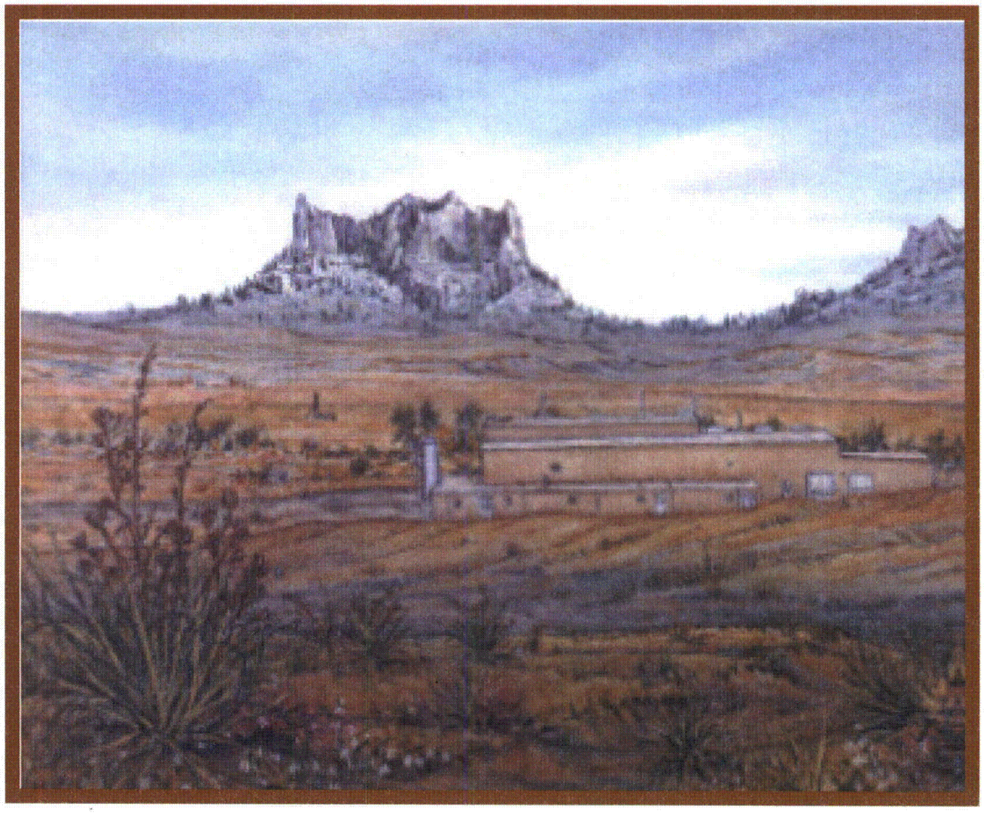
Application for Amendment of USNRC Source Materials License SUA-1534 Marsland Expansion Area Crawford, Nebraska

Volume I

Technical Report



Prepared by
Crow Butte Resources, Inc.
86 Crow Butte Road
Crawford, Nebraska 69339

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CROW BUTTE RESOURCES, INC.

Nuclear Regulatory Commission

Technical Report

Volume I

Marsland Expansion Area

May 2012

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ACRONYMS AND ABBREVIATIONS

μCi/ml	microCurie per milliliter
$\mu g/m^3$	micrograms per cubic meter
μmhos/cm	micromhos per centimeter
μR/hr	microRoentgens per hour
ACL	Alternative Concentration Limit
AERMOD	AMS/EPA Regulatory Model
ALARA	As Low as Reasonably Achievable
ALI	Annual Limit on Intake
AMS	American Meteorological Society
amsl	above mean sea level
ANSI	American National Standards Institute
AOR	area of review
AP	air permit
API	American Petroleum Institute
ASOS	automated surface observing systems
ASTM	ASTM International
ATV	all-terrain vehicle
BBS	Breeding Bird Society
BEA	Bureau of Economic Analysis
bgs	below ground surface
BLM	Bureau of Land Management
BMP	Best Management Practice
BNSF	Burlington Northern Santa Fe
BPT	best practicable technology
$CaCO_3$	calcium carbonate
CAD	computer-aided design
CBR	Crow Butte Resources, Inc.
CDERA	Carribean Disaster Emergency Response Agency
CEDE	Committed Effective Dose Equivalent
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGA	Compressed Gas Association
cm^2	square centimeter
cm/sec	centimeters per second
CO	carbon monoxide
CO_2	carbon dioxide
COOP	Cooperative Observer Program
CPF	Central Processing Facility

cpm	counts per minute
CPS	counts per second
CRSO	Corporate Radiation Safety Officer
CSC	Chadron State College
D/W/Y	day/week/year
DAC	derived air concentration
dBA	A-weighted decibels
DDE	deep dose equivalent
DDW	deep disposal well
DEM	digital elevation model
DFIRM	Digital Floodplain Insurance Rate Map
DLG	Digital Line Graph
DOE	Department of Energy
DOT	Department of Transportation
DPS	Distinct Population Segment
DQO	Data Quality Objective
dpm	disintegrations per minute
DUSA	Dension Mines, USA
EA	Environmental Assessment
Eh	oxifation-reduction potential
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Ecological Study Area
ESRI	Earth Sciences and Resources Institute
ET	evapotranspiration
FEMA	Federal Emergency Management Agency
FESA	Federal Endangered Species Act
ft amsl	feet above mean sea level
ft/day	feet per day
ft^2/day	square feet per day
ft^3	cubic feet
g	gravity
GAM/NAT	natural gamma
GIS	Geographic Information System
GNIS	Geographical Names Information System
gpd	gallons per day
gpd/ft	gallons per day per foot
gpm	gallons per minute
GPS	Global Positioning System
GR	gamma ray
H_2O_2	hydrogen peroxide

H_2S	hydrogen sulfide
HDPE	high-density polyethylene
HEPA	high-efficiency particulate arrestor
HMR	Hazardous Materials Regulation
HPIC	High-Pressure Ionization Chamber
HPRCC	High Plains Regional Climate Center
HPT	Health Physics Technician
HSMS	Health and Safety Management System
HUC	hierarchal hydrologic unit (hydrologic unit code)
HWA	Hayden-Wing Associates
i	exposure period
ICRP	International Commission on Radiological Protection
Ir	annual intake of radionuclide r by inhalation
ISO	International Organization for Standardization
ISR	in-situ recovery
IX	ion exchange
JFD	joint frequency distribution
km	kilometers
LAN	local area network
lbs	pounds
LDE	Lens Dose Equivalent
LLD	lower limit of detection
LSA	Low Specific Activity
LULC	land use and land cover
Ma	million years ago
m^2	square meters
m/s	meters per second
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MBTA	Migratory Bird Treaty Act
MCL	Maximum Contaminant Level
md	millidarcies
MDC	Minimum Detectable Concentration
MEA	Marsland Expansion Area
MeV	million electron volts
mg/cm^2	milligrams per square centimeter
mg/L	milligrams per liter
Mgal/day	million gallons per day
MILDOS-AREA	calculation of radiation dose from uranium recovery operations
MIT	mechanical integrity testing
MM	Mercalli Modified
mm	millimeters

mph	miles per hour
mR/hr	milliRoentgens per hour
mRem	millirem
mRem/yr	millirem per year
MSHA	Mine Safety and Health Administration
mSv	milliSievert
MU	mine unit
n	number of exposure periods in the year
NA	not applicable
$NACO_3$	Sodium Carbonate
$NaHCO_3$	sodium bicarbonateNa_2S sodium sulfide
NAAQS	National Ambient Air Quality Standards
NAD 1927	North American Datum of 1927
NaI	sodium iodide
NAIP	National Agricultural Imagery Program
NaOH	sodium hydroxide
NASS	National Agricultural Statistics Service
NBELF	Nebraska Board of Educational Lands and Funds
NCCPE	Nebraska's Coordinating Commission for Postsecondary Education
NCDC	National Climate Data Center
NCRP	National Council of Radiation Protection
NDA	Nebraska Department of Agriculture
NDE	Nebraska Department of Education
NDED	Nebraska Department of Economic Development
NDEQ	Nebraska Department of Environmental Quality
NDHHS	Nebraska Department of Health and Human Services
NDNR	Nebraska Department of Natural Resources
NDOL	Nebraska Department of Labor
NDOR	Nebraska Department of Roads
NED	national elevation dataset
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NGPC	Nebraska Game and Parks Commission
NGS	National Geodetic Society
NHD	national hydrography database
NIOSH	National Institute of Occupational Saftey and Health
NLCD	national land cover data
N-N	neutron-neutron
NNHP	Nebraska Natural Heritage Program
NNLP	Nebraska Natural Legacy Project
NO_2	nitrogen dioxide

NOAA	National Ocean and Atmospheric Administration
NOGCC	Nebraska Oil and Gas Conservation Commission
NOI	Notice of Intent
NOU	Nebraska Ornithologists Union
NO_x	nitrogen oxides
NPDES	National Pollution Discharge Elimination System
NPPD	Nebraska Public Power District
NPS	National Park Service
NRC	Nuclear Regulatory Commission
NRCS	National Resources Conservation Service
NRPH	National Register of Historic Places
NRS	Nebraska Revised Statutes
NSHS	Nebraska State Historical Society
NTEA	North Trend Expansion Area
NTU	nephelometric turbidity unit
NVLAP	National Voluntary Laboratory Accrediation Program
NWI	National Wetlands Inventory
NWS	National Weather Service
O_2	gaseous oxygen
OHSAS	Occupational Health and Safety Management System
OSHA	Occupational Safety and Health Administration
OSLD	optically stimulated luminescence dosimeter
PAD	Personal Alpha Dosimeter
PBL	performance-based license
PBLC	Performance-Based License Condition
pCi/l	picoCuries per liter
person-Rem/yr	person-Rem per year
PFYC	potential fossil yield classification system
PM_{10}	particulate matter measuring 10 micrometers or less in diameter
$PM_{2.5}$	particulate matter measuring 2.5 micrometers or less in diameter
PPE	personal protective equipment
ppm	parts per million
PPMP	Preoperational/Preconstruction Monitoring Program
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
psig	pound-force per square inch gauge
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	Quality Assurance/Quality Control
QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan

QC	quality control
rad/d	rad per day
RCRA	Resource Conservation and Recovery Act
R&D	research and development
Rem	Roentgen equivalent man
RES	single point resistance
RG	Regulatory Guide
RL	reporting limit
RMP	Risk Management Program
RO	reverse osmosis
ROI	radius of influence
RPPA	Respiratory Protection Program Administrator
RSIC	Radiation Safety Institute of Canada
RSO	Radiation Safety Officer
RUSLE	Revised Universal Soil Loss Equation
RWP	radiation work permit
SCDA	sequential control and data acquisition
SCS	Soil Conservation Service
SDE	shallow dose equivalent
SER	Safety Evaluation Report
SERP	Safety and Environmental Review Panel
SHEQMS	Safety, Health, Environment and Quality Management System
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SOP	standard operating procedure
SP	spontaneous potential
SPCC	Spill Prevention, Control, and Countermeasure
SRWP	Standing Radiation Work Permit
SS	stainless steel
SSC	structure, system, or component
SU	standard unit
SSURGO	soil survey geographic database
SWMA	State Wildlife Management Area
SWPPP	Storm Water Pollution Prevention Plan
TCEA	Three Crow Expansion Area
TCR	The Chadron Record
TDS	total dissolved solids
T&E	threatened and endangered
TEDE	Total Effective Dose Equivalent
TER	Technical Evaluation Report
THC	total hydrocarbon

TLD	thermoluminescent dosimeter
TMDL	total maximum daily load
TSP	total suspended particulates
TSS	total suspended solids
U_3O_8	uranium oxide
UCL	Upper Control Limit
UDC	uranyl dicarbonate
U-nat	natural uranium
UIC	underground injection control
UMTRCA	Uranium Mill Tailings Radiation Control Act
UNRI	Urban Natural Resource Institute
US	United States
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USCB	United States Census Bureau
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USLE	universal soil loss equation
UTC	uranyl tricarbonate
VOC	volatile organic compound
VRM	visual resource management
VTPD	vehicle trips per day
WFC	Wyoming Fuel Company
WL	Working Level; measured concentration of radon decay products
WLM	working level month
WRCC	Western Regional Climate Center
WSA	Wilderness Study Area
x	number of radionuclides of interest
XRD	x-ray diffraction
yd^3	cubic yards
ZOEI	zone of endangering influence

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1. PROPOSED ACTIVITIES

1.1 Licensing Action Requested

Crow Butte Resources, Inc. (CBR) makes this application to the United States Nuclear Regulatory Commission (NRC) to amend Radioactive Source Materials License SUA-1534, for development of additional uranium *in-situ* recovery (ISR) operations in Dawes County, Nebraska. The area proposed for use as a satellite facility to the main CBR Central Processing Facility (CPF) is referred to as the Marsland Expansion Area (MEA).

By letter dated Nov. 27, 2007, CBR applied for the renewal of Source Materials License No. SUA-1534 for the CPF. This renewal will allow for the continued operation of the current CPF. The NRC issued a draft license by letter dated May 23, 2011. Following comments by CBR, the NRC issued a second draft of the CBR renewal license on August 11, 2011. While negotiations continue, the current license remains in effect.

The application is presented primarily in the NRC format found in NRC Regulatory Guide (RG) 3.46, *"Standard Format and Content of License Applications, Including Environmental Reports, For In Situ Uranium Solution Mining"* (June 1982). NRC document NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* (June 2003) was followed to ensure that all information is provided to allow NRC Staff to complete their review of this amendment application.

1.2 Crow Butte Uranium Project Background

The original CPF was developed by Wyoming Fuel Company, which constructed an R&D Facility in 1986. The project was subsequently acquired and operated by Ferret Exploration Company of Nebraska until May 1994, when the name was changed to Crow Butte Resources, Inc. This change was only a name change and not an ownership change. CBR is the owner and operator of the Crow Butte Project.

The land (fee and leases) at the CPF is owned by Crow Butte Land Company, which is a Nebraska corporation. All of the officers and directors of Crow Butte Land Company are U.S. Citizens. Crow Butte Land Company is owned by CBR, which is the licensed operator of the facility. CBR, which does business as Cameco Resources, is also a Nebraska corporation. All of its officers are U.S. citizens, as are two thirds of its directors. CBR is owned by Cameco US Holdings, Inc., which is a U.S. corporation registered in Nevada. For Cameco US Holdings, three quarters of the officers are U.S. citizens, as are two thirds of the directors. Cameco US Holdings is held by Cameco Corporation, which is a Canadian corporation that is publicly traded on both the Toronto and New York Stock Exchanges.

The R&D Facility was located in N½ SE¼ of section 19, Township (T) 31 North (N), Range (R) 51 West (W). Operations at this facility were initiated in July 1986, and mining took place in two wellfields (WF-1 and WF-2). Mining in WF-2 was completed in 1987, and restoration of that wellfield has been completed. WF-1 was incorporated into Mine Unit 1 of current operations.

The current production wellfield is located within the current license area as shown in **Figure 1.7-2**. The main production facility is located in section 19, T31N, R51W, Dawes County, Nebraska.

The current license area is approximately 2,861 acres, and the surface area affected over the estimated life of the project is approximately 2,000 acres.

CBR has successfully operated the current production area since commercial operations began in 1991. Production of uranium has been maintained at design quantities throughout that period with no adverse environmental impacts. Groundwater restoration for Mine Unit 1 has been completed and approved by the NRC and Nebraska Department of Environmental Quality (NDEQ), with NRC issuing the final approval on February 12, 2003. The operating history and schedules for the current production area are discussed in more detail in Section 1.7.

1.3 Site Location and Description

The proposed MEA is located within sections 26, 35, 36 of T30N, R51W; sections 1, 2, 11, 12, 13 of T29N R51W; and sections 7, 18, 19, 20, 29, 30 of T29N, R50W. The project area encompasses 4,622.3 acres. The MEA satellite facility is located approximately 11 miles (17.7 km) south-southeast of the CPF and approximately 4.5 miles (7.2 km) northeast of the community of Marsland. **Figure 1.3-1** shows the locations of the current license area and the proposed MEA.

All of the mineral resources leased within the MEA are privately owned, with the exception of the SW ¼ section of section 36 of T30N, R51W. This quarter section is designated as State Trust Land and is a small part of the nearly 1,300,000 acres of land now held in Trust for Nebraska's K-12 public schools. The Trustee of Nebraska's School trust lands is the Board of Educational Lands and Funds (NBELF 2010). The surface and mineral rights are under lease between Cameco and the State of Nebraska. There are no federal surface lands or minerals in the MEA license boundary. **Figure 1.3-2** shows surface land ownership in the proposed MEA.

1.4 Ore Body Description

Similar to the CPF, uranium will also be recovered from the basal sandstone of the Chadron Formation. The depth of the ore body in the MEA ranges from 800 to 1,250 feet below ground surface (bgs). The width varies from approximately 1,000 feet to 4,000 feet. The ore body ranges in grade from 0.11 percent to 0.33 percent uranium oxide (U_3O_8), with an average grade estimated at 0.17 percent U_3O_8. The ore-grade uranium deposits underlying the MEA are depicted in **Figure 1.4-1**.

1.5 Solution Mining Method and Recovery Process

The ISR process for uranium recovery consists of an oxidation step which occurs underground. Gaseous oxygen O_2) or hydrogen peroxide (H_2O_2) is used to oxidize the uranium, and bicarbonate is used for dissolution. The uranium-bearing solution is recovered from the wellfield, and the uranium is extracted in the CPF process building. The CPF process uses the following steps:

- Loading of uranium complexes onto ion exchange (IX) resin,
- Reconstitution of the solution by the addition of bicarbonate and O_2,
- Elution of the uranium complexes from the resin, and
- Drying and packaging of the uranium.

1.5.1 Advantages of ISR Uranium Mining

ISR uranium mining is a proven technology that has been demonstrated commercially in Wyoming, Texas, and at Crow Butte in Nebraska. ISR mining of uranium is environmentally superior to conventional open pit and underground uranium mining because:

- ISR mining results in significantly less surface disturbance because mine pits, waste dumps, haul roads, and tailings ponds are not needed.
- ISR mining carries a much lower water demand than conventional mining and milling, avoiding the water usage associated with pit dewatering, conventional milling, and tailings transport.
- The lack of heavy equipment, haul roads, waste dumps, and other features result in very little air quality degradation.
- Fewer employees are needed at ISR mines, thereby reducing transportation and socioeconomic concerns.
- Aquifers are not excavated, but remain intact during and after ISR mining.
- Tailings ponds are not used, thereby eliminating a major groundwater pollution concern.
- The majority of other contaminants (e.g., heavy metals) remain where they occur naturally instead of being relocated to waste dumps and tailings ponds with additional environmental concern.

1.5.2 Ore Amenability to the ISR Mining Method

Amenability of the uranium deposits in the current CBR license area to ISR mining was demonstrated initially through core studies. Results of the core studies were confirmed in the R&D project at the CPF site using bicarbonate/carbonate leaching solutions with O_2. Reports concerning the results of the R&D activities, including restoration of affected groundwater, were previously submitted to NRC and the NDEQ.

The information and experience gained during these pilot programs formed the basis for the commercial uranium ISR mining operations. The current operation, including the successful restoration of groundwater in Mine Unit 1, demonstrates that such a program can be implemented at the MEA with minimal short-term environmental impacts and with no significant risk to the public health or safety. The remainder of this application describes the mining and reclamation plans for the current CBR license area and the MEA, and the concurrent environmental monitoring programs employed to ensure that any impact to the environment or public is minimal.

1.6 Operating Plans, Design Throughput, and Production

The CPF is licensed for a flow rate of 9,000 gallons per minute (gpm), excluding restoration flow, under License No. SUA-1534. Total annual production is limited to 2,000,000 pounds of yellowcake.

Uranium extracted from the Marsland wellfield will be processed at a satellite facility located within the MEA. The MEA will operate at an overall average production flow rate of 6,000 gpm (excluding 1,500 gpm for restoration). The anticipated bleed rate is assumed to be 0.5 to 2.0 percent of the total mining flow. The MEA will operate with an expected annual production rate of approximately 600,000 pounds (lbs) U_3O_8. Indicated ore reserves as U_3O_8 for the MEA are 6,161,679 lbs with an additional inferred estimate of 3,389,518 lbs. Total reserves for the MEA are currently estimated at 9,551,197 lbs. The uranium extracted from the MEA will be loaded onto IX resin in the MEA satellite facility, which will then be transported by tanker truck to the main plant for elution, precipitation, drying, and packaging. Barren resin will be returned to the MEA satellite facility by tanker truck. The MEA operations are discussed in more detail in Section 3. The proposed MEA encompasses approximately 4,622.3 acres. Over the life of the project, an estimated 1,753 acres may be impacted.

1.7 Proposed Operating Schedules

1.7.1 Current Production Area

Sufficient reserves in the current license area have been estimated to allow mining operations to continue until the end of 2014. Completion of groundwater restoration in the current license area is scheduled for 2023, with site remediation to be completed by 2025. Projected production and restoration schedules for the CPF are shown on **Figure 1.7-1**. The current status of the 11 mine units are shown in **Table 1.7-1**. In 2010, the total annual production rate for the CPF was 592,541 pounds U_3O_8, and in 2009 it was 700,000 pounds U_3O_8. Additional mine unit plans are developed approximately 1 year prior to the planned commencement of new mining operations. For the current production area, production is ongoing in Mine Units 7, 8, 9, 10, and 11. Mine Unit 1 has been restored, and restoration is occurring in Mine Units 2, 3, 4, 5, and 6. The layout of the current and planned mine units in the current license area is shown on **Figure 1.7-2**.

1.7.2 Marsland Expansion Area

The proposed MEA project site map and schedule are shown on **Figures 1.7-3** and **1.7-4,** respectively. There is a potential for 11 mine units, with construction for Mine Unit 1 (MU-1) to commence in 2014. Production for the project (all MUs) will start in 2015 and terminate in 2039. Restoration in designated MUs will commence in the year 2020 and be completed in 2044. Site reclamation will be completed in 2046.

The MEA will be subdivided into an appropriate number of MUs (**Figure 1.7-5**). Each MU will contain a number of wellhouses where injection and recovery solutions from the satellite plant building are distributed to the individual wells. The injection and production manifold piping from the MEA satellite facility to the wellhouses will be either polyvinyl chloride (PVC) or high-density polyethylene (HDPE) with butt-welded joints or an equivalent. Pressure switches will be installed to each injection manifold in the wellhouse to alert the plant and wellfield operators of increasing manifold pressures. Pressure gauges, pressure shutdown switches, and pressure transducers will be used to monitor and control trunkline pressures. Oxidizer will be added to the injection stream, and all injection lines off of the injection manifold will be equipped with totalizing flowmeters, which will be monitored in the satellite Control Room. The MEA wellfield will be designed in a manner consistent with the existing CPF wellfield. More detailed information about the site operations is discussed in Section 3.

1.7.3 Three Crow Expansion Area Schedule

On July 12, 2010, CBR submitted a Class III UIC Application and Aquifer Exemption Petition for the proposed Three Crow Expansion Area (TCEA), which will be used as a satellite facility supporting the CPF. On August 3, 2010, CBR submitted a request to the NRC for an amendment to Source Materials License SUA-1534 for the development of the TCEA. In 2011, CBR advised the NDEQ and NRC of a possible change from a full satellite facility (production of impregnated resin for transport to the main CPF) to use of pipelines to transport all process fluids from the TCEA to the CPF. If feasible, the revised license would allow for construction and operation of these process pipelines. CBR requested that the NRC and NDEQ suspend review of the respective TCEA applications so that CBR could supplement the applications with the alternate approach.

1.7.4 North Trend Expansion Area Schedule

The proposed North Trend Expansion Area (NTEA) will consist of a support satellite facility for the CPF. CBR has received approval from the NDEQ for a Class III Underground Injection Control (UIC) permit (NDEQ 2011a) and an aquifer exemption (NDEQ 2011b) that will allow for construction and operation of the satellite facility for ISR mining of the proposed NTEA. A radioactive source material license amendment for the NTEA is pending before the NRC for the proposed NTEA. This proposed NTEA satellite facility will be an operation very similar to the MEA. Current plans are for this project to be constructed in 2023, operated from 2024 into 2032, with groundwater restoration activities ongoing from 2026 through 2035. Final site reclamation would be completed in 2035.

1.8 Waste Management and Disposal

1.8.1 Liquid Waste

There were three wastewater disposal options considered for the proposed satellite facility: evaporation in solar evaporation ponds, deep well injection, and land application. The currently selected method of disposal will be deep well injection with no plans for evaporation ponds. In lieu of evaporation ponds, the site will employ wastewater surge/equalization tanks (total capacity of 300,000 gallons) to temporarily hold wastewater prior to pumping to the deep disposal well (DDW) for injection. There are currently no plans for land application of wastewaters. However, this option could be applied if such disposal is deemed feasible and more beneficial for a specific wastewater stream. Any such action would require an NRC license amendment and a discharge permit from the NDEQ.

Operation of the MEA satellite facility will result in the following liquid waste streams:

- **Water generated during well development** - This water is recovered groundwater similar to well development water currently produced at the CPF. This water will be disposed of in the processing circuit or in an onsite DDW.
- **Liquid process waste** - The operation of the satellite facility results in one primary source of liquid waste - a production bleed. This bleed will be routed to the onsite DDW.
- **Aquifer restoration** - Restoration of **the affected aquifer** (which commences following mining operations) results in the production of wastewater similar to that produced during

current restoration activities at the CPF (See **Figure 6.1-1**). This wastewater will be disposed of in an onsite DDW.

