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WATER RESOURCES DIVISION

MERCURY IN THE CARSON AND TRUCKEE RIVER BASINS OF NEVADA

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SUMMARY

Upstream from major pre-1900 ore milling in the Carson and Truckee River basins, "background" concentrations of total mercury in the upper 1 to 3 inches of sand- to clay-sized stream-bottom sediment are less than 0.1 ug/g (microgram per gram1/). Downstream, measured concentrations were as much as 200 times the background level. Greatest concentrations were encountered in the Carson River basin within and immediately upstream from Lahontan Reservoir. Data for the Carson River near Fort Churchill suggest that most of the mercury in the sampled bottom sediment may be present as mercuric sulfide or as a component of one or more non-methyl organic compounds or complexes, rather than existing in the metallic state. Regardless of state, this reservoir of mercury is of concern because of its possible availability to the aquatic food chain and, ultimately, to man.

Among 48 samples of surface water from 29 sites in the two basins, the maximum measured total-mercury concentration was 6.3 ug/l (micrograms per liter2/), for a sample from the Carson River near Fort Churchill. Except downstream from Lahontan Reservoir, most other measured values were less than 1 ug/l. (The U.S. Environmental Protection Agency interim limit for drinking water is 5 ug/l.) The total-mercury content of stream waters is related to the mercury content of bottom sediments and the rate of streamflow, because the latter affects the suspended-sediment transporting capability of the stream. Near Fort Churchill, total-mercury concentrations that might be expected at streamflows greater than those of 1971-72 are: as much as 10-15 ug/l or more at 2,000 cfs (cubic feet per second), and as much as 10-20 ug/l or more at 3,000 cfs. Elsewhere, expectable concentrations are much less because the bottom sediment contains much less mercury.

The mercury contents of water samples from 36 wells in the Carson and Truckee basins were all less than 1 ug/l, indicating that mercury is not a problem in ground water, even adjacent to areas where stream-bottom sediment is enriched in mercury.

Limited data indicate that the Carson River above Lahontan Reservoir and the reservoir itself contain only trace amounts of dissolved arsenic, cyanide, selenium, and silver. Among 17 additional trace metals analyzed for on four unfiltered samples from the river above the reservoir, only six of the metals were consistently present in concentrations exceeding detection limits. Maximum measured concentrations for the six metals were:

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1. Micrograms per gram are equivalent to "parts per million." The term "total" refers to all extractable forms of mercury.

2. Micrograms per liter are equivalent to "parts per billion." The term "total mercury" refers to all extractable forms, both dissolved and associated with suspended sediment, for a whole-water (unfiltered) sample.

aluminum, >670 ug/l; iron, 2,500 ug/l; manganese, 1,100 ug/l; molybdenum, 15 ug/l; titanium, 110 ug/l; and vanadium, 15 ug/l. Presumably, the detected metals were associated largely or almost entirely with the suspended-sediment phase of the water samples.

Selenium and silver concentrations in sampled well waters from the Carson and Truckee basins were uniformly low, with one exception--a selenium concentration of 18 ug/l for the water of a shallow well southwest of Fallon (Public Health Service limit, 10 ug/l). The arsenic content of 15 sampled well waters ranged from 0 to 1,500 ug/l (0 to 1.5 ppm), with seven of the values greater than 50 ug/l (the Public Health Service limit).

INTRODUCTION

Prior to 1900, mercury was used during the milling of ores from the Comstock Lode. Almost 15 million pounds of the mercury escaped recovery (Smith, 1943, p. 257), with much of it being incorporated in the mill tailings. This report summarizes and discusses the findings of a 1-year study of mercury and, to a lesser extent, several other trace substances in the water and related sediment of the Carson and Truckee River basins, made by the U.S. Geological Survey in cooperation with the Nevada Division of Health.

BRIEF ANALYSIS OF THE CHEMICAL DATA

Mercury content of fine-grained surficial sediment from stream, canal, drain, and lake bottoms

The total-mercury content of sampled bottom sediment is listed in table 1 (appendix) and shown in figure 1 (also in appendix). The sampled material ranged in size from coarse sand to clay, and represented the uppermost 1-3 inches of bottom sediment; that is, the sediment most intimately associated with the overlying water. Data for the Carson River at Cradlebaugh Bridge and the Truckee River at Farad (sites 3 and 25) suggest that the "background" concentration of mercury upstream from major pre-1900 ore-milling activity is not more than 0.1 µg/g. In contrast, the largest concentration measured during this study was 200 times that great (20 µg/g, at site 15).

In the Carson basin, concentrations increase in a down-river direction from Cradlebaugh Bridge to Lahontan Reservoir. Below the reservoir, the distribution of mercury is less systematic, and the concentrations are characteristically less than in sediments of either the reservoir or the river immediately above the reservoir.

The trend upstream from Lahontan Reservoir presumably is due to mill-tailings contributions along the river which progressively enrich the mercury content of bottom sediments in a downstream direction. This trend also requires minimal contributions of mercury-poor sediment from tributaries in the same reach of river. Lahontan Reservoir has been the terminal point for most of the mercury-rich sediment since impoundment began in about 1915, which helps explain why concentrations are less below the reservoir than within or above.

Observations during this study suggest that the mercury is associated more with the silt and clay fractions of the sampled bottom sediment than with the coarser material. However, this accounts only in part for the site-to-site differences in measured mercury content downstream from the mills.

