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1982 ENVIRONMENTAL MONITORING REPORT U.S. DEPARTMENT OF ENERGY FACILITIES - GRAND JUNCTION, COLORADO, AND MONTICELLO, UTAH

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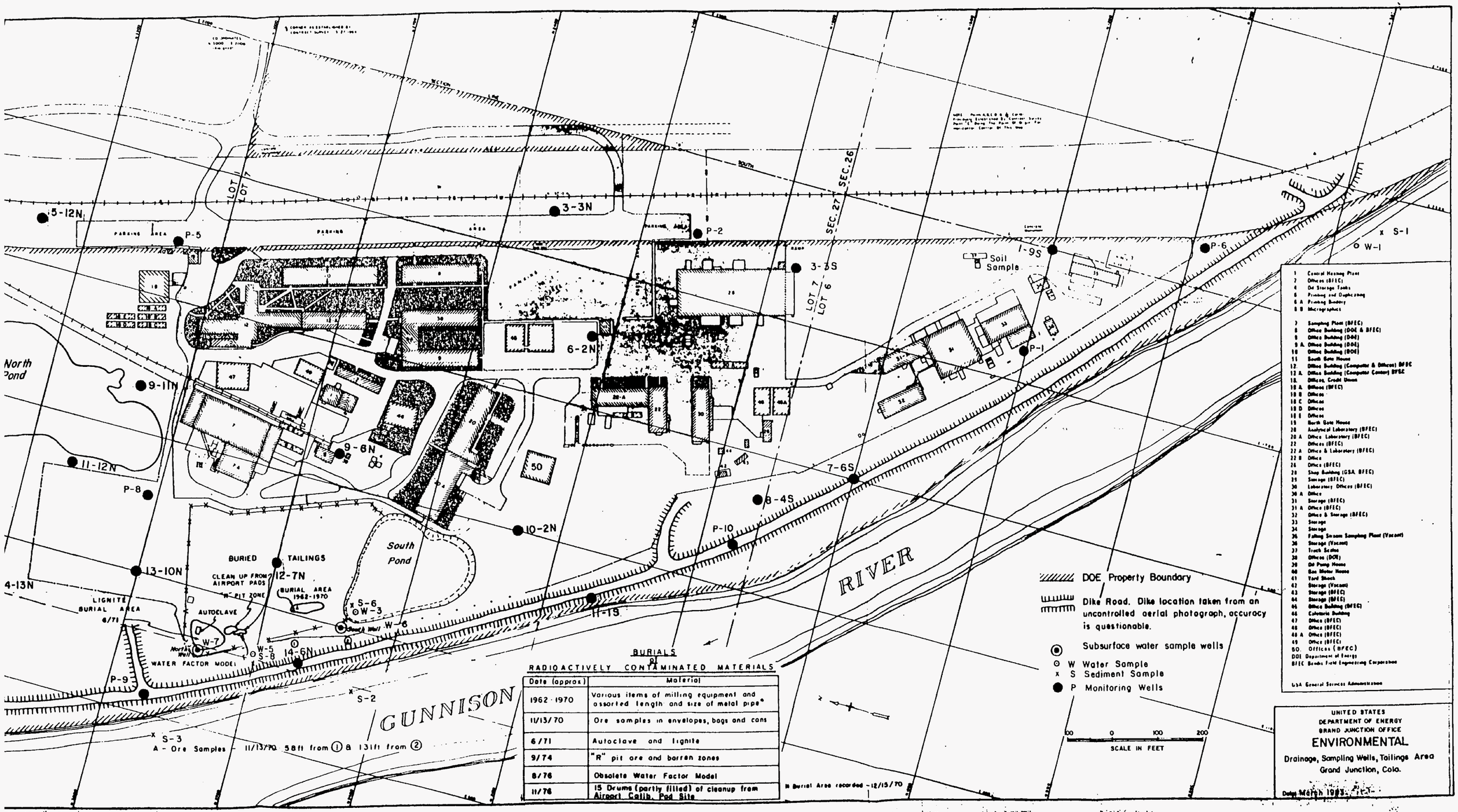
ABSTRACT

The shallow gravel aquifer underneath the Grand Junction, Colorado, Department of Energy facility is contaminated by uranium-mill tailings. According to Colorado water-quality standards, the aquifer is unfit for agricultural use--the lowest-use classification. This report describes 1982 monitoring activities and the location and levels of contamination. The contaminated aquifer's threat to the nearby Gunnison River system is probably negligible, but this cannot be verified without additional testing. Because there were no significant process changes and because no significant air-quality impacts were noted in previous years, no air-quality data were obtained in 1982.

The shallow aquifer underneath the Monticello, Utah, property is also contaminated by uranium-mill tailings. The creek flowing through the property is contaminated at levels exceeding Utah water-quality standards for several miles downstream. This report describes a portion of a much larger environmental study currently underway at the site. Levels of water contamination and radon emission probably require mitigation to meet State of Utah and Federal regulations.



BURIALS

RADIOACTIVELY CONTAMINATED MATERIALS

Date (approx)	Material
1962-1970	Various items of milling equipment and assorted length and size of metal pipe*
11/13/70	Ore samples in envelopes, bags and cans
6/71	Autoclave and lignite
9/74	"R" pit ore and barren zones
8/76	Obsolete Water Factor Model
11/76	15 Drums (partly filled) of cleanup from Airport Calib. Pad Site

* Burial Area recorded - 12/15/70

Figure 1. Drainage, Sampling Wells, and Tailings Area, Grand Junction Area Office, U.S. Department of Energy, Grand Junction, Colorado

INTRODUCTION

This report describes environmental monitoring activities carried out at the Grand Junction Area Office (GJAO) and the uranium mill site in Monticello, Utah. The Grand Junction Area Office is located on a 48.6-acre tract along the Gunnison River, south of the city of Grand Junction. Forty-three buildings house the many functions of the organization. The Monticello, Utah, facility covers a tract approximately 77 acres in size. This area is fenced with six access gates. The site contains an estimated 1.6 million tons of stabilized radioactive mill tailings.

GRAND JUNCTION AREA OFFICE

The Grand Junction Area Office (GJAO), U.S. Department of Energy (DOE), develops, supports, and/or administers a variety of programs. Historically, the office has been most heavily involved in uranium procurement, evaluating domestic uranium resources, and advancing geologic and geophysical exploration techniques. In recent years the scope of activities has broadened to include providing considerable support to the Government's various remedial action programs and to the National Waste Terminal Storage (NWTS) program. Housed on the facility are fully equipped laboratories for analytical chemistry, mineralogy-petrology, and electronics. Research groups at the facility have also received funding for specific projects from a variety of entities ranging from the Environmental Protection Agency to the Department of Defense. Bendix Field Engineering Corporation (BFEC) is the operating contractor for the government-owned/contractor-operated (GOCO) facility.

AIR QUALITY

No air-quality monitoring activities were carried out at the GJAO facility in 1982. The 1980 and 1981 reports (BFEC-1981-3 and BFEC-1982-4, respectively) described air-quality impacts from the sample plant, analytical laboratory, employee automobiles, and the central heating plant. It was concluded that no significant impacts were observed or expected.

Current operations at GJAO do not emit significant quantities of radiation into the atmosphere. The only source of radon emission is the tailings buried on the compound. Radon flux measurements taken in 1979 indicated that there may be a violation of the EPA standard for inactive uranium mill tailings along the west boundary of the compound. Additional surveys for the determination of radon emission are planned in 1984.

For additional details, refer to Radiometric Survey of the Grand Junction Facility (BFEC-1982-5).

PCB (POLY-CHLORINATED BIPHENYLS) MONITORING

During 1982 a program was completed that identified and determined the total quantity of PCBs and PCB-contaminated fluids on the facility. All facility transformers were opened and oil samples taken. These samples were analyzed, based on methods and standards provided by the EPA, in the facility's

chemistry laboratory. Of 51 tested units, four were PCB transformers (500 parts per million or greater) and 13 were found to be PCB-contaminated (50 to 499 ppm). The four PCB transformers contain approximately 324 gallons of fluid. The 13 PCB-contaminated transformers contain approximately 830 gallons of fluid. In addition to these units, the facility has approximately 20 pounds of PCB-contaminated waste material which will soon be disposed of in accordance with EPA regulations.

WATER MONITORING

The water monitoring program was improved substantially in 1982 by the addition of a series of new monitoring wells. The purpose of the new wells was to provide a comprehensive characterization of the contaminated aquifer underneath the GJAO facility. The new wells were sampled twice, once in July and again in October. The original monitoring network was sampled in April, July, and October.

Sampling

Ground- and surface-water samples were collected with a peristaltic pump. Samples were filtered through a 0.45 m filter in-line with the collection vessel. Samples were preserved and analyzed according to procedures prescribed in Methods for Chemical Analysis of Water and Wastes (EPA-600/4-79-020). Measurements of pH, conductivity, and Eh were performed in the field with a flow-through cell to exclude air. The alkalinity measurement was made at the time of collection with a Hach digital titrator.

Contamination Sources

There are no point-source discharges or waste treatment activities on the facility. Water contamination is the result of uranium mill tailings and tailings-contaminated materials. Uranium milling, analysis, and storage were all carried out for 25 to 30 years; these activities ceased in the mid-1970s. All present contamination is believed to be the result of these past activities. There is an area designated as containing buried tailings; however, several surveys (BFEC-1982-5) have indicated the presence of tailings at other locations.

Surface Water

Figure 1 shows the surface water sites sampled in 1982. The data are contained in Tables 1 and 2. The North Pond is contaminated principally by uranium. Recharge is by the shallow gravel aquifer underlying the compound. Contamination levels are similar to those observed in previous years. The uranium concentration in the three samplings averaged more than 0.7 milligrams per liter (mg/l).