Domestic sewage will be disposed of in an onsite wastewater treatment (i.e., septic) system permitted by the NDEQ under the Class V UIC Regulations.

Sources and methods of handling liquid wastes are discussed in more detail in Section 4.

1.8.2 Solid Waste

Solid wastes generated consist of wastes such as spent resin, resin fines, filters, miscellaneous pipe and fittings, and domestic trash. These wastes are classified as contaminated 11 e.(2) byproduct material or non-contaminated waste according to radiological survey results. Contaminated byproduct waste that cannot be decontaminated is packaged and stored until it can be shipped to a licensed 11 e.(2) byproduct material waste disposal site or licensed mill tailings facility. Non-contaminated solid waste is collected regularly on the site and disposed of in a sanitary landfill permitted by the NDEQ.

CBR currently has a contractual agreement with Dension Mines (USA) Corp. (DUSA) for the disposal of 11e.(2) byproduct materials at DUSA's White Mesa Mill site located near Blanding, Utah (CBR and DUSA 2010). The White Mesa Mill is licensed by the NRC to allow the disposal of byproduct material generated as a result of uranium mining and processing by placement of the byproduct material in the White Mesa Mill's tailings impoundment. Unless terminated by either party, the contract shall be automatically renewed each year for a maximum of four additional periods (i.e., up to June 30, 2015 at the latest).

1.8.3 Contaminated Equipment

Materials and equipment that become contaminated as a result of normal operations are decontaminated if possible and disposed of by conventional methods. Equipment and materials that cannot be decontaminated are treated in the same manner as other contaminated solid waste discussed in Section 1.8.2.

1.9 Groundwater Restoration

Restoration activities will be carried out at the MEA concurrent with mining activities. The restoration process will be similar to that used to restore the wellfield at the current CBR license area, and will consist of four basic activities:

- **Groundwater transfer**- groundwater is transferred between the MU commencing restoration and an MU commencing production or another water source.
- **Groundwater sweep**- water is pumped from the wellfield with no injection, which results in an influx of baseline quality water from the wellfield perimeter.
- **Groundwater treatment**- water from production wells is pumped to the satellite plant, where combinations of IX, reverse osmosis (RO), filtration, and other treatment methods take place.
- **Wellfield recirculation** - water is recirculated by pumping from the production wells and reinjecting the recovered solution. This will act to homogenize the quality of the aquifer.

Following these restoration phases, a groundwater stabilization monitoring program is initiated. Once the restoration values are reached and maintained, restoration is deemed complete. Results are documented in a Restoration Report and submitted to the NDEQ and the NRC for approval. Groundwater restoration is described in more detail in Section 6.

1.10 Decommissioning and Reclamation

At the completion of mine life and after groundwater restoration has been completed, all injection and recovery wells will be plugged and the site decommissioned. Decommissioning will include satellite facility disassembly and disposal and land reclamation of all disturbed areas. Applicable NRC Regulatory Guidelines will be followed. Decommissioning and reclamation are discussed in more detail in Section 6.

1.11 Surety Arrangements

CBR maintains an NRC-approved financial surety arrangement consistent with 10 Code of Federal Regulations (CFR) 40, Appendix A, Criterion 9 to cover the estimated costs of reclamation. Crow Butte maintains an Irrevocable Standby Letter of Credit issued by the Royal Bank of Canada in favor of the State of Nebraska in the present amount of $35,248,294. The surety amount is revised annually in accordance with the requirements of SUA-1534. The surety amount will be revised to reflect the estimated costs of reclamation activities for the MEA as development activities proceed. At Marsland, the estimated surety amount for the first wellhouse put into operations is $1,641,969.

1.12 References

Crow Butte Resources and Dennis Mines (USA) (DUSA) Corporation (CBR and DUSA). 2010. Byproduct Disposal Agreement for Disposal of CBR Byproduct Waste at White Mesa Mill. June 1.

Nebraska Board of Educational Land and Funds (NBELF). 2010. Sixty-Seventh Biennial Report. 2008-2010. September 30.

Nebraska Department of Environmental Quality (NDEQ). 2011a. Class III Underground Injection Control (UIC) Permit for North Trend Expansion Area. Effective August 11, 2011.

NDEQ. 2011b. Aquifer Exemption Order Granting Approval of CBR Request for Exemption for Portion of Chadron Formation at North Trend Expansion Area. April 7.

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Table 1.7-1 Current Crow Butte Production Area Mine Unit Status

Mine Unit	Production Initiated	Current Status
Mine Unit 1	April 1991	Groundwater Restored
Mine Unit 2	March 1992	Groundwater Restoration
Mine Unit 3	January 1993	Groundwater Restoration
Mine Unit 4	March 1994	Groundwater Restoration
Mine Unit 5	January 1996	Groundwater Restoration
Mine Unit 6	March 1998	Groundwater Restoration
Mine Unit 7	July 1999	Production
Mine Unit 8	July 2002	Production
Mine Unit 9	October 2003	Production
Mine Unit 10	August 2007	Production
Mine Unit 11	November 2010	Production

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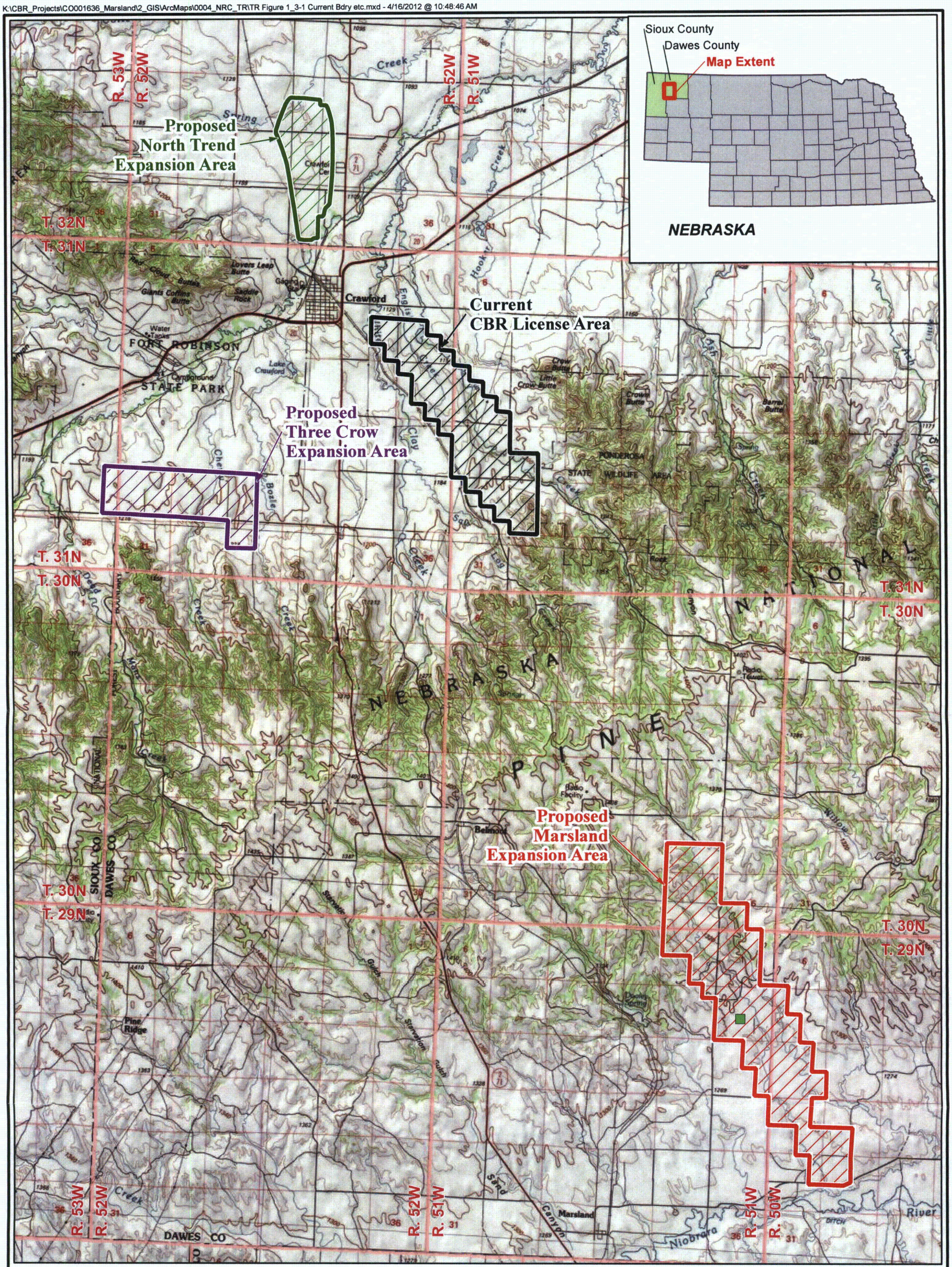


LEGEND

- Proposed Marsland Satellite Facility Site
- Proposed Marsland Expansion Area
- Proposed Three Crow Expansion Area
- Proposed North Trend Expansion Area
- Current CBR License Area

N

0 1 2
Miles

PROJECTION: NAD 1927,
STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: US TOPO MAPS, SERVICED
BY ESRI ARCGIS ONLINE

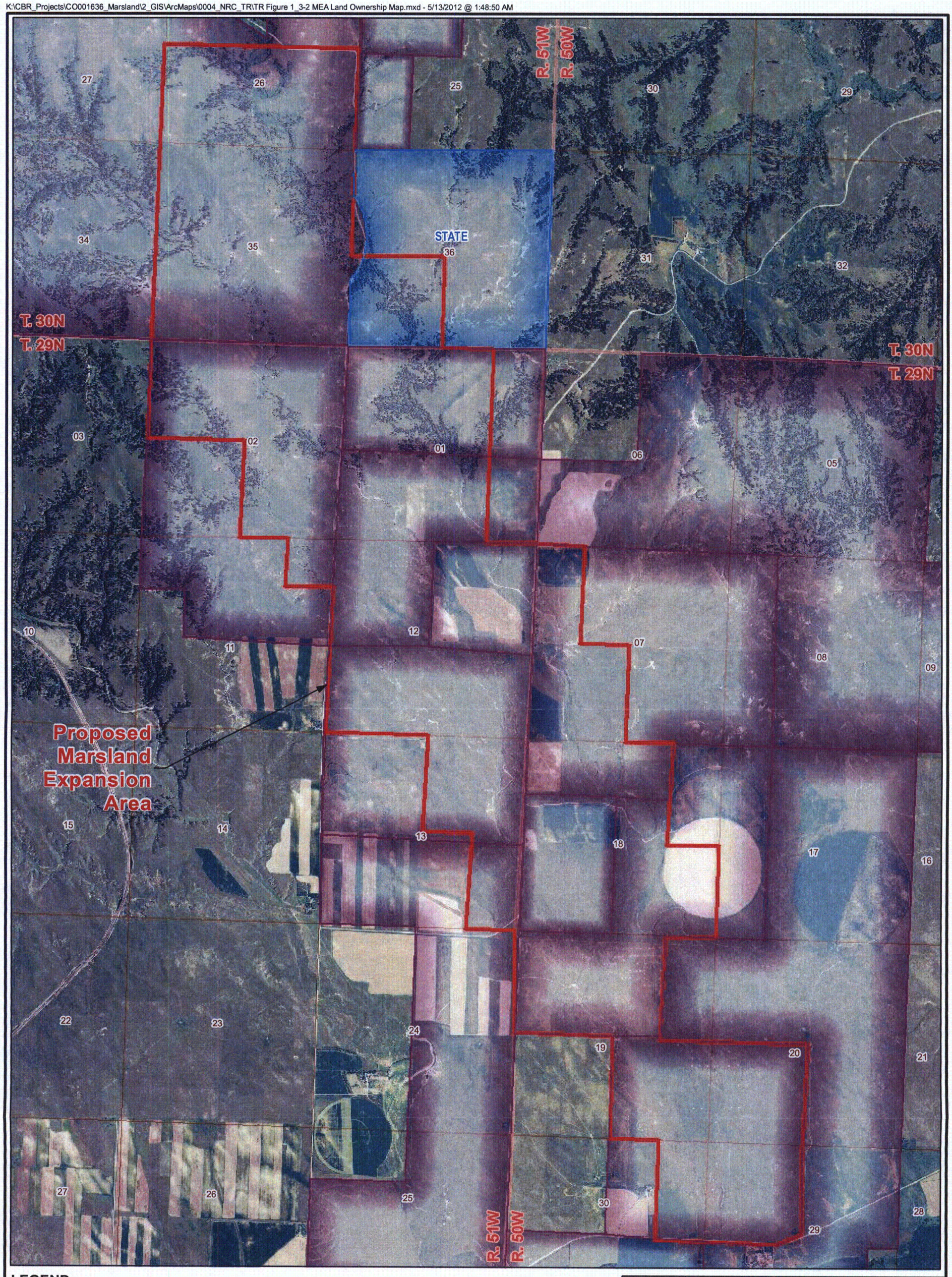
CROW BUTTE RESOURCES, INC.

FIGURE 1.3-1
CROW BUTTE RESOURCES INC.
CURRENT LICENSE AREA
AND PROPOSED EXPANSION AREAS

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

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 1_3-2 MEA Land Ownership Map.mxd - 5/13/2012 @ 1:48:50 AM



LEGEND

- Proposed Marsland Expansion Area
- Private Land
- State Land

N

0 1,250 2,500
Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 1.3-2
MARSLAND EXPANSION AREA
LAND OWNERSHIP

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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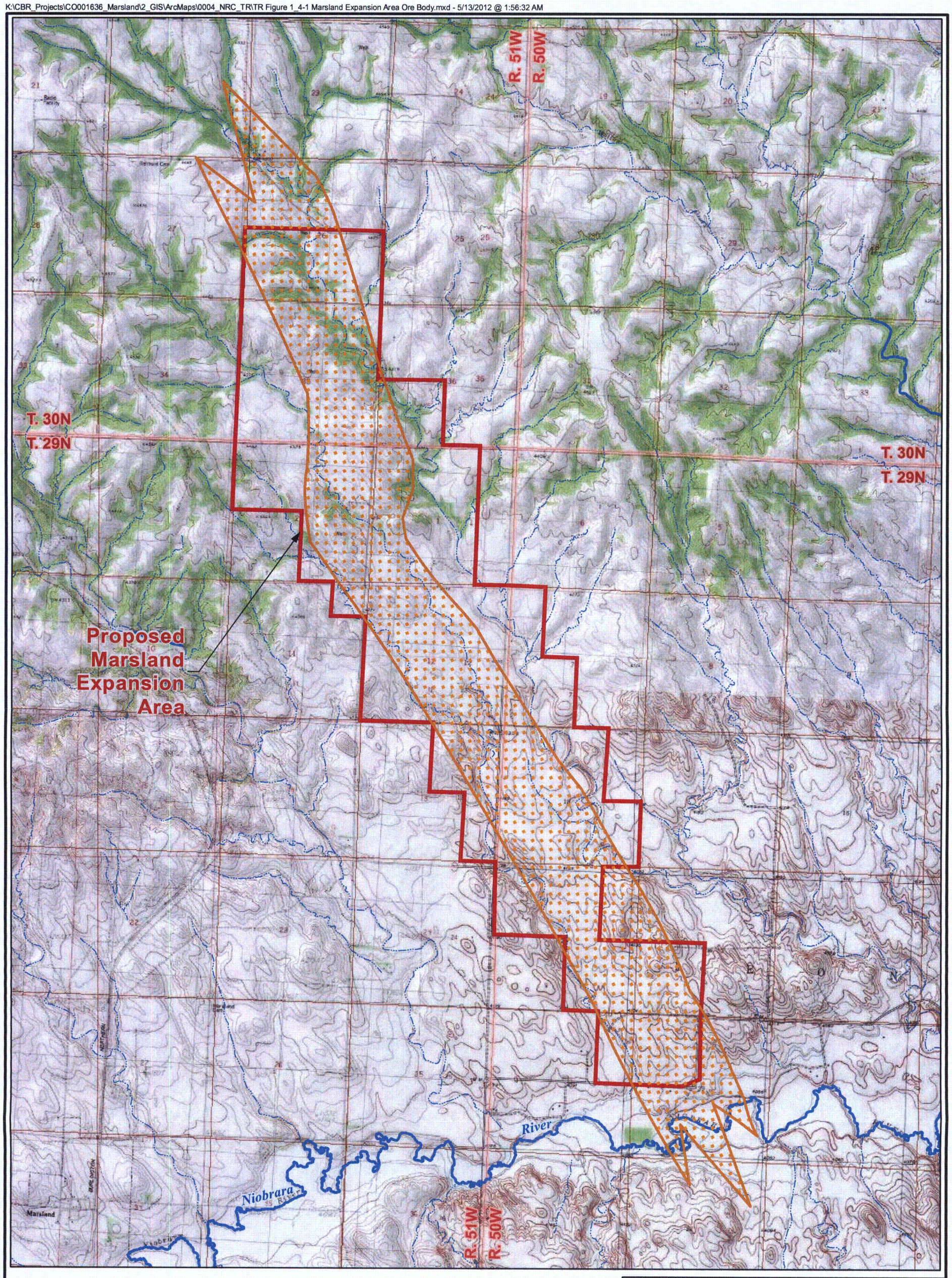
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 1_4-1 Marsland Expansion Area Ore Body.mxd - 5/13/2012 @ 1:56:32 AM



LEGEND

- Estimated Ore Body
- Proposed Marsland Expansion Area
- Perennial Stream/River
- Intermittent Stream/River

N

0 1,750 3,500

Feet

PROJECTION: NAD1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: USA TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 1.4-1
MARSLAND EXPANSION AREA
ESTIMATED ORE BODY

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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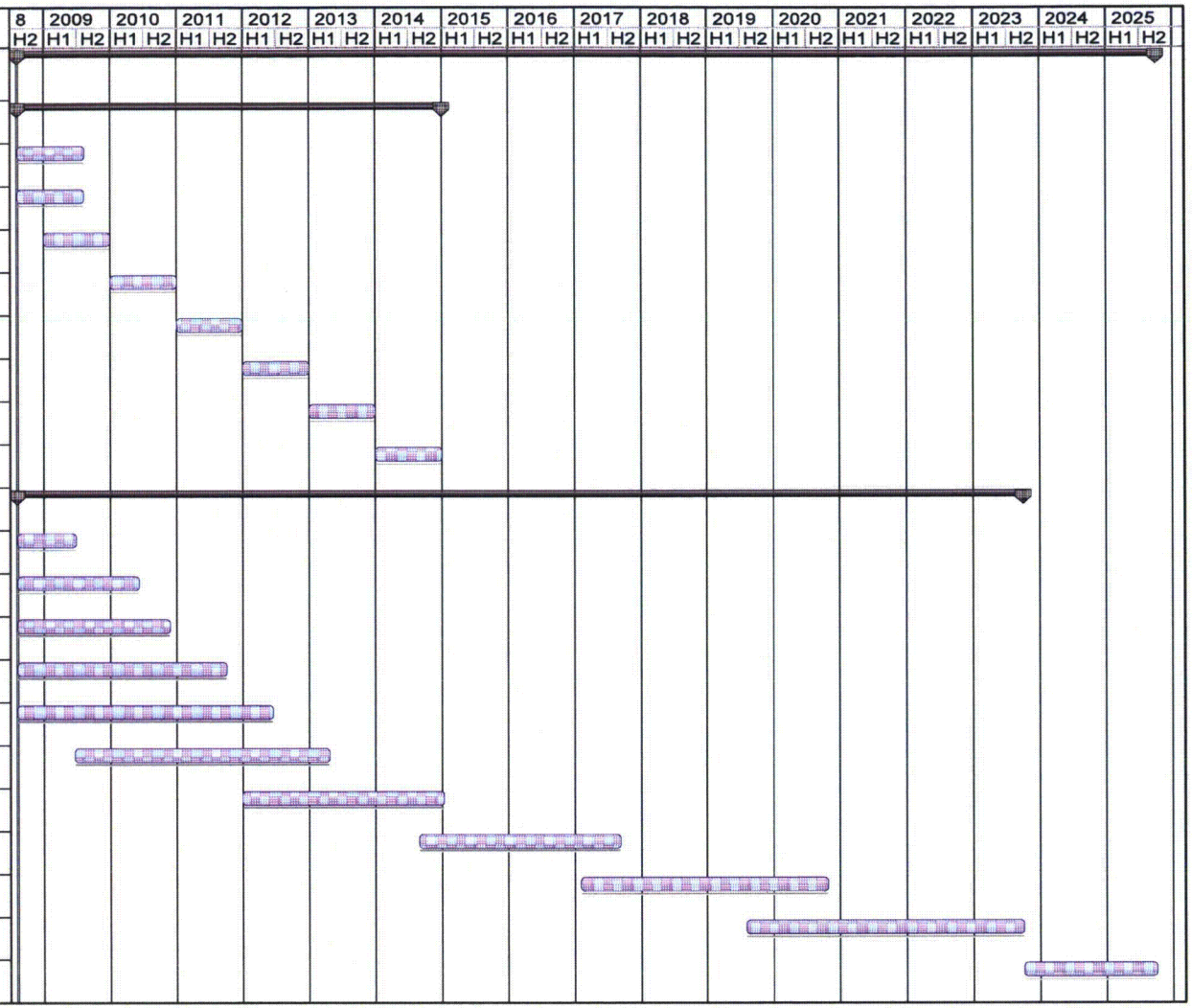
www.arcadis-us.com

ID	Task Name
1	**Current Production Area**
2	**Current Production Area**
3	Year 2007 at 800,000 lbs
4	Year 2008 at 800,000 lbs
5	Year 2009 at 800,000 lbs
6	Year 2010 at 800,000 lbs
7	Year 2011 at 800,000 lbs
8	Year 2012 at 700,000 lbs
9	Year 2013 at 600,000 lbs
10	Year 2014 at 500,000 lbs
11	**Groundwater Restoration**
12	MU2
13	MU3
14	MU4
15	MU5
16	MU6
17	MU7
18	MU8
19	MU9
20	MU10
21	MU11
22	**Final Site Reclamation**



Task

Group By Summary

CROW BUTTE RESOURCES, INC.

FIGURE 1.7-1
CURRENT PRODUCTION AREA
MINE UNIT SCHEDULE

PROJECT: CO001636.00001 MAPPED BY: JC CHECKED BY: JEC

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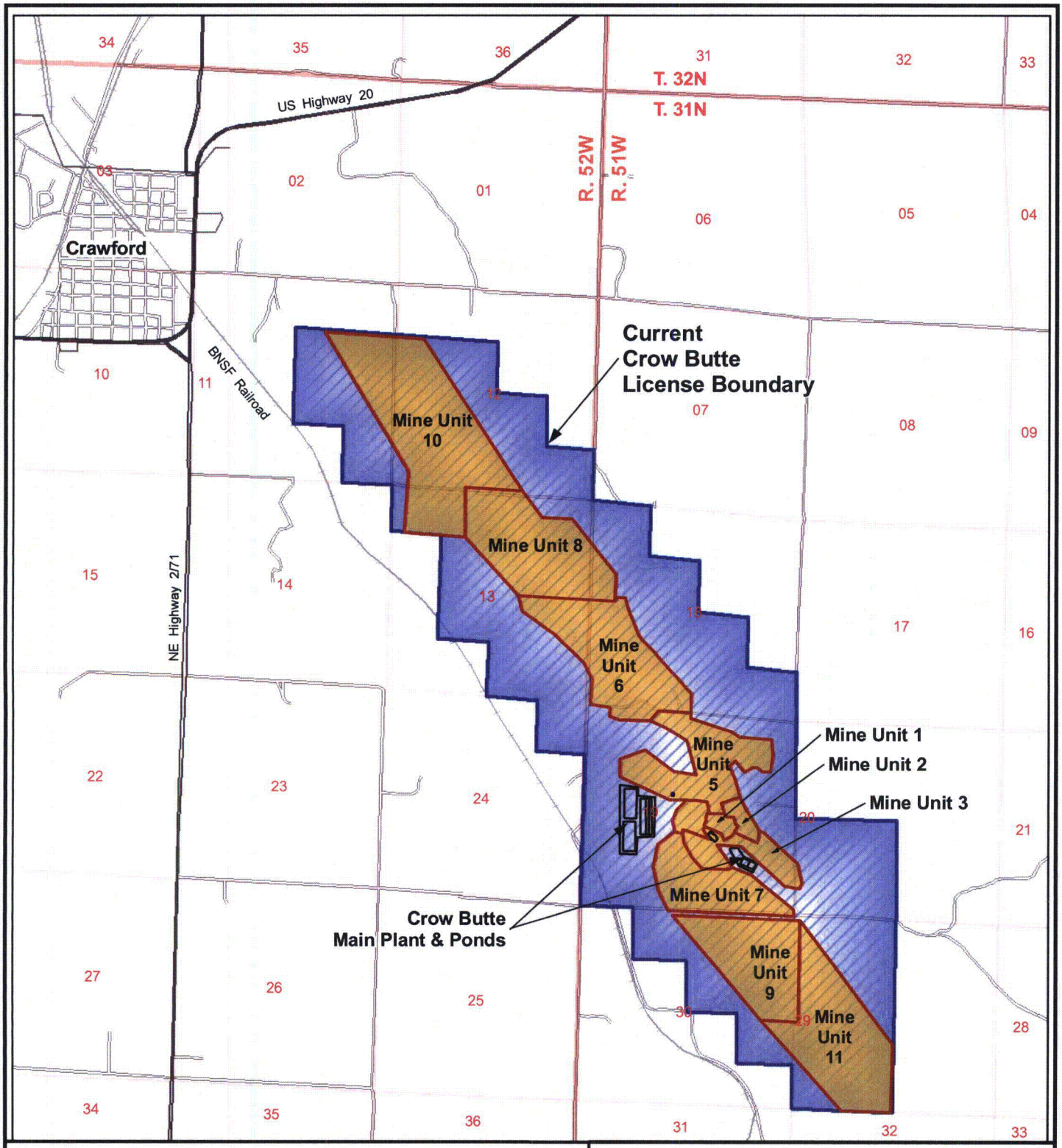
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 1_7-1 Current Production Area Schedule.ai @ 11/08/2011



LEGEND

- Aquifer Exemption and License Area
- Present Mine Units
- Facility: plant/pond

N
W — E

0 2,500 5,000 Feet

CROW BUTTE RESOURCES, INC.