In the Truckee basin, the bottom sediment of Steamboat Creek contains mercury in greater-than-background concentrations (table 1), probably as a result of ore-milling activity in Washoe Valley. The concentrations apparently decrease in a downstream direction owing to "dilution" by sediment containing only background quantities of mercury. Because the amount of sediment contributed to the Truckee River by Steamboat Creek is small compared with the quantity transported by the river itself, the above-normal mercury contributions of the creek are diluted considerably in the river. Thus, despite a total-mercury concentration of about 0.5 µg/g for bottom sediment of Steamboat Creek near its mouth (site 28), the comparable value for the Truckee River several miles downstream is only about 0.1 µg/g (site 29).

Mercury can be present in several forms of differing toxicity:

1. As the non-ionized element (dissolved, gaseous, or as the liquid metal).
2. As an ion (in solution or sorbed on particulate matter).
3. As part of a dissolved chemical complex (organic or inorganic).
4. As part of a solid chemical compound (organic or inorganic).

Because mercury associated with gold and silver ore milling in the late 1800's was initially present in the metallic, elemental state, semiquantitative analyses for elemental mercury (that is, analysis without prior oxidation-digestion or reduction of non-elemental forms) have been performed on sediment samples from several sites in the Carson and Truckee basins (samples collected in October and December 1971, respectively). Results indicate negligible or only trace amounts at all sites as follows:

Sites 3 and 8-10 on the Carson River and sites 25 and 27-30 on the Truckee River and Steamboat Creek: 0.000 μg/g.
Site 11, Carson River east of Dayton: 0.005 μg/g (in contrast to 3.3 μg/g of total mercury).
Site 12a, Carson River west of Fort Churchill: 0.02 μg/g versus 6.8 μg/g total).
Site 12b, Bucklin Ditch west of Fort Churchill: 0.009 μg/g versus 15 μg/g total).

A more detailed evaluation was made on a combined sediment sample from sites 12a and 12b (collected May 8, 1972). The analytical techniques and their probable significance are as follows:

Acidification and oxidation (digestion) followed by reduction before determination (measures total mercury content): 9.5 μg/g as Hg.
Reduction, only, before determination (may be a semiquantitative measure of the metallic plus reducible cationic mercury content): 0.000 μg/g as Hg.
No treatment before determination (a semiquantitative measure of metallic mercury content): 0.000 μg/g as Hg.
Methyl mercury determination (by J. E. Longbottom, Environmental Protection Agency, Cincinnati, Ohio): 0.002 μg/g as Hg.

These results permit the interpretation that most of the mercury in sampled bottom sediment at site 12 may be present as mercuric sulfide or as a component of one or more non-methyl organic compounds or complexes. The chemical state of mercury at depths greater than 1-3 inches is unknown.

In summary, mercury, apparently as a component of a sulfide or non-methyl organic substance, is present in concentrations that far exceed "background" levels in bottom sediment of the Carson River and other water bodies. This reservoir of mercury is of concern because of its availability to the aquatic food chain and, ultimately, to man.

Mercury content of surface waters

The mercury content of surface waters is listed in table 2 (appendix), and the sites are shown in figure 1. Among 48 unfiltered samples collected at 29 sites in the Carson and Truckee basins, the maximum concentration of total mercury[1] was 6.3 μg/l, for a sample from the Carson River near Fort Churchill (site 13) during a period of snowmelt runoff in May 1972. (The U.S. Environmental Protection Agency interim limit for drinking water is 5 μg/l of mercury.)

In the Carson basin above Lahontan Reservoir (sites 1-13), only nine of 26 values exceeded 1.0 μg/l, the higher concentrations generally being associated with higher rates of streamflow. Mercury content of unfiltered water from Lahontan Reservoir was uniformly low when sampled in June 1972 (sites 14-16). Downstream from the reservoir (sites 18-24), total mercury exceeded 1.0 μg/l in seven of nine samples, with the highest value 4.3 μg/l.

In the Truckee basin, stream waters contained uniformly small amounts of total mercury when sampled. Steamboat Creek was sampled only at low flow, however, and may contain somewhat greater concentrations during periods of high flow.

Dissolved mercury[2] was determined on samples from the Carson River at Cradlebaugh Bridge and Weeks (sites 3 and 13) during periods of above-average flow. The dissolved increment represented a significant part of the total concentration (dissolved plus particulate) in March 1972, during the first major snowmelt runoff of the season. This may reflect the flushing action of early-season runoff. The same initial flushing may also be shown by the data for Weeks in May 1972: dissolved-mercury content decreased between May 8 (soon after the start of late spring snowmelt) and May 19, even though streamflow and total mercury (dissolved plus particulate) increased somewhat during the same period.

The limited amount of dissolved-mercury data suggests that at low concentrations of dissolved plus particulate mercury (less than 1-2 μg/l), a significant part of the total can be present in dissolved form. At higher total concentrations, in contrast, most of the mercury is associated with the suspended-sediment phase.

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1. Total mercury includes all extractable forms, either dissolved or associated with suspended sediment, for a whole-water (unfiltered) sample.

2. The term "dissolved mercury" refers to all extractable forms in a filtered sample.

Filtered and unfiltered water samples collected near Fort Churchill (site 13) on May 8, 1972, have been evaluated in detail to determine the forms in which mercury was present. The analytical techniques and their probable significance are as follows:

Acidification and oxidation (digestion) followed by reduction before determination (measures total mercury content):

Unfiltered, 6.0 μg/l as Hg
Filtered, 0.8 μg/l as Hg

Reduction, only, before determination (may be a semiquantitative measure of metallic plus reducible cationic mercury content):

Unfiltered, 0.2 μg/l as Hg
Filtered, 0.2 μg/l as Hg

No treatment before determination (a semiquantitative measure of metallic mercury content):

Unfiltered, 0.0 μg/l as Hg
Filtered, 0.0 μg/l as Hg

Methyl mercury determination (by J. E. Longbottom, Environmental Protection Agency, Cincinnati, Ohio):

Unfiltered, 0.00 μg/l as Hg.

