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GEOLOGICAL SURVEY

Analyses of bottom material collected at nine areas in the western United States for the DOI irrigation drainage task group

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This report is preliminary and has not been reviewed for conformity with the U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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INTRODUCTION

The Department of Interior (DOI), has formed a multi-agency task group on irrigation drainage in response to Congressional requests to examine the potential for damage to lands affected by DOI irrigation projects. As a result the task group is conducting field-screening studies at nine areas in the western United States (fig. 1). The objective of the field-screening studies is to determine whether or not irrigation practices have potential to cause or are responsible for harmful effects on human health, fish and wildlife, or other water users. Brief descriptions of the nine study areas are as follows:

Tulare Lake, California: The study area includes about 5,000 square miles in the southern end of the San Joaquin Valley. The Kern and Pixley National Wildlife Refuges (NWR) are included in the study area.

Salton Sea, California: The study area encompasses about 8,300 square miles of the Imperial and Coachella Valleys in southeastern California. This study area includes the Salton Sea NWR.

Sun River, Montana: The study area is located within Teton and Cascade counties of west-central Montana and includes three separate units: the Fairfield Bench irrigation project along the Sun River; Freezout Lake Game Management Area, a state waterfowl refuge; and Benton Lake NWR.

Milk River, Montana: The study area is located in north-central Montana and includes the Bowdoin NWR and the area encompassed by the Milk River irrigation project.

Laguna Atascosa NWR, Texas: The portion of the Lower Rio Grande River Valley from Falcon Dam to Laguna Madre on the Gulf of Mexico is included in the study area. The Laguna Atascosa NWR is located on the east edge of the valley and adjacent to Laguna Madre.

Kendrick, Wyoming: The study area includes about 700 square miles of Natrona county in central Wyoming. This consists of the Platte River Valley and its terraces from the Alcova Reservoir to the city of Casper. The Kendrick Irrigation Project serves about 24,000 acres.

Stillwater Wildlife Management Area (WMA), Nevada: The study area is located within Churchill county within the Lower Carson River Basin. The area contains about 350 square miles, including the Stillwater NWR and the Stillwater WMA.

Middle Green River, Utah: The study area is located about 12 miles south of Vernal, Utah and adjacent to the Green River. It includes the Jensen Unit of the Central Utah Irrigation Project and Stewart Lake, a state managed wildlife area.

Lower Colorado River, Arizona: The study area includes parts of the Colorado River Valley from Davis Dam to below Laguna Dam, and parts of the Gila River Valley from the confluence of the Salt and Gila Rivers to the Colorado River. These areas are included in Yuma, Maricopa, and Mohave counties in Arizona; and Imperial, Riverside, and San Bernardino counties in California. The Havasu NWR, Cibola NWR, and Imperial NWR are included within the study area.

The field-screening studies are being conducted by personnel from DOI, U.S. Geological Survey, Bureau of Reclamation, and Fish and Wildlife Service, plus other Federal and State agencies as appropriate. The media being sampled consists of water, bottom materials, plant tissue, and animal tissue. This report refers only to the analyses of the minus-230-mesh (0.063-mm) fraction from bottom materials. Bottom materials refers to the uppermost 5 to 10 cm of material obtained from the sediments deposited in streams, rivers, marshes, ponds, lakes, and drainage ditches.

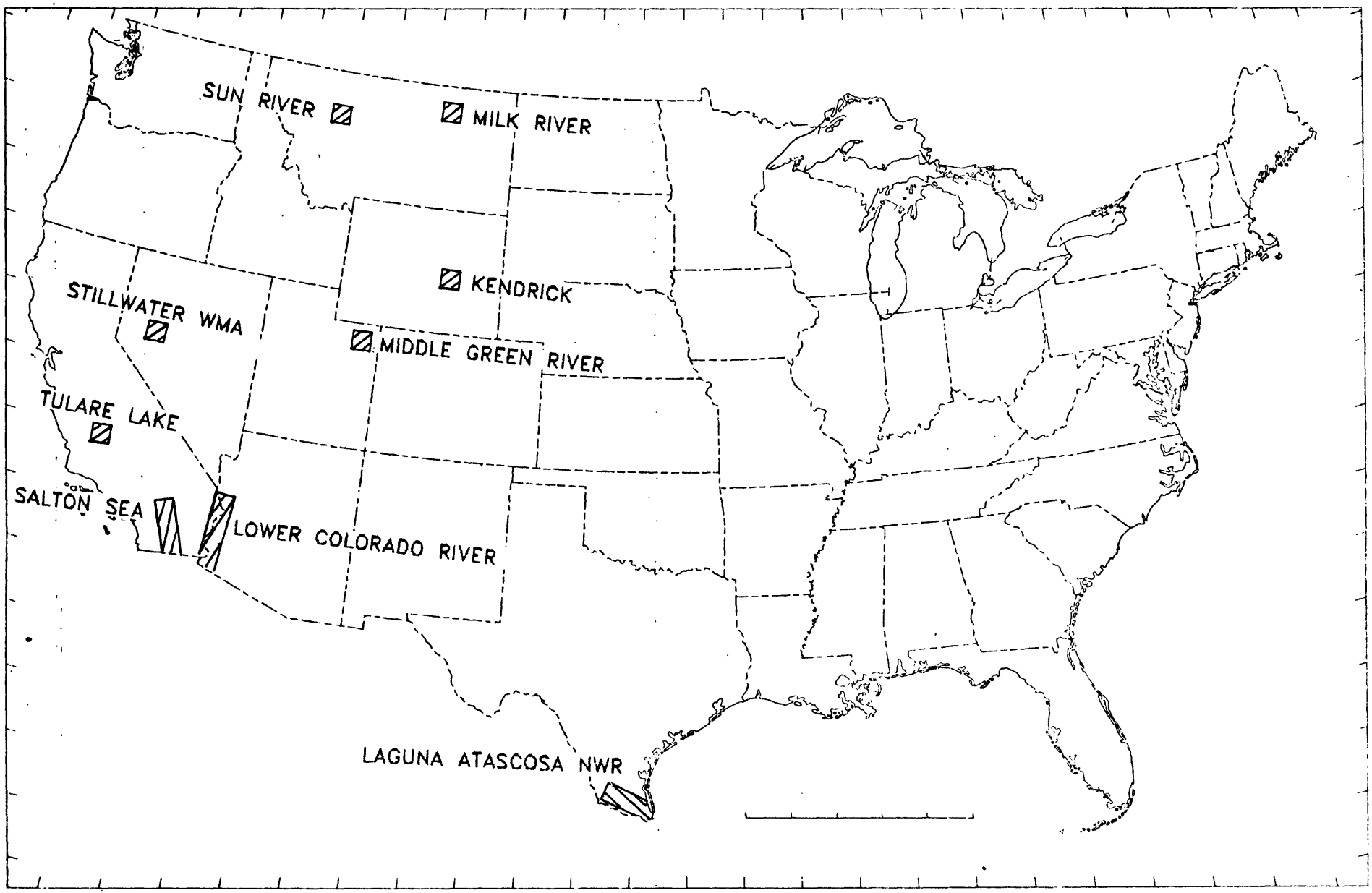

Figure 1. Map showing the general locations of the nine western United States field-screening project areas.

FIELD SAMPLING

Bottom materials were collected from the nine study areas (fig. 1) between May and September of 1986 and in March of 1987. The majority of the samples were collected by on-site team members from Water Resources Division of the U.S. Geological Survey, however, the Geologic Division representative visited seven of the nine sites and assisted in field collections of bottom materials at these sites. The locations to be sampled were selected by the on-site team members. At all sampling locations, sediment collection consisted of the uppermost 5 to 10 cm of material available. Samples from Salton Sea and Tulare Lake study areas were sieved in the field using stainless steel or nylon mesh sieves and native water, while all other samples were sieved in the laboratory after air drying and mechanical disaggregation.

SAMPLE PREPARATION

Samples were mailed to the Geologic Division Analytical Laboratories of the U.S. Geological Survey in Denver in a wet state. Bulk unsieved samples of bottom material were also obtained from all locations sampled. Samples from locations, where the material was field sieved, consisted of a slurry of sediment and water. All samples, whether they represented bulk or sieved material, were air dried at ambient temperature. The dry field-sieved samples were disaggregated and received no further preparation before analyses. The bulk samples, where no field sieved sample was collected, were treated in a different way. If only a bulk sample was collected, the bulk sample was disaggregated and the minus-10-mesh (2-mm) material was saved. The minus-10-mesh material was dry sieved through a 230-mesh sieve and the material passing the sieve was saved for analyses.