FIGURE 1.7-2
CURRENT LICENSE AREA
MINE UNIT MAP

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: LW

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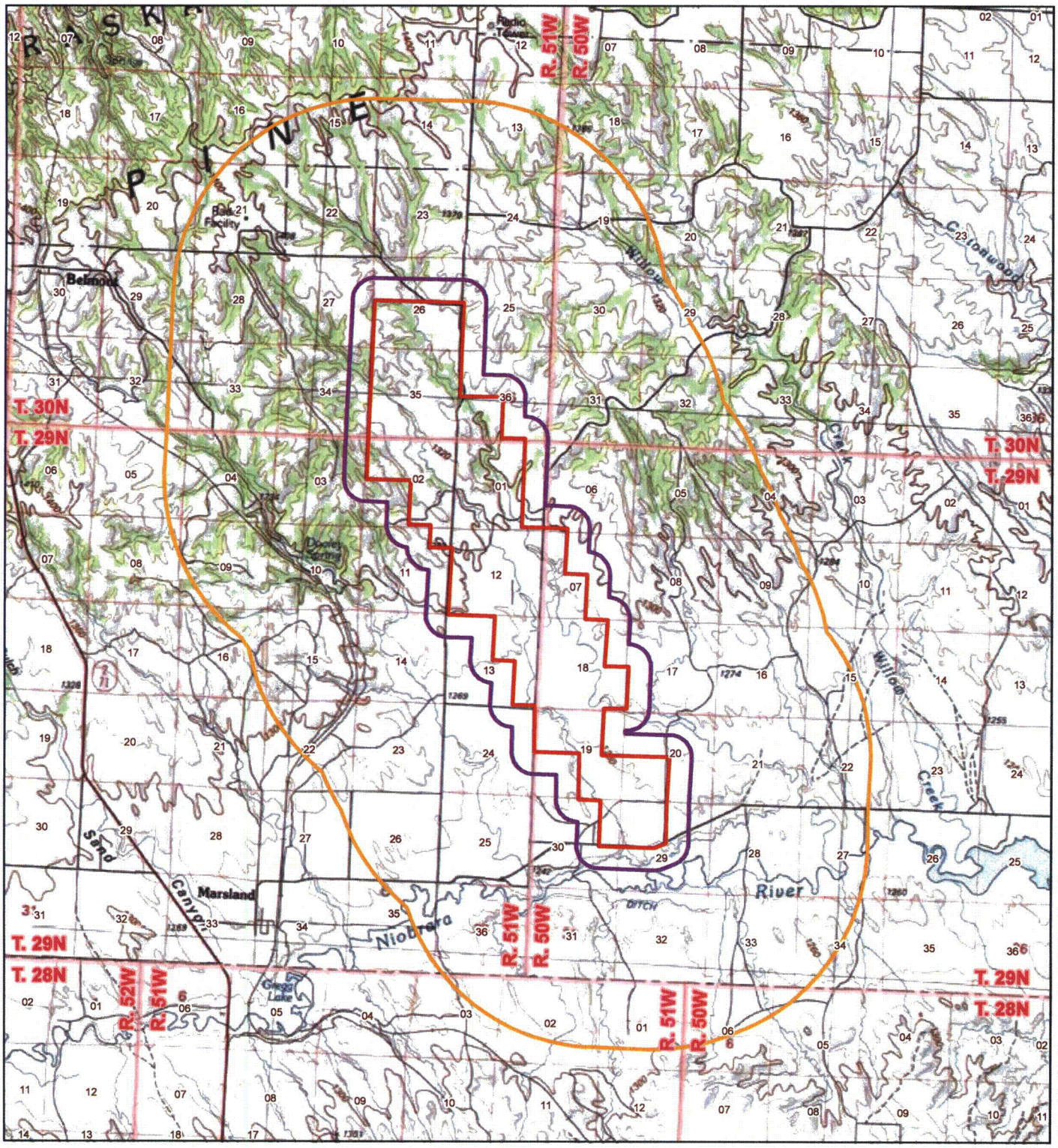
K:\CBR_Projects\CO001396_ThreeCrow\2_GIS\ArcMaps\0001_TR\Fig_1_7-2 Current License Area Mine Unit Map.mxd - 1/19/2010 @ 3:38:53 PM



LEGEND

- Proposed Marsland Expansion Area
- ZOEI Boundary (1/4-mile fixed radius)
- AOR Boundary (2-mile fixed radius)

ZOEI = Zone of Endangering Influence

AOR = Area of Review

N

0 4,000 8,000

Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 1.7-3
PROJECT LOCATION MAP
ZOEI AND AOR

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

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630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
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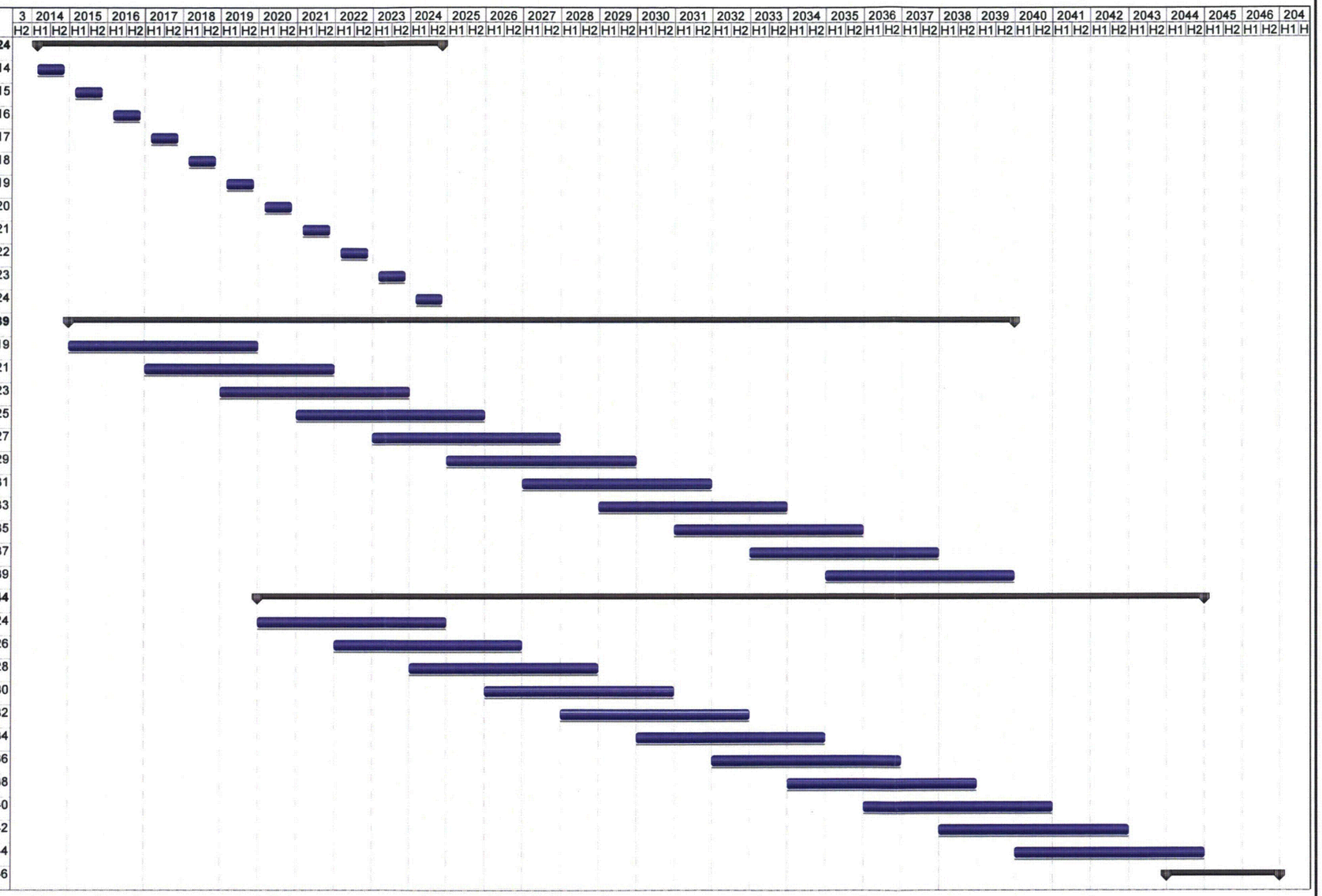
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 1_7-3 Project Loc_ ZOEI and AOR.mxd - 3/15/2012 @ 2:16:01 PM

ID	Task Name	Duration	Start	Finish
1	**Facility Construction**	**2795 days?**	**Mon 3/3/14**	**Fri 11/15/24**
2	MU-1	185 days?	Mon 3/3/14	Fri 11/14/14
3	MU-2	185 days?	Mon 3/2/15	Sun 11/15/15
4	MU-3	186 days?	Tue 3/1/16	Tue 11/15/16
5	MU-4	186 days?	Wed 3/1/17	Wed 11/15/17
6	MU-5	186 days?	Thu 3/1/18	Thu 11/15/18
7	MU-A	186 days?	Fri 3/1/19	Fri 11/15/19
8	MU-B	185 days?	Mon 3/2/20	Fri 11/13/20
9	MU-C	186 days?	Mon 3/1/21	Mon 11/15/21
10	MU-D	186 days?	Tue 3/1/22	Tue 11/15/22
11	MU-E	186 days?	Wed 3/1/23	Wed 11/15/23
12	MU-F	186 days?	Fri 3/1/24	Fri 11/15/24
13	**Production**	**6522 days?**	**Thu 1/1/15**	**Fri 12/30/39**
14	MU-1	1304 days?	Thu 1/1/15	Tue 12/31/19
15	MU-2	1305 days?	Mon 1/2/17	Fri 12/31/21
16	MU-3	1304 days?	Tue 1/1/19	Sun 12/31/23
17	MU-4	1304 days?	Fri 1/1/21	Wed 12/31/25
18	MU-5	1305 days?	Mon 1/2/23	Fri 12/31/27
19	MU-A	1304 days?	Wed 1/1/25	Mon 12/31/29
20	MU-B	1304 days?	Fri 1/1/27	Wed 12/31/31
21	MU-C	1305 days?	Mon 1/1/29	Sat 12/31/33
22	MU-D	1304 days?	Wed 1/1/31	Mon 12/31/35
23	MU-E	1304 days?	Mon 1/3/33	Thu 12/31/37
24	MU-F	1305 days?	Mon 1/1/35	Fri 12/30/39
25	**Groundwater Restoration**	**6523 days?**	**Wed 1/1/20**	**Fri 12/30/44**
26	MU-1	1305 days?	Wed 1/1/20	Tue 12/31/24
27	MU-2	1304 days?	Mon 1/3/22	Thu 12/31/26
28	MU-3	1305 days?	Mon 1/1/24	Fri 12/29/28
29	MU-4	1304 days?	Thu 1/1/26	Tue 12/31/30
30	MU-5	1305 days?	Mon 1/3/28	Fri 12/31/32
31	MU-A	1304 days?	Tue 1/1/30	Fri 12/29/34
32	MU-B	1305 days?	Thu 1/1/32	Wed 12/31/36
33	MU-C	1305 days?	Mon 1/2/34	Fri 12/31/38
34	MU-D	1305 days?	Tue 1/1/36	Mon 12/31/40
35	MU-E	1304 days?	Fri 1/1/38	Wed 12/31/42
36	MU-F	1305 days?	Mon 1/2/40	Fri 12/30/44
37	**Site Reclamation**	782 days?	Fri 1/1/44	Mon 12/31/46



Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

CROW BUTTE RESOURCES, INC.

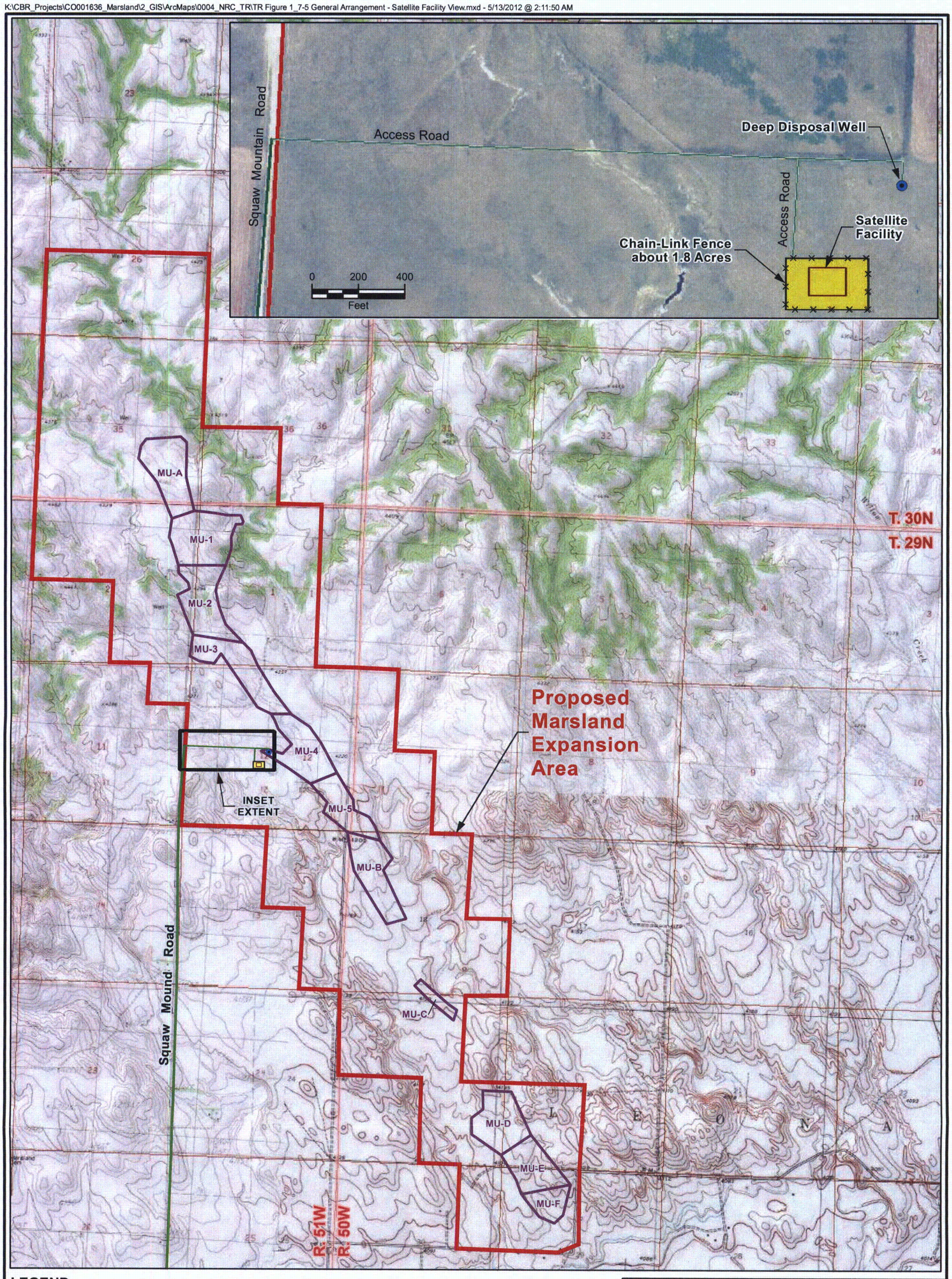
FIGURE 1.7-4
MARSLAND EXPANSION AREA
MINING AND RESTORATION SCHEDULE

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

ARCADIS 630 Plaza Drive, Ste. 100 Highlands Ranch, CO 80129 P: 720-344-3500 F: 720-344-3535 www.arcadis-us.com

K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 1_7-4 MEA Mining and Restoration Schedule.ai @ 11/08/2011

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 1_7-5 General Arrangement - Satellite Facility View.mxd - 5/13/2012 @ 2:11:50 AM



LEGEND

- Proposed Deep Disposal Well
- Squaw Mound Road
- Access Road
- Satellite Facility (Approximate)
- Restricted Area
- Mine Unit
- Proposed Marsland Expansion Area

N

0 1,500 3,000
Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 1.7-5
GENERAL ARRANGEMENT
SATELLITE FACILITY VIEW

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

2. SITE CHARACTERISTICS

2.1 Site Location and Layout

The location of the current license area is sections 11, 12, 13, 24 of T31N, R52W and sections 18, 19, 20, 29, 30 of T31 N, R51W, Dawes County, Nebraska. The proposed MEA is located in sections 26, 35, 36 of T30N, R51W; sections 1, 2, 11, 12, and 13 of T29N, R51W; and sections 7, 18, 19, 20, 29, and 30 of T29N, R50W. The MEA is located approximately 4 miles (6.4 km) north-northeast of the unincorporated community of Marsland, Nebraska (**Figure 1.7-3**).

The maps used in this section and other sections of this amendment application are Vector 7.5-minute quad maps. These are computer-aided design (CAD)/geographic information systems (GIS) drawings where each road, stream, and contour line is an individual entity. The layers in these maps were derived from the U.S. Census Bureau TIGER/Line data, U.S. Geological Survey (USGS) Digital Line Graph (DLG) Data, USGS Digital Elevation Model (DEM) data, Bureau of Land Management (BLM) Section Line data, National Geodetic Survey (NGS) Benchmark data, and USGS Geographical Names Information System (GNIS) data. This base map was then used for each of the figures prepared for this document with the addition of the pertinent information for that figure.

The longitudes and latitudes for the site boundary vertices and satellite facility are identified in **Table 2.1-1**. The datum for all topography maps in this application was North American Datum of 1927 (NAD 1927), and the geographic coordinate reference system (projection) was: *NAD_1927_StatePlane_Nebraska_North_FIPS_2601 (US_Foot).*

Figure 1.7-3 shows the general area surrounding the proposed project area, including the proposed MEA, Area of Review (AOR and Zone of Endangering Influence [ZOEI]).

Figure 1.7-2 shows the general project site layout and Restricted Areas for the current license area including the CPF building area, the RO facility, the current mine unit boundaries, the DDW, and the R&D and commercial evaporation ponds.

Figure 1.7-5 shows the proposed location of the proposed satellite facility, mine units, access roads, fencing, DDW, and restricted areas within the MEA. The latitude and longitude for the center of the satellite facility is provided in **Table 2.1-1**.

Figure 1.3-1 shows the project location in relation to the CPF and the proposed MEA. This figure shows topographical features; drainage and surface water features; nearby population centers; political boundaries; and principal highways, railroads, transmission lines, and waterways.

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Table 2.1-1 Latitude and Longitude and Coordinates for Marsland License Boundary and Satellite Facility

Layer	Geographic Projection: NAD 83 (Degrees)		Geographic Projection: NAD 27 (Degree)		NAD1927 StatePlane Nebraska North FIPS 2601(US Foot)	
	Latitude	Longitude	Latitude	Longitude	Northing	Easting
A	42.52461	-103.25442	42.52465	-103.25394	450895	1123033
A	42.52468	-103.24920	42.52472	-103.24872	450866	1124440
A	42.51029	-103.24918	42.51033	-103.24870	445626	1124246
A	42.51036	-103.24407	42.51039	-103.24359	445596	1125624
A	42.51033	-103.23921	42.51037	-103.23874	445538	1126931
A	42.50310	-103.23930	42.50313	-103.23883	442903	1126807
A	42.50310	-103.23445	42.50314	-103.23397	442855	1128115
A	42.49589	-103.23448	42.49593	-103.23400	440230	1128008
A	42.49592	-103.22959	42.49596	-103.22911	440192	1129326
A	42.48841	-103.22989	42.48845	-103.22942	437459	1129139
A	42.48850	-103.22466	42.48854	-103.22418	437439	1130551
A	42.48170	-103.22463	42.48174	-103.22415	434962	1130465
A	42.48154	-103.22961	42.48157	-103.22913	434953	1129121
A	42.47391	-103.22974	42.47394	-103.22926	432176	1128981
A	42.47403	-103.21492	42.47407	-103.21444	432071	1132978
A	42.46658	-103.21511	42.46662	-103.21463	429360	1132823
A	42.45989	-103.21489	42.45992	-103.21442	426919	1132790
A	42.45907	-103.21733	42.45911	-103.21685	426647	1132122
A	42.45906	-103.22453	42.45910	-103.22405	426716	1130180
A	42.45905	-103.22948	42.45909	-103.22900	426765	1128845
A	42.46652	-103.22949	42.46656	-103.22901	429485	1128946
A	42.46650	-103.23441	42.46654	-103.23393	429528	1127619
A	42.47407	-103.23454	42.47411	-103.23406	432286	1127689
A	42.47403	-103.24448	42.47406	-103.24400	432371	1125008
A	42.48159	-103.24470	42.48163	-103.24422	435128	1125053
A	42.48157	-103.24962	42.48160	-103.24914	435169	1123729
A	42.48868	-103.24941	42.48872	-103.24893	437759	1123882
A	42.48865	-103.25435	42.48868	-103.25387	437797	1122551
A	42.49578	-103.25417	42.49581	-103.25369	440391	1122698
A	42.49569	-103.26447	42.49572	-103.26399	440466	1119922
A	42.50650	-103.26428	42.50654	-103.26380	444400	1120125
A	42.50643	-103.26915	42.50646	-103.26867	444424	1118811
A	42.51002	-103.26904	42.51005	-103.26856	445730	1118891
A	42.50993	-103.27387	42.50997	-103.27339	445749	1117589
A	42.51717	-103.27379	42.51720	-103.27331	448384	1117712
A	42.51706	-103.28353	42.51710	-103.28305	448446	1115085
A	42.52437	-103.28351	42.52440	-103.28303	451107	1115195
A	42.54628	-103.28332	42.54631	-103.28284	459083	1115553
A	42.54648	-103.26386	42.54651	-103.26339	458955	1120795
A	42.53894	-103.26382	42.53898	-103.26334	456210	1120702
A	42.53115	-103.26385	42.53119	-103.26337	453374	1120585
A	42.53136	-103.25447	42.53139	-103.25399	453351	1123113
A	42.52461	-103.25442	42.52465	-103.25394	450895	1123033
B	42.50130	-103.25545	42.50134	-103.25497	442416	1122430

Notes:

A = Marsland Permit Boundary

B = *Center of Satellite Facility*

2.2 Uses of Adjacent Lands and Waters

This section evaluates the effects of the proposed uranium mining on the physical, ecological, and social characteristics of the surrounding environments. Land and water use in the current Crow Butte license area are discussed in the license renewal application previously submitted for NRC License Number SUA-1534 (NRC 2007a). Land and water use for the proposed NTEA are discussed in a license amendment application submitted to the NRC on May 30, 2007 (NRC 2007b). In addition, land and water use are discussed in a license amendment application for the proposed TCEA (NRC 2010), which is pending.

This section describes the nature and extent of present and projected land and water use and trends in population or industrial patterns. The information for the CPF was initially developed over a 9-month period in 1982 as part of the R&D License Application, updated in 1987 for the Commercial License Application, and in 1997 and 2007 during license renewal. The information for the MEA was developed in 2011. Preliminary data were obtained from several sources including previous licensing documents supported by field studies and interviews with various state and local officials.

NUREG 1569 requires a discussion of land and water use in the proposed MEA and within a 2.0-mile (3.3 km) distance from the site boundary. The NDEQ requires an assessment of a 2.25-mile (3.62 km) radius of the proposed project site boundary (AOR) for the Class III UIC application. Therefore, the NRC's 2.0-mile radius has been extended to 2.25 miles for consistency. Land use within the MEA and the 2.25-mile AOR is illustrated on **Figure 2.2-1**.

Land use and water use data were updated from previous license applications by additional data collection and review, personal communications, and site reconnaissance. Population distribution characteristics were updated using current 2010 Census data and other applicable sources (USCB 2011).

Little change in land use has been noted in recent decades, reflecting the stagnant nature of economic activity and a slight decline in the populations of the City of Crawford and Dawes County.

2.2.1 General Setting

The MEA is located in southwestern Dawes County, Nebraska, just south of the Pine Ridge. The center of the MEA is located approximately 4.0 miles north-northeast of the community of Marsland (**Figure 2.2-1**). The main access route to the MEA is via State Highway (SH) 2/71 west of Marsland, then east along Niobrara Street and River Road, and then north on either Squaw Mound Road or Hollibaugh Road.

2.2.2 Land Use

Land use of the MEA and surrounding AOR is dominated by agricultural uses (**Figure 2.2-1 and Figure 2.8-1**). **Table 2.2-1** describes major land use types, including those depicted on **Figure 2.2-1**. Land use acreages for the AOR (**Table 2.2-2**) and MEA (**Table 2.2-3**) are presented in **Figure 2.2-1** in 22 ½ sectors centered on each of 16 compass points radiating out from the

proposed satellite facility. Major land uses within the MEA and AOR are further discussed below.

