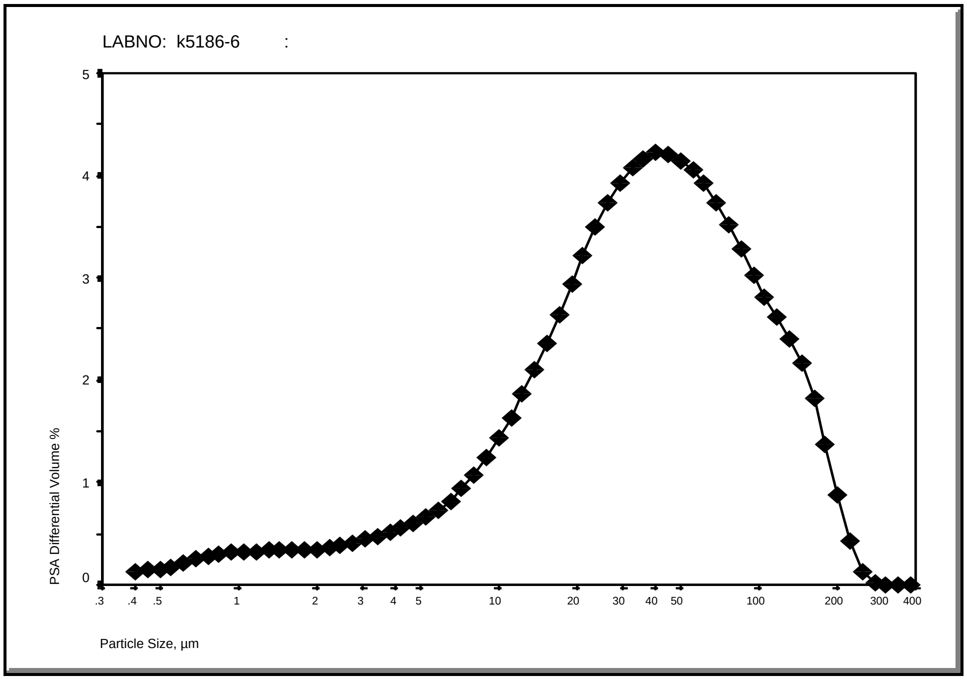


Figure A4-6a Adjusted particle size distribution for Station s1.

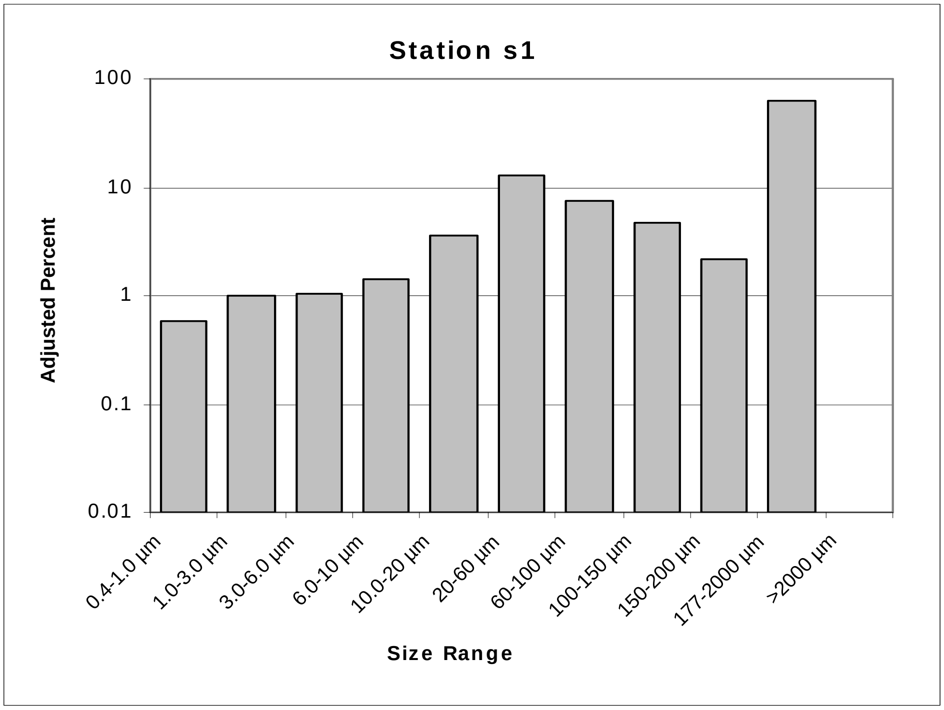


Figure A4-6b Adjusted particle size distribution for Station s1, duplicate field composite.

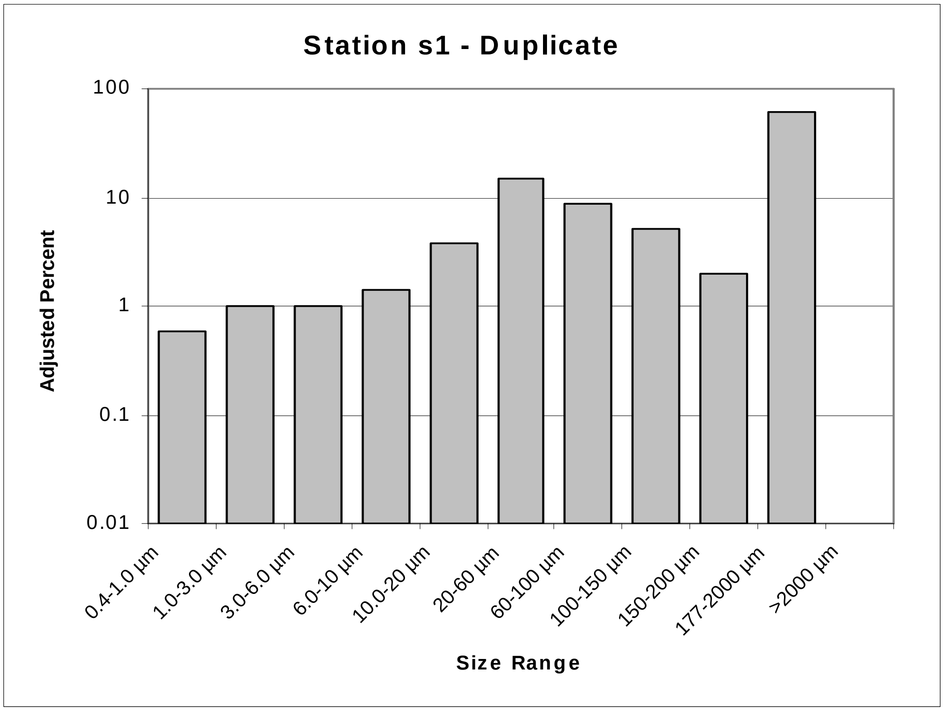


Figure A4-7 Adjusted particle size distribution for Station s2.

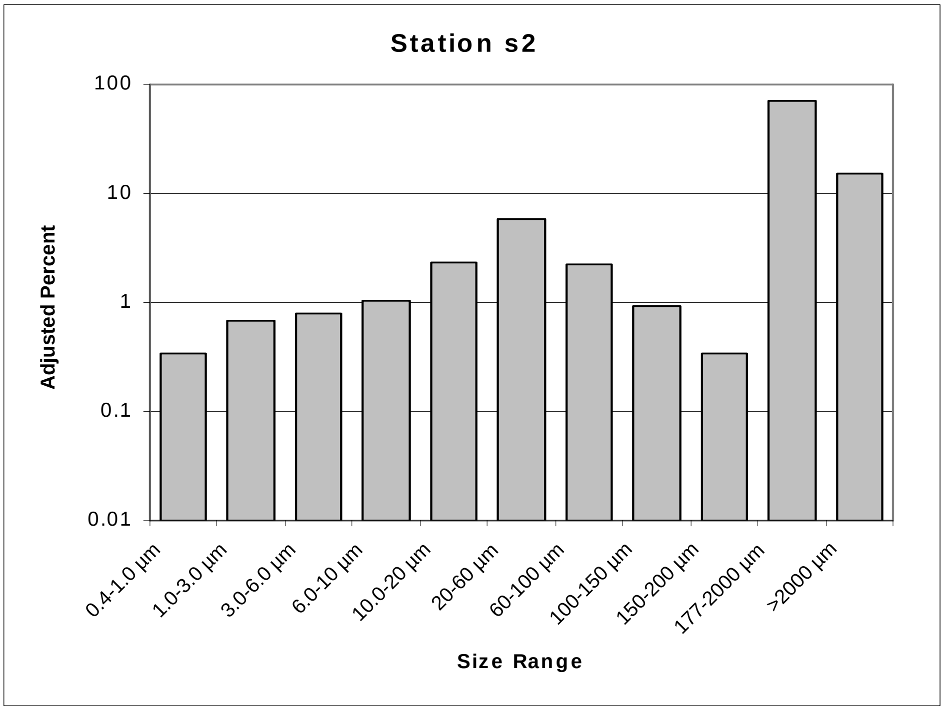


Figure A4-8 Adjusted particle size distribution for Station s3.