These data suggest the following distribution of mercury in the streamflow:

	μg/l in sediment-water mixture	
	Water	Suspended sediment
Total mercury	0.8	5.2
Reducible cationic mercury (semiquantitative)	.2	.0
Metallic mercury (semiquantitative)	.0	.0
Methyl mercury	.00	.00
Other forms, including non-methyl organic mercury (semiquantitative)	.6	a 5.2

a. May also include mercuric sulfide.

As with the stream-bottom sediment, this distribution implies that most of the mercury in both liquid and suspended-sediment phases of the streamflow may be present as a component of one or more non-methyl organic compounds or complexes; mercury in the suspended-sediment phase also may be present as a sulfide. The only other apparent difference between the forms of mercury in sediment and water is that a trace amount of reducible cationic mercury was detected in the liquid (dissolved) phase of the streamflow sample, but not in the suspended or bottom sediments.

Along the Carson River between Dayton and Lahontan Reservoir, where the quantity of mercury in stream-bottom sediment is well above background levels, a crude relation doubtless exists at medium and high streamflow between the mercury content of unfiltered streamwater and the rate of stream discharge. This is to be expected because the discharge rate controls the suspended-sediment carrying capability of the stream, and the sediment is mercury-rich. The relation is shown by data for 1971-72 at sites 12a and 13, near Fort Churchill. On this basis, it can be assumed that because peak discharges during 1971-72 were well below those of many recent years, the peak mercury concentrations during 1971-72 probably were less than those associated with higher flows. For example, extrapolation of data on the quantity of suspended sediment and its mercury content at site 13 suggests that total mercury might amount to as much as 10-15 μg/l or more at a discharge of 2,000 cfs, and as much as 10-20 μg/l or more at 3,000 cfs. Upstream from the Fort Churchill area, and elsewhere in the Carson and Truckee basins, the mercury content of stream-bottom sediment is less (table 1), so the maximum expectable concentrations in streamwater would also be less. This is shown by the contrasting mercury data for May 18-19, 1972, at the Cradlebaugh, Dayton, and Fort Churchill sites:

Site no.	Approximate mercury content of sampled bottom sediment (μg/g)	Estimated streamflow (cfs)	Suspended-sediment content of streamflow (mg/l)	Total-mercury concentration in streamflow (μg/l)
3	0.04	925	220	0.2
10	2	900	250 (est.)	.7
13	9	850	300	6.3

Mercury content of well waters

The mercury content of 36 well waters is listed in table 4 (appendix), and the sites are shown in figure 2 (also in appendix). All concentrations were less than the 5-μg/l limit for drinking water proposed by the U.S. Environmental Protection Agency--in fact, all were less than 1 μg/l. The low concentrations indicate that mercury is not a major problem in ground water, even adjacent to areas where stream-bottom sediment is enriched in mercury.

Other trace constituents

In addition to mercury, several other trace constituents have been determined on surface and well waters. Arsenic, selenium, and silver were measured on seven surface-water samples from the Carson River basin, and cyanide was determined on three of the samples (table 2). Concentrations were characteristically low. Only the selenium content of the river at Cradlebaugh Bridge (site 3) approached or equaled the mandatory limits established by the U.S. Public Health Service for drinking water (arsenic, 50 μg/l; cyanide, 0.2 mg/l; selenium, 10 μg/l; silver, 50 μg/l). The only trends suggested by the data are a downstream increase in arsenic content at low flow (Sept. 1971) and a downstream decrease in selenium at low and high flows.

Spectrographic analyses for 17 trace metals were made on four unfiltered samples from the Carson River upstream from Lahontan Reservoir (table 3, in appendix). Three of the samples were collected during a period of low flow in September 1971. The data show decreasing concentrations in a downstream direction for the six detected metals (aluminum, iron, manganese, molybdenum, titanium, and vanadium; the other 11 metals were below limits of detection). Because most of the trace-metal content presumably is associated with the suspended-sediment component of the samples, it is not surprising that the downstream changes correspond with diminished streamflow and a resultant decrease in suspended-sediment content.

The fourth sample was collected near Fort Churchill during the spring snowmelt runoff, on May 19, 1972. Metals present in detectable concentrations were the same as those in the low-flow samples, except for molybdenum. Concentrations were of the same order of magnitude as the largest reported low-flow values. The river contained much greater trace-metal concentrations near Fort Churchill (sites 12a and 13) in May than in September, because discharge and, therefore, metal-bearing suspended-sediment content were greater in May. Peak discharges on the Carson River were much less in 1972 than in several recent years. Presumably, the maximum trace-element concentrations also were less than in previous years, because of the relation between quantities of flow, suspended sediment, and trace metals. The largest concentrations detected during this study were: aluminum, >670 μg/l; iron, 2,500 μg/l; manganese, 1,100 μg/l; molybdenum, 15 μg/l; titanium, 110 μg/l; and vanadium, 15 μg/l.

Arsenic, selenium, and silver were determined in 16 well waters from the Carson and Truckee basins (table 4, in appendix). Concentrations of silver were uniformly low. All but one of the selenium values also were low; the one exception was 18 μg/l (almost twice the U.S. Public Health Service drinking-water limit) for the shallow well at site 45, southwest of Fallon. By far the greatest measured arsenic concentration was 1,500 μg/l (1.5 ppm), also for the well at site 45. This concentration far exceeds the Public Health Service mandatory limit of 50 μg/l, but the water from this well is too salty for drinking purposes; the owners drink bottled water instead. Several sampled well waters that are used for drinking purposes in both the lower Carson basin and Truckee Meadows also contained more than 50 μg/l of arsenic (table 4).