Rangeland comprises the greatest land cover within the 2.25-mile AOR (74 percent). Forest lands (13.8 percent), cropland (7.7 percent), and recreational land (4.3 percent) are the other significant land cover types. Less than 0.07 percent (30 acres) of the AOR is accounted for by wetlands. Scattered rural residences are mostly associated with agricultural operations.

Residential and commercial land uses in Dawes County are concentrated within the city limits of Crawford and Chadron and in the communities of Whitney and Marsland. Industrial land uses within the city limits of Crawford are generally associated with railroad facilities.

Within the MEA, rangeland is the dominant land use (82.3 percent), with cropland (9.9 percent) and forestland (7.7 percent) accounting for smaller areas.

2.2.2.1 Agriculture

Several of the soil types found in the vicinity of the MEA are classified as prime farmland. However, in Dawes County, soils are classified by the U.S. Natural Resource Conservation Service (NRCS) as prime farmland only if irrigated. According to 2009 Census of Agriculture for Nebraska, nearly 9 percent of Dawes County agricultural land is irrigated, and about 16 percent of harvested cropland acreage is irrigated (NASS 2009a). The remainder of the irrigated land is used for pasture, habitat, or rangeland (NASS 2009b). Irrigated land is found both in the MEA and in the AOR.

Table 2.2-4 and **Table 2.2-5** show agricultural productivity within Dawes County. Wheat and forage are the major crops grown on croplands in Dawes County. Most of these crops are used for livestock feed while the remaining crops are commercially sold. In 2010, total wheat production in Dawes County was 1,195,000 bushels, a decrease of 24 percent from 2009 production (NASS 2011). In 2010, 96,600 tons of forage was grown; this was a decrease of approximately 11 percent from the 2009 harvest. Non-livestock agricultural lands in Dawes County had a value of $14.10 per acre, indicating that crop production on existing farmed lands in the AOR have a potential value (assuming full use of lands) of $41,230; $6,260 in the MEA (NASS 2009a).

In 2007, 69,429 head of livestock was reported in Dawes County (NASS 2009a). The livestock inventory for Dawes County indicates that cattle account for more than 90 percent of all livestock. Livestock account for approximately 56 percent of the total market value of all agricultural products sold in 2007; this is a slight decrease from 2002, when livestock accounted for approximately 60 percent of market value. In 2007, cash receipts for livestock and products totaled $34,300,000 in Dawes County (NASS 2009a). Livestock and livestock products had a value of $55.62 per acre, indicating that livestock production on rangeland within the AOR has a potential value (assuming full use of lands) of approximately $1,530,000; $200,230 in the MEA (NASS 2009a).

2.2.2.2 Recreation

Recreational opportunities provided by federal and state lands in Dawes County have become an increasingly important component of the local economy. There are no developed recreation

facilities within the MEA or the AOR. Nearby recreational facilities in Dawes County include the Ponderosa State Wildlife Management Area (SWMA), Chadron State Park, Soldier Creek Wilderness Area, the Red Cloud Picnic Area, trails in the Nebraska National Forest, Box Butte Reservoir State Recreation Area, and Fort Robinson State Park (DeLorme Maps 2005). Approximate distances from the proposed MEA satellite facility to local and regional recreational facilities are presented in **Table 2.2-6**.

2.2.2.3 Residential

In 2010, there were a total of 567 houses in the City of Crawford, with 470 occupied (334 owner-occupied and 136 renter-occupied), and 418 houses in the Village of Hemingford, with 315 occupied (253 owner-occupied and 82 renter-occupied) (USCB 2011).

Based on site reconnaissance in May 2011 and a combination of Google Earth and Nebraska Department of Natural Resources (NDNR) aerial imagery of the area, there are two housing units in the MEA, only one of which was occupied at the time of the reconnaissance. The occupied residence is located in SW¼ NW¼ Section 7, and the unoccupied residence is located in T29N, R50W and SE¼ NE¼ Section 2, T29N, R51W, as shown on **Figure 2.2-2**. The AOR contains an additional 25 structures, of which seven are occupied. There are a total of eight occupied housing units within the MEA and the 2.25-mile AOR.

Table 2.2-7 shows the distance to the nearest residence within the 2.25-mile AOR and to the nearest site boundary from the center of the MEA for each 22 ½° sector centered on each compass point. There are two residences within 1 mile (1.6 km) of the center point of the proposed MEA.

2.2.2.4 Habitat

Habitat lands are those dedicated wholly or partially to the production, protection, or management of species of fish or wildlife. Significant areas classified as habitat nearest to the MEA include the Ponderosa SWMA, located approximately 5.2 miles north of the MEA boundary; the Fort Robinson WMA, located 13.7 miles northwest of the MEA boundary; and the Petersen WMA, located 13.8 miles north-northwest. There is no land within the MEA used primarily for wildlife habitat. Wildlife habitat is a secondary use of rangeland, forestland, and recreational land within the MEA and the 2.25-mile AOR. An evaluation of habitat in the MEA is included in Section 2.8, with habitat types in the MEA shown in **Figure 2.8-1**.

2.2.2.5 Industrial and Mining

Numerous exploratory wells targeting mineral resources and hydrocarbons have been drilled in the MEA and the AOR. Besides CBR, Conoco, Amoco Minerals, Santa Fe Mining, and Union Carbide have also drilled exploratory test holes for uranium resources in the general area. With the exception of these exploratory wells, there are no other industrial facilities within the 2.25-mile AOR.

There is one oil and gas exploratory well located within the MEA or the 0.25-mile ZOEI, but four abandoned wells are present within the 2.25-mile AOR (**Figure 2.2-3**). Based upon review of public records, all the referenced oil and gas wells have been properly plugged and abandoned in accordance with the Nebraska Oil and Gas Conservation Commission regulations (NOGCC

2011). A discussion of oil and gas test holes pertinent to the MEA is presented in Section 2.6.1.1 (see Pierre Shale subheading under Montana Group).

The nearest operating uranium recovery facility is the CBR operations located approximately 7.5 miles to the north-northwest of the MEA (NRC 2011a). The location of the MEA site in relation to other proposed CBR satellite facilities is shown on **Figure 1.3-1**.

Project descriptions and locations of operating and proposed uranium recovery facilities in neighboring Wyoming and South Dakota can be found at the NRC website (NRC 2011a). The other uranium *in-situ* facilities nearest to the MEA in eastern Wyoming and western South Dakota in different stages of development are identified in **Table 2.2-8**. There are no existing or proposed uranium recovery facilities located within 75 miles of the proposed MEA project. The nearest operating uranium recovery facility is the Power Resources, Inc. Smith Ranch/Highland Central Processing Plant in Wyoming, and the nearest proposed uranium in-situ facilities are Powertech Uranium Corporation's Dewey-Burdock facility located in Fall River and Custer Counties of South Dakota and the Uranium One's Moore Ranch project located in Converse County, Wyoming.

Other than CBR uranium recovery activities, there are no other known planned uranium recovery operations in Nebraska (NRC 2011b). There are two nuclear power reactors located in extreme eastern Nebraska that are more than 300 miles from the proposed MEA project site. The nearest licensed nuclear fuel cycle facility (a gas centrifuge uranium enrichment facility) is located in Idaho Falls, Idaho and operated by AREVA Enrichment Services.

2.2.2.6 Commercial and Services

There are no known retail or commercial establishments within the MEA or the 2.25-mile AOR. The nearest retail and commercial establishments are found in Crawford and Hemingford, which are located more than 11 miles from any point on the MEA.

2.2.2.7 Transportation and Utilities

SH 2/71 runs to the west of the MEA. It converges with U.S. Highway 20 in the City of Crawford north-northwest of the MEA. The northern portion of the MEA is accessed from SH 2/71 via East Belmont Road; the southern portion of the MEA is accessed from SH 2/71 via River Road and Hollibaugh Road. The 2010 average daily traffic counts for a segment of Highway 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. No railways cross the MEA; a Burlington Northern Santa Fe rail line runs to the west of the MEA and through a small portion of the 2.25-mile AOR between the MEA and SH 2/71.

2.2.2.8 References

DeLorme Maps. 2005. Nebraska Atlas and Gazetteer; Third Edition. Yarmouth, Maine.

National Agricultural Statistics Service (NASS). 2009a Census of Agriculture Volume 1 Chapter 2: Nebraska County Level Data. Issued February, 2009. [Web Page]. Located at: http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Nebraska/index.asp. Accessed July 2011.

NASS. 2009b. Quick Stats Nebraska County Data - Livestock. [Web Page]. Located at: http://www.nass.usda.gov/QuickStats. Accessed on: July 2011.

NASS. 2009c. Quick Stats Nebraska County Data-Crops. [Web Page]. Located at: http://www.nass.usda.gov/QuickStats/PullData_US_CNTY.jsp. Accessed on: July 2011.

NASS. 2011. QuickStats Ad-hoc Query Tool. [Web Page]. Located at: http://quickstats.nass.usda.gov. Accessed June 2011.

Nebraska Department of Roads (NDOR). 2010. Annual Average 24-Hour Traffic; Year Ending December 31, 2010. [Web Page]. Located at: http://www.dor.state.ne.us/maps/Statewide%20Traffic%20Flow%20Maps/2010-Statewide-Traffic-Flow-Map.pdf. Accessed on: November 19, 2011.

Nebraska Game and Parks Commission. (NGPC). 2007. Nebraska Game and Parks Interactive Map. [Web Page]. Located at: http://mapserver.ngpc.state.ne.us/website/gpc_land/viewer.htm. Accessed on: January 25, 2007.

Nebraska Oil and Gas Conservation Commission (NOGCC). 2011. [Web Page]. Located at: http://www.nogcc.ne.gov/ (Well data and publications). Accessed on: October 7, 2011.

Nebraska Public Power Corporation (NPPC). 2005. Economic Importance of and Economic Impacts Associated with Livestock Production in Dawes County. Prepared by Donis N. Petersan, Ph.D., CEcD Economist. Economic Development Department, Nebraska Public Power District. [Web Page]. Located at: http://sites.nppd.com/library.asp#ag. Accessed on: August 25, 2008.

U.S. Census Bureau (USCB). 2011. Census 2000 Summary File 1 (SF 1) 100-Percent Data, Detailed Tables. [Web Page]. Located at: http://factfinder2.census.gov. Accessed on: September 2011.

U.S. Department of Agriculture. Natural Resources Conservation Service (NRCS). 2007. National Cooperative Soil Survey Web Soil Survey. [Web Page]. Located at: http://websoilsurvey.nrcs.usda.gov/app/. Accessed on: January 25, 2007.

U.S. Nuclear Regulatory Commission (NRC). 2007a. Renewal Application for 2007 License Renewal, USNRC Source Materials License SUA-1534, Crow Butte License Area November 27. ML073480266/ML073480267.

NRC. 2007b. Application for Amendment of USNRC Source Materials License SUA-1534, North Trend Expansion Area, Crawford, Nebraska, Volume I, Technical Report. May 30. ML071760344.

NRC. 2010. Application for Amendment of USNRC Source Materials License SUA-1534, Three Crow Expansion Area, Crawford, Nebraska, Volume I, Technical Report. August 03. ML1012230171.

NRC. 2011a. Nebraska. [Web Page]. Located at: http://www.nrc.gov/info-finder/region-state/nebraska.html. Accessed on: October 7, 2011.

NRC. 2011b. Locations of Fuel Cycle Facilities. [Web Page]. Located at: http://www.nrc.gov/info-finder/materials/fuel-cycle. Accessed on: October 7, 2011.

2.2.3 Water Use Information

2.2.3.1 Dawes County Water Use

Every 5 years since 1950, the USGS assesses U.S. water use (USGS 2005) and includes water use estimates for the State of Nebraska. For Nebraska water use data, the USGS works in cooperation with the NDNR. The latest study examines usage in 2005. The 2005 USGS report presents water usage in each state by county. The next report was scheduled to be issued in 2010, but due to delays, the next report completion and data availability is not expected until 2014 (USGS 2005).

Estimated water use in 2005 for Dawes County, Nebraska is presented in **Table 2.2-9** (USGS 2005). The total 2005 population for Dawes County was 8,636 people, with public supply groundwater and surface water use totaling 2,590,000gallons per day (gpd). Irrigation using groundwater and surface water accounted for a total of 24,550,000gpd to irrigate an estimated 13 thousand acres. Essentially all of the rural residents of Dawes County use groundwater for their domestic supply.

A summary of the number and types of registered non-abandoned water wells located in Dawes County as of August 23, 2011 is presented in **Table 2.2-10.** Note that this table refers to registered wells. Under current Nebraska law, water supply wells used solely for domestic purposes and completed prior to September 09, 1993, do not have to be registered (NRS 2008). Therefore, there are a number of domestic/agricultural and agricultural unregistered wells located in Dawes County. CBR identifies such wells through interviews with landowners and local drillers.

There are a total of 5,609 registered water wells in Dawes County used for a variety of purposes, as described in **Table 2.2-10**. According to the NDNR, there are a total of 243 domestic and 252 livestock wells located in Dawes County. There are 40 public water supply wells located in Dawes County (NDNR 2011a). Livestock water wells make up the majority of the wells identified in the MEA.

2.2.4 Marsland Expansion Area Project Area

The town nearest to the MEA project site is Marsland, NE, which is located approximately 4 miles southwest of the nearest MEA license boundary. There is no public water supply system for Marsland. The residential homes scattered throughout the MEA area are supplied with domestic water from private wells. Private well use is discussed in more detail below.

In general, groundwater supplies in the vicinity of the MEA are limited due to topography and shallow geology (University of Nebraska-Lincoln 1986). Groundwater quality in the vicinity near the MEA is generally poor (Engberg and Spalding 1978). Locally, groundwater is obtained from the Arikaree and Brule Formations. The primary groundwater supply is the Brule Formation, typically encountered at depths from approximately 50 to 350 feet bgs. In general, the static water level for Brule Formation wells in the MEA ranges from 50 to 150 feet bgs, depending on local topography (**Figures 2.6-3a** through **2.6-3n** and **1.4-1**).

Groundwater from the underlying basal sandstone of the Chadron Formation is not used as a domestic supply within the MEA because of the greater depth (800 to 1150 feet bgs) and inferior water quality. Gosselin et al. (1996) state that: (1) "*the sands near the bottom of the Chadron*

Formation yield sodium-sulphate water with high total dissolved solids," and (2) in proximity to "*uranium deposits in the Crawford area, groundwater from the Chadron Formation is not suitable for domestic or livestock purposes because of high radium concentrations*." In addition, it is economically impractical to install water supply wells into the deeper basal sandstone of the Chadron Formation in the vicinity of the MEA, in contrast to the vicinity of the NTEA where most basal sandstone of the Chadron Formation wells either flow at the surface or have water levels very close to surface elevation because of artesian pressure.

Based on the American Water Works Association Research Foundation (AWWARF), the average household water use annually (including outdoor) is approximately 350 gpd (Mayer et al. 1999). This suggests a daily indoor per capita water use of 69.3 gallons. Because there is only one occupied residence located within the proposed MEA (NW¼ SW¼ Section 7, T29N R50W), water use would be expected to use an average of approximately 350 gpd. Eight occupied residences have been identified within the 2.25-mile AOR. Therefore, water use would be expected to average about 2,800 gpd for the entire area.

CBR conducted an updated water user survey in 2010 and 2011 to identify and locate all private water supply wells within the 2.25-mile AOR of the proposed MEA. The water user survey targeted the location, depth, casing size, depth to water, and flow rate of all wells within the area that were (or potentially could be) used as domestic, agricultural, or livestock water supply. **Table 2.2-11** and **Appendix A** list the active and abandoned water supply wells within the MEA and AOR. The locations of all active and abandoned water supply wells are depicted on **Figure 2.7-6** and **2.9-3.** Available NDNR water well registrations within the AOR are presented in **Appendix E-1** and available well abandonment records in the AOR are shown in **Appendix D-2**.

There are a total of 108 active private water supply wells within the AOR and outside of the license boundary (**Table 2.2-11**). Within this grouping of active private wells, 14 wells are classified as agricultural use, 23 wells are classified as domestic use, four wells are classified as garden use, 88 wells are classified as livestock use, and one well has an unknown well use. It should be noted that 20 of these wells have multiple or mixed well use classifications. In terms of aquifer assignments, five wells are assigned to the Arikaree Formation, 37 wells are assigned to the Arikaree/Brule, 35 wells are assigned to the Brule Formation, and 32 wells are unassigned.

Within the MEA, there are a total of 13 active private water supply wells (**Table 2.2-11**). Within this grouping of active private wells, one well is classified as domestic use, ten wells are classified as livestock use, and two wells have an "other" well use. In terms of aquifer assignments, one well is assigned to the Arikaree Formation, two wells are assigned to the Arikaree/Brule, five wells are assigned to the Brule Formation, and three wells are unassigned.

For all of the active private wells described above that remain unassigned to a formation, information provided by the well owner and from nearby wells was insufficient to accurately determine the well completion depth. However, based on discussions with land owners and known completion depths of private water supply wells in the area, these wells have suggested well completions within the Arikaree or Brule Formations (**Table 2.2-11**). Well construction and water quality information for these wells are not available in the NDNR water well data retrieval database (NDNR 2011b) or known by the well owner. Based on available information, all water supply wells within the MEA and AOR are completed in the relatively shallow Arikaree and

Brule Formations, with no domestic or agricultural use of groundwater from the basal sandstone of the Chadron Formation (**Figure 2.7-6 and 2.9-3** and **Table 2.2-11**).

There are currently seven private water supply wells included in the quarterly monitoring program (Wells 703, 723, 725, 727, 741, 745, and 759; **Figure2.9-3**). Well 727 is the only private well located within the MEA license boundary and is completed within the Arikaree and Brule Formations (**Table 2.2-11**). The remaining six private water supply wells are located outside, but within 0.5 mile, of the MEA license boundary and are all completed within the Brule Formation (**Table 2.2-11**).

Based on population projections, future water use within the MEA and AOR will likely be a continuation of present use (see Section 2.3). It is unlikely that any irrigation will be developed within the license area due to the limited water supplies, topography, and climate. Irrigation within the review area is anticipated to be consistent with the past. It is anticipated that the residents of Marsland will continue to use water supplied exclusively by private wells.

2.2.4.1 Wellhead Protection Area

The nearest town to the MEA project site is Marsland, NE. It is located approximately 4.0 miles southwest of the nearest MEA license boundary. Marsland is an unincorporated community, with the only business being a U.S. Post Office. There are scattered homesites in the area with domestic water being supplied by private wells. Approximately eight households and ten people can be found in the immediate area of Marsland (Key to the City 2011). There is no public water supply system; therefore, there is no wellhead protection plan. The other nearest communities to the proposed MEA are the Town of Hemingford, NE and City of Crawford, NE, which are located approximately 12 miles (to the southeast) and 11.5 miles (to the northwest), respectively, from the nearest license boundary of the MEA. The City of Crawford and Town of Hemingford have well protection plans in place (NE IDs NE3101303 and NE3104505, respectively). However, these communities are located at a distance from the MEA that precludes any potential impacts from the MEA operations. A horizontal distance of 1,000 feet is the minimum required separation of a city water supply well (used for domestic, irrigation, stock, or heat pump purposes) from potential sources of contamination (NDHHS 2010). The minimum horizontal distances required for additional potential sources of contamination range from 10 to 1,000 feet and are provided in **Table 2.2-12**.

2.2.4.2 References

Engberg, R.A. and Spalding, R.F. 1978. Groundwater quality atlas of Nebraska: Lincoln, University of Nebraska—Lincoln, Conservation and Survey Division Resource Atlas No.3, 39 p.

Gosselin, D. C., Headrick, J., Chen, X-H., Summerside, S. E. 1996. Regional Analysis of Rural Domestic Well-water Quality -- Hat Creek-White River Drainage Basin; from Domestic Water-well Quality in Rural Nebraska, Nebraska Department of Health.

Key to the City. 2011. Marsland, Nebraska. [Web Page]. Located at: http://www.usacitiesonline.com/. Accessed on: August 10, 2011.

Mayer, W. M., DeOreo, W.B., Opitz, E.M., Kiefer, J.C., Davis, W.Y., Dziegielewski, B., and Nelson, J.O. 1999. Sponsored by American Water Works Association Research Foundation. (AWWARF). Residential End Uses of Water. 310 p.

Nebraska Department of Natural Resources (NDNR). 2011a. State of Nebraska Department of Natural Resources Summary of Non-Abandoned Registered Wells on File After Second Quarter 2011. [Web Page]. Located at: http://dnr.ne.gov/GroundWater/PDF_Files/Summary_non-AbandonedRegisteredWells_SecondQuarter2011.pdf. Accessed on: August 23.

NDNR. 2011b. Summary Report Registered Groundwater Wells by County. [Web Page]. Located at: http://dnrdata.dnr.ne.gov/wellssql/Summary.asp?type=county. Accessed on:. August 23, 2011.

Nebraska Department of Health and Human Services (NDHHS). 2010. Nebraska Administrative Code: Title 179. Public Water Systems, Chapter 7, 7-007 Design Standards, 7-007.03 Wells/Groundwater Source(s). April 4.

Nebraska Revised Statutes (NRS). 2008. Chapter 46: Irrigation and Regulation of Water. Section 46-602: Registration of water wells; forms; replacement; change in ownership; illegal water well; decommissioning required.

United States Geological Survey (USGS). 1999. National Handbook of Recommended Methods for Water Data Acquisition – Chapter 11. [Web Page]. Located at: http://water.usgs.gov/pubs/chapter11/.http://water.usgs.gov/pubs/chapter11/. Accessed on: May 20, 2008.

USGS. 2005. Estimated Use of Water in the United States County-Level Data for 2005. [Web Page]. Located at: http://water.usgs.gov/watuse/data/2005/index.html. Accessed on: August 23, 2011.

University of Nebraska-Lincoln. 1986. The Groundwater Atlas of Nebraska, Resource Atlas No. 4. Conservation and Survey Division.

Table 2.2-1 Major Land Use Definitions

Croplands (C)	Harvested cropland, including grasslands cut for hay, cultivated summer-fallow, and idle cropland.
Commercial and Services (C/S)	Areas used predominantly for the sale of products and services. Institutional land uses, such as various educational, religious, health, and military facilities, are also components of this category.
Forested Land (F)	Areas with a tree-crown density of 10 percent or more that are stocked with trees capable of producing timber or other wood products and exert an influence on the climate or water regime. This category does not indicate economic use.
Habitat (H)	Land dedicated wholly or partially to the production, protection, or management of species of fish or wildlife.
Industrial (I)	Areas such as rail yards, warehouses, and other facilities used for industrial manufacturing or other industrial purposes.
Mines, Quarries, or Gravel Pits (M)	Those extractive mining activities that have significant surface expression.
Pastureland (P)	Land used primarily for the long-term production of adapted, domesticated forage plants to be grazed by livestock or occasionally cut and cured for livestock feed.
Rangeland (R)	Land, roughly west of the 100th meridian, where the natural vegetation is predominantly grasses, grass-like plants, forbs, or shrubs, which is used wholly or partially for the grazing of livestock. This category includes wooded areas where grasses are established in clearings and beneath the overstory.
Urban Residential (UR)	Residential land uses range from high-density, represented by multi-family units, to low-density, where houses are on lots of more than 1 acre. These areas are found in and around Crawford and Ft. Robinson. Areas of sparse residential land use, such as farmsteads, will be included in categories to which they are related.
Water (W)	Areas of land mass that are persistently water-covered.
Recreational (RC)	Land used for public or private leisure, including developed recreational facilities such as parks, camps, and amusement areas, as well as areas for less intensive use such as hiking, canoeing, and other undeveloped recreational uses.

