NUTRIENTS, PESTICIDES, SURFACTANTS, AND TRACE METALS IN GROUND WATER FROM THE HOWE AND MUD LAKE AREAS UPGRADIENT FROM THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO

By

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U.S. GEOLOGICAL SURVEY

Open-File Report 90-565

Prepared in cooperation with the

U.S. DEPARTMENT OF ENERGY

Idaho Falls, Idaho

October 1990

U.S. DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

For readers who prefer to use International System (SI) units rather than units used in this report, the following conversion factors may be used:

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

Metric units used in this report that do not have commonly used inch-pound equivalents are mL (milliliter); L (liter); g (gram); μg/L (microgram per liter); mg/L (milligram per liter); and μS/cm (microsiemens per centimeter at 25 degrees Celsius).

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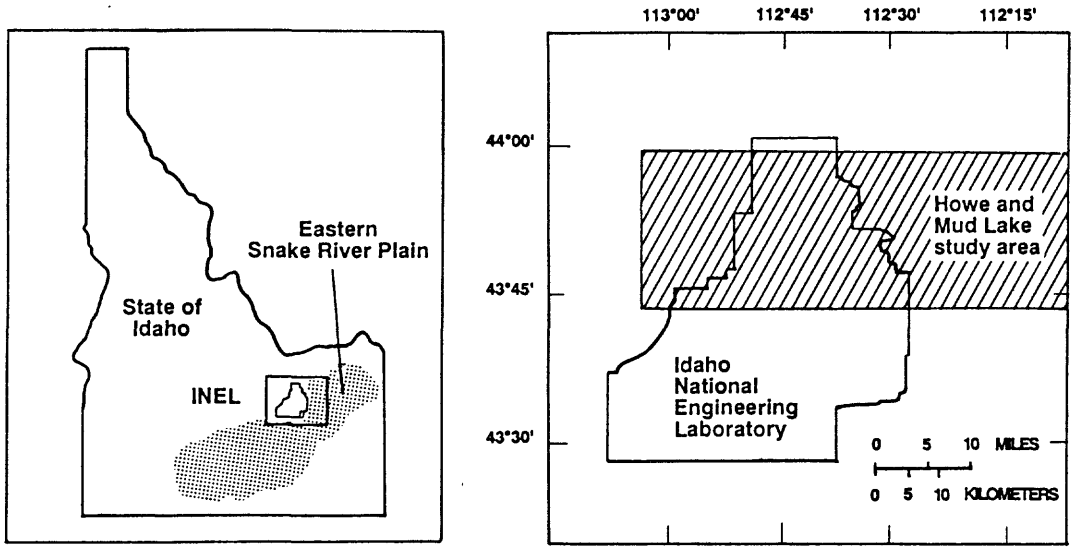
ABSTRACT

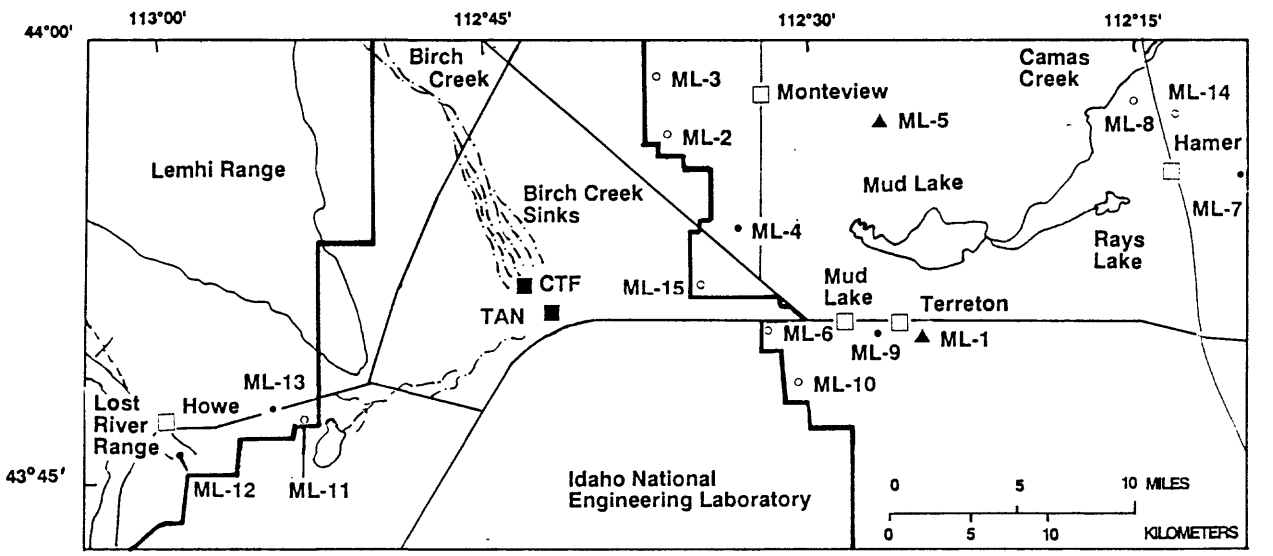
Reconnaissance-level sampling for selected nutrients, pesticides, and surfactants in ground water upgradient from the Idaho National Engineering Laboratory was conducted during June 1989. Water samples collected from eight irrigation wells, five domestic or livestock wells, and two irrigation canals were analyzed for nutrients, herbicides, insecticides and polychlorinated compounds, and surfactants. In addition to the above constituents, water samples from one irrigation well, one domestic well, and one irrigation canal were analyzed for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

