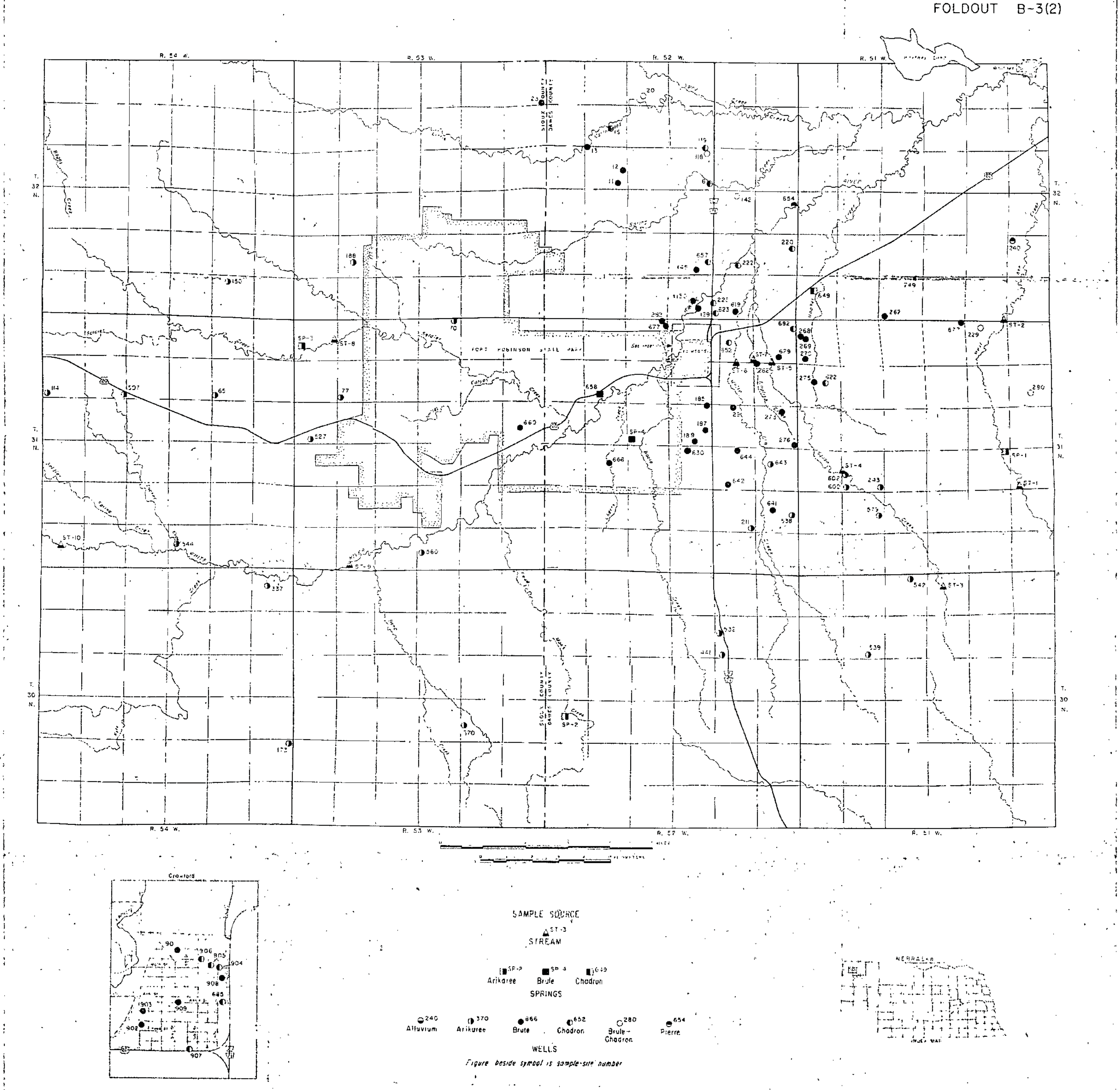
United States Nuclear Regulatory Commission Official Hearing Exhibit		
In the Matter of:	CROW BUTTE RESOURCES, INC. (License Renewal for the In Situ Leach Facility, Crawford, Nebraska)	
	ASLBP #: 08-867-02-OLA-BD01	
	Docket #: 04008943	
	Exhibit #: INT-006-00-BD01	**Identified:** 8/18/2015
	Admitted: 8/18/2015	**Withdrawn:**
	Rejected:	**Stricken:**
	Other:	

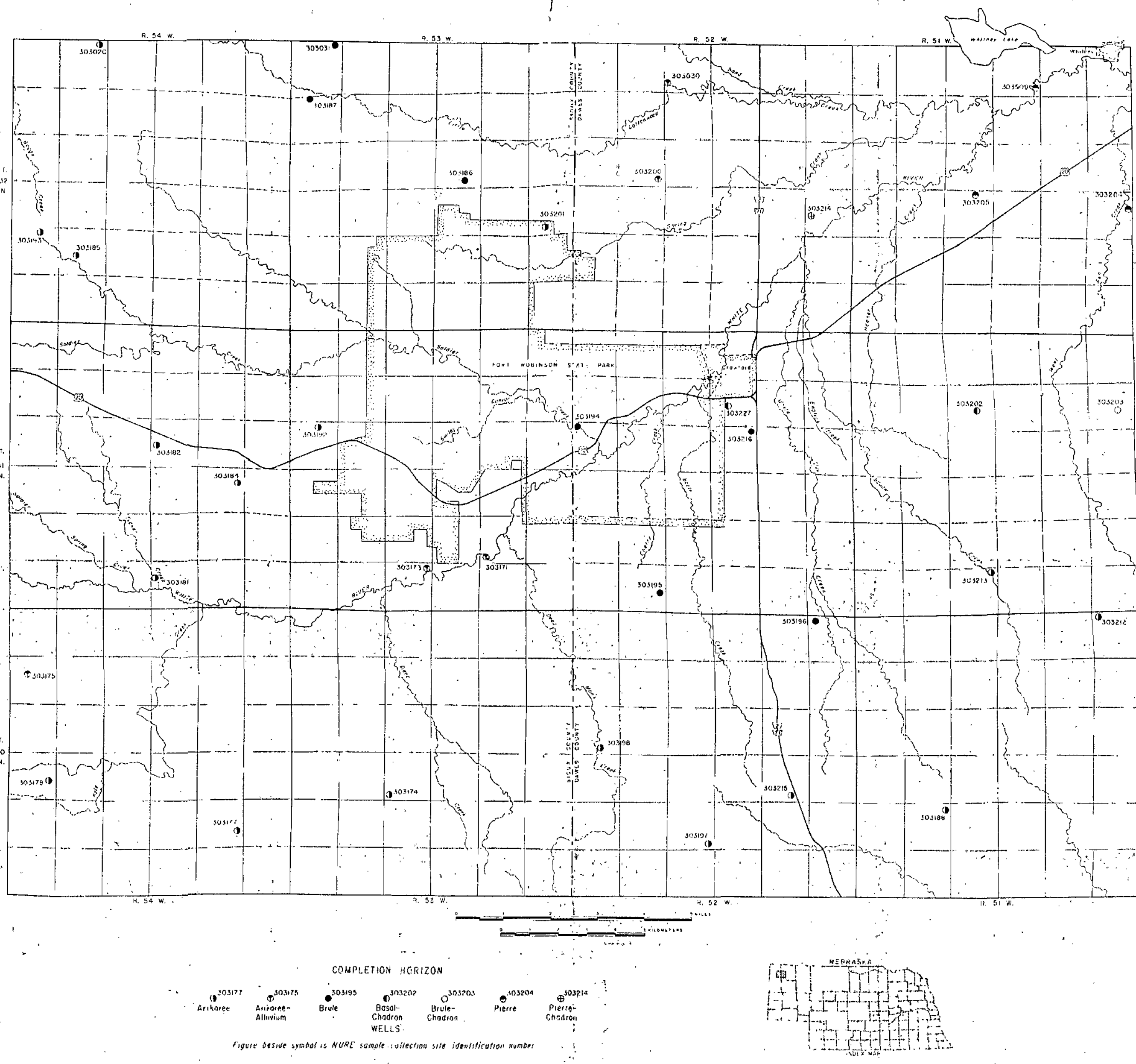
INT-006

FOLDOUT B-3(2)



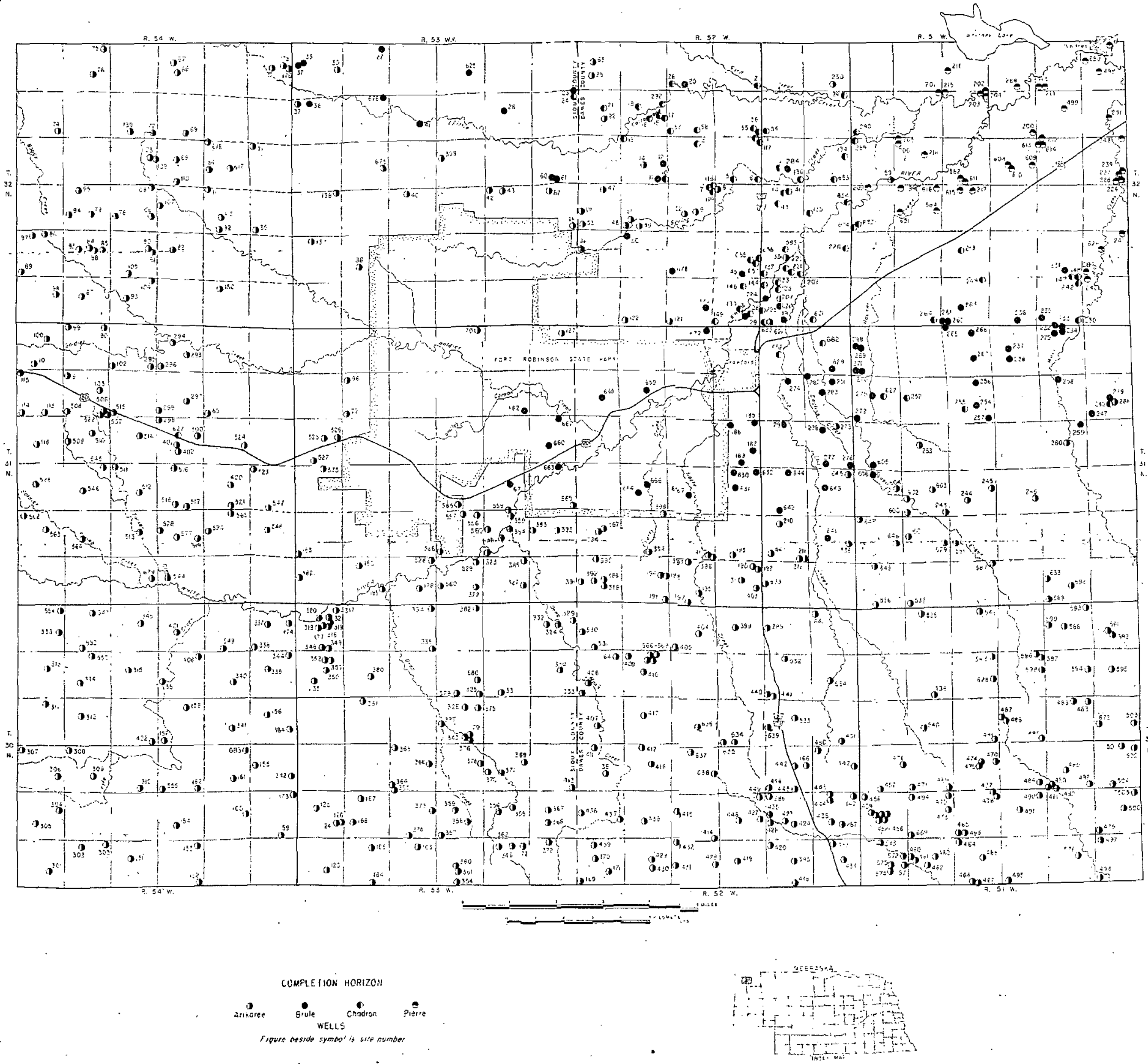
SITES SAMPLED IN PROJECT AREA

FOLDOUT A-2

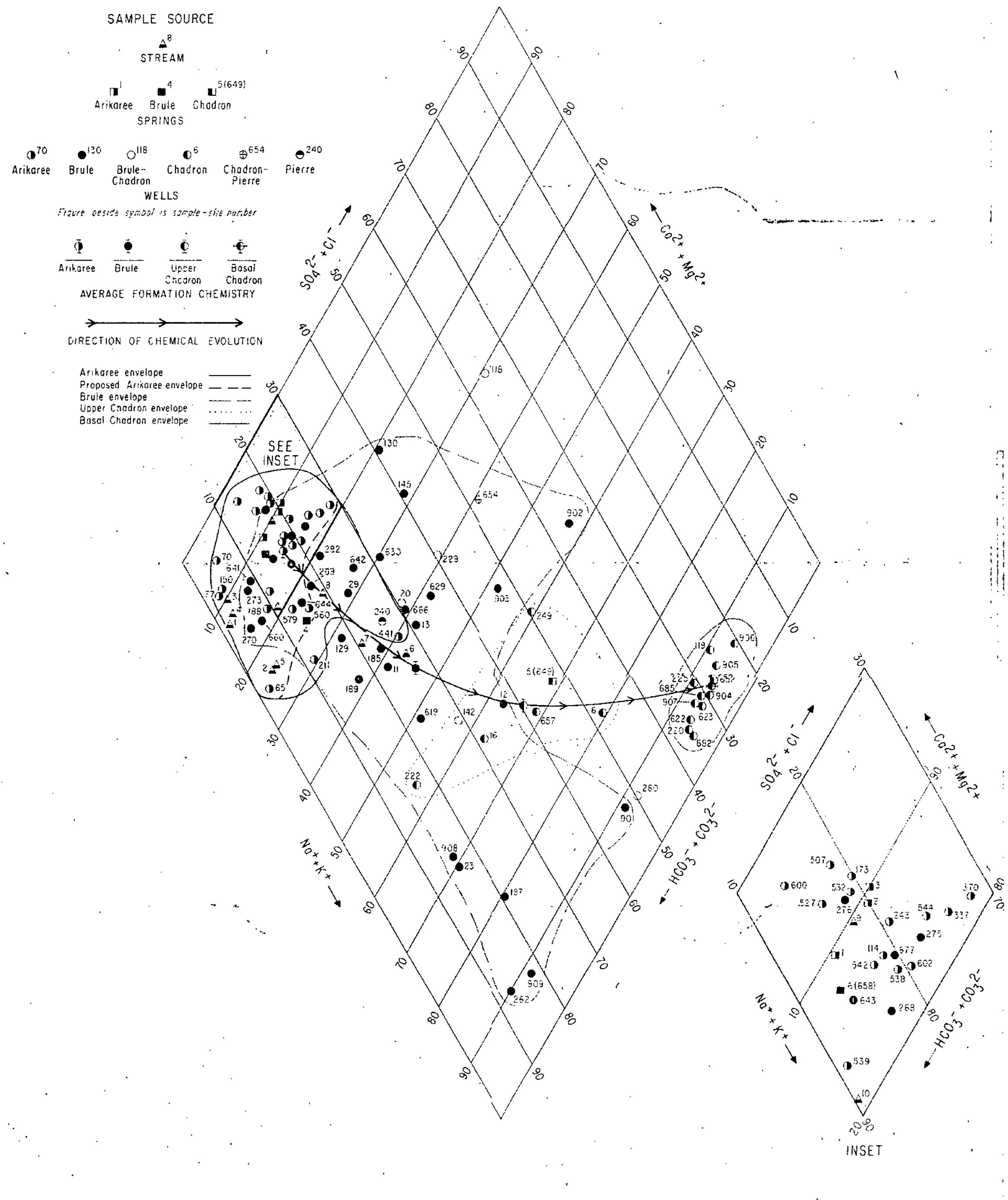


GROUNDWATER SAMPLE SITES FROM NURE PROGRAM
(Arendt et al, 1980)

FOLDOUT B-1



WELLS INVENTORIED IN PROJECT AREA



PIPER DIAGRAM

Baseline hydrogeochemical Investigation in a part of Northwest Nebraska

A Report Prepared for the
Nebraska Department of Environmental Control

by

The Conservation and Survey Division
Institute of Agriculture and Natural Resources
University of Nebraska-Lincoln, 68588
402/472-3471

Principal Investigator
Roy Spalding

June 1, 1982

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ABSTRACT

Summaries of available background hydrological, geological, and water quality data indicate that there has been a sparcity of hydrologic and geologic data collected within the designated area. Past water quality data was primarily restricted to those of the National Uranium Resource Evaluation (NURE) project. Data from this project, although helpful from the standpoint of major ion and uranium distribution does not have reliable trace metal analyses or uranium and radium isotopic results. This uranium data from the NURE project indicated anomalously high uranium concentrations from both sediments and groundwaters of the White River formation.

During the fall fo 1981 a comprehensive inventory of wells and springs identified and described 721 existing wells and 8 significant springs.

Detailed water quality analysis was performed on 81 selected wells, 6 springs and 10 surface water samples within the project boundaries.

Lowest conductivities were associated with wells of the Arikaree unit ($\bar{x}$=332 umohs/ cm^2) and highest conductivities were in artesian wells completed in the basal Chadron (x= 1824 umohs/cm^2). The distribution of major ions described an evolutionary trend from a Ca-HCO_3 type groundwater in the Arikaree unit to a Na-SO_4-Cl type groundwater from the basal Chadron. This evolutionary trend towards a progressively older, more mineralized and oxygen depleted groundwater with age, allows unit identification of the groundwater source. The end members; the Arikaree and basal Chadron are most easily identified while water presumed to originate from the Brule and upper Chadron sands have considerable overlap.

