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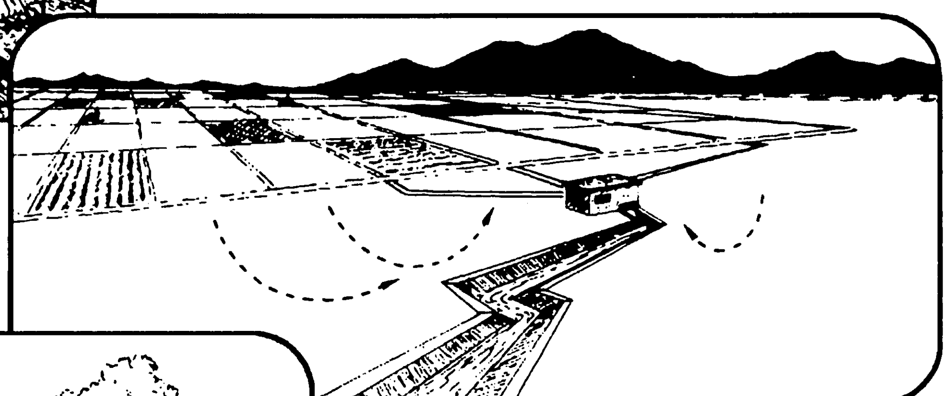
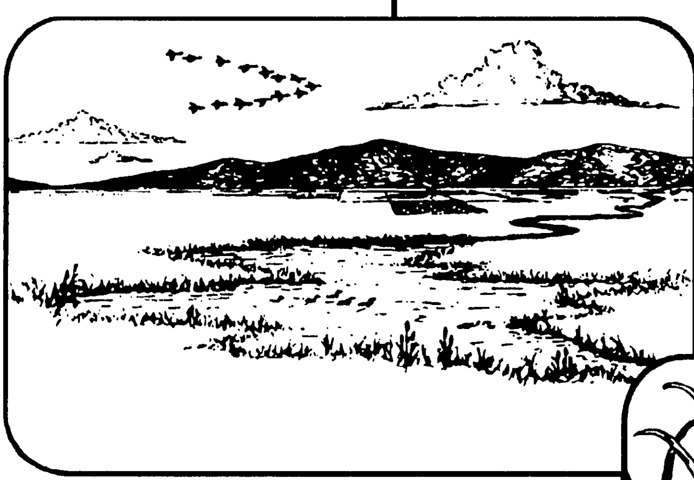
Field screening of water quality, bottom sediment, and biota associated with irrigation on the Uintah and Ouray Indian Reservation, eastern Utah, 1995





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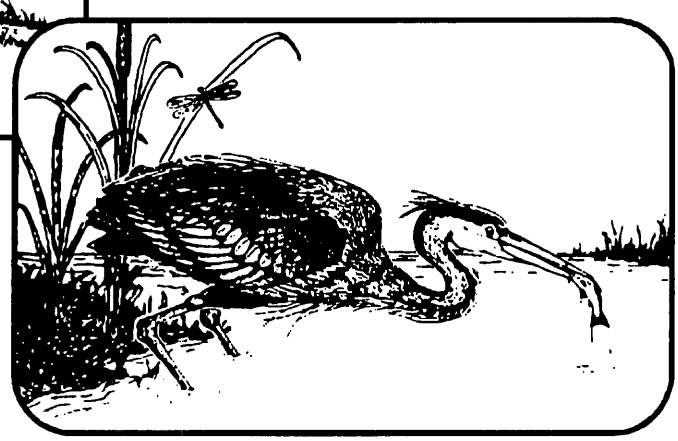

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FIELD SCREENING OF WATER QUALITY, BOTTOM SEDIMENT, AND BIOTA ASSOCIATED WITH IRRIGATION ON THE UINTAH AND OURAY INDIAN RESERVATION, EASTERN UTAH, 1995

By Doyle Stephens, U.S. Geological Survey; and
Bruce Waddell, U.S. Fish and Wildlife Service

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Salt Lake City, Utah
1998

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

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Denver, Colorado 80225

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
acre	4,047	square meter
acre-foot	1,233	cubic meter
acre-foot per year	0.00003907	cubic meter per second
cubic foot per second	0.02832	cubic meter per second
inch	25.4	millimeter
pound	0.4536	kilogram
mile	1.609	kilometer

Water temperature is reported in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 1.8\ (°C) + 32.$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Chemical concentration and water temperature are reported only in metric units. Chemical concentration in water is reported in milligrams per liter (mg/L) or micrograms per liter (μg/L). Milligrams per liter is a unit expressing the solute per unit volume (liter) of water and is about the same as parts per million unless concentrations are greater than 7,000 milligrams per liter. One thousand micrograms per liter is equivalent to 1 milligram per liter. Radioactivity is expressed in picocuries per liter (pCi/L), which is the amount of radioactive decay producing 2.2 disintegrations per minute in a unit volume (liter) of water. Specific conductance is reported in microsiemens per centimeter at 25 degrees Celsius (μS/cm). Chemical concentration in sediment and biological tissues is reported in micrograms per gram (μg/g), which is equal to parts per million (ppm), or micrograms per kilogram (μg/kg), which is equal to parts per billion (ppb).

To compare dry-weight tissue concentration to wet weight, the equation is:

$$\text{wet weight} = \text{dry weight concentration} \times [1-(\text{percent moisture}/100)].$$

FIELD SCREENING OF WATER QUALITY, BOTTOM SEDIMENT, AND BIOTA ASSOCIATED WITH IRRIGATION ON THE UINTAH AND OURAY INDIAN RESERVATION, EASTERN UTAH, 1995

By Doyle Stephens, U.S. Geological Survey, Salt Lake City, Utah, and
Bruce Waddell, U.S. Fish and Wildlife Service, Salt Lake City, Utah

ABSTRACT

Field screening of water quality, bottom sediment, and biota was done by the U.S. Geological Survey and U.S. Fish and Wildlife Service during 1995 at selected sites on the Uintah and Ouray Indian Reservation of eastern Utah to determine if irrigation or project mitigation water delivered by the U.S. Department of the Interior caused adverse effects on fish and wildlife resources or on human health. Generally, the water was hard and ranged from calcium bicarbonate to sodium sulfate types in composition. Dissolved-solids concentration in water from 40 percent of the sites exceeded the State agricultural standard of 1,200 milligrams per liter. The high concentration of dissolved solids could adversely affect some agricultural crops but was not hazardous to waterbirds. High temperatures and widely fluctuating dissolved-oxygen concentrations in water samples collected from several sites failed to meet Utah class 3A or 3B standards for aquatic wildlife protection, particularly those samples collected in August. Concentrations of dissolved boron exceeded the agricultural standard of 750 micrograms per liter at 12 sites and the recommended maximum of 5,000 micrograms per liter for livestock water at 3 sites. Dissolved uranium, expressed as alpha radiation, was 68 picocuries per liter in seepage entering Bottle Hollow Reservoir and exceeded Utah water-quality standards for drinking water supply, wildlife protection, and agricultural use. Generally, trace elements, organochlorine residues, and polychlorinated biphenyl compounds (commonly referred to as PCBs) were not detected in biota at potentially hazardous concentrations. Concentrations of selenium generally were small; however, fish in one area had a selenium concentration of 8.3 micrograms per gram dry weight, and selenium concentration was 10.7 micrograms per gram dry weight in invertebrates. Concentrations of boron in aquatic plants and plankton were as high as 722 micrograms per gram and 82 micrograms per gram dry weight, respectively.

INTRODUCTION

Background

Studies by the U.S. Fish and Wildlife Service (USFWS) in the Western United States have related the incidence of mortality, embryo teratogenesis, and reproductive failures of aquatic birds and fish to high concentrations of selenium in irrigation drainage. These adverse effects were discovered in 1983 at the Kesterson National Wildlife Refuge in western San Joaquin Valley, California, where irrigation drainwater was impounded.

In response to widespread concern about the general nature and extent of contaminant problems associated with irrigation drainage, the U.S. Department of the Interior (DOI) developed the Irrigation Drainage Program (currently called the National Irrigation Water Quality Program or NIWQP) in 1985 and formed an interbureau Task Group on Irrigation Drainage to address water-quality problems related to irrigation drainage for which DOI may have responsibility. Subsequently, 39 areas that warranted reconnaissance-level or field-screening studies were identified based on 4 areas of DOI responsibility: (1) irrigation or drainage facilities constructed or managed by the DOI; (2) National Wildlife Refuges managed by the DOI that receive irrigation drainage; (3) other migratory-bird or endangered-species management areas that receive water from DOI-funded projects; and (4) public and private drinking-water supplies that may be affected by drainwater from DOI irrigation facilities.

The discovery of the effects of selenium on the health of biota has led to more than a decade of scientific investigation regarding the quality of irrigation water and its potentially harmful effects on humans, fish, and wildlife (Feltz and others, 1991; Peterson and Nebeker, 1992). Selenium concentrations that exceed the water-quality criterion for the protection of aquatic life (U.S. Environmental Protection Agency, 1987a) have been detected in surface and subsurface drainage from irrigated land throughout the West (Feltz and Engberg, 1994), specifically in the Uintah Basin (Stephens and others, 1988, 1992, Stephens and Waddell, 1998). Additionally, arsenic, heavy metals, and pesticide residues have been detected in numerous areas of the Western United States that receive irrigation drainage. Concentrations can become toxic to aquatic life where naturally occurring elements such as selenium and associated constituents are leached from soil and underlying geologic formations by irrigation water and accumulated by evaporative and bioaccumulation processes. Wetlands and closed-basin ponds are particularly susceptible sites.

Purpose and Scope

This report contains the results of a field-screening study during 1995 of the physical, chemical, and biological conditions associated with water developed as part of the Uintah Indian Irrigation Project of the Bureau of Indian Affairs (BIA), the Central Utah Project (CUP), and the Central Utah Project Completion Act (CUPCA) (Public Law 102-575) of the DOI. Physical and chemical data are presented and comparisons are made to applicable State of Utah and other quality criteria for water, bottom sediment, and biota believed to be representative of the irrigated and wetland areas within the Uintah and Ouray Indian Reservation. Included are six areas previously selected as mitigation land for Ute tribal losses resulting from development of the Bonneville Unit of the CUP. Data collected during this study will enable the DOI to determine if irrigation or mitigation water delivered by these projects causes, or has the potential to cause, significant adverse effects on fish and wildlife resources or human health on the Reservation, with emphasis on the Duchesne River Basin.

Acknowledgments

This study could not have been done without the cooperation and assistance of the Ute Tribe. We are grateful for the help of tribal members Kelly Cambridge and Allowin Myore in locating sites and collecting and processing samples. The coordination and facilities provided by Gerald Cobell and the USFWS Fisheries Assistance Office in Roosevelt, Utah, greatly aided our study. Our thanks to Todd Finlayson (USFWS), who directed much of the biological sampling.

General Description of the Area

The Uintah and Ouray Indian Reservation covers about 4,000,000 acres of trust land, fee land, private land, National Forest land and Bureau of Land Management (BLM) land along the Green River in north-central Utah (fig. 1). The Reservation is divided into a northern segment centered around the Duchesne River and a southern segment extending downstream to the Book Cliffs. Virtually all the population, water resources, and irrigation are in the northern segment, specifically the Duchesne River Basin (fig. 2). The southern segment is rugged, high country with few inhabitants, and the small amount of irrigation east of the Green River is mostly along the White River. There is considerable involvement of reservation lands in the CUP; within the northern segment, there are about 60,000 acres of Indian agricultural lands receiving 3 to 4 acre-feet of project water per acre (Fred Chavez, BIA, oral commun., 1993). About 38,500 acres of non-Indian agricultural land within the confines of the Reservation receive supplemental CUP water. The principal water source for the area is snowmelt runoff transported by streams on the southern slope of the Uinta Mountains; namely, the Uinta River, Whiterocks River, Yellowstone River, Lake Fork River, and Strawberry River. The Duchesne River is the largest receiving stream and discharges to the Green River. Strawberry Reservoir (35 miles west of Duchesne) and Starvation Reservoir are the most important impoundments constructed by the CUP. Smaller project and private reservoirs include Lake Borham (also called Midview Reservoir), Big Sand Wash, Twin Pots, Montes Creek, Bottle Hollow, Cedar View, and Brough and are located on or adjacent to Reservation lands. Water in all reservoirs is used for irrigation and by fish and wildlife resources. There is an extensive system of pri-

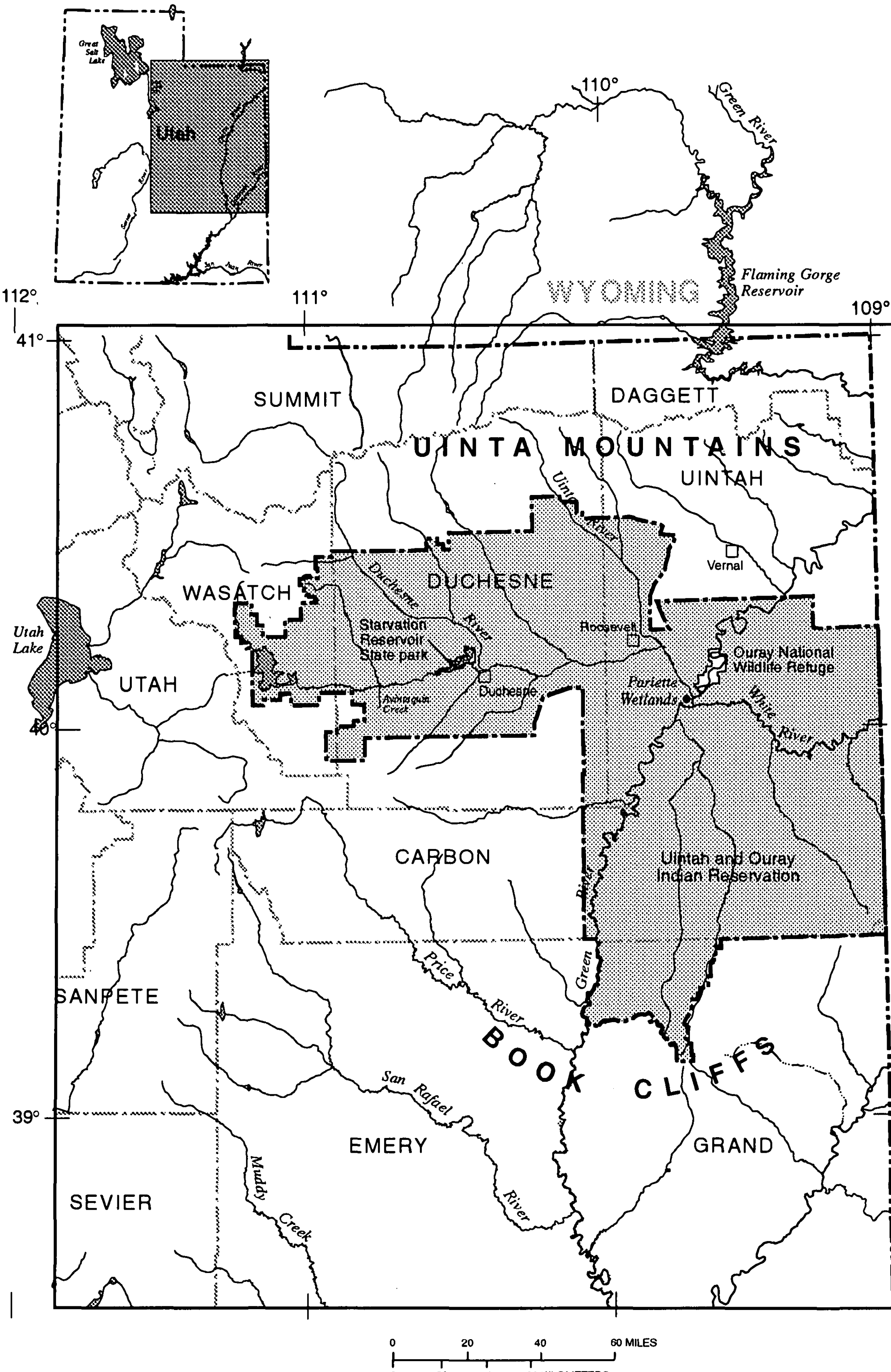

Figure 1. Location of the Uintah and Ouray Indian Reservation, Utah.