Concentrations of nitrite plus nitrate as nitrogen ranged from less than the reporting level to 6.10 mg/L (milligrams per liter), and orthophosphate concentrations as phosphorus ranged from less than the reporting level to 0.070 mg/L (micrograms per liter). Concentrations of 2,4-D in two water samples were 0.01 μg/L and 0.10 μg/L. Water samples analyzed for 15 other herbicides, 10 carbamate insecticides, 11 organophosphorus insecticides, and 15 organochlorine insecticides, gross polychlorinated biphenyls, and gross polychlorinated naphthalenes all had concentrations below their reporting levels. Concentrations of surfactants ranged from 0.02 to 0.35 mg/L. Arsenic, barium, chromium, selenium, and silver concentrations exceeded reporting levels in most of the samples.

INTRODUCTION

The INEL (Idaho National Engineering Laboratory) includes about 890 mi^2 of the eastern Snake River Plain in southeastern Idaho (fig. 1). The INEL was established in 1949 and is used by the U.S. Department of Energy to develop nuclear energy, nuclear safety research, defense programs, and advanced energy concepts.





EXPLANATION

- • ML-4 LOCATION OF DOMESTIC OR LIVESTOCK WELL AT WHICH WATER SAMPLE WAS COLLECTED–entry, ML-4, is site identifier shown in tables 2,4,7, and 9.
- ○ ML-2 LOCATION OF IRRIGATION WELL AT WHICH WATER SAMPLE WAS COLLECTED–entry, ML-2, is site identifier shown in tables 2,4,7, and 9.
- ▲ ML-1 LOCATION OF IRRIGATION CANAL AT WHICH WATER SAMPLE WAS COLLECTED–entry ML-1, is site identifier shown in tables 2,4,7, and 9.

- TAN Test Area North
- CTF Contained Test Facility (formerly called Loss of Fluid Test Facility - LOFT)
- —— INEL Boundary
- ■ Facilities
- □ Towns
- —— Roads

Figure 1.--Locations of the Idaho National Engineering Laboratory, the Howe and Mud Lake study area, and sample sites.

During June 1989, a sampling program was conducted to document the concentrations of nutrients, pesticides, and surfactants in ground water and surface water upgradient from the INEL in the Howe and Mud Lake areas. Water samples were collected from eight irrigation wells, five domestic or livestock wells, and two irrigation canals. Samples from one irrigation well, one domestic well, and one irrigation canal were analyzed for dissolved trace metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

This report describes the methods used to collect the water samples and summarizes the concentrations of nutrients, pesticides, surfactants, and trace metals in those samples. The samples were analyzed by the U.S. Geological Survey's NWQL (National Water Quality Laboratory) in Arvada, Colorado.