Uranium and radium concentrations ranged from 0.02 - 98.0 ug/l and <0.1 - 181 pCi/l, respectively. Highest uranium levels were associated with oxidizing groundwaters in Brule and upper

Chadron units while highest Radium levels probably are indicative of adjacent uranium ore bodies. No samples from the Arikaree, Brule or upper Chadron units had radium levels above 0.5 pCi/l. Only in the basal Chadron did radium amounts exceed the maximum contaminant level (MCL) of 5 pCi/l.

The pathfinder elements As, V, and Mo showed some positive association with uranium in the oxidizing well waters of the White River Group . Arsenic levels exceeded the MCL of 50 ppb in only one well water.

Nitrate levels in all well waters were low indicating minimum surface contamination.

Surface water quality appeared directly related to seepage from nearby units. Highest pathfinder element levels and uranium concentrations were in streams cutting the White River Group.

Well-numbering system

Each well referred to in this report is identified by a number indicating its location in the U.S. Bureau of Land Management's survey of Nebraska. The figure preceding N (for "north") indicates the township, the figure preceding W (for"west") indicates the range, and the figure preceding the lowercase letters indicates the section. The lowercase letters denote location within the section. As shown in figure 1, the first of these letters indicates the quarter section, the second the quarter-quarter section, and the third, if given, the quarter-qu rter-quarter section. Thus, in this system of numbering, a test hole or well in the SE1/4 SE1/4 SE1/4 section 17, Township of 30 North, Range 47 West, is identified by the number 30N-47W-17ddd.

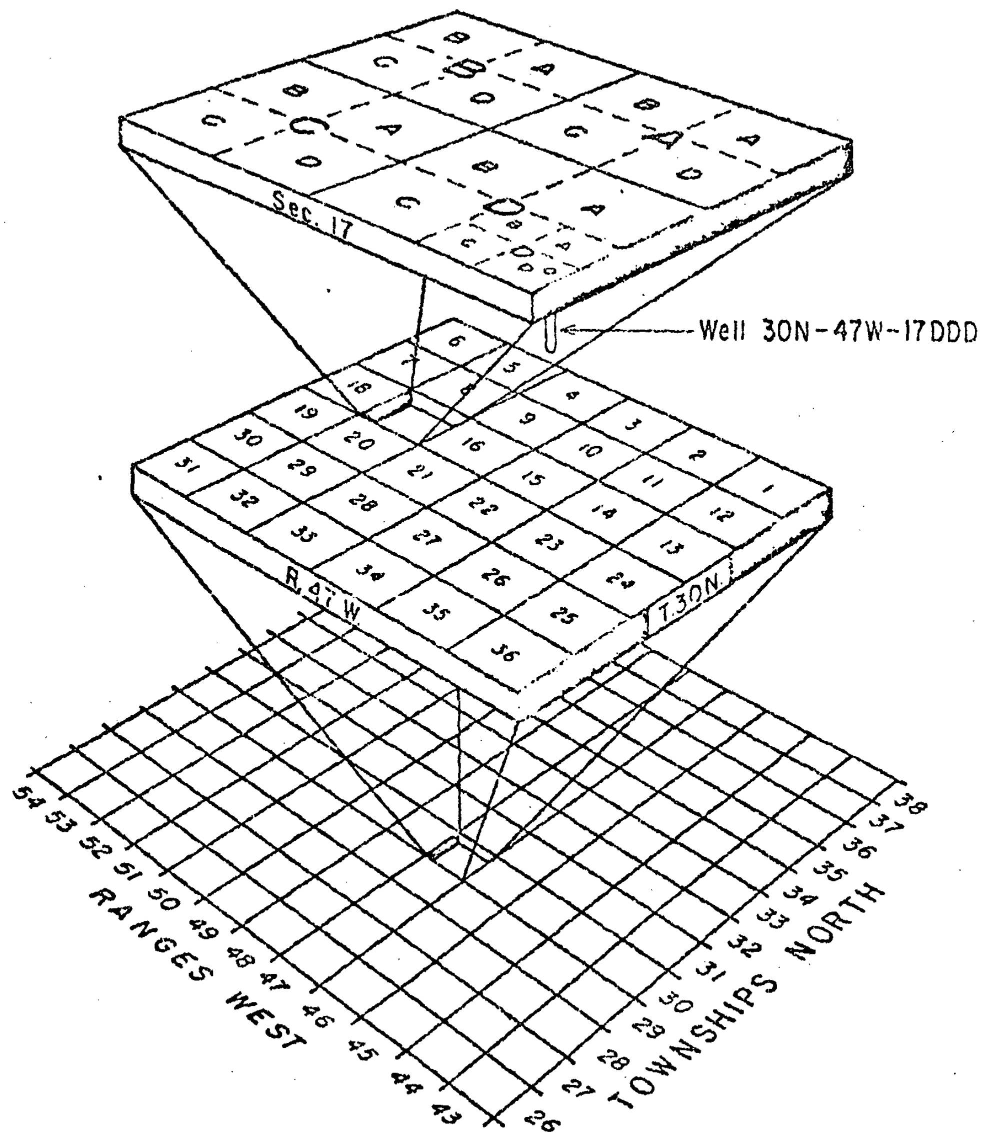

Fig. 1 System used for identifying wells according to location

ACKNOWLEDGMENTS

Dr. Arthur Struempler of Chadron State College was most cooperative in assisting us in this investigation. Dr. Struempler, with the help of his son Michael, did the project water sample collection and provided analyses for all but the radioactive constituents.

The efforts of several members of the Conservation and Survey staff are also greatly appreciated. They include Dr. Marvin P. Carlson, Mr. A. Douglas Druliner, Dr. Charles Lindau, Ms. Cynthia Norris, Mr. Frank Smith, Ms. Mary Spalding, Mr. James Swinehart, and Mr. Lowell Whiteside.

INTRODUCTION

The primary purpose of this project was to provide a water quality baseline for an area of northwest Nebraska. A twelve township project area was defined along the White River drainage basin in Sioux and Dawes counties (Figure A-3(1)). Of principal concern was the current groundwater chemistry and the hydrogeological relationships. Fieldwork and analysis was a coordinated effort of the Division, the Department of Environmental Control and Chadron State College.

Additional tasks of this project included summaries of background hydrologic, geologic and water quality investigations and an inventory of the location of all wells within the project area.

Historical USGS Surface water,

Suspended sediment and seepage records

Tasks A-1 and A-4

Water quality samples from station 0644500 located near Whitney Nebraska on the White River were collected from August 1969 through September 1971 by the U.S. Geological Survey (USDI, 1969a,1970,1971). The data demonstrated a general trend of high dissolved solids at periods of low flow and low dissolved solids at periods of high flow. This trend is primarily associated with the concentration effects of evaporation during low flow stages. Throughout this period contaminants such as nitrates and pesticides remained at low levels. Uranium and radium analyses are not available in these reports.

No seepage or sediment studies are reported for the investigated area; however point seepage measurements and sediment characteristics from the Slim Butte , South Dakota station on the White River were recorded during the mid sixties (USDI, 1971a). Suspended sediment analyses indicated that a major percentage of sediment load was from clay-sized particles. According to Mike Ellis (personal communication), the clays were predominantly bentonitic and presumed to be from dissociated volcanic ash beds in Nebraska. Such clays would tend to release dissolved uranium to the river waters.

Several stream-gaging stations have been maintained by the U.S. Geological Survey within the project area. Station 444000 on the White River at Crawford has data for 1931-'43 and 1947 to present (USDI, 1950, USDI, 1960, USDI, 1970, USDI, 1971-81). Discharge extremes in cubic feet per second are a maximum of 1580 and a minimum of 2.7. Mean discharge is 20.2 cf/s.

National Uranium Resource Evaluation (NURE) Results

Task A-2

Both stream sediment and groundwater samples were collected in the northern half of the Panhandle (Alliance 1:250,000 sheet) during 1979. Sediment sampling for the NURE program was performed by Biospheric Consultants International. Groundwater sampling utilized student help from Chadron State College and the University of Nebraska.

Stream Sediment Data

Approximately 10% of the 523 stream sediment samples collected in the Alliance sheet were located within the boundaries of the current project. Total uranium concentrations ranged from 2.5 to 4.5 ppm (Arendt et al.,1980). Thus background uranium concentrations are slightly higher than the average crustal abundance which is 2.7 ppm (Taylor, 1964).

Within the project area, high background levels of hot acid soluble uranium occurred in sediments from the White River Group and Pierre Shale. Adams and Weaver (1958) reported that most marine shales such as the Pierre contain higher than average uranium levels and approach those of primary igneous rock (mainly granite). According to Piller and Adams (1962) ash beds with anomalous uranium concentrations commonly occur in marine Cretaceous shales in the western U.S. Similar ash beds frequently are noted in drilling through the White River Group and generally are considered by Arendt et al.(1980) to be the most probable source of elevated uranium and arsenic (an associated element) levels in these Oligocene sediments.

Groundwater Data

Thirty-six of the 514 groundwater samples collected from existing wells within the Alliance sheet are located in the project area (Foldout A-2). Split samples were collected at each site during May - June 1979. One sample was analyzed for nitrate at the Department of Environmental Control in Lincoln and the remaining sample was shipped to Union Carbide Corp. in Oak Ridge, Tenn. for major ion and trace metal analyses. Temperature, pH, alkalinity, hydrogen sulfide and conductivity were determined in the field. The data (Table A-2a) are grouped according to producing horizon. In some cases there is a low degree of confidence in the assigned producing horizon since the investigated area is geologically complex and lacking in sufficient control points.

Except for uranium, sulfate, chloride, arsenic and selenium, the remaining 27 elements (Table A-2a) were analyzed by plasma source emission spectrometry. Uranium concentrations were determined by either fluorometry or isotope dilution mass spectrometry. Arsenic and selenium were determined by hydride generation atomic absorption and chloride and sulfate were determined spectrophotometrically. Details of sampling, analyses and statistical procedures are presented in Arendt et al. (1979).

The results of the Alliance report indicated that the Oligocene formations (Chadron and Brule) of the White River group provide the most favorable geologic unit for potential uranium mineralization. This conclusion was based upon the occurrence of uranium levels adjusted for total dissolved solids by the formula 1000(uranium/specific conductance).

TABLE 6-2a. ANALYTICAL DATA FROM INVESTIGATED AREA COLLECTED FOR CORE PROGRAM (ARENDT ET AL. 1980)
WELLS PRODUCING FROM ARIKAREE AND YOUNGER STRATA

ID NO.	LEGAL LOCATION	WELL TYPE	WELL DEPTH(ft.)	PRODUCING HORIZON	TEMP. °C	pH	D.O. mg/l	H_2S	COND. µmhos/cm²	Ca^{2+}	Mg^{+2}	Na^+	K^+	HCO_3^-	SO_4^{2-} (mg/l)	Cl^-	NO_3^-	PO_4^{3-}	SiO_2
303020	32N-54W-S05AA	H,S	95	Ta	12	7.7	7.5	ND	360	38	8.3	6.9	4.8	263	14	<10	3.1	<.12	60
303030	32N-52W-S04CC	H,S	23	Ta/Qal	12	7.5	5.7	ND	790	69	16	113	30	366	156	<10	8.9	<.12	67
303171	31N-53W-S26CC	H	89	Ta/Qal	12	8.2	5.6	ND	350	16	0.4	86	16	172	54	<10	4.0	<.12	6.3
303173	31N-53W-S33AA	H	79	Ta/Qal	14	7.7	8.3	ND	220	45	5.7	7.7	7.5	175	5	<10	3.5	<.12	74
303174	30N-53W-S21CC	H,S	335	Ta	15	7.8	8.1	ND	220	40	7.5	8.4	2.2	164	<5	<10	8.4	<.12	76
303175	30N-54W-S07BD	H	30	Ta/Qal	13	7.9	9.2	ND	230	41	7.7	9.5	4.6	160	<5	<10	7.5	<.12	74
303177	30N-54W-S26DA	S	266	Ta	13	7.9	7.6	ND	230	42	5.2	9.5	6.9	147	<5	<10	7.5	<.12	63
303178	30N-54W-S19DA	S	374	Ta	14	7.5	9.8	ND	420	42	5.2	9.5	6.9	166	<5	<10	7.1	<.12	65
303181	31N-54W-S34BC	H	30	Ta	14	7.7	8.5	ND	350	41	7.3	8.7	7.2	170	<5	<10	3.8	<.12	71
303182	31N-54W-S15CB	H,S	404	Ta	14	7.7	9.5	ND	340	36	9.5	10	8.5	162	<5	<10	5.8	<.12	70
303184	31N-54W-S23AD	H,S	443	Ta	13	7.0	9.0	ND	470	48	8.1	3.4	4.7	150	<5	<10	22	<.12	61
303185	32N-54W-S29CA	H,S	282	Ta	14	7.2	8.9	ND	470	45	6.4	5.2	6.3	168	<5	<10	5.3	<.12	62
303188	30N-51W-S29AA	S	207	Ta	12	7.5	9.3	ND	390	83	7.9	7.8	5.2	290	<5	<10	3.1	<.12	64
303192	31N-53W-S18AB	S	443	Ta	14	8.0	10.4	ND	340	46	7.7	4.7	5.3	196	<5	<10	4.4	<.12	58
303193	32N-54W-S30AB	S	295	Ta	14	8.0	9.5	ND	330	37	8.7	6.9	6.9	183	<5	<10	3.1	<.12	65
303197	30N-52W-S22DD	H,S	312	Ta	14	7.2	9.5	ND	410	39	8.7	6.9	2.0	192	<5	<10	3.1	<.12	77
303198	30N-52W-S12DC	H	30	Ta	11	7.3	9.2	ND	430	45	6.8	11	2.2	188	<5	<10	4.0	<.12	70
303200	32N-52W-S17DD	H	26	Ta/Qal	11	6.9	5.5	ND	770	91	11	80	19	356	42	200	8.4	0.40	72
303201	32N-53W-S24CD	H	88	Ta	12	7.1	7.2	ND	400	51	4.3	26	9.3	236	5	<10	3.5	<.12	66
303212	30N-51W-S01BB	H	177	Ta	12	7.6	10.5	ND	530	92	5.7	4.4	3.6	223	20	<10	93	<.12	54
303213	31N-51W-S33AA	H	39	Ta	12	7.2	5.5	ND	510	80	9.9	9.7	6.2	344	14	<10	8.9	<.12	53
303215	30N-52W-S23DC	H,S	344	Ta	14	7.3	10.3	ND	430	36	5.3	13	2.2	188	14	<10	3.3	<.12	78

H= house; S=stock

TABLE A-2a (CONTINUED)

WELLS PRODUCING FROM THE BRULE FORMATION

ID NO.	LEGAL LOCATION	WELL TYPE	WELL DEPTH(ft.)	PRODUCING HORIZON	TEMP. °C	pH	D.O. mg/l	H_2S	COND. umhos/cm²	Ca^{2+}	Mg^{+2}	Na^+	K^+	HCO_3^-	SO_4^{2-}	Cl^-	NO_3^-	PO_4^{3-}	SiO_2
										←					mg/l				→
303031	32N-53W-S05AA	H,S	161	Tb	14	7.9	13.1	ND	380	41	4.7	33	7.2	190	14	<10	28	<.12	65
303186	32N-53W-S15DC	S	158	Tb	14	7.3	8.3	ND	390	40	5.2	9.7	9.2	180	<5	<10	2.7	<.12	71
303187	32N-53W-S07BA	NONE	33	Tb	12	7.3	2.9	ND	440	62	8.5	8.3	7.2	217	<5	<10	31	<.12	52
303194	31N-52W-S18BB	S	148	Tb	15	8.3	5.1	ND	520	7.5	0.7	108	11	230	40	<10	3.1	<.12	82
303195	31N-52W-S32DA	H,S	197	Tb	14	6.7	9.3	ND	490	28	3.0	3.5	7.6	186	5	<10	2.7	0.20	70
303196	30N-52W-S01BB	H,S	194	Tb	12	6.9	8.6	ND	680	69	4.6	54	18	334	10	<10	20	<.12	68
303216	31N-52W-S15AA	H	98	Tb	14	7.2	9.9	ND	580	49	5.4	49	17	336	39	11	14	<.12	64

Table A-2a (Continued)

WELLS PRODUCING FROM THE UPPER CHADRON, LOWER BRULE AND PIERRE FORMATIONS

ID NO.	LEGAL LOCATION	WELL TYPE	WELL DEPTH (ft.)	PRODUCING HORIZON	TEMP. °C	pH	D.O. mg/l	H_2S	COND. µmhos/cm²	Ca^{2+} (mg/l)	Mg^{+2}	Na^+	K^+	CO_3^{2-}	HCO_3^-	SO_4^{2-}	Cl^-	NO_3^-	PO_4^{3-}	SiO_2
303203	31N-51W-S12DB	H,S	541	Tb/Tc	14	8.0	9.1	ND	1040	11	0.7	174	8.9	20	336	137	86	0.9	<.12	72
303204	32N-51W-S24AD	H,S	49	Kp	16	7.1	5.1	ND	1040	63	14	103	14		468	132	15	<.08	<.12	50
303205	32N-51W-S21AB	H,S	59	Kp	14	7.4	9.5	ND	2380	69	9.5	285	20		392	792	78	58	<.12	59
303214	32N-52W-S24CB	H	49	Tc/Kp	13	6.9	8.9	ND	590	46	2.4	50	23		300	40	20	13	<.12	69
303509	32N-51W-S03DC	H,S	52	Kp	13	7.4	2.9	ND	1980	76	17.8	306	29		716	900	24	1.3	0.28	38