REFERENCE

Smith, G. H., 1943, The history of the Comstock Lode, 1850-1920: Nev. Univ. Bull., v. 37, no. 3, 305 p.

APPENDIX

Numbering System for Hydrologic Sites

The numbering system for hydrologic sites in this report (tables 2 and 4) indicates location on the basis of the rectangular subdivision of public lands, referenced to the Mount Diablo base line and meridian. Each number consists of three units: the first is the township north of the base line; the second unit, separated from the first by a slant, is the range east of the meridian; the third unit, separated from the second by a dash, designates the square-mile section. The section number is followed by letters that indicate the quarter section, quarter-quarter section, and so on; the letters a, b, c, and d designate the northeast, northwest, southwest, and southeast quarters, respectively. For example, site 17/24-35adb is in NW¼SE¼NE¼ sec. 35, T. 17 N., R. 24 E.

Table 1.--Mercury content of finer-grained sediment from stream, canal, drain, and lake bottoms

Site no.[1]	Source	Date sampled	Total mercury (μg/g as Hg)[2]	Source and characteristics of the sediment (all samples represent the top 1-3 inches of sediment)
3	Carson River at Cradlebaugh Bridge, 8 miles south of Carson City	9-22-71	0.041	About 40 percent of sample from calm area at streamside: thin organic top coating, underlain by black clay. About 60 percent from active area at midstream: coarse to fine sand.
4	Carson River at Pinon Hills crossing 3 miles southeast of Carson City	12- 1-70	.10	Off right (east) bank.
8	Carson River at new bridge, 3 miles east of Carson City	12- 1-70	.44	Off left (north) bank: sample included some organic material.
		9-22-71	.98	About 50 percent from off right (south) bank: very coarse sand to silt. About 50 percent from calm area off left bank: thin organic top coating, underlain by gray to black coarse sand and black clay.
9	Carson River at Eureka Millsite, 8 miles east of Carson City	9-22-71	1.2	About equal amounts from calm areas off each bank: thin organic top coating, underlain by 1-cm layer of black clay, underlain by gray, coarse to fine sand.
10	Carson River at Dayton	12- 1-70	2.1	Off left bank: sample included small roots and other organic material.
		9-21-71	.31	Calm area off left bank: brownish tan organic top coating, underlain by very coarse to fine sand; organic-to-inorganic ratio in this sample is greater than in any other, which may explain seemingly low mercury content.
11	Carson River 7 miles east of Dayton	12- 1-70	3.7	Off left bank.
		9-21-71	3.5	Calm area off left bank: coarse to very fine sand, with considerable fine organic material, mostly as top coating.
12a	Carson River 2 miles west of Ft. Churchill	12- 1-70	11	Off left bank.
		9-21-71	6.8	Pool immediately below Bucklin Ditch diversion. About 20 percent from off right bank: fine sand to clay. About 60 percent from mid-pool: medium sand to clay. About 20 percent from off left bank: fine sand to clay.
12b	Bucklin Ditch 2 miles west of Ft. Churchill	9-21-71	15	Fifty feet downstream from point of diversion. Bottom material at mid-ditch: dark gray to black silt and clay with sulfide odor.
12a+b	Carson River and Bucklin Ditch	5- 8-72	9.5	About 50 percent each from river and ditch: samples similar in appearance to those collected 9-21-71. Grain size: clay, 1 percent; silt, 9 percent; sand, 88 percent; and coarser material, 2 percent.
14	Lahontan Reservoir near upstream end	6-14-72	12	Bottom 10 feet below water surface: dark brown clay and silt.
15	Lahontan Reservoir near The Narrows	6-14-72	20	Bottom 49 feet below water surface: tan clay underlain by gray clay.
16	Lahontan Reservoir near dam	6-14-72	5.3	Bottom 76 feet below water surface: tan clay underlain by gray clay.
17	Truckee Canal near Lahontan Reservoir	1-26-72	.28	Canal bottom off left bank: coarse sand to clay, brown.
18	Carson River, 1 mile east of Lahontan Reservoir	1-26-72	.62	Midstream: medium to very fine sand with some finer sediment and organic material.
19	V Canal 5 miles west of Fallon	1-25-72	.43	Midcanal: fine sand to clay, brown.
20	South Branch Carson River 3 miles southwest of Fallon	1-25-72	3.0	Midstream: medium sand to silt, brown; considerable $CaCO_3$.
21	L Drain 8 miles south of Fallon	1-25-72	.34	Mid-ditch: fine sand to clay, black with sulfide odor.
22	Stillwater Slough Cutoff Drain 14 miles east-northeast of Fallon	1-25-72	4.0	About 50 percent from mid-ditch: very fine sand to clay, dark brown. About 50 percent from off banks: silt to clay, black. Considerable $CaCO_3$.
23	Outlet, Stillwater Point Reservoir, 14 miles east of Fallon	1-25-72	.05	About equal amounts from off each bank: fine sand to clay, light brown (probably bank slump rather than from reservoir). Moderate amount of $CaCO_3$.
24	Carson River 14 miles northeast of Fallon	1-25-72	.83	Midstream: coarse to fine sand, with some finer sediment and organic material; light brown; moderate amount of $CaCO_3$.
25	Truckee River at Farad, Calif.	12- 7-71	.020	About equal amounts from off each bank: thin, light brown organic top coating, underlain by medium sand to clay.
26	Ophir Creek at Highway 395 (17/19-35cca)	7-11-72	.13	At left bank: reddish brown organic co[illegible] underlain by coarse to fine sand with some finer sediment.
27	Steamboat Creek at Steamboat	12- 8-71	1.2	About equal amounts from off each bank and midstream: coarse sand to clay.
28	Steamboat Creek near mouth, upstream from Reno-Sparks S.T.P.	12- 8-71	.48	About 50 percent from midstream: medium sand to silt. About 50 percent from off banks: silt to clay, with appreciable organic material.
29	Truckee River at Lockwood, 3 miles downstream from S.T.P.	12- 7-71	.075	About equal amounts from off each bank: thin, light brown organic top coating, underlain by fine sand to clay.
30	Truckee River 4 miles south of Nixon	12- 7-71	.065	About equal amounts from off each bank: thin, light brown organic top coating, underlain by fine sand to clay.