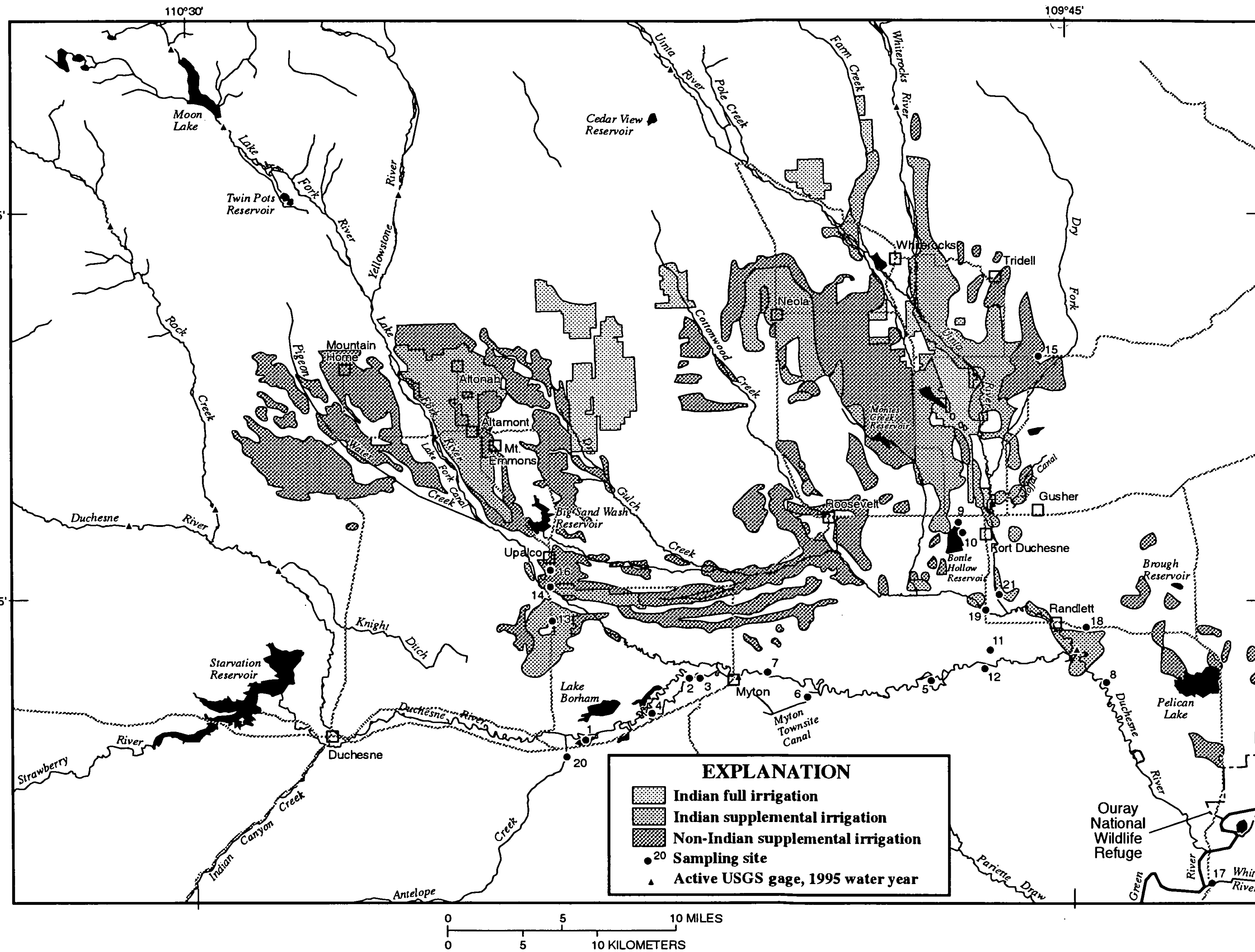

Figure 2. Selected hydrologic features, sampling sites, and active U.S. Geological Survey (USGS) streamflow-gaging stations within the Duchesne River Basin, Utah. *Delineation of irrigated lands from Bureau of Reclamation (1967, 1970)*

vate and CUP-constructed canals throughout the Duchesne River Basin.

Geology of the Reservation is varied, but most of the formations are early Tertiary in age and include the Uinta Formation, Green River Formation, and Duchesne River Formation, all of which are considered "seleniferous in areas" by Rosenfeld and Beath (1964). Most of the high elevation areas consist of glacial material and the Mutual Formation, but the west fork of the Duchesne River flows through the Mesa Verde Group of Cretaceous age and Jurassic-age rocks. The source areas for the streams on the south border of the Duchesne River Basin, (Avintaquin, Antelope, and Indian Canyon Creeks) are underlain by the Green River Formation. Water in these streams contains considerable evaporites, boron, and some selenium.

Fish and Wildlife Use

The Green River flows through the Reservation and is designated as Critical Habitat for four species of endangered fish: razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*), bonytail chub (*G. elegans*), and Colorado squawfish (*Ptychocheilus lucius*). Bald eagles (*Haliaeetus lencocephalus*) use the area during the winter. All rivers, ponds, reservoirs, and canals are used by waterbirds for feeding and nesting, and the Green River is a principal migration corridor for the Pacific Flyway. The USFWS leases a small part of the Ouray National Wildlife Refuge from the Ute Tribe.

The BLM manages Pariette Wetlands, an area with considerable waterfowl use in Pariette Draw. Although within the Reservation boundary, the surrounding drainage consists primarily of public lands managed by BLM. Most of the water supply for Pariette Draw, however, originates from private and Reservation lands. There are no formal State waterfowl management areas within the Reservation boundary.

Previous Studies

During low flow, several streams in the southern Duchesne River drainage contain high concentrations of boron; as much as 20,000 μg/L has been found in the downstream reach of Indian Canyon Creek (Mundorff, 1977, p. 2). Few data exist for selenium and boron in water within the Reservation boundary. An upland area 1 mile southeast of Myton along the Myton Townsite Canal, which is being considered by the Utah Division of Wildlife Resources as a wetland-upland preserve, contained 5 μg/L of selenium in irrigation drainwater; a farm pond near Pelican Lake contained 4 μg/L of selenium; and boron is a potentially serious problem in water in Pariette Wetlands and near the town of Myton. Data from an earlier study of irrigation water quality in Pariette Wetlands showed selenium concentrations as high as 7 μg/L and boron concentrations as high as 2,300 μg/L in ponds in the wetlands. Concentrations of selenium in pied-billed grebe (*Podilymbus podiceps*) eggs and carp (*Cyprinus carpio*) were as high as 16.9 μg/g dry weight (DW) (Stephens and others, 1992, p. 134). Agricultural problems associated with salinity are common and the Natural Resources Conservation Service has an active on-farm salinity-control program operating within the Duchesne River Basin.

A potential risk to human health from mercury in fish tissue has been identified on Ute-owned Bottle Hollow Reservoir. Data collected in 1993 showed that 20 percent of trout with body weights exceeding 3 pounds contained mercury concentrations in excess of 0.3 μg/g (wet weight, WW). None of the fish exceeded the 1 μg/g WW advisory level for human consumption set by the Food and Drug Administration but there is concern that mercury could be accumulating in fish within the lake (Cobell and others, 1994). The reservoir was constructed as a CUP mitigation project on a municipal dump site but receives water from both the Uinta River and irrigation return flows. Because of the potential mercury problem, the reservoir has been managed as a catch and release fishery since 1993. The source of the mercury has not been determined, but a water sample collected in July 1994 in the Uinta River near Neola, a source of water for Bottle Hollow Reservoir, contained 0.2 μg/L of mercury.

During 1994, the U.S. Geological Survey (USGS), in cooperation with the Central Utah Water Conservancy District, collected and analyzed surface-water and bottom-sediment samples at 14 sites in the Duchesne River Basin as part of the CUPCA. The study was designed to determine the potential for surface-water contamination if certain features associated with the Upalco Unit and Uintah Unit of the CUP were constructed. The sample sites generally were located where water from larger streams and rivers entered and exited the project boundaries. Generally, the quality of water entering the project was excellent and contamination at lower-elevation sites was minimal. Concentrations of dissolved solids generally increased substantially in a downstream direction. Several samples of water from the Lake Fork River at Myton contained dissolved solids (1,560 and 1,700 mg/L) that exceeded the Utah agricultural protection standard of 1,200 mg/L, gross alpha radiation (16 pCi/L) that exceeded the Utah wildlife protection standard of 15 pCi/L, and dissolved mercury (0.02 µg/L) that exceeded the Utah wildlife protection standard of 0.012 µg/L as a 4-day average. Three samples from the Duchesne River at Randlett exceeded the standard for dissolved solids and one sample exceeded the standard for gross alpha radiation. Boron in one sample from the Duchesne River at Myton exceeded the Utah standard for agricultural protection (750 µg/L). Four samples from the Uinta River at Randlett exceeded the dissolved-solids standard and one sample exceeded the gross alpha radiation standard (21 pCi/L) (CH2M Hill and Horrocks Engineering, 1996).

Concentrations of trace elements in samples of bottom sediment collected from each of the CUP sites generally were within the 95 percent confidence interval for soils in the Uinta Basin (Tidball and Severson, 1982) or were less than values determined in other studies to adversely affect biota (Beyer, 1990). Arsenic concentrations in bottom sediment from Midview Reservoir (Lake Borham) and the Duchesne River at Myton exceeded the screening criterion of 4 µg/g DW (Persaud and others, 1990). The only site where multiple trace elements exceeded screening criteria was a small farm pond near the confluence of Pigeon Water Creek and the Lake Fork River, where a cadmium concentration of 2 µg/g DW exceeded a "no observed effect level" of 1 µg/g (MacDonald, 1993), and a lead concentration of 300 µg/g DW exceeded the "permissible exposure limit" of 160 µg/g (MacDonald, 1993).

Development of Water for the Reservation

Presently, the Uintah Indian Irrigation Project of the BIA provides a maximum water allocation of 3 acre-feet per acre from March 1 to November 1 of each year for about 16,000 acres. The water is distributed from the Lake Fork, Uintah, and Whiterocks Rivers (fig. 1).

Long-term development of water on Indian and non-Indian lands throughout the Uintah Basin mostly has been a result of the CUP, a water-development plan designed to permit Utah to use a substantial portion of its allotted share of Colorado River water. The original CUP consisted of six units: Vernal, Jensen, Bonneville, Upalco, Uintah, and Ute Indian, but the Upalco and Uintah Units have been reduced in scope under CUPCA. The Ute Indian Unit was planned to provide water for Indian and non-Indian lands but was not funded by Congress. The last unit under construction is the Bonneville Unit, which involves transbasin diversion of water from the Uintah and Ouray Indian Reservation to communities along the Wasatch Front. To acquire water from the Ute Tribe, the United States (the Bureau of Reclamation and the BIA), the Ute Tribe, and the Central Utah Water Conservancy District entered into the Ute Indian Deferral Agreement of 1965 wherein the Ute Tribe agreed to defer development of 15,242 acres of irrigable land and provide the water for the Bonneville Unit. In return, the non-Indian parties (1) recognized the Indian water rights to 36,450 acres served or to be served by the Duchesne River; and (2) the U.S. Government agreed to develop substitute water resources and distribution facilities for the Ute Tribe by January 1, 2005.

In 1980, the Utah State legislature approved a Ute Indian Water Compact intended to resolve present and future controversies concerning the amount, distribution, and use of waters claimed by the Ute Tribe. The compact provides for a depletion of 248,943 acre-feet annually and a related diversion of 471,035 acre-feet annually for all uses. The Ute Tribe also has a water right to an annual depletion of 10,000 acre-feet for municipal and industrial use. The total acreage under or planned for irrigation with Indian-owned water is recognized as 129,201 acres, less 7 percent (to 120,157 acres) to reflect nonproductive uses such as roads and rights-of-way. This compact was revised in 1990 but it is not known if the revision has been ratified by the Ute Tribe or the U.S. Government.

Because none of the Uintah Basin projects intended to assist the Ute Tribe have been constructed, the CUPCA attempted to address the terms of the 1965 deferral agreement and the Revised Ute Indian Compact of 1990. Under Title V of the CUPCA, in lieu of projects originally planned under the 1965 deferral agreement, the Ute Tribe would receive a share of Bonneville Unit revenues, a development fund, aid in the improvement of farming operations, and economic opportunities on the Reservation and other benefits designed to improve natural resources such as stream improvement and removal of contaminants from Bottle Hollow Reservoir.

Sample Collection and Analysis

Location of Sampling Sites

The 1994 sampling done for the CUP program concentrated on principal streams and rivers in the Duchesne River Basin. Small streams and canals servicing or draining project lands were not sampled. The present study was done to determine if irrigation water causes or may cause adverse effects on fish and wildlife resources or on human health through consumption of the resources on Reservation lands. Sampling sites for water, bottom sediment, and biota used in the 1995 field screening are listed in table 1 and shown in figures 2 and 3. In general, the 20 water-sampling sites were chosen to determine trace-element concentrations in irrigation return flows and drainwater (if any) entering and leaving Reservation lands or reservoirs. Eleven sites were selected to determine if contamination was present in six wildlife mitigation areas owned by the Ute Tribe along the Duchesne River (fig. 3). Sites for sediment sampling were selected in areas where water enters fish or waterbird habitat in wetlands or reservoirs. The assignment of a Utah Water-Quality Class applicable at each site was based on information from the Utah Department of Environmental Quality (1994). For some sites, this assignment may not be applicable and its use was to guide the interpretation of the data. Biota were collected at some of the 20 water-sampling sites and 4 areas of impounded water and riparian zones selected on an "as available" basis. Water samples were collected in June or early July and again in late August when water use for irrigation and returns are maximum. Biota samples were collected from May through August.

Collection and Analysis of Water and Bottom Sediment Samples

Water samples were collected and processed using a modification of the trace-element sampling protocol developed by the USGS. Where water was sampled from wide streams or sources not known to be well mixed, a DH48-TM sampler (U.S. Geological Survey, 1977, p. 3-20) was employed with equal-width depth-integrated procedures. Field measurements of discharge, water temperature, dissolved oxygen, pH, and specific conductance were made at the time water samples were collected. Samples were filtered in the field using 0.45-micrometer porosity cartridge filters, acidified with nitric acid where necessary, and submitted to the USGS laboratory in Arvada, Colorado, for analysis of major ions, trace elements, and uranium using methods in Fishman and Friedman (1989). The sanitary quality of the water, as estimated by bacterial sampling, was not determined in this study. Similarly, the eutrophication potential of the water, as indicated by the nutrients nitrogen and phosphorus, was not determined. Because nutrients were not analyzed, the presence of un-ionized ammonia at concentrations that may be potentially toxic to fish was not evaluated.

Quality-control samples consisted of equipment blanks of inorganically free water processed using sampling equipment in the field and analyses of the cartridge filters used in sample preparation. Contamination of water samples by sampling and processing equipment was less than the reporting limit for all trace elements (table 2).

Nineteen samples, each composited from five cores of bottom sediment (maximum 8 inches in length), were collected using a BMH53 sampler but were not sieved in the field (U.S. Geological Survey, 1977, p. 3-37). These samples were then submitted to the USGS laboratory for sieving and analysis of the less-than-63-micrometer fraction using Inductively Coupled Plasma analysis for trace elements. Selenium was analyzed separately using total digestion and hydride generation-atomic absorption spectrometry; mercury was analyzed by digestion and cold vapor analysis. Four samples of bottom sediment were analyzed to determine the extent of contamination by chlorinated hydrocarbons associated with past drainage from the agricultural areas. The sediment collected for analysis of chlorinated hydrocarbon compounds was sieved to select the less-than-2-mm fraction, placed in cleansed and baked glass jars, and submitted to the USGS laboratory for analysis.

Collection and Analysis of Biological Samples

Samples of aquatic plants, aquatic invertebrates, fish, and bird eggs were collected between May and August 1995. Most of the samples were collected at six areas identified by the Ute Tribe as sites for potential wetland or upland development (fig. 3).

Samples of fish tissue were composited from five individual whole fish of similar species and age class. Composite samples of small fish consisted of a minimum of 10 grams WW when available. Fish (minnows) were collected opportunistically by sweep-netting or with trammel nets. Aquatic plants were collected as whole composite samples of single taxa and

Table 1. Sampling sites in the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Site identification numbers consist of 6-digit latitude, 7-digit longitude, and a 2-digit sequence number for sites 1-20]

Site number (figs. 2 and 3)	Site name	Site identification	Applicable Utah Water-Quality Class[1]			
			1	2	3	4
1	Mitigation Area 6—Channel to west pond	400937110112401	C	B	A	Yes
2	Mitigation Area 5—Gray Mountain Canal inflow to oxbow	401158110061301	C	B	A	Yes
3	Mitigation Area 5—Open drain to oxbow in Section 27	401158110054201	C	B	A	Yes
4	Mitigation Area 4—Gray Mountain Canal inflow to pond	401037110080601	C	B	A	Yes
5	Mitigation Area 3—Outflow from oxbow in center of Section 29	401147109541601		B	B	Yes
6	Mitigation Area 2—Spring in pond, 1000 West 8000 South	401112110002701		B	B	Yes
7	Mitigation Area 2—Seepage from Dry Gulch Canal to pond	401210110022301		B	B	Yes
8	Mitigation Area 1—Wissiup Ditch at diversion from Duchesne River	401138109453201		B	B	Yes
9	Seepage inflow to north side of Bottle Hollow Reservoir	401752109524901		B	B	Yes
10	Outflow from Bottle Hollow Reservoir at dam	401728109523701		B	A	Yes
11	Open drain from Ouray School Canal on Independence Road	401256109511801		B	B	Yes
12	Myton Townsite Canal at discharge to Duchesne River	401213109513501		B	B	Yes
13	Seepage from Red Cap Canal near State Roads 86-87	401414110130001	C	B	A	Yes
14	Seepage from lateral 5 of Lake Fork Canal near State Roads 86-87	401533110130501	C	B		Yes
15	West Fork of Deep Creek Canal at 7000 North 10000 East near LaPoint	402413109484301		B	A	Yes
16	C Canal at State Road 87 south of Upalco	401611110130401	C	B		Yes
17	White River at State Road 88 near Ouray	400351109402501		B	C	Yes
18	Henry Jim Canal at State Road 88 crossing near Randlett	401346109430001	C	B		Yes
19	Dry Gulch Creek at State Road 88 crossing above Uinta River	401429109513001		B	B	Yes
20	Antelope Creek at 10500 South Street near Bridgeland	400858110122101	C	B	A	Yes
21	Randlett Farms west of Ft. Duchesne	4012561095120		B	B	Yes
22	Oxbow Pond in Area 5	4012031100538	C	B	A	Yes
23	Pond in Area 6	4009421101125	C	B	A	Yes
24	Oxbow Pond at 6000 West in Area 5	4012021100608	C	B	A	Yes

[1]Utah Water-Quality Class refers to the beneficial use designation:

1C—Protected for domestic purposes with prior treatment.
2B—Protected for secondary contact recreation such as boating or wading.
3A—Protected for cold water species of game fish and other cold water aquatic life.
3B—Protected for warm water species of game fish and other warm water aquatic life.
3C—Protected for nongame fish and other aquatic life.
4—Protected for agricultural uses. Utah Class 4 applies to all sites.

