

Table 2.9-8 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID: Date Collected: Formation:	BOW 2010-1		BOW 2010-1		BOW 2010-1		BOW 2010-2		BOW 2010-2		BOW 2010-2		BOW 2010-3		BOW 2010-3		BOW 2010-3		
	3/9/2011		3/24/2011		4/6/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011		
	BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																			
Alkalinity Total as CaCO ₃	mg/L	211	1	217	1	212	1	187	1	187	1	182	1	177	1	145	1	171	1
Bicarbonate as HCO ₃	mg/L	139	1	67	1	48	1	152	1	122	1	148	1	154	1	94	1	144	1
Carbonate as CO ₃	mg/L	58	1	97	1	104	1	38	1	52	1	37	1	31	1	41	1	32	1
Chloride	mg/L	44	1	55	1	63	1	27	1	32	1	31	1	38	1	37	1	32	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.6	0.1	0.5	0.1	0.5	0.1
Magnesium	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.3	0.1	1.3	0.1	1.3	0.1	<0.1	0.1	1.1	0.1	1.1	0.1	1	0.1	0.5	0.1	0.8	0.1
Potassium	mg/L	12	1	12	1	12	1	11	1	12	1	11	1	12	1	10	1	10	1
Silica	mg/L	105	0.2	108	0.2	110	0.2	85.9	0.2	95.1	0.2	88.1	0.2	79.3	0.2	86.5	0.2	87	0.2
Sodium	mg/L	144	1	156	1	145	1	107	1	112	1	107	1	126	1	109	1	118	1
Sulfate	mg/L	60	2	61	2	62	2	37	2	39	2	37	1	60	2	60	2	60	2
PHYSICAL PROPERTIES																			
Conductivity @ 25 °C	umhos/cm	682	1	724	1	763	1	518	1	542	1	515	1	584	1	527	1	550	1
pH	s.u.	9.56	0.01	9.88	0.01	10	0.01	9.32	0.01	9.58	0.01	9.38	0.01	9.22	0.01	9.57	0.01	9.41	0.01
Total Dissolved Solids @ 180 °C	mg/L	456	10	508	10	537	10	377	10	396	10	342	10	411	10	375	10	374	10
METALS, DISSOLVED																			
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.018	0.001	0.017	0.001	0.014	0.001	0.005	0.001	0.004	0.001	0.005	0.001	0.01	0.001	0.009	0.001	0.009	0.001
Barium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Boron	mg/L	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.3	0.1
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
Calcium	mg/L	5	1	5	1	5	1	7	1	6	1	6	1	7	1	5	1	5	1
Chromium	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Copper	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Manganese	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Mercury	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Molybdenum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nickel	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Selenium	mg/L	0.021	0.001	0.021	0.001	0.016	0.001	0.002	0.001	0.001	0.001	ND	0.001	0.006	0.001	0.003	0.001	0.003	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Zinc	mg/L	0.04	0.01	0.04	0.01	0.08	0.01	0.03	0.01	0.07	0.01	0.06	0.01	0.05	0.01	0.15	0.01	0.11	0.01
DATA QUALITY																			
A/C Balance (± 5)	%	0.0283		0.476		-3.96		0.0154		-0.717		-0.824		1.57		-0.182		0.062	
Anions	meq/L	6.83		7.29		7.44		5.3		5.57		5.37		5.95		5.27		5.65	
Cations	meq/L	6.83		7.36		6.87		5.3		5.49		5.29		6.14		5.25		5.66	
Solids Total Dissolved Calculated	mg/L	532		567		560		410		439		418		454		420		442	

Notes:
mg/L = milligrams per Liter
umhos/cm = micromhos per centimeter
s.u. = standard unit
meq/L = milliequivalents per Liter
RL = Analyte Reporting Limit

Table 2.9-8 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID: Date Collected: Formation:		BOW 2010-4A		BOW 2010-4A		BOW 2010-4A		BOW 2010-5		BOW 2010-5		BOW 2010-5		BOW 2010-6		BOW 2010-6		BOW 2010-6	
		4/5/2011		4/19/2011		5/3/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																			
Alkalinity Total as CaCO ₃	mg/L	175	1	131	1	125	1	151	1	151	1	152	1	144	1	143	1	143	1
Bicarbonate as HCO ₃	mg/L	180	1	95	1	114	1	174	1	170	1	177	1	165	1	159	1	168	1
Carbonate as CO ₃	mg/L	16	1	32	1	19	1	5	1	7	1	4	1	6	1	7	1	3	1
Chloride	mg/L	24	1	33	1	28	1	7	1	7	1	5	1	2	1	10	1	10	1
Fluoride	mg/L	0.5	0.1	0.5	0.1	0.5	0.1	0.6	0.1	0.5	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.6	0.1
Magnesium	mg/L	2	1	<1	1	<1	1	7	1	7	1	7	1	7	1	7	1	7	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.2	0.1	1.2	0.1	1.1	0.1	0.9	0.1	0.9	0.1	0.9	0.1	1	0.1	1	0.1	1	0.1
Potassium	mg/L	11	1	9	1	8	1	4	1	5	1	4	1	4	1	5	1	5	1
Silica	mg/L	78.2	0.2	70.6	0.2	75.6	0.2	72.1	0.2	83.9	0.2	78.6	0.2	67.4	0.2	73.7	0.2	71.5	0.2
Sodium	mg/L	100	1	95	1	84	1	26	1	28	1	27	1	24	1	25	1	25	1
Sulfate	mg/L	50	2	50	1	49	1	9	1	9	1	9	1	2	1	10	1	10	1
PHYSICAL PROPERTIES																			
Conductivity @ 25 °C	umhos/cm	514	1	474	1	446	1	313	1	307	1	307	1	320	1	309	1	310	1
pH	s.u.	8.92	0.01	9.4	0.01	9.31	0.01	8.23	0.01	8.34	0.01	8.19	0.01	8.31	0.01	8.5	0.01	8.27	0.01
Total Dissolved Solids @ 180 °C	mg/L	358	10	345	10	316	10	231	10	228	10	200	10	216	10	225	10	206	10
METALS, DISSOLVED																			
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.015	0.001	0.014	0.001	0.015	0.001	0.003	0.001	0.004	0.001	0.003	0.001	0.005	0.001	0.005	0.001	0.005	0.001
Barium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.1
Boron	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
Calcium	mg/L	13	1	7	1	6	1	29	1	29	1	29	1	31	1	31	1	32	1
Chromium	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Copper	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Manganese	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Mercury	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Molybdenum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nickel	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Selenium	mg/L	0.009	0.001	0.011	0.001	0.012	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Zinc	mg/L	<0.01	0.01	0.01	0.01	<0.01	0.01	0.06	0.01	0.09	0.01	0.1	0.01	0.03	0.01	0.06	0.01	0.07	0.01
DATA QUALITY																			
A/C Balance (± 5)	%	1.48		0.755		-1.89		-3.95		-1.58		-1.82		2.6		-1.63		-1.34	
Anions	meq/L	5.3		4.7		4.4		3.51		3.48		3.45		3.1		3.43		3.44	
Cations	meq/L	5.46		4.77		4.24		3.24		3.37		3.33		3.27		3.32		3.34	
Solids Total Dissolved Calculated	mg/L	409		368		256		269		285		277		248		271		269	

Notes:
mg/L = milligrams per Liter
umhos/cm = micromhos per centimeter
s.u. = standard unit
meq/L = milliequivalents per Liter
RL = Analyte Reporting Limit

Table 2.9-8 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID: Date Collected: Formation:	BOW 2010-7		BOW 2010-7		BOW 2010-7		BOW 2010-8		BOW 2010-8		BOW 2010-8		
	4/5/2011		4/19/2011		5/3/2011		4/5/2011		4/19/2011		5/3/2011		
	BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS													
Alkalinity Total as CaCO ₃	mg/L	190	1	185	1	180	1	182	1	182	1	179	1
Bicarbonate as HCO ₃	mg/L	202	1	182	1	191	1	198	1	172	1	189	1
Carbonate as CO ₃	mg/L	15	1	21	1	14	1	12	1	24	1	14	1
Chloride	mg/L	23	1	28	1	25	1	7	1	13	1	9	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.5	0.1	0.5	0.1	0.5	0.1
Magnesium	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.2	0.1	1	0.1	1	0.1	0.8	0.1	0.6	0.1	0.7	0.1
Potassium	mg/L	11	1	10	1	9	1	10	1	12	1	10	1
Silica	mg/L	80.9	0.2	76.9	0.2	80.1	0.2	81.4	0.2	76.3	0.2	80.2	0.2
Sodium	mg/L	118	1	119	1	106	1	83	1	90	1	79	1
Sulfate	mg/L	55	2	54	2	52	2	27	1	24	1	24	1
PHYSICAL PROPERTIES													
Conductivity @ 25 °C	umhos/cm	547	1	540	1	535	1	407	1	428	1	410	1
pH	s.u.	8.76	0.01	9	0.01	8.93	0.01	8.65	0.01	9.15	0.01	8.93	0.01
Total Dissolved Solids @ 180 °C	mg/L	376	10	411	10	376	10	306	10	326	10	299	10
METALS, DISSOLVED													
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.028	0.001	0.029	0.001	0.03	0.001	0.006	0.001	0.005	0.001	0.006	0.001
Barium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Boron	mg/L	0.2	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
Calcium	mg/L	8	1	5	1	6	1	11	1	8	1	9	1
Chromium	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Copper	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Manganese	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Mercury	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Molybdenum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nickel	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Selenium	mg/L	0.21	0.001	0.22	0.001	0.235	0.001	ND	0.001	ND	0.001	ND	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Zinc	mg/L	<0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	0.01
DATA QUALITY													
A/C Balance (± 5)	%	1.35		0.159		-2.68		0.681		0.853		-2.91	
Anions	meq/L	5.72		5.71		5.48		4.46		4.57		4.39	
Cations	meq/L	5.88		5.73		5.2		4.52		4.65		4.14	
Solids Total Dissolved Calculated	mg/L	439		430		312		355		356		241	

Notes:

mg/L = milligrams per Liter

umhos/cm = micromhos per centimeter

s.u. = standard unit

meq/L = milliequivalents per Liter

RL = Analyte Reporting Limit

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Table 2.9-9 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

Location ID: Date Collected: Formation:		BOW 2010-1		BOW 2010-1		BOW 2010-1		BOW 2010-2		BOW 2010-2		BOW 2010-2		BOW 2010-3		BOW 2010-3		BOW 2010-3	
		3/9/2011		3/24/2011		4/6/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7	0.7	<0.8	0.8	<0.7	0.7	<0.7	0.7	<0.8	0.8	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.4		0.5		0.4		0.4		0.5		0.5		0.4		0.5		0.5	
Lead 210 MDC	pCi/L	0.7		0.8		0.7		0.7		0.8		0.8		0.7		0.8		0.8	
Polonium 210	pCi/L	<0.7	0.7	<1.2	1.2	<0.5	0.5	<0.7	0.7	<0.9	0.9	<0.6	0.6	<0.6	0.6	<0.9	0.9	<0.7	0.7
Polonium 210 precision (±)	pCi/L	0.4		0.4		0.4		0.3		0.5		0.4		0.2		0.7		0.4	
Polonium 210 MDC	pCi/L	0.7		1.2		0.5		0.7		0.9		0.6		0.6		0.9		0.7	
Radium 226	pCi/L	<0.15	0.15	0.66	0.14	<0.1	0.1	0.31	0.15	0.26	0.1	<0.21	0.21	0.38	0.15	0.23	0.11	<0.22	0.22
Radium 226 precision (±)	pCi/L	0.1		0.19		0.06		0.14		0.11		0.09		0.15		0.11		0.1	
Radium 226 MDC	pCi/L	0.15		0.14		0.1		0.15		0.1		0.21		0.15		0.11		0.22	
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.06		0.06		0.07		0.09		0.04		0.08		0.08		0.07		0.1	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.2	
Uranium	mg/L	0.0032	0.0003	0.0024	0.0003	0.002	0.0003	0.0031	0.0003	0.0032	0.0003	0.0035	0.0003	0.0041	0.0003	0.0035	0.0003	0.0041	0.0003
Uranium Activity	uCi/mL	2.20E-09	2.00E-10	1.60E-09	2.00E-10	1.30E-09	2.00E-10	2.10E-09	2.00E-10	2.20E-09	2.00E-10	2.40E-09	2.00E-10	2.80E-09	2.00E-10	2.40E-09	2.00E-10	2.80E-09	2.00E-10
RADIONUCLIDES-SUSPENDED																			
Lead 210	pCi/L	<1.2	1.2	<0.8	0.8	<0.9	0.9	<1.3	1.3	<0.9	0.9	<0.7	0.7	<1.2	1.2	<0.9	0.9	<0.7	0.7
Lead 210 precision (±)	pCi/L	0.7		0.5		0.5		0.8		0.6		0.4		0.7		0.6		0.4	
Lead 210 MDC	pCi/L	1.2		0.8		0.9		1.3		0.9		0.7		1.2		0.9		0.7	
Polonium 210	pCi/L	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.2	0.2	0.3	0.2
Polonium 210 precision (±)	pCi/L	0.2		0.2		0.2		0.2		0.3		0.2		0.2		0.2		0.2	
Polonium 210 MDC	pCi/L	0.3		0.2		0.2		0.3		0.3		0.2		0.2		0.2		0.2	
Radium 226	pCi/L	0.14	0.13	0.21	0.09	<0.1	0.1	<0.14	0.14	0.28	0.09	<0.14	0.14	<0.14	0.14	0.15	0.08	<0.14	0.14
Radium 226 precision (±)	pCi/L	0.1		0.09		0.06		0.08		0.1		0.08		0.09		0.08		0.06	
Radium 226 MDC	pCi/L	0.13		0.09		0.1		0.14		0.09		0.14		0.14		0.08		0.14	
Thorium 230	pCi/L	<0.05	0.05	<0.1	0.1	0.3	0.1	<0.06	0.06	0.2	0.1	<0.1	0.1	<0.08	0.08	<0.1	0.1	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.05		0.1		0.2		0.05		0.1		0.1		0.05		0.1		0.08	
Thorium 230 MDC	pCi/L	0.05		0.1		0.1		0.06		0.1		0.1		0.08		0.1		0.1	
METALS, SUSPENDED																			
Uranium	mg/L	0.0004	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	0.0017	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003
Uranium Activity	uCi/mL	2.90E-10	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	1.20E-09	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL - Analyte reporting limit.

Table 2.9-9 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:		BOW 2010-4A		BOW 2010-4A		BOW 2010-4A		BOW 2010-5		BOW 2010-5		BOW 2010-5		BOW 2010-6		BOW 2010-6		BOW 2010-6	
Date Collected:		4/5/2011		4/19/2011		5/3/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7	0.7	<1.9	1.9	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.4		1.1		0.5		0.4		0.5		0.5		0.4		0.5		0.5	
Lead 210 MDC	pCi/L	0.7		1.9		0.8		0.7		0.8		0.8		0.7		0.8		0.8	
Polonium 210	pCi/L	<1.1	1.1	<0.7	0.7	<0.5	0.5	<0.6	0.6	<0.6	0.6	<0.5	0.5	<0.5	0.5	<0.9	0.9	<0.6	0.6
Polonium 210 precision (±)	pCi/L	0.6		0.5		0.5		0.3		0.3		0.3		0.3		0.5		0.3	
Polonium 210 MDC	pCi/L	1.1		0.7		0.5		0.6		0.6		0.5		0.5		0.9		0.6	
Radium 226	pCi/L	<0.2	0.2	0.2	0.1	<0.1	0.1	0.36	0.15	0.41	0.11	<0.16	0.16	<0.13	0.13	0.34	0.11	<0.17	0.17
Radium 226 precision (±)	pCi/L	0.1		0.1		0.09		0.15		0.13		0.08		0.08		0.12		0.08	
Radium 226 MDC	pCi/L	0.2		0.1		0.1		0.15		0.11		0.16		0.13		0.11		0.17	
Thorium 230	pCi/L	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.1		0.09		0.09		0.06		0.07		0.09		0.08		0.06		0.1	
Thorium 230 MDC	pCi/L	0.2		0.2		0.1		0.1		0.1		0.1		0.1		0.1		0.1	
Uranium	mg/L	0.0095	0.0003	0.0053	0.0003	0.0061	0.0003	0.0061	0.0003	0.0075	0.0003	0.0076	0.0003	0.0052	0.0003	0.0055	0.0003	0.0058	0.0003
Uranium Activity	uCi/mL	6.40E-09	2.00E-10	3.60E-09	2.00E-10	4.10E-09	2.00E-10	4.10E-09	2.00E-10	5.10E-09	2.00E-10	5.20E-09	2.00E-10	3.60E-09	2.00E-10	3.70E-09	2.00E-10	3.90E-09	2.00E-10
RADIONUCLIDES-SUSPENDED																			
Lead 210	pCi/L	<1.1	1.1	<0.9	0.9	<1.1	1.1	<1.2	1.2	<0.9	0.9	<0.7	0.7	<1.2	1.2	<1.1	1.1	<0.7	0.7
Lead 210 precision (±)	pCi/L	0.7		0.5		0.6		0.7		0.5		0.4		0.7		0.6		0.4	
Lead 210 MDC	pCi/L	1.1		0.9		1.1		1.2		0.9		0.7		1.2		1.1		0.7	
Polonium 210	pCi/L	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.2	0.2
Polonium 210 precision (±)	pCi/L	0.08		0.1		0.1		0.1		0.1		0.1		0.2		0.2		0.08	
Polonium 210 MDC	pCi/L	0.2		0.2		0.3		0.3		0.2		0.2		0.2		0.3		0.2	
Radium 226	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.13	0.13	0.14	0.08	<0.15	0.15	<0.13	0.13	0.16	0.08	<0.13	0.13
Radium 226 precision (±)	pCi/L	0.07		0.05		0.07		0.08		0.08		0.06		0.08		0.08		0.05	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.13		0.08		0.15		0.13		0.08		0.13	
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.07	0.07	<0.1	0.1	<0.1	0.1	<0.05	0.05	<0.2	0.2	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.08		0.09		0.06		0.04		0.09		0.06		0.04		0.1		0.07	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.07		0.1		0.1		0.05		0.2		0.1	
METALS, SUSPENDED																			
Uranium	mg/L	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003
Uranium Activity	uCi/mL	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL = Analyte reporting limit.

Table 2.9-9 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:		BOW 2010-7		BOW 2010-7		BOW 2010-7		BOW 2010-8		BOW 2010-8		BOW 2010-8	
Date Collected:		4/5/2011		4/19/2011		5/3/2011		4/5/2011		4/19/2011		5/3/2011	
Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED													
Lead 210	pCi/L	<0.7	0.7	<0.9	0.9	<0.8	0.8	<0.7	0.7	<0.9	0.9	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.4		0.5		0.5		0.4		0.5		0.5	
Lead 210 MDC	pCi/L	0.7		0.9		0.8		0.7		0.9		0.8	
Polonium 210	pCi/L	<1.1	1.1	<0.6	0.6	<0.9	0.9	<1.1	1.1	<1.1	1.1	<0.6	0.6
Polonium 210 precision (±)	pCi/L	0.7		0.3		0.7		0.5		0.9		0.3	
Polonium 210 MDC	pCi/L	1.1		0.6		0.9		1.1		1.1		0.6	
Radium 226	pCi/L	<0.1	0.1	0.5	0.1	0.6	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.06		0.1		0.2		0.08		0.08		0.1	
Radium 226 MDC	pCi/L	0.1		0.1		0.2		0.2		0.1		0.1	
Thorium 230	pCi/L	<0.1	0.1	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.07		0.08		0.1		0.07		0.09		0.09	
Thorium 230 MDC	pCi/L	0.1		0.2		0.1		0.1		0.2		0.2	
Uranium	mg/L	0.0059	0.0003	0.0049	0.0003	0.0049	0.0003	0.0075	0.0003	0.007	0.0003	0.0069	0.0003
Uranium Activity	uCi/mL	4.00E-09	2.00E-10	3.30E-09	2.00E-10	3.30E-09	2.00E-10	5.00E-09	2.00E-10	4.70E-09	2.00E-10	4.70E-09	2.00E-10
RADIONUCLIDES-SUSPENDED													
Lead 210	pCi/L	<1.1	1.1	<0.9	0.9	<0.9	0.9	<1.1	1.1	<0.9	0.9	<0.9	0.9
Lead 210 precision (±)	pCi/L	0.7		0.6		0.5		0.7		0.5		0.5	
Lead 210 MDC	pCi/L	1.1		0.9		0.9		1.1		0.9		0.9	
Polonium 210	pCi/L	<0.2	0.2	0.5	0.2	<0.2	0.2	<0.2	0.2	<0.4	0.4	<0.2	0.2
Polonium 210 precision (±)	pCi/L	0.02		0.3		0.2		0.2		0.2		0.07	
Polonium 210 MDC	pCi/L	0.2		0.2		0.2		0.2		0.4		0.2	
Radium 226	pCi/L	0.6	0.1	0.3	0.1	0.2	0.1	0.3	0.1	<0.1	0.1	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.1		0.1		0.1		0.09		0.05		0.07	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1	
Thorium 230	pCi/L	0.2	0.1	0.2	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.3	0.1
Thorium 230 precision (±)	pCi/L	0.1		0.1		0.08		0.09		0.07		0.1	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1	
METALS, SUSPENDED													
Uranium	mg/L	0.0005	0.0003	0.0004	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003
Uranium Activity	uCi/mL	3.70E-10	2.00E-10	3.20E-10	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL - Analyte reporting limit.