1. Sites are listed and numbered in downstream order. See figure 1.
2. Dry-weight concentrations.

Table 2.--Mercury content and other characteristics of surface waters

Site no.[1]	Name	Location code (see text)	Date sampled	Streamflow (cubic feet per second)[2]	Water temperature °F	Water temperature °C	Specific conductance (micromhos per cm at 25°C)	Mercury (µg/l as Hg) Total[3]	Mercury (µg/l as Hg) Dissolved	Dissolved arsenic (µg/l as As)	Cyanide (mg/l as CN)	Dissolved selenium (µg/l as Se)	Dissolved silver (µg/l as Ag)
	CARSON RIVER BASIN												
1	Leviathan Creek, 15 miles southeast of Gardnerville	10/21-11bbaa	6-22-72	1e	65	18.5	1,240	0.1	--	--	--	--	--
2	Minden-Gardnerville S.T.P. effluent (pre-chlorine)	13/20-30badd	6-22-72	1e	62	16.5	511	.2	--	--	--	--	--
3	Carson River at Cradlebaugh Bridge, 8 miles south of Carson City	14/20-30caa	7-19-71	370e	69	20.5	214	.2	--	--	--	--	--
			9-22-71	50e	53	11.5	326	.3	--	0	--	10	2
			3- 9-72	700e	46	7.5		1.7	1.1	--	--	--	--
			5-18-72	925e	55	13.0	106	.2	.1	0	0.00	7	0
4	Carson River at Pinon Hills crossing, 3 miles southeast of Carson City	15/20-26acc	12- 1-70	320e	36	2.0	303	<.5	--	--	--	--	--
5	N. Kings Canyon Creek, west of Carson City	15/19-23bad	11-25-70	3-5e	39	4.0	68	<.5	--	--	--	--	--
6	Ash Canyon Creek, west of Carson City	15/19-12cdcd	11-25-70	10-15e	41	5.0	80	1.1	--	--	--	--	--
7	Stream at N. Edmonds Drive (predominantly effluent from Carson City S.T.P.)	15/20-15bdd	9-22-71	1-2e	61	16.0	580	.3	--	--	--	--	--
8	Carson River at new bridge, 3 miles east of Carson City	15/20-12bcb	12- 1-70	320e	36	2.5	327	<.5	--	--	--	--	--
			9-22-71	50e	58	14.5	538	.9	--	--	--	--	--
9	Carson River at Eureka Millsite, 8 miles east of Carson City	15/21-4bba	9-22-71	50e	61	16.0	546	.4	--	--	--	--	--
10	Carson River at Dayton	16/21-23dab	12- 1-70	330e	37	3.0	324	<.5	--	--	--	--	--
			7-19-71	320±e	74	23.5	230	.5	--	--	--	--	--
			9-21-71	20-40e	67	19.5	606	.5	--	1	--	3	3
			3- 9-72	700e	51	10.5		1.6	--	--	--	--	--
			5-19-72	900e	53	11.5	131	.7	--	--	--	--	--
11	Carson River, 7 miles east of Dayton	17/22-35dba	12- 1-70	340e	37	3.0	334	<.5	--	--	--	--	--
			9-21-71	20-30e	68	20.0	679	1.3	--	--	--	--	--
12a	Carson River, 2 miles west of Ft. Churchill	17/24-32dbc	12- 1-70	350	37	3.0	323	1.0	--	--	--	--	--
			7-19-71	281	75	24.0	321	2.4	--	--	--	--	--
			9-21-71	22	53	11.5	653	.4	--	4	--	0	1
13	Carson River at Weeks, 1 mile east of Ft. Churchill	17/24-35adb	3- 9-72	650e	53	11.5	179	4.0	1.2	--	--	--	--
			5- 8-72	725e	54	12.5	162	6.0	.8	--	--	--	--
			5-19-72	850e	56	13.5	152	6.3	.3	0	.00	0	0
14	Lahontan Reservoir near upstream end (depth, 1 foot)	17/25-12ccc	6-14-72	--	67	19.5	184	.5	--	--	--	--	--
15	Lahontan Reservoir near The Narrows	18/25-22dbc											
	(1 foot)		6-14-72	--	66	19.0	252	.2	--	--	--	--	--
	(45 feet)		6-14-72	--	60	15.5	266	.4	--	--	--	--	--
16	Lahontan Reservoir near dam	18/26-9bb											
	(1 foot)		6-14-72	--	71	21.5	242	.2	.0	10	--	0	0
	(35 feet)		6-14-72	--	63	17.0	232	.2	--	--	--	--	--
	(70 feet)		6-14-72	--	57	14.0	251	.2	.0	10	.00	2	0
17	Truckee Canal near Lahontan Reservoir	19/26-33adc	7-20-71	220e	75	24.0	204	.7	--	--	--	--	--
18	Carson River, 1 mile east of Lahontan Reservoir	19/26-34ddb	7-19-71	1,040	63	17.0	245	.4	--	--	--	--	--
			1-26-72	3.7	36	2.5	444	3.4	--	--	--	--	--
19	V Canal, 5 miles west of Fallon	19/28-29ccb	7-19-71	400e	66	19.0	245	1.6	--	--	--	--	--
20	S. Branch Carson River, 3 miles southwest of Fallon	18/28-3ddc	1-25-72	1e	41	5.0	665	3.6	--	--	--	--	--
21	L Drain, 8 miles south of Fallon	18/29-35daa	6-28-72	1e	79	26.0	4,120	.4	--	--	--	--	--
22	Stillwater Slough Cutoff Drain, 14 miles east-northeast of Fallon	20/31-32cdd	7-20-71	25e	74	23.5	1,390	1.6	--	--	--	--	--
			1-25-72	1-2e	38	3.5	7,140	4.3	--	--	--	--	--
23	Outlet, Stillwater Point Reservoir, 14 miles east of Fallon	19/31-16bab	1-25-72	4-6e	35	1.5	1,940	2.1	--	--	--	--	--
24	Carson River, 14 miles northeast of Fallon	21/30-19cd	1-25-72	3.0	33	.5	1,190	3.1	--	--	--	--	--
	TRUCKEE RIVER BASIN												
25	Truckee River at Farad, Calif.	18/17-12aac	7-27-71	645	64	17.5	81	.0	--	--	--	--	--
27	Steamboat Creek at Steamboat	18/20-33cda	7-27-71	8.3	75	24.0	264	.3	--	--	--	--	--
28	Steamboat Creek near mouth, upstream from Reno-Sparks S.T.P.	19/20-14bcd	12- 8-71	35e	32	.0	729	.6	--	--	--	--	--
29	Truckee River at Lockwood, 3 miles downstream from S.T.P.	19/21-17dda	7-27-71	500e	72	22.0	213	.2	--	--	--	--	--
30	Truckee River, 4 miles south of Nixon	22/24-18bca	7-27-71	348	81	27.0	321	.2	--	--	--	--	--
			12- 7-71	50	35	1.5	686	.3	--	--	--	--	--