WELLS PRODUCING FROM THE BASAL CHADRON SANDS

ID NO.	LEGAL LOCATION	WELL TYPE	WELL DEPTH (ft.)	PRODUCING HORIZON	TEMP. °C	pH	D.O. mg/l	H_2S	COND. µmhos/cm²	Ca^{2+} (mg/l)	Mg^{+2}	Na^+	K^+	CO_3^{2-}	HCO_3^-	SO_4^{2-}	Cl^-	NO_3^-	PO_4^{3-}	SiO_2
303202	31N-51W-S09DB	H,S	640	Tc	14	8.4	4.7	ND	430	3	0.2	107	6.9	1.2	186	20	<10	3.1	<.12	72
303227	31N-52W-S10CA	H,S	425	Tc	17	8.0	1.2	ND	1990	17	4.1	262	12		326	457	165	<.08	<.12	9

Table A- 2a (Continued)

WELLS PRODUCING FROM THE ARIKAREE AND YOUNGER STRATA

ID NUMBER	Ag	Al	As	B	Ba	Ce	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Se	Sr	V	Zn	Zr	U
	TRACE METALS (ug/l)																			
303020	<2	<10	3.7	16	101	<30	<2	<4	<2	24	10	<2	7	11	0.6	313	<4	61	<2	5.2
303030	<2	<10	7.0	158	13.	<30	<2	<4	<2	12	66	<2	<4	6	0.6	1273	10	77	<2	40.2
303171	3	<10	10.4	116	23	32	3	5	<2	17	25	<2	10	<4	0.3	198	10	153	5	20.8
303173	<2	<10	2.6	23	87	<30	<2	<4	<2	15	12	<2	<4	4	0.3	373	7	480	2	7.1
303174	<2	<10	3.7	23	32	<30	<2	<4	<2	18	13	<2	<4	<4	0.4	366	7	10	<2	5.5
303175	<2	14	2.3	26	91	<30	<2	<4	<2	16	15	<2	<4	5	0.3	303	12	30	<2	5.8
303177	<2	<10	3.7	26	51	<30	<2	<4	<2	17	18	<2	5	<4	0.3	303	<4	43	<2	3.4
303178	<2	<10	3.8	26	51	<30	<2	<4	<2	17	18	<2	5	<4	0.4	303	<4	43	<2	5.6
303181	3	<10	2.7	24	128	<30	2	<4	<2	16	12	<2	<4	<4	0.4	243	18	56	<2	7.7
303182	<2	<10	2.4	24	66	<30	<2	<4	<2	17	14	<2	<4	<4	0.2	224	11	95	<2	7.1
303184	<2	<10	1.3	20	53	<30	<2	<4	<2	17	10	<2	<4	<4	0.2	269	<4	42	<2	4.0
303185	<2	80	1.9	24	60	<30	<2	<4	<2	16	11	<2	<4	<4	0.4	247	<4	107	<2	3.9
303188	<2	<10	3.7	31	42	<30	<2	<4	<2	17	14	8	4	<4	0.3	351	6	1167	2	4.9
303192	3	<10	1.1	24	49	<30	5	4	<2	15	12	2	<4	5	0.3	174	21	109	3	4.6
303193	2	<10	2.8	27	73	<30	<2	<4	<2	17	11	2	<4	<4	0.4	206	8	121	<2	3.7
303197	<2	<10	4.7	21	19	<30	<2	<4	<2	17	19	<2	<4	6	0.4	396	<4	105	<2	9.6
303198	2	<10	3.4	26	38	<30	<2	<4	<2	19	17	<2	12	<4	0.3	436	<4	100	3	7.0
303200	3	<10	19	96	129	<30	<2	<4	<2	<10	61	<2	21	8	0.8	1371	13	60	2	35.8
303201	3	<10	5.4	49	93	32	<2	5	<2	<10	35	2	7	8	0.3	473	60	150	4	12.2
303212	2	46	1.3	29	177	<30	<2	<4	<2	<10	12	2	<4	<4	<0.2	588	<4	52	3	2.7
303213	<2	31	1.3	29	321	<30	<2	<4	<2	<10	19	8	<4	<4	<0.2	529	<4	1108	<2	5.6
303215	<2	20	4.5	36	28	<30	<2	<4	<2	<10	16	3	<4	<6	<0.2	407	9	134	<2	7.2

All analyses for : Be(1 ug/l; Sc <1 ug/l; Ti <2 ug/l; and Y≤ 2 ug/l

Table A - 2a (continued)

WELLS PRODUCING FROM THE EAGLE FORMATION

ID NUMBER	Ag	Al	As	B	Ba	Ce	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Se	Sr	V	Zn	Zr	U
	TRACE METALS (ug/l)																			
303031	<2	<10	2.1	21	126	<30	<2	<4	<2	<10	18	6	<4	<4	0.3	385	<4	214	<2	11.3
303185	<2	<10	1.8	20	51	<30	<2	<4	<2	13	10	<2	5	<4	0.3	364	<4	359	<2	8.1
303187	<2	<10	0.6	28	29	<30	<2	<4	16	14	14	7	9	6	0.3	437	<4	138	<2	6.9
303194	5	<10	64	157	14	42	2	5	<2	48	29	<2	9	<4	0.4	106	21	60	6	6.4
303195	5	<10	4.2	30	61	36	<2	<4	<2	17	10	33	11	13	0.3	132	<4	86	6	9.0
303196	<2	<10	3.5	79	213	<30	<2	<4	<2	12	50	13	<4	<4	0.4	1254	<4	36	<2	21.7
303216	<2	28	8.0	109	113	<30	<2	<4	<2	<10	37	<2	<4	4	<0.2	800	10	102	<2	19.1

All analyses for : Be<1 ug/l; Sc <1 ug/l; Tl <2 ug/l; and Y≤ 2 ug/l

Table A- 2e (continued)

WELLS PRODUCING FROM THE UPPER CHADRON, LOWER BRULE AND PIERRE FORMATIONS

ID NUMBER	Ag	Al	As	B	Ba	Ce	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Se	Sr	V	Zn	Zr	U
	TRACE METALS (ug/l)																			
303203	<2	<10	6.7	647	25	<30	<2	<4	<2	31	50	<2	28	4	0.4	238	<4	28	<2	5.8
303204	<2	<10	7.6	163	103	<30	<2	<4	<2	<10	87	82	12	<4	0.3	937	<4	23	<2	23.6
303205	2	<10	18.4	444	21	<30	2	<4	<2	<10	153	<2	9	4	0.4	1781	5	18	2	85.9
303214	<2	<10	7.7	12	88	<30	<2	<4	<2	<10	52	<2	<4	<4	0.5	784	<4	48	<2	18.6
303509	<2	<10	13.6	336	73	<30	<2	<4	<2	<10	258	<2	9	<4	0.5	1239	48	34	<2	18.0

WELLS COMPLETED IN THE BASAL CHADRON SANDS

ID NUMBER	Ag	Al	As	B	Ba	Ce	Co	Cr	Cu	Fe	Li	Mn	Mo	Ni	Se	Sr	V	Zn	Zr	U
	TRACE METALS (ug/l)																			
303202	<2	<10	38	151	6	<30	<2	<4	<2	<10	31	2	<4	<4	0.8	47	13	10	<2	5.9
303227	4	<10	<5	1216	8	38	9	<4	<2	<10	100	10	16	<4	0.2	348	11	14	4	2.8

All analyses for : Be <1 ug/l; Sc <1 ug/l; Ti <2 ug/l; and Y < 2 ug/l

EXPLANATION OF ABBREVIATIONS: Ta:Arikaree ;Qal:Alluvium ;Tb:Brule ;Kp:Pierre ; Tc:Chadron ;D.O. :Dissolved Oxygen ;Cond.: Conductivity ;H: Household ; S: Stock ; ND: no data .

TABLE 8 - 2b

GENERALIZED PHYSICAL AND CHEMICAL CHARACTERISTICS OF ANALYZED WATERS

TEMPERATURE (°C)

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	11-13	12-15	13-16	14-17
MEAN	13	13.57	16	15.5
Std.DEVIATION	1.13	1.04	1.09	1.5

WELL DEPTH (Ft.)

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	23-443	33-197	49-541	423-640
MEAN	200.5	141.3	150	531.5
Std.DEVIATION	148.7	53.7	195.5	108.5

pH

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	6.9-8.2	6.7-8.3	6.9-8.9	8.0-8.4
MEAN	7.54	7.37	7.36	8.20
Std.DEVIATION	0.35	0.51	0.37	0.2

D.O. (mg/l)

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	5.5-10.4	2.9-13.1	2.9-9.1	1.2-4.7
MEAN	8.22	8.2	7.1	2.95
Std.DEVIATION	1.67	3.07	2.63	1.75

COND. (uMHOS/CM.)

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	220-790	380-650	590-1930	430-1990
MEAN	409.6	481.4	1406	1219
Std.DEVIATION	146.1	93.1	665.2	780

Ca^{2+} (mg/l)

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	16-92	7.5-62	11-76	3-17
MEAN	48.2	42.3	53	10
Std.DEVIATION	18	19.2	23.2	7

Mg^{2+} (mg/l)

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	0.4-11	0.7-8.5	0.7-17.8	0.2-4.1
MEAN	7.43	4.59	8.88	2
Std.DEVIATION	2.88	2.20	6.56	1.95

Na^{+} (mg/l)

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	3.4-113	8.3-108	50-306	107-262
MEAN	20.28	38.2	183.6	184.5
Std.DEVIATION	29.7	33.89	99.7	77.5

K^{+} (mg/l)

	Ta	Tb	Tb/Tc/Kg	Tc
RANGE	2-30	7.2-17	8.9-24	6.8-12
MEAN	7.52	10.74	17.98	9.40
Std.DEVIATION	6.42	3.86	5.72	2.60

CO_3^{-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE			20	1.8
MEAN			20	1.8
Std.DEVIATION			0	0

HCO_3^{-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	147-366	180-336	300-710	186-326
MEAN	208.82	239	441.2	256
Std.DEVIATION	66.85	62.99	145.87	70

SO_4^{2-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<5-156	<5-40	40-900	20-457
MEAN	<17.68	<16.86	400.2	232.5
Std.DEVIATION	>32.68	>14.65	367.2	218.5

NO_3^{-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	3.1-93	2.7-31	<.08-58	<.08-3.1
MEAN	10.20	14.50	<15.06	<1.57
Std.DEVIATION	18.91	11.3	>22.17	>1.51

PO_4^{3-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<.12-.46	<.12-.2	<.12-.28	<.12
MEAN	<.13	<.13	<.15	<.12
Std.DEVIATION	>.06	>.03	>.06	0

Cl^{-} (mg/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<10-200	<10-11	15-56	<10-165
MEAN	<18.64	<0.16	40.6	<87.50
Std.DEVIATION	>39.39	>0.35	34.75	>77.50

Table A-2b (continued)

SiO_2 (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	6.3-78	52-82	38-72	9-72
MEAN	64.01	67.43	57.6	40.5
Std.DEVIATION	14.34	8.35	12.50	31.5

Ag (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<2-3	<2-5	<2-2	<2-4
MEAN	<2.23	<2.86	<2	<3
Std.DEVIATION	>0.42	>1.34	>0	>0

Al (ug/l)

	Ta	Tb	Ta/Tc/Kp	Tc
RANGE	<10- 80	<10-28	<10	<10
MEAN	<16.41	<12.57	?<10	<10
Std.DEVIATION	>16.31	>6.30	>0	>0

As (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1.3-1.9	0.6-64	6.7-18.4	<5-38
MEAN	4.22	12.03	10.80	<21.50
Std.DEVIATION	3.83	21.33	4.52	>16.50

B (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	16-158	20-157	12-647	151-1216
MEAN	39.73	63.43	320.40	683.5
Std.DEVIATION	35.13	49.47	220.03	532.5

Ba (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	13-128	14-213	21-103	6-8
MEAN	78.41	86.71	62.00	7
Std.DEVIATION	66.27	64.07	33.25	1

Ce (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<30-32	<30-42	<30	<30-38
MEAN	<30.18	<32.57	<30	<34
Std.DEVIATION	>0.37	>4.37	>0	>4

Co (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<2-3	<2-2	<2-2	<2-9
MEAN	<2.18	<2	<2	<5
Std.DEVIATION	>0.65	>0	>0	>3

Cr (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<4-5	<4-5	<4	<4
MEAN	<4.09	<4.14	<4	<4
Std.DEVIATION	>0.29	>0.35	>0	>0

Cu (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<2	<2-16	<2	<2
MEAN	<2	<4	<2	<2
Std.DEVIATION	>0	>4.9	>0	>0

Fe (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<10-24	<10-46	<10-31	<10
MEAN	<15.32	<17.71	<14.20	<10
Std.DEVIATION	>3.52	>12.57	>8.40	>0

Li (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	11- 66	10-50	50-258	31-100
MEAN	20.00	24.0	120	65.5
Std.DEVIATION	14.84	14.13	78.42	34.3

Mn (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<2-8	<2-33	<2-82	2-10
MEAN	<2.59	<9.29	<18.0	6
Std.DEVIATION	>1.73	>10.36	>32.0	4

Mo (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<4-21	<4-11	<4-28	<4-16
MEAN	<5.77	<5.57	<12.40	<10
Std.DEVIATION	>3.93	>2.77	>8.21	>6

Ni (ug/l)

	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<4-11	<4-13	<4-4	<4
MEAN	<4.95	<5.29	<4	<4
Std.DEVIATION	>1.80	>3.15	>0	>0

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
317	30N 53W 06 AA	125	HOUSEHOLD
318	30N 53W 06 AC	60	HOUSEHOLD
319	30N 53W 06 AC	30	HOUSEHOLD
320	30N 53W 06 AC	30	HOUSEHOLD
321	30N 53W 06 AC	30	HOUSEHOLD
322	31N 53W 34 DA	72	HOUSEHOLD, STOCK
323	31N 53W 26 CC	90	HOUSEHOLD, STOCK
324	30N 53W 01 AC	60	STOCK
325	30N 53W 10 DD	390	STOCK
326	30N 53W 15 AB	380	STOCK
327	31N 53W 35 DA	80	HOUSEHOLD, STOCK
328	31N 53W 33 AA	60	HOUSEHOLD
329	30N 53W 01 AD	60	HOUSEHOLD, STOCK
330	30N 53W 12 AC	30	STOCK
331	30N 53W 11 CD	380	STOCK
332	30N 53W 01 BD	60	STOCK
333	30N 52W 07 CC	50	HOUSEHOLD
334	30N 53W 04 AA	104	HOUSEHOLD, STOCK
335	30N 53W 04 DD	128	STOCK
336	32N 52W 26 DB	40	HOUSEHOLD, STOCK
337	30N 54W 01 BD	30	HOUSEHOLD, STOCK
338	30N 54W 01 CC	60	STOCK
339	30N 54W 12 BD	60	STOCK
340	30N 54W 11 DB	220	STOCK
341	30N 54W 14 DB	220	STOCK
342	30N 54W 24 DA	160	STOCK
343	30N 53W 15 DC	64	STOCK
344	30N 54W 12 AA	60	STOCK
345	30N 54W 04 AC	230	NOT REPORTED
346	30N 53W 35 AB	200	STOCK
347	30N 54W 05 AB	180	STOCK
348	30N 53W 06 DC	40	HOUSEHOLD, STOCK
349	30N 53W 06 DC	70	STOCK, HOUSEHOLD
350	30N 53W 07 AC	40	STOCK
351	30N 53W 07 CA	50	HOUSEHOLD
352	30N 53W 07 AB	40	HOUSEHOLD
353	30N 53W 07 AB	40	HOUSEHOLD
354	30N 53W 34 CD	252	STOCK
355	30N 53W 26 AC	180	STOCK
356	30N 53W 26 BD	210	HOUSEHOLD, STOCK
357	30N 53W 27 CC	310	STOCK
358	30N 53W 27 DB	270	STOCK
359	30N 53W 27 BD	290	STOCK
360	30N 53W 34 CA	252	HOUSEHOLD, STOCK
361	30N 53W 34 CA	300	STOCK, IRRIGATION

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
362	30N 53W 35 BA	270	STOCK
363	30N 53W 21 BB	250	STOCK
364	30N 53W 21 CC	252	NOT REPORTED
365	30N 53W 21 CC	300	HOUSEHOLD, STOCK
366	30N 53W 21 AD	270	STOCK
367	30N 53W 25 BD	300	NOT REPORTED
368	30N 53W 25 CA	240	HOUSEHOLD, STOCK
369	30N 53W 23 AD	140	STOCK
370	30N 53W 23 CB	300	STOCK
371	30N 53W 23 CA	90	STOCK
372	30N 53W 36 BA	250	STOCK
373	30N 53W 28 AD	260	HOUSEHOLD, STOCK
374	30N 53W 28 CD	270	STOCK
375	30N 53W 15 AA	300	STOCK
376	30N 53W 15 DC	18	HOUSEHOLD, STOCK
377	30N 53W 15 CB	64	STOCK
378	30N 53W 22 AD	62	STOCK
379	30N 53W 10 CD	400	STOCK
380	30N 53W 08 DB	440	STOCK
381	30N 53W 17 BA	400	STOCK
382	30N 53W 03 AA	110	STOCK
383	31N 53W 25 BC	100	HOUSEHOLD
384	31N 53W 26 AC	80	STOCK
385	31N 53W 35 AA	90	STOCK
386	31N 52W 30 AC	80	HOUSEHOLD, STOCK
387	31N 52W 30 AC	N.R.	NOT REPORTED
388	31N 52W 31 DB	300	HOUSEHOLD, STOCK
389	31N 52W 31 DB	166	HOUSEHOLD, STOCK
390	31N 52W 31 BA	100	STOCK
391	31N 52W 31 CB	160	STOCK
392	31N 52W 31 BC	160	STOCK
393	31N 53W 25 AC	90	STOCK
394	31N 52W 29 DB	65	HOUSEHOLD, STOCK
395	30N 52W 35 AC	190	HOUSEHOLD, STOCK
396	31N 52W 28 DD	100	STOCK
397	31N 52W 33 BA	120	STOCK
398	31N 52W 29 AA	120	HOUSEHOLD, STOCK
399	30N 52W 03 BD	60	STOCK
400	31N 54W 23 AC	250	STOCK
401	31B 54W 15 CA	408	HOUSEHOLD, STOCK
402	31N 54W 15 CA	400	HOUSEHOLD, STOCK
403	31N 52W 34 DA	180	HOUSEHOLD
404	30N 52W 04 DB	N.R.	STOCK
405	30N 52W 04 CC	40	STOCK
406	30N 52W 07 CA	50	STOCK
407	30N 52W 18 CA	70	HOUSEHOLD, IRRIGATION

