Table 6.1-24 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 6.1-24 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 6.1-25 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2011

Table 6.1-25 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 6.1-25 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 6.1-26 Summary of NDEQ Non-Radiological Water QWuality Data for Niobrara River Above Box Butte Reservoir – 2003-2011

Table 6.1-26 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 ug/L for 2002 – 2007, with detected values for years 2008 through 2011.

Table 6.1-27 NDEQ Water Quality Data for Niobrara River Below Box Butte Reservoir – 2008

Table 6.1-27 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 @ 25ºC	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 6.1-28 NDEQ Water Quality for Niobrara River Below Box Butte Reservoir – 2008 (Range Values)

Table 6.1-28 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 6.1-29 Niobrara River Dissolved Radiological Water Quality Baseline Data Collected by Crow Butte (2011-2012)

Table 6.1-29 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 6.1-29 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 6.1-29 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 6.1-29 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 6.1-29 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 6.1-29 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 6.1-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte (2011-2012)

Table 6.1-30 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 6.1-30 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 6.1-30 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 6.1-30 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 6.1-30 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 6.1-31 Niobrara River Non-Radiological Water Quality Baseline Data Collected by Crown Butte (2011-2012)

Table 6.1-31 Niobrara River Non-Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte Group	Units	N1 (Niobrara River West Site) 2/11/2011		N1 (Niobrara River West Site) 5/16/2011		N1 (Niobrara River West Site) 6/24/2011		N1 (Niobrara River West Site) 8/12/2011		N1 (Niobrara River West Site) 11/28/2011		N1 (Niobrara River West Site) 1/13/2012		N1 (Niobrara River West Site) 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 6.1-31 Niobrara River Non-Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte Group	Units	N2 (Niobrara River East Site) 2/11/2011		N2 (Niobrara River East Site) 5/16/2011		N2 (Niobrara River East Site) 6/24/2011		N2 (Niobrara River East Site) 8/12/2011		N2 (Niobrara River East Site) 11/28/2011		N2 (Niobrara River East Site) 1/13/2011		N2 (Niobrara River East Site) 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.l05	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 6.1-32 Summary of Radiological Baseline Data for Niobrara River Near Marsland Expansion Area Collected by Crow Butte

Table 6.1-32 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
NIOBRARA 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
NIOBRARA 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 6.1-29 and 6.1-30.

[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 6.1-33 Summary of Non-Radiological Baseline Data for Niobrara River Near Marsland Expansion Area Collected by Crow Butte

Table 6.1-33 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 6.1-31.
s.u. = standard unit
mg/L = milligrams per liter
RL = Reporting Limit
µmhos/cm = micromhos per centimeter

Table 6.1-34 Daily Contents in Acre-Feet of Water for Box Butte Reservoir (USGS 06455000)– 2003 to 2013

Table 6.1-34 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 6.1-34 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

[a]Average of average values presented in table.

ND = No data

USGS = U.S. Geological Survey

Table 6.1-35 Range Values for Box Butte Reservoir Water Contents

Table 6.1-35 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 6.1-36 Parameters Used to Estimate Wet-weight Vegetable Concentrations from Dry-weight Soil Concentrations

Table 6.1-36 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	

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)

Table 6.1-37 Total Radionuclides and Metals in Tissue of Northern Pike Collected from Inlet of Box Butte Reservoir

Table 6.1-37 Total Radionuclides and Metals in Tissue of Northern Pike Collected from Inlet of Box Butte Reservoir

Radionuclide - Total	Result [a]	Units	Qualifiers	RL	Result	Units	Qualifiers	RL
	August 22, 2011				May 25, 2012			
Lead 210	<1E-06	uCi/kg	U	1E-06	7.9E-07	uCi/kg	U	7.9E-07
Lead 210 Precision (+)	7.0E-07	uCi/kg	--	--	8.1E-07	uCi/kg	--	--
Lead 210 MDC	1.0E-06	uCi/kg	--	--	1.0E-06	uCi/kg	--	--
Polonium 210	5.0E-07	uCi/kg	--	5.0E-07	2.8E-07	uCi/kg	U	2.8E-07
Polonium 210 Precision (+)	4.E-07	uCi/kg	--	--	1.0E-06	uCi/kg	--	--
Polonium 210 MDC	5.0E-07	uCi/kg	--	--	2.1E-06	uCi/kg	--	--
Radium 226	<2E-07	uCi/kg	U	2.0E-07	2.2E-07	uCi/kg	--	2.2E-07
Radium 226 Precision (+)	1.0E-07	uCi/kg	--	--	1.5E-07	uCi/kg	--	--
Radium 226 MDC	2.0E-07	uCi/kg	--	--	1.9E-07	uCi/kg	--	--
Thorium 230	1.0E-05	uCi/kg	--	8.0E-06	6.7E-08	uCi/kg	U	6.7E-08
Thorium 230 Precision (+)	6.0E-06	uCi/kg		--	5.8E-06	uCi/kg	--	--
Thorium 230 MDC	8.0E-06	uCi/kg	--	--	1.4E-05	uCi/kg	--	--
Metals - Total							--	--
Uranium, Total	<0.0003	mg/kg	--	0.0003	0.00099	mg/kg	D	0.00040
Uranium, Activity	<2E-07	uCi/kg	--	2.0E-07	6.7E-07	uCi/kg	D	2.7E-07

[a] Results reported on a wet weight basis (as received) for composite of two or more samples (digestion, radiochemistry)..

uCi/kg = microcuries per kilogram.

U = Not detected at the reporting limit.

D = RL increased due to sample matrix,

RL = Analyte reporting limit.

MDC = Minimum detectable concentration.

mg/kg – milligram per kilogram

Table 6.1-38 Radionuclide and Metal Analyses for Niobrara River Sample Locations N-1 and N-2 Sediments

Table 6.1-38 Radionuclide and Metal Analyses for Niobrara River Sample Locations N-1 and N-2 Sediment Samples

Radionuclide	Units	Result	Reporting Limit (RL)
		3/20/2013 (Collection Date)	
N - 1			
Lead-210	pCi/g - dry	0.3	0.2
Lead 210 precision (+)	pCi/g - dry	0.1	--
Lead 210 MDC	pCi/g - dry	0.2	--
Radium 226	pCi/g - dry	0.4	0.04
Radium 226 precision (+)	pCi/g - dry	0.06	--
Radium 226 MDC	pCi/g - dry	0.04	--
Thorium 230	pCi/g - dry	0.2	0.2
Thorium 230 precision (+)	pCi/g - dry	0.1	--
Thorium 230 MDC	pCi/g - dry	0.2	--
METALS			
Uranium	mg/kg - dry	0.4	0.3
Uranium Activity	pCi/g - dry	0.3	0.2
N - 2			
Lead-210	pCi/g - dry	0.3	0.2
Lead 210 precision (+)	pCi/g - dry	0.1	
Lead 210 MDC	pCi/g - dry	0.2	
Radium 226	pCi/g - dry	0.4	0.04
Radium 226 precision (+)	pCi/g - dry	0.06	
Radium 226 MDC	pCi/g - dry	0.04	
Thorium 230	pCi/g - dry	0.2	0.2
Thorium 230 precision (+)	pCi/g - dry	0.1	
Thorium 230 MDC	pCi/g - dry	0.2	
METALS			
Uranium	mg/kg - dry	0.4	0.3
Uranium Activity	pCi/g - dry	0.3	0.2

MED – Marsland Ephermeral Drainage
RL - Analyte reporting limit
MDC – Minimum detectable concentration
mg/kg-dry – milligram/kilogram-dry weight
pCi/g-dry – picocuries per gram -dry weight

Table 6.1-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED) Sample Locations

Table 6.1-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED) Sample Locations

Radionuclide	Units	Result	Reporting Limit (RL)		Result	Reporting Limit (RL)
		12/02/2011 (Collection Date)			3/20/2013 (Collection Date)	
MED - 1						
Lead-210	pCi/g-dry	0.2	0.2		<0.2	0.2
Lead 210 precision (+)	pCi/g-dry	0.1	--		0.1 U	
Lead 210 MDC	pCi/g-dry	0.2	--		0.2	
Radium 226	pCi/g-dry	0.3	0.02		0.2	0.04
Radium 226 precision (+)	pCi/g-dry	0.04	--		0.05	
Radium 226 MDC	pCi/g-dry	0.02	--		0.04	
Thorium 230	pCi/g-dry	0.4	0.1		<0.1 U	0.1
Thorium 230 precision (+)	pCi/g-dry	0.2	--		0.1	
Thorium 230 MDC	pCi/g-dry	0.1	--		0.1	
METALS						
Uranium	mg/kg-dry	0.5	0.3		<0.3	0.3
Uranium Activity	pCi/g-dry	0.3	0.2		<0.2	0.2
MED - 2						
Lead-210	pCi/g-dry	0.7	0.2		0.4	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.4	0.02		0.4	0.04
Radium 226 precision (+)	pCi/g-dry	0.04			0.06	
Radium 226 MDC	pCi/g-dry	0.02 U			0.04	
Thorium 230	pCi/g-dry	<0.2	0.2		0.2	0.2
Thorium 230 precision (+)	pCi/g-dry	0.1			0.1	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	
METALS						
Uranium	mg/kg-dry	0.5	0.3		0.4	0.3
Uranium Activity	pCi/g-dry	0.3	0.2		0.3	0.2
MED - 3						
Lead-210	pCi/g-dry	0.6	0.2		0.3	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.4	0.02		0.3	0.04

Table 6.1-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED) Sample Locations

Radionuclide	Units	Result	Reporting Limit (RL)		Result	Reporting Limit (RL)
		12/02/2011 (Collection Date)			3/20/2013 (Collection Date)	
Radium 226 precision (+)	pCi/g-dry	0.04			0.06	
Radium 226 MDC	pCi/g-dry	0.02			0.04	
Thorium 230	pCi/g-dry	0.2	0.2		0.2	0.2
Thorium 230 precision (+)	pCi/g-dry	0.1			0.1	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	
METALS						
Uranium	mg/kg-dry	0.5	0.3		<0.3	0.3
Uranium Activity	pCi/g-dry	0.3	0.2		<0.2	0.2
MED - 4						
Lead-210	pCi/g-dry	1.3	0.2		0.9	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.8	0.02		0.7	0.04
Radium 226 precision (+)	pCi/g-dry	0.06			0.08	
Radium 226 MDC	pCi/g-dry	0.02			0.04	
Thorium 230	pCi/g-dry	0.5	0.2		0.3	0.2
Thorium 230 precision (+)	pCi/g-dry	0.2			0.2	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	
METALS						
Uranium	mg/kg-dry	1.0	0.3		0.7	0.3
Uranium Activity	pCi/g-dry	0.7	0.2		0.5	0.2
MED - 5						
Lead-210	pCi/g-dry	1.5	0.2		0.9	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.8	0.02		0.5	0.04
Radium 226 precision (+)	pCi/g-dry	0.06			0.07	
Radium 226 MDC	pCi/g-dry	0.02			0.04	
Thorium 230	pCi/g-dry	0.3	0.2		0.2	0.2
Thorium 230 precision (+)	pCi/g-dry	0.2			0.1	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	

Table 6.1-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED) Sample Locations

Radionuclide	Units	Result	Reporting Limit (RL)		Result	Reporting Limit (RL)
		12/02/2011 (Collection Date)			3/20/2013 (Collection Date)	
METALS						
Uranium	mg/kg-dry	0.9	0.3		0.5	0.3
Uranium Activity	pCi/g-dry	0.6	0.2		0.3	0.2
MED - 6						
Lead-210	pCi/g-dry	1.3	0.2		0.4	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.6	0.02		0.3	0.04
Radium 226 precision (+)	pCi/g-dry	0.05			0.06	
Radium 226 MDC	pCi/g-dry	0.02			0.04	
Thorium 230	pCi/g-dry	0.2	0.2		<0.2	0.2
Thorium 230 precision (+)	pCi/g-dry	0.1			0.07	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	
METALS						
Uranium	mg/kg-dry	0.6	0.3		<0.3	0.3
Uranium Activity	pCi/g-dry	0.4	0.2		<0.2	0.2

