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Water Quality Criteria Data Book
Volume 2

Inorganic Chemical Pollution of Freshwater

U.S. ENVIRONMENTAL PROTECTION AGENCY

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Water Quality Criteria Data Book, Vol. 2

INORGANIC CHEMICAL POLLUTION OF FRESHWATER

by

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for the

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ABSTRACT

A survey of the literature dealing with inorganic chemical compounds was conducted to obtain and reference data relevant to the establishment of water quality criteria. More than 5,000 publications were reviewed. While nearly 300 inorganic species may exist in freshwater only 87 were identified in the literature. A wide distribution in concentrations in potable and polluted water was found.

Data on acute toxicity, chronic toxicity, carcinogenicity, mutagenicity, and teratogenicity of inorganic chemicals have been tabulated. Because of the design of most of these toxicological determinations, it is difficult to extrapolate from this data to human health. This inability is furthered in that the concentrations of many materials in freshwater are reported in terms of elemental analysis alone without reference to the ionic or complex form of the material. However, toxicity varies with the complex ion and oxidation state.

Correlations have been made of minimum lethal oral dose versus maximum concentrations reported in freshwater, and of minimum chronic toxic dose versus maximum concentration reported in drinking water. Examples of inorganic species which approach a safety limit have been observed.

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SECTION I

CONCLUSIONS

1. A survey of available literature on inorganic chemical pollution of water disclosed that 266 inorganic chemicals, because of solubility and other properties, can potentially pollute fresh water. Of these, 87 have been identified as being present in fresh water.

2. Although evidence which directly relates the presence of inorganic chemicals in water with human health occurs more frequently with inorganic chemicals than with organic chemicals, specific information as regards dose is generally lacking.

3. The reported sources of inorganic chemicals in freshwater are, except for a few used as pesticides, fertilizers and detergents, almost entirely industrial and municipal in origin.

4. Concentrations of chemicals in freshwater in the US were reported almost exclusively for basic elements. Since health effects are dependent upon the form of the elements reported, it is difficult to relate this information to health with any degree of certainty. In addition, the toxicity information available, though providing substantial detail, presented relatively little information which would be useful in determining safety levels for acute exposure and safety criteria for long-term exposure. In particular, data on chronic threshold or maximum "no-effect" doses are virtually nonexistent. Some inorganic compounds at appropriate doses show beneficial long-term effects.

5. The proportion of inorganic chemicals which are carcinogenic is only somewhat smaller than that for organic compounds (18% vs. 22.5%) and, like organic chemicals, all compounds examined for mutagenicity are positive. On the other hand, the proportion of teratogenic inorganic chemicals is much less than that for organic compounds (20% vs. 62.5%).

6. Examination of the relationship between highest concentrations of inorganic chemicals reported in water and lowest doeses of these reported to have produced a lethal or a chronic effect show that not only is raw freshwater in some localities unfit for consumption, but also some drinking water supplies are a hazard to health.

SECTION II

RECOMMENDATIONS

As it has been noted in the Abstract, factual information upon which quality criteria of water can be rationally based is generally lacking in the literature. Thus, while it is not possible to make specific recommendations concerning new threshold or permissable limits of inorganic chemicals in freshwater, we believe it important to say a few words under this heading concerning the need for directed toxicological investigation designed to provide such information. It is our belief that only through a more directed accumulation of such data will it be possible in the future to establish extensive, valid water quality criteria for man.

If in fact it is desirable, as we believe, to discover and relate to man the toxicity of those chemicals known to exist in freshwater then it is axiomatic that chronic toxicity data must be generated using that form of the inorganic material present in water and a mammalian species to which that material should be administered orally at reasonable concentrations. We recognize that such a research program would indeed be formidable, but it is also believed that in its absence the continued accumulation of data on the concentration of toxic chemicals in water will be ineffective insofar as the ability to use this data in determining what water supplies may be safe for human consumption.

The generation of data relative to carcinogenicity, mutagenicity and teratogenicity is a greater problem and, while we would recommend that a systematic identification of these hazards be conducted, cost of such an undertaking make it prohibitive except on a selected basis. Unfortunately, such selection usually results from publicity directed at a particular chemical species and, since studies of carcinogenicity require an extended period of time, results pertinent to question of safety usually result a number of years after the initial concern.

We further recommend the summarizing and referencing of the world-wide literature on water quality criteria as it relates to radioneuclides in freshwater. Such a report would seem a logical complement to the existing report on organic chemicals in freshwater and this report on inorganic chemicals in freshwater.

SECTION III

INTRODUCTION

This report on the relationship between inorganic chemical pollution of freshwater and health is an extension of the report entitled, "Water Quality Criteria Data Book Volume I, Organic Chemical Pollution of Freshwater," and is, therefore, supplementary in nature. Many of the general statements made in the earlier report also apply in this instance. This is particularly true for the introduction, quality of the literature, and general remarks referable to quality criteria. On the other hand, the approach has been different to the extent that since the inorganic chemicals consist of a finite list of elements and their ionic forms, compounds and complexes, the search for pertinent information was in large part directed by this listing. The informational content in the two studies does differ somewhat. For example, the organic chemical study contains a much greater amount of chronic toxicity information relevant to "no-effect" or "threshold doses." Pertinent foreign literature was generally lacking for inorganic chemicals, however.

SECTION IV

METHODS AND APPROACH

LITERATURE SEARCH

More than 5000 publications, the titles and abstracts of which appeared to be pertinent, were collected. Of these, 273 were found to have information which could be used. In carrying out the literature search, the sources explored were essentially the same as those listed in the report entitled, "Water Quality Criteria Data Book Volume I, Organic Chemical Pollution of Freshwater." Where possible, only available, recent information was used.

QUALITY OF LITERATURE

As with the literature reviewed for "Water Quality Criteria Data Book Volume I, Organic Chemical Pollution of Freshwater," the quality of the literature searched was not of high order. Information concerning origin of pollutant and its geographical location from the point at which the sample was taken for study was rarely reported. Descriptions of the waters being investigated were generally lacking, while a large body of literature was devoted to extensive examination of inorganic chemicals which have little relationship to health but a pertinent relationship to the quality of water for domestic and industrial purposes. Toxicity information characterizing dose relationships, which would be useful in arriving at quality criteria, was also generally lacking. Only a few chronic toxicity studies presented information pertinent to the problem of determining health standards. Carcinogenicity, teratogenicity, and mutagenicity studies rarely performed dose-relationship investigations which are of considerable importance due to the fact that measures to entirely eliminate such compounds from freshwater are not a practical possibility in a significant number of instances. Therefore, we ought to know levels which can be tolerated with safety on a long-term basis. Nearly all the literature concerned with determinations of inorganic chemicals in water failed to identify the form of the element found. This is of importance because of the high variability in toxicity between different forms of the same element.

INFORMATION EXTRACTED

The concentrations of chemicals in water were obtained together with information as to source and location. Toxicity information including carcinogenicity, teratogenicity, and mutagenicity was obtained along with available data on duration, dose-effects, comparison of results with control data, species of animals used, effects perceived, and other information likely to be pertinent. Where possible, only the oral route of administration was considered; where this was not available alternative routes of administration were presented and denoted as such. Toxicity data obtained with non-mammalian species could be excluded from this report, as opposed to the organic chemical study in which data on fish was used because of the paucity of pertinent mammalian data.

SECTION V

PROBLEMS IN DATA INTERPRETATION

It should be readily apparent that water contains a mixture of ions. It is logical to assume that the presence of diverse chemical species can either potentiate or mitigate the toxicity of one particular constituent of interest by causing further damage at the site of action, interferring with detoxification mechanisms, competing for the active site, competing for a transport pathway, etc. Unfortunately, toxicity data is collected entirely on pure compounds, and the results of measurements of the water concentration of potentially hazardous materials are usually reported in isolation. Because of the lack of relevant data, we have had to ignore what may be an important consideration.

In our previous report on organic chemical pollution of freshwater and health, comments were made concerning the inadequacy of the analytical methods used on water samples for the determination of the potential health effects of organic pollutants. While most of these arguments apply to this study, further emphasis should be placed on the importance of determining the true identity of materials found in water. As can be seen in Table II, in which the concentration of inorganic materials found in water is listed, except for a few materials such as bicarbonate, no statement is made concerning the ionic form of the materials. This is presumably the result of performing many of these analyses by atomic absorption spectroscopy which does not differentiate between various ionic forms. However, in many cases just the parent elements have been identified. Since toxicity is based upon the various ionic species, the data is of little value in applying pertinent toxicity information and evaluating the hazards to health.

Both the ionic species with different oxidation numbers and the various oxidized and complex forms of the elements are important. A few examples can best illustrate this consideration. Chromium ion in the +6 oxidation state shows a chronic toxicity when administered at 5 mg/l/day. Chromium with a +3 oxidation number, however, does not show any toxicity at this dose level. Tellurium with a +6 oxidation number has been reported to be a positive carcinogen. However, tellurium with a +4 oxidation number has been demonstrated in like experiments to be negative insofar as cancer producing activity is concerned. Finally, in terms of acute toxicity, arsenite will kill animals at a dose of 18 mg/kg of body weight. However, arsenate ion is more than 10 times less toxic, causing lethal effects at 238 mg/kg. These examples should show the inportance of improving analytical methods to differentiate chemical species if this data is to be applied to questions of human health.

In the study on organic pollutants, we dealt extensively with the problem of choosing model animal species. The same consideration applies here. For instance, when niobium ion was tested in the mouse it was found to decrease the growth rate but increase the longevity of the animal. However, when tested in the rat, the growth rate was significantly increased while the longevity was decreased. In neither species was survival affected. In trying to extrapolate to man, there is no basis for determing whether man reacts like the rat or mouse.

In reviewing the literature, difficulty in making objective determinations of toxicity are hindered by the increased publicity and speculation in the area of the health hazard of pollutants. Thus, the current strong emphasis on mercury pollution has focused attention in that direction. On the basis of its concentration in water, mercury in water *per se* is much less of a problem to human health than a number of other compounds found in the course of this study. The mercuric ion has been reported as being present mainly in slit and not in water. The high concentrations of mercury approaching what might be toxic levels are never found in water but in hydrophobic materials in which they can be concentrated (such as the flesh of fish). Another area of speculation relates to the potential toxicity of nitrates resulting from an interaction of this ion with secondary amines so as to yield nitrosoamines with carcinogenic capability. However, since such reactions in dilute aqueous media remain in the realm of speculation, we have not included information indicating nitrites as toxic in this sense.

As opposed to the organic pollutants, some inorganic compounds appear to be beneficial. There apparently is an optimal level of fluoride at which beneficial results are obtained. The same is true of iodine. Increasing interest is being expressed on the association between cardiovascular disease and the mineral content of water. A definite correlation between increased cardiovascular disease, bronchitis, and other causes of death has been made with the calcium content of waters (35). Such information found in the literature, however, is not directly pertinent to the direction of this study, but it has occasionally been included with data on the toxicity of such materials.

SECTION VI

INORGANIC CHEMICALS IN FRESHWATER

POTENTIAL INORGANIC POLLUTANTS IN FRESHWATER

Table I lists the non-radioactive inorganic pollutants which we believe are of potentital concern in freshwater. The list has been compiled from among all those potential ions, salts, and organometallic compounds which theoretically might be found in freshwater. Specifically, only those compounds which are both soluable and stable in water are included. Since most inorganic compounds which are soluble in water ionize, the list is composed primarily of ions.

Although an unlimited number of inorganic compounds theoretically exist, those expected in freshwater are limited to those contained in this list. The major reason for this is that many inorganic compounds and organometallic compounds do not occur in any significant extent in nature, nor are they involved in industrial processes which would release them into freshwater. Also, the long list of salts to be found in various reference volumes are not pertinent to the potential inorganic pollutants of freshwater. As mentioned above, these salts are either insoluble or they dissociate to ions in water such that those specific combinations of cations with anions which yield salts are not relevant to water pollution.

Even when one considers the ions alone, however, most can be discounted from being in water. This is because most are laboratory curiosities which in the presence of the hydrolytic and oxidative environment decompose upon solution. Thus, most complex ions in dilute solution become simpler ionic species; oxides become hydroxides, hydrides release hydrogen, etc. Disproportionation and neutralization reactions are also important.

Another factor to be considered is hydration effects. Metals, for instance, cannot be found as pollutants in freshwater but only in sediments. Although justification can be made for considering such sediments in suspension to be part of the water and thus involved in health effects, we have not done so here. Thus, in the text and tables, an uncharged elemental chemical species refers to an undefined ionic or other soluble form of the parent element. Certain metals, of course, do become hydrated and ionized upon addition to water.

The reaction of metallic sodium to yield sodium ion in water is well known. In this fashion we have considered only those forms of elements which would be present in water and these are the inorganic chemicals which are listed in Table I. Thus, liquid bromine can exist dissolved in water. Likewise, oxygen gas can exist in water in a dissolved form. However, with a gas such as sulphur dioxide (SO_2), the form found in water is the sulfite ion and it is only this form of SO_2 which has been considered here.

Insofar as the organometallic compounds and a few non-charged inorganic compounds are concerned, solubility is the limiting factor. Those compounds which are defined as insoluble, although perhaps reaching minute levels in water, have not been considered as being pollutants. Therefore, most of the organometallic compounds are excluded.

One further note should be made concerning carbon. One entry exists in the Table for "elemental" carbon. However, this is included only as an example. Except for carbonate and bicarbonate ions, we have considered that measures of the carbon content of water refer to organic species which have been included in our previous report on the "Water Quality Criteria Data Book Volume I, Organic Chemical Pollution of Freshwater."

TABLE I - LISTING OF INORGANIC POLLUTANTS IN FRESH WATER

Aluminum	Al
aluminum ion	Al^{+++}
Antimony	Sb
stibous	Sb^{+++}
stibic	Sb^{+++++}
triethylantimony	$Sb(C_2H_5)_3$
Argon	A
Arsenic	As
arsenous	As^{+++}
arsenic	As^{+++++}
arsenide	As^{---}
metaarsenite	AsO_2^-
arsenite	AsO_3
metaarsenate	AsO_3^-
arsenate	AsO_4^{---}
cacodylate	$As(CH_3)_2^{++}$
methylarsenate	$HasCH_3^-$
phenylarsenate	$C_6H_5AsO_3H^-$
arsine	H_3As
trimethylarsine	$As(CH_3)_3$
tetramethyldiarsyl	$As_2(CH_3)_4$
Barium	Ba
barium ion	Ba^{++}
Beryllium	Be
beryllium ion	Be^{++}
Bismuth	Bi
bismuthous	Bi^{++}
bismuthic	Bi^{+++}
Boron	B
boron ion	B^{+++}
metaborate	BO_2^-
peroxyborate	BO_3^-
borate	BO_3^{---}
diborate	$B_2O_5^{----}$
tetraborate	$B_4O_7^{--}$
pentaborate	$B_5O_8^-$
borotungstate	$BW_{12}O_{40}^{-----}$
organoborate	RBO_2H^-
trimethylboron	$B(CH_3)_3$
decaborane	$B_{10}H_{14}$
Bromine	Br
bromide	Br^-
bromate	BrO_3^-
hypobromate	BrO^-
bromaurate	$AuBr_4^-$
bromoplatinate	$PtBr_6^{--}$
bromoselenate	$SeBr_6^{--}$
bromostannate	$SnBr_6^{--}$
liquid bromine	Br_2
Cadmium	Cd
cadmium ion	Cd^{++}
Calcium	Ca
calcium ion	Ca^{++}
Carbon	C
carbonate	CO_3^{--}
bicarbonate	HCO_3^-
carbon monoxide	CO
carbon dioxide	CO_2
carbonyl sulfide	COS
carbon disulfide	CS_2

TABLE I -(CONT.) - LISTING OF INORGANIC POLLUTANTS IN FRESH WATER

Cerium	Ce
cerrous	Ce^{+++}
cerric	Ce^{++++}
Cesium	Cs
cesium ion	Cs^{+}
Chlorine	Cl
chloride	Cl^{-}
hypochlorite	ClO^{-}
chlorate	ClO_3^{-}
perchlorate	ClO_4^{-}
chloraurate	$AuCl_4^{-}$
chloroplatinate	$PtCl_6^{--}$
chlorostannate	$SnCl_6^{--}$
chloroplumbate	$PbCl_6^{--}$
chlorine gas	Cl_2
Chromium	Cr
chromous	Cr^{++}
chromic	Cr^{+++}
chromate	CrO_4^{--}
peroxychromate	CrO_8^{---}
dichromate	$Cr_2O_7^{--}$
Cobalt	Co
cobaltous	Co^{++}
cobaltic	Co^{+++}
Copper	Cu
cuprous	Cu^{+}
cupric	Cu^{++}
Dysprosium	Dy
Erbium	Er
Europium	Eu

Fluorine	F
fluoride	F^{-}
fluoborate	BF_4^{-}
hexabluophosphate	PF_6^{-}
fluorophosphate	PO_3F^{--}
difluorophosphate	$PO_2F_2^{-}$
fluosilicate	SiF_6^{--}
fluoaluminate	AlF_6^{---}
fluosulfonate	SO_3F^{-}
fluorine gas	F_2
Gadolinium	Gd
Gallium	Ga
Germanium	Ge
ethylgermanium oxide	$(C_2H_5GeO)_2O$
Gold	Au
aurous	Au^{+}
auric	Au^{+++}
Hafnium	Hf
Helium	He
Holmium	Ho
Hydrogen	H
hydrogen ion	H^{+}
hydrogen gas	H_2
deuterium	D
Indium	In
Iodine	I
iodide	I^{-}
iodate	IO_3^{-}
periodate	IO_4^{-}
paraperiodate	HIO_5^{--}
iodine solid	I_2

TABLE I (CONT.) - LISTING OF INORGANIC POLLUTANTS IN FRESH WATER

Iridium	Ir
Iron	Fe
ferrous	Fe^{++}
ferric	Fe^{+++}
ferrocyanide	$Fe(CN)_6^{---}$
ferricyanide	$Fe(CN)_6^{----}$
Krypton	Kr
Lanthanum	La
Lead	Pb
plumbic	Pb^{++}
plumbate	PbO_4^{----}
Lithium	Li
lithium ion	Li^+
Lutetium	Lu
Magnesium	Mg
magnesium ion	Mg^{++}
Manganese	Mn
manganous	Mn^{++}
manganic	Mn^{+++}
permanganate	MnO_4^-
manganate	MnO_4^{--}
Mercury	Hg
mercurous	Hg^+
mercuric	Hg^{++}
ammonomercuric	$Hg(NH_2)^+$
organomercuric	RHg^+
diorganomercury	HgR_2
Molybdenum	Mo
molybdic	Mo^{++++++}
molybdate	MoO_4^{--}
paramolybdate	$Mo_7O_{24}^{------}$
phosphomolybdate	$PMo_{12}O_{40}^{---}$
Neodymium	Nd
Neon	Ne
Nickel	Ni
nickelous	Ni^{++}
hexaminenickel	$Ni(NH_3)_6^{--}$
Niobium	Nb
Nitrogen	N
azide	N_3^-
nitrite	NO_2^-
nitrate	NO_3^-
cyanide	CN^-
cyanate	OCN^-
thiocyanate	SCN^-
ammonium	NH_4^+
carbamate	$NH_2CO_2^-$
cyanaurate	$Au(CN)_4^-$
cyanocobaltate	$Co(CN)_6^{---}$
nitrogen gas	N_2
nitrous oxide	N_2O
nitric oxide	NO
hydrazine	NH_2NH_2
hydroxylamine	NH_2OH
Osmium	Os
Oxygen	O
peroxide	O_2^{--}
hydroxide	OH^-
oxygen gas	O_2
ozone	O_3
Palladium	Pd

TABLE I (CONT.) - LISTING OF INORGANIC POLLUTANTS IN FRESH WATER

Phosphorus	P
metaphosphate	PO_3^-
hypophosphate	PO_3^{--}
phosphite	PO_3^{---}
phosphate	PO_4^{---}
pyrophosphate	$P_2O_7^{----}$
hypophosphite	$H_2PO_2^-$
phosphine	H_3P
Platinum	Pt
platinic	Pt^{++++}
Potassium	K
potassium ion	K^+
Praseodymium	Pr
Radium	Ra
Rhenium	Re
perrhenate	ReO_4^-
Rhodium	Rh
Rubidium	Rb
rubidium ion	Rb^+
Ruthenium	Ru
Samarium	Sm
Scandium	Sc
Selenium	Se
selenium ion	Se^{++++}
selenide	Se^{--}
selenite	SeO_3^{--}
selenate	SeO_4^{--}
Silicon	Si
metasilicate	SiO_3^{--}
silicate	SiO_4^{----}
disilicate	$Si_2O_5^{--}$
Silver	Ag
argentous	Ag^+
argentic	Ag^{++}
Sodium	Na
sodium ion	Na^+
Strontium	Sr
strontium ion	Sr^{++}
Sulfur	S
sulfide	S^{--}
sulfite	SO_3^{--}
sulfate	SO_4^{--}
thiosulfate	$S_2O_3^{--}$
hydrosulfite	$S_2O_4^{--}$
pyrosulfite	$S_2O_5^{--}$
dithionate	$S_2O_6^{--}$
pyrosulfate	$S_2O_7^{--}$
peroxydisulfate	$S_2O_8^{--}$
trithionate	$S_3O_6^{--}$
tetrathionate	$S_4O_6^{--}$
pentathionate	$S_5O_6^{--}$
sulfur dioxide	SO_2
hydrogen sulfide	H_2S
Tantalum	Ta
Tellurium	Te
tellurate	TeO_4^{--}
diethyl telluride	$(C_2H_5)_2Te$
dimethyl telluronium-dichloride	$C_2H_6Cl_2Te$
Terbium	Tb
Thallium	Tl
thallium ion	Tl^+
Thorium	Th

TABLE I (CONT.) - LISTING OF INORGANIC POLLUTANTS IN FRESH WATER

Thulium	Tm
Tin	Sn
stannous	Sn^{++}
stannic	Sn^{++++}
organostannic	RSn^{+++}
diorganostannic	R_2Sn^{++}
Titanium	Ti
Tungsten	W
tungsten ion	W^{++++}
tungstate	WO_4^{--}
phosphotungstate	$P(W_3O_{10})_4^{---}$
Uranium	U
uranous	U^{++++}
uranic	U^{++++++}
Vanadium	V
vanadate	VO_3^{-}
Xenon	Xe
Ytterbium	Yb
Yttrium	Y
Zinc	Zn
zinc ion	Zn^{++}
Zirconium	Zr

CONCENTRATION OF INORGANIC POLLUTANTS IN FRESHWATER

Table II lists the concentrations of inorganic pollutants found in freshwater. Where large amounts of detailed information were available, average or range of concentations are given with dates over which determinations were made. The source of the chemical is given where this information was available, together with the location where the sample was obtained. No attempt was made in searching through the literature to assess the quality of the quantitative results. Techniques used by different investigators, sampling methods, and the sensitivity of analytical procedures were not assessed. In almost every instance, the agent cited was the essential element, with no description of the ionic form included. Therefore, it is difficult to relate the reported concentrations to health because toxicity is dependent upon the ionic, salt, or complex forms of the element.

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Aluminum Al		New Jersey Surface water		1968	241
		1) spring flow	0.09-0.33		
		2) summer flow	0.08-0.31		
	Industrial waste, mine drainage	Northeast Basin	Mean Positive: 0.028	1962-67	111
		North Atlantic Basin	0.022		
		Southeast Basin	0.117		
		Tennessee R. Basin	0.030		
		Ohio R. Basin	0.141		
		Lake Erie Basin	0.056		
		Upper Mississippi R. Basin	0.018		
		Western Great Lakes Basin	0.017		
		Missouri R. Basin	0.213		
		Lower Mississippi R. Basin	0.068		
		Colorado R. Basin	0.050		
		Western Gulf Basin	0.333		
		Pacific Northwest Basin	0.030		
		California Basin	0.063		
		Great Basin	0.015		
		Alaska Basin	0.011		
		Yellowstone R. near Sidney, Mont.	2.760 (max. conc.)		111
	Weathering of rock	Apalachicola R. near Blounstown, Fla.	0.073-2.550	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.462-1.640		
		Colorado R. at Yuma, Ariz.	0.012-0.153		
		Columbia R. above Dalles, Oreg.	0.082-0.238		
		Hudson R. at Green Island, N.Y.	0.225-0.775		
		Mississippi R. near Baton Rouge, La.	0.281-1.050		
		Mobile R. at Mt. Vernon Landing, Ala.	0.084-0.818		
		Sacramento R. at Sacramento, Calif.	0.060-1.110		
		Susquehanna R. at Conowingo, Md.	0.027-0.102		
		Yukon R. at Mountain Village Alaska	0.082		

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Aluminum (con t.)	Weathering of rock	Streams in California	Average: 0.015		222
	Weathering of rock and acid waters	North Atlantic Slope Basins (max. at Potomac R. at Kitzmiller, Md.)	0.0-6.2	1964-65	178
		Ohio R. Basin (max. at Trade-water R. at Olney, Ky.)	0.0-21.0	1964-65	179
		St. Lawrence R. Basin (max. at St. Louis R. at Scanlon, Minn.)	0.0-1.3		179
		Missouri R. Basin (max. at Cedar Creek near Columbia, Mo.)	0.0->6.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Chippewa R. near Milan, Minn.)	0.0-2.9		180
		California Gulch and Arkansas R. at Malta, Colo. (max. at California Gulch)	<0.0025-11.6	1964-65	181
		Lehigh R. Basin (max. at Lehigh R. at Walnutport, Pa. - 1950)	0.0-1.7	1945-66	180
Antimony Sb	Weathering of rock	Principal rivers of U.S.	None detected	1958-59	47,58
		Selected drinking water supplies in:			
		Delaware	<0.0100-<0.0200	1962-63	44
		New York	<0.0030-<0.0400		
		Pennsylvania	<0.0100-<0.0200		
		Kentucky	<0.0090		
		Maryland	<0.0070-<0.0080		
		North Carolina	<0.0050-<0.0100		
		Virginia	<0.0060-<0.0100		
		West Virginia	<0.0200		
		Alabama	<0.0030-<0.0300		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Antimony (cont.)		Selected drinking water supplies in:		
		Florida	<0.0100-<0.0200 1962-63	44
		Georgia	<0.0030-<0.0200	
		Mississippi	<0.0060-<0.0300	
		South Carolina	<0.0070	
		Tennessee	<0.0080-<0.0100	
		Illinois	<0.0200-<0.0300	
		Indiana	<0.0200-<0.0400	
		Michigan	<0.0020-<0.0200	
		Ohio	<0.0100-<0.0300	
		Wisconsin	<0.0200-<0.0300	
		Iowa	<0.0200-<0.0300	
		Kansas	<0.0300-<0.0500	
		Minnesota	<0.0040-<0.0100	
		Missouri	<0.0100-<0.0300	
		Nebraska	<0.0300-<0.0400	
		North Dakota	<0.0250-<0.0350	
		South Dakota	<0.0500-<0.0700	
		Louisiana	<0.0200	
		New Mexico	<0.0200-<0.0500	
		Oklahoma	<0.0400-<0.0500	
		Texas	<0.0200-0.1000	
		Colorado	<0.0090-<0.0200	
		Idaho	<0.0600	
		Montana	<0.0100	
		Utah	<0.0200-<0.0400	
		Arizona	<0.0800	
		California	<0.0090-<0.0700	
		Hawaii	<0.0020	
		Oregon	<0.0080	
		Washington	<0.0020-0.0200	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Arsenic As		Kansas R. at Lawrence	0.003	1970	132
		Kansas R. at Topeka	0.008	1970	168,36
	Laundry detergent discharge into sewage system	Kansas R. and Lawrence R.	0.002-0.010	1970	9
		Kansas R.	0.002-0.008		7
	Mineral rock; waste from industry and mining activity; residues from pesticides	Northeast Basin	Mean Positive: 0.034	1962-67	111
		North Atlantic Basin	0.047		
		Southeast Basin	0.035		
		Tennessee R. Basin	0.050		
		Ohio R. Basin	0.066		
		Lake Erie Basin	0.308		
		Upper Mississippi R. Basin	0.069		
		Western Great Lakes Basin	0.037		
		Missouri R. Basin	0.123		
		Lower Mississippi R. Basin	0.091		
		Colorado R. Basin	0.053		
		Western Gulf Basin	0.022		
		Pacific Northwest Basin	0.068		
		Great Basin	0.020		
		Alaska Basin	0.034		
		Maumee R. at Toledo, Ohio	0.336 (max. conc.)		111
		Principal rivers of U.S.	None detected	1958-59	47,58
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Tolt R. near Carnation, Wash.)	0.0-0.01	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.0-0.01	1964-65	183
		Snake R. Basin	0.0		183

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Arsenic (cont.)		Selected drinking water supplies in:			
		Connecticut	<0.010	1962-63	44
		Maine	<0.010		
		Massachusetts	-		
		New Hampshire	<0.010		
		Vermont	<0.010		
		Delaware	<0.010		
		New York	<0.010		
		Pennsylvania	<0.010		
		Kentucky	<0.010		
		Maryland	<0.010		
		North Carolina	<0.010		
		Virginia	<0.010		
		W. Virginia	<0.010		
		Alabama	<0.010		
		Florida	<0.010		
		Georgia	<0.010		
		Mississippi	<0.010		
		South Carolina	<0.010		
		Tennessee	<0.010		
		Illinois	<0.010		
		Indiana	<0.010		
		Michigan	<0.010		
		Ohio	<0.010		
		Wisconsin	<0.010		
		Iowa	<0.010		
		Kansas	<0.010		
		Minnesota	<0.010		
		Missouri	<0.010		
		Nebraska	<0.010		
		North Dakota	<0.010		
		South Dakota	<0.010		
		Louisiana	<0.010		
		New Mexico	<0.010		
		Oklahoma	<0.010		
		Texas	<0.010		
		Colorado	0.000-<0.010		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Arsenic (cont.)		Selected drinking water supplies in:			
		Idaho	<0.010-0.010	1962-63	44
		Montana	<0.010		
		Utah	<0.010		
		Arizona	<0.010		
		California	<0.010-0.020		
		Hawaii	<0.010		
		Nevada	-		
		Oregon	<0.010		
		Washington	<0.010		
Barium Ba	Weathering of rock; brines from oil well wastes	Northeast Basin	Mean Positive: 0.021	1962-67	111
		North Atlantic Basin	0.025		
		Southeast Basin	0.026		
		Tennessee R. Basin	0.025		
		Ohio R. Basin	0.043		
		Lake Erie Basin	0.042		
		Upper Mississippi R. Basin	0.039		
		Western Great Lakes Basin	0.015		
		Missouri R. Basin	0.063		
		Lower Mississippi R. Basin	0.090		
		Colorado R. Basin	0.060		
		Western Gulf Basin	0.067		
		Pacific Northwest Basin	0.027		
		California Basin	0.042		
		Great Basin	0.041		
		Alaska Basin	0.017		
		Coosa R. Below Rome, Ga.	0.340 (max. conc.)		111
	Weathering of rock; brines from oil well wastes	Apalachicola R. at Blounstown, Fla.	0.021-0.042	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.043-0.132		
		Colorado R. at Yuma, Ariz.	0.128-0.152		
		Columbia R. above Dalles, Oreg.	0.033-0.048		
		Hudson R. at Green Island, N.Y.	0.028-0.060		
		Mississippi R. Near Baton Rouge, La.	0.072-0.127		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Barium (cont.)	Weathering of rock, brines from oil well wastes	Mobile R. at Mt. Vernon Landing, Ala.	0.047-0.075	1958-59	47,58
		Sacramento R. at Sacramento, Calif.	0.009-0.056		
		Susquehanna R. at Conowingo, Md.	0.024-0.038		
		Yukon R. at Mountain Village, Alaska	0.026-0.109		
	Weathering of rock, brines from oil well wastes	North Atlantic Slope Basins (max. at Assunpink Creek at Trenton, N.J.)	0.010-0.150	1964-65	178
		Selected drinking water supplies in:			
		Connecticut	0.005	1962	49
		Maine	0.0020		
		New Hampshire	0.0040-0.0060		
		Vermont	0.0060		
		Delaware	0.0050-<0.0100		
		New York	<0.0006-0.0800		
		Pennsylvania	0.0020-0.0400		
		Kentucky	0.0300		
		Maryland	0.0060-0.0130		
		North Carolina	<0.0010-<0.0030		
		Virginia	0.0100-<0.0230		
		West Virginia	0.0200		
		Alabama	0.0008-0.0800		
		Florida	0.0030-0.0080		
		Georgia	<0.0007-0.0190		
		Mississippi	0.0300		
		S. Carolina	0.0130-0.0300		
		Tennessee	0.008-0.0300		
		Illinois	0.0200-0.0300		
		Indiana	<0.0050-0.0400		
		Michigan	0.0020-0.0200		
		Ohio	0.0050-0.0900		
		Wisconsin	0.0030-0.0100		
		Iowa	<0.0040-0.0200		
		Kansas	<0.0070-0.1000		
		Minnesota	<0.0030-0.0030		
		Missouri	0.0100-0.0900		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Barium (cont.)		Selected drinking water supplies in:		
		Nebraska	0.0070-<0.0090 1962-63	44
		North Dakota	<0.0060-<0.0090	
		South Dakota	0.0200-3.0000	
		Louisiana	<0.0050-0.0710	
		New Mexico	0.0250-0.0500	
		Oklahoma	0.0030-0.0090	
		Texas	0.0200-0.2000	
		Colorado	<0.0020-0.0200	
		Idaho	<0.0100-0.0100	
		Montana	<0.0020=0.0100	
		Utah	0.0050=0.0400	
		Arizona	0.0140-0.1230	
		California	<0.0020-0.0700	
		Hawaii	<0.0005	
		Nevada	0.0220	
		Oregon	0.0050	
		Washington	0.0020-0.0600	
Beryllium Be	Effluent from atomic reactors, metallurgy, aircraft, rocket and missile fuel industries; weathering of mineral beryl	Drinking water	0.00001-0.0007	238
		Northeast Basin	Mean Positive: 0.0002 1962-67	111
		North Atlantic Basin	0.00012	
		Southeast Basin	0.00005	
		Tennessee R. Basin	0.00016	
		Ohio R. Basin	0.00028	
		Lake Erie Basin	0.00017	
		Western Great Lakes Basin	0.00005	
		Missouri R. Basin	0.00023	
		Pacific Northwest Basin	0.00002	
		Monongahela R. at Pittsburgh, Pa.	0.00122 1962-67 (max. conc.)	111

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Beryllium (cont.)	Weathering of mineral beryl	Apalachicola R. at Blounstown, Fla.	0-<0.000058	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0-<0.00022		
		Colorado R. at Yuma, Ariz.	0.0		
		Columbia R. above Dalles, Oreg.	0.0		
		Hudson R. at Green Island, N.Y.	0.0		
		Mississippi R. near Baton Rouge, La.	0.0		
		Mobile R. at Mt. Vernon Landing, Ala.	0.0		
		Sacramento R. at Sacramento, Calif.	0.0		
		Susquehanna R. at Conowingo, Md.	0.0		
		Yukon R. at Mountain Village, Alaska	0.0		
		Streams in California	None detected		222
	Weathering of rock	North Atlantic Slope Basins (max. at Delaware R. at Trenton, N.J.)	<0.00005-<0.0024	1964-65	178
		Lower Mississippi R. Basin: California Gulch, Arkansas R. and a few minor streams (max. at California Gulch at Malta, Colorado)	0.0-<0.040		181
		Selected drinking water supplies in:		1962-63	44
		Connecticut	0.00000	1962-63	
		Maine	0.00000		
		Massachusetts	-		
		New Hampshire	0.00000-<0.00001		
		Vermont	<0.00001		
		Delaware	<0.00070-<0.00100		
		New York	<0.00002-<0.00100		
		Pennsylvania	<0.00001-<0.00100		
		Kentucky	<0.00004		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Beryllium (cont.)		Selected drinking water supplies in:		
		Maryland	<0.00001-<0.00004 1962-63	44
		North Carolina	<0.00003-<0.00050	
		Virginia	<0.00002-<0.00006	
		W. Virginia	<0.00010	
		Alabama	<0.00002-<0.00010	
		Florida	<0.00002-<0.00070	
		Georgia	<0.00001-<0.00100	
		Mississippi	<0.00003-<0.00100	
		South Carolina	<0.00001-<0.00003	
		Tennessee	<0.00004-<0.00006	
		Illinois	<0.00010-<0.00200	
		Indiana	<0.00010-<0.00200	
		Michigan	<0.00001-<0.00100	
		Ohio	<0.00005-<0.00200	
		Wisconsin	<0.00003-<0.00100	
		Iowa	<0.00010	
		Kansas	<0.00020	
		Minnesota	<0.00020-<0.00060	
		Missouri	<0.00007-<0.00010	
		Nebraska	<0.00020	
		North Dakota	<0.00100-<0.00200	
		South Dakota	<0.00030	
		Louisiana	<0.00005-<0.00100	
		New Mexico	<0.00100-<0.00250	
		Oklahoma	<0.00020-<0.00030	
		Texas	<0.00004-<0.00500	
		Colorado	<0.00050-<0.00100	
		Idaho	<0.00030-<0.0050	
		Montana	<0.00005-<0.00007	
		Utah	<0.00100-<0.00250	
		Arizona	<0.00010-<0.00040	
		California	<0.00004-<0.00040	
		Hawaii	<0.00001	
		Nevada	<0.00002	
		Oregon	<0.00040	
		Washington	<0.00001-0.00008	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Bismuth Bi	Weathering of rock	Principal rivers of U.S.	None detected	1958-59	47,58
		Streams in California	0.0006-0.0008		232
	Weathering of rock	Lower Mississippi R. Basin: California Gulch and Arkansas R. at Malta, Colorado (max. at California Gulch)	<0.00026-<0.020	1954-55	181
		Selected drinking water supplies in:			
		Connecticut	0.0000	1962-63	44
		Maine	<0.0003		
		New Hampshire	<0.0003		
		Vermont	<0.0008		
		Delaware	<0.0070-<0.0100		
		New York	<0.0020-<0.0200		
		Pennsylvania	<0.0004-<0.0300		
		Kentucky	<0.0040		
		Maryland	<0.0010-<0.0030		
		North Carolina	<0.0030-<0.0050		
		Virginia	<0.0020-<0.0060		
		W. Virginia	<0.0100		
		Alabama	<0.0020-<0.0100		
		Florida	<0.0020-<0.0100		
		Georgia	<0.0010-<0.0100		
		Mississippi	<0.0030-<0.0100		
		South Carolina	<0.0010-<0.0030		
		Tennessee	<0.0040-<0.0060		
		Illinois	<0.0100-<0.0150		
		Indiana	<0.0100-<0.0200		
		Michigan	<0.0010-<0.0100		
		Ohio	<0.0050-<0.0160		
		Wisconsin	<0.0020-<0.0100		
		Iowa	<0.0100		
		Kansas	<0.0200		
		Minnesota	<0.0020-<0.0060		
		Missouri	<0.0070-<0.0100		
		Nebraska	<0.0200-0.0200		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Bismuth (cont.)		Selected drinking water supplies in:		
		North Dakota	<0.0100-<0.0200 1962-63	44
		South Dakota	<0.0300	
		Louisiana	<0.0400-<0.0100	
		New Mexico	<0.0100-<0.0250	
		Oklahoma	<0.0200-<0.0300	
		Texas	<0.0030-<0.0500	
		Colorado	<0.0050-<0.0100	
		Idaho	<0.0300	
		Montana	<0.0050-<0.0070	
		Utah	<0.0080-<0.0250	
		Arizona	<0.0090-<0.0400	
		California	<0.0040-<0.0400	
		Hawaii	<0.0010	
		Nevada	<0.0020	
		Oregon	<0.0040	
		Washington	<0.0010-0.0080	
Boron B	Large masses of boron-bearing rock	California	100	257
	Weathering of boron-bearing rock; waste from cleaning operations	Northeast Basin	Mean Positive: 0.032 1962-67	111
		North Atlantic Basin	0.042	
		Southeast Basin	0.029	
		Tennessee R. Basin	0.024	
		Ohio R. Basin	0.067	
		Lake Erie Basin	0.210	
		Upper Mississippi R. Basin	0.105	
		Western Great Lakes Basin	0.019	
		Missouri R. Basin	0.154	
		Lower Mississippi R. Basin	0.131	
		Colorado R. Basin	0.179	
		Western Gulf Basin	0.289	
		Pacific Northwest Basin	0.030	
		California Basin	0.143	
		Great Basin	0.084	
		Alaska Basin	0.028	
		Colorado R. at Yuma, Ariz.	1.800 (max. conc.)	111