1. Sites are listed and numbered in downstream order. See figure 1.
2. Estimated flows are indicated by "e." All other values are measured.
3. All stream-sample collection in 1971-72 employed standard suspended-sediment sampling techniques that provide a true indication of the average mercury content, vertically and across the stream. Sampling in late 1970 did not employ these techniques, and the results should therefore be considered semiquantitative at best.

Table 3.--Spectrographic trace-metal analyses of unfiltered water from Carson River

[Results are for extracted-metal content, in micrograms per liter]

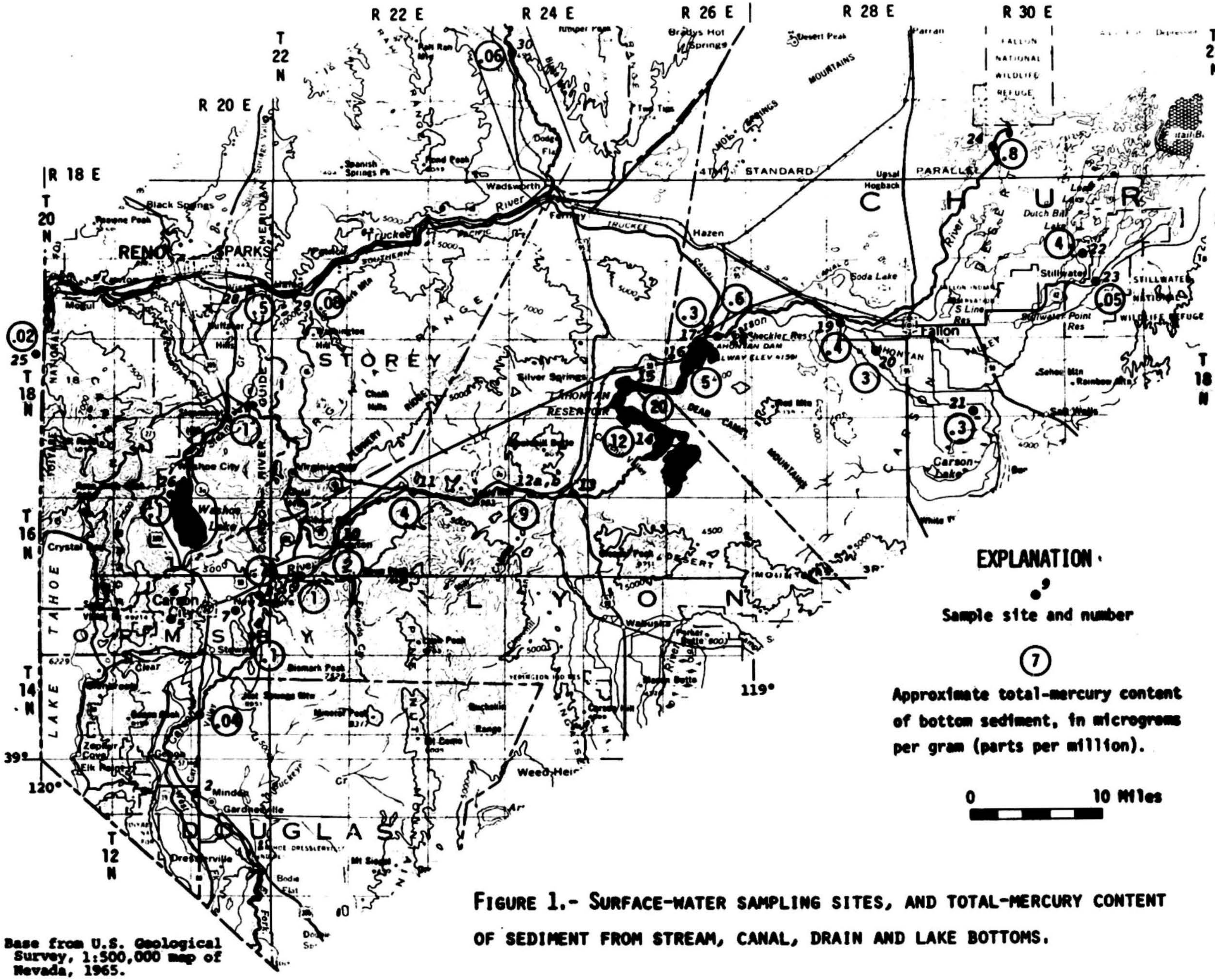
	Site number (see fig. 1)			
	3	10	12	13
Date	9-22-71	9-22-71	9-21-71	5-19-72
Streamflow (cubic feet per second)1/	50e	20-40e	22	850e
Aluminum (Al)	>670	330	43	500
Beryllium (Be)	<1.3	<1.3	<1.3	<1.0
Bismuth (Bi)	<.7	<.7	<.7	<.5
Cadmium (Cd)	<3.3	<3.3	<3.3	<2.5
Chromium (Cr)	<3.3	<3.3	<3.3	<2.5
Cobalt (Co)	<3.3	<3.3	<3.3	<2.5
Copper (Cu)	<3.3	<3.3	<3.3	<2.5
Gallium (Ga)	<13	<13	<13	<10
Germanium (Ge)	<.7	<.7	<.7	<.5
Iron (Fe)	1,800	310	65	2,500
Lead (Pb)	<3.3	<3.3	<3.3	<2.5
Manganese (Mn)	1,100	280	47	750
Molybdenum (Mo)	15	13	<.3	<.5
Nickel (Ni)	<.7	<.7	<.3	4.0
Titanium (Ti)	110	15	<1.3	110
Vanadium (V)	11	8.0	1.5	15
Zinc (Zn)	<13	<13	<13	<10