Geohydrologic Setting

The eastern Snake River Plain is a northeast-trending structural basin about 200 mi long and 50 to 70 mi wide. The plain is underlain by a layered sequence of basaltic lava flows and cinder beds intercalated with eolian, fluvial, and lacustrine sedimentary deposits. Individual lava flows generally range from 10 to 50 ft in thickness, although the average thickness may be from 20 to 25 ft (Mundorff and others, 1964, p. 143). The sedimentary deposits consist mainly of lenticular beds of sand, silt, and clay with lesser amounts of gravel. Locally, rhyolitic lava flows and tuffs crop out or occur at depth. The basaltic lava flows and intercalated sedimentary deposits combine to form the Snake River Plain aquifer, which is the main source of ground water on the plain.

The Snake River Plain aquifer is recharged by the infiltration of precipitation and irrigation water, and by underflow from tributary valleys on the perimeter of the plain. Water recharged to the aquifer generally moves to the southwest and is discharged to springs along the Snake River approximately 100 mi southwest of the INEL (Mann, 1989, p. 4).

The Little Lost River, Birch Creek, Camas Creek, and Mud Lake are the principal sources of water that recharge the aquifer in the Howe and Mud Lake areas (Robertson and others, 1974). The general direction of ground-water movement is southwestward near Mud Lake and southward near Howe (Pittman and others, 1988, figure 9, p. 16). Water-level contours for the Snake River Plain aquifer (Stearns and others, 1939, plate 12; Lindholm and others, 1988) indicate the hydraulic gradient is steeper in the vicinity of Mud Lake than at the INEL. The steep hydraulic gradient is in an area where the upper part of the aquifer is composed of a thick sequence of sedimentary deposits.

Previous Investigations

The U.S. Geological Survey has conducted geologic, hydrologic, and water-quality investigations at the INEL since it was selected as a reactor testing area in 1949. Ground-water quality studies routinely include analyses of selected common ions, trace metals, and radionuclides. Pesticides in ground water were investigated at the INEL in 1980; results are described in a report by Leenheer and Bagby (1982). No investigation of pesticides in ground water has been conducted in the Mud Lake or Howe areas by the U.S. Geological Survey. Nutrients as nitrite plus nitrate (as nitrogen) were investigated in the Mud Lake and Howe areas as part of a general reconnaissance on ground-water quality in the eastern Snake River basin and east-central Idaho valleys by Parliman (1982 and 1983). Selected trace metals in ground water at the INEL were investigated and described by Mann and Knobel (1988).

Acknowledgments

The authors gratefully acknowledge the well owners in the Howe and Mud Lake areas for granting permission to collect the water samples.

METHODS AND QUALITY ASSURANCE

The methodology used in sampling for the nutrients, pesticides, surfactants, and trace metals generally followed the guidelines established by Claassen (1982), Feltz and others (1985), and Wood (1981). Methods used in the field and quality assurance practices are outlined in the following sections.

Sample Containers and Preservatives

Sample containers and preservatives differ depending on the constituent(s) for which analyses are requested. Samples analyzed by the NWQL are contained and preserved in accordance with laboratory requirements specified by Feltz and others (1985). Containers and preservatives were supplied by the NWQL and had undergone a rigorous quality control procedure (Pritt, 1989, p. 75) to eliminate sample contamination. Containers and preservatives used for this study are listed in table 1. The 1-liter glass bottles used to collect carbamate insecticides were covered with aluminum foil to protect the samples from direct sunlight.

Sampling Locations and Sample Collection

Samples were collected from five irrigation wells equipped with spigots located near their turbine pumps (ML-6, 10, 11, 14, and 15); three irrigation wells equipped with discharge pipes open to irrigation ditches (ML-2, 3, and 8); five domestic or livestock wells equipped with spigots located near their pressure tanks (ML-4, 7, 9, 12, and 13); and from the midpoints of two irrigation canals with open channel flow (ML-1, and 5). Sample sites are shown in figure 1.

Prior to sampling, domestic or livestock wells were pumped long enough to ensure that the pressure tanks and plumbing systems had been thoroughly flushed. When flushing was complete, samples were collected from the spigot. After collection, sample containers were sealed with laboratory

Table 1.--Containers and preservatives used for water samples, Howe and Mud Lake areas, Idaho

[Abbreviations: L, liter; mL, milliliter; $HgCl_2$, mercuric chloride; NaCl, sodium chloride; HNO_3, nitric acid; $K_2Cr_2O_7$, potassium dichromate; °C, degrees Celsius. Samples for nutrients, pesticides, surfactants, and trace metals were shipped by overnight-delivery mail. Analyses by U.S. Geological Survey's NWQL (National Water Quality Laboratory.)]