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Boron (cont.)	Weathering of rock	Apalachicola R. at Blounstown, Fla.	0.005-0.011	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.014-0.019		
		Colorado R. at Yuma, Ariz.	0.034-0.052		
		Columbia R. at Dalles, Oreg.	0.0039-0.011		
		Hudson R. at Green Island, N.Y.	0.009-0.020		
		Mississippi R. near Baton Rouge, La.	0.0061-0.029		
		Mobile R. at Mt. Vernon Landing, Ala.	0.0016-0.017		
		Sacramento R. at Sacramento, Calif.	0.0098-0.025		
		Susquehanna R. at Conowingo, Md.	0.0043-0.016		
		Yukon R. at Mountain Village, Alaska	0.011-0.013		
	Weathering of rock	Colorado R. Basin (max. at Virgin R. at Littlefield, Ariz.)	0.0-1.0	1964-65	182
		Pacific Slope Basins in Calif. (max. at Cache Creek near Capay, Calif.)	0.0-4.8		
		Great Basin excluding Great Salt Lake (max. at Humboldt R. near Rye Patch, Nev.)	0.0-0.6	1964-65	183
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Colville R. at Kettle Falls, Wash.)	0.0-0.15		183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.0-0.12		183
		Snake R. Basin (max. at Palouse R. at Hooper, Wash.)	0.0-0.09		183
		North Atlantic Slope Basins (max. at Raritan R. at Manville, N.J.)	0.006-0.57		178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Choctawhatchee R. near Newton, Ala.)	0.0-0.22		178

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Boron (cont.)		St. Lawrence R. Basin (max. at St. Louis R. at Scanlon, Minn.)	0.02-0.26	1964-65	111
		Missouri R. Basin (max. at Horse Creek near Vale, S. Dak.)	0.0-1.3	1964-65	180
		Hudson R. and Upper Mississippi R. Basin (max. at Mission Bay of Devils Lake near Devils Lake, N. Dak.)	0.0-6.5		180
		Lower Mississippi R. Basin (max. at Cottonwood R. near Plymouth, Kans.)	0.0-3.1	1964-65	181
		Western Gulf of Mexico Basins (max. at Rio Grande at El Paso, Tex.)	0.0-0.74		181
		Illinois surface waters (max. at Kaskaskia R. at Shelbyville-1960)	0.0-0.7	1956-66	86
		Selected drinking water supplies in:			
		Connecticut	0.090	1962-63	44
		Maine	0.060		
		Massachusetts	-		
		New Hampshire	0.050-0.060		
		Vermont	0.050		
		Delaware	0.070-0.140		
		New York	0.000-0.140		
		Pennsylvania	0.040-0.150		
		Kentucky	0.170		
		Maryland	0.010-0.110		
		North Carolina	0.020-0.060		
		Virginia	0.030-0.380		
		W. Virginia	0.120		
		Alabama	0.020-0.210		
		Florida	0.020-0.120		
		Georgia	0.020-0.110		
		Mississippi	0.020-0.740		
		South Carolina	0.020-0.090		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Boron (con t.)		Selected drinking water supplies in:			
		Tennessee	0.070-0.110	1962-63	44
		Illinois	0.090-0.110		
		Indiana	0.020-0.150		
		Michigan	0.000-0.100		
		Ohio	0.020-0.140		
		Wisconsin	0.030-0.090		
		Iowa	0.120-0.150		
		Kansas	0.170		
		Minnesota	0.020-0.030		
		Missouri	0.060-0.100		
		Nebraska	0.080-0.210		
		North Dakota	0.120-0.200		
		South Dakota	0.080-0.210		
		Louisiana	0.030-0.740		
		New Mexico	0.030-0.090		
		Oklahoma	0.150-0.170		
		Texas	0.030-0.560		
		Colorado	0.070-0.130		
		Idaho	0.170-0.210		
		Montana	0.050-0.120		
		Utah	0.020-0.080		
		Arizona	0.020-0.620		
		California	0.030-0.500		
		Hawaii	0.020		
		Nevada	0.040		
		Oregon	0.040		
		Washington	0.000-0.100		
Bromine Br	Rainfall, combustion of leaded gasoline containing ethylene dibromide	Lake Superior, Mich.	0.007-0.033	1969	239
		Lake Superior tributaries	0.005-0.260		
		Lake Michigan	0.011-0.021		
		Lake Huron	0.013-0.029		
		St. Clair R.	0.019-0.039		
		Lake St. Clair	0.045-0.055		
		Detroit R.	0.020-0.028		
		Lake Erie	0.020-0.054		
		Lake Ontario	0.038-0.077		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Cadmium Cd	Electroplating plants; weathering of ores	Northeast Basin	Mean Positive: 0.005	1962-67	111
		North Atlantic Basin	0.003		
		Southeast Basin	0.005		
		Ohio R. Basin	0.007		
		Lake Erie Basin	0.050		
		Upper Mississippi R. Basin	0.006		
		Western Great Lakes Basin	0.005		
		Colorado R. Basin	0.002		
		Western Gulf Basin	0.010		
		Packfic Northwest Basin	0.005		
		Great Basin	0.001		
		Cuyahoga R. at Cleveland, Ohio	0.120 (max. conc.)		111
	Weathering of rock	Principal rivers of U.S.	None detected	1958-59	47,58
		Streams in California	None detected		222
	Weathering of rock	Lower Mississippi R. Basin: California Gulch, Arkansas R. and a few minor streams (max. at California Gulch at Malta, Colo.)	0.0-<0.100	1964-65	181
		Selected drinking water supplies in:			
		Connecticut	0.0000	1962-63	44
		Maine	0.0001		
		New Hampshire	<0.0001		
		Vermont	0.0003		
		Delaware	<0.0030-<0.0050		
		New York	<0.0010-<0.0100		
		Pennsylvania	0.0001-<0.0120		
		Kentucky	<0.0030		
		Maryland	<0.0010-0.0020		
		North Carolina	<0.0020-<0.0030		
		Virginia	<0.0010-<0.0040		
		West Virginia	<0.0060		
		Alabama	<0.0008-<0.0080		
		Florida	0.0005-<0.0050		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Cadmium (cont.)		Selected drinking water supplies in:			
		Georgia	<0.0010-<0.0050	1962-63	44
		Mississippi	<0.0020-<0.0060		
		South Carolina	<0.0020- 0.0030		
		Tennessee	<0.0020-<0.0040		
		Illinois	<0.0050-<0.0080		
		Indiana	<0.0050-<0.0100		
		Michigan	<0.0006-<0.0050		
		Ohio	<0.0030-<0.0080		
		Wisconsin	<0.0005-<0.0090		
		Iowa	<0.0060- 0.0090		
		Kansas	<0.0100		
		Minnesota	<0.0010-<0.0030		
		Missouri	<0.0040-<0.0070		
		Nebraska	<0.0100		
		North Dakota	<0.0060-<0.0090		
		South Dakota	<0.0200		
		Louisiana	<0.0010-<0.0050		
		New Mexico	<0.0060-<0.0130		
		Oklahoma	<0.0100-<0.0200		
		Texas	<0.005 -<0.0300		
		Colorado	<0.0020-<0.0060		
		Idaho	<0.0200		
		Montana	<0.0030-<0.0040		
		Utah	<0.0040-<0.0130		
		Arizona	<0.0020-<0.0030		
		California	<0.0030-<0.0200		
		Hawaii	0.0007		
		Nevada	<0.0040		
		Oregon	<0.0020		
		Washington	<0.0006-<0.0050		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Calcium Ca		Surface waters in U.S.	8.5	Aug. 1961	133
			28.0	Sept. 1961	
			37.0	Oct. 1961	
			84.0	1961	
		Surface waters in 98 U.S. rivers	11-408	1961	155
		Drinking water of 163 U.S. metropolitan areas	Average: 31.1	1950-51	206
		New Jersey surface waters:			241
		1) spring flow	1.0-18.3		
		2) summer flow	0.9-31.3		
		New Jersey surface waters - Big Flat Brook:			241
		Calcareous - Site 1	35.0		
		Acidic - Site 2	11.2		
		Platte R. near Venice, Neb.	46.8	1969	39
		Platte R. at Ashland, Neb.	54.0	1969	
		Elkhorn R. at Q Street, Neb.	55.6	1969	
	Bozeman City Sewage Treatment Plant; slaughter house and stockyard, etc., Montana	Rocky Creek and East Gallatin R. (various locations along river from sources of pollution)	Range: 1.90-2.10		227
	Weathering of rock	Colorado R. Basin (max. at San Rafael R. near Green River, Utah	Range: 20.0-441.0	1964-65	182
		Pacific Slope Basins in California (max. at Salinas R. near Spreckles, Calif.)	2.8-131.0		182
		Great Basin excluding Great Salt Lake, Utah (max. at Kennecott Drain near Magna, Utah)	4.8-451.0		182
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Carb Creek near Smyrna, Wash.)	2.0-52.0		182

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Calcium Ca (cont.)		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	2.0-53.0	1964-65	183
		Snake R. Basin (max. at Snake R. at Heise, Idaho)	6.8-54.0		183
		Alaska (max. at Tanana R. near Tanacross, Alaska)	1.6-38.0		183
		North Atlantic Slope Basins (max. at Little Schulykill R. at S. Tamaqua, Pa.)	0.4-224.0	1964-65	178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Shark R. near Homestead, Fla.)	0.04-1910.0		178
		Ohio R. Basin (max. at Salt Fork near Cambridge, Ohio)	0.6-203.0	1964-65	179
		St. Lawrence R. Basin (max. at Fairville Creek at Fairville Sta., N.Y.)	4.0-226.0		179
		Missouri R. Basin (max. at Cedar Creek near Columbia, Mo.)	4.2-445.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Eastern Stump Lake near Lakota, N. Dak.)	20.0-531.0		180
		Lower Mississippi R. Basin (max. at Apishapa R. near Fowler, Colo.)	1.2-539.0	1964-65	181
		Western Gulf of Mexico Basins (max. at Colorado R. near Ira, Tex.)	5.0-1320.0		181
		Illinois surface waters (max. at Beaucoup Creek near Matthews-1964)	9.6-374.6	1956-66	86
		Lehigh R. Basin (max. at Nesquehoning Creek near Nesquehoning, Pa.-1945)	0.7-64.0	1945-66	130

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Calcium (cont.)		Selected drinking water supplies in:		
		Connecticut	8.5 1962-63	44
		Maine	3.2	
		Massachusetts	-	
		New Hampshire	3.6-4.0	
		Vermont	15.0	
		Delaware	18.0-23.0	
		New York	5.0-77.0	
		Pennsylvania	26.0-42.0	
		Kentucky	31.0	
		Maryland	7.2-30.0	
		North Carolina	12.0-14.0	
		Virginia	10.0-28.0	
		W. Virginia	46.0	
		Alabama	5.6-22.0	
		Florida	20.0-36.0	
		Georgia	8.0-24.0	
		Mississippi	1.2-41.0	
		South Carolina	3.2-9.0	
		Tennessee	25.0-39.0	
		Illinois	29.0-54.0	
		Indiana	45.0-77.0	
		Michigan	15.0-36.0	
		Ohio	22.0-42.0	
		Wisconsin	19.0-57.0	
		Iowa	16.0-48.0	
		Kansas	34.0-76.0	
		Minnesota	14.0-18.0	
		Missouri	23.0-48.0	
		Nebraska	40.0-67.0	
		North Dakota	27.0-35.0	
		South Dakota	25.0-66.0	
		Louisiana	1.6-23.0	
		New Mexico	34.0-81.0	
		Oklahoma	26.0-47.0	
		Texas	10.0-89.0	
		Colorado	11.0-207.0	
		Idaho	54.0-56.0	
		Montana	15.0-17.0	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Calcium (cont.)		Selected drinking water supplies in:			
		Utah	38.0-81.0	1962-63	44
		Arizona	41.0-99.0		
		California	8.8-35.0		
		Hawaii	0.8		
		Nevada	12.0		
		Oregon	13.0		
		Washington	6.4-32.0		
Carbon C	Bozeman City Sewage Treatment Plant; slaughter house and stockyards, etc., (Montana)	Rocky Creek and East Gallatin R. (various locations along rivers from sources of pollution)	38.00-63.90		227
Carbonate ion $CO_3^{=}$	Weathering of rock	Colorado R. Basin (max. at Yellow Creek near White River, Colo.)	0.0-102.0	1964-65	182
		Great Basin excluding Great Salt Lake (max. at Jordan R. at Salt Lake City, Utah)	0.0-13.0		182
		Pacific Slope Basins in California (max. at Salinas R. near Spreckles, Calif.)	0.0-49.0		182
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Flathead R. at Columbia Falls, Mont.)	0.0-80.0		182
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Columbia R. at Washougal, Wash.)	0.0-1.0		182
		Snake R. Basin (max. at Snake R. at King Hill, Idaho)	0.0-6.0		182
		North Atlantic Slope Basins	0.0	1964-65	178
		South Atlantic Slope Basins	0.0		178
		Ohio R. Basin (max. at Great Miami R. at Elizabethtown, Ohio)	0.0-11.0		179
		St. Lawrence R. Basin (max. at Maumee R. at Toledo, Ohio)	0.0-18.0		179

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Carbonate (cont.)	Weathering of rock	Missouri R. Basin (max. at Knife R. near Golden Valley, N. Dak.)	0.0-39.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Souris R. near Verendrye, N. Dak.)	0.0-32.0		180
		Lower Mississippi R. Basin (max. at Arkansas R. at Arkansas City, Kans.)	0.00-24.0		181
Bicarbonate ion HCO_3^-		Surface water of 98 U.S. cities	14-242	1961	155
		Drinking water in 163 metropolitan areas of U.S.	Average: 98.1	1950-51	206
	Bozeman City Sewage Treatment Plant; Slaughter house and stockyards, etc., (Montana)	Rocky Creek and East Gallatin R. (various locations along rivers from sources of pollution)	3.23-4.72		227
	Weathering of rock	Colorado R. Basin (max. at Yellow Creek near White River, Colo.)	42.0-1600.0	1964-65	182
		Pacific Slope Basins in California (max. at Salinas R. near Spreckles, Calif.)	8.0-792.0		182
		Great Basin excluding Great Salt Lake (max. at Goggin Drain near Magna, Utah)	19.0-408.0		182
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Crab Creek near Smyrna, Wash.)	12.0-379.0	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	11.0-254.0		183
		Snake River Basin (max. at Boise R. at Notus, Idaho)	29.0-278.0		183
		Alaska (max. at Tanana R. near Tanacross, Alaska)	16.0-157.0		183

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Bicarbonate (cont.)	Weathering of rock	North Atlantic Slope Basins (max. at Cobbs Creek near Upper Darby, Pa.)	0.0-2630.0	1964-65	178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (Phillippe Creek near Sarasota, Fla.)	0.0-452.0		178
		Ohio R. Basin (max. at Great Miami R. at Middletown, Ohio)	0.0-344.0		179
		St. Lawrence R. Basin (max. at Trumansburg Creek at Trumansburg, N.Y.)	0.0-382.0		179
		Missouri R. Basin (max. at Bitter Lake near Wauboy, S. Dak.)	0.0-2630.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at East Devils Lake near Hamar, N. Dak.)	71.0-1950.0		180
		Western Gulf of Mexico Basins (max. at Chambers Creek near Corsicana, Tex.)	0.0-434.0	1964-65	181
		Lehigh R. Basin (max. at Monocacy Creek at Bethlehem, Pa.-1963)	0.0-208.0	1945-66	130
Cerium Ce		Principal rivers of U.S.	None detected	1958-59	47,58
Cesium Cs		Principal rivers of U.S.	None detected	1958-59	47
Chlorine Cl		Lake Superior	0.5-2.8		239
		Lake Superior tributaries	0.4-8.3		239
		Lake Michigan	44.0-56.4		239
		Lake Huron	4.3-5.7		239
		St. Clair R.	16.0-82.0		239
		Lake St. Clair	19.0-22.0		239
		Detroit R.	6.8-51.0		239
		Lake Erie	13.0-24.0		239
		Lake Ontario	23.0-24.0		239

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Chloride ion Cl^-		New Jersey surface waters			241
		1) spring flow	8.5-20.0	1968	
		2) summer flow	6.7-15.5		
		New Jersey surface water			241
		Big Flat Brook :			
		Calcareous - Site 1	11.5		
		Acidic - Site 2	4.0		
	Sewage discharge	Santa Anna R. at Prado Dam	89-152	1952-68	12
		Platte R. near Venice, Neb.	6.8		39
		Platte R. near Ashland, Neb.	6.8		39
		Elkhorn R. at Q Street, Neb.	10.1		39
		Surface waters of 98 U.S. rivers	1-702	1961	155
		Surface waters of U.S. rivers	5.5	Aug. 1961	133
			8.0	Sept. 1961	
			10.0	Oct. 1961	
			83.0	1961	
		Drinking water for 163 metropolitan areas of U.S.	20.1	1950-51	206
	Highway deicing	Seven Maine rivers	July <0.5-7.1	1965-67	95
			Oct. <0.5-7.8		
			Apr. <0.5-3.8		
	Municipal and industrial pollution	Lower Detroit R.	7-70		5
	Weathering of rock	Colorado R. Basin (max. at Dolores R. near Cisco, Utah)	1.0-1840.0	1964-65	182
		Pacific Slope Basins in Calif. (max. at Salt Slough near Los Banos, Calif.)	0.0-524		182

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Chloride (cont.)	Weathering of rock	Great Basin excluding Great Salt Lake (max. at Goggin Drain near Magna, Utah)	0.0-3420.0	1964-65	83
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Crab Creek near Smyrna, Wash.)	0.2-60.0		83
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.5-30.0		83
		Snake R. Basin (max. at Snake R. at King Hill, Idaho)	0.0-26.0		83
		Alaska (max. at Anchor R. at Anchor Point, Alaska)	0.4-5.7		83
		North Atlantic Slope Basins (max. at Byberry Creek at Philadelphia, Pa.)	0.0-970.0	1964-65	178
		South Atlantic Slope Basins (max. at Shark R. near Homestead, Fla.)	0.5-21,900.0		178
		Ohio R. Basin (max. at Tuscarawas R. at Newcomerstown, Ohio	0.2-1290.0	1964-65	179
		St. Lawrence R. Basin (max. at Grand R. at Painesville, Ohio)	0.0-7220.0		179
		Missouri R. Basin (max. at Saline R. at Wilson Dam, Kans.)	0.0-2030.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Eastern Stump Lake near Lakota, N. Dak.)	0.6-12,600		180
		Lower Mississippi R. Basin (max. at Bayou Funny Louis near Trout, La.)	0.6-17,200.0	1964-65	181
		Western Gulf of Mexico Basins (max. at Mission R. at Refugio, Tex.)	0.1-36,900.0		181
		Illinois surface waters (max. at Bonpas Creek at Browns-1964)	1.0-1350.0	1956-66	86
		Lehigh R. Basin (max. as Asquashicola Creek at Palmerton-1964)	0.5-49.0	1945-66	130

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Chloride (cont.)		Selected drinking water supplies in:		44
		Connecticut	3.8 1962-63	
		Maine	4.0	
		Massachusetts	18.0	
		New Hampshire	3.6-4.0	
		Vermont	6.0	
		Delaware	33.0-38.0	
		New Jersey	6.0	
		New York	3.7-42.0	
		Pennsylvania	7.0-23.0	
		Kentucky	6.5-26.0	
		Maryland	6.5-15.0	
		North Carolina	7.0-8.0	
		Virginia	11.4-32.6	
		W. Virginia	43.0	
		Alabama	2.0-12.8	
		Florida	9.0-46.0	
		Georgia	5.3	
		Mississippi	27.0-50.0	
		South Carolina	3.6-9.5	
		Tennessee	4.0-31.0	
		Illinois	14.0-25.0	
		Indiana	7.0-31.0	
		Michigan	2.0-50.0	
		Ohio	7.0-45.0	
		Wisconsin	7.0-9.0	
		Iowa	11.5	
		Kansas	28.3-83.0	
		Minnesota	3.5	
		Missouri	15.0-16.0	
		Nebraska	15.0	
		North Dakota	16.0	
		South Dakota	112.0	
		Louisiana	7.0	
		New Mexico	-	
		Oklahoma	130.0-143.0	
		Texas	10.0-461.0	
		Colorado	6.0-35.0	
		Idaho	45.0-50.0	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Chloride (cont.)		Selected drinking water supplies in:			
		Montana	5.0-7.1	1962-63	44
		Utah	8.0-50.0		
		Arizona	68.0-605.0		
		California	-		
		Hawaii	5.6		
		Nevada	5.0		
		Oregon	-		
		Washington	1.5-3.9		
Chromium Cr	Industrial waste	Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Issaquah Creek near Issaquah, Wash.)	0.0-0.02	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Columbia R. below McNary Dam, near Umatilla, Oreg.)	0.0-0.02		183
		Snake R. Basin	0.0		183
		North Atlantic Slope Basins (max. at Elizabeth R. at Elizabeth, N.J.)	0.0002-0.350	1964-65	178
		Lower Mississippi R. Basin: California Gulch, Arkansas R. and a few minor streams (max. at California Gulch at Malta, Colo.)	0.0-<0.100	1964-65	181
		New Jersey surface water		1968	241
		1) spring flow	0.001-0.003		
		2) summer flow	0.011-0.025		
		New Jersey surface water			241
		Big Flat Brook:			
		Calcareous - Site 1	0.002		
		Acidic - Site 2	0.002		
	Industrial waste	Northeast Basin	Mean Positive: 0.014	1962-67	111
		North Atlantic Basin	0.006		
		Southeast Basin	0.004		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Chromium (cont.)	Industrial waste	Tennessee R. Basin	Mean Positive: 0.006	1962-67	111
		Ohio R. Basin	0.007		
		Lake Erie Basin	0.012		
		Upper Mississippi R. Basin	0.007		
		Western Great Lakes Basin	0.006		
		Missouri R. Basin	0.017		
		Lower Mississippi R. Basin	0.016		
		Colorado R. Basin	0.016		
		Western Gulf Basin	0.025		
		Pacific Northwest Basin	0.006		
		California Basin	0.015		
		Great Basin	0.004		
		Alaska Basin	0.009		
		St. Lawrence R. at Massena, N.Y.	0.112 (max. conc.)	1962-67	111
		Apalachicola R. near Blounstown, Fla.	0.0022-0.0078	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0024-0.030		47,58
		Colorado R. at Yuma, Ariz.	0.010-0.024		47,58
		Columbia R. above Dalles, Oreg.	0.0092-0.020		47,58
		Hudson R. at Green Island, N.Y.	0.015-0.040		47,58
		Mississippi R. at Baton Rouge, La.	0.0026-0.084		47,58
		Mobile R. at Mt. Vernon Landing, Ala.	0.0019-0.0068		47,58
		Sacramento R. at Sacramento, Calif.	<0.00072-0.0070		47,58
		Susquehanna R. at Conowingo, Md.	0.0013-0.0045		47,58
		Yukon R. at Mountain Village, Alaska	0.0023-0.0070		47,58
		Selected drinking water supplies in:			44
		Connecticut	0.0000		
		Maine	0.0001		
		New Hampshire	<0.0001-<0.0002		
		Vermont	<0.0004		
		Delaware	<0.0010-<0.0020		
		New York	<0.0003-<0.0040		
		Pennsylvania	<0.0002-<0.0080		
		Kentucky	<0.0009		
		Maryland	<0.0010-<0.0020		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Chromium (cont.)		Selected drinking water supplies in:		
		North Carolina	<0.0005-0.003 1962-63	44
		Virginia	<0.0006-<0.0020	
		W. Virginia	<0.002	
		Alabama	<0.0003-<0.0030	
		Florida	<0.0010-0.0020	
		Georgia	<0.0003-0.0110	
		Mississippi	0.0010-<0.0030	
		South Carolina	<0.0007-<0.0020	
		Tennessee	<0.0008-<0.0010	
		Illinois	<0.0020-<0.0030	
		Indiana	<0.0020-<0.0100	
		Michigan	<0.0002-0.0030	
		Ohio	<0.0020-0.0080	
		Wisconsin	<0.0010-<0.0030	
		Iowa	<0.0020-<0.0030	
		Kansas	<0.0030-<0.0050	
		Minnesota	<0.0007-0.0010	
		Missouri	<0.0010-<0.0020	
		Nebraska	<0.0030-<0.0040	
		North Dakota	<0.0030-<0.0040	
		South Dakota	<0.0050-<0.0070	
		Louisiana	<0.0020-<0.0040	
		New Mexico	<0.0050-<0.0060	
		Oklahoma	<0.0040-<0.0050	
		Texas	<0.002-<0.0080	
		Colorado	<0.0009-<0.0020	
		Idaho	<0.0060	
		Montana	<0.0010	
		Utah	<0.0020-<0.0050	
		Arizona	<0.0040-<0.0080	
		California	<0.0009-<0.0070	
		Hawaii	<0.0002	
		Nevada	0.0040	
		Oregon	<0.0008	
		Washington	<0.0003-0.0100	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Chromium (cont.)	Industrial waste	Pacific Slope Basins in Washington and UPper Columbia R. Basin (max. at Spokane R. near Otis Orchards, Wash.)	0.0-0.1	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin	0.0		183
		Snake R. Basin	0.0		183
Cobalt Co	Weathering of rock	Northeast Basin	Mean Positive: 0.014	1962-67	111
		North Atlantic Basin	0.009		111
		Southeast Basin	0.001		111
		Ohio R. Basin	0.019		111
		Lake Erie Basin	0.033		111
		Upper Mississippi R. Basin	0.018		111
		Western Great Lakes Basin	0.011		111
		Missouri R. Basin	0.008		111
		Lower Mississippi R. Basin	0.036		111
		Colorado R. Basin	0.011		111
		Pacific Northwest Basin	0.008		111
		Allegheny R. at Pittsburgh, Pa.	0.048 (max. conc.)		111
	Weathering of rock	Apalachicola R. near Blounstown, Fla.	0.0-<0.00075	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0-0.0052		47,58
		Colorado R. at Yuma, Ariz.	0.0		47,58
		Columbia R. above Dalles, Oreg.	0.0-<0.0011		47,58
		Hudson R. at Green Island, N.Y.	0.0-<0.0013		47,58
		Mississippi R. near Baton Rouge, La.	0.0-0.0058		47,58
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-<0.00089		47,58
		Sacramento R. at Sacramento, Calif.	0.0-<0.0033		47,58
		Susquehanna R. at Conowingo, Md.	0.0-trace		47,58
		Yukon R. at Mountain Village, Alaska	0.0-trace		47,58
		Vermont rivers	Detected		273
		65 streams in California	.00074-0.015		222
		North Atlantic Slope Basins (max. at Passaic R. near Chatam, N.J.)	<0.0003-<0.007	1964-65	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Cobalt Co (cont.)		Lower Mississippi R. Basin: California Gulch, Arkansas R. and a few minor streams (max. at California Gulch at Malta, Colo.)	0.0-0.112	1964-65	181
		Selected drinking water supplies in:			44
		Connecticut	0.0000	1962-63	
		Maine	<0.0001		
		New Hampshire	<0.0001-<0.0002		
		Vermont	<0.0004		
		Delaware	<0.0030-<0.0050		
		New York	<0.0006-<0.0080		
		Pennsylvania	<0.0002-<0.0240		
		Kentucky	<0.0020		
		Maryland	<0.0010-<0.0020		
		North Carolina	<0.0010-<0.0030		
		Virginia	<0.0010-<0.0030		
		W. Virginia	<0.0040		
		Alabama	<0.0005-<0.0050		
		Florida	<0.0010-<0.0050		
		Georgia	<0.0007-<0.0080		
		Mississippi	<0.0010-<0.0060		
		South Carolina	<0.0010-<0.0070		
		Tennessee	<0.0020-<0.0030		
		Illinois	<0.0020-<0.0080		
		Indiana	<0.0050-<0.0100		
		Michigan	<0.0004-<0.004		
		Ohio	<0.0020-<0.0080		
		Wisconsin	<0.0010-<0.0060		
		Iowa	<0.0040-<0.0060		
		Kansas	<0.0070-<0.0100		
		Minnesota	<0.0010-<0.0030		
		Missouri	<0.0030-<0.0050		
		Nebraska	<0.0070-<0.0090		
		North Dakota	<0.0060-<0.0090		
		South Dakota	<0.0100		
		Louisiana	<0.0020-<0.0050		
		New Mexico	<0.0050-<0.0060		
		Oklahoma	<0.0090-<0.0100		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Cobalt (cont.)		Selected drinking water supplies in:		44
		Texas	<0.0050-<0.0300 1962-63	
		Colorado	<0.0020-<0.0060	
		Idaho	<0.0100	
		Montana	<0.0020-<0.0030	
		Utah	<0.0040-<0.0130	
		Arizona	<0.0040-<0.0200	
		California	<0.0020-<0.0100	
		Hawaii	<0.0005	
		Nevada	<0.0090	
		Oregon	<0.0020	
		Washington	<0.0004-<0.0020	
Copper Cu		New Jersey surface waters		241
		1) spring flow	0.013-0.020 1968	
		2) summer flow	0.022-0.030	
		New Jersey surface water		241
		Big Flat Brook:		
		Calcareous - Site 1	0.016	
		Acidic - Site 2	0.022	
	Corrosive action of water on copper and brass tubing; industrial effluents; herbicide; weathering of rock	Northeast Basin	Mean Positive: 0.015 1962-67	111
		North Atlantic Basin	0.017	111
		Southeast Basin	0.014	111
		Tennessee R. Basin	0.011	111
		Ohio R. Basin	0.023	111
		Lake Erie Basin	0.011	111
		Upper Mississippi R. Basin	0.014	111
		Western Great Lakes Basin	0.007	111
		Missouri R. Basin	0.017	111
		Lower Mississippi R. Basin	0.019	111
		Colorado R. Basin	0.010	111
		Western Gulf Basin	0.011	111
		Pacific Northwest Basin	0.009	111
		California Basin	0.012	111
		Great Basin	0.012	111
		Alaska Basin	0.009	111

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Copper (cont.)	Corrosive action of water on copper and brass tubing; industrial effluents; herbicide; weathering of rock	Apalachicola R. near Blounstown, Fla.	0.0021-0.0051	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0036-0.010		47,58
		Colorado R. at Yuma, Ariz.	0.0085-0.0088		47,58
		Columbia R. above Dalles, Oreg.	0.003-0.027		47,58
		Hudson R. at Green Island, N.Y.	0.0045-0.044		47,58
		Mississippi R. near Baton Rouge, La.	0.0069-0.074		47,58
		Mobile R. at Mt. Vernon Landing, Ala.	0.0027-0.028		47,58
		Sacramento R. at Sacramento, Calif.	0.0014-0.014		47,58
		Susquehanna R. at Conowingo, Md.	0.0051-0.105		47,58
		Yukon R. at Mountain Village, Alaska	0.0025-0.0063		47,58
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at N. Fork Stillaquamish R. near Arlington, Wash.)	0.0-0.10	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.01-0.05		183
		Snake R. Basin (max. at Palouse R. at Hooper, Wash.)	0.01-0.05		183
		North Atlantic Slope Basins (max. at Raritan R. at Stanton, N.J.)	0.0008-0.340	1964-65	178
		Lower Mississippi R. Basin: California Gulch, Arkansas R. and a few minor streams (max. at California Gulch at Malta, Colo.)	0.0-7.0		181
		Streams in California	Average: 0.018		222
		Monongahela R, Pittsburgh, Pa.	0.28 (max. conc.)	1962-67	111

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Copper (cont.)		Selected drinking water supplies in:			
		Connecticut	0.0009	1962-63	44
		Maine	0.0040		
		Massachusetts	-		
		New Hampshire	0.0400-0.0460		
		Vermont	0.0160		
		Delaware	0.0100-0.0500		
		New York	0.0010-0.0800		
		Pennsylvania	<0.0004-0.2000		
		Kentucky	<0.0010-<0.0030		
		Maryland	<0.001-0.0020		
		North Carolina	0.0020-0.0500		
		Virginia	<0.0002-0.1000		
		W. Virginia	0.0200		
		Alabama	0.0003-0.0020		
		Florida	0.0010-0.0100		
		Georgia	0.0020-0.0150		
		Mississippi	0.0030-0.0100		
		South Carolina	0.0007-0.0700		
		Tennessee	0.0030-0.0400		
		Illinois	<0.0008-0.0090		
		Indiana	0.004-0.300		
		Michigan	0.0009-0.0400		
		Ohio	0.0020-0.0400		
		Wisconsin	0.0060-0.9800		
		Iowa	<0.0006-0.006		
		Kansas	<0.0010		
		Minnesota	<0.0030-0.0040		
		Missouri	0.0010-0.0090		
		Nebraska	0.0080-0.0100		
		North Dakota	0.0070-0.0100		
		South Dakota	<0.0020		
		Louisiana	0.0010-0.0180		
		New Mexico	0.0030-0.0200		
		Oklahoma	<0.0010-0.0100		
		Texas	<0.0020-0.1000		
		Colorado	0.0060-0.01600		
		Idaho	0.006-0.0100		
		Montana	0.0030-0.2000		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Copper (cont.)		Selected drinking water supplies in:			44
		Utah	0.0010-0.0030	1962-63	
		Arizona	<0.0020-0.0350		
		California	0.0004-0.2000		
		Hawaii	0.0200		
		Nevada	0.0080		
		Oregon	0.0080		
		Washington	0.001-0.0600		
Dysprosium Dy		Principal rivers of U.S.	None detected	1958-59	47,58
Erbium Er		Principal rivers of U.S.	None detected	1958-59	47,58
Europium Eu		Principal rivers of U.S.	None detected	1958-59	47,58
Fluoride ion F^-		Surface waters of U.S.	0.1	June 1961	133
			0	Sept 1961	133
			0.4	Oct. 1961	133
			0.4	1961	133
		Drinking water of 163 metropolitan areas in U.S.	Average: 0.25	1950-51	206
	Bozeman City Sewage Treatment Plant; slaughter house and stockyards, etc., (Montana)	Rocky Creek and East Gallatin R. (various locations along rivers from sources of pollution)	3.6-16.0		227
	Weathering of rock	Colorado R. Basin (max. at Virgin R. below Littlefield, Ariz.)	0.0-0.9	1964-65	182
		Pacific Slope Basins in Calif. (max. at Colusa Trough near Colusa, Calif.)	0.1-0.7		

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Fluoride F^- (cont.)		Great Basin excluding Great Salt Lake (max. at Humboldt R. near Rye Patch, Nev.)	0.0-0.8	1964-65	183
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Crab Creek near Smyrna, Wash.)	0.0-1.0		183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.0-0.5		183
		Snake R. Basin (max. at Snake R. at King Hill, Idaho)	0.0-0.9		183
		Alaska (max. at Tonsina R. at Tonsina, Alaska)	0.0-0.6		183
		North Atlantic Slope Basins (max. at Wissachickon Creek at Fort Washington, Pa.)	0.0-1.4	1964-65	178
		South Atlantic Slope Basins (max. at Alafia R. at Lithia, Fla.)	0.0-17.0		178
		Ohio R. Basin (max. at Tuscarawas R. at Newcomerstown, Ohio)	0.0-4.2	1964-65	179
		St. Lawrence R. Basin (max. at Black R. at Elyria, Ohio)	0.0-1.7		
		Missouri R. Basin (max. at Cedar Creek near Columbia, Mo.)	0.0-3.4	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Souris R. near Verendrye, N. Dak.)	0.0-1.2		180
		Lower Mississippi R. Basin (max. at Center Creek at Oronogo, Mo.)	0.0-15.0		181
		Western Gulf of Mexico Basins (max. at Double Mountain Fork Brazos R. at Justiceburg, Tex.)	0.0-2.1		181
		Illinois surface waters (max. at Illinois R. at Peoria-1964)	0.0-2.4	1956-66	86

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Fluoride F^- (cont.)		Lehigh R. Basin (max. at Lehigh R. a at Bethlehem, Pa.-1966)	0.0-1.6	1945-66	130
	Natural sources	Community water supplies with natural fluoride content of 0.7 mg/l or greater:			
		Alabama	0.7-3.2	1969	152
		Arizona	*0.3-9.7		
		Arkansas	0.8-1.6		
		California	*0.1-4.0		
		Colorado	0.7-4.0		
		Connecticut	0.7-2.1		
		Florida	*0.6-2.4		
		Georgia	0.7-3.5		
		Idaho	0.7-4.2		
		Illinois	*0.2-5.8		
		Indiana	0.7-2.2		
		Iowa	*0.4-6.0		
		Kansas	0.7-4.0		
		Kentucky	0.8-1.2		
		Louisiana	0.7-8.0		
		Maine	1.8		
		Maryland	0.8-4.5		
		Michigan	0.7-2.0		
		Minnesota	0.8-3.6		
		Mississippi	*0.5-2.0		
		Missouri	0.7-5.0		
		Montana	0.7-5.0		
		Nebraska	0.7-1.5		
		New Hampshire	0.7-1.3		
		New Jersey	0.7-2.0		
		New Mexico	0.7-11.0		
		New York	0.7-2.9		
		North Dakota	0.7-5.4		
		Ohio	0.7-2.4		
		Oklahoma	0.7-13.6		

*below 7 mg/l reading due to communities reporting maximum and minimum conc. within system.