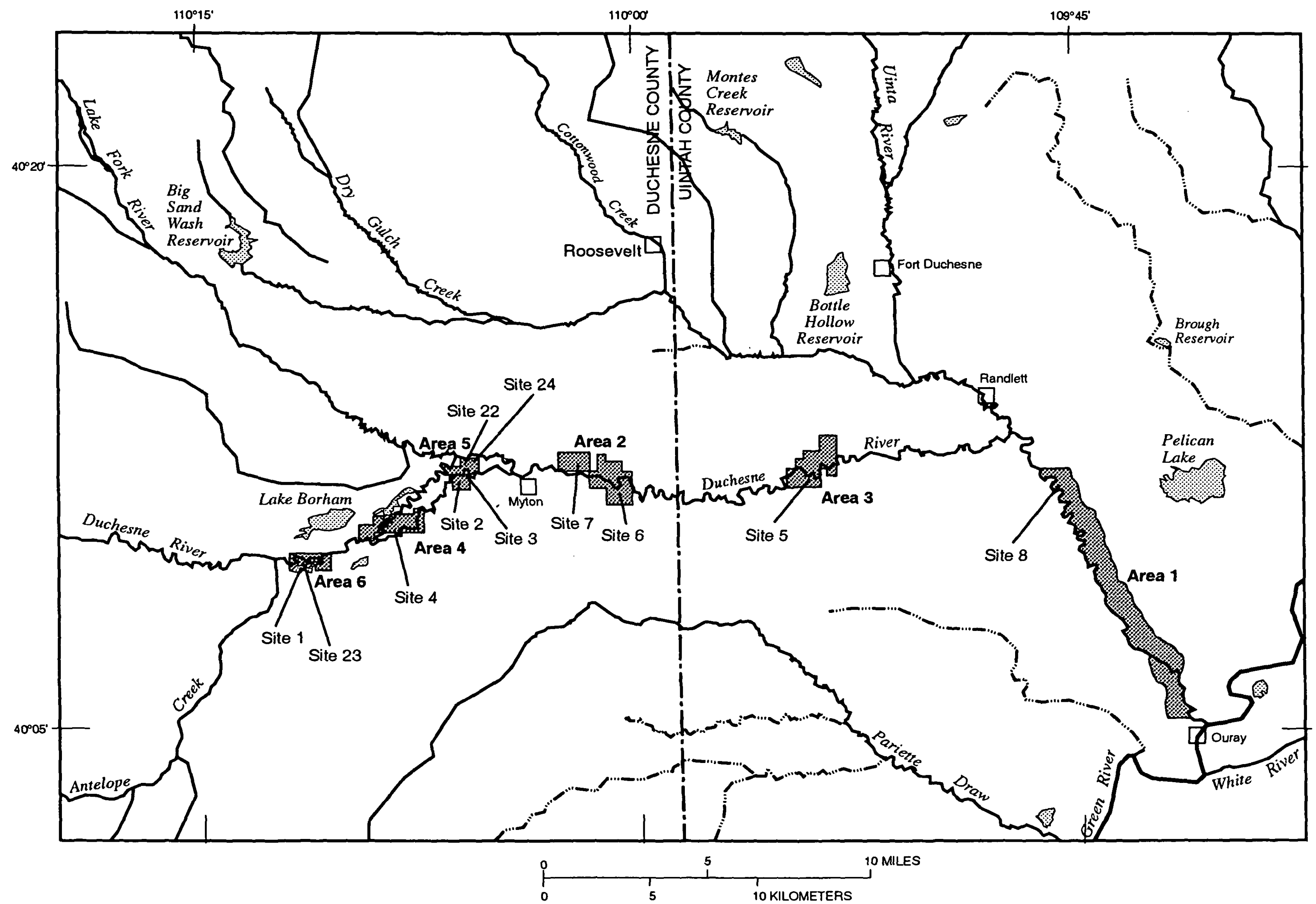

Figure 3. Location of sampling sites within wetland and upland areas being considered for development by the Ute Tribe. Area numbers are consistent with those assigned by the Central Utah Project.

Table 2. Concentrations of constituents determined in equipment field blanks during water sampling at the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[°C, degrees Celsius; mg/L, milligrams per liter; <, less than; µg/L, micrograms per liter]

Site number (fig. 2)	Site name	Date	Time	Solids, dissolved, residue at 180 °C (mg/L)	Alkalinity, lab (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Sodium, dissolved (mg/L as Na)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
15	West Fork of Deep Creek Canal at 7000 North 10000 East near Lapoint	08-23-95	1426	2	2.0	<0.02	<0.01	<0.10	<0.20	<0.10	<0.10
17	White River at State Road 88 near Ouray	07-19-95	1400	<1	1.4	<.02	<.01	<.10	<.20	<.10	<.10

Site number	Date	Sulfate, dissolved (mg/L as SO_4)	Arsenic, dissolved (µg/L as As)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Copper, dissolved (µg/L as Cu)	Lead, dissolved (µg/L as Pb)	Mercury, dissolved (µg/L as Hg)	Molybdenum, dissolved (µg/L as Mo)	Selenium, dissolved (µg/L as Se)	Uranium, natural, dissolved (µg/L as U)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
15	08-23-95	<.10	<1	<10	<1.0	<1	<1	<1	<.1	<1	<1	<.40	<1	<3
17	07-19-95	<.10	<1	<10	<1.0	<1	<1	<1	<.1	<1	<1	<.40	<1	<3

stored in plastic bags. Invertebrate samples were collected with light traps (Espinosa and Clark, 1972) and by picking from bottom sediment and plants. Invertebrate samples were sorted by taxa with forceps if sufficient biomass could be obtained or composited. Bird eggs were collected randomly from nests and measured, and the contents were examined to determine embryo presence, age, and condition. Nests were revisited to determine whether eggs hatched. If unhatched eggs were found, they were examined.

All forceps, pans, scalpels, and other small instruments used to process samples were rinsed with a 10-percent solution of nitric acid, followed by acetone, and then rinsed with deionized water. Samples were either stored in acid-cleansed glass jars or in plastic bags. Ten tissue samples (bird eggs and fish) were collected and either placed in ultra-cleansed jars or wrapped in aluminum foil and placed in a plastic bag, frozen, and analyzed for organochlorine compounds. Samples of invertebrates and plants were collected as available. Samples were placed on dry ice in the field and kept frozen until delivered to the laboratory for chemical analysis. All analyses were performed at Geochemical and Environmental Research Group in College Station, Texas, under contract with the USFWS. Samples were analyzed for arsenic and selenium by hydride generation or graphite furnace atomic-absorption spectroscopy (AAS), for mercury by cold vapor AAS, and for other trace elements by using inductively coupled plasma atomic-emission spectroscopy. Ten samples were analyzed for organochlorine pesticide residues by solvent extraction and analysis using gas-liquid chromatography (GLC).

Laboratory quality control was assured through the Patuxent Analytical Control Facility (PACF) of the USFWS, Laurel, Maryland. The precision and accuracy of laboratory analyses were confirmed with procedural blanks, duplicate analyses, test recoveries of spiked material, and reference-material analyses. Interlaboratory tests among USFWS and contract analytical laboratories also were part of the PACF quality-assurance review.

Evaluation of Data

Concentrations of constituents and elements in water were evaluated using Utah Water Quality Standards for Class 3 protection (aquatic wildlife) and Class 1C criteria and standards for drinking-water protection (table 1). The association of applicable standards with each site is based on the drainage area in which the site is located, and the standard may not be strictly applicable at each site. There is no State water-quality standard established to protect aquatic wildlife from uranium. However, the concentration of dissolved uranium in µg/L can be expressed as an estimate of alpha radiation, in picocuries per liter (pCi/L), by multiplying by 0.68. The State standard for alpha radiation to protect aquatic wildlife is 15 pCi/L. As there are no State or U.S. Environmental Protection Agency (USEPA) criteria for boron relative to wildlife protection, the recommended maximums of 1,000 µg/L to protect sensitive aquatic organisms (Eisler, 1990) and 5,000 µg/L to protect livestock (Eisler, 1990) were used. The State standard for boron in water used for irrigation is 750 µg/L. As moderate concentrations of selenium have been reported in water and biota within the drainage, the occurrence of this element was examined in all samples. A summary of criteria for selenium effects on biota is presented in table 3. In general, research in the last 10 years has resulted in a lowering of concentration criteria compared to the criteria summarized by Lemly and Smith (1987).

RESULTS OF THE SCREENING STUDY

Water-Quality Data

The concentrations of selected elements and constituents in water samples from sites in the Uintah and Ouray Indian Reservation during 1995 are shown in tables 4 and 5 (at the back of the report). In general, the water was hard, ranging from a calcium bicarbonate to a sodium sulfate type, with a dissolved-solids concentration ranging from 109 mg/L (C Canal at State Road 87) to 3,620 mg/L (seepage inflow to Bottle Hollow Reservoir) (fig. 4). Water from 40 percent of the sites had at least one sample that exceeded the State agricultural standard of 1,200 mg/L for dissolved solids (table 4), and 30 percent of the sites had water samples that exceeded the standard on two collection dates. This is a significant impairment because most of the water is used for agricultural purposes.

Saline water can be hazardous to waterbirds. While adult ducks can excrete salts through the nasal glands, ducklings lack this ability. Mitcham and Wobeser (1988) reported that ducklings given naturally

Table 3. Criteria for selenium effects on fish and wildlife
[µg/L, micrograms per liter; <, less than; >, greater than; mg/kg, milligrams per kilogram; µg/g, micrograms per gram]

Medium	No effect[1]	Level of concern[2]	Toxicity threshold[3]
Water, µg/L (total recoverable)	<1	1-2	[4]>2
Sediment, mg/kg (dry weight)	<2	[5]4	>4
Dietary[6] µg/g (dry weight)	<2	2-3	[7]>3
Waterbird eggs[8], µg/g (dry weight)	<3	[7]3-[9]8	>8
Warm water fish, µg/g (dry weight, whole body)	<3	[7]4	>4
Cold water fish, µg/g (dry weight, whole body)	<2	[8]4	>4

[1]Selenium concentrations less than this criterion in various media do not appear to be related to any discernible adverse effects on fish and wildlife and are typical of background concentrations in environments not affected by selenium.

[2]Selenium concentrations at this criterion in various media are rarely related to any discernible adverse effects on fish and wildlife but are elevated above typical background concentrations.

[3]Selenium concentrations exceeding this criterion in various media appear to be related to adverse effects on some fish and wildlife species, such as increased risk of teratogenesis and embryo mortality.

[4]Peterson and Nebeker (1992).

[5]Lemly and Smith (1987).

[6]Dietary criteria are based on an average daily exposure.

[7]Lemly (1993).

[8]Waterbird criteria are based on population mean.

[9]Skorupa and Ohlendorf (1991).

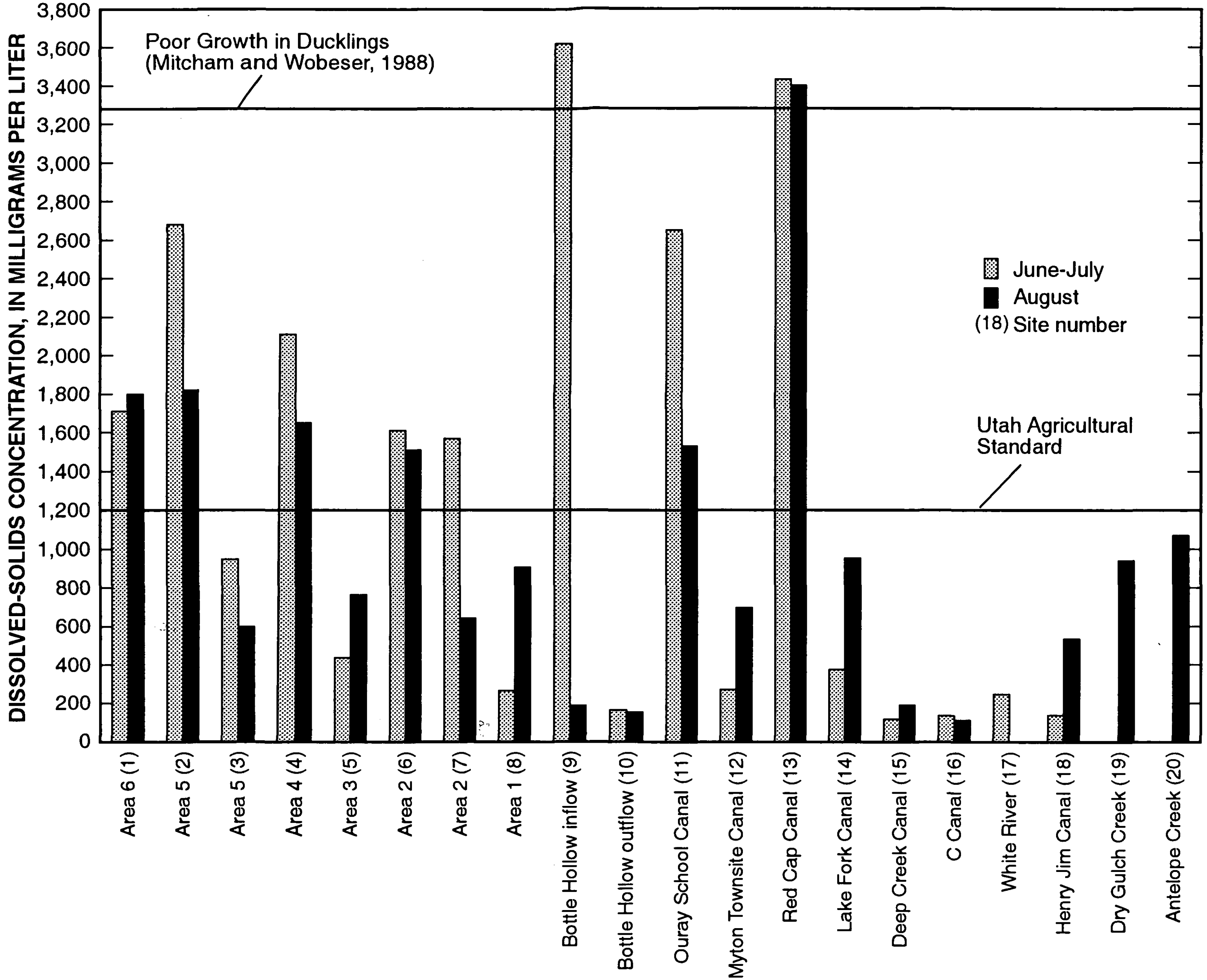

Figure 4. Dissolved-solids concentration in water from the Uintah and Ouray Indian Reservation of eastern Utah, 1995.

saline water with conductivity values of 3,750 to 7,490 µS/cm grew as well as ducklings given fresh water for up to 14 days. Water with conductivity of 4,000 µS/cm caused poor growth in ducklings after 14 days. At a conductivity of 7,720 µS/cm (about 5,300 mg/L dissolved solids), ducklings grew poorly during a 14-day experiment, and 60 percent of ducklings given water with a conductivity of 20,000 µS/cm died. Although dissolved solids with conductivities as high as 4,220 µS/cm in some waters in the study area may adversely affect some crops, it is unlikely that they are hazardous to waterbirds.

Water temperatures and dissolved-oxygen concentrations at several sites did not meet Utah Class 3A or 3B standards for aquatic wildlife protection. The Class 3A water-temperature maximum is 20°C. This value was exceeded at several sites in water samples collected in August. Sites where the standard is applicable and was exceeded were limited to site 4 (Mitigation Area 4) (25°C) and site 20 on Antelope Creek (21°C). The Class 3 wildlife-protection standards for dissolved oxygen specify a minimum concentration for 3A of 8 mg/L for early life stages of sensitive species and 4 mg/L for other species; for 3B of 5 mg/L and 3 mg/L, respectively; and for 3C a minimum of 3 mg/L. These values were not met in water sampled in June at site 6 (2.7 mg/L), and site 11 (2.2 mg/L) or in August at site 6 (2 mg/L) and site 7 (0.4 mg/L) (fig. 5). Generally, the failure of water to meet dissolved-oxygen standards at these sites was because the associated ground water also was low in dissolved oxygen.