The South Pond was formerly used as a sewage lagoon. Currently, its principal source of effluent is storm run-off from the parking lots. Only slight contamination with uranium is observed; the average of five samples in two years

Table 1. Analyses of Surface Water Samples Collected at GJAO

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l Co	mg/l Cu	mg/l F	mg/l Fe	mg/l K
North Pond	4/82	<0.05	0.025	--	--	318	<0.025	0.83	<1	<0.1	--
North Pond	7/82	<0.10	0.017	<0.10	306	675	--	--	2	0.09	31
North Pond	10/82	<0.10	0.023	<0.10	400	460	--	--	--	<0.05	38
South Pond	4/82	0.2	0.025	--	--	106	<0.025	<0.025	2	0.32	--
South Pond	7/82	<0.10	<0.001	<0.10	61	140	--	--	2	0.22	3.6
South Pond	10/82	<0.10	<0.001	<0.10	43	58	--	--	--	0.20	6
Drainage Ditch	4/82	<0.05	0.025	--	--	220	<0.025	<0.025	<1	0.75	--
Drainage Ditch North	7/82	<0.10	0.088	0.10	175	125	--	--	2	0.36	19
Drainage Ditch South	7/82	<0.10	0.026	<0.10	138	122	--	--	2	0.30	9
Drainage Ditch	10/82	<0.10	0.020	<0.10	230	94	--	--	--	0.05	35

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l Ni	mg/l NO_3-N	mg/l PO_4	pCi/l ^{226}Ra	mg/l Se	mg/l Si
North Pond	4/82	--	0.046	0.15		<0.025	<1	3	<2	0.007	--
North Pond	7/82	217	0.05	0.07	1210	--	2	--	<2	<0.010	4.9
North Pond	10/82	294	0.12	0.07	1225	--	<1	--	--	<0.010	8.6
South Pond	4/82	--	<0.025	0.05	108	<0.025	<1	<1	<2	<0.005	--
South Pond	7/82	18	<0.05	0.13	76	--	<1	--	<2	<0.010	3.2
South Pond	10/82	11	<0.05	0.11		--	<1	--	--	<0.010	1.2
Drainage Ditch	4/82	--	0.046	5.20		<0.025	<1	<1	<2	<0.005	--
Drainage Ditch North	7/82	57	0.27	0.52	290	--	<1	--	9.	<0.010	7.3
Drainage Ditch South	7/82	45	0.06	0.14	191	--	<1	--	<2	<0.010	11.1
Drainage Ditch	10/82	48	0.55	0.33	191	--	2	--	--	0.010	6.0

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh
North Pond	4/82	2812	0.86	0.030	<0.025	8.2	2080	21	235	--
North Pond	7/82	3459	0.850	<0.050	<0.050	7.9	8100	40	257	--
North Pond	10/82	3822	0.5	<0.05	<0.05	7.8	5500	13	235	-100
South Pond	4/82	120	--	0.030	0.030	7.3	550	14	128	--
South Pond	7/82	127	0.008	<0.050	<0.050	7.4	860	20	160	--
South Pond	10/82	52	0.011	<0.05	0.05	7.2	400	12	165	- 80
Drainage Ditch	4/82	700	3.44	0.030	<0.025	7.5	1160	17	428	--
Drainage Ditch North	7/82	952	0.500	<0.050	<0.050	7.7	2150	28	534	--
Drainage Ditch South	7/82	412	0.120	<0.050	<0.050	7.5	2100	38	381	--
Drainage Ditch	10/82	510	1.4	<0.05	<0.05	7.6	1350	9	380	+ 60

Table 2. Gunnison River Samples

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l Co	mg/l Cu	mg/l F	mg/l Fe	mg/l K
Upstream (S-1)	4/82	0.16	<0.025	--	--	7	<0.025	<0.025	<1	0.13	--
Upstream (S-1)	10/82	<0.10	<0.010	<0.10	88	8	--	--	--	<0.05	5
Middle (S-4)	4/82	<0.05	<0.025	--	--	5	<0.025	<0.025	<1	<0.1	--
Middle (S-4)	10/82	<0.10	<0.010	<0.10	90	4	--	--	--	<0.05	3
Downstream (S-5)	4/82	<0.05	<0.025	--	--	6	<0.025	<0.025	<1	<0.1	--
Downstream (S-5)	10/82	<0.10	<0.010	<0.10	112	46	--	--	--	0.05	6

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l Ni	mg/l NO_3-N	mg/l PO_4	pCi/l ^{226}Ra	mg/l Se	mg/l Si
Upstream (S-1)	4/82		<0.025	<0.02	--	<0.025	<1	<1	<2	<0.005	--
Upstream (S-1)	10/82	30	<0.05	<0.05	49	--	<1	--	--	<0.010	6.0
Middle (S-4)	4/82		<0.025	<0.02	--	<0.025	<1	1	<2	<0.005	--
Middle (S-4)	10/82	32	<0.05	<0.05	52	--	<1	--	--	<0.010	5.4
Downstream (S-5)	4/82		<0.025	<0.02	--	<0.025	<1	<1	<2	<0.005	--
Downstream (S-5)	10/82	33	<0.05	<0.05	76	--	<1	--	--	<0.010	5.3

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh
Upstream (S-1)	4/82	138	---	<0.025	0.025	7.8	450	11	97	--
Upstream (S-1)	10/82	248	0.008	<0.05	<0.05	8.2	600	11	130	+155
Middle (S-4)	4/82	158	---	<0.025	0.025	7.5	450	20	83	--
Middle (S-4)	10/82	296	0.008	<0.05	<0.05	8.5	550	9	130	+100
Downstream (S-5)	4/82	157	---	<0.025	0.025	7.4	420	11	104	--
Downstream (S-5)	10/82	323	0.011	<0.05	<0.05	7.9	970	15	135	+ 60

was 0.012 mg/l. Previously, this pond has been characterized by a very high Biochemical Oxygen Demand (BOD). This measurement was not repeated in 1982, but levels should be very much decreased since the sewage input has been eliminated.

The drainage ditch has been shown previously as a source of very high levels of uranium mill tailings contaminants, particularly uranium, molybdenum, and radium. Formerly, the South Pond overflowed into the ditch more or less continuously. However, it has been observed on numerous visual inspections that the lagoon has not contained enough water to overflow since the compound was connected to the city sewer system in 1981.

Chemical analysis of the ditch water showed some substantial changes since the South Pond overflow has ceased. Radium is no longer detectable. Levels of iron and aluminum have dropped as much as two orders of magnitude from 1981 measurements. Not all concentrations have changed, however; the amount of uranium and molybdenum remains very high.

The Gunnison River was sampled upstream, downstream, and alongside the facility in April and in October. No significant differences in the three samples were noted for either sampling period. Slight increases for a few ions are evident, but the differences are not sufficient to suggest contamination from the site.

It was obvious that the level of water in the ditch rose and fell with the river level; thus, there is a strong likelihood that contaminated water enters the river. Apparently, the volume of water in the river is sufficient to quickly dilute contaminants to background levels. The 1981 Environmental Monitoring Report described some weak evidence for river contamination. This is explained in part by the lower average flows in the river in 1981 relative to 1982. The river flow for the sampling dates in 1982 were 790 cubic feet per second (cfs), 1380 cfs, and 1760 cfs for the April, July, and October sampling dates, respectively.

An additional problem in assessing possible contamination of the river is the nature of the samples collected. All the river samples have been "grab" samples collected from the river bank. Studies have shown that this does not yield an accurate picture of the concentration of material in a river (see, for example, Jaffe et al., 1982). A more extensive sampling study should be performed to verify whether the river is affected by the GJAO compound.

Ground Water

The ground-water monitoring network is now rather extensive. Thirty-two new monitoring wells have been added to the north and south wells first described in the 1980 report and wells P-1 through P-10 first described in the 1981 report (Figure 1).

The chemical analyses of the wells will be described empirically. The data cannot be interpreted in a quantitative manner without substantial hydrologic testing.

Based on the results of the 1981 data, wells P-2, P-6, 1-9-S(D), 3-3-N(D), and 5-12-N(D) should be sampling background. (The designation "D" refers to a two-well multilevel system at the particular location.) Uranium levels in P-2 and P-6 reported in the 1981 report were less than 0.01 mg/l. However, during 1982, all these wells showed levels of uranium above the expected background concentration. Uranium contents ranged from approximately 0.02 mg/l in P-2 to more than 0.8 mg/l in the shallow well at location 1-9-S. Except for the 1-9-S well the concentration of uranium ranges from 0.02 to 0.07 mg/l. There are, however, other anomalies. For example, selenium is detected in wells 5-12-N(D) and 1-9-S(D). Contamination with zinc, vanadium, and manganese is evident in one or more wells. It is no longer clear whether any of these wells sample background. All are in close proximity to known contamination. On the other hand, it is also possible that the levels may indeed reflect local background. It appears that an additional well, or wells, may be needed farther south of the facility. New wells should not be placed without a delineation of flow patterns by hydrologic testing.

Another hypothesis is that the persistently high river levels observed throughout 1982 may have caused a gradient toward the east, resulting in movement of the contaminated aquifer into this group of wells. Sampling at low water levels, then, might show a reversal with the gradient now toward the west, resulting in little or no contamination evident in these wells.

The discussion that follows focuses on individual contaminants. Figure 1 and Tables 3 and 4 can be consulted for specific locations and concentrations.

Uranium contamination is evident in all wells. Eleven wells contained more than 1 mg/l uranium for at least one of the sampling periods. The highest concentrations were found in wells 8-4-S and 10-2-N, which are within the facility fence but west of buildings 50 and 30, respectively.