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Fluoride F^- (cont.)		Community water supplies with natural fluoride content of 0.7 mg/l or greater:		152
		Oregon	0.7-2.1 1969	
		Rhode Island	0.8-1.4	
		South Carolina	0.7-4.5	
		South Dakota	*0.4-7.8	
		Texas	0.7-7.6	
		Utah	0.7-1.4	
		Virginia	*0.6-10.1	
		Washington	*0.5-2.1	
		West Virginia	0.8	
		Wisconsin	*0.4-2.5	
		Wyoming	*0.4-1.4	
		Alaska	1.4-2.6	
		Selected drinking water supplies in:		44
		Connecticut	1.0 1962-63	
		Maine	0.0	
		Massachusetts	-	
		New Hampshire	0.0-0.2	
		Vermont	0.5	
		Delaware	1.1	
		New York	0.0-1.0	
		Pennsylvania	0.1-1.0	
		Kentucky	0.2	
		Maryland	0.2-1.1	
		North Carolina	0.8-1.0	
		Virginia	0.7-1.0	
		W. Virginia	0.4	
		Alabama	0.0-0.8	
		Florida	0.2-1.2	
		Georgia	0.0-0.4	
		Mississippi	0.1-0.5	
		South Carolina	0.0-0.2	
		Tennessee	0.2-0.9	

*below 7 mg/l reading due to communities reporting maximum and minimum conc. within system.

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Fluoride F^- (cont.)		Selected drinking water supplies in:			44
		Illinois	0.2-1.4	1962-63	
		Indiana	0.1-1.4		
		Michigan	0.1-1.1		
		Ohio	0.2-1.0		
		Wisconsin	0.2-1.1		
		Iowa	0.2-1.2		
		Kansas	0.6-1.1		
		Minnesota	0.0-1.0		
		Missouri	1.1-1.2		
		Nebraska	0.4-0.6		
		North Dakota	0.9-1.4		
		South Dakota	0.4-0.9		
		Louisiana	0.1-1.1		
		New Mexico	0.5=0.6		
		Oklahoma	0.9-1.0		
		Texas	0.3-0.9		
		Colorado	0.9-1.3		
		Idaho	0.7-0.8		
		Montana	0.1-0.2		
		Utah	0.1-0.3		
		Arizona	0.5-1.1		
		California	0.0-0.6		
		Hawaii	0.0		
		Nevada	<0.1		
		Oregon	0.0		
		Washington	0.0-0.4		
Gadolinium Gd		Principal rivers of U.S.	None detected	1958-59	47,58
Gallium Ga		Principal rivers of U.S.	None detected	1958-59	47,58
		Streams in California	None detected		222
		Lower Mississippi R. Basin: California Gulch and Arkansas R. at Malta, Colo. (max. at California Gulch)	<0.0005-<0.40	1964-65	181

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Germanium Ge		Principal rivers of U.S.	None detected 1958-59	47,58
		Streams in California	0.00041 and 0.0037	222
		Lower Mississippi R. Basin: California Gulch and Arkansas R. at Malta, Colo. (max. at California Gulch)	<0.00025-<0.020 1964-65	181
Gold Au		Fresh and ground waters	0.000001-0.044	103
		Principal rivers in U.S.	None detected 1958-59	47,58
Hafnium Hf		Principal rivers of U.S.	None detected 1958-59	47,58
Holmium Ho		Principal rivers of U.S.	None detected 1958-59	47,58
Hydrogen ion H^+		Pacific Slope Basins in Washington and Upper Columbia R. Basin High - Little Spokane R. at Dartford, Wash. Low - Stillaguamish R. near Silvana, Wash.	0.0004-0.000004 1964-65	183
		Snake River Basin High - Snake R. at King Hill, Idaho Low - Palouse R. at Hooper, Wash.	0.0001-0.000004	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin	0.00032-0.000005	183
		Alaska High - Tanana R. near Tanacross, Alaska Low - Anchor R. at Anchor Point, Alaska	0.00012-0.000004	183

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Hydrogen ion (cont.) H+		Colorado R. Basin High - Dolores R. near Cisco, Utah Low - Green R. near LaBarge, Wyo.	0.00032-0.000002 1964-65	182
		Great Basin excluding Great Salt Lake High - Jordan R. at Salt Lake City, Utah Low - Kennecott Drain near Magna, Utah	0.0004-0.00000063	182
		Pacific Slope Basins in California High - Shasta R. near Yreka, Calif. Low - Calaveras R. near Stockton, Calif.	0.00032-0.0000016	182
		North Atlantic Slope Basins High - Neshaminy Creek near Langhone, Pa. Low - Potomas R. at Steyer, Md.	0.63-0.0000025	178
		South Atlantic Slope and Eastern Gulf of Mexico Basins High - Miami Canal near Miami, Fla. Low - St. Mary's R. near MacClenny, Fla.	0.032-0.000004	178
		Ohio R. Basin High - Collins R. near McMinnville, Tenn. Low - Kiskiminetas R. at Leechburg, Pa.	0.79-0.0000005	179
		St. Lawrence R. Basin High - Maumee R. at Toledo, Ohio Low - Black R. at Elyria, Ohio	0.032-0.000012	179
		Missouri R. Basin High - Kiowa Creek near Lyman, Neb.	0.50-0.000002 1964-65	180
		Hudson R. and Upper Mississippi R. Basins High - Big Coulee near Churches Ferry, N. Dak. Low - Sheyenne R. at Lisbon, N. Dak.	0.0002-0.0000032	180

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Hydrogen ion (cont.) H+		Lower Mississippi R. Basin High - Arkansas R. at Arkansas City, Kansas Low - California Gulch at Malta, Colo.	0.50-0.0000004	1964-65	181
		Western Gulf of Mexico Basins High - Old R. near Cove, Tex. Low - Rabbit Creek at Kilgore, Tex.	0.10-0.0000025		181
		Lehigh R. Basin High - Jordan Creek at Guthsville, Pa.-1960 Low - Quakake Creek tributary at Hudsondale, Pa.-1945	0.79-0.0000016	1964-65	130
Indium In	Industrial	Principal rivers of U.S.	None detected	1958-59	47,58
Iodine I	Industrial waste, natural brines	Lake Superior	0.0004-0.0022		239
		Lake Superior tributaries	0.0003-0.0041		
		Lake Michigan	0.0007-0.0014		
		Lake Huron	0.0009-0.0021		
		St. Clair R.	0.0014-0.0031		
		Lake St. Clair	0.0015-0.0021		
		Detroit R.	0.0010-0.0017		
		Lake Erie	0.0009-0.0042		
		Lake Ontario	0.0018-0.0055		
		Potomac R.	0.0045		256
	Sewage treatment plant effluent	Patuxent R. (near point of discharge)	0.019		256
Iridium Ir		Principal rivers of U.S.	None detected	1958-59	47,58
Iron Fe		98 U.S. rivers	0.02-3.0 (1 yr. range)		155
		Surface waters in U.S.	0.0 0.17 0.40	Aug. 1961 Sept 1961 Oct. 1961	133

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Iron Fe (cont.)	Dissolved mineral matter	1,400 wells in Blythertle, Ark.	0.01	1961	155
		Drinking water of 163 metropolitan areas in U.S.	Average: 0.12	1950-51	206
		Platte R. near Venice, Neb.	0.42	1969	39
		Platte R. at Ashland, Neb.	0.41		39
		Elkhorn R. at Q Street, Neb.	0.35		39
		New Jersey surface waters		1968	241
		1) spring flow	0.07-0.54		
		2) summer flow	0.12-2.0		
		New Jersey surface water		1968	241
		Big Flat Brook			
		Calcareous - Site 1	0.08		
		Acidic - Site 2	0.03		
		Northeast Basin	Mean Positive: 0.051	1962-67	111
		North Atlantic Basin	0.019		
		Southeast Basin	0.120		
		Tennessee R. Basin	0.037		
		Ohio R. Basin	0.028		
		Lake Erie Basin	0.035		
		Upper Mississippi R. Basin	0.035		
		Western Great Lakes Basin	0.022		
		Missouri R. Basin	0.037		
		Lower Mississippi R. Basin	0.069		
		Colorado R. Basin	0.040		
		Western Gulf Basin	0.173		
		Pacific Northwest Basin	0.032		
		California Basin	0.046		
		Great Basin	0.070		
		Alaska Basin	0.025		
		Sabine R. near Ruliff, Tex.	0.952 (max. conc.)		111

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Iron (undefined)	Municipal and industrial	Lake Erie	0.020	1966	5
	Weathering of rock, acid waters, etc.	Apalachicola R. near Blounstown, Fla.	0.085-1.22	1958-59	47
		Atchafalaya R. at Krotz Springs, La.	0.517-1.24		
		Colorado R. at Yuma, Ariz.	0.111-0.160		
		Columbia R. above Dalles, Oreg.	0.131-0.280		
		Hudson R. at Green Island, N.Y.	0.207-0.650		
		Mississippi R. at Baton Rouge, La.	0.663-1.67		
		Mobile R. at Mt. Vernon Landing, Ala.	0.125-0.735		
		Sacramento R. at Sacramento, Calif.	0.112-1.210		
		Susquehanna R. at Conowingo, Md.	0.031-0.154		
		Yukon R. at Mountain Village, Alaska	1.130		
	" " "	Colorado R. Basin (Maximum - Yampa R. near Maybell, Colo.)	0.00-0.79	1964-65	182
		Pacific Slope Basins in California Crater Lake near Crater Lake, Oreg.	0.01	1964-65	182
		Great Basin excluding Great Salt Lake (Maximum - Weber R. at Gateway, Utah)	0.0-0.21		182
Iron Fe		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Issaquah Creek near Issaquah, Wash.)	0.00-0.74	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.03-0.32		183

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Iron Fe (cont.)		Snake R. Basin (max. at Snake R. at Clarkston, Wash.)	0.0-0.43		183
		Alaska (max. at Matanuska R. at Palmer, Alaska)	0.0-0.74		183
		North Atlantic Slope Basin (max. at Mullica R. near Batsta, N.Y.)	0.0-3.5	1964-1965	178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Pasquotank R. near Elizabeth City, N.C.)	0.0-1.4		178
		Ohio R. Basin (max. at Tradewater R. at Olney, Ky.)	0.0-21.0	1964-65	179
		St. Lawrence R. Basin (max. at Black R. at Elyria, Ohio)	0.0-3.9		
		Missouri R. Basin (max. at Cedar Creek, near Columbia, Mo.)	0.0-15.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Bois de Sioux R. near White Rock, S.D.)	0.0-0.95		180
		Lower Mississippi R. Basin (max. at California Gulch at Malta, Colo.)	0.0-34.0	1964-65	181
		Western Gulf of Mexico Basins (max. at Angelina R. near Zavalla, Tex.)	0.0-1.7		181
		Surface waters in Illinois (max. at Bay Creek at Nebo-1966)	0.0-116.0	1956-66	86
		Lehigh R. Basin (max. at Lehigh R. at Lehigh Tanner, Pa.-1959)	0.0-1.2	1945-66	130
		Streams in California	Average: 0.033		222

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Iron (cont.)		Selected drinking water supplies in:	1962-63	44
		Connecticut	0.0020	
		Maine	0.0150	
		Massachusetts	-	
		New Hampshire	0.0770-0.1000	
		Vermont	0.0270	
		Delaware	0.0050-0.0400	
		New York	0.0050-0.3000	
		Pennsylvania	0.0000-0.0600	
		Kentucky	0.0030-0.0200	
		Maryland	0.0400-0.0600	
		North Carolina	0.0100-0.0200	
		Virginia	0.0050-0.0810	
		W. Virginia	0.2000	
		Alabama	0.0090-0.0500	
		Florida	0.0030-0.0100	
		Georgia	0.0040-0.0330	
		Mississippi	0.0500-0.0800	
		South Carolina	0.0100-0.2730	
		Tennessee	0.0040-0.0400	
		Illinois	<0.0080-0.0500	
		Indiana	0.0100-0.200	
		Michigan	0.0060-0.2500	
		Ohio	0.0050-0.1000	
		Wisconsin	0.0050-0.0290	
		Iowa	0.0040-0.0600	
		Kansas	<0.0070-0.0200	
		Minnesota	0.003-0.0100	
		Missouri	0.0200-0.1000	
		Nebraska	0.0300-0.0700	
		North Dakota	<0.0070-0.0350	
		South Dakota	0.0500-1.0000	
		Louisiana	0.0050-0.1410	
		New Mexico	0.0130-0.0200	
		Oklahoma	0.0200-0.3000	
		Texas	<0.0070-0.2000	
		Colorado	0.0090=0.0400	
		Idaho	0.0200-0.1000	
		Montana	0.0700-0.2000	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Iron (cont.)		Selected drinking water supplies in:	1962-63	44
		Utah	0.0050-0.0130	
		Arizona	0.0050-0.2000	
		California	0.0200-1.0000	
		Hawaii	0.2000	
		Nevada	0.2550	
		Oregon	0.0500	
		Washington	0.0100-0.3000	
Lanthanum La		Principal rivers of U.S.		47
		Hudson R. at Green Island, N.Y.	0.0-trace	
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-trace	
		Susquehanna R. at Conowingo, Md.	0.0-trace	
Lead Pb	Weathering of limestone and galena; various mining and industrial effluents	Northeast Basin	Mean Positive: 0.017 1962-67	111
		North Atlantic Basin	0.014	
		Southeast Basin	0.008	
		Tennessee R. Basin	0.017	
		Ohio R. Basin	0.030	
		Lake Erie Basin	0.039	
		Upper Mississippi R. Basin	0.033	
		Western Great Lakes Basin	0.014	
		Missouri R. Basin	0.039	
		Lower Mississippi R. Basin	0.037	
		Colorado R. Basin	0.032	
		Western Gulf Basin	0.004	
		Pacific Northwest	0.015	
		California Basin	0.004	
		Great Basin	0.018	
		Alaska Basin	0.012	
		Ohio R. at Evansville, Ind.	0.140 (max. conc.)	111

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Lead (cont.)	Weathering of limestone and galena; various mining and industrial effluents	Apalachicola R. near Blounstown, Fla.	0.0021-0.0062	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0011-0.011		
		Colorado R. at Yuma, Ariz.	<0.008-0.016		
		Columbia R. above Dalles, Oreg.	<.0012-0.0050		
		Hudson R. at Green Island, N.Y.	0.0029-0.010		
		Mississippi R. near Baton Rouge, La.	0.004-0.009		
		Mobile R. at Mt. Vernon Landing, Ala.	0.0012-0.015		
		Sacramento R. at Sacramento, Calif.	0.0-0.0045		
		Susquehanna R. at Conowingo, Md.	0.0011-0.0072		
		Yukon R. at Mountain Village, Alaska	0.0015-0.0086		
		Streams in California	Average: 0.0057		222
		North Atlantic Slope Basins (max. at Assunpink Creek at Trenton, N.J.)	<0.0012-0.240	1964-65	178
		Lower Mississippi R. Basin: California Gulch, Arkansas R. and a few minor streams (max. at California Gulch at Malta, Colo.)	0.0-1.0	1964-65	181
		Selected drinking water supplies in:		1962-63	44
		Connecticut	0.0001		
		Maine	0.0003		
		Massachusetts	-		
		New Hampshire	0.0004-0.0006		
		Vermont	0.0010		
		Delaware	<0.0070-<0.0100		
		New York	<0.0020-<0.0200		
		Pennsylvania	0.0005-<0.0120		
		Kentucky	<0.0040		
		Maryland	<0.0010-<0.0040		
		North Carolina	<0.0030-0.0050		
		Virginia	0.0020-<0.0060		
		W. Virginia	0.0100		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Lead (cont.)		Selected drinking water supplies in:	1962-63	44
		Alabama	<0.0020-<0.0100	
		Florida	0.0020-<0.0100	
		Georgia	<0.0020-0.0330	
		Mississippi	<0.0030-<0.0100	
		South Carolina	<0.0030-0.0030	
		Tennessee	<0.0040-0.0060	
		Illinois	<0.0100-<0.0150	
		Indiana	<0.0100-0.0200	
		Michigan	<0.0010-<0.0100	
		Ohio	<0.0050-<0.0160	
		Wisconsin	0.0020-0.0200	
		Iowa	0.0100	
		Kansas	<0.0200	
		Minnesota	<0.0020-<0.0060	
		Missouri	<0.0070-<0.0100	
		Nebraska	<0.0200	
		North Dakota	0.0100-0.0200	
		South Dakota	<0.0300	
		Louisiana	<0.0020-<0.0100	
		New Mexico	<0.0100-<0.0250	
		Oklahoma	<0.0200-0.1000	
		Texas	<0.0080-0.1000	
		Colorado	<0.0050-<0-0100	
		Idaho	<0.0300	
		Montana	<0.0050-<0.0070	
		Utah	<0.0080-<0.0250	
		Arizona	<0.0040-<0.0080	
		California	<0.0040-<0.0400	
		Hawaii	0.0100	
		Nevada	<0.0040	
		Oregon	<0.0040	
		Washington	0.0020-0.0500	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Lithium Li	Industrial waste and small amount of rock weathering	Apalachicola R. near Blounstown, Fla.	<0.000075-0.00070	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0019-0.0045		
		Colorado R. at Yuma, Ariz.	0.035-0.037		
		Columbia R. above Dalles, Oreg.	0.00059-0.0039		
		Hudson R. at Green Island, N.Y.	0.00028-0.0022		
		Mississippi R. near Baton Rouge, La.	0.0018-0.0049		
		Mobile R. at Mt. Vernon Landing, Ala.	0.00014-0.0024		
		Sacramento R. at Sacramento, Calif.	0.00066-0.0021		
		Susquehanna R. at Conowingo, Md.	0.0034-0.0035		
		Yukon R. at Mountain Village, Alaska	0.0020		
		North Atlantic Slope Basins (max. at Raritan R. at Manville, N.J.)	0.0-0.027	1964-65	178
Lutetium Lu		Principal rivers of U.S.	None detected	1958-59	47
Magnesium Mg		Surface waters of U.S.	2.6 Aug. 1961		133
			7.0 Sept.1961		
			8.9 Oct. 1961		
			28.0 1961		
		Drinking water for 163 metropolitan areas in U.S.	Average: 9.75	1950-51	206
		Platte R. near Venice, Neb.	11.3	1969	39
		Platte R. at Ashland, Neb.	13.2		
		Elkhorn R. at Q Street, Neb.	20.4		
		New Jersey surface waters		1968	241
		1) spring flow	0.6-9.0		
		2) summer flow	0.40-15.3		
		New Jersey surface waters			241
		Big Flat Brook:			
		Calcareous - Site 1	7.5		
		Acidic - Site 2	2.4		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Magnesium Mg (cont.)	Bozeman city sewage treatment plant; slaughter house and stockyard, etc. (Montana)	Rocky Creek and East Gallatin R. (various locations along rivers from sources of pollution)	1.41-2.01		227
	Weathering of rock	Colorado R. Basin (max. at San Rafael R. near Green River, Utah)	2.3-243.0	1964-65	182
		Pacific Slope Basins in California (max. at San Benito R. near Willow Creek School, Calif.)	0.0-120.0		182
		Great Basin excluding Great Salt Lake (max. at Goggin Drain near Magna, Utah)	0.1-382.0		182
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Crab Creek near Smyrna, Wash.)	0.2-32.0	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.5-20.0		183
		Snake R. Basin (max. at Snake R. at King Hill, Idaho)	0.2-22.0		183
		Alaska (max. at Nenana R. near Healy, Alaska)	0.5-13.0		183
		North Atlantic Slope Basins (max. at Little Schulykill R. at South Tamaqua, Pa.)	0.2-136.0	1964-65	178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Shark R. near Homestead, Fla.)	0.0-1480.0		178
		Ohio R. Basin (max. at Monongahela R. at Charleroi, Pa.)	0.1-54.0	1964-65	179
		St. Lawrence R. Basin (max. at Black Creek at Churchville, N.Y.)	0.5-48.0		179

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Magnesium Mg (cont.)		Missouri R. Basin (max. at Medicine Lake near Florence, S. Dak.)	0.1-12,000.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Eastern Stump Lake near Lokota, N. Dak.)	3.0-7,500.0		180
		Lower Mississippi R. Basin (max. at Purgatoire R. near Las Animas, Colo.)	0.0-573.0	1964-65	181
		Western Gulf of Mexico Basins (max. at Colorado R. near Ira, Tex.)	0.0-573.0		181
		Illinois surface waters (max. at Wolf Creek near Beecher City-1963)	0.1-225.3	1956-66	86
		Lehigh R. Basin (max. at Nesquehoning Creek near Nesquehoning, Pa.-1945)	0.3-25.0	1945-66	130
		Selected drinking water supplies in:		1962-63	44
		Connecticut	3.2		
		Maine	0.5		
		Massachusetts	-		
		New Hampshire	0.5-1.2		
		Vermont	6.5		
		Delaware	9.2		
		New York	2.7-33.0		
		Pennsylvania	1.2-19.0		
		Kentucky	2.4		
		Maryland	2.9-5.8		
		North Carolina	1.5-2.9		
		Virginia	2.9-8.7		
		W. Virginia	9.7		
		Alabama	1.2-12.0		
		Florida	2.4-4.6		
		Georgia	1.0-19.0		
		Mississippi	0.8-13.0		
		South Carolina	1.0-3.0		
		Tennessee	6.3-7.8		
		Illinois	9.7-29.0		
		Indiana	11.0-31.0		

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Magnesium Mg (cont.)		Selected drinking water supplies in:		1962-63	44
		Michigan	1.9-11.0		
		Ohio	4.3-26.0		
		Wisconsin	1.0-35.0		
		Iowa	22.0-30.0		
		Kansas	15.0-25.0		
		Minnesota	4.4-5.3		
		Missouri	11.0-17.0		
		Nebraska	9.7-14.0		
		North Dakota	3.9-9.7		
		South Dakota	14.0-39.0		
		Louisiana	<0.1-8.0		
		New Mexico	5.8-16.0		
		Oklahoma	14.0-21.0		
		Texas	2.9-33.0		
		Colorado	2.9-33.0		
		Idaho	39.0-48.0		
		Montana	3.4-6.3		
		Utah	8.7-40.0		
		Arizona	2.9-31.0		
		California	5.3-19.0		
		Hawaii	2.9		
		Nevada	4.4		
		Oregon	0.7		
		Washington	4.0-16.0		
Manganese Mn	Dissolved mineral matter	Well, Mansfield, Mass.	0.30	1961	155
		Surface waters in Mass., N.J., Calif., Ohio, Md., and Holland Wanaque Reservoir, N.J.	0.0-0.90		264
		Surface and ground waters in U.S.	0.0-0.16	1961	133

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Manganese (cont.)	Dissolved mineral matter; acid mine waste (Ohio Basin)	Northeast Basin	Mean Positive: 0.0035	1962-67	111
		North Atlantic Basin	0.0027		
		Southeast Basin	0.0028		
		Tennessee R. Basin	0.0037		
		Ohio R. Basin	0.232		
		Lake Erie Basin	0.138		
		Upper Mississippi R. Basin	0.0098		
		Western Great Lakes Basin	0.0023		
		Missouri R. Basin	0.0138		
		Lower Mississippi R. Basin	0.009		
		Colorado R. Basin	0.012		
		Western Gulf Basin	0.010		
		Pacific Northwest Basin	0.0028		
		California Basin	0.0028		
		Great Basin	0.0078		
		Alaska	0.0018		
	Dissolved mineral matter	Apalachicola R. near Blounstown, Fla.	0.004-0.025	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.012-0.100		
		Colorado R. at Yuma, Ariz.	0.021-0.037		
		Columbia R. above Dalles, Oreg.	0.0055-0.014		
		Hudson R. at Green Island, N.Y.	0.035-0.150		
		Mississippi R. near Baton Rouge, La.	0.012-0.185		
		Mobile R. at Mt. Vernon Landing, Ala.	0.0067-0.020		
		Sacramento R. at Sacramento, Calif.	0.0063-0.050		
		Susquehanna R. at Conowingo, Md.	<0.0021-0.079		
		Yukon R. at Mountain Village, Alaska	0.181		
		Streams in California	Average: 0.0071		222
		North Atlantic Slope Basins (max. at Schulykill R. at Cressona, Pa.)	0.0-7.4		178
	Dissolved mineral matter; acid mine waste (Ohio Basin)	Allegheny R. at Pittsburgh, Pa.	3.230 (max. conc.)	1962-67	111

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Manganese (cont.)	Weathering of rock	Ohio R. Basin (max. at Tradewater R. at Olney, Ky.)	0.0-29.0	1964-65	179
		St. Lawrence R. Basin (max. at Sandusky R. near Fremont, Ohio)	0.0-1.2		179
		Missouri R. Basin (max. at Cedar Creek near Columbia, Mo.)	0.0-50.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Sheyenne R. near Cooperstown, N. Dak.)	0.0-3.8		
		Lower Mississippi R. Basin (max. at California Gulch at Malta, Colo.)	0.0-340.0		181
		Illinois surface waters (max. at Otter Creek near Palmyra-1964)	0.0-4.2	1956-66	86
		Lehigh R. Basin (max. at Lehigh R. at Catasauqua, Pa.-1945)	0.0-0.65	1945-66	130
		Selected drinking water supplies in:		1962-63	44
		Connecticut	0.0000		
		Maine	0.0004		
		Massachusetts	-		
		New Hampshire	0.0020-0.0026		
		Vermont	0.0006		
		Delaware	<0.0050-0.0200		
		New York	<0.0030-<0.0200		
		Pennsylvania	0.0000-0.0680		
		Kentucky	<0.0030		
		Maryland	<0.0010-0.0300		
		North Carolina	0.0050-0.0300		
		Virginia	0.0020=0.0900		
		W. Virginia	0.2000		
		Alabama	<0.0010-0.0200		
		Florida	<0.0002-<0.0050		
		Georgia	<0.0010-0.0230		
		Mississippi	<0.0060-0.0600		
		South Carolina	0.0025-0.0700		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Manganese (cont.)		Selected drinking water supplies in:		1962-63	44
		Tennessee	<0.0030-<0.0050		
		Illinois	<0.0050-0.0100		
		Indiana	0.0090-0.2000		
		Michigan	0.0010-0.0070		
		Ohio	<0.0040-0.1000		
		Wisconsin	<0.0002-0.1000		
		Iowa	<0.0080-2.0000		
		Kansas	<0.0100-<0.0200		
		Minnesota	<0.0010-<0.0030		
		Missouri	<0.0050-<0.0090		
		Nebraska	<0.0100-0.0200		
		North Dakota	<0.0060-0.0090		
		South Dakota	<0.0300-0.3000		
		Louisiana	<0.0004-0.0120		
		New Mexico	<0.0060-<0.0130		
		Oklahoma	0.0200		
		Texas	<0.0040-0.1000		
		Colorado	<0.0020-0.0200		
		Idaho	<0.0200-<0.0300		
		Montana	0.0100-0.0400		
		Utah	<0.0040-<0.0130		
		Arizona	<0.0009-0.0030		
		California	<0.0040-0.1000		
		Hawaii	0.0100		
		Nevada	0.0150		
		Oregon	<0.0030		
		Washington	<0.0050-0.0300		
Mercury Hg	Caustic-chlorine plants, vinyl chloride plants; pulp and paper mills; mines from Hg containing ores	9 municipal water supplies, Denver, Colo.	0.05		131
		Principal rivers of U.S.	None detected	1958-59	47,58
Mercuric Chloride $HgCl_2$	Caustic-chlorine plant in Michigan	Detroit R.	Very high		141

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Molybdenum Mo	Mineral weathering	Northeast Basin	Mean Positive: 0.025	1962-67	111
		North Atlantic Basin	0.033		
		Southeast Basin	0.015		
		Tennessee R. Basin	0.025		
		Ohio R. Basin	0.070		
		Lake Erie Basin	0.068		
		Upper Mississippi R. Basin	0.088		
		Western Great Lakes Basin	0.028		
		Missouri R. Basin	0.083		
		Lower Mississippi R. Basin	0.095		
		Colorado R. Basin	0.130		
		Western Gulf Basin	0.024		
		Pacific Northwest Basin	0.030		
		California Basin	0.045		
		Great Basin	0.145		
		Alaska Basin	0.017		
		Arkansas R. at Coolidge, Kans.	1.100 (max. conc.)		111
	Mineral weathering	Apalachicola R. near Blounstown, Fla.	0.0-0.0062	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0-<0.0027		
		Colorado R. at Yuma, Ariz.	0.0065-0.0069		
		Columbia R. above Dalles, Oreg.	found-0.0021		
		Hudson R. at Green Island, N.Y.	0.0-0.0017		
		Mississippi R. near Baton Rouge, La.	0.0-<0.0026		
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-0.00035		
		Sacramento R. at Sacramento, Calif.	0.0-<0.00047		
		Susquehanna R. at Conowingo, Md.	0.0-0.00054		
		Yukon R. at Mountain Village, Alaska	0.0-0.0012		
	Molybdenum deposits and their processing	Surface waters of Colorado (max. at East Fork Eagle R.)	0.0-3.8	1965	10
		Streams in California	0.0001-0.005		222

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Molybdenum Mo (cont.)	Molybdenum-bearing ores and processing plant effluent	Tenmile Creek (receiving effluent)	8.5-1.57 spring 1967	61
		Dillon Reservoir (about 20 miles downstream from plant)	0.188-0.452 1967-69	
		Marston filter plant - finished water	0.040 1970	61
		North Atlantic Slope Basins (max. at Raritan R. at Manville, N.J.)	0.00008-0.014 1964-65	178
		Lower Mississippi R. Basin: California Gulch and Arkansas R. at Malta, Colo. (max. at California Gulch)	<0.00025-<0.020 1964-65	181
		Selected drinking water supplies in:		44
		Connecticut	<0.0001	
		Maine	<0.0006	
		Massachusetts	-	
		New Hampshire	<0.0007-<0.0008	
		Vermont	<0.0020	
		Delaware	0.0100-0.0200	
		New York	<0.0006-<0.0080	
		Pennsylvania	<0.0010-<0.0680	
		Kentucky	<0.0020	
		Maryland	<0.0010-0.0030	
		North Carolina	<0.0010-<0.0030	
		Virginia	<0.0010-0.0050	
		W. Virginia	<0.0040	
		Alabama	<0.0005-<0.0050	
		Florida	<0.0030-<0.0080	
		Georgia	<0.0007-<0.0050	
		Mississippi	<0.0010-<0.0060	
		South Carolina	<0.0010-<0.0020	
		Tennessee	<0.0020-<0.0080	
		Illinois	<0.0050-<0.0080	
		Indiana	<0.0100-0.0100	
		Michigan	<0.0004-0.0050	
		Ohio	<0.0030-0.0100	
		Wisconsin	<0.0050-0.0470	
		Iowa	<0.0060-<0.0100	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Molybdenum Mo (cont.)		Selected drinking water supplies in:		1962-63	44
		Kansas	0.0100		
		Minnesota	<0.0010-<0.0030		
		Missouri	0.0040-0.0070		
		Nebraska	0.0070-0.0200		
		North Dakota	<0.0060-<0.0090		
		South Dakota	<0.0100-0.0100		
		Louisiana	<0.0050-<0.0190		
		New Mexico	<0.0060-<0.0130		
		Oklahoma	0.0100		
		Texas	<0.0040-0.0300		
		Colorado	<0.0020-<0.0060		
		Idaho	0.0200		
		Montana	<0.0020-0.0040		
		Utah	0.0040-<0.0130		
		Arizona	0.0161-0.0410		
		California	<0.0020-0.0300		
		Hawaii	<0.0005		
		Nevada	<0.0020		
		Oregon	<0.0020		
		Washington	<0.0004-0.0050		
Neodymium Nd		Principal rivers of U.S.	None detected	1958-59	47,58
Nickel Ni		New Jersey surface waters		1968	241
		1) spring flow	0.002-0.009		
		2) summer flow	0.001-0.017		
		New Jersey surface waters			241
		Big Flat Brook			
		Calcareous - Site 1	0.006		
		Acidic - Site 2	0.001		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Nickel (cont.)	Metal plating; some weathering (insoluble compounds)	Northeast Basin	Mean Positive: 0.008	1962-67	111
		North Atlantic Basin	0.008		
		Southeast Basin	0.004		
		Tennessee R. Basin	0.004		
		Ohio R. Basin	0.031		
		Lake Erie	0.056		
		Upper Mississippi R. Basin	0.015		
		Western Great Lakes Basin	0.010		
		Missouri R. Basin	0.005		
		Lower Mississippi R. Basin	0.017		
		Colorado R. Basin	0.012		
		Western Gulf Basin	0.003		
		Pacific Northwest Basin	0.010		
		California Basin	0.010		
		Great Basin	0.004		
		Alaska Basin	0.005		
		Cuyahoga R. at Cleveland, Ohio	0.130 (max. conc.)		111
		U.S. waters	0.001-0.07	1960-61	128
		Apalachicola R. near Blounstown, Fla.	0.0026-0.034	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	found-0.047		
		Colorado R. at Yuma, Ariz.	0.0-0.30		
		Columbia R. above Dalles, Oreg.	found-0.036		
		Hudson R. at Green Island, N.Y.	0.0055-0.071		
		Mississippi R. near Baton Rouge, La.	found-0.033		
		Mobile R. at Mt. Vernon Landing, Ala.	0.0061-0.029		
		Sacramento R. at Sacramento, Calif.	found-0.020		
		Susquehanna R. at Conowingo, Md.	found-0.011		
		Yukon R. at Mountain Village, Alaska	found-0.017		
		Streams in California	0.001-0.005		222
		North Atlantic Slope Basins (max. at Assunpink Creek at Trenton, N.J.)	0.0005-0.260	1964-65	178

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Nickel (cont.)		Lower Mississippi R. Basin: California Gulch and Arkansas R. at Malta, Colo. (max. at California Gulch)	0.0-0.069	1964-65	181
		Selected drinking water supplies in:		1962-63	44
		Connecticut	0.0000		
		Maine	<0.0001		
		Massachusetts	-		
		New Hampshire	<0.0001-<0.0002		
		Vermont	<0.0004		
		Delaware	0.0030-0.0050		
		New York	<0.0005-<0.0080		
		Pennsylvania	<0.0002-0.1000		
		Kentucky	<0.0020		
		Maryland	<0.0010-<0.0020		
		North Carolina	<0.0010-<0.0030		
		Virginia	<0.0010-0.0050		
		W. Virginia	<.0.0040		
		Alabama	<0.0005-<0.0050		
		Florida	<0.0010-<0.0050		
		Georgia	<0.0007-<0.0050		
		Mississippi	0.0010-<0.0060		
		South Carolina	<0.0010-0.0080		
		Tennessee	<0.0020-<0.0030		
		Illinois	<0.0050=<0.0080		
		Indiana	<0.0050-<0.0100		
		Michigan	<0.0004-<0.0050		
		Ohio	<0.0030-<0.0080		
		Wisconsin	<0.0010-0.0100		
		Iowa	<0.0040-0.0090		
		Kansas	<0.0070-0.0100		
		Minnesota	<0.0010-<0.0030		
		Missouri	<0.0030-<0.0050		
		Nebraska	<0.0070-<0.0090		
		North Dakota	<0.0060-<0.0090		
		South Dakota	<0.0100		
		Louisiana	<0.0020-<0.0050		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Nickel (cont.)		Selected drinking water supplies in:		1962-63	44
		New Mexico	<0.0060-<0.0130		
		Oklahoma	<0.0090-<0.0100		
		Texas	<0.0050-<0.0300		
		Colorado	<0.0020-<0.0060		
		Idaho	<0.0100		
		Montana	0.0020-0.0040		
		Utah	<0.0040-<0.0130		
		Arizona	<0.0020-<0.0080		
		California	<0.0020-<0.0100		
		Hawaii	0.0020		
		Nevada	<0.0040		
		Oregon	<0.0020		
		Washington	<0.0004-<0.0030		
Niobium Nb		Principal rivers of U.S.	None detected	1958-59	47,58
		Tap water from laboratory	0.00958		209
		Tap water from laboratory (four days in pipes)	0.0235		
Nitrite ion NO_2^-	Municipal and industrial	Lake Erie	0.002	1966	5
Nitrate ion NO_3^-		Surface waters of 98 U.S. rivers	Range: 0.1-10.0	1960-61	155
		Surface waters of U.S.	4.7	Aug. 1961	133
			0.5	Sept 1961	
			3.2	Oct. 1961	
			1.4	1961	
		Missouri R. water		1951-66	125
		in Omaha, Neb.	0.2-8.6	monthly composite	
		in Kansas City, Mo.	1.8	" "	
		in St. Louis County, Mo.	1.0-9.0	" "	
		in St. Louis, Mo.	2.1-11.3	" "	

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Nitrate ion NO_3^- (cont.)	Municipal waste	Hudson R.	0.2-1.0	1970	90
	Industrial mfg. of ammonium nitrate	Iowa	10.0-100.0	1948	260
		Ohio, 10% of municipal water supply	<1.0	July 1947	260
		Mahoning R.	∿10	March 1948	260
		Ohio rural water supplies	10.0-100.0	1948	260
		Drinking water in 163 metropolitan areas in U.S.	Average: 2.3	1950-51	206
	Agricultural	Missouri wells	≦5-300		225
	Municipal and industrial pollution	Lake Erie	1.0	1966	5
		Colorado R. Basin (max. at Gila R. below Gillespie Dam, Ariz.)	0.00-60.0	1964-65	182
		Pacific Slope Basins in Calif. (max. at Salinas R. near Sprechles, Calif.)	0.0-38.0		182
		Great Basin excluding Great Salt Lake (max. at Jordan R. at Salt Lake City, Utah)	0.0-17.0		183
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Flett Creek at Tacoma, Wash.)	0.0-12.0	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.0-4.2		183
		Snake R. Basin (max. at Palouse R. at Hooper, Wash.)	0.0-14.0		183
		Alaska (max. at Trail R. near Lowing, Alaska	0.0-2.8		183
		North Atlantic Slope Basins (max. at Rockaway R. at Pine Brook, N.J.)	0.0-62.0		178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Plantation Rd. Canal near Fort Lauderdale, Fla.)	0.0-620.0		178