Table 2.2-2 Present Major Land Use Within a 2.25-Mile (3.6-KM) Radius of the Proposed Marsland Expansion Area License Boundary

COMPASS SECTOR[1]	LAND USE[2, 3] (ACRES)					TOTAL ACRES
	Cropland	Drainage/Potential Wetland	Forest Land	Rangeland	Recreational Land	
E	9.0	38.5	-	1,580.7	-	1,628.2
ENE	42.8	37.4	414.5	859.8	-	1,354.5
ESE	764.1	66.0	-	1,793.2	-	2,623.4
N	59.2	77.4	653.0	2,537.3	244.8	3,571.8
NE	177.4	35.8	535.4	772.7	-	1,521.4
NNE	108.0	49.6	636.4	1,679.7	-	2,473.7
NNW	1.0	71.8	613.8	2,464.3	802.9	3,953.8
NW	47.2	63.3	1,024.8	1,769.7	187.3	3,092.3
S	379.5	138.3	-	2,393.8	-	2,911.6
SE	314.3	200.0	-	3,352.9	-	3,867.2
SSE	169.3	81.2	-	3,694.3	-	3,944.8
SSW	585.6	64.2	-	884.2	-	1,534.1
SW	34.6	25.0	0.1	981.2	-	1,040.9
W	70.8	45.8	489.0	782.1	-	1,387.6
WNW	121.1	63.2	679.6	1,102.8	-	1,966.8
WSW	40.5	17.7	25.0	923.7	-	1,006.8
TOTAL	2,924.4	1,075.3	5,071.6	27,572.4	1,235.0	37,878.6

[1] 22 1/2° sectors centered on each of the 16 compass points

[2] See Table 2.2-1 for an explanation of major land use types: C = cropland; F = forested land; R = rangeland; RR = rangeland rehabilitation; SB = structural biotope; RC = recreational. Land uses not identified: mines, quarries or gravel pits; pastureland; water; habitat; commercial/services; urban residential; industrial

[3] Values are inclusive of MEA

Table 2.2-3 Present Land Use Within the Proposed Marsland Expansion Area License Boundary

COMPASS SECTOR[1]	LAND USE (ACRES)				
	Cropland	Drainage/Potential Wetland	Forest Land	Rangeland	TOTAL ACRES
E	4.9	3.8	-	121.6	130.4
ENE	40.5	4.0	-	61.9	106.4
ESE	44.4	8.1	-	174.3	226.7
N	59.2	21.1	127.5	395.1	602.9
NE	46.6	4.5	-	44.0	95.1
NNE	55.7	5.4	11.1	73.8	146.1
NNW	1.0	26.0	164.3	1,009.5	1,200.7
NW	0.4	10.6	57.1	300.8	368.8
S	4.6	0.9	-	42.0	47.5
SE	144.8	17.2	-	552.5	714.5
SSE	37.5	19.1	-	778.1	834.7
SSW	3.1	0.7	-	17.6	21.4
SW	0.6	0.4	-	34.2	35.3
W	0.2	0.4	-	25.8	26.5
WNW	0.2	1.0	-	31.5	32.7
WSW	0.3	0.3	-	32.0	32.7
TOTAL	443.9	123.7	360.1	3,694.6	4,622.3

Table 2.2-4 Agricultural Yields for Croplands in Dawes County 2010

Crop	Harvested		Yield		Production
	Acres[a]	km^2	Per acre	Per km^2	
Corn (bu)	1,900	7.7	121.6 bu	30,049.17 bu	231,000 bu
Oats (bu)	400	1.6	38.0 bu	9,391.99 bu	15,200 bu
Wheat (bu)	35,200	142.4	33.9 bu	8,390.72 bu	1,195,000 bu
Forage (tons)	52,700	213.2	1.8 tons	453.04 tons	96,600 tons

Source: NASS 2011
Notes: bu bushels
[a]1 acre = 0.0040469 km^2

Table 2.2-5 Livestock Inventory for Dawes County 2007

Livestock	Number	Percentage of Total	Animal Units [a]	
			Pounds (000s)	Percent
All cattle, except dairy	69,405	96.2	69,405	99.5
Dairy cattle	24	0.03	24	0.03
Hogs and pigs	321	0.4	71	0.1
Sheep and lambs	1,294	1.8	259	0.4
Chickens	1,092	1.5	5	0.008
Total animals	72,136	100.0	69,763.9	100.0

Source: NASS 2009a

Notes: [a] Animal unit conversions:

1 cow = 1,000 lb.
1 hog = 220 lb.
1 sheep = 200 lb.
1 chicken = 5 lb.
1 animal unit = 1,000 lb.

Table 2.2-6 Recreational Facilities Within 50 Miles of the Proposed Marsland Expansion Area

Name of Recreational Facility	Distance From MEA Boundary (miles)
Box Butte Reservoir and Wildlife Area	~3
Ponderosa Wildlife Management Area	~5
Fort Robinson State Park	~9
Legend Buttes Golf Course	~11
Roberts Trailhead and Campground	~11
Crawford City Park	~12
Peterson Wildlife Management Area	~14
Chadron State Park	~16
Red Cloud Campground	~16
Soldier Creek Wilderness	~16
Whitney Lake	~16
Ridgeview Country Club Golf Course	~21
Agate Fossil Beds National Monument	~22
Hudson-Meng Bison Bonebed	~22
Toadstool Geologic Park	~24
Museum of the Fur Trade	~26
Walgren Lake State Recreation Area	~32
Gilbert-Baker Wildlife Area	~34
Warbonnet Battlefield	~35

Source: DeLorme Maps 2005

Table 2.2-7 Distance to Nearest Residence and Site Boundary from Center of MEA for each Compass Sector

Compass Sector[1]	Nearest Residence (ft.)	Nearest Site Boundary (ft.)
North	None	8,490
North-Northeast	None	3,688
Northeast	10,849	3,853
East-Northeast	None	4,481
East	3,070	4,403
East-Southeast	None	5,731
Southeast	21,364	8,106
South-Southeast	15,560	4,732
South	11,562	2,017
South-Southwest	7,305	2,046
Southwest	None	2,383
West-Southwest	3,335	2,480
West	None	2,404
West-Northwest	16,407	2,430
Northwest	None	2,799
North-Northwest	6,899	8,693

[1] 22 $^1/_2$° Sectors centered on each of the 16 compass points
None = No residence within the 2.25-mile radius of the MEA boundary for this specific sector.

Table 2.2-8 Uranium Recovery Activities in Region of Proposed Marsland Expansion Area

Company	Site	Design	Location (County)	Status
Eastern Wyoming				
Uranium One	Willow Creek	ISR-Restart	Johnson & Campbell	License approved
Uranerz Energy Corp.	Nichols Ranch	ISR-New	Johnson & Campbell	License approved
Uranium One	Moore Ranch	ISR-New	Converse	License approved
Uranium One	Allemand-Ross	ISR-Expansion	Converse	Application pending
Uranium One	Ludeman	ISR-New	Converse	Reapplication pending
Strategy Energy, Inc.	Ross	ISR-New	Oshoto & Cook	Technical review
Power Resources, Inc.	Smith Ranch Highland CPP	ISR-Expansion	Converse	Renewal
AUC LLC	Reno Creek	ISR-New	Campbell	Pre-submittal audit
Power Resources, Inc.	Ruby Ranch	ISR-Expansion	Campbell	Application pending
Power Resources, Inc.	Ruth	ISR-Expansion (for Smith Ranch Highland CPP)	Campbell	Pending operations plan approval (satellite facility)
Power Resources, Inc.	North Butte	ISR-Operations Plan	Campbell	Pending operations plan approval
The Bootheel Project, LLC	Bootheel	ISR-New	Albany	Application pending
Western Nebraska				
Crow Butte Resources, Inc.	Crow Butte Production Facilities	ISR-License Renewal	Dawes	License renewal (draft license issued)
Crow Butte Resources, Inc.	North Trend	ISR-Expansion	Dawes	License approval pending
Crow Butte Resources, Inc.	Three Crow	ISR-Expansion	Dawes	Review deferred
Crow Butte Resources, Inc.	Marsland	ISR-Expansion	Dawes	Application pending
Western South Dakota				
Powertech Uranium Corp.	Dewey Burdock	ISR-New	Custer & Fall River	Technical review

Notes: ISR – In-situ Recovery
RAI – Request for Additional Information

Table 2.2-9 USGS Estimated Water Use in Dawes County 2005

Total Population Served	Public Supply - Million Gallons Per Day				Irrigation (Mgal/da)			1000s
	Ground-water Withdrawals	Surface Water Withdrawals	Total Withdrawals	Domestic Deliveries	Ground-water Withdrawals	Surface Water Withdrawals	Total Withdrawals	Acres Irrigated Total
8,636	1.47	1.12	2.59	1.77	14.24	10.31	24.55	13

Source: USGS 2005

Table 2.2-10 Summary of Non-Abandoned Registered Water Wells for Dawes County on File as of August 23, 2011

Number of Registered Wells						Average Well Depth	Average Static Level	Average Pumping Level	Total Registered Acres, Irrigation [c]	Number of Replacement Wells
Commercial	**Domestic**	**Irrigation**	**Monitoring [a]**	**Other Wells [b]**	**Total**					
500	243	137	637	4,092	**5,609**	530.21	174.90	291.12	22,110.63	33
Other Wells (Registered)										
Ground Heat Exchange	Injection	Observation [d]	Other [e]	Recovery	Livestock	Public Water Supply [f]	Public Water Supply [g]		Total Other Wells	
5	916	8	16	2,855	252	16	24		**4,092**	

Source: NDNR 2011a

[a] Monitoring (Groundwater Quality)

[b] Listed below (Other Wells [Registered])

[c] The same acreage may be reported under more than one well registration.

[d] Observation (Groundwater Levels)

[e] Other (Lake Supply, Fountain, Geothermal, Wildlife, Wetlands, Recreation, Plant & Lagoon, Sprinkler, Test, Vapor Monitoring)

[f] With spacing protection (A well owned and operated by a city, village, municipal corporation, metropolitan utility district, reclamation district, or sanitary improvement district that provides water to the public fit for human consumption through at least 15 service connections or regularly serves at least 5 individuals)

[g] Without spacing protection (A well *not* owned or operated by a city, village, municipal corporation, metropolitan utility district, reclamation district, or sanitary improvement district that provides the public with water fit for human consumption through at least 15 service connections or regularly serves at least 25 individuals)

Table 2.2-11 Active, Inactive and Abandoned Water Supply Wells in the Marsland Expansion Area and 2.25-Mile Area of Review

Well No.	Estimated Depth (ft)	Formation	Well Use	Well Status
ACTIVE AND INACTIVE WELLS				
Wells Located Within License Boundary (13 active and 2 inactive)				
700	180–200	Brule	Livestock	Active
701	180–200	Brule	Livestock	Active [c]
705	Unknown	Arikaree	Livestock	Active
720	Unknown	Unknown[a]	Other	Active
721	Unknown	Unknown[a]	Other	Active
722	160	Brule	Livestock	Active
727	180	Arikaree/Brule	Livestock	Active
728	260	Brule	Livestock	Active
730	Unknown	Unknown[a]	Domestic	Active
731	180	Brule	Livestock	Active
733	Unknown	Unknown[a]	Livestock	Active
744	80	Arikaree	Livestock	Active
747	225	Arikaree/Brule	Livestock	Active
787	130	Brule	Livestock	Inactive
788	130–140	Arikaree	Livestock	Inactive
Wells Located Within 1 Km Radius of License Boundary (30 active and 2 inactive)				
702	180–200	Brule	Livestock	Active
703	280	Brule	Domestic/Livestock	Active
704	Unknown	Unknown[a]	Livestock	Active
707	Unknown	Unknown[a]	Livestock	Active
719	160	Brule	Livestock	Active
723	220	Brule	Domestic/Livestock	Active
724	Unknown	Unknown[a]	Domestic/Livestock	Inactive
725	240	Brule	Livestock	Active
729	Unknown	Unknown[a]	Livestock	Active
732	280	Brule	Agricultural	Active
735	375	Brule[b]	Livestock	Active
736	200	Brule[b]	Agricultural	Active
739	60	Arikaree	Livestock/Garden	Active
740	110	Brule	Agricultural	Active
741	190	Brule	Agricultural	Active
743	140	Brule[b]	Livestock	Active
745	140[c]	Brule	Livestock	Active
746	Unknown	Unknown[a]	Livestock	Active
748	Unknown	Unknown[a]	Livestock	Active
749	Unknown	Unknown[a]	Livestock	Active
750	Unknown	Unknown[a]	Livestock	Active
752	200–300	Brule	Domestic/Livestock	Active
753	200–300	Brule	Domestic/Livestock	Active
754	200–300	Brule	Livestock	Active
755	200–300	Brule	Livestock	Active

Table 2.2-11 Active, Inactive and Abandoned Water Supply Wells in the Marsland Expansion Area and 2.25-Mile Area of Review

Well No.	Estimated Depth (ft)	Formation	Well Use	Well Status
756	200–300	Brule	Livestock	Active
759	200–300	Brule	Livestock	Active
777	60	Arikaree	Domestic/Garden	Active
778	60	Arikaree	Garden	Active
802	180–200	Brule	Livestock	Active
834	300	Brule	Domestic/Livestock	Inactive
843	300	Brule[b]	Livestock	Active
Wells Located Between 1 and 2 Km Radius (24 active and 2 inactive)				
706	Unknown	Unknown[a]	Livestock	Active
714	135	Brule[b]	Domestic/Livestock	Active
715	135	Arikaree	Agricultural	Active
716	135	Brule	Agricultural	Active
734	300	Brule[b]	Livestock	Active
737	340	Brule[b]	Agricultural	Inactive
742	60	Arikaree[b]	Livestock	Active
760	Unknown	Unknown[a]	Agricultural	Active
761	Unknown	Unknown[a]	Livestock	Active
774	200–300	Arikaree/Brule[b]	Domestic/Livestock	Active
790	Unknown	Unknown[a]	Livestock	Active
794	300	Arikaree/Brule[b]	Domestic/Livestock	Active
795	350	Arikaree/Brule[b]	Domestic/Livestock	Active
796	350	Arikaree/Brule[b]	Domestic/Livestock	Active
799	250	Brule	Livestock	Active
809	300	Brule	Livestock	Active
810	>300	Unknown[a]	Domestic/Livestock	Active
811	>300	Unknown[a]	Domestic/Livestock	Active
815	140	Brule	Domestic	Active
816	140	Brule	Livestock	Active
817	160	Brule	Livestock	Active
821	160	Brule[b]	Livestock	Active
835	300	Brule	Livestock	Inactive
836	220	Brule	Livestock	Active
841	220	Brule[b]	Livestock	Active
845	Unknown	Unknown[a]	Domestic/Livestock	Active
Wells Located Between 2 Km Radius and AOR Boundary (54 active, 8 inactive and 1 unknown)				
708	Unknown	Unknown[a]	Livestock	Active
709	Unknown	Unknown[a]	Livestock	Active
710	Unknown	Unknown[a]	Livestock	Active
711	Unknown	Unknown[a]	Livestock	Active
712	Unknown	Unknown[a]	Livestock	Active
713	Unknown	Unknown[a]	Livestock	Active
717	160	Arikaree/Brule	Livestock	Active
738	260	Arikaree/Brule[b]	Livestock	Active

Table 2.2-11 Active, Inactive and Abandoned Water Supply Wells in the Marsland Expansion Area and 2.25-Mile Area of Review

Well No.	Estimated Depth (ft)	Formation	Well Use	Well Status
751	Unknown	Unknown[a]	Livestock	Active
762	200–300	Arikaree/Brule[b]	Livestock	Active
763	200–300	Arikaree/Brule[b]	Livestock	Active
764	200–300	Arikaree/Brule[b]	Livestock	Active
765	200–300	Arikaree/Brule[b]	Livestock	Active
767	200–300	Arikaree/Brule[b]	Livestock	Active
768	200–300	Arikaree/Brule[b]	Domestic	Active
769	200–300	Arikaree/Brule[b]	Livestock	Active
771	200–300	Arikaree/Brule[b]	Livestock	Active
772	200–300	Arikaree/Brule[b]	Livestock	Active
773	200–300	Arikaree/Brule[b]	Livestock	Active
775	220	Arikaree/Brule[b]	Livestock	Active
776	200–300	Arikaree/Brule[b]	Livestock	Active
781	60	Arikaree/Brule	Livestock	Active
782	100	Brule[b]	Agricultural	Active
783	70	Arikaree/Brule[b]	Domestic	Active
784	40–60	Arikaree/Brule[b]	Livestock	Inactive
785	140	Arikaree/Brule[b]	Livestock	Inactive
786	140	Arikaree/Brule[b]	Livestock	Inactive
791	Unknown	Unknown[a]	Livestock	Active
792	Unknown	Unknown[a]	Livestock	Active
793	300	Arikaree/Brule[b]	Livestock	Active
798	200	Brule	Livestock	Active
800	Unknown	Unknown[a]	Livestock	Active
801	220	Arikaree/Brule[b]	Domestic/Garden	Active
803	Unknown	Unknown[a]	Livestock	Active
804	Deep	Unknown[a]	Domestic/Livestock	Active
805	Shallow	Unknown[a]	Livestock	Inactive
806	Unknown	Unknown[a]	Livestock	Inactive
808	160	Arikaree/Brule[b]	Domestic/Livestock	Active
812	260	Unknown[a]	Domestic/Livestock	Active
813	280	Unknown[a]	Livestock	Active
814	Unknown	Unknown[a]	CBR Exploration	Inactive
818	140	Arikaree/Brule[b]	Livestock	Active
819	140	Arikaree/Brule[b]	Livestock	Active
822	140	Brule[b]	Livestock	Active
823	100	Arikaree/Brule[b]	Livestock	Active
827	Unknown	Unknown[a]	Livestock	Active
828	160	Arikaree/Brule[b]	Domestic	Active
837	300	Brule[b]	Livestock	Active
838	300	Arikaree/Brule[b]	Livestock	Active
839	300	Arikaree/Brule[b]	Livestock	Active
840	300	Arikaree/Brule[b]	Livestock	Active
842	300	Arikaree/Brule[b]	Livestock	Active

Table 2.2-11 Active, Inactive and Abandoned Water Supply Wells in the Marsland Expansion Area and 2.25-Mile Area of Review

Well No.	Estimated Depth (ft)	Formation	Well Use	Well Status
846	Unknown	Unknown[a]	Livestock	Active
849	Unknown	Unknown[a]	Livestock	Active
850	200	Arikaree/Brule[b]	Agricultural	Active
851	140	Arikaree/Brule[b]	Agricultural	Active
853	150	Arikaree/Brule[b]	Agricultural	Active
856	Unknown	Unknown[a]	Unknown	Unknown
857	40–50	Arikaree/Brule[b]	Domestic/Agricultural	Inactive
858	200	Arikaree/Brule[b]	Agricultural	Active
859	120	Arikaree/Brule[b]	Domestic	Inactive
861	40	Arikaree/Brule[b]	Domestic/Livestock/ Agricultural	Active
862	155	Arikaree/Brule[b]	Domestic/Agricultural	Active
ABANDONED WELLS				
Wells Located Within License Boundary				
726A	300	Brule	Unknown	Abandoned
Wells Located Within 1 Km Radius of License Boundary				
868A	Unknown	Unknown[a]	Unknown	Abandoned
869A	Unknown	Unknown[a]	Unknown	Abandoned
Wells Located Between 1 and 2 Km Radius				
867A	Unknown	Unknown[a]	Unknown	Abandoned

[a] Information provided by well owner and information from nearby wells are insufficient to make a definitive determination of aquifer utilized. However, discussions with land owners and known completion depths of private water wells in the area suggest that these wells are completed within the Arikaree Formation or the Brule Formation.

[b] Information provided by well owner and information from nearby wells indicate that one or more aquifer is utilized, but cannot be specifically determined. Assigned formation based on available information.

[c] Well is designated as active but is unused.

Table 2.2-12 Minimal Horizontal Distance Separating a Municipal Water Well from Potential Sources of Contamination

Potential Source of Contamination	Distance	
	Feet	Meters
Water well	1,000	305
Sewage lagoon	1,000	305
Land application of municipal/industrial waste material	1,000	305
Feedlot or feedlot runoff	1,000	305
Underground disposal system (septic system, cesspool, etc.)	500	153
Corral	500	153
Pit toilet/vault toilet	500	153
Wastewater holding tanks	500	153
Sanitary landfill/dump	500	153
Chemical or petroleum product storage	500	153
Sanitary treatment plant	500	153
Sewage wet well	500	153
Sanitary sewer connection	100	153
Sanitary sewer manhole	100	153
Sanitary sewer line	50	15

Source: NDHHS 2010.

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_2-1 Land Use.mxd - 3/16/2012 @ 3:34:09 AM

LEGEND

- Proposed Marsland Satellite Plant Centroid
- Compass Sector Boundary
- Proposed Marsland Expansion Area
- Area of Review
- Nebraska National Forest Boundary

Land Use*

- Cropland
- Drainage/Potential Wetland
- Forest Land
- Rangeland
- Recreational Land

* Land use data were interpreted from aerial image. The delineation of "Drainage/Potential Wetland" type also referenced NHD Flowlines and NWI Wetland Dataset.

N

0 2,250 4,500

Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.2-1
MARSLAND EXPANSION AREA
LAND USE

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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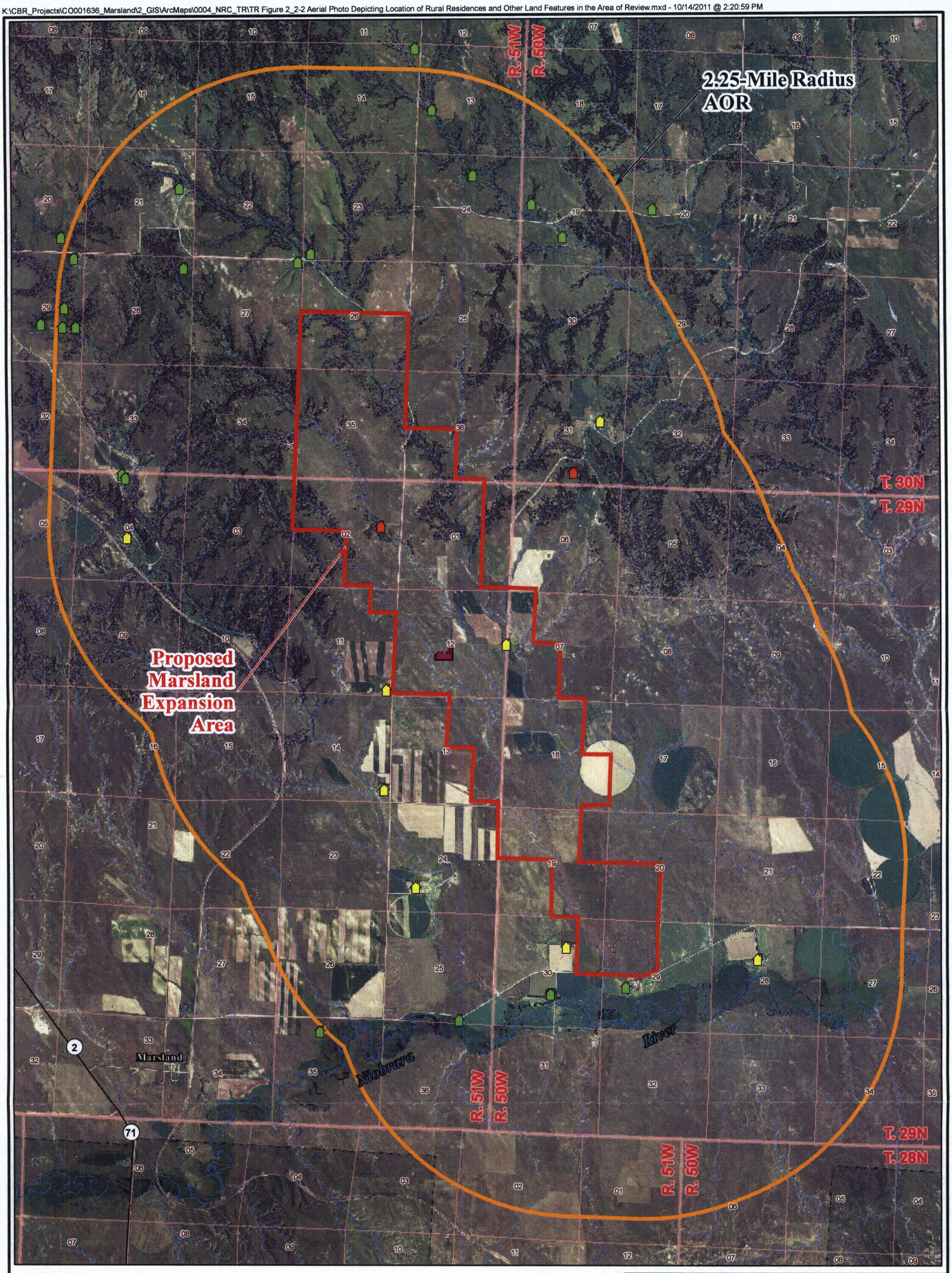
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_2-2 Aerial Photo Depicting Location of Rural Residences and Other Land Features in the Area of Review.mxd - 10/14/2011 @ 2:20:59 PM



LEGEND

- Structure
- Satellite Plant
- Occupied Residence
- Unoccupied Residence
- Proposed Marsland Expansion Area
- Area of Review (AOR)
- Intermittent Stream/River
- Perennial Stream/River

N

0 3,000 6,000
Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.2-2
AERIAL PHOTO DEPICTING LOCATION OF RURAL RESIDENCES AND OTHER LAND FEATURES IN THE AREA OF REVIEW

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

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Highlands Ranch, CO 80129
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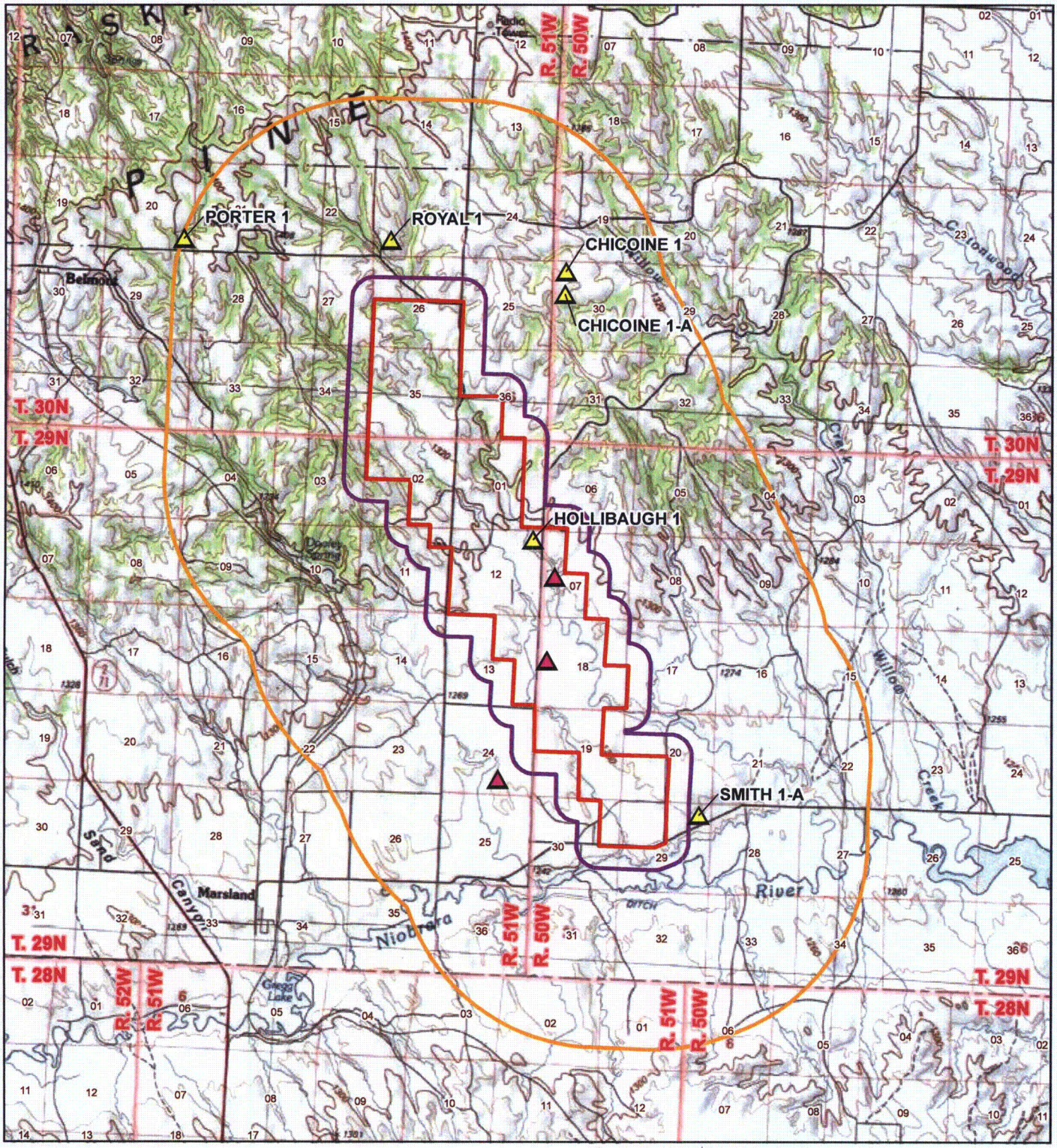
www.arcadis-us.com



LEGEND

- Sand/Gravel Pit, Inactive
- Dry Hole, Dry and Abandoned
- Proposed Marsland Expansion Area
- ZOEI Boundary (1/4-mile fixed radius)
- AOR Boundary (2-mile fixed radius)

Sources for Sand/Gravel Pits

1. Dawes County, (http://dawes.assessor.gisworkshop.com/Assessor/index.jsp), Accessed on 08/03/2011, and
2. Burchett, R.R. 1971. Directory of Nebraska Quarries, Pits and Mines. Resource Report Number 5. University of Nebraska Conservation and Survey Division, Lincoln. March.