Because there is no State aquatic-wildlife standard for dissolved boron, the recommended maximums of 1,000 µg/L to protect sensitive aquatic species and 5,000 µg/L to protect livestock (Eisler, 1990) were used as a guideline. The concentration of boron ranged from 40 to 10,000 µg/L in water samples collected for this study. Concentrations exceeded 1,000 µg/L at 11 sites (fig. 6). The State water-quality standard for boron is

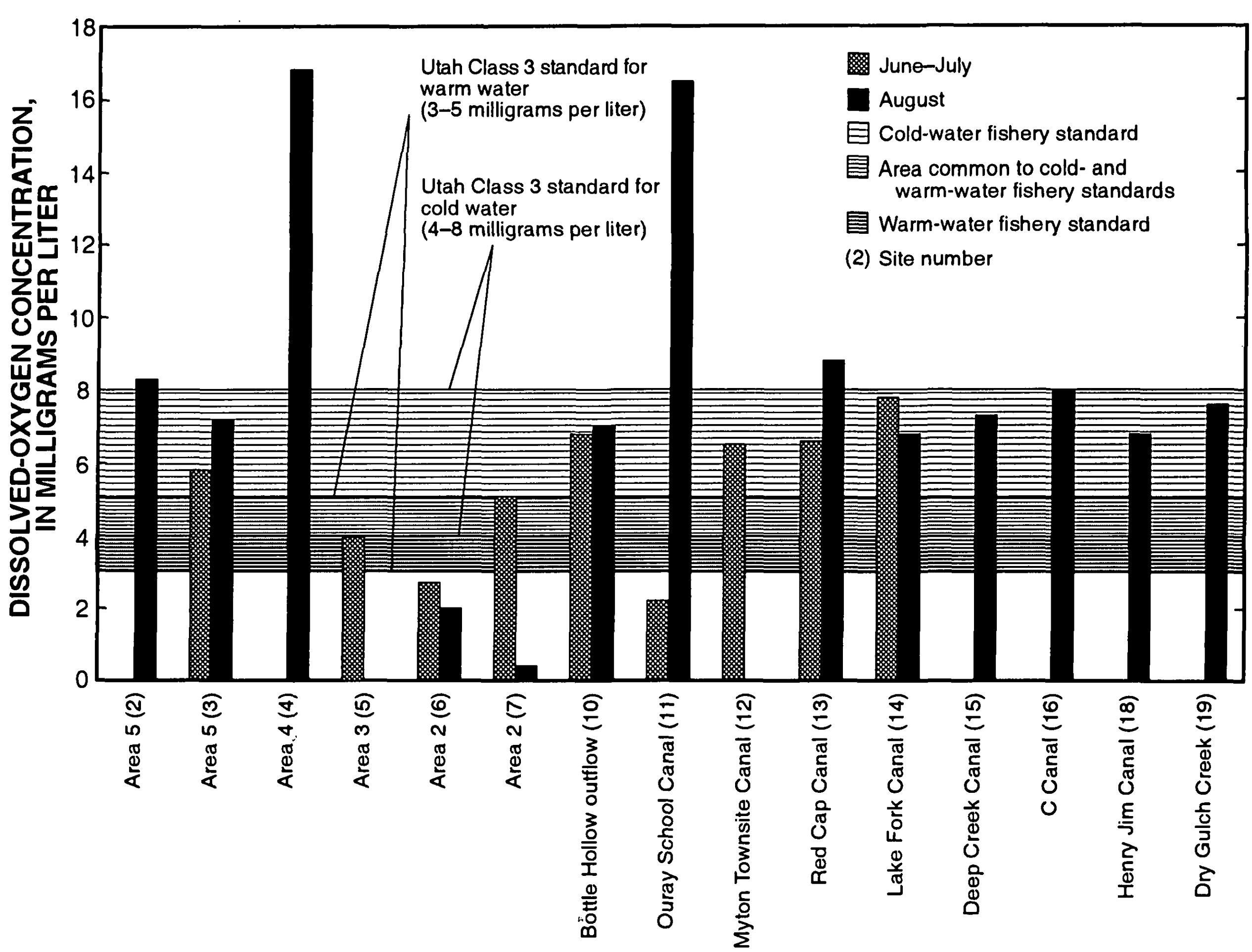

Figure 5. Concentration of dissolved oxygen in water samples from the Uintah and Ouray Indian Reservation of eastern Utah, 1995.

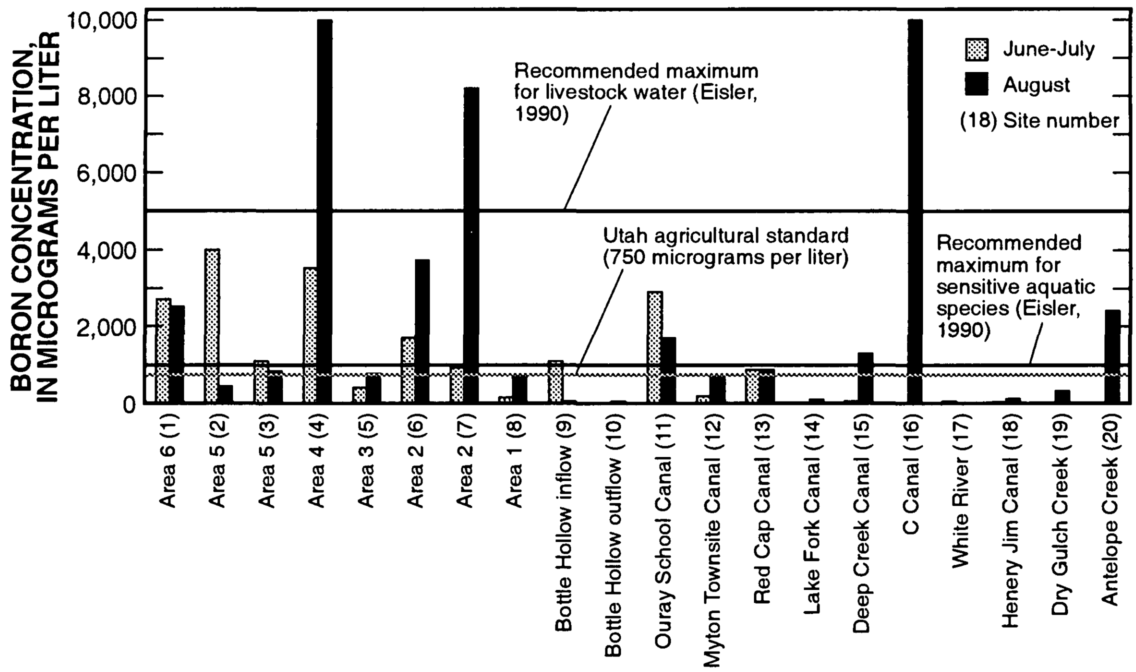

Figure 6. Concentration of dissolved boron in water samples from the Uintah and Ouray Indian Reservation of eastern Utah, 1995.

750 μg/L to protect sensitive crops. Concentrations of boron in 20 (54 percent) of the 37 water samples from 12 sites analyzed exceeded 750 μg/L. Samples collected during both June through July and August at seven of the sites had boron concentrations consistently greater than 800 μg/L. Alfalfa, the dominant crop in the area, is tolerant to boron concentrations of 2,000 to 4,000 μg/L. The recommended maximum concentration of boron in livestock drinking water is 5,000 μg/L, although livestock can tolerate up to 40,000 μg/L, and adverse effects typically occur at concentrations greater than 150,000 μg/L (Eisler, 1990). Concentrations of boron from sites 4, 7, and 16 in August exceeded the recommended maximum of 5,000 μg/L for livestock water. The discharge at site 16 (C Canal at State Road 87) was 100 ft^3/s, which results in a daily boron load of 5,300 pounds. The C Canal receives water from the Lake Fork River, and a water sample from the Lake Fork River collected in 1993 contained only 560 μg/L.

Uranium was the only other constituent present in elevated concentrations which, when expressed as alpha radiation, exceeded the water-quality standard of 15 pCi/L (for drinking water supply, wildlife protection, and agricultural use) in seepage entering Bottle Hollow Reservoir (100 μg/L as uranium, 68 pCi/L as alpha radiation). The source of the uranium in the seepage is not known, but soils in the Uintah Basin contain about 2.4 to 5.2 ppm DW uranium (Tidball and Severson, 1982). Uranium also is present in concentrations from 0.1 to 10 μg/L in most water (Hem, 1985). Concentrations exceeding 10 μg/L were found only at sites 4, 9, 13, 14, and 19 (figs. 2 and 3).

Concentrations of selenium in water samples did not exceed a recognized level of concern of 2 μg/L (table 3). Concentrations of 2 μg/L were present in June in the Gray Mountain Canal inflow at Mitigation Area 4 (site 5), and in August in seepage from the Red Cap Canal (site 13) and in Antelope Creek (site 20). Selenium concentrations in water did not appear to be hazardous to fish or waterfowl in this study.

The effects of irrigation water on potential surface drinking-water supplies on Reservation lands appear to be insignificant. Of the constituents measured, only uranium was present at a concentration that exceeded water-quality criteria for drinking-water supplies from sites that could be use-classified as Utah Class 1C (table 1).

Bottom-Sediment Data

The concentrations of selected inorganic elements in bottom sediment collected from each site and representative values from soils in the Uinta Basin and part of eastern Colorado are shown in table 6 (at back of report). In general, most elements were present in bottom sediment at concentrations similar to those found in soils in the area. However, several sites contained bottom sediment that exceeded background concentrations for several elements. In Mitigation Area 4, sediment near the inflow of Gray Mountain Canal contained the alkaline earth minerals calcium and strontium at more than twice the concentrations found in soils; molybdenum concentration was three times as great as in soils; and selenium concentration, at 2 µg/g DW, was more than three times as great as in soils. It is unlikely that the calcium and strontium concentrations pose any problems because calcium and strontium have low toxicities and these concentrations are within the broad range of concentrations observed for soils throughout the United States (Shacklette and others, 1971) and are indicative of soils formed under conditions of carbonate deposition. Molybdenum in range plants can be toxic to grazing animals (at concentrations greater than 10-12 µg/g DW for sheep) when copper concentrations are low, but there is no information on the effects of molybdenum on waterbirds. The source of the molybdenum may be fertilizer or naturally occurring mineral deposits such as molybdenite, which has been reported in the Duchesne River Basin near Ouray, Utah (Bullock, 1960). The selenium concentration, at 2 µg/g DW, is more than in typical soils but is less than the 4 µg/g DW regarded as a toxicity threshold for adverse effects on wildlife (Lemly and Smith, 1987).

Concentrations of aluminum, cobalt, and scandium in bottom sediment of the Myton Townsite Canal at the point of discharge to the Duchesne River slightly exceeded the upper ranges reported for soils in the area, but were too low to endanger wildlife. In Mitigation Area 6, the open channel to a small pond contained concentrations of lead (32 µg/g DW) and strontium (1,400 µg/g DW) that were as high as or higher than the upper range for soils in the area. The 90 µg/g DW boron concentration appears high relative to other sediment samples from the area but is within the range of <20 to 300 µg/g DW for soils in the United States (Shacklette and others, 1971). As indicated in the previous paragraph, strontium has low toxicity; and the lead concentration, although higher than normal for soils, is considerably less than the 132 µg/g DW value regarded as a toxicity threshold (U.S. Environmental Protection Agency, 1987b). Bottom sediment from Antelope Creek near Bridgeland contained an arsenic concentration of 25 µg/g DW, which is at the upper range for soils in the area and near the value of 33 µg/g DW regarded as a toxicity threshold for adverse effects on wildlife (U.S. Environmental Protection Agency, 1987b).

Bottom sediment associated with seepage from the Red Cap Canal near State Roads 86 and 87 contained selenium at a concentration of 4 µg/g that may adversely affect wildlife. This was the highest selenium concentration measured in bottom sediment but the extent of the contamination and its local effect on biota are not known.

Concentrations of chlorinated hydrocarbon compounds in bottom sediment from four sites are shown in table 7 (at the back of the report). All compounds were present in concentrations less than analytical reporting levels, except DDE at 0.2 µg/kg DW in sediment from the pond at Mitigation Area 4, which receives water from the Gray Mountain Canal. The compounds DDE and DDD are degradation products of DDT. All three compounds are very toxic to aquatic life and most criteria for their occurrence in sediment use a total value for all three forms. Using data from the lowest 10 percentile of concentrations where adverse effects were observed, Long and Morgan (1990) calculated the threshold level of effect to be 3 µg/kg DW. This indicates an unknown amount of DDT contamination was present at this site in Mitigation Area 4 but has degraded or been diluted to a no-effect concentration.

Biological Data

Wildlife Observations

All sampled areas were near the Duchesne River (fig. 3). Mitigation Areas 5 and 6 were affected by high water levels for about 10 days because of localized and spring flooding. Wetland areas were extensively searched for near-water nests and upland waterbird nests.

Mitigation Area 1 (Wissiup Bottom, site 8) had the potential for considerable waterbird use but was not sampled because of the extensive flooding. Potential sources of contamination are irrigation drainage from adjacent cropland and from fuel and oil leakage from a pump operating on the irrigation ditch. This area is located about 3 miles southeast of the confluence of the Duchesne and Uintah Rivers.

Mitigation Area 2 was sampled at two sites separated by the Duchesne River. Invertebrates and plants were collected south of the river (site 6). The largest pond is a spring and ground-water-fed oxbow with vegetation composed primarily of bulrush. The site north of the river (site 7) was partly affected by flooding for about 10 days. The largest pond at this site is lined with cattails and bulrush. Fish, invertebrates, and plants were collected from the large pond, and invertebrates and plants were collected from a small pond to the southeast.

The largest pond at Mitigation Area 3 is an old oxbow fed by irrigation water from the Myton Townsite Canal. The pond is thickly vegetated with bulrush and cattail. Invertebrates, plants, and a mallard egg from in and around the pond were sampled.

The largest pond at Mitigation Area 4 is fed by irrigation water from the Gray Mountain Canal. Water flows out of the pond and across the area in a small channel. An oil sheen was observed on the pond twice and ground-water seepage into the pond was evident. Fish, plants, invertebrates, and bird eggs were collected in this area.

Sampling focused on two sites in Mitigation Area 5 that were contiguous with canal flow from Mitigation Area 4. The west site (site 24) receives water from a branch of the Duchesne River that flows through Mitigation Area 4 to the east site (site 22) in Area 5. The west site consists of a series of beaver ponds where fish and invertebrates were collected. The east site is a deep oxbow lined with bulrushes. It receives water from the west site and from a canal paralleling 5500 West Street near Myton. Plants and invertebrates were collected from this site.

Mitigation Area 6 has an extensive wetland surrounding a pond and much of the area is on private land that extends onto Reservation lands. Samples were collected on the Reservation part of the area. Extensive waterbird use of the pond was observed. Sources of water were the Gray Mountain Canal and seeps. Invertebrates, plants, and bird eggs were collected at this site.

A large pond was sampled at the Ute Tribe's Randlett Farms 2.5 miles west and 1.25 miles south of Randlett. A similar pond lies farther east but was not sampled. Sources of water are the Ouray School Canal from the west and seepage from the north. There was waterbird use of the pond, and large numbers of leopard frogs (*Rana pipiens*) were observed in late summer. Fish, bird eggs, plants, and invertebrates were sampled at this site.

Because the study focused on small ponds and drainages, the body of Bottle Hollow Reservoir was not investigated. However, samples of bird eggs were collected where a small tributary enters the reservoir in the northeast corner.

A seep downgradient from the Red Cap Canal was sampled adjacent to Highway 86. One plant sample was collected.

Biological Tissue Analyses

In 1995, 54 samples of biota were collected and analyzed for trace elements, and 10 samples were collected and analyzed for hydrocarbon residues. Trace elements were analyzed in 14 samples of plants, 21 samples of invertebrates, 7 samples of fish (3 for organic residues), and 12 samples of waterbird eggs (7 for organic residues). Waterbird eggs collected and analyzed for trace elements included two American coot (*Fulica americana*), two pied-billed-grebe, four mallard (*Anas platyrhyncos*), three cinnamon teal (*Anas cyanoptora*), and one sora rail (*Porzana carolina*). Nesting attempts were monitored until their fate was determined. Contaminant-related reproductive effects were not observed; however, all but two eggs collected were incubated less than 13 days. One egg failed to hatch but this failure was not associated with elevated concentrations of any trace elements. Fish samples consisted of small, unidentified fish or minnows except at Mitigation Area 5 where common carp were collected.

Concentrations of trace elements are presented in tables 8 through 11. Generally, concentrations of trace elements in biological tissues are less than thresholds associated with adverse effects. In some samples, however, concentrations of selenium, boron, and vanadium, either singly or in combination, were considered at or greater than threshold levels.

Concentrations of boron in food items used by waterbirds are summarized in figure 7. Geometric-mean boron concentration in aquatic macroinvertebrates (including Corixidae, Chironomidae, and Odonates) on the Uintah and Ouray Indian Reservation ranged from 6.4 to 22.8 µg/g DW. Boron concentration in individual samples ranged from 9.0 in aquatic invertebrates to 722 µg/g DW in *Potamogeton* spp. (tables 8 and 9), plankton was as high as 82 µg/g. It is uncertain if waterbirds feeding on these foods are adversely affected by the boron content. Smith and Anders (1989) and Stanley and others (1996) showed that mallards fed 1,000 µg/g DW dietary boron laid eggs that had substantially lower hatching success. Similarly, Stanley and others (1996) found the duckling growth also was substantially reduced at 1,000 µg/g DW. The presence of varying amounts of protein in the diets appears to complicate determination of the effects of selenium and boron (Stanley and others, 1996; Hoffman and others, 1991). However, no eggs were found with boron concentrations that equaled or exceeded values associated with reproductive impairment (Stan-

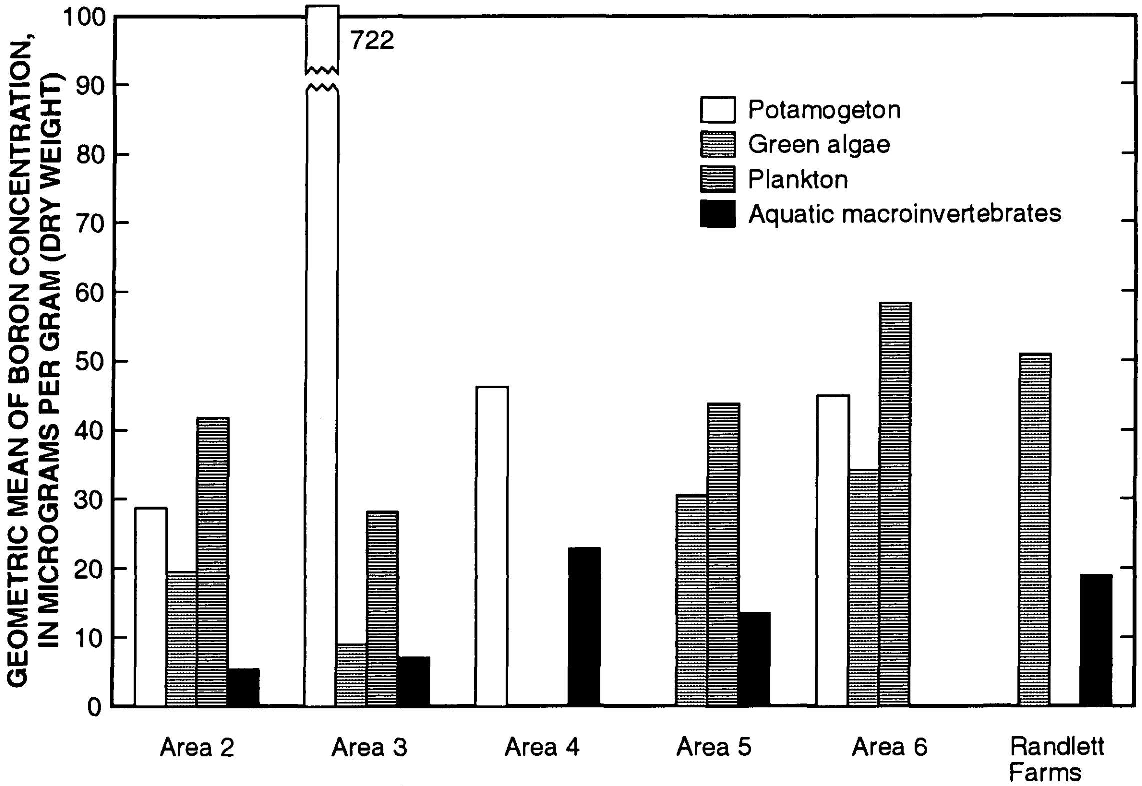

Figure 7. Geometric-mean concentration of boron in potamogeton, green algae, plankton, and aquatic macroinvertebrates from sites in the Uintah and Ouray Indian Reservation of eastern Utah, 1995.

ley and others, 1996). Concentrations of boron in green algae (including Chara) and non-planktonic invertebrates appeared closely correlated, but comparisons with other species were hampered by sample sizes. Boron concentrations exceeded 3 μg/g DW in four waterbird eggs (from less than 2.0 to 6.6 μg/g DW) (table 10). Boron concentration in fish ranged from 1.2 to 17.7 μg/g DW.