Type of constituent	Container		Preservative		Other treatment
	Type	Size	Type	Size	
Pesticides	Glass, baked wrapped in aluminum foil	1 L	None	None	Chill 4 °C
Nutrients	Polyethylene, brown	250 mL	$HgCl_2$/ NaCl	1 mL	Filter, chill 4 °C
Metals	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	Filter
Mercury	Glass, acid-rinsed	250 mL	$K_2Cr_2O_7$/ HNO_3	10 mL	Filter
Surfactants	Polyethylene	250 mL	None	None	Chill 4 °C

film, labeled, and stored under secured conditions. The containers were then packed in ice chests, sealed, and shipped daily by overnight-delivery mail to the NWQL.

Conditions at the sampling site during sample collection were recorded in a field logbook and a chain-of-custody record was used to track samples from the time of collection until delivery to the analyzing laboratory. These records are available for inspection at the U.S. Geological Survey Project Office at the INEL. Field measurements of pH, specific conductance, and water temperature are listed in table 2.

Quality Assurance

A detailed description of internal quality control and of the overall quality assurance practices used by the U.S. Geological Survey's NWQL is

Table 2.--Results of field measurements for pH, specific conductance, and temperature of water from selected sites, Howe and Mud Lake areas, Idaho

[Site identifier: see figure 1 for location of sites. Units: pH, negative base-10 logarithm of hydrogen ion activity in moles per liter; specific conductance, microsiemens per centimeter at 25 °C (degrees Celsius); temperature, °C; -- indicates missing field data.]

Site identifier	Type of sample[1]	Date sampled	Time	pH	Specific conductance	Temperature
ML-1	C	06/05/89	1015	8.6	228	17.1
ML-2	I_o	06/05/89	1235	7.5	1190	14.8
ML-3	I_o	06/05/89	1345	7.3	1450	13.0
ML-4	DL	06/05/89	1500	8.1	480	13.8
ML-5	C	06/06/89	0930	8.1	280	13.5
ML-6	I_s	06/06/89	1100	8.4	330	15.7
ML-7	DL	06/06/89	1330	7.9	358	14.6
ML-8	I_o	06/06/89	1430	8.0	258	14.6
ML-9	DL	06/07/89	1130	7.8	714	13.7
ML-10	I_s	06/07/89	1310	--	--	--
ML-11	I_s	06/07/89	0930	8.2	361	15.1
ML-12	DL	06/08/89	1050	8.1	268	16.4
ML-13	DL	06/08/89	1230	7.9	575	12.7
ML-14	I_s	06/13/89	1020	8.1	287	14.7
ML-15	I_s	06/13/89	1220	8.1	522	16.5

[1] C = canal; I_o = irrigation well, open pipe; DL = domestic or livestock well; I_s = irrigation well, spigot.

provided in reports by Friedman and Erdman (1982) and Jones (1987). The water samples were collected in accordance with a draft quality assurance plan for quality of water activities conducted by personnel assigned to the INEL Project Office. The draft plan was finalized in June 1989 and is available for inspection at the U.S. Geological Survey's Project Office at the INEL. A comparative study to determine agreement between analytical results for individual water-sample pairs by laboratories involved in the INEL Project Office's quality assurance program was summarized by Wegner (1989).

NUTRIENTS

Water samples from all 15 sites were analyzed for dissolved ammonia (as nitrogen), nitrite (as nitrogen), nitrite plus nitrate (as nitrogen), and orthophosphate (as phosphorus). The proposed maximum contaminant levels and reporting levels for nitrite, and nitrite plus nitrate are shown in table 3. A maximum contaminant level has not been established or proposed for ammonia and orthophosphate.

Table 3.--Proposed maximum contaminant levels and reporting levels of nutrients for which water samples were analyzed

[Proposed maximum contaminant level: established maximum contaminant level for nitrate (as nitrogen) is 10 milligrams per liter in both community and noncommunity water systems (U.S. Environmental Protection Agency, 1987, p. 530; proposed maximum contaminant levels are from J. Rodin, U.S. Environmental Protection Agency, written commun., 1989). Units are mg/L (milligrams per liter). Reporting levels are from Feltz and others (1985). Symbols: -- indicates that a maximum contaminant level has not been established or proposed for that constituent.]