MED - Marsland Ephermeral Drainage
RL - Analyte reporting limit
U – Not detected at the reporting limit
MDC - Minimum detectable concentration
mg/kg-dry - milligram/kilogram-dry weight
pCi/g-dry - picocuries per gram -dry weight

Table 6.1-40 Marsland Expansion Area Gamma Exposure Results

Table 6.1-40 Marsland Expansion Area Gamma Exposure Results

Location	Exposure of Dosimeter (mRems ambient dose equivalent)		Net Cumulative Totals			Number of Dosimeters Reported
	Gross	Net	Calendar Quarter	Year to Date	Permanent	
	10/01/2011 – 12/31/2011					
Transient Control	13.9	-1.0	--	--	--	--
Deploy Control	15.0	0.0	--	--	--	--
MA-1	21.7	6.7	6.7	6.7	6.7	1
MA-2	21.6	6.7	6.7	6.7	6.7	1
MA-3	21.4	6.5	6.5	6.5	6.5	1
MA-4	19.9	5.0	5.0	5.0	5.0	1
MA-5	20.9	5.9	5.9	5.9	5.9	1
1/01/2012 – 3/31/2012						
Transient Control	25.7	-0.6	Q1	2012	--	--
Deploy Control	26.3	0	--	--	--	--
MA-1	32.8	6.5	6.5	6.5	13.2	1
MA-2	33.8	7.5	7.5	7.5	14.2	1
MA-3	31.4	5.1	5.1	5.1	11.6	1
MA-4	40.8	14.5	14.5	14.5	19.5	1
MA-5	32.5	6.2	6.2	6.2	12.1	1
4/01/2012 – 6/30/2012						
Transient Control	30.7	--	Q2	2012	--	--
Deploy Control	30.3	--	--	--	--	--
MA-1	40.0	9.6	9.6	16.1	22.8	1
MA-2	Lost Badge	--	--	7.5	14.2	1
MA-3	34.9	4.6	4.6	9.7	16.2	1
MA-4	40.9	10.5	10.5	25.0	30.0	1
MA-5	38.1	7.7	7.7	13.9	19.8	1
7/01/2012 – 9/30/2012						
Transient Control	--	--	Q3	2012	--	--
Deploy Control	28.8	--	--	--	--	--
MA-1	38.6	9.9	9.9	26.0	32.7	1
MA-2	39.2	10.4	10.4	17.9	24.6	1
MA-3	37.5	8.7	8.7	18.3	24.8	1
MA-4	39.2	10.4	10.4	35.5	40.5	1
MA-5	33.3	4.5	4.5	18.4	24.3	1
10/01/2012 – 12/31/2012						
Transient Control	--	--	Q4	2012	--	--
Deploy Control	27.3	--	--	--	--	--
MA-1	39.2	11.9	11.9	37.9	44.6	1
MA-2	36.8	9.5	9.5	27.4	34.1	1

Table 6.1-40 Marsland Expansion Area Gamma Exposure Results

Location	Exposure of Dosimeter (mRems ambient dose equivalent)		Net Cumulative Totals			Number of Dosimeters Reported
	Gross	Net	Calendar Quarter	Year to Date	Permanent	
MA-3	34.5	7.2	7.2	25.6	32.2	1
MA-4	37.3	10.0	10.0	45.5	50.5	1
MA-5	34.0	6.8	6.8	25.2	31.1	1

mRems – millirems
MA-1 air sampling locations
Minimum Detectable Dose = 0.1 mRems ambient dose equivalent

Table 6.1-41 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program

Table 6.1-41 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program

	Sample Collection				Sample Analysis	
Type of Sample	**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: · Private Wells · Arikaree Wells · 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	Monthly	Monthly	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-2320, Pb-210, & Pb-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 (alternate of garden soil sampling to be used)			1	

Table 6.1-41 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program

	Sample Collection				Sample Analysis	
Type of Sample	**Number**	**Location**	**Method**	**Frequency**	**Frequency**	**Type of Analysis**
Fish	Each Body of Water	Collection of fish from Niobrara River (headwaters of Box Butte Reservoir)	Grab	Semiannually	2	Natural Uranium, Ra-226, Th-230, Pb-210, & 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 & Pb210 (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 3.4-4**) . 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 3.4-4

Table 6.1-42 Marsland Expansion Area Operational Effluent and Environmental Monitoring Plan

Table 6.1-42 Marsland Expansion Area Operational Effluent and Environmental Monitoring Plan

Type of Sample	Sample Collection			Sample Analysis		
	Number	Location	Method	Frequency	Frequency	Type of Analysis
AIR						
Particulates	3	At or near site boundaries and in sector(s) having the highest predicted concentrations of airborne particulates[a]	Continuous	Weekly filter change or more frequently as required by dust loading	Quarterly composites of weekly samples	Nat-Uranium, Ra-226, Th-230, Pb-210
	1	At or close to nearest residence(s)[a]	Continuous	Weekly filter change or more frequently as required by dust loading	Quarterly composites of weekly samples	Nat-Uranium, Ra-226, Th-230, Pb-210
	1	Control or background location[a]	Continuous	Weekly filter change or more frequently as required by dust loading	Quarterly composites of weekly samples	Nat-Uranium, Ra-226, Th-230, Pb-210
Radon Gas	5	Same locations as air particulates[a]	Continuous using RadTrak type DRNF	Continuous	Continuous	Rn-222
WATER						
Groundwater	One each	Wells (within license boundary and 1 km radius [c] · Private wells · MEA Brule wells · MEA Ore Zone wells	Grab	Quarterly	Quarterly	Dissolved and suspended Nat-Uranium, Ra-226, Th-230, Pb-210, Po-210
Surface Water	Two from each of 3 designated ephemeral drainage sampling points (total of 6 samples)	Surface waters passing through license area (subject to available flow)[b,d]	Grab	Quarterly	Quarterly	Suspended and dissolved Nat-Uranium, Ra-226, Th-230, Pb-210, Po-210

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Table 6.1-42 Marsland Expansion Area Operational Effluent and Environmental Monitoring Plan

Type of Sample	Sample Collection			Sample Analysis		
	Number	Location	Method	Frequency	Frequency	Type of Analysis
VEGETATION	None	N/A	N/A	N/A	N/A	N/A
FOOD	None	N/A	N/A	N/A	N/A	N/A
FISH	None	N/A	N/A	N/A	N/A	N/A
SOIL AND SEDIMENT						
Soil	5 or more	At same locations used for collection of air particulate samples[a]	Grab (0 to 5 cm)	Annually	Annually	Nat-Uranium, Ra-226, Pb-210
Sediment	Two from each ephemeral drainage sampling points (6)	Same as surface water sample locations[b, d]	Grab (minimum of 3 samples for each sample composite)	Annually	Annually	Nat-Uranium, Ra-226, Th-230, Pb-210
DIRECT RADIATION						
Continuous	One each	Air monitoring stations[a]	Dosimeter	Continuous	Quarterly	Gamma exposure rate, using Sodium Iodide scintillometer

[a] Figure 6.1-2
[b] Figure 3.4-4
[c] Figures 3.1-3 and 3.4-7
[d] upstream and downstream
N/A = not applicable
MEA = Marsland Expansion Area

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Deleted: 2
Deleted: 9
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Figure 6.1-1 Marsland Preoperational/Preconstruction Monitoring 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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FIGURE 6.1-1
REMAINING MARSLAND PRE-OP MONITORING PROGRAM TIMELINE

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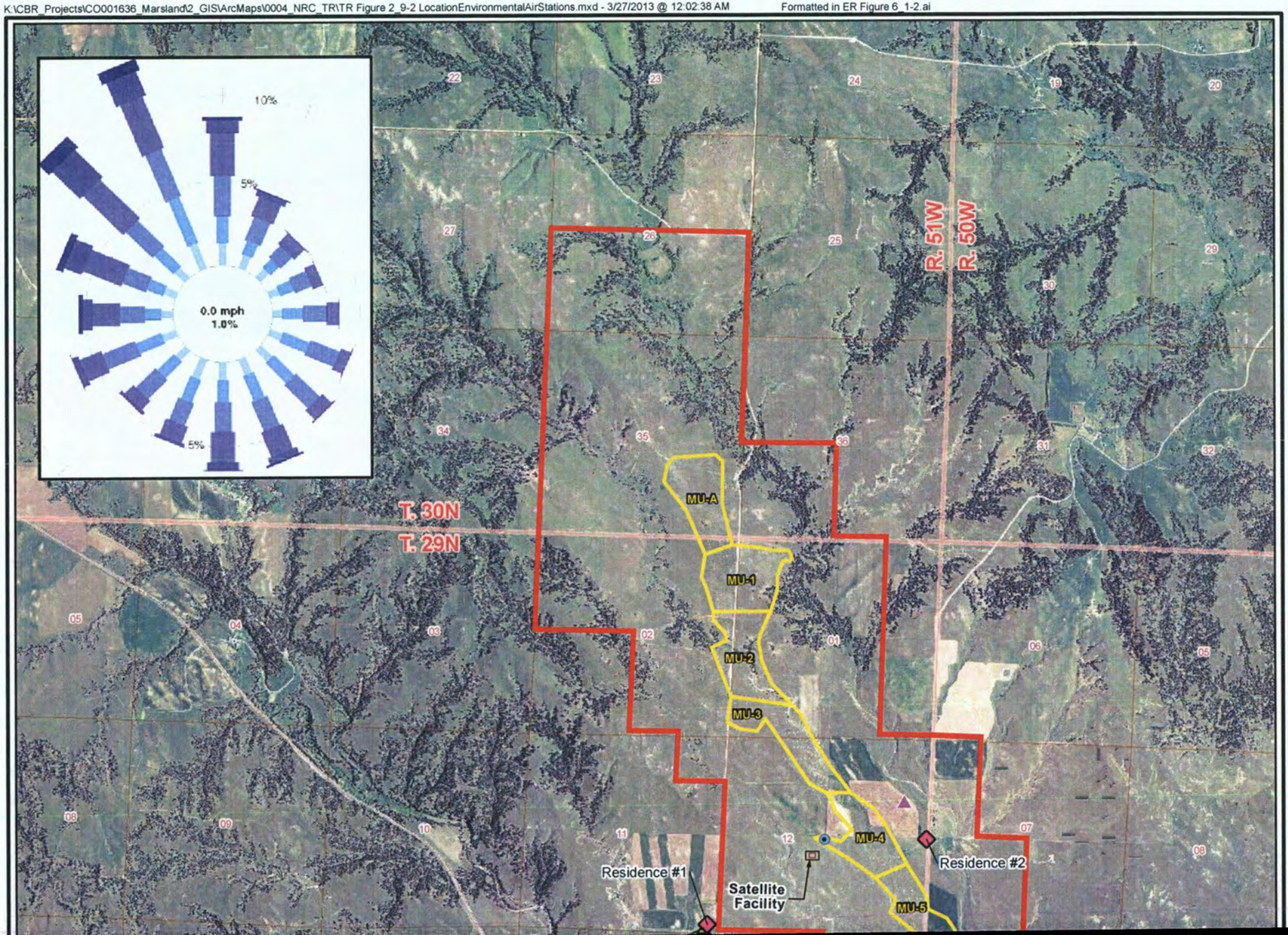
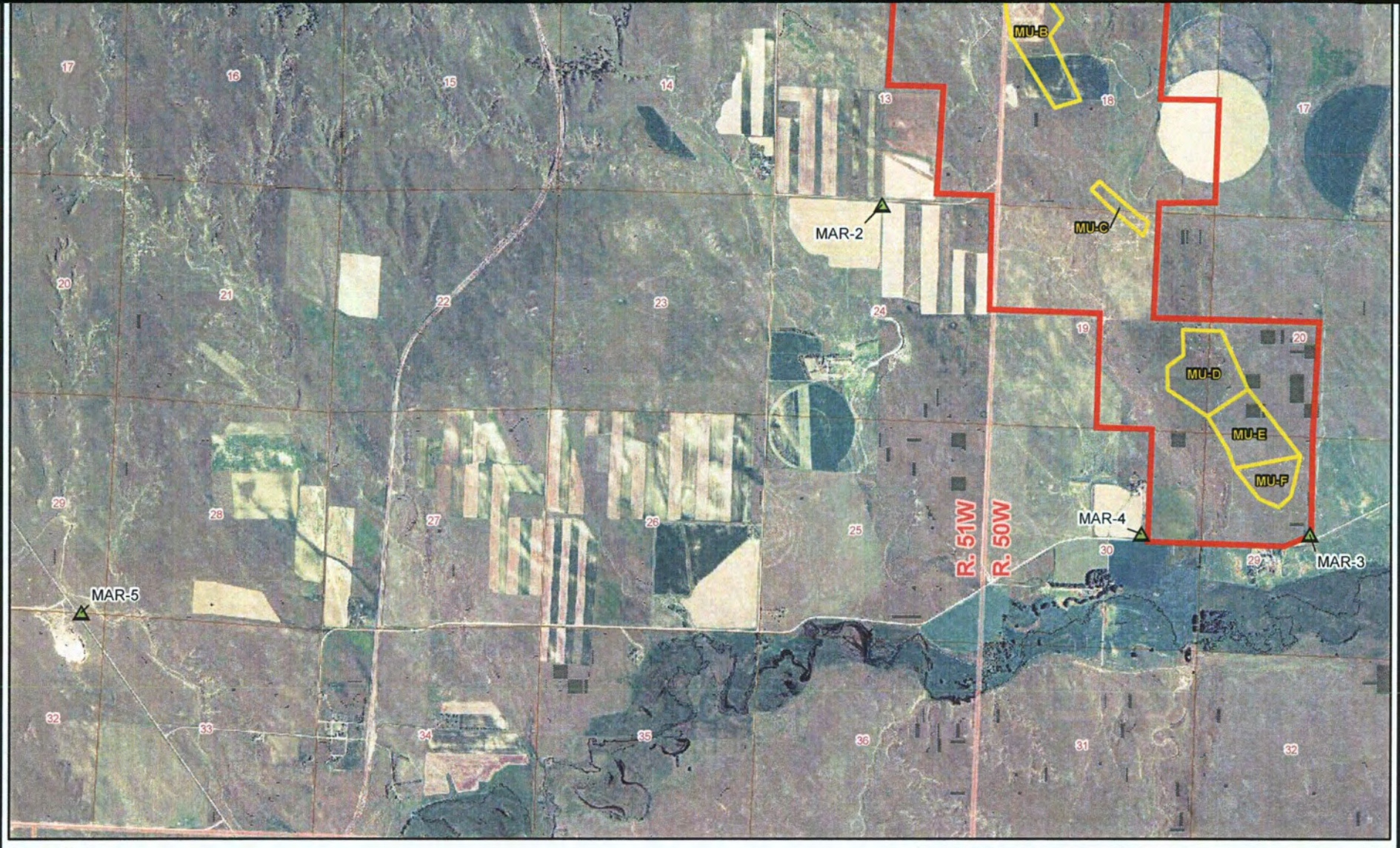
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator_ER\ER Figure 6_1-1 Remaining Marsland Pre-Op Monitoring Program Timeline.ai @ 1/8/2014