The levels in most of the other wells are greater than 0.1 mg/l. For example, the average concentration in wells P-4, 10-19-N, P-7, 5-17-N, and P-1 along the north dike is 0.81 mg/l. Similarly, on the west the average concentration in wells P-9, 14-6-N, 11-1-S, P-10, 7-6-S, and 8-4-S is 0.68 mg/l. Some of the wells are within 10 feet of the river.

Molybdenum contamination is also widespread throughout the monitoring system. The highest concentrations were found in well 13-10-N, just north of the buried tailings area. The concentration in this well was 0.73 mg/l in August and 0.72 mg/l in October. All the wells around the perimeter of the compound have detectable molybdenum. Of those on the dike, none have a concentration lower than 0.14 mg/l, and some concentrations are as high as 0.5 mg/l.

Arsenic contamination is localized in the vicinity of the buried tailings area. The multilevel well pair is located on the dike between the buried tailings area and the river. Concentrations of arsenic in this well pair were 0.17 to 0.25 mg/l in the two samplings. These wells are within 10 feet of the river. The wells immediately to the north of the buried tailings area, P-9, 13-10-N(D), and 11-12-N(D), also show detectable arsenic, but at levels less than 0.05 mg/l. The North and South wells show substantially higher levels of arsenic. However, these wells may be screened through tailings and may not be representative of the ground water.

Table 3. "Old" Wells Sampled at GJAO

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l Co	mg/l Cu	mg/l F	mg/l Fe	mg/l K
North Well	4/82	<0.05	0.6	--	--	118	<0.025	<0.025	<1	0.9	--
North Well	7/82	<0.10	0.523	<0.10	98	80	--	--	1	0.75	13
North Well	10/82	<0.10	0.406	<0.10	99	48	--	--	--	0.80	17
South Well	4/82	<0.05	0.125	--	--	115	<0.025	<0.025	<1	0.84	--
South Well	7/82	<0.10	0.115	0.10	108	100	--	--	1	0.70	11.9
South Well	10/82	<0.10	0.133	0.13	111	73	--	--	--	0.60	14
P-1	4/82	<0.05	<0.025	--	--	142	<0.025	0.039	<1	<1.1	--
P-1	7/82	<0.10	<0.010	<0.1	147	85	--	--	<1	<0.05	6
P-1	10/82	<0.10	<0.010	<0.10	165	89	--	--	--	<0.05	7
P-2	4/82	<0.05	<0.025	--	--	24	<0.025	0.049	<1	0.75	--
P-2	7/82	<0.10	<0.010	<0.1	193	83	--	--	<1	0.95	7
P-2	10/82	<0.10	<0.010	<0.10	220	83	--	--	--	0.75	9

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l Ni	mg/l NO_3-N	mg/l PO_4	pCi/l ^{226}Ra	mg/l Se	mg/l Si
North Well	4/82	--	(0.60)	3.93	--	<0.025	<1	<1	12	<0.005	--
North Well	7/82	15	0.08	3.16	155	--	<1	--	<2	<0.010	9.3
North Well	10/82	17	<0.05	3.2	156	--	<1	--	--	<0.010	9.1
South Well	4/82		<0.025	2.97	--	<0.025	<1	<1	<2	<0.005	--
South Well	7/82	26	<0.05	3.10	113	--	<1	--	19	<0.010	11.8
South Well	10/82	28	<0.05	3.18	113	--	<1	--	--	<0.010	10.6
P-1	4/82		0.367	0.80	--	<0.025	<1	<1	3	0.018	--
P-1	7/82	33	0.50	0.73	314	--	9	--	<2	0.106	8.1
P-1	10/82	35	0.44	0.84	314	--	8	--	--	0.107	6.4
P-2	4/82		<0.025	1.60	--	<0.025	<1	<1	<2	<0.005	--
P-2	7/82	66	<0.05	1.34	300	--	<1	--	<2	<0.010	9.6
P-2	10/82	70	<0.05	1.31	301	--	<1	--	--	<0.010	8.3

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
North Well	4/82	262	0.18	0.030	<0.025	6.8	1050	14	426	--	--
North Well	7/82	295	0.100	<0.050	<0.050	7.2	1100	18	267	--	6.1
North Well	10/82	278	0.099	<0.05	<0.05	7.3	1100	16	300	- 90	6.9
South Well	4/82	76	--	0.030	<0.025	7.2	850	14	375	--	--
South Well	7/82	141	0.018	<0.050	<0.050	7.5	990	20	447	--	5.9
South Well	10/82	110	0.005	<0.05	<0.05	7.4	1100	16	435	-135	6.5
P-1	4/82	1063	0.60	<0.025	<0.025	7.3	1400	16	189	--	--
P-1	7/82	834	1.200	<0.050	<0.050	7.7	1900	20	228	--	11.6
P-1	10/82	791	1.2	<0.05	<0.05	7.8	1900	17	230	+120	13.9
P-2	4/82	1118	--	<0.025	<0.025	7.8	1550	20	228	--	--
P-2	7/82	1205	0.023	<0.050	<0.050	7.7	2050	18.5	207	--	14.6
P-2	10/82	1138	0.034	<0.05	<0.05	7.7	2090	17	250	-100	14.8

Table 3. "Old" Wells Sampled at GJAO (continued)

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l Co	mg/l Cu	mg/l F	mg/l Fe	mg/l K
P-3 deep	4/82	<0.05	<0.025	--	--	75	<0.025	0.042	5	1.48	--
P-3 deep	7/82	<0.10	<0.01	<0.01	110	25	--	--	<1	0.93	8
P-3 deep	10/82	<0.10	<0.01	<0.1	126	22	--	--	--	0.55	9
P-3 shallow	4/82	<0.05	<0.025	--	--	90	<0.025	0.089	15	1.15	--
P-3 shallow	7/82	<0.10	<0.01	<0.01	72	44	--		1	0.35	11
P-4	4/82	<0.05	<0.025	--	366	530	<0.025	0.115	<1	0.05	--
P-4	7/82	<0.10	<0.010	<0.01	366	490	--	--	3	0.20	20
P-4	10/82	<0.10	<0.01	<0.10	440	425	--	--	--	0.20	24
P-6	4/82	<0.05	<0.025	--	--	18	<0.025	0.041	2	0.58	--
P-6	7/82	<0.10	<0.010	<0.01	90	137	--	--	1	0.52	7
P-6	10/82	<0.10	<0.01	<0.10	86	24	--	--	--	0.35	8

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l Ni	mg/l NO_3-N	mg/l PO_4	pCi/l ^{226}Ra	mg/l Se	mg/l Si
P-3 deep	4/82	--	0.259	2.88	--	<0.025	<1	<1	<2	<0.005	--
P-3 deep	7/82	20	0.13	1.78	287	--	<1	--	<2	<0.010	11.6
P-3 deep	10/82	23	0.13	1.87	312	--	<1	--	--	<0.01	8.3
P-3 shallow	4/82	--	0.12	4.10	--	<0.025	<1	<1	<2	<0.005	10.0
P-3 shallow	7/82	29	0.35	1.38	720	--	<1	--	<2	<0.010	11.6
P-4	4/82	--	0.082	3.17	--	<0.025	<1	1	<2	<0.005	--
P-4	7/82	208	0.12	2.23	1260	--	<1	--	<2	<0.010	10.3
P-4	10/82	260	0.12	2.72	1345	--	<1	--	--	<0.010	9.1
P-6	4/82	--	<0.025	1.18	--	<0.025	<1	<1	2	<0.005	--
P-6	7/82	19	<0.05	0.84	379	--	<1	--	<2	<0.010	9.8
P-6	10/82	18	0.05	0.82	365	--	<1	--	--	<0.01	8.5

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
P-3 deep	4/82	1118	0.7	<0.025	<0.025	6.9	1520	13	234	--	4.8
P-3 deep	7/82	823	0.470	<0.050	<0.050	7.2	1680	27	201	-70	4.3
P-3 deep	10/82	766	--	<0.05	<0.05	7.4	1520	15	235	--	4.5
P-3 shallow	4/82	2946	1.06	<0.025	0.060	6.9	3000	14	409	--	4.8
P-3 shallow	7/82	1470	0.525	<0.050	<0.050	7.3	3230	29	366	--	3.8
P-4	4/82	4254	0.068	<0.025	0.025	6.9	3500	15	501	--	--
P-4	7/82	3112	0.680	<0.050	0.061	7.2	6500	20	486	--	8.5
P-4	10/82	3834	0.6	<0.05	<0.05	7.1	6500	16	530	-30	8.5
P-6	4/82	892	--	<0.025	0.025	7.7	1400	14	263	--	--
P-6	7/82	823	0.048	<0.050	<0.050	7.5	1850	20	254	--	10.8
P-6	10/82	727	0.038	<0.05	<0.05	7.7	1600	14	350	-50	11

Table 3. "Old" Wells Sampled at GJAO (continued)

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l Co	mg/l Cu	mg/l F	mg/l Fe	mg/l K
P-7	4/82	<0.05	<0.025	--	--	224	<0.025	0.093	7	0.45	--
P-7	7/82	<0.10	<0.010	<0.10	247	190	--	--	1	0.40	13
P-7	10/82	<0.10	<0.010	<0.10	192	84	--	--	--	0.10	12
P-8	4/82	<0.05	0.029	--	--	112	<0.025	0.046	<1	<0.1	--
P-8	7/82	<0.10	0.031	0.1	194	175	--	--	<1	<0.05	9
P-8	10/82	<0.10	0.022	<0.1	245	126	--	--	--	<0.05	10
P-9	4/82	<0.05	<0.025	--	--	41	<0.025	<0.025	2	0.11	--
P-9	7/82	0.46	<0.010	<0.1	92	9	--	--	1	<0.05	4
P-9	10/82	<0.10	<0.010	<0.10	135	7	--	--	--	0.05	5
P-10	4/82	<0.05	<0.025	--	--	88	<0.025	0.028	<1	<0.1	--
P-10	7/82	0.19	<0.010	<0.10	100	15	--	--	1	<0.05	5
P-10	10/82	<0.10	<0.010	<0.10	112	14	--	--	--	0.75	7