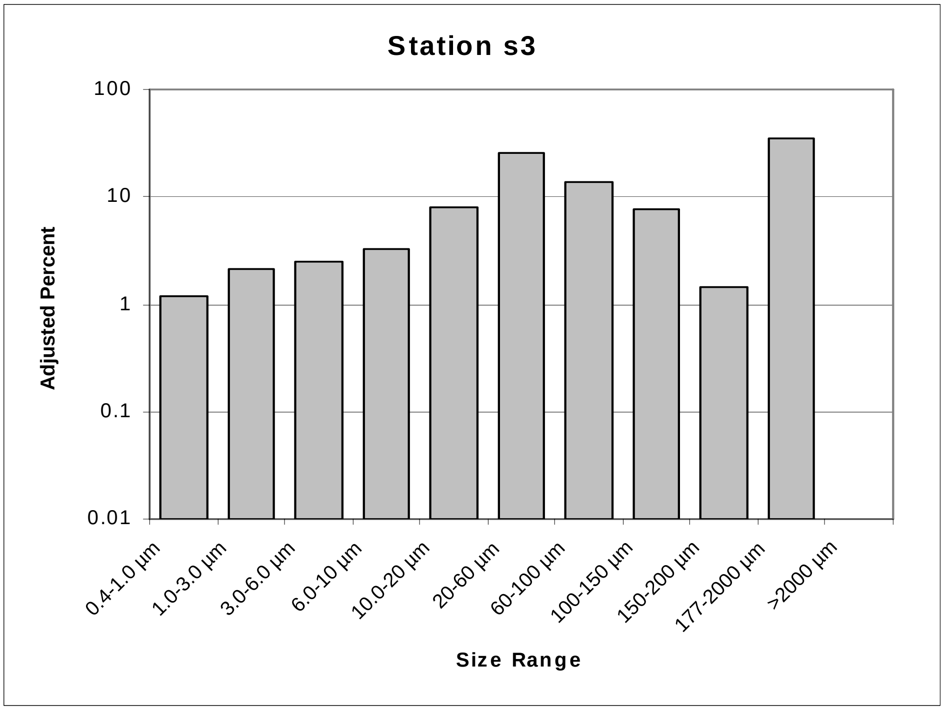


Figure A4-9 Adjusted particle size distribution for Station s4.

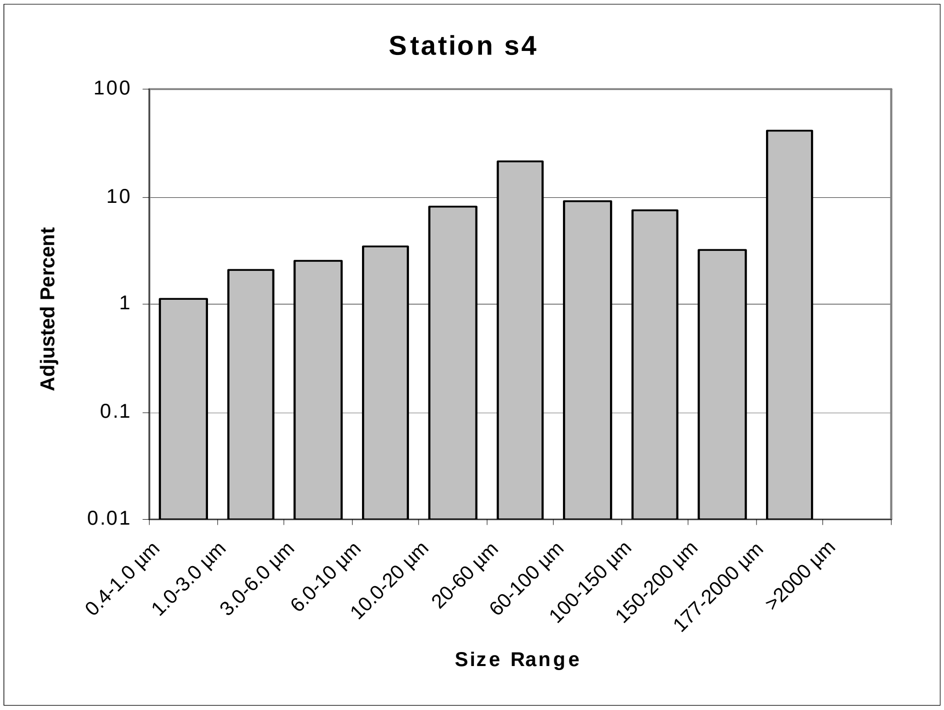
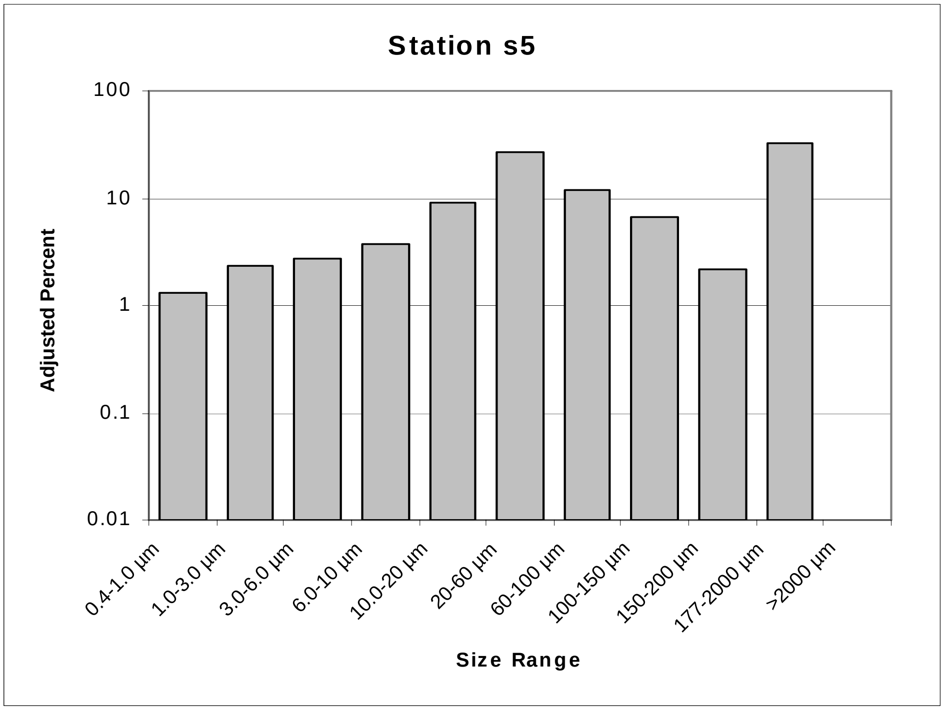


Figure A4-10 Adjusted particle size distribution for Station s5.

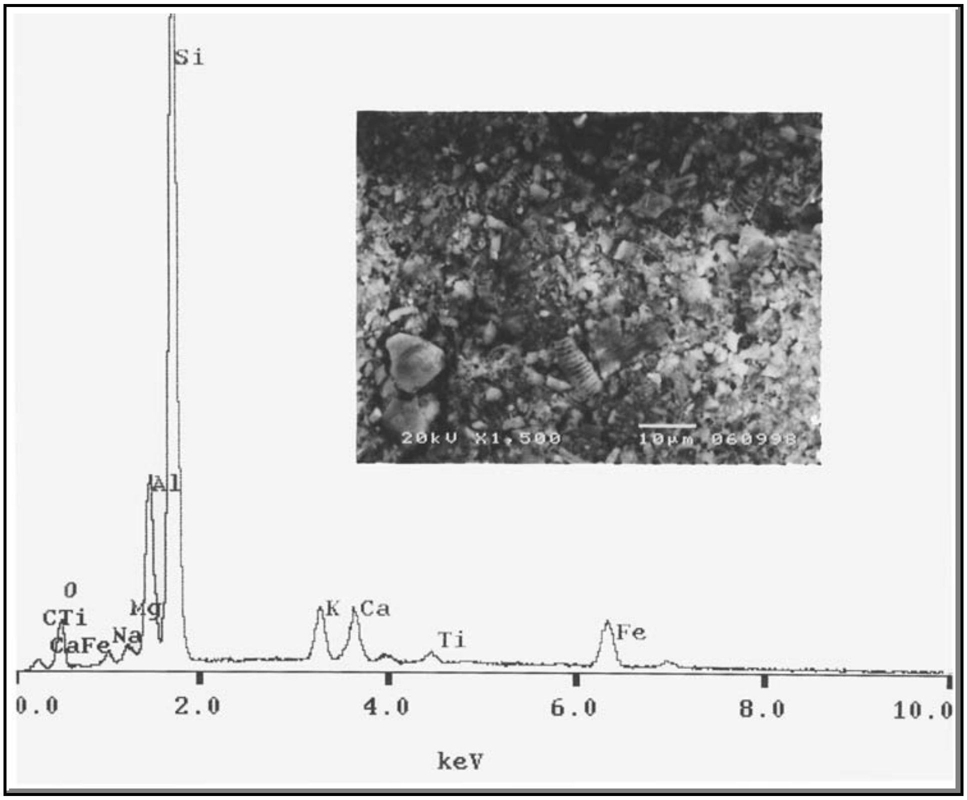


APPENDIX 5

Petrographic and SEM Data for Lake Owyhee Bottom Sediments

May 1998

Figure A5-1 ***Sediment Station s1:*** SEM photomicrograph with X-ray fluorescence spectrum showing qualitatively identified elements. Below are element maps imaged for this sample.