Figure 6.1-2 Location of Environmental Air Sampling Stations at Marsland Expansion Area

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_9-2 LocationEnvironmentalAirStations.mxd - 3/27/2013 @ 12:02:38 AM Formatted in ER Figure 6_1-2.ai





LEGEND

- Proposed Deep Disposal Well
- Air Sample Station
- Met Station
- Residence
- Mine Unit
- Proposed Marsland Expansion Area

N

0 3,000 6,000

Feet

PROJECTION: NAD1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: USDA NAIP IMAGERY 2010

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FIGURE 6.1-2
LOCATION OF ENVIRONMENTAL AIR SAMPLING STATIONS AT MARSLAND EXPANSION AREA

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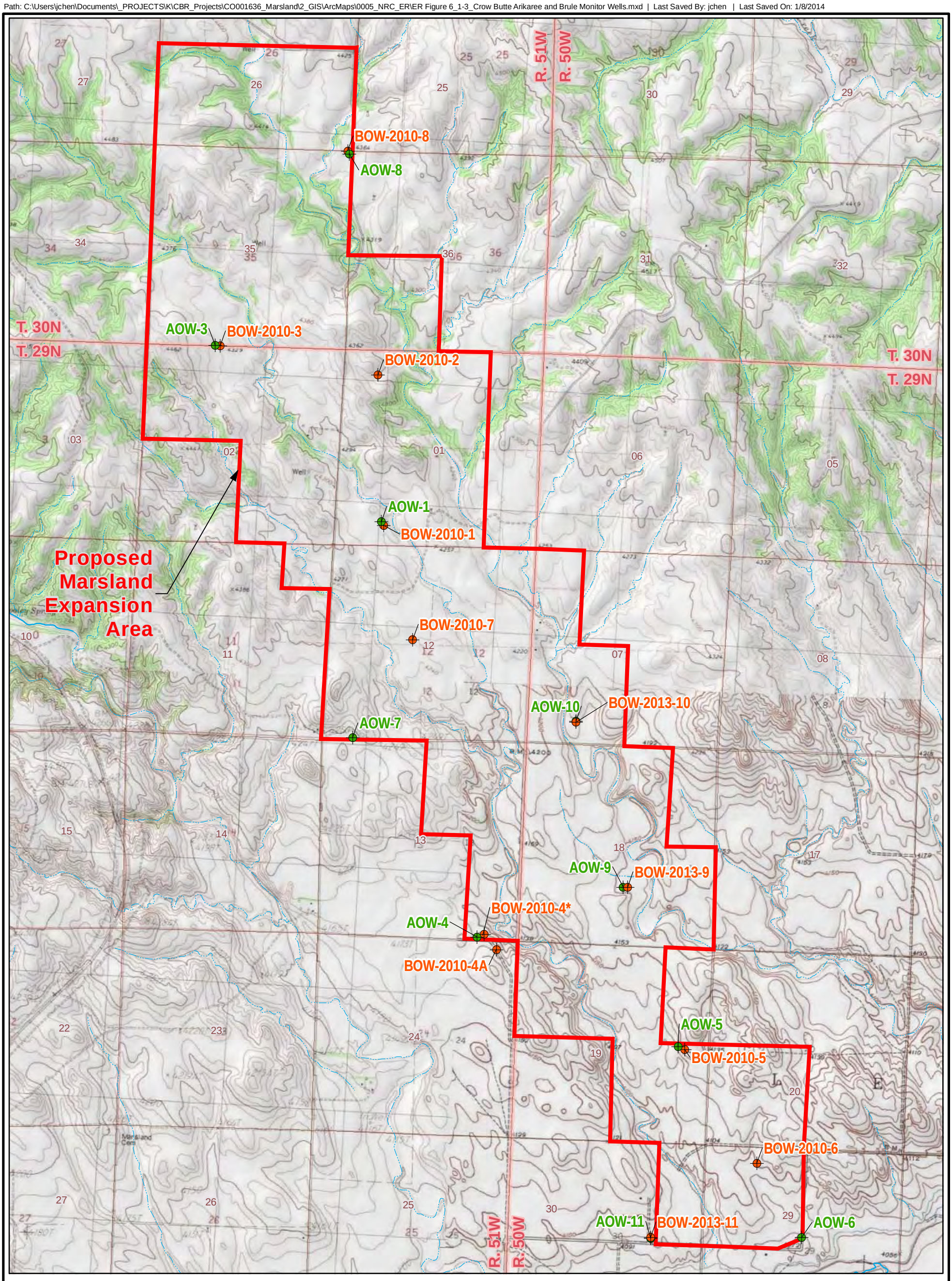
Figure 6.1-3 Arikaree and Brule Monitor Wells within MEA License Boundary

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-3_Crow Butte Arikaree and Brule Monitor Wells.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

- Arikaree Group Well
- Brule Formation Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River

* BOW-2010-4 is inactive and scheduled to be abandoned.

N

0 1,250 2,500

Feet

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

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FIGURE 6.1-3
MARSLAND
ARIKAREE AND BRULE MONITOR WELLS

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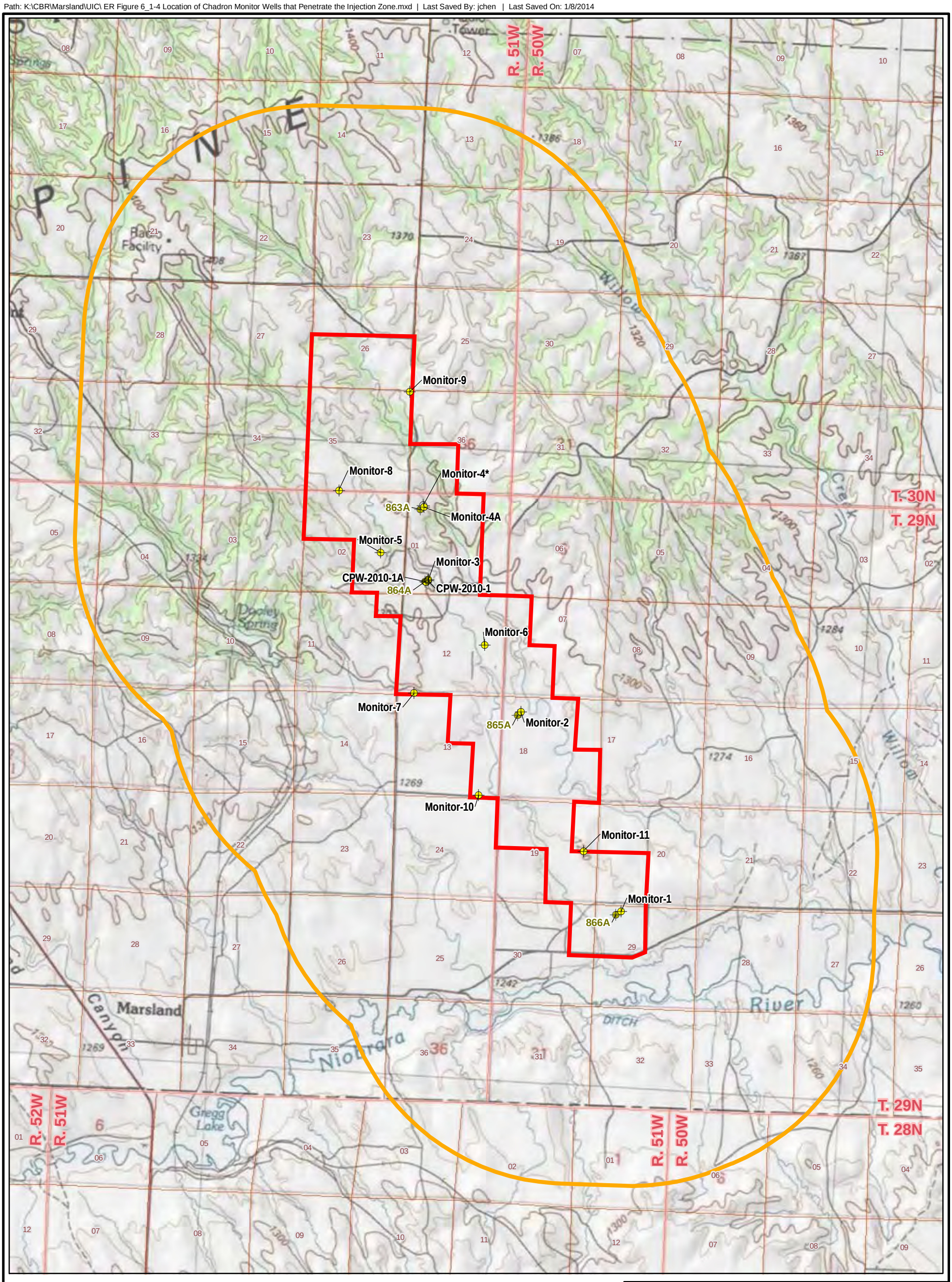
Figure 6.1-4 Location of MEA Active, Inactive, and Abandoned Chadron Monitor Wells that Penetrate the Injection Zone