ANALYTICAL TECHNIQUES

The following discussion of analytical techniques provides an overview of the methods used in this study. In addition to the references cited under each method, details for all methods are given in Baedecker (in press).

Induction-Coupled Plasma Spectroscopy

Samples were analyzed simultaneously for 30 elements (table 1) using induction coupled plasma (ICP). Each sample (0.200 g) was totally dissolved using a low-temperature digestion with concentrated hydrochloric, hydrofluoric, nitric, and perchloric acids (Crock and others, 1983). The acidic sample solution was taken to dryness and the residue was dissolved with 1 ml of aqua regia and then diluted to 10 g. Reagent blanks, reference materials, and sample replicates were all digested by the same procedure and analyzed at the same time as the samples. The limits of determination are shown in table 1. The relative standard deviation (RSD) for replicate determinations of most elements is about 5 percent.

Cold-Vapor Atomic Absorption Spectroscopy

Cold vapor atomic absorption spectroscopy was used to determine mercury (Kennedy and Crock, 1987). A 0.1-g sample was digested with nitric acid and sodium dichromate and then mixed with hydroxylamine hydrochloride and stannous chloride to produce a vapor of elemental mercury. The mercury was determined

with a flameless atomic absorption spectrometer. The determination limit is given in table 1. The RSD for the method is about 10 percent.

Delayed-Neutron Activation Analysis

Uranium and thorium were determined by delayed neutron activation analysis (DNAA) using a 10-g sample (Millard, 1976). After activation of the sample with thermal neutrons, the delayed neutrons from U-235 were measured and the sample was re-irradiated with fast neutrons; the delayed neutrons from U-235, U-238, and Th-232 were measured. Using the natural U-238/U-235 isotopic ratio and the two delayed neutron measurements, thorium was calculated by difference. For concentrations of at least 1 and 10 ppm uranium and thorium, respectively, and a Th/U ratio greater than 3, the RSD for the uranium determination is about 5 percent. The determination limit for uranium and thorium is given in table 1.

Continuous-Flow Hydride Generation

Arsenic and selenium were determined by continuous flow hydride generation and atomic absorption spectroscopy (Briggs and Crock, 1986; Crock and Lichte, 1982). One gram of sample was digested with nitric, perchloric, sulfuric, and hydrofluoric acids. After digestion, the sample was diluted to 100 ml with 10% HCl. The sample solution was reacted with sodium borohydride in order to generate the gaseous hydrides which were swept into the heated quartz furnace of an atomic absorption spectrometer. Arsenic was determined using a calibration curve and selenium was determined using the method of standard additions. Determination limits for arsenic and selenium are shown in table 1. The RSD for the determination of both elements was about 10 percent.

Hot-Water Extractable

Boron was determined by a hot-water extraction (Crock and Severson, 1980). A 10-g aliquot of soil was placed in a 50-mL polyethylene centrifuge tube. Each sample was then wetted with 20 mL of deionized water, capped, and shaken to wet the entire sample. The tubes were placed in a boiling water bath for approximately 1 hour. After the extraction was complete, the samples were centrifuged at 1,500 rpm to separate the sample from the solution. The supernatant solution was acidified with 1 mL of concentrated nitric acid and lutetium internal standard added. The solution was analyzed for boron on a Jarrell Ash model 1160 simultaneous ICAP instrument. The precision (RSD) was about 7% for the samples and standards tested. The determination limit for the method was 0.4 ppm in the solid sample.

PRESENTATION OF RESULTS

Information on the analytical methods used and the limits of determination for each method and each element are presented in table 1. Table 2 gives a listing of the sampling locations, sample description, and the field identifier which corresponds to the data tabulation (table 3) for each of the 31 elements. Silver and cadmium results are not listed in table 3. For silver and cadmium, all the reported values were below the limit of determination.

A summary of the results from several background environmental geochemical studies are presented in table 4, along with a summary of the data from the present study. In the present study, samples of bottom sediment were collected and the minus-0.063-mm fraction analyzed. The validity of the soil baselines for use in making comparisons to the bottom material data is questionable. However, it can be rationalized that such comparisons are marginally acceptable because bottom sediments are derived from soils, and the climate, geology, and soils of areas adjacent to those for which the baselines were developed are reasonably similar. Geometric means for the present study are not included in table 4 because such an "average" value based on all study areas would be misleading because the study areas are located over a large geographic region with differing geology, climate, and soil. Instead, the observed range is presented. The minimum and maximum values provide an indication as to whether or not some samples from the nine study areas contain extreme values in their element content relative to existing background data. In order to determine where these extreme samples are located, it is necessary to refer to table 3.

REFERENCES CITED

Baedecker, P. A., in press, Methods for geochemical analyses: U.S. Geological Survey Bulletin 1790.

Briggs, P. H., and Crock, J. G., 1986, Automated determination of total selenium in rocks, soils, and plants: U.S. Geological Survey Open-File Report 86-40, 20 p.

Crock, J. G., and Lichte, F. E., 1982, An improved method for the determination of trace levels of arsenic and antimony in geologic materials by automated hydride generation-atomic absorption spectroscopy: Analytica Chimica Acta, v. 144, p. 223-233.

Crock, J. G., Lichte, F. E., and Briggs, P. E., 1983, Determination of elements in National Bureau of Standards Geologic Reference Materials SRM 278 obsidian and SRM 688 basalt by inductively coupled argon plasma-atomic emission spectrometry: Geostandards Newsletter, v. 7, p. 335-340.

Crock, J. G., and Severson, R. C., 1980, Four reference soil and rock samples for measuring element availability in the western energy regions: U.S. Geological Survey Circular 841, 16 p.

Ebens, R. J. and Shacklette, H. T., 1982, Geochemistry of some rocks, mine spoils, stream sediments, soils, plants, and waters in the western energy region of the conterminous United States: U.S. Geological Survey Professional Paper 1237, 173 p.

Kennedy, K. R., and Crock, J. G., 1987, Determination of mercury in geologic materials by continuous-flow, cold-vapor, atomic absorption spectrometry: Analytical Letters, v. 20, p. 899-908.

Millard, H. T., Jr., 1976, Determination of uranium and thorium in U.S.G.S. standard rocks by the delayed neutron technique, in Flanagan, F. J., ed., Descriptions and analyses of eight new USGS rock standards: U.S. Geological Survey Professional Paper 840, p. 61-70.

Severson, R. C., and Tidball, R. R., 1979, Spatial variation in total element concentration in soil within the northern Great Plains coal region: U.S. Geological Survey Professional Paper 1134-A, 18 p.

Severson, R. C., Paveglio, F., Hatfield, D. B., and Briggs, P., 1987a, Analytical results of soil sampling by two filed methods--A comparison: U.S. Geological Survey Open-File Report 84-354, 14 p.

Severson, R. C., Tidball, R. R., and Wilson, S. A., 1987b, Chemical composition of soils in the composition of soils in the western San Joaquin Valley, California, p. 75-87, in Summers, J. B., ed., Toxic substances in agricultural water supply and drainage: U.S. Committee on Irrigation and Drainage, Denver, CO, 358 p.

Shacklette, H. T. and Boerngen, J. G., 1984, Element concentrations in soils and other surficial materials of the conterminous United States: U.S. Geological Survey Professional Paper 1270, 105 p.

Tidball, R. R., Severson, R. C., Gent, C. A., and Riddle, G. O., in press, Distribution patterns for element associations in soils of the San Joaquin Valley, California, in Selenium in irrigated agriculture: American Society of Agronomy Special Publication.

Table 1.--Listing of approximate determination limits for elements determined.