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Table 2.9-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) – Chadron Wells

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Table 2.9-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) – Chadron Wells

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Table 2.9-12 Stream Gaging Stations on Niobrara River in Vicinity of Headwaters of Niobrara River

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Table 2.9-13 Summary of Niobrara River Flow Measurements 1999 - 2012

Stream Sampling Location	Flow (cubic feet per second [cfs])		
	Average Flow	Minimum Flow	Maximum Flow
Niobrara River at Wyoming State Line 06454000	3.03 (1.7 – 4.4)	2.4 (0.6 – 5.3)	4.2 (1.6 – 13.0)
Niobrara River at Agate 06454100 Stream flow data for 2006 – 2010.	10.5 (5.4 – 17.9)	8.1 (0.9 – 20.0)	14.0 (4.8 – 55.0)
Niobrara River above Box Butte Reservoir 06454500	19.6 (10.1 – 34.9)	14.5 (3.8 – 40.0)	28.3 (8.1 – 129)
Niobrara River below Box Butte Reservoir 06455500	14.5 (0.7 – 87)	3.8 (0.4 – 84.0)	29.7 (0.54 – 180.0)
Extremes for Period of Record and By Year (1999 – 2012)¹			
Peak Discharge			Drainage Area
Date	Flow ft ³ /sec	Gage Height feet	Square Miles
Niobrara River at Wyoming State Line (USGS 06454000)			455
3/06/2012	115	Information Not Available	7/11/2012 1.75
3/11/2011	451	Information Not Available	2/09/2011 2.32
12/31/2010	10.2	Information Not Available	10/01/2010 2.09
7/02/2009	11.2	4.56	9/12/2009 1.59
5/03/2008	18.0	4.80	8/28/2008 1.1
4/02/2007	7.1	3.34	7/25/2007
3/30/2006	7.5	3.22	8/24/2006 0.96
6/13/2005	13.0	4.38	7/23/2005 1.4
9/05/2004	21.0	3.61 ^c	9/02/2004 0.57
4/29/2003	8.6	3.10 ^f	8/22-23/2003 1.3
4/26/2002	12.0	2.94 ^g	8/17-18/2002 1.4
5/06/2001	11.0	2.76 ⁱ	9/05/2001 1.6
2/22/2000	21	3.69	9/18/2000 1.3
4/28/1999	9.9	2.37 ^j	9/15-16/1999 1.4
8/16/1977	2,120	8.28	8/09/1975 0.54

Table 2.9-13 Summary of Niobrara River Flow Measurements 1999 - 2012

Peak Discharge			Minimum Discharge	Drainage Area	
Date	Flow ft3/sec	Gage Height feet	Date	ft3/sec	Square Miles
Niobrara River at Agate (USGS 06454100) ^a					840
3/11/2012	35.8	Information Not Available	8/23/2012	1.08	
3/14/2011	223	Information Not Available	8/18/2011	3.32	
2/26/2010	278	Information Not Available	8/14/2010	3.7	
6/14/2009	63	6.18	12/27/2009	5.1	
3/04/2008	23	4.05	8/02-4/2008	3.0	
3/08/2007	20	4.02	5/29/2007	9.6	
7/02/2006	24.6	Information Not Available	2/25/2006	0.83	
12/29/2005	13.5	Information Not Available	11/28/2005	5.48	
2004	ND				
2003	ND				
2002	ND				
2001	ND				
1999	ND				
Niobrara River above Box Butte Reservoir (USGS 06454500)					1,400
1/12/2012	100	Information Not Available	9/02/2012	2.2	
2/01/2011	108	Information Not Available	7/21/2011	5.7	
12/31/2010	57.3	--	12/11/2010	6.3	
7/23/2009	187	5.78	8/21/2009	8.5	
7/09/2008	384	7.26	10/03/2008	8.0	
7/28/2007	41	4.18	7/26/2007	3.8	
11/28/2006	167	5.53 ^b	6/06-07/2006	6.7	
6/13/2005	80	4.41 ^c	5/29/2005	9.6	
3/09/2004	51	3.75 ^d	6/15-16/2004	6.2	
3/20/2003	43	3.58	8/15/2003	5.8	
3/29/2002	53	3.76 ^b	7/31 - 8/02/2002	4.1	
3/14/2001	52	3.79	7/08-09/2001	7.9	
7/11/2000	202	5.59	8/24/2000	8.7	
4/13/1999	45	3.63 ^k	8/13-30/1999	11.0	
7/28/1951	4,950	10.3	9/26/1953	1.6	
Niobrara River below Box Butte Reservoir (USGS 06455500)					460
7/20/2012	160	Information Not Available	5/18/2012	0.63	
7/14/2011	148	Information Not Available	10/30/2011	0.80	
12/31/2010	0.935	--	10/01/2010	0.72	
7/17/2009	157	4.29	11/05/2009	0.56	
7/30/2008	165	4.29	11/05-06/2008	0.56	

Table 2.9-13 Summary of Niobrara River Flow Measurements 1999 - 2012

Peak Discharge			Minimum Discharge	Drainage Area	
Date	Flow ft ³ /sec	Gage Height feet	Date	ft ³ /sec	Square Miles
7/15/2007	153	4.23	11/15-16/2007	0.40	
7/17/2006	164	4.26	8/23/2006	0.70	
7/24/2005	143	4.16	10/11/2005	0.63	
7/20/2004	152	4.20	9/12/2004	0.65	
7/16/2003	151	4.14	8/27/2003	0.47	
6/30/2002	170	4.32	9/02-07/2002	0.52	
7/02/1968	616	5.04	Many days in 1947 & 1951	0.1	
8/01/2001	148	4.26	9/27-30/2001	0.64	
7/09/2000	148	4.21	9/14/2000	0.75	
7/27/1999	195	4.43	10/01/1999	0.87	
Period of Record					
Niobrara River at Wyoming State Line (USGS 06454000)			1955 to Quarter 3 2012		
Niobrara River at Agate (USGS 06454100)			3 rd Quarter 2005 – Quarter 3 2012		
Niobrara River above Box Butte Reservoir (USGS 06454500)			Oct. 1946 to Quarter 3 2012		
Niobrara River below Box Butte reservoir (USGS 06455500)			Oct. 1946 to Quarter 3 2012		

^a Stream flow data for 2006 – 2010 in Table 2.9-14; Records are fair, except estimated records are poor.

^b Maximum gage height of 5.64 feet February 10 due to backwater from ice.

^c Maximum gage height of 4.66 feet January 05 due to backwater from ice.

^d Maximum gage height of 4.82 feet due to backwater from ice conditions.

^e Maximum gage height of 4.59 feet due to backwater from ice conditions.

^f Maximum gage height 3.34 feet February 3 due to backwater from ice conditions.

^g Maximum gage height of 3.56 feet due to backwater from ice conditions.

^h Maximum gage height of 4.67 feet on March 1 due to backwater from ice conditions.

ⁱ Maximum gage height of 3.01 feet December 16 due to backwater from ice conditions.

^j Maximum gage height of 2.64 feet from a high water mark.

^k Maximum gage height of 5.07 feet December 20 due to backwater from ice.

^l 2012 data is for Quarters 1 through 3; Quarter 4 data not yet available.

ND = No data

ft³/sec = cubic feet per second

USGS = U.S. Geological survey

Sources: NDNR. 2013.

Williams.2013

Table 2.9-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
cubic feet per second (cfs) - Mean												
Niobrara River at Wyoming State Line (USGS 06454000)												
1999												
Mean	4.03	4.40	5.08	6.85	5.02	5.48	3.24	1.95	2.47	2.94	3.44	3.64
Maximum	4.3	4.40	7.5	8.4	7.7	6.8	6.0	2.8	4.2	3.4	4.6	4.1
Minimum	3.5	3.9	4.2	5.3	3.9	4.1	2.3	1.4	1.6	2.7	2.8	3.2
2000												
Mean	3.66	5.12	5.94	6.79	5.51	3.00	1.97	1.77	1.80	2.54	3.09	2.85
Maximum	4.1	13.0	9.0	12.0	8.9	4.5	2.6	2.1	2.5	3.2	4.8	3.0
Minimum	3.3	3.4	4.8	4.4	4.1	2.5	1.5	1.5	1.3	2.3	2.7	2.6
2001												
Mean	3.08	3.26	5.50	6.07	4.68	3.11	2.36	1.78	2.03	2.56	3.37	3.20
Maximum	3.4	3.7	6.8	9.5	9.0	4.9	3.4	2.0	2.7	2.9	3.9	4.0
Minimum	2.9	2.9	3.6	4.9	3.2	2.5	1.9	1.6	1.6	2.0	2.8	2.7
2002												
Mean	3.36	3.54	3.77	5.09	3.63	2.64	1.98	1.54	1.94	1.86	2.54	3.17
Maximum	3.7	3.8	6.1	7.1	5.1	3.5	2.5	1.6	2.4	2.3	3.4	3.4
Minimum	2.6	3.2	3.2	4.2	3.0	2.0	1.6	1.4	1.5	1.5	1.4	2.9
2003												
Mean	3.23	3.52	4.56	4.66	4.41	3.03	1.87	1.58	2.37	2.45	2.6	2.65
Maximum	3.6	3.8	6.0	6.8	5.6	4.2	2.5	2.5	3.4	2.9	2.6	2.8
Minimum	2.9	3.3	3.5	3.9	3.7	2.3	1.5	1.3	2.0	2.4	2.6	2.6
2004												
Mean	2.85	3.08	3.79	3.12	2.81	1.72	2.18	1.40	2.17	2.6	3.0	3.3
Maximum	3.1	4.0	5.5	3.6	3.3	2.7	6.4	2.1	11.0	3.4	3.3	3.5
Minimum	2.7	2.5	2.0	2.5	2.5	1.1	1.2	0.83	0.57	2.1	2.6	3.0
2005												
Mean	2.9	3.4	3.5	3.4	3.1	3.1	2.1	2.2	1.8	2.0	3.0	2.7
Maximum	3.5	3.6	4.0	5.3	6.3	12.0	3.1	5.3	2.2	2.6	3.3	3.0
Minimum	2.5	3.2	3.2	2.7	2.4	1.8	1.4	1.5	1.5	1.4	2.6	2.2

Table 2.9-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
cubic feet per second (cfs) - Mean												
2006												
Mean	2.9	3.0	4.2	3.5	3.2	2.2	1.9	1.5	2.0	2.7	2.8	2.9
Maximum	3.3	4.3	6.7	5.5	4.2	4.3	4.1	3.0	3.1	3.0	3.2	3.3
Minimum	2.6	2.7	3.5	2.6	2.7	1.5	1.4	0.96	1.7	2.3	2.4	2.5
2007												
Mean	2.8	2.9	3.4	3.7	2.9	1.9	1.6	1.3	1.5	2.2	2.3	2.0
Maximum	3.4	3.5	5.3	6.2	3.1	2.2	2.8	1.7	1.9	2.7	2.8	2.3
Minimum	2.4	2.3	2.8	3.2	2.3	1.6	0.82	1.0	1.1	1.6	1.7	1.7
2008												
Mean	2.3	3.2	3.0	2.9	4.1	2.9	2.2	1.7	1.7	2.0	2.4	2.6
Maximum	3.0	4.1	4.2	4.1	6.9	4.9	2.8	2.6	2.5	2.5	2.8	3.2
Minimum	1.4	2.0	2.4	2.3	2.4	2.1	1.8	1.1	1.3	1.6	2.1	2.2
2009												
Mean	2.6	3.2	6.6	3.6	3.3	3.7	3.4	2.2	1.8	2.2	2.6	2.7
Maximum	3.7	3.8	12.0	4.6	4.5	4.9	6.7	2.5	2.0	1.9	2.5	2.6
Minimum	1.9	2.1	3.5	3.0	2.9	2.3	2.0	2.0	1.6	2.5	2.7	3.1
2010 ^a												
Mean	2.9	2.9	3.6	3.5	3.9	4.0	2.3	2.0	1.8	2.4	2.8	2.9
Maximum	3.0	4.5	4.6	3.7	4.6	7.4	2.9	2.1	2.1	2.11	2.7	2.8
Minimum	2.4	2.4	3.4	3.4	3.2	2.5	2.0	1.9	1.9	2.73	2.9	3.0
2011 ^a												
Mean	3.3	17.6	16.6	5.1	7.3	5.4	3.4	2.8	2.7	3.2	3.7	3.7
Maximum	4.5	136	142	5.7	11.4	8.1	4.5	2.9	2.8	3.6	3.8	3.9
Minimum	2.8	3.1	5.2	4.9	4.7	4.3	2.7	2.7	2.5	2.9	3.4	3.2
2012 ^{a, b}												
Mean	3.8	3.9	7.2	3.5	3.1	2.2	2.0	2.1	2.2	NA	NA	NA
Maximum	3.9	4.3	46.3	3.8	3.7	2.7	2.2	2.3	2.5	NA	NA	NA
Minimum	3.6	3.7	3.7	3.0	2.6	1.9	1.8	2.0	1.9	NA	NA	NA

Table 2.9-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
cubic feet per second (cfs) - Mean												
Niobrara River at Agate (USGS 06454100)												
2006												
Mean	13.0	13.6	19.0	14.7	9.3	5.9	6.0	4.1	6.0	6.1	9.5	9.9
Maximum	14.0	17.0	21.0	20.0	13.0	10.0	14.0	5.9	7.9	7.4	12.0	11.0
Minimum	11.0	0.9	17.0	12.0	5.1	3.8	2.1	3.0	4.5	5.1	5.7	8.2
2007												
Mean	9.7	9.6	14.7	13.3	8.3	6.2	3.4	4.1	5.5	6.8	8.3	7.7
Maximum	10.0	14.0	17.0	18.0	11.0	8.4	4.8	5.6	6.2	8.0	9.0	9.0
Minimum	9.0	8.0	11.0	11.0	6.1	2.9	2.2	2.8	4.7	6.0	7.0	7.0
2008												
Mean	7.0	8.1	14.8	10.9	9.4	10.8	5.4	4.9	7.8	8.0	8.8	7.1
Maximum	7.0	14.0	18.0	13.0	17.0	16.0	8.0	7.0	9.0	9.2	11.0	10.0
Minimum	7.0	7.0	13.0	7.0	6.0	8.0	4.0	3.0	6.0	6.8	7.0	5.1
2009												
Mean	6.2	10.1	15.3	19.6	12.1	21.2	9.9	8.1	8.6	14.1	15.4	10.2
Maximum	7.3	15.0	18.0	28.0	19.0	55.0	15.0	5.7	9.7	19.0	22.0	12.0
Minimum	5.2	7.3	15.0	15.0	5.3	9.4	6.5	11.0	7.4	10.0	11.0	11.0
2010 ^a												
Mean	10.7	12.1	25.7	24.1	20.5	17.5	8.5	5.8	6.6	8.7	11.3	12.7
Maximum	11.0	20.0	31.0	31.0	27.0	33.0	11.0	7.0	8.0	7.0	8.0	10.0
Minimum	10.0	11.0	20.0	19.0	11.0	8.0	7.0	4.0	6.0	12.0	14.0	15.0
2011												
Mean	12.6	22.9	32.3	18.2	24.8	14.8	7.5	5.9	7.2	10.4	14.3	11.6
Maximum	16	63	102	22	36	25	10	9	10	13.3	15.7	14.4
Minimum	10	12	20	16	17	9	6	4	6	6.86	12.4	10.1
2012 ^b												
Mean	9.6	6.2	11.6	6.2	3.7	3.5	2.5	2.9	3.6	N/A	N/A	N/A
Maximum	11.8	7.1	31.4	8.6	4.9	5.1	3.7	4.1	5.2	N/A	N/A	N/A
Minimum	7.2	5.3	6.9	4.8	2.3	2.1	2.0	1.6	2.6	N/A	N/A	N/A

Table 2.9-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
cubic feet per second (cfs) - Mean												
Niobrara River above Box Butte Reservoir (USGS 06454500)												
1999												
Mean	26.9	34.1	34.4	36.6	26.3	22.2	18.3	12.5	18.9	21.9	24.9	26.5
Maximum	30	39	37	43	37	31	26	17	22	25	28	29
Minimum	19	28	32	40	15	14	13	11	14	18	21	24
2000												
Mean	28.1	32.3	42.7	43.1	47.7	15.0	15.6	11.2	11.4	19.8	22.9	18.4
Maximum	31	40	60	65	74	24	44	17	15	33	29	22
Minimum	20	20	36	33	30	8.8	11	8.7	9.3	10	18	16
2001												
Mean	22.7	25.6	40.8	43.0	28.8	15.8	13.9	9.04	10.9	16.7	20.1	21.9
Maximum	28	28	48	48	47	22	28	11	14	19	22	24
Minimum	19	23	29	38	11	11	9.4	7.9	8.2	11	18	17
2002												
Mean	22.1	25.7	32.2	35.7	19.5	9.47	6.33	6.27	10.1	11.2	16.8	19.9
Maximum	25	32	47	45	31	11	8.7	8.1	15	14	21	22
Minimum	19	21	21	21	10	8.2	4.1	4.1	6.4	10	14	19
2003												
Mean	20.1	23.8	31.9	28.0	22.6	12.2	9.18	7.84	8.48	10.4	14.0	16.4
Maximum	23	26	41	39	31	15	12	9.5	9.7	12	15	18
Minimum	18	20	23	21	13	9.8	7.6	5.8	7.0	9.1	12	15
2004												
Mean	17.5	19.7	31.4	19.8	10.5	8.6	10.2	10.0	13.1	17.0	16.8	17.4
Maximum	19	37	46	26	16	15	14	16	16	18	18	18
Minimum	16	16	24	15	7.1	6.2	7.1	6.9	8.8	16	15	17
2005												
Mean	18.9	26.3	27.5	32.4	23.6	33.4	12.3	14.2	13.6	16.5	18.9	16.3
Maximum	24	28	30	49	43	72	17	17	15	19	23	21
Minimum	15	24	26	28	9.6	14	9.7	10	13	14	14	12

Table 2.9-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
cubic feet per second (cfs) - Mean												
2006												
Mean	19.9	22.8	35.9	29.0	15.6	11.0	9.6	8.1	10.1	11.1	15.0	13.6
Maximum	26	27	42	39	34	22	13	11	12	13	17	15
Minimum	12	19	23	11	10	6.7	8.1	6.9	8.7	10	11	13
2007												
Mean	15.9	18.4	26.8	22.9	13.4	8.3	8.4	6.4	6.7	9.4	10.8	10.9
Maximum	19	22	30	27	20	18	20	8.6	14	10	14	16
Minimum	14	15	22	19	7.8	4.2	3.8	4.5	5.4	8	9.9	10
2008												
Mean	11.2	12.4	25.2	27.6	24.0	16.0	13.5	9.0	10.9	11.3	14.4	11.8
Maximum	15	19	33	42	110	28	50	9	12	13	18	14
Minimum	9.7	11	20	10	13	12	10	9	9.8	9.7	13	9.6
2009												
Mean	12.5	16.4	24.2	57.1	24.5	28.0	29.6	14.7	13.4	23.2 ^a	29.2 ^a	20.7 ^a
Maximum	16	20	30	129	41	50	92	28	19	35 ^a	42 ^a	23 ^a
Minimum	9.8	13	21	28	9.8	9.3	11	8.5	9.3	14 ^a	21 ^a	16 ^a
2010 ^a												
Mean	15.8	13.9	52.1	43.5	43.0	41.2	18.8	11.7	9.8	13.1	22.4	22.2
Maximum	23	35	104	75	82	76	28	21	11	9.1	17.8	18.4
Minimum	13	9	36	28	23	14	12	8	9	22.3	27.0	26.0
2011 ^a												
Mean	17.9	20.9	49.5	36.8	48.4	34.7	12.5	10.7	12.1	16.1	12.3	26.4
Maximum	26.7	26	68.1	43.3	95.2	59	25.7	13	31.4	19	26.7	42.1
Minimum	12.7	14	37.4	32	26	24.7	7.23	6.99	6.88	12.6	2.26	21.3
2012 ^{a, b}												
Mean	27.4	24.6	40.1	27.5	11.2	7.5	5.8	5.7	5.8	N/A	N/A	N/A
Maximum	83.2	38.9	49.1	45.8	13.6	8.8	6.9	6.4	7.0	N/A	N/A	N/A
Minimum	15.2	17.4	23.5	12.3	8.4	6.9	5.2	5.0	3.3	N/A	N/A	N/A