Constituent	Proposed maximum contaminant level	Reporting level
Ammonia (as nitrogen)	--	0.010
Nitrite (as nitrogen)	1	0.010
Nitrite plus nitrate (as nitrogen)	10	0.010
Orthophosphate (as phosphorus)	--	0.010

Concentrations of ammonia, nitrite, nitrite plus nitrate, and orthophosphate dissolved in water are shown in table 4. Concentrations of ammonia ranged from less than the reporting level to 0.160 mg/L. Nitrite concentrations ranged from less than the reporting level to the reporting level of 0.010 mg/L. The concentrations of nitrite plus nitrate ranged from less than the reporting level to 6.10 mg/L and were consistently less than the proposed maximum contaminant level of 10 mg/L. Orthophosphate concentrations as phosphorus ranged from less than the reporting level to 0.070 mg/L.

PESTICIDES

Water samples were collected from the 15 sampling sites for pesticide analyses. Pesticides included herbicides, insecticides, and polychlorinated compounds.

Herbicides

Water samples from 2 of the 15 sites had reportable concentrations of 2,4-D; water samples from site ML-1 contained 0.01 µg/L and water samples from ML-2 contained 0.10 µg/L. Both concentrations were considerably less than the established maximum contaminant level of 100 µg/L. No other herbicides from the other 13 sites where water samples were collected exceeded the reporting level . The proposed maximum contaminant levels and reporting levels of 16 herbicides are shown in table 5.

Insecticides and Polychlorinated Compounds

Concentrations of 10 carbamate insecticides, 11 organophosphorus insecticides, 15 organochlorine insecticides, gross polychlorinated biphenyls (PCB), and gross polychlorinated naphthalenes (PCN) were determined by the NWQL. At all 15 sites, concentrations of those constituents were less than

Table 4.--Concentrations of nutrients dissolved in water, Howe and Mud Lake areas, Idaho

[Analyses by U.S. Geological Survey's National Water Quality Laboratory. Analytical results in mg/L (milligrams per liter); <0.010 indicates the concentration was less than the reporting level of 0.010 mg/L. Site identifier: see figure 1 for location of sites. N indicates nitrogen; P indicates phosphorus]

Site identifier	Type of sample[1]	Date sampled	Ammonia (as N)	Nitrite (as N)	Nitrite + nitrate (as N)	Ortho-phosphate (as P)
ML-1	C	06/05/89	0.030	<0.010	<0.10	0.041
ML-2	I_o	06/05/89	0.041	<0.010	3.80	0.050
ML-3	I_o	06/05/89	0.060	<0.010	6.10	0.021
ML-4	DL	06/05/89	0.030	<0.010	2.00	0.070
ML-5	C	06/06/89	<0.010	<0.010	0.81	0.021
ML-6	I_s	06/06/89	0.160	<0.010	0.55	0.021
ML-7	DL	06/06/89	0.041	<0.010	1.00	0.030
ML-8	I_o	06/06/89	0.021	<0.010	3.70	0.021
ML-9	DL	06/07/89	0.041	<0.010	5.40	0.021
ML-10	I_s	06/07/89	0.060	0.010	1.80	0.030
ML-11	I_s	06/07/89	0.030	<0.010	0.80	0.010
ML-12	DL	06/08/89	0.021	<0.010	0.19	0.010
ML-13	DL	06/08/89	0.030	<0.010	2.60	0.021
ML-14	I_s	06/13/89	0.080	<0.010	2.30	0.021
ML-15	I_s	06/13/89	0.030	<0.010	2.30	<0.010

[1] C = canal; I_o = irrigation well, open pipe; DL = domestic or livestock well; I_s = irrigation well, spigot.

Table 5.--Maximum contaminant levels and reporting levels of herbicides for which water samples were analyzed

[Maximum contaminant levels are shown in μg/L (micrograms per liter) and apply only to community water systems (U.S. Environmental Protection Agency, 1987, p. 530); maximum contaminant levels have not been established or proposed for most of the herbicides shown on the table; values shown in parentheses are proposed maximum contaminant levels (J. Rodin, U.S. Environmental Protection Agency, written commun., 1989). Reporting levels are from Feltz and others (1985). Symbols: -- indicates that a maximum contaminant level has not been established or proposed for that compound.]