Concentrations of selenium in biota generally were low. The selenium concentration in plants did not exceed the dietary level of concern of 3 μg/g DW (Lemly, 1993). In aquatic invertebrates from Mitigation Areas 4 and 6, five samples (24 percent) had concentrations exceeding 3 μg/g DW. Geometric-mean concentrations in invertebrates were highest (10.7 μg/g DW) at Mitigation Area 4 and exceeded 3 μg/g DW in water boatmen (Corixidae) at Mitigation Area 6 (fig. 8). The highest concentration of selenium in fish, 8.3 μg/g DW, was from Mitigation Area 4 and exceeded the reproductive toxicity threshold for fish of 4 μg/g DW (Lemly, 1993). The selenium concentration in water from Mitigation Area 4 was 2 μg/L. Concentrations of selenium in all waterbird eggs were less than the known reproductive toxicity threshold of 8 μg/g DW in populations. Only eggs from Mitigation Area 6 and Bottle Hollow Reservoir had concentrations of selenium that exceeded the 3 μg/g DW for reproductive effects (Lemly, 1993). Unfortunately, fish samples were not available from Mitigation Area 6 for comparison. No important interactions between selenium and boron in waterbirds have been identified (Stanley and others, 1996).

Vanadium concentrations in biological tissues generally were less than established effect levels. For some biota, effect levels have not been established. However, the concentration of vanadium in plankton from Mitigation Areas 2, 3, and 6 ranged from 2.0 to 7.9 μg/g DW, which was at or near dietary effect levels of 1.2 and 10 μg/g DW reported for juvenile rainbow trout (Hilton and Bettger, 1988 *in* Hamilton and others, 1996). There is concern that even slightly elevated concentrations of vanadium may act additively or synergistically with trace elements such as selenium to produce adverse effects on biota at concentrations that are less than toxicity threshold levels for individual elements (Hamilton, 1995; Hamilton and others, 1996).

Analyses for organochlorine pesticides and polychlorinated biphenyls (PCBs) were done on three fish

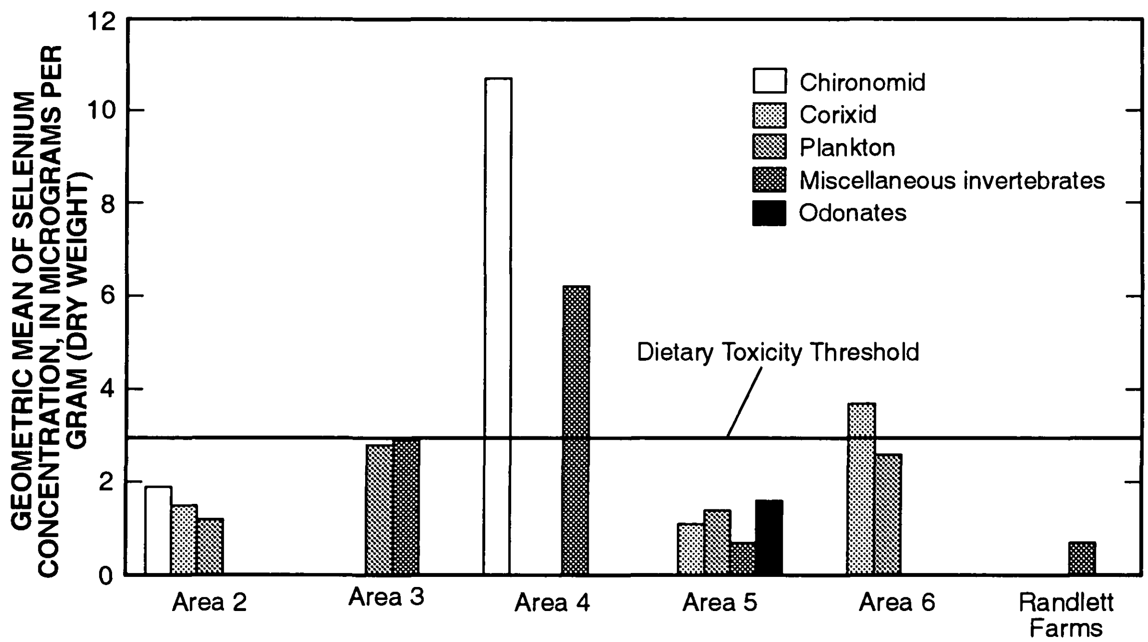

Figure 8. Geometric-mean concentration of selenium in plankton and invertebrates from sites in the Uintah and Ouray Indian Reservation of eastern Utah, 1995.

samples and seven waterbird eggs. Concentrations of most compounds were less than laboratory reporting limits and concentrations of all detected compounds were less than known concern levels (tables 12-15).

SUMMARY AND CONCLUSIONS

The water quality of samples collected at selected sites on the Uintah and Ouray Indian Reservation generally was suitable for use by fish and wildlife. However, the concentration of dissolved salts (as measured by dissolved-solids concentration) was high in water from several sites, particularly where agricultural return flows discharge to the Duchesne River. Dissolved-solids concentration exceeded the State agricultural use standard of 1,200 mg/L at 40 percent of the sites that were sampled. Although these concentrations may adversely affect plant growth, they are not expected to be hazardous to most waterbirds. Water temperatures slightly exceeding 20°C (Utah Class 3A standard for cold water fisheries) were measured at sites 4 and 20 in August 1995.

Dissolved-oxygen concentrations at three sites did not meet the Utah Class 3B standard for wildlife protection. A spring supplying water to Mitigation Area 2 (site 6) had dissolved-oxygen concentrations near 2 mg/L during both samplings, and the concentration in drainage to the Ouray School Canal (site 11) was near 2 mg/L. The only extremely low concentration was 0.4 mg/L, measured in seepage that discharges from the Dry Gulch Canal to a pond in Mitigation Area 2 (site 7). The low oxygen concentrations at these sites are likely caused by the influence of ground water that is typically low in dissolved oxygen. High concentrations of organic material in the water also may deplete oxygen as a result of bacterial respiration.

Dissolved boron was the contaminant most frequently measured at potentially hazardous concentrations in water. Sixty percent of the sites and 54 percent of water samples from the 20 sampling sites had boron concentrations that exceeded the 750 µg/L standard established to protect agricultural crops. At sites 4, 7, and 16, concentrations exceeded the recommended maximum of 5,000 µg/L for watering livestock. Stream discharge at sites 4 and 7 was considerably less than 1 ft^3/s, so the total load was not high. However, the discharge at site 16 (C Canal at State Road 87) was 100 ft^3/s, and the boron concentration was 10,000 µg/L. This is a daily boron load of 5,300 pounds. Because the C Canal receives water from the Lake Fork River by way of the Lake Fork Canal, the high concentrations of boron were unexpected. Sampling done by the CUP on the Lake Fork River downstream near Myton in 1993-94 showed a maximum boron concentration of 560 µg/L.

In June, a concentration of 100 µg/L uranium (68 pCi/L) was detected in seepage entering Bottle Hollow Reservoir at site 9. Although this exceeds most standards for water use, by August the seepage flow was minimal and the uranium concentration declined to 1.2 μg/L. The source of the uranium likely was geologic materials in the seepage flowpath. Concentrations of selenium did not exceed 2 μg/L in any water samples analyzed. Concentrations of the trace elements boron, selenium, and vanadium in biological tissues were equal to, or greater than, levels at which some adverse effects may occur in wildlife. Guidelines for the biological effects of boron in bird diets are unclear, but effects on growth and reproduction are not known to occur until concentrations exceed 1,000 μg/g. Boron was present at concentrations exceeding 3 μg/g in some waterbird eggs, yet no mortalities were observed in 12 waterbird eggs randomly sampled during this study. However, one egg was found that had not hatched, but this might not be related to elevated trace-element concentration. Boron exceeded 30 μg/g in many other biological tissues. Potential effects of boron in the diet of ducklings could include reduced growth.

Generally, selenium concentrations were low in most biological tissues, but elevated concentrations in dietary items (invertebrates) were found in Mitigation Areas 4 and 6. Concentrations of selenium in waterbird eggs were less than 8 μg/g DW, which is the level associated with known reproductive impairment in birds.

Vanadium, a trace element often associated with selenium, was present in plankton from Mitigation Areas 2 and 6 at concentrations near concern levels for sensitive species. The significance of vanadium in these areas is not known, but vanadium may have the ability to act cumulatively or synergistically with other trace elements. Organochlorine and PCB compounds were not detected in waterbird eggs at concentrations known to be hazardous to biota.

Conclusions of the screening study are:

1. High concentrations of dissolved salts, occasionally high water temperatures during summer, and widely fluctuating concentrations of dissolved oxygen may limit the types of aquatic species and their growth and reproduction in some areas of the Uintah and Ouray Indian Reservation.
2. Boron concentrations are moderately high in water and biota samples from many sites, particularly in Mitigation Areas 2, 4, and 5. This could affect development and management of these areas for wildlife or agricultural use by the Ute Tribe. However, adverse effects on waterbird growth and reproduction are expected to be minimal or are unlikely.
3. Selenium generally is not a problem in the area. Only low concentrations were found in biota in Mitigation Areas 4 and 6.
4. The effects of irrigation water on the quality of surface-water drinking supplies are insignificant.

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Table 4. Locations where at least one water sample failed to meet Utah water-quality standards or where biological tissue samples exceeded concentrations associated with adverse effects on biota on the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[mg/L, milligrams per liter; µg/L, micrograms per liter; µg/g, micrograms per gram]

Location	Site number (figs. 2 and 3)	Water			Biological tissue	
		Dissolved-solids concentration	Dissolved oxygen	Boron	Plants/ Invertebrates boron	Invertebrates selenium
Standard or criteria		1,200 mg/L[1]	<3 mg/L[2]	Greater than 750 µg/L[3]	Greater than 1,000 µg/g dry weight	Greater than 3 µg/g dry weight[5]
Mitigation Area 2	6	x	x	x		
Mitigation Area 2	7	x	x	x		
Mitigation Area 3	5				x[4]	
Mitigation Area 4	4	x		x		x
Mitigation Area 5	3			x		
Mitigation Area 5	2	x		x		
Mitigation Area 5	22, 24					
Mitigation Area 6	1	x		x		
Mitigation Area 6	23					x
Bottle Hollow Reservoir inflow	9	x		x		
Ouray School Canal drain	11	x	x	x		
Red Cap Canal seepage	13	x		x		
West Fork Deep Creek Canal	15			x		
C Canal at State Road 87	16			x		
Antelope Creek	20			x		

[1] Utah agricultural-use standard.
[2] Utah Class 3B aquatic-wildlife standard (1-day average).
[3] Utah agricultural-use standard.
[4] Potamogeton contained 720 µg/L. No samples exceeded the 1,000 µg/g threshold identified as hazardous to waterfowl by Stanley and others (1996) and Smith and Anders (1989).
[5] Lowest level for adverse effects in bird diets (Lemly, 1993).

Table 5. Physical properties and concentrations of selected elements and constituents in water samples from sites in the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[ft^3/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; µg/L, micrograms per liter; —, no data; <, less than]

Site number (from table 1, figs. 2 and 3)	Location	Date	Time	Discharge (ft^3/s)	Temperature, water (°C)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)	Solids, dissolved, residue at 180°C (mg/L)	Hardness, total (mg/L as $CaCO_3$)	Alkalinity, lab, (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)
1	Mitigation Area 6—Channel to west pond	06-06-95	0945	0.04	9.0	2,200	7.8	—	—	1,710	940	393	180	120
		08-28-95	1510	.08	19.5	2,350	8.1	—	—	1,800	1,000	356	190	130
2	Mitigation Area 5—Gray Mountain Canal inflow to oxbow	06-06-95	1320	1.5	17.0	3,100	7.9	—	—	2,680	1,200	380	230	150
		08-22-95	1240	1.0	20.0	2,300	7.7	8.3	111	1,820	760	398	140	100
3	Mitigation Area 5—Open drain to oxbow in section 27	06-23-95	1030	.37	15.0	1,320	—	5.8	69	948	430	255	83	55
		08-22-95	1100	4.1	18.0	946	8.0	7.2	92	599	310	271	56	42
4	Mitigation Area 4—Gray Mountain Canal inflow to pond	06-06-95	1045	.58	10.5	2,650	7.8	—	—	2,110	1,000	275	240	100
		08-22-95	1535	.60	25.0	2,070	8.0	16.8	247	1,650	700	263	160	72
5	Mitigation Area 3—Outflow from oxbow in section 29	06-22-95	0930	2.5	15.0	690	—	3.9	46	438	240	182	59	23
		08-29-95	1100	2.1	18.5	1,160	—	—	—	764	420	283	93	45
6	Mitigation Area 2—Spring in Pond near 1000 West 8000 South	06-21-95	1400	.41	10.5	2,200	7.4	2.7	29	1,610	780	393	130	110
		08-22-95	0950	—	13.0	2,020	7.2	2.0	23	1,510	690	373	120	94
7	Mitigation Area 2—Seepage from Dry Gulch Canal to pond	06-22-95	1230	.01	20.0	2,200	—	5.1	67	1,570	460	317	100	52
		08-22-95	0845	—	22.0	1,250	7.5	0.4	6	641	280	249	62	31
8	Mitigation Area 1—Wissiup Ditch at Diversion from Duchesne River	07-19-95	1130	60	21.0	435	8.1	—	—	263	150	112	33	16
		08-29-95	1230	23	22.0	1,380	—	—	—	904	440	272	93	51
9	Seepage inflow to north side of Bottle Hollow Reservoir	06-06-95	1410	.03	20.0	3,700	7.5	—	—	3,620	2,200	279	530	210
		08-29-95	0945	—	23.0	330	—	—	—	186	150	104	40	110
10	Outflow from Bottle Hollow Reservoir	07-20-95	0945	10	20.0	275	7.8	6.8	90	161	120	82	31	9.6
		08-23-95	1525	13	23.5	250	8.2	7.0	100	151	110	86	30	9.3
11	Open drain from Ouray School Canal on Independence Road	06-21-95	1000	.10	12.5	3,500	7.6	2.2	25	2,650	820	510	130	120
		08-21-95	1434	.86	26.5	2,110	8.1	16.5	246	1,530	470	291	76	68
12	Myton Townsite Canal at discharge to Duchesne River	06-21-95	1230	1.7	16.0	450	7.8	6.5	79	270	160	133	42	14
		08-21-95	1545	.01	20.5	1,040	7.9	—	—	695	350	246	73	41
13	Seepage from Red Cap Canal near State Roads 86, 87	06-22-95	1415	.02	24.0	4,200	—	6.6	96	3,430	940	341	230	89
		08-23-95	1045	.02	20.0	4,220	7.9	8.8	119	3,400	760	343	180	76

Table 5. Physical properties and concentrations of selected elements and constituents in water samples from sites in the Uintah and Ouray Indian Reservation of eastern Utah, 1995—Continued