Table 2.9-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
cubic feet per second (cfs) - Mean												
Niobrara River below Box Butte Reservoir (USGS 06455500)												
1999												
Mean	1.14	1.25	1.30	1.41	1.27	1.11	96.6	104	7.23	0.93	0.93	0.93
Maximum	1.2	1.4	1.4	1.7	1.4	1.3	180	128	89	1.0	1.0	.95
Minimum	1.1	1.1	1.2	1.3	1.2	1.0	1.0	64	0.95	0.85	0.86	0.87
2000												
Mean	0.94	0.99	1.15	1.22	1.23	13.7	116	84.5	3.55	0.74	0.79	0.72
Maximum	0.97	1.1	1.3	1.9	1.6	110	145	122	64	0.84	0.82	0.78
Minimum	0.90	0.93	1.1	1.1	1.1	1.1	84	61	0.75	0.70	0.75	0.67
2001												
Mean	0.71	0.70	0.74	0.79	0.87	0.79	83.1	105	14.4	0.65	0.66	0.66
Maximum	0.73	0.72	0.76	0.86	0.97	1.1	144	146	67	0.80	0.74	0.70
Minimum	0.67	0.70	0.72	0.72	0.82	0.72	0.76	68	0.64	0.60	0.64	0.64
2002												
Mean	0.71	0.69	0.74	0.79	0.78	18.9	121	57.4	0.59	0.54	0.56	0.54
Maximum	0.73	0.72	0.79	0.92	0.92	148	161	108	0.91	0.54	0.62	0.57
Minimum	0.64	0.66	0.70	0.76	0.73	0.70	76	0.53	0.52	0.52	0.54	0.52
2003												
Mean	0.53	0.56	0.60	0.71	0.72	0.71	96.9	77.3	0.86	0.77	0.75	0.74
Maximum	0.54	0.57	0.67	0.96	0.82	0.76	146	125	3.4	0.85	0.77	0.78
Minimum	0.52	0.54	0.57	0.64	0.67	0.67	0.63	0.47	0.49	0.72	0.71	0.70
2004												
Mean	0.77	0.77	0.82	0.88	0.84	0.86	71.8	65.9	2.21	0.71	0.71	0.72
Maximum	0.79	0.84	1.0	0.93	0.89	0.93	143	119	45	0.85	0.74	0.77
Minimum	0.74	0.74	0.73	0.85	0.77	0.76	0.87	0.75	0.65	0.63	0.66	0.69
2005												
Mean	0.76	0.79	0.82	0.93	0.95	1.0	76	76.3	13.1	0.77	0.79	0.83
Maximum	0.82	0.89	0.87	1.4	1.2	1.5	140	129	104	0.89	1.1	1.1
Minimum	0.69	0.72	0.79	0.83	0.79	0.94	0.88	0.87	0.69	0.74	0.74	0.79

Table 2.9-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
cubic feet per second (cfs) - Mean												
2006												
Mean	0.77	0.82	0.85	0.92	0.93	9.3	111.6	47	14.0	0.54	0.46	0.60
Maximum	0.84	1.1	0.87	1.0	1.1	69	158	109	77	0.61	0.58	0.64
Minimum	0.72	0.80	0.81	0.85	0.86	0.85	70	0.70	0.72	0.45	0.40	0.53
2007												
Mean	0.66	0.73	0.87	0.77	0.79	1.2	94.6	24.7	0.59	0.63	0.68	0.67
Maximum	0.80	0.83	1.0	0.87	0.86	9.7	147	127	0.62	0.69	0.79	0.80
Minimum	0.63	0.65	0.74	0.69	0.72	0.76	1.2	0.63	0.56	0.58	0.56	0.62
2008												
Mean	0.64	0.63	0.75	0.87	0.97	0.95	70.0	30.6	0.67	0.63	0.69	0.67
Maximum	0.68	0.69	0.83	0.94	1.2	1.1	157	140	0.84	0.74	0.80	0.78
Minimum	0.59	0.60	0.69	0.80	0.90	0.90	0.75	0.64	0.61	0.62	0.61	0.60
2009												
Mean	0.64	0.67	0.72	0.95	0.98	1.0	60.2	69.0	6.24	0.79 ^a	0.82 ^a	0.80 ^a
Maximum	0.69	0.68	0.80	1.3	1.1	1.2	135	132	29	0.9 ^a	0.85 ^a	0.93 ^a
Minimum	0.62	0.65	0.68	0.77	0.88	0.96	0.90	0.85	0.72	0.75 ^a	0.78 ^a	0.83 ^a
2010 ^a												
Mean	0.77	0.81	0.87	0.78	1.1	1.24	45.8	108.7	0.75	0.78	0.81	0.83
Maximum	0.79	0.86	0.89	1.41	1.2	1.88	165	165	0.96	0.74	0.78	0.80
Minimum	0.73	0.78	0.84	0.90	0.95	1.02	1.23	18.6	0.73	0.83	0.83	0.90
2011 ^a												
Mean	0.9	0.9	0.9	1.0	1.1	1.3	100	76.8	20	2.4	0.9	0.9
Maximum	0.9	0.9	1.0	1.1	2.1	2.3	138	115	109	31.2	0.9	0.9
Minimum	0.8	0.8	0.9	0.9	1.0	1.2	1.1	1.0	0.9	0.8	0.9	0.9
2012 ^{a, b}												
Mean	0.9	1.0	0.9	0.9	3.5	15.9	141.5	46.2	0.7	N/A	N/A	N/A
Maximum	0.9	1.0	1.1	1.0	30.8	88.7	157	142	0.8	N/A	N/A	N/A
Minimum	0.9	0.9	0.8	0.7	0.6	0.8	95.1	0.7	0.7	N/A	N/A	N/A

Notes:

^a Provisional data starting 10/01/2010 – no QA/QC by the NDNR at the time of posting (Williams 2013).

^b Data only available for January through September, 2013 (Williams 2013).

N/A = Not Available from NDNR (Williams 2013).

USGS = U.S. Geological Survey

NDNR = Nebraska Department of Natural Resources

QA/QC = quality assurance/quality control

Source: NDNR 2011a; Lindeman 2011; Williams 2013

Table 2.9-15 NDEQ 2002 Field Measurements of pH and Dissolved Oxygen for Station Number SNI4NIOBR402 (Niobrara River above Box Butte Reservoir)

Measurement Date/Time	Parameter	Result	Units
1/2/2002 12:40:00 PM	pH-Field	8.08	s.u.
1/3/2002 10:30:00 AM	pH-Field	8.06	s.u.
1/3/2002 12:14:00 PM	pH-Field	8.06	s.u.
1/7/2002 8:45:00 AM	Dissolved Oxygen (Winkler)	8.09	mg/L
1/8/2002 2:30:00 PM	pH-Field	8.1	s.u.
1/10/2002 2:35:00 PM	pH-Field	8.1	s.u.
2/5/2002 7:30:00 AM	pH-Field	8.05	s.u.
2/5/2002 3:15:00 PM	pH-Field	8.1	s.u.
2/5/2002 4:15:00 PM	pH-Field	8.0	s.u.
2/5/2002 4:30:00 PM	pH-Field	8.0	s.u.
3/4/2002 10:15:00 AM	pH-Field	8.0	s.u.
3/5/2002 10:45:00 AM	pH-Field	8.07	s.u.
3/5/2002 11:00:00 AM	pH-Field	8.08	s.u.
3/5/2002 12:35:00 PM	pH-Field	8.07	s.u.
3/7/2002 8:20:00 AM	pH-Field	8.09	s.u.
4/1/2002 10:45:00 AM	pH-Field	8.05	s.u.
4/3/2002 3:00:00 PM	pH-Field	8.09	s.u.
5/7/2002 8:36:00 AM	pH-Field	8.05	s.u.
5/7/2002 9:00:00 AM	pH-Field	8.01	s.u.
5/7/2002 10:30:00 AM	pH-Field	8.07	s.u.
5/7/2002 10:59:00 AM	pH-Field	8.05	s.u.
5/9/2002 11:00:00 AM	pH-Field	8.04	s.u.
6/11/2002 11:40:00 AM	Dissolved Oxygen (Winkler)	8.03	mg/L
6/12/2002 11:00:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
6/12/2002 11:30:00 AM	Dissolved Oxygen (Winkler)	8.09	mg/L
6/12/2002 1:35:00 PM	pH-Field	8.0	s.u.
6/17/2002	pH-Field	8.0	s.u.
6/18/2002 9:25:00 AM	pH-Field	8.07	s.u.
6/18/2002 9:51:00 AM	pH-Field	8.02	s.u.
7/8/2002 9:10:00 AM	Dissolved Oxygen (Winkler)	8.0	mg/L
7/9/2002 8:45:00 AM	pH-Field	8.07	s.u.
7/9/2002 5:15:00 PM	pH-Field	8.06	s.u.
7/9/2002 6:20:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/10/2002 2:15:00 PM	pH-Field	8.04	s.u.
7/16/2002 9:18:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/16/2002 12:50:00 PM	pH-Field	8.08	s.u.
7/16/2002 1:00:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/16/2002 1:00:00 PM	pH-Field	8.03	s.u.
7/18/2002 10:25:00 AM	pH-Field	8.06	s.u.
8/5/2002 2:45:00 PM	pH-Field	8.08	s.u.
8/6/2002 11:45:00 AM	pH-Field	8.06	s.u.
8/6/2002 12:00:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
8/7/2002 2:30:00 PM	Dissolved Oxygen (Winkler)	8.01	mg/L
9/3/2002 7:25:00 AM	pH-Field	8.0	s.u.
9/3/2002 11:45:00 AM	pH-Field	8.02	s.u.
9/3/2002 2:00:00 PM	pH-Field	8.05	s.u.
9/10/2002 11:45:00 AM	pH-Field	8.04	s.u.
9/11/2002 9:45:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
9/11/2002 10:15:00 AM	pH-Field	8.02	s.u.
10/7/2002 11:20:00 AM	pH-Field	8.04	s.u.
10/7/2002 1:00:00 PM	pH-Field	8.06	s.u.

Table 2.9-15 NDEQ 2002 Field Measurements of pH and Dissolved Oxygen for Station Number SNI4NIOBR402 (Niobrara River above Box Butte Reservoir)

Measurement Date/Time	Parameter	Result	Units
10/7/2002 1:45:00 PM	pH-Field	8.07	s.u.
10/7/2002 2:40:00 PM	pH-Field	8.0	s.u.
10/8/2002 12:00:00 PM	pH-Field	8.08	s.u.
11/4/2002 9:45:00 AM	pH-Field	8.02	s.u.
11/4/2002 11:00:00 AM	pH-Field	8.09	s.u.
11/5/2002 10:30:00 AM	pH-Field	8.01	s.u.
11/5/2002 2:30:00 PM	pH-Field	8.01	s.u.
11/5/2002 3:00:00 PM	pH-Field	8.05	s.u.
11/8/2002 8:45:00 AM	pH-Field	8.0	s.u.
12/2/2002 8:05:00 AM	pH-Field	8.09	s.u.
12/2/2002 9:15:00 AM	pH-Field	8.03	s.u.
12/2/2002 10:30:00 AM	pH-Field	8.04	s.u.
12/2/2002 12:20:00 PM	pH-Field	8.01	s.u.
12/2/2002 12:30:00 PM	pH-Field	8.06	s.u.
12/2/2002 1:30:00 PM	pH-Field	8.04	s.u.
12/2/2002 3:00:00 PM	pH-Field	8.06	s.u.
12/3/2002 10:00:00 AM	pH-Field	8.07	s.u.

Notes:

mg/L = milligrams per liter

NDEQ = Nebraska Department of Environmental Quality

s.u. = standard unit

Source: Ihrle 2013a

Table 2.9-16 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2002

Constituent	Unit	6/07/2002	7/08/2002	8/06/2002	9/03/2002	10/07/2002	11/04/2002	12/02/2002	RL
Major Ions									
Calcium, Dissolved	mg/L	ND	45.7	ND	ND	44.6	ND	ND	0.15
Chloride, Total	mg/L	4.01	3.90	4.09	4.05	4.44	4.88	4.97	0.15
Magnesium, Dissolved as Mg	mg/L	ND	7.65	ND	ND	7.79	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.059	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.95	1.03	0.84	0.80	1.22	1.37	1.23	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	0.059	<0.04	0.041	0.043	<0.04	0.046	<0.04	0.04
Sodium, Dissolved	mg/L	ND	23.2	ND	ND	23.3	ND	ND	0.15
Physical Properties									
Specific Conductance	µmhos/cm @25°C	367	244	369	368	361	397	410	N/A
Alkalinity, Total	mg/L	176	162	170	172	169	184	193	N/A
Chemical Oxygen Demand (COD)	mg/L	<12	<12	<12	<12	<12	<12	12.5	12
Dissolved Oxygen, Field	mg/L	9.31	7.89	9.4	10.46	9.73	12.66	12.06	N/A
pH, Field	s.u.	8.34	7.5	8.11	8.22	8.29	8.48	8.17	N/A
Suspended Solids, Total (TSS)	mg/L	9.5	14	11.5	5.5	18.5	33	20	N/A
Temperature, Water (Field)	°C	22.7	29	20.8	16.9	16.4	3.54	3.84	N/A
Turbidity, Lab	NTU	6.64	8.73	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	ND	ND	5.7	6.2	10.8	17	13.5	N/A
Metals									
Arsenic, Dissolved	ug/L	ND	<10	ND	ND	<10	ND	ND	10
Cadmium, Dissolved	µg/L	ND	<1	ND	ND	<1	ND	ND	1
Chromium, Dissolved	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Copper	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Lead, Dissolved	µg/L	ND	<5	ND	ND	<5	ND	ND	5
Mercury, Dissolved as Hg	µg/L	ND	<1	ND	ND	<1	ND	ND	1
Nickel, Dissolved	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Selenium, Total	µg/L	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	<1	ND	ND	<1	ND	ND	1

Table 2.9-16 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2002

Constituent	Unit	6/07/2002	7/08/2002	8/06/2002	9/03/2002	10/07/2002	11/04/2002	12/02/2002	RL
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow									
Gage Height	inches	3.07	3.0	3.0	3.02	3.11	3.18	3.29	N/A
Stream Discharge	cfs	ND	ND	ND	ND	ND	ND	ND	N/A

Source: Ihrie 2013a

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

umhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ = Nebraska Department of Environmental Quality

RL = reporting limit

Table 2.9-17 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2003

Constituent	Unit	Jan 13	Feb 1	Mar 7	Apr 8	May 5	Jun 9	Jul 7	Aug 5	Sept 8	Oct 6	Nov 3	Dec 1	RL
Major Ions														
Calcium, Dissolved	mg/L	58.2	ND	ND	54.7	ND	ND	46.3	ND	47.8	ND	ND	ND	0.15
Chloride, Total	mg/L	4.5	4.6	5.2	5.7	6.1	5.0	4.8	4.8	4.3	4.6	4.68	5.2	1.0
Magnesium, Dissolved	mg/L	9.18	ND	ND	10.3	ND	ND	7.99	ND	ND	8.28	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.08	0.05	0.05	<0.05	0.11	<0.05	0.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.34	1.26	1.26	0.48	0.59	0.76	0.97	1.00	1.11	1.14	1.18	1.13	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	0.53	0.56	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	<0.04	0.06	0.04	0.04	<0.04	0.05	0.08	0.07	0.04	0.06	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	23.4	ND	ND	25.2	ND	ND	24.6	ND	ND	24.6	ND	ND	0.15
Physical Properties														
Specific Conductance	µmhos/cm @25°C	400	377	402	429	440	388	374	343	ND	384	383	420	N/A
Alkalinity	mg/L	207	180	199	212	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	<12	<12	<12	20.3	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	12.19	11.52	11.69	9.72	9.57	8.65	8.27	8.06	ND	9.41	9.88	9.9	N/A
pH, Field	s.u.	8.2	7.76	8.17	8.36	8.37	8.45	8.1	8.2	ND	8.18	8.0	8.17	N/A
Suspended Solids, Total (TSS)	mg/L	9.0	23.5	13.0	18.5	20.0	12.5	35.0	36.0	12.0	22.5	5.0	8.0	N/A
Temperature, Water (Field)	°C	3.84	3.92	4.02	10.55	11.11	21.09	22.26	24.52	ND	10.49	4.17	3.76	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	6.01	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	0.2	16.1	6.6	10	12.4	10.5	24.8	41.9	ND	35.3	8.9	8.5	N/A
Metals, Dissolved														
Arsenic, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Cadmium, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1
Chromium, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Copper, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Lead, Dissolved	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Mercury, Dissolved as Hg	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1
Nickel, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1

Table 2.9-17 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2003

Constituent	Unit	Jan 13	Feb 1	Mar 7	Apr 8	May 5	Jun 9	Jul 7	Aug 5	Sept 8	Oct 6	Nov 3	Dec 1	RL
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	<10	ND	ND	<10	ND	ND	10
Stream Flow														
Gage Height	inches	3.25	3.35	3.3	3.49	3.33	ND	3.07	3.05	3.05	3.11	3.14	3.19	N/A
Stream Discharge	cfs	ND	27	23.3	39	25.5	13.6	10.3	9.04	9.44	11.8	13.6	16.3	N/A

Notes:

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

µmhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ = Nebraska Department of Environmental Quality

RL = reporting limit

Source: Ihrie 2013a

Table 2.9-18 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2004

Parameter	Unit	Jan 12	Feb 2	Feb 29	Apr 5	Apr 19	May 2	May 17	Jun 7	Jun 21	July 6	Jul 19	Reporting Limit
Major Ions													
Calcium, Dissolved	mg/L	51.3	ND	ND	55.6	ND	ND	ND	ND	ND	43.1	ND	0.15
Chloride, Total	mg/L	5.2	4.59	5.08	5.44	5.29	4.92	4.33	4.32	4.06	3.92	4.30	1
Magnesium, Dissolved as Mg	mg/L	9.3	ND	ND	11	ND	ND	ND	ND	ND	8.07	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	<0.05	<0.05	0.060	<0.05	<0.05	1.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.36	1.28	0.606	0.469	0.679	0.908	1.03	0.882	0.896	0.964	0.963	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	0.603	0.528	<0.5	0.635	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	<0.04	<0.04	0.073	0.045	<0.04	0.13	<0.04	<0.04	<0.04	0.053	<0.04	0.04
Sodium, Dissolved	mg/L	24.3	ND	ND	ND	ND	ND	ND	ND	ND	24.5	ND	0.15
Physical Properties													
Specific Conductance	µmhos/cm @25°C	408	408	345	377	364	359	314	345	364	348	336	N/A
Alkalinity	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	9.32	8.64	6.1	9.09	9.55	8.98	9.15	8.93	9.48	8.39	8.22	N/A
pH, Field	s.u.	8.05	7.59	7.8	8.15	8.26	8.48	8.43	8.35	8.3	8.19	8.11	N/A
Suspended Solids, Total (TSS)	mg/L	10.5	8.5	33	11.5	5	<5	5.5	<5	<5	23	19	5
Temperature, Water (Field)	°C	4.7	0.82	0.69	10.17	10.23	15.23	12.61	16.13	13.79	17	19.21	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	5.6	11.5	41.7	10.4	4.3	3.8	3.2	8.5	85.4	21.4	20.9	N/A
Metals, Dissolved													
Arsenic, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Cadmium, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Chromium, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Copper, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Lead, Dissolved	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Mercury, Dissolved as Hg	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Nickel, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Silver, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Zinc, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Stream Flow													
Gage Height	inches	ND	ND	3.5	3.38	3.27	3.22	ND	3.08	3.11	3.12	3.08	N/A
Stream Discharge	cfs	18.7	19.3	40	29.4	21.3	18.1	11.12	10.3	12.1	12.6	10.7	N/A

Table 2.9-18 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2004

Parameter	Concentration	Aug 1	Aug 16	Sept 6	Sept 20	Oct 4	Nov 2	Dec 6	Reporting Limit
Major Ions									
Calcium, Dissolved	mg/L	ND	ND	ND	ND	53	ND	ND	0.15
Chloride, Total	mg/L	4.24	4.64	6.52	5.25	4.82	5.34	5.13	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	ND	8.86	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.054	<0.05	0.070	<0.05	0.212	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.962	0.927	0.920	0.837	0.790	0.896	1.10	0.05
Nitrogen as N, Total Kjeldahl	mg/L	0.678	0.770	1.13	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	0.061	0.074	0.119	<0.04	<0.04	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	25	ND	ND	0.15
Physical Properties									
Specific Conductance	µmhos/cm @25°C	331	356	382	387	357	383	421	N/A
Alkalinity	mg/L	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	7.17	8.42	8.83	8.14	9.27	10.22	10.55	N/A
pH, Field	s.u.	8.18	7.96	7.09	7.17	8.03	8.05	7.77	N/A
Suspended Solids, Total (TSS)	mg/L	25	36	61.5	20	25.5	9	6.5	5
Temperature, Water (Field)	°C	26.45	16.45	14.98	16.46	10.21	3.96	1.67	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	4.23	N/A
Turbidity, Field	NTU	17.7	207	94.1	14.8	23.3	15.2	ND	N/A
Metals, Dissolved									
Arsenic, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Cadmium, Dissolved	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Chromium, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Copper, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Lead, Dissolved	µg/L	ND	ND	ND	ND	<5	ND	ND	5
Mercury, Dissolved as Hg	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Nickel, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Selenium, Total	µg/L	ND	ND	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Zinc, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Stream Flow									
Gage Height	inches	3.05	3.12	3.22	3.18	3.21	3.22	3.23	N/A
Stream Discharge	cfs	9.44	12.6	18.1	15.8	17.5	16.9	18.7	N/A

Notes:

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

umhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ = Nebraska Department of Environmental Quality