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l Ni	mg/l NO_3-N	mg/l PO_4	pCi/l ^{226}Ra	mg/l Se	mg/l Si
P-7	4/82	--	0.434	2.66	--	<0.025	<1	<1	<2	0.005	--
P-7	7/82	61	0.45	1.95	975	--	<1	--	<2	<0.010	10.48
P-7	10/82	44	0.39	1.66	830	--	<1	--	--	<0.010	9.3
P-8	4/82	--	<0.025	0.50	--	<0.025	10	<1	<2	0.027	--
P-8	7/82	76	<0.05	0.38	318	--	16	--	<2	0.033	<1.0
P-8	10/82	82	<0.05	0.43	320	--	20	--	--	0.036	11.8
P-9	4/82	--	0.303	0.56	--	<0.025	<1	<1	<2	<0.005	--
P-9	7/82	18	0.30	0.24	68	--	1	--	<2	<0.010	7.6
P-9	10/82	27	0.27	0.53	74	--	<1	--	--	<0.010	5.4
P-10	4/82	--	0.516	3.70	--	<0.025	2	<1	<2	<0.005	--
P-10	7/82	20	0.36	1.24	148	1	1	--	<2	<0.010	6.4
P-10	10/82	25	0.33	2.39	174	--	<1	--	--	<0.010	5.1

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
P-7	4/82	2751	1.22	<0.025	0.025	6.9	2700	15	451	--	--
P-7	7/82	2441	1.100	<0.050	<0.050	7.2	4480	24	399	--	13.0
P-7	10/82	1656	0.7	<0.05	<0.05	7.6	3350	15	415	0	13.1
P-8	4/82	1047	0.44	0.200	0.025	6.8	1700	16	363	--	--
P-8	7/82	848	0.380	0.140	<0.050	7.2	2070	20.5	352	--	5.3
P-8	10/82	1018	0.384	0.18	0.05	7.2	2350	19	365	+175	5.7
P-9	4/82	346	1.2	0.090	0.025	6.6	950	13	298	--	--
P-9	7/82	196	0.320	0.076	<0.050	7.1	700	18	228	--	17.9
P-9	10/82	343	0.348	0.11	<0.05	7.3	850	14	225	+ 80	17.8
P-10	4/82	935	1.9	0.200	0.025	6.7	1680	14	268	--	--
P-10	7/82	361	0.750	0.139	0.050	7.1	1020	20	268	--	16.8
P-10	10/82	426	0.8	0.19	<0.05	7.1	1150	16	285	- 80	16.8

Table 4. "New" Wells Sampled at GJAO

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l F	mg/l Fe	mg/l K
3-3-S	7/82	<0.10	<0.010	<0.10	124	137	1	0.13	7
3-3-S	10/82	<0.10	<0.010	<0.10	189	97	—	<0.05	10
1-9-S shallow	7/82	<0.10	<0.010	<0.10	106	17	1	<0.05	5
1-9-S shallow	10/82	<0.10	<0.010	<0.10	127	16	—	0.05	7
1-9-S deep	7/82	<0.10	<0.010	<0.10	75	23	1	<0.05	6
1-9-S deep	10/82	<0.10	<0.010	<0.10	116	30	—	0.15	8
3-3-N (North)	7/82	<0.10	<0.010	<0.10	170	74	<1	<0.05	9
3-3-N (North)	10/82	<0.10	<0.010	<0.10	204	81	—	<0.05	11
3-3-N (South)	7/82	<0.10	<0.010	<0.10	248	107	<1	<0.05	11
3-3-N (South)	10/82	<0.10	<0.010	<0.10	310	115		1.00	14

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l NO_3-N	pCi/l ^{226}Ra	mg/l Se	mg/l Si
3-3-S	7/82	44	<0.05	0.71	300	3	<2	0.029	10.3
3-3-S	10/82	72	<0.05	0.82	496	7	—	0.061	11.1
1-9-S shallow	7/82	39	<0.05	0.46	95	11	<2	0.037	12.3
1-9-S shallow	10/82	56	<0.05	0.54	118	5	—	0.026	11.0
1-9-S deep	7/82	14	<0.05	0.59	205	<1	<2	<0.010	8.7
1-9-S deep	10/82	22	<0.05	0.87	315	<1	—	<0.010	7.4
3-3-N (North)	7/82	56	<0.05	0.63	408	3	<2	0.027	11.6
3-3-N (North)	10/82	60	<0.05	0.84	436	3	—	0.024	11.4
3-3-N (South)	7/82	57	<0.05	1.06	405	<1	<2	<0.010	10.6
3-3-N (South)	10/82	65	<0.05	1.30	480	<1		<0.010	9.4

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
3-3-S	7/82	876	0.022	<0.05	<0.050	7.6	1880	20	192	—	12.6
3-3-S	10/82	1196	0.066	<0.50	<0.05	7.6	2600	19	255	+130	13.4
1-9-S shallow	7/82	304	0.850	<0.050	<0.050	7.5	1000	21	250	—	13.0
1-9-S shallow	10/82	419	0.7	<0.05	0.05	7.5	1200	18	310	+ 90	13.4
1-9-S deep	7/82	470	0.025	0.136	<0.050	7.8	1230	20	166	—	13.3
1-9-S deep	10/82	736	0.039	<0.05	<0.05	7.8	1700	17.5	220	- 40	13.8
3-3-N (North)	7/82	1147	0.036	<0.050	<0.050	7.5	2500	24.5	202	—	10.8
3-3-N (North)	10/82	1104	0.042	<0.05	<0.05	7.5	2530	18	245	+ 25	11.5
3-3-N (South)	7/82	1376	0.035	<0.05	<0.050	7.9	2700	22	185	—	11.0
3-3-N (South)	10/82	1497	0.026	<0.05	<0.05	7.6	2940	18	260	-150	11.5

Table 4. "New" Wells Sampled at GJAO (continued)

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l F	mg/l Fe	mg/l K
5-12-N shallow	7/82	<0.10	<0.010	<0.10	268	141	1	0.88	7
5-12-N shallow	10/82	<0.10	<0.010	<0.10	366	162	--	<0.05	9
5-12-N deep	7/82	<0.10	<0.010	<0.10	225	177	<1	<0.05	6
5-12-N deep	10/82	<0.10	<0.010	<0.10	329	276	--	<0.05	9
6-2-N	7/82	<0.10	<0.010	<0.10	214	96	<1	0.23	8
6-2-N	10/82	<0.10	<0.010	<0.10	262	107	--	<0.05	10
7-6-S	7/82	<0.10	<0.010	<0.10	135	50	1	0.05	5
7-6-S	10/82	<0.10	<0.010	<0.10	176	44	--	<0.05	7
8-4-S	7/82	<0.10	<0.010	<0.10	260	86	1	<0.05	10
8-4-S	10/82	<0.10	<0.010	<0.10	300	118	--	<0.05	13

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l NO_3-N	pCi/l ^{226}Ra	mg/l Se	mg/l Si
5-12-N shallow	7/82	109	<0.05	0.33	302	2	<2	0.011	11.4
5-12-N shallow	10/82	136	<0.05	0.31	348	<1	--	0.012	11.9
5-12-N deep	7/82	99	<0.05	0.31	323	1	<2	<0.010	11.1
5-12-N deep	10/82	130	<0.05	0.47	360	<1	--	0.010	11.1
6-2-N	7/82	70	0.11	0.94	275	12	<2	0.119	11.4
6-2-N	10/82	79	0.09	1.30	286	15	--	0.107	9.2
7-6-S	7/82	53	0.18	0.58	194	7	<2	0.016	10.0
7-6-S	10/82	60	0.14	0.45	210	5	--	<0.010	7.9
8-4-S	7/82	72	0.34	1.19	317	24	<2	0.057	8.9
8-4-S	10/82	75	0.38	1.34	341	18	--	0.077	7.7

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
5-12-N shallow	7/82	1180	0.067	<0.050	0.070	7.2	2400	21	297	--	8.5
5-12-N shallow	10/82	1380	0.073	<0.05	<0.05	7.1	2900	18	400	+ 80	8.7
5-12-N deep	7/82	1029	0.041	<0.050	0.143	7.3	2460	23	295	--	8.7
5-12-N deep	10/82	1378	0.063	<0.05	<0.05	7.1	2780	17	370	+ 70	9.0
6-2-N	7/82	1000	0.660	<0.050	<0.050	7.5	2100	23	261	--	13.1
6-2-N	10/82	920	0.7	<0.05	<0.05	7.5	2300	18	320	+100	13.5
7-6-S	7/82	528	0.830	<0.050	0.050	7.2	1300	18	306	--	17.9
7-6-S	10/82	573	0.9	0.09	<0.05	7.2	1400	14	330	+ 10	17.8
8-4-S	7/82	1135	1.000	<0.091	0.058	7.0	2390	24	281	--	5.9
8-4-S	10/82	1044	1.1	<0.05	<0.05	6.9	2500	17	360	+120	5.9

Table 4. "New" Wells Sampled at GJAO (continued)