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
408	30N 54W 10 AA	260	STOCK
409	30N 52W 08 BB	60	HOUSEHOLD
410	30N 52W 08 BD	60	HOUSEHOLD
411	30N 52W 19 BA	N.R.	HOUSEHOLD
412	30N 52W 20 BA	250	HOUSEHOLD, STOCK
413	30N 53W 24 DD	N.R.	STOCK
414	30N 52W 28 DD	320	HOUSEHOLD, STOCK
415	30N 52W 28 DC	350	STOCK
416	30N 52W 20 AC	310	STOCK
417	30N 52W 17 BD	310	STOCK
418	30N 52W 35 DC	190	STOCK
419	30N 52W 34 BD	100	STOCK
420	30N 52W 35 BB	180	HOUSEHOLD
421	30N 54W 03 CA	200	STOCK
422	30N 54W 16 DD	400	STOCK
423	30N 52W 26 CA	40	HOUSEHOLD, STOCK
424	30N 52W 26 DB	360	ABANDONED
425	30N 52W 26 BC	260	STOCK
426	30N 52W 26 CB	360	STOCK
427	30N 52W 27 DA	350	STOCK
428	30N 52W 33 AD	320	HOUSEHOLD, STOCK
429	30N 52W 32 AC	300	STOCK
430	30N 52W 32 DB	300	HOUSEHOLD, STOCK
431	30N 52W 33 CB	250	STOCK
432	30N 52W 33 BB	280	STOCK
433	30N 52W 36 BA	150	HOUSEHOLD, STOCK
434	30N 52W 36 AC	180	STOCK
435	30N 52W 25 CA	160	HOUSEHOLD, STOCK
436	30N 52W 30 BC	200	INDUSTRIAL
437	30N 52W 30 DA	300	STOCK
438	30N 52W 29 CA	200	STOCK
439	30N 52W 31 BA	300	STOCK
440	30N 52W 11 CC	400	HOUSEHOLD, STOCK
441	30N 52W 11 CC	430	HOUSEHOLD
442	30N 52W 23 AC	285	HOUSEHOLD, STOCK
443	30N 52W 25 BA	180	HOUSEHOLD
444	30N 52W 25 BA	180	STOCK
445	30N 52W 23 DC	200	HOUSEHOLD, STOCK
446	30N 52W 23 CC	400	STOCK
447	30N 52W 24 AD	265	HOUSEHOLD
448	30N 52W 27 CA	190	STOCK
449	30N 52W 27 AA	180	STOCK
450	30N 52W 24 BB	265	STOCK
451	30N 52W 13 DC	150	HOUSEHOLD
452	30N 51W 30 BD	200	HOUSEHOLD
453	30N 51W 30 BD	185	HOUSEHOLD, STOCK

Note: No page 25

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
455	30N 51W 30 BD	235	HOUSEHOLD
456	30N 51W 30 BD	200	STOCK
457	30N 51W 19 CD	278	HOUSEHOLD,STOCK
458	30N 51W 30 BB	260	STOCK
459	31N 51W 30 BD	240	PUBLIC SUPPLY
460	30N 51W 32 BC	125	HOUSEHOLD, IRRIGATION
461	30N 51W 32 BC	35	HOUSEHOLD,STOCK
462	30N 51W 32 CA	60	STOCK
463	30N 51W 32 AC	270	STOCK
464	30N 51W 33 BB	100	NOT REPORTED
465	30N 51W 28 CC	260	NOT REPORTED
466	30N 51W 33 CD	150	STOCK
467	30N 51W 33 CD	150	STOCK
468	30N 51W 33 AC	200	STOCK
469	30N 51W 20 DD	165	HOUSEHOLD,STOCK
470	30N 51W 21 AD	232	STOCK
471	30N 51W 20 CC	150	STOCK
472	30N 51W 29 AA	130	HOUSEHOLD,STOCK
473	30N 51W 29 AD	184	STOCK
474	30N 51W 21 AC	220	HOUSEHOLD,STOCK
475	30N 51W 21 AC	260	HOUSEHOLD,STOCK
476	30N 51W 19 AD	340	STOCK
477	30N 51W 28 AA	300	STOCK
478	30N 51W 28 AA	280	STOCK
479	30N 51W 25 CC	100	STOCK
480	30N 51W 23 CC	150	STOCK, HOUSEHOLD
481	30N 51W 23 CC	100	HOUSEHOLD,STOCK
482	30N 51W 23 CA	100	HOUSEHOLD,STOCK
483	30N 51W 14 AA	310	HOUSEHOLDS,TOCK
484	30N 51W 22 DD	65	STOCK
485	30N 51W 23 CA	180	STOCK
486	30N 51W 15 DD	200	STOCK
487	30N 51W 15 BC	310	STOCK
488	30N 51W 15 BC	310	STOCK
489	30N 51W 14 AB	300	STOCK
490	30N 51W 27 AA	80	STOCK
491	30N 51W 27 BD	50	STOCK
492	30N 51W 23 DD	200	STOCK
493	30N 51W 28 CC	50	STOCK
494	30N 51W 29 BB	200	STOCK
495	30N 51W 34 CC	225	STOCK
496	30N 51W 36 CC	100	STOCK
497	30N 51W 36 BB	100	STOCK
500	30N 51W 25 AC	150	STOCK
501	30N 51W 24 AB	150	STOCK
502	30N 51W 24 AA	120	STOCK

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
502	30N 51W 24 AA	120	STOCK
503	30N 51W 13 DA	250	STOCK
504	30N 51W 24 CD	265	STOCK
505	30N 51W 25 AA	250	STOCK
506	31N 54W 08 DD	350	STOCK
507	31N 54W 08 DD	350	STOCK, HOUSEHOLD
508	31N 54W 08 CC	300	STOCK
509	31N 54W 17 CB	300	STOCK
510	31N 54W 17 AC	300	STOCK
511	31N 54W 21 BB	400	STOCK
512	31N 54W 21 DB	400	STOCK
513	31N 54W 28 AC	100	STOCK
514	31N 54W 16 AC	400	STOCK
515	31N 54W 09 CC	400	STOCK
516	31N 54W 22 BA	400	STOCK
517	31N 54W 22 DC	350	STOCK
518	31N 54W 22 CD	400	STOCK
519	31N 54W 27 DA	250	STOCK
520	31N 54W 26 BC	350	STOCK
521	31N 54W 23 DC	350	STOCK
522	31N 54W 08 DD	400	STOCK, HOUSEHOLD
523	31N 54W 24 BB	360	HOUSEHOLD, STOCK
524	31N 54W 11 DA	360	STOCK
525	31N 53W 18 AC	360	STOCK
526	31N 53W 18 AD	360	STOCK
527	31N 53W 18 CD	515	NOT REPORTED
528	31N 54W 19 BD	300	STOCK
529	31N 53W 34 AA	125	HOUSEHOLD
530	30N 52W 06 CB	50	HOUSEHOLD, STOCK
531	30N 52W 06 CD	50	STOCK
532	30N 52W 11 BA	140	HOUSEHOLD
533	30N 52W 14 AC	320	STOCK
534	30N 52W 12 CA	40	HOUSEHOLD, STOCK
535	30N 51W 05 BA	110	HOUSEHOLD, STOCK
536	31N 51W 31 CD	80	STOCK
537	31N 51W 32 CC	180	STOCK
538	31N 52W 25 DA	60	HOUSEHOLD, STOCK
539	30N 51W 08 DC	280	HOUSEHOLD, STOCK
540	30N 51W 17 CA	275	STOCK
541	30N 51W 16 DD	250	STOCK
542	30N 51W 04 AB	250	HOUSEHOLD, STOCK
543	30N 51W 09 AA	250	STOCK
544	31N 54W 34 BC	35	HOUSEHOLD
545	31N 54W 20 AA	100	STOCK
546	31N 54W 20 CA	400	STOCK
547	31N 54W 24 CD	280	STOCK

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
548	31N 54W 25 BC	250	STOCK
549	30N 54W 02 CD	140	STOCK
550	30N 54W 08 AB	300	STOCK
551	30N 54W 10 CB	80	HOUSEHOLD, STOCK
552	30N 54W 05 CD	40	STOCK
553	30N 54W 06 DA	360	STOCK
554	30N 54W 06 AA	300	STOCK
555	30N 54W 22 CC	N.R.	STOCK
556	31N 53W 27 AA	60	HOUSEHOLD, STOCK
557	31N 53W 27 AB	60	STOCK
558	31N 53W 26 AB	60	HOUSEHOLD
559	31N 53W 26 AB	60	NOT REPORTED
560	31N 53W 34 CB	70	STOCK
561	31N 53W 26 CA	60	STOCK
562	31N 54W 30 BB	200	STOCK
563	31N 54W 30 AC	150	STOCK
564	31N 54W 29 CA	120	NOT REPORTED
565	31N 54W 26 AB	250	STOCK
566	30N 52W 08 AB	100	HOUSEHOLD, STOCK
567	30N 52W 08 AB	100	STOCK
568	30N 52W 08 AB	100	HOUSEHOLD
569	30N 52W 08 AB	100	IRRIGATION
570	30N 51W 31 DB	160	HOUSEHOLD, IRRIGATION
571	30N 51W 31 DA	160	IRRIGATION
572	30N 51W 31 AD	100	STOCK
573	30N 51W 31 BA	160	STOCK
574	30N 51W 31 DB	100	STOCK
575	31N 53W 19 AB	220	STOCK
576	30N 51W 35 AC	200	STOCK
577	31N 54W 27 CA	350	STOCK
578	31N 54W 27 DC	320	STOCK
579	31N 51W 29 DA	60	HOUSEHOLD, IRRIGATION
580	31N 53W 26 BC	60	IRRIGATION
581	31N 51W 28 CB	50	PUBLIC SUPPLY
585	31N 53W 22 CD	100	HOUSEHOLD, IRRIGATION
586	31N 53W 27 CC	125	WILDLIFE
587	31N 51W 33 AA	27	HOUSEHOLD
588	30N 51W 02 BD	213	HOUSEHOLD, STOCK
589	31N 51W 35 CC	220	STOCK
590	30N 51W 02 AA	210	STOCK
591	30N 51W 01 CA	200	STOCK
592	31N 51W 35 DB	300	HOUSEHOLD, STOCK
593	30N 51W 01 CA	300	NOT REPORTED
594	30N 51W 11 AD	300	STOCK
595	30N 51W 12 BD	300	STOCK
596	30N 51W 10 AA	300	HOUSEHOLD, STOCK

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
597	30N 51W 10 AA	300	STOCK
598	30N 51W 10 AD	300	STOCK
599	30N 51W 02 BC	300	STOCK
600	31N 51W 20 CC	70	HOUSEHOLD, STOCK
601	31N 51W 29 BC	79	STOCK
602	31N 51W 20 CB	60	HOUSEHOLD, STOCK
603	31N 51W 20 AC	90	STOCK
604	31N 51W 19 AD	N.R.	STOCK
617	32N 54W 14 DB	396	STOCK
618	32N 54W 14 BB	409	STOCK
624	32N 52W 35 CC	70	STOCK
628	30N 51W 09 DA	N.R.	STOCK
633	31N 51W 35 BC	140	HOUSEHOLD, STOCK
634	30N 52W 15 CC	320	STOCK
635	30N 52W 15 CC	330	HOUSEHOLD, STOCK
636	30N 52W 16 DB	300	STOCK
637	30N 52W 21 BA	300	STOCK
638	30N 52W 21 DA	400	STOCK
639	30N 52W 14 CB	280	HOUSEHOLD, STOCK
640	30N 52W 01 BB	85	HOUSEHOLD, STOCK
645	31N 52W 24 AA	80	STOCK
646	31N 51W 30 DA	175	STOCK
647	31N 51W 30 BB	100	STOCK
648	31N 51W 31 BA	120	STOCK
665	31N 53W 24 DD	150	STOCK
669	30N 51W 29 CC	180	STOCK
672	30N 51W 13 CB	280	HOUSEHOLD, STOCK
675	32N 53W 17 DA	130	HOUSEHOLD, STOCK
679	31N 54W 33 AD	200	STOCK
680	30N 53W 10 DA	300	STOCK
683	30N 54W 23 AA	N.R.	NOT REPORTED

THE FOLLOWING WELLS ARE IDENTIFIED AS CHADRON

WELL #	LEGAL LOCATION	DEPTH (FT.)	USES
001	32N 52W 15 AA	30	HOUSEHOLD, STOCK
002	32N 52W 03 DD	N.R.	HOUSEHOLD, STOCK
003	32N 52W 14 CA	35	STOCK
004	32N 52W 16 AD	40	STOCK
005	32N 52W 15 CD	15	STOCK
006	32N 52W 15 DD	35	HOUSEHOLD, STOCK
007	32N 52W 21 AA	N.R.	NOT REPT.
010	32N 52W 17 DD	40	HOUSEHOLD, STOCK
015	32N 52W 08 DA	30	HOUSEHOLD
016	32N 52W 08 DB	30	HOUSEHOLD
017	32N 52W 08 DA	30	STOCK
018	32N 52W 08 BD	30	HOUSEHOLD, STOCK
021	32N 52W 07 AC	150	STOCK
024	32N 52W 12 AA	45	STOCK
028	32N 52W 04 CC	30	HOUSEHOLD, STOCK
054	32N 52W 11 CC	35	STOCK
055	32N 52W 10 DA	65	HOUSEHOLD, STOCK
056	32N 52W 10 DD	40	HOUSEHOLD, STOCK
057	32N 52W 09 CC	50	HOUSEHOLD, STOCK
058	32N 52W 09 DC	40-45	HOUSEHOLD, STOCK
117	32N 52W 15 AA	100	STOCK
118	32N 52W 27 AA	100	HOUSEHOLD, STOCK
119	32N 52W 27 AA	250	STOCK
120	32N 52W 34 DD	60	HOUSEHOLD, IRRIGATION
132	32N 52W 26 CC	35	STOCK
133	32N 52W 35 BA	65	HOUSEHOLD
134	32N 52W 13 AD	50	STOCK
135	32N 52W 24 CB	N.R.	HOUSEHOLD, STOCK
136	32N 52W 14 DD	40	HOUSEHOLD, STOCK
141	32N 52W 23 AB	35	HOUSEHOLD, STOCK
142	32N 52W 23 AB	35	HOUSEHOLD, STOCK
143	32N 52W 23 BD	35	STOCK
144	32N 52W 35 BB	55	STOCK
146	32N 52W 34 AB	50	STOCK
147	32N 51W 35 AA	30	STOCK
148	32N 51W 35 AA	30	STOCK
149	32N 52W 34 CC	N.R.	STOCK
208	32N 52W 26 DD	52	HOUSEHOLD, STOCK
219	32N 51W 23 BD	35	STOCK
220	32N 52W 25 AD	100	HOUSEHOLD, STOCK
221	32N 52W 26 DC	160	NONE
222	32N 52W 26 DC	30	HOUSEHOLD, STOCK
223	32N 52W 35 BD	35	HOUSEHOLD, STOCK
225	32N 52W 35 CB	480	STOCK, IRRIGATION
230	32N 51W 35 DD	35	STOCK

WELL ID	LEGAL LOCATION	DEPTH (FT.)	USES
242	32N 51W 35 AA	35	STOCK
249	32N 51W 33 AA	50	HOUSEHOLD, STOCK
252	31N 51W 08 BC	400	HOUSEHOLD, STOCK
255	31N 51W 09 CA	675	STOCK
264	32N 51W 32 DD	60	STOCK
280	31N 51W 12 DB	520	HOUSEHOLD
289	32N 51W 18 BB	60	HOUSEHOLD, STOCK
290	32N 51W 07 CC	N.R.	EMPTY HOUSE
292	32N 52W 08 AD	40	HOUSEHOLD
501	618 MAIN, CRAWFORD	198	IRRIGATION, (ARTESI/
503	TEXACO STATION, CRAWFORD	N.R.	IRRIGATION, (ARTESI/
583	32N 52W 26 AC	50	STOCK
621	32N 52W 36 CC	125	HOUSEHOLD, STOCK
622	31N 51W 07 AC	300	STOCK, (ARTESIAN)
623	32N 52W 35 CC	280	STOCK, (ARTESIAN)
627	31N 54W 15 BD	610	IRRIGATION
652	31N 52W 02 CA	280	HOUSEHOLD, STOCK
653	32N 52W 13 DC	60	STOCK
655	32N 52W 27 DA	670	IRRIGATION
656	32N 52W 27 DA	110	IRRIGATION
657	32N 52W 27 DA	110	IRRIGATION
673	32N 51W 19 CC	90	HOUSEHOLD, STOCK
674	32N 51W 19 CC	75	STOCK
682	31N 52W 01 BD	600	IRRIGATION (ARTESIAN)
685	CERAMIC SHOP, CRAWFORD	380	IRRIGATION (ARTESIAN)
902	7 COATES, CRAWFORD	N.R.	IRRIGATION
904	701 MAIN, CRAWFORD	280	IRRIGATION (ARTESIAN
905	618 MAIN, CRAWFORD	198	IRRIGATION
906	520 PINE, CRAWFORD	285	IRRIGATION
907	SOUTHGATE, CRAWFORD	N.R.	IRRIGATION
911	119 LINN, CRAWFORD	160	HOUSEHOLD