Path: K:\CBR\Marsland\UIC\ ER Figure 6_1-4 Location of Chadron Monitor Wells that Penetrate the Injection Zone.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

- Proposed Marsland Expansion Area
- Area of Review (AOR)

Pumping Test Monitoring Wells

- Monitor-5 — Active Basal Sandstone of the Chadron Formation Well and Well ID
- Monitor-4* — Inactive Basal Sandstone of the Chadron Formation Well and Well ID
- 865A — Abandoned Chadron Monitor Well and Well ID

N

0 0.5 1

Miles

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

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FIGURE 6.1-4
LOCATION OF MEA ACTIVE, INACTIVE AND ABANDONED CHADRON MONITOR WELLS THAT PENETRATE THE INJECTION ZONE

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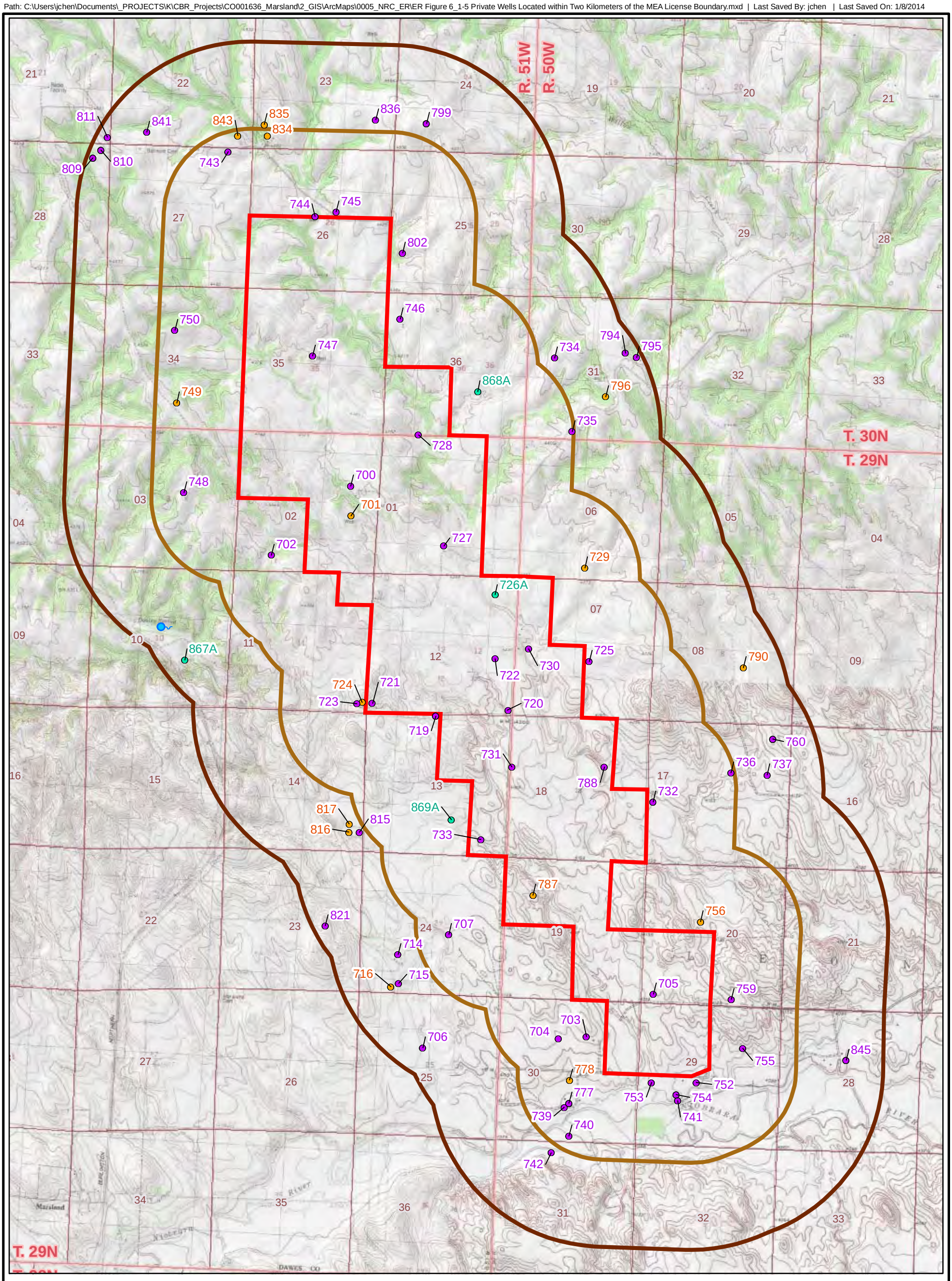
Figure 6.1-5 Private Wells Located within 1 and 2 Kilometers of the MEA License Boundary

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-5 Private Wells Located within Two Kilometers of the MEA License Boundary.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



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

Natural Spring

N

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 6.1-5
PRIVATE WELLS LOCATED WITHIN ONE AND TWO KILOMETERS OF THE MEA LICENSE BOUNDARY

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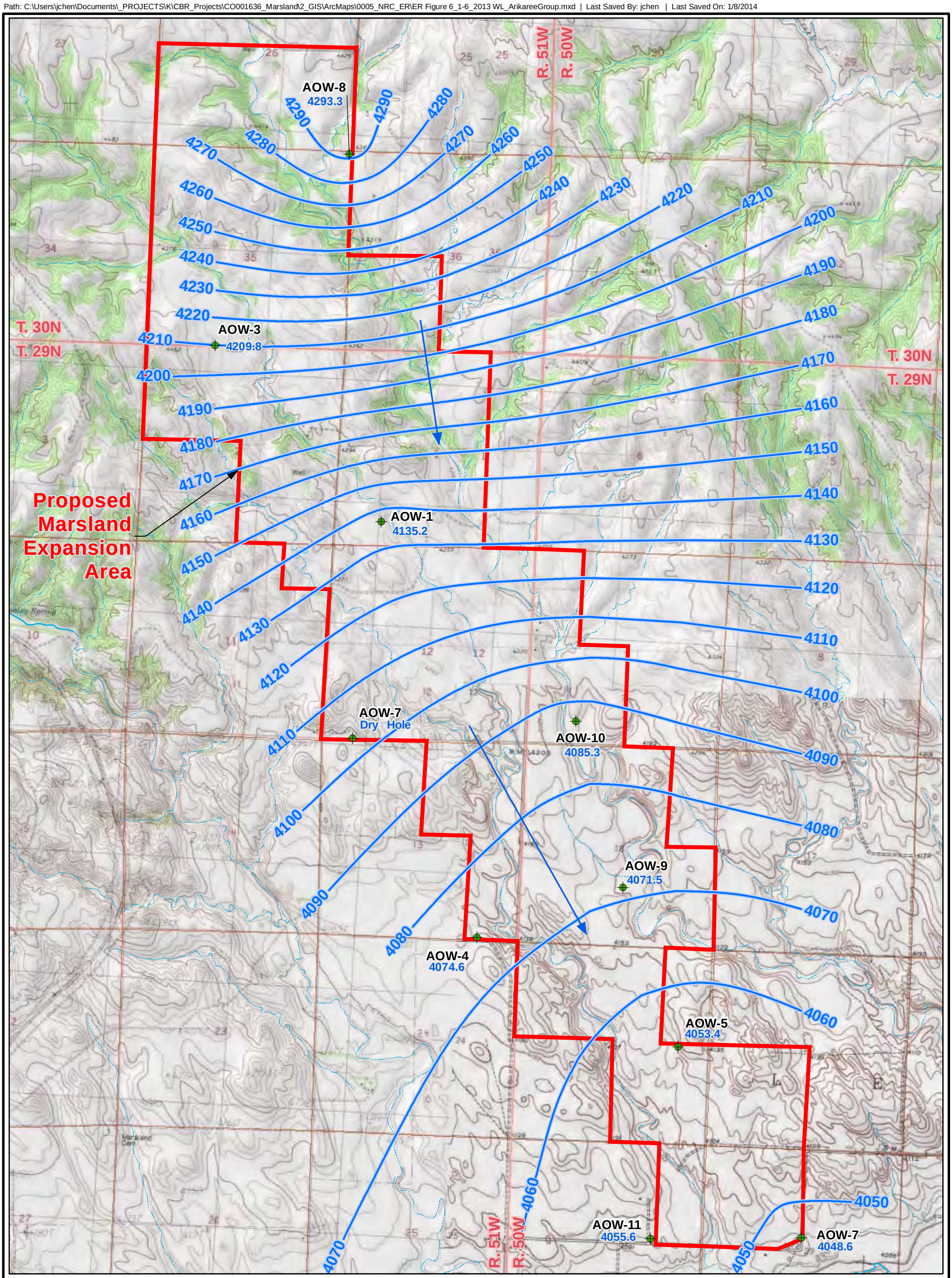
Figure 6.1-6 Marsland Expansion Area Potentiometric Surface Arikaree Group (10/17/2013)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-6_2013 WL_ArikareeGroup.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

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

N

0 1,250 2,500

Feet

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

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FIGURE 6.1-6
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
ARIKAREE GROUP (10/17/2013)

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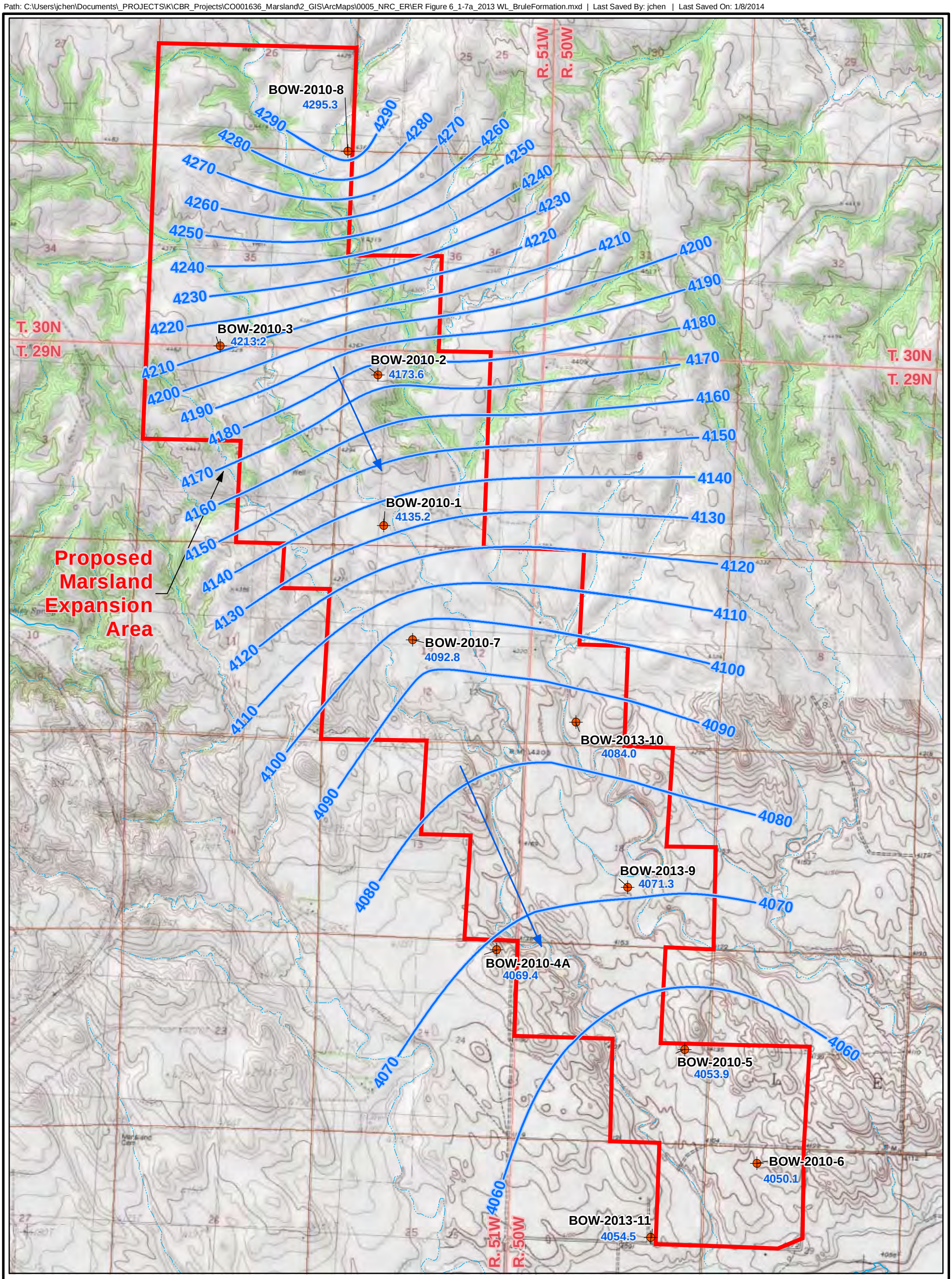
Figure 6.1-7a Marsland Expansion Area Potentiometric Surface Brule Formation (10/17/2013)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-7a_2013 WL_BruleFormation.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