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l F	mg/l Fe	mg/l K
9-6-N	7/82	<0.10	<0.010	<0.10	178	134	1	0.05	8
9-6-N	10/82	<0.10	<0.010	<0.10	192	134	--	0.05	10
9-11-N	7/82	<0.10	<0.010	<0.10	221	181	1	<0.05	9
9-11-N	10/82	<0.10	<0.010	<0.10	270	162	—	<0.05	12
10-2-N shallow	7/82	<0.10	<0.010	<0.10	281	228	1	<0.05	13
10-2-N shallow	10/82	<0.10	<0.010	<0.10	314	263	—	<0.05	20
10-2-N deep	7/82	<0.10	<0.010	<0.10	340	218	1	<0.05	12
10-2-N deep	10/82	<0.10	<0.010	<0.10	340	218	—	<0.05	14
10-19-N	7/82	<0.10	<0.010	<0.10	140	200	1	0.26	10
10-19-N	10/82	<0.10	<0.010	<0.10	350	280	—	0.20	17

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l NO_3-N	pCi/l ^{226}Ra	mg/l Se	mg/l Si
9-6-N	7/82	73	<0.05	0.32	292	14	<2	0.038	13.6
9-6-N	10/82	73	<0.05	0.14	287	17	—	0.033	11.4
9-11-N	7/82	91	<0.05	0.51	397	15	<2	0.034	15.0
9-11-N	10/82	93	<0.05	0.38	429	17	—	0.036	12.6
10-2-N shallow	7/82	142	0.27	1.80	625	18	<2	0.055	12.0
10-2-N shallow	10/82	150	0.22	1.78	799	38	—	0.093	10.6
10-2-N deep	7/82	106	0.39	1.78	560	32	<2	0.093	10.6
10-2-N deep	10/82	109	0.35	1.95	561	36	--	0.076	8.5
10-19-N	7/82	62	0.29	1.20	860	< 1	<2	<0.010	10.0
10-19-N	10/82	145	0.27	2.51	1225	< 1	—	<0.010	8.7

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
9-6-N	7/82	829	0.340	0.050	<0.050	7.1	2200	21	326	—	11.0
9-6-N	10/82	754	0.356	<0.050	<0.05	7.3	2150	18	390	+ 60	16.6
9-11-N	7/82	971	0.570	0.734	<0.050	7.1	2800	22	379	—	10.8
9-11-N	10/82	1012	0.688	0.93	<0.05	7.2	2700	20	410	+200	10.7
10-2-N shallow	7/82	1828	1.360	<0.050	<0.050	7.0	4000	22	331	—	11.9
10-2-N shallow	10/82	1783	1.200	<0.050	<0.050	7.2	4050	18	340	+190	17.3
10-2-N deep	7/82	2024	1.5	<0.050	<0.05	7.1	3500	20.5	308	—	11.3
10-2-N deep	10/82	1557	1.200	<0.05	<0.050	7.4	3300	16	345	+180	17.3
10-19-N	7/82	2174	0.720	<0.050	0.050	7.4	3610	20	371	—	14.6
10-19-N	10/82	2958	0.8	<0.05	<0.05	7.6	5100	14	535	+ 60	14.4

Table 4. "New" Wells Sampled at GJAO (continued)

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l F	mg/l Fe	mg/l K
11-1-S	7/82	<0.10	<.010	<0.10	118	62	1	0.37	7
11-1-S	10/82	<0.10	<.010	<0.10	202	94	--	<0.05	12
11-12-N shallow	7/82	<0.10	.029	<0.10	208	159	<1	<0.05	10
11-12-N shallow	10/82	<0.10	.036	<0.10	270	118	--	<0.05	11
11-12-N deep	7/82	<0.10	.038	<0.10	202	129	<1	<0.05	9
11-12-N deep	10/82	<0.10	.044	<0.10	280	156	--	<0.05	11
11-15-N	7/82	<0.10	<.010	<0.10	318	321	1	0.38	10
11-15-N	10/82	<0.10	<.010	<0.10	450	220	--	0.05	14
12-7-N deep	7/82	<0.10	0.071	<0.10	125	170	1	0.89	11
12-7-N deep	10/82	<0.10	0.036	<0.10	125	83	--	0.90	15

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l NO_3-N	pCi/l ^{226}Ra	mg/l Se	mg/l Si
11-1-S	7/82	52	0.25	0.83	345	2	<2	<0.010	8.6
11-1-S	10/82	68	0.32	0.68	446	2	--	<0.01	6.2
11-12-N shallow	7/82	72	<0.05	0.55	349	13	<2	0.025	12.6
11-12-N shallow	10/82	82	0.08	0.53	365	16	--	0.030	14.1
11-12-N deep	7/82	70	<0.05	0.36	345	14	<2	0.025	12.7
11-12-N deep	10/82	83	0.08	0.41	370	18	--	0.032	13.4
11-15-N	7/82	90	0.16	1.44	595	<1	<2	<0.010	9.6
11-15-N	10/82	114	0.23	2.14	714	3	--	<0.010	11.0
12-7-N deep	7/82	26	<0.05	3.46	120	1	<2	<0.010	13.7
12-7-N deep	10/82	29	<0.05	3.65	127	2	--	<0.010	13.6

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
11-1-S	7/82	863	0.420	<0.050	0.065	7.5	1800	17	303	—	17.1
11-1-S	10/82	1337	0.9	0.05	<0.05	7.6	2450	15	250	+100	17.3
11-12-N shallow	7/82	1062	0.360	0.131	0.063	7.2	2020	17.5	360	—	4.7
11-12-N shallow	10/82	1019	0.317	0.22	<0.05	7.1	2380	17	375	+ 70	5.0
11-12-N deep	7/82	1043	0.350	0.160	0.063	7.3	2280	17	349	—	4.6
11-12-N deep	10/82	1044	0.355	0.22	<0.05	7.1	2400	17	370	+ 30	5.0
11-15-N	7/82	2062	0.380	<0.05	0.056	7.2	3420	17.5	407	—	5.9
11-15-N	10/82	2088	0.6	<0.05	<0.05	7.0	3650	15	435	- 90	5.8
12-7-N deep	7/82	32	0.008	<0.05	<0.050	7.2	1150	26	480	—	7.8
12-7-N deep	10/82	76	0.003	<0.05	<0.05	7.2	1200	19	520	-140	8.4

Table 4. "New" Wells Sampled at GJAO (continued)

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l F	mg/l Fe	mg/l K
12-7-N shallow	7/82	<0.10	0.039	0.15	122	170	1	0.30	12
12-7-N shallow	10/82	<0.10	0.026	0.19	124	116	—	0.25	14
13-10-N	7/82	<0.10	0.015	<0.10	136	105	1	2.90	14
13-10-N	10/82	<0.10	0.032	<0.10	153	92	—	2.40	16
13-16-N deep	7/82	<0.10	<0.010	<0.10	362	278	1	1.66	16
13-16-N deep	10/82	<0.10	<0.010	<0.10	420	200	—	1.85	22
13-16-N shallow	7/82	<0.10	0.024	0.10	405	325	1	0.77	17
13-16-N shallow	10/82	<0.10	<0.010	<0.10	420	236	—	1.60	19
14-6-N (North)	7/82	0.11	0.177	0.10	83	46	1	2.70	14
14-6-N (North)	10/82	<0.10	0.249	<0.10	81	20	—	3.60	18

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l NO_3-N	pCi/l ^{226}Ra	mg/l Se	mg/l Si
12-7-N shallow	7/82	26	<0.05	3.49	119	<1	8	<0.010	14.3
12-7-N shallow	10/82	29	<0.05	3.62	123	<1	—	<0.010	13.5
13-10-N	7/82	22	0.73	3.16	184	<1	<2	<0.010	10.4
13-10-N	10/82	22	0.72	3.16	215	<1	—	<0.010	9.9
13-16-N deep	7/82	101	0.28	5.70	630	<1	<2	<0.010	12.63
13-16-N deep	10/82	105	0.33	5.65	678	<1	—	<0.010	12.8
13-16-N shallow	7/82	119	0.07	4.93	970	<1	<2	<0.010	19.8
13-16-N shallow	10/82	130	0.05	5.28	920	<1	—	<0.010	17.8
14-6-N (North)	7/82	17	<0.05	3.20	95	<1	<2	<0.010	10.4
14-6-N (North)	10/82	17	<0.05	3.08	108	<1	—	<0.010	10.5

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
12-7-N shallow	7/82	29	0.004	<0.050	<0.050	7.2	1250	24.5	499	—	7.3
12-7-N shallow	10/82	70	0.002	<0.05	<0.05	7.2	1250	19	490	-135	7.8
13-10-N	7/82	362	0.460	<0.050	<0.050	7.1	1300	22	332	—	6.6
13-10-N	10/82	449	0.7	<0.05	<0.05	7.2	1370	19	380	-120	6.9
13-16-N deep	7/82	2088	0.760	<0.050	<0.050	6.9	4100	26	499	—	4.9
13-16-N deep	10/82	1830	1.0	<0.05	<0.05	6.8	3900	17	515	-280	5.5
13-16-N shallow	7/82	1676	0.200	<0.050	<0.050	6.7	5040	21	1270	—	5.7
13-16-N shallow	10/82	1783	0.170	<0.05	<0.05	6.9	4600	18	1431	-340	5.9
14-6-N (North)	7/82	208	0.064	<0.050	0.082	7.2	900	17	278	—	16.8
14-6-N (North)	10/82	244	0.043	<0.05	<0.05	7.3	850	14	220	-160	16.7

Table 4. "New" Wells Sampled at GJAO (continued)