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Nitrate ion NO_3^- (cont.)		Ohio R. Basin (max. at Great Miami R. at Elizabethtown, Ohio)	0.0-23.0	1964-65	179
		St. Lawrence R. Basin (max. at Black R. at Elyria, Ohio)	0.2-113.0		179
		Missouri R. Basin (max. at Horse Creek near Vale, S. Dak.)	0.0-77.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Blue Earth R. near Rapidan, Minn.)	0.0-24.0		180
		Lower Mississippi R. Basin (max. at Fountain Creek at Pueblo, Colo.)	0.0-302.0		181
		Western Gulf of Mexico Basins (max. at Yegua Creek near Somerville, Tex.)	0.0-54.0		181
		Illinois surface waters (max. at Illinois R. Meredosia-1962)	0.0-48.4	1956-66	86
		Lehigh R. Basin (max. at Black Creek near Weatherly-1963)	0.0-23.0	1945-66	130
		Selected drinking water supplies in:			44
		Connecticut	0.00		
		Maine	0.1		
		Massachusetts	0.0		
		New Hampshire	0.1		
		Vermont	0.0		
		New Jersey	0.0		
		New York	0.0-45.7		
		Pennsylvania	0.0-4.4		
		Kentucky	0.5-1.3		
		Maryland	0.3-1.8		
		North Carolina	0.1		
		Virginia	0.7-4.9		
		W. Virginia	-		
		Alabama	0.0-3.4		
		Florida	0.2-0.6		
		Georgia	0.8		
		Mississippi	0.0-4.4		
		South Carolina	0.0-0.3		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Nitrate ion NO_3^- (cont.)		Selected drinking water supplies in:		1962-63	44
		Tennessee	1.7-2.9		
		Illinois	1.1-2.6		
		Indiana	0.1-1.7		
		Michigan	0.0-0.2		
		Ohio	0.0-0.6		
		Wisconsin	0.1-0.3		
		Iowa	0.1		
		Kansas	5.5-5.8		
		Minnesota	0.3		
		Missouri	3.2-5.0		
		Nebraska	0.2		
		North Dakota	-		
		Oklahoma	0.8-0.9		
		Texas	0.0-5.6		
		Colorado	0.0-3.6		
		Idaho	1.4-2.2		
		Montana	0.2-1.0		
		Utah	0.5-12.0		
		Arizona	1.0-99.8		
		Hawaii	1.6		
		Nevada	0.0		
		Washington	0.8-1.8		
Cyanide ion CN^-	Train wreck in Dunreith, Indiana, Jan. 1, 1968	Buck Creek (downstream from Dunreith)	405	Jan. 3, 1968	147
		Big Blue River	20	"	147
		Various sites downstream to Seymour, Ind.	0.015-15.6	"	147
Ammonium ion NH_4^+	Fertilizer spill	Missouri R.			
		Omaha, Neb.	0.05-13.0	1951-66	125
		Kansas City, Mo.	0.0-6.3		
		St. Louis County, Mo.	0.0-13.0		
		St. Louis, Mo.	0.0		
	Municipal and industrial	Lake Erie	0.027	1966	5
		Illinois surface waters (max. at Rock R. at Como-1957)	0.0-2.2	1945-66	86

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Osmium Os		Principal rivers of U.S.	None detected 1958-59	47,58
Palladium Pd		Principal rivers of U.S.	None detected 1958-59	47
Phosphorus P	Detergents	Lake Erie	0.0-0.65	117
		U.S. rivers	0.01-1	34
	Downstream from a domestic sewage treatment plant effluent	Wisconsin Creek	0.4	34
		Lakes and reservoirs in Illinois	0-0.1	34
	Heavy domestic or agricultural drainage	Lake water	0.8	34
		Northeast Basin	Mean Positive: 0.044 1962-67	111
		North Atlantic Basin	0.048	
		Southeast Basin	0.043	
		Tennessee R. Basin	0.042	
		Ohio R. Basin	0.130	
		Lake Erie Basin	0.153	
		Upper Mississippi R. Basin	0.243	
		Western Great Lakes Basin	0.031	
		Missouri R. Basin	0.353	
		Lower Mississippi R. Basin	0.081	
		Colorado R. Basin	0.121	
		Western Gulf Basin	0.173	
		Pacific Northwest Basin	0.047	
		California	0.083	
		Great Basin	0.037	
		Alaska Basin	0.040	
		Big Sioux R. Below Sioux Falls, S. Dak.	5.040 (max. conc.)	111

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Phosphorus P (cont.)		Apalachicola R. near Blounstown, Fla.	0-<0.058	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0-<0.186		
		Colorado R. at Yuma, Ariz.	0.0		
		Columbia R. at Dalles, Oreg.	0.0		
		Hudson R. at Green Island, N.Y.	0.0		
		Mississippi R. near Baton Rouge, La.	0.0-<0.223		
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-<0.098		
		Sacramento R. at Sacramento, Calif.	0.0-<0.110		
		Susquehanna R. at Conowingo, Md.	0.0		
		Yukon R. at Mountain Village, Alaska	<0.195		
		Ohio R. Basin (max. at Kanawha R. at Winfield, W. Va.)	0.0-13.1	1964-65	179
		St. Lawrence R. Basin (max. at Maumee R. at Toledo, Ohio)	0.02-3.3		179
		Missouri R. Basin (max. at East Fork Chariton R. near Huntsville, Mo.)	0.0-0.06		180
		Lower Mississippi R. Basin (max. at Center Creek near Carterville, Mo.)	0.0-11.8		181
Phosphate ion PO_4^-		Wolf R., Wisconsin	∿0.09-0.58	1966-68	175
		Upper Fox River, Wisconsin	∿0.13-1.55		
		Lake Winnebago Shores, Wisconsin	0.15-0.82		
	Municipal and industrial pollution	Detroit R. (mouth - U.S. portion)	<0.18 1.2 (maximum)		5
		Detroit R. (western basin)	<0.1		
	Detergents, water treatment, domestic and industrial sewage, fertilizers	Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Issaquah Creek near Isaaquah, Wash.)	0.0-0.99	1964-65	183

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Phosphate PO_4 (cont.)		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.0-0.48	1964-65	183
		Snake R. Basin (max. at Palouse R. at Hooper, Wash.)	0.08-1.0		183
		North Atlantic Slope Basins (max. at Rockaway R. at Pine Brook, N.J.)	0.0-25.0	1964-65	178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Mill Branch - tributary near Fort Meade, Fla.)	0.0-603.0		178
		Lower Mississippi R. Basin (max. at Center Creek near Carterville, Mo.)	0.0-31.0	1964-65	181
		Western Gulf of Mexico Basins (max. at Trinity R. near Rosser, Tex.)	0.36-10.00		181
		Illinois surface waters (max. at Illinois R. at Peoria-1963)	0.0-9.4	1956-66	86
		Stream in Davis mine, Rowe, Mass.,	0.17	1968	100
		Providence R.	1.34	1969	
Platinum Pt		Principal rivers of U.S.	None detected	1958-59	47,58
Potassium K		98 rivers in U.S.		1961	155
		Surface waters in U.S.	1.5	Aug. 1961	133
			0.9	Sept. 1961	
			5.1	Oct. 1961	
			4.0	1961	
		New Jersey surface waters		1968	241
		1) spring flow	0.6-9.0		
		2) summer flow	0.40-15.3		

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Potassium K (cont.)		New Jersey surface water			241
		Big Flat Brook			
		Calcareous - Site 1	6.6		
		Acidic - Site 2	0.6		
	Bozeman city sewage treatment plant; slaughter house and stockyard, etc. (Montana)	Rocky Creek and East Gallatin R. (various locations along rivers from sources of pollution)	1.96-6.65		227
	Weathering of rock	Colorado R. Basin (max. at Dolores R. near Cisco, Utah)	0.8-35.0	1964-65	182
		Pacific Slope in California (max. at Salinas R. near Spreckles, Calif.)	0.0-23.0		182
		Great Basin excluding Great Salt Lake (max. at Humboldt R. near Rye Patch, Nev.)	0.5-12.0		182
		Pacific Slope Basin in Washington and Upper Columbia R. Basin (max. at Crab Creek near Smyrna, Wash.)	0.0-20.0		182
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.1-7.8		182
		Snake R. Basin (max. at Palouse R. at Hooper, Wash.)	0.4-5.8		182
		Alaska (max. at Anchor R. at Anchor Point, Alaska)	0.0-8.0		182
		North Atlantic Slope Basins (max. at Wissahickon Creek at Fort Washington, Pa.)	0.0-15.0		178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Shark R. near Homestead, Fla.)	0.0-440.0		178

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Potassium K (cont.)		Ohio R. Basin (max. at Kiskiminetas R. at Leechburg, Pa.)	0.0-13.0	1964-65	179
		St. Lawrence R. Basin (max. at Trumansburg Creek at Trumansburg, N.Y.)	0.1-7.8		179
		Missouri R. Basin (max. at Bitter Lake near Waubay, S. Dak.)	0.6-1010.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Eastern Stump Lake near Lakota, N. Dak.)	0.8-1400.0		180
		Lower Mississippi R. Basin (max. at Little R. near Rochelle, La.)	0.2-109.0		181
		Western Gulf of Mexico Basins (max. at Mission R. at Refugio, Tex.)	0.5-112.0		181
		Lehigh R. Basin (max. at Lehigh R. at Glendon, Pa.-1957)	0.0-7.0	1945-66	130
Praseodymium Pr		Principal rivers of U.S.	None detected	1958-59	47,58
Rhenium Re		Principal rivers of U.S.	None detected	1958-59	47,58
Rhodium Rh		Principal rivers of U.S.	None detected		47,58
Rubidium Rb		Apalachicola R. near Blounstown, Fla.	<0.00075-0.002	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0002-<0.0027		
		Colorado R. at Yuma, Ariz.	0.0-<0.008		
		Columbia R. above Dalles, Oreg.	<0.0011-0.0014		
		Hudson R. at Green Island, N.Y.	<0.0011-0.0021		
		Mississippi R. near Baton Rouge, La.	0.0025-0.0074		
		Mobile R. at Mt. Vernon Landing, Ala.	<0.00089-0.0039		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Rubidium Rb (cont.)		Sacramento R. at Sacramento, Calif.	0.001-<0.0016	1958-59	47,58
		Susquehanna R. at Conowingo, Md.	<0.0015-<0.0021		
		Yukon R. at Mountain Village, Alaska	0.0		
		North Atlantic Slope Basins (max. at Passaic R. near Chatam, N.J.)	0.00006-0.016	1964-65	178
		Lower Mississippi R. Basins	0.0	1964-65	181
Ruthenium Ru		Principal rivers of U.S.	None detected	1958-59	47,58
Samarium Sm		Principal rivers of U.S.	None detected	1958-59	47,58
Scandium Sc		Apalachicola R. near Blounstown, Fla.	0.0-trace		47
		Atchafalaya R. at Krotz Springs, La.	0.0-trace		47
		Hudson R. at Green Island, N.Y.	0.0-trace		47
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-trace		47
Selenium Se		Selected drinking water supplies in:			44
		Connecticut	<0.010		
		Maine	<0.010		
		New Hampshire	<0.010		
		Vermont	<0.010		
		Delaware	<0.010		
		New York	<0.010		
		Pennsylvania	<0.010		
		Kentucky	<0.010		
		Maryland	<0.010		
		North Carolina	<0.010		
		Virginia	<0.010		
		W. Virginia	<0.010		
		Alabama	<0.010		
		Florida	<0.010		
		Georgia	<0.010		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Selenium (cont.)		Selected drinking water supplies in:	1962-63	44
		Mississippi	<0.010	
		South Carolina	<0.010	
		Tennessee	<0.010	
		Illinois	<0.010	
		Indiana	<0.010	
		Michigan	<0.010	
		Ohio	<0.010	
		Wisconsin	<0.010	
		Iowa	<0.010	
		Kansas	<0.010	
		Minnesota	<0.010	
		Missouri	<0.010	
		Nebraska	<0.010	
		North Dakota	<0.010	
		South Dakota	<0.010	
		Louisiana	<0.010	
		New Mexico	<0.010	
		Oklahoma	<0.010	
		Texas	<0.010	
		Colorado	<0.0005-<0.010	
		Idaho	<0.010	
		Montana	<0.010	
		Utah	<0.010	
		Arizona	<0.010	
		California	<0.010	
		Hawaii	<0.010	
		Nevada	<0.010	
		Oregon	<0.010	
		Washington	<0.010	
Silicon Si		New Jersey surface waters	1968	241
		1) spring flow	3.5-11.2	
		2) summer flow	3.7-12.1	
		New Jersey surface water		241
		Big Flat Brook		
		Calcareous - Site 1	2.5	
		Acidic - Site 2	4.0	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	Year	REFERENCE
Silicon dioxide SiO_2	Weathering of rock	Surface waters of 98 U.S. rivers	8-48	1961	155
		Missouri R.		1951-66	125
		Omaha, Neb.	4.2-16.0		
		Kansas City, Mo.	2.0-24.0		
		St. Louis County, Mo.	5.0-20.0		
		St. Louis, Mo.	7.5-13.6		
	Weathering of rock	Colorado R. Basin (max. at Gila R. near Gila, N. M.)	1.5-39.0	1964-65	182
		Pacific Slope Basins in California (max. at Shasta R. near Yreka, Calif.)	2.5-51.0	1964-65	182
		Great Basin excluding Great Salt Lake (max. at Goggin Drain near Magna, Utah)	1.2-60.0		182
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Crab Creek near Smyrna, Wash.)	0.9-32.0	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Champoeg Creek near Champoeg, Ore.)	3.6-39.0		183
		Snake R. Basin (max. at Boise R. at Notus, Idaho)	3.7-34.0		183
		Alaska (max. at Anchor R. at Anchor Point, Alaska)	3.0-31.0		183
		North Atlantic Slope Basins (max. at Wippany R. near Wippany, N.J.)	0.3-3.0		178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Alafia R. at Lithia, Fla.)	0.2-65.0		178
		Ohio R. Basin (max. at Tradewater R. at Olney, Ky.)	0.4-4990.0		179
		St. Lawrence R. Basin (max. at St. Louis R. at Scanlon, Minn.)	0.7-17.0		179

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Silicon dioxide (cont.)		Missouri R. Basin (max. at Hale Drain near Scottsbluff, Neb.)	2.2-69.0		180
		Hudson R. and Upper Mississippi R. Basins (max. at Big Coulee near Churches Ferry, N. Dak.)	2.9-66.0		180
		Lower Mississippi R. Basin (max. at Canadian R. near Amarillo, Tex.)	0.6-73.0		181
		Western Gulf of Mexico Basins (max. at Croton Creek near Joyton, Tex.)	0.1-56.0		181
		Surface waters in Illinois (max. at Cache R. at Forman-1957)	0.6-66.7	1956-66	86
		Lehigh R. Basin (max. at Lehigh R. at Bethlehem, Pa.-1960)	1.1-14.0	1945-66	130
Silver Ag	Leaching of ores; electroplating; processing of food and beverages	Northeast Basin	Mean Positive: 0.0019	1962-67	111
		North Atlantic Basin	0.0009		
		Southeast Basin	0.0004		
		Ohio R. Basin	0.0021		
		Lake Erie Basin	0.0053		
		Upper Mississippi R. Basin	0.0034		
		Western Great Lakes Basin	0.0014		
		Missouri R. Basin	0.0012		
		Lower Mississippi R. Basin	0.0043		
		Colorado R. Basin	0.0058		
		Pacific Northwest Basin	0.0009		
		Great Basin	0.0003		
		Alaska Basin	0.0011		
		Colorado R. at Loma, Colo.	0.038 (max. conc.)	1962-67	111
		Apalachicola R. near Blounstown, Fla.	<0.000058-0.00011	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0-0.00033		47,58
		Colorado R. at Yuma, Ariz.	0-0.001		
		Columbia R. near Dalles, Ore.	0.00009-0.00015		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Silver (cont.)		Hudson R. at Green Island, N.Y.	<0.00013-0.00059	1958-59	47,58
		Mississippi R. near Baton Rouge, La.	0-<0.00022		
		Mobile R. at Mt. Vernon Landing, Ala.	<0.000085-0.00028		
		Sacramento R. at Sacramento, Calif.	0-<0.00016		
		Susquehanna R. at Conowingo, Md.	0.0-0.00029		
		Yukon R. at Mountain Village, Alaska	<0.00020-0.00031		
		North Atlantic Slope Basins (max. at Wippany R. at Morristown, N. J.)	0.0-0.00012	1964-65	178
Sodium Na	Recharge water purchased from the metropolitan water district	Santa Ana R., Calif.	high	1970	194
		Platte R. near Venice , Neb.	31.6	1969	39
		Platte R. at Ashland , Neb.	33.1	1969	
		Elkhorn R. at Q Street , Neb.	24.3	1969	
		New Jersey surface waters		1968	241
		summer flow	3.0-9.6		
		New Jersey surface water			241
		Big Flat Brook			
		Calcareous - Site 1	3.7		
		Acidic - Site 2	2.5		
	Highway deicing	Seven rivers in Maine	<0.5-10.7	July	95
			0.5-8.8	October	
			0.5-10.7	April	
	Weathering of rock, etc.	Colorado R. Basin (max. at Dolores R. near Cisco, Utah)	2.3-1160.0	1964-65	182
		Pacific Slope Basins in California (max. at San Benito R. near Willow Creek School, Calif.)	1.3-298.0		182
		Great Basin excluding Great Salt Lake (max. at Goggin Drain near Magna, Utah)	1.4-5260.0		182

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Sodium (cont.)		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Crab Creek near Smyrna, Wash.)	0.7-139.0	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet)	1.6-46.0		183
		Snake R. Basin (max. at Boise R. at Notus, Idaho)	1.3-57.0		183
		Alaska (max. at Matanuska R. at Palmer, Alaska)	0.5-12.0		183
		North Atlantic Slope Basins (max. at Potomac R. near Morgantown, Md.*)	0.4-3070	1964-65	178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Shark R. near Homestead, Fla.)	0.7-12,500.0		178
		Ohio R. Basin (max. at Lynch R. near Glenville, W. Va.)	0.5-258.0		179
		St. Lawrence R. Basin (max. at Oswego R. at Oswego, N.Y.)	0.8-210.0		179
		Missouri R. Basin (max. at Medicine Lake near Florence, S. Dak.)	1.4-6,940.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Eastern Stump Lake near Lakota, N. Dak.)	1.2-24,300.0		180
		Lower Mississippi R. Basin (max. at Little R. near Rochelle, La.)	0.2-5,860.0	1964-65	181
		Western Gulf of Mexico Basins (max. at Mission R. at Refugio, Tex.)	1.0-21,400		181
		Illinois surface waters (max. at Wolf Creek near Beecher City-1963)	0.0-1,407.0		86

*calculated as Na+K, reported as Na

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Sodium (cont.)		Lehigh R. Basin (max. at Aquashicola Creek at Palmerton, Pa.-1957)	0.5-44.0	130
		Selected drinking water supplies in:	1962-63	44
		Connecticut	2.5	
		Maine	1.5	
		New Hampshire	2.5-4.0	
		Vermont	3.5	
		Delaware	12.0-13.0	
		New York	2.0-14.0	
		Pennsylvania	4.5-14.0	
		Kentucky	3.0	
		Maryland	4.0-8.5	
		North Carolina	3.5-6.5	
		Virginia	6.0-120.0	
		W. Virginia	17.0	
		Alabama	2.5-54.0	
		Florida	8.0-22.0	
		Georgia	2.5-12.0	
		Mississippi	1.8-149.0	
		South Carolina	3.5-19.0	
		Tennessee	4.1-9.5	
		Illinois	6.5-15.0	
		Indiana	8.0-27.0	
		Michigan	2.2-26.0	
		Ohio	7.0-34.0	
		Wisconsin	4.0-6.0	
		Iowa	7.0-34.0	
		Kansas	45.0-73.0	
		Minnesota	1.0-5.0	
		Missouri	9.5-13.0	
		Nebraska	23.0-50.0	
		North Dakota	33.0-54.0	
		South Dakota	17.0-150.0	
		Louisiana	26.0-138.0	
		New Mexico	28.0-47.0	
		Oklahoma	85.0-100.0	
		Texas	20.0-300.0	
		Colorado	2.0-44.0	
		Idaho	63.0-76.0	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Sodium (cont.)		Selected drinking water supplies in:		1962-63	44
		Montana	4.5-11.0		
		Utah	3.5-25.0		
		Arizona	59.0-372.0		
		California	4.0-170.0		
		Hawaii	3.2		
		Nevada	7.0		
		Oregon	3.6		
		Washington	3.2-6.0		
Strontium Sr		Public water supply, Wanbeska, Wisconsin			146
		1) Northtown	38	1959	
		2) Baxter Street	24	1959	
		3) Moreland	12	1959	
		New Jersey surface waters		1968	241
		1) spring flow	0.004-0.040		
		2) summer flow	0.002-0.129		
		New Jersey surface water Big Flat Brook			241
		Calcareous - Site 1	0.500		
		Acidic - Site 2	0.030		
	Weathering of rock	Northeast Basin	Mean Positive: 0.076	1962-67	111
		North Atlantic Basin	0.062		
		Southeast Basin	0.026		
		Tennessee R. Basin	0.047		
		Ohio R. Basin	0.130		
		Lake Erie Basin	0.260		
		Upper Mississippi R. Basin	0.105		
		Western Great Lakes Basin	0.044		
		Missouri R. Basin	0.342		
		Lower Mississippi R. Basin	0.540		
		Colorado R. Basin	0.697		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Strontium (cont.)	Weathering of rock	Western Gulf Basin	Mean Positive: 0.652	1962-67	111
		Pacific Northwest	0.068		
		California Basin	0.153		
		Great Basin	0.152		
		Alaska Basin	0.081		
		Arkansas R. at Coolidge, Kans.	5.00 (max. conc.)	1962-67	111
		Apalachicola R. near Blounstown, Fla.	0.0075-0.034	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.011-0.154		
		Colorado R. at Yuma, Ariz.	0.715-0.802		
		Columbia R. above Dalles, Ore.	0.030-0.112		
		Hudson R. at Green Island, N.Y.	0.072-0.106		
		Mississippi R. near Baton Rouge, La.	0.034-0.105		
		Mobile R. at Mt. Vernon Landing, Ala.	0.039-0.068		
		Sacramento R. at Sacramento, Calif.	0.0063-0.061		
		Susquehanna R. at Conowingo, Md.	0.012-0.074		
		Yukon R. at Mountain Village, Alaska	0.015-0.129		
		North Atlantic Slope Basins (max. at Raritan R. at Manville, N.J.)	0.0008-1.1	1964-65	178
Sulfate ion SO_4		Surface waters of 98 U.S. rivers	4.0-473		155
		Missouri R. water		1951-66	125
		in Omaha, Neb.	46.0-253.0		
		in Kansas City, Mo.	36.0-286.0		
		in St. Louis County, Mo.	35.0-206.0		
		in St. Louis, Mo.	45.0-203.0		
		Hudson R., Nyack, N.Y.	25	1969	125
		Drinking water of 163 metropolitan areas of U.S.	Average: 43.9	1950-51	206
		Platte R. near Venice, Neb.	67.2	1969	39

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Sulfate (cont.)		Platte R. at Ashland, Neb.	63.5	1969	39
		Elkhorn R. at Q Street, Neb.	50.2	1969	39
	Bozeman city sewage treatment plant; slaughter house and stockyard, etc. (Montana)	Rocky Creek and East Gallatin R. (various locations along rivers from sources of pollution)	20.02		227
	Acid mine drainage	Deepwater Creek, Henry County, Mo.	140-200	1966-67	25
		Montrose Reservoir, Henry, County, Mo.	230		25
	Weathering of rock, mine waste, etc.	Colorado R. Basin (max. at Price R. at Woodside, Utah)	2.5-3,690.0	1964-65	182
		Pacific Slope Basins in Calif. (max. at Salt Slough near Los Banos, Calif.)	0.0-675.0		182
		Great Basin excluding Great Salt Lake (max. at Goggin Drain near Magna, Utah)	0.0-2,260.0	1964-65	183
		Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Crab Creek near Smyrna, Wash.)	0.0-170.0		183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin (max. at Walla Walla R. near Touchet, Wash.)	0.0-59.0		183
		Snake R. Basin (max. at Boise R. at Notero, Idaho)	0.0-80.0		183
		Alaska (max. at Nenana R. near Healy, Alaska)	0.5-47.0		183
		North Atlantic Slope Basins (max. at Ostsquago Creek at Fort Plain, N.Y.)	3.6-960.0		178
		South Atlantic Slope and Eastern Gulf of Mexico Basins (max. at Shark R. near Homestead, Fla.)	0.0-2,560.0		178

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Sulfate (con t.)		Ohio R. Basin (max. at Lynch Runn near Glenville, W. Va.	0.4-1,530.0	1964-65	179
		St. Lawrence R. Basin (max. at Fairville Creek at Fairville Sta., N N.Y.)	5.0-426.0		
		Missouri R. Basin (max. at Medicine Lake near Florence, S. Dak.)	0.0-61,600.0	1964-65	180
		Hudson R. and Upper Mississippi R. Basins (max. at Eastern Stump Lake near Lakota, N. Dak.)	5.5-66,000.0		180
		Lower Mississippi R. Basin (max. at Arkansas R. at Lamar, Colo.)	0.0-2,710.0	1964-65	181
		Western Gulf of Mexico Basins (max. at Colorado R. near Ira, Tex.)	4.0-4,360.0		181
		Illinois surface waters (max. at Beaucoup Creek near Matthews-1964)	1.6-1,627.0	1956-66	86
		Lehigh R. Basin (max. at Nesquehoning mine drainage tunnel-1965)	0.5-965.0	1945-66	130
		Selected drinking water supplies in:		1962-63	44
		Connecticut	0.00		
		Maine	4.9		
		Massachusetts	19.0		
		Vermont	10.8		
		Delaware	48.0-52.0		
		New Jersey	40.0		
		New York	10.0-36.5		
		Pennsylvania	42.0-70.0		
		Kentucky	36.0-84.0		
		Maryland	8.6-39.0		
		North Carolina	9.7-21.4		
		Virginia	12.7-38.8		
		W. Virginia	153.0		
		Alabama	2.1-82.0		
		Florida	9.0-45.0		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Sulfate (cont.)		Selected drinking water supplies in:	1962-63	44
		Georgia	6.0	
		Mississippi	1.4-56.5	
		Tennessee	1.6-29.0	
		Illinois	28.0-58.0	
		Indiana	33.0-73.0	
		Michigan	2.0-33.0	
		Ohio	30.0-117.0	
		Wisconsin	23.0-27.0	
		Iowa	99.0	
		Kansas	120.0-136.0	
		Minnesota	3.0	
		Missouri	58.9-69.4	
		Nebraska	191.0	
		North Dakota	40.0	
		South Dakota	51.0	
		Oklahoma	76.0-136.0	
		Texas	7.0-205.0	
		Colorado	20.0-130.0	
		Idaho	106.0-118.0	
		Montana	10.0-57.0	
		Utah	11.0-141.0	
		Arizona	60.0-205.0	
		Nevada	19.2	
		Washington	3.3-10.7	
Tantalum Ta		Principal U.S. rivers	None detected 1958-59	47,58
Tellurium Te		Principal rivers of U.S.	None detected 1958-59	47,58
Terbium Tb		Principal rivers of U.S.	None detected 1958-59	47,58
Thallium Tl		Principal rivers of U.S.	None detected 1958-59	47,58

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Thorium Th	Naturally occurring minerals	Weber R., Utah	0.00041		273
		Little Cottonwood Creek, Utah	<0.0015		
		Williams Creek, Idaho	0.00004		
		Blye Mountain, Calif.	0.00033		
		Well-Arches National Monument, Utah	0.0002		
		Hot Spring-Pyramid Lake, Nevada	0.0002		
		Truckee R. Nevada	0.0002		
		Walker R. Nevada	0.0005		
		Humbolt R., Nevada	0.00017		
		Carson R., Nevada	0.0001		
		Sevier R., Utah	0.00008		
		Lake Tahoe, Calif.	<0.00003		
		Pyramid Lake, Nevada	0.0002		
		Principal rivers of U.S.	None detected	1958-59	47,58
Thulium Tm		Principal rivers of U.S.	None detected	1958-59	47,58
Tin Sn		Apalachicola R. near Blounstown, Fla.	0.0-0.0013	1958-59	47,58
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-0.0014		47,58
		North Atlantic Slope Basins (max. at Passaic R. at Chatam, N.J.)	<0.0003-0.011	1964-65	178
		Selected drinking water supplies in:			44
		Connecticut	-		
		Delaware	<0.0030-<0.0050		
		New York	<0.006-<0.0080		
		Pennsylvania	<0.0030-<0.0060		
		Kentucky	<0.0020		
		Maryland	<0.0010=<0.0029		
		North Carolina	<0.0010-<0.0030		
		Virginia	<0.0010-<0.0030		
		W. Virginia	<0.0040		
		Alabama	<0.0005-<0.0050		
		Florida	<0.0030-<0.0050		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Tin (cont.)		Selected drinking water supplies in:		1962-63	44
		Georgia	<0.0007-<0.0050		
		Mississippi	<0.0010-<0.0060		
		South Carolina	<0.0010		
		Tennessee	<0.0020-<0.0030		
		Illinois	<0.0050-<0.0080		
		Indiana	<0.0050-<0.0100		
		Michigan	<0.0004-<0.0050		
		Ohio	<0.0020-<0.0080		
		Wisconsin	<0.0050-<0.0060		
		Iowa	<0.0040-<0.0060		
		Kansas	<0.0070-<0.0100		
		Minnesota	<0.0010-<0.0030		
		Missouri	<0.0050		
		Nebraska	<0.0070-<0.0090		
		North Dakota	<010060-<0.0090		
		South Dakota	<0.0100		
		Louisiana	<0.0050-0.0300		
		New Mexico	<0.0060-<0.0130		
		Oklahoma	<0.0090-<0.0100		
		Texas	<0.0050-0.0400		
		Colorado	<0.0020-<0.0060		
		Idaho	0.0100		
		Montana	<0.0020-<0.0030		
		Utah	<0.0040-<0.0130		
		Arizona	<0.0200		
		California	<0.0020-<0.0100		
		Hawaii	<0.0005		
		Oregon	<0.0020		
		Washington	<0.0004-<0.0020		
Titanium Ti		Apalachicola R. near Blounstown, Fla.	<0.0008-0.099	1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.001-0.107		
		Colorado R. at Yuma, Ariz.	<0.008-0.010		
		Columbia R. above Dalles, Ore.	0.0021-0.0052		
		Hudson R. at Green Island, N.Y.	<0.0014-0.055		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)		REFERENCE
Titanium (cont.)		Mississippi R. near Baton Rouge, La.	0.0067-0.072	1958-59	47,58
		Mobile R. at Mt. Vernon Landing, Ala.	0.0027-0.038		
		Sacramento R. at Sacramento, Calif.	<0.00086-0.106		
		Susquehanna R. at Conowingo, Md.	0.0-0.0057		
		Yukon R. at Mountain Village, Alaska	<0.002-0.016		
		Streams in California	Average: 0.0065		222
		North Atlantic Slope Basins (max. at Passaic R. at Little Falls, N.J.)	<0.0003-0.027	1964-65	178
		Lower Mississippi R. Basin: California Gulch and Arkansas R. at Malta, Colo. (max. at California Gulch)	<0.00051-<0.040	1964-65	181
Tungsten W		Principal rivers of U.S.	None detected	1958-59	47,58
Uranium U	Naturally occurring minerals	Walker R., Calif.	0.0009		273
		Weber R., Utah	0.0013		
		Little Cottonwood Creek, Utah	0.002		
		Williams Creek, Idaho	0.0003		
		Blye Mountain, Calif.	0.00004		
		Well-Arches National Monument, Utah	0.0050		
		Hot Spring-Pyramid Lake, Nevada	0.00008		
		Truchee R., Nevada	0.0046		
		Walker R., Nevada	0.016		
		Humbolt R., Nevada	0.0072		
		Carson R., Nevada	0.0047		
		Sevier R., Utah	0.0081		
		Lake Tahoe, Calif.	0.0008		
		Pyramid Lake, Nevada (South End)	0.016		
		Pyramid Lake, Nevada (North End)	0.025		
		Walker Lake	0.077		
		Mono Lake	0.139		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Uranium U (cont.)		Drinking water	0.002-0.05	1968	160
		Drinking water	0.04-0.05	1969	158
	Uranium ore processing mill	Surface waters	Detected		274
		Principal rivers of U.S.	None detected	1958-59	47,58
		North Atlantic Slope Basins (max. at Susquehanna R. at Harrisburg, Pa. and Potomac R. at Hancock, Md.)	<0.0004-0.0006	1960-61	178
		St. Lawrence R. Basin Genessee R. at Rochester, N.Y.	<0.0004	1960-61	179
		South Atlantic Slope Basins (max. at Yadkin R. at Yadkin College, N.C. and St. Johns R. at Christmas, Fla.)	<0.0004-0.0007	1960-61	183
		Gulf of Mexico Basin (max. at Missouri R. at Nebraska City, Neb.)	<0.0004.0.0066	1960-61	47,58
		Colorado R. at Yuma, Ariz.	0.0076		47,58
		Pacific Coast Basins (max. at San Joaquin R. at Vernalis, Calif.)	<0.0004-0.008		183
		Yukon R. at Rampart, Alaska	0.0014		47,58
		Red.R. (N) at Grand Forks, N.D.	0.0014		47,58

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)	REFERENCE
Vanadium	Uranium-vanadium milling operations	Colorado R. Basin	0.002-0.0492 1969	122
		New Mexico waters	0.02-0.15	131
	Minerals	Northeast Basin	Mean Positive: 0.009 1962-67	111
		North Atlantic Basin	0.012	
		Southeast Basin	0.010	
		Tennessee R. Basin	0.022	
		Lake Erie Basin	0.054	
		Upper Mississippi R. Basin	0.020	
		Missouri R. Basin	0.171	
		Lower Mississippi R. Basin	0.025	
		Colorado R. Basin	0.105	
		Western Gulf Basin	0.009	
		Pacific Northwest Basin	0.013	
		California Basin	0.030	
		Alaska Basin	0.032	
		Apalachicola R. near Blounstown, Fla.	0.0-0.0022 1958-59	47,58
		Atchafalaya R. at Krotz Springs, La.	0.0-<0.0065	47,58
		Columbia R. above Dalles, Ore.	0.0-0.004	47,58
		Hudson R. at Green Island, N.Y.	0.0-0.0056	47,58
		Mississippi R. near Baton Rouge, La.	0.0-<0.0055	47,58
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-0.004	47,58
		Sacramento R. at Sacramento, Calif.	0.0-0.0067 1958-59	47
		Streams in California	Average: 0.003	222
		North Atlantic Slope Basins (max. at Elizabeth R. at Elizabeth, N.J.)	<0.0002-0.018	178
		Lower Mississippi R. Basin: California Gulch at Malta, Colo.	0.0-<0.020	181

TABLE II(CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Vanadium (cont.)		Selected drinking water supplies in:	1962-63	44
		Connecticut	0.0000	
		Maine	<0.0001	
		New Hampshire	<0.0001-<0.0002	
		Vermont	<0.0004	
		Delaware	0.0030-<0.0050	
		New York	<0.0006-<0.0080	
		Pennsylvania	<0.0002-<0.0120	
		Kentucky	<0.0020	
		Maryland	<0.0010-<0.0030	
		North Carolina	<0.0010-<0.0030	
		Virginia	<0.0010-<0.0050	
		W. Virginia	<0.0040	
		Alabama	<0.0005-<0.0050	
		Florida	<0.0010-0.0050	
		Georgia	<0.0007-<0.0050	
		Mississippi	<0.0010-<0.0060	
		South Carolina	<0.0010-<0.0030	
		Tennessee	<0.0020-<0.0030	
		Illinois	<0.0050-<0.0080	
		Indiana	<0.0050-<0.0100	
		Michigan	<0.0004-<0.0050	
		Ohio	<0.0030-<0.0080	
		Wisconsin	<0.0010-<0.0060	
		Iowa	<0.0040-0.0060	
		Kansas	<0.0070-<0.0100	
		Minnesota	<0.0010-0.0030	
		Missouri	<0.0030-<0.0050	
		Nebraska	<0.0070-<0.0090	
		North Dakota	<0.0060-<0.0090	
		South Dakota	<0.0100	
		Louisiana	<0.0020-<0.0050	
		New Mexico	<0.0060-0.0130	
		Oklahoma	<0.0090-<0.0100	
		Texas	<0.0050-<0.0300	
		Colorado	<0.0020-<0.0060	
		Idaho	0.0300-0.0500	
		Montana	<0.0020-<0.0030	
		Utah	<0.0020-<0.0130	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Vanadium (cont.)		Selected drinking water supplies in:		1962-63	47
		Arizona	<0.0040-<0.0200		
		California	<0.0020-0.0200		
		Hawaii	0.0010		
		Nevada	<0.0040		
		Oregon	<0.0020		
		Washington	<0.0004-<0.0030		
Ytterbium Yb		Apalachicola R. near Blounstown, Fla.	0.0-trace	1958-59	47
		Atchafalaya R. at Krotz Springs, La.	0.0-trace		47
		Hudson R. at Green Island, N.Y.	0.0-trace		47
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-trace		47
Yttrium Y		Apalachicola R. near Blounstown, Fla.	0.0-trace		47
		Atchafalaya R. at Krotz Springs, La.	0.0-trace		47
		Hudson R. at Green Island, N.Y.	0.0-trace		47
		Mississippi R. near Baton Rouge, La.	0.0-trace		47
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-trace		47
Zinc Zn		New Jersey surface waters		1968	241
		1) spring flow	0.010-0.019		
		2) summer flow	0.010-0.085		
		New Jersey surface waters			241
		Big Flat Brook			
		Calcareous - Site 1	0.010		
		Acidic - Site 2	0.010		
		Northeast Basin	Mean Positive: 0.096	1962-67	241
		North Atlantic Basin	0.049		
		Southeast Basin	0.052		
		Tennessee R. Basin	0.028		
		Ohio R. Basin	0.081		

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Zinc (cont.)		Lake Erie	0.205	1962-67	111
		Upper Mississippi R. Basin	0.045		
		Western Great Lakes Basin	0.024		
		Missouri R. Basin	0.039		
		Lower Mississippi R. Basin	0.085		
		Colorado R. Basin	0.051		
		Western Gulf Basin	0.092		
		Pacific Northwest Basin	0.040		
		California Basin	0.016		
		Great Basin	0.044		
		Alaska Basin	0.028		
		Hudson R. at Green Island, N.Y.	0.0-<0.125	1958-59	47,58
		Sacramento R. at Sacramento, Calif.	0.0-<0.110		
		Susquehanna R. at Conowingo, Md.	0.0-trace		
	Industrial waste and some weathering of rock	Pacific Slope Basins in Washington and Upper Columbia R. Basin (max. at Spokane R. near Otis Orchards, Wash.)	0.05-0.40	1964-65	183
		Pacific Slope Basins in Oregon and Lower Columbia R. Basin	0.05		183
		Snake R. Basin	0.05		183
		North Atlantic Slope Basins (max. at Assunpink Creek at Trenton, N.J.)	0.008-0.730		178
		Lower Mississippi R. Basin: California Gulch, Arkansas R. and a few minor streams (max. at California Gulch at Malta, Colo.)	<0.00005-860.0		181
		Streams in California	Average: 0.029		222
		Cuyahoga R. at Cleveland, O.	1.182 (max. conc.)		111

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/1)	REFERENCE
Zinc (cont.)		Selected drinking water supplies in:	1962-63	44
		Connecticut	<0.05	
		Maine	0.04	
		New Hampshire	0.03-0.19	
		Vermont	0.00	
		Delaware	0.04-<0.05	
		New York	0.02-3.00	
		Pennsylvania	0.00-1.00	
		Kentucky	<0.40	
		Maryland	0.00-<0.40	
		North Carolina	<0.03-<0.3	
		Virginia	0.01-<0.60	
		W. Virginia	<1.00	
		Alabama	<0.2-<1.0	
		Florida	<0.01-<0.05	
		Georgia	0.01-<0.05	
		Mississippi	<0.06-<0.30	
		South Carolina	0.02-<0.90	
		Tennessee	<0.40-<0.60	
		Illinois	<0.05-<1.00	
		Indiana	<0.05-<2.00	
		Michigan	<0.05-<0.9	
		Ohio	<0.05-<0.8	
		Wisconsin	0.00-0.47	
		Iowa	<1.00	
		Kansas	<2.00	
		Minnesota	<0.01-<0.03	
		Missouri	<0.7-<1.00	
		Nebraska	<2.00	
		North Dakota	<0.06-<0.09	
		South Dakota	<3.00	
		Louisiana	0.00-<0.05	
		New Mexico	<0.06-<0.13	
		Oklahoma	<2.00-<3.00	
		Texas	0.01-<4.00	
		Colorado	<0.02-0.10	
		Idaho	<3.00	
		Montana	<0.50-<0.70	
		Utah	<0.04-<0.13	
		Arizona	0.01-<4.00	

TABLE II (CONT.) - CONCENTRATION OF INORGANIC POLLUTANTS IN FRESH WATER

AGENT	SOURCE	LOCATION	CONCENTRATION (mg/l)		REFERENCE
Zinc (cont.)		Selected drinking water supplies in:		1962-63	44
		California	0.10-<4.00		
		Hawaii	0.40		
		Nevada	0.08		
		Oregon	<0.40		
		Washington	<0.10-<0.80		
Zirconium Zr		Apalachicola R. near Blounstown, Fla.	0.0-trace	1958-59	47
		Atchafalaya R. at Krotz Springs, La.	0.0-trace		47
		Hudson R. at Green Island, N.Y.	0.0-trace		47
		Mississippi R. near Baton Rouge, La.	0.0-trace		47
		Mobile R. at Mt. Vernon Landing, Ala.	0.0-trace		47
		Sacramento R. at Sacramento, Calif.	0.0-trace		47
		North Atlantic Slope Basins (max. at Passaic R. near Chatam, N.J.)	<0.0003-<0.012	1964-65	178

SECTION VII

TOXICITY OF INORGANIC CHEMICALS

ACUTE TOXICITY

Table III presents available acute toxicity information on inorganic pollutants in freshwater as these relate to the animal species in which the toxicity was examined, the dose used, the effect found, and occasionally the minimum lethal dose (MLD). A separate column has been reserved for the LD_{50} of the compounds. The LD_{50} is an estimation of the dose which could be expected to kill one-half of an unlimited population of a specific strain of animals.