Analytical method	Determination limit	Elements
Continuous flow hydride generation	0.1 ppm	As, Se
Cold vapor atomic absorption spectroscopy	0.02 ppm	Hg
Delayed neutron activation analysis	0.2 ppm	U
	2.0 ppm	Th
Induction coupled plasma	2.0 ppm	Ag, Cd, La, Li, Mo, Ni, Sc, Sr, V, Y
	0.05 %	Al, Ca, Fe, K, Mg, Na, P, Ti
	1.0 ppm	Ba, Be, Co, Cr, Cu, Yb
	4.0 ppm	Ce, Ga, Mn, Nd, Pb, Zn
Hot-water extractable	0.4 ppm	B

TABLE 2--Listing of laboratory sample codes (Field ID) and their corresponding locations by study area

[First two characters in the Field ID identify the study area; the second two digits identify sample sequence; the fifth digit, S, represents sieved samples; the next two digits indicate the year the sample was collected; the final digits, when present, indicate splits of the same sample]

Field ID	Sample name and description	Latitude	Longitude
	Tulare Lake, California (Roy Schroeder)		
TL01S86	Poso Creek	35-43-05	119-34-37
TL02S86	Kern #2	35-44-35	119-34-36
TL03S86	Goose Lake Canal	35-42-51	119-37-31
TL04S86	West Farmers Pond 3B	35-43-20	119-43-40
TL05S86	Deer Creek	35-54-28	119-23-49
TL06S86	Kern #1	35-43-07	119-35-14
TL07S86	West Farmers Pond 1	35-42-20	119-42-50
TL08S86	West Farmers Pond Sump	35-43-00	119-43-30
TL09S86	West Farmers Pond 3A	35-43-20	119-43-20
	Salton Sea, California (Jim Setmire)		
SS01S86	Alamo River Delta	33-12-03	115-36-07
SS02S86	Whitewater River above Hwy 111	33-42-38	116-16-36
SS03S86	Whitewater River at Outlet	33-31-29	116-04-38
SS04S86	Avenue 64 Evacuation Channel	33-35-03	116-07-05
SS05S86	Alamo River at Intl. Boundary	32-40-32	115-22-06
SS06S86	Alamo River at Imperial WMA	33-02-40	115-29-15
SS07S86	Alamo River at Outlet	33-12-03	115-36-07
SS08S86	Trifolium #1 Drain	33-04-59	115-43-01
SS09S86	Trifolium #4 Drain	33-04-29	115-36-47
SS10S86	Vail #4A Drain	33-10-09	115-36-47
SS11S86	T-Drain	33-14-31	115-34-40
SS12S86	East Highline Canal	32-41-52	115-16-55
SS13S86	Salton Sea Composite	33-12-00	115-42-00
SS14S86	New River at Outlet	33-06-38	115-41-00
SS15S861	New River at Mid-point,July 11	32-52-36	115-37-13
SS15S862	New River at Mid-point,July 14	32-52-36	115-37-13
SS16S86	New River at Intl. Boundary	32-39-57	115-30-08
	Sun River, Montana (Roger Knapton)		
SR01S86	Benton Lake (pool 6) site 31	47-38-55	111-18-40
SR02S86	Benton Lake (pool 5) site 30	47-39-10	111-18-00
SR03S86	Benton Lake (pool 2) site 26	47-41-10	111-21-20
SR04S86	Benton Lake (pool 3) site 27	47-40-45	111-20-00
SR05S86	Benton Lake (pool 4) site 28	47-40-10	111-20-25
SR06S86	Benton Lake seep site 24	47-39-17	111-21-00
SR07S861	Benton Lake seep site 25	47-39-08	111-19-45

TABLE 2--Listing of laboratory sample codes (Field ID) and their corresponding locations by study area (continued)

[First two characters in the Field ID identify the study area; the second two digits identify sample sequence; the fifth digit, S, represents sieved samples; the next two digits indicate the year the sample was collected; the final digits, when present, indicate splits of the same sample]

Field ID	Sample name and description	Latitude	Longitude
	Sun River, Montana (Roger Knapton)		
SR07S862	Benton Lake seep site 25	47-39-08	111-19-45
SR08S86	Lake Creek at Mouth site 22	47-41-35	111-22-15
SR09S86	Muddy Creek at Power water supply site 4	47-42-47	111-43-22
SR10S86	Muddy Ck. at Vaughn site 7	47-33-42	111-32-33
SR11S86	Pond No. 1 site 21	47-42-40	112-03-00
SR12S86	Priest Butte Lake site 20	47-44-50	112-07-00
SR13S86	Freezeout Lake site 19	47-38-25	112-01-30
SR14S86	Sun Riv. below Ft. Shaw site 9	47-32-08	111-43-00
	Milk River, Montana (John Lambing)		
MR01S86	Lake Bowdoin site 7	48-23-35	107-42-35
MR02S861	Lake Bowdoin site 8	48-25-37	107-40-53
MR02S862	Lake Bowdoin site 8	48-25-37	107-40-53
MR03S86	Lake Bowdoin site 9	48-24-30	107-40-40
MR04S86	Drumbo Unit site 12	48-22-20	107-40-15
MR05S86	Dry Lake Unit site 11	48-24-30	107-35-00
MR06S86	Lakeside Unit site 10	48-25-35	107-39-15
	Laguna Atascosa NWR, Texas (Frank Wells)		
LA01S86	Pelican Lk. at Lag. Atas. NWR	26-12-37	097-19-50
LA02S86	Laguna Atas. at Lag. Atas. NWR	26-14-10	097-23-12
LA03S86	Cayo Atascosa at Hwy 106 near Rio Hondo	26-11-43	097-24-03
LA04S86	Resaca de Los Cuates at Hwy 77 at Russelltown	26-04-35	097-34-30
LA05S86	Resaca de Los Cuates at Hwy 106 near Rio Hondo	26-11-30	097-21-48
LA06S86	Arroyo Colo. above Rio Hondo	26-11-41	097-36-05
LA07S86	Laguna Madre Estuary nr mouth of Harlingen Ship Canal	26-21-12	097-19-44
LA08S86	Cayo Atas. at Crossing No. 2	26-19-38	097-23-20
LA09S86	Athel Pond at Lag. Atas. NWR	26-13-26	097-21-58
LA10S86	Falcon Res. nr Falcon Heights	26-33-37	099-10-01
LA11S86	Rio Grande above Anzalduas Dam	26-08-20	098-20-06
LA12S86	Main Floodway (Llano Grande Lk) near Progresso	26-07-10	097-57-39

TABLE 2--Listing of laboratory sample codes (Field ID) and their corresponding locations by study area (continued)

[First two characters in the Field ID identify the study area; the second two digits identify sample sequence; the fifth digit, S, represents sieved samples; the next two digits indicate the year the sample was collected; the final digits, when present, indicate splits of the same sample]

Field ID	Sample name and description	Latitude	Longitude
	Laguna Atascosa NWR, Texas (Frank Wells)		
LA13S86	Cayo Atascosa at Crossing No. 1	26-16-00	097-23-37
LA14S86	Resaca de Los Fresnos at Hwy 77 at San Benito	26-07-50	097-38-33
LA15S86	Arroyo Colo. nr Mouth of Old Channel	26-20-36	097-26-08
	Kendrick, Wyoming (Dave Peterson)		
KW01S86	North Platte Riv. nr Alcova	42-34-27	106-41-31
KW02S86	Bates Creek at mouth	42-40-34	106-36-09
KW03S86	Poison Spring Ck. at mouth	42-42-55	106-34-43
KW04S86	Rasmus Lee Lake	42-44-35	106-37-03
KW05S86	Poison Spider Ck. at Mouth	42-46-44	106-31-46
KW06S86	Oregon Trail Drain at Mouth	42-49-41	106-24-51
KW07S86	North Platte Riv. at Casper Water Intake	42-50-31	106-21-33
KW08S86	Casper Ck at mouth at North Platte River	42-40-52	106-21-52
KW09S86	No. Platte Riv. below Casper	42-51-40	106-12-53
	Stillwater WMA, Nevada (Ray Hoffman)		
SN01S86	Washoe Lake nr Carson City, NV	39-14-48	119-47-22
SN02S86	Carson Valley-Williams Slough	39-00-46	119-48-17
SN03S87	Carson Lk. drain abv Carson Lk.	39-20-38	118-44-37
SN04S87	Carson Lake Spring Pond Unit	39-19-51	118-44-50
SN05S87	So. Lead Lake near Stillwater	39-36-43	118-31-05
SN06S87	Lead Lake at Millens Landing	39-36-54	118-31-55
SN07S87	Paiute Drain below TJ Drain	39-36-38	118-33-04
SN08S87	Paiute Dr. at Wildlife Entrance	39-36-33	118-33-19
SN09S87	TJ Drain at Wildlife Entrance	39-36-32	118-33-14
SN10S87	Carson Lake Island Unit	38-21-08	118-41-35
SN11S87	Stillwater Reservor, So. End	39-29-50	118-31-52
SN12S87	Stillwater Point Reservoir No.	39-31-54	118-28-54
SN13S87	Carson Lake Big Water Unit	39-17-43	118-42-42
SN14S87	Carson Riv. below Lahonton Res.	39-27-50	119-02-45
SN15S87	Stillwater Slough at Stillwater	39-31-17	118-32-47
SN16S87	Stillwater Pt. Diversion Drain	39-29-29	118-32-22
SN17S87	Sheckler Reservoir at Outlet	38-25-44	118-54-21

TABLE 2--Listing of laboratory sample codes (Field ID) and their corresponding locations by study area (continued)