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l F	mg/l Fe	mg/l K
14-6-N South	7/82	<0.10	0.185	<0.10	76	25	1	1.61	11
14-6-N South	10/82	<0.10	0.240	<0.10	95	11	--	2.20	16
14-13-N shallow	7/82	<0.10	<0.010	<0.10	156	126	<1	<0.05	10
14-13-N shallow	10/82	<0.10	0.010	<0.10	196	106	--	<0.05	14
14-13-N deep	7/82	<0.10	<0.010	<0.10	190	109	<1	0.99	13
14-13-N deep	10/82	<0.10	<0.010	<0.10	220	142	--	0.35	16
15-17-N	7/82	<0.10	<0.010	<0.10	181	228	1	3.20	15
15-17-N	10/82	<0.10	<0.010	<0.10	250	160	--	2.05	16
17-13-N	7/82	<0.10	<0.010	<0.10	76	10	<1	0.16	3
17-13-N	10/82	<0.10	<0.010	<0.10	92	7	--	0.05	5

Sample Site	Date Sampled	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l NO_3-N	pCi/l ^{226}Ra	mg/l Se	mg/l Si
14-6-N South	7/82	14	0.05	2.33	83	1	<2	<0.01	10.3
14-6-N South	10/82	20	<0.05	2.90	88	<1	--	<0.01	9.8
14-13-N shallow	7/82	37	0.67	<0.05	449	<1	<2	<0.01	13.4
14-13-N shallow	10/82	46	0.52	<0.05	437	<1	--	<0.01	13.2
14-13-N deep	7/82	43	0.38	1.83	350	2	<2	<0.01	11.0
14-13-N deep	10/82	43	0.36	1.88	351	4	--	<0.01	11.4
15-17-N	7/82	91	0.34	3.45	910	<1	<2	<0.01	8.9
15-17-N	10/82	61	0.48	2.75	890	<1	--	<0.01	8.2
17-13-N	7/82	18	<0.05	1.05	117	<1	<2	<0.01	7.9
17-13-N	10/82	25	<0.05	1.32	117	<1	--	<0.01	7.2

Sample Site	Date Sampled	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv Eh	Depth In Water
14-6-N South	7/82	215	0.150	<0.050	0.050	7.1	790	18	200	—	17.2
14-6-N South	10/82	312	0.127	<0.05	<0.05	7.0	820	16	245	-100	17.1
14-13-N shallow	7/82	1006	0.810	<0.050	<0.050	7.5	2410	28	366	—	7.8
14-13-N shallow	10/82	828	0.8	<0.05	<0.05	7.6	2300	17	410	- 10	7.8
14-13-N deep	7/82	963	0.590	<0.050	<0.05	7.3	2300	27	306	—	6.9
14-13-N deep	10/82	764	0.540	<0.05	<0.050	7.3	2100	16	340	- 40	7.0
15-17-N	7/82	2438	0.170	<0.050	0.056	7.4	3940	20	405	—	16.8
15-17-N	10/82	2001	0.8	<0.05	<0.05	7.7	4100	14	450	-160	16.7
17-13-N	7/82	406	0.037	<0.050	0.100	7.5	820	18	157	—	17.2
17-13-N	10/82	382	0.044	<0.05	<0.05	7.9	800	12	230	+160	16.8

Selenium contamination is localized on the south end of the compound. Highest concentrations are found in wells P-1 and 6-2-N, which had concentrations slightly greater than 0.1 mg/l. Well P-1 is south of building 33 and well 6-2-N is just inside the facility fence near the parking lot. Several other wells show selenium contamination, and most are south of well 6-2-N. Wells along the dike generally show selenium levels of less than 0.01 mg/l.

Potential radium contamination is always a concern because of the nature of the buried waste. However, conditions of high pH, high sulfate, and low barium lead to little or no radium migration. This is, in fact, the case on the GJAO site. Radium is not detectable in most of the wells. Only one of the 12-7-N pair, located in the middle of the buried tailings, and the south well, adjacent to the buried tailings, showed detectable radium.

The drinking water standard for nitrate-nitrogen is 10 mg/l, and several wells show concentrations exceeding this limit. All of these wells are roughly between wells 8-4-S (west of Building 31) and 11-12-N(D) (near the north lagoon). None of the perimeter wells contain high levels of nitrate.

Colorado Water Quality Control Act

Colorado water quality standards were reviewed with respect to contamination observed on the GJAO compound. The following is the range of numerical standards for some of the contaminants found in the gravel aquifer.

Element	Maximum Contaminant Level (Depending on Use Class and Alkalinity)
Arsenic	0.05 - 0.1 mg/l
Selenium	0.01 - 0.05 mg/l
Uranium	0.03 - 1.4 mg/l
Zinc	0.05 - 5.0 mg/l
Radium-226 and -228	5.0 pCi/l

Application of these standards is complicated by the use of varying contaminant levels for many trace elements, depending on use classification and alkalinity. The thrust of the Colorado statute is to clean up existing polluted waters and to prevent further degradation of any waters of the state. The shallow gravel aquifer underneath the GJAO compound is contaminated at levels that make it unfit for agricultural purposes, the lowest use class defined. The language in the Act seems to exempt past practices. In other words, the shallow aquifer is not being used for any purpose, hence, it may be interpreted that the Department of Energy is not mandated to clean it up. On the other hand, existing operations are not permitted to cause further degradation.

Contamination of the river is another matter. The regulations clearly prohibit any facility from degrading the quality of the river. Hence, it is important to understand how much contaminated water enters the river and whether the levels are increasing or decreasing. These questions can only be answered with additional hydrologic testing and geochemical modeling.

North and South Pond Sediments

Sediment samples were collected from the North and South Ponds to determine contaminant levels for possible clean-up operations. These samples were collected away from the banks by using a small boat but were still "grab" samples.

The North Pond sediments did not contain high levels of contamination. The average radium value of the nine samples was 3 picocuries per gram (pCi/g). Uranium, selenium, and molybdenum were also found in concentrations exceeding background but by no more than a factor of two or three.

In contrast, South Pond sediments evidence the many years of the laboratory's yellow cake analyses and resulting effluent. The average of the six sediment samples for radium was 22 pCi/g with a high of 51 pCi/g. The Environmental Protection Agency's final standards for radium clean-up are 5 pCi/g above background at the surface and 15 pCi/g above background buried. Both are averaged over a specific volume, but it can be concluded that the South Pond sediments will quite likely require removal. The average uranium concentration of the sediments is nearly 800 parts per million (ppm). This shows considerable disequilibrium, as expected, because of the release of yellow cake. Arsenic, copper, lead, and zinc are also found in concentrations considerably above background. A grid will have to be established and the South Pond sampled more systematically to determine how much material must be removed.

RECOMMENDATIONS

The data obtained during the past three years cannot be fully interpreted without further information. Accordingly, if funding levels will permit, the following recommendations will be implemented in the monitoring program.

- Increase frequency of chemical sampling and analysis to quarterly.
- Increase frequency of water level measurements to monthly.
- Perform tests necessary to clearly define the hydrologic characteristics of the aquifer.
- Use a geochemical model such as PHREEQE to simulate mixing of the contaminated aquifer and Gunnison River water.
- More extensive sampling of the river and placement of additional background wells may be required once results are available from the above procedural changes.
- Perform radon measurements along the waste area boundaries.

SUMMARY

Leaching of uranium mill tailings continues to contaminate the shallow aquifer underneath the GJAO facility. The close proximity to the river of high concentrations of uranium, molybdenum, selenium, and arsenic merits close continued monitoring. Available information from similar sites indicates that the effects of precipitation and dilution would cause the net effect on the river to be negligible. Unfortunately, without the increased sampling and analysis efforts recommended above, that statement cannot be made with certainty.

MONTICELLO TAILINGS SITE

The Monticello, Utah, site was formerly a Government-owned uranium processing mill. An excellent summary of the site's history is presented in Summary History of Domestic Uranium Procurement Under U.S. Atomic Energy Commission Contracts, GJBX-220(82). Various reports for the last several years have described the results of environmental monitoring and remedial action activities.

Clean-up and final disposition of the site is being funded under the Surplus Facilities Management Program (SFMP). An extensive site characterization, begun in early 1982, is being undertaken as part of this program. Preliminary results from the SFMP work are not discussed in this report. It must be noted that the data presented here represent only a small portion of the environmental monitoring activities carried out during 1982.

AIR QUALITY

There are no active operations on the facility. Thus, any air quality problems would be due to blowing dust or radon emanation. Air particulate samplers will be installed in 1983 as part of the SFMP project. Since the piles have an excellent vegetative cover, it is not expected that dust blown from the piles would be significant.

Radon or radon flux measurements were not made in 1982. The 1981 results reported last year indicated that radon emanation far exceeds the EPA final standard for inactive mill tailings sites. These measurements, however, were not taken at the site boundary and require verification. Such measurements are being taken in 1983 as part of the SFMP project.

WATER MONITORING

Sampling

Ground- and surface-water samples were collected with a peristaltic pump. Samples were filtered through a 0.45-μm filter in-line with the collection vessel. Samples were preserved and analyzed according to procedures prescribed in Methods for Chemical Analysis of Water and Waste (EPA-600/4-79-020). Measurements of pH, conductivity, and Eh were performed in the field with a flow-through cell to exclude air. The alkalinity measurement was made at the time of collection with a Hach digital titrator.

Contamination Sources

Water contamination results from the leaching of uranium mill tailings. There are four separate piles on the site. The three piles on the north side of the creek are contributing to the water quality problems (see Figure 2). The acid pile on the south side of the creek is unsaturated and is apparently not a source of contamination to the creek or the shallow aquifer.