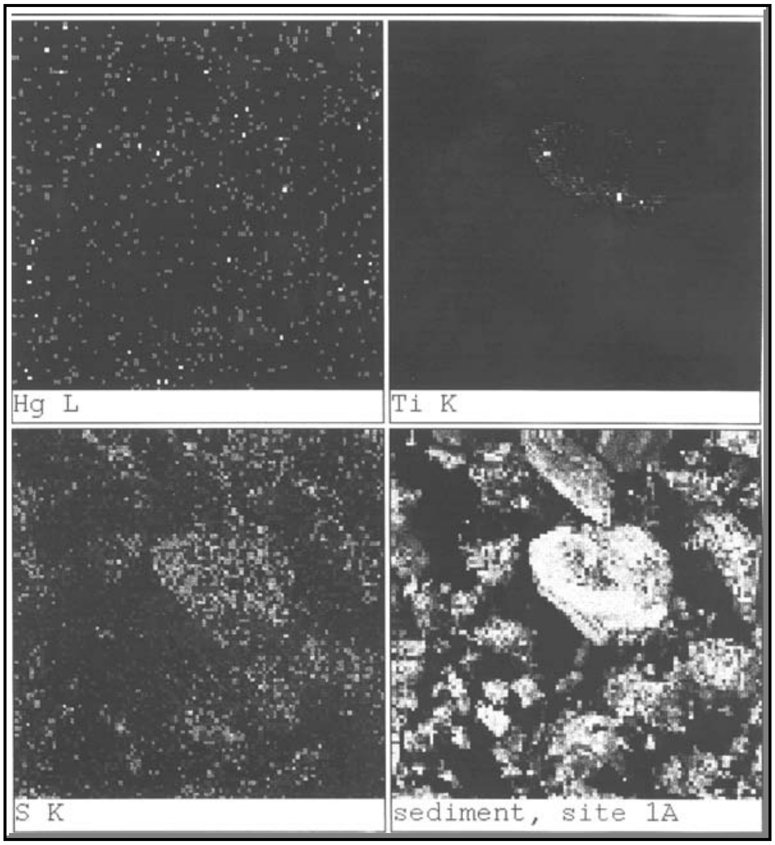


Figure A5-2 ***Sediment Station s2:*** SEM photomicrograph with X-ray fluorescence spectrum showing qualitatively identified elements. Closeup of SEM image below shows diatom frustules.

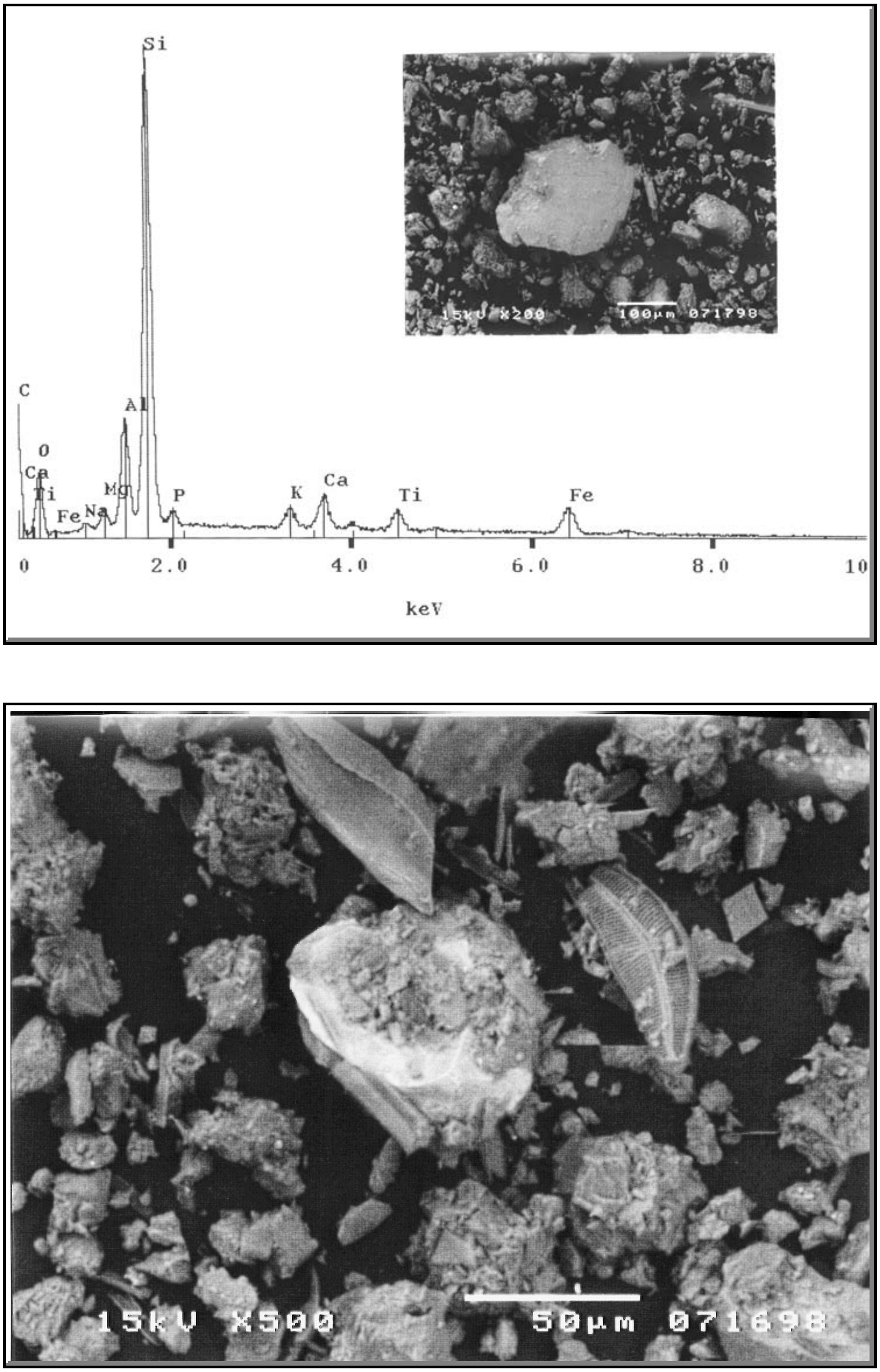
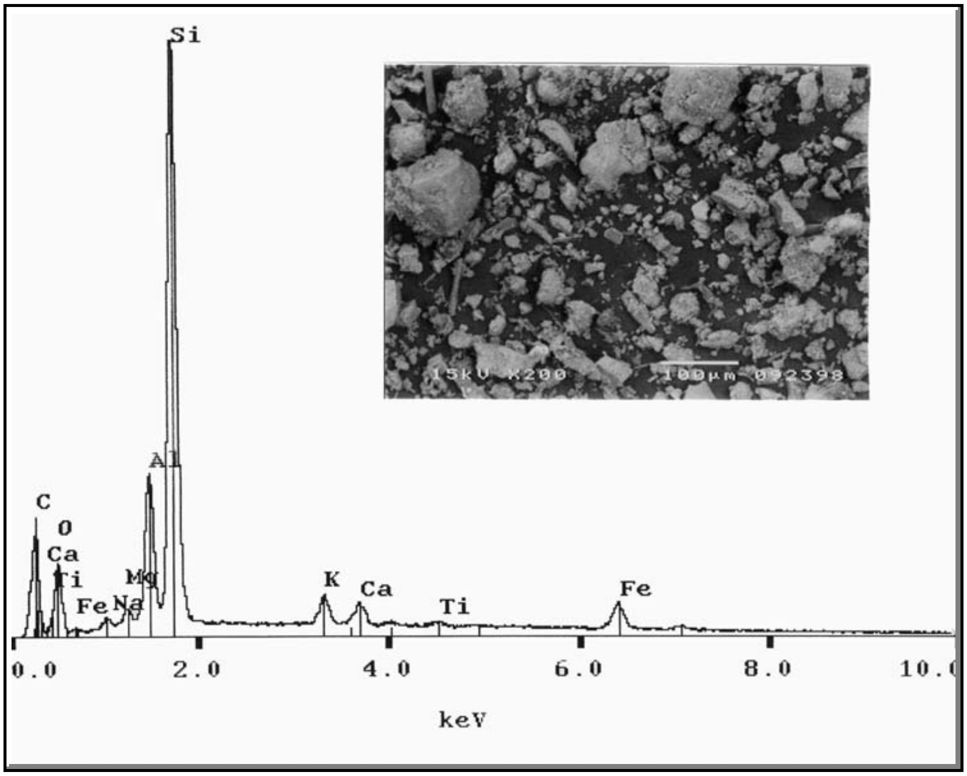


Figure A5-3 ***Sediment Station s3:*** SEM photomicrograph with X-ray fluorescence spectrum showing qualitatively identified elements. Mapping of elements is shown below.