Triazines and other nitrogen-containing herbicides: reporting level is 0.1 μg/L.

Herbicide	Maximum contaminant level	Herbicide	Maximum contaminant level
Alachlor	(2.0)	Prometon	--
Ametryn	--	Prometryn	--
Atrazine	(2.0)	Propazine	--
Cyanazine	--	Simazine	--
Metolachlor	--	Simetryn	--
Metribuzin	--	Trifluralin	--

Chlorophenoxy acid herbicides: reporting level is 0.01 μg/L.

Herbicide	Maximum contaminant level	Herbicide	Maximum contaminant level
2,4-D	100 (70)	Silvex	10 (50)
2,4-DP	--	2,4,5-T	--

their reporting levels. The maximum contaminant levels and reporting levels of insecticides and gross polychlorinated compounds are shown in table 6.

SURFACTANTS

Surfactants, methylene blue active substances (MBAS), occur in natural waters almost exclusively as a result of pollution (Goerlitz and Brown, 1972, p. 11). Concentrations of surfactants in the water samples analyzed were all above the reporting level of 0.01 mg/L and ranged from 0.02 to 0.35 mg/L. The maximum contaminant level is 0.05 mg/L and applies only to public water systems (U.S. Environmental Protection Agency, 1987, p. 593). Concentrations of MBAS are shown in table 7.

TRACE METALS

Water samples from one irrigation well, one domestic well, and one irrigation canal were analyzed for dissolved trace metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The maximum contaminant level and reporting level for each of the eight trace metals are shown in table 8. The concentrations of cadmium, lead, and mercury in the three samples were less than their respective reporting levels defined in Feltz and others (1985).

Arsenic, barium, chromium, selenium, and silver were detectable in most samples at concentrations greater than their reporting levels (tables 8 and 9). All the values, except one, were less than the maximum contaminant level established by the U.S. Environmental Protection Agency (table 8). The concentration of 50 μg/L of chromium in ML-12 is at the maximum contaminant level (table 8), but is less than the 100 μg/L proposed maximum contaminant level (J. Rodin, U.S. Environmental Protection Agency, written commun., 1989).

Dissolved concentrations of arsenic, barium, chromium, selenium, and silver in the three water samples ranged as follows: arsenic, 2 to 5 μg/L;

Table 6.--Maximum contaminant levels and reporting levels of insecticides and gross polychlorinated compounds for which water samples were analyzed

[Maximum contaminant levels are shown in μg/L (micrograms per liter) and apply only to community water systems (U.S. Environmental Protection Agency, 1987, p. 530); values shown in parentheses are proposed maximum contaminant levels (J. Rodin, U.S. Environmental Protection Agency, written commun., 1989). Reporting levels are from Feltz and others (1985). Symbols: -- indicates that a maximum contaminant level has not been established.]

Carbamate insecticides: reporting level is 0.5 μg/L

Insecticide	Maximum contaminant level	Insecticide	Maximum contaminant level
Aldicarb	(10)	3-Hydroxycarbofuran	--
Aldicarb sulfoxide	(10)	Methomyl	--
Aldicarb sulfone	(40)	1-Naphthol	--
Carbaryl (Sevin)	--	Oxamyl	--
Carbofuran	(40)	Propham	--

Organophosphorus insecticides: reporting level is 0.01 μg/L

Insecticide	Maximum contaminant level	Insecticide	Maximum contaminant level
Chlorpyrifos; Dursban	--	Methyl parathion	--
Diazinon	--	Methyl trithion	--
Disulfoton	--	Parathion	--
Ethion	--	Phorate	--
Fonofos	--	Trithion	--
Malathion	--		

Table 6.--Maximum contaminant levels and reporting levels of insecticides and gross polychlorinated compounds for which water samples were analyzed--Continued

Organochlorine insecticides: reporting level is 0.01 µg/L except for chlordane and perthane (0.1 µg/L), and toxaphene (1.0 µg/L)

Insecticide	Maximum contaminant level	Insecticide	Maximum contaminant level
Aldrin	--	Heptachlor	(0.4)
Chlordane	(2.0)	Heptachlor epoxide	(0.2)
DDD	--	Lindane	4.0
DDE	--		(0.2)
DDT	--	Methoxychlor	100
Dieldrin	--		(400)
Endosulfan	--	Mirex	--
Endrin	0.2	Perthane	--
		Toxaphene	5.0

Gross polychlorinated compounds, reporting level is 0.1 µg/L

Compound	Maximum contaminant level
Gross polychlorinated biphenyls (PCB)	(0.5)
Gross polychlorinated naphthalenes (PCN)	--

Table 7.--Concentrations of surfactants, methylene blue active substances (MBAS) dissolved in water, Howe and Mud Lake areas, Idaho

[Analyses by U.S. Geological Survey's National Water Quality Laboratory. Analytical results in mg/L (milligrams per liter). Site identifier: see figure 1 for location of sites.]