THE FOLLOWING ARE IDENTIFIED AS PIERRE FORMATION

WELL ID.	LEGAL LOCATION	DEPTH (FT.)	USES
199	32N 51W 20 BB	20	NOT REPT.
200	32N 51W 10 DD	75	STOCK
201	32N 51W 08 AA	N.R.	STOCK
202	32N 51W 09 AA	36	NOT REPT.
203	32N 51W 09 AA	N.R.	STOCK
204	32N 51W 09 AA	47	STOCK
205	32N 51W 17 BB	40	HOUSEHOLD
206	32N 51W 17 BB	50-60	STOCK
209	32N 51W 19 BA	18	HOUSEHOLD, STOCK
213	32N 51W 02 CC	30	STOCK
214	32N 51W 02 CC	30	NOT REPT.
215	32N 51W 09 BB	35	NOT REPT.
216	32N 51W 04 CB	35	NOT REPT.
217	32N 51W 21 AB	60	HOUSEHOLD, STOCK
218	32N 51W 17 AC	60	STOCK
226	32N 51W 13 DD	31	HOUSEHOLD
227	32N 51W 13 DD	31	HOUSEHOLD
228	32N 51W 13 DD	31	HOUSEHOLD, STOCK
239	32N 51W 13 DD	40	NOT REPT.
240	32N 51W 25 BB	44	HOUSEHOLD, STOCK
241	32N 51W 25 AA	28	STOCK
248	32N 51W 13 AA	25	STOCK
284	32N 51W 14 CA	40-50	STOCK
288	32N 51W 03 DC	28	HOUSEHOLD, STOCK
291	32N 51W 12 DB	50	HOUSEHOLD
498	32N 51W 01 CA	26	NOT REPT.
499	32N 51W 11 AC	39	NOT REPT.
582	32N 51W 16 CD	45	STOCK
584	32N 51W 20 DA	27	NOT REPT.
607	32N 51W 01 AB	50	IRRIGATION
608	32N 51W 15 CA	100	HOUSEHOLD, STOCK
609	32N 51W 15 DA	N.R.	STOCK
610	32N 51W 15 CA	100	STOCK
611	32N 51W 16 CD	60	STOCK
612	32N 51W 14 BB	35	NOT REPT.
613	32N 51W 14 BB	35	NOT REPT.
614	32N 51W 14 BB	35	STOCK
615	32N 51W 21 BA	60	NOT REPT.
616	32N 51W 20 AA	41	NOT REPT.
626	32N 51W 25 BD	50	STOCK
650	32N 51W 01 BC	50	HOUSEHOLD
651	32N 51W 20 CB	60	HOUSEHOLD, STOCK
654	32N 52W 24 AD	40	HOUSEHOLD, STOCK
684	32N 51W 25 CC	N.R.	NOT REPT.

THE FOLLOWING ARE LISTED AS IN THE BRULE FORMATION

WELL ID	LEGAL LOCATION	DEPTH (FT.)	USES
011	32N 52W 17 DD	20	HOUSEHOLD (SPRING)
012	32N 52W 17 DA	50	HOUSEHOLD, STOCK
013	32N 52W 17 BB	150	HOUSEHOLD, STOCK
020	32N 52W 04 CD	28	HOUSEHOLD, STOCK
023	32N 53W 12 AA	45	HOUSEHOLD
026	32N 53W 11 BD	200	IRRIGATION
027	32N 53W 05 AA	100	HOUSEHOLD, STOCK
029	31N 52W 14 BA	40-50	STOCK
032	32N 53W 06 BC	280	HOUSEHOLD, STOCK
033	32N 53W 06 BC	220	HOUSEHOLD, STOCK
036	32N 53W 07 BA	N.R.	NOT REPORTED
041	32N 53W 09 DB	40	STOCK
050	32N 52W 29 BB	160	STOCK
060	32N 53W 13 CD	140	HOUSEHOLD, STOCK
061	32N 53W 13 CD	140	STOCK, IRRIGATION
120	32N 52W 33 DA	80	HOUSEHOLD
129	32N 52W 34 DD	60	HOUSEHOLD, IRRIGATION
130	32N 52W 34 DC	45	HOUSE, STOCK, IRRIGATION
145	32N 52W 27 DC	50	HOUSEHOLD, STOCK
185	31N 52W 15 AA	100	HOUSEHOLD, STOCK
186	31N 52W 15 BA	100	STOCK
187	31N 52W 15 DA	70	STOCK
189	31N 52W 15 DC	60	HOUSEHOLD
224	32N 52W 35 BC	84	HOUSEHOLD
229	31N 51W 02 BA	80	HOUSEHOLD, STOCK
231	32N 51W 26 DC	35	STOCK
232	31N 51W 02 BA	75	STOCK
233	31N 51W 02 LA	75	HOUSEHOLD
234	31N 51W 02 BA	75	STOCK
235	32N 51W 35 CC	75	STOCK
236	32N 51W 34 DC	75	STOCK
237	31N 51W 03 BD	N.R.	NOT REPORTED
238	31N 51W 03 CA	75	STOCK
247	31N 51W 12 CC	400+	NOT REPORTED
251	31N 52W 12 AB	70	STOCK
254	31N 51W 09 DB	115	HOUSEHOLD
256	31N 51W 09 AB	40	STOCK, IRRIGATION
257	31N 51W 09 DD	400	HOUSEHOLD
258	31N 51W 11 BA	90	HOUSEHOLD, STOCK
259	31N 51W 14 AA	65	HOUSEHOLD, STOCK
261	32N 51W 33 CC	50	HOUSEHOLD
262	32N 51W 33 CC	80	STOCK
263	32N 51W 33 CA	60	STOCK
265	31N 51W 04 BB	50	STOCK
266	31N 51W 04 AB	80	STOCK
267	31N 51W 04 DB	310	STOCK
268	31N 51W 06 BC	45	HOUSEHOLD, STOCK
269	31N 51W 06 BC	18	HOUSEHOLD, STOCK
270	31N 51W 06 CC	40	NOT REPORTED
271	31N 51W 06 CC	N.R.	NOT REPORTED
272	31N 51W 07 CC	N.R.	STOCK
273	31N 52W 13 AB	N.R.	HOUSEHOLD

WELL ID	LEGAL LOCATION	DEPTH (FT.)	USES
274	31N 52W 11 AB	N.R.	NOT REPORTED
275	31N 51W 07 BD	25	STOCK
276	31N 52W 13 DD	25	HOUSEHOLD , STOCK
277	31N 52W 13 CD	35	STOCK
278	31N 52W 13 BA	38	STOCK
279	31N 51W 12 DB	110	IRRIGATION
282	31N 52W 12 BB	40	HOUSEHOLD, STOCK
283	31N 52W 12 DD	N.R.	NOT REPORTED
605	31N 51W 18 CD	32	HOUSEHOLD, STOCK
606	31N 51W 19 BA	40	STOCK
619	32N 52W 35 DC	125	HOUSEHOLD, STOCK
620	32N 52W 35 CA	120	STOCK
625	32N 53W 03 DB	660	NOT REPORTED
629	31N 52W 01 DC	55	HOUSEHOLD, STOCK
630	31N 52W 22 BA	80	HOUSEHOLD, STOCK
631	31N 52W 22 BD	80	STOCK
632	31N 52W 22 AA	N.R.	NOT REPORTED
641	31N 52W 25 BD	95	HOUSEHOLD, STOCK
642	31N 52W 23 CD	60	STOCK
643	31N 52W 24 BD	< 100	HOUSEHOLD
644	31N 52W 23 AB	< 100	STOCK
659	31N 52W 08 AC	380	STOCK
660	31N 53W 13 CA	150	STOCK
661	31N 53W 13 AB	N.R.	STOCK
662	31N 53W 11 DD	150	STOCK
663	31N 53W 24 AB	70	NOT REPORTED
664	31N 52W 20 CA	150	STOCK
666	31N 52W 20 AC	150	STOCK
667	31N 52W 21 CA	150	STOCK
668	31N 52W 07 DB	300	STOCK
671	31N 53W 23 AD	40	HOUSEHOLD, STOCK
676	32N 53W 08 AA	45	STOCK
677	31N 51W 04 AA	60	HOUSEHOLD, STOCK
678	32N 52W 28 CC	N.R.	NOT REPORTED
901	311 OAK, CRAWFORD	45	IRRIGATION
902	7 COATES, CRAWFORD	55	IRRIGATION
903	14 PADDOCK, CRAWFORD	100	IRRIGATION
908	723 ELM, CRAWFORD	40	IRRIGATION
909	311 ANNIN, CRAWFORD	60	IRRIGATION
	406 LINN, CRAWFORD	50	IRRIGATION
	315 OAK, CRAWFORD	45	IRRIGATION
	235 MAIN, CRAWFORD	50	NOT REPORTED
	602 E.MAIN, CRAWFORD	80	IRRIGATION
	136 LINN, CRAWFORD	50	IRRIGATION
	1109 6TH, CRAWFORD	60	IRRIGATION
	216 PADDOCK, CRAWFORD	50	IRRIGATION
	233 PADDOCK, CRAWFORD	50	IRRIGATION
	1100 1ST, CRAWFORD	45	IRRIGATION
	418 ANNIN, CRAWFORD	60	HOUSEHOLD, IRRIGATI
	111 ANNIN, CRAWFORD	N.R.	HOUSEHOLD, IRRIGATI
	113 LINN, CRAWFORD	N.R.	IRRIGATION
	302 LINN, CRAWFORD	50	HOUSEHOLD, IRRIGATI

LEGAL LOCATION	DEPTH (FT.)	USES
302 LINN, CRAWFORD	80	IRRIGATION
119 PINE, CRAWFORD	54	IRRIGATION
1023S. HOSPITAL DRIVE, CRAWFORD	N.R.	HOUSEHOLD, IRRIGATI
409 MAIN, CRAWFORD	28	IRRIGATION
1115 HALE PARK, CRAWFORD	N.R.	IRRIGATION
623 ELM, CRAWFORD	30	IRRIGATION
314 PADDOCK, CRAWFORD	50	HOUSEHOLD, IRRIGATI
115 OAKS, CRAWFORD	36	IRRIGATION
821 1ST, CRAWFORD	27	IRRIGATION
141 LINN, CRAWFORD	70	IRRIGATION
702 4TH, CRAWFORD	50	IRRIGATION
915 5TH, CRAWFORD	57	IRRIGATION
502 ANNIN, CRAWFORD	60	IRRIGATION

northeastern portion of the investigated area (T32N, R51W) the wells are completed in either the Tertiary Chadron or the Cretaceous Pierre formations. In general, wells near Crawford and within T31N, R51W produce from the Tertiary Brule and/or the Tertiary Chadron formations.

Within the proposed mining area in the northeastern sections of T31N, R51W the principal water-bearing formation for domestic use is the Brule. Sand lenses and filled fracture channels provide low to moderate yielding strata for wells within the Brule. Many wells in the Tertiary Chadron near and east of Crawford are artesian. These wells are producing from sands of the lower Chadron.

By far most wells within the investigated area are used for watering stock (Table B-1b)

TABLE B-1b. SUMMARY OF WELL USE WITHIN INVESTIGATED AREA

		(PRIMARY WELL USE)							
UNIT	TOTAL	STOCK	DOMESTIC	IRRIG.	WILDLIFE	NOT REPT.	ABANDONED	INDUSTRIAL	PUBLIC SUPPLY
ARIKAREE	484	308	142	3	2	23	3	1	2
BRULE	112	37	37	26	-	12	-	-	-
CHADRON	76	24	35	11	-	2	2	-	-
PIERRE	43	16	12	1	-	14	-	-	-
TOTALS	715	388	226	41	2	51	5	1	2
% OF TOTAL		54	32	6	<1	7	<1	<1	<1

Many of the domestic wells also were used to water stock, trees and lawns. In such cases a priority was given to the well's use as a sole source of potable water for the household. In addition several stock wells also were used for small-scale irrigation. In such cases priority was given to their use for stock. Although Crawford derives its water from the White River, public supply wells serve schools and campgrounds.

SPRINGS

Seven active springs were inventoried within the investigated area (Table B-1c). These springs represent the larger and better known springs in the investigated area.

Table B-1c. Spring Inventory

Spring ID	Legal Location	Uses	Probable producing Unit
	SAMPLED		
SP-1	31N 51W 23 AA	Not Rept.	Ta
SP-2	30N 52W 19 BD	Not Rept.	Ta
SP-3	31N 53W 06 CA	Not Rept.	Ta
SP-4	31N 52W 16 CC	Not Rept.	Tb
SP-5 (649)	32N 51W 31 BD	Household	Tc
SP-6 (658)	31N 52W 08 CD	Public Supply	Tb
	NOT SAMPLED		
SP-7 (681)	31N 51W 11 DD	Household	Tc or Kp
SP-8 (140)	32N 52W 13 CA	Not Rept.	Tc

Several smaller seasonal springs and seeps along rivers and creeks probably do occur but to our knowledge these were not active during late summer and fall 1981 when the inventory took place.

SELECTED SITES FOR STREAM SAMPLING

TASK B-2

Ten samples were collected from streams dissecting the area. The stream samples were collected by wading into the middle of the main flow and sampling halfway between the surface and bottom of the stream.

The distribution of the sampling sites is shown on Foldout B-3(2). The legal locations are listed in Table B-2. Sites were selected on the rationale that at least one sample would be taken from each of the major streams in the area and more than one taken from selected streams flowing through the proposed mining area. On this basis samples ST-8, ST-9 and ST-10 are from streams cutting into the Arikaree Formation in the western part of the study area. Samples ST-1 and ST-2 are from Ash Creek which flow on the Cretaceous Pierre Shale in the eastern part of the study area. The remaining streams sampled cut into the Brule formation and are in part within the proposed uranium mining area. They include Squaw, White Clay and English creeks. Since Squaw Creek is centrally located within the proposed mining area, upper (ST-3), middle (ST-4) and lower (ST-5) samples were collected.

TABLE B-2. STREAM SAMPLING SITES

Sample Site No.	LEGAL LOCATION	
ST-1	31N 51W 24 CC	STREAM #1 (UPPER ASH)
ST-2	31N 51W 02 AA	STREAM #2 (LOWER ASH)
ST-3	30N 51W 03 BB	STREAM #3 (UPPER SQUAW CREEK)
ST-4	31N 51W 20 BC	STREAM #4 (MIDDLE SQUAW CREEK)
ST-5	31N 52W 12 BA	STREAM #5 (LOWER SQUAW CREEK)
ST-6	31N 52W 11 AB	STREAM #6 (WHITE CLAY CREEK)
ST-7	31N 52W 12 BB	STREAM #7 (ENGLISH CREEK)
ST-8	31N 53W 06 DA	STREAM #8 (SO. FORK SOLDIER CREEK)
ST-9	31N 53W 32 CD	STREAM #9 (MIDDLE WHITE RIVER)
ST-10	31N 54W 31 CA	STREAM #10 (WHITE RIVER NEAR ANDREWS NEBRASKA)

BASELINE DETERMINATION OF MAJOR IONS

TASK B - 3(1)

Introduction

Major ions include the cations calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}) and potassium (K^{+}) and the anions bicarbonate (HCO_3^{-}), sulfate (SO_4^{2-}) and chloride (Cl^{-}). The hydrogeologic units are characterized by different groundwater chemistries and can be classified by the distribution of these ions.

Methods

Except for bicarbonate all analyses were done on samples that had been filtered through 0.45 um filters. The samples for cation analysis were acidified after filtration.

Calcium, magnesium, sodium and potassium were measured by standard atomic absorption methods (APHA, 1975).

Sulfate was analyzed by turbidimetric titration (APHA, 1975).

Bicarbonate was measured at the collection site (APHA,1975).

Chloride was measured by titration with mercuric nitrate (APHA, 1975).

Results and Discussion

The results of the major ion analyses (Appendix A, Table 1) are represented graphically in a diamond-shaped field [Foldout B-3(1)] known as a Piper diagram (Piper,1944). Piper diagrams provide a basis for comparing water types as they relate to geologic formations. In this case the total concentration (expressed in percentage on a milliequivalent basis) of 8 major ions are plotted. On a milliequivalent basis the total cations minus the total anions should be near zero to maintain an electrochemically neutral solution. The major ion balances (Appendix A,Table 1) indicate that this prerequisite has been met and that the quality of the major ion data is good.

The Piper diagram [Foldout B-3(1)] shows two distinctly

different hydrochemical facies. These tend to cluster at the extreme left and the extreme right sides of the diamond field. These clusters represent the Ca^{2+} – HCO_3^- type groundwater of the Arikaree unit and the Na^+ – SO_4^{2-}, Cl^- type groundwater of the basal Chadron unit. These two groundwater types represent the end members in the evolution of groundwater chemistry within the investigated area. This represents a normal sequence in major ion evolution and requires hundreds of thousands of years.

In the cation sequence, soluble calcium exchanges with sodium on clays and a "natural softening" of the water takes place. Also as gypsum is dissolved a high degree of supersaturation causes calcium and magnesium to precipitate out as calcite and dolomite. This results in an eventual lowering of the HCO_3^- concentration and an increase in the SO_4^{2-} concentration. The final step in the evolutionary sequence produces Na^+ – Cl^- type groundwater. This step is being approached in the groundwater of the basal Chadron formation. The Cl^- increases probably result from the upward migration of Cl^- from the Cretaceous Pierre shale.