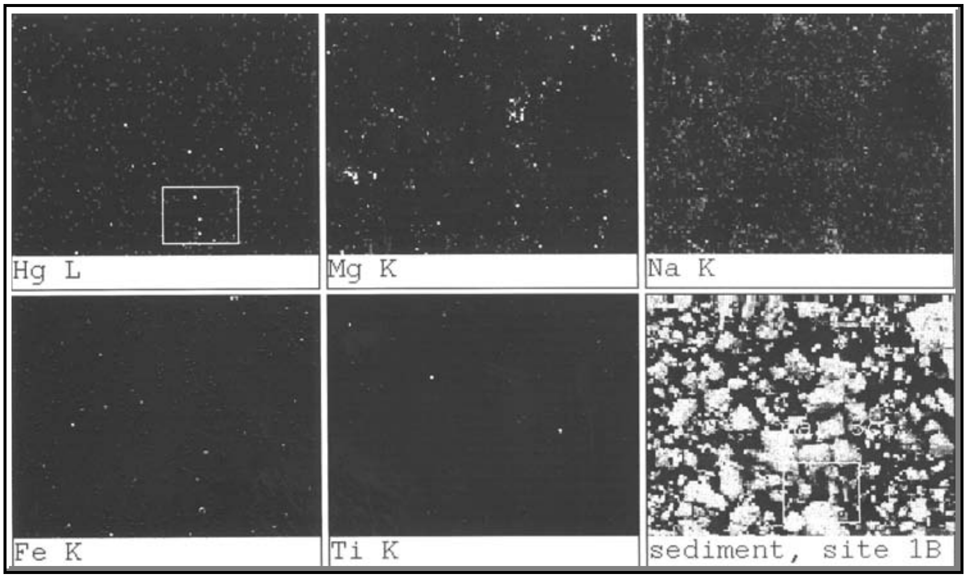
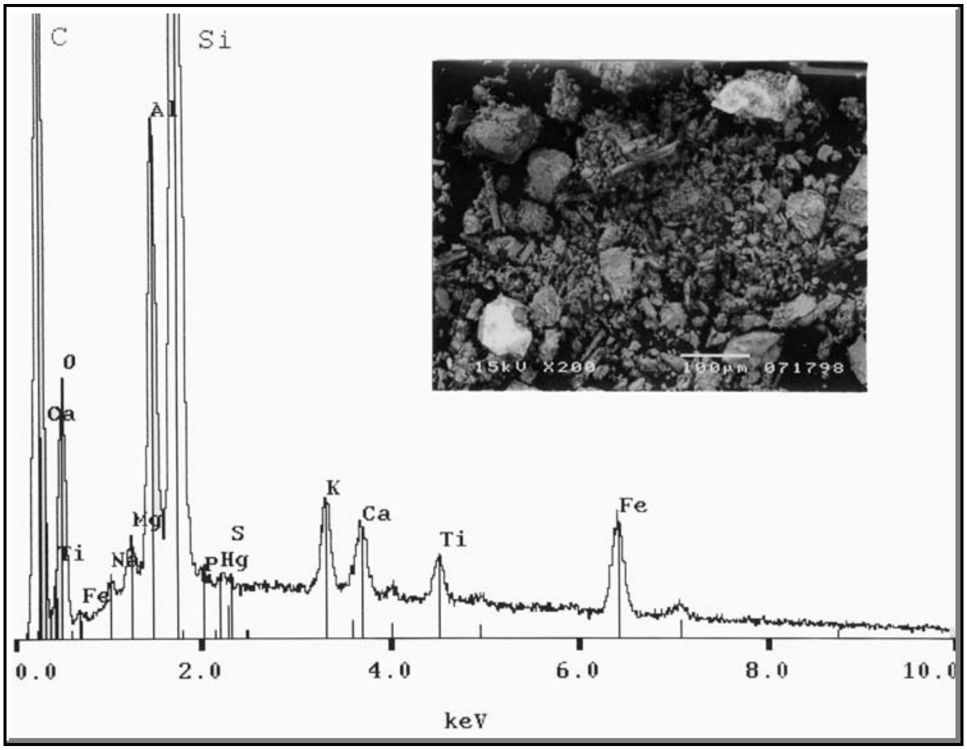


Figure A5-4 ***Sediment Station s4:*** SEM photomicrograph with X-ray fluorescence spectrum showing qualitatively identified elements. Element mapping of SEM image for Hg is shown below.



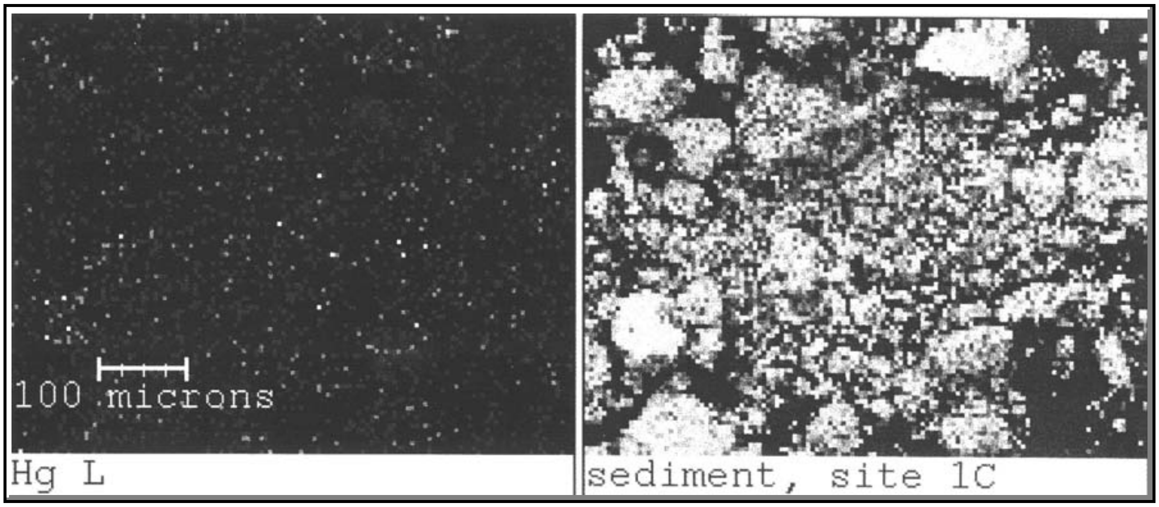


Figure A5-5 ***Sediment Station s5:*** SEM photomicrograph with X-ray fluorescence spectrum showing qualitatively identified elements.

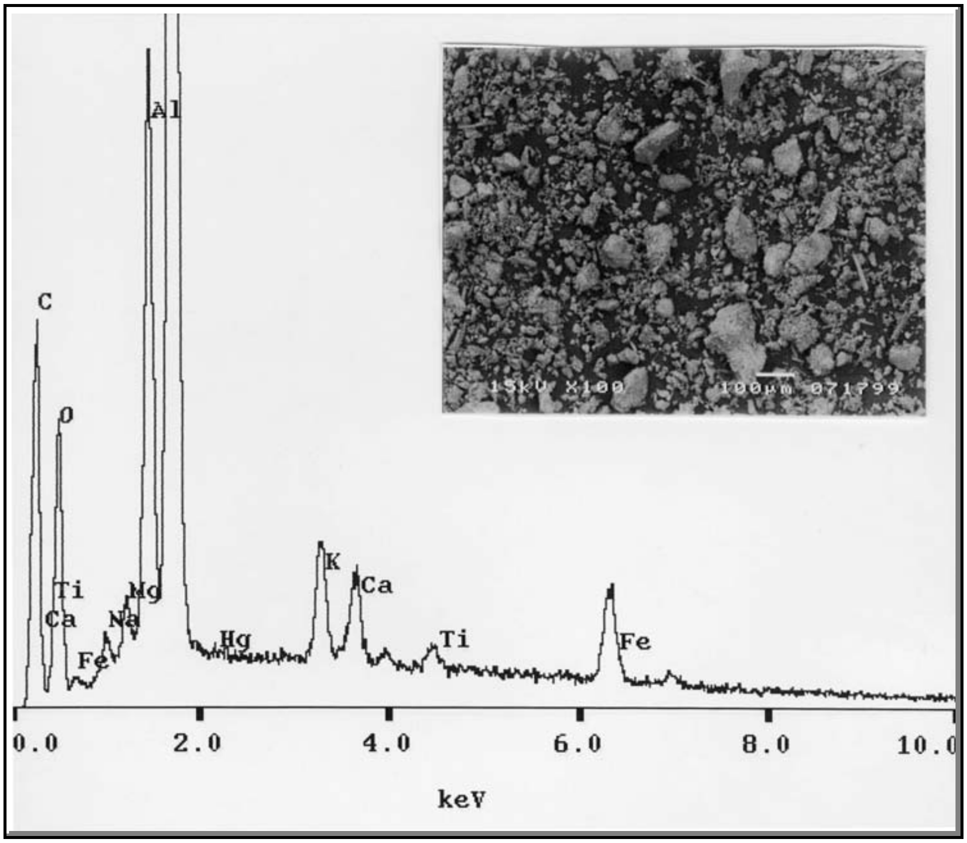
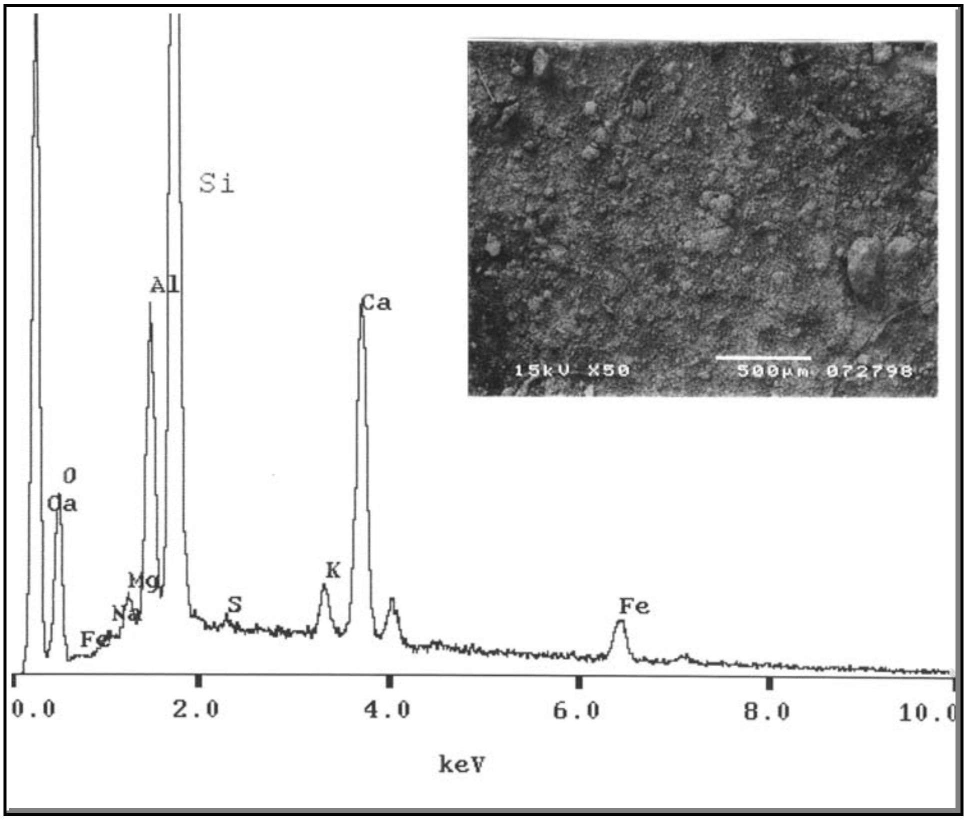