1. Estimated flows are indicated by "e." Quantity at site 12 was measured.

Table 4.--Mercury content and other characteristics of well waters

Site no. (see fig. 2)	Owner	Location code (see text)	Well depth (feet)	Use 1/	Date sampled	Water temperature °F	Water temperature °C	Specific conductance (micromhos per cm at 25°C)	Dissolved mercury (µg/l as Hg)	Dissolved arsenic (µg/l as As)	Dissolved selenium (µg/l as Se)	Dissolved silver (µg/l as Ag)
		CARSON CITY AND GARDNERVILLE										
31	Gardnerville Town Water Co. (well 3)	12/20-4baaa	343	P	6-22-72	53	11.5	456	0.1	0	0	0
32	Carson City Water Dept. (well 3)	15/19-12da	470	P	7-11-72	53	11.5	164	.0	0	0	0
33	Carson City Water Dept. (well 4)	[illegible]/20-17dd	604	P	7-11-72			197	.0	19	0	0
		DAYTON - FORT CHURCHILL AREA										
34	Ray Walmsley	16/21-23dbba	71	D	6-21-72	--	--	572	.9	--	--	--
35	Anchor Trailer Court	-26bcba	108	P	6-23-72	59	15.0	1,390	.1	--	--	--
36	Norman Allen	-26bdac	102	D	6-23-72	60	15.5	1,370	.3	0	0	0
37	Dayton Valley Water Users Association	16/22-4dbcc	260	P	6-21-72	--	--	1,120	.7	--	--	--
38	Litton Engineering Laboratories	-6cddd	120	D	6-21-72	91	33.0	1,280	.5	--	--	--
39	Sagebrush "Ranch"	17/22-30ddb	177	P	6-28-72	--	--	1,040	.0	--	--	--
40	Joe Chaves	-34accd	35±	D	6-23-72	--	--	962	.0	--	--	--
41	Hodges Transportation, Inc.	17/23-36baab	68	D	6-23-72	63	17.0	788	.1	--	--	--
42	Ft. Churchill State Park	17/24-35cbbc	209	P	6-26-72	--	--	887	.0	14	1	0
43	Nicholas Cipriano	17/25-20dab	192	D	6-26-72	--	--	254	.0	--	--	--
44	Lahontan State Recreation Area	18/25-33aac	120	P	6-26-72	64	18.0	278	.0	--	--	--
		FALLON AREA										
45	Steve Hancock	17/28-2daad	20	DS	6-28-72	--	--	5,140	.1	1,500	18	0
46	J. W. Baker	18/28-2daad	27	D	6-28-72	--	--	335	.0	--	--	--
47	Norval Moore	-5badd	32	D	6-29-72	--	--	408	.0	--	--	--
48	Roy Risi	18/29-12cbbd	20±	DS	7- 5-72	--	--	597	.1	--	--	--
49	James Thomas	-19aaab	25±	D	7- 5-72	--	--	812	.0	--	--	--
50	Nevada Cattle Feeding Co.	-27dcbb	149	D	7- 5-72	--	--	1,860	.0	110	0	0
51	George Frey	19/27-22bca	27±	S	6-29-72	58	14.5	484	.0	3	2	0
52	Frank McCueskey	19/28-20ada	23	D	6-29-72	63	17.0	942	.0	--	--	--
53	James W. York Meat Co.	-27badc	37	CD	6-29-72			1,320	.0	--	--	--
54	Schiela Williams	19/29-8cbc	20-30	D	6-29-72	59	15.0	2,260	.0	--	--	--
55	Fallon Water Co. (well 3)	-30cba	484	P	6-29-72	69	20.5	838	.0	74	0	0
56	U.S. Navy (well 2)	-33cbb	530	P	6-28-72	68	20.0	967	.1	77	0	1
57	Donald Weishaupt	19/30-11addd	250±	D	6-29-72	--	--	7,070	.0	--	--	--
58	W. L. Nygren	-19aab	15±	D	6-29-72	67	19.5	2,060	.0	--	--	--
59	Lyle de Braga	-24bbb	568	S	7- 5-72	77	25.0	7,140	.1	--	--	--
60	John Perazzo	-30bcbd	20±	D	6-29-72	65	18.5	575	.0	--	--	--
61	John Bell	19/31-7dcbd	204	DH	7- 5-72	205	96.0	7,100	.2	40	0	0
62	Unknown ("Timber Lake" well)	21/30-30acac	985	SW	6-26-72	62	16.5	2,930	.1	2	--	0
		TRUCKEE MEADOWS										
63	Trans Sierra Water Co. (well 2)	18/20-27bcb	188	P	7-11-72	65	18.5	1,120	.0	89	0	0
64	Sierra Pacific Power Co. (High St. well)	19/19-12bcd	530	P	6-20-72	63	17.0	405	.9	--	0	0
65	Nevada Lakeshore Co.	-24cba	1,006	P	6-20-72	130	54.5	965	.5	95	4	0
66	Hidden Valley Water Division	19/20-21bcb	346	P	6-20-72	59	15.0	346	.1	74	1	0