[First two characters in the Field ID identify the study area; the second two digits identify sample sequence; the fifth digit, S, represents sieved samples; the next two digits indicate the year the sample was collected; the final digits, when present, indicate splits of the same sample]

Field ID	Sample name and description	Latitude	Longitude
	Middle Green River, Utah (Doyle Stephens)		
GR01S86	J1 Drain	40-21-36	109-20-41
GR02S86	J2 Drain	40-41-46	109-22-03
GR03S86	J3 Drain	40-21-34	109-22-10
GR04S86	J4 Drain	40-21-20	109-22-19
GR04S86	J4 Drain	40-21-20	109-22-19
GR05S86	Ashley Creek	40-22-29	109-24-27
GR06S86	Marsh 4720	40-20-01	109-22-57
GR07S86	Stewart Outlet	40-20-46	109-21-45
	Lower Colorado River, Arizona (Dean Radke)		
LC01S86	Colo. Riv. near Topock, AZ	34-41-15	114-27-43
LC02S86	Colo. Riv. below Parker Dam	34-17-44	114-08-22
LC03S86	Bill Williams Riv. nr Planet	34-15-43	114-01-40
LC04S86	CRIR Lower Main Drain nr Parker	33-45-40	114-29-05
LC05S86	Topock Ms inlet nr Needles 1600	34-50-10	114-35-03
LC06S86	Topock Ms inlet nr Needles 1645	34-50-10	114-35-03
LC07S86	Topock Ms inlet nr Needles 1730	34-50-10	114-35-03
LC08S86	Colo. Riv. below Davis Dam	35-11-30	114-34-17
LC09S86	Colo. Riv. above Imperial Dam	32-53-01	114-28-00
LC10S86	Palo Verde Outfall Drain	33-21-41	114-43-20
LC11S86	Colo. Riv. below Cibola Valley (Draper Lake)	33-13-16	114-40-18
LC12S86	Colo. Riv. above Outfall Drain (Palo Verde Oxbow Lake)	33-43-55	114-30-40

Table 3.--Listing of sample identification and results of analysis.

[Values followed by an "L" indicate less than the limit of deterination; Values followed by a "B" incicate that the sample was not analyzed.]

Sample	Al, %	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm
1 TL01S861	8.5	10	2.8	590	1.0	2.9	70	16	69	31
2 TL02S861	7.5	3.9	8.2	600	1.0	2.5	56	11	62	22
3 TL03S861	7.8	6.2	2.1	650	1.0	2.1	67	10	58	22
4 TL04S861	7.0	8.3	160	500	1.0	1.4	42	14	120	37
5 TL05S861	9.0	3.5	1.5	720	1.0	2.7	64	17	69	37
6 TL06S861	8.3	15	4.7	610	2.0	2.9	79	12	46	29
7 TL07S861	6.7	5.2	110	440	1.0	4.0	41	13	120	37
8 TL08S861	7.4	6.7	140	520	1.0	1.4	42	16	130	45
9 TL09S861	6.9	8.2	210	470	1.0	1.5	41	14	120	37
10 SS01S861	6.0	5.5	2.9	510	1.0	6.2	61	10	54	24
11 SS02S861	7.9	2.4	.8	690	2.0	3.7	210	19	81	34
12 SS03S861	7.8	5.0	.00B	710	2.0	6.4	100	28	210	64
13 SS04S861	8.2	4.4	1.8	620	2.0	5.4	110	22	75	61
14 SS05S861	6.5	6.3	2.6	510	1.0	5.1	70	11	58	26
15 SS06S861	6.0	5.6	2.0	550	1.0	5.3	64	9.0	53	25
16 SS07S861	7.1	6.3	2.1	520	2.0	5.5	68	12	62	30
17 SS08S861	6.2	5.8	3.2	550	1.0	6.5	63	10	53	28
18 SS09S861	5.7	5.6	2.4	590	1.0	5.2	75	10	56	21
19 SS10S861	6.2	7.2	1.7	500	1.0	6.0	62	11	53	30
20 SS11S861	6.9	7.6	19	550	2.0	6.5	69	11	57	37
21 SS12S861	5.0	4.5	1.1	690	1.0	4.9	87	8.0	50	23
22 SS13S861	5.9	8.8	15	480	1.0	6.6	59	10	52	26
23 SS14S861	5.6	4.7	2.3	720	1.0	4.7	100	11	70	23
24 SS15S861	6.3	5.4	6.0	580	1.0	5.1	77	10	63	30
25 SS15S862	7.0	11	5.8	780	2.0	5.5	92	14	73	27
26 SS16S861	6.3	6.3	3.2	550	1.0	4.9	69	10	64	56
27 SR01S861	9.8	14	1.4	870	2.0	.77	71	12	130	44
28 SR02S861	9.2	12	1.7	820	2.0	1.4	67	12	120	47
29 SR03S861	9.1	9.0	1.1	970	2.0	.65	73	11	130	42
30 SR04S861	8.5	12	3.9	700	2.0	2.7	58	11	110	43
31 SR05S861	9.3	8.3	1.1	870	2.0	1.3	62	11	130	40
32 SR06S861	6.6	7.1	2.3	46	1.0	3.3	45	10	71	26
33 SR07S861	6.8	7.8	6.3	31	2.0	1.8	47	18	66	32
34 SR07S862	6.8	10	6.8	65	2.0	1.8	49	20	64	32
35 SR08S861	8.3	7.8	2.0	910	2.0	.7	70	14	110	35
36 SR09S861	6.1	8.4	1.4	990	1.0	1.6	56	10	84	24
37 SR10S861	5.1	6.5	.9	960	1.0	2.3	63	8.0	55	16
38 SR11S861	7.7	5.3	2.1	690	2.0	3.4	61	11	67	29
39 SR12S861	6.0	5.8	3.2	710	1.0	6.4	54	7.0	39	13
40 SR13S861	7.2	9.3	3.9	690	1.0	4.4	59	10	51	24
41 SR14S861	5.6	6.8	1.3	780	1.0	7.6	57	9.0	47	21
42 MR01S861	5.9	6.6	6.1	940	1.0	4.6	60	10	58	20
43 MR02S861	5.8	4.7	27	500	1.0	1.9	48	11	62	21
44 MR02S862	5.9	4.5	29	310	1.0	2.0	52	11	64	22
45 MR03S861	5.7	7.5	5.2	800	1.0	4.2	100	10	76	21
46 MR04S861	6.5	6.7	5.9	730	1.0	2.2	56	12	80	35
47 MR05S861	8.5	8.6	.00B	730	2.0	.84	60	13	99	37
48 MR06S861	5.8	5.4	1.2	780	1.0	1.1	59	9.0	61	23