Figure A5-6 ***Suspended sediments*** collected from water at Station 1. This is the SEM photomicrograph with X-ray fluorescence spectrum showing qualitatively identified elements. The prominent Ca peaks are thought to be an evaporation artifact.



APPENDIX 6

Summary of Sampling and Analysis Error for Lake Owyhee Sediment and Water Samples 1996-1999

Table A6-1 Fractional shovelling composite sediment sample preparation variability with respect to percent H_2O and particle size fractions. For all samples, n = 5.

Station	***Weight Percent H_2O***		***Dry:Wet Fraction***		***Wet <80 Fraction***		***Percent Plus 10-mesh, dry basis***		***Percent 10 to 80 mesh, dry basis***		***Percent Minus 80 mesh, dry basis***	
	mean, percent	**std dev, percent**	**mean**	**std dev**	**mean**	**std dev**	**mean, percent**	**std dev, percent**	**mean, percent**	**std dev, percent**	**mean, percent**	**std dev, percent**
s1 - comp1	**29.0**	4.10	**0.710**	0.0414	**0.259**	0.0669	**0.00**		**63.1**	11.1	**36.9**	11.1
s1 - comp2	**31.0**	4.50	**0.690**	0.0453	**0.269**	0.0657	**0.00**		**60.4**	11.4	**39.6**	11.4
s2	**33.3**	12.6	**0.667**	0.1263	**0.0841**	0.0694	**15.0**	7.30	**70.1**	12.1	**14.9**	16.2
s3	**47.8**	1.60	**0.523**	0.0160	**0.342**	0.0148	**0.00**		**34.6**	1.90	**65.4**	1.90
s4	**46.0**	4.30	**0.540**	0.0429	**0.322**	0.0502	**0.00**		**40.6**	5.40	**59.4**	5.40
s5	**42.2**	2.20	**0.578**	0.0219	**0.390**	0.0207	**0.00**		**32.6**	3.00	**67.4**	3.00

Table A6-2 Lake Owyhee sediment sampling analytical repeatability. Two 5-dredge composite samples were collected at Station s1. At Station s1, two fractional spooning subsamples were collected from one of the two 5-dredge composites for Hg and Me-Hg analysis. A single fractional spooning subsample was collected from the second 5-dredge composite at Station s1. At Station s2, another two fractional spooning subsamples were collected from the single 5-dredge composite for Hg and Me-Hg analysis.

Calculations for:		Station s1	Station s1: Hg Only	Station s1	Station s1	Station s2: Hg Only	All Stations	All Stations	All Stations	All Stations	All Stations	All Stations	All Stations	All Stations
Number of Samples:		n=2	n=2	n=2	n=5	n=2	n= 7 to 12	n= 7 to 12	n= 7 to 12	n= 7 to 12	n= 7 to 12	n= 7 to 12	n= 7 to 12	n= 7 to 12
Analyte	Units	Analytical Grab Subsamp. RPD:	Fractional Spooning Subsam.p. Duplicate RPD**:	5-Dredge Composite Duplicate RPD:	Percent Relative Standard Deviation	Fractional Spooning Subsamp. Duplicate RPD**:	Total Number of Samples	Global Minimum	Global Maximum	Global Mean	Global Median	Global Range	Std. Deviation	Percent RSD
TIC	mg/kg	ND		ND	ND		12		-0.020					ND
TOC	mg/kg	0.00		0.00	8.87		12	1.39	2.08	1.58	1.52	0.690	0.242	43.7
Total P	mg/kg	12.4		4.55	16.9		12	498	648	588	599	150	44.2	25.5
Ag	mg/kg	ND		ND	ND		7		-0.800					ND
As	mg/kg	ND		ND	ND		7		-14.0					ND
B	mg/kg	17.4		18.5	27.2		7	6.55	11.20	8.59	8.57	4.65	1.63	54.1
Ba	mg/kg	0.00		1.91	1.92		7	259	320	277	272	61.0	21.5	22.0
Be	mg/kg	1.90		7.45	8.47		7	0.730	1.06	0.860	0.837	0.330	0.119	38.4
Ca	mg/kg	4.79		1.30	4.81		7	5300	6590	5820	5670	1290	481	22.1
Cd	mg/kg	ND		ND	ND		7		-0.800					ND
Co	mg/kg	4.22		1.27	2.24		7	11.6	13.7	12.4	12.1	2.1	0.77	6.16
Cr	mg/kg	62.6		53.2	46.0		7	15.1	34.2	20.9	19.6	19.1	6.25	30.0
Cu	mg/kg	1.90		29.9	18.2		7	32.1	96.4	49.1	39.9	64.3	22.1	44.9
Fe	mg/kg	7.32		7.91	5.87		7	16400	22200	19100	18700	5800	2030	10.6
Total Hg	*µg/kg*	*5.53*	*5.27*	*34.4*	*17.4*	*54.5*	*8*	*152*	*410*	*270*	*212*	*247*	*104*	*38.4*
Me-Hg	*µg/kg*	*0.840*	*0.764*	*18.5*	*9.34*	*16.3*	*8*	*2.39*	*5.35*	*3.63*	*3.63*	*2.96*	*0.88*	*24.3*
Li	mg/kg	5.10		3.90	3.41		7	15.1	21.3	17.6	17.8	6.20	2.30	13.0
Mg	mg/kg	3.39		5.44	3.56		7	4470	5260	4850	4800	790	272	5.61
Mn	mg/kg	2.07		3.43	2.23		7	373	752	465	435	379	132	28.5
Mo	mg/kg	ND		ND	ND		7		-2.00					ND
Ni	mg/kg	7.00		13.3	8.37		7	17.5	22.7	20.0	20.1	5.20	1.57	7.86
Pb	mg/kg	40.0		12.1	21.9		7	8.87	16.2	11.9	10.7	7.33	2.74	22.9
Sb	mg/kg	ND		ND	ND		6		-4.00					ND
Se	mg/kg	8.33		19.7	12.4		7	27.6	43.2	34.2	35.1	15.6	5.70	16.7
V	mg/kg	8.89		9.71	7.17		7	24.5	35.0	29.5	28.9	10.5	3.78	12.8
Zn	mg/kg	4.65		1.30	2.45		7	56.7	82.6	63.8	59.4	25.9	9.25	14.5
	** 2 fractional spooning field subsamples for Hg from same 5-dredge composite performed at 2 sampling stations.													

Table A6-3 Repeatability for Lake Owyhee water sample duplicate analyses.