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

N

0 1,250 2,500

Feet

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

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FIGURE 6.1-7a
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
BRULE FORMATION (10/17/2013)

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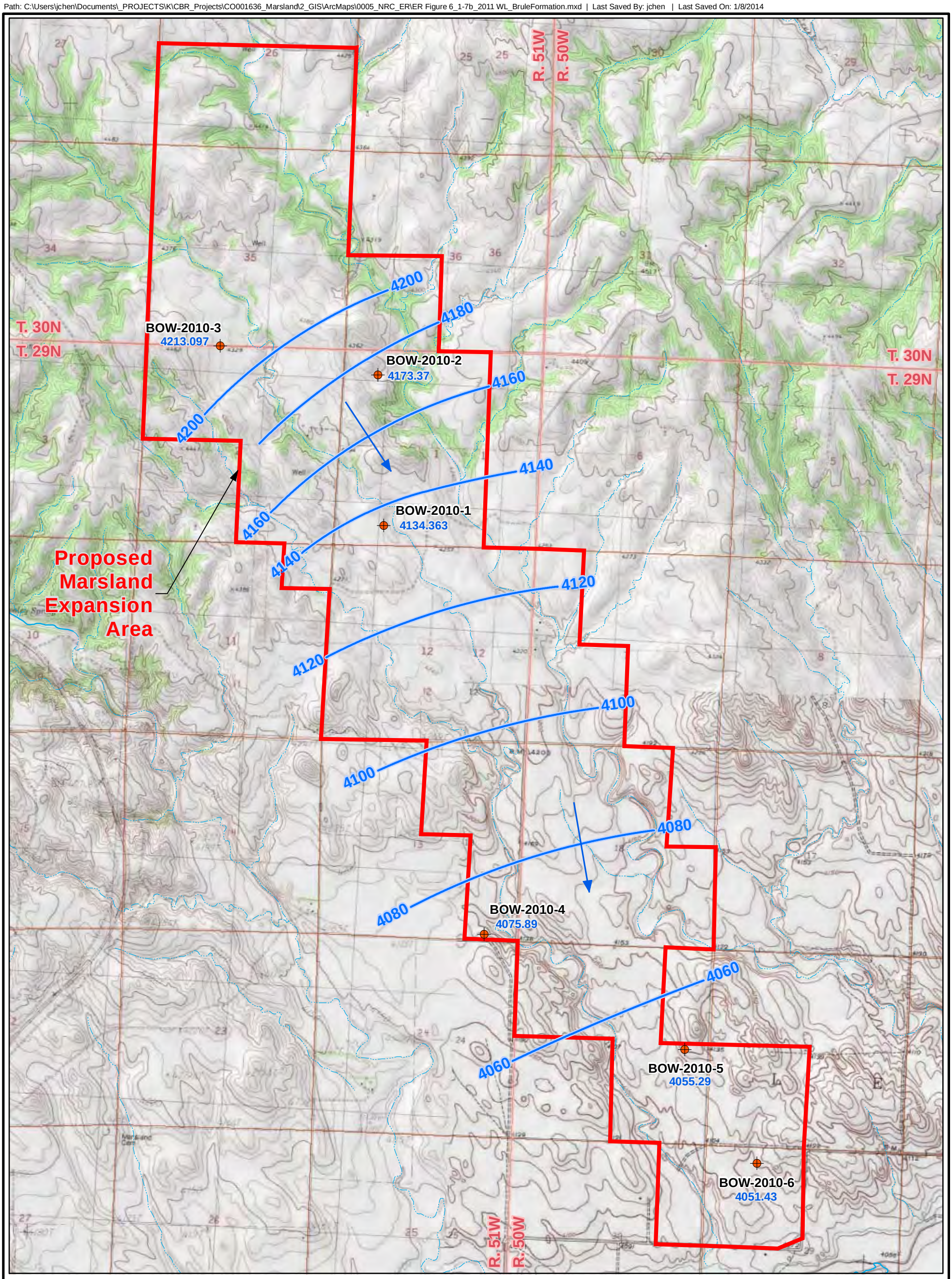
Figure 6.1-7b Marsland Expansion Area Potentiometric Surface Brule Formation (2/22/11)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-7b_2011 WL_BruleFormation.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

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

N

0 1,250 2,500

Feet

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

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FIGURE 6.1-7b
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
BRULE FORMATION (2/22/11)

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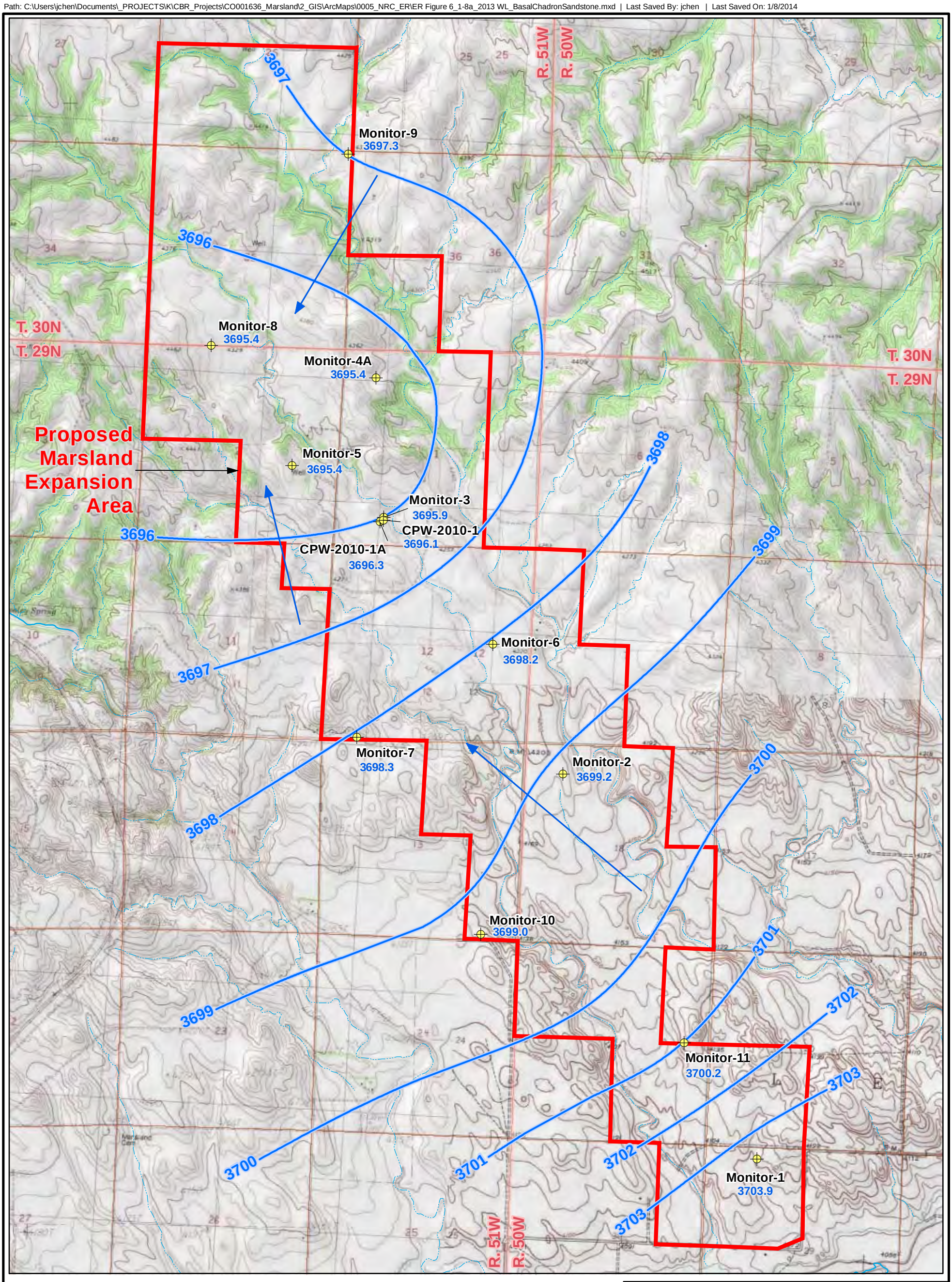
Figure 6.1-8a Marsland Expansion Area Potentiometric Surface Basal Chadron Sandstone (10/17/2013)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-8a_2013 WL_BasalChadronSandstone.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



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

N

0 1,250 2,500

Feet

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

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FIGURE 6.1-8a
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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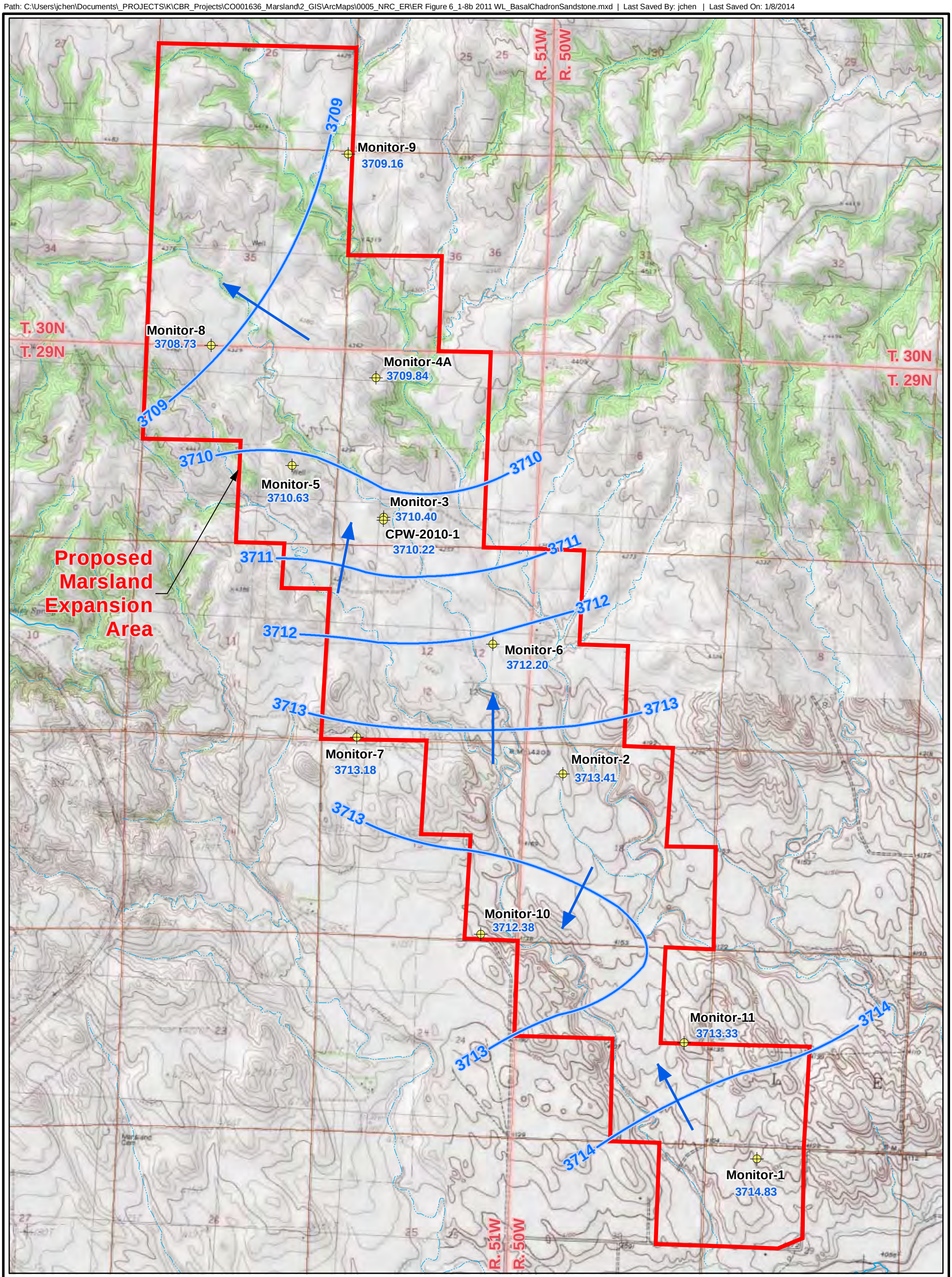
Figure 6.1-8b Marsland Expansion Area Potentiometric Surface Basal Chadron Sandstone (2/22/11)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-8b 2011 WL_BasalChadronSandstone.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