Site number (from table 1, figs. 2 and 3)	Date	Potassium, dissolved (mg/L as K)	Sodium, dissolved (mg/L as Na)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Sulfate, dissolved (mg/L as SO_4)	Arsenic, dissolved (µg/L as As)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Copper, dissolved (µg/L as Cu)	Lead, dissolved (µg/L as Pb)	Mercury, dissolved (µg/L as Hg)	Molybdenum, dissolved (µg/L as Mo)	Selenium, dissolved (µg/L as Se)	Uranium, natural, dissolved (µg/L as U)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
1	06-06-95	4.1	200	55	2.1	780	4	2,700	<1.0	<1	<1	<1	<0	<0.1	29	<1	6.4	<10
	08-28-95	3.3	190	63	1.8	870	3	2,500	<1.0	<1	<1	<1	<.1	23	1	2.3	3	<10
2	06-06-95	3.4	410	71	1.3	1,400	3	4,000	<1.0	<1	<1	<1	<.1	22	<1	8.3	2	<10
	08-22-95	3.5	260	57	.90	870	3	430	<1.0	<1	<1	<1	<.1	11	<1	5.3	1	<10
3	06-23-95	6.0	120	27	.60	420	3	1,100	<1.0	<1	<1	<1	<.1	16	<1	3.8	2	<3
	08-22-95	6.1	82	21	.50	200	4	820	<1.0	<1	1	<1	<.1	10	<1	3.9	2	5
4	06-06-95	2.5	300	47	1.0	1,200	<1	3,500	<1.0	<1	<1	<1	<.1	41	2	19	1	<10
	08-22-95	2.2	210	39	1.1	860	<1	10,000	<1.0	<1	<1	<1	<.1	38	1	18	1	<10
5	06-22-95	2.6	49	10	.40	150	3	410	<1.0	<1	<1	<1	<.1	6	<1	3.7	1	10
	08-29-95	3.2	97	25	.70	320	4	760	<1.0	<1	<1	<1	<.1	12	<2	10	2	<3
6	06-21-95	2.6	230	59	.70	740	1	1,700	<1.0	<1	1	<1	<.1	19	<1	10	<1	<10
	08-22-95	2.8	220	54	.80	690	<1	3,700	<1.0	<1	1	<1	<.1	20	<1	9.6	<1	<3
7	06-22-95	1.1	340	100	.60	700	4	920	<1.0	<1	1	<1	<.1	2	<1	4.5	3	<10
	08-22-95	6.6	100	34	.50	210	8	8,200	<1.0	<1	2	<1	<.1	6	<1	6.1	3	<3
8	07-19-95	1.5	31	13	.20	78	2	160	<1.0	<1	1	<1	<.1	1	<1	1.9	2	<3
	08-29-95	4.1	130	58	.60	380	4	660	<1.0	<1	2	<1	<.1	6	<1	9.1	3	<3
9	06-06-95	3.7	240	110	3.5	2,100	3	1,100	<1.0	<1	<1	<1	<.1	16	<1	100	5	<10
	08-29-95	1.8	8.3	4.3	.30	49	1	40	<1.0	<1	1	<1	<.1	2	<1	1.2	1	<3
10	07-20-95	1.5	7.9	4.2	.20	42	1	40	<1.0	<1	1	<1	<.1	2	<1	1.7	1	6
	08-23-95	1.5	7.6	4.2	.20	41	1	40	<1.0	<1	<1	<1	<.1	<1	<1	1.5	1	<3
11	06-21-95	.50	580	160	.60	1,200	12	2,900	<1.0	<1	<1	1	<.1	7	<1	4.1	4	<10
	08-21-95	5.7	300	94	.50	740	5	1,700	<1.0	<1	<1	1	<.1	4	<2	3.3	3	<10
12	06-21-95	.60	28	6.6	.30	82	2	190	<1.0	<1	1	<1	<.1	3	<1	3.0	3	7
	08-21-95	2.5	90	23	.70	290	4	670	<1.0	<1	<1	<1	<.1	8	<2	6.5	2	<3
13	06-22-95	4.9	770	95	.70	2,000	<1	870	<1.0	<1	<1	2	<.1	3	<1	20	2	<10
	08-23-95	4.9	730	91	.70	2,000	<1	880	<1.0	<1	<1	<1	<.1	1	2	19	2	<10

Table 5. Physical properties and concentrations of selected elements and constituents in water samples from sites in the Uintah and Ouray Indian Reservation of eastern Utah, 1995—Continued

Site number (from table 1, figs. 2 and 3)	Location	Date	Time	Discharge (ft^3/s)	Temperature, water (°C)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Oxygen, dissolved (mg/L)	Oxygen, dissolved (percent saturation)	Solids, dissolved, residue at 180°C (mg/L)	Hardness, total (mg/L as $CaCO_3$)	Alkalinity, lab, (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)
14	Seepage from lateral 5 of Lake Fork	06-22-95	1530	1.0	16.0	575	8.2	7.8	96	375	280	215	72	25
	Canal near State Roads 86, 87	08-23-95	1000	.27	15.5	1,270	7.7	6.8	84	952	640	298	160	59
15	West Fork of Deep Creek Canal at 7000	07-18-95	1530	3.9	18.5	188	8.4	—	—	115	69	66	17	6.4
	North 10000 East near Lapoint	08-23-95	1425	4.0	22.5	312	8.4	7.3	103	189	130	129	34	12
16	C Canal at State Road 87	07-18-95	1645	162	14.5	230	8.1	—	—	134	100	91	22	12
	south of Upalco	08-23-95	0900	100	17.5	195	7.9	8.0	104	109	89	84	19	10
17	White River at State Road 88 near Ouray	07-19-95	0945	—	19.0	415	8.1	—	—	247	160	125	42	13
18	Henry Jim Canal at State Road 88	07-19-95	1045	10	19.0	220	8.2	—	—	135	88	79	21	8.6
	crossing near Randlett	08-21-95	1655	12	22.5	812	8.3	6.8	94	534	330	225	61	43
19	Dry Gulch Creek at State Road 88 crossing near Uinta River	08-21-95	1324	64	20.5	1,350	8.1	7.6	101	940	460	263	94	54
20	Antelope Creek at 10500 South Street near Bridgeland	08-28-95	1410	3.8	21.0	1,600	8.3	—	—	1,070	520	331	88	74

Table 5. Physical properties and concentrations of selected elements and constituents in water samples from sites in the Uintah and Ouray Indian Reservation of eastern Utah, 1995—Continued

Site number (from table 1, figs. 2 and 3)	Date	Potassium, dissolved (mg/L as K)	Sodium, dissolved (mg/L as Na)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Sulfate, dissolved (mg/L as SO_4)	Arsenic, dissolved (µg/L as As)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Copper, dissolved (µg/L as Cu)	Lead, dissolved (µg/L as Pb)	Mercury, dissolved (µg/L as Hg)	Molybdenum, dissolved (µg/L as Mo)	Selenium, dissolved (µg/L as Se)	Uranium, natural, dissolved (µg/L as U)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
14	06-22-95	2.4	11	6.1	0.70	85	3	70	<1.0	<1	2	<1	<0.1	2	<1	3.0	2	<3
	08-23-95	3.7	36	11	1.2	410	1	100	<1.0	<1	1	<1	<.1	3	<1	12	<1	<3
15	07-18-95	1.2	9.7	2.6	.10	18	<1	40	<1.0	<1	<1	<1	<.1	<1	<1	1.0	2	4
	08-23-95	1.6	14	5.3	.20	28	1	1,300	<1.0	<1	<1	<1	<.1	2	<1	1.4	2	<3
16	07-18-95	1.2	4.1	4.4	.20	14	3	30	<1.0	<1	1	<1	<.1	<1	<1	.80	<1	<3
	08-23-95	.90	3.3	3.5	.20	11	3	10,000	<1.0	<1	<1	<1	<.1	1	<1	.60	1	<3
17	07-19-95	1.2	22	4.0	.20	70	1	50	<1.0	<1	1	<1	<.1	2	<1	1.0	3	9
18	07-19-95	1.2	8.8	4.1	.10	25	1	30	<1.0	<1	1	<1	<.1	<1	<1	.70	2	5
	08-21-95	3.2	47	20	.40	180	2	120	<1.0	<1	1	<1	<.1	2	<1	4.0	2	<3
19	08-21-95	3.8	120	74	.80	360	4	310	<1.0	<1	1	<1	<.1	4	<1	14	4	<3
20	08-28-95	4.1	150	32	1.1	490	6	2,400	<1.0	<1	<1	<1	<.1	28	2	4.9	3	<3

Table 6. Concentrations of selected inorganic elements in the less-than-63-micron fraction of bottom-sediment samples from the Uintah and Ouray Indian Reservation of eastern Utah during 1995 compared with the 95-percent confidence interval for soils in the Piceance Basin, Colorado, and Uintah Basin, Utah, areas representative of the Colorado Plateau

[Concentrations reported in percent or micrograms per gram (dry weight); <, less than; —, no data]

Site number (figs. 2 and 3)	Location	Date	Aluminum, percent	Iron, percent	Calcium, percent	Magnesium, percent	Phosphorus, percent	Potassium, percent	Sodium, percent
	Bottom sediment from the Uintah and Ouray Indian Reservation								
1	Mitigation Area 6—Channel to west pond	08-28-95	4.4	2.2	10	4.0	0.12	2.0	0.72
2	Mitigation Area 5—Gray Mountain Canal inflow to oxbow	08-22-95	2.8	1.1	5.9	1.6	.07	1.3	.42
3	Mitigation Area 5—Open drain to oxbow in Section 27	08-22-95	2.2	.94	7.2	1.4	.07	1.1	.35
4	Mitigation Area 4—Gray Mountain Canal inflow to pond	08-22-95	1.9	.89	25	1.4	.06	.75	.32
5	Mitigation Area 3—Outflow from oxbow in center of Section 29	08-29-95	4.7	1.8	5.2	1.6	.08	1.8	.62
6	Mitigation Area 2—Spring in pond at 1000 West near 8000 South	08-22-95	1.3	.35	1.0	.19	.02	.54	.36
7	Mitigation Area 2—Seepage from Dry Gulch canal to pond	08-22-95	5.5	2.4	7.5	1.7	.11	1.8	.59
8	Mitigation Area 1—Wissiup Ditch at diversion from Duchesne River	08-29-95	2.8	1.0	3.3	.88	.04	1.2	.42
9	Seepage inflow to north side of Bottle Hollow Reservoir	08-29-95	2.1	.84	4.3	.84	.04	1.0	.15
10	Outflow of Bottle Hollow Reservoir	08-23-95	3.6	1.8	5.0	1.3	.06	1.4	.08
11	Open drain from Ouray School Canal on Independence Road	08-21-95	4.1	1.8	3.9	1.5	.06	1.3	.44
12	Myton Townsite Canal at discharge to Duchesne River	08-21-95	6.6	3.4	4.1	2.0	.09	2.0	.61
13	Seepage from Red Cap Canal near State Roads 86, 87	08-23-95	3.7	1.4	3.5	.57	.07	1.4	.67
14	Seepage from lateral 5 of Lake Fork Canal near State Roads 86, 87	08-23-95	5.1	2.4	8.4	1.2	.07	1.5	.20
15	West Fork of Deep Creek Canal at 7000 North 10000 East near Lapoint	08-23-95	2.6	1.1	2.7	.88	.05	1.3	.20
16	C Canal at State Road 87 south of Upalco	08-23-95	.74	.43	.44	.12	.01	.34	.09
18	Henry Jim Canal at State Road 88 crossing near Randlett	08-21-95	5.0	2.2	6.1	1.9	.08	1.8	.15
19	Dry Gulch Creek at State Road 88 crossing above Uinta River	08-21-95	1.2	.51	1.2	.22	.02	.46	.16
20	Antelope Creek at 10500 South Street near Bridgeland	08-28-95	5.2	2.0	8.6	2.8	.10	2.1	1.8
	Soils in Piceance[1] and Uinta Basins[2]								
95-percent confidence interval for all samples		—	3.4-5.8	1-2	.001-11	.45-3.9	—	1.2-3	.14-2.1

Table 6. Concentrations of selected inorganic elements in the less-than-63-micron fraction of bottom-sediment samples from the Uintah and Ouray Indian Reservation of eastern Utah during 1995 compared with the 95-percent confidence interval for soils in the Piceance Basin, Colorado, and Uintah Basin, Utah, areas representative of the Colorado Plateau—Continued

Site number (figs. 2 and 3)	Date	Arsenic (µg/g)	Barium (µg/g)	Beryl-mium (µg/g)	Boron, recover-able (µg/g as B)	Bis-muth (µg/g)	Cad-mium (µg/g)	Cer-ium (µg/g)	Chro-mium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Euro-pium (µg/g)	Gallium (µg/g)
Bottom sediment from the Uintah and Ouray Indian Reservation													
1	08-28-95	<10	450	2	90	<10	<2	49	44	10	25	<2	18
2	08-22-95	24	380	<1	20	<10	<2	32	25	4	9	<2	10
3	08-22-95	<10	340	<1	20	<10	<2	26	18	4	7	<2	5
4	08-22-95	16	150	<1	40	<10	<2	17	17	3	11	<2	6
5	08-29-95	<10	500	1	20	<10	<2	52	34	10	14	<2	11
6	08-22-95	<10	180	<1	<10	<10	<2	14	8	1	3	<2	<4
7	08-22-95	13	520	2	20	<10	<2	51	48	9	24	<2	18
8	08-29-95	<10	470	1	<10	<10	<2	36	21	4	5	<2	6
9	08-29-95	<10	370	<1	10	<10	<2	28	4	19	5	<2	5
10	08-23-95	<10	440	1	<10	<10	<2	42	7	34	10	<2	12
11	08-21-95	<10	470	1	10	<10	<2	43	7	36	11	<2	10
12	08-21-95	<10	500	2	20	<10	<2	68	13	62	26	<2	17
13	08-23-95	<10	1100	1	20	<10	<2	47	5	29	17	<2	9
14	08-23-95	17	440	2	10	<10	<2	59	9	43	20	<2	12
15	08-23-95	<10	440	<1	<10	<10	<2	34	5	22	5	<2	7
16	08-23-95	<10	220	<1	<10	<10	<2	17	1	9	2	<2	<4
18	08-21-95	<10	580	2	<10	<10	<2	55	12	49	15	<2	12
19	08-21-95	<10	380	<1	<10	<10	<2	19	2	10	3	<2	<4
20	08-28-95	25	650	2	30	<10	<2	47	9	43	16	<2	19
Soils in Piceance[1] and Uinta Basins[2]													
95-percent confidence interval		3.5-25	640-2,250	1.1-5.3	—	—	—	25-110	4.4-12	27-94	9.5-95	—	8.6-26

Table 6. Concentrations of selected inorganic elements in the less-than-63-micron fraction of bottom-sediment samples from the Uintah and Ouray Indian Reservation of eastern Utah during 1995 compared with the 95-percent confidence interval for soils in the Piceance Basin, Colorado, and Uintah Basin, Utah, areas representative of the Colorado Plateau—Continued

Site number (figs. 2 and 3)	Date	Gold (µg/g)	Holmium (µg/g)	Lanthanum (µg/g)	Lead (µg/g)	Lithium (µg/g)	Manganese (µg/g)	Mercury (µg/g as Hg)	Molybdenum (µg/g)	Neodymium (µg/g)	Nickel (µg/g)	Niobium (µg/g)	Scandium (µg/g)
Bottom sediment from the Uintah and Ouray Indian Reservation													
1	08-28-95	<8	<4	29	32	13	580	.01	<2	18	18	8	7
2	08-22-95	<8	<4	18	12	37	310	<.01	<2	14	9	<4	3
3	08-22-95	<8	<4	15	7	32	430	.01	4	9	8	<4	3
4	08-22-95	<8	<4	11	6	35	480	<.01	36	<4	11	<4	3
5	08-29-95	<8	<4	25	22	41	320	.01	<2	22	17	8	5
6	08-22-95	<8	<4	8	5	8	35	<.01	6	6	3	<4	<2
7	08-22-95	<8	<4	29	25	42	450	.01	4	22	17	13	8
8	08-29-95	<8	<4	22	6	21	230	<.01	<2	16	8	<4	3
9	08-29-95	<8	<4	14	9	17	200	<.01	<2	12	7	<4	2
10	08-23-95	<8	<4	24	17	27	410	.01	<2	18	14	<4	5
11	08-21-95	<8	<4	25	10	36	360	<.01	<2	18	15	8	6
12	08-21-95	<8	<4	38	17	51	430	.03	<2	29	25	17	12
13	08-23-95	<8	<4	26	14	23	260	.01	<2	20	11	7	4
14	08-23-95	<8	<4	34	10	39	400	.03	<2	24	18	9	7
15	08-23-95	<8	<4	18	9	16	220	<.01	<2	15	8	4	3
16	08-23-95	<8	<4	10	<4	5	120	<.01	<2	7	2	<4	<2
18	08-21-95	<8	<4	32	13	35	320	.02	<2	25	20	9	7
19	08-21-95	<8	<4	10	5	8	160	<.01	<2	7	4	<4	<2
20	08-28-95	<8	<4	27	26	10	540	<.01	2	18	18	7	6
Soils in Piceance[1] and Uinta Basins[2]													
95-percent confidence interval				29-52	4.5-32	14-100	—	.016-.046	2.7-12	—	9.9-40	—	5.5-11

Table 6. Concentrations of selected inorganic elements in the less-than-63-micron fraction of bottom-sediment samples from the Uintah and Ouray Indian Reservation of eastern Utah during 1995 compared with the 95-percent confidence interval for soils in the Piceance Basin, Colorado, and Uintah Basin, Utah, areas representative of the Colorado Plateau—Continued

Site number (figs. 2 and 3)	Date	Selenium, total (µg/g)	Silver (µg/g)	Strontium (µg/g)	Tantalum (µg/g)	Thorium (µg/g)	Tin (µg/g)	Titanium percent	Uranium (µg/g)	Vanadium (µg/g)	Ytterbium (µg/g)	Yttrium (µg/g)	Zinc (µg/g)
Bottom sediment from the Uintah and Ouray Indian Reservation													
1	08-28-95	<10	<2	1,400	<40	11	<5	.22	<100	65	1	15	81
2	08-22-95	<1	<2	290	<40	7	<5	.11	<100	29	1	10	50
3	08-22-95	<1	<2	650	<40	4	<5	.09	<100	21	<1	8	50
4	08-22-95	2	<2	2,200	<40	4	<5	.07	<100	23	<1	6	61
5	08-29-95	<1	<2	300	<40	7	<5	.20	<100	42	1	15	61
6	08-22-95	<1	<2	120	<40	<4	<5	.04	<100	9	<1	4	19
7	08-22-95	<1	<2	580	<40	11	<5	.24	<100	65	2	17	78
8	08-29-95	<1	<2	190	<40	9	<5	.12	<100	24	<1	10	37
9	08-29-95	<1	<2	160	<40	4	<5	.10	<100	18	<1	8	38
10	08-23-95	<1	<2	100	<40	7	<5	.16	<100	47	2	14	55
11	08-21-95	<1	<2	260	<40	10	<5	.16	<100	46	1	13	54
12	08-21-95	<1	<2	360	<40	15	<5	.32	<100	89	2	23	86
13	08-23-95	4	<2	360	<40	7	<5	.15	<100	32	1	13	42
14	08-23-95	<1	<2	490	<40	13	<5	.20	<100	58	1	15	60
15	08-23-95	<1	<2	91	<40	5	<5	.14	<100	24	1	12	35
16	08-23-95	<1	<2	36	<40	<4	<5	.04	<100	8	<1	4	9
18	08-21-95	<1	<2	220	<40	13	<5	.21	<100	82	2	18	72
19	08-21-95	<1	<2	79	<40	<4	<5	.05	<100	11	<1	4	20
20	08-28-95	<10	<2	870	<40	7	<5	.20	<100	59	1	14	67
Soils in Piceance[1] and Uinta Basins[2]													
95-percent confidence interval		.01-.58	—	190-740	—	5.5-16	—	.21-.33	2.4-5.2	40-120	1.4-4.6	11-29	33-110

[1]The Piceance Basin, Colorado, is 80 miles southeast of the study area.