1. Uses are abbreviated as follows: commercial, C; domestic, D; home heating, H; public supply, P; stock, S; wildfowl, W.



EXPLANATION

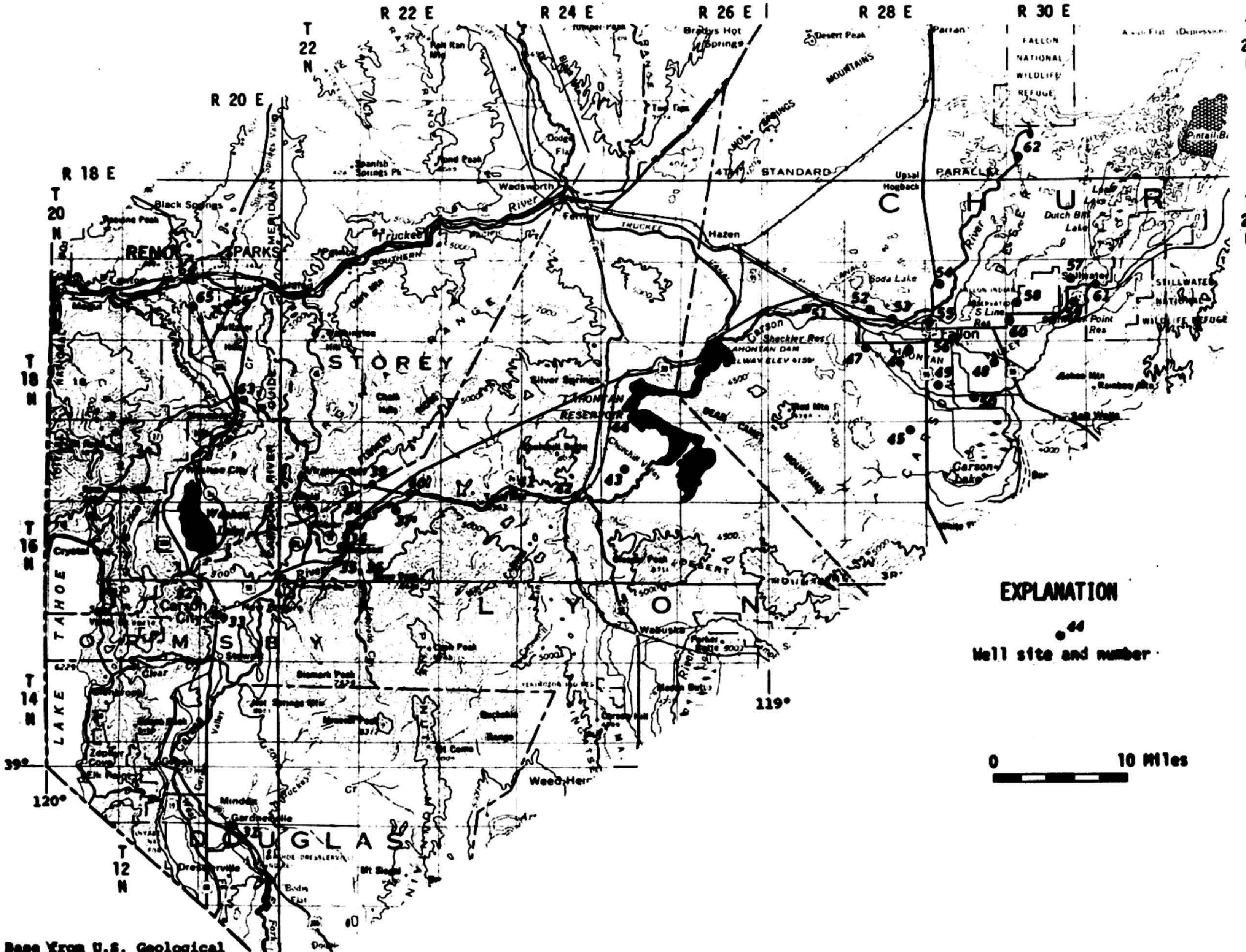
•⁹ Sample site and number

⑦ Approximate total-mercury content of bottom sediment, in micrograms per gram (parts per million).

0 — 10 Miles

FIGURE 1.- SURFACE-WATER SAMPLING SITES, AND TOTAL-MERCURY CONTENT OF SEDIMENT FROM STREAM, CANAL, DRAIN AND LAKE BOTTOMS.

Base from U.S. Geological Survey, 1:500,000 map of Nevada, 1965.



Base from U.S. Geological Survey, 1:500,000 map of Nevada, 1965.

FIGURE 2.- WELL-WATER SAMPLING SITES.