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	Al, %	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm
49 LA01S861	7.8	3.7	5.9	350	2.0	6.3	62	9.0	53	61
50 LA02S861	6.2	7.8	5.2	470	1.0	7.8	50	10	39	19
51 LA03S861	7.1	9.0	3.7	400	2.0	8.5	59	12	49	26
52 LA04S861	5.9	6.2	2.1	510	1.0	7.8	52	9.0	37	22
53 LA05S861	5.3	6.5	4.8	440	1.0	7.2	47	9.0	32	18
54 LA06S861	7.4	5.0	3.7	510	2.0	11	61	13	53	32
55 LA07S861	6.0	6.7	11	430	1.0	7.9	51	10	42	18
56 LA08S861	5.8	5.2	.00B	510	1.0	6.7	59	9.0	40	17
57 LA09S861	5.8	8.9	12	350	1.0	11	48	10	39	22
58 LA10S861	5.0	5.4	.8	580	1L	6.3	95	11	57	10
59 LA11S861	6.2	5.1	2.3	490	1.0	9.2	53	11	47	16
60 LA12S861	6.6	5.6	4.0	480	1.0	11	56	12	46	28
61 LA13S861	5.9	4.9	6.4	460	1.0	8.5	59	10	41	30
62 LA14S861	6.4	9.4	1.7	480	1.0	10	57	13	48	54
63 LA15S861	7.3	4.0	5.4	380	2.0	5.2	57	11	52	21
64 KW01S861	5.6	5.7	.9	730	1.0	3.5	88	7.0	47	17
65 KW02S861	6.0	6.0	1.0	740	1.0	4.5	69	10	65	19
66 KW03S861	6.1	11	3.5	500	1.0	7.7	65	8.0	64	18
67 KW04S861	5.1	4.3	5.8	660	1.0	2.8	57	6.0	45	11
68 KW05S861	5.8	6.7	2.6	710	1.0	2.6	67	10	75	17
69 KW06S861	6.7	9.7	1.6	770	1.0	4.9	71	9.0	88	24
70 KW07S861	5.8	6.0	1.2	650	1.0	3.0	76	9.0	57	18
71 KW08S861	6.2	7.6	3.1	840	1.0	3.9	64	10	79	19
72 KW09S861	5.4	5.6	.7	720	1.0	3.0	69	8.0	54	16
73 SN01S861	4.6	2.8	1.8	430	1L	5.2	21	12	20	35
74 SN02S861	8.6	5.3	3.1	950	1.0	2.4	59	18	49	38
75 SN03S871	8.7	10	.00B	850	1.0	3.5	56	13	50	27
76 SN04S871	7.3	20	.00B	650	1.0	5.3	53	15	32	53
77 SN05S871	7.7	16	.00B	710	1.0	4.9	56	11	43	30
78 SN06S871	8.5	12	.00B	800	1.0	4.0	53	11	41	25
79 SN07S871	8.2	8.9	.00B	1200	1.0	6.9	57	15	34	41
80 SN08S871	7.8	14	.00B	770	1.0	5.9	52	13	42	32
81 SN09S871	7.9	31	.00B	720	1.0	4.4	52	12	42	32
82 SN10S871	7.9	19	.00B	740	1.0	5.3	57	15	34	56
83 SN11S871	8.7	9.6	.00B	890	1.0	3.6	55	14	37	37
84 SN12S871	8.4	11	.00B	780	2.0	4.2	64	15	58	38
85 SN13S871	7.7	16	.00B	710	1.0	5.5	54	15	32	45
86 SN14S871	8.5	11	.00B	830	1.0	3.6	69	18	85	32
87 SN15S871	8.7	7.8	.00B	810	1.0	3.4	61	13	51	36
88 SN16S871	8.6	9.9	.00B	930	1.0	4.0	60	13	43	31
89 SN17S871	8.4	8.8	.00B	1000	2.0	3.5	85	16	100	22
90 GR01S861	4.9	3.4	2.4	530	1.0	9.3	53	8.0	60	23
91 GR02S861	5.5	5.5	2.5	530	1.0	7.1	52	8.0	61	17
92 GR03S861	5.0	2.5	4.3	390	1.0	13	41	7.0	61	19
93 GR04S861	5.2	4.8	5.2	470	1.0	8.3	48	8.0	64	21
94 GR05S861	4.6	7.4	3.7	490	1.0	8.0	45	7.0	71	16
95 GR06S861	6.1	7.7	5.2	480	2.0	6.6	58	9.0	140	18
96 GR07S861	5.7	9.2	2.2	660	2.0	4.7	68	9.0	62	22

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	Al, %	As, ppm	B, ppm	Ba, ppm	Be, ppm	Ca, %	Ce, ppm	Co, ppm	Cr, ppm	Cu, ppm
97 LC01S861	6.1	7.9	.9	680	2.0	5.5	97	13	57	48
98 LC02S861	3.6	4.5	1.0	520	1L	18	55	8.0	35	29
99 LC03S861	8.3	12	1.0	740	2.0	4.2	140	23	94	110
100 LC04S861	4.9	6.2	1.0	660	1.0	6.1	74	9.0	43	16
101 LC05S861	5.3	7.6	.7	530	1.0	7.1	54	9.0	43	19
102 LC06S861	5.3	6.1	.6	530	1.0	7.0	52	9.0	41	18
103 LC07S861	5.3	6.6	.6	530	1.0	7.1	52	9.0	41	18
104 LC08S861	4.7	8.1	.00B	840	2.0	5.7	150	10	56	18
105 LC09S861	3.9	8.3	1.4	480	1L	19	45	7.0	34	21
106 LC10S861	5.1	5.4	2.1	640	1.0	6.3	60	9.0	39	15
107 LC11S861	5.5	9.2	1.5	550	1.0	7.4	59	10	40	25
108 LC12S861	4.6	8.5	1.2	520	1L	9.8	54	8.0	31	20

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %	Mn, ppm	Mo, ppm	Na, %
1 TL01S861	4.4	20	.03	2.0	36	64	1.7	740	2L	1.5
2 TL02S861	3.1	17	.05	2.1	30	51	1.4	500	2L	2.0
3 TL03S861	2.8	17	.04	2.0	34	44	1.0	480	2L	2.1
4 TL04S861	3.8	15	.02	1.9	21	49	2.0	510	6.0	4.6
5 TL05S861	4.9	21	.04	2.0	32	44	1.7	880	2L	1.9
6 TL06S861	3.8	20	.02	2.4	44	80	1.7	660	2L	2.1
7 TL07S861	3.6	15	.03	1.7	21	56	2.3	530	40	3.5
8 TL08S861	4.2	17	.02L	1.8	22	59	2.4	520	6.0	3.3
9 TL09S861	3.8	16	.02	1.8	21	52	2.2	480	5.0	5.3
10 SS01S861	2.4	14	.02	1.7	31	40	1.6	540	2L	.73
11 SS02S861	6.0	22	.06	2.3	110	22	1.7	1000	2L	2.0
12 SS03S861	6.1	26	.11	2.2	52	46	2.3	3000	3.0	1.4
13 SS04S861	5.2	24	.02	2.3	55	47	2.1	1100	2.0	1.4
14 SS05S861	2.9	16	.04	1.9	36	43	1.6	1500	2L	.7
15 SS06S861	2.5	13	.10	1.8	33	39	1.6	580	2L	.75
16 SS07S861	3.0	16	.03	2.1	34	50	1.8	530	2L	.69
17 SS08S861	2.6	14	.02	1.9	32	47	1.7	440	2L	.82
18 SS09S861	2.5	13	.03	1.8	38	37	1.7	580	2L	.94
19 SS10S861	2.6	14	.02	1.9	32	42	1.7	720	2L	.77
20 SS11S861	2.8	16	.02	2.0	35	68	1.9	510	2L	1.3
21 SS12S861	2.3	11	.03	1.8	43	29	1.4	550	2L	.88
22 SS13S861	2.5	13	.04	2.0	31	54	1.8	520	4.0	2.8
23 SS14S861	3.0	12	.10	1.8	52	37	1.5	630	2L	.79
24 SS15S861	2.8	14	.04	1.9	39	48	1.6	490	2L	1.0
25 SS15S862	3.6	16	.05	2.0	47	57	1.7	490	2.0	.95
26 SS16S861	2.8	14	.11	1.8	35	43	1.6	470	2.0	.81
27 SR01S861	3.9	22	.03	2.3	41	68	1.5	260	2L	.52
28 SR02S861	3.6	22	.04	2.3	38	65	1.4	330	2L	.46
29 SR03S861	3.4	21	.03	2.2	41	70	1.0	240	2L	.38
30 SR04S861	3.2	20	.06	2.0	34	66	1.5	500	2L	.55
31 SR05S861	3.6	22	.05	2.2	36	71	1.5	370	2L	.46
32 SR06S861	2.7	15	.03	1.3	24	49	2.7	260	2L	2.1
33 SR07S861	2.4	13	.03	1.4	24	180	2.6	260	2L	2.3
34 SR07S862	2.4	13	.03	1.4	26	180	2.4	250	2L	2.0
35 SR08S861	3.1	19	.04	1.7	40	67	1.2	200	2L	.53
36 SR09S861	2.5	13	.03	1.4	31	48	1.1	230	2L	.61
37 SR10S861	1.9	11	.02	1.1	36	30	.98	240	2L	.7
38 SR11S861	3.1	17	.02	1.7	34	46	2.0	360	2L	.62
39 SR12S861	1.9	13	.02L	1.5	29	36	2.6	370	2L	1.2
40 SR13S861	2.7	16	.02L	1.7	33	44	2.2	410	2L	1.1
41 SR14S861	2.4	13	.02	1.5	30	35	2.4	430	2L	.86
42 MR01S861	2.3	12	.02	1.5	32	33	1.4	470	2L	1.4
43 MR02S861	2.7	13	.03	1.6	27	54	1.8	500	2L	2.4
44 MR02S862	2.8	13	.02	1.6	28	55	1.9	510	2L	2.6
45 MR03S861	3.1	13	.03	1.5	56	38	1.6	480	2L	1.2
46 MR04S861	2.8	13	.02L	1.5	31	43	1.1	430	2L	1.2
47 MR05S861	4.1	19	.03	1.8	35	54	1.5	330	2L	1.6
48 MR06S861	2.2	11	.02L	1.5	33	25	.58	240	2L	1.1