Sources for Oil/Gas Test Holes

Nebraska Oil and Gas Conservation Commission, (http://www.nogcc.ne.gov/NOGCCPublications.aspx), Accessed on 08/01/2011

N

0 4,000 8,000

Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 2.2-3
MARSLAND EXPANSION AREA
LOCATIONS OF GRAVEL PITS AND OIL/GAS TEST HOLES

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

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K:\CBR_Projects\...01636_Marsland2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_2-3 Gravel Pits and OG Test Holes.mxd.mxd - 11/8/20..._11:16:59 PM

2.3 Population Distribution

Information presented in this section concerns those demographic and social characteristics of the environs that may be affected by the proposed expansion of the Crow Butte Uranium Project to include operations in the MEA. Data were obtained through the 1980, 1990, and 2000 Decennial Census, with updates from the 2010 census; various State of Nebraska government agencies; and other publicly available sources.

2.3.1 Demography

2.3.1.1 Regional Population

The area within a 50-mile (80-km) radius of the project site includes portions of six counties in northwestern Nebraska, two counties in southwestern South Dakota, and two counties in eastern Wyoming. Because the 50-mile (80-km) radius extends only slightly into two very rural portions of Garden County, Nebraska and Niobrara and Goshen Counties in Wyoming, these areas are not discussed in detail beyond data summarized in **Table 2.3-1** through **Table 2.3-3**. **Figure 2.3-1** depicts significant population centers within a 50-mile (80-km) radius of the proposed MEA.

Historical and current population trends in the project area counties and communities are contained in **Table 2.3-1**. Most counties have experienced a decline in population since either the 1970 or 1980 decennial census; the exceptions are Shannon County, South Dakota and Goshen County, Wyoming, which have both seen population increases. All of the Nebraska counties comprising the project area experienced slight growth or actual population decline between 1960 and 1980 and population decline between 1980 and 2010. The state experienced its fastest growth since the 1920s during the years between 1990 and 2000. The total state population in 2010 was 1,826,000, which was a 6.7-percent increase over the 2000 population of 1,711,000. The Nebraska counties in the project area experienced little of the 15.7-percent growth spurt seen state-wide in the 1990-2010 period; only Scotts Bluff and Dawes Counties registered positive population growth in this time period, and that growth was less than 3 percent. In general, population trends for the past two decades show that population in urban areas is increasing, while population in rural areas is declining. Areas within 50 miles (80 km) of the project site that are defined as urban (all territory, population, and housing units in urbanized areas and in places of more than 2,500 persons outside of urbanized areas) by the U.S. Census 2000 are the Cities of Chadron and Alliance, Nebraska (USCB 2003a).

Dawes County grew slightly between 1990 and 2000, gaining 1.8 percent in population; this is attributed to growth in the City of Chadron, which more than offset the population declines in other communities in the county. This population growth has not offset the large loss of population that occurred in the 1980 to 1990 time period; the population today remains below its 1980 level. The City of Chadron and the City of Crawford are the nearest large communities in Dawes County to the project site. The City of Chadron is located approximately 25 miles (40 km) northeast of the project site; its 2010 population was recorded at 5,851 - an increase of 3.9 percent from 2000 (USCB 2011). The City of Crawford, within 15 miles (24 km) of the site, had a 2010 population of 1997 - an almost 10 percent decrease from 2000 (USCB 2011). The population declines in the City of Crawford were greater than the losses in most other communities and the county as a whole.

Sioux County has been losing population since the 1970 decennial census; the pace of these losses has fluctuated over the last 40 years, but has averaged approximately 10 percent per decade. The population decline was slowest in the 1990 to 2000 period due to a population increase of nearly 16 percent in the City of Harrison.

Box Butte County experienced a significant gain in population in the 1970 to 1980 timeframe, but has been losing population ever since. The population decline has averaged approximately 6 percent per decade since the 1980 Census, with the county losing 7 percent of its population since the 2000 Census. The Village of Hemingford, the nearest significant community in Box Butte County to the project site, has seen fluctuating population levels since the 1970 Census, although the Village lost approximately 19 percent of its population in the past decade.

Similarly, Sheridan County saw a gain in population in the 1970 to 1980 timeframe, but has been steadily losing population at an average rate of approximately 10 percent per decade since. This decline in population has been seen in the county's larger communities of Hay Springs and Rushville, both of which have similar rates of decline in their populations since 1980.

Scotts Bluff and Morrill Counties have experienced less severe population losses over the 1980 to 2010 timeframe, with losses of 6 and 1.1 percent per decade, respectively. The communities of Scotts Bluff and Minatare in Scotts Bluff County have experienced population growth of 0.7 and 2.1 percent, respectively, since the 2000 Census.

Within South Dakota, portions of Fall River and Shannon Counties fall inside the 50-mile (80-km) study area. Fall River County experienced population growth in the 1970 to 1980 period, but has lost more than 16 percent of its population in the last 30 years despite a small positive growth rate in the 1990t o 2000 period. The county-wide trends in population growth and loss are mirrored in the community of Oelrichs, which has lost more than 21 percent of its population since 1980. Shannon County, on the other hand, has grown by an average of better than 15 percent per decade since 1970; this growth has been realized in significant swings, with 38 percent growth in the 1970 to 1980 period followed by a 12.5 percent decline in population over the 1980 to 1990 period, which was then followed by a decade of nearly 26 percent growth from 1990 to 2000 and then 9 percent growth from 2000 to 2010. Much of the growth occurred in the Pine Ridge and Oglala Census Designated Places, which are urban areas as defined by the U.S. Census, but are not incorporated municipalities.

The population declines in the counties within the 50-mile (80-km) radius reflect trends in the overall region, where population declines have been attributed to the declines in the rural farming-based economy and limited economic opportunities for youth. Persistent drought conditions have also contributed to the shrinking of the agriculture-based economy. Rural residents have been migrating to larger cities, depopulating the largely rural Great Plains states. Many of the people migrating out of the state are young adults and families, which results in fewer people of childbearing age, and therefore, fewer children. This trend also contributes to the increasing proportion of the elderly population in the state (UNRI 2008).

2.3.1.2 Population Characteristics

2010 population by age and sex for counties within 50 miles (80 km) of the MEA is shown in **Table 2.3-2**. Overall, 74.5 percent of the population in the region is more than 18 years old. Fewer than 20 percent of the populations of Garden, Fall River, and Niobrara Counties are under

the age of 18; Shannon County has the youngest population, with nearly 40 percent of its population under the age of 18. Females slightly outnumbered males in all but four counties, with an overall population of 50.6 percent female to 49.4 percent male (USCB 2011).

In 2010, 81.5 percent of the population of the 11 counties was classified as white. American Indians comprised the largest non-white classification. The largest American Indian population is found in Shannon County, South Dakota, where American Indians comprise 96 percent of the 13,586 people in the county (USCB 2011).

2.3.1.3 Population Projections

The projected population for selected years by county within the 50-mile (80-km) radius of the proposed MEA Project is shown in **Table 2.3-3**. The population is expected to decrease or hold steady in all 11 counties surrounding the project area. These counties are primarily rural, with agriculture-based economies. It is anticipated that the declining population trends of the last two decades will continue into the foreseeable future for these counties as populations shift to more urban counties (e.g., Douglas, Lancaster, Sarpy). The largest declines are projected for Dawes and Garden Counties, which are each expected to lose more than 20 percent of their current populations by the year 2030.

2.3.1.4 Seasonal Population and Visitors

According to the Final Environmental Impact Statement for the Northern Great Plains Management Plans Revision (May 2001), the various state parks in northwest Nebraska (the Pine Ridge Ranger District and the Oglala National Grassland) are increasingly becoming regional tourist destinations.

Approximately 345,923 people visited Fort Robinson State Park in 2010. This number represents a 25 percent decrease from 460,154 in 2007 and a 2 percent decrease from 356,352 in 1993 (NDED 2011). Approximately 50 percent of the visitors in 2002 were from other states, which is an increase in the number of out-of-state visitors from 1981, as the majority of 1981 visitors were Nebraskan families. It is likely that the decline of visitors from Nebraska has resulted from the overall decline of population in rural counties within a few hours commuting distance of the park.

There were 55,000 visitors to the Pine Ridge District of the Nebraska National Forest in 2001. Camping and motorized travel/sightseeing are the two most popular recreation categories within the Pine Ridge Ranger District and the Oglala National Grassland.

The forest provides a wide range of other undeveloped backcountry recreation opportunities such as hunting, hiking, backpacking, fishing, and wildlife observation. The district provides the greatest number of miles of mountain biking trails in the state. District trails also attract horseback riders and off-highway motorized vehicle use. The Pine Ridge is an important destination for deer hunting, and provides the most popular turkey hunting area in Nebraska.

One source of seasonal population in this region is Chadron State College, located approximately 21.6 miles (35 km) from the site. During the fall seasons of 2005, 2006, 2007, 2008, 2009, 2010, and 2011, the enrollment was 2,601, 2,767, 2,726, 2,769, 2,744, 2,759, and 2,609, respectively (CSC 2010a, 2010b, Haag 2012, and Universities.com 2010). The average enrollment from 1994 through 1999 was 2,944, with a range of 2,768 to 3,189 (NCCPE 2005). Enrollment from 2011

(2,609) versus this later average of 2,944 is a 0.11 percent reduction in student enrollment. A rising enrollment trend has been observed at the college since 2006, with an overall increase near 30 percent during the period (Haag 2012). Actual enrollment values presented in this paragraph may vary depending on the time of the year of the enrollment count.

2.3.1.5 Schools

The City of Crawford is served by the City of Crawford Public School District. The Crawford High School and grade school are presently under capacity (Vogl pers. comm. 2010). Enrollment for the 2010-2011 school years was 138 in the grade school and 109 in the high school; this represents a decline of about 9.5 percent in total enrollment for both schools from the 2007-2008 school years (NDE 2011a).

The Village of Hemingford is served by the Hemingford Public Schools. Enrollment for the 2010-2011 school years was 219 in the grade school and 173 in the high school, an increase of more than 9 percent in total enrollment for both schools from the 2007-2008 school years (NDE 2011b). This enrollment level is lower than in past years, reflecting continuing pressures on population levels in the area.

Families moving into the Crawford or Hemingford School Districts as a result of the proposed MEA operations would not stress the current school system.

2.3.1.6 Sectorial Population

Existing population, as determined for the original analysis in the CBR commercial license application prepared in 1987 for the 50-mile (80-km) radius, was estimated for 16 compass sectors, by concentric circles of 0.6, 1.2, 1.9, 2.5, 3.1, 6.2, 12.4, 18.6, 24.9, 31, 37.3, 43.5, and 50 miles (80 km) (1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70, and 80 km) from the site (a total of 208 sectors). 2010 US Census data were used; subtotals by sector and compass points as well as the total populations are shown in **Table 2.3-4**.

Population within the 50-mile (80-km) radius was estimated using the following techniques:

- U.S. Census 2010 data were used to estimate the total population within a 50-mile (80-km) radius, measured from the center of the proposed MEA site. The data were created by Geographic Data Technology, Inc., a division of Earth Sciences and Research Institute (ESRI), from Census 2000 boundary and demographic information for block groups within the United States.
- ArcInfo GIS was used to extract data from U.S. Census 2000 population estimates for 40 Census Tract Block Groups located wholly or partially within the 50-mile (80-km) radius from the approximate center of the MEA site. Urban areas within each county were generally assigned their own block group.
- To assign a population to each sector, a percentage area of each sector within one or more block groups was calculated for all of the block groups.
- 2010 U.S. Census of population estimates for cities and counties in Nebraska, South Dakota, and Wyoming were used to determine total urban population.

2.3.2 Local Socioeconomic Characteristics

2.3.2.1 Major Economic Sectors

In 2009, average annual unemployment rates in Dawes and Box Butte Counties decreased from the 2008 rates. **Table 2.3-5** summarizes unemployment rates and employment in the Nebraska project area counties, as well as the overall change in employment in economic sectors between 1994 and 2009. Dawes and Box Butte Counties exhibited unemployment rates at 4.4 percent in Dawes County and 6.8 percent in Box Butte County in 2009. The Dawes County unemployment rate was slightly lower than the statewide rate of 4.7 percent, whereas the Box Butte County rate was significantly higher (NDOL 2010).

The major economic sectors in the project area have changed little in recent years, although individual sectors have shifted in their relative proportion in the overall economy. The area continues to depend on trades, government, and services. Economic sectors in the City of Crawford area include farming, ranching, cattle feed lots, tourism, and retail sales.

Agriculture accounted for a significant portion (19.2 percent) of the total employed labor force in Dawes County in 2009. During the same time period, farm employment was 2.0 percent of total employment in Box Butte County. Retail trade accounted for 14.7 percent of total employment in Dawes County, followed by local government employment (12.6 percent), leisure and hospitality (11.1 percent), education and health services (9.8 percent), and state government (6.5 percent). Mining and construction accounted for 5.0 percent. In Box Butte County, the largest four non-farm employment sectors are local transportation, communication and utility services (20.2 percent); local government (17.7 percent); production (8.6 percent); and leisure and hospitality (8.0 percent) (NDOL 2010).

While agriculture employment is not dominant, agriculture provides the economic base for the counties, as other economic sectors support the agricultural industry. Events that affect agriculture are generally felt throughout rural economies. According to the Nebraska Department of Economic Development (NDED 2010), farm employment in Nebraska is expected to decline by nearly 14,000 jobs (20 percent) between 2000 and 2045, while overall non-farm employment will increase by nearly 26 percent. The decrease in jobs in the agricultural sector could continue to fuel migration from rural counties to urban areas, resulting in overall declines in other sectors of the local economy as dollars spent from personal income and agricultural business expenditures move out of the counties.

Per capita personal income is the income that is received by persons from all sources, including wages and other income, over the course of 1 year. In 2010, personal income in Dawes County was $28,981, which was 74 percent of the state average of $39,332. The county ranks 87th out of 93 counties in the state (BEA 2011). In 2010, personal income in Box Butte County was $35,225, which was 89 percent of the state average of $39,332. Box Butte County ranks 58th out of 93 counties in the state.

2.3.2.2 Housing

Between 1970 and 1980, total housing units increased by 17 percent in Dawes County from 3,388 to 3,965 units (USCB 1990a). After a decline in total units during the 1980s, growth increased by 2.4 percent from 3,909 units in 1990 to 4,004 units in 2000, and then increased again by 6.2

percent to 4,252 units in 2010. The City of Chadron, the largest community in Dawes County and within 25 miles (40 km) of the project site, experienced a negligible increase (0.3 percent) in housing stock between 1980 and 1990, a 5 percent increase between 1990 and 2000, and a 4.4 percent increase to 2,559 units between 2000 and 2010. Between 1980 and 1990, the City of Crawford housing stock decreased by nearly 7 percent to 576 (USCB 2003a). The number of housing units continued to decline through 2010, when 567 units were reported.

Box Butte County, which borders Dawes County to the south, exhibited a 1 percent loss in total housing units between 1990 and 2000, when 5,488 units were counted in the 2000 Census; a similarly small loss of 10 units was reported in the following decade, with a total of 5,478 units reported in 2010. In the Village of Hemingford, 418 housing units were reported in 2010; this represents a slight decrease from the 438 units reported in 2000.

In 2000, Dawes and Box Butte Counties had homeowner vacancy rates of 1.7 and 1.4 percent, respectively. In 2010, these rates were 2.3 and 2.4 percent, respectively. As of June 2011, there were six single-family housing units for sale in the City of Crawford. Five of the units were listed at prices below $100,000. One unit was listed at a price higher than $250,000. Three new single-family housing units were constructed between 2006 and 2008 in the City of Crawford, and average new home construction costs were $70,000 (NPPD 2012); one permit was issued in 2009 for a home with a construction cost of $60,000. In Hemingford, one permit was issued in 2006 for a residence with a construction cost of $25,100. The median gross rent for the City of Crawford in 2009 was $440 per month; in the Village of Hemingford, the median gross rent was $344 (Advameg 2010).

The demand for rental housing did not change significantly between 1990 and 2000, as rental vacancy rates were 11.8 percent in Dawes County and 15.4 percent in Box Butte County in 2000 (USCB 2003c) compared with 1990 rental vacancy rates of 12.6 percent and 14.9 percent, respectively (USCB 1990b). Similar rates continue to be seen: the rental vacancy rate in Dawes County is currently 10.2 percent, and 17.7 percent in Box Butte County (USCB 2011).

High interest rates and tax rates were the major deterrents for potential homebuyers in the project area in the past. Current deterrents are economic uncertainty and unemployment, as home mortgage interest rates have recently been at historic lows.

The majority of housing demand expected over the next two decades in Dawes County is most likely to occur in the City of Chadron, reflecting a continued shift from rural to more urbanized environments.

The purchase of homes by Crow Butte employees provides the City of Crawford with ad valorem property taxes. The City of Crawford levies taxes at a dollar per hundred of valuation. In 2010, the total levy was 0.424539, which would result in taxes on a $50,000 property of approximately $212 per year. The Village of Hemingford levies taxes at a dollar per hundred of valuation. In 2010, the total levy was 0.98062, which would result in taxes on a $50,000 property of approximately $490 per year (NE Revenue 2010).

2.3.3 Environmental Justice

The 2010 Census provides population characteristics for Census Tracts, which contain Block Groups that are further divided into Blocks. The Blocks are the smallest Census areas that contain the race characteristics of the population in the MEA region. The MEA contains all or a portion of, or is adjacent to, 23 Blocks within Census Tract 9506 in Dawes County. Census Bureau-generated 2009 data on the poverty status of school district populations were used as a proxy.

The affected area selected for the Environmental Justice analysis includes the racial characteristics of the population within Census Tract Blocks within the MEA, and the poverty status of students enrolled in local school districts.

The State of Nebraska was selected to be the geographic area to compare the demographic data for the population in the affected Blocks. This determination was based on the need for a larger geographic area encompassing affected area Block Groups in which equivalent quantitative resource information is provided. The population characteristics of the MEA are compared with Nebraska population characteristics to determine whether there are concentrations of minority or low income populations in the MEA relative to the state.

According to the 2010 Census, and summarized in **Table 2.3-6**, the combined population of the Census Block Groups within or adjacent to the MEA was 32. The entire population was white; with one individual identified as Hispanic. The next nearest minority populations reside within the City of Crawford, located approximately 15 miles (24.1 km) north-northwest of the MEA, and the Village of Hemingford, located approximately 15 miles (24.1 km) south-southeast. Races in the City of Crawford consist of white non-Hispanic (95.6%), American Indian (0.9%), Hispanic (1.0%), persons reporting two or more races (2.3%), and smaller percentages of other races. Races in the Village of Hemingford consist of white non-Hispanic (96.1%), American Indian (1.2%), Hispanic (4.6%), persons reporting two or more races (2.1%), and smaller percentages of other races. The total percentage is greater than 100 percent because Hispanics could be counted in other races.

No concentrations of minority populations were identified as residing in rural areas near the proposed MEA. There would be no disproportionate impact to any minority population from the construction and implementation of the MEA.

The schools located nearest the MEA are those in the City of Crawford (operated by Crawford Public Schools), the Village of Hemingford (operated by Hemingford Public Schools), and in the community of Marsland (the Pink Public School operated by the Sioux County Public Schools). 12.9 percent of all students aged 5 to 17 in the State of Nebraska are identified as living in families in poverty. This compares to 22.8 percent of students in the Crawford Public Schools, 13.8 percent in the Hemingford Public Schools, and 19.8 percent in the Sioux County Public Schools. These data indicate that more students in the vicinity of the MEA live in families in poverty than are found in the state as a whole. Lower income levels are characteristic of predominantly rural populations and small communities that serve as a local center of agricultural activity. No adverse environmental impacts would occur to the population within the MEA from proposed Project activities; therefore, there would be no disproportionate adverse impact to populations living below the poverty level in these Block Groups.

2.3.4 References

Advameg, Inc. 2010. *Crawford, Nebraska*. [Web Page]. City-Data.com. Located at: http://www.city-data.com/city/Crawford-Nebraska.html. Accessed on: February 25, 2010.

Bureau of Economic Analysis (BEA). 2011. Personal Income and Per Capita Income by County for Nebraska 2005-2007. [Web Page]. Located at: http://www.bea.gov/regional/reis/. Accessed on: August 11, 2011.

Chadron State College (CSC). 2010a. *Student Enrollment Information*. [Web Page]. Located at: http://www.csc.edu/ir/enrollment.csc. [225, 2006 and 2007 data]. Accessed on: February 25, 2010.

CSC. 2010b. *Enrollment Quick Facts*. [Web Page]. Located at: http://www.csc.edu/ir/quickfacts.csc. [2008 data]. Accessed on: February 25, 2010.

Haag, Justin. 2012. CSC Information Services. Rapid City Journal. January 10.

Nebraska Department of Education (NDE). 2011a. Education Directory Search. [Web Page]. Located at: http://educdirsrc.education.ne.gov/default.aspx. Accessed on: November 21, 2011.

NDE. 2011b. 2009-2010 State of the Schools Report. [Web Page]. Located at: http://reportcard.education.ne.gov. Accessed on: June, 2011.

Nebraska Department of Economic Development (NDED). 2010. Projected Nebraska Farm and Nonfarm Employment 1998 to 2045. [Web Page]. Located at: http://www.neded.org/files/research/stathand/csecc3.gif. Accessed on: January 15, 2010.

NDED. 2011. Tourism and recreation. [Web Page]. Located at: http://www.neded.org/search-ne-ded?q=recreational+area+attendance. Accessed on: November 21, 2011.

Nebraska Department of Labor (NDOL). 2010. Labor Force/Work Force Summaries. [Web Page]. Located at: http://www.dol.nebraska.gov/nwd/center.cfm?PRICAT=3&SUBCAT=4F. Accessed on: February 26, 2010.

Nebraska Department of Revenue Property Assessment Division (NE Revenue). 2010. Reference List of All Individual Taxing Subdivisions & Tax Rates for Tax Year 2010. [Web Page]. Located at: http://www.revenue.ne.gov/PAD/research/valuation/tax_entity_all/taxentity_allcnty2010.pdf. Accessed on : February 26, 2010.

Nebraska Department Property Assessment and Taxation. (NDPA&T). 2010. Research Reports [Valuation, Taxes Levied, & Tax Rate Data]. [Web Page]. Located at: http://pat.nol.org/researchReports/map/index.html. Accessed on: February 25, 2010.

Nebraska Public Power District (NPPD). 2012. Community Facts – Crawford Nebraska. [Web Page]. Located at: http://sites.nppd.com/aedc/fastfacts.asp?city=Crawford. Accessed on: April 16, 2012.