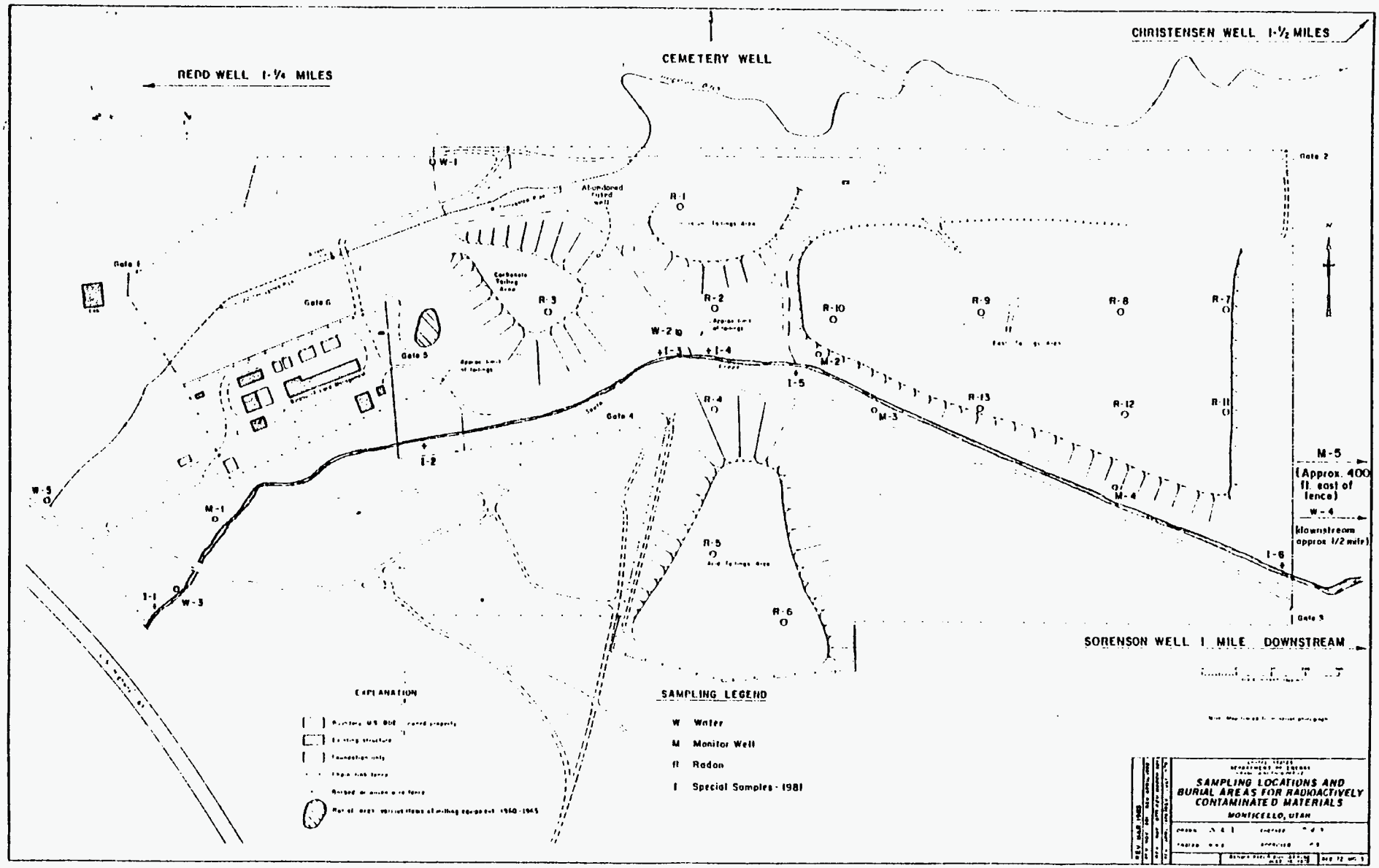


Figure 2. Sampling Locations and Burial Areas for Radioactively Contaminated Materials, Monticello Tailings Site, Monticello, Utah

Surface Water

Tables 5 and 6 present the analytical data for surface-water samples collected during 1982. Figure 2 shows sample locations. Sample location W-3 is used as a background location for South Creek. Unfortunately, the creek was dry at this location in August; hence, a sample was collected from the irrigation ditch north of the creek. The sample location was on the east side but adjacent to the entrance road and was designated W-15. This sample contained an anomalous level of arsenic but no other contaminants. The source of the arsenic is most likely the Mancos shale through which the ditch flows. The W-3 samples, as in previous years, displayed no contamination.

Sample location W-2 is a permanent seep flowing between the carbonate and vanadium piles. Very high concentrations of several contaminants are always evident. For example, arsenic, molybdenum, uranium, and selenium are all found in concentrations exceeding 1 mg/l. This is roughly three orders of magnitude above background concentrations. Some radium was found in W-2 but at concentrations that would be rapidly diluted to background by the creek.

The area around W-2, particularly below the carbonate pile, is marshy. There is another seep that fills a pool roughly 10 feet by 30 feet directly below the carbonate pile. This was sampled in August and is designated the CO_3 seep. This seep also contains very high concentrations of uranium, molybdenum, arsenic, and selenium.

Observations of the various seeps on the property lead to some significant speculation. For example, the CO_3 seep was dry during the wet winter months and full during the dry summer. In contrast, a small pool east of the acid pile contained water all winter but dried up in the summer. The reason for this may be the irrigation ditch which runs north of the tailings piles. This ditch is full in the summer, dry in the winter, and may be a water source for the piles when it is running.

Sample location W-4 is approximately 1/4 mile below the east boundary. Arsenic, molybdenum, selenium, uranium, and vanadium are all found in the creek at this point. The concentration levels range up to a factor of approximately 100 times background. The concentrations measured in 1982 are quite similar to those observed in previous years.

The Sorenson sample is collected one mile farther downstream. The concentrations of uranium, molybdenum, and selenium observed at W-4 persist at this sample location also. Note, in fact, that samples collected up to 1-1/2 miles farther downstream remain at these contamination levels.

Livestock are grazed all along this creek. It is clear that it is used as their water source. A study of the potential for toxic effects will be completed as part of the SFMP program.

Sorenson Spring is a seep located just above the Sorenson sample location. A sample was collected to determine if it contributed to the contamination in the creek. This spring is not contaminated and would only serve to dilute the contamination observed at the Sorenson location.

Table 5. Analyses of Surface Water Samples Collected at Monticello During 1982

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l Co	mg/l Cr	mg/l F	mg/l Fe	mg/l K	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l NO_3-N
W-3	4/82	<0.05	<0.025	—	—	13	<0.025	<0.025	<1	<0.1	—	—	<0.025	—	—	<1
W-3	9/82	<0.01	<0.010	0.071	94	7	—	—	—	<0.05	2	13	<0.05	<0.1	21	<1
W-2	4/82	0.07	2.600	—	—	1389	<0.025	<0.025	<1	<0.1	—	—	8.830	—	—	32
W-2	8/82	0.365	0.332	<0.10	122	1970	—	—	2	0.11	194	138	4.5	0.18	3050	49
W-2	9/82	0.02	0.880	0.072	50	1488	—	—	—	<0.05	232	71	9.79	<0.1	3540	51
M-4	4/82	<0.05	<0.025	—	—	16	<0.025	<0.025	<1	<0.1	—	—	0.095	—	—	1
M-4	8/82	<0.100	0.019	<0.10	194	81	—	—	<1	<0.05	16	45	0.08	0.20	208	2
M-4	9/82	0.02	0.024	0.044	112	37	—	—	—	<0.05	14	25	0.13	0.2	149	3
Sorenson	4/82	<0.05	<0.025	—	—	24	<0.025	<0.025	<1	<0.1	—	—	0.091	—	—	1
Sorenson	8/82	<0.100	<0.010	<0.010	112	39	—	—	<1	0.10	8	35	<0.05	0.09	133	<1
Sorenson	9/82	0.01	<0.010	0.048	128	42	—	—	—	0.10	11	33	0.14	0.1	139	<1

Sample Site	Date Sampled	mg/l PO_4	pCi/l ^{226}Ra	mg/l Se	mg/l Si	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/cm CDT	°C Temp	mg/l $CaCO_3$ Alky	mv eH
W-3	4/82	<1	<2	<0.005	—	82	0.002	0.044	<0.05	8.4	400	11	152	+160
W-3	9/82	—	—	<0.010	7.06	87	0.004	<0.05	—	8.3	450	11	210	—
W-2	4/82	<1	9	1.800	—	3605	1.16	116.000	—	9.3	5500	18	990	—
W-2	8/82	—	3	1.800	9.6	4250	1.56	86.	<0.050	8.9	10500	17.5	961	+200
W-2	9/82	—	<2	1.080	1.42	4414	0.7	105.0	<0.05	10.1	15000	27	495	+ 60
W-4	4/82	<1	<2	0.016	—	253	0.24	0.322	—	7.5	800	14	263	—
W-4	8/82	—	<2	0.025	7.7	550	0.220	0.52	0.080	6.8	1700	16	369	+ 60
W-4	9/82	—	<2	0.031	8.20	306	0.475	0.69	<0.05	7.2	1050	17	262	+215
Sorenson	4/82	<1	<2	0.027	—	291	0.26	0.178	—	8.2	890	14	284	—
Sorenson	8/82	—	—	<0.010	5.4	452	0.100	<0.05	0.120	7.8	1300	24	258	+ 40
Sorenson	9/82	—	<2	0.015	2.89	338	0.519	0.11	<0.05	7.5	1000	12	272	+180