All doses, except where indicated, were administered orally. Other routes of administration are included in Table III only if oral data was not available. Pertinent information on species other than mammals, if included, is presented only if data on mammals or adequate data on mammalian spcies were not available.

Many of the same factors need to be considered in assessing toxicity data as were pointed out in "Water Quality Criteria Data Book Volume I, Organic Chemical Pollution of Freshwater." Chemical interaction is of more significance with inorganic materials than with organic compounds. The formation of complex ions and salts results in materials in water which may have distinct toxic actions from the particular ionic species involved in such reactions. While microbal decomposition of inorganic species cannot occur, the microbal transformation of one form of an element to another has become well known with the recognition that metallic mercury will result in soluble forms of mercury by the action of micro-organisms. Many of the particular salts which have been measured for toxicity in animals have a low solubility in water. When administered by the oral route, this low solubility may result in a decreased toxicity. Thus if a different salt of a particular ion were tested, an entirely different pattern of symptoms might result.

Unlike the case with organic compounds, one can be reasonably certain of the initial purity of the inorganic material which was used in testing for toxicity. One can never be certain, however, as to what toxicity would have resulted if a particular material were tested in the presence of other compounds. The synergistic effects observed with organic compounds also apply to inorganic species. This can be especially true of inorganic materials that are administered in the presence of chelating agents or of cations administered in diets relatively deficient in other specific cationic species.

One further caveat is necessary in evaluating toxicity data obtained with inorganic chemical compounds. It is possible to kill an animal with a large dose of sodium chloride, although sodium chloride is considered not to have significant acute toxicity. High concentrations of inorganic materials can upset the water balance of animals, however. The extent to which a chemical species results in toxicity due to its ionic strength or buffering effect versus the poisonous nature of one of its ionic constituents is difficult to assess when large quantities are administered. Thus in Table III large LD_{50} values should not necessarily be the cause for undue attention.

TABLE III - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Aluminum chloride	Mouse			1,130	170
				3,730	228
Antimony	Human	100 mg	Lethal		26,131,165
		97.2 mg	Lethal to adult		131
		48.6 mg	Lethal to child		131
	Laboratory animals	50 mg	Death; acute symptoms		131
Antimony potassium tartrate	Rabbit			115	26
				115-120	228
		10-20 mg/kg	Lethal		
	Rat	300 mg/kg	Minimum lethal dose		
	Mouse			599-666	228
	Rat	110 mg/kg	Cardiac lesions, congestion of liver with some degeneration and polymorphonuclear infiltration and toxic glomerular nephritis.		
Antimony trichloride	Rat			675	10
	Guinea pig			574	10

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Antimony trifluoride	Guinea pig	110 mg/kg	Lethal		131
Antimony pentachloride	Rat			1,115	10
	Guinea pig			900	10
Arsenic (undefined)	Human	130 mg	Lethal		131
		100 mg	Severe poisoning; cumulative toxic effect; small eruptions on hands and soles of feet, sometimes developing into cancer; possible liver damage and heart ailments, causal factor for Hoff's disease.		131
	Laboratory animals	9 mg/kg	Lethal		131
		20 mg	Lethal or acute symptoms		165
	Dog	10-20 mg	Toxic		131
	Swine	50-100 mg	Toxic		131
	Sheep, goat, horse	1,000-1,500 mg	Toxic		131
	Cow	1,500-3,000 mg	Toxic		131

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50}(mg/kg)	REFERENCE
Arsenic (metal)	Human	Ingestion	Burning and dryness of mouth and throat, dysphagia, colicky abdominal pain, projectile vomiting, profuse diarrhea, hematuria, shock, paralysis, and increased permeability of the splanchnic capillary bed.		250
Arsenic trioxide	Human	70-180 mg	Fatal		250
	Rat			<50	246
				75-500	26
				138	8
				138±13	228
	Dog	30-70 mg/kg	Lethal		228
Arsenite ion	Human	Ingestion	>400 people died in decade		208
	Rat and mouse			18.36	208
Sodium arsenite	Human	325 mg	Lethal		131
	Rat			<50	246
				70	102
	Guinea pig	14-30 mg/kg	Lethal		228
Arsenate ion	Rat and mouse			238	208

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Calcium arsenate	Rat			298	131
Arsine	Human	Ingestion	Hemolysis of RBC; headache, anorexia, nausea, vomiting and paresthesia, jaundice and tenderness of liver and spleen.		250
		250 ppm	Lethal in 30 minutes		250
	Guinea pig	0.5-2 ppm	Increased red cell fragility, leukopenia, and a rapid fall of red cells to 80% of normal.		250
Barium (undefined)	Human	500-600 mg	Lethal		131
Barium carbonate	Human	800 mg	Lethal		174
	Rabbit	170-300 mg/kg	Lethal		228
	Rat			800	131
		50-200 mg/kg	Lethal		200
				$1,480 \pm 340$	228
		50-200 mg/kg	Lethal		228

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Barium carbonate (cont.)	Mouse	200 mg/kg	Lethal		228,200
	Rabbit			170-130	200
	Guinea pig			1,000	200
Barium chloride	Human	100 mg/kg	Lethal		200
	Rat			250	59
	Dog			90	131
	Mouse	7-14 mg/kg	Lethal		200
	Rat	355-533 mg/kg	Lethal		228
	Dog	90 mg/kg	Lethal		200,228
	Horse	800-1,000 mg/kg	Lethal		200,228
	Rabbit	170/kg	Lethal		200,228
Barium fluoride	Guinea pig			350	131,228
Barium nitrate	Rabbit	300-600 mg/kg	Lethal		174
	Dog	2,000 8,000 mg/kg	Lethal		174
Beryllium (metal)	Rabbit	40 mg injected	19/24 died from liver necrosis; 2/24 had pulmonary infections.		16

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Beryllium chloride	Mouse			92	198
	Rat			86	198
Beryllium sulfate	Mouse			80	198
	Rat			82	198
Bismuth (undefined)	Human	Single injection	Damage to kidneys and anuria		26
Boron (undefined)	Mouse	1,000-4,000 mg/kg	Intoxication in liver		252
Boric acid	Laboratory animals			1,200-3,450	252
	Human	250-330 mg/kg	Lethal		174
	Mouse			3,450±158	228
	Rat			5,140	228
				2,660±220	228
	Dog			>1,000	228
Sodium borate	Human	83-250 mg/kg	Lethal		131

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Sodium bromate	Rabbit	580 mg/kg	Minimum lethal dose		131
Cadmium (undefined)	Human	150 mg/kg	Lethal in 1.5 hrs.		131
		14.5 mg	Nausea and vomiting		131
	Dog	150-600 mg/kg	Lethal		131
	Mouse	50-100 mg/kg	Lethal		121
	Rabbit	300-500 mg	Lethal		121
Cadmium chloride	Rabbit	150-300 mg/kg	Lethal		131
		70-150 mg/kg	Lethal		228
	Cat	125 mg/l of food	Lethal		131
	Gerbil	S.C.*	Acute damage to ovarian tissue		106
	Rat			88	228
Calcium chloride	Rat	3,650 mg/kg	Lethal		131
				4,000	228
	Rabbit	1,384 mg/kg	Lethal		228

*Subcutaneous

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Bicarbonate ion	Human	700 mg/1	Unhealthful to most people		131
Sodium carbonate	Rat	10,000-20,000 mg/kg	Lethal to young		131
Cerium chloride	Rabbit			50-60 I.V.*	26
	Mouse			35.3 I.V.	26
	Laboratory animals	10 mg I.V.*	Paralysis of heart muscle and degenerative changes in blood cells		26
	Laboratory animals	10 mg P.O.** and S.C.	None of the above effects observed possibly due to longer contact with nucleic acids which converts Ce to insoluble compounds.		26
Sodium chlorate	Rat			12,000	131
	Laboratory animals	20,000-40,000 mg/1	Considered non-toxic		131
	Rat	12,000 mg/kg	Lethal		228
	Rabbit	8,000-12,000 mg/kg	Lethal		228

* Intravenous
** Oral

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Sodium chlorate (cont.)	Cat	1,350-1,940 mg/kg	Lethal		228
	Dog	700 mg/kg	Lethal		228
Ammonium perchlorate	Mouse and rabbit			1,900	219
	Rat			4,200	219
Chromium Cr^{+6}	Rat	500 mg/kg	Maximum non-toxic limit		131
Potassium dichromate	Human	10 mg/l for 15 days	Nausea		131
	Human	10 mg/l in drinking water for 3 wks. (0.35 mg/kg/day)	No effect except 3 periods of vomiting		269
	Rat	500 mg/l in drinking water	Toxic		269
	Dog	2,829 mg/kg	Lethal		228
Cobalt (undefined)	Human		Low toxicity		131
	Dog			>30	131
	Laboratory animal		Vomiting by local irritation		131

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Copper (undefined)	Human	10,000 mg/kg	Lethal		78
	Human	60-100 mg	Gastroenteritis with nausea and intestinal irritation		131
		10-30 mg	No poisoning even after many days		131
		44 mg/1 in water contaminated by corroded drinking fountain			131
	Sheep	18,000-182,000 mg/kg	Lethal		131
Copper chloride	Rat			940	228
Copper nitrate	Rat			140	228
Copper sulfate	Human	10-15 grains	Severe abdominal pain, vomiting, diarrhea, hematuria and convulsions, possibly fatal.		26
	Human	Ingestion	Hemolytic anemia		26
	Laboratory animals	890 mg	Intense inflammation of the gastro-intestinal tract		26
	Rat			300	228

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Aluminum fluoride	Mouse			103	170
Magnesium fluoride	Guinea pig	1,000 mg/kg	Lethal		228
Gallium (undefined)	Rat	110-121 mg/kg S.C.	Lethal		26
		47 mg/kg I.V.	Lethal		26
	Rabbit	97 mg/kg S.C.	Lethal		26
		43 mg/kg I.V.	Lethal		26
	Dog	Fatal dose	Severe gastro-intestinal disturbance with anoexia, diarrhea, and blood in feces; rapidly progressive debility and weakness culminating in coma and death		26
Gallium citrate & Gallium lactate	Mouse	S.C.		600	26
	Dog & goat	I.V.		10-15	26
Germanium (undefined)	Rabbit	586 mg/kg S.C.	Lethal		26

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50}(mg/kg)	REFERENCE
Germanium (undefined) (cont.)	Laboratory animals	Lethal	Hypothermia, listlessness, diarrhea, cyanosis, and almost complete respiratory an cardiac depression; edema, hemorrhage of lungs, petechial hemorrhage in walls of small intestine and peritoneal effusion		26
Indium (undefined)	Mouse	Dose which caused death in 3-6 days	Failure to eat, loss of weight, dirty roughened coat, muscular twitchings and dyspnea		26
Indium chloride	Rat			1.8 I.P.*	42
				4.1 I.V.	42
		20 mg/kg I.V.	Severe hepatic damage and death within a few days		65
Indium sulfate	Laboratory animals	20-30 mg for 27 days	No ill effects		26
	Rabbit	1300-2000 mg	Minimal lethal dose		228
Potassium iodide	Human	300-1300 mg	Iodism in sensitive individuals		131
	Mouse			1980-2070	131

*Intraperitoneal

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Ferrous chloride	Human	100 mg/kg	Acute poisoning of 2-1/2-year old girl		131
	Dog	200-800 mg	No physiological effect		131
	Rat	984-1986 mg/kg	Lethal		228
	Rabbit	890 mg/kg	Lethal		228
Ferric chloride	Rat			900	131,228
Lanthanum acetate	Rat			10,000	228
Lanthanum nitrate	Rat			1450	131
	Rat			4500	228
Lead (unidentified)	Human		Irritability, vomiting, convulsions, coma, and death		218
			Encephalopathy		26
Lead acetate	Dog	300 mg/kg	Lethal		228
Lead carbonate	Guinea pig	1000 mg/kg	Minimum lethal dose		228

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Lead chloride	Guinea pig	1500-2000 mg/kg	Minimum lethal dose		228
Lead oleate	Guinea pig	8000 mg/kg	Lethal		228
Lead sulfate	Guinea pig	35,000 mg/kg	Minimum lethal dose		228
Lithium (undefined)	Laboratory animals	P.O. or I.V.	Anorexia, nausea, vomiting, diarrhea, and salivation; loss of weight, dehydration and fall of body temperature		26
Lithim citrate	Human	20 grains 3Xday	Ataxia, general weakness and epileptiform convulsions		26
Lithium fluoride	Guinea pig			200	131
	Guinea pig	200 mg/kg	Lethal		228
Magnesium chloride	Laboratory animals	40,000 mg/kg	Diarrhea, loss of appetite and possible death		131
Magnesium sulfate	Human	200 mg/kg	Lethal		131
Manganese (undefined)	Human		Possible association with hemochromatosis		26

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Mercury (undefined)	Human	1000-2000 mg/kg	Lethal		136
		Ingestion of a toxic dose	Paresthesia of mouth, hands, feet, etc. Constriction of visual fields, hearing difficulty, speech disorders, neurasthenia, inability to write, read, or recall basic things, emotional instability, ataxia, stupor, coma, and death in extreme cases.		55, 56, 57
Mercuric chloride	Rabbit	3 mg/kg/day for 3 days. S.C.	Impairment of blood platelet aggregation		71
	Rabbit			37	228
	Human	170-330 mg/kg	Fatal		131
		1.7 mg/kg	Acute poisoning		165
		8 mg/kg	Fatal		165, 75
	Rat			37	131
	Dog	10-15 mg/kg	Lethal		136

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Methyl-mercuric chloride	Rat	Sublethal I.P.	Higher rate of litter resorption; decrease in fertility rate; increase in percentage of fetuses born dead		56
	Mouse	125 mg/kg	Death w/out neurological symptoms		235
		85 mg/kg	" " "		235
		58 mg/kg	Death with neurological symptoms in all mice		235
		40 mg/kg	Survival with neurological symptoms in some mice		235
		28 mg/kg	Survival w/out neurological symptoms in all mice		235
		18.5 mg/kg	" " "		235
		18.5 mg/kg/day for 7 days	Death with neurological symptoms in all mice		235
		12.5 mg/kg/day for 7 days	Survival with neurological symptoms in all mice up to the 30th day		235
		8.5 and 5.8 mg/kg/day for 7 days	Survival w/out neurological symptoms in all mice		235

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Molybdenum (undefined)	Rat	116 mg/kg	Lethal		61
Ammonium molybate	Rat			333	131
	Rat and guinea pig	1,200 mg/kg	Anorexia, colic, trembling, uncoordinated movements and dyspnea		131
	Guinea pig	203 mg/kg	Lethal		228
	Rabbit	1,870 mg/kg	Lethal		228
	Cat	>1,600-3,200 mg/kg	Lethal		228
Calcium molybdate	Rat			101	131
Nickel (salts)	Laboratory animals	Large dose	Gastro-intestinal irritation with vomiting and diarrhea		26
	Dog	500 mg	Lethal		26
Nickel carbonate	Rat			250-1,000 ppm	205
Nickel chloride	Dog			1.5-30	205
Niobium chloride	Rat			41	228

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Potassium niobate	Rat			725	43
Sodium cyanate	Rat	300 mg/kg	Lethal		269
Hydrogen cyanide	Human	50-60 mg	Lethal		131
		161 mg	Lethal in 15 minutes		131
	Cow	390-920 mg	Toxic - lethal		131
	Sheep	40-100 mg	Toxic - lethal		131
	Horse	390 mg	Toxic - lethal		131
	Dog	30-40 mg	Toxic - lethal		131
Potassium cyanide	Rat	10-15 mg/kg	Minimum lethal dose		228
				10	72
	Dog	5.3 mg/kg	Lethal		228
Sodium cyanide	Human	200 mg	Lethal		131
	Sheep	5.21 mg/kg	Lethal		131
Hydrazine	Rat			60	131
	Mouse			60	131

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Nitrite ion	Human			20	118
Sodium nitrite	Dog	330 mg/kg	Minimum lethal dose		131,228
Nitrate ion	Human	117-583 mg/kg	Lethal		118
Potassium nitrate	Human	8,000-39,000 mg	Lethal		131
	Dog	6,000 mg	Lethal		131
	Horse	50,000 mg	Toxic		131
	Cow	240,000 mg	Toxic		131
	Sheep	30,000 mg	Toxic		131
Sodium nitrate	Cow	240,000 mg	Lethal		131
	Sheep	20,000 mg	Lethal		131
	Dog	6,000 mg	Lethal		131
	Pig	90,000 mg	Lethal		131
	Rat ♂	1,100-2,000 mg/kg	Minimum lethal dose		228
	Rat ♀	57-130 mg/kg	Minimum lethal dose		228

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Potassium hydroxide	Human	43 mg/kg	Lethal		131
Sodium hydroxide	Human	1.95 mg/kg	Lethal		131
	Rat	10,000 mg/l	Nervousness, sore eyes, diarrhea, retarded growth		131
	Rabbit	943 mg/kg (10% solution)	Lethal		228
Palladium	Rabbit	0.6 mg/kg I.V.	Damage mainly to heart, kidneys, bone marrow and liver		26
Potassium chloride	Rat	2,430 mg/kg	Lethal		228
Rubidum (undefined)	Laboratory animals	Large amount in low potassium diet	Violent tetanic spasms, followed by death in few weeks		26
Selenium (undefined)	Human	2-4 mg/kg	Minimum lethal dose		23
		Large dose	Vomiting, garlic odor of breath, dyspnea, tetanic spasms and death from respiratory failure; eye lesions; acute congestion of liver, kidney; atony of smooth muscles and erosion of long bones		26
	Rat	0.012 mg/kg	Near sub-threshold		23

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENTS	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Selenium (undefined) (cont.)	Sheep	0.4 mg/kg	Stimulated the inhibitory process of brain cortex up to 10-20 days		247
Selenous acid	Chick	Injected at Day 4 of incubation	Low RBC count and hemoglobin values; decrease in uptake of tritiated thymidine; decrease in the lymphocyte of the bursa of Fabricius and spleen removed from 19-day-old chicks		116
Potassium selenate	Chick (embryo)			2.00 ppm	83
Sodium selenate	Rabbit	4 mg/kg	$Lethal_{100}$		228
Sodium selenite	Lamb	3.5 mg/kg	Lethal in 10-12 hours		115
	Rabbit	4 mg/kg	$Lethal_{100}$		228
				6.3	30
Silver nitrate	Human	10,000 mg	Lethal		131
Potassium sulfate	Human	45,000 mg	Lethal		131
Sodium sulfate	Poultry	7,500 mg/1	Lethal in 1/3 in 15 days		131

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENTS	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Tantalum chloride	Laboratory animals			958	26
	Rat	50% solution		1,900	228
Tantalum fluoride				1,150	26
Tellurite ion	Rat	2.5 mg/kg	Minimum lethal dose		165
Potassium tellurite	Dog	700 mg	Drowsiness and vomiting		26
		500 mg I.V.	Death preceded by convulsions		26
		500 mg	Lethal		26
Sodium tellurite	Mouse			20	119
	Rat			83	119
	Guinea pig			45	119
	Rabbit			67	119
Tellurate ion	Rat	20-30 mg/kg	Minimum lethal dose		165
Sodium tellurate	Mouse			165	119
	Rat			385	119

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENTS	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Thallium (undefined)	Human			3-17	165
		12 mg/kg	Lethal		174
	Dog	12-15 mg/kg S.C. or I.V.	Lethal		26
	Laboratory animals	Acute dose	Restlessness, ataxia, convulsive movements followed by partial paralysis, tremors, dyspnea, loss of weight, hemorrhagic diarrhea and death from respiratory failure; lesions in small intestine, kidneys, lungs and nervous tissue		26
Thallous acetate	Rat, rabbit, dog			32	131
	Rat, rabbit, dog	26-39 mg/kg	Lethal		41
Thallous oxide	Rat, rabbit, dog			39	131
	Rat, rabbit, dog	21-31 mg/kg	Lethal		41
Stannous chloride	Dog	500 mg/kg	Paralysis		26

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Tungsten (salts)	Rat	2% with sodium tungstate; and 5% with ammonium paratungstate	Lethal		131
Uranium (undefined)	Rat			2,083	20
	Rabbit			400	20
Vanadium (undefined)	Rat	1 mg/kg	Minimum lethal dose		214
Vanadium pentoxide	Human	30 mg I.V.	Lethal		26,128
	Human	Toxic	Nausea, vomiting, rise in temperature, albuminuria, hematuria, diarrhea, emaciation, nervous disturbance, and a dry hacking cough		26
Calcium vanadate	Chick			300-350	131
Yttrium chloride	Rat	350 mg/kg I.P.	Lethal		60
Yttrium nitrate	Rat	350 mg/kg I.P.	Lethal		60
Yttrium oxide	Rat	500 mg/kg I.P.	Lethal		60

TABLE III (CONT.) - MAMMALIAN ACUTE TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	LD_{50} (mg/kg)	REFERENCE
Zinc (salts)	Human	Large	Corrosive action on digestive membrane		26
Zinc chloride	Human	6,000 mg	Lethal		131
	Rat			350	26
	Mouse			350	26
	Guinea pig			200	26
Zinc sulfate	Human	45,000 mg	Lethal		131
	Rat	2,200 mg/kg	Lethal		228
	Rabbit	1,914-2,200 mg/kg	Lethal		228
	Guinea pig	1% solution for 10 days	Increased number of polychromatocytes; appearance of basophilic granuloerythrocytes, lower hemoglobin conc., and neutrophilic leucocytosis with a shift to the left		70

CHRONIC TOXICITY

Table IV presents available chronic toxicity of inorganic pollutants in freshwater in accordance with the species of animals used, dose examined, and effects perceived. Again, doses are oral unless otherwise indicated. It will be noted that the methods of oral administration were highly variable, and in some instances the different techniques of administration could not be brought to a common expression. In other instances, especially in man, doses were not available. Only a relatively few studies demonstrated dose-related effects which would allow an assessment of maximum non-effective or threshold doses important for arriving at quality criteria. Information on maximum no-effect concentrations in the Table are usually of Russian origin and represent the Russian practice of using animal data directly as standards for man, with no safety factor applied. The advisability of this approach is discussed in the report entitled, "Water Quality Criteria Data Book Volume I, Organic Chemical Pollution of Freshwater."

TABLE IV - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Aluminum (undefined)	Animal	1,400 ppm in diet	Lowered level of inorganic phosphorus in bone	26
	Man	Large amounts	Change in route of elimination of inorganic phosphorus	26
Aluminum chloride	Rabbit	10 and 20 mg/kg for 6 mos.	No effect on hemoglobin, erythrocyte, leucocyte, blood sugar or cholinesterase concentration	170
		4 mg/l (0.50 mg/kg/day)	Maximum no-effect dose	170
Antimony (undefined)	Rat	≤ 1,000 mg/kg/day in food	Normal growth but consistent injury to heart	131
	Rabbit	In food	Progressive increase in hemoglobin and in total red cells	131
	Cat	In food	Decrease in white cells	131
	Rat		Increase in serum cholesterol and serum glucose in female; increase in effect on aortic plaques; no effect on blood pressure	203
Antimony ion Sb^{+3}	Mouse	5 mg/l for life (0.50 mg/kg/day)	Significant decrease in growth rate; no effect on survival or longevity	203
	Rat	5 mg/l for life (0.73 mg/kg/day)	Significant decrease in survival and longevity; no effect on growth rate	203

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Antimony potassium tartrate	Human	I.V.* for schistosomiasis	Severe electrocardiographic abnormalities, skin eruptions and pneumonia. Moderate toxicity includes injury to internal organs and severe toxicity includes serious debilitating effects or death.	131
	Human	I.V. for schistosomiasis	Adams-Stokes syndrome with severe ventricular arrhythmia	26
	Human		Injury to liver	26
	Rat	Up to 100 mg/kg for 12 mos.	Consistent injury to the heart	26
Antimony trichloride	Guinea Pig	0.046 mg/kg for 6 mos.	Slight reduction in blood HS-concns; no effect on hemoglobin and reticulocyte concns, muscular chronaxy, or electroencephalograms	10
Arsenic (undefined)	Laboratory animals	0.5 mg/kg/day	Change in conditioned reflexes	4
		2.5 mg/kg/day	Morphological changes in blood and impairment of kidney function; cumulative in organs	9
	Human	Prolonged ingestion of sublethal doses	Possible damage to liver; chronic arsenic poisoning	165

*Intravenous

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Arsenic (cont.)	Human	Chronic intoxication	Weakness, loss of appetite, gastrointestinal disturbances, peripheral neuritis, occasional hepatitis and skin disorders	8,174
			Neurologic changes, increased salivation, hoarseness, cough, laryngitis, conjunctivitis, colicky abdominal pain and various skin changes	250
Sodium arsenite	Mouse	5 mg/l for life (0.50 mg/kg/day)	Significant decrease in survival and longevity	203
			Increase in serum cholesterol, decrease in serum glucose, no effect on blood pressure	203
Barium (undefined)	Human		Possible effect on heart, blood vessels and nerves; constricts blood vessels to cause increase in blood pressure; muscle stimulant especially to heart; does not accumulate in bone muscle, kidney or other tissue	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Barium chloride	Rat	20 mg/kg/day and 10 mg/kg/day drinking water for 6.5 mos.	Change in conditioned reflexes; slight structural change in tissues; increased blood cholinesterase activity	59
		5 mg/kg/day in drinking water for 6.5 mos.	No change in conditioned reflexes; no change in tissues, very slight decrease in cholinesterase activity in 2/3 animals	59
	Rabbit	5, 2.5 and 1 mg/kg/day in drinking water for 13.2 mos.	Decrease in cholinesterase activity at 5 mg/kg; no change at other doses; no change in blood picture	59
		5 mg/kg or 100 mg/1	Maximum no-effect dose	59
Beryllium (undefined)	Human		Not harmful when taken internally through the digestive tract	131
	Laboratory animal	0.001 mg/1 (long-term)	Maximum no-effect dose	199
	Dog, Rabbit and Rat	Inhalation of Be salt aerosols	Effect on hemopoiesis	230
	Rabbit	Inhalation of Be salt aerosols	Depressed blood sugar level	230

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Beryllium sulfate	Laboratory animals	0.001 mg/kg/day for 8.5 mos.	Decrease in hemoglobin level; decrease in reticulocyte number in first 2 mos.; erythropoiesis in bone marrow; no pathological changes in internal organs	198
	Rat	0.001-0.0001 mg/kg/day for 8.5 mos.	Disturbance in conditioned reflexes	198
		0.00001 mg/kg or 0.0002 mg/l (long-term)	Maximum no-effect dose	198
Potassium bismuth	Laboratory animal	0.025 mg/kg (long-term)	Decrease in hydrosulfide groups of blood serum and liver, decrease in succinate dehydrogenase	48
Bismuth sulfate	Laboratory animals	0.05 mg/kg (long-term)	Decrease in hydrosulfide groups of blood serum and liver, decrease in succinate dehydrogenase	48
Boric acid	Animal	2,500 mg/l in drinking water (250 mg/kg/day)	Growth inhibited	131,257
Cadmium (undefined)	Rat	In drinking water or food	Decrease in hemoglobin content of blood	131
	Rabbit	0.005 mg/kg for 5 mos. in diet	No change in blood morphology, glycogenic function or histology	121

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Cadmium (undefined) (cont.)	Human	From water and food	Hypertension linked to increased retention of Cd in kidneys	126,231,265
	Human	From water-"high conc."	Disorders of renal function; phosphate level in the blood serum decreases; sizeable loss of minerals from the bones. "Itai etai" disease.	28, 29
	Rabbit	I.V. 6-8 wkly. injections	Aortic strips obtained developed a significantly lower active tension to angiotension in comparison with aortic strips from normotensive animals	265
	Rat	10 mg/l in drinking water for 2-4 mos. (1.5 mg/kg/day)	Chronic arterial hypertension	207
	Human	0.03-35 mg/m^3 by inhalation	Weight of children differed significantly from those of non-exposed females	244
	Laboratory animals	Small doses	Damage to vascularture of the testes, causing hemorrhages and necrosis of tissue and consequent sterility	126

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Cadmium (undefined) (cont.)	Mouse	5 mg/l for life (0.50 mg/kg/day)	Significant decrease in survival and longevity; no effect on growth rate	126
	Rat	5 mg/l for life (0.73 mg/kg/day)	Significant increase in growth rate, decrease in survival and longevity; causes hypertension	203
	Rat		Increase in blood pressure; increased incidence of aortic plaques; increase in serum cholesterol in female; no effect on serum glucose	203
	Rat		Hypertension; cardiac enlargement; renal arteriolar hypertrophy and early schlerosis	203
Cadmium acetate	Rat	845-8,450 ppm in diet	Decrease in body weight, reduced protein and fat digestion, and decreased phosphorus absorption; increase in mortality	263
		845 ppm in diet	Liver and heart tissue exhibited increased malic dehydrogenase and glucose 6 phosphate dehydrogenase activities	263

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Cadmium acetate (cont.)	Rat	10.25-20.5 ppm in diet	Significant decrease in bone citric acid concentrations	263
Cadmium chloride	Rat	98-815 ppm in food for 100 days	Severe anemia, cardiac hypertrophy, and bleaching of the incisor teeth; no effect found on bone	29
	Laboratory animal	25-50 mg/kg S.C.* or I.V.	Hemorrhagic infarction in ovaries, ovarian duct and uterus; acute necrosis of granulosa cells of Graafian follicles and hemorrhages into the paraluteal cells	110
	Rabbit	0.41 mg/kg/day S.C. 5X/wk. for 7 mos.	Severe protunuria and extensive tubular damage	253
	Rat and Fowl	4.4 mg/kg (injected)	Inhibition of carbonic anhydrase activity in the testes followed by increased enzyme activity 10 minutes after injection	99
		14.8-14,800 mg/1 *in vitro*	Inhibition of carbonic anhydrase activity in the testes	99

*S.C. - Subcutaneous

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Cadmium chloride (cont.)	Rat	40 mg/l in drinking water (5.8 mg/kg/day)	Increased incidence of caries	131
		50 mg/l in food or water (7.3 mg/kg/day)	Decrease in blood hemoglobin; pigmentation of tooth enamel	131
		16 mg/l in diet (2.3 mg/kg/day)	Bleaching of teeth	131
		31 mg/l in diet (4.5 mg/kg/day)	Change in growth rate	131
	Rat and Dog	0.1-10.0 mg/l in drinking water for 1 year (0.0005-1.5 mg/kg/day)	Retained by kidney and liver; no other effects	131
	Rat	50 mg/l for 3 mos. (7.3 mg/kg/day)	Reduction in growth rate; reduction in water consumption; reduction in blood hemoglobin; bleached teeth	131
	Cat	0.56 mg/day	No cumulative effect	131
	Rabbit	0.41 mg/kg 5 days/wk. for 24 wks.	Nephrosis; decreased hemoglobin; large amounts of cadmium in renal cortex; alkaline phosphatase activity decreased; tubular damage in renal cortex	173

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Cadmium sulfate	Rat	Exposure up to 7 mos.	Weight of newborn significantly below that of control; livers of newborn rats 2.5X as much Cd as controls; within 3 mos. 7% control and 26% treated died	244
	Human	0.5-4 mg/l (<0.02-.14 mg/kg/day)	Phagocytosis of red cells and thrombocytes	76
	Human	185 mg/l in drinking water for 255 or 112 days (<6.5 mg/kg/day)	No external manifestations of pathological effects; degenerative changes in liver, kidney, heart spleen and brain	98
		0.19 mg/l in drinking water for 255 or 112 days (<.006 mg/kg/day)	Slight changes in kidneys	98
Calcium (undefined)	Human	From hard water in the states in the watershed of the Missouri-Mississippi river and its tributaries	Correlation with lower death rates from coronary heart disease	201
	Human	From hard water	Correlation with lower death rates from coronary heart disease	268

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Calcium (undefined) (cont.)	Human	Soft water (low Ca)	Related to mortality and cardiovascular disease	189,206
		Excessive conc. in water	Predisposing to the formation of concretions in the body such as kidney or bladder stones	131
		100-150 mg/l in drinking water (<3.5-5.2 mg/kg/day)	Elevated occurrence of uriinary disease, arthritis and polyarthritis	266
		Hard water areas	Lower death rate from cardiovascular diseases and to a lesser extent bronchitis mortality rate than in soft water areas	35
		Hard and soft water areas of Colorado	No correlation with hypertension and/or hypertensive heart disease	148
	Pig	Hard and soft drinking water	Does not influence the formation of early arteriosclerotic lesions	177
Calcium carbonate	Human	From hard water	Correlation with lower death rate from cariovascular disease	6,268

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Calcium chloride	Cow	10,000-15,000 mg/1 (500-700 mg/kg/day)	Moderate effect on nerves and appetite	131
	Sheep	20,000-25,000 mg/1	Tolerated for 6 weeks	131
Calcium hydroxide	Rat	1,800 mg/1 for several generations (260 mg/kg/day)	No ill effects	131
	Rat	50 and 350 mg/1 in drinking water for 3 mos. (7.3 and 51 mg/kg/day)	Significant weight loss; decrease in hemoglobin and RBC; decrease in phagocytes; inhibition of gastric secretion	254
Calcium sulfate	Rat	2,400 mg/1 (350 mg/kg/day)	Normal growth and reproduction	131
		Saturated $CaSO_4$ solution	Satisfactory growth	131
	Human	High level of NaCl and $CaSO_4$	Correlated with glaucoma in Irtutsk district in USSR	270
Bicarbonate ion	Human	Soft water	Associated with higher death rates from degenerative cardiovascular disease	204,206
Calcium bicarbonate ion	Human, rat	3.5 gm in drinking water	Disturbance of purine metabolism	266