Source: Ihrie 2013a

Table 2.9-19 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2005

Parameter	Concentration	Jan 10	Feb 7	Mar 7	Apr 4	Apr 18	May 1	May 16	Jun 6	Jun 20	July 11	Jul 25	Reporting Limit
Major Ions													
Calcium	Suspended mg/L	49.8	ND	ND	52.3	ND	ND	ND	ND	ND	50.4	ND	0.15
Chloride, Total	mg/L	4.76	4.44	4.69	5.24	5.1	6.4	4.94	5.22	7.21	5.46	4.58	1
Magnesium, Dissolved as Mg	mg/L	9.14	ND	ND	10.7	ND	ND	ND	ND	ND	9.7	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	0.064	<0.05	<0.05	<0.05	0.173	<0.05	<0.05	0.089	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.279	0.670	0.431	0.393	0.427	0.330	0.297	0.323	0.194	0.658	0.917	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	0.637	0.680	0.672	0.804	1.102	0.598	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.047	0.054	0.708	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	23.8	ND	ND	26.1	ND	ND	ND	ND	ND	24.4		
Physical Properties													
Dissolved Oxygen, Field	mg/L	9.39	8.93	7.37	7.28	5.39	5.1	9.13	9.17	8.42	8.35	7.64	N/A
pH, Field	s.u.	7.81	7.84	7.5	8.12	8.21	8.26	8.24	8.06	8.33	8.14	7.94	N/A
Total Suspended Solids (TSS)	mg/L	7.0	10.5	8	5	<5	5	12.5	21	19.5	24	20	5
Specific Conductance, Field	µmhos/cm @25°C	360	381	404	416	428	470	432	454	347	340	368	N/A
Temperature, Field (Celsius)	°C	2.01	0.24	4.41	9.39	13.28	9.43	14.86	16.87	18.92	21.25	21.25	N/A
Turbidity, Lab	NTU	ND	ND	14.8	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	8	59.4	14.8	2.3	2.7	2.5	7.7	11.8	7.8	17.1	18.3	N/A
Metals, Dissolved													
Arsenic	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Cadmium	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Chromium	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Copper	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Lead	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Mercury	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Nickel	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Mercury	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Selenium	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Silver	Ug/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Zinc	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Stream Flow													
Gage height	inches	3.2	3.37	3.51	3.79	3.69	3.97	3.78	3.73	ND	ND	3.1	N/A
Stream discharge	cfs	16.9	28.6	40.6	58.6	50.9	68.1	56.2	53.2	0.351	16.3	11.6	N/A

Table 2.9-19 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2005

Parameter	Concentration	Aug 8	Aug 22	Sept 11	Sept 26	Oct 11	Nov 07	Dec 5	Reporting Limit
Major Ions									
	Suspended								
Calcium	mg/L	ND	ND	ND	ND	49.3	ND	ND	0.15
Chloride, Total	mg/L	4.30	5.28	5.26	4.91	6.79	4.49	4.95	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	ND	9.17	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.071	<0.05	<0.05	0.075	0.102	0.078	0.058	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.961	0.560	0.785	0.976	0.925	0.907	1.266	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	1.206	<0.5	<0.5	<0.5	1.130	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	0.047	0.050	0.048	<0.04	0.052	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	26.2	ND	ND	5
Physical Properties									
Dissolved Oxygen, Field	mg/L	7.98	7.9	8	9.1	9.32	10.15	10.57	N/A
pH, Field	s.u.	8.19	8.18	8	8.08	8.1	8.05	8.27	N/A
Total Suspended Solids, TSS	mg/L	21	40.5	30.5	27.5	21	17	6	5
Specific Conductance, Field	µmhos/cm @25°C	367	409	353	389	413	402	418	N/A
Temperature, Field (Celsius),	°C	18.41	17.97	22.47	10.16	9.04	6.35	-0.25	N/A
Turbidity, Lab	NTU	ND	ND	43.9	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	15.5	24.6	26.1	28.8	19.4	15.5	11.4	N/A
Metals, Dissolved									
Arsenic	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	<5	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Selenium	µg/L	ND	ND	ND	ND	<5	ND	ND	5
Silver	Ug/L	ND	ND	ND	ND	<1	ND	ND	1
Zinc	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Stream Flow									
Gage height	inches	3.1	3.2	3.2	3.21	3.27	3.27	4.0	N/A
Stream discharge	cfs	11.6	16.9	16.9	17.5	21.3	21	70	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
µmhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
Source: Ihrie 2013a

Table 2.9-20 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2006

Parameter	Unit	Jan 9	Feb 6	Mar 8	Apr 3	Apr 17	May 1	May 15	Jun 5	Jun 20	July 10	Aug 8	Reporting Limit
Major Ions, Suspended													
Calcium	mg/L	50.5	ND	ND	56.3	ND	ND	ND	ND	ND	44.8	ND	1
Chloride, Total	mg/L	4.90	4.50	14.83	6.31	5.17	5.30	3.61	3.75	3.42	4.09	4.14	1
Magnesium, Dissolved as Mg	mg/L	9.3	ND	ND	11.3	ND	ND	ND	ND	ND	8.09	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.065	0.195	0.053	0.091	<0.05	0.154	0.071	<0.05	0.058	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.005	1.063	0.379	0.257	0.301	0.165	0.468	0.544	1.012	0.997	1.012	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.50	<0.50	<0.50	0.581	0.652	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	0.045	0.04
Sodium, Dissolved	mg/L	24.4	ND	ND	34.3	ND	ND	ND	ND	ND	23.27	ND	5
Physical Properties													
Dissolved Oxygen, Field	mg/L	10.3	11.0	8.9	8.71	7.49	8.88	7.69	6.86	6.09	5.37	4.78	N/A
pH, Field	s.u.	7.48	7.94	8.01	7.83	8.05	8.08	8.18	8.24	8.39	7.98	8.22	N/A
Total Suspended Solids, TSS	mg/L	5	6	9	9.0	12.0	8.5	15.5	10.0	20.0	28.5	32.5	5
Specific Conductance, Field	µmhos/cm @ 25°C	359	361	394	407	439	423	405	360	345	329	362	N/A
Temperature, Field (Celsius)	°C	1.47	1.68	5.75	7	13.66	12.96	13.7	16.62	17.47	16.36	19.51	N/A
Turbidity, Field	NTU	6	14.2	7.7	6.3	6.8	5.3	ND	18.1	30	41.2	35.1	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	10.1	ND	ND	ND	ND	N/A
Metals, Dissolved													
Arsenic	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Cadmium	µg/L	<1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	<1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Mercury	µg/L	<1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Silver	µg/L	<1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Zinc	µg/L	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow													
Gage Height	inches	4.21	3.94	4.31	4.34	4.11	4.12	3.68	3.23	3.15	3.13	3.09	N/A
Stream discharge	cfs	85	66.2	92.5	94.8	ND	77.7	50.3	18.7	14.1	0.3	11.2	N/A

Table 2.9-20 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2006

Parameter	Unit	Aug 21	Sept 11	Sept 25	Oct 2	Nov 6	Dec 4	Reporting Limit
Major Ions, Suspended								
Calcium	mg/L	ND	ND	ND	47.5	ND	ND	0.15
Chloride	mg/L	4.25	4.49	3.84	4.09	4.41	5.14	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	8.2	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.050	0.064	0.081	<0.05	0.099	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N) (mg/L)	mg/L	1.130	1.153	1.30	1.220	1.166	1.376	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.50	0.664	<0.50	0.86	<0.50	<0.50	0.5
Phosphorus, Total as P	mg/L	<0.04	0.092	<0.04	<0.04	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	24.05	ND	ND	5
Physical Properties								
Dissolved Oxygen	mg/L	8.1	8.62	9.36	8.61	9.69	11.18	N/A
pH	s.u.	7.83	7.93	7.82	7.88	7.87	7.96	N/A
Total Suspended Solids, TSS	mg/L	30.5	25	31.5	32.5	31	7.0	5
Specific Conductance	µmhos/cm @ 25°C	357	340	363	355	390	404	N/A
Temperature, Celsius	°C	16.27	13.51	10.04	11.37	5.06	1.16	N/A
Turbidity, Field	NTU	27.2	28.5	30	25.9	28.5	24.8	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	
Metals, Dissolved								
Arsenic	µg/L	ND	ND	ND	<1	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	10
Mercury	µg/L	ND	ND	ND	ND	ND	ND	1
Selenium	µg/L	ND	ND	ND	<5	ND	ND	5
Silver	µg/L	ND	ND	ND	ND	ND	ND	1
Zinc	µg/L	ND	ND	ND	ND	ND	ND	10
Stream Flow								
Gage Height	inches	3.1	3.14	3.14	3.11	3.22	3.24	N/A
Stream discharge	cfs	11.6	13.6	13.6	12.1	18.1	19.3	N/A

Notes:

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

µmhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ = Nebraska Department of Environmental Quality

Source: Ihrie 2013a

Table 2.9-21 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2007

Parameter	Concentration	Jan 8	Feb 5	Mar 5	Apr 2	Apr 16	May 7	May 21	Jun 4	Jun 11	Jul 9	Reporting Limit
Major Ions, Suspended												
Calcium	mg/L	55.17	ND	ND	53.61	ND	ND	ND	ND	ND	ND	0.15
Chloride, Total	mg/L	4.98	ND	4.79	5.95	5.13	4.80	4.26	4.10	3.77	4.64	1
Magnesium, Dissolved as Mg	mg/L	9.51	ND	ND	10.63	ND	ND	ND	ND	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.10	<0.05	<0.05	0.05	<0.05	0.07	ND	<0.05	0.05	0.06	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.37	1.58	0.85	0.23	0.36	0.46	0.56	0.80	0.84	0.67	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	0.534	0.508	<0.5	<0.5	<0.5	0.77	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.050	0.217	<0.04	0.057	0.04
Sodium, Dissolved	mg/L	25.44	ND	ND	28.34	ND	ND	ND	ND	ND	ND	0.15
Physical Properties												
Dissolved Oxygen, Field	mg/L	9.8	9.5	9.6	9.6	9.1	ND	7.1	8.1	8.2	6.2	N/A
pH, Field	s.u.	7.73	7.3	7.2	7.75	7.95	ND	9.92	7.81	8.14	7.61	N/A
Total Suspended Solids, TSS	mg/L	<5	<5	<5	<5	<5	<5	<5	5	<5	25.5	5
Specific Conductance	µmhos/cm @ 25°C	385	372	338	416	419	ND	362	374	371	368	N/A
Temperature, Water (Field)	°C	1.5	0.2	1.0	8.6	9.5	ND	15.1	14.4	17.2	18.9	N/A
Turbidity, Field	NTU	8.2	23.5	29.9	0.9	14.3	ND	37.8	14.6	25.3	63.3	N/A
Metals, Dissolved												
Arsenic	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow												
Gage Height		3.88	4.63	5.25	5.56	4.49	ND	4.86	4.09	4.85	3.98	N/A
Stream Discharge		62.4	117.8	172.1	201.6	194.8	ND	137.1	76.3	136.3	68.7	N/A

Table 2.9-21 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2007

Parameter	Concentration	Jul 23	Aug 6	Aug 20	Sept 10	Sept 24	Oct 1	Nov 5	Dec 3	Reporting Limit
Major Ions, Suspended										
Calcium	mg/L	ND	48.84	ND	ND	ND	45.21	ND	ND	0.15
Chloride	mg/L	3.65	3.92	4.03	3.81	3.63	3.83	4.22	4.21	1
Magnesium, Dissolved as Mg	mg/L	ND	8.35	ND	ND	ND	7.94	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.23	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.88	0.93	0.96	1.12	1.08	1.12	1.21	1.38	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	0.056	<0.04	0.053	<0.04	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	23.87	ND	ND	ND	ND	22.32	ND	ND	0.15
Physical Properties										
Dissolved Oxygen, Field	mg/L	6.6	7.0	7.3	8.5	7.9	9.0	8.3	8.5	N/A
pH, Field	s.u.	7.74	7.76	7.84	7.38	7.66	7.38	7.36	7.63	N/A
Total Suspended Solids, TSS	mg/L	33.0	26.5	25.5	18.0	24.0	18.5	13.5	9.0	5
Specific Conductance	µmhos/cm @ 25°C	369	364	356	356	342	341	340	349	N/A
Temperature, Water (Field)	°C	19.7	19.6	18.4	11.6	12.9	10.6	5.5	2.0	N/A
Turbidity, Field	NTU	37.5	22.9	15.7	21.7	42.1	30.9	28.6	--	N/A
Metals, Dissolved										
Arsenic	µg/L	<10	ND	<10	ND	ND	<10	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	<5	ND	ND	<5	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow										
Gage Height	inches	3.68	3.53	3.72	3.09	3.00	3.04	3.04	10.7	N/A
Stream Discharge	cfs	50.3	41.7	37.2	11.2	7.5	9.0	9.0	10.7	N/A

Notes:

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

µmhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ – Nebraska Department of Environmental Quality

Source: Ihrie 2013a

Table 2.9-22 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2008

Parameter	Concentration	Jan 7	Feb 4	Mar 3	Apr 7	May 5	May 12	May 19	May 27	Jun 2	Jun 9	Reporting Limit
Major Ions, Suspended												
Calcium	mg/L	42.82	ND	ND	52.23	ND	ND	ND	ND	ND	ND	0.15
Chloride, Total	mg/L	4.47	3.95	5.01	5.12	4.81	6.59	4.81	4.41	6.33	4.54	1
Magnesium, Dissolved as Mg	mg/L	8.33	ND	ND	10.39	ND	ND	ND	ND	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.09	0.14	0.07	<0.05	0.08	<0.05	0.08	<0.05	0.06	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.34	1.4	0.64	0.31	0.72	0.3	0.44	0.53	0.51	0.36	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	0.77	0.53	<0.5	0.8	0.69	0.53	0.97	0.69	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	0.06	0.04	<0.04	0.05	0.06	<0.04	0.06	0.06	0.04
Sodium, Dissolved	mg/L	24.56	ND	ND	26.53	ND	ND	ND	ND	ND	ND	0.15
Physical Properties												
Dissolved Oxygen, Field	mg/L	11.43	11.23	11.71	9.63	9.39	9.38	8.44	9.78	8.25	9.38	N/A
pH, Field	s.u.	8.58	8.46	8.42	7.88	8.15	8.26	8.12	8.07	8.13	8.38	N/A
Total Suspended Solids, TSS	mg/L	17	6	37.5	16	6.5	27.5	22	14	38	14.5	5
Specific Conductance	µmhos/cm @ 25°C	396	328	334	395	356	410	100	374	471	464	N/A
Temperature, Water (Field)	°C	1.52	1.64	2.32	5	10.5	11.97	15.14	10.3	14.8	14.47	N/A
Turbidity, Field	NTU	ND	ND	ND	ND	13.6	10.6	9.2	11.3	27.7	13.2	N/A
Metals, Dissolved												
Arsenic	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow												
Gage Height	inches	3.12	3.09	3.51	3.53	3.28	3.36	3.19	3.22	3.20	3.2	N/A
Stream Discharge	cfs	12.6	11.2	40.6	41.7	78.2	27.8	16.3	18.1	16.9	16.9	N/A

Table 2.9-22 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2008

Parameter	Concentration	Jun 16	Jun 23	Jun 30	Jul 7	Jul 14	Jul 21	Jul 28	Aug 4	Aug 11	Aug 18	Reporting Limit
Major Ions, Suspended												
Calcium	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.15
Chloride, Total	mg/L	4.15	4.52	4.08	4.3	ND	ND	ND	ND	3.46	3.58	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.09	0.07	<0.05	<0.05	<0.05	ND	ND	ND	<0.05	0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.54	0.3	0.59	0.7	0.82	ND	ND	ND	ND	0.91	0.05
Nitrogen as N, Total Kjeldahl	mg/L	0.64	1.41	0.55	0.62	<0.5	ND	ND	ND	0.62	<0.5	0.5
Phosphorus, Total as P	mg/L	0.07	0.17	0.04	0.05	<0.04	ND	ND	ND	0.05	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.15
Physical Properties												
Dissolved Oxygen, Field	mg/L	8.91	8.53	8.45	8.10	8.23	7.71	7.69	7.84	8.14	8.50	N/A
pH, Field	s.u.	8.11	8.21	8.36	8.07	8.14	8.19	7.99	8.19	7.92	8.07	N/A
Total Suspended Solids, TSS	mg/L	30.5	177	38	45	26	ND	ND	ND	ND	41.5	5
Specific Conductance	µmhos/cm @ 25°C	539	503	489	393	391	378	458	456	490	502	N/A
Temperature, Water (Field)	°C	14.47	19.0	16.82	18.21	16.68	18.56	18.6	18.2	18.1	15.5	N/A
Turbidity, Lab, Field	NTU	13.3	117	83.8	39.6	48.2	34	34.5	39.7	32.7	28.7	N/A
Metals, Dissolved												
Arsenic	µg/L	ND	ND	<10	ND	ND	ND	ND	ND	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	ND	ND	<5	ND	ND	<5	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow												
Gage Height	inches	3.11	3.14	3.11	3.11	2.99	3.1	3.05	2.87	2.77	2.81	N/A
Stream Discharge	cfs	12.1	13.6	12.1	12.1	7.24	11.6	9.44	4.42	2.54	3.24	N/A

Table 2.9-22 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2008

Parameter	Concentration	Aug 25	Sept 1	Sept 8	Sept 15	Sept 22	Sept 29	Oct 6	Nov 3	Dec.01	Reporting Limit
Major Ions, Suspended											
Calcium	mg/L	ND	ND	ND	ND	ND	ND	44.43	ND	ND	0.15
Chloride	mg/L	4.31	4.32	5.19	4.75	ND	4.96	4.64	4.67	5.32	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	ND	ND	ND	7.91	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	0.08	<0.05	<0.05	ND	0.05	0.07	0.13	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.04	1.25	0.91	0.89	ND	0.98	1.01	1.06	1.01	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total as P	mg/L	0.04	0.04	<0.04	0.04	ND	0.04	0.13	0.06	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	23.87	ND	ND	0.15
Physical Properties											
Dissolved Oxygen, Field	mg/L	8.34	8.32	9.03	9.12	ND	9.17	8.92	6.29	ND	N/A
pH, Field	s.u.	7.79	8.14	8.17	8.37	ND	7.98	8.15	8.11	8.01	N/A
Total Suspended Solids, TSS	mg/L	35	14.5	23.5	15.5	ND	21.5	15.5	10	5.5	5
Specific Conductance	Umhos/cm @ 25°C	349	343	348	366	ND	363	352	359	374	N/A
Temperature, Water (Field)	°C	17.79	15.7	10.4	11	ND	10.5	12.2	8.7	1.48	N/A
Turbidity, Field	NTU	21.6	19	20.6	15.5	ND	35.4	122	9.5	5.3	N/A
Metals, Dissolved											
Arsenic	µg/L	ND	ND	ND	ND	ND	ND	5.41	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	ND	ND	ND	ND	ND	ND	<5	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow											
Gage Height	inches	2.76	3.49	3.78	3.5	ND	3.58	3.08	3.12	3.19	N/A
Stream Discharge	cfs	2.38	39	56.2	40	ND	41.7	10.7	14.7	16.3	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
umhos/cm = micromhos per centimeter
< = less than
ND = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
Source: Ihrie 2013a

Table 2.9-23 NDEQ Water Quality Data for the Niobrara River Above Box Butte Reservoir - 2009

Parameter	Concentration	Jan 5	Feb 2	Mar 2	Apr 6	Apr 7	May 4	Jun 2	Reporting Limit
Major Ions, Suspended									
Calcium	mg/L	48.96	ND	ND	ND	46.68	ND	ND	0.15
Chloride, Total	mg/L	4.56	4.30	4.41	ND	6.34	5.96	4.21	1
Magnesium, Dissolved	mg/L	8.60	ND	ND	ND	11.54	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	0.08	<0.05	ND	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.50	1.05	0.44	ND	0.41	0.16	0.39	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	ND	0.83	0.63	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	0.04	ND	<0.04	0.05	0.26	0.04
Sodium, Dissolved	mg/L	25.71	ND	ND	ND	40.55	ND	ND	ND
Physical Properties									
Dissolved Oxygen, Field	mg/L	ND	ND	6.85	3.34	ND	5.40	ND	N/A
pH, Field	s.u.	7.81	8.02	8.01	8.09	ND	ND	8.87	N/A
Total Suspended Solids, TSS	mg/L	8.5	8	<5	ND	18.5	<5	14.5	5
Specific Conductance	µmhos/cm @ 25°C	395	371	378	428	ND	465	409	N/A
Temperature, Water (Field)	°C	-0.22	0.44	3.01	-0.24	ND	9.68	13.65	N/A
Turbidity, Field	NTU	4.2	36.8	6.1	60	ND	2.7	10.6	N/A
Metals, Dissolved									
Arsenic	µg/L	5.69	ND	ND	ND	<10	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow									
Gage Height	inches	4.03	3.29	3.57	ND	ND	4.04	3.65	N/A
Stream Discharge	cfs	72.1	22.6	43.9	ND	ND	72.8	48.5	N/A

Table F.1-13 NDEQ Water Quality Data for the Niobrara River Above Box Butte Reservoir - 2009