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

N

0 1,250 2,500

Feet

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

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FIGURE 6.1-8b
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
BASAL SANDSTONE OF
THE CHADRON FORMATION (2/22/11)

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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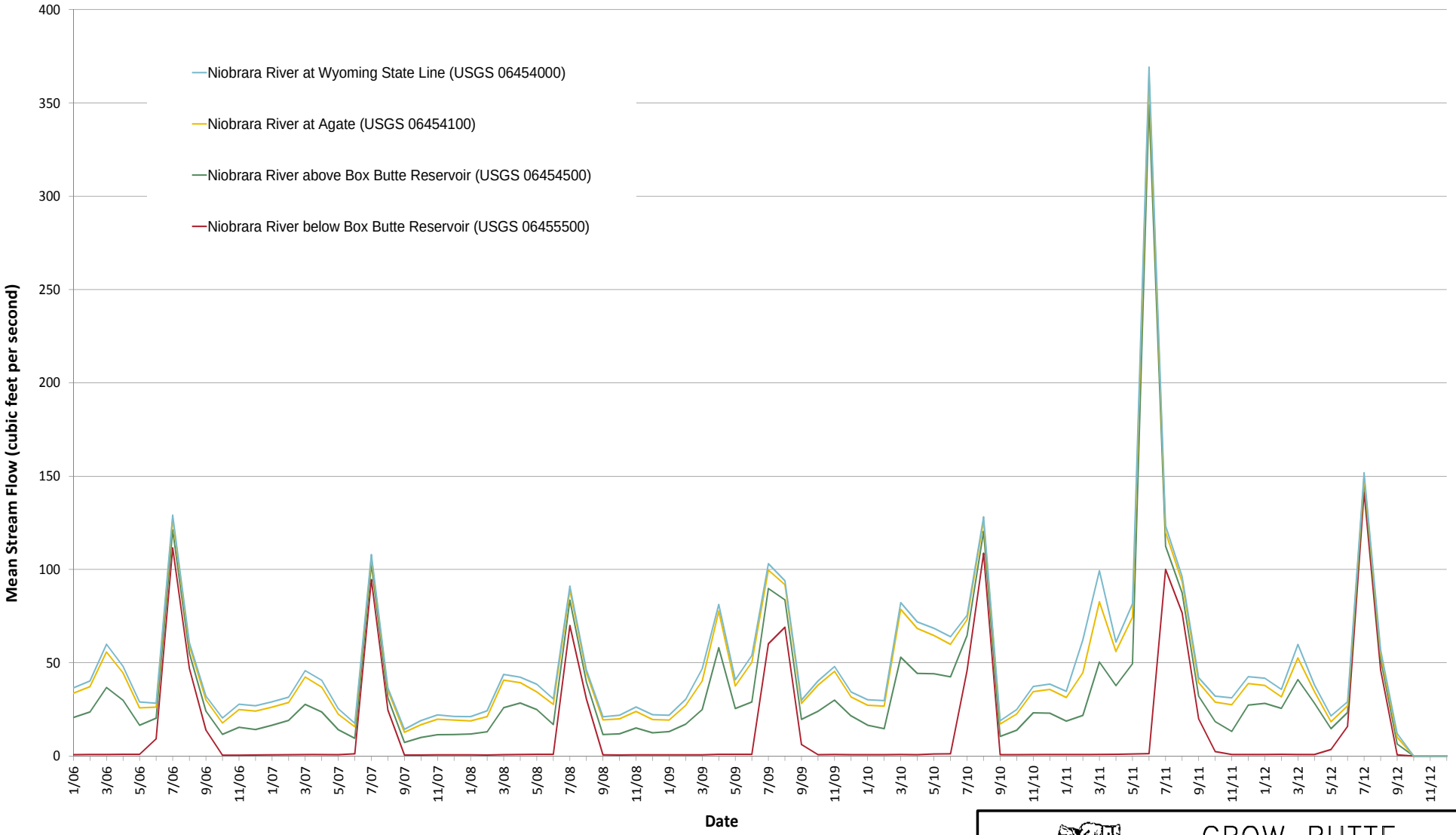
Figure 6.1-9 Mean Stream Flow (cfs) for Niobrara River Stream Gaging Stations in Upper Area in Niobrara River



Source: Williams.2013; Table F.1-3

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FIGURE 6.1-9
UPPER NIOBRARA RIVER AVERAGE FLOWS AT USGS/NDNR STREAM GAGING STATIONS

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K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorNIC_Fig_F 1-5 Upper Niobrara River Average Flows at USGS_NDNR Stream Gaging Stations4.ai @ 09/04/2013

Figure 6.1-10 USGS/NDNR Stream Gaging Stations and NDEQ Sampling Locations for Niobrara River

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ERIER Figure 6_1-10 USGS GagingStations and NDEQ Sampling Locations for Niobrara River.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014

Niobrara River at WY-NE State Line
USGS/NDNR 06454000

Niobrara River at Agate
USGS/NDNR 06454100

Niobrara River above Box Butte Reservoir
USGS/NDNR 06454500
NDEQ SNI4NIOBR402

Niobrara River below Box Butte Reservoir
USGS/NDNR 06455500
NDEQ SNI4NIOBRA20

Box Butte Reservoir from Niobrara River
USGS/NDNR 06455000

T32N R57W T32N R56W T32N R55W T32N R54W T32N R53W T32N R52W T32N R51W T32N R50W T32N R49W
T31N R57W T31N R56W T31N R55W T31N R54W T31N R53W T31N R52W T31N R51W T31N R50W T31N R49W
T30N R57W T30N R56W T30N R55W T30N R54W T30N R53W T30N R52W T30N R51W T30N R50W T30N R49W
T29N R57W T29N R56W T29N R55W T29N R54W T29N R53W T29N R52W T29N R51W T29N R50W T29N R49W
T28N R58W T28N R57W T28N R56W T28N R55W T28N R54W T28N R53W T28N R52W T28N R51W T28N R49W
T27N R58W T27N R57W T27N R56W T27N R55W T27N R54W T27N R53W T27N R52W T27N R51W T27N R49W

US 20 Harrison Fort Robinson State Park Chadron State Park Agate Fossil Beds National Monument *Niobrara River* ROYVILLE FLAT Marsland Box Butte Reservoir State Rec Area SIOUX DAWES BOX BUTTE NE-71-Dodge-Rd 1179 m 1187 m 1270 m 1229 m

LEGEND

- USGS/NDNR Stream Gaging Station and NDEQ Sampling Location
- Niobrara River
- Proposed Marsland Expansion Area
- Area of Review (AOR)

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH FIPS 2600
SOURCE: TOPOGRAPHIC MAP, SERVICED BY ESRI ARCGIS ONLINE

N

0 2 4
Miles

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-10
USGS/NDNR STREAM GAGING STATIONS AND NDEQ SAMPLING LOCATIONS FOR NIOBRARA RIVER

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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7 COST-BENEFIT ANALYSIS

7.1 General

The general need for production of uranium is assumed to be an integral part of the nuclear fuel cycle with the ultimate objective being the operation of nuclear power reactors. In reactor licensing evaluations, the benefits of the energy produced are weighed against environmental costs including a prorated share of the environmental costs of the uranium fuel cycle. The incremental impacts of typical mining and milling operation required for the fuel cycle are justified in terms of the benefits of energy generation to society in general. However, the specific site-related benefits and costs of an individual fuel-cycle facility such as the CPF and the proposed satellite facility must be reasonable as compared to that typical operation.

7.2 Economic Impacts

Monetary benefits have accrued to the community from the presence of the CPF, such as local expenditures of operating funds and the federal, state, and local taxes paid by the project. Against these monetary benefits are the monetary costs to the communities involved, such as those for new or expanded schools and other community services. While it is not possible to arrive at an exact numerical balance between these benefits and costs for any one community (or for the project) because of the ability of the community and possibly the project to alter the benefits and costs, this section summarizes the economic impact of the project to date and projects the incremental impacts from operation of the proposed satellite facility.

7.2.1 Tax Revenues

Table 4.10-1 summarizes the tax revenues from the CPF.

Future tax revenues are dependent on uranium prices, which cannot be accurately forecast; however, these taxes also somewhat depend on the number of pounds of uranium produced by CBR. To the extent that uranium prices remain at current levels (spot market of approximately \$50 per pound U_3O_8 in August 2011 [UxC 2011]), the production from MEA should contribute to higher tax revenues.

The present taxes are based on a relatively consistent production rate of 800,000 pounds per year. The additional production from the MEA facility should be approximately 553,000 pounds per year. The incremental contribution to taxes would be on the order of \$950,000 per year in combined taxes.

7.2.2 Temporary and Permanent Jobs

7.2.2.1 Current Staffing Levels

CBR currently employs approximately 68 employees and two contractors employing 14 people on a full-time basis. Short-term contractors and part-time employees are also employed for specific projects and/or during the summer months. This level of employment is significant to the local economies. Total employment in Dawes County in 2010 was 5,691 (BEA 2011). Based on these statistics, CBR currently provides approximately 1.5 percent of all employment in Dawes County. In 2009, the CBR total payroll was \$4,155,000. Of the total Dawes County wage and salary payments of \$106,652,000 in 2009, the CBR payroll represented about 4 percent.

Total CBR payroll for the past 5 years was:

2006	$2,543,000
2007	$3,822,000
2008	$3,941,000
2009	$4,155,000
2010	$4,200,000

The average annual wage for all workers in Dawes County was $27,347 in 2009. By comparison, the average wage for CBR was approximately $58,821. Entry-level workers for CBR earn a minimum of $16.15 per hour or $33,600 per year, not including overtime, bonus, or benefits.

7.2.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of the MEA will provide approximately 10 to 15 temporary construction jobs for up to 1 year. Permanent CBR employees will perform all other facility construction (e.g., wells and wellfields).

CBR actively pursues a policy of hiring and training local residents to fill all possible positions. Due to the technical skills required for some positions, a small percentage of the current mine staff members (less than 5 percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of positions required at the current facility and those that will be created by any future expansion will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. The annual unemployment rate in Dawes County in 2010 was 4.5 percent, equating to 216 individuals (BLS 2011). CBR expects that any new positions will be filled from this pool of available labor.

CBR projects that the current staffing level will increase by 10 to 12 full-time CBR employees. These new employees will be needed for facility operators and wellfield operator and maintenance positions. Contractor employees (e.g., drilling rig operators) may also increase by four to seven employees depending on the desired production rate. The majority if not all of these new positions will be filled with local hires.