The evolution is exemplified best by the progression of the ratios of $Ca^{2+} + Mg^{2+} / Na^+ + K^+$ and $HCO_3^- / SO_4^{2-} + Cl^-$ in Table B-3(1). An arrow drawn through plotted points of the average formation concentrations [Foldout B-3(1)] indicates a gradual evolution to the Na^+ – SO_4^{2-}, Cl^- groundwater of the basal Chadron.

It appears that most large excursions of ions from the basal Chadron to the Brule formation caused by mining activities could easily be identified. The one exception might be in the Crawford area where Brule wells 901 and 909 have cation ratios similar to those of the basal Chadron. The Brule envelope [Foldout B-3(1)] does overlap wells in both the Arikaree and the upper Chadron formations. Thus chemically distinguishing Brule groundwater from that in the other formations (excluding the basal Chadron) is most difficult.

Table B- 3(1)

Baseline concentrations of major ions

in analyzed waters

Ca^{2+} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	48-73	30-78	40-88	8-101	15-114	13-25
MEAN	61	56	51	58	68	19
Std. DEVIATION	9	13	16	23	30	5

Mg^{2+} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	4-11	4-10	1-13	1-15	1-14	2-6
MEAN	6.8	7.2	6.2	5.8	7.8	3.1
Std. DEVIATION	2.4	2.0	2.5	2.7	3.8	1.4

Na^{+} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	7-127	9-37	3-35	7-210	21-270	310-540
MEAN	31	18	11	53	117	399
Std. DEVIATION	43	10	7	48	69	66

K^{+} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1-13	2-13	1-8	4-46	6-25	5-14
MEAN	5.3	5.9	3.4	10.1	14.8	11.5
Std. DEVIATION	3.7	3.3	1.5	8.2	5.2	2.3

Cation Ratios

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
Ca/Mg	8.9	7.8	8.3	9.9	8.8	6.3
Na/K	5.8	3.1	3.1	5.3	7.8	34.7
(Ca+Mg)/(Na+K)	1.9	2.6	4.0	0.98	0.61	0.05

Table B- 3(1) (continued)

HCO_3^- (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	190-250	180-310	120-270	160-420	175-460	280-370
MEAN	217	221	179	271	331	323
Std. DEVIATION	26	36	45	69	89	29

SO_4^{2-} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1-98	1-20	1-17	5-260	20-320	175-600
MEAN	21	6.5	4.8	39	118	382
Std. DEVIATION	35	6.9	4.6	50	84	123

Cl^- (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	10-60	2-26	3-30	3-113	15-110	110-240
MEAN	26	12	16	29	56	183
Std. DEVIATION	17	10	8	25	27	36

Anion Ratios

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
$HCO_3/(SO_4+Cl)$	4.6	12.0	8.5	4.0	1.9	0.57

MAJOR ION BALANCE

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	.09-7.3	-3.2- +7.8	-5.3 - +5.5	-8.-+6.9	-9 -+5.9	-5 - +6.9
MEAN	+3.08	+1.68	+0.77	+2.00	-0.08	+0.94
Std. DEVIATION	2.3	4.1	4.1	3.8	4.6	3.4

This process, however, may be enhanced by looking at other parameters. As an example, Arikaree wells 441 and 211 force the downward movement of the Arikaree envelope in Foldout B-3(1). These wells contained the highest uranium levels and lowest uranium activity ratios in the formation water (Appendix A, Table 1). This significant chemical difference signifies that these wells may indeed be Brule. This change would further confine the Arikaree envelope [dashed line in Foldout B-3(1)] and eliminate a significant amount of the Brule-Arikaree overlap.

In general the observed trends in chemical character [Foldout B - 3(1)] of the streams appear to be closely associated with the formation they dissect. Upper Ash Creek (ST-1), Soldier Creek (ST-8) and White River (ST-9, ST-10) have chemical characteristics similar to the groundwater in the Arikaree and undoubtedly receive most of their baseflow from this formation. The sampling locations for Lower Squaw (ST-5), White Clay (ST-6) and English (ST-7) Creeks are in the Brule formation and the water has chemical characteristics of that formation. The sample from middle Squaw Creek (ST-4) has characteristics similar to the upper Squaw Creek sample (ST-3) and probably receives its major contribution from upgradient Arikaree seep. Sample ST-2 from Lower Ash Creek would appear to have a significant contribution from the Brule formation; however, this portion of the stream may also be receiving seepage water from the Pierre formation. The chemical characteristics of groundwater in the Pierre formation were not well documented in this study due to the sparcity of wells sampled from this formation.

Chemical characteristics of the springs indicate that sample 649 is receiving water from the Chadron formation and Spring SP-4 probably originates in the Brule. The remaining springs have chemical characteristics similar to those of the Arikaree formation.

BASELINE DETERMINATIONS OF PHYSICAL CHARACTERISTICS OF ANALYZED WATERS TASK B-3 (2)

Introduction

Well depth, temperature, conductivity, pH, Eh, and H_2S are reported for 83 groundwater samples collected from the investigated area (Appendix A). The data are grouped according to the suspected producing horizon (Appendix A). Differences and similarities in the physical characteristics of the water from each producing horizon will be emphasized in this section.

In addition to the aforementioned groundwater samples, 16 surface water samples - 6 from active springs and 10 from rivers and creeks - were collected and analyzed. The physical data are tabulated in Appendix A.

The location of the sampling sites is shown in Foldout B-3(2).

Methods

Well depth was determined during discussions with the property owner and the local well drillers. In the majority of cases the reported well depths appear to be relatively accurate.

Temperatures were recorded with a mercury thermometer (± 0.2°C) immersed in a bucket of the water. For wells water was discharged into the bucket until the temperature stabilized.

Conductivity was determined with a temperature compensated conductivity probe contained in a Hach Direct Reading Environmental Laboratory (DREL/4).

Both pH and Eh were measured at the time of sampling with an Orion 408 A/F meter. Measurements of pH were made using a combination electrode [Orion pH (91-05)] and the double buffer technique. The estimated error is 0.05 pH units. Eh measurements were determined in a flow-through electrode system. At least 15

minutes were allowed to pass before equilibrium was assumed and the Eh potential recorded. Eh potentials are based upon the saturated calomel reference electrode standard and were measured with an Orion model 96-78 redox electrode and have not been corrected.

Any odor resembling H_2S was confirmed using the lead acetate paper method (0 - 5 ppm) contained in the Hach DREL/4.

Results and Discussion

The artesian flow from flowing groundwater in the deeper basal Chadron demonstrated higher average temperatures, conductivities and pH values than groundwater from wells producing in younger strata [Table B-3(2)] . The temperature increase appears related primarily to the geothermal gradient where there is an increase of 0.56° C for every 55-foot increase in depth.

The high conductivity in the groundwater from the basal Chadron relates directly to a high dissolved solids content and indicates that the groundwater is old. An increased residence time within a formation generally promotes a more highly mineralized groundwater such as that which characterizes the basal Chadron. The average dissolved solids of ~ 1200 mg/l (~0.65 X conductivity) is considerably greater than the 500 mg/l level normally advocated by the U.S. Public Health Service for public supply systems. In contrast the low dissolved solids of ~ 215 mg/l in water from the Arikaree and younger strata indicate that these waters have had a relatively short residence in the formation. In regard to dissolved solids the proposition holds that poorer quality water results from a longer residence time in the formation.

The generalized increase in pH with the increase in age of the formation is anticipated in the normal evolution of mineralized groundwaters from the western Great Plains. The increased pH is believed to be associated with a depletion of hydrogen ions during

TABLE B- 3(2).

Baseline determinations of physical

characteristics of analyzed waters

WELL DEPTH (Ft.)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE			30-527	18-150	30-520	100-600
MEAN			230.3	68.0	91.8	313
Std. DEVIATION			157.9	35.5	131.9	128.3

TEMPERATURE °C

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	12-26	12-24	12-18	10-19	12-18	15-23
MEAN	15.7	19.6	14.4	14.2	14.5	16.5
Std. DEVIATION	4.9	3.1	1.4	1.7	1.7	2.1

CONDUCTIVITY (uMHOS/CM)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	310-730	275-500	240-540	315-1210	485-1350	1460-2450
MEAN	443	386	332	610	893	1824
Std. DEVIATION	138	78	83	223	[illegible]	272

pH

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	6.9-7.8	6.9-8.6	6.9-8.2	7.0-8.4	6.9-7.8	6.9-8.4
MEAN	7.4	8.0	7.5	7.6	7.4	7.9
Std. DEVIATION	.3	.6	.4	.4	.3	.5

Eh *

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	80-700	70-700	-350-+700	-95-+250	-30-+290	-380-+70
MEAN	217	227	197	132	117	-245
Std. DEVIATION	217	172	200	83	75	124

H_2S (ppm)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	ND	ND	ND	ND	ND	0.1-5
MEAN	ND	ND	ND	ND	ND	1.5
Std. DEVIATION	ND	ND	ND	ND	ND	1.9

ND = Not detected

* All Eh values are based on Calomel reference and are not corrected.

carbonate dissolution.

Eh values and H_2S levels are indicators of the oxidizing conditions of the groundwater. In general the oxidizing nature of the formation waters demonstrated a trend towards lower oxidizing capacity with apparent increased residence time in the formation [Table B-3(2)]. The relatively high Eh values in the Arikaree and younger formation waters suggest that recharge occurs rapidly through fractures . Negative average Eh values in the basal Chadron formation indicate that this water is reducing relative to the H^+/H_2 couple. Negative redox potentials result from consumption of oxygen by bacterial oxidation of organic matter.

The observed H_2S levels in the groundwater of the basal Chadron formation indicate the presence of anaerobic sulfate reducers. These bacteria convert organic matter and sufate to hydrogen sulfide and bicarbonate. Although not usually harmful at low levels, the presence of the rotten egg odor of H_2S makes the basal Chadron waters less palatable.

BASELINE MEASUREMENTS OF TRACE METALS

TASK B-3 (3)-NONRADIOACTIVE

Introduction

The samples were analyzed for the trace metals arsenic (As), selenium (Se), vanadium (V), and molybdenum (Mo) because they are considered pathfinder elements for potential uranium ore bodies (Wanty et al., 1981) and in western states V and Mo are byproducts of uranium mining. Elevated levels of vanadium in run-off off have occasionally resulted from uranium mining and milling operations (Hopkins et al.,1977).

Methods

Arsenic and selenium were determined by the hydride generation method using an argon-hydrogen flame and a Perkin Elmer 303 atomic absorption spectrophotometer (APHA,1975) The detection limits for both elements were 0.5 ppb.

Molybdenum was analyzed by flameless atomization using a Perkin Elmer HGA-2000 graphite furnace. The detection limit was 1 ppb.

Vanadium was detected using a spectrophotometric technique via the gallic acid method (APHA,1975). The detection limit for vanadium was 0.5 ppb.

Results and Discussion

Selenium levels were very low in all analyzed groundwater samples (Appendix A, Table 1). Only 3 samples contained Se concentrations greater than 1 ppb. All three samples were from groundwater from the Brule formation and none of them had concentrations above 2 ppb. In terms of water quality no samples approached or exceeded the current maximum contaminant level (MCL) of 10 ppb Se. These low selenium levels negate the use of selenium as an indicator of potential uranium

deposits within this investigated area.

Arsenic levels were quite variable but showed a generalized increase in older oxidizing formation waters [Table B-3(3)a]. This is demonstrated in a trend towards higher average As concentrations in lower Brule and upper Chadron formation waters than in either the Brule or Arikaree waters.

Soluble arsenic levels are controlled by the oxidation potential of the groundwater. Arsenic would precipitate only in strongly reducing environments in the presence of sulfide. Extremely low As levels in the basal Chadron are associated with the strongly reducing nature of that formation. Therefore, in slightly oxidizing environments such as those reported in the upper Chadron and lower Brule where there are occurrences of relatively high arsenic levels in the sediments, the groundwater could become enriched in As. Such enrichment appears to be occurring in the vicinity of wells 006, 016, 249 and 654 and also in Brule wells 901, 902, 903, 908, 909, 262, 023 and 187. These wells also contained relatively high uranium levels and low U-234/U-238 disequilibrium ratios. The above association is suggestive of an accumulation of elements which are presently dispersing (Osmond and Cowart, 1976 and Wanty et al., 1981). Arsenic levels exceeded the maximum contaminant level (MCL) of 50 ppb in only one well (006). Thus in terms of the water quality, arsenic is not of particular concern in the groundwater of the investigated area.

Molybdenum is often associated with reduced uranium ores as molybdenum sulfide. Similarly to arsenic the highest concentrations are expected in oxidized and moderately reduced waters. Molybdenum is slightly more stable than uranium in reducing groundwater and therefore molybdenum ore tends to be concentrated slightly downgradient from uranium ore bodies.

Molybdenum levels range from 1 (minimum detectable) to 12 ppb

TABLE B - 3(3) a.

BASELINE MEASUREMENTS OF TRACE METALS

IN ANALYZED WATERS

As (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	2-12	1-9	1-11	1-26	1-81	0.5-1
MEAN	4.3	4.1	3.2	6.9	15.6	0.54
Std.DEVIATION	3.5	2.3	2.3	6.3	20.7	1.14

Se (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<1	<1	<1	<1-1.6	<1	<1
MEAN	<1	<1	<1	<1.1	<1	<1

V (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1.1-9.0	3.0-10.7	0.5-9.7	1.6-27	0.9-155	0.5-20
MEAN	3.6	4.9	4.5	6.9	17.0	6.0
STD. DEVIATION	2.8	2.3	2.3	6.3	41.8	5.1

Mo (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1-5	1-6	1-5	1-7	1-12	1-10
MEAN	2	2.6	1.8	2.9	5.4	4.8
STD. DEVIATION	1.4	1.5	1.2	2.6	2.9	2.9

(Appendix A). As predicted molybdenum demonstrated a trend similar to that of arsenic; that is, the average concentrations increased with the apparent age of the oxidizing formations. The highest molybdenum levels generally were found in wells with the highest arsenic and uranium concentrations and were in the White River Group. Thus the soluble molybdenum concentrations probably are associated with dispersing accumulations.

Molybdenum levels in the basal Chadron ranged from 1 - 10 ppb (Appendix A). The levels were elevated slightly in samples containing uranium concentrations greater than 10 ppb and are probably higher because the wells are screened near the ore accumulations.

Vanadium levels have been shown to follow trends similar to those of uranium in the vicinity of uranium ore bodies in south Texas (Langmuir and Chatham, 1980). These trends are substantiated by the occurrences of high grade ore-bearing minerals containing both elements.

In the investigated area, vanadium followed trends in the oxidizing formations similar to those discussed for the other pathfinder elements. The major difference was that the V concentration range (0.5- 155 ppb) was much greater than that of the other non-radioactive trace elements. While no samples from the Arikaree contained over 10 ppb V, 9 samples from the White River group contained 10 ppb or more. These samples also contained more than 10 ppb U (Appendix A) and probably are related to dispersing mineral accumulations.

Vanadium levels in the basal Chadron formation ranged from 0.5 - 20 ppb with no apparent association with uranium or any of the other pathfinder elements. The reasons for the relatively high V levels in wells 622 and 652 remain unresolved.

Spring and stream levels of the pathfinder elements generally were low (Appendix A). Slightly elevated As and Mo appeared in #649 which is believed to be a spring originating in the Chadron formation. Highest concentrations of pathfinder elements result from a relatively high component of White River Group seepage in the base flow of the creeks.

Neither molybdenum nor vanadium has maximum concentration level (MCL) values , and therefore it is not a water quality concern at ppb levels.

BASELINE DETERMINATIONS OF RADIOACTIVE CONSTITUENTS

TASK B-3(3)

Introduction

Uranium (U-238, $t_{1/2}$=4.5X 10^9 yr.) and radium (Ra-226, $t_{1/2}$ = 1620 yr.) are the two most mobile elements in the uranium natural decay series. Their mobility in groundwater combined with their relatively long half-lives allows them to be transported considerable distances from their points of origin. This potential for transport is dependent on the geochemical nature of the rocks and the rates of groundwater flow. It is essential to know the premining soluble levels of these nuclides if a future assessment of the impact of the mining activity is to occur. This is especially appropro for in situ leach mining where the uranium is remobilized by various lixiviants and restoration of the formation water is necessary. In some instances significant increases in U-238 and Ra-226 levels above background have been reported in post restoration groundwaters (Thompson, 1980).

Uranium isotopic ratios (U-234/U-238) were determined because uranium activity ratios cover the total U alpha particle activity in drinking water (EPA, 1980) and because uranium activity ratios are valuable in prospecting for uranium deposits.

Methods

Uranium and uranium isotopes were measured by standard isotope dilution - alpha spectrometry techniques using electrode deposition of purified uranium on polished stainless planchettes and a 2-9 day counting time with PGT - 400 mm. surface barrier detectors interfaced with a Canberra 4096 multi-channel analyzer split 4 ways (EPA, 1980; Cowart and Osmond; 1977 and Spalding and Druliner, 1981).

Radium was determined by the radon emanation technique (EPA, 1979) using scintillator-coated lucite Lucas cells and RCA photomultiplier tubes (Reid, 1979).

Results and Discussion

Radium 226 levels ranged from less than 0.1 pCi/l to 181 pCi/l (Appendix A). Lowest average levels occurred in groundwater from the Arikaree Group [Table B-3(3)] where only 5 of 23 samples contained >0.11 pCi/l. The highest average Ra-226 levels [Table B-3(3)] occurred in the basal Chadron formation where only 1 of 12 samples contained < 0.11 pCi/l. Unlike the previously discussed trace metals, radium concentrations generally are too low in natural systems to be controlled by chemical precipitation ($RaSO_4$) and therefore Ra-226 levels are dependent on the proximity of dispersing sources and chemical exchange. For that reason and the potential of radium to form soluble chloride complexes, anomalous radium levels are useful indicators of parent uranium ore accumulations. Elevated radium levels in artesian wells in northwestern Crawford appear to signify a nearby ore accumulation. Several of these wells in the basal Chadron formation have radium levels greater than the MCL for public supply systems of 5 pCi/l. None of the wells in the other formations that were surveyed had Ra-226 levels greater than 0.5 pCi/l.