Parameter	Concentration	Jul 21	Aug 10	Sept 8	Oct 5	Nov 2	Nov 3	Dec 7	Reporting Limit
Major Ions, Suspended									
Calcium	mg/L	53.07	ND	ND	ND	ND	ND	ND	0.15
Chloride, Total	mg/L	3.99	4.13	4.92	6.10	ND	7.35	5.57	1
Magnesium, Dissolved	mg/L	11.27	ND	ND	ND	ND	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.08	<0.05	<0.05	<0.05	ND	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.60	0.58	0.84	0.78	ND	0.34	0.87	0.05
Nitrogen as N, Total Kjeldahl	mg/L	1.03	0.75	<0.5	<0.5	ND	<0.5	<0.5	0.5
Phosphorus, Total as P	mg/L	0.08	0.10	0.05	0.05	ND	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	29.44	ND	ND	ND	ND	ND	ND	ND
Physical Properties									
Dissolved Oxygen, Field	mg/L	8.12	8.33	8.83	9.81	11.10	ND	11.94	N/A
pH, Field	s.u.	8.24	8.18	8.18	8.86	8.42	ND	8.23	N/A
Total Suspended Solids, TSS	mg/L	52	51.5	28	28.5	ND	22	12	5
Specific Conductance	µmhos/cm @ 25°C	431	383	363	377	424	ND	433	N/A
Temperature, Water (Field)	°C	17.8	16.58	17.53	7.84	5.51	ND	-0.25	N/A
Turbidity, Field	NTU	21.8	24.9	24.1	16.6	14.3	ND	34	N/A
Metals, Dissolved									
Arsenic	µg/L	7.26	ND	ND	ND	ND	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow									
Gage Height	inches	3.31	3.36	3.14	3.32	3.47	ND	4.12	N/A
Stream Discharge	cfs	24.0	27.8	13.6	24.8	37.2	ND	78.5	N/A

Source: Ihrie 2013a; Ihrie 2011. cfs = cubic feet per second µg/L = micrograms per liter mg/L = milligrams per Liter NTU = Nephelometric Turbidity Units s.u. = standard unit
 umhos/cm = micromhos per centimeter < = less than NA = No data N/A = not applicable ND = not detected NDEQ = Nebraska Department of Environmental
 Quality

Table 2.9-24 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2010

Constituent	Unit	Jan 4	Feb 1	Mar 1	Apr 5	May 3	Jun 7	Jul 19	Aug 3	Sept 7	Oct 11	Nov 1	Dec 6	RL
Major Ions														
Calcium, Dissolved	mg/L	53.75	ND	ND	52	ND	ND	48.1	ND	ND	43.2	ND	ND	0.15
Chloride, Total	mg/L	5.35	5.44	5.15	5.98	6.15	4.27	3.97	5.01	4.13	4.73	5.23	5.78	1.0
Magnesium, Dissolved	mg/L	10.12	ND	ND	<0.15	ND	ND	<0.15	ND	ND	8.0	ND		0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.196	<0.05	<0.05	0.0879	<0.05	<0.05	0.068	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.392	1.323	0.725	0.205	0.226	0.329	1.09	1.2	1.07	1.09	0.961	1.4	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.50	<0.50	1.734	0.607	0.778	1.02	1.15	1.08	<0.50	<0.50	0.518	<0.50	0.5
Phosphorus, Total	mg/L	<0.04	<0.04	0.201	<0.04	<0.04	0.074	0.179	0.183	<0.04	0.065	0.077	<0.04	0.04
Sodium, Dissolved	mg/L	26.97	ND	ND	25.8	ND	ND	25.3	ND	ND	22.3	ND	ND	0.15
Physical Properties														
Specific Conductance	µmhos/cm @25°C	385	385	297	458	353	ND	414	408	337	379	395	410	N/A
Alkalinity	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	12.14	9.97	9.56	10.48	10.83	ND	7.11	7.8	ND	11.47	11.31	11.21	N/A
pH, Field	s.u.	8.45	8.43	8.57	8.25	8.26	ND	8.19	8.27	8.46	8.59	8.65	8.43	N/A
Suspended Solids, Total (TSS)	mg/L	21	18	32	10	15	41.5	129	114	30	23.5	55.5	38.5	5
Temperature, Water (Field)	°C	0.96	0.82	1.62	5.72	10.92	ND	18.63	20.16	11.66	10.76	7.77	1.39	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	233	19.9	26.2	9.5	40.3	ND	ND	ND	ND	24.2	44	24.9	N/A
Metals, Dissolved														
Arsenic, Dissolved	µg/L	<10	ND	ND	4.98	ND	ND	7.19	ND	ND	5.47	ND	ND	10
Cadmium, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10

Table 2.9-24 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2010

Constituent	Unit	Jan 4	Feb 1	Mar 1	Apr 5	May 3	Jun 7	Jul 19	Aug 3	Sept 7	Oct 11	Nov 1	Dec 6	RL
Stream Flow														
Gage Height	inches	3.42	3.46	3.95	4.05	2.29	3.71	3.25	3.11	3.11	3.17	3.38	3.41	N/A
Stream Discharge	cfs	32.7	36.2	66.8	73.5	24.2	52	20	12.1	12.1	15.2	29.4	31.9	N/A

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

umhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ = Nebraska Department of Environmental Quality

RL = reporting limit

Source: Ihrie 2013a

Table 2.9-25 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2011

Constituent	Unit	Jan 3	Feb 14	Mar 6	Apr 11	May 3	Jun 6	Jul 18	Aug 1	Sept 6	Oct 3	Nov 7	Dec 5	RL
Major Ions														
Calcium, Dissolved	mg/L	49.2	ND	ND	49.6	ND	ND	45.6	ND	ND	46.5	ND	ND	0.15
Chloride, Total	mg/L	4.88	4.95	4.75	5.63	4.57	5.2	4.96	4.74	4.0	4.43	4.89	5.14	1.0
Magnesium, Dissolved	mg/L	9.2	ND	ND	9.67	ND	ND	8.26	ND	ND	8.0	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.070	0.066	0.094	<0.05	<0.05	<0.05	0.086	<0.05	<0.05	0.068	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.5	1.34	0.276	0.43	0.351	0.27	1.16	1.07	1.16	1.18	1.09	1.34	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.50	0.732	0.89	<0.50	<0.50	0.884	2.17	0.571	<0.50	<0.50	<0.50	<0.50	0.5
Phosphorus, Total	mg/L	<0.04	0.099	0.081	0.041	<0.04	0.071	0.45	0.090	0.045	0.048	<0.04	0.163	0.04
Sodium, Dissolved	mg/L	24	ND	ND	21.4	ND	ND	23.1	ND	ND	24.4	ND	ND	0.15
Physical Properties														
Specific Conductance	µmhos/cm @25°C	388	405	347	441	437	501	401	396	388	358	435	528	N/A
Alkalinity	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	8.94	10.94	12.78	12.62	13.06	7.61	6.9	10.31	10.2	10.24	12.43	12.92	N/A
pH, Field	s.u.	8.32	8.53	8.18	8.0	8.48	8.31	8.3	8.23	8.32	8.23	9.04	8.54	N/A
Suspended Solids, Total (TSS)	mg/L	11.5	77	59	36.5	16.5	49.5	297	61	34	36.3	32.5	57.5	5
Temperature, Water (Field)	°C	0.06	3.1	1.66	8.25	10.79	20.37	24.79	20.71	15.89	14.02	3.36	-0.26	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	17.5	34.6	29.4	20.7	12.1	36.5	193	61.4	29.9	36.9	22.9	12.6	N/A
Metals, Dissolved														
Arsenic, Dissolved	µg/L	5.81	ND	ND	6.46	ND	ND	7.33	ND	ND	5.57	ND	ND	10
Cadmium, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10

Table 2.9-25 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2011

Constituent	Unit	Jan 3	Feb 14	Mar 6	Apr 11	May 3	Jun 6	Jul 18	Aug 1	Sept 6	Oct 3	Nov 7	Dec 5	RL
Stream Flow														
Gage Height	inches	4.42	3.49	4.17	3.8	3.8	3.93	3.3	3.1	3.14	3.14	3.3	3.72	N/A
Stream Discharge	cfs	101	39	82.1	57.5	57.5	65.5	23.3	11.7	13.6	13.6	23.3	52.6	N/A

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

µmhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ = Nebraska Department of Environmental Quality

RL = reporting limit

Source: Ihrie 2013a

Table 2.9-26 Summary of NDEQ Non-Radiological Water Quality Data for Niobrara River Above Box Butte Reservoir 2003 - 2011

Constituent	Unit	Average Value	Minimum Value	Maximum Value	Total Observations	Number of Values Less Than RL	RL
Major Ions							
Calcium, Dissolved	mg/L	49.95	42.82	58.2	36	0	0.15
Chloride	mg/L	4.83	3.46	7.35	131	0	1.0
Magnesium, Dissolved	mg/L	8.92	<0.15	11.54	35	1	0.15
Nitrogen, Total Ammonia as N	mg/L	0.06	<0.05 ^a	1.05	150	90	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.85	0.16	1.58	146	0	0.05
Nitrogen as N, Total Kjeldahl	mg/L	0.44	0.5 ^a	2.17	151	100	0.5
Phosphorus, Total	mg/L	0.05	<0.04 ^a	0.71	152	78	0.04
Sodium, Dissolved	mg/L	25.5	21.4	40.6	35	0	0.15
Physical Properties							
Alkalinity	mg/L	184	162	212	13	--	--
Dissolved Oxygen	mg/L	8.85	3.34	12.9	139	--	--
Chemical Oxygen Demand (COD)	mg/L	7.9	<12 ^a	20.3	12	9	12
pH	s.u.	8.09	7.1	9.92	211	--	--
Specific Conductance	µmhos/cm @25°C	386	100	539	151	--	--
Suspended Solids, Total (TSS)	mg/L	24.7	<5 ^a	297	150	14	5.0
Temperature	°C	11.13	-0.26	29.0	142	--	--
Turbidity, Field	NTU	27.7	0.2	233	139	--	--
Metals, Dissolved							
Arsenic, Dissolved ^b	µg/L	5.93	<10 ^a	7.33	39	29	10
Cadmium, Dissolved	µg/L	<1	<1	<1	16	16	1
Chromium, Dissolved	µg/L	<10	<10	<10	16	16	10
Copper, Dissolved	µg/L	<10	<10	<10	16	16	10
Lead, Dissolved	µg/L	<5	<5	<5	16	16	5
Mercury, Dissolved as Hg	µg/L	<1	<1	<1	16	16	1
Nickel, Dissolved	µg/L	<10	<10	<10	16	16	10
Selenium, Total	µg/L	<5	<5	<5	39	39	5
Silver, Dissolved	µg/L	<1	<1	<1	16	16	1
Zinc, Dissolved	µg/L	<10	<10	<10	16	16	10
Stream Flow							
Gage Height	inches	3.5	2.3	10.7	144	--	--
Stream Discharge	cfs	36.3	0.35	201.6	142	--	--

Source: Ihrie 2013a RL = Reporting Limit cfs = cubic feet per second µg/L = micrograms per Liter mg/L = milligrams per Liter NTU = Nephelometric Turbidity Units
s.u. = standard unit µmhos/cm = micromhos per centimeter < = less than NDEQ = Nebraska Department of Environmental Quality

^a Value of one-half of Less Than Reporting Limit used for calculating average values.

^b Arsenic values were below the RL of 10 µg/L for 2002 – 2007, with detected values for years 2008 through 2011.

Revised December 2013

Table 2.9-27 NDEQ Water Quality Data for Niobrara River Below Box Butte Reservoir - 2008

Parameter	Concentration	May 12	May 19	May 27	Jun 2	Jun 9	Jun16	Jun 23	Jun 30	Jul 7	Jul 14	Aug 11	Aug 18	Aug 25	Sept 1	Sept 8	Sept 15	Sept 29	Reporting Limit
Major Ions, Suspended																			
Calcium	mg/L																		0.15
Chloride	mg/L	5.66	--	3.53	3.63	4.11	3.61	3.63	3.8	3.97	--	4.09	3.28	4.31	4.56	4.06	4.16	4.47	1
Magnesium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	ND	ND		--								1
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	<0.05	<0.05	0.1	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.16	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	<0.05	0.57	0.51	0.4	0.42	0.37	0.3	0.39	0.36	<0.05	--	0.9	0.93	0.91	0.7	0.85	0.82	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.51	<0.5	0.7	<0.5	0.73	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	ND	ND										
Physical Properties																			
Dissolved Oxygen, Field	mg/L	9.04	7.21	10.57	8.71	10.07	8.69	8.77	9.22	7.75	7.13	--	--	--	--	--	--	--	N/A
pH, Field	s.u.	8.04	8.05	8.15	8.17	8.33	-8.13	8.19	8.3	8.03	8.31	--	--	--	--	--	--	--	N/A
Total Suspended Solids, TSS	mg/L	5	<5	<5	8	<5	<5	6.5	<5	5.5	27.5	--	6.0	5.0	5.0	<5	<5	<5	5
Specific Conductance	µmhos/cm @ 25°C	408	312	325	357	380	440	431	434	360	348	--	--	--	--	--	--	--	N/A
Temperature, Water (Field)	°C	9.82	13.97	9.09	14.99	13.45	14.89	18.88	16.23	18.48	20.2	--	--	--	--	--	--	--	N/A
Turbidity, Field	NTU	1.0	4.5	4.5	9.8	2.6	39.1	17.1	5.9	55.9	20.4	--	--	--	--	--	--	--	N/A
Metals, Dissolved																			
Arsenic	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Selenium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Stream Flow																			
Gage Height	inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND								
Stream Discharge	cfs	0.9	0.9	1	1	1	0.9	0.9	0.9	0.9	127								

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
µmhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality

Source: Ihrie 2013a

Table 2.9-28 Summary of NDEQ Water Quality for Niobrara River Below Box Butte Reservoir 2008

Parameter	Minimum	Maximum
	mg/L	
Chloride	3.28	5.66
Nitrogen, Total Ammonia as N ^a	<0.05	0.16
Nitrogen, Total (Nitrate + Nitrite as N) ^b	<0.05	0.93
Nitrogen as N, Total Kjeldahl	<0.05	0.73
Phosphorus, Total ^c	<0.04	0.05
Suspended Solids, Total (TSS) ^d	<5.0	27.5

^a 15 of 17 measurements <0.05 mg/L

^b 14 of 17 measurements <0.05 mg/L

^c 15 of 17 measurements below <0.04 mg/L

^d 15 of 16 measurements below 8.0 mg/L

mg/L = milligrams per liter

NDEQ = Nebraska Department of Environmental Quality

**Table 2.9-29 Niobrara River Dissolved Radiological Water Quality Baseline Data
Collected by Crow Butte**

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
January 2011				
Lead 210	<0.8 U	0.8	<0.8 U	0.8
Lead 210 MDC	0.8	--	0.8	--
Lead 210 precision (±)	0.5	--	0.5	--
Polonium 210	<0.7 U	0.7	<0.7 U	0.7
Polonium 210 MDC	0.7	--	0.7	--
Polonium 210 precision (±)	0.5	--	0.4	--
Radium 226	1.3	0.16	1.3	0.14
Radium 226 MDC	0.16	--	0.14	--
Radium 226 precision (±)	0.25	--	0.24	--
Thorium 230	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	0.2	--	0.1	--
Thorium 230 precision (±)	0.1	--	0.05	--
Uranium Activity (uCi/ml)	5.9E-09	2.0E-10	5.1E-09	2.0E-10
Uranium (metal) (mg/l)	8.7E-03	3.0E-04	7.6E-03	3.0E-04
February 2011				
Lead 210	<1 U	1.2	<1 U	1.2
Lead 210 MDC	1.2	--	1.2	--
Lead 210 precision (±)	0.7	--	0.7	--
Polonium 210	0.8	0.5	<1 U	0.9
Polonium 210 MDC	0.5	--	0.9	--
Polonium 210 precision (±)	0.6	--	0.3	--
Radium 226	1.3	0.09	0.46	0.11
Radium 226 MDC	0.09	--	0.11	--
Radium 226 precision (±)	0.2	--	0.14	--
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2	--	0.2	--
Thorium 230 precision (±)	0.08	--	0.07	--
Uranium Activity (uCi/ml)	5.4E-09	2.0E-10	4.9E-09	2.0E-10
Uranium (metal) (mg/l)	7.9E-03	3.0E-04	7.3E-03	3.0E-04
March 2011				
Lead 210	<0.9 U	0.9	<0.9 U	0.9
Lead 210 MDC	0.9	--	0.9	--
Lead 210 precision (±)	0.5	--	0.5	--
Polonium 210	<0.6 U	0.6	<0.6 U	0.6
Polonium 210 MDC	0.6	--	0.6	--
Polonium 210 precision (±)	0.3	--	0.4	--
Radium 226	0.56	0.12	1	0.12

**Table 2.9-29 Niobrara River Dissolved Radiological Water Quality Baseline Data
Collected by Crow Butte**

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
Radium 226 MDC	0.12	--	0.12	--
Radium 226 precision (±)	0.15	--	0.19	--
Thorium 230	<0.3 U	0.3	<0.1 U	0.1
Thorium 230 MDC	0.3	--	0.1	--
Thorium 230 precision (±)	0.1	--	0.07	--
Uranium Activity (uCi/ml)	5.0E-09	2.0E-10	5.4E-09	2.0E-10
Uranium (metal) (mg/l)	7.4E-03	3.0E-04	8.0E-03	3.0E-04
April 2011				
Lead 210	<1.6	1.6	<0.8	0.8
Lead 210 MDC	1.6	--	0.8	--
Lead 210 precision (±)	1	--	0.5	--
Polonium 210	<0.6 U	0.6	<0.6 U	0.6
Polonium 210 MDC	0.5	--	0.6	--
Polonium 210 precision (±)	0.4	--	0.3	--
Radium 226	0.2	0.1	<0.1	0.1
Radium 226 MDC	0.1	--	0.1	--
Radium 226 precision (±)	0.09	--	0.04	--
Thorium 230	<0.2	0.2	<0.8	0.8
Thorium 230 MDC	0.2	--	0.8	--
Thorium 230 precision (±)	0.1	--	0.4	--
Uranium Activity (uCi/ml)	7.0E-09	2.0E-10	5.9E-09	2.0E-10
Uranium (metal) (mg/l)	1.04E-02	3.0E-04	8.8E-03	3.0E-04
May 2011				
Lead 210	<1.2 U	1.2	<1.2 U	1.2
Lead 210 MDC	1.2	--	1.2	--
Lead 210 precision (±)	0.7	--	0.7	--
Polonium 210	<0.6 U	0.6	<0.6 U	0.6
Polonium 210 MDC	0.6	--	0.6	--
Polonium 210 precision (±)	0.4	--	0.3	--
Radium 226	0.3	0.1	<0.2 U	0.2
Radium 226 MDC	0.1	--	0.2	--
Radium 226 precision (±)	0.1	--	0.08	--
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2	--	0.2	--
Thorium 230 precision (±)	0.1	--	0.1	--
Uranium Activity (uCi/ml)	5.8E-09	2.0E-10	5.0E-09	2.0E-10
Uranium (metal) (mg/l)	8.5E-03	3.0E-04	7.3E-03	3.0E-04

**Table 2.9-29 Niobrara River Dissolved Radiological Water Quality Baseline Data
Collected by Crow Butte**

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
June 2011				
Lead 210	<1.1 U	1.1	<1.1 U	1.1
Lead 210 MDC	1.1	--	1.1	--
Lead 210 precision (±)	0.6	--	0.7	--
Polonium 210	<0.4 U	0.4	<0.4 U	0.4
Polonium 210 MDC	0.4	--	0.4	--
Polonium 210 precision (±)	0.2	--	0.2	--
Radium 226	0.27	0.15	0.17	0.16
Radium 226 MDC	0.15	--	0.16	--
Radium 226 precision (±)	0.13	--	0.12	--
Thorium 230	<0.1 U	0.1	<0.3 U	0.3
Thorium 230 MDC	0.1	--	0.3	--
Thorium 230 precision (±)	0.04	--	0.2	--
Uranium Activity (uCi/ml)	1.2E-09	2.0E-10	3.3E-09	2.0E-10
Uranium (metal) (mg/l)	6.3E-03	3.0E-04	4.8E-03	3.0E-04
July 2011				
Lead 210	<0.8 U	0.8	<0.8 U	0.8
Lead 210 MDC	0.8		0.8	
Lead 210 precision (±)	0.5		0.5	
Polonium 210	<0.7U	0.7	<0.8 U	0.8
Polonium 210 MDC	0.7		0.8	
Polonium 210 precision (±)	0.4		0.6	
Radium 226	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.05		0.07	
Thorium 230	<0.1 U	0.1	<0.4 U	0.4
Thorium 230 MDC	0.1		0.4	
Thorium 230 precision (±)	0.08		0.2	
Uranium Activity (uCi/ml)	4.8E-09	2.0E-10	3.6E-09	2.0E-10
Uranium (metal) (mg/l)	7.1E-03	3.0E-04	5.3E-03	3.0E-04
August 2011				
Lead 210	<0.6 U	0.6	<0.6 U	0.6
Lead 210 MDC	0.6		0.6	
Lead 210 precision (±)	0.4		0.4	
Polonium 210	<0.4 U	0.4	<0.6 U	0.6
Polonium 210 MDC	0.4		0.6	
Polonium 210 precision (±)	0.2		0.2	
Radium 226	0.52	0.15	<0.14 U	0.14