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %	Mn, ppm	Mo, ppm	Na, %
49 LA01S861	3.0	18	.02	2.1	33	51	1.7	280	2L	1.1
50 LA02S861	2.4	14	.02L	1.7	27	37	1.2	620	2L	1.2
51 LA03S861	3.2	17	.02	1.6	31	45	1.5	1600	2L	.88
52 LA04S861	2.4	14	.02	1.6	28	32	.92	630	2L	1.1
53 LA05S861	2.1	11	.02L	1.4	25	30	.95	560	2L	1.2
54 LA06S861	3.2	17	.06	1.8	32	46	1.3	1300	2L	.91
55 LA07S861	2.5	14	.02L	1.9	28	38	2.3	700	2L	2.5
56 LA08SB61	2.4	13	.03	1.8	31	37	2.0	730	2.0	1.6
57 LA09S861	2.6	13	.05	1.5	25	40	1.5	550	2L	2.4
58 LA10SB61	3.2	11	.11	1.2	51	24	.62	520	2L	1.4
59 LA11SB61	2.7	13	.16	1.5	28	36	.97	560	2L	.93
60 LA12S861	2.9	16	.04	1.6	29	41	1.2	890	2L	.82
61 LA13S861	2.4	12	.18	1.7	32	36	1.4	690	2L	1.2
62 LA14SB61	3.1	15	.04	1.5	30	40	1.1	730	2L	.8
63 LA15S861	3.3	16	.04	1.9	31	40	1.5	570	2L	1.6
64 KW01S861	2.1	11	.02L	1.5	52	31	1.1	380	2L	.94
65 KW02S861	2.4	13	.04	1.5	41	46	1.4	610	2L	.59
66 KW03S861	2.1	13	.03	1.3	38	39	1.4	560	2L	1.2
67 KW04S861	1.6	10	.02	1.6	34	29	.75	270	2L	1.1
68 KW05S861	2.4	12	.02	1.4	40	44	1.3	410	2L	.8
69 KW06S861	2.4	15	.02	1.6	42	52	1.2	220	4.0	.5
70 KW07S861	2.4	13	.04	1.7	40	35	1.1	390	2.0	.71
71 KW08S861	2.8	13	.04	1.5	39	48	1.4	890	2L	.73
72 KW09S861	2.1	11	.02	1.4	39	32	1.2	330	2L	.77
73 SN01S861	4.1	14	.67	1.1	13	81	1.9	530	2L	.76
74 SN02S861	4.4	19	.08	1.8	31	39	1.3	860	2L	1.9
75 SN03S871	3.4	17	1.7	2.0	31	30	1.1	680	4.0	2.5
76 SN04S871	3.6	17	9.0	2.2	29	63	1.6	1200	7.0	1.7
77 SN05S871	2.8	15	2.9	1.9	30	52	1.4	620	7.0	2.1
78 SN06S871	2.6	16	.35	2.0	28	38	1.2	550	3.0	2.4
79 SN07S871	3.3	17	.04	2.2	32	94	1.6	1100	2L	1.9
80 SN08S871	3.2	16	.51	1.9	28	55	1.4	790	2L	1.7
81 SN09S871	3.3	15	.18	1.9	28	49	1.4	670	11.0	2.8
82 SN10S871	3.7	18	18	2.3	31	67	1.7	1100	4.0	1.8
83 SN11S871	3.4	18	1.9	2.3	30	72	1.4	900	2L	2.1
84 SN12S871	3.9	18	.08	2.7	35	94	1.9	840	2L	2.0
85 SN13S871	3.6	18	3.8	2.5	30	86	2.4	910	2.0	2.5
86 SN14S871	5.4	19	6.6	1.8	37	36	1.4	1400	2L	2.1
87 SN15S871	3.4	17	14	2.0	33	43	1.2	690	8.0	2.4
88 SN16S871	3.4	18	2.8	2.1	33	57	1.3	1100	2L	2.2
89 SN17S871	6.3	18	.22	2.1	47	25	1.1	830	2L	2.5
90 GR01S861	1.9	11	.02	1.6	28	31	1.4	540	2L	.68
91 GR02S861	2.1	13	.03	1.7	27	38	1.6	560	2L	.56
92 GR03S861	1.8	11	.02	1.6	21	39	1.5	490	2L	.43
93 GR04S861	2.0	13	.02L	1.8	27	42	1.8	670	2L	.46
94 GR05S861	1.8	11	.03	1.7	25	35	1.9	430	2L	.4
95 GR06S861	2.4	15	.03	1.8	33	51	1.9	590	2.0	.44
96 GR07S861	2.5	14	.02	2.0	37	38	1.4	430	2L	.71

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	Fe, %	Ga, ppm	Hg, ppm	K, %	La, ppm	Li, ppm	Mg, %	Mn, ppm	Mo, ppm	Na, %
97 LC01S861	2.9	14	.05	1.8	49	33	1.6	480	2L	1.2
98 LC02S861	1.6	9	.03	1.1	26	23	1.2	350	2L	.68
99 LC03S861	4.8	22	.07	1.9	75	68	2.0	1200	2L	1.1
100 LC04S861	2.5	12	.02	1.9	40	31	1.5	2800	2L	.8
101 LC05S861	2.0	11	.02	1.8	29	34	1.7	470	2L	.73
102 LC06S861	2.0	11	.02	1.8	28	34	1.7	470	2L	.74
103 LC07S861	2.0	11	.02	1.9	29	34	1.7	460	2L	.73
104 LC08S861	3.0	12	.03	1.8	80	23	1.0	580	2L	1.1
105 LC09S861	1.6	8	.04	1.3	24	28	1.3	460	2L	.51
106 LC10S861	2.2	11	.02	1.9	33	33	1.4	1500	2L	1.0
107 LC11S861	2.2	12	.04	1.9	32	36	1.6	620	2L	.83
108 LC12S861	1.7	9	.03	1.7	28	28	1.4	480	2L	.8

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm	Sr, ppm	Th, ppm	Ti, %	U, ppm
1 TL01S861	28	35	.10	15	15	.2	330	14.0	.42	5.16
2 TL02S861	24	32	.09	16	11	.1	340	13.2	.34	3.64
3 TL03S861	28	26	.09	17	11	.1	330	16.2	.37	6.75
4 TL04S861	20	72	.12	12	15	2.0	270	9.79	.32	5.06
5 TL05S861	30	31	.10	16	17	.1	280	15.6	.57	5.75
6 TL06S861	32	25	.09	17	12	.1L	450	22.4	.40	5.55
7 TL07S861	19	68	.13	13	14	19.0	460	6.10L	.30	12.1
8 TL08S861	20	77	.13	11	17	2.8	310	8.56	.33	4.94
9 TL09S861	20	71	.12	11	15	5.0	290	9.06	.32	4.40
10 SS01S861	28	24	.12	17	9.0	.8	350	11.1	.25	3.83
11 SS02S861	95	30	.21	21	20	.1L	350	56.0	.60	14.6
12 SS03S861	44	170	.17	30	19	.5	460	18.9	.64	5.53
13 SS04S861	47	42	.14	22	19	.4	410	21.3	.55	5.06
14 SS05S861	32	26	.10	21	10	1.6	280	12.2	.30	4.84
15 SS06S861	30	23	.10	20	9.0	.6	280	7.89	.27	4.01
16 SS07S861	30	28	.09	21	11	.4	290	10.5	.29	3.79
17 SS08S861	28	24	.14	20	9.0	1.9	450	9.02	.26	4.43
18 SS09S861	36	22	.12	17	9.0	.4	270	9.51	.31	4.37
19 SS10S861	30	25	.10	20	10	1.2	330	9.57	.25	3.46
20 SS11S861	30	26	.08	21	11	.7	400	9.54	.28	4.68
21 SS12S861	38	22	.09	28	8.0	.9	250	12.7	.29	5.88
22 SS13S861	27	24	.08	18	9.0	3.3	530	9.8	.25	7.94
23 SS14S861	47	22	.12	22	9.0	.6	260	19.2	.39	7.69
24 SS15S861	37	25	.10	23	10	.6	290	10.6	.32	6.11
25 SS15S862	41	35	.10	25	12	1.3	390	12.0	.35	7.52
26 SS16S861	31	26	.10	52	10	1.0	280	9.94	.29	4.92
27 SR01S861	33	39	.09	20	15	.3	180	10.6	.39	3.42
28 SR02S861	31	37	.09	25	14	.6	210	8.32	.36	3.79
29 SR03S861	34	35	.09	24	14	.8	200	10.7	.41	4.18
30 SR04S861	27	34	.12	23	13	.9	260	9.14	.31	3.14
31 SR05S861	29	36	.10	21	14	.5	200	14.0	.36	3.45
32 SR06S861	20	26	.06	11	9.0	1.1	320	13.1	.25	12.0
33 SR07S861	27	130	.10	9	8.0	6.7	200	11.6	.24	3.11
34 SR07S862	30	130	.10	15	8.0	5.9	210	8.86	.23	3.56
35 SR08S861	33	51	.08	19	12	2.3	170	8.9	.41	4.72
36 SR09S861	26	30	.09	15	8.0	.8	190	8.55	.27	3.62
37 SR10S861	29	20	.08	12	6.0	.5	200	11.7	.24	4.45
38 SR11S861	26	25	.08	20	10	1.0	220	9.93	.32	3.59
39 SR12S861	23	15	.07	12	5.0	3.9	470	8.2	.20	3.19
40 SR13S861	26	20	.07	17	8.0	.6	320	11.2	.28	3.63
41 SR14S861	24	18	.08	17	7.0	.6	250	8.94	.24	3.16
42 MR01S861	27	22	.08	12	7.0	.3	330	10.3	.29	5.17
43 MR02S861	22	24	.09	20	8.0	.4	320	9.69	.27	3.56
44 MR02S862	23	25	.09	17	8.0	.5	330	7.84	.28	3.36
45 MR03S861	45	26	.13	16	8.0	.3	420	18.9	.40	6.58
46 MR04S861	26	29	.06	12	9.0	.3	320	9.45	.32	3.95
47 MR05S861	27	37	.07	19	13	.4	220	10.1	.36	4.16
48 MR06S861	26	20	.05	14	7.0	.6	200	8.64	.29	3.43