Slightly elevated radium levels (>0.2 pCi/l) in several groundwater samples from the Brule, lower Brule and upper Chadron were associated with anomalously high U concentrations. Water-bearing sand lenses have dispersed soluble uranium from sediments and over time these waters appear to have become slightly enriched in Ra-226 via radioactive decay in the U-238 decay series.

Uranium levels ranged from 0.02 - 98 ug/l and U-234/U-238 activity ratios ranged from 1.50 - 12.60. With the exception of wells 211 and 441 , all Arikaree groundwater contained less than 8 ppb uranium. Both of these wells contained anomalously low isotopic ratios and high relative U levels for the Arikaree Group. As discussed in the major ion section both samples are more similar chemically to groundwater from the Brule than the Arikaree Group .

Average uranium concentrations show a marked increase and U-234/U-238 ratios demonstrate a marked decrease in the oxidizing waters of the White River group relative to those of the Arikaree [Table B-3(3)]. This is a normal progression of events for oxidizing formation waters which have undergone continuous leaching for long periods of time. As more Uranium-234 is preferentially leached from the grain surfaces, the surface slowly becomes depleted with respect to U-234 and eventually equilibrium is reached (U-234/U-238 =1) in groundwater. If leaching continues, ratios considerably below 1 occur as is evidenced by groundwater ratios in Florida Miocene formations (Osmond et al. 1968). The effects of this leaching are especially evident in the upper Chadron formation (wells 006, 016 and 249) where uranium concentrations are greater than 50 ppb and disequilibrium ratios range from 1.49 - 1.66.

The highly variable uranium levels and isotopic ratios in the basal Chadron sands typify those of a reducing aquifer with known uranium deposits (Osmond and Cowart, 1976). In this formation, uranium levels range from 0.02 - 22.5 ppb and disequilibrium ratios range from 1.69 - 12.60. The ratios greater than 4.0 are associated with uranium levels below 1 ppb. These low levels and high ratios occur on the downgradient side of deposits. The highly reducing nature of this groundwater is thought to prohibit further solute migration of U. (Osmond and Cowart, 1976). High isotopic ratios are a direct result of alpha recoil which preferentially ejects the U-234 nuclide into solution. High uranium levels (>10 ppb) occur in close proximity to the ore body and are related to movement of the uranium within the deposit. The relatively high ratios (> 3.2) in wells 904, 905 and 906 are suggestive of conditions on the downgradient side of an ore body (Cowart and Osmond, 1977).

Presently there is not an MCL for either uranium or uranium activity because of the additional complexity of uranium being both

TABLE B - 3(3).

BASELINE MEASUREMENTS OF RADIOACTIVE

CONSTITUENTS IN ANALYZED WATERS

Ra-226 (pCi/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	<.1-.15	<.1-.16	<.1-.14	<.1-.40	<.1-.48	>.10-181
MEAN	<.11	<.11	<.10	<.18	<.20	34
STD. DEVIATION	>.02	>.02	>.01	>.08	>.12	58

U-238 (ug/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	2.2-15.7	3.3-11.8	3.1-15.8	3.8-46.7	2.8-98.0	.02-22.5
MEAN	7.6	6.0	5.7	16.8	29.6	6.2
STD. DEVIATION	4.8	2.9	2.7	11.9	27.5	7.6

U-234/U-238

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	1.99-2.26	1.88-2.33	1.87-2.61	1.68-2.35	1.5-2.9	1.69-12.
MEAN	2.09	2.12	2.23	1.96	1.90	5.22
STD. DEVIATION	.10	.16	.21	.19	.35	3.2

chemically and radiologically toxic (EPA,1981). A level of 3 ppb has an equivalent activity of ~ 1 pCi/l. The activity of U-238 in pCi is multiplied by the U-234/U-238 disequilibrium ratio to calculate the contribution (pCi) from U-234. The total activity (pCi/l) from uranium represents the summation of the pCi/l of both nuclides. The range in the total pCi/l for the investigated formation waters is from less than .02 to ~ 50 pCi/l. If the suggested MCL for U of 10 pCi/l (Lappenbusch, 1979) was approved, several groundwater samples from the White River Group would not comply.

The source classification of seepage water into springs and streams by uranium and radium levels and disequilibrium ratios appears in good agreement with the previously discussed major ion classification. Highest levels of U and Ra are in springs and streams associated with the White River Group. Lower disequilibrium ratios of ~ 2 were common in streams draining the Brule while higher ratios occurred in streams draining the Arikaree and Pierre units. Thus uranium and radium levels in these streams can be used to characterize base flow from the adjacent strata and provide further confirmatory evidence of the origins of this surface water.

BASELINE DETERMINATION OF NUTRIENTS

TASK B - 3 (4)

Introduction

The nutrients nitrogen (N), phosphorus (P) and silicon (Si) are important in water quality investigations. In surface water, excesses in concentration can result in eutrophication while in groundwater elevated levels of nitrate-nitrogen (NO_3-N) (> 10 mg/l) are reported to cause cyanosis in infants. Elevated nitrate (NO_3^-) levels in groundwater are also reliable indicators of contamination from anthropogenic activities.

Methods

Nitrate, phosphate and silicate were determined on filtered samples by EPA-accepted spectrophotometric techniques using Hach Company reagents.

Results and Discussion

Nitrate levels in the investigated groundwater were all less than 9.0 ppm (<2ppm NO_3-N) (Appendix A). Thus the groundwater is considered pristine (Exner and Spalding , 1979) and inputs from fertilizer, barnyard and septic tank leachates are (insignificant considerations).

In comparison to other areas in Nebraska the groundwater appears as some of the least influenced by agricultural activities. Since the primary agricultural use is as rangeland, the data indicate that stock wells within the investigated area presently are not being contaminated by leachate from manure near the wells. No wells contained NO_3-N levels that approach the present MCL of 10.0 ppm (45 ppm for NO_3^-). Thus, in terms of health, groundwater nitrate is not a problem in this area.

Phosphate levels range from the minimum detectable (0.10 mg/l) to 2.2 mg/l and generally were ~ 0.5 ppm [Table B -3(4)]. No trends were observed. Phosphate is not considered harmful in drinking water

TABLE B - 3(4)

BASELINE DETERMINATIONS OF NUTRIENT

LEVELS IN ANALYZED WATERS

NO_3^- AS N (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	0.02-0.5	0.1-0.9	0.02-1.5	0.09-1.8	0.1-1.9	0.1-1.6
MEAN	.20	.20	.27	.49	.58	.63
Std.DEVIATION	.13	.24	.30	.31	.53	.61

NO_3^- (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	0.1-2	0.5-4	0.1-7.0	0.4-8	0.5-8.5	0.5-7.2
MEAN	.87	.88	1.3	2.2	2.6	2.8
STD.DEVIATION	.58	1.1	1.4	1.4	2.4	2.7

PO_4^{3-} (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	0.1-1.5	0.05-0.80	0.1-1.05	0.13-1.5	0.1-2.2	0.13-1.7
MEAN	.52	.32	.45	.33	.57	.44
STD. DEVIATION	.46	.21	.28	.26	.63	.52

SiO_2 (mg/l)

	SPRINGS	STREAMS	Ta	Tb	Tb/Tc/Kp	Tc
RANGE	53-67	38-67	22-68	31-88	35-70	0-20
MEAN	60	50	54	57	55	14
STD. DEVIATION	5	8	9	10	9	3

and does not have an MCL.

In oxidizing formations silica levels generally were at or above their saturation level with respect to silica gel, however, they were well below saturation levels in the reducing basal Chadron formation. High Na^+ levels may be instrumental in the uptake of SiO_2 in the authigenic formation of clays in the basal Chadron.

Concentrations of nitrate, phosphate and silica in streams (Appendix A) of the area were slightly lower than the average concentrations in the groundwater of the underlying rocks [Table B-3(4)]. This decrease may be partially due to algal assimilation of these nutrients.

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APPENDIX A

PHYSICAL AND CHEMICAL DATA FROM WELLS COMPLETED IN THE ARIKAREE AND YOUNGER STRATA

ID #	LEGAL LOCATION	WELL TYPE	WELL DEPTH (FT)	PROD. HORZ.	TEMP °C	pH	REDOX INDICATORS Eh[*]	H_2S mg/l	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+} --mg/l--	Mg^{2+}	Na^+	K^+	MAJOR ANIONS HCO_3^- ---mg/l---	SO_4^{2-}	Cl^-	MAJOR ION BALANCE	NUTRIENTS NO_3^- --mg/l--	PO_4^{3-}	SiO_2	SI_c	SI_{sg}	TRACE METALS As --ug/l--	V	Mo	Se	RADIOACTIVE CONSTITUENTS Ra-226 pCi/l	U-238 ug/l	U-234/U-238 A.R.
065	31 54 11 CC	S	420	Ta	16	7.8	+230	ND	280	52	3	10	4	220	1.0	3	- 5.3	1.3	.75	47	SS	S	2	3.4	1	<1	<0.1	3.8	2.24
070	31 53 03 AA	H,S	98	Ta	15	7.7	+110	ND	320	60	6	3	2	180	1.0	11	+ 4.8	2.5	.25	53	S	S	1	2.4	1	<1	<0.1	3.2	2.17
077	31 53 08 CC	S	420	Ta	14	8.2	N.A.	ND	250	42	8	4	4	190	1.0	3	- 3.3	0.1	.41	22	SS	U	1	0.5	2	<1	.12	6.3	2.21
114	31 54 07 CC	H,S	343	Ta	15	7.5	+185	ND	300	48	6	8	5	180	8.9	18	- 4.1	0.9	.40	53	U	S	3	6.0	2	<1	<0.1	6.0	2.61
150	32 54 35 BA	S	420	Ta	15	7.9	+140	ND	250	46	4	4	4	150	1.0	3	+ 5.6	0.6	.52	55	S	S	2	9.2	3	<1	<0.1	3.4	2.23
173	30 54 25 AA	S	350	Ta	13	6.9	+ 30	ND	280	45	13	6	2	150	1.0	21	- .41	0.7	1.05	68	U	SS	2	5.0	1	<1	<0.1	4.6	2.42
188	32 53 29 CA	S	275	Ta	15	7.9	+200	ND	250	43	1	8	5	170	2.0	3	- 4.2	0.8	.53	47	SS	S	1	3.3	2	<1	<0.1	5.3	2.59
211	31 52 26 DD	S	180	Ta	12	7.3	+100	ND	500	72	4	35	8	270	17.0	9	+ 5.5	1.0	.30	65	U	SS	5	5.6	5	<1	0.11	9.5	1.88
243	31 51 20 DD	S,H	65	Ta	13	7.1	+190	ND	540	88	7	16	4	250	13.0	29	+ 4.4	7.0	.31	51	U	S	4	1.4	1	<1	0.11	5.9	1.89
276	31 52 13 DD	H,S	25	Tb	13	7.6	+140	ND	390	64	5	7	2	190	10	17	+ 1.6	1.7	.19	45	U	S	1	3.2	1	<1	.24	3.0	2.34
337	30 54 01 BD	S,H	30	Ta/Qal	14	7.6	+310	ND	340	32	7	9	3	130	8.0	20	- 4.9	1.1	1.05	58	U	SS	4	6.9	1	<1	<0.1	6.5	2.46
370	30 53 23 CA	S	300	Ta	15	6.9	+130	ND	240	38	6	12	2	120	1.0	27	+ 3.4	0.7	.17	67	U	SS	11	7.1	2	<1	<0.1	6.0	2.53
507	31 54 08 DD	S,H	350	Ta	18	8.2	+210	ND	260	52	6	4	2	180	1.0	23	- 4.8	0.5	.64	55	SS	S	1	5.5	1	<1	<0.1	2.5	2.42
527	31 53 18 CD	I	515BF	Ta	15	7.9	+ 90	ND	390	50	8	4	3	170	1.0	19	+ .52	0.8	.41	57	SS	SS	2	5.8	1	<1	<0.1	4.0	2.21
532	30 52 11 BA	H	140	Ta	14	7.6	+250	ND	290	54	4	6	2	145	1.0	20	+ 5.7	1.0	.28	53	U	SS	2	3.4	1	<1	<0.1	4.1	2.13
538	31 52 25 DD	S,H	60	Ta	12	7.0	+ 90	ND	460	83	6	18	4	250	8.0	30	+ 3.6	1.0	.35	52	U	SS	5	3.4	1	<1	0.13	5.9	2.00
539	30 51 08 DC	S,H	280	Ta	15	7.4	+180	ND	310	40	8	11	2	150	1.0	10	+ 6.8	0.5	.23	58	SS	SS	7	9.7	4	<1	.10	7.9	2.31
542	30 51 04 AB	S,H	250	Ta	16	7.4	+150	ND	280	39	5	8	2	140	1.0	18	- 1.4	0.4	.25	58	U	SS	4	2.7	1	<1	<0.1	3.5	2.25
544	30 54 34 BC	H	35	Ta	13	7.6	+700	ND	280	38	6	7	5	140	3.0	23	- 3.6	1.0	.40	48	U	S	3	2.0	3	<1	<0.1	6.8	2.40
550	31 53 34 CB	S	70	Ta/Qal	14	7.6	+320	ND	340	40	6	16	4	150	8.0	10	+ 5.5	1.1	1.05	59	U	SS	3	3.3	1	<1	.13	7.2	2.23
579	31 51 29 DA	H,I	60	Ta	14	7.5	+700	ND	380	42	7	16	3	170	7.0	10	+ 3.3	2.0	.10	45	U	S	1	1.9	4	<1	<0.1	5.5	2.22
600	31 51 20 CC	S,H	70	Ta	14	7.4	+230	ND	430	83	11	4	1	260	9.0	19	+ 2.3	2.5	.31	55	U	SS	2	7.0	1	<1	<0.1	5.1	2.08
602	31 51 20 CB	S,H	60	Ta	14	7.5	+190	ND	390	63	8	16	4	230	11.0	26	- 1.7	1.0	.33	46	U	S	4	5.0	1	<1	0.13	3.1	2.15