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Potassium bicarbonate	Sheep	50,000 mg/l	Adverse effects on appetite and growth	131
Sodium bicarbonate	Rat	15,000-20,000 mg/l in drinking water (2,200-2,900 mg/kg/day)	Thirst, diarrhea, impaired growth	259
Sodium carbonate	Livestock	High conc. in drinking water	Diarrhea, malnutrition, unsatisfactory growth and may in erfere with reproduction	131
	Rat	10,000-1 ,000 mg/l (1,500-2,800 mg/kg/day)	Inhibited growth	131
Chloride ion	Human	Up to 1,000 mg/l (<35 mg/kg/day)	Not harmful in hot dry areas	131
		High conc. of chlorides, sulfates, in drinking water	Apparently accounts for finding high incidence of cholelitliasis and cholecytitis in a region of the USSR.	175
Chlorine Cl_2	Human	90 mg/l (<3.2 mg/kg/day)	Strong physiological effects	131
		Chlorinated drinking water	May cause asthma, colitis, and eczema	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Chlorine Cl_2 (cont.)	Mice	200 mg/l in drinking water (20 mg/kg/day)	No effect	131
	Rat	100 mg/l/day in drinking water (15 mg/kg/day)	No toxic effect on fertility, growth, or blood picture, or on the histology of liver, spleen, kidneys, or other organs	45
	Rat	High doses - long term	Irritating effect on upper sections of digestive tract	80
Ammonium perchlorate	Rabbit	190 mg/kg or 3 mos.	Effect on cholinergic and vegetative nervous systems	219
		2 mg/kg, long-term	Influence on thyroid activity	219
		0.25 mg/kg or 5 mg/l long-term	Max. no-effect dose	219
Chromium ion Cr^{+6}	Human	1.0-25.0 mg/l in well water	No ill effects on physical exam of entire family	131
	Rat	5 mg/l in drinking water with 11 mg/l selenium (0.73 mg/kg/day)	Increase in mortality	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Chromium ion Cr^{+6} (cont.)	Rat (cont.)	25 mg/l in drinking water for 6 mos. (3.6 mg/kg/day)	Slight drop in hemoglobin, no histological changes. Large amount of Cr^{+6} in kidney, liver and bony tissue	59
		0.005 mg/kg in drinking water for 6 mos.	No change in conditioned reflexes	59
	Human	25 mg/l in drinking water for 3 years (<0.9 mg/kg/day)	No harmful effects	269
	Mouse	5 mg/l for life (0.50 mg/kg/day)	Significant increase in growth rate; decrease in survival and longevity	203
Chromium ion Cr^{+3}	Mouse and rat	5 mg/l for life (0.50-0.73 mg/kg/day)	Significant increase in growth, survival and longevity	203
	Rat	Diet deficient in Cr	Antherosclerosis; relative hypercholesteremia which increased with age, and mild to moderate hyperglycemia; increased incidence of aortic plaques	203
Chromium (undefined)	Rat		Decrease in serum cholesterol, serum glucose; decreased aortic plaques; no effect on blood pressure	203
Potassium chromate	Rabbit	500 mg/l in drinking water (62.5 mg/kg/day)	No effect on food utilization	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Potassium chromate (cont)	Rat	11 mg/1 for 1 year (1.6 mg/kg/day)	No significant difference in weight, food, intake, or water consumption or blood analysis	131
Zinc chromate	Rat	10,000 mg/1 in drinking water (1500 mg/kg/day)	Markedly interfered with digestion	131
Cobalt (undefined)	Animal	25 mg/day	Affected hemoglobin conc. of blood	131
		Small amount daily	Polycythemia	131
	Calves	500 mg in diet/day as salt	Loss of appetite and and weight	131
	Rat	100 mg/1 in drinking water (15 mg/kg/day)	Tissue damage	131
Cobaltic chloride	Rat	Injections	Polycythemia	196
Cobaltic sulfate	Lamb	5 mg/day for 10 mos.	Anemia	131
	Cattle	50 mg/100/k/day (1.1 mg/kg/day)	Blood changes	131
		Higher doses than above	Appetite, growth, and coördination also affected	131
	Bull	10 g/d. 90-127 days	Tolerated	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Cupric sulfate	Cattle	1000/mg/lb. (2200 mg/kg/day)	Loss of appetite; copper accumulation in liver, jaundice and yellow discoloration of whole animal	131
	Sheep	1500 mg daily for 30-80 days	Chronic poisoning	131
	Dog	4000 mg daily	Slight effect	131
Fluorine	Human	Live in area of a fluorine-emitting aluminum factory	Bluish skin spots in women and children attributed to capillary damage	31
	Rat	Extract of dust emitted from aluminum factory + NaF (4.4 mg/day) during pregnancy S.C.	No cutaneous lesions or increased capillary fragility of skin	31
		Extract of dust emitted from aluminum factory + NaF (0.44 mg/day) in first 10 days of life S.C.	No cutaneous lesions or increased capillary fragility of skin	31
Fluoride ion	Human	<5 mg/1	No harmful effects except mottling of teeth	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Fluoride ion (cont.)	Human	0.2-6.0 mg/1	Mild to severe mottling	131
		4.4-12.0 mg/1	Chronic fluorosis and affected skeletal system	131
		11.8 mg/1	Fluorine intoxication	131
		12.0 mg/1	Affects deciduous teeth	131
	Sheep	1.0 mg/1	Fluoride poisoning	131
		4.0 mg/1	Mottled and pitted teeth	131
		20.0 mg/1	20% weight reduction	131
		120 mg/1day	Threshold for general health	131
	Cattle	1.0 mg/kg	Mottling of teeth	131
		3.0 mg/kg	Bone damage and death	131
	Dogs	5 mg	Hypertension	131
	Cows	11.78 mg/1	Mottling teeth	131
		18 mg./1	Slowly increasing fluorosis	131
	Mice	1.4-4.5 mg/1	Mottling of teeth	131
	Livestock	High - in water, food, etc.	Mottling, staining, hypocalcification, pitting and abrasion of teeth; degree of osteofluorosis; abnormal amount of fluorine in urine; intermittent lameness	221
	Human	1.0-9.2 mg/1	Skeletal fluorosis	258

TABLE IV (CONT.) - MAMMALIAN CHORNIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Fluoride ion (cont.)	Human	1.2-5.7 mg/l (water consumed during lifetime)	Fluoride osteosclerosis; died of terminal septicemia and pneumonia (2 cases)	258
	Rat	0.2-0.3 mg/l in drinking water	Conditioned reflexes developed faster than controls	243
		15 mg/l in drinking water	Retarded development; slight decrease in excretion of pyruvic acid in urine, blood sugar, activity of blood cholinesterase, thyroid activity and oxygen consumption	243
	Calves	100 mg/l in drinking water for 11 mos.	Depression of calcium absorption rate from gastrointestinal tract; increase in rate of removal of calcium from bone; decrease in mineral density, larger intertrabecular spases and prominent resorption cavities in metacarpal bones	184
	Human	High quantities in drinking water over period of years	Disorder affecting teeth, skeletal system and nervous system; no significant alteration in thyroid, adrenocortical or parathyroid functions; serum enzymes normal except increase in serum alkaline phosphatase level	184

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Fluoride ion (cont.)	Rat	450 ppm in diet	Increased plasma fluoride; reduction in growth rate and food intake	131
		2-6 mg infused into femoral vein/day	Decrease in food intake possibly due to effect on cellular metabolism	131
Aluminum fluoride	Rabbit	18 mg/kg/day for 6 mos.	Loss of weight, fall in hemoglobin value, changes in cholinesterase activity and marked mottling of tooth enamel	170
		3 mg/1 (0.4 mg/kg/day)	Maximum no-effect dose	170
Sodium fluoride	Rat	1.5 and 15.0 mg/1 in drinking water for 6 mos. (0.2 and 2.2 mg/kg/day)	No changes in cardiac activity	109
		15.0 mg/1 in drinking water for 6 mos. (2.2 mg/kg/day)	Manifested some functional disturbances in brain cortex	109
Gallium (undefined)	Mouse	5 mg/1 for life (0.5 mg/kg/day)	Significant decrease in growth rate and longevity	203
Gallium chloride	Laboratory animals	1,000 ppm in diet for 13 weeks	No ill effects	26

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Sodium germanate	Mouse	5 mg/1 for life (0.5 mg/kg/day)	Significant decrease in survival, longevity	203
	Rat	5 mg/1 for life (0.73 mg/kg/day)	Significant decrease in survival	212
	Rat	5 mg/1 for life (0.73 mg/kg/day)	Decrease in serum cholesterol in male, increase in female; increase in serum glucose in female; increased effect on aorta plaques; no effect on blood pressure; hepatic cell degeneration and necrosis and fatty degeneration of liver; proteinuria	203,212
Indium chloride	Rat	0-4% in diet for 3 mos.	Marked weight depression at 4% level, slight depression at 2.4% - increase in lung weight at both levels	42
Indium (undefined)	Mouse	5 mg/1 (0.5 mg/kg/day)	Significant decrease in growth rate; no effect on survival or longevity	203
			Hemorrhagic lesions in lung, liver and kidneys; inflammatory and degenerative changes in liver, kidneys and heart	65
Potassium iodide	Rat	10,000 mg/1 in drinking water (1,500 mg/kg/day)	Inhibits reproduction	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Lead (undefined)	Animal	0.18 mg/l in soft water (0.02 mg/kg/day)	Lead poisoning	131
	Rat	0.005 mg/kg	CNS changes	131
	Human	2.0-4.0 mg/l for 3 mos. (<.07-.14 mg/kg/day)	Harmful range	165
	Human	From drinking water - high conc.	Disorder of renal function; phosphate level in the blood serum decreases; sizeable loss of minerals from bone	28
	Rat		Increase in serum cholesterol in female; decrease in serum glucose in male; no effect on aortic plaques or blood pressure	203
	Human	Chronic lead poisoning	Microcytic anemia and encephalopathy	218
Lead Pb	Human		Much like multiple sclerosis; CNS damage	266
	Higher Animals and Humans		Changes in blood enzymes; blood serum adolase activity increased	266
	Animal		Cellular abberations of erythrocytes; swollen mitochondria, simple and compound vacuoles, clusters of ferrin in the cells; blockage of heme synthesis	266

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Lead Pb (cont.)	Mouse and Rat	25 mg/l for life (2.5 and 3.6 mg/kg/day)	Significant decrease in survival and longevity; no effect on growth rate	203
	Rat		Significant increase in serum cholesterol in female only; decrease in serum glucose in male; no effect on blood pressure or aortic plaques	203
Lead acetate	Rat	5 mg/l in drinking water for life (0.73 mg/kg/day)	Progressively toxic in terms of life span compared to controls	202
		5 mg/l in drinking water + chromium (essential for optimal metabolic function) for life span (0.73 mg/kg/day)	No increase in mortality compared to controls	202
			38.5% vs. 11.4% (controls) died of infectious diseases	202
			78.5% vs. 34.6% (controls) died during epidemic of viral pneumonia	202
			No increased incidence of hypertension, diabetes, or hypercholesteremia	202
Lead carbonate	Mouse (suckling)	In diet of maternal animals immediately after giving birth	Faulty growth and development; hematologic evidence of lead poisoning; neuropathological changes	192

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Lithium (undefined)	Human	From drinking water	Correlation with ischemic heart disease	22
		From drinking water in 100 U.S. cities	Negative correlation between Li level and atherosclerotic heart mortality	255
Lithium carbonate	Human	300-1,800 mg/day for treatment of manic-depression (5-30 mg/kg/day)	Tremor of hands, diarrhea, skin rash, alopecia, confusion, toxic psychosis, coma and convulsions	248
Magnesium (undefined)	Human	From hard water in the states in the watershed of the Missouri-Mississippi River with its tributaries	Correlation with lower death rates from coronary heart disease	201
	Human	Hard water areas	Correlation with lower death rates from coronary heart disease	268
		Hard and soft water areas of Colorado	No correlation with hypertension and/or hypertensive heart disease	148
	Pigs	Hard and soft drinking water	Does not influence the formation of early arteriosclerotic lesions	177
Magnesium chloride	Pig	20 g daily	No adverse effect	131
	Horses	400 g daily	No adverse effect	131

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Magnesium chloride (cont.)	Sheep	60 g daily	No adverse effect	131
	Rat		No effect on tooth decay	131
		10,000-15,000 mg/l (1,500-2,200 mg/kg/day)	Interfered with growth	131
Magnesium sulfate	Human	Excessive conc. in drinking water (1,000-2,000 mg)	Purgative effect	131
	Rat and Other Small Animals	High conc.	Retarded growth, caused emaciation, rough coat, diarrhea, and increased mortality among the young	131
	Rabbit	Distilled water with $MgSO_4$ added	No cases of atherosclerosis vs. results with hard water, high fat and cholesterol diet and regular diet with distilled water	38
Manganese (undefined)	Human		Three persons died as a result of poisoning by well water contaminated by manganese derived from dry cell batteries buried nearby	131
			Encephalitis-like disease traced to Mn in drinking water in area outside Tokyo	131
			Cause of a race disease endemic in Manchukuo	131
	Rabbit	500-600 mg/kg/day	Stunted growth and interfered with bone development	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Manganese (cont.)	Rat	5 mg/kg for life span	Decrease in serum glucose; no effect on blood pressure, serum cholesterol or aortic plaques	203
Manganous chloride	Rat	8 mg/kg daily I.P.*	Appreciable damage to seminiferous tubules at 150 days and at 180 days 50% of tubules were degenerated	32
Manganous sulfate	Rat	0.55-9.9 mg in diet	1.9-9.9 mg. had inhibiting effect on rat's thyroid	107
Mercury (undefined)	Human	Over a long period of time - in food, water, etc.	Anxiety, excessive self-consciousness, difficulty in concentrating, irritability, resentment of criticism, headache, fatigue, blushing and excessive perspiration	140
	Human	Small amounts	Produce kidney damage, muscular tremors, irritability, and depression	137
Ethylmercuric chloride	Human	From flour treated with Agrosan-GN (West Pakistan)	Effect on CNS; optic nerve atrophy frequently observed, blindness often permanent	57
Methyl mercuric chloride	Human	From fish	Neurological disturbance and death in inhabitants of Minamata Bay, Japan	97
	Human (fetus)		Damage to brain cells	123

*Intraperitoneal

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Methyl mercuric chloride (cont.)	Human (survivors of Minimata)	From fish	Cerebellar ataxia, blindness, and dysarthria	138
Methyl mercury	Human	From swine whose feed had been contaminated with Panogen (Alamagordo, N. M.)	Visual difficulties, bizarre behavior, difficulty in walking, lethargy and coma	57
	Human	From water, fish, etc.	Partial brain damage	139
	Human (infant)	From mother (3 mos. pregnant) eating swine whose feed had been contaminated with Panogen	Markedly abnormal electroencephalogram	246
Methyl mercuric dicyandiamide	Chicken	Wheat treated with compound at a rate of 12 mg/kg/day for 35-44 days	No clinical signs of poisoning	85
	Ferret	Muscle and liver of above chickens (Hg content equivalent to 5 or 7 mg/kg)	Ataxia, trembling and paralysis; degenerative changes in CNS and peripheral nervous system; high Hg levels in kidney, liver, brain, skeletal muscle and gonads; death by 58th day	85
	Human	From wheat in Guatemala	Encephalitis-like effects	57

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Methyl mercuric sulfide CH_3HgSCH_3	Rat	1.3 mg/kg/day for 3 mos.	Lesions of granular cell layer in cerebellum closely related to course of vessels; pathological changes in granular cells: disappearance of organelles and diminution of nuclear substance, changes in mitochondria.	135
Mercuric chloride	Rat	2, 3, and 4 mg/kg/day in drinking water	Decrease in alkaline phosphatase activity in neutrophils	127
Phenylmercuric chloride	Swine (5 wks. old)	3.6 or 7.1 mg/kg for $\leq$90 days	Typhlitis, colitis and nephrosis; high levels of Hg in kidney and colon	242
		0.3 mg/kg for $\leq$90 days	No lesions on kidneys, BUN 15 mg/100 ml in 2/5 animals	242
		0.59 mg/kg for $\leq$90 days	No lesions on kidneys; BUN 17-22 mg/100 ml in 3/5 animals	242
		1.2 mg/kg for $\leq$90 days	No lesions on kidneys; BUN 15-20 in 3/5 animals	242
		3.6 mg/kg for $\leq$90 days	Minimal-moderate renal lesions on 4/5 animals; BUN: 20-90 mg/100 ml	242
		7.1 mg/kg for $\leq$90 days	Minimal-severe renal lesions in 4/5 animals; BUN: 18-140 mg/100 ml	242

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Molybdenum (undefined)	Rat		Increase in serum glucose; no effect on blood pressure, serum cholesterol or aortic plaques	203
	Cattle	100-350 mg in diet (long-term)	Severe diarrhea, anemia, loss of weight and discoloring of hide	61
Molybdenum ion Mo^{+6}	Rat and Mouse	10 mg/1 for life (1-1.5 mg/kg/day)	No effect on growth rate, survival or longevity	203
Ammonium molybdate	Laboratory animals	500 mg/day	Anorexia, listlessness and loss of weight	131
	Rabbit	10.2-100.4 mg/kg/day for 6 mos.	Retardation of weight gain	11
		5.1 mg/kg/day for 6 mos.	Raise in erythocyte count, but became reversed as experiment proceeded. Rise in SH groups in serum	11
		1.02 mg/kg/day for 6 mos.	Rise in SH groups and a decrease in content of Vitamin C in the liver	11
		0.051 mg/kg or 1.02 mg/1	Maximum no-effect dose	11
	Rat	1.02 mg/kg for 2-1/2 mos. in milk	Marked rise in WBC; histological changes in liver	167
		2.04 mg-kg for 20 days after 0.5 mg/kg for 2-1/2 mos.	Similar effects but more pronounced than above; focal granular dystrophy of the kidneys	167

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Ammonium molybdate (cont.)	Rabbit	0.051-0.1 mg/kg	Increase in cystine, histidine, arginine, glycine, threonine, alanine, valine, leucine, and isoleucine in blood serum	247
		0.51 mg/kg	Decrease in arginine, glutamic acid, methionine and valine in serum; increase in cystine, histidine, glycine, thronine, alanine, leucine, isoleucine and phenylalanine in blood serum	247
		1.02 and 2.04 mg/kg	Decrease in cystine, arginine, glycine, glutamic acid, threonine, alanine, methionine, and phenylalanine; histidine increased significantly at 1.02 mg/kg and decreased significantly at 2.04 mg/kg	247
Molybdenum trioxide MoO_3		P.O. or inhalation	Changes chiefly in liver and kidneys; some evidence of cellular breakdown in lungs; granulets of a Mo compound in a few cells	61
Nickel (undefined)			Capacity to inhibit enzyme systems	128
	Rat		Decrease in serum cholesterol in male, decrease in serum glucose in female; no effect on blood pressure or aortic plaques	203

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Nickel carbonate	Calf	62.5, 250, 1,000 ppm in total diet from 13-21 wks. of age	Reduced feed intake and growth rate at 250 and 1,000 ppm; kidneys were nephritic; no effect on ruminal, abomasal, duodenal, liver and testicular histology	164
Nickel chloride	Cat and Dog	4-12 mg/kg/day - 200 days	No apparent effect	131
Niobium (undefined)	Rat		Decrease in serum cholesterol in male; no effect on serum glucose, blood pressure, or on aortic plaques	203
Niobium ion Nb^{+5}	Mouse	5 mg/1 for life (0.5 mg/kg/day)	Significant decrease in growth rate, increase in longevity and no effect on survival	203
	Rat	5 mg/1 for life (0.7 mg/kg/day)	Significant increase in growth rate, decrease in longevity and no effect on survival	203
Niobium chloride $NbCl_5$	Rat	29.1 mg/kg (repeated injections)	Renal injury	43
Potassium niobate	Rat	29.5 mg/kg (repeated injections)	Renal damage	43
		In diet	No lesions on liver, kidney or spleen	43

TABLE IV (CONT.) - MAMMLIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Ammonia	Rabbit	50-80 ml of 0.5% ammonia for 17 mos. (80-130 mg/kg/day)	Chronic acidosis and tissue changes	131
Hydrogen cyanide	Rat	100-300 mg/kg diet for 2 yrs.	No signs of toxicity; no hematological or pathological changes	131
Ammonium thiocyanate	Laboratory animals	0.005 mg/kg	Effect on carbohydrate and cholesterol exchange	112
Potassium thiocyanate	Laboratory animals	0.005 mg/kg	Effect on carbohydrate and cholesterol exchange	112
Hydrazine	Rat	100 mg/l in drinking water (15 mg/kg/day)	Reluctant to drink the water	131
	Guinea Pigs	0.5 mg/l (0.07 mg/kg/day)	Pronounced decrease in hemoglobin; thyroid function disturbance; decrease in SH groups in whole blood; disturbance in liver function	50
Nitrite ion	Mice		Reduced activity patterns in experiment carried out in a barrier activity box	77
Sodium nitrite	Rat	300 and 450 mg/kg in drinking water for 56 days (44-66 mg/kg/day)	Decrease in weight gain; increase in methemoglobin levels	77

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Sodium nitrite (cont.)	Rat	3.0 mg/l in drinking water during last week of pregnancy (0.4 mg/kg/day)	High level of methemoglobin	77
		3.0 mg/l after birth of litter (0.4 mg/kg/day)	No effect on suckling rats	77
Nitrate ion	Human	High conc. in drinking water used for infant formula (>50 mg/l)	Methemoglobinemia	1, 40,131 197,206,231
			Methemoglobinemia causing hypoxia found in infants, school children and adults	151
		>45 mg/l	Methemoglobinemia in infants	96
			Period of 3 yrs: 139 cases of nitrate poisoning with 14 deaths	192
	Laboratory animals		Inhibits iodine and Vitamin A metabolism; may have effect on pregnancy	267
	Human	From drinking water	Methemoglobin level elevated in certain diseases; fluctuation of level following the degree of Vitamin C saturation of the organism	114

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Nitrate ion (cont.)	Human (infant)	>100 mg/l in drinking water and some leafy green vegetables	Alimentary methemoglobinemia	150, 223
	Human	From food and water	Methemoglobinemia	77,118
	Human (children)	88.5-117 mg/l drinking water (<3 mg/kg/day)	Methemoglobinemia	233
	Dog	22.13-110.67 mg/l in drinking water (1.0-5.1 mg/kg/day)	Methemoglobinemia in from 4/8-19/22 animals	233
	Human (<6 mos. old)	524 mg/l nitrates 0.07 mg/l nitrites 368 mg/l chlorides in water used to prepare formula	Developed cyanosis as a result of methemoglobinemia	108
	Human (12-14 yrs.)	105 mg/l in drinking water (<3.7 mg/kg/day)	Increase in reaction time to conditional visual and auditory stimuli compared to control children. Suggests probable effect of nitrates on CNS	171
	Human	Drinking water in Colorado (high nitrate areas)	Possible relationship to hypertension	148
Potassium nitrate	Rat	2%	2 out of 8 rats had normal litters	267
	Guinea Pig	5,000 mg/l and 30,000 mg/l in drinking water (700-4,000 mg/kg/day)	Evidence of reproductive disturbance	267

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Potassium nitrate (cont.)	Human	Various conc.	Diuretic, vomiting, diarrhea, muscular weakness, collapse and death	131
Sodium nitrate	Cow	6,200 mg/1 (400 mg/kg/day)	Frenzy, paralysis, diuresis, cyanosis and death	131
	Pig	1,740-2,970 mg/1 in soup prepared with well water	Death from methemoglobinemia	131
Palladium (undefined)	Mouse	5 mg/1 for life (0.5 mg/kg/day)	Significant increase in growth rate, survival and longevity	203
Potassium chloride	Human	153-191 mg/kg	Effects on nervous system and kidneys	131
Rhodium ion Rh^{+4}	Mouse	5 mg/1 for life (0.5 mg/kg/day)	Decrease in growth rate; no effect on survival or longevity	203
Rubidium	Animals	High conc. in low K diet	Irritation of muscular nerves	131
Scandium	Mouse	5 mg/1 for life (0.5 mg/kg/day)	Significant decrease in growth rate	203
Selenium (undefined)	Human	From seliniferous areas	High rate of dental caries; tendency for increased malocclusion and gingivitis	131
		5-7 mg/1 in food	Harmful to liver	165
		In water	Increase susceptibility to dental caries, G.I. disturbances, icterus	231

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Selenium (cont.)	Livestock		Anemia, liver damage and icterus	84
Selenium ion Se^{+4}	Mouse	3 mg/l for life	Significant increase in growth rate	203
	Rat	3 mg/l for life	Most animals died young	203
			Increase in serum cholesterol; increase in serum glucose in female; no effect on blood pressure or aortic plaques	203
Selenium ion Se^{+6}	Mouse	3 mg/l for life	Significant decrease in growth rate	203
	Rat	3 mg/l for life	Significant increase in longevity	203
			Increase in serum cholesterol; no effect on serum glucose, blood pressure or on aortic plaques	203
Selenium dioxide	Rat	4 mg/kg/day for 40 days	Caused hyperchromic anemia decreased serum cholinesterase, dystrophic changes in liver and kidney, slight dystrophic changes in epithelium of seminiferous ducts of testicle	73

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Selenium dioxide (cont.)	Rat	2 mg/kg/day for 30 days	Caused hypochromic anemia, decrease in serum cholinesterase, dystrophic changes in liver and kidneys of some animals	73
	Rat	1 mg/kg/day for 30 days	Caused hypochromic anemia and a decrease in serum cholinesterase	73
Selenite ion	Rat	In food and Fe^{59} injected	Extensive decline of the hemoglobin concentration and of the newly incorporated Fe^{59} in blood occurred at same time. At death, overall reduction of hemoglobin less than reduction of label; hemoglobinuria in final stages. Indication anemia caused by hemolysis rather than a defect in RBC synthesis	84
Sodium selenite	Lamb	0.1-1 mg/kg	Decreased argyrophilia; reduced blood glutathione	115
Silver (undefined)	Human	1 g I.V.	Produces argyria	131
	Rabbit	0.25 and 0.025 mg/kg/day for 11 mos.	Marked effect on immunological capacity	15
			Histopathological changes in the vascular, nervous, and glial tissue of the encephalon and medulla	15
			Effect on conditioned reflexes	15

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Silver (cont.)	Rabbit		No effect on hemoglobin, RBC, differential WBC, the proteinogenic function of the liver or on serum SH groups	15
		0.0025 mg/kg or 0.05 mg/l	Maximum ineffective dose	15
Sodium (undefined)	Human	High conc. in drinking water	In conditions such as congestive heart failure, hypertension, renal disease, cirrhosis of the liver and in pregnancy, in which water is poorly eliminated, the presence of sodium in plasma causes further retention of water, resulting in progressive circulatory and respiratory distress. In toxemia of pregnancy patient has marked edema and stores water and sodium in great excess.	194
Sodium chloride	Livestock	From salt poisoning in water	Malnutrition, wasting disease	131
	Swine	7000 mg/l in drinking water	Slight scouring	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Sodium chloride (cont.)	Cattle	7,000 mg/l in drinking water (360 mg/kg/day)	Reduction in weight	131
	Rat	10,000 mg/l in drinking water (1,500 mg/kg/day)	Decreased reproduction	131
		15,000 mg/l in drinking water (2,200 mg/gk/day)	Retarded growth, some deaths	131
	Cattle	15,000 mg/l in drinking water (800 mg/kg/day)	Reduced water intake	131
		15-17,600 mg/l in drinking water (8-900 mg/kg/day)	Sickened or killed	131
Sulfate ion	Cattle	From drinking water in Minn. 3,590 and 2,104 mg/l (190 and 110 mg/kg/day)	Developed rundown, ragged appearance, and eventually weakened and died	131
	Dog	2,500 mg/l (115 mg/kg/day)	Diarrhea	193

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Sulfate ion (cont.)	Human (infant)	600-1,000 mg/l (<21 mg/kg/day)	Diarrhea	193
	Human	High concentration of chlorides and sulfates in drinking water	Apparently accounts for finding high incidence of cholelithiasis and cholecytitis in a region of the USSR	175
Sodium sulfate	Cattle	7,000-10,000 mg/l in drinking water (370-520 mg/kg/day)	Weight loss	131
Sodium sulfite	Rat	15,000 mg/l in drinking water (2,200 mg/kg/day)	No apparent effect	131
Ammonium persulfate	Dog	23,850 mg/kg for 16 mos.	No effect	131
Tellurium ion Te^{+4}	Mouse	2 mg/l for life (0.2 mg/kg/day)	Significant decrease in longevity; no effect on growth rate or survival	203
	Rat	2 mg/l for life (0.3 mg/kg/day)	No effect on growth rate, survival or longevity	203
	Rat		Increase in serum cholesterol; increase in serum glucose in female; no effect on blood pressure or aortic plaques	203
Te^{+6}	Mouse	2 mg/l for life (0.2 mg/kg/day)	No effect on growth rate, survival or longevity	203

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Sodium tellurite	Rat and rabbit	0.005-0.5 mg/kg/day for 7 mos.	Marked reduction in the blood catalase activity during first month; Vitamin C depletion of suprarenals and lungs	119
		0.05 or 0.5 mg/kg/day for 7 mos.	Catalase activity remained low through experiment; some inhibition of blood cholinesterase activity	119
		0.5 mg/kg/day for 7 mos.	Some disturbance in glycogenic function of liver; reduced level of free serum SH groups	119
	Rat	0.005-0.5 mg/kg/day for 7 mos.	Dark-colored granular and thread-like inclusions in all internal organs; disturbance in conditioned reflexes. After cessation of dosage, cerebral cortex showed focal changes in the interneuronic connections and nerve cells, denticular dilations of the dendrites and shrinkage of nerve cells with lysis of the nuclei; decrease in cholinesterase activity and in content of SH groups in the grey matter of the cortex	119
		0.01 mg/1 or 0.0005 mg/kg/day	Ineffective toxic dose	119

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Sodium tellurite (cont.)	Rat	0.005-1 mg/kg	Some disturbances in the rate of nervous processes and morphological changes in brain tissue	120
		0.0005 mg/kg	No changes in brain cortex	120
Thallium Salts (undefined)	Animal		Cumulative poison, 4 X as toxic as arsenous oxide; effects sympathetic nervous system; causes muscular pain, endocrine disturbances and loss of hair	131
Thallous acetate	Rat	0.003% in diet	Marked growth depression after 30 days	41
Thallous oxide	Rat	0.0035% in diet	Marked growth depression after 30 days	41
Thorium (undefined)	Rat	17,500 mg/kg (other doses I.V., I.M. and I.T.)	Simple compounds: content of Th equal in organic and mineral components of bone. Complex compounds: appreciable increase in Th content in organic component of bone	169
Thorium dioxide	Dog, rat, rabbits and guinea pig	5.69 mg/cu.m. by inhalation (1 yr. exposure)	No toxic effects	88
Tin (undefined)	Rabbits	1 g every 6-10 days (40 mg/kg/day)	Death in 1-2 mos. with renal and hepatic degeneration and paralysis of hind legs	211

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Stannous-chloride	Mouse	5 mg/l for life (0.5 mg/kg/day)	No effect on growth rate, survival or longevity	203
	Rat	5 mg/l for life (0.7 mg/kg/day)	Significant decrease in survival and longevity; no effect on growth rate	212
			Increase in serum cholesterol and serum glucose in female; increase in effect on aortic plaques; no effect on blood pressure; fatty degeration of liver, hepatic cellular degeneration of necrosis; vacuolar changes in proximal convoluted tubule of kidney	212
	Dog	500 mg/kg/day in milk (23 mg/kg/day)	Paralysis after 14 mos.	18
Sodium stannous-tartrate	Rabbit, cat dog	0.5-12.5 mg/kg daily until death, s.c.	Diarrhea; death preceded by paralysis and twitching of limbs. Cats were more sensitive and also developed anesthesia of limbs; vomiting in cats and dogs	18
	Rabbit	I.V. injections	Albuminuria	18
	Laboratory animals		Spleen has bluish-grey appearance due to deposition of tin in reticulo-endothelial cells	18

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Titanium (undefined)	Laboratory animals	1 mg/1 (periodic introduction)	No harmful reactions or functional changes; histological investigation negative	216, 217
Titanium ion Ti^{+4}	Mouse	5 mg/1 for life	Significant increase in growth rate, decrease in survival & longevity	203
Tungsten salts (undefined)	Rat	2.5-5 mg/1 in drinking water	Slightly reduced the toxicity of selenium to rats fed a ration containing 11 mg/1 of selenium	131
		1,000-5,000 mg/1 (150-730 mg/kg/day)	Retarded growth	131
Uranium (undefined)	Laboratory animals	30-60 mg/1 (3-6 mg/kg/day)	Inhibition of nucleic acid metabolism in kidney and liver	162
	Human	0.04-0.05 mg/1 in water sources of town A. 0.002-0.004 mg/1 in water sources of town B	Residual and amino nitrogen, prothrombin and SH groups and thermal coagulation time were normal in A and B; catalase index below normal in A and B; vitamin C content in blood and urine 2/3 normal in A and B, serum albumen was lower and α, and λ-globulins higher in A	159
	Rabbit	0.6 and 60 mg/1 for 13 mos.	Does not confirm albumin/globulin data from towns A and B	159
	Laboratory animals	Long-term chronic	Effect on reproductive maturity and reproductive cycle; changes in natural immunity characteristic, cardiovascular system, thyroid gland, and blood phosphatase	157

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Uranium (natural)	Rat	6 and 60 mg/l (long-term)	Retards sexual maturity; decrease ub oxygen consumption at 60; inhibited thyroid function, increased parathyroid function; serum contained smaller amounts of inorganic phosphorus and larger amounts of alkaline phosphatase;	188
		0.6 mg/l (long-term)	Inhibits thyroid function, increased parathyroid function, serum contained smaller amount of inorganic phosphorus and larger ants of alkaline phosphatase than controls	188
		0.06 mg/l (long-term)	No effect	188
Uranium - VI	Rat	60 mg/l for 11 mos. (9 mg/kg/day)	Inhibited metabolism of nucleic acids in kidneys and liver; increase in serum alkaline phosphatase; no change in weight gain; no significant difference between experimental and control in urea, creatinine and serum chloride levels	163
		6 mg/l for 11 mos. (0.9 mg/kg/day)	Increase in alkaline phosphatase activity	163
		0.6 mg/l for 11 mos. (0.1 mg/kg/day)	No significant effect	163

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Uranium (solid)	Rat and rabbit	208 and 40 mg/kg respectively 10 times and 417 and 80 mg/kg respectively 10 times	Distribution greatest in bone, also found in liver, kidney and spleen. Poisoning caused structural changes in kidneys	20
Uranyl fluoride	Rat	0.25 and 0.5% in diet	Tendency toward anemia	131
	Rat	≥ 0.15% in diet	Definite renal tubular damage	131
Uranyl nitrate	Rat	0.02 mg/kg	No significnat incidence of atypical white blood cells	190
	Rabbit	2.11 mg/kg for 12 mos.	No variation from controls in weight gain, decrease in activity of acid phosphatase in spleen; inhibition of the metabolism of nucleic acids in kidneys and liver; no change in urea, creatinine or serum chloride levels	163
		0.042-0.42 mg/kg for 12 mos.	No significant changes	163
	Dog	2.11 mg/kg for 21 mos.	Changes in blood morphology, disturbance of thyroid function; increased basal metabolism; changes in hepatic function; effect on heart; hematopoietic deficiency	163
		0.21 mg/kg for 21 mos.	Hematopoietic deficiency	163

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Vanadium (undefined	Rat	10 mg/kg	Fatal; damaged gastrointestinal tract, liver and kidneys	214
	Rabbit	1 mg/kg	Developed hypochronic anemia; blood and urine phosphorus rose to considerably higher level	214
	Animals		Reduced blood cholesterol levels and cholesterol and phospholipid metabolism in liver; inhibits sulfhydryl-dependent succinic dehydrogenase of liver and reduces levels of cysteine in hair and fingernails	128
	Rat		Increase in serum cholesterol in female; decrease in serum cholesterol in male and increase in serum glucose; no effect on aortic plaques or blood pressure	203
Vanadium ion V^{+4}	Rat and mouse	5 mg/l for life (0.5 and 0.7 mg/kg/day)	No significant effect on growth rate, survival or longevity	203
Vanadium Pentoxide	Rabbit	100 mg/kg of diet	Lowered free cholesterol and phospholipid content of liver	131
	Human	In drinking water	Correlated with the lowest incidence of coronary heart disease in New Mexico	131

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Yttrium	Mouse	5 mg/l for life (0.5 mg/kg/day)	Significant decrease in growth rate, survival and longevity	203
Zinc (undefined)	Human	From drinking water high concentration	Disorder of renal function; phosphate level in the blood serum decreases; sizable loss of minerals from the bones; "Itai Itai" disease	28
	Rat	34.4 mg/day for 35-53 weeks (150 mg/kg/day)	Non-toxic	176
		0.5-1% in food	Reduced growth, anemia, poor reproduction	176
		0.5% in food	Reduces liver catalase and cytochrome oxidase, reduces weight and fat of liver, lowers Ca/P of femurs, increased urinary and fecal nitrogen, reduces urinary and fecal nitrogen, reduces urinary phosphate and sulfate; depresses food intake, inhibits copper and causes anemia	176
	Rat	1% in food	Anemia and reduced cytochrome oxidase	176
		0.4% in food	Reduces liver ferritint hemosiderin	176
		0.75% in food	Decreases bone calcium	176

TABLE IV (CONT.) - MAMMALIAN CHRONIC TOXICITY OF INORGANIC CHEMICALS

AGENT	SPECIES	DOSE	EFFECT	REFERENCE
Zinc carbonate	Rat	0.96-1.92% for 30 weeks	Drop in hemoglobin to 10.2 and 6.1 g/100 ml respectively	176
Zinc sulfate	Dog (chloralosed)	8-16 mg	Arterial and cardiac depressor	33
	Rat, Cat, Frog, Snail	8-16 mg	Arterial and cardiac depressor	33
	Rat	3,000 mg/kg	Some arrest in growth	33
Zirconium Zr	Mouse	5 mg/l for life (0.5 mg/kg/day)	No significant effect on growth rate, survival, or longevity	33
		5 mg/l for life (0.7 mg/kg/day)	Significant increase in growth rate; no effect on survival or longevity	203
	Rat		Increase in serum cholesterol and serum glucose in female; no effect on blood pressure	203

CARCINOGENICITY

Table V lists the carcinogenicity of mammals of inorganic compounds examined by the oral route of administration. Fifty inorganic chemicals were examined in mammalian species, including human. Significantly, only a few of these showed positive results (potassium, arsenate, palladium, rhenium^{+4}, selenium^{+4}, tellurium^{+6}, yttrium, zinc, and zinc chloride). Some showed a decrease in tumor incidence (sodium germanate and nickel). The nine inorganics which show positive carcinogenic effects were not examined for dose effects.

For the sake of completeness, and in the event that carcinogenicity of inorganic pollutants in freshwater will need to be assessed in terms other than oral administration, Table Va is presented. It will be noted that, using routes of administration other than oral, the proportion of compounds which are carcinogenic increases.