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm	Sr, ppm	Th, ppm	Ti, %	U, ppm
49 LA01S861	26	25	.06	41	10	.3	360	10.8	.32	4.70
50 LA02S861	21	18	.05	15	6.0	.3	440	8.54	.26	3.42
51 LA03S861	25	24	.10	22	9.0	.5	450	10.5	.29	3.59
52 LA04S861	22	17	.08	17	6.0	.7	460	9.12	.29	4.04
53 LA05S861	19	15	.06	15	5.0	.4	420	8.83	.25	3.08
54 LA06S861	25	23	.11	28	9.0	.5	450	7.34	.31	3.88
55 LA07S861	22	17	.06	15	6.0	.4	450	9.12	.30	3.63
56 LA08S861	25	16	.05	13	6.0	.4	480	11.9	.32	5.90
57 LA09S861	19	19	.07	16	6.0	.5	670	8.51	.24	3.00
58 LA10S861	40	13	.04	15	6.0	.3	330	16.1	.59	6.99
59 LA11S861	22	18	.05	16	7.0	.4	350	10.6	.28	3.51
60 LA12S861	23	22	.11	33	8.0	.5	440	10.7	.28	3.67
61 LA13S861	24	19	.05	16	6.0	.3	450	12.9	.29	4.81
62 LA14S861	24	21	.08	45	8.0	.6	470	11.47	.31	3.95
63 LA15S861	25	22	.06	16	9.0	.4	320	8.17	.33	3.54
64 KW01S861	42	18	.07	17	6.0	1.2	210	17.6	.25	6.08
65 KW02S861	33	25	.06	20	8.0	.9	220	15.3	.25	4.90
66 KW03S861	30	25	.07	18	6.0	25	710	13.2	.20	6.77
67 KW04S861	28	17	.06	13	5.0	17	290	11.8	.21	7.76
68 KW05S861	32	27	.08	17	8.0	2.5	200	9.82	.26	4.86
69 KW06S861	34	38	.09	19	8.0	4.9	260	14.5	.25	5.49
70 KW07S861	33	24	.09	21	8.0	1.1	180	12.7	.26	6.34
71 KW08S861	30	29	.09	22	8.0	16	280	10.5	.25	4.80
72 KW09S861	33	21	.07	18	6.0	1.0	180	11.6	.22	4.66
73 SN01S861	9	11	.13	19	6.0	.1	620	7.70L	.20	14.8
74 SN02S861	29	23	.16	24	13	.2	610	11.7	.47	5.16
75 SN03S871	29	17	.15	16	9.0	.5	640	.00B	.43	.00B
76 SN04S871	26	22	.14	24	10	1.2	580	.00B	.32	.00B
77 SN05S871	28	17	.14	19	9.0	.8	650	.00B	.32	.00B
78 SN06S871	28	16	.13	17	9.0	.5	620	.00B	.35	.00B
79 SN07S871	27	27	.11	19	9.0	.2	810	.00B	.32	.00B
80 SN08S871	25	21	.12	17	10	.4	590	.00B	.32	.00B
81 SN09S871	25	19	.11	16	10	.8	640	.00B	.35	.00B
82 SN10S871	28	21	.12	46	10	.9	680	.00B	.34	.00B
83 SN11S871	26	19	.12	19	10	.4	570	.00B	.37	.00B
84 SN12S871	32	24	.15	18	12	.4	570	.00B	.42	.00B
85 SN13S871	27	22	.12	21	10	.3	820	.00B	.33	.00B
86 SN14S871	35	23	.16	25	12	.6	610	.00B	.62	.00B
87 SN15S871	31	18	.14	23	10	.7	630	.00B	.43	.00B
88 SN16S871	30	19	.14	21	10	.5	610	.00B	.42	.00B
89 SN17S871	43	26	.17	21	10	.1L	570	.00B	.60	.00B
90 GR01S861	23	21	.11	15	7.0	10	510	5.20L	.20	7.72
91 GR02S861	24	26	.11	17	8.0	12	330	6.00L	.21	11.2
92 GR03S861	17	25	.10	14	8.0	48	800	8.30L	.17	18.6
93 GR04S861	22	27	.09	14	7.0	85	430	6.70L	.20	14.2
94 GR05S861	22	25	.10	15	6.0	7.1	330	5.9	.19	5.5
95 GR06S861	28	27	.10	20	9.0	4.2	380	4.70L	.24	7.22
96 GR07S861	32	24	.09	19	8.0	5.1	320	12.0	.25	9.18

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	Nd, ppm	Ni, ppm	P, %	Pb, ppm	Sc, ppm	Se, ppm	Sr, ppm	Th, ppm	Ti, %	U, ppm
97 LC01S861	39	28	.07	36	8.0	1.2	350	15.7	.30	3.79
98 LC02S861	18	17	.06	19	4.0	3.3	870	7.6	.20	3.96
99 LC03S861	57	59	.11	42	15	.7	390	21.3	.47	4.45
100 LC04S861	36	16	.10	17	6.0	.3	300	12.0	.25	4.35
101 LC05S861	27	17	.08	20	6.0	.1L	300	11.5	.21	3.27
102 LC06S861	26	17	.08	22	6.0	.6	300	11.9	.21	3.21
103 LC07S861	26	18	.08	24	6.0	.6	300	11.3	.21	3.27
104 LC08S861	75	20	.14	22	10	1.3	310	.0B	.44	.0B
105 LC09S861	20	16	.05	16	6.0	7.1	920	.0B	.16	.0B
106 LC10S861	32	16	.08	15	7.0	.5	360	.0B	.25	.0B
107 LC11S861	31	20	.08	23	8.0	2.3	360	.0B	.23	.0B
108 LC12S861	25	16	.07	20	6.0	3.6	470	.0B	.20	.0B

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
1 TL01S861	110	24	2.0	110
2 TL02S861	79	18	2.0	79
3 TL03S861	77	19	2.0	70
4 TL04S861	110	18	2.0	110
5 TL05S861	120	29	3.0	110
6 TL06S861	100	20	2.0	95
7 TL07S861	110	17	2.0	97
8 TL08S861	130	18	2.0	110
9 TL09S861	110	17	2.0	110
10 SS01S861	66	19	2.0	70
11 SS02S861	140	56	5.0	110
12 SS03S861	130	30	3.0	510
13 SS04S861	120	31	3.0	130
14 SS05S861	77	22	2.0	97
15 SS06S861	67	20	2.0	68
16 SS07S861	83	22	2.0	89
17 SS08S861	72	20	2.0	78
18 SS09S861	68	24	3.0	67
19 SS10S861	70	20	2.0	72
20 SS11S861	83	21	2.0	77
21 SS12S861	60	25	3.0	70
22 SS13S861	70	19	2.0	79
23 SS14S861	82	30	3.0	71
24 SS15S861	77	24	3.0	75
25 SS15S862	96	27	3.0	120
26 SS16S861	74	22	2.0	120
27 SR01S861	210	21	2.0	120
28 SR02S861	190	19	2.0	130
29 SR03S861	210	20	2.0	120
30 SR04S861	180	18	2.0	130
31 SR05S861	200	18	2.0	120
32 SR06S861	110	16	2.0	67
33 SR07S861	100	49	3.0	190
34 SR07S862	100	52	3.0	200
35 SR08S861	180	27	3.0	140
36 SR09S861	140	18	2.0	98
37 SR10S861	82	20	2.0	68
38 SR11S861	110	20	2.0	100
39 SR12S861	67	15	2.0	55
40 SR13S861	83	18	2.0	82
41 SR14S861	77	17	2.0	69
42 MR01S861	70	17	2.0	60
43 MR02S861	80	15	2.0	95
44 MR02S862	82	16	2.0	98
45 MR03S861	84	21	3.0	72
46 MR04S861	97	18	2.0	77
47 MR05S861	160	21	2.0	120
48 MR06S861	71	16	2.0	83

Table 3.--Listing of sample identification and results of analysis (continued).