Station:			Station 1 05/07/98			Station 8 05/05/97			Station 8 08/14/97			Overall Average
Analyte	units	Sample Treatment	SAMPLE	DUPLICATE	Relative Percent Difference	SAMPLE	DUPLICATE	Relative Percent Difference	SAMPLE	DUPLICATE	Relative Percent Difference	Relative Percent Difference
Ca	mg/L	Filtered	14.3	14.2	0.70	13.4	13.4	0.00	14.6	14.4	1.38	0.69
Mg	mg/L	Filtered	3.7	3.7	0.00	3.9	3.9	0.00	4.1	4.1	0.00	0.00
Na	mg/L	Filtered	10.8	10.9	0.92	15.6	15.7	0.64	18.4	18.7	1.62	1.06
K	mg/L	Filtered	2.3	2.4	4.26	2.7	2.7	0.00	2.9	3	3.39	2.55
HCO3	mg/L	Filtered	76	76	0.00	81	81	0.00	91	91	0.00	0.00
CO3	mg/L	Filtered	0	0	NA	0	0	NA	0	0	NA	NC
SO4	mg/L	Filtered	8.2	8.1	1.23	13.3	13.3	0.00	13.2	13.2	0.00	0.41
Cl	mg/L	Filtered	3.5	3.5	0.00	5	5	0.00	4.8	5.7	17.1	5.71
SiO2	mg/L	Unfiltered			NC	24.3	24.7	1.63	25	24.6	1.61	1.62
TOC	mg/L	Unfiltered	4.6	4.6	0.00	5.1	5.1	0.00	4.8	4.9	2.06	0.69
DOC	mg/L	Filtered	4	3.9	2.53	4.9	4.7	4.17	4.3	4.2	2.35	3.02
Total-P	mg/L	Unfiltered	0.1	0.093	7.25	0.117	0.116	0.86	0.117	0.119	1.69	3.27
Total-P	mg/L	Filtered			NC	0.078	0.071	9.40	0.078	0.079	1.27	5.33
Ortho-P	mg/L	Filtered	0.04	0.041	2.47	0.058	0.057	1.74	0.069	0.069	0.00	1.40
NO3NO2	mg/L	Filtered	0.18	0.18	0.00	0.32	0.31	3.17	0.36	0.36	0.00	1.06
NH3	mg/L	Filtered			NC	0.005	0.005	0.00	0.005	0.005	0.00	0.00
TKN	mg/L	Unfiltered	0.36	0.39	8.00	0.34	0.36	5.71	0.42	0.37	12.7	8.79
Total-Hg	ng/L	Unfiltered	101.1	102.8	1.67	36.9	36.3	1.64	30.8	31.0	0.52	1.27
Total-Hg	ng/L	Filtered	5.77	.	NC	6.81	6.88	1.02	2.9	6.19	72.4	36.7
Me-Hg	ng/L	Unfiltered	1.7	1.854	8.67	0.84	0.792	5.88	0.391	0.34	14.0	9.50
Me-Hg	ng/L	Filtered	0.114	0.131	13.9	0.429	0.431	0.47	0.199	0.234	16.2	10.2
Ag	µg/L	Unfiltered	-0.012	-0.012	0.00	0.0261	0.0251	3.91	-0.007	-0.007	0.00	1.30
Ag	µg/L	Filtered	-0.012	-0.012	0.00	0.0073	0.0079	7.89	-0.005	-0.005	0.00	2.63
As	µg/L	Unfiltered	13.8	12.7	8.30	3.67	3.68	0.27	4.3002	4.37	1.61	3.39
As	µg/L	Filtered	11.5	11.7	1.72	3.31	3.28	0.91	4.165	4.61	10.14	4.26
Be	µg/L	Unfiltered	0.203	0.175	14.8	0.0877	0.0887	1.13	0.1096	0.0935	15.85	10.6
Be	µg/L	Filtered	0.003	0.007	80.0	0.0114	0.0144	23.3	0.027	0.0431	45.93	49.7

		Station:	***Station 1 05/07/98***			***Station 8 05/05/97***			***Station 8 08/14/97***			***Overall Average***
Analyte	***units***	***Sample Treatment***	***SAMPLE***	***DUPLICATE***	**Relative Percent Difference**	***SAMPLE***	***DUPLICATE***	**Relative Percent Difference**	***SAMPLE***	***DUPLICATE***	**Relative Percent Difference**	**Relative Percent Difference**
Cd	**µg/L**	Unfiltered	0.0693	0.0705	***1.72***	0.016	0.0171	***6.65***	0.0191	0.0165	**14.6**	***7.66***
Cd	**µg/L**	Filtered	0.0138	0.0174	***23.1***	0.002	0.0052	***88.9***	0.0109	0.0142	**26.3**	***46.1***
Co	**µg/L**	Unfiltered	1.56	1.55	***0.64***	0.422	0.454	***7.31***	0.4021	0.41	**1.95**	***3.30***
Co	**µg/L**	Filtered	0.451	0.436	***3.38***	0.086	0.0938	***8.68***	0.0618	0.1102	**56.3**	***22.8***
Cr	**µg/L**	Unfiltered	5.4	3.07	***55.0***	0.882	0.972	***9.71***	1.6998	1.95	**13.7**	***26.2***
Cr	**µg/L**	Filtered	0.876	0.736	***17.4***	0.251	0.295	***16.1***	2.2735	2.698	**17.1**	***16.9***
Cu	**µg/L**	Unfiltered	4.85	4.8	***1.04***	2.43	2.59	***6.37***	4.0594	4.09	**0.75**	***2.72***
Cu	**µg/L**	Filtered	2.1	2.07	***1.44***	1.44	1.55	***7.36***	2.5789	2.917	**12.3**	***7.03***
Ni	**µg/L**	Unfiltered	2.68	2.57	***4.19***	1.43	0.989	***36.5***	2.3954	2.396	**0.03**	***13.6***
Ni	**µg/L**	Filtered	0.564	0.532	***5.84***	0.315	0.374	***17.1***	1.5255	1.6937	**10.5**	***11.1***
Pb	**µg/L**	Unfiltered	1.67	1.66	***0.60***	0.571	0.597	***4.45***	0.9674	0.8117	**17.5**	***7.52***
Pb	**µg/L**	Filtered	0.0713	0.0712	***0.14***	0.0584	0.0678	***14.9***	0.5801	0.2959	**64.9**	***26.6***
Sb	**µg/L**	Unfiltered	0.431	0.4099	***5.02***	0.219	0.217	***0.92***	0.208	0.184	**12.2**	***6.06***
Sb	**µg/L**	Filtered	0.354	0.357	***0.84***	0.1971	0.204	***3.44***	0.176	0.2047	**15.1**	***6.45***
Se	**µg/L**	Unfiltered	0.441	0.442	***0.23***	0.101	0.0663	***41.5***	0.7581	0.8327	**9.38**	***17.0***
Se	**µg/L**	Filtered	0.446	0.488	***8.99***	0.184	0.263	***35.4***	0.5532	0.5349	**3.36**	***15.9***
Tl	**µg/L**	Unfiltered	0.0425	0.04	***6.06***	0.0206	0.0224	***8.37***	0.0182	0.0174	**4.49**	***6.31***
Tl	**µg/L**	Filtered	0.004	0.004	***0.00***	0.0076	0.0087	***13.5***	-0.006	-0.006	**0.00**	***4.50***
U	**µg/L**	Unfiltered	3.15	3.11	***1.28***	0.699	0.72	***2.96***				***2.12***
U	**µg/L**	Filtered	2.7879	2.81	***0.79***	0.626	0.652	***4.07***				***2.43***
V	**µg/L**	Unfiltered	15.7	14.9	***5.23***	4.86	5.09	***4.62***	7.3021	7.326	**0.33**	***3.39***
V	**µg/L**	Filtered	10.1	10.1	***0.00***	3.51	3.65	***3.91***	5.2407	5.7119	**8.60**	***4.17***
Zn	**µg/L**	Unfiltered	8.99	8.65	***3.85***	4.17	4.29	***2.84***	4.4662	4.343	**2.80**	***3.16***
Zn	**µg/L**	Filtered	0.508	0.499	***1.79***	0.668	0.834	***22.1***	1.1012	2.1234	**63.4**	***29.1***

APPENDIX 7:

Hydrologic Data for Inflow and Outflow at Lake Owyhee

Figure A7-1 Average monthly inflow measured at USGS gaging station 13181000, located on the Owyhee RIver at Rome, Oregon. The period of record for these averages is water years 1950-1998. Note the y-axis log scale.