**Table 2.9-29 Niobrara River Dissolved Radiological Water Quality Baseline Data
Collected by Crow Butte**

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
Radium 226 MDC	0.15		0.14	
Radium 226 precision (±)	0.15		0.1	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	0.07		0.08	
Uranium Activity (uCi/ml)	2.4E-10	2.0E-10	5.2E-09	2.0E-10
Uranium (metal) (mg/l)	4.0E-04	3.0E-04	7.7E-03	3.0E-04
September 2011				
Lead 210	<0.7 U	0.7	<0.7 U	0.7
Lead 210 MDC	0.7		0.7	
Lead 210 precision (±)	0.4		0.4	
Polonium 210	<0.4 U	0.4	<0.6 U	0.6
Polonium 210 MDC	0.4		0.6	
Polonium 210 precision (±)	0.2		0.5	
Radium 226	0.52	0.15	<0.14 U	0.14
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	0.2		0.1	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	0.07		0.06	
Uranium Activity (uCi/ml)	5.0E-09	2.0E-10	4.5E-09	2.0E-10
Uranium (metal) (mg/l)	7.3E-03	3.0E-04	6.6E-03	3.0E-04
October 2011				
Lead 210	<0.8 U	0.8	<0.8 U	0.8
Lead 210 MDC	0.8		0.8	
Lead 210 precision (±)	0.5		0.5	
Polonium 210	<0.9 U	0.9	3.2	0.6
Polonium 210 MDC	0.9		0.6	
Polonium 210 precision (±)	0.5		1.3	
Radium 226	1	0.1	0.1	0.09
Radium 226 MDC	0.1		0.09	
Radium 226 precision (±)	0.2		0.07	
Thorium 230	<0.3 U	0.3	<0.1 U	0.1
Thorium 230 MDC	0.3		0.1	
Thorium 230 precision (±)	0.1		0.07	
Uranium Activity (uCi/ml)	6.8E-09	2.0E-10	6.1E-09	2.0E-10
Uranium (metal) (mg/l)	1.0E-02	3.0E-04	9.0E-03	3.0E-04

**Table 2.9-29 Niobrara River Dissolved Radiological Water Quality Baseline Data
Collected by Crow Butte**

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
November 2011				
Lead 210	<1.0 U	1	<1.0 U	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	0.7		0.7	
Polonium 210	<0.5 U	0.5	4.6	0.5
Polonium 210 MDC	0.5		0.5	
Polonium 210 precision (±)	0.3		1.6	
Radium 226	1.2	0.1	0.2	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.2		0.1	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	0.08		0.09	
Uranium Activity (uCi/ml)	6.1E-09	2.0E-10	5.0E-09	2.0E-10
Uranium (metal) (mg/l)	9.0E-03	3.0E-04	7.5E-03	3.0E-04
January 2012				
Lead 210	<0.9 U	0.9	<0.9 U	0.9
Lead 210 MDC	0.9		0.9	
Lead 210 precision (±)	0.5		0.5	
Polonium 210	0.8	0.6	<0.6 U	0.6
Polonium 210 MDC	0.6		0.6	
Polonium 210 precision (±)	0.7		0.4	
Radium 226	1.7	0.1	0.2	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.3		0.1	
Thorium 230	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	0.1		0.2	
Thorium 230 precision (±)	0.06		0.06	
Uranium Activity (uCi/ml)	1.2E-09	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	1.8E-03	3.0E-04	<3.0E-04	3.0E-04

**Table 2.9-29 Niobrara River Dissolved Radiological Water Quality Baseline Data
Collected by Crow Butte**

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
February 2012				
Lead 210	< 1.0 U	1	50	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	NA		2.2	
Polonium 210	< 1.0 U	1	< 1.0 U	1
Polonium 210 MDC	1		1	
Polonium 210 precision (±)	NA		NA	
Radium 226	< 0.2 U	0.2	< 0.2 U	0.2
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	NA		NA	
Thorium 230	< 0.2 U	0.2	< 0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	NA		NA	
Uranium Activity (uCi/ml)	4.3E+00	2.00E-01	4.6E+00	2.00E-01
Uranium (metal) (mg/l)	6.4E-03	3.0E-04	6.8E-03	3.0E-04
March 2012				
Lead 210	1.7	1	< 1.0 U	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	0.6		NA	
Polonium 210	< 1.0 U	1	< 1.0 U	1
Polonium 210 MDC	1		1	
Polonium 210 precision (±)	NA		NA	
Radium 226	< 0.2 U	0.2	< 0.2 U	0.2
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	NA		NA	
Thorium 230	< 0.2 U	0.2	< 0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	NA		NA	
Uranium Activity (uCi/ml)	4.4E+00	2.00E-01	4.9E+00	2.00E-01
Uranium (metal) (mg/l)	6.5E-03	3.0E-04	7.2E-03	3.0E-04

Notes:

MDC = minimum detectable concentration

mg/l = milligrams per liter

pCi/l = picoCuries per liter

RL = reporting limit

U = Not detected at minimum detectable concentration

uCi/l = microCuries per liter

NA = Not Applicable, not detected below the RL

Table 2.9-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
January 2011				
Lead 210	<1.0 U	1	<1.1U	1.1
Lead 210 MDC	1	--	1.1	--
Lead 210 precision (±)	0.6	--	0.6	--
Polonium 210	<0.3 U	0.3	<0.3 U	0.3
Polonium 210 MDC	0.3	--	0.3	--
Polonium 210 precision (±)	0.1	--	0.1	--
Radium 226	<0.18 U	0.18	<0.13 U	0.13
Radium 226 MDC	0.18	--	0.13	--
Radium 226 precision (±)	0.08	--	0.07	--
Thorium 230	<0.2 U	0.2	<0.06 U	0.06
Thorium 230 MDC	0.2	--	0.06	--
Thorium 230 precision (±)	0.2	--	0.04	--
Uranium Activity (uCi/ml)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-07
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
February 2011				
Lead 210	1.4	1	<1 U	0.9
Lead 210 MDC	1	--	0.9	--
Lead 210 precision (±)	0.6	--	0.5	--
Polonium 210	<0.5 U	0.5	<0.2 U	0.2
Polonium 210 MDC	0.5	--	0.2	--
Polonium 210 precision (±)	0.2	--	0.2	--
Radium 226	<0.2 U	0.19	<0.2 U	0.19
Radium 226 MDC	0.19	--	0.19	--
Radium 226 precision (±)	0.13	--	0.08	--
Thorium 230	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1	--	0.1	--
Thorium 230 precision (±)	0.09	--	0.07	--
Uranium Activity (uCi/ml)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
March 2011				
Lead 210	<0.9 U	0.9	<0.9 U	0.9
Lead 210 MDC	0.9	--	0.9	--
Lead 210 precision (±)	0.5	--	0.5	--
Polonium 210	<0.2 U	0.2	0.3	0.2
Polonium 210 MDC	0.2	--	0.2	--
Polonium 210 precision (±)	0.1	--	0.3	--
Radium 226	<0.13 U	0.13	<0.13 U	0.13
Radium 226 MDC	0.13	--	0.13	--
Radium 226 precision (±)	0.06	--	0.06	--
Thorium 230	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1	--	0.1	--
Thorium 230 precision (±)	0.1	--	0.1	--
Uranium Activity (uCi/ml)	<2.0E-10	2.0E-10	3.4E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	5.0E-04	3.0E-04

Table 2.9-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
April 2011	No suspended analyses performed			
May 2011				
Lead 210	<1.1 U	1.1	<0.9 U	0.9
Lead 210 MDC	1.1	--	0.9	--
Lead 210 precision (±)	0.6	--	0.5	--
Polonium 210	<0.2 U	0.2	<0.2 U	0.2
Polonium 210 MDC	0.2	--	0.2	--
Polonium 210 precision (±)	0.2	--	0.1	--
Radium 226	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	0.1	--	0.1	--
Radium 226 precision (±)	0.06	--	0.04	--
Thorium 230	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1	--	0.1	--
Thorium 230 precision (±)	0.06	--	0.06	--
Uranium Activity (uCi/ml)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
June 2011				
Lead 210	<9.0 U	9	<0.8 U	0.8
Lead 210 MDC	9	--	0.8	--
Lead 210 precision (±)	5.3	--	0.5	--
Polonium 210	<0.2 U	0.2	<0.2 U	0.2
Polonium 210 MDC	0.2	--	0.2	--
Polonium 210 precision (±)	0.2	--	0.1	--
Radium 226	<0.13 U	0.13	<0.12 U	0.12
Radium 226 MDC	0.13	--	0.12	--
Radium 226 precision (±)	0.07	--	0.06	--
Thorium 230	0.07	0.05	<0.04 U	0.04
Thorium 230 MDC	0.05	--	0.04	--
Thorium 230 precision (±)	0.04	--	0.03	--
Uranium Activity (uCi/mL)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
July 2011				
Lead 210	0.7	0.5	<0.5 U	0.5
Lead 210 MDC	0.5		0.5	
Lead 210 precision (±)	0.3		0.3	
Polonium 210	<0.2 U	0.7	<0.2 U	0.2
Polonium 210 MDC	0.2		0.2	
Polonium 210 precision (±)	0.2		0.1	
Radium 226	<0.1 U	0.2	<0.1 U	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.06		0.09	
Thorium 230	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.08		0.08	

Table 2.9-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
Uranium Activity (uCi/mL)	3.6E-09	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	5.0E-04	3.0E-04	<3.0E-04	3.0E-04
August 2011				
Lead 210	<0.8 U	<0.8	<0.7 U	0.7
Lead 210 MDC	0.8	0.8	0.7	
Lead 210 precision (±)	0.5	0.5	0.4	
Polonium 210	0.4	0.4	<0.3 U	0.3
Polonium 210 MDC	0.2	0.2	0.3	
Polonium 210 precision (±)	0.3	0.3	0.2	
Radium 226	0.14	0.14	<0.08 U	0.08
Radium 226 MDC	0.08	0.08	0.08	
Radium 226 precision (±)	0.07	0.07	0.05	
Thorium 230	0.1	0.1	0.1	0.07
Thorium 230 MDC	0.05	0.05	0.07	
Thorium 230 precision (±)	0.05	0.05	0.05	
Uranium Activity (uCi/mL)	2.4E-10	2.0E-10	2.2E-10	2.0E-10
Uranium (metal) (mg/l)	4.0E-04	3.0E-04	3.0E-04	3.0E-04
September 2011				
Lead 210	<0.6 U	0.6	<0.6 U	0.6
Lead 210 MDC	0.6		0.6	
Lead 210 precision (±)	0.3		0.3	
Polonium 210	<0.2 U	0.2	0.3	0.2
Polonium 210 MDC	0.2		0.2	
Polonium 210 precision (±)	0.1		0.2	
Radium 226	0.1	0.1	0.1	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.06		0.06	
Thorium 230	0.2	0.1	0.2	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.1		0.1	
Uranium Activity (uCi/mL)	2.2E-10	2.0E-10	4.5E-09	2.0E-10
Uranium (metal) (mg/l)	3.0E-04	3.0E-04	6.6E-03	3.0E-04
October 2011				
Lead 210	<0.5 U	0.5	<0.9 U	0.9
Lead 210 MDC	0.5		0.9	
Lead 210 precision (±)	0.3		0.6	
Polonium 210	0.3	0.3	0.3	0.3
Polonium 210 MDC	0.3		0.3	
Polonium 210 precision (±)	0.2		0.3	
Radium 226	<0.06 U	0.06	0.08	0.06
Radium 226 MDC	0.06		0.06	
Radium 226 precision (±)	0.03		0.05	
Thorium 230	0.2	0.1	0.2	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.1		0.1	

Table 2.9-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
Uranium Activity (uCi/mL)	2.3E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	3.0E-04 B	3.0E-04	<3.0E-04	3.0E-04
November 2011				
Lead 210	<0.6 U	0.6	<0.7 U	0.7
Lead 210 MDC	0.6		0.7	
Lead 210 precision (±)	0.4		0.4	
Polonium 210	<0.4 U	0.4	<0.4 U	0.4
Polonium 210 MDC	0.4		0.4	
Polonium 210 precision (±)	0.2		0.3	
Radium 226	0.1	0.1	0.1	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.05		0.05	
Thorium 230	0.1	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.07		0.07	
Uranium Activity (uCi/mL)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
January 2012				
Lead 210	<0.7 U	0.7	<0.8 U	0.8
Lead 210 MDC	0.7		0.8	
Lead 210 precision (±)	0.4		0.5	
Polonium 210	<0.8 U	0.8	<0.8 U	0.8
Polonium 210 MDC	0.8		0.8	
Polonium 210 precision (±)	0.3		0.3	
Radium 226	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.05		0.07	
Thorium 230	<0.1 U	0.1	0.2	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.08		0.1	
Uranium Activity (uCi/mL)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04

Table 2.9-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
February 2012				
Lead 210	<1.0 U	1	<1.0 U	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	NA		NA	
Polonium 210	<1.0 U	1	<1.0 U	1
Polonium 210 MDC	1		1	
Polonium 210 precision (±)	NA		NA	
Radium 226	<0.2 U	0.2	<0.2 U	0.2
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	NA		NA	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	NA		NA	
Uranium Activity (uCi/mL)	<2.0E-01	2.0E-01	<2.0E-01	2.0E-01
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
March 2012				
Lead 210	1.7	1	2.1	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	0.6		0.5	
Polonium 210	<1.0 U	1	<1.0 U	1
Polonium 210 MDC	1		1	
Polonium 210 precision (±)	NA		NA	
Radium 226	<0.2 U	0.2	<0.2 U	0.2
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	NA		NA	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	NA		NA	
Uranium Activity (uCi/mL)	<2.0E-01	2.0E-01	<2.0E-01	2.0E-01
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04

Notes:

B = Analyte was detected in the method blank

U = Not detected at minimum detectable concentration

MDC = minimum detectable concentration

pCi/l = picoCuries per liter

RL = reporting limit

uCi/ml = microCuries per milliliter

NA = Not Applicable, not detected below the RL

Table 2.9-31 Niobrara River Non-Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte Group	Units	N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)	
		2/11/2011		5/16/2011		6/24/2011		8/12/2011		11/28/2011		1/13/2012		2/21/2012	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
Major Ions															
Alkalinity Total as CaCO3	mg/L	230	1	261	1	235	1	185	1	208	1	187	1	190	5
Bicarbonate as HCO3	mg/L	271	1	297	1	286	1	226	1	254	1	229	1	232	5
Carbonate as CO3	mg/L	5	1	10	1	<1	1	<1	1	<1	1	<1	1	<5	5
Calcium	mg/L	60	1	58	1	53	1	46	1	53	1	52	1	50	1
Chloride	mg/L	6	1	6	1	4	1	5	1	5	1	5	1	4	1
Fluoride	mg/L	0.7	0.1	0.8	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.6	0.1
Magnesium	mg/L	11	1	12	1	11	1	9	1	11	1	9	1	9	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.1	0.1
Nitrogen Nitrate+Nitrite as N	mg/L	1.4	0.1	0.2	0.1	0.4	0.1	1	0.1	1.1	0.1	1.5	0.1	1	0.1
Potassium	mg/L	8	1	10	1	8	1	6	1	8	1	8	1	8	1
Silica	mg/L	62.4	0.2	41.3	0.2	45.2	0.2	58.1	0.2	53.1	0.2	58.1	0.2	51	1
Sodium	mg/L	22	1	38	1	25	1	24	1	23	1	22	1	22	1
Sulfate	mg/L	13	1	12	1	10	1	13	1	15	1	13	1	11	1
Physical Properties															
Conductivity @ 25 C	umhos/cm	460	1	498	1	443	1	388	1	440	1	422	1	420	1
pH	s.u.	8.11	0.01	8.38	0.01	8.16	0.01	8.2	0.01	8.05	0.01	8.13	0.01	7.9	0.1
Solids Total Dissolved TDS @ 180 C	mg/L	315	10	335	10	313	10	262	10	276	10	252	10	290	10
Metals Dissolved															
Aluminum	mg/L	<0.1	0.1	0.2	0.1	<0.1	0.1	0.2	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.006	0.001	0.008	0.001	0.006	0.001	0.007	0.001	0.006	0.001	<0.001	0.001	0.005	0.001
Barium	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1
Boron	mg/L	<0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
Chromium	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Copper	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.1	0.1
Iron	mg/L	<0.03	0.03	0.2	0.03	0.07	0.03	0.27	0.03	0.04	0.03	<0.03	0.03	0.05	0.05
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.05	0.05
Manganese	mg/L	<0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01
Mercury	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Molybdenum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nickel	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Selenium	mg/L	<0.001	0.001	<0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	<0.001	0.001	<0.001	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.02	0.02
Zinc	mg/L	<0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.01	<0.01	0.01	<0.01	0.01
Data Quality															
A/C Balance (± 5)	%	-0.594	--	1.1	--	-2.06	--	-0.351	--	-0.0267	--	1.95	--	1.61	--
Anions	meq/L	5.16	--	5.69	--	5.07	--	4.21	--	4.73	--	4.31	--	4.26	--
Cations	meq/L	5.1	--	5.82	--	4.87	--	4.18	--	4.72	--	4.48	--	4.40	--
Solids Total Dissolved Calculated	mg/L	344	--	342	--	312	--	292	--	312	--	302	--	270	--

Notes:
meq/L = milliequivalents per liter
mg/L = milligrams per liter
ND = not detected
RL = reporting limit
s.u. = standard units
umhos/cm = micromhos per centimeter

Table 2.9-31 Niobrara River Non-Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte Group	Units	N2 (Niobrara River East Site)		N2 (Niobrara River East Site)		N2 (Niobrara River East Site)		N2 (Niobrara River East Site)		N2 (Niobrara River East Site)		N2 (Niobrara River East Site)		N2 (Niobrara River East Site)	
		2/11/2011		5/16/2011		6/24/2011		8/12/2011		11/28/2011		1/13/2011		2/21/2012	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
Major Ions															
Alkalinity Total as CaCO3	mg/L	223	1	253	1	253	1	180	1	184	1	211	1	179	5
Bicarbonate as HCO3	mg/L	262	1	290	1	308	1	219	1	224	1	257	1	218	5
Carbonate as CO3	mg/L	5	1	9	1	<1	1	<1	1	<1	1	<1	1	<5	5
Calcium	mg/L	57	1	56	1	54	1	48	1	49	1	57	1	47	1
Chloride	mg/L	5	1	5	1	5	1	5	1	5	1	6	1	4	1
Fluoride	mg/L	0.7	0.1	0.8	0.1	0.8	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.6	0.1
Magnesium	mg/L	10	1	12	1	12	1	9	1	9	1	10	1	8	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<1	0.05	<0.05	0.05	<0.1	0.1
Nitrogen Nitrate+Nitrite as N	mg/L	1.2	0.1	<0.1	0.1	<0.1	0.1	0.9	0.1	1.3	0.1	1.6	0.1	1	0.1
Potassium	mg/L	7	1	9	1	11	1	7	1	7	1	9	1	7	1
Silica	mg/L	59.1	0.2	41.6	0.2	48.4	0.2	64.8	0.2	58.6	0.2	63	0.2	49	1
Sodium	mg/L	20	1	36	1	29	1	24	1	23	1	23	1	21	1
Sulfate	mg/L	12	1	12	1	9	1	13	1	14	1	17	1	12	1
Physical Properties															
Conductivity @ 25 C	umhos/cm	437	1	478	1	481	1	387	1	406	1	475	1	398	1
pH	s.u.	7.91	0.01	8.3	0.01	7.84	0.01	8.21	0.01	8.16	0.01	7.92	0.01	7.90	1
Solids Total Dissolved TDS @ 180 C	mg/L	302	10	326	10	334	10	258	10	275	10	300	10	270	10
Metals Dissolved															
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.3	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.005	0.001	0.006	0.001	0.006	0.001	0.007	0.001	0.006	0.001	0.006	0.001	0.005	0.001
Barium	mg/L	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.1
Boron	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	0.1
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.105	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
Chromium	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Copper	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.1	0.1
Iron	mg/L	0.04	0.03	0.08	0.03	0.04	0.03	0.3	0.03	0.03	0.03	0.04	0.03	<0.05	0.05
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	<0.05	0.05
Manganese	mg/L	0.02	0.01	<0.01	0.01	0.04	0.01	0.06	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01
Mercury	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Molybdenum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nickel	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Selenium	mg/L	0.002	0.001	<0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001	<0.001	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.02	0.02
Zinc	mg/L	<0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Data Quality															
A/C Balance (± 5)	%	-2.5	--	0.802	--	-1.79	--	2.51	--	2.19	--	0.624	--	1.03	--
Anions	meq/L	4.95	--	5.5	--	5.42	--	4.11	--	4.22	--	4.9	--	4.03	--
Cations	meq/L	4.71	--	5.58	--	5.23	--	4.32	--	4.41	--	4.96	--	4.11	--
Solids Total Dissolved Calculated	mg/L	325	--	330	--	334	--	300	--	298	--	333	--	260	--

Notes:
MDC = Minimum detectable concentration
pCi/L - picocuries per liter
RL = reporting limit
mg/L = milligrams per liter
meq/L = milliequivalents per liter
s.u. = standard units
umhos/cm = micromhos per centimeter

Table 2.9-32 Summary of Radiological Baseline Data for Niobrara River Near Marsland Expansion Area Collected by Crow Butte

Analyte	Concentration (pCi/L) ^a		Non-Detection Frequency ^b	Non-Detection Value ^c	
	Minimum	Maximum		Minimum	Maximum
NIORARA RIVER UPGRADIENT SAMPLING POINT N-1					
Dissolved Radiological Analytes					
Lead 210	<0.6	1.7	13/14	0.6	1.6
Polonium 210	<0.4	0.8	12/14	0.4	0.9
Radium 226	<0.1	1.7	3/14	0.09	0.16
Thorium 230	<0.1	<0.3	14/14	0.1	0.3
Uranium Activity μ(Ci/ml)	2.4E-10	4.4E+00	0/14	2.0E-10	2.0E-01
Uranium (mg/L)	4.0E-04	1.04E-02	0/14	3.0E-04	3.0E-04
Suspended Radiological Analytes					
Lead 210	<0.5	<9.0	10/13	0.5	9.0
Polonium 210	<0.2	0.4	10/13	0.2	1.0
Radium 226	<0.06	0.14	10/13	0.06	0.2
Thorium 230	<0.1	0.2	9/13	0.05	0.2
Uranium Activity (μCi/ml)	<2.0E-10	3.6E-09	9/13	2.0E-10	2.0E-01
Uranium (mg/L)	<3.0E-04	5.0E-04	10/13	3.0E-04	3.0E-04
NIORARA RIVER DOWNGRADIENT SAMPLING POINT N-2					
Dissolved Radiological Analytes					
Lead 210	<0.6	50	13/14	0.6	1.2
Polonium 210	<0.4	4.6	12/14	0.4	0.9
Radium 226	<0.1	1.3	7/14	0.09	0.2
Thorium 230	<0.1	<0.8	14/14	0.1	0.8
Uranium Activity (μCi/ml)	<2.0E-10	4.9E+00	1/14	2.0E-10	2.0E-01
Uranium (mg/L)	<3.0E-04	9.0E-03	1/14	3.0E-04	3.0E-04
Suspended Radiological Analytes					
Lead 210	<0.5	2.1	12/13	0.5	1.1
Polonium 210	<0.2	0.3	10/13	0.2	1.0
Radium 226	<0.08	0.1	10/13	0.01	0.2
Thorium 230	<0.04	0.2	9/13	0.04	0.2
Uranium Activity (μCi/ml)	<2.0E-10	4.5E-09	10/13	2.0E-10	2.0E-01
Uranium (mg/L)	<3.0E-04	6.6E-04	10/13	3.0E-04	3.0E-04

^a Unless noted otherwise. Individual analytical results with RLs are presented in Tables 2.9-29 and 2.9-30.