Table 6. Special Surface Water Sites Collected at Monticello During 1982

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l Co	mg/l Cr	mg/l F	mg/l Fe	mg/l K	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na
W-1	8/82	<0.100	0.059	<0.10	209	17	--	--	1	<0.05	4	42	<0.05	<0.05	45
1 mi Below Sorenson	4/82	<0.05	<0.025	--	--	23	<0.025	<0.025	<1	<0.1	--	--	0.075	--	--
1-1/2 mi Below Sorenson	4/82	<0.05	<0.025	--	--	24	<0.025	<0.025	<1	<0.1	--	--	0.071	--	--
Sorenson Spring	4/82	<0.05	<0.025	--	--	30	<0.025	<0.025	<1	0.86	--	--	<0.025	--	--
Sommerville Pond	4/82	<0.05	<0.025	--	--	<1	<0.025	<0.025	<1	<0.1	--	--	<0.025	--	--
Montezuma Creek	4/82	<0.05	<0.025	--	--	59	<0.025	<0.025	<1	<0.1	--	--	0.025	--	--
CO_3 Seep	8/82	<0.100	0.424	<0.10	56	2652	--	--	1	0.14	315	350	8.2	0.31	8000
Sommerville Pond Inlet	4/82	<0.05	<0.025	--	--	<1	<0.025	<0.025	<1	<0.1	--	--	<0.025	--	--

Sample Site	Date Sampled	mg/l NO_3-N	mg/l PO_4	pCi/l ^{226}Ra	mg/l Se	mg/l Si	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/ CDT	°C Temp	mg/l $CaCO_3$ Alky	mv eH
W-1	8/82		--	<2	<0.010	6.1	400	0.004	0.08	<0.050	8.1	1040	15	350	+70
1 mi Below Sorenson	4/82	<1	<1	<2	0.026	--	296	0.24	0.166	--	7.9	900	12	267	--
1-1/2 mi Below Sorenson	4/82	1	<1	--	0.026	--	291	0.34	0.154	--	--	--	--	--	--
Sorenson Spring	4/82	1	<1	<2	<0.005	--	317	0.002	<0.025	--	7.2	900	11	229	--
Sommerville Pond	4/82	<1	<1	2	<0.005	--	6	0.02	0.033	--	8.2	330	15	148	--
Montezuma Creek	4/82	<1	<1	--	0.010	--	356	0.14	0.030	--	--	--	--	--	--
CO_3 Seep	8/82	<1	--	6	1.300	13.0	10010	3.1	95.	<0.050	8.9	26000	18	1611	-200
Sommerville Pond Inlet	4/82	14	<1	2	<0.005	--	6	0.02	0.033	--	8.2	330	15	148	--
		<1													

A pipe located on top of the drop structure at the east boundary of the site indicates that the Sommerville Pond (also located near the east boundary) is filled at that point. Samples collected at that point and from the pond contained anomalous uranium but in a concentration lower than is observed below the drop structure. In fact, concentrations one mile downstream are ten times higher than at the pond inlet. It is obvious that contaminated ground water flows from under the site and enters the creek below the drop structure. This is also apparent because of the appearance of numerous seeps along the creek and the resulting increase in the flow.

One sample was also collected in Montezuma Creek about 4-1/2 miles downstream from the site. The concentration of 0.14 mg/l uranium is considerably above background. More study is needed to determine whether the contamination is due to the tailings pile or natural sources.

Ground Water

Wells M-1 through M-5 are not properly constructed monitoring wells, and for this reason they are not being used as part of the SFMP monitoring network. They were sampled twice in 1982 to maintain continuity with the previous environmental reports.

Well M-1 (Table 7) was originally expected to be sampling background but it shows anomalously high uranium content. This has been observed in all previous samplings. Whether the contamination is from a natural or anthropogenic source, it is still much less than the wells downgradient from the pile.

Wells M-2 through M-4 are located within the tailings area. They are very contaminated, as expected. The principal contaminant is uranium, found in concentrations as high as 3 mg/l. Poor well construction precludes meaningful interpretation of these data.

Well M-5 is approximately 100 yards from the east boundary fence. High levels of selenium, molybdenum, and particularly uranium are found. Concentrations are significantly higher than those in the nearby creek. There are visible seeps just downstream of this area where the creek contamination rises. The shallow ground water apparently enters the creek in this area causing the increasing levels of contamination.

Utah Water Pollution Control Act

The Utah Water Pollution Control Act has significant implications for the Monticello site.

Specific water quality standards are adopted under the Wastewater Disposal Regulations, Part II. This section also classifies the affected streams. South Creek and tributaries from its confluence with Montezuma Creek to its headwaters are listed in "Use Classes" 3A (aquatic life) and 4 (agricultural). Montezuma Creek and tributaries upstream from Monticello are listed under Class 1C (domestic use) as well as 3A and 4. The following numerical standards are relevant to the Monticello pile. This information is taken from Part II, Appendix A, page 8.

Table 7. Analyses of Well Water Samples Collected at Monticello During 1982

Sample Site	Date Sampled	mg/l Al	mg/l As	mg/l Ba	mg/l Ca	mg/l Cl	mg/l Co	mg/l Cr	mg/l F	mg/l Fe	mg/l K	mg/l Mg	mg/l Mo	mg/l Mn	mg/l Na	mg/l NO_3-N
M-1	4/82	<0.05	<0.025	--	--	13	<0.025	<0.025	<1	1.06	--	--	<0.025	--	--	<1
M-1	8/82	<0.100	<0.010	0.12	130	6	--	--	<1	1.68	2	18	<0.05	0.61	28	<1
M-2	4/82	<0.05	<0.025	--	--	111	<0.025	<0.025	<1	0.16	--	--	<0.025	--	--	<1
M-2	8/82	0.100	0.063	<0.10	186	152	--	--	<1	1.39	27	39	0.18	4.42	412	1
M-3	4/82	<0.05	<0.025	--	--	48	<0.025	<0.025	<1	<0.1	--	--	<0.025	--	--	159
M-3	8/82	0.275	<0.010	<0.10	492	48	--	--	2	<0.05	3	190	<0.05	0.13	1068	147
M-4	4/82	<0.05	<0.025	--	--	26	<0.025	<0.025	<1	<0.1	--	--	0.548	--	--	3
M-4	8/82	0.143	<0.010	<0.10	107	35	--	--	1	0.47	3	31	0.18	0.85	210	2
M-5	4/82	<0.05	<0.025	--	--	39	<0.025	<0.025	<1	<0.1	--	--	0.297	--	--	2
M-5	8/82	<0.100	0.011	0.14	162	95	--	--	1	1.00	21	37	0.06	1.25	260	1

Sample Site	Date Sampled	mg/l PO_4	pCi/l ^{226}Ra	mg/l Se	mg/l Si	mg/l SO_4	mg/l U	mg/l V	mg/l Zn	pH	µmhos/ CDT	°C Temp	mg/l $CaCO_3$ Alky	mv eH	Depth In Water
M-1	4/82	<1	3	<0.005	--	154	0.06	<0.025	--	7.3	620	10	266	--	--
M-1	8/82	--	--	<0.010	7.1	156	0.008	<0.05	<0.050	6.5	700	14	274	- 75	11.0
M-2	4/82	<1	4	<0.005	--	859	0.99	0.196	0.16	7.2	2500	10	1168	--	--
M-2	8/82	--	--	<0.010	8.5	733	0.480	0.50	<0.050	6.9	2300	17	670	-130	15.9
M-3	4/82	<1	<2	0.072	--	3303	1.53	<0.025	--	7.2	3000	10	531	--	--
M-3	8/82	--	--	0.059	8.1	2764	1.3	<0.05	1.050	7.0	5500	18.5	465	+140	--
M-4	4/82	<1	<2	0.011	--	370	2.81	<0.025	--	7.2	850	9	355	--	--
M-4	8/82	--	--	<0.010	11.5	322	1.90	<0.05	0.050	7.2	1350	19	440	+ 10	13.3
M-5	4/82	<1	<2	0.038	--	396	0.8	0.246	--	6.9	1150	12	360	--	--
M-5	8/82	--	--	0.011	7.9	550	0.510	0.20	0.610	6.8	1600	14	411	-140	14.5

Element	Class 1C	Class 3A	Class 4
Arsenic	0.05 mg/l	*	0.1 mg/l
Selenium	0.01 mg/l	0.05 mg/l	0.05 mg/l
Zinc	*	0.05 mg/l	*
Gross alpha	15 pCi/l	15 pCi/l†	15 pCi/l†

*Insufficient evidence to warrant the establishment of numerical standard.

†Investigations should be conducted to develop more information where these pollution indicator levels are exceeded.

Arsenic and selenium contamination is detectable in South Creek but has remained less than the cited standards. Zinc concentrations fluctuate considerably, but concentrations double the Class 3A standard have been observed one mile from the pile. None of these elements are detected in the background creek samples.

A gross-alpha value can be calculated based on the uranium concentration. Three samplings at a location one mile from the pile yielded an average gross alpha of approximately 100 picocuries per liter (pCi/l) during 1982 with the highest value at 170 pCi/l.

Montezuma Creek, at its confluence with South Creek, had a calculated gross alpha of 75 pCi/l when it was sampled in August. Contamination at this point is still clearly attributable to the tailings pile. Class 1C standards apply at this location as well.

The standards also apply to ground water. The wells downgradient from the pile generally show more contamination than the nearby creek. Thus, the water is clearly unfit for Classes 3A and 4.

The Class 1C designation would apply if the aquifer contained "a sufficient quantity (of water) to supply a public system." All wells yield only small amounts of water; therefore, the Class 1C designation would not apply.

RECOMMENDATIONS

It is inappropriate to make additional environmental monitoring recommendations until the completion of the SFMP site characterization study.

SUMMARY

South Creek and Montezuma Creek are contaminated by the government-owned tailings piles to levels exceeding numerical standards of the State of Utah. Consequently, remedial action options under the SFMP project will probably require mitigation of the water contamination. Further radon-emission studies are required to determine if the EPA standards are exceeded, as indicated by 1981 studies.

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