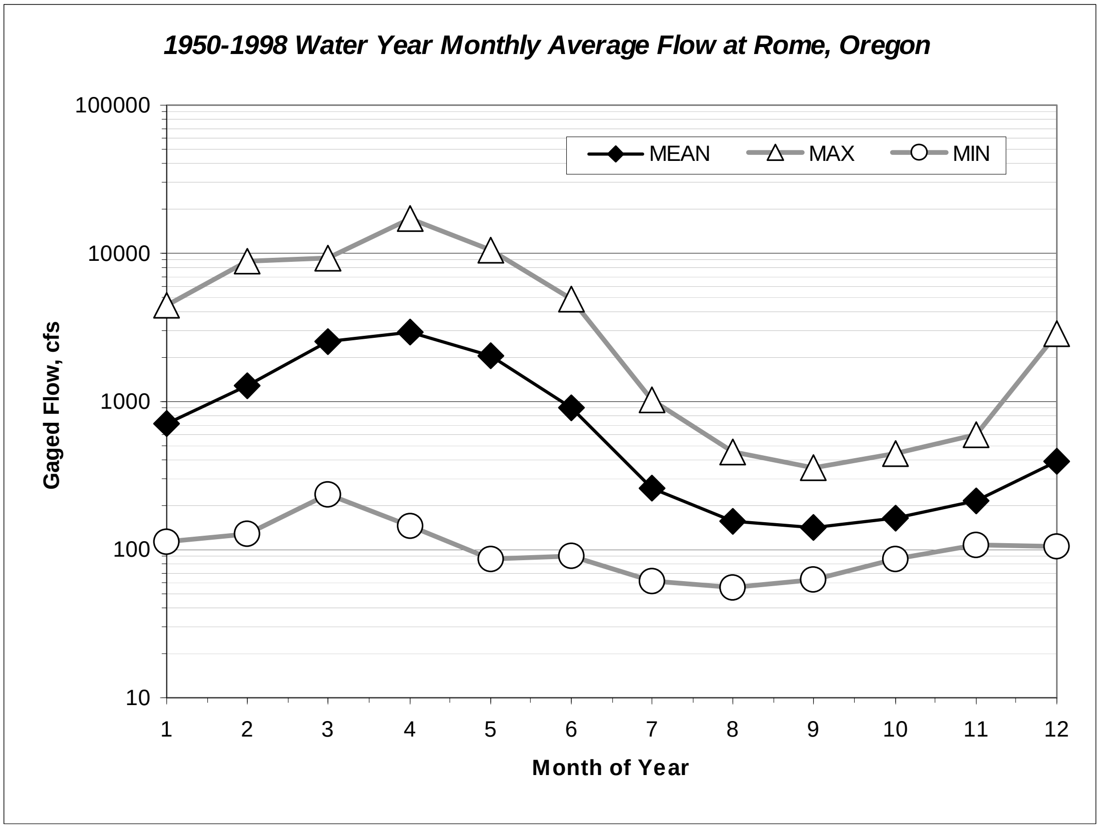


Figure A7-2 Average daily inflow discharge at the Rome, Oregon USGS gage station (in gray), and total release discharges at Owyhee Dam (in black) for the period of this study.

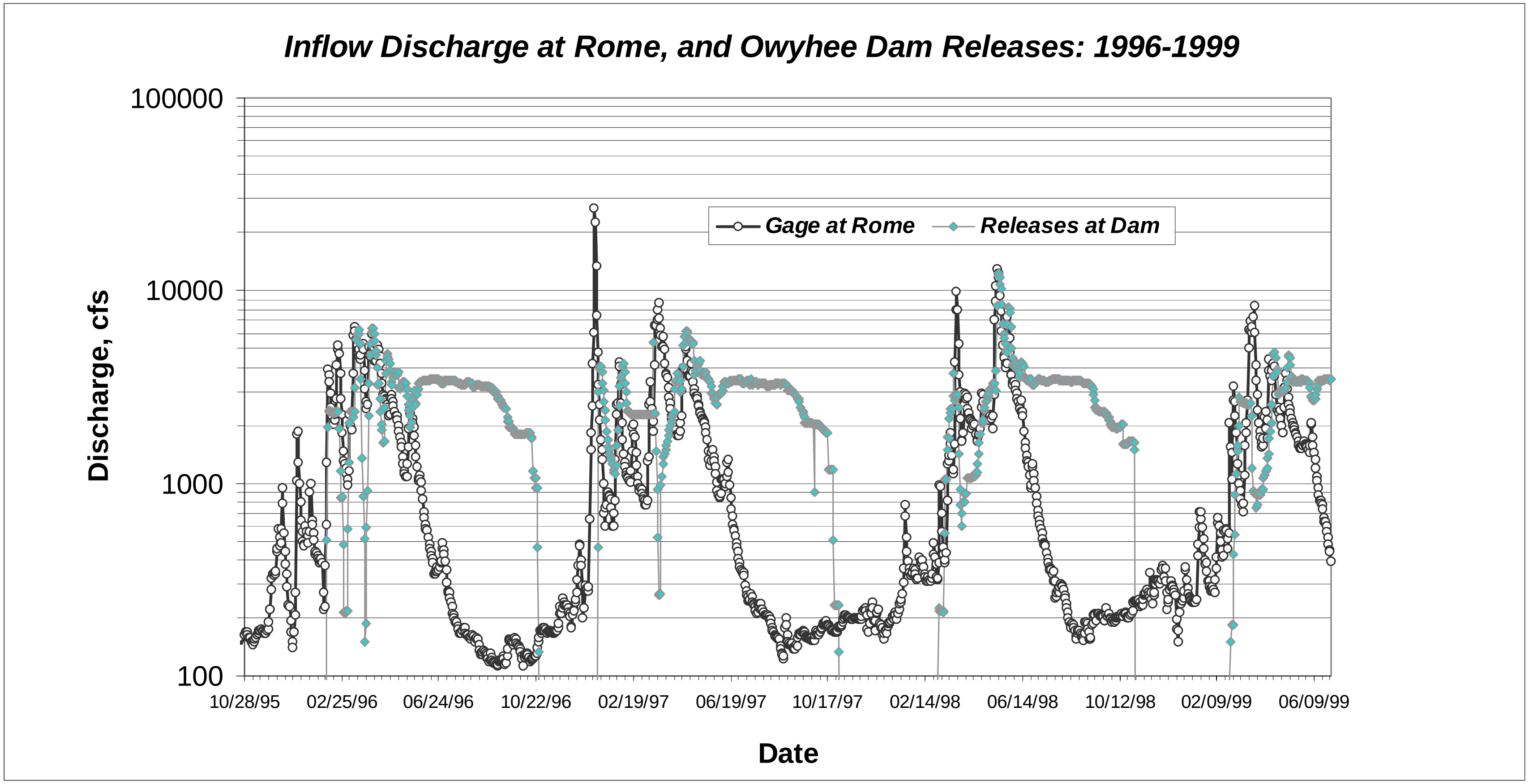


Figure A7-3 Average daily reservoir surface elevation behind Owyhee Dam for the period of this study.