^b Number of samples with values less than the Non-Detection Limit; 5/6 = five of six samples with values below the detection limit.

^c The minimum and maximum non-detection values for all samples during that testing period.

mg/L = milligrams per liter

pCi/L = picoCuries per liter

µCi/ml = microCuries per milliliter

Table 2.9-33 Summary of Non-Radiological Baseline Data for Niobrara River Near Marsland Expansion Area Collected by Crow Butte

Analytes	Units	Crow Butte Niobrara River Sampling Locations			
		N-1		N-2	
		Minimum	Maximum	Minimum	Maximum
Alkalinity	mg/L	185	261	179	253
Bicarbonate	mg/L	226	297	218	308
Carbonate	mg/L	<1	10	<1	9
Conductivity @ 25° C	µmhos/cm	388	498	387	481
Calcium	mg/L	46	60	47	57
Chloride	mg/L	4	6	4	6
Fluoride	mg/L	0.6	0.8	0.6	0.8
Magnesium	mg/L	9	12	8	12
Nitrogen Ammonia as N	mg/L	<0.05	<0.1	<0.05	<1.0
Nitrogen Nitrate-Nitrite as N	mg/L	0.2	1.5	<0.1	1.6
Potassium	mg/L	6	10	7	11
Silicia	mg/L	41.3	62.4	41.6	64.8
Sodium	mg/L	22	38	20	36
Sulfate	mg/L	10	15	9	17
pH	s.u.	7.90	8.38	7.84	8.3
Total Dissolved Solids @ 180° C	mg/L	252	335	258	334
Dissolved Metals	The majority of parameters were measured at or below the RL (see Table 2.9-28.				

Individual analytical results with RLs are presented in Table 2.9-31.

s.u. = standard unit

mg/L = milligrams per liter

RL = Reporting Limit

µmhos/cm = micromhos per centimeter

Table 2.9-34 Daily Contents in Acre-Feet of Water for Box Butte Reservoir (USGS 06455000)– 2003 to August 2013

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
Acre-feet												
2003												
Mean	8,489	9,899	11,053	12,365	13,503	13,380	11,134	5,236	4,151	4,841	5,587	6,376
Minimum	7,740	9,449	10,394	11,743	12,775	11,865	7,922	3,517	3,848	4,455	5,209	5,992
Maximum	9,390	10,359	11,818	13,167	14,000	14,588	14,051	7,805	4,434	5,176	5,974	6,950
2004												
Mean	7,182	8,138	9,232	9,969	11,743	11,610	9,468	4,779	4,018	5,142	6,205	7,266
Minimum	6,856	7,755	8,586	8,965	10,822	11,537	6,890	2,803	3,460	4,604	5,730	6,745
Maximum	7,683	8,775	9,976	11,158	11,865	11,715	11,658	7,137	4,566	5,695	6,712	7,769
2005												
Mean	8,285	9,482	10,710	12,018	13,504	14,668	12,782	7,578	5,691	6,752	7,668	8,662
Minimum	7,805	8,878	10,140	11,361	12,912	13,970	9,660	5,678	5,270	6,053	7,143	8,188
Maximum	8,839	10,089	11,324	12,872	13,949	15,158	15,137	9,593	6,035	7,110	8,151	9,169
2006												
Mean	9,811	10,956	12,473	14,207	14,968	14,703	9,481	4,465	3,891	4,084	4,497	4,815
Minimum	9,202	10,429	11,537	13,555	14,715	13,687	5,962	3,522	3,599	3,834	4,096	4,588
Maximum	10,385	11,500	13,475	14,683	15,094	14,936	13,535	5,968	4,366	4,229	4,802	5,081
2007												
Mean	5,381	6,102	6,791	--	--	11,312	7,073	3,603	3,830	4,311	4,912	5,559
Minimum	5,065	5,760	6,583	--	--	11,090	3,809	2,352	3,628	4,054	4,631	5,215
Maximum	5,730	6,524	7,063	--	--	11,445	11,213	4,721	4,019	4,609	5,192	5,895
2008												
Mean	5,019	5,570	6,636	7,923	9,034	9,502	7,200	4,212	4,308	4,699	5,474	6,130
Minimum	4,759	5,293	5,970	7,306	8,415	9,278	4,677	3,608	4,039	4,546	5,125	5,821
Maximum	5,275	5,914	7,272	8,361	9,220	9,572	9,563	4,999	4,536	4,875	5,797	6,375
2009												
Mean	6,682	7,375	8,360	10,159	11,859	12,619	11,155	7,021	6,273	7,029	8,508	9,733
Minimum	6,394	7,020	7,816	8,992	11,398	12,174	7,852	5,177	6,158	6,466	7,794	9,204
Maximum	7,000	7,765	8,943	11,313	12,095	12,950	13,512	8,562	6,446	7,743	9,171	10,213

Table 2.9-34 Daily Contents in Acre-Feet of Water for Box Butte Reservoir (USGS 06455000)– 2003 to August 2013

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
Acre-feet												
2010												
Mean	10,650	11,550	13,893	16,421	18,491	20,587	20,265	13,904	11,666	12,048	12,884	13,938
Minimum	10,240	11,096	12,363	15,293	17,669	19,479	16,939	11,303	11,560	11,782	12,403	13,396
Maximum	11,068	12,293	15,180	17,644	19,440	21,432	21,500	18,366	11,782	12,373	13,344	14,523
2011												
Mean	14,909	15,942	18,007	20,264	22,174	24,478	21,075	14,939	12,694	13,044	13,860	15,278
Minimum	14,512	15,407	16,569	19,427	21,147	23,930	17,546	12,695	12,164	12,644	13,470	15,090
Maximum	15,384	16,510	19,349	21,120	23,844	24,927	24,942	16,819	12,868	13,428	14,304	15,464
2012												
Mean	15,973	17,002	18,440	19,820	20,026	18,998	11,713	6,090	6,211	6,680	7,311	7,969
Minimum	15,498	16,486	17,620	19,284	19,739	17,424	7,445	5,275	6,057	6,394	7,007	7,650
Maximum	16,463	17,583	19,272	20,291	20,318	19,726	16,939	7,142	6,388	6,986	7,628	8,308
2013												
Mean	8,648	9,329	10,229	11,497	12,336	12,965	12,412	6,541	5,295	ND	ND	ND
Minimum	8,338	9,000	9,699	10,837	5,322	12,960	8,855	5,209	5,121	ND	ND	ND
Maximum	8,976	9,673	10,800	12,393	12,981	12,971	12,971	8,280	5,977	ND	ND	ND
2003-2013 Summary												
Mean ^a	9,184	10,122	11,439	13,464	14,764	14,984	12,160	5,271	16,184	6,196	7,691	8,573
Minimum	4,759	5,293	5,970	7,306	5,322	9,278	3,809	2,352	3,460	3,834	4,096	4,588
Maximum	16,463	17,583	19,349	21,120	23,844	21,927	24,942	18,366	12,868	13,428	14,304	15,464

Source: USBR 2013 b

^aAverage of average values presented in table.

ND = No data

USGS = U.S. Geological Survey

Table 2.9-35 Range Values for Box Butte Reservoir Water Contents

Date	Average	Minimum	Maximum
	Acre-feet		
2003 – 2013	6,196 – 14,984	2,352 – 9,278	12,868 – 24,942

USGS Station 06455000

USGS = U.S. Geological Survey

Source: USBR 2011b

Table 2.9-36 Parameters Used to Estimate Wet-weight Vegetable Concentrations from Dry-weight Soil Concentrations

Parameter	Parameter Description	Plant Type	Radionuclide	Value	Unit
ML _v	Mass Loading factor	Root Vegetables	Parameter is not Radionuclide Specific	0.1	pCi/kg dry-weight plant per pCi/g dry-weight soil
		Leafy Vegetables			
		Fruits			
B _{jv}	Concentration Factor for Root Uptake	Root Vegetables	Natural Uranium	0.014	pCi/kg dry-weight plant per pCi/g dry-weight soil
			Thorium-230	0.00012	
			Radium-226	0.0032	
			Lead-210	0.0032	
			Polonium-210	0.009	
		Leafy Vegetables	Natural Uranium	0.017	
			Thorium-230	0.0025	
			Radium-226	0.075	
			Lead-210	0.0058	
			Polonium-210	0.0025	
		Fruits	Natural Uranium	0.004	
			Thorium-230	0.000085	
			Radium-226	0.0061	
			Lead-210	0.009	
			Polonium-210	0.0004	
W _v	Dry weight to Wet Weight Conversion Factor	Root Vegetables	Not Radionuclide Specific	0.2	Unitless
		Leafy Vegetables		0.25	
		Fruits		0.18	

Notes:

ML_v = plant soil mass-loading factor for re-suspension of soil to plant v (pCi/kg dry-weight plant per pCi/g dry-weight soil)

B_{jv} = concentration factor for uptake of radionuclide j from the soil in plant v (pCi/kg dry-weight plant per pCi/g dry-weight soil)

W_v = dry to wet-weight conversion factor (unitless)

pCi/g = picoCuries per gram

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**Table 2.9-37 Total Radionuclides and Metals in Tissue of Northern Pike Collected from
Inlet of Box Butte Reservoir**

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Table 2.9-38 Radionuclide and Metal Analyses for Niobrara River Sample Locations N-1 and N-2

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**Table 2.9-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED)
Sample Locations**

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Table 2.9-40 Marsland Expansion Area Gamma Exposure Results

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Table 2.9-41 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
Air Particulates	3	On MEA northern boundary	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
	1	Nearest Resident	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
	1	Control background location east of MEA License Boundary	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
Radon Gas	3	On MEA northern boundary	Continuous	Quarterly	Quarterly	Rn-222
	1	Nearest Resident	Continuous	Quarterly	Quarterly	Rn-222
	1	Control background location east of MEA License Boundary	Continuous	Quarterly	Quarterly	Rn-222
Groundwater	1	Wells within MEA license boundary and 2 km radius: <ul style="list-style-type: none"> • Private Wells • <u>Arikaree Wells</u> • MEA Brule Wells • MEA Ore Zone Wells (See Figures 2.7-6 and 2.9-3)	Grab	Quarterly	Quarterly	Suspended & Dissolved Natural Uranium, Ra-226, Th-230, Th-230 Pb-210 & Po-210
Surface Water	2 ^a	Niobrara River (N-1 and N-2) Ephemeral Drainages	Grab	<u>Monthly</u>	<u>Monthly</u>	Suspended & Dissolved Natural Uranium, Ra-226, Th-230
			Grab		Semiannually	Suspended & Dissolved Pb-210 & Po-210
Vegetation	3	Grazing areas near the site in different sectors that will have the highest predicted air particulate concentrations during milling operations	Grab	3 times during grazing season	3 Times	Natural Uranium, Ra-226, Th-230, Pb-210, & Po-210
Food	3	Crops	Grab	Time of Harvest or Slaughter	1	Natural Uranium, Ra-226, Th-230, Pb-210, & Po-210
	3	Livestock			1	
	3	Private Garden Vegetables (<u>alternate of garden soil sampling to be used</u>)			1	
Fish	Each Body of	Collection of fish from Niobrara River (<u>headwaters of Box Butte Reservoir</u>)	Grab	Semiannually	2	Natural Uranium, Ra-226, Th-230, Pb-210,

Table 2.9-41 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
	Water					& Po-210
Surface Soil ^b	Up to 40	300 meter intervals to a distance of 1500 meters in each of 8 directions from center-point of satellite facility; additional transects through wellfields	Grab	Once prior to construction. Repeat for location disturbed by excavation, leveling or contouring	1	All samples for Ra-226, 10% of samples natural uranium, Th-230 & Pb-210
	5	Same location used for collection of air particulates	Grab	Once prior to construction	1	Natural Uranium, Ra-226, Th-230 & Pb-210
Subsurface Soil ^c	5	At center-point of satellite facility & at distances of 750 meters in each of 4 directions	Grab	Once prior to construction. Repeat for location disturbed by construction	1	Ra-226 (all samples) Natural Uranium, Th-203 & Pb-210 (one set of samples)
Sediment ^d	1 from each stream (2) & ephemeral drainage (6) sampling points	Up and down gradient samples from ephemeral drainages (total of 6 samples) & Niobrara River (N-1 & N-2)	Grab (Composite samples)	Once following spring runoff & late summer following period of extended low flow	2	Natural Uranium, Ra-226, Th-230 & Pb-210
Direct Radiation (Survey)	Up to 80	150 meter intervals to a distance of 1500 meters in each of 8 directions from center-point of satellite facility	Grab	Once prior to construction. Repeat for areas disturbed by site preparation or construction	1	Gamma exposure using sodium iodide scintillometer
Direct Radiation (Continuous)	5	Same location used for collection of air particulates	Grab	Once prior to construction	1	Gamma exposure using a continuous integrating device

^a Two samples from the Niobrara River per sampling event and one (1) from each sampling point (total of 6) located on ephemeral streams (Figure 2.7-4). MEA = Marsland Expansion Area

^b Surface soil samples collected to a depth of 5 cm using a consistent technique.

^c Subsurface soil samples collected to a depth of 1 meter; samples divided into 3 equal sections for analysis.

^d Sediment sample locations shown in Figure 2.7-4

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Figure 2.9-1 Remaining Marsland Preoperational/Preconstruction Monitoring Program Timeline

Task	Start	Finish ^b	2013										2014									
			4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	
Surface Water (Niobrara River)	9/16/2013	10/31/2014																				
Surface Water (Ephemeral Drainages) ^a	4/24/2013	7/01/2014																				
Vegetation (Forage)	7/01/2013	2/01/2014																				
Food (Fish)	1/01/2014	7/01/2014																				
Food (Livestock)	2/01/2014	7/01/2014																				
Food (Crops, Alternate Soil Sampling)	7/01/2013	2/01/2014																				
Soil	5/01/2014	7/01/2014																				
Sediment	9/18/2013	7/01/2014																				
Direct Radiation ^c	4/24/2013	7/01/2014																				

Notes:

^a Sampling will be collected as water as water flow is available; through 12/15/2013 water has not been available.

^b Data will be submitted to the NRC.

^c Survey interval measurements pending; quarterly measurements at air particulate monitoring stations complete.

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**Technical Report
Marsland Expansion Area**



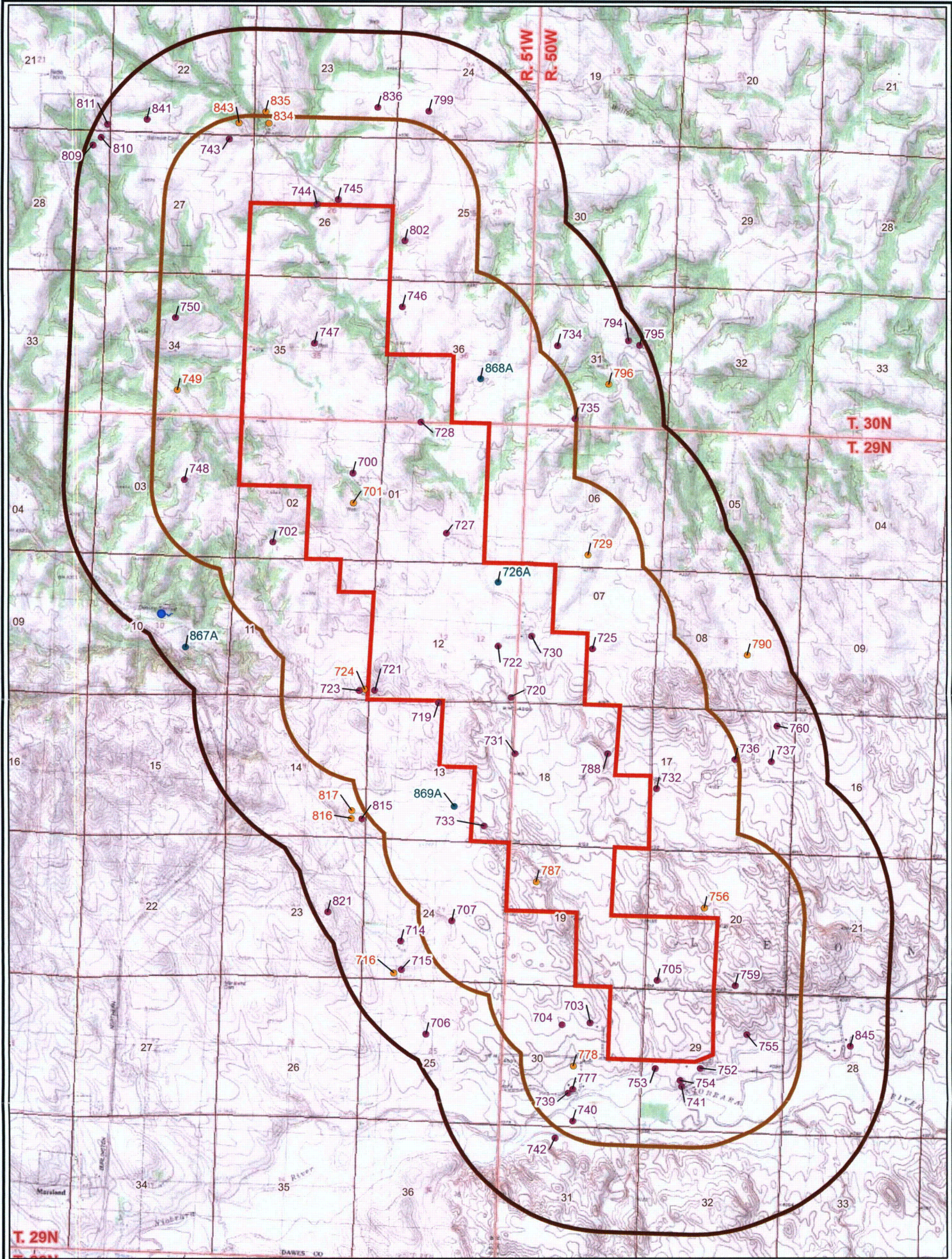
Figure 2.9-2 Locations of Environmental Air Sampling Stations at Marsland Expansion Area

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**Technical Report
Marland Expansion Area**



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LEGEND

- Proposed Marsland Expansion Area (MEA)
- 2-Kilometer Radius of MEA
- 1-Kilometer Radius of MEA
- Private Water Supply Wells**
- 733 Active Well
- 778 Inactive Well
- 869A Abandoned Well