Nebraska's Coordinating Commission for Postsecondary Education (NCCPE). 2005. *2005 Nebraska Higher Education Progress Report for the LR75 Legislative Evaluation Task Force:* Volume *One*. [Web Page] Located at: http://www.ccpe.state.ne.us/publicdoc/ccpe/reports/LR174/2005/default.asp. Accessed on: February 25, 2010.

U.S. Department of Commerce, Census Bureau (USCB). 1990a. 1990 Census of Population and Housing – Population and Housing Counts - Nebraska. CPH-2-29. [Web Page] Located at: http://www.census.gov/prod/cen1990/cph2/cph-2.html. Accessed on: February 25, 2010.

USCB. 1990b. 1990 Census of Housing – General Housing Characteristics - Nebraska. CH-1-29. [Web Page] Located at: http://www.census.gov/prod/cen1990/ch1/ch-1.html. Accessedon: February 25, 2010.

USCB. 2000a. Census 2000 Summary File 1 (SF 1) 100-Percent Data. All Blocks in a County – Dawes County, Nebraska. [Web Page]. Located at: http://factfinder.census.gov/servlet/DCGeoSelectServlet. Accessed on: February 25, 2010.

USCB. 2000b. Census 2000 Summary File 1 (SF 1) 100-Percent Data. All Blocks in a County – Sioux County, Nebraska. [Web Page]. Located at: http://factfinder.census.gov/servlet/DCGeoSelectServlet. Accessed on: February 25, 2010.

USCB. 2001. Census of Population and Housing – Profiles of General Demographic Characteristics – Nebraska. DP-1-29. Issued May 2001. [Web Page] Located at: http://www.census.gov/prod/cen2000/index.html. Accessed on: February 27, 2010.

USCB. 2003a. 2000 Census of Population and Housing - Population and Housing Unit Counts - Nebraska. PHC-3-29. Issued September 2003. [Web Page] Located at: http://www.census.gov/prod/cen2000/index.html. Accessed on: February 27, 2010.

USCB. 2003b. 2000 Census of Population and Housing - Population and Housing Unit Counts – South Dakota. PHC-3-43. Issued September 2003. [Web Page] Located at: http://www.census.gov/prod/cen2000/index.html. Accessed on: February 27, 2010.

USCB. 2003c. 2000 Census of Population and Housing – Summary Population and Housing Characteristics - Nebraska. PHC-1-29. Issued September 2003. [Web Page]. Located at: http://www.census.gov/prod/cen2000/index.html. Accessed on: February 27, 2010.

USCB. 2009a. 2008 Population Estimates – County Characteristics. [Web Page]. Located at: http://www.census.gov/popest/counties/asrh/CC-EST2008-agesex.html. Accessed on: February 27, 2010.

USCB. 2009b. Download Center - 2008 Population Estimates. [Web Page]. Located at: http://factfinder.census.gov/servlet/DCGeoSelectServlet?ds_name=PEP_2008_EST. Accessed on: December 20, 2009.

USCB. 2010a. Dawes County, Nebraska – Quick Facts. [Web Page]. Located at: http://quickfacts.census.gov/qfd/states/31/31045.html. Accessed on: February 27, 2010.

USCB. 2010b. Box Butte County, Nebraska – Quick Facts. [Web Page]. Located at: http://quickfacts.census.gov/qfd/states/31/31013.html. Accessed on: February 27, 2010.

USCB. 2011. 2010 SF1 100% Data. [Web Page]. Located at: http://factfinder2.census.gov . Accessed on: September 2011.

Universities.com. 2010. Chadron State College. [Web Page]. Located at: http://www.universities.com/edu/Chadron_State_College.html. Accessed on: March 14, 2012.

University of Nebraska Rural Initiative (UNRI). 2008. Nebraska Population Growth Continues to be Concentrated in Metropolitan Counties. 4 pg. [Web Page]. Located at: http://ruralinitiative.nebraska.edu/growth/index.html.

University of Nebraska, Bureau of Business Research (UNL-BBR). 2009. Population Projections of Nebraska, 2000-2020. [Web Page]. Located at: http://www.bbr.unl.edu/PopProjections. Accessed: on December 20, 2009.

Vogl, B. 2010. Personal communication with Jason Adams [ARCADIS] via phone regarding school capacities. February 26, 2010.

Wyoming Department of Administration and Information, Economic Analysis Division. 2009. Wyoming Population Estimates and Forecasts from 2000 to 2030. [Web Page]. Located at: http://eadiv.state.wy.us/pop/wyc&sc30.htm. Accessed on: February 26, 2010.

Table 2.3-1 Historical and Current Population Change for Counties and Cities within 80 Km of the Marsland Expansion Area,1970-2010

State County City	Population					Average Annual Percent Change			
	1970	1980	1990	2000	2010	1970/ 1980	1980/ 1990	1990/ 2000	2000/ 2010
Nebraska									
Dawes County	**9,761**	**9,609**	**9,021**	**9,060**	**9,182**	**-1.6%**	**-6.1%**	**0.4%**	**1.3%**
Chadron	5,921	5,933	5,588	5,634	5,851	0.2%	-5.8%	0.8%	3.9%
Crawford	1,291	1,315	1,115	1,107	997	1.9%	-15.2%	-0.7%	-9.9%
Fort Robinson	NA	NA	NA	NA	NA	NA	NA	NA	NA
Marsland	17	27	NA	NA	NA	58.8%	NA	NA	NA
Whitney	82	72	38	87	77	-12.2%	-47.2%	128.9%	-11.5%
Box Butte County	**10,094**	**13,696**	**13,130**	**12,158**	**11,308**	**35.7%**	**-4.1%**	**-7.4%**	**-7.0%**
Alliance	6,862	9,869	9,765	8,959	8,491	43.8%	-1.1%	-8.3%	-5.2%
Berea	NA	NA	NA	NA	41	NA	NA	NA	NA
Hemingford	734	1,023	953	993	803	39.4%	-6.8%	4.2%	-19.1%
Garden County	**2,929**	**2,802**	**2,460**	**2,292**	**2,057**	**-4.3%**	**-12.2%**	**-6.8%**	**-10.3%**
Morrill County	**5,813**	**6,085**	**5,423**	**5,440**	**5,042**	**4.7%**	**-10.9%**	**0.3%**	**-7.3%**
Scotts Bluff County	**36,432**	**38,344**	**36,025**	**36,951**	**36,970**	**5.2%**	**-6.0%**	**2.6%**	**0.1%**
Minatare	939	969	807	810	816	3.2%	-16.7%	0.4%	0.7%
Mintle	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mitchell	1,842	1,956	1,743	1,831	1,702	6.2%	-10.9%	5.0%	-7.0%
Scottsbluff	14,507	14,156	13,711	14,732	15,039	-2.4%	-3.1%	7.4%	2.1%
Sheridan County	**7,285**	**7,544**	**6,750**	**6,198**	**5,469**	**3.6%**	**-10.5%**	**-8.2%**	**-11.8%**
Clinton	NA	NA	NA	30	41	NA	NA	NA	36.7%
Hay Springs	682	794	693	652	570	16.4%	-12.7%	-5.9%	-12.6%
Pine Ridge	NA	NA	16	14	NA	NA	NA	-12.5%	NA
Rushville	1,137	1,217	1,127	999	890	7.0%	-7.4%	-11.4%	-10.9%
Sioux County	**2,034**	**1,845**	**1,549**	**1,475**	**1,311**	**-9.3%**	**-16.0%**	**-4.8%**	**-11.1%**
Harrison	377	361	241	279	251	-4.2%	-33.2%	15.8%	-10.0%

Table 2.3-1 Historical and Current Population Change for Counties and Cities within 80 Km of the Marsland Expansion Area,1970-2010

State County City	Population					Average Annual Percent Change			
	1970	1980	1990	2000	2010	1970/ 1980	1980/ 1990	1990/ 2000	2000/ 2010
South Dakota									
Fall River County	**7,505**	**8,439**	**7,353**	**7,453**	**7,044**	**12.4%**	**-12.9%**	**1.4%**	**-5.5%**
Hot Springs	4,434	4,742	4,325	4,129	3,711	6.9%	-8.8%	-4.5%	-10.1%
Oelrichs	94	124	138	145	126	31.9%	11.3%	5.1%	-13.1%
Rumford	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ardmore	14	16	NA	NA	NA	14.3%	NA	NA	NA
Shannon County	**8,198**	**11,323**	**9,902**	**12,466**	**13,586**	**38.1%**	**-12.5%**	**25.9%**	**9.0%**
Wyoming									
Goshen County	**10,885**	**12,040**	**12,373**	**12,538**	**13,249**	**10.6%**	**2.8%**	**1.3%**	**5.7%**
Niobrara County	**2,924**	**2,924**	**2,499**	**2,407**	**2,484**	**0.0%**	**-14.5%**	**-3.7%**	**3.2%**
Van Tassell	21	10	8	19	15	-52.4%	-20.0%	137.5%	-21.1%

[1] 1980 was the last year that Ardmore had a recorded population.
Sources: U.S. Bureau of the Census 2011

Table 2.3-2 Population by Age and Sex for Counties Within the 80-Kilometer Radius of the Marsland Expansion Area 2010

County	Age	Male	Female	Total	Total Percent Breakdown
Nebraska					
Box Butte	Under 18	1,433	1,416	2,849	25.2%
	18 - 64	3,395	3,351	6,746	59.7%
	65+	713	1,000	1,713	15.1%
	Total	5,541	5,767	11,308	100.0%
Dawes	Under 18	906	860	1,766	19.2%
	18 - 64	2,999	2,917	5,916	64.4%
	65+	654	846	1,500	16.3%
	Total	4,559	4,623	9,182	100.0%
Morrill	Under 18	615	595	1,210	24.0%
	18 - 64	1,462	1,389	2,851	56.5%
	65+	440	541	981	19.5%
	Total	2,517	2,525	5,042	100.0%
Scotts Bluff	Under 18	4,637	4,515	9,152	24.7%
	18 - 64	10,574	11,029	21,603	58.3%
	65+	2,602	3,613	6,215	17.0%
	Total	17,813	19,157	36,970	100.0%
Sheridan	Under 18	661	632	1,293	23.6%
	18 - 64	1,473	1,491	2,964	54.2%
	65+	520	692	1,212	22.2%
	Total	2,654	2,815	5,469	100.0%
Sioux	Under 18	159	134	293	22.3%
	18 - 64	384	354	738	56.3%
	65+	130	150	280	21.4%
	Total	673	638	1,311	100.0%
South Dakota					
Fall River	Under 18	706	628	1,334	18.8%
	18 - 64	2,106	2,016	4,122	58.1%
	65+	291	1,347	1,638	23.1%
	Total	3,103	3,991	7,094	100.0%
Shannon	Under 18	2,737	2,605	5,342	39.3%
	18 - 64	3,636	3,809	7,445	54.8%
	65+	328	471	799	5.9%
	Total	6,701	6,885	13,586	100.0%
Wyoming					
Goshen	Under 18	1,411	1,290	2,701	20.4%
	18 - 64	4,340	3,708	8,048	60.7%
	65+	1,155	1,345	2,500	18.9%
	Total	6,906	6,343	13,249	100.0%
Niobrara	Under 18	259	211	470	18.9%
	18 - 64	665	836	1,501	60.4%
	65+	235	278	513	20.7%
	Total	1,159	1,325	2,484	100.0%

Source: USCB 2009a

Table 2.3-3 Population Projections for Counties Within an 80-Kilometer Radius of the Current Crow Butte Project Area 2000–2020

County	Census 2000	Census 2010	Projected 2020	Projected 2025	Projected 2030
Box Butte	12,158	11,308	9,588	8,827	8,050
Dawes	9,060	9,182	8,646	8,451	8,207
Garden	2,292	2,057	1,737	1,664	1,595
Morrill	5,423	5,042	4,886	4,761	4,625
Scotts Bluff	36,025	36,970	35,627	35,148	34,647
Sheridan	6,198	5,469	5,261	5,170	5,086
Sioux	1,475	1,311	1,271	1,189	1,103
Fall River	7,453	7,094	N/A	N/A	N/A
Shannon	12,466	13,586	N/A	N/A	N/A
Goshen	12,538	13,249	11,820	11,790	11,800
Niobrara	2,407	2,484	2,330	2,330	2,240

Sources: University of Nebraska-Lincoln, Bureau of Business Research 2009.
Wyoming Department of Administration and Information 2010.

N/A No projection available

Table 2.3-4 2010 Population Within an 80-Kilometer Radius of the Marsland Expansion Area

	0–1	1–2	2–3	3–4	4–5	5–10	10–20	20–30	30–40	40–50	50–60	60–70	70–80	Total
N	0	0	0	1	1	525	37	58	73	107	137	162	183	1,284
NNE	0	0	0	1	1	327	44	63	88	113	137	169	289	1,232
NE	0	0	0	1	1	7	33	60	249	233	134	133	682	1,533
ENE	0	0	0	1	1	7	29	48	679	5,100	138	159	437	6,599
E	0	0	0	1	1	7	29	48	70	103	282	733	247	1,521
ESE	0	0	0	1	1	7	29	48	68	114	187	128	63	646
SE	0	0	0	1	1	7	29	58	161	242	262	471	8,230	9,462
SSE	0	0	0	1	1	7	29	111	188	211	158	185	640	1,531
S	0	0	0	1	1	7	29	88	128	136	133	193	875	1,591
SSW	0	0	0	1	1	6	15	21	29	62	97	115	1,083	1,430
SW	0	0	0	1	1	3	13	21	29	41	69	103	315	596
WSW	0	0	0	0	0	3	13	21	29	38	58	85	98	345
W	0	0	0	0	0	3	13	21	29	38	52	62	72	290
WNW	0	0	0	0	0	3	13	21	29	38	33	32	37	206
NW	0	0	0	1	1	3	13	21	29	38	60	89	66	321
NNW	0	0	0	1	11	270	17	21	29	65	133	153	168	868
Total	0	0	0	13	23	1,192	385	729	1,907	6,679	2,070	2,972	13,485	29,455

Notes:
[a] Current population living between 10 km and 80 km of the mine site was estimated using 2010 Census data. See Section 2.3.1 for a detailed description of the methodology.

Table 2.3-5 Annual Average Labor Force and Employment Economic Sectors for Dawes and Box Butte Counties 1994 and 2009

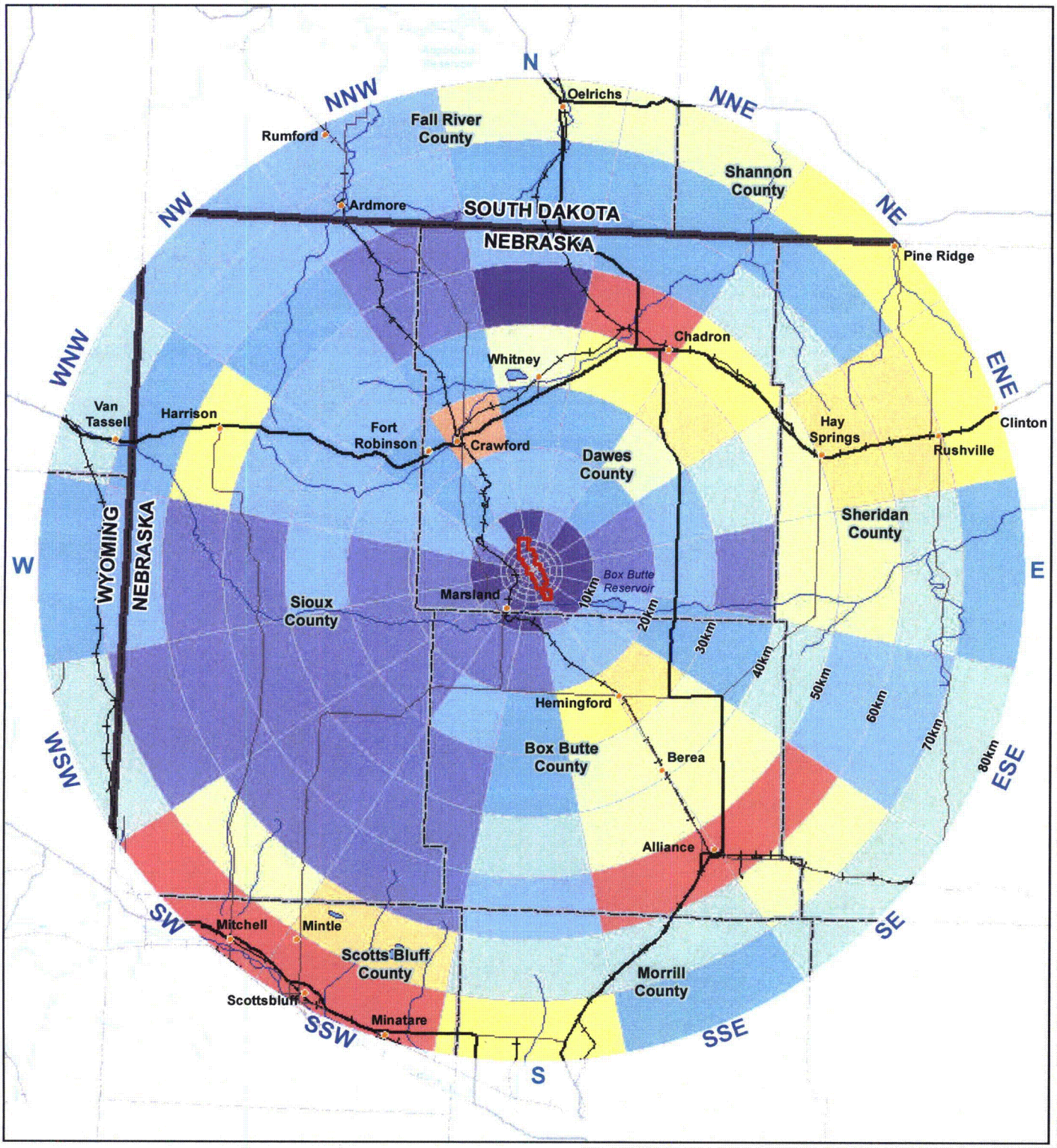
Sectors	Dawes		Box Butte	
	1994	2009	1994	2009
Labor Force	4,490	4,788	6,156	5,821
Unemployment	149	210	235	397
Unemployment Rate	3.3	4.4	3.8	6.8
Employment	4,341	4,578	5,921	5,424
Farm Employment	862	877	763	213
Non-Farm Employment Total	3,479	3,701	5,446	5,315
Manufacturing	165	13	402	N/A
Construction and Mining	136	228	80	126
Transportation, Communication, and Utilities	N/A	N/A	1,909	2,305
Retail	824	673	840	429
Wholesale	128	87	265	298
Financial, Insurance, and Real Estate	77	123	215	168
Information	N/A	46	N/A	103
Professional and Business Services	N/A	N/A	N/A	170
Education and Health Services	N/A	449	N/A	428
Leisure and Hospitality	N/A	507	N/A	433
Other Services	N/A	119	N/A	145
Government	1,384	1,000	955	1,095
Federal	144	124	65	61
State	721	297	67	75
Local	519	579	824	960

N/A = not available
Sources: NDOL 2010

Table 2.3-6 Population and Demographics for Census Blocks Overlain or Adjacent to the MEA with Populations Recorded in 2010 Census

Population	Nebraska	Percent of Nebraska Pop.	Dawes County	Percent of Dawes County Pop.	Block Group 3, Census Tract 9506, Dawes County									
					Block 3332	% of Block 3332	Block 3446	% of Block 3446	Block 3457	% of Block 3457	Block 3572	% of Block 3572	Block 3573	% of Block 3573
Total Population	1,826,341	100.0%	9,182	100.0%	19	100%	1	100%	1	100%	3	100%	8	100%
White alone	1,572,838	86.1	8,208	89.4	19	100%	1	100%	1	100%	3	100%	8	100%
Black or African American	82,885	4.5	134	1.5	0	0%	0	0%	0	0%	0	0%	0	0%
American Indian and Alaska Native	18,427	1.0	362	3.9	0	0%	0	0%	0	0%	0	0%	0	0%
Asian alone	32,293	1.8	95	1.0	0	0%	0	0%	0	0%	0	0%	0	0%
Native Hawaiian and Other Pacific Islander	1,279	0.1	46	0.5	0	0%	0	0%	0	0%	0	0%	0	0%
Some other race	79,109	4.3	104	1.1	0	0%	0	0%	0	0%	0	0%	0	0%
Two or more races	39,510	2.2	233	2.5	0	0%	0	0%	0	0%	0	0%	0	0%
Hispanic or Latino	167,405	9.2	306	3.3	1	5.3%	0	0%	0	0%	0	0%	0	0%
Percent below poverty level +	12.2%	-	20.4%	-	-	-	-	-	-	-	-	-	-	-

* data for Block Group only
+ USCB 2009b [SAIPE data for 2009 (SAPIE = Small Are Income and Poverty estimates)
Source: USCB 2011



LEGEND

Proposed Cameco/Marsland Expansion Area

Population (Census 2010)

0 - 6	86 - 208
7 - 18	209 - 523
19 - 31	524 - 1,101
32 - 51	1,102 - 2,997
52 - 85	2,998 - 19,150

N

0 5 10 15 Miles

0 10 20 30 Kilometers

CROW BUTTE RESOURCES, INC.

FIGURE 2.3-1
SIGNIFICANT POPULATION CENTERS WITHIN AN 80-Km (50 mi) RADIUS OF THE MARSLAND SITE

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: CM

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_3-1 Pop_Rose_byBlock_2010data.mxd - 10/14/2011 @ 12:00:42 PM

2.4 Regional Historic, Archeological, Architectural, Scenic and Natural Landmarks

2.4.1 Historic, Archeological, and Cultural Resources

There have been few cultural resources investigations on private land in southern Dawes County. Cultural resources investigations have been more numerous around the White River and the Cities of Chadron and Crawford about 10 miles (16.1 km) to 15 miles (24.1 km) to the north, and the results of those surveys can serve as a cultural context for comparison to the MEA. Known resources in that area include indigenous people, artifact scatters, faunal kill and processing sites, and camps; fur trade and other contact period sites; the Sidney-Deadwood Trail; historic railroads; historic farming sites; Fort Robinson; and the Cities of Chadron and Crawford. In the mid 1800s, this region was occupied predominantly by bands of Lakota Sioux and Cheyenne. In the 1870s, the Red Cloud Indian Agency was located at Fort Robinson west of Crawford. By 1878, the tribes had officially been relocated to reservations, but sporadic Lakota and Cheyenne resistance continued through the 1880s. The MEA is south of the Pine Ridge Escarpment near the Niobrara River, and the nearby Town of Marsland is small in comparison to the Cities of Chadron and Crawford. The Town of Marsland is located along the Sidney-Deadwood Trail, along one of the historic railroad corridors that also passed through Crawford, and along a major river that would have attracted fur trappers. The fur trade in northwest Nebraska was centered along the White and Niobrara Rivers.

The proposed MEA is located on private lands east of SH 2/71 and north of the Niobrara River. An archaeological files search through the Archaeology Division of the Nebraska State Historical Society (NSHS) indicated that there have been no previous archaeological investigations within 1 mile (1.6 km) of the MEA and that no archaeological sites have been previously reported. An architectural and structural properties search through the Nebraska State Historic Preservation Officer (SHPO) indicated that four historic structures (DWOO-240, DWOO-241, DWOO-242, and DWOO-243) have been reported in the study area. Two of these structures are within the MEA and the other two are close to the MEA. A search of the BLM Public Land Patent Records indicates that nine patents were granted for lands in the MEA from 1891 to 1917. This is consistent with the completion of the Chicago, Burlington, and Quincy Railroad through Crawford in 1889, which made the land more accessible to homesteaders, and with a brief moist period in the region between 1910 and 1920. A search of the National Register of Historic Places (NRHP) online database for Dawes County yielded 11 sites in the northern portions of the county. None of these NRHP-listed sites is within 10 miles (16.1 km) of the MEA. Fort Robinson and the Red Cloud Indian Agency, about 15 miles (24.1 km) north-northwest of the MEA, are also listed as a National Historic Landmark.

ARCADIS completed an intensive pedestrian block cultural resources inventory of approximately 4,500 acres for the MEA during the period from November 2010 to February 2011 (Graves et al. 2011). The MEA was inventoried for the presence of euroamerican and indigenous peoples' properties (cultural resources that are listed or eligible for listing on the NRHP) and may be impacted by proposed mine development. Graves et al. (2011) recorded 15 newly discovered euroamerican historic sites and five euroamerican historic isolated finds and updated the documentation on two of the previously recorded historic farmstead sites (DWOO-242 and DWOO-243).

ARCADIS submitted the "Cameco Resources Marsland Expansion Area Uranium Project Cultural Resource Inventory" report and associated Nebraska Archeological Site Survey Forms to the Nebraska State Historic Preservation Society/State Historic Preservation Office on April 28, 2011, and SHPO concurrence was granted by the Deputy State Historic Preservation Officer on May 19, 2011.

CBR requested ARCADIS complete a field survey of an additional 160 acres in section 36 T30N R51W completed during the original field investigation but not reported in the original report. The 160 acres was field investigated by ARCADIS on February 19, 2011 and no new cultural resources were discovered. One historic bridge (25DW362) was identified in section 36 T30N R51W and reported within the original cultural resource inventory report. An addendum to the original cultural resources report was prepared to address the additional 160 acres (Graves 2012).Historic site 25DW362 was recommended not eligible for listing on the NRHP with SHPO concurrence.

The Nebraska SHPO concurred with the findings of the addition to the cultural resources report that no archaeological, architectural, or historic context property resources will be affected by the proposed project (NSHS 2012). As stated in the SHPO concurrence letter, the SHPO's review does not constitute the opinions of any Native American Tribes that may have an interest in Traditional Cultural Properties potentially affected by this project.