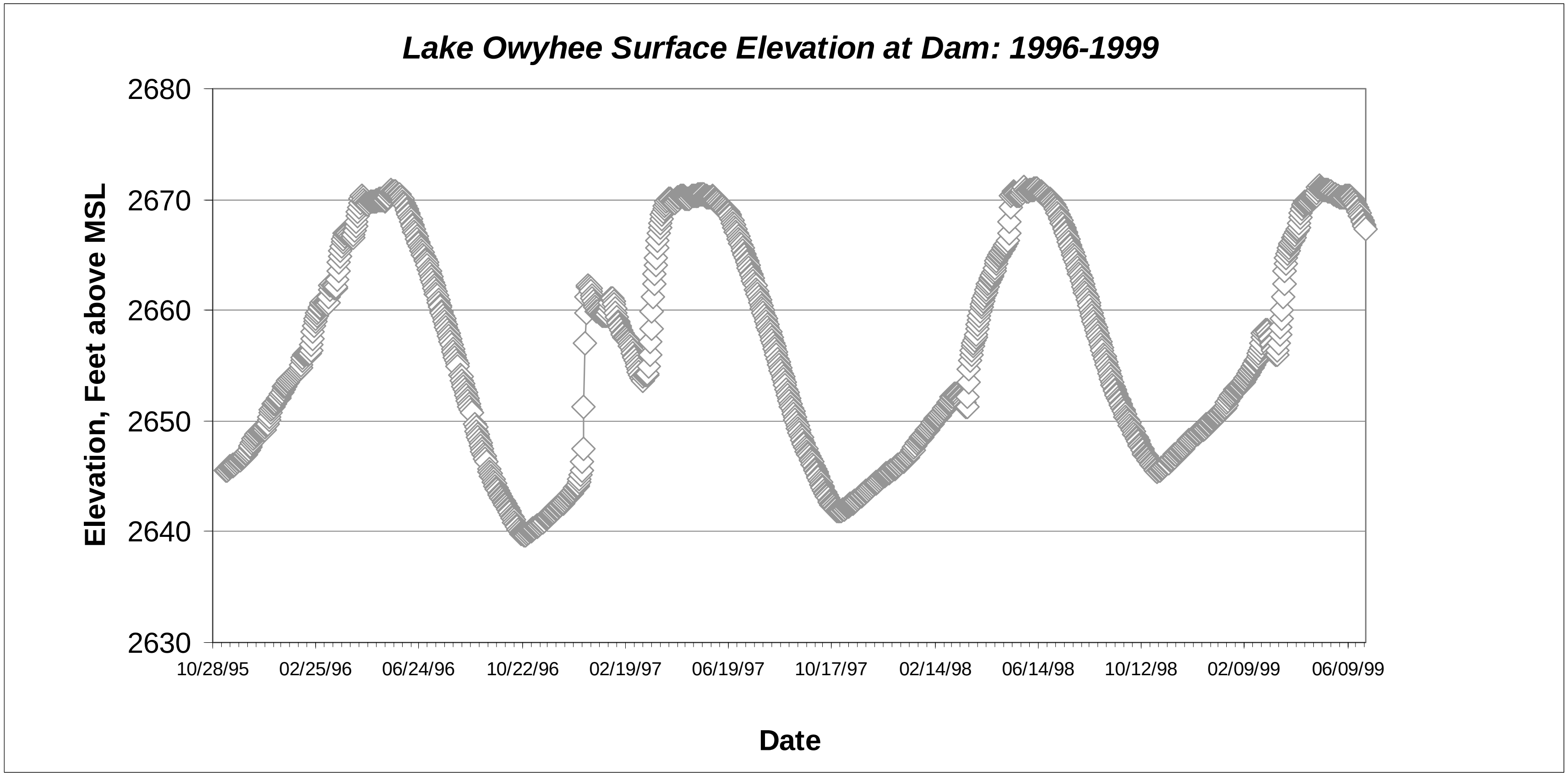
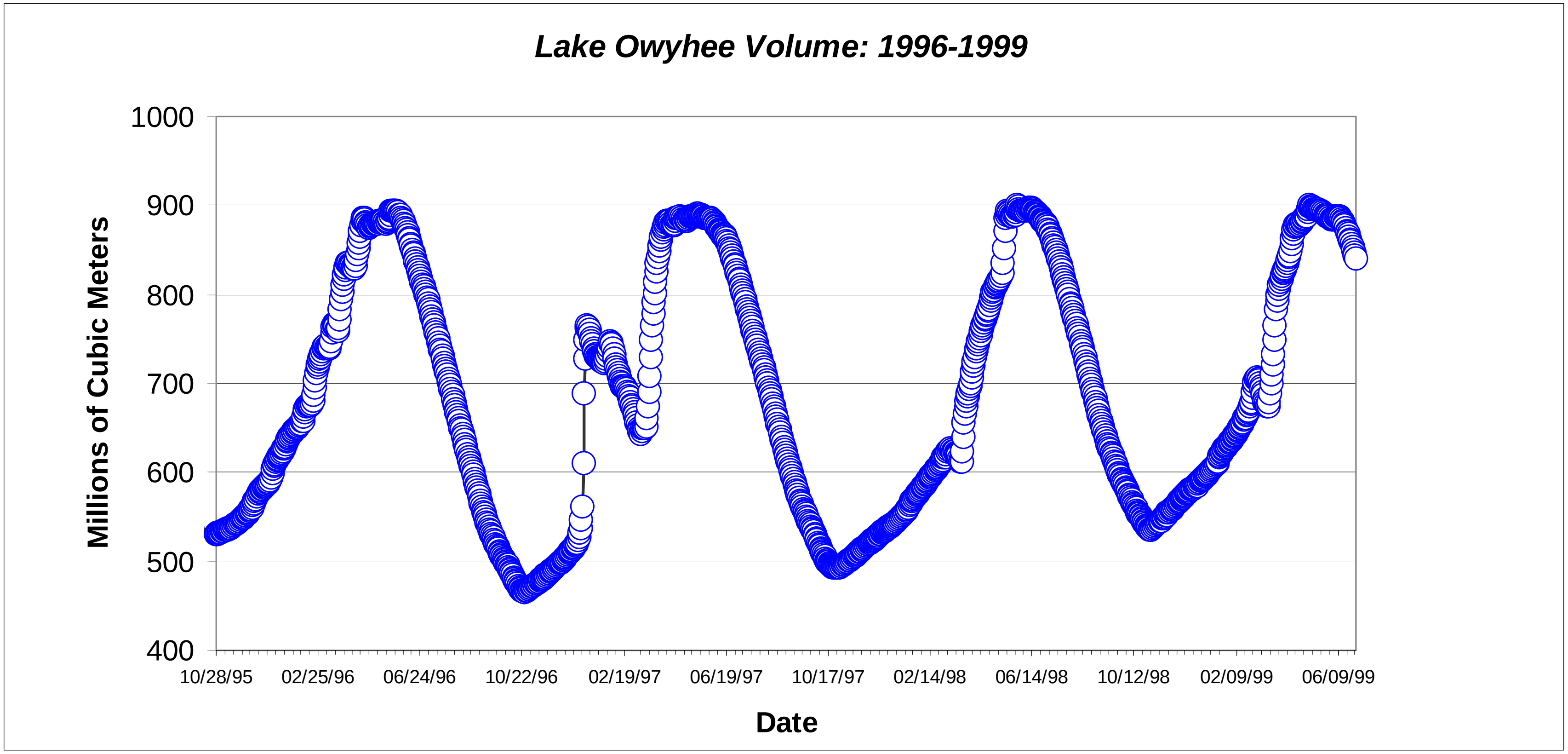


Figure A7-4 Average daily reservoir volume in millions of m^3, for Lake Owyhee.



APPENDIX 8:

Bibliography of Geology References for the Lake Owyhee Watershed

Evans, J.G., 1987, *Geologic Map of the Owyhee Canyon Wilderness Study Area, Malheur County, Oregon,* U.S. Geological Survey Miscellaneous Field Studies Map 1926, scale 1:62,500.

Evans, J.G., 1991, *Geologic Map of the Lower Owyhee Canyon Wilderness Study Area, Malheur County, Oregon*, U.S. Geological Survey Miscellaneous Field Studies Map MF-2167, scale 1:50,000.

Evans, J.G., J.D. Hoffman, D.M. Kulik, and L.M. Linne, M., 1987, *Mineral Resources of the Owyhee Canyon Wilderness Study Area, Malheur County, Oregon,* U.S. Geological Survey Bulletin 1719-E.

Evans, J.G., R.L. Turner, D. Plouff, D.L. Sawatzky, and J.M. Linne, 1988, *Mineral Resources of the Upper West Little Owyhee Wilderness Study Area, Malheur County, Oregon*, U.S. Geological Survey Bulletin 1719-H.

Evans, J.G., R.L. Turner, A. Griscom, D.L. Sawatzky, and J.D. Causey, 1990, *Mineral Resources of the Lower Owyhee Canyon Wilderness Study Area, Malheur County, Oregon*, U.S. Geological Survey Bulletin 1741-F.

Ferns, M.L., 1988, *Geology and Mineral Resources Map of the Owyhee Dam Quadrangle, Malheur County, Oregon*, Oregon Department of Geology and Mineral Industries Geological Map Series GMS-55, scale 1:24,000.

Ferns, M.L., and M.L. Cummings, 1992, *Geology and Mineral Resources of The Elhow Quadrangle, Malheur County, Oregon,* Oregon Department of Geology and Mineral Industries Geological Map Series GMS-62, scale 1:24,000.

Ferns, M.L., H.C. Brooks, J.G. Evans, and M.L. Cummings, 1993, *Geologic Map of the Vale 1:100,000 Quadrangle. Malheur County, Oregon, and Owyhee County, Idaho*, Oregon Department of Geology and Mineral Resources Geological Map Series GMS-77, scale 1:100,000.

Ferns, M.L., H.C. Brooks, J.G. Evans, and M.L. Cummings, 1993, *Geologic Map of the Mahogany Mountain 1:100,000 Quadrangle. Malheur County, Oregon, and Owyhee County, Idaho*, Oregon Department of Geology and Mineral Resources Geological Map Series GMS-78, scale 1:100,000.

Gray. J.J., N.N. Peterson, J. Clayton, and G. Baxter, 1983, *Geology and Mineral Resources of 18 BLM Wilderness Study Areas, Harney and Malheur Counties, Oregon,* Oregon Department of Geology and Mineral Industries Open-File Report 0-83-2, 108 p.

Kittleman. L.R., A.R. Green, A.R. Hagood. A.M. Johnson, J.M. McMurray, R.G. Russell, and D.A. Weeden, 1965, *Cenozoic Stratigraphy of the Owyhee Region, Southeastern Oregon*, University of Oregon Museum of Natural History Bulletin, Vol. 1, Eugene, Oregon.

Kittlernan, L.R., A.R. Green, A.R. Hagood. A.M. Johnson, J.M. McMurray, R.G. Russell, R.G., and D.A. Weeden, 1965, *Guide to the Geology of the Owyhee Region of Oregon,* University of Oregon Museum of Natural History Bulletin, Vol 21, Eugene, Oregon.

Robinson, M.L., W.T. Meyer, J.S. Lovell, and A.L. Klawitter, A.L., 1984, *Geology-Energy-Mineral Resource Survey, Northern Malheur Resource Area, Vale District, Oregon*, Barringer Resources Inc. report to the BLM. contract No. YA-551-CT3-44038, 4 volumes.

Rytuba, J.J., D.B. Vander Meulen. V.E. Barlock, and M.L. Ferns, 1990, *Field Guide to Hot-spring Gold Deposits in the Lake Owyhee Volcanic Field, Eastern Oregon: Geology and Ore Deposits of the Great Basin*, Geological Society of Nevada Field Trip Guide No.10.

Vander Meulen, D.B., J.J. Rytuba, H.D. King, D. Plouff; and D.F. Scott, 1987, *Mineral Resources of the Honeycombs Wilderness Study Area, Matheur County, Oregon*, U.S. Geological Survey Bulletin 1741-A.

Vander Meulen, D.B., A. Griscom, H.D. King, and J.R. Benham,1989, *Mineral Resources of the Upper Leslie Gulch and Slocum Creek Wilderness Study Areas, Malheur County, Oregon*, U.S. Geological Survey Bulletin 1741-D.

Vander Meulen, D.B., V.E. Barlock, P.S. Plumley, J.G. Frisken, A. Griscom, and J.D. Causey, *Mineral Resources of the Blue Canyon and Owyhee Breaks Wilderness Study Areas, Malheur County, Oregon*, U.S. Geological Survey Bulletin 1741-G.