These additional positions should increase payroll by approximately $40,000 per month, or $400,000 to $480,000 per year.

7.2.3 **Impact on the Local Economy**

In addition to providing a significant number of well-paid jobs in the local communities of Crawford, Harrison, and Chadron, Nebraska, CBR actively supports the local economies through purchasing procedures that emphasize obtaining all possible supplies and services available in the local area.

Total CBR payments made to Nebraska businesses for the past 4 years were:

2006	$4,396,000
2007	$5,167,000
2008	$7,685,000
2009	$7,838,700
2010	$4,330,900

The vast majority of these purchases were made in the City of Crawford and Dawes County.

This level of business is expected to continue dependent upon CBR project activities in any given year. As production at the CPF mine site ceases due to depleted ore reserves, expansion areas will be brought on stream. These expansion areas will be sequenced (brought on line) in a manner that will continue CPF production consistent with current production rates. CPF project activities should increase somewhat with the addition of expanded production from the proposed MEA and from restoration activities, although not in strict proportion to production. While there are some savings due to some fixed costs, there are additional expenses that are expected to be higher (wellfield development). Therefore, it can be assumed that the overall effect on local purchases will be relatively proportional to the number of pounds produced. In addition, mineral royalty payments accrue to local landowners. This should translate to additional purchases of $3,650,000 to $4,350,000 per year.

7.2.4 Economic Impact Summary

As discussed in this section, CBR currently provides a significant economic impact to the local Dawes County economy. Approval of the proposed project would have a positive impact on the local economy as summarized in **Table 4.10-2**.

7.2.5 Estimated Value of Marsland Resource

CBR continues to develop the reserve estimates for the MEA. Based on the current recoverable resource estimate of 5,667,926 pounds of U_3O_8 and the current market price of uranium ($50 per pound in August 2011 [UxC 2011]), the total estimated value of the energy resources at MEA is approximately $283,396,300. This value will fluctuate as the market price and realized price vary.

7.2.6 Short-Term External Costs

7.2.6.1 Housing Impacts

The available housing resources should be adequate to support short-term needs during facility construction. In 2010, a total of 568 housing units were vacant in Dawes County out of a total housing base of 4,252 units (USCB 2011). Of the vacant units, 168 were available for rent. In addition to this availability of rental housing units, there are two small hotels in the City of Crawford that generally have vacancies and routinely provide units for itinerant workers such as railroad crews. Temporary housing resources have experienced little change in the past two decades.

Recent data for the City of Crawford indicate that, in 2010, there were a total of 567 houses in the City, with 470 occupied (334 by owners and 136 by renters; USCB 2011). This indicates that 97

housing units were available for purchase or rent. In 2008, the housing density was 467 houses/condos per square mile. The median rent being asked for vacant rental units in 2008 was $337/month. The median purchase price for a home was $51,856 (Advameg 2010).

7.2.6.2 Noise and Congestion

CBR projects an increase in the noise and congestion in the immediate area of the satellite facility during initial construction of the facility. This will include heavy truck and equipment traffic and access to the job site by construction workers. These impacts will be most noticeable to residents in the immediate vicinity of the facility and will be temporary in nature. The increase in noise should be considered in light of the project location, which is two minor rural roads (Hollibaugh and River Roads) used primarily for access.

A BNSF rail line is located east of SH 2/71 and is approximately 1.1 miles (17.7 km) from the MEA boundary at the closest point. Noise from the trains on the BNSF rail line would be intermittently audible to receptors within and in close proximity to the MEA. Dust from construction activities will be controlled using standard dust suppression techniques used in the construction industry.

7.2.6.3 Local Services

As previously noted, CBR actively recruits and trains local residents for positions at the mine. CBR expects that the majority of permanent positions at the MEA will be filled with local hires. As a result of employing the local workforce, the impact on local services should be minimal. In many cases, these services (e.g., schools) are underused due to population trends in the area.

7.2.7 Long-Term External Costs

7.2.7.1 Housing and Services

Because of the small number of people who have needed to move into the area to support CBR activities in the past, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of long-term positions that will be created by the MEA project will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. As stated earlier, CBR expects that the new positions at the satellite facility will be filled from the local pool of available labor.

7.2.7.2 Noise and Congestion

CBR projects a minor increase in the long-term noise and traffic congestion in the immediate area of the satellite facility. Most of this will consist of increased traffic from employees commuting to and from the work site and performing work in the wellfield. Some increase in heavy truck traffic will occur due to deliveries of process chemicals such as O_2 and the shipment of IX resin from the satellite facility to the CPF. Delivery and IX shipments should average two per day. These impacts will be most noticeable to residents in the immediate vicinity of the facility.

The 2008 average daily traffic counts for a segment of SH 2/71 near Marsland at the southern end of the MEA was 675 total vehicles, including 90 heavy commercial vehicles. Traffic levels on SH 2/71 increase to 695 total vehicles, including 90 heavy commercial vehicles in the vicinity of East Belmont Road (NDOR 2010). Secondary and private roads connect with East Belmont

Road, River Road, Hollibaugh Road, and Squaw Mound Road to provide access to residences and agricultural lands within the MEA. The limited additional traffic related to the MEA operation will not significantly affect these routes.

7.2.7.3 Aesthetic Impacts

The primary visible surface structures proposed for the MEA include wellhead covers, wellhouses, electrical distribution lines, and DDW buildings, and one satellite processing building. The project will use existing and new roads to access each mine unit and wellhouse, DDW buildings, and the satellite processing building. Project development would alter the physical setting and visual quality of portions of the landscape, which would affect the overall landscape to some degree. The proposed facilities would introduce new elements into the landscape and would alter the existing form, line, color, and texture that characterize the existing landscape. The project would primarily affect agricultural land.

In foreground-middleground views, the satellite processing building, wellhouses, DDW buildings, and associated access road clearings would be the most obvious features of development. Clearings and access roads would be visible as light tan exposed soils in geometrically shaped areas with straight, linear edges that provide some textural and color contrasts with the surrounding cropland. The satellite facility processing building, wellhouses, wellhead covers, and DDW buildings would be painted to harmonize with the surrounding soil and vegetation cover. These facilities would be visible from Squaw Mound Road and the residence within the license boundary, but would be subordinate in scale to the rural landscape.

The electric distribution line poles would be an estimated 20 feet tall, and would be located throughout the project area to connect wellhouses with existing lines. The distribution lines are similar in appearance to those typical of the rural landscape, but would occur at a higher density than on adjacent lands. The lines would be obvious to viewers at the viewing areas, but would not change the rural character of the existing landscape.

Wellhead covers would be difficult to discern in the landscape from any sensitive viewing area. The form and textural contrast would be very weak because the relatively low profile (3 feet high) and small size of these would disappear into the surrounding textures of soil and vegetation. Generally, color contrasts are most likely to be visible in foreground-middleground distance zone. However, the wellhead covers would be painted a tan color that would harmonize with the surrounding vegetation and soil colors. Therefore, contrast of line, form, texture, and color would be low. The facilities would not be noticeable to the casual observer. Wellhead covers would be visually subordinate to the landscape in foreground-middleground distance zone.

7.2.7.4 Land Access Restrictions

Property owners of land located within the immediate wellfield and facility boundaries will lose access and free use of these areas during mining and reclamation. The areas impacted are all used for agricultural purposes, and the owners will lose the ability to use the areas for production purposes. Offsetting these land use restrictions are the surface lease and mineral royalty payments to the landowners.

7.2.8 Most Affected Population

The expected impacts from the proposed MEA can be characterized as an incremental increase in the impacts from current CBR operations. For the most part, the impact from operation of the current Crow Butte Uranium Project has been positive. CBR has provided much needed well compensated employment opportunities for the local population. Additionally, the policy of purchasing goods and services locally to the extent possible has had a positive economic impact on an area facing economic challenges. Tax expenditures, particularly the recent increases in local property taxes paid due to the increase in the price of uranium, have had a positive economic impact on local government-provided services.

Offsetting these positive impacts to the local population are increases in noise, traffic congestion, and aesthetic impacts for residents in and adjacent to the proposed satellite facility. Most residents located in the proposed license area are landowners who have mineral and/or surface leases with CBR and will benefit economically from the presence of the facility.

7.2.9 Satellite Facility Decommissioning Costs

Approval of the proposed satellite facility will result in CBR incurring additional decommissioning liabilities for the installed facilities. The actual estimated decommissioning costs will be included in the annual surety update required by SUA-1534 submitted to the NDEQ and the NRC for approval prior to construction activities.

This section presents a written estimate of the costs for "environmental protection" deemed to be necessary during and after the cessation of operations. These cost estimates focus on costs associated with the restoration and reclamation (decommissioning) of the MEA in order to ensure that adequate funds are available for permanent closure of the project. The cost estimates address the above-referenced "measures" of concern. The estimated decommissioning costs will be included in the annual surety update required by SUA-1534 submitted to the NDEQ and the NRC for approval prior to construction activities.

The NRC requires a financial surety arrangement consistent with 10 CFR 40, Appendix A, Criterion 9 to cover costs of reclamation activities. Evidence of financial responsibility in the form of a letter of credit or other form satisfactory to the NDEQ in accordance with Title 122, Chapter 13, shall be provided to the NDEQ in an amount equal to or greater than the total costs indicated in the Surety Cost Estimate as required, along with an audit statement from an independent professional auditing firm. CBR will review the cost estimate annually and update in order to ensure adequacy of the dollar amount. The purpose is to ensure that there are sufficient funds available for decontamination, decommissioning, and reclamation of the facility in the event CBR is incapable of performing the tasks. NRC License SUA-1534 requires that CBR continuously maintain an approved surety instrument for Crow Butte Resources, Inc., in favor of the State of Nebraska. CBR is required to ensure that the financial assurance instrument, when authorized by the State of Nebraska, identifies the NRC-related portion of the instrument and covers the aboveground decommissioning and decontamination, the cost of off-site disposal of solid byproduct material, soil and water sample analyses, and groundwater restoration associated with the site. The basis for the cost estimate is the NRC-approved site closure plan or the NRC-approved revisions to the plan. Reclamation or decommissioning plan cost estimates and annual updates will follow the outline in Appendix C to RG-1569, entitled "Recommended Outline for Site-Specific In-Situ Leach Facility Reclamation and Stabilization Cost Estimates."

Groundwater and surface reclamation and restoration methods to be used for the MEA are discussed in Section 5. A decommissioning plan shall be based on factors such as the mine plan, baseline environmental information, and any other factors that will assure the long-term physical, geotechnical, and geochemical stability of the site. Restoration of a specific MU can start as soon as mining is completed, hence the importance of integrating the mine plan and the decommissioning plan. Restoration of a specific MU can occur while uranium recovery operations continue at other MUs. Once groundwater restoration has been completed in the final MU and approved by the NDEQ, decommissioning of the satellite processing plant, remaining CPF evaporation ponds, and other structures can be initiated.

The cost estimates presented in this section are based on the cost per year to restore one MU and reclaim one MU (surface and subsurface features). The CBR mine plan calls for sequential restoration and reclamation, and CBR will have approximately two to three MUs in restoration, mining, or reclamation at any one time. The surety cost estimates will be adjusted as necessary when additional MUs are to be brought on line and the proposed operations are better defined. A current and updated surety is required at least 90 days prior to commencement of construction of a new MU or significant expansion.