[2]Data from Tidball and Severson (1982).

Table 7. Concentrations of selected chlorinated hydrocarbon compounds in the less-than-2-millimeter fraction of bottom-sediment samples from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per kilogram (dry weight); <, less than]

Site number (figs. 2 and 3)	Location	Date	Aldrin, total in bottom material (µg/kg)	Chlordane, total in bottom material (µg/kg)	P,P-DDT, recover in bottom material (µg/kg)	P,P-DDD, recover in bottom material (µg/kg)	P,P-DDE, recover in bottom material (µg/kg)	Dieldrin, total in bottom material (µg/kg)	Endosulfan, total in bottom material (µg/kg)
1	Mitigation Area 6—Channel to west pond	08-28-95	<0.10	<1.0	<0.10	<0.10	<0.10	<0.10	<0.10
4	Mitigation Area 4—Gray Mountain Canal inflow to pond	08-22-95	<.10	<1.0	<.10	<.10	.20	<.10	<.10
6	Spring in pond, 1000 West 8000 South	08-22-95	<.10	<1.0	<.10	<.10	<.10	<.10	<.10
9	Seepage inflow to north side of Bottle Hollow Reservoir	08-30-95	<.10	<1.0	<1.10	<.10	<.10	<.10	<.10

Site number (figs. 2 and 3)	Date	Endrin, total in bottom material (µg/kg)	Heptachlor, total in bottom material (µg/kg)	Heptachlor epoxide, total in bottom material (µg/kg)	Lindane, total in bottom material (µg/kg)	Methoxychlor, total in bottom material (µg/kg)	Mirex, total in bottom material (µg/kg)	Perthane, total in bottom material (µg/kg)	PCB, total in bottom material (µg/kg)	PCN, total in bottom material (µg/kg)	Toxaphene, total in bottom material (µg/kg)
1	08-28-95	<.10	<.10	<.10	<.10	<.80	<.10	<1.0	<1.0	<1.0	<10.0
4	08-22-95	<.10	<.10	<.10	<.10	<.80	<.10	<1.0	<1.0	<1.0	<10.0
6	08-22-95	<.10	<.10	<.10	<.10	<.80	<.10	<1.0	<1.0	<1.0	<10.0
9	08-30-95	<.10	<.10	<.10	<.10	<.80	<.10	<1.0	<1.0	<1.0	<10.0

Table 8. Trace-element concentrations in aquatic plants from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per gram (dry weight); <, less than]

Site number (figs. 2 and 3)	Location	Species	Percent moisture	Aluminum	Arsenic	Boron	Barium	Beryllium	Cadmium	Chro-mium	Copper
14	Highway 86 Seep	Chara	80.3	209	6.7	17	29	<0.1	<0.1	0.69	1.0
6	Mitigation Area 2	Green Algae	87.1	48	4.4	16	1,485	<.1	.1	.65	6.4
7	Mitigation Area 2	Chara	70.0	20.0	6.1	23	26	<.1	<.1	<.5	<.50
7	Mitigation Area 2	Potamogeton	91.6	96	2.9	29	30	<.1	<.1	1.35	5.2
5	Mitigation Area 3	Chara	82.8	71	4.9	9	274	<.1	<.1	<.5	.6
5	Mitigation Area 3	Potamogeton	89.9	104	1.6	722	93	<.1	<.1	.63	1.8
4	Mitigation Area 4	Chara	76.2	223	3.6	46	34	<.1	<.1	<.5	1.1
3	Mitigation Area 5	Chara	83.8	212	7.0	26	109	<.1	<.1	<.5	2.3
3	Mitigation Area 5	Chara	83.2	350	6.7	36	169	<.1	<.1	<.5	2.7
22	Mitigation Area 5	Potamogeton	88.8	706	7.0	316	56	<.1	<.1	1.99	6.4
23	Mitigation Area 6	Chara	80.0	51	5.6	34	62	<.1	<.1	<.5	1.3
23	Mitigation Area 6	Potamogeton	92.1	178	2.8	45	21	<.1	<.1	.54	1.4
21	Randlett Farms	Chara	86.8	46	31.7	40	84	<.1	<.1	.60	1.6
21	Randlett Farms	Green Algae	87.1	79.	16.5	65	1,427	<.1	<.1	.78	2.1

Table 8. Trace-element concentrations in aquatic plants from the Uintah and Ouray Indian Reservation of eastern Utah, 1995—Continued

Site number (figs. 2 and 3)	Location	Species	Iron	Mercury	Magne-sium	Manga-nese	Molyb-denum	Nickel	Lead	Sele-nium	Stron-tium	Vana-dium	Zinc
14	Highway 86 Seep	Chara	1,339	<0.05	5,126	201	<2	<0.5	<0.5	0.7	2,625	1.8	12
6	Mitigation Area 2	Green Algae	106	<.05	3,437	19	4.8	4	<5	<.5	233	2.8	12
7	Mitigation Area 2	Chara	274	<.05	5,931	1,252	<2	.5	<5	<.5	4,182	2.1	6
7	Mitigation Area 2	Potamogeton	868	<.05	2,562	1,732	<2	1.2	<5	<.5	152	.7	39
5	Mitigation Area 3	Chara	139	<.05	5,639	362	<2	<.5	<5	<.5	1,462	1.3	10
5	Mitigation Area 3	Potamogeton	282	<.05	7,674	1,081	3.3	1.6	<5	<.5	276	1.2	24
4	Mitigation Area 4	Chara	279	<.05	5,315	338	<2	1.6	<5	.6	3,096	1.9	11
3	Mitigation Area 5	Chara	256	<.05	8,628	1,089	<2	.8	<5	<.5	3,043	3.7	21
3	Mitigation Area 5	Chara	419	<.05	8,859	1,377	<2	1.3	<5	<.5	3,439	4.1	22
22	Mitigation Area 5	Potamogeton	886	.05	5,064	2,589	2.3	1.1	.5	.6	567	1.0	19
23	Mitigation Area 6	Chara	127	<.05	8,254	136	<2	<.5	<5	.6	6,698	2.9	11
23	Mitigation Area 6	Potamogeton	456	<.05	4,365	365	3.3	1.1	<5	.9	1,660	2.1	33
21	Randlett Farms	Chara	778	<.05	9,456	2,237	<2	1.2	<5	<.5	1,823	4.6	15
21	Randlett Farms	Green Algae	309	<.05	6,253	1,822	<2	2.6	<5	<.5	606	2.7	16

Table 9. Trace-element concentrations in aquatic invertebrates from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per gram (dry weight); <, less than]

Site number (figs. 2 and 3)	Location	Species	Percent moisture	Aluminum	Arsenic	Boron	Barium	Beryl-lium	Cad-mium	Chro-mium	Copper	Iron
7	Mitigation Area 2	Chironomidae	90.2	3,020	1.4	8.5	52	<0.10	<0.1	7.15	14.2	2,260
7	Mitigation Area 2	Corixidae	86.5	220	<.5	5	10	<.10	<.1	2.03	25.7	253
6	Mitigation Area 2	Corixidae	74.8	8	.7	6.3	<1.0	<.10	.2	.58	19.5	132
6	Mitigation Area 2	Plankton	86.6	4,372	5.9	41.9	33	.23	<.1	5.1	16.9	2,521
7	Mitigation Area 2	Plankton	85.8	2,769	5	45.4	33	.15	<.1	3.97	12.2	1,730
7	Mitigation Area 2	Corixidae	82.2	46	<.5	6.3	5	<.10	<.1	3.37	55.9	157
7	Mitigation Area 2	Plankton	93.1	1,214	3.8	38.2	105	<.10	<.1	7.16	41.8	1,374
5	Mitigation Area 3	Mixed invertebrates	78.5	50	<.5	7.1	4	<.10	<.1	2.01	2.4	162
5	Mitigation Area 3	Plankton	86.5	1,251	5	28.1	33	<.10	<.1	3.01	9.6	1,197
4	Mitigation Area 4	Chironomidae	91.1	1,568	1.1	30.3	23	.11	<.1	4.29	25.8	1,428
4	Mitigation Area 4	Mixed invertebrates	87.2	58	.6	17.1	2	<.10	<.1	2.03	20.2	175
22	Mitigation Area 5	Corixidae	86.4	94	<.5	6.2	15	<.10	<.1	1.06	29	155
22	Mitigation Area 5	Odonates	89.3	164	.5	22.9	8	<.10	<.1	3.8	28.4	201
24	Mitigation Area 5	Mixed invertebrates	91.8	49	.9	17.1	8	<.10	<.1	4.02	13.8	186
24	Mitigation Area 5	Corixidae	93.6	181	.9	13.6	74	<.10	<.1	1.48	10.3	259
24	Mitigation Area 5	Plankton	88.2	176	5.2	43.8	31	.45	<.1	1.62	9.3	521
23	Mitigation Area 6	Corixidae	86.3	154	<.5	6.7	15	<.10	<.1	.98	19.7	238
23	Mitigation Area 6	Corixidae	85.1	126	1.3	18.1	195	<.10	<.1	.95	7.8	215
23	Mitigation Area 6	Plankton	78.3	2,921	7.5	41.2	37	<.10	<.1	4.81	17.6	2,229
23	Mitigation Area 6	Plankton	81	1,947	8.2	82.3	92	.14	<.1	3.37	8.3	1,510
21	Randlett Farms	Mixed invertebrates	90.2	191	1.2	18.9	21	<.10	<.1	1.98	13	258

Table 9. Trace-element concentrations in aquatic invertebrates from the Uintah and Ouray Indian Reservation of eastern Utah, 1995—Continued

Site number (figs. 2 and 3)	Location	Species	Mercury	Magne-sium	Manga-nese	Molyb-denum	Nickel	Lead	Selenium	Strontium	Vanadium	Zinc
7	Mitigation Area 2	Chironomidae	<0.05	2,542	69	<2.0	<1.0	1.3	1.9	105	4	62
7	Mitigation Area 2	Corixidae	<.05	1,379	47	<2.0	<1.0	1.3	1.1	48	<.5	145
6	Mitigation Area 2	Corixidae	.09	1,714	35	<2.0	<1.0	<.5	2.8	76	<.5	135
6	Mitigation Area 2	Plankton	.05	3,945	70	<2.0	3.3	1.9	1.3	980	7.5	96
7	Mitigation Area 2	Plankton	.05	3,752	88	<2.0	1.9	.7	1.2	929	5.7	90
7	Mitigation Area 2	Corixidae	<.05	1,210	6	2.1	<1.0	1.6	1.2	40	.7	165
7	Mitigation Area 2	Plankton	<.05	4,547	18	11.7	1.9	4	1.1	903	7.9	62
5	Mitigation Area 3	Mixed invertebrates	.19	1,374	25	<2.0	<1.0	<.5	2.9	94	<.5	140
5	Mitigation Area 3	Plankton	.08	3,165	40	2.4	1.1	2.8	2.8	596	2.0	85
4	Mitigation Area 4	Chironomidae	<.05	2,820	83	12.8	2.5	.8	10.7	301	3.1	66
4	Mitigation Area 4	Mixed invertebrates	<.05	1,526	16	3.1	<1.0	<.5	6.2	91	<.5	139
22	Mitigation Area 5	Corixidae	.07	1,536	86	<2.0	<1.0	<.5	1	49	.9	180
22	Mitigation Area 5	Odonates	.07	1,676	433	<2.0	<1.0	<.5	1.6	56	.6	77
24	Mitigation Area 5	Mixed invertebrates	<.05	1,861	48	<2.0	<1.0	<.5	.7	74	.9	90
24	Mitigation Area 5	Corixidae	<.05	1,589	120	<2.0	1.4	<.5	1.2	62	1.2	147
24	Mitigation Area 5	Plankton	<.05	3,426	73	<2.0	2.0	.5	1.4	493	<.5	74
23	Mitigation Area 6	Corixidae	<.05	1,510	24	<2.0	1.1	<.5	4.4	30	1.2	138
23	Mitigation Area 6	Corixidae	<.05	1,955	91	<2.0	1.3	<.5	3.1	199	1.0	116
23	Mitigation Area 6	Plankton	<.05	5,057	50	<2.0	2.6	1.1	3.4	1,646	6.9	87
23	Mitigation Area 6	Plankton	.09	5,575	61	<2.0	1.8	.6	2.4	2,385	3.9	82
21	Randlett Farms	Mixed invertebrates	.08	2,018	47	<2.0	<1.0	<.5	.7	68	<.5	119

Table 10. Trace-element concentrations in fish from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per gram (dry weight); <, less than]

Site number (figs. 2 and 3)	Location	Species	Percent moisture	Aluminum	Arsenic	Boron	Barium	Beryllium	Cadmium	Chromium	Copper	Iron
6	Mitigation Area 2	Fathead Minnow	85	680	<0.5	3.3	19	<0.10	<0.1	2.4	5	457
6	Mitigation Area 2	Fathead Minnow	84.1	681	.6	17.7	20	.14	<.1	12.1	7.2	606
4	Mitigation Area 4	Mixed Fish	78.4	69	<.5	5	4	<.10	<.1	1.8	9.2	134
3	Mitigation Area 5	Common Carp	73	116	<.5	1.2	6	<.10	<.1	.9	4.2	185
3	Mitigation Area 5	Common Carp	75.6	268	<.5	1.2	6	<.10	<.1	1.2	3	312
21	Randlett Farms	Mixed Fish	81.7	51	<.5	2.5	8	<.10	<.1	1.4	7.7	101
21	Randlett Farms	Fathead Minnow	85.4	21	<.5	4	5	<.10	<.1	1.6	8.3	72

Site number (figs. 2 and 3)	Location	Species	Mercury	Magnesium	Manganese	Molybdenum	Nickel	Lead	Selenium	Strontium	Vanadium	Zinc
6	Mitigation Area 2	Fathead Minnow	0.05	2,096	54	<2.0	<1	<0.5	1.6	198	0.8	148
6	Mitigation Area 2	Fathead Minnow	<.05	2,208	91	13.2	2.7	<.5	1.4	281	4.0	121
4	Mitigation Area 4	Mixed Fish	.09	1,629	29	<2.0	2.8	<.5	8.3	284	3.0	199
3	Mitigation Area 5	Common Carp	<.05	1,414	56	<2.0	<1	<.5	1.6	272	.8	370
3	Mitigation Area 5	Common Carp	<.05	1,583	32	<2.0	<1	<.5	1.4	258	1.0	377
21	Randlett Farms	Mixed Fish	.13	1,959	33	<2.0	<1	<.5	1.2	238	<.5	138
21	Randlett Farms	Fathead Minnow	.11	2,006	22	<2.0	<1	<.5	1.2	280	<.5	131

Table 11. Trace-element concentrations in waterbird eggs from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per gram (dry weight); see figs. 2 and 3 for site location; where site number is not reported, organisms were collected within the area but not at a numbered site; <, less than]

Site number	Location	Species	Percent moisture	Aliuminum	Arsenic	Boron	Barium	Beryllium	Cadmium	Chromium	Copper	Iron
9	Bottle Hollow Reservoir	American Coot	75.46	<5	<0.5	<2.0	19	<0.1	<0.1	<0.5	2.5	104
9	Bottle Hollow Reservoir	Pied-billed Grebe	77.06	<5	<.5	<2.0	7	<.1	<.1	.68	2.8	130
	Mitigation Area 3	Mallard	69.36	<5	.6	<2.0	5	<.1	<.1	<.5	3.9	121
	Mitigation Area 4	Mallard	67.90	<5	.6	6.6	2	<.1	<.1	<.5	4.0	131
	Mitigation Area 4	Mallard	69.05	<5	.6	3.8	4	<.1	<.1	<.5	3.3	131
	Mitigation Area 4	Sora	75.35	<5	<.5	<2.0	<1	<.1	<.1	<.5	3.1	100
4	Mitigation Area 4	Teal	69.47	<5	1.3	4.6	2	.14	<.1	<.5	5.8	87
23	Mitigation Area 6	American Coot	73.86	<5	<.5	3.2	2	<.1	<.1	<.5	5.4	153
	Mitigation Area 6	Mallard	70.86	<5	.8	<2.0	10	<.1	<.1	<.5	4.8	129
23	Mitigation Area 6	Pied-billed Grebe	75.58	<5	<.5	<2.0	<1	<.1	<.1	.50	3.8	164
	Mitigation Area 6	Teal	69.46	<5	<.5	<2.0	3	<.1	<.1	<.5	3.1	93
21	Randlett Farms	Teal	69.31	<5	<.5	<2.0	3	<.1	<.1	<.5	2.9	109