[*] All Eh values are based on Calomel reference and are not corrected

PHYSICAL AND CHEMICAL DATA FROM WELLS COMPLETED IN THE BRULE FORMATION

ID #	LEGAL LOCATION	WELL TYPE	WELL DEPTH (FT)	PROD. HORZ.	TEMP °C	pH	REDOX INDICATORS Eh[1]	REDOX INDICATORS H_2S mg/l	COND. uMHOS/CM.	MAJOR CATIONS CA^{2+} --mg/l--	Mg^{2+}	Na^+	K^+	MAJOR ANIONS HCO_3^- ---mg/l---	SO_4^{2-}	Cl^-	MAJOR ION BALANCE	NUTRIENTS NO_3^- --mg/l--	PO_4^{3-}	SiO_2	SI_c	SI_{sg}	TRACE METALS As -----ug/l-----	V	Mo	Se	RADIOACTIVE Ra-226 pCi/l	U-238 ug/l	CONSTITUENT U-234/U-238 A.R.
011	32 52 17 DD	H	20	Tb	13	7.4	+130	ND	600	60	5	49	11	290	36	24	- 3.7	2.5	1.5	88	U	SS	1	4.4	1	<1	.19	19.3	2.14
012	32 52 17 DA	H,S	50	Tb	18	8.2	+110	ND	600	36	2	75	6	230	71	25	- 5.5	2.5	.35	57	SS	S	5	6.0	3	<1	.15	19.3	1.93
013	32 52 17 BB	H,S	150	Tb	15	7.8	+120	ND	550	50	6	48	7	250	59	22	- 6.8	4.5	.15	57	SS	SS	8	6.3	1	<1	.27	21.9	1.92
023	32 53 12 AA	H	45	Tb	15	9.0	+120	ND	830	32	4	100	12	290	13	24	- 8.0	8.0	.25	62	SS	SS	12	6.2	2	<1	.23	23.1	1.63
029	31 52 14 BA	S	45	Tb	14	7.8	+170	ND	450	55	5	25	8	225	25	23	- 4.8	2.5	.14	55	SS	SS	2	3.4	2	<1	.39	15.1	2.01
129	32 52 34 DD	H,I	60	Tb	16	7.4	+100	ND	698	71	5	38	7	310	19	28	- 4.3	1.5	.39	57	S	S	10	4.0	1	<1	.15	6.8	2.14
130	32 52 34 DC	H,S,I	45	Tb	14	7.4	+100	ND	520	73	6	21	6	210	47	47	- 5.4	3.0	.20	60	SS	SS	7	4.3	5	<1	<0.1	5.0	2.17
145	32 52 27 DC	H,S	50	Tb	14	7.1	+200	ND	520	60	5	27	8	190	36	50	- 5.3	2.5	.15	60	SS	SS	4	2.2	2	<1	.12	16.5	2.13
185	31 52 15 AA	H,S	100	Tb	15	7.5	+165	ND	540	57	4	42	10	290	28	12	- 4.1	1.8	.23	37	U	U	5	9.4	4	<1	.17	15.9	2.23
187	31 52 15 DA	H,I	70	Tb	15	8.3	+150	ND	450	17	1	80	13	220	26	14	+ 1.8	1.5	.23	46	S	S	8	28.0	4	<1	<0.1	11.1	1.56
189	31 52 15 DC	S	60	Tb	14	7.7	+220	ND	530	52	4	37	11	280	18	22	- 7.9	3.2	.20	62	SS	SS	5	5.0	3	<1	.18	5.4	1.78
262	32 51 33 CC	S	90	Tb	19	8.4	+240	ND	890	11	2	145	5	390	13	27	- 2.3	3.0	.34	75	SS	SS	26	27.0	2	1.6	<0.1	46.7	1.74
268	31 51 06 BC	H,S	45	Tb	16	7.5	+145	ND	550	76	4	17	4	270	25	14	- 4.0	1.5	.28	60	SS	SS	2	3.4	2	1.5	.12	13.2	1.91
269	31 51 06 BC	H,S	19	Tb	10	7.3	+ 95	ND	570	75	8	26	6	270	25	17	+ 1.9	2.5	.22	31	U	U	5	7.4	1	<1	.20	7.1	2.05
270	31 51 06 CC	NR	40	Tb	12	7.2	+160	ND	610	96	6	20	8	330	8	4	+ 5.1	2.5	.43	53	U	SS	1	8.2	3	<1	.12	7.3	1.99
273	31 52 13 AB	NR	50	Tb	14	7.6	+250	ND	420	69	9	12	4	250	12	3	+ 3.7	1.5	.20	53	SS	S	4	6.2	3	<1	.34	10.3	2.08
275	31 51 07 BD	S	25	Tb	13	7.2	+ 30	ND	400	67	7	14	5	190	10	25	+ 6.8	1.3	.46	48	U	S	3	1.8	1	<1	.13	6.9	2.12
282	31 52 12 BB	H,S	40	Tb	14	7.4	+150	ND	690	101	11	32	8	370	33	37	- 2.0	2.8	.21	53	SS	S	8	5.0	1	<1	.22	29.4	1.99
441	30 52 11 CC	H	430	Tb	16	6.9	+150	ND	275	27	3	23	4	120	6.0	21	- .04	0.5	.22	65	U	SS	3	5.4	2	<1	.14	15.8	1.87
619	32 52 35 DC	H,S	125	Tb	15	7.6	+125	ND	685	55	5	73	11	330	35	32	- 3.3	0.8	.33	60	SS	SS	9	1.7	5	<1	.16	15.7	1.80
629	31 52 01 DC	H,S	55	Tb	15	7.4	+ 95	ND	810	72	8	65	15	300	65	50	- 3.7	2.5	.58	60	U	SS	6	4.0	4	<1	<0.1	18.0	1.85
630	31 52 22 BA	H,S	80	Tb	14	7.6	+170	ND	450	55	6	27	10	210	25	38	- 4.2	2.2	.20	52	U	S	2	3.0	2	<1	.20	19.4	1.94
641	31 52 25 BD	H,S	95	Tb	14	7.5	+180	ND	500	79	8	14	3	290	11	9	+ .29	0.8	.20	65	SS	SS	3	2.2	3	<1	.15	8.3	2.06
642	31 52 23 CD	S	60	Tb	12	7.2	- 10	ND	450	68	8	31	9	240	20	35	+ 1.6	1.1	.24	50	U	S	2	3.2	1	<1	.21	17.9	2.02
643	31 52 24 BD	H	<100	Tb	13	7.4	+140	ND	450	77	8	15	4	275	11	19	- .42	1.1	.31	55	U	SS	3	5.1	1	<1	.25	4.5	2.06
644	31 52 23 AB	S	<100	Tb	14	7.7	+160	ND	450	63	6	22	6	230	11	16	+ 2.8	2.0	.23	57	SS	SS	2	1.6	3	<1	.25	14.9	2.01
660	31 53 13 CA	S	150	Tb	14	7.0	+250	ND	350	50	5	11	6	195	5	4	+ 1.5	1.0	.13	57	U	SS	2	3.8	2	<1	<0.1	10.9	1.97
666	31 52 20 AC	S	150	Tb	14	7.0	+250	ND	350	38	7	29	14	160	11	32	+ 5.0	1.1	.13	57	U	SS	3	3.2	1	<1	.13	17.0	1.94
677	31 51 04 AA	H,S	60	Tb	15	7.6	+165	ND	315	51	4	9	4	180	8	19	- 4.3	0.9	.24	67	U	SS	2	5.4	1	<1	.15	6.8	2.35
901	311 OAK, CRAWFORD	I	45	Tb	17	8.0	- 45	ND	890	13	3	210	10	370	110	113	- 5.9	1.4	.35	66	U	SS	23	7.9	4	<1	.10	37.4	1.71
902	7 COATES, CRAWFORD	I	55	Tb	13	7.6	+ 70	ND	1110	82	8	135	30	270	240	94	- 4.7	0.4	.33	50	S	S	10	6.1	7	<1	.14	16.2	1.76
903	14 PADDOCK, CRAWF.	I	100	Tb	13	7.5	+170	ND	1210	97	15	125	46	420	165	95	- 1.3	2.7	.47	53	SS	S	14	18.0	2	1.5	.40	46.4	1.59
908	723 ELM, CRAWFORD	I	40	Tb	13	7.5	+170	ND	1120	39	6	115	20	420	45	15	- 2.4	4.0	1.0	70	U	SS	22	6.8	5	<1	.31	44.1	1.72
909	311 ANNIN, CRAWF.	I	60	Tb	14	8.1	- 95	ND	600	8	2	120	13	330	33	18	- 4.1	2.0	.24	71	U	SS	14	21.0	4	<1	.13	26.2	1.68

[1] All Eh values are based on calomel reference and are not corrected.

PHYSICAL AND CHEMICAL DATA FROM WELLS COMPLETED IN THE LOWER BRULE, UPPER CHADRON AND PIERRE

ID #	LEGAL LOCATION	WELL TYPE	WELL DEPTH (FT)	PROD. HORZ.	TEMP °C	pH	REDOX INDICATORS Eh*	REDOX INDICATORS H_2S mg/l	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+} --mg/l--	Mg^{2+}	Na^+	K^+	MAJOR ANIONS HCO_3^- ---mg/l---	SO_4^{2-}	Cl^-	MAJOR ION BALANCE	NUTRIENTS NO_3^- --mg/l--	PO_4^{3-}	SiO_2	SI_c	SI_{sg}	TRACE METALS As --ug/l--	V	Mo	Se	RADIOACTIVE CONSTITUENTS Ra-226 pCi/l	U-238 ug/l	U-234/U-238 A.R.
006	32 52 15 DD	H,S	35	Tc	15	7.6	+160	ND	1350	51	7	270	25	460	320	61	- 1.2	1.8	.40	35	SS	U	81	155.0	12	<1	.28	98.0	1.49
016	32 52 08 DB	H	30	Tc	14	7.6	+ 85	ND	1140	76	9	165	18	460	120	33	+ 4.5	8.5	.45	55	SS	SS	28	4.0	7	<1	<.10	53.4	1.66
020	32 52 04 CD	H,S	28	Tc/Tb	18	7.5	+130	ND	890	74	13	61	13	370	100	15	- 5.2	1.3	.20	57	SS	S	7	7.5	4	<1	.26	31.8	1.76
118	32 52 27 AA	H,S	100	Tc/Tb	16	7.0	+290	ND	950	100	6	54	10	210	210	65	- 9.0	2.0	.32	53	SS	S	11	2.0	4	<1	.13	12.9	2.10
142	32 52 23 AB	H,S	35	Tc/Tb	14	7.7	+ 80	ND	620	43	3	68	12	250	46	27	- 1.9	2.7	.35	63	U	SS	4	2.4	1	<1	.10	14.5	1.71
222	32 52 26 DC	H,S	30	Tc	17	7.5	+200	ND	640	53	11	95	23	380	20	31	+ 4.5	1.1	.28	50	S	S	8	13.0	5	<1	<.10	13.2	1.85
229	31 51 02 BA	H,S	80	Tc/Tb	13	6.8	+ 65	ND	605	69	14	63	11	250	58	55	+ 5.0	1.1	.33	58	SS	SS	7	5.2	4	<1	.14	14.5	1.90
249	32 51 33 AA	H,S	50	Tc	13	7.0	+110	ND	1110	84	7	152	18	360	140	110	- .51	2.3	.22	49	SS	S	12	4.0	3	<1	.48	65.4	1.59
654	32 52 24 AD	H,S	40	Ka/Tc	14	7.8	+ 90	ND	1100	106	11	95	10	340	190	77	- 5.6	7.0	2.2	52	SS	S	13	10.0	7	<1	.37	29.8	1.85
657	32 52 27 DA	I	110	Tc	13	7.2	+135	ND	485	25	4	70	17	175	38	48	- .02	2.2	.30	65	U	SS	9	2.2	3	<1	.13	14.6	2.15

PHYSICAL AND CHEMICAL DATA FROM FLOWING WELLS SLOTTED IN THE BASAL CHADRON SANDS

ID #	LEGAL LOCATION	WELL TYPE	WELL DEPTH (FT)	PROD. HORZ.	TEMP °C	pH	REDOX INDICATORS Eh*	REDOX INDICATORS H_2S mg/l	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+} --mg/l--	Mg^{2+}	Na^+	K^+	MAJOR ANIONS HCO_3^- ---mg/l---	SO_4^{2-}	Cl^-	MAJOR ION BALANCE	NUTRIENTS NO_3^- --mg/l--	PO_4^{3-}	SiO_2	SI_c	SI_{sg}	TRACE METALS As --ug/l--	V	Mo	Se	RADIOACTIVE CONSTITUENTS Ra-226 pCi/l	U-238 ug/l	U-234/U-238 A.R.
119	32 52 27 AA	S	250	Tc	23	7.0	-165	ND	2450	32	6	480	13	310	540	140	+ 6.9	ND	.18	14	U	U	0.5	4.2	5	<1	13.8	0.7	12.6
220	32 52 25 AD	H,S	100	Tc	16	8.2	-295	5.0	1460	15	2	335	12	360	175	240	- 2.0	7.2	.20	18	SS	U	0.5	0.5	2	<1	<.10	0.4	1.81
225	32 52 35 CB	S,I	480	Tc	17	6.9	-300	ND	2150	22	2	310	12	280	370	110	- 1.1	ND	.20	12	U	U	0.5	4.1	1	<1	.63	0.03	7.94
240	32 51 25 BB	H,S	44	Kp	12	7.2	+ 70	ND	775	114	8	81	8	400	44	50	+ 5.9	0.5	1.7	54	SS	SS	3	0.5	6	<1	.14	4.6	1.82
280	31 51 12 DB	H	520	Tc/Tb	15	7.7	- 30	ND	1050	15	1	230	12	320	125	95	+ 2.8	0.5	.10	70	U	SS	4	0.9	9	<1	.14	2.8	2.90
622	31 51 07 AC	S	300	Tc	15	8.0	-310	1.0	1680	16	2	325	10	320	180	220	+ .46	0.5	.27	16	U	U	0.5	20.0	3	<1	1.04	.02	8.32
623	32 52 35 CC	S	290	Tc	17	8.4	-340	0.1	2150	13	2	325	10	320	380	130	- 5.0	ND	.13	9	SS	U	0.5	1.9	5	<1	.14	.02	4.06
652	31 52 02 CA	H,S	280	Tc	16	7.8	-290	3.0	1690	16	2	395	11	320	410	187	- 1.7	0.5	.24	13	U	U	0.5	11.0	4	<1	5.1	1.1	1.69
682	31 52 01 BD	I	600	Tc	15	8.1	-285	5.0	1600	14	2	400	5	370	290	175	+ 3.7	3.0	.27	14	U	U	0.5	1.4	NA	<1	24	0.80	5.28
685	31 52 02 CC	I	380	Tc	16	8.1	-270	0.5	1710	22	4	440	13	370	400	187	+ 3.0	ND	.15	12	SS	U	1.0	4.3	9	<1	1.2	15.90	2.26
904	701 MAIN CRAWF.	I	280	Tc	15	8.2	-380	0.1	1620	17	4	400	12	320	325	200	+ 3.3	ND	.19	15	S	U	0.5	7.2	8	<1	43	15.70	3.41
905	618 MAIN CRAWF.	I	198	Tc	15	8.2	-320	0.1	1750	18	5	420	12	320	425	200	+ .36	ND	.24	14	S	U	0.5	8.5	1	<1	141	11.8	3.23
906	520 PINE CRAWF.	I	285	Tc	16	7.8	-265	0.1	1830	23	4	540	14	280	600	200	+ 5.3	ND	1.5	20	SS	U	0.5	4.2	10	<1	181	22.50	3.97
907	SOUTH GATE CRAW.	I	NR	Tc	17	7.7	-250	0.1	1800	25	2	420	14	300	485	202	- 2.0	ND	1.7	15	U	U	0.5	4.5	5	<1	3.0	2.92	8.10

* All Eh values are based on Calomel reference and are not corrected.

PHYSICAL AND CHEMICAL DATA FROM SPRINGS

ID	LEGAL LOCATION	TEMP	pH	REDOX INDICATORS Eh*	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	MAJOR ANIONS HCO_3^-	SO_4^{2-}	Cl^-	MAJOR ION BALANCE	NUTRIENTS NO_3^-	PO_4^{3-}	SiO_2	SI_c	SI_{sg}	TRACE METALS As	Mo	V	Se	RADIOACTIVE CONSTITUENTS Ra-226	U-238	U-234/U-238
#		°C				--mg/l--				---mg/l---				--mg/l--					--ug/l--				pCi/l	ug/l	A.R.
SP-1	31 51 23 AA (NEAR LEVI)	12	7.5	>700	350	56	5	8	1	180	10	10	+ 1.8	0.5	.10	60	U	SS	3	2	1.7	<1	.12	5.5	2.26
SP-2	30 52 19 BD DEAD MAN'S CRK.	26	6.9	+ 85	480	73	9	10	4	230	1	31	+ 2.1	0.1	1.5	67	U	S	4	1	1.1	<1	<0.1	2.2	2.18
SP-3	31 53 06 CA SO.SOLDIER CRK.	13	7.7	+120	310	57	11	7	4	190	1	27	+ 3.0	0.7	.25	50	S	S	2	1	9.0	<1	<0.1	3.3	2.00
SP-4	31 52 16 CC FREDS 1ST FISH POND	13	7.3	+110	400	60	6	24	5	210	13	10	+ 7.3	1.0	.46	58	U	SS	3	1	5.1	<1	<0.1	12.0	1.99
649	32 51 31 BD MRS. BRITTON M,H,S	17	7.8	+125	730	48	4	127	13	250	98	60	+ 4.2	2.0	.45	62	SS	SS	12	5	1.2	<1	.10	15.7	2.00
658	31 52 08 CD FT.ROB'S.H2O SUPPLY	13	7.6	+160	390	71	6	10	5	240	2	21	+ .09	0.9	.30	53	SS	SS	2	2	3.8	<1	.15	6.8	2.12

PHYSICAL AND CHEMICAL DATA FROM STREAMS

ID	LEGAL LOCATION	TEMP	pH	REDOX INDICATORS Eh*	COND. uMHOS/CM.	MAJOR CATIONS Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	MAJOR ANIONS HCO_3^-	SO_4^{2-}	Cl^-	MAJOR ION BALANCE	NUTRIENTS NO_3^-	PO_4^{3-}	SiO_2	SI_c	SI_{sg}	TRACE METALS As	Mo	V	Se	RADIOACTIVE CONSTITUENTS Ra-226	U-238	U-234/U-238
#		°C				--mg/l--				---mg/l---				--mg/l--					--ug/l--				pCi/l	ug/l	A.R.
ST-1	31 51 24 CC UPPER ASH	12	8.4	+230	390	60	10	12	2	240	1	3	+ 4.4	0.5	.05	53	SS	SS	3	3	3.7	<1	<0.1	4.1	2.26
ST-2	31 51 02 AA LOWER ASH	24	8.6	+240	350	40	8	17	4	200	4	3	+ .58	0.5	.05	54	SS	U	4	3	3.4	<1	.10	5.4	2.20
ST-3	30 51 03 BD UPPER SQUAW	15	8.1	+230	495	68	7	9	3	240	5	2	+ 3.9	0.5	.14	67	SS	SS	4	2	7.3	<1	<0.1	3.9	2.03
ST-4	31 51 20 BC MIDDLE SQUAW	20	8.6	>700	370	64	7	11	3	220	1	2	+ 7.9	0.5	.35	44	SS	U	2	2	3.4	<1	<0.1	3.3	1.98
ST-5	31 52 12 BA LOWER SQUAW	21	7.8	+110	500	78	5	27	10	310	11	3	+ 2.8	0.5	.47	42	SS	U	9	3	5.7	<1	.13	6.3	1.88
ST-6	31 52 11 AB WHITE CLAY CREEK	22	7.1	+295	420	30	7	32	8	180	18	25	- 5.7	4.0	.33	42	U	U	6	6	5.1	<1	.16	11.8	2.00
ST-7	31 52 12 BB ENGLISH CREEK	20	6.9	+165	460	54	10	37	13	230	20	20	+ 6.6	1.0	.35	38	U	U	7	4	3.2	<1	.15	111.4	1.97
ST-8	31 53 06 DA SO. FORK SOLDIER CR.	22	8.5	+ 90	290	51	4	18	6	200	1	26	- 3.2	0.1	.30	45	SS	U	1	1	3.0	<1	<0.1	4.2	2.33
ST-9	31 53 32 CD MIDDLE WHITE RIVER	19	8.1	+140	305	58	9	7	5	210	1	25	- 1.5	0.5	.39	53	SS	S	2	1	3.6	<1	<0.1	4.9	2.30
ST10	31 54 31 CA WEST WHITE RIVER	19	8.3	+ 70	275	46	5	12	5	130	3	10	+ .61	.75	.30	57	SS	S	3	1	10.7	<1	<0.1	4.8	2.29

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