Cost information is presented in the following tables located in **Appendix P**:

Table P.1-1	Primary Assumptions Serving as the Basis for Surety Cost Estimates Associated with Restoration and Reclamation of One (1) Mine Unit
Table P.1-2	Marsland Total Restoration and Reclamation – 2013 Surety Estimate
Table P.1-3	Marsland Groundwater Restoration – 2013 Surety Estimate
Table P.1-4	Marsland Wellfield Reclamation – 2013 Surety Estimate
Table P.1-5	Marsland Well Abandonment Unit – 2013 Surety Estimate
Table P.1-6	Marsland Satellite Facility Equipment Decommissioning – 2013 Surety Estimate
Table P.1-7	Marsland Building Demolition Cost – 2013 Surety Estimate
Table P.1-8	Marsland Miscellaneous Site Reclamation – 2013 Surety Estimate
Table P.1-9	Marsland Deep Disposal Well Reclamation – 2013 Surety Estimate
Table P.1-10	Marsland Groundwater IX Treatment (GIX) Restoration 9Unit Cost]
Table P.1-11	Marsland Groundwater Reverse Osmosis (RO) Treatment [Unit Cost] – 2013 Surety Estimate
Table P.1-12	Marsland Groundwater Recirculation [Unit Cost] – 2013 Surety Estimate
Table P.1-13	Marsland Well Abandonment [Unit Cost] – 2013 Surety Estimate
Table P.1-14	Five Year Mechanical Integrity Tests (MIT) – 2013 Surety Estimate
Table P.1-15	Marsland Master Cost Basis – 2013 Surety Estimate

Table P.1-1 presents the primary assumptions that serve as the basis for the surety cost estimates associated with restoration and reclamation of one MU (as of June 11, 2013). **Table P.1-2** provides a summary of the total estimated costs for projected restoration and reclamation activities for MU 1 ($2,286,647), which includes a contract administration and contingency fees of 10 and 15 percent, respectively. The remaining tables further refine the cost estimates and the basis for the tasks and cost estimates. The DDWs will operate under a separate UIC permit, but

the reclamation cost estimates for this well have been provided as part of the total surety estimate for the MEA.

7.3 The Benefit Cost Summary

The benefit-cost summary for a fuel-cycle facility such as the CPF involves comparing the societal benefit of a constant U_3O_8 supply (ultimately providing energy) against possible local environmental costs for which there is no directly related compensation. For this project, there are basically three of these potentially uncompensated environmental costs:

- Groundwater impact
- Radiological impact
- Disturbance of the land

The groundwater impact is considered to be temporary in nature, as restoration activities will restore the groundwater to a pre-mining quality. The successful restoration of groundwater at the CPF during the R&D project and the commercial restoration of MU 1 have demonstrated that the restoration process can meet this criterion successfully.

The radiological impacts of the current and proposed project are small, with all radioactive wastes being transported and disposed of offsite. Radiological impacts to air and water are also minimal. Extensive ongoing environmental monitoring of air, water, and vegetation has shown no appreciable impact to the environment from the CPF.

The disturbance of the land for a satellite facility and related activities is quite small, especially when compared with conventional surface mining techniques. All of the disturbed land will be reclaimed after the project is decommissioned and will become available for previous uses.

7.4 Summary

In considering the energy value of the U_3O_8 produced to U.S. energy needs, the economic benefit to the local communities, the minimal radiological impacts, minimal disturbance of land, and mitigable nature of all other impacts, it is believed that the overall benefit-cost balance for the proposed MEA is favorable, and that amending SUA-1534 is the appropriate regulatory action.

8 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

This ER has characterized the existing baseline environment of the MEA and the surrounding area in Section 3. The potential environmental impacts (adverse and positive) of the proposed action were discussed in detail in Section 4. In this impact analysis, CBR identified unavoidable impacts of the proposed action. Alternatives for mitigation were discussed in Section 5.

This section summarizes the environmental impacts that cannot be avoided. Where available, means of mitigation is summarized.

Table 8.1-1 summarizes the unavoidable environmental impacts of the proposed construction, operation, and decommissioning of the MEA. Each impact is quantified (where possible). All impacts are short-term (i.e., the predicted impact will exist during the construction, operation, and decommissioning of the MEA). No significant long-term impacts have been identified that would extend beyond the duration of the project. For each impact, mitigative measures are summarized.

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Table 8.1-1 Unavoidable Environmental Impacts

Table 8-1 Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
Production		
Production of U3O8 (lbs./yr.)	600,000	None
Use of Natural Resources		
Temporary Land Surface Impacts (acres)	Significant land surface impacts to 14 acre satellite plant site; minimal disturbance to remaining 1,629 acres of wellfield; impacted for the duration of the project.	Sediment and topsoil management during construction and operation; Surface reclamation following operational activities to return surface to pre-operational condition.
Temporary Land Use Impacts	Restriction of agricultural use of proposed 4,487 acre site; restricted access for the duration of the project.	Surface reclamation following operational activities to return surface to pre-operational use.
Lost cattle production ($/yr.)	$27,292	Compensation to landowners through surface leases and/or mineral royalties.
Lost crop production ($/yr)	$1,011	Compensation to landowners through surface leases and/or mineral royalties.
Groundwater consumption in Basal Chadron Formation (net gpm)	50	None
Groundwater quality impacts	Temporary impacts to groundwater quality in the basal sandstone of the Chadron Formation mining zone.	Proven groundwater restoration following mining to return Chadron groundwater quality to baseline or pre-operational water uses.
Visual and scenic impacts	Noticeable minor industrial component in existing agricultural/rural landscape; VRM Class III objectives met.	Use of harmonizing colors; use of existing vegetation and topography; avoidance of straight line site roads to follow topography; removal of construction debris.
Emissions		
Dust emissions (tons/yr.)	23.7	Dust control measures implemented where appropriate.
Radon emissions (Curies/yr.)	Additional maximum dose rate within 80 km = 1.6 person-rem/yr	None
Radiological Impacts		
Additional maximum predicted dose (mrem/yr.)	21.0 (nearby resident)	None
Highest dose rate at cities and towns within an 80 km radius of MEA was at Towns of Marsland and Hemingford, NE (m/rem/yr)	0.9	None

Table 8-1 Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
Socioeconomic Impacts		
Employment		
Additional full time employment	10 to 12	None
Additional contractor employment	4 to 7	None
Part time and contractor employment (during satellite construction)	10 to 15	None
Additional CBR payroll ($/yr.)	$400,000 to $480,000	None
Taxes Paid ($/yr.)	$1,000,000 to $1,200,000	None
Local purchases	$3,650,000 to $4,350,000	None
Waste Management Impacts		
Wastewater (gpm)	65	None
Solid waste produced (yd^3/yr.)	700	None
11(e)2 byproduct waste produced (yd^3/yr.)	60	None

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10 LIST OF PREPARERS

The following individuals and organizations were involved in the preparation of the Technical Report and this Environmental Report supporting the amendment request for Source Materials License SUA-1534 to allow development of the MEA:

Crow Butte Resources, Inc.
PO Box 169
Crawford, Nebraska 69339

Jim Stokey, Ph.D.	Mine Manager
Larry Teahon	Manager, Safety, Health, Environment and Quality
Wade Beins	Senior Geologist
Rhonda Grantham	Supervisor of Radiation Safety & Regulatory Affairs / RSO
Jessica Horwitz	Cameco Staff Geologist
Walter Nelson	Environmental Leadership Coordinator

Cameco Resources
2020 Carey Avenue, Suite 600
Cheyenne, Wyoming 82001

Lee Snowhite	Senior Engineer
John Schmuck	Senior Permitting Manager
Josh Leftwich	Director of Licensing
Tom Young	Vice-President, Operations

Cameco Resources
Casper Development Group
Casper, WY 82601

Bryan Soliz	Director Exploration and Development

Aqui-Ver, Inc.
4800 Wadsworth Boulevard
Suite 400
Wheat Ridge, CO 80033

Bob Lewis	Senior Hydrogeologist

Hayden-Wing Associates, LLC
Natural Resource Consultants
2308 South 8th Street
Laramie, WY 82070

Chad Olsen	Senior Wildlife Biologist

ARCADIS US Inc.,
630 Plaza Drive, Suite 100
Highlands Ranch, Colorado 80129

Jerry Koblitz	Principal-in-Charge/Quality Control Officer
Jack Cearley	Project Manager
Eric Cowan	Project Management/Document Coordination
Jason Adams	Staff Scientist – Geologist
Matt Spurlin	Hydrologist/3D Visualization Specialist
Leone Gaston	Senior Hydrology Specialist
Carl Spath, Ph.D.	Archeologist
Russel Jalbert	Senior Environmental Scientist
Richard Londergan	Principal Scientist
Craig Devine	Senior Hydrology Scientist
Conrad Mulligan	Senior Scientist
Allison Haraminac	Staff Scientist – Biologist
Adam Graves	Principal Investigator
Natalie Graves	Project Archaeologist
Hugh Roberts	Senior Engineer
Shan Zou	Project Engineer
Ann Acharya	Sediment Transport Analyst
Zachery Cobell	Surface Water Hydrologist.
Andrea Rayner	Scientist
Chris Witty	Project Engineer
Mike Holle	GIS Specialist
Debra Ballheim	Technical Editor
Matthew Hoefer	CAD Drafter 3
Mike Holle	GIS Specialist
Jie Chen	GIS Specialist/CAD Specialist
Clayre Brown	Word Processing

Appendix A

Water User Survey Information for Active and Abandoned Water Supply Wells within 2.25-Mile Area of Review

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Crow Butte Marsland Expansion Area (MEA) – Compiled Environmental Report (ER)
ADAMS Package No. ML17325B322

Note and Errata

The documents in the above-referenced ADAMS package constitute a compiled Environmental Report (ER) for Crow Butte Marsland Expansion Area (MEA) license amendment application. The NRC staff has compiled this set of documents in one ADAMS package to provide a single reference version of the ER to cite in the staff's environmental review documents. The package contains the most recent ER text, tables, figures, and appendices based on the original ER, (dated May 16, 2012) and updates submitted in August 2013, December 2013, January 2014, and April 2014. This compiled ER is based on documents that are publicly available in ADAMS. The staff has dated this compiled ER April 25, 2014, to correspond to the date of the last ER update provided by the applicant.

In the compiled ER, tables and figures have been inserted at the end of each chapter, after the corresponding caption pages.

The NRC staff has made reasonable efforts to ensure the correctness of this compiled ER. If you discover any errors, please contact Jean Trefethen, Environmental Project Manager jean.trefethen@nrc.gov.

The following table lists errata that were discovered when compiling this document:

Table/Figure Title (List of Tables/Figures)	**Table/Fig No. (text)**	**Table/Fig No. (caption page)**	**Table/Fig No. (actual table)**
Table 3.1-7 Uranium Recovery Activities in Region of Proposed Marsland Expansion Area	3.1-7	3.1-7	3.1-8
Table 3.3-4 USGS Abbreviated Modified Mercalli (MM) Intensity Scale	3.3-4	3.3-4	3.3-3
Table 3.3-5 Historical Earthquakes in Northwestern Nebraska in Close Proximity to the Chadron and Cambridge Arches (1884 – 2009)	3.3-5	3.3-5	3.3-4
Table 3.3-6 Earthquakes in Wyoming and South Dakota Within 125 miles of City of Crawford, NE (1992 – 2009)	3.3-6	3.3-6	3.3-5
Table 3.3-7 Summary of Soil Resources Within the MEA	3.3-7	3.3-7	3.3-6
Table 3.4-6 Water Levels – Arikaree Group, Brule Formation and Basal Chadron Sandstone of Chadron Formation	Included in list of tables but not referred to in text of the April 2014 ER update		

Table/Figure Title (List of Tables/Figures)	Table/Fig No. (text)	Table/Fig No. (caption page)	Table/Fig No. (actual table)
Table 3.4-7 Summary of 2011 Marsland Pumping Test #8 Well Information	3.4-7	3.4-7	3.4-6
Table 3.4-8 Summary of 2011 Marsland Pumping Test Results	3.4-8	3.4-8	3.4-7
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Table. 8.1-1	8.1-1	8.1-1	8-1
Figure 3.3-17 Earthquake Hazard Ranking in the U.S.	3.3-17	3.3-17	3.3-14
Figure 3.3-18 Seismic Hazard Map for Nebraska (2008)	3.3-18	3.3-18	3.3-15
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Figure 3.12-1 Disposal Water Balance Marsland Expansion Area Figure 3.12-2 Marsland Expansion Area Water Balance and Process Flow Diagram Figure 3.12-3 Marsland Hydraulic Containment Analyses	Provided with the August 2013 ER update, and referred to in text of April 2014 ER update, but not included in List of Figures. These figures can be found after Figure 3.10-1 in Compiled ER.		