Sample	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
49 LA01S861	82	22	3.0	99
50 LA02S861	59	18	2.0	64
51 LA03S861	77	21	2.0	100
52 LA04S861	55	19	2.0	78
53 LA05S861	49	17	2.0	61
54 LA06S861	77	22	3.0	100
55 LA07S861	63	18	2.0	65
56 LA08S861	60	19	2.0	59
57 LA09S861	65	18	2.0	82
58 LA10S861	81	21	3.0	60
59 LA11S861	69	19	2.0	75
60 LA12S861	68	20	2.0	95
61 LA13S861	64	19	2.0	67
62 LA14S861	76	21	2.0	130
63 LA15S861	67	20	2.0	94
64 KW01S861	61	22	3.0	55
65 KW02S861	110	19	2.0	84
66 KW03S861	100	17	2.0	83
67 KW04S861	67	15	2.0	49
68 KW05S861	110	20	2.0	87
69 KW06S861	180	20	2.0	110
70 KW07S861	97	22	2.0	77
71 KW08S861	130	19	2.0	99
72 KW09S861	84	19	2.0	69
73 SN01S861	76	5	1L	90
74 SN02S861	110	14	2.0	110
75 SN03S871	110	16	2.0	71
76 SN04S871	110	13	2.0	96
77 SN05S871	88	16	2.0	59
78 SN06S871	79	16	2.0	57
79 SN07S871	92	16	2.0	80
80 SN08S871	93	15	2.0	73
81 SN09S871	99	15	2.0	70
82 SN10S871	92	14	2.0	93
83 SN11S871	94	14	2.0	83
84 SN12S871	110	18	2.0	85
85 SN13S871	94	14	2.0	89
86 SN14S871	170	19	2.0	100
87 SN15S871	97	17	2.0	81
88 SN16S871	98	16	2.0	77
89 SN17S871	190	22	3.0	88
90 GR01S861	65	16	2.0	75
91 GR02S861	110	18	2.0	75
92 GR03S861	99	14	2.0	74
93 GR04S861	99	16	2.0	70
94 GR05S861	120	17	2.0	71
95 GR06S861	110	19	2.0	84
96 GR07S861	73	19	2.0	72

Table 3.--Listing of sample identification and results of analysis (continued).

	Sample	V, ppm	Y, ppm	Yb, ppm	Zn, ppm
97	LC01S861	58	23	3.0	110
98	LC02S861	36	13	2.0	52
99	LC03S861	86	33	3.0	150
100	LC04S861	55	20	2.0	57
101	LC05S861	56	17	2.0	65
102	LC06S861	56	17	2.0	63
103	LC07S861	56	17	2.0	63
104	LC08S861	73	43	5.0	66
105	LC09S861	43	14	2.0	49
106	LC10S861	54	19	2.0	53
107	LC11S861	59	19	2.0	74
108	LC12S861	47	16	2.0	62

Table 4.--Concentrations of elements in soils from selected studies.

Element	Western United States[1]		Northern Great Plains[2]		San Joaquin Valley[3]		Piceance/Unita Basin[4]		Present Study
	Geometric mean	Observed range	Geometric mean	Observed range	Geometric mean	Observed range	Geometric mean	Observed range	Observed range
Ag, ppm	---[5]	---	---	---	---	---	---	---	---
Al, %	5.8	0.5->10	5.6	3.4-12	7.3	3.2-12	4.6	2.1-6.8	3.6-9.8
As, ppm	5.5	<0.1-97	7.1	<0.1-26	8.8	3.4-21	9.3	4.2-23	2.4-15
B, ppm	23	<20-300	41	<2.2-99	---	---	7.4	2.4->100	0.6-210[6]
Ba, ppm	580	70-5,000	1,100	420-2,320	750	54-2,300	1200	710-1900	310-990
Be, ppm	0.68	<1-15	1.6	<0.22-3.5	1.0	<1.0-3.0	2.4	0.88-4.4	1.0-2.0
Ca, %	1.8	0.06-32	0.97	<0.014-7.0	2.0	0.99-7.7	5.5	0.72-13	0.65-19
Cd, ppm	---	---	---	---	---	---	---	---	---
Ce, ppm	65	<150-300	38	<22-130	39	17-88	52	25-110	21-210
Co, ppm	7.1	<3-50	6.4	<1.0-23	15	5.0-34	7.3	4.0-12	6.0-28
Cr, ppm	41	3-2,000	45	11-160	130	57-320	50	20-98	20-210
Cu, ppm	21	2-300	19	4.3-110	31	2.0-86	30	12-85	10-110
Fe, %	2.1	0.1->10	2.1	0.26-6.5	3.5	1.5-8.5	2.0	1.1-2.8	1.6-6.1
Ga, ppm	16	<5-70	11	4.2-29	16	6.0-39	15	7.2-29	8.0-26
Hg, ppm	0.046	<0.01-4.6	0.023	<0.01-0.07	0.054	<0.02-2.5	0.027	0.02-0.05	<0.02-18
K, %	1.8	0.19-6.3	1.8	1.3-2.7	1.9	0.83-4.6	2.1	0.96-3.1	1.1-2.4
La, ppm	30	<30-200	23	<10-49	21	9.0-51	39	26-65	13-110
Li, ppm	22	5.0-130	19	7.0-40	51	15-170	37	15-85	22-180
Mg, %	0.74	0.03->10	0.66	0.18-2.7	1.5	0.39-4.6	1.4	0.45-3.9	0.58-2.7
Mn, ppm	380	30-5000	460	<200-3800	520	250-1400	450	190-740	200-3000
Mo, ppm	0.85	<3-7	3.8	<1.0-12	---	---	5.7	2.6-10	<2.0-40
Na, %	0.97	0.05-10	0.83	0.22-1.6	1.4	0.75-2.8	1.1	0.3-2.0	0.38-5.3
Nd, ppm	36	<70-300	---	<46-140	18	8.0-45	---	<53-74	9.0-95
Ni, ppm	15	<5-700	18	4.3-64	87	6.0-380	20	8.9-35	11-170
P, %	0.032	0.004-0.45	0.074	<0.044-0.13	0.061	0.03-0.17	---	---	0.04-0.21
Pb, ppm	17	<10-700	16	5.1-41	17	7.0-96	12	4.8-26	9.0-52
Sc, ppm	8.2	<5.0-50	5.4	<3.0-17	11	3.0-30	7.8	3.1-12	4.0-20
Se, ppm	0.23	<0.1-4.3	0.45	<0.1-20	0.68	<0.01-4.5	0.079	<0.1-0.57	<0.1-85
Sr, ppm	200	10-3000	160	58-440	250	140-990	370	170-770	170-920
Ti, %	0.22	0.05-2.0	0.2	0.11-0.37	0.30	0.08-0.68	0.27	0.07-0.42	0.16-0.64
Th, ppm	9.1	2.4-31	8.4	3.0-13	9.7	<4.0-26	9.3	5.4-30	<4.7-18.6
U, ppm	2.5	0.68-7.9	2.3	1.1-4.9	---	---	3.5	2.4-6.0	3.0-56
V, ppm	70	70-500	54	20-96	100	30-260	68	41-110	36-210
Y, ppm	22	<10-150	18	3.1-54	14	7.0-31	18	11-29	5.0-56
Yb, ppm	2.6	<1.0-20	2.4	0.78-5.8	1.7	<1.0-4.0	2.6	1.4-4.6	<1.0-5.0
Zn, ppm	55	10-2,100	63	14-170	88	27-230	65	33-110	49-510

[1]Shacklette and Boerngen, 1974
[2]Severson and Tidball, 1979
[3]Severson and others, 1987b
[4]Ebens and Shacklette, 1982
[5]No data available
[6]Hot-water soluble