Site number	Location	Species	Mercury	Magnesium	Manganese	Molybdenum	Nickel	Lead	Selenium	Strontium	Vanadium	Zinc
9	Bottle Hollow Reservoir	American Coot	0.22	477	1.9	<2	<0.5	<0.5	1.8	12.6	<0.5	66
9	Bottle Hollow Reservoir	Pied-billed Grebe	3.54	380	2.8	<2	.6	<.5	3.2	9.9	<.5	55
	Mitigation Area 3	Mallard	.14	488	1.6	<2	<.5	<.5	2.8	17.0	<.5	57
	Mitigation Area 4	Mallard	.15	403	3.0	<2	<.5	<.5	2.4	21.8	<.5	63
	Mitigation Area 4	Mallard	.45	428	2.0	<2	<.5	<.5	2.2	18.6	<.5	62
	Mitigation Area 4	Sora	.47	370	2.3	<2	1.1	<.5	2.0	29.5	.5	56
4	Mitigation Area 4	Teal	.55	342	4.0	<2	<.5	<.5	2.3	35.3	1.2	64
23	Mitigation Area 6	American Coot	.06	574	2.2	4.3	<.5	<.5	4.3	46.5	1.7	58
	Mitigation Area 6	Mallard	.08	443	2.5	<2	.6	<.5	3.3	9.3	2.1	67
23	Mitigation Area 6	Pied-billed Grebe	2.12	424	5.4	2.1	1.3	<.5	6.0	46.3	2.5	61
	Mitigation Area 6	Teal	.20	364	1.8	<2	2.1	<.5	4.3	32.3	2.0	54
21	Randlett Farms	Teal	.22	359	3.2	<2	<.5	<.5	1.2	18.2	1.4	52

Table 12. Concentrations of organochlorine pesticides in waterbird eggs from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per gram (wet weight); where site number is not reported, organisims were collected within the area but not at a numbered site; <, less than]

Site number (figs. 2 and 3)	Location	Species	Percent lipid	Percent moisture	Aldrin	alpha BHC	alpha chlordane	beta BHC	cis-nonachlor	delta BHC
9	Bottle Hollow Reservoir	American Coot	7.69	79.6	<0.00097	<0.00097	<0.00097	<0.00097	<0.00097	<0.00097
	Mitigation Area 3	Mallard	13.50	72.6	<.00076	<.00076	<.00076	<.00076	<.00076	<.00076
	Mitigation Area 4	Mallard	13.02	68.6	<.00094	<.00094	<.00094	<.00094	<.00094	<.00094
	Mitigation Area 4	Mallard	11.21	67.5	<.00096	<.00096	<.00096	<.00096	<.00096	<.00096
23	Mitigation Area 6	American Coot	8.45	77.3	<.00095	<.00095	<.00095	<.00095	<.00095	<.00095
	Mitigation Area 6	Mallard	13.09	72.7	<.00087	<.00087	<.00087	<.00087	<.00087	<.00087
21	Randlett Farms	Teal	11.00	71.3	<.00091	<.00091	<.00091	<.00091	<.00091	<.00091

Site number (figs. 2 and 3)	Location	Dieldrin	Endosulfan II	Endrin	gamma BHC	gamma chlordane	HCB	Heptachlor	Heptachlor epoxide	Mirex
9	Bottle Hollow Reservoir	0.0016	<0.00194	<0.00097	<0.00097	<0.00097	0.00130	<0.00097	<0.00097	<0.00097
	Mitigation Area 3	.0018	<.00153	<.00076	<.00076	<.00076	.00099	<.00076	<.00076	<.00076
	Mitigation Area 4	.0031	<.00188	<.00094	<.00094	.00121	.00145	<.00094	.00110	<.00094
	Mitigation Area 4	<.00096	<.00191	<.00096	<.00096	.00229	<.00096	<.00096	<.00096	<.00096
23	Mitigation Area 6	.0020	<.00190	<.00095	<.00095	<.00095	<.00095	<.00095	<.00095	<.00095
	Mitigation Area 6	.0038	<.00173	<.00087	<.00087	<.00087	<.00087	<.00087	.00232	<.00087
21	Randlett Farms	.0011	<.00182	<.00091	<.00091	<.00091	<.00091	<.00091	<.00091	<.00091

Site number (figs. 2 and 3)	Location	op-DDD	op-DDE	op-DDT	Oxy-chlordane	pp-DDD	pp-DDE	pp-DDT	PCB, total	trans-nonachlor
9	Bottle Hollow Reservoir	<0.00097	<0.00097	<0.00097	<0.00097	<0.00097	0.00921	<0.00097	0.01204	<0.00097
	Mitigation Area 3	<.00076	<.00076	<.00076	<.00076	<.00076	.01804	.00203	.00868	<.00076
	Mitigation Area 4	<.00094	.00166	<.00094	.00322	<.00094	.07574	<.00094	.15313	.00510
	Mitigation Area 4	<.00096	<.00096	<.00096	.00161	<.00096	.04453	<.00096	.10003	.00201
23	Mitigation Area 6	<.00095	<.00095	<.00095	<.00095	<.00095	.01709	<.00095	.01160	<.00095
	Mitigation Area 6	<.00087	<.00087	<.00087	.00097	<.00087	.02063	.00295	<.00087	.00101
21	Randlett Farms	<.00091	<.00091	<.00091	<.00091	<.00091	.02392	<.00091	<.00091	<.00091

Table 13. Concentrations of polychlorinated biphenyls (PCBs) in waterbird eggs from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per gram (wet weight); where site number is not reported, organisms were collected within the area but not at a numbered site; <, less than]

Site number (figs. 2 and 3)	Location	Species	Percent lipid	Percent moisture	PCB 7	PCB 8	PCB 15	PCB 16/32	PCB 18	PCB 22	PCB 24
9	Bottle Hollow Reservoir	American Coot	7.69	79.6	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194
	Mitigation Area 3	Mallard	13.50	72.6	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153
	Mitigation Area 4	Mallard	13.02	68.6	<.00188	<.00188	<.00188	<.00188	<.00188	<.00188	<.00188
	Mitigation Area 4	Mallard	11.21	67.5	<.00191	<.00191	<.00191	<.00191	<.00191	<.00191	<.00191
23	Mitigation Area 6	American Coot	8.45	77.3	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190
	Mitigation Area 6	Mallard	13.09	72.7	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173
21	Randlett Farms	Teal	11.00	71.3	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182

Site number (figs. 2 and 3)	Location	PCB 25	PCB 26	PCB 28	PCB 29	PCB 33	PCB 37/42	PCB 40	PCB 41/64	PCB 44	PCB 45
9	Bottle Hollow Reservoir	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194
	Mitigation Area 3	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153
	Mitigation Area 4	<.00188	<.00188	<.00188	<.00188	<.00188	<.00188	<.00188	<.00188	<.00188	<.00188
	Mitigation Area 4	<.00191	<.00191	<.00191	<.00191	<.00191	<.00191	<.00191	<.00191	<.00191	<.00191
23	Mitigation Area 6	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190
	Mitigation Area 6	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173
21	Randlett Farms	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182

Site number (figs. 2 and 3)	Location	PCB 46	PCB 47/48	PCB 49	PCB 50	PCB 52	PCB 60/56	PCB 66	PCB 70	PCB 74	PCB 82
9	Bottle Hollow Reservoir	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	0.00261	<0.00194	<0.00194	<0.00194	<0.00194
	Mitigation Area 3	<.00153	<.00153	<.00153	<.00153	<.00153	.00207	<.00153	<.00153	<.00153	<.00153
	Mitigation Area 4	<.00188	<.00188	<.00188	<.00188	<.00188	.00300	<.00188	<.00188	<.00188	<.00188
	Mitigation Area 4	<.00191	<.00191	<.00191	<.00191	<.00191	.00840	<.00191	<.00191	<.00191	<.00191
23	Mitigation Area 6	<.00190	<.00190	<.00190	<.00190	<.00190	.00247	<.00190	<.00190	<.00190	<.00190
	Mitigation Area 6	<.00173	<.00173	<.00173	<.00173	<.00173	.00218	<.00173	<.00173	<.00173	<.00173
21	Randlett Farms	<.00182	<.00182	<.00182	<.00182	<.00182	.00231	<.00182	<.00182	<.00182	<.00182

Table 13. Concentrations of polychlorinated biphenyls (PCBs) in waterbird eggs from the Uintah and Ouray Indian Reservation of eastern Utah, 1995—Continued

Site number (figs. 2 and 3)	Location	PCB 83	PCB 84	PCB 85	PCB 87	PCB 88	PCB 92	PCB 97	PCB 99	PCB 101	PCB 105
9	Bottle Hollow Reservoir	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194
	Mitigation Area 3	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153
	Mitigation Area 4	<.00188	<.00188	<.00188	<.00188	<.00188	.01085	<.00188	.01235	.00460	.00594
	Mitigation Area 4	<.00191	.00260	<.00191	<.00191	<.00191	<.00191	<.00191	.00519	<.00191	<.00191
23	Mitigation Area 6	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190
	Mitigation Area 6	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173
21	Randlett Farms	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182

Site number (figs. 2 and 3)	Location	PCB 107/ 108/144	PCB 110/77	PCB 116/ 108/149	PCB 128	PCB 129	PCB 136	PCB 137	PCB 138	PCB 141	PCB 146
9	Bottle Hollow Reservoir	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194
	Mitigation Area 3	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153
	Mitigation Area 4	<.00188	<.00188	.01204	.00223	<.00188	<.00188	<.00188	.02188	<.00188	.00665
	Mitigation Area 4	<.00191	<.00191	.00455	<.00191	<.00191	<.00191	<.00191	.01216	<.00191	.00431
23	Mitigation Area 6	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190
	Mitigation Area 6	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173
21	Randlett Farms	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182

Site number (figs. 2 and 3)	Location	PCB 149	PCB 151	PCB 153	PCB 156/171/ 202	PCB 158	PCB 167	PCB 170	PCB 172	PCB 174
9	Bottle Hollow Reservoir	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194
	Mitigation Area 3	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153
	Mitigation Area 4	<.00188	<.00188	.03146	<.00188	<.00188	<.00188	.00555	<.00188	<.00188
	Mitigation Area 4	<.00191	<.00191	.02264	<.00191	<.00191	<.00191	.00478	<.00191	<.00191
23	Mitigation Area 6	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190
	Mitigation Area 6	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173
21	Randlett Farms	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182

Table 13. Concentrations of polychlorinated biphenyls (PCBs) in waterbird eggs from the Uintah and Ouray Indian Reservation of eastern Utah, 1995—Continued

Site number (figs. 2 and 3)	Location	PCB 177	PCB 178	PCB 180	PCB 183	PCB 185	PCB 187/182/159	PCB 188	PCB 189	PCB 191
9	Bottle Hollow Reservoir	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194
	Mitigation Area 3	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153
	Mitigation Area 4	<.00188	<.00188	0.01425	0.00196	<.00188	0.00710	<.00188	<.00188	<.00188
	Mitigation Area 4	<.00191	<.00191	0.01230	<.00191	<.00191	0.00570	<.00191	<.00191	<.00191
23	Mitigation Area 6	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190
	Mitigation Area 6	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173
21	Randlett Farms	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182

Site number (figs. 2 and 3)	Location	PCB 194	PCB 195	PCB 196	PCB 200	PCB 201	PCB 205	PCB 206	PCB 209	PCB Unknown
9	Bottle Hollow Reservoir	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194	<0.00194
	Mitigation Area 3	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153	<.00153
	Mitigation Area 4	<.00188	<.00188	0.00188	<.00188	<.00188	<.00188	<.00188	<.00188	<.00188
	Mitigation Area 4	0.0026	<.00191	0.00219	<.00191	0.00324	<.00191	<.00191	<.00191	<.00191
23	Mitigation Area 6	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190	<.00190
	Mitigation Area 6	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173	<.00173
21	Randlett Farms	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182	<.00182

Table 14. Concentrations of polychlorinated biphenyls (PCBs) in fish from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per gram (wet weight); <, less than]

Site number (figs. 2 and 3)	Location	Species	Percent lipid	Percent moisture	PCB 7	PCB 8	PCB 15	PCB 16/32	PCB 18	PCB 22	PCB 24
6	Mitigation Area 2	Fathead Minnow	0.81	85.85	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038
3	Mitigation Area 5	Common Carp	1.77	75.27	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038
21	Randlett Farms	Mixed Fish	0.91	83.52	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040

Site number (figs. 2 and 3)	Location	PCB 25	PCB 26	PCB 28	PCB 29	PCB 33	PCB 37/42	PCB 40	PCB 41/64	PCB 44	PCB 45
6	Mitigation Area 2	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038
3	Mitigation Area 5	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	.00038	<.00038
21	Randlett Farms	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040

Site number (figs. 2 and 3)	Location	PCB 46	PCB 47/48	PCB 49	PCB 50	PCB 52	PCB 60/56	PCB 66	PCB 70	PCB 74	PCB 82
6	Mitigation Area 2	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	0.00062	<0.00038	<0.00038	<0.00038	<0.00038
3	Mitigation Area 5	<.00038	<.00038	<.00038	<.00038	<.00038	.00066	0.00043	<.00038	.00054	<.00038
21	Randlett Farms	<.00040	<.00040	<.00040	<.00040	<.00040	.00061	<.00040	<.00040	<.00040	<.00040

Site number (figs. 2 and 3)	Location	PCB 83	PCB 84	PCB 85	PCB 87	PCB 88	PCB 92	PCB 97	PCB 99	PCB 101	PCB 105
6	Mitigation Area 2	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	0.00055	<0.00038	<0.00038
3	Mitigation Area 5	<.00038	<.00038	<.00038	<.00038	<.00038	.00140	<.00038	.00050	<.00038	<.00038
21	Randlett Farms	<.00040	<.00040	<.00040	<.00040	<.00040	.00082	<.00040	<.00040	<.00040	<.00040

Table 14. Concentrations of polychlorinated biphenyls (PCBs) in fish from the Uintah and Ouray Indian Reservation of eastern Utah, 1995—Continued

Site number (figs. 2 and 3)	Location	PCB 10/ 108/144	PCB 110/77	PCB 116/ 108/149	PCB 128	PCB 129	PCB 136	PCB 137	PCB 138	PCB 141	PCB 146
6	Mitigation Area 2	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038
3	Mitigation Area 5	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038
21	Randlett Farms	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040

Site number (figs. 2 and 3)	Location	PCB 149	PCB 151	PCB 153	PCB 156/171/ 202	PCB 158	PCB 167	PCB 170	PCB 172	PCB 174
6	Mitigation Area 2	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038
3	Mitigation Area 5	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	.00165	<.00038	<.00038
21	Randlett Farms	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040

Site number (figs. 2 and 3)	Location	PCB 177	PCB 187	PCB 180	PCB 183	PCB 185	PCB 187/182/ 159	PCB 188	PCB 189	PCB 191
6	Mitigation Area 2	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038
3	Mitigation Area 5	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038
21	Randlett Farms	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040

Site number (figs. 2 and 3)	Location	PCB 194	PCB 195	PCB 196	PCB 200	PCB 201	PCB 205	PCB 206	PCB 209	PCB Unknown
6	Mitigation Area 2	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038
3	Mitigation Area 5	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038	<.00038
21	Randlett Farms	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040	<.00040

Table 15. Concentrations of organochlorine pesticides in fish from the Uintah and Ouray Indian Reservation of eastern Utah, 1995

[Concentrations reported in micrograms per gram (wet weight); <, less than]

Site number (figs. 2 and 3)	Location	Species	Percent lipid	Percent moisture	Aldrin	alpha BHC	alpha chlordane	beta BHC	cis-nonachlor	delta BHC	Dieldrin
6	Mitigation Area 2	Fathead Minnow	0.81	85.85	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019
3	Mitigation Area 5	Common Carp	1.77	75.27	<.00019	.00053	<.00019	<.00019	<.00019	<.00019	<.00019
21	Randlett Farms	Mixed Fish	.91	83.52	<.00019	.00066	.00034	<.00019	<.00019	<.00019	<.00019

Site number (figs. 2 and 3)	Location	Endosulfan	Endrin	gamma BHC	gamma chlordane	HCB	Heptachlor	Heptachor epoxide	Mirex	op-DDD
6	Mitigation Area 2	<0.00038	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019	<0.00019
3	Mitigation Area 5	<.00038	<.00019	<.00019	<.00019	<.00019	<.00019	0.00029	<.00019	.00023
21	Randlett Farms	<.00040	<.00019	<.00019	<.00019	<.00019	<.00019	<.00019	<.00019	<.00019

Site number (figs. 2 and 3)	Location	op-DDE	op-DDT	Oxy-chlordane	pp-DDD	pp-DDE	pp-DDT	PCB-Total	trans-nonachlor
6	Mitigation Area 2	<0.00019	<0.00019	<0.00019	<0.00019	0.00084	<0.00019	0.00330	<0.00019
3	Mitigation Area 5	.00028	<.00019	<.00019	.00326	.00586	<.00019	.00664	.00020
21	Randlett Farms	<.00019	<.00019	<.00019	.00265	.00506	<.00020	.00226	.00024

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