TABLE V - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY THE ORAL ROUTE OF ADMINISTRATION

AGENT	SPECIES	ANIMALS WITH TUMORS	DOSE	REFERENCE
Antimony Sb^{+3}	Mouse and rat	Negative	5 mg/l for life span	203
Antimony trioxide	Rat	Negative	2% in diet for 8 mos.	220
		0/20	2% in diet for $\leq$ 240 d.	220
		0/10	5.0 g suspended in 5 ml water	220
		0/10	2.5 g suspended in 5 ml water	220
Arsenic trioxide	Mouse	0/75	0.01% solution in drinking water	19
		Possible decrease in methylcholanthrene-induced skin tumors in one strain of mouse	0.01% in drinking water for 8 mos.	145
Sodium arsenite	Mouse	Significant decrease in tumor incidence	8.67 mg/l for life span	203
	Rat	Significant decrease in tumor incidence	8.67 mg/l for life span	212
	Rat	No tumors above control	8.67 mg/l in drinking water for life span plus 0.80 mg/kg of diet	105
Potassium arsenate (Fowler's solution)	Human	Positive	-	208
Beryllium carbonate	Rat	Negative	3, 6% in diet, 14-160 days	220

TABLE V (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY THE ORAL ROUTE OF ADMINISTRATION

AGENT	SPECIES	ANIMALS WITH TUMORS	DOSE	REFERENCE
Bismuth carbonate	Rat	Negative	2% in diet for life span	52
Sodium bromide	Dog	0/4	128 mg/kg/d. in capsule in food	220
Cadmium	Mouse and rat	Negative	5 mg/l for life span	203
Cadmium chloride	Rat	0/16	0.1, 0.5, 2.5, 5.0, 10.0 and 50.0 ppm in drinking water	220
Cadmium oxide	Pig	Negative	170 mg/d. in food for 3 days, off 6 wks; 170 mg/d. for 3 days	220
		Negative	170 mg/d. in food	226
Chromium Cr^{+3}	Mouse and rat	Negative	5 mg/l for life span	203
Chromic chloride	Rat	0/21	76 mg/l in drinking water for 1 year	228
Chromium Cr^{+6}	Mouse and rat	Negative	5 mg/l for life span	203
Potassium chromate	Rabbit	0/3	100 mg every other day	220
	Rat	0/21	93 ppm in drinking water for 1 year	220
		0/80	1.68, 8.22, 16.81, 28.76, and 41.08 ppm in drinking water	220
Calcium fluoride	Rat	Negative	200 ppm in riboflavin deficient diet for 5 wks.	220

TABLE V (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY THE ORAL ROUTE OF ADMINISTRATION

AGENT	SPECIES	ANIMALS WITH TUMORS	DOSE	REFERENCE
Sodium fluoride NaF	Sheep	0/16	Mean of 33 mg/day for 26 mos., 20 ppm	220
		0/16	Mean of 18 mg/day for 26 mos., 10 ppm	220
	Rat	Negative	4 mg/day in water for 14 wks.	220
	Rat	Negative	2 mg/day in water for 14 wks.	220
	Rat	Negative	1, 5, 10, 50, or 100 ppm in 15-20 ml soln/day in diet for 107, 192 and 210 days	220
	Rabbit	Negative	30-140 mg/kg/day as 5% suspension for 30-200 days	220
		0/13	50 mg/kg/day	220
		0/10	30 mg/kg/day	220
		0/11	10 mg/kg/day	220
		0/30	10-50 mg/kg/day as 1, 3, or 5% soln or susp. for 4-12 wks.	220
	Rat	Negative	828.95, 221.05, 110.53, 22.1, 11.05, 4.42 ppm in diet	220
	Rabbit	0/3	100 mg/kg/day	220
	Dog	0/1	20 mg/kg (2% soln)/day for 146 days	220
Sodium silico-fluoride	Rat	Negative	120 ppm in riboflavin deficient diet for 5 wks.	220

TABLE V (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY THE ORAL ROUTE OF ADMINISTRATION

AGENT	SPECIES	ANIMALS WITH TUMORS	DOSE	REFERENCE
Gallium	Mouse	Negative	5 mg/l for life span	203
Sodium germanate	Mouse	No tumors above control	11.47 mg/l for life span plus 0.73 mg/kg of diet	105
	Mouse	Decreased incidence	11.47 mg/l for life span	203
	Rat	Decreased incidence	11.47 mg/l for life span	229
Indium	Mouse	Negative	5 mg/l for life span	203
Iodine	Rat	25/154 (ademoma of thyroid and pituitary)	Chronic iodine deficient diet	21
Lead	Mouse	Negative	In drinking water	71
Pb^{+2}	Mouse and Rat	Negative	25 mg/l for life span	203
Lead acetate	Rabbit	0/12	2 ml soln 20% every second day	220
Mercuric chloride	Rat	0/8	0.030 mg in water every second day	220
Molybdenum Mo^{+6}	Rat and mouse	Negative	10 mg/l for life span	203
Nickel Ni^{+2}	Mouse	Significant decrease in tumor incidence	5 mg/l for life span	203
Niobium Nb^{+5}	Mouse and rat	Negative	5 mg/l for life span	203
Potassium thiocyanate	Rat	0/10	50 mg/kg/day in diet for 30 days	220
		0/36	7.5 mg/day + 0.03 mg thyroxin/day fed low-iodine diet for 18 mos.	220

TABLE V (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY THE ORAL ROUTE OF ADMINISTRATION

AGENT	SPECIES	ANIMALS WITH TUMORS	DOSE	REFERENCE
Potassium thiocyanate (cont.)	Rat	0/35	7.5 mg/day in low-iodine diet over 18 mos.	220
Hydrazine	Rat	0/10	0.2 mg/ml of drinking water for 14 wks.	220
		0/10	0.5 mg/ml of drinking water for 4 wks.	220
		0/10	1 mg/ml of drinking water for 3 wks.	220
		0/10	2 mg/ml of drinking water for 4 wks.	220
		0/10	0/1 mg/ml of drinking water for 14 wks.	220
Palladium	Mouse	Positive	5 mg/1 for life span	203
Rhodium Rh^{+4}	Mouse	Positive	5 mg/1 for life span	203
Scandium	Mouse	Negative	5 mg/1 for life span	203
Selenium Se^{+4}	Mouse	Positive	3 mg/1 for life span	203
Se^{+6}	Mouse and rat	Positive	3 mg/1 for life span	203
Sodium selenite	Rat	Negative	-	71
		0/6	10 ppm in diet for 42 days	220
	Laboratory animal	0/6	In diet	71

TABLE V (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY THE ORAL ROUTE OF ADMINISTRATION

AGENT	SPECIES	ANIMALS WITH TUMORS	DOSE	REFERENCE
Potassium selenate	Rat	Negative	4.2, 7.0 and 21.0 ppm in drinking water	220
Sodium chloride	Sheep	0/40	0.5, 4.8, 9.1, or 13% in diet for 253 days	220
	Rat	0/30	9.8% in diet ad lib	220
		0/30	8.4% in diet ad lib	220
		0/30	7.0% in diet ad lib	220
		0/30	5.6% in diet ad lib	220
Tellurium Te^{+4}	Mouse and rat	Negative	2 mg/l for life span	203
Te^{+6}	Mouse	Positive	2 mg/l for life span	203
Stannous chloride	Mouse	No tumors above control	8 mg/l for life span in drinking water plus 0.63 mg/kg of diet	165
	Mouse and rat	Negative	8 mg/l for life span in drinking water	203
Stannous oleate	Rat	Negative	5,000 ppm in diet	71
Sodium chlorostannate	Rat	3/30	2% in diet	71
Titanium	Rat	Negative	As salt in drinking water for life span	71
Vanadium V^{+4}	Mouse and rat	Negative	5 mg/l for life span in drinking water	203
Vanadium pentoxide	Rabbit	0/5	100 ppm in diet for 68 days	220

TABLE V (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY THE ORAL ROUTE OF ADMINISTRATION

AGENT	SPECIES	ANIMALS WITH TUMORS	DOSE	REFERENCE
Vanadyl sulfate	Mouse	6/38	14.43 mg/l for life span in drinking water + 9.23 mg/kg of diet	105
		15/141	Control for above	105
Yttrium	Mouse	Positive	5 mg/l for life span in drinking water	203
Zinc	Mouse	Positive	5-30 mg/l in drinking water 2-3 years up to 16 generations	81
Zinc chloride	Rodent	Positive	In drinking water	71
Zirconium	Mouse and rat	Negative	5 mg/l in drinking water for life span	71

TABLE Va - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Aluminum	Rat	0	Powder 100 mg susp. in water or alcohol I.P.*	220
		0	Powder 50 mg susp. in water or alcohol I.T.** inj.	220
		0/26	95 mg dust and 5 mg quartz dust susp. in 1.5 ml saline I.T.	220
		0/12	100 mg dust susp. in 1.5 ml saline I.T.	220
	Rabbit	0/6	0.5 g powder susp. in 4 ml saline 4 at monthly intervals I.T.	220
Aluminum hydroxide	Mouse	0/15	0.1, 0.2, 0.3, 0.4 or 0.5 ml as a susp. I.P.	220
	Rat	0/24	14 and 50 mg dust in 1.1 ml saline	220
		0/12	60 mg dust in 1.1 ml saline I.T.	220
Aluminum oxide	Rabbit	0/4	300 mg in 3 ml saline, 15 mg in 1 ml saline 10X in 4 wks. I.T. and I.V.***	220
		0/11	500 mg in 4 ml saline, 25 mg in 1 ml saline 10X in 4 wks. I.T. and I.V.	220
	Guinea Pig	0/40	200 mg in 2 ml saline, 10 mg in 0.5 ml saline 10X in 4 wks. I.T. and I.V.	220
	Mouse	0/40	15 mg in 0.25 ml saline, 2 mg in 0.35 ml saline 4 X in 4 wks. I.T. and I.V.	220
		0/30	10 mg in 0.5 ml water I.P.	220

*I.P. - Intraperitoneal
**I.T. - Intratracheal
***I.V. - Intravenous

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Aluminum oxide (Cont.)	Rat	0/12	50 mg in 1 ml water I.P.	220
	Rabbit	0/6	0.5 g dust in 4 ml saline susp. 4 at monthly intervals I.T.	220
	Rat	0/12	50 mg dust (0.02 μ in diameter) in 1.1 ml saline	220
	Rat	0/12	50 mg dust (<1 μ in diameter) in 1.1 ml saline	220
		0/18	35 mg susp. in 1 ml tap water	220
Aluminum phosphate	Rat	0/30	50 mg dust in 1.1 ml saline I.T.	220
Arsenic		May be carcinogenic		71, 231
	Human	Positive (epidermal cells)		104
		Arsenic waters may be carcinogenic to skin and liver		131
	Rat	No tumors above control	0.2 ml lanolin intrafemoral; repeated in 10 mos.	91
		No tumors above control	0.05 ml lanolin suspension monthly for 6 mos. intrapleural	91
		11/20 (4 adenofibromas, 3 adrenal angiomas, 1 adrenal cortical adenoma, 1 endometrial fibrous polyp, 2 basophilic pituitary adenomas, 2 hepatomas, 2 abdominal sarcomas)	0.1 ml of 1% lanolin susp. in paranasal sinuses 3X	91

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Arsenic (Cont.)		8/20 (3 adenofibromas of breast, 2 basophilic adenomas of hypophysis, 1 cortical adenoma of adrenal gland, 2 cavernous angiomas of adrenal gland)	Control for above: 0.2 ml lanolin in paranasal sinus 2X with 2 mo. interval	91
Arsenic trioxide	Human	No significant change in cancer mortality compared to non-arsenical industry	Normal exposure in arsenical industry	275
Sodium arsenate	Mouse	0/87	1.58% soln in water containing 2.5% Tween, topical	19
Barium sulfate	Rat	0/24	26 μg susp., once weekly for 10 wks. I.T. insufflation	220
Barium sulfide	Mouse	0/35	Cream mixed with water applied for few minutes, topical	220
Beryllium	Laboratory animals	Positive		230,231,121
	Rabbit	Positive (bone sarcomas)		196
	Rat	+/20 (7 mammary adenofibromas, 1 cortical adenoma, 2 round-cell sarcomas, 1 teratomatous cancer)	0.5 ml of 10% soln intrafemoral	91
		3/25 (1 spindle-cell sarcoma, 2 lymph node sarcomas)	Control for above: 0.2 ml lanolin intrafemoral	91

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Beryllium (Cont.)	Rat	3/20 (1 mediastinal round-cell sarcoma, 1 osteogenic fibrosarcoma of spine, 1 round-cell sarcoma in liver and marrow of sternum)	0.5 ml of 10% soln intrapleural	91
		7/25 (1 fibrosarcoma and squamous-cell papilloma of forestomach, 1 papillary cystadenoma of ovary, 3 angiomas of adrenal medulla, and 4 mammary adenofibromas)	Control for above: 0.05 ml lanolin intrapleural 1X/mo.	91
	Rabbit	2/24	40 mg I.V.	16
	Rabbit	Bone sarcomas	I.V.	196
Beryllium oxide	Rabbit	Bone sarcomas	I.V.	196
	Guinea Pig	0/6	3 mg/kg/day for 40 days S.C.*	220
	Rat	Positive (pulmonary epidermoid, squamous cell or adenomatous neoplasia)	12.49 mg in 0.25 ml saline 3X/wk. at wkly. intervals I.T.	220
Beryllium silicate	Rabbit	Positive (bone sarcomas)	I.V.	196

*S.C. - Subcutaneous

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Beryllium silicate (cont.)	Rabbit	1/17	2X/wk. (6 or 10 injections)	17
Beryllium sulfate	Rat	Positive (pulmonary epidermoid, squamous cell or adenomatous neoplasia)	12.49 mg in 0.25 ml saline 3X/wk. at wkly. intervals I.T.	220
Zinc beryllium silicate	Mouse and Rabbit	Positive (bone sarcoma)	I.V.	196
	Rabbit	6/17	2X/wk. (6 or 10 injections)	17
Cadmium sulfate	Rabbit	0/5	1 mg every second day S.C.	220
		0/5	0.5 mg every second day S.C.	220
		0/6	0.5 ml of 0.3% soln/kg 6 days/wk. for 10 wks. S.C.	220
		0/18	1.21 mg/kg 6 days/wk. up to 10 wks. S.C.	220
Carbon (graphite)	Rat	0/17	Plates 7 x 7 x 0.1 mm S.C.	220
Cerium		Positive	S.C. implant	82
Cerium chloride	Rat	0/10	60 mg/ml 100 mg/kg	220
Chromium	Human	Positive (bronchogenic carcinoma)	Industrial exposure	68,71,144,196
	Rabbit	2/8 (1 at site of injection, 1 endometrial papillary cystic adenoma, 1 vaginal hemangioma, 1 pleural fibrolipoma)	0.4 ml of a 35% susp. powdered Cr in lanolin; after 30 mos. reinjected with 2X original dose intrafemoral	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Chromium (Cont.)	Rabbit	0/2	Control for above: 0.2 ml lanolin intrafemoral	220
	Rat	Positive (2 spindle cell sarcomas, 1 cellular fibroma, 2 round cell sarcomas of ileocecal lymph nodes, 1 adreno-medullary hemangioma, 1 pancreatic insuloma)		220
		4/30	Control for above: gelatin intrafemoral	220
		No tumors above control	6 monthly doses of 0.05 ml of a 33.6% susp. of powdered chromium in lanolin intrapleural	220
		No tumors above control	6 wkly. doses of 0.1 ml of a 0.5% susp. of powdered chromium in 2.5% gelatin-saline soln intra-pleural	220
		7/25 (4 ileo-cecal round cell sarcomas, 1 adreno-medullary hemangioma, 2 pulmonary papillary adenomas)	6 wkly. doses of 0.18 ml of 0.05% susp. of powdered Cr in a 2.5% gelatin-saline soln. I.V. vena saphena	220
		No tumors above control	2 monthly doses of 0.1 ml of a 33.6% Cr susp. in lanolin para-nasal	220
		5/25	6 wkly. doses of 0.1 ml of 0.05% Cr susp. in a 2.5% gelatin soln I.P.	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Chromium Cr^{+3}		Positive		79
Chromic acid	Cock	Positive	2 ml of 2% soln injected into testicles	79
Chromium trioxide	Rat	15/19 (sarcoma at implant site)	25 mg in 50 mg sheep fat intra-muscular implant	93
		14/20 (sarcoma at implant site)	25 mg in 50 mg sheep fat intra-pleural implant	93
Barium chromate	Rat	Negative	25 mg in 50 mg sheep fat intra-muscular and intrapleural implant	220
	Mouse	76.3% of survivors with pulmonary adenomas; 51.7% with multiple tumors	2.35 mg in 0.1 ml of 1% saline susp. given 9X at 4-6 wk. intervals I.V.	220
		63.3% of survivors with pulmonary adenomas; 47.4% with multiple tumors	Control for above: barium sulfate	220
		73.9% with pulmonary adenomas; 52.9% with multiple tumors	0.24 and 0.47 mg in 0.3 ml of 1% saline susp. in olive oil given 5X at 4-6 wk. intervals I.T.	220
		68.2% with pulmonary adenomas; 40.0% with multiple tumors	Control for above: barium sulfate in olive oil	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Calcium chromate	Rat	8/13 21/35 (sarcomas at site)	25 mg in 50 mg sheep fat intramuscular implant and intrapleural implant	93
		3/218 (intrathoracic fibro-sarcomas)	10 mg every 2 mos. I.T. 5X	92
		+/6 (3 sarcomas at implant site)	12.5 mg in gelatin capsule. Intrapleural implant	220
		+/6 (2 sarcomas at implant site)	12.5 mg in gelatin capsule. I.M.* implant	220
	Mouse	1/52 (spindle cell sarcoma)	10 mg dust/20 mg sheep fat as pellet. I.M. implant	220
		0/52	Control for above: I.M. sheep fat implant	220
	Mouse	1/52	10 mg dust in 0.2 ml trica-pylin S.C.	220
Calcium chromate (sintered)	Mouse	9/52	10 mg dust/20 mg sheep fat as pellet. I.M. implant	220
		0/52	Control for above: I.M. sheep fat implant	220

*I.M. - Intramuscular

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Calcium chromate (sintered)	Rat	0/52	10 mg dust in 0.2 ml triaprylin S.C.	220
(Cont.)	Rat	8/14 17/26 (sarcoma at site)	25 mg in 50 mg sheep fat intramuscular implant and intrapleural implant	220
Strontium chromate	Rat	2/218 (fibrosarcoma of lung)	Up to 10 mg every 2 mos. I.T. 5X	92
Zinc chromate	Rat	Negative	10 mg every 2 mos. 5X I.T.	92
Sodium dichromate	Rat	3/39 2/39 (adenocarcinoma of right lung, reticulum cell sarcoma of liver, round cell sarcoma of ileocecal lymph node, squamous cell carcinoma of the uterine mucosa)	2 mg/mo., 16 inj., I.P. and I.M.	92
Cobalt		Positive		59,71
	Rabbit	Positive (fibrosarcoma at site)		196
	Rat	5/20 (rhabdomyosarcomas)	400 mesh powder with fowl serum, 0.028 g in 0.4 ml serum I.M.	83,87,220
	Guinea Pig	0/6	25 mg of dust susp. in saline diluted to 10% susp., injected 1 wk. apart I.T.	220
		0/6	25 mg of dust susp. in saline, diluted to 10% susp. I.T.	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Cobalt (Cont.)	Guinea Pig	0/6	50 mg of dust susp. in saline, diluted to 10% susp. I.T.	220
		Negative	Two 5 mg doses of dust susp. in saline, diluted to 10% susp., injected 1 wk. apart I.T.	
	Rat	9/20 (5 rhabdomyofibrosarcomas, 3 fibrosarcomas, 1 round cell sarcoma at injection site)	Susp. of 0.028 g powdered Co in 0.4 ml fowl serum I.M.	220
		8/10 (5 rhabdomyofibrosarcomas, 2 sarcomas, 1 fibrosarcomas, 1 fibrosarcoma at injection site)	Susp. of 0.028 g powdered Co in 0.4 ml fowl serum I.M.	220
		Negative	3-10 mg susp. in saline I.T.	220
		+/30 (sarcomas at injection site)	Susp. of 0.28 g powdered Co in 0.4 ml fowl serum I.M.	220
Cobalt chloride	Rat	Negative	0.4% soln 6X/wk. receiving from 2.5-10 mg/kg S.C.	220
		Negative	2 mg/day I.P.	220
	Rabbit	0/5	5 mg/kg alternate days and alternate wks. for 20 wks.	220
	Dog	0/2	5 mg/kg alternate days and alternate wks. for 20 wks.	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Cobaltic oxide	Guinea pig	0/6	150 mg dust susp. in saline in 10% susp. in 3 equal quantities at wkly. intervals	220
Copper		Negative		71
Copper sulfate	Rat	0/20	0.1% 3X/wk. I.P.	220
Dysprosium		Positive	Implanted S.C.	82
Gadolinium		Positive	Implanted S.C.	82
Gold	Rat	Negative	I.V.	71
		9 sarcomas	17 x 0.02 mm discs, 6 under skin of back, 4 I.P., 2 under skin of abdomen	220
	Mouse	3 sarcomas	12 x 0.02 mm discs, 6 under skin of back, 4 I.P., 2 under skin of abdomen	220
	Rat	68/77	17 mm disc; 8/animal S.C.	220
		0/31	Fragments 1 x 1 x 0.02 mm S.C.	220
Iron	Mouse	0/20	S.C.	220
		0/20	20 mg wkly. for 16 wks.	220
Iron-dextran complex	Rat	Positive	Injection	71

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Iron-dextran complex (Cont.)	Rat	Negative	Pellets of 25 mg Fe suspended in 50 mg wool fat in right pleural cavity; 12 mos. later same put into right thigh	92
	Rat	16/23	20 mg Fe/wk. I.M.	222
Ferrous sulfate	Mouse	1/20 (fibroma)	2.5 mg/wk. for 16 wks.	220,222
Lanthanum	Rat	0/120	75, 150, and 300 mg/kg I.P.	220
Lanthanum chloride		0/15	60 mg/ml 100 mg/kg I.P.	220
Lanthanum nitrate		0/10	450 mg/kg in water I.P.	220
Lead phosphate	Rat	Positive	Injected	71
		Negative	Injected	71
Magnesium	Rat	Negative	8 mg-5 m strips bladder and I.M.	220
		Negative		71
Manganese		Negative		71
Manganese chloride	Rat	0/20	4% 3X/wk. I.P.	220
	Rat and Rabbit	Negative	1% soln, 2 ml/day intradermal	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Potassium permanganate	Mouse	0/50	S.C.	220
Mercury	Rat	Positive	I.P. every 2 wks.	71
	Rat	+39 (spindle cell sarcoma of penitoneum)	0.05 ml twice at 14 day intervals I.P.	71
		5/39 (abdominal spindle cell sarcomas)	0.05 ml 1X/wk. for 2 wks. I.P.	71
Nickel	Human - Nickel workers	Positive (lung, nasal sinuses)		24,144,234
	Human	Positive	In nickel-containing drugs	263
		Positive		128
	Rat	3/34 (spindle cell sarcoma, squamous cell carcinoma of uterine endometrium and skin of cheek)	0.02 ml susp. nickel powder intrapleural injection	92
		5/17 (osteogenic spindle cell sarcoma, squamous cell sarcoma, round cell sarcoma in abdominal cavity)	50 mg susp. in lanolin intrafemoral injection	54
		4/10 (similar to tumors from intrafemoral injection)	50 mg susp. in lanolin. Intrapleural injection monthly 5X	54

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Nickel (Cont.)	Rat	1/3 (round cell sarcoma of thoracical and abdominal lymph nodes)	0.1 ml of 12.5% susp. in lanolin into nasal sinuses every 2 mos. 3X	54
		Control for above	Absence of similar tumors	54
		+/100 (27 malignant at site; 20 additional malignant and benign tumors elsewhere)	0.1 ml of 5% gelatin-saline susp. Intrafemoral implantation repeated in surviving rats after 18 mos.	53
		+/23 (no malignant at site; 10 malignant and benign elsewhere)	Control for above	53
		+/25 (7 sarcoma in region of groin, 1 mammary fibroadenoma, 2 mammary adenomas, 3 basophilic pituitary adenomas, 3 adrenomedullary hemangiomas)	0.5 ml/kg of 0.5% susp. in gelatin-saline soln 1X/wk. 6X I.V. (vena saphena)	53
	Rabbit	0/10	0.5 ml/kg of a 1% susp. in gelatin-saline soln 1X/wk. I.V. 6X	53
	Mouse	0/50	0.02 ml of a 0.05% susp. in gelatin-saline soln I.M.	53
		0/50	0.02 ml of a 0.06% susp. in gelatin-saline soln. Intrapleural	53

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Nickel (Cont.)	Rat	Positive	Injected into femoral cavity, pleural cavity and nasal sinuses	196
Nickel chloride	Rat	Negative	2 mg/day I.P.	220
Nickel sulfide	Rat	Positive	Implantation	71
Potassium cyanate	Mouse	7/15 (papillomas)	2.5 mg in saline once, 4 days subsequent treated with twice-weekly skin applications of 5% croton oil soln for 40 wks. I.P.	220
		13/46 (11 papillomas, 2 pulmonary adenomas)	Control for above ;croton oil	220
Phosphorus	Dog	Negative	1 mg/kg/day in peanut oil soln, 5 mg/ml S.C.	220
Platinum	Rat	Positive (sarcomas)	Discs 17 x 0.02 mm, 6 under skin of back, 4 I.P., 2 under abdominal skin	220
	Mouse	Positive (6 sarcomas)	Discs 12 x 0.02 mm, 6 under skin of back, 4 I.P., 2 under abdominal skin	220
	Rat	52/69 (sarcomas)	17 mm disc implanted S.C. 8/rat	220
	Rat	0/31	Fragments 1 x 1 x 0.02 mm S.C.	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Praseodynium		Positive	S.C. implantation	220
Ammonium potassium selenide	Rat	Positive		71
Silicon dioxide	Rat, Guinea Pig, Mouse, Rabbit	Negative	S.C., I.P., I.T., intramesenteric injection, and I.V. various doses for various lengths of time	220
	Rat	+/30 (2 hepatic reticulum cell sarcomas, 1 mammary adenofibroma, 3 uterine carcinomas)	300 mg powder I.P.	220
	Rat	4 uterine carcinomas, 1 ovarian carcinoma		220
	Rat	+/45 (1 lymph node reticulum cell sarcoma, 1 hepatic cholangioma, 2 hepatic reticulum cell sarcomas, 2 pulmonary mesotheliomas, 1 uterine carcinoma, 1 ovarian cystadenoma)	300 mg powder once S.C.	220
		+/200 (11 reticulum cell sarcomas, 1 pulmonary adenoma, 3 mammary adenofibromas, 1 renal carcinoma	Control for above	220
Calcium silicate	Rat	0/14	25 mg dust 3X about 1 wk. apart I.T.	220
		0/16	5 mg of dust I.T.	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Silver	Rat	Positive	Colloidal silver I.V.	71
	Rat	Positive	Imbedded silver foil	166
	Rat	0/13	Implanted in bladder	220
	Mouse	Positive (1 sarcoma)	Discs 12 x 0.02 mm, 6 under skin of back, 4 I.P., 2 under abdominal skin	220
		Positive (5 sarcomas)	Discs 17 x 0.02 mm, 6 under skin of back, 4 I.P., 2 under abdominal skin	220
		+/84 (65 sarcomas)	17 mm disc implanted 8/animal	220
		14/25 (fibrosarcoma at site)	2 pieces of foil, 1.5 cm wide S.C. abdominal wall	220
		0/35	Fragments 1 x 1 x 0.02 mm S.C.	220
Silver nitrate	Mouse	Negative	Fused crystals; colonic mucosa through anus	220
Tantalum	Rat	Positive	S.C. imbedded	82
	Rat	2/25 (fibrosarcoma at site)	2 pieces of foil 1.5 cm wide S.C. in abdominal wall	220
	Dog	Negative	0.010 in. thick and 0.25 in. in diameter disc. I.M. implant	220
Tantalum oxide	Guinea Pig	0/6	150 mg dust susp. in saline in 10% susp. in 3 equal quantities at wkly. intervals. I.T. injection	220

TABLE Va (CONT.) - CARCINOGENICITY IN MAMMALS OF INORGANIC CHEMICALS EXAMINED BY ROUTES OF ADMINISTRATION OTHER THAN ORAL

AGENT	SPECIES	ANIMALS WITH TUMOR	DOSE	REFERENCE
Tantalum oxide (Cont.)	Guinea Pig	Negative	100 mg dust susp. in saline in 10% susp.	220
Uranium U	Rat	11/33 (sarcomas at site)	50 mg U in susp.; intrafemoral injection	94
		2/33 (sarcomas-chest wall)	50 mg U in susp.; intrapleural injection	94
Ytterbium	Rat	Positive	S.C. embedding	82

MUTAGENICITY AND TERATOGENICITY

Table VI lists the teratogenicity and mutagenicity of inorganic chemicals. Nineteen inorganic chemicals have been examined for teratogenicity. Four of these, or approximately 20%, are negative. The remainder show teratogenic anomalies of one form or another. Two of these (lithium carbonate and methyl mercury) have been shown to be teratogenic in humans. In the case of lithium carbonate, the effects seen were club feet and meningomyocoele. In the case of methyl mercury, the effects were the result of eating contaminated fish.

Fifteen inorganic compounds have been examined for mutagenicity, and all have shown some change indicative of possible mutagenic effects. Three of these (manganous nitrate, lead, and methyl mercury) have shown effects in humans, with a fourth (sodium diarsenate) identified as showing *in vitro* effects on chromosomes. The effect of lead in the human was a result of chronic poisoning which showed excess chromosome breaks. The data on methyl mercury was the result of eating contaminated fish which caused a higher incidence of chromosome breaks. The usual caution (discussed in Water Quality Criteria Data Book Volume I, Organic Chemical Pollution in Freshwater") in interpreting mutagenic effects, should be applied.

TABLE VI - MUTAGENICITY AND TERATOGENICITY OF INORGANIC CHEMICALS

	MUTAGENICITY				TERATOGENICITY			
AGENT	SPECIES	DOSE	EFFECT	REF.	SPECIES	DOSE	EFFECT	REF.
Aluminum chloride	Insect	-	Point mutations	67				
Sodium arsenate					Hamster	15-25 mg/kg I.V.*	Anencephaly, renal agenesis, and rib malformations	180
						20 mg/kg I.V. on 8th day of gestation	Exencephaly	
						20 mg/kg I.V.	84% offspring malformed or resorbed; exencephaly, encephalocele, cleft-palate, microanophthalmia and ear malformations	89
Sodium diarsenate	Human	*In vitro*	Pulverization of chromosomes	218				
Boron							Positive	37
Cadmium					Hamster	High	Positive	231
Cadmium nitrate	Insect	-	Point mutations	67				
Cadmium sulfate					Hamster	2 mg/kg I.V. on 8th day of gestation	Exencephaly, microphthalmia, cleft lip/palate	62

*I.V. - Intravenous

TABLE VI (CONT.) - MUTAGENICITY AND TERATOGENICITY OF INORGANIC CHEMICALS

	MUTAGENICITY				TERATOGENICITY			
AGENT	SPECIES	DOSE	EFFECT	REF.	SPECIES	DOSE	EFFECT	REF.
Cadmium sulfate (cont.)					Hamster	2 mg/kg I.V.	72% offspring malformed or resorbed, encephalocele, cleft palate/lip, exencephaly, and microanophthalmia	89
						2 mg/kg I.V. on 8th day of gestation	Severe facial abnormalities	64
Cobalt					Hamster		Negative	64
Cobalt chloride	Chick		Disturbance of normal mitosis	87	Chick	0.5% in ova	Overdevelopment of neural and mesodermal structures especially of notochord and heart	2
Gallium sulfate					Rat	30 and 40 mg/kg, I.V. on 8th day of gestation	Possible teratogen 1 limb bud abnormality, 1 spina bifida and 1 exencephaly out of 21 mothers	65
Germanium trioxide					Rat	40 and 100 mg/kg I.V. on 8th day of gestation	Negative	65
Indium nitrate					Hamster	0.5 and 1.0 mg/kg I.V. on 8th day of gestation	Malformation of limbs, especially digits; some microphthalmia and fusion of ribs	65

TABLE VI (CONT.) - MUTAGENICITY AND TERATOGENICITY OF INORGANIC CHEMICALS

	MUTAGENICITY				TERATOGENICITY			
AGENT	SPECIES	DOSE	EFFECT	REF.	SPECIES	DOSE	EFFECT	REF.
Ferrous chloride	Micro-organisms		Point mutations	67				
Lead	Human	Chronic poisoning	Excess chromosome breaks	218				
Lead acetate	Mammal	-	Chromosome aberrations	67	Hamster	50 mg/kg I.V. on 8th day of gestation	Tail malformations	62
Lithium carbonate					Human	900-1,200 mg/day as treatment for manic-depression beginning 8 wks. prior to conception	Child with bilateral club feet and meningomyecele in lumbar region	248
Lithium chloride					Chick	0.05 ml or 0.2 ml after incubation 18-30 or 18-24 hrs.	Unclosure of neural tube, retardation and severe inhibition of development, eye-defect, enlargement of aorta and myocoele, and tissue transformation	156
					Chick	11.8 mM or 15.7 mM	Cyslopia	191

TABLE VI (CONT.) - MUTAGENICITY AND TERATOGENICITY OF INORGANIC CHEMICALS

	MUTAGENICITY				TERATOGENICITY			
AGENT	SPECIES	DOSE	EFFECT	REF.	SPECIES	DOSE	EFFECT	REF.
Manganous acetate	Micro-organisms		Point mutations	67				
Manganous nitrate	Human		C-mitosis	123				
Methyl mercury	Human	Swedes eating fish 3 times/ wk.	Significantly higher frequency of lymphocyte chromosome breakage than in control subjects	56	Human	From fish	Congenital cases born	187
	Human	From fish	Chromosome breaks (lymphocytes)	224				
	Fruit flies, onion root cells	≤0.1 ppm	Inhibition of mitosis and chromosome breaks	56	Human	From fish	19 infants born with congenital cerebral paresis	57
	Fruit fly	0.25 ppm in food	Offspring with one extra chromosome	134				
	Onion	0.05 ppm	Chromosome break	266				
	Fruit fly		Weak mutagen	266				
	Fruit fly		XXY daughters and XO sons	266				
	Fruit fly	0.25 mg Hg/l	XXY daughters	185				
	Onion root tip		C-mitosis	185				

TABLE VI (CONT.) - MUTAGENICITY AND TERATOGENICITY OF INORGANIC CHEMICALS

	MUTAGENICITY				TERATOGENICITY			
AGENT	SPECIES	DOSE	EFFECT	REF.	SPECIES	DOSE	EFFECT	REF.
Methyl mercury chloride	Onion root tip		Chromosome stickiness, C-mitosis, various mitotic disturbances, low frequency of chromosome breakage	220				
	Human	10^{-5}--10^{-4}	C-mitosis (leucocytes)	68				
Methyl mercury dicyandiamide					Chick		Negative	240
Phenyl mercury	Onion root tip	0.05 ppm	Chromosome breaks	266				
	Fruit fly		Weak mutagen	266				
			XXY daughters and XO sons	266				
		0.025 mg Hg/l	XXY daughters	185				
	Onion root tip	∿0.25 μM	C-mitosis	185				
Hyponitrites	*Vicia faba*		Chromosome breaks	218				
Hydrazine	Mammal		Chromosome aberrations	67				
Pyrophosphates	*Vicia faba*		Chromosome breaks	218				
Sodium selenite					Hamster	2 mg/kg I.V.	Negative, 6% malformed or resorbed	89

TABLE VI (CONT.) - MUTAGENICITY AND TERATOGENICITY OF INORGANIC CHEMICALS

		MUTAGENICITY			TERATOGENICITY			
AGENT	SPECIES	DOSE	EFFECT	REF.	SPECIES	DOSE	EFFECT	REF.
Sodium chloride					Mouse	2,500 and 1,900 mg/kg S.C.* at 10 or 11 days gestation	Shortness of forelimb and foot, malformed wrist and ankle joint and various digital defects	154
Thallium					Chick	-	Achondroplasia	37
Thallium sulfate					Rat	2.5 mg/kg on 8, 9, 10 or on 12, 13, 14th day of gestation; 10.0 mg/kg on 12, 13, 14th day of gestation I.P.**	Hydronephrosis, brachygnathia,missing or nonossification of vertebral bodies and phalange nonossification	74
Zinc sulfate	Rainbow trout	79.02 mg/1	Mitosis completely inhibited after 96 hrs.	49				
		44.45 mg/1	Destructive changes in cell structure of gonads	49				

*S.C. - subcutaneous
**I.P. - intraperitoneal

SECTION VIII

SOURCES OF INORGANIC POLLUTANTS IN FRESHWATER

Table VII lists compounds and their sources in accordance with the overall categorization of industrial, agricultural, municipal, and domestic. It can be seen that the sources of inorganic chemical pollutants in freshwater are principally from industrial and municipal sources. Industrial sources are subcategorized according to type of industry and show that inorganic chemicals derive from a variety of types of industry.

The agricultural sources, as with organic pollutants, are principally derived from the use of inorganic chemical fertilizers, insecticides, pesticides, and herbicides. The domestic sources are due to the use of detergents.

Table VIIa presents sources of inorganic compounds as reported in the available literature and again shows industry as the principal source of chemicals which are or potentially could be present in freshwater.

TABLE VII - SOURCES OF INORGANIC CHEMICALS FOUND IN FRESH WATER

A. INDUSTRIAL

Unspecified

Arsenic	Iodine	Mercuric Chloride
Boron	Iron	Nitrite
Chloride	Lead	Nitrate
Chromium	Lithium	Ammonium Ion
Copper	Magnesium	Phosphate Ion
Indium	Mercury	Zinc

Mining Operations

Aluminum	Manganese	Sulfate
Arsenic	Mercury	Uranium
Lead	Molybdenum	Vanadium

Petroleum and Fuel

Barium	Beryllium	Bromine

Metallurgy and Electroplating

Beryllium	Nickel
Cadmium	Silver

Atomic Reactors

Beryllium

Accidental Spills

Ammonium Ion	Cyanide Ion	Nitrate

TABLE VII (CONT.) - SOURCES OF INORGANIC CHEMICALS FOUND IN FRESH WATER

INDUSTRIAL (CONT.)

Caustic Chloride and Vinyl Chloride Plants

Mercury

Mercuric Chloride

Pulp and Paper Mills

Mercury

B. MUNICIPAL (including sewage treatment)

Boron	Iodine	Phosphate Ion
Calcium	Iron	Phosphorus
Carbon	Magnesium	Potassium
Bicarbonate	Nitrite	Sodium
Chloride Ion	Nitrate	Sulfate
Fluoride	Ammonium Ion	

C. DOMESTIC

Arsenic	Phosphorus	Phosphate Ion

D. AGRICULTURAL

Arsenic	Nitrate	Phosphate Ion
Copper	Phosphorus	

E. NATURAL

Natural sources were reported for all but 10 of the 45 inorganic chemicals which have been found in fresh water. Those for which natural sources were not reported are: carbon, chromium, indium, mercury, mercuric chloride, nitrite, nitrate, ammonium ion, phosphorus and phosphate ion.

TABLE VIIa - SOURCES OF INORGANIC CHEMICALS

INDUSTRIAL

Chemical Industry:

Aluminum	Cupric nitrate	Potassium chloride
Aluminum fluoride	Cyanate	Potassium hydroxide
Ammonia	Ethylmercuric chloride	Potassium sulfate
Ammonia nitrate	Ferric chloride	Sodium bisulfite
Ammonia sulfide	Ferrous sulfate	Sodium chloride
Ammonia thiocyanate	Gallium	Sodium hydroxide
Arsenic	Hydrochloric acid	Sodium sulfate
Barium	Hydrogen sulfide	Sodium sulfide
Boric acid	Hydrazine	Sulfuric acid
Borate,sodium	Iodine	Tantalum
Cadmium	Nitric acid	Titanium
Cadmium chloride	Mercury	Uranium
Carbonate	Mercuric chloride	Yttrium
Bicarbonate,sodium	Methylmercuric chloride	Zinc
Copper	Osmium	Zinc chloride
Cupric chloride	Ozone	Zinc sulfate

Ore Processing:

Cadmium	Lead	Bromate, Na
Cadmium sulfate	Mercuric chloride	Ammonium molybdate
Ammonium chloride		

Ink Manufacturing:

Mercuric chloride	Cobalt chloride	Nickel nitrate
Cupric chloride	Ferric sulfate	

TABLE VIIa (CONT.) - SOURCES OF INORGANIC CHEMICALS

INDUSTRIAL (CONT.)