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

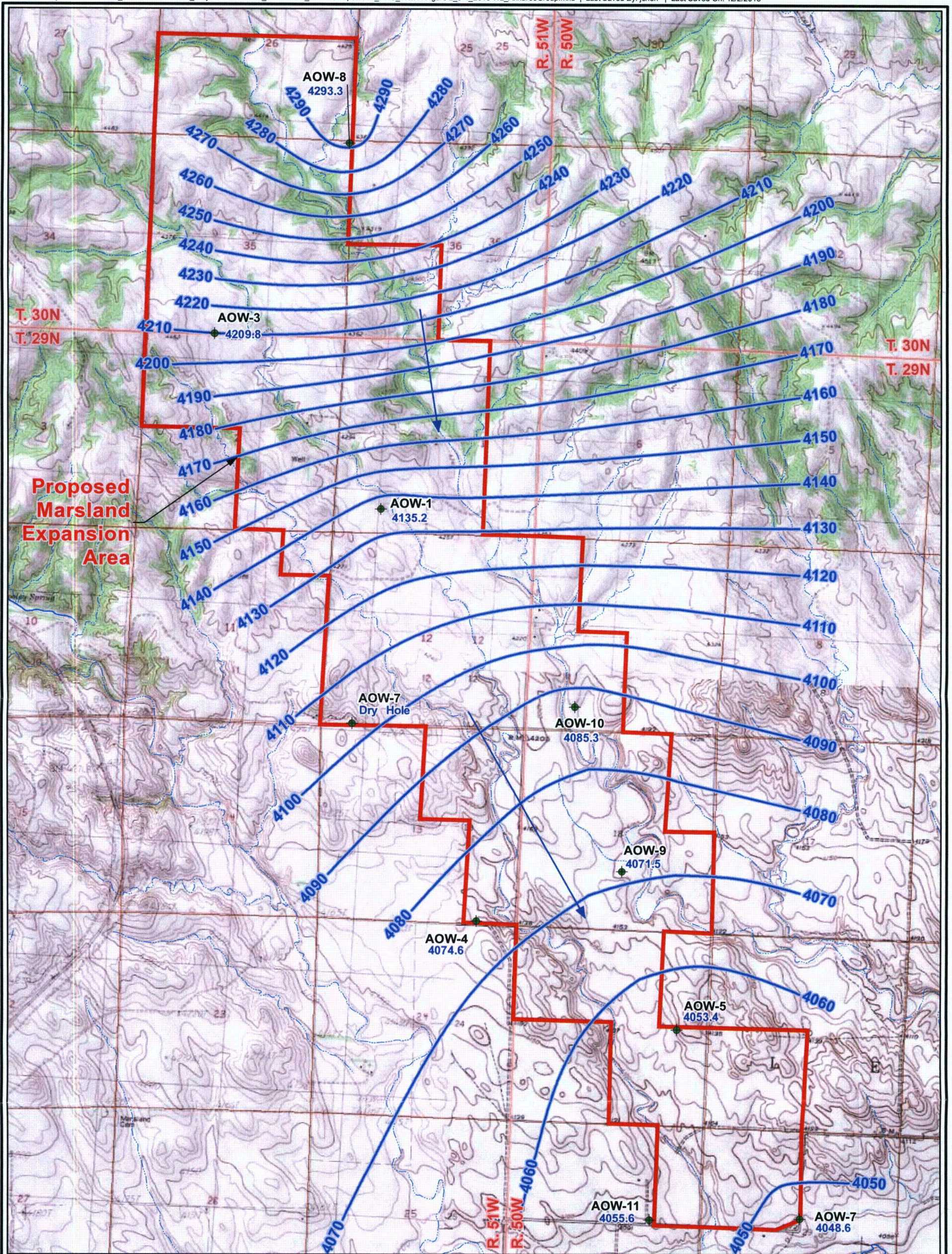
0 1,750 3,500 Feet
0 500 1,000 Meters

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FIGURE 2.9-3
PRIVATE WELLS LOCATED WITHIN ONE AND TWO KILOMETERS OF THE MEA LICENSE BOUNDARY

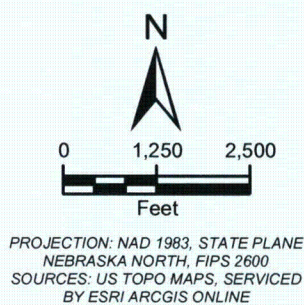
PROJECT: CO001636 MAPPED BY: JC CHECKED BY: J.CEARLEY

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LEGEND

-  Arikaree Group Monitoring Well
-  Proposed Marland Expansion Area
-  Intermittent Stream/River
-  Groundwater Elevation Contour
-  4055.6 Water Level (feet-above mean sea level)
-  Groundwater Flow Direction



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FIGURE 2.9-4
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
ARIKAREE GROUP (10/17/2013)

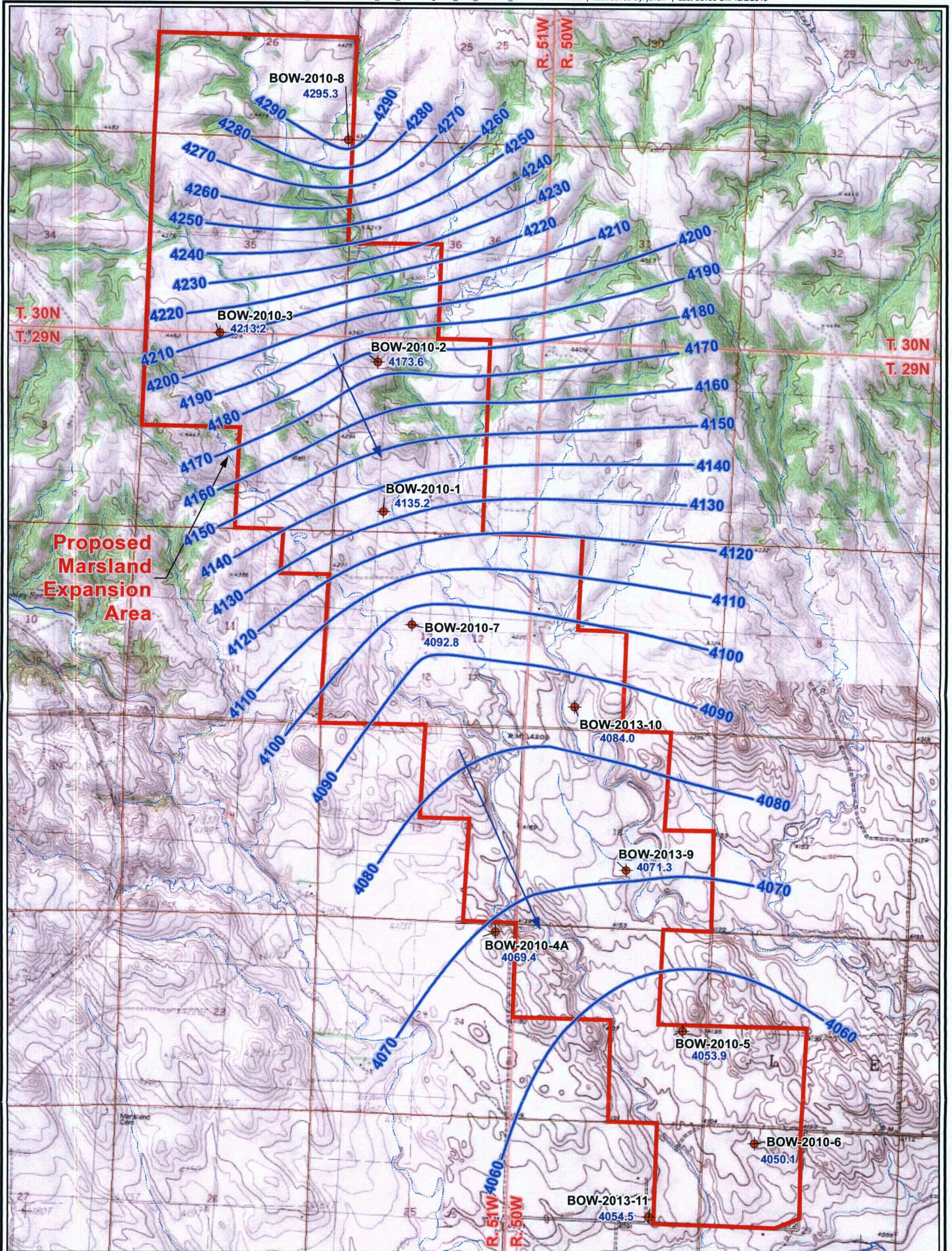
PROJECT: CO001636

MAPPED BY: JC

CHECKED BY: MS

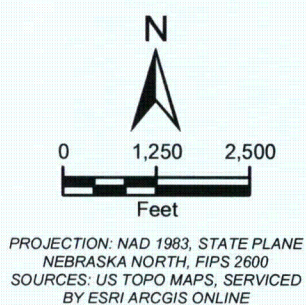


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LEGEND

- Brule Formation Well
- Proposed Marland Expansion Area
- Intermittent Stream/River
- Groundwater Elevation Contour
- 4054.5 Water Level (feet-above mean sea level)
- Groundwater Flow Direction



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FIGURE 2.9-5a MARSLAND EXPANSION AREA POTENTIOMETRIC SURFACE BRULE FORMATION (10/17/2013)

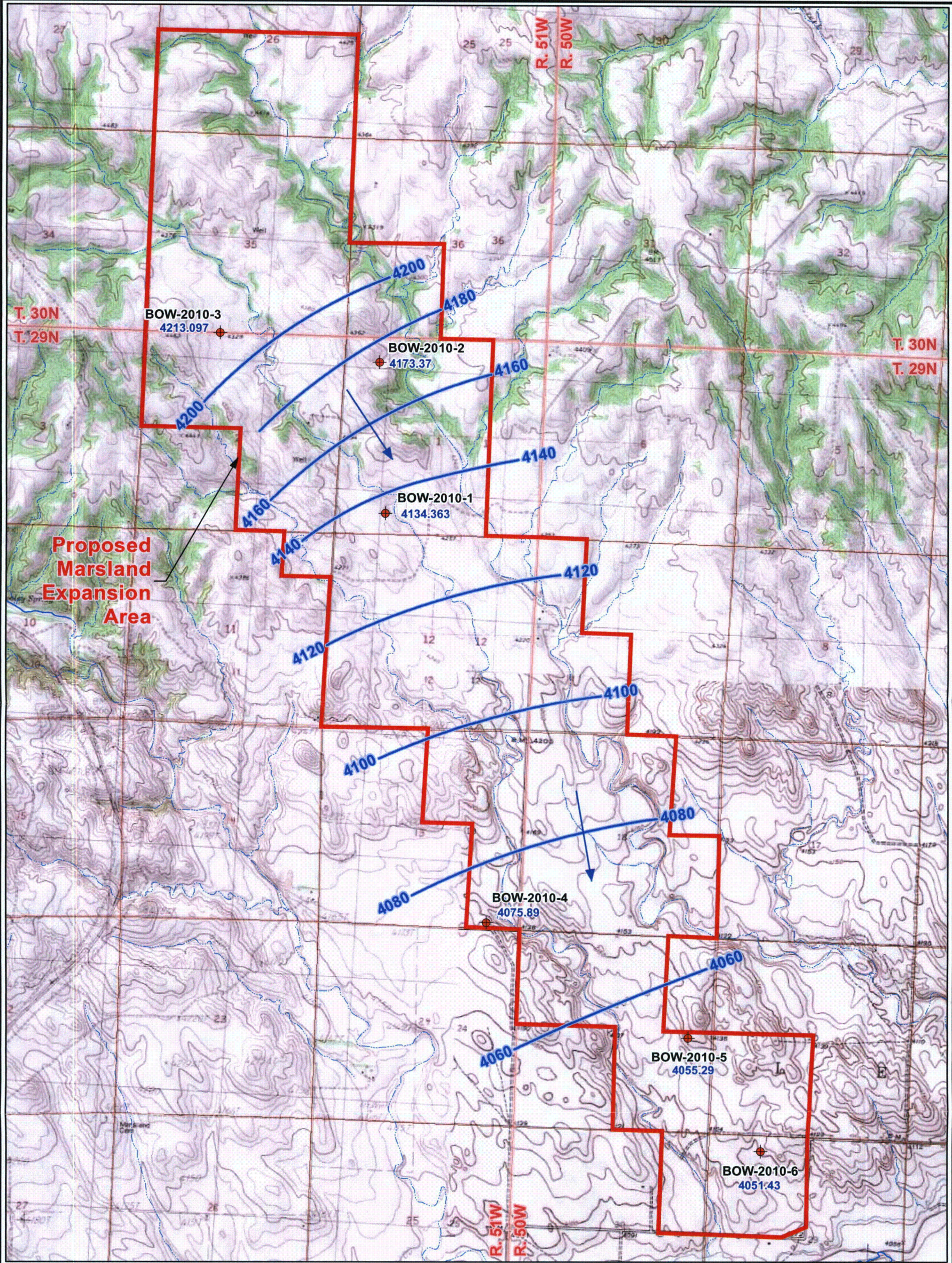
PROJECT: CO001636

MAPPED BY: JC

CHECKED BY: MS

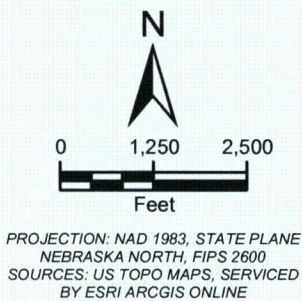


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LEGEND

- Brule Formation Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River
- Groundwater Elevation Contour
- Groundwater Flow Direction
- 4051.43** Water Level (feet-above mean sea level)



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FIGURE 2.9-5b
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
BRULE FORMATION (2/22/11)

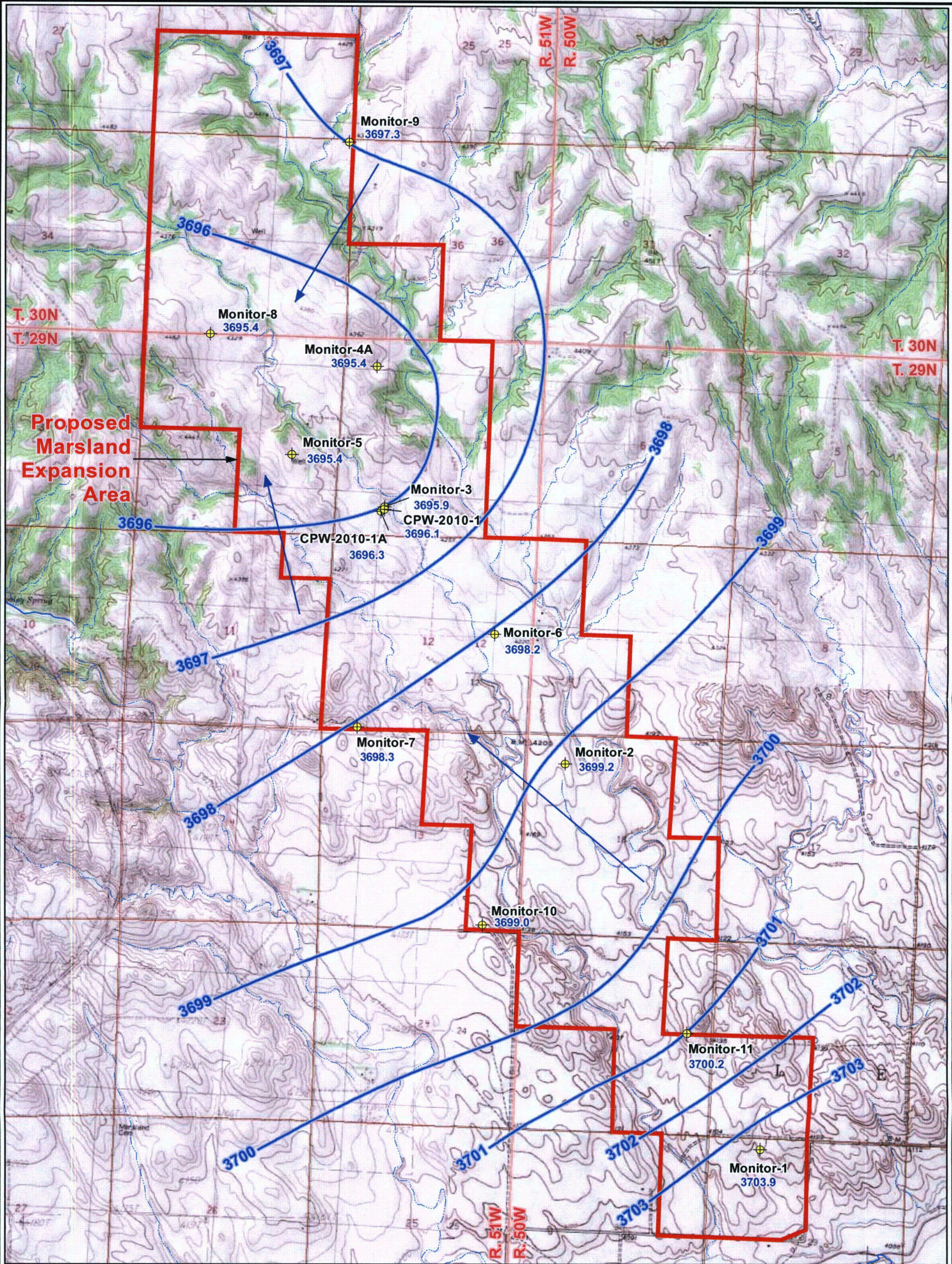
PROJECT: CO001636

MAPPED BY: JC

CHECKED BY: MS

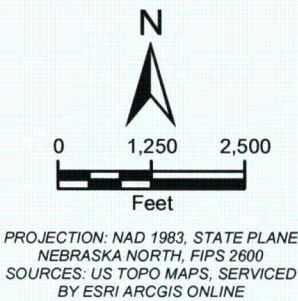


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LEGEND

- Basal Sandstone of the Chadron Formation Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River
- Groundwater Elevation Contour
- 3703.9 Water Level (feet-above mean sea level)
- Groundwater Flow Direction



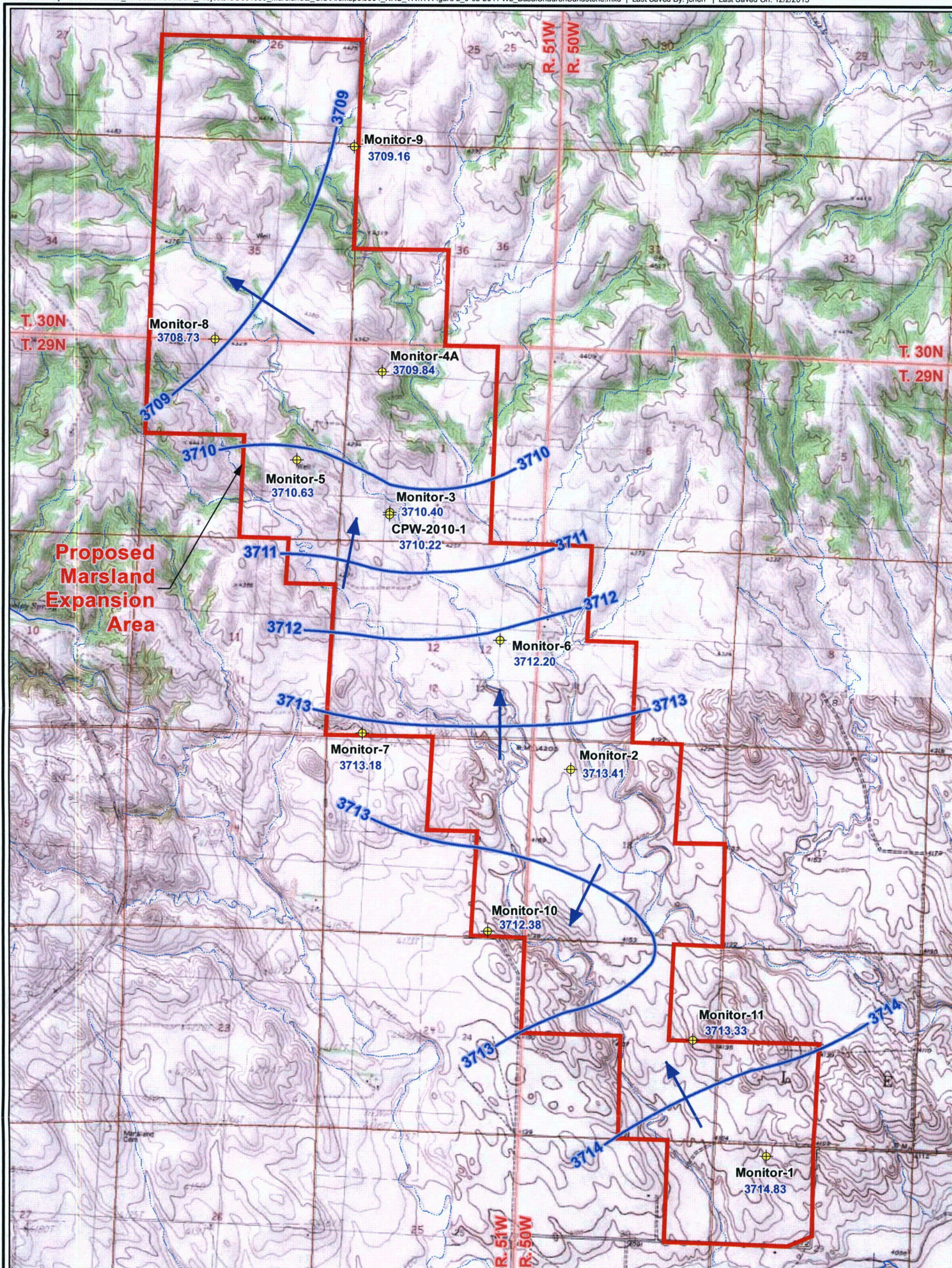
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FIGURE 2.9-6a
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
BASAL SANDSTONE OF
THE CHADRON FORMATION (10/17/2013)


PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

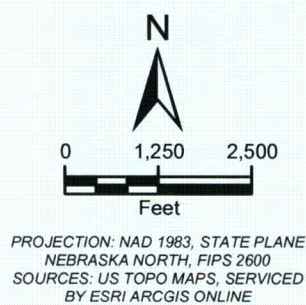


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LEGEND

-  Basal Sandstone of the Chadron Formation Well
-  Proposed Marsland Expansion Area
-  Intermittent Stream/River
-  Groundwater Elevation Contour
-  3714.83 Water Level (feet-above mean sea level)
-  Groundwater Flow Direction



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**FIGURE 2.9-6b
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
BASAL SANDSTONE OF
THE CHADRON FORMATION (2/22/11)**

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