Site identifier	Type of sample[1]	Date sampled	MBAS
ML-1	C	06/05/89	0.02
ML-2	I_o	06/05/89	0.30
ML-3	I_o	06/05/89	0.35
ML-4	DL	06/05/89	0.04
ML-5	C	06/06/89	0.03
ML-6	I_s	06/06/89	0.03
ML-7	DL	06/06/89	0.04
ML-8	I_o	06/06/89	0.13
ML-9	DL	06/07/89	0.24
ML-10	I_s	06/07/89	0.06
ML-11	I_s	06/07/89	0.06
ML-12	DL	06/08/89	0.05
ML-13	DL	06/08/89	0.11
ML-14	I_s	06/13/89	0.07
ML-15	I_s	06/13/89	0.30

[1] C = canal; I_o = irrigation well, open pipe; DL = domestic or livestock well; I_s = irrigation well, spigot.

Table 8.--Maximum contaminant levels and reporting levels of trace metals for which water samples were analyzed

[The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1987, p. 530) for community water systems and are included only for comparison purposes; proposed maximum contaminant levels--shown in parentheses--are from J. Rodin (U.S. Environmental Protection Agency, written commun., 1989). Units are in µg/L (micrograms per liter). Reporting levels are from Feltz and others (1985).]

Constituent	Maximum contaminant level	Reporting level
Arsenic	50 (30)	1
Barium	1,000 (5,000)	2
Cadmium	10 (5)	1
Chromium	50 (100)	1
Lead	50	5
Mercury	2	0.1
Selenium	10	1
Silver	50	1

barium, 32 to 110 µg/L; chromium, 1 to 50 µg/L; selenium, less than the reporting level at one site to 2 µg/L; and silver, less than the reporting level at two sites to 2 µg/L in ML-12 (table 9).

Table 9.--Concentrations of selected trace metals dissolved in water, Howe and Mud Lake areas, Idaho

[Analyses by U.S. Geological Survey's National Water Quality Laboratory. Analytical results in µg/L (micrograms per liter); <1 indicates the concentration was less than the reporting level of 1 µg/L. Concentrations of cadmium, lead, and mercury were less than their respective reporting levels (see table 8). Site identifier: see figure 1 for locations.]

Site identifier	Arsenic	Barium	Chromium	Selenium	Silver
ML-1	2	32	1	<1	<1
ML-2	3	110	6	2	<1
ML-12	5	100	50	1	2

SUMMARY

The U.S. Geological Survey, in cooperation with the U.S. Department of Energy, collected and analyzed water samples from 15 sites near Howe and Mud Lake, Idaho, for manmade pollutants and naturally occurring contaminants. Samples were collected from eight irrigation wells, five domestic or livestock wells, and two irrigation canals. The samples were analyzed for nutrients, herbicides, insecticides and polychlorinated compounds, and surfactants. In addition, water samples from one irrigation well, one domestic well, and one irrigation canal were analyzed for dissolved trace metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

Concentrations of nitrite plus nitrate as nitrogen ranged from less than the reporting level to 6.10 mg/L, and orthophosphate concentrations as phosphorus ranged from less than the reporting level to 0.070 mg/L. Concentrations of 2,4-D in two samples were 0.01 and 0.10 µg/L. Analyses of

water samples for 15 other herbicides, 10 carbamate insecticides, 11 organophosphorus insecticides, and 15 organochlorine insecticides, gross polychlorinated biphenyls, and gross polychlorinated naphthalenes indicated that all concentrations were below reporting levels. Concentrations of surfactants ranged from 0.02 to 0.35 mg/L. Concentrations of arsenic, barium, chromium, selenium, and silver exceeded reporting levels in most of the samples.

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