Dye and Pigment Industry

- Aluminum
- Aluminum ammonium sulfate
- Aluminum potassium sulfate
- Ammonium chloride
- Antimony fluoride
- Arsenic
- Arsenate, Na
- Arsenite, Na
- Cadmium
- Cadmium chloride
- Chlorate
- Cupric chloride
- Cupric nitrate
- Cupric sulfate
- Ferric chloride
- Ferric potassium sulfate
- Ferric sulfate
- Lead nitrate
- Lead sulfate
- Magnesium chloride
- Magnesium sulfate
- Nitrate
- Potassium hydroxide
- Selenium
- Thallium
- Thallous acetate
- Thallous oxide
- Titanium

Petroleum:

- Bromine
- Carbon monoxide
- Boric Acid
- Magnesium chloride
- Ammonium
- Ammonium carbonate
- Ammonium sulfide
- Cyanide
- Ammonium thiocyanate
- Ammonium ferrocyanide

TABLE VIIa (CONT.) - SOURCES OF INORGANIC CHEMICALS

INDUSTRIAL (CONT.)

Pottery and Porcelain:

Antimony fluoride	Ammonium dichromate
Arsenic	Magnesium sulfate
Boric Acid	Uranium
Sodium chromate	

Water Treatment Plants:

Aluminate, Na	Sodium fluorosilicate	Ozone
Chloride	Iodine	Tribasic phosphate
Fluoride	Ferric chloride	Pyrophosphate, Na
Sodium fluoride	Ferric sulfate	

Alloy Manufacturing:

Berylium chloride	Indium	Palladium
Gallium	Osmium	Tantalum

Wood Preservation:

Arsenic	Ammonium fluoride	Potassium hydroxide
Boric Acid	Magnesium fluorosilicate	Zinc sulfate
Borate, Na		

Metallurgy:

Arsine	Lead nitrate	Tungsten

TABLE VIIa (CONT.) - SOURCES OF INORGANIC CHEMICALS

INDUSTRIAL (CONT.)

Electroplating industry:

Bismuth	Sodium dichromate	Sodium cyanide
Cupric nitrate	Cupric sulfate	Sodium tellurite
Cupric chloride	Indium	Tungsten
Sodium chromate	Mercuric chloride	Zinc sulfate
Potassium dichromate	Cyanide	

Paint Industry:

Barium	Potassium dichromate	Osmium
Barium chloride	Sodium dichromate	Titanium
Barium sulfide	Lead chloride	Zinc sulfate
Sodium chromate	Lead sulfate	

Photography:

Bromide, Na	Lead nitrate	Tribasic phosphate
Cadmium chloride	Ammonium molybdate	Uranium
Ammonium dichromate	Ammonium sulfite	
Chloroauric acid	Potassium thiocyanate	
Potassium iodine	Nitrate	

Glass Industry:

Antimony	Cobalt	Sodium nitrate
Arsenic	Calcium fluoride	Titanium
Barium	Chloroauric acid	Vanadium
Boric Acid	Lanthanum	

TABLE VIIa (CONT.) - SOURCES OF INORGANIC CHEMICALS

INDUSTRIAL (CONT.)

Paper Mills:

Aluminum	Potassium dichromate	Sodium hydrosulfide
Aluminum potassium sulfate	Ozone	Tantalum
Calcium sulfate	Tribasic phosphate	Titanium
Carbonate	Sodium sulfite	Vanadium
Chlorine	Sodium bisulfite	Mercuric chloride
Sodium chromate	Hydrogen sulfite	

Dye and Tanning:

Aluminum nitrate	Sodium dichromate	Tribasic phosphate
Aluminum potassium sulfate	Cupric sulfate	Hydrogen sulfide
Arsenic	Ferric sulfate	Sodium hydrosulfide
Barium chloride	Magnesium sulfate	Zinc sulfate
Sodium chromate	Mercuric chloride	
Potassium dichromate	Ammonium chloride	

Pharmaceutical:

Aluminum sulfate	Cupric sulfate	Ferric sulfate
Bromate, Na	Gallium	Osmium
Bromine	Hydrochloric Acid	Tantalum
Bicarbonate	Iodine	Mercury

TABLE VIIa (CONT.) - SOURCES OF INORGANIC CHEMICALS

INDUSTRIAL (CONT.)

Textile Plants:

Aluminate, Na	Chlorine	Magnesium sulfate
Ammonium fluoride	Chlorate	Mercuric chloride
Ammonium thiocyanate	Cupric chloride	Nickel sulfate
Antimony	Cupric nitrate	Nitrate
Arsenate, Na	Ferric potassium sulfate	Ozone
Barium chloride	Ferric sulfate	Potassium thiocyanate
Boric acid	Lead nitrate	Sodium hydroxide
Cadmium	Lead sulfate	Sodium bisulfite

Embalming:

Barium fluoride	Mercuric chloride	Zinc chloride

Rubber Industry:

Antimony	Barium sulfide	Tantalum

Nuclear Technology:

Cobalt	Hydrazine peroxide	Uranium
Fluorine	Indium	Yttrium
Hydrazine		

Nickel Plating Plants:

Nickel chloride	Nickel nitrate	Nickel sulfate

TABLE VIIa (CONT.) - SOURCES OF INORGANIC CHEMICALS

INDUSTRIALS (CONT.)

General Industry:

Antimony	Fluoride	Magnesium chloride
Ammonia sulfate	Gallium	Manganous chloride
Barium	Hydrochloric acid	Osmium
Barium nitrate	Hydrazine	Nitric acid
Boric acid	Hydrogen sulfide	Sodium
Bicarbonate	Iron	Sodium fluoride
Calcium	Iodine	Sodium sulfite
Chromium	Lead	Strontium chloride
Cobalt chloride	Lead sulfate	Sulfuric acid
Copper	Lithium chloride	Sulfur
Calcium fluoride	Lithium fluoride	Tantalum
Cyanide		

Pyrotechnics:

Lithium chloride	Ammonium nitrate	Strontium chloride
Magnesium nitrate	Ammonium thiocyanate	Strontium nitrate

Electronic Tube Manufacturing:

Barium nitrate	Berylium nitrate	Berylium sulfate

Food Stuff Containers Manufacturing:

Indium	Ferric sulfate

TABLE VIIa (CONT.) - SOURCES OF INORGANIC CHEMICALS

INDUSTRIAL (CONT.)

Disinfectants Manufacturing:

Potassium permanganate	Sodium bisulfite
Manganese chloride	Sulfur

DOMESTIC

Detergents:

Potassium hydroxide	Tribasic phosphate
Phosphoric acid	

TABLE VIIa (CONT.) - SOURCES OF INORGANIC CHEMICALS

AGRICULTURAL

Fertilizers:

Cadmium	Ammonium sulfate	Potassium sulfate
Magnesium sulfate	Sodium nitrate	Sulfur
Manganous sulfate	Potassium chloride	

Insecticides:

Sodium arsenate	Ammonium fluoride	Selenium
Sodium arsenite	Potassium fluoride	Sulfur
Fluoride	Hydrogen cyanide	

Pesticides:

Arsenic	Sodium fluoride	Thallous acetate
Sodium arsenite	Sodium fluoroaluminate	Thallous oxide
Arsenic trioxide	Thallium	

Herbicides:

Borate, Na

SECTION IX

QUALITY CRITERIA

As pointed out in the report on the "Water Quality Criteria Data Book Volume I, Organic Chemical Pollution of Freshwater", chemical quality criteria of water for human consumption should be based on concentrations which, when exceeded, are likely to produce adverse health effects. As also previously pointed out, this approach applies only to chemicals in isolation and disregards the products of interactions between chemicals and ignores possible synergistic biological effects of chemicals acting in combination.

In order to arrive at quality criteria, we are highly dependent upon animal toxicity data and must consider the type of information which would be most useful. Although in this and the previous report we present LD_{50} data on acute toxicity (Table X), we do so only because it is traditionally available because of its use in pharmacotoxicological evaluations and not because of its applicability to chemical water quality criteria. The only acute toxicity information which is of value for our purposes is that which reveals the highest dose which does not produce death in animals. This information can be used as a baseline to determine concentrations in water likely to be acutely hazardous to man (Table IX, page 240).

Although acute toxicity information is useful in accidental or uniquely polluted situations, of equal if not greater importance is information on the highest dose which produces no effect when ingested daily on a long-term basis (Table XI). As can be seen in this Table, the pertinent information is generally lacking and quality criteria in most instances must of necessity be based upon arbitrary decisions. Therefore, it seems that if sound water criteria are to be set, there is a need to perform toxicological studies specifically to provide necessary information, especially for those chemicals which are thought to be most hazardous to health. Such studies should examine dose-relationships and include the investigation of carcinogenic, teratogenic and mutagenic effects. Dose-relationships are important because it is unlikely that inorganic chemicals can be removed entirely from water and we should know levels in water which can be tolerated from the health point of view.

Figure 1 (page 244) illustrates the relationship between reported minimum lethal oral dose and highest reported concentrations of inorganic chemicals in freshwater in the U.S. Naturally only those chemicals for which both types of information are available can be included. Maximum and usual mean water intake for a 70 kg man with a 100-fold safety factor is included in the Figure and shows that a number of inorganic chemicals are either within the danger levels (to the right of the water intake levels) or are uncomfortably close to them.

Even less information of this nature is available for chronic effects of inorganic chemicals found in drinking water (Fig. 2, page 246) and raw freshwater (Fig. 3, page 248). Out of approximately two dozen inorganic chemicals which can be related in this manner, about 50% are either frankly within or near the danger zone (again considering a hundred-fold safety factor to account for individual variation) for drinking water and about 40% within the danger zone for raw freshwater. When we consider that the chemicals represented in Figure 2 have been found in the indicated concentrations in drinking water, the matter is of some concern. This concern is even greater when we further consider that the chronic toxicity doses presented are based on frank toxic effects and not on more subtle effects which might be indicative of eventual health problems when ingested on a long-term basis.

In essence the information contained in this section shows that existing quality criteria are available for only a few inorganic chemicals, that pertinent toxicity data upon which to base standards are generally lacking and that both freshwater and drinking water in particular locations in the U.S. contain inorganic chemicals at concentrations which can be considered to be a health hazard. Because of the limited data, however, it is not possible to determine how widespread or how severe such a hazard might be.

TABLE VIII

REPORTED PERMISSABLE CONCENTRATIONS

OF INORGANIC POLLUTANTS IN FRESHWATER

Data for drinking water in the United States (p. 236) was obtained from a "Survey of Community Water Supply Systems" (129) and the California Water Quality Control Boards "Water Quality Criteria" (131). The more recent data (p. 239) was obtained from "Raw-Water Quality Criteria for Public Supplies" (186) and "Water Quality Criteria Report of the National Technical Advisory Committee to the Secretary of the Interior" (261).

Data for drinking water in Europe (p. 237) was obtained from "River Pollution Causes and Effects" (276) and the California "Water Quality Criteria" (131).

Data for drinking water in the USSR are referenced as to source within the Table (p. 238). Only half of these standards are identified as having been made as the basis of toxicological considerations.

TABLE VIII - **USPHS DRINKING WATER STANDARDS IN THE U.S. - 1962**

AGENT	RECOMMENDED LIMIT (mg/1)	MANDATORY LIMIT (mg/1)
Arsenic	0.01	0.05
Barium		1.0
Boron	1.0	5.0
Cadmium		0.01
Chloride	250.0	
$Chromium^{+6}$		0.05
Copper	1.0	
Cyanide	0.01	0.2
Fluoride	Varies	Varies
Iron	0.3	
Lead		0.05
Manganese	0.05	
Nitrate	45.0	
Selenium		0.01
Silver		0.05
Sulfate	250	
Zinc	5.0	

TABLE VIII (CONT.) - 1961 WHO EUROPEAN STANDARD FOR DRINKING WATER

AGENT	PERMISSIBLE LIMIT (mg/1)	EXCESSIVE LIMIT (mg/1)
Arsenic		0.2
Cadmium		0.05
$Chromium^{+6}$		0.05
Copper	1.0	1.5
Cyanide		0.01
Fluoride	1.5	
Iron	0.1	
Lead	0.1	
Manganese	0.1	0.5
Nitrate	50.0	
Selenium		0.05
Sulfate	250.0	
Zinc		5.0

TABLE VIII (CONT.) - USSR MAXIMUM PERMISSIBLE CONCENTRATION OF INORGANIC CHEMICALS IN RESERVOIR WATERS

AGENT	MPC (mg/1)	LIMITING INDEX	REFERENCE
Aluminum	0.5	Organoleptic	170,10,157
Antimony	0.05	-	
Arsenic	0.05	Sanitary-toxicological	153,157
Barium	4.0	Organoleptic	153
Bismuth			
Bi^{+3}	0.5	Sanitary-toxicological	215
Bi^{+5}	0.1	Sanitary-toxicological	215
Cadmium	0.01	General sanitary	153
Cadmium	0.0001	Toxicological	98
Cobalt	1.0	General sanitary	153
Copper	0.1	General sanitary	153
Cyanide	0.1	Sanitary-toxicological	153
Fluorine	1.5	Sanitary-toxicological	153,170
Iron	0.5	Organoleptic	153
Lead	0.1	Sanitary-toxicological	153,157
Mercury	0.005	Sanitary-toxicological	128,153,157
Molybdenum	0.5	-	157
Nickel	0.1	Sanitary-toxicological	153
Selenium	0.01	Sanitary-toxicological	153,159
Sulfides	None	General sanitary	153,216
Titanium	0.1	Sanitary-toxicological	216
Uranium	0.6	-	157
Vanadium	0.1	Sanitary-toxicological	153,157
Zinc	1.0	General sanitary	153

TABLE VIII (CONT.)

SURFACE WATER CRITERIA FOR PUBLIC WATER SUPPLIES IN THE U.S. - 1968

AGENT	PERMISSIBLE LIMIT (mg/1)	DESIRABLE LIMIT (mg/1)
Ammonia	0.5	Absent
Arsenic	0.05	Absent
Barium	1.0	Absent
Boron	1.0	Absent
Cadmium	0.01	Absent
Chloride	250.0	<25.0
$Chromium^{+6}$	0.05	Absent
Copper	1.0	Virtually absent
Cyanide	0.20	Absent
Fluoride	Varies	Varies
Iron	0.3	Virtually absent
Lead	0.05	Absent
Manganese	0.05	Absent
Nitrates and Nitrites	10.0	Virtually absent
Phosphorus	Varies	Varies
Selenium	0.01	Absent
Silver	0.05	Absent
Sulfate	250.0	<50.0
Uranyl ion	5.0	Absent
Zinc	5.0	Virtually absent

TABLE IX - RANKING OF REPORTED ACUTE MINIMUM LETHAL ORAL DOSE (mg/kg) IN MAMMALS

HCN	0.8	SbF_3	110
NiCl	1.5	Sb	115
$HgCl_2$	2	Mo	116
Se	2	NO_3^-	117
$TeO_3^=$	2.5	KNO_3	133
Tl	3	$CdCl_2$	150
NaCN	3.3	Na_2TeO_4	165
SeO_3^-	3.5	$AgNO_3$	170
$BaCl_2$	7	LiF	200
Ba	8	$MgSO_4$	200
As	9	AsO_4^-	238
KCN	10	boric acid	250
As_2O_3	12	$Ba(NO_3)_2$	300
$BaCO_3$	13	$CaVO_4$	300
Sb	16	NaOCN	300
AsO_2^-	18	MoO_3	333
NO_2^-	20	BaF_2	350
Na_2TeO_3	20	U	400
$TeO_4^=$	20	$NaNO_3$	410
Tl_2O	21	Cr^{+6}	550
TlOAc	26	$SbCl_3$	574
Co	33	$NaBrO_3$	380
Ni	34	K_3NbO_4	725
$NbCl_5$	41	$ZnSO_4$	750
KOH	43	K_2SO_4	750
Cd	50	$SbCl_5$	900
CH_3HgCl	58	$FeCl_3$	900
NH_2NH_2	60	Hg	1000
$BeSO_4$	80	$AlCl_3$	1130
Na borate	83	$LaNO_3$	1450
$BeCl_2$	86	NH_4ClO_4	1900
$FeCl_2$	100	KI	1980
$ZnCl_2$	100	$CaCl_2$	3650
$CaMoO_4$	101	Na_2CO_3	10,000
AlF_3	103	Cu	10,000
		$NaClO_3$	12,000

TABLE X - ACUTE TOXICITY RANKING OF INORGANIC POLLUTANTS IN FRESH WATER AS DETERMINED BY LD_{50} IN MAMMALS USING ORAL ADMINISTRATION

<u>0 - 49 mg/kg</u>

Arsenite ion	Nitrite ion
Arsenic trioxide	Sodium selenite
Sodium arsenite	Sodium tellurite
Mercuric chloride	Thallium
Niobium chloride	Thallous acetate
Potassium cyanide	Thallous oxide
Nickel chloride	

<u>50 - 99 mg/kg</u>

Barium chloride	Cadmium chloride
Beryllium chloride	Hydrazine
Beryllium sulfate	

<u>100 - 199 mg/kg</u>

Antimony potassium tartrate	Calcium molybdate
Copper nitrate	Sodium tellurate
Aluminum fluoride	

<u>200 - 299 mg/kg</u>

Arsenate ion	Lithium fluoride
Calcium arsenate	Zinc chloride
Barium carbonate	

TABLE X (CONT.) - ACUTE TOXICITY RANKING OF INORGANIC POLLUTANTS IN FRESH WATER AS DETERMINED BY LD_{50} IN MAMMALS USING ORAL ADMINISTRATION

<u>300 - 499 mg/kg</u>

Barium fluoride	Calcium vanadate
Copper sulfate	Uranium
Ammonium molybdate	

<u>500 - 999 mg/kg</u>

Antimony trichloride	Potassium niobate
Copper chloride	Tantalum chloride
Ferric chloride	

<u>1000 - 5000 mg/kg</u>

Aluminum chloride	Calcium chloride
Antimony pentachloride	Potassium iodine
Boric acid	Lanthanum nitrate
Ammonium perchlorate	Tantalum fluoride

<u>>5000 mg/kg</u>

Lanthanum acetate	Sodium chlorate

TABLE XI- RANKING OF REPORTED ORAL THRESHOLD DOSES

	mg/l	mg/kg
Beryllium sulfate	0.0002	0.00001
Beryllium	0.001	-
Silver	0.05	0.0025
Aluminum molybdate	1.02	0.051
Aluminum fluoride	3.0	0.40
Aluminum chloride	4.0	0.50
Ammonium perchlorate	5.0	0.25
Barium chloride	100.0	5.00

FIGURE 1: RELATIONSHIP BETWEEN LETHALITY AND CONCENTRATIONS REPORTED IN FRESH WATER IN THE UNITED STATES

Figure 1 illustrates the relationship between the available reported minimum lethal oral dose of inorganic chemicals and maximum concentration of these chemicals which have been reported in fresh water in the United States. The diagonal lines denote the area of potential toxicity for man calculated on the basis of the mean maximum water requirement of man (35 ml/kg x 70 kg) and the mean usual daily intake of drinking water of man (one liter). The usual safety factor of one hundred times the value obtained with animal models has been included in calculating these limits. Thus, for example, a compound producing lethality at a dose of 100 mg/kg could produce cases of fatal poisoning if present in water at 29 mg/liter (on the basis of the consumption of 2.45 liters) or 70 mg/liter (on the basis of 1 liter consumption) if the 100-fold safety factor is considered.

In order to include in the graph as many elements as possible, the relationship has been represented on a logarithmic scale. Those elements placed just outside the limit of the graph indicate compounds which were reported at either a lower concentration in water or a higher lethal dose than represented by the graph. It will be noted that of all those compounds for which concentrations in water and minimum lethal oral dose are available, three fall within the usual and possible consumption of water by man and a number fall uncomfortably close to these levels of consumption.

Fig. 1: Relationship between Lethality and Concentrations reported in Fresh Water in the United States

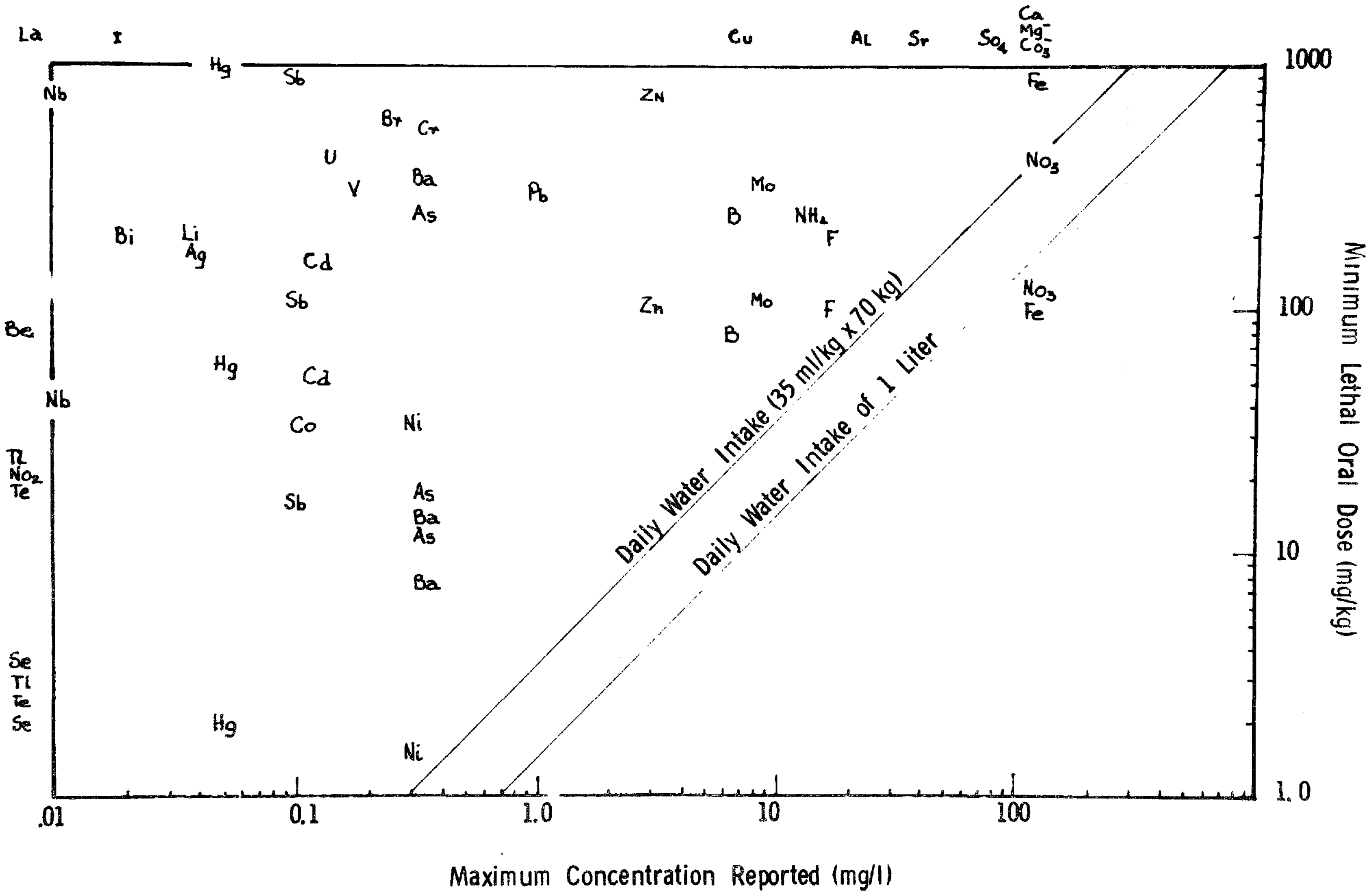


FIGURE 2: RELATIONSHIP BETWEEN CHRONIC TOXICITY AND CONCENTRATIONS REPORTED IN DRINKING WATER IN THE UNITED STATES

Figure 2 illustrates the relationship between the reported lowest dose at which a chronic effect occurs (involving tissue damage, organ damage, growth effects or death) caused by inorganic chemicals and maximum concentration of these chemicals which have been reported in drinking water in the United States. It is to be realized that the chronic toxicity effects do not include reported biochemical or cellular changes which might be related to health. As described for Figure 1, the diagonal lines denote the area of potential toxicity for man based on the mean maximum and mean usual levels of human consumption of water and an applied safety factor of 100. We find that there are nine reported inorganic chemicals which fall into the usual and possible water consumption of man and three which are uncomfortably close to these levels of water consumption.

Only two threshold or maximum no-effect doses are available for use on this graph. These are for barium and chloride shown encircled. It is most likely that if this type of information had been available for other chemicals, many of them, if not all, would fall into the danger zone based on mean daily water consumption of man.

Fig. 2: Relationship between Chronic Toxicity and Concentrations reported in Drinking Water in the United States

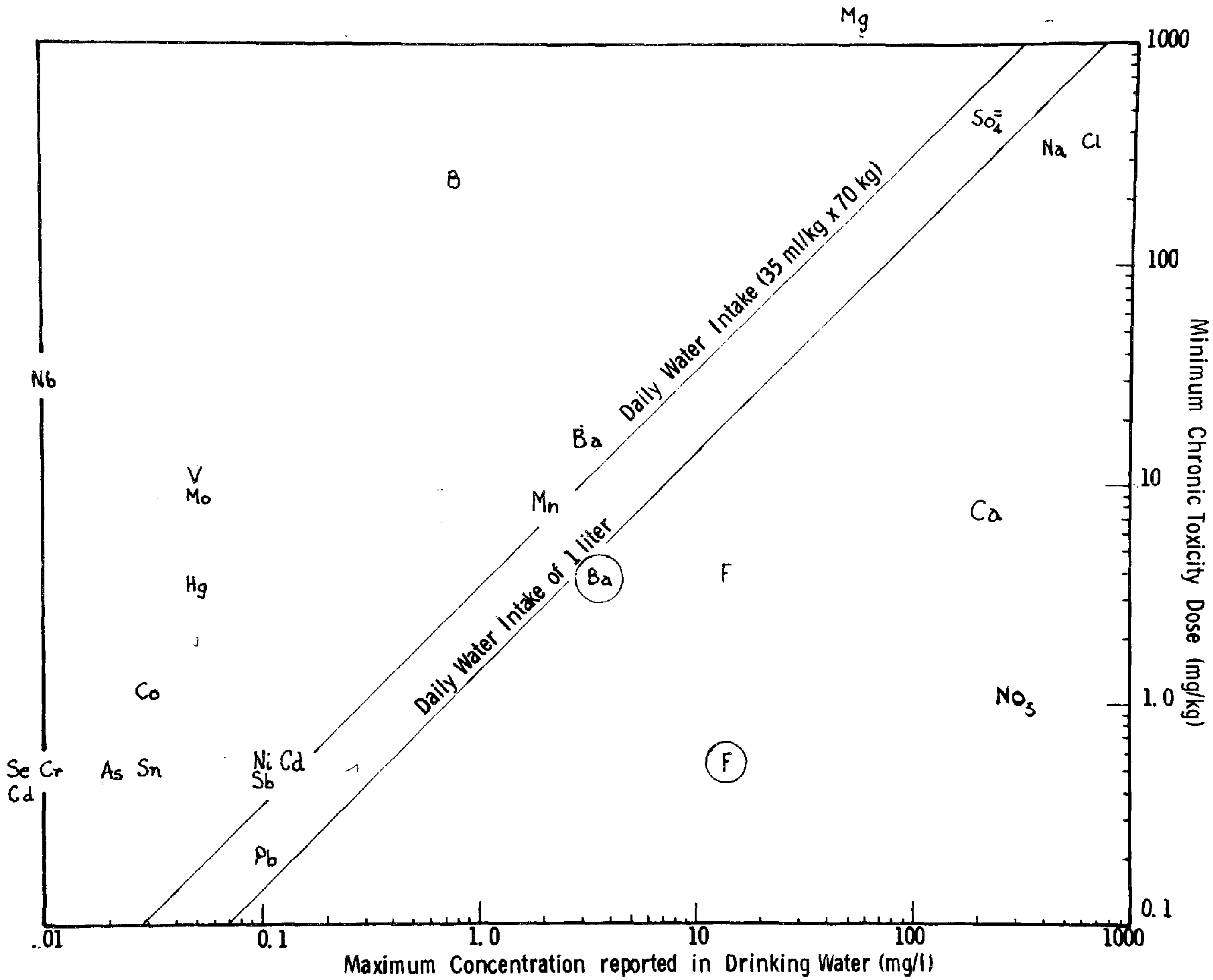
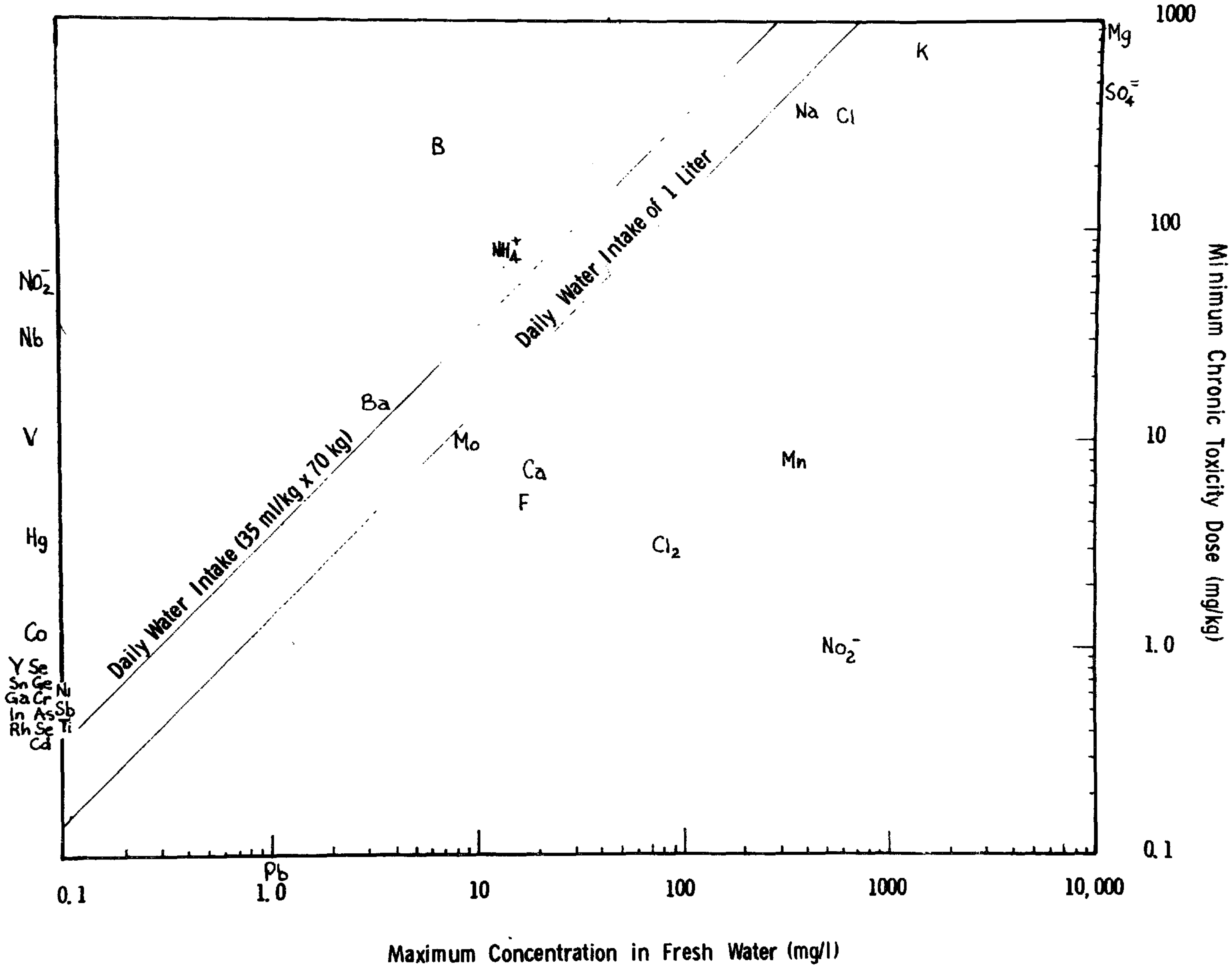


FIGURE 3: RELATIONSHIP BETWEEN CHRONIC TOXICITY AND CONCENTRATIONS REPORTED IN FRESH WATER IN THE UNITED STATES

Figure 3 illustrates the relationship between the reported lowest dose in which a chronic effect was seen and maximum concentration of inorganic chemicals which have been reported in raw "fresh water" in the United States. We find that there are 12 inorganic chemicals whose chronic toxicity doses fall within the normal consumption of water for man with a number of chemicals falling uncomfortably close to the maximum water requirements of man.

Fig. 3: Relationship between Chronic Toxicity and Concentrations Reported in Fresh Water in the United States



SECTION X

HEALTH EFFECTS OF INORGANIC CHEMICALS IN FRESHWATER

In discussing the health effects of chemicals in water, there is a temptation to extrapolate beyond available information. Although there are reasonable assumptions by which this can be done, we have chosen to deal only with those health effects which are supportable by existing facts available to us in terms of known concentrations in water and known toxicological information and the relationship between these as depicted in Figures 1, 2, and 3 on pages 243, 245, and 247 respectively, applying a safety factor of 100.

It is, of course, obvious that the information contained in these Figures is limited to those chemicals where both types of information (concentration in water and toxicity in mammals) are available. It should also be understood that the concentrations depicted in Figures 1, 2, and 3 are maximum concentrations found in raw water in the case of Figures 1 and 3 and drinking water in the case of Figure 2 and that the toxicity information is based on minimum doses found in mammals within a safety factor of 100 applied according to maximum and usual water consumption of a 70 kg man.

In Figure 1 we find nitrate and iron within concentrations which have been reported as acutely lethal.

In Figure 2 for drinking water we find sulphate, nitrate, sodium, chloride, fluoride, calcium, manganese, lead, and cadmium within chronic toxicity danger limits within nickel, antimony, lead, and barium close to these limits.

At the indicated dose, sulfate produces diarrhea in human infants, nitrate ion produces methomoglobinemia, sodium and chloride (as NaCl) cause loss of weight, fluoride causes severe mottling of teeth and affects the skeletal system, calcium at the level indicated has been correlated with increased urinary disease and arthritic conditions in humans, manganese is reported to cause kidney damage and inhibition of thyroid runction in the rat, while cadmium has been shown to produce a variety of cardiovascular and renal effects. Lead, of course, produces a variety of toxic effects in a number of organ systems including the central nervous system.

Examination of the chronic effects of barium, nickel and antimony at the indicated doses show that barium produces structural tissue changes, antimony induces a significant decrease in growth in the mouse and a decrease in survival and longevity in the rat. Nickel affects food intake, growth rate and renal changes.

These reported chronic effects are at doses which produce an effect and are not maximum no-effect doses which, if available, would more than likely shift many of these chemicals well within the danger limits as shown for the threshold or maximum no-effect doses for barium and fluoride (circled symbols).

In essence the limited available data on the relationship between concentration of inorganic chemicals in water and health effects indicate that water in the U.S. contains inorganic chemicals in concentrations which when ingested could either be acutely lethal especially in susceptible individuals or produce frank organ or tissue damage when ingested daily on a long-term basis. Inorganic chemicals which can produce long-term effects are found at undesirable concentrations not only in raw water but also in water supplies intended for human consumption. Because water treatment methods are not intended to remove chemicals in general, the existence of high concentrations in raw water which might be treated for domestic use is of some concern.

The full impact of carcinogens, teratogens and mutagens in water cannot be fully evaluated at this time because of the general unavailability of dose-effect relationships to determine threshold or maximum no-effect doses. It would be desirable that both organic and inorganic substances with these effects be eliminated from water entirely, but this is probably an impractical solution and some level in water must be tolerated. At this time the establishment of such a level for each compound can be derived only on an arbitrary basis.

Relatively speaking, the proportion of inorganic carcinogenic chemicals is about the same as that of organic carcinogenic chemicals ($\sim$20%). On the other hand, a smaller proportion of inorganic chemicals are teratogenic ($\sim$20% vs. 60%) and all organic as well as inorganic chemicals examined for mutagenicity are positive. The exact meaning of this mutagenic information must be approached with caution.

Theoretically all freshwater sources can be used for human consumption after treatment. However, treatment of such water is aimed at elimination of microorganisms, turbidity and organoleptic effects and, if this treatment removes chemical pollutants, it is by accident rather than design. Therefore, Figure 3 is presented on the same basis as Figure 2 for concentrations of organic chemicals which have been found in raw water in the U.S. and their chronic toxicity. We find that for a total of about 30 chemicals which have been found in "freshwater" 12 or approximately 40% fall within the danger zone of normal human water consumption. In addition to those chemicals already discussed with Figure 2 we have these additional chemicals: magnesium, potassium, molybdenum and chlorine. As will be noted, all 12 chemicals are within the average consumption of water by man allowing for the 100-fold safety factor.

At the indicated concentrations, magnesium can retard growth, potassium produces neural, muscular and renal effects, molybdenum causes anemia, gastrointestinal effects and loss of weight and chlorine can induce strong physiological effects. Again as with Figure 2, threshold or maximum no-effect doses would most likely place many compounds outside the danger zone with levels which would be of health concern. Again, it should be emphasized that the chemicals depicted in Figure 3 are limited only to those for which both concentration in water and toxicity data are available.

Unlike organic chemicals, many of the inorganic chemicals have shown beneficial effects. Calcium has been consistently shown to lower death rates from coronary heart disease in man, fluoride at concentrations less than 4 mg/l has been shown to reduce the incidence of dental caries, niobium at 5 mg/l orally increases longevity (however, at the expense of a decreased growth rate in the mouse, but with the opposite effect in the rat), selenium at 3 mg/l increases growth rate in the mouse and longevity in the rat, zirconium at 5 mg/l increases growth in the rat.

In terms of carcinogenicity, sodium arsenite, sodium germanate, and nickel (Ni^{+3}), all decrease tumor incidence when administered orally.

Therefore, some inorganic chemicals which are found or could be found in water have beneficial health effects.

SECTION XI

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SECTION XII

INDEX TO INORGANIC CHEMICALS

A

B

Z

1 Accession Number	2 Subject Field & Group	**SELECTED WATER RESOURCES ABSTRACTS** INPUT TRANSACTION FORM

5 Organization

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27 Abstract

A survey of the literature dealing with inorganic chemical compounds was conducted to obtain and reference data relevant to the establishment of water quality criteria. More than 5,000 publications were reviewed. While nearly 300 inorganic species may exist in freshwater only 87 were identified in the literature. A wide distribution in concentrations in potable and polluted water was found.

Data on acute toxicity, chronic toxicity, carcinogenicity, mutagenicity, and teratogenicity of inorganic chemicals have been tabulated. Because of the design of most of these toxicological determinations, it is difficult to extrapolate from this data to human health. This inability is furthered in that the concentrations of many materials in freshwater are reported in terms of elemental analysis alone without reference to the ionic or complex form of the material. However, toxicity varies with the complex ion and oxidation state.

Correlations have been made of minimum lethal oral dose versus maximum concentrations reported in freshwater, and of minimum chronic toxic dose versus maximum concentration reported in drinking water. Examples of inorganic species which approach a safety limit have been observed.

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