No indigenous people sites or artifacts were found in the project area. Regardless, a process for tribal identification of Traditional Cultural Properties is being developed and will be implemented during review of the MEA Environmental Report to satisfy the National Environmental Policy Act (NEPA).

The newly recorded historic sites included six farmsteads (25DW359, 25DW360, 25DW361, 25DW365, 25DW366, and 25DW370), three artifact scatters (25DW357, 25DW363, and 25DW369), two cisterns (25DW358 and 25DW364), one corral and windmill (25DW367), one bridge (25DW362), one dugout depression and berm (25DW368), and one stone quarry (25DW371). All of these sites were recommended not eligible for the NRHP.

The previously recorded farmstead sites were recorded jointly by SHPO and NSHS as part of a historic building survey of Dawes County in 2005 as the B. Chapman House (DWOO-242; built about 1910) and an abandoned farmhouse (DWOO-243; built about 1890). Updated documentation was prepared for the two buildings in the survey area. This documentation included the completion of NSHS archaeological site survey forms that included recording of associated artifacts and features in addition to the buildings. Updated documentation of the DWOO-242 included a concrete cistern, a storage shed, two modern propane tanks, and historic and modern artifacts. The house is well maintained and appears to be occupied. Site DWOO-243 is more extensive. This site includes two abandoned 1½-story farmhouses; a smaller 1-story house; two storage sheds; one stock shelter; one foundation with a chicken coop gate; two metal grain bins; abandoned vehicles, wagons, and farm implements; a network of fenced enclosures; and a large pile of historic debris.

All of the newly recorded historic sites were recommended not eligible for the NRHP and do not qualify as historic properties. Isolated finds are by definition not eligible for the NRHP. Historic farmstead DWOO-242 is recommended not eligible for the NRHP, but appears to be currently or

recently occupied. Site DWOO-243 may have the potential to yield information important in history and may be potentially eligible for the NRHP. Avoidance of these two sites by project actions is recommended. If these recommendations are followed, the proposed project will have no adverse effect on historic properties, and no further cultural resource investigations are recommended.

Specific information included in cultural resources investigations falls under the confidentiality requirement for archaeological resources under Section 304 of the National Historic Preservation Act (16 U.S.C. 470w-3(a)). In addition, disclosure of such information is protected under Nebraska State Statute Section 84-712.05 (13 and 14). The cultural resources inventory report and Attachment A of that report have been marked "FOR OFFICIAL USE ONLY: DISCLOSURE OF SITE LOCATIONS IS PROHIBITED (43 CFR 7.18). In compliance with Nebraska SHPO, NRC NUREG-1569 Section 24, and NDEQ Title 122 Ch. 11 Sections 006.07, "These materials should be treated as confidential information for the purpose of public disclosure of this NRC license amendment." The cultural resources report will be submitted to the NRC and State of Nebraska SHPO under separate cover.

2.4.2 Scenic Resources

2.4.2.1 Introduction

The MEA is on private land that is not managed to protect scenic quality by any public agency. The MEA is located on generally level ground south of the Pine Ridge area of northwestern Nebraska, and may be visible from some public roads in the areas. The existing landscape and the visual effect of the proposed facilities have been inventoried and assessed for the proposed project using the BLM Visual Resource Management (VRM) system.

2.4.2.2 Methods

The VRM system is the basic tool used by the BLM to inventory and manage visual resources on public lands. The VRM inventory process involves rating the visual appeal of a tract of land, measuring public concern for scenic quality, and determining whether the tract of land is visible from travel routes or observation points.

The scenic quality inventory was based on methods provided in BLM Manual 8410 – Visual Resource Inventory (BLM 1986a). The key factors of landform, vegetation, water, color, influence of adjacent scenery, scarcity, and cultural modifications were evaluated according to the rating criteria, and provided with a score for each key factor (BLM 1986b). The criteria for each key factor ranged from high to moderate to low quality based on the variety of line, form, color, texture, and scale of the factor within the landscape. A score was associated with each rating criterion, with a higher score applied to greater complexity and variety for each factor in the landscape. The results of the inventory and the associated score for each key factor are summarized in **Table 2.4-1**. According to NUREG-1569; 2.4.3(7), if the visual resource evaluation rating is 19 or less, no further evaluation is required. The total score of the scenic quality inventory is 9; however, an analysis was prepared to reflect the growing concern some residents may have for the scenic resource, as Dawes County is expected to continue to develop tourism in the region.

VRM Classes

The elements used to determine the visual resource inventory class is the scenic quality, sensitivity levels, variety classes, and distance zones. Each of the elements used to identify the VRM Class is defined below:

Scenic Quality – Scenic quality is a measure of the visual appeal of a tract of land. In the visual resource inventory process, public lands are assigned an A, B, or C rating based on the apparent scenic quality, which is determined using seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. During the rating process, each of these factors is ranked comparatively against similar features within the physiographic province.

Sensitivity Level – A degree or measure of viewer interest in the scenic qualities of the landscape. Factors to consider include 1) type of users, 2) amount of use, 3) public interest, 4) adjacent land uses, and 5) special areas. Three levels of sensitivity have been defined:

- Sensitivity Level 1 – The highest sensitivity level, referring to areas seen from travel routes and use areas with moderate to high use.
- Sensitivity Level 2 – An average sensitivity level, referring to areas seen from travel routes and use areas with low to moderate use.
- Sensitivity Level 3 – The lowest sensitivity level, referring to areas seen from travel routes and use areas with low use.

Distance Zones – Areas of landscapes denoted by specified distances from the observer, particularly on roads, trails, concentrated-use areas, rivers, and other locations. The three categories are foreground-middleground, background, and seldom seen.

- Foreground-Middleground – The area visible from a travel route, use area, or other observer position to a distance of 3 miles (4.8 km) to 5 miles (8.0 km). The outer boundary of this zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape and vegetation is apparent only in pattern or outline.
- Background - The viewing area of a distance zone that lies beyond the foreground and middleground. This area usually measures from a minimum of 3 miles (4.8 km) to 5 miles (8.0 km) to a maximum of about 15 miles (24.1 km) from a travel route, use area, or other observer position. Atmospheric conditions in some areas may limit the maximum to about 8 miles (12.9 km) or increase it beyond 15 miles (24.1 km).
- Seldom Seen – The area is screened from view by landforms, buildings, other landscape elements, or distance.

The visual resource inventory classes are used to develop VRM classes, which are generally assigned by the BLM through the resource management plan process. VRM objectives are developed to protect scenic public lands, especially those that receive the greatest amount of public viewing. The following VRM classes are objectives that outline the amount of disturbance an area can tolerate before it no longer meets the visual quality of that class.

- Class I Objective: To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.

- Class II Objective: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low.
- Class III Objective: To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate.
- Class IV Objective: To provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

The Scenic Quality, Sensitivity Level, and Distance Zone inventory levels are combined to assign a VRM Class to inventoried lands as shown in **Table 2.4-2**.

2.4.2.3 Affected Environment

The MEA lies mostly in the Sandy and Silty Tableland ecoregion, with the northern portion of the MEA lying in the Pine Ridge Escarpment; both are a subregion of the Western High Plains ecoregion. The physiography of the Pine Ridge Escarpment is characterized by alternating ridges and valleys with entrenched channels and rock outcrops, with elevations increasing from the northeast to the southeast. Vegetation includes ponderosa pine woodlands with Rocky Mountain juniper, western snowberry, skunkbush sumac, choke cherry, and Arkansas rose. Mixed grass prairie is also found, containing little bluestem, western wheatgrass, prairie sandreed, needle-and-thread, blue grama, and threadleaf sedge. The physiography of the Sandy and Silty Table is characterized by tablelands with areas of moderate relief, with some areas of isolated sand dunes, and canyons along stream valleys. Vegetation includes mixed grass prairie containing blue grama, little bluestem, threadleaf sedge, and needle-and-thread, and some scattered Sand Hills prairie with sand reed and little bluestem (EPA 2011).

The MEA landscape is rural and agricultural in character, and is composed primarily of scenery that is common for the ecoregion. Vegetation cover consists of grassy meadows and croplands interspersed with shrubby riparian growth along drainages. The landscape colors are dominated by tan, gold, and green vegetation. The colors and values (degrees of lightness and darkness) of soils and vegetation are similar, exhibiting little contrast during most months of the year, although the dark greens of Ponderosa pine visible in the background from the MEA exhibit striking color contrasts throughout the year. The scenic quality of the MEA is enhanced by the backdrop of the slopes covered with Ponderosa pine in the Nebraska National Forest to the south.

The characteristic landscape of the MEA consists of flat to rolling hills dissected by tributaries of the Niobrara River, which is located south of the MEA. The terrain becomes progressively higher in elevation to the north. The MEA is blocked from view along the entirety of SH 2/71 by low ridges located close to the highway. Portions of the MEA are visible from E. Belmont Road, Squaw Mound Road, Hollibaugh Road, and River Road.

The visual character of the landscape includes human modification from a variety of land uses, including open lands, cropland, roadways, rural residences, and utility corridors. Open land used for grazing activities is the dominant land use in the MEA. The northern portion of the MEA is accessible from E. Belmont Road, and the southern portion from River Road. Both are gravel-surfaced county roads, which in turn connects to SH 2/71, one of the primary north-south roadways through Dawes County. Human modifications to the natural landscape evident in the

MEA include private roads, rural residences, agricultural implements, and electric distribution lines.

2.4.2.4 MEA Visual Inventory

Most of the MEA is characterized by the low, rolling plains and agricultural land uses characteristic of the area in northwestern Nebraska. The scenic quality of the MEA landscape is typical of the ecoregion, and is rated as Class B. There are no Class A landscapes visible from the MEA.

Sensitive Viewing Areas

Sensitive viewing areas in the MEA include E. Belmont Road, River Road, Squaw Mound Road, and Hollibaugh Road (the primary transportation routes through and adjacent to the MEA) and rural residences. In general, residents and other users of the region are accustomed to viewing human modification in the rural landscape, but could be sensitive to increased levels of development.

The characteristic landscape of the MEA as viewed from any of the roads and the residences consists of a broad expanse of mixed grass prairie and cropland with scenic backdrops to the north. The MEA is located more than 3.5 miles (5.6 km) east of State Highway 2/71 at its nearest point, and is not visible from the highway. Public use of county and private roads within the MEA is relatively low, with motorists falling into the categories of local ranchers and residents.

The greatest number of viewers of the proposed facilities would be traveling on either E. Belmont Road, River Road, Squaw Mound Road, or Hollibaugh Road. The majority of motorists on the road would be residents within and outside of the MEA. There is one occupied residence within the MEA. The MEA landscape is also within view of five residences within the 2.25-mile (3.62-km) AOR.

The level of use on E. Belmont Road, River Road, Squaw Mound Road, or Hollibaugh Road and residences within or near to the MEA is low to moderate, or a Sensitivity Level 2, due to the fact that River Road is one of only three routes into Box Butte Reservoir State Recreation Area. Viewers at isolated rural residences with views of the project area are few.

A potential sensitive viewing area is the Nebraska National Forest located north of the north boundary of the MEA. However, there are no developed campgrounds or other facilities within the National Forest that could view the MEA due to the topography of the area. Individuals hiking through the National Forest could view the MEA in the background. While the level of concern for scenic landscapes would be high for many park visitors, the MEA would not be visible from most of the National Forest.

VRM Class

Based on the project area Class B scenic quality; the Sensitivity Level 2 (Medium) as viewed from E. Belmont Road, River Road, Squaw Mound Road, or Hollibaugh Road, and residences; and the location of the project area in the background distance zone as seen from the Nebraska National Forest, the MEA has been assigned Class III for both the visual resource inventory and the VRM objective.

2.4.3 References

BLM. 1986b. *Visual Resource Contrast Rating*. BLM Manual Handbook 8431-1.

Graves, Adam, Natalie Graves, Maureen Boyle, and Ashley Howder. 2011. Marsland Expansion Area Uranium Project Cultural Resource Inventory. ARCADIS U.S., Inc., Buffalo, Wyoming. Prepared for Cameco Resources, Crawford, Nebraska. 152 pages plus attachments. April.

U.S. Department of Interior Bureau of Land Management (BLM). 1986a. *Visual Resource Inventory*. BLM Manual Handbook 8410-1.

U.S. Environmental Protection Agency (EPA). 2011. Ecoregions of Kansas and Nebraska. [Web Page]. Located at: http://www.epa.gov/wed/pages/ecoregions/ksne_eco.htm. Accessed on: March 26, 2011.

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Table 2.4-1 Scenic Quality Inventory and Evaluation for the Marsland Expansion Area

Key Factor	Rating Criteria	Score
Landform	Flat to rolling terrain with no interesting landscape features	1
Vegetation	Some variety of vegetation; cropland, range, riparian	3
Water	Water is present, but not evident as viewed from residences and roads	0
Color	Some variety in colors and contrasts with vegetation and soil	3
Influence of adjacent scenery	Low influence due to lack of topographical relief and similar adjacent scenery	1
Scarcity	Landscape is common for the region	1
Cultural modifications	Existing modifications are agricultural, and introduce no discordant elements	0
	Total Score	9

Table 2.4-2 Determining BLM Visual Resource Inventory Classes

Visual Sensitivity		High			Medium			Low
Special Areas		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	II	III	III/IV	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
Distance Zones		f/m	b	ss	f/m	b	ss	ss

f/m = foreground-middleground
b = background
ss = seldom seen

2.5 Climate, Meteorology and Air Quality

2.5.1 Introduction

The proposed MEA is located in a semi-arid or steppe climate. The area is characterized by abundant sunshine, low relative humidity, and sustained winds which lead to high evaporative demand. There are also large diurnal and annual variations in temperature. The region has cold, harsh winters; hot, dry summers; and relatively warm, moist springs and autumns. Temperature extremes range from roughly -25° F in the winter to 100° F in the summer. The "last freeze" occurs during late May and the "first freeze" in mid to late September. The area has a growing season of approximately 120 days (HPRCC 2011).

Yearly precipitation totals typically range from 13 to 16 inches. Migratory storm systems that originate in the Pacific Ocean release a majority of their moisture over the Rocky or Cascade Mountains. Major precipitation events can occur when these systems regain moisture already present in the area or moisture advected from the Gulf of Mexico. The region is prone to severe thunderstorm events throughout the spring and early summer months, and much of the precipitation is attributed to these events. In a typical year, the area will experience four or five severe thunderstorm events (as defined by the National Weather Service [NWS] criteria) and 40 to 50 thunderstorm days. Autumn stratiform rain events also contribute to precipitation totals, but to a lesser degree. Snow frequents the region throughout winter months (30 to 50 inches per year), but generally provides less moisture than rain events.

Windy conditions are fairly common to the area. Roughly 3 percent of the time, hourly wind speed averages exceed 25 miles (40.2 km) per hour (mph). The predominant wind directions are north-northwesterly and northwesterly, with the wind blowing from those directions roughly 25 percent of the time. Surface wind speeds are relatively moderate at a year-round, hourly average of 10 to 11 mph. Higher average wind speeds are encountered during the winter months, while summer months experience lower average wind speeds.

For the regional analysis, meteorological data have been compiled for 21 sites surrounding the MEA. Data were acquired for these sites through the Western Regional Climate Center (WRCC 2011) for Cooperative Observer Program (COOP) and Automated Surface Observation Stations (ASOS) operated by the NWS. Among these regional sites, the Scottsbluff Airport was selected as most representative of the MEA meteorology. Scottsbluff is less than 50 miles (80 km) south of the project site, with an elevation roughly 300 ft lower than the project area. It is also the closest NWS station to the project site with hourly wind and relative humidity data. Available hourly data from Scottsbluff represent the last 15 years.

For the site-specific analysis, meteorological data from the MEA meteorological station were used. These data were collected during the 1-year baseline monitoring period extending from August 24, 2010 through August 29, 2011. **Table 2.5-1** provides the station ID, coordinates, and period of operation for the regional and site-specific meteorological stations. The locations of the regional and MEA meteorological station are shown on **Figure 2.5-1**.

These sites have been analyzed collectively to evaluate regional climatic temperature and precipitation in the proposed project area. The NWS sites have also been incorporated into the snowfall discussion. The nearest available long-term monitoring site that continuously records all

weather parameters is the Scottsbluff Airport. This site was analyzed for the regional wind summaries. At the project site, hourly average meteorological data include wind speed, wind direction, sigma theta, temperature, relative humidity, precipitation, and solar radiation. Evapotranspiration rates were calculated for both the Scottsbluff site and project site by applying Penman's equation to available solar radiation, wind speed, temperature, and relative humidity data. As solar radiation data were not available from the Scottsbluff data set, estimated monthly averages for solar radiation were obtained for the Scottsbluff area from the U.S. Department of Energy's National Renewable Energy Laboratory (NREL 1990).

In the information that follows, a regional overview is presented first. This section includes a discussion of the maximum and minimum temperatures and relative humidity, annual precipitation including snowfall estimates, a brief wind speed and direction summary, and a discussion of evapotranspiration rates. A combination of monitoring stations is analyzed for the regional overview of temperature, snowfall, and total precipitation.

A site-specific analysis follows the regional overview. Most of this analysis is based on the onsite monitoring. An in-depth wind analysis summarizes average wind speeds and directions, wind roses, wind speed frequency distributions, and a joint (wind speed and direction) frequency distribution to characterize the wind data for the MEA by atmospheric stability class. A discussion of monthly and seasonal data is included for the temperature, precipitation, evapotranspiration, and wind parameters. General upper atmosphere data from the NWS station at Rapid City, South Dakota are used to represent the project site.

The site-specific analysis includes a justification for using wind data from the baseline monitoring year to predict meteorological conditions over the long term. This is necessary to validate air sampling locations and MILDOS dispersion modeling inputs. The short- and-long term wind data from the Scottsbluff site are correlated for this purpose.

2.5.2 Regional

2.5.2.1 Temperature

The annual average temperature for the region is approximately 48° F (8.9° C). The Scottsbluff Airport meteorological station is considered to be representative of the region.

Figure 2.5-2 shows monthly average temperatures for the Scottsbluff Airport site, along with the monthly maximum and minimum temperatures over the last 15 years. July has the highest average monthly temperature (74.5° F), followed by August. December records the lowest average temperatures for the year (26.0° F), followed by January. **Table 2.5-3** shows average, minimum, and maximum monthly temperatures for the Scottsbluff Airport site. Low temperatures in the region can drop to nearly -30° F, while high temperatures can reach around 107° F.

Large diurnal temperature variations occur in the region due in large part to its high altitude and low humidity. **Figure 2.5-2** depicts the monthly diurnal temperature variation for the Scottsbluff Airport site from 1996 through August, 2011. Spring and summer daily variations of 30° F are common, with maximum temperature variations exceeding 40° F during extremely dry periods. Less daily variation is observed during the cooler portions of the year, as fall and winter have average variations of roughly 20° F. This can be attributed to the more stable atmospheric

conditions in the region during the fall and winter months. Stable periods have much lower mixing heights and accompanying lapse rates, allowing for less temperature variation.

On a year-round basis, daily maximum temperatures in the project region average approximately 60° F, and daily minimum temperatures average approximately 33° F. July has the highest maximum temperatures, with averages near 90° F, while the lowest minimum temperatures are observed in January with averages near 10° F (NCDC 2011). Annual average minimum and maximum temperatures are shown on **Figure 2.5-4** and **Figure 2.5-5**, respectively.

2.5.2.2 Relative Humidity

The Scottsbluff Airport site records relative humidity (dew point) data. The graph on **Figure 2.5-6** charts monthly average relative humidity values for this site. The Scottsbluff Airport data are from 1996 through August, 2011. These data indicate that July has the driest air, with relative humidity averaging around 58 percent. The winter months of December, January, and February make up the most humid part of the year, with average relative humidity approaching 70 percent. The overall average relative humidity is 63 percent at Scottsbluff Airport.

Relative humidity is a temperature-based calculation which reflects the fraction of moisture present relative to the amount of moisture for saturated air at that temperature. Warmer air holds more moisture at saturation than colder air. Therefore, for a given amount of moisture in the air, relative humidity maximum values occur more frequently in the early mornings, while minimum values typically occur during the mid-afternoon hours. The summer months exhibit a much greater variation in relative humidity between morning and afternoon values due to greater temperature variations (**Figure 2.5-7**).

2.5.2.3 Precipitation

The region is characterized by moderately dry conditions. The Scottsbluff Airport received measurable (>0.01 in) precipitation on an average of 82 days per year between 1996 and 2011. Average annual precipitation during that period was 15.2 inches per year. In general, the project region has an annual average from 14 to 23 inches (**Figure 2.5-12**). Spring showers and thunderstorms produce nearly half of the precipitation at Scottsbluff Airport (**Figure 2.5-8**). May and June are typically the wettest months of the year; with most of the region receiving an average greater than 2 inches for each of those months (**Figure 2.5-9**). The region receives less precipitation in January than in any other month, averaging generally 0.5 inch or less. The winter months (December through February) typically account for less than 10 percent of the yearly precipitation totals. Only moderate precipitation occurs in late summer, when atmospheric conditions are more stable and the absence of convective activity limits storm development.

Severe weather does arise throughout the region, but is limited on average to five or six severe events per year. These severe events are generally split between hail and damaging wind events. Tornadoes can occur but are rare in western Nebraska.

Average annual snowfall varies throughout the region. Major snowstorms (more than 5 in/day) are relatively infrequent in the region. The region experiences fewer than three major snowstorms per year. Hay Springs, Nebraska has the highest annual snowfall of the sites closest to the project, with an average of 52 inches, while Sidney, Nebraska has the lowest averages at

30.7 inches per year. The interpolated values (**Figure 2.5-13**) show average snowfall of 30 to 60 inches per year in the project region.

Snowfall at the Scottsbluff Airport site averaged 38.2 inches per year over the last 15 years. Monthly average snow amounts are depicted on **Figure 2.5-10**, which shows the highest amount of snowfall in March. Monthly snowfall amounts in the overall region follow a similar pattern (**Figure 2.5-11**).

2.5.2.4 Wind Patterns

Year-round wind speeds in the area average between 8 and 11 mph. **Table 2.5-3** shows monthly averages for the Scottsbluff Airport site. The overall average wind speed at this site was 8.9 mph for the 1996 to 2011 period analyzed in this study. Mean monthly average wind speeds are lowest in the summer months and highest in April at nearly 11 mph.

Table 2.5-3 also shows monthly maximum hourly wind speeds. High wind events are fairly common in this region; wind data from this site show every month recording peak hourly wind speeds greater than 30 mph during the 15-year period analyzed.

Figure 2.5-14 graphs the monthly average and monthly maximum wind speeds listed in **Table 2.5-3.**

Figure 2.5-15 shows the 15-year wind rose for the Scottsbluff Airport site. Predominant winds are generally from the west-northwesterly or northwesterly directions. These winds, often associated with storm fronts, dominate the late fall, winter, and early spring seasons. A secondary mode occurs from the east-southeasterly or easterly directions. These winds are generally associated with the summer season when regional high pressure dominates. The highest wind speeds tend to occur from the northwesterly direction. **Table 2.5-4** provides the same information as the wind rose, but in tabular form.

Winds at the Scottsbluff Airport site and throughout the region exhibit a diurnal pattern. **Figure 2.5-16** shows the pattern at Scottsbluff for each season of the year. Wind speeds peak during the early afternoon for the winter and fall seasons. During spring and summer, wind speeds peak in late afternoon. This is largely due to longer daylight hours and the predominant effect of solar heating on wind patterns. **Figure 2.5-16** also shows that the highest average wind speeds occur during the spring season, when the atmosphere tends to be least stable and storm systems are the strongest. The lowest wind speeds occur during summer, when the atmosphere is generally stable and storm systems are weak.

2.5.2.5 Heating, Cooling, and Growing Degree Days

Figure 2.5-17 summarizes the monthly cooling, heating, and growing degree days for Scottsbluff, Nebraska (NWS meteorological monitoring site 257665). The data are assumed to be indicative of the project area due to its proximity and comparable elevation.

The heating and cooling degree days are included to show deviation of the average daily temperature from a predefined base temperature. In this case, 50° F has been selected as the base temperature for computation of growing degree days. The base temperature for computing heating and cooling degree days is 65° F. The number of heating degree days is computed by

taking the average of the high and low temperatures occurring that day and subtracting it from the base temperature. The calculation for growing and cooling degree days is the same, except that the base temperature is subtracted from the average of the high and low temperatures for the day. Negative values are disregarded for both calculations.

As expected, the graphs of heating degree days and cooling degree days are inversely related, and the growing and cooling degree days are directly related. The maximum number of heating degree days occurs in December and January, at roughly 1,200 degree days. This coincides with the months having the lowest minimum average temperatures. Conversely, July registers the most growing degree days with nearly 700, and the most cooling degree days at fewer than 300. This also corresponds to July having the highest average temperature.

2.5.2.6 Evapotranspiration

The project region is characterized by high evaporative demand during much of the year. This demand is related to dry air (low dew points), high daytime temperatures, and moderate wind speeds. **Figure 2.5-18** graphs monthly potential evapotranspiration (ET) rates, in inches of water per month, at the Scottsbluff Airport site. Potential ET is an estimate only, calculated using the Penman Equation (Jensen et al. 1990). Meteorological inputs to this equation include wind speed, barometric pressure, solar radiation, and temperature and humidity extremes.

For the Scottsbluff site, barometric pressure was estimated based on the elevation. Because solar radiation data were not available at this site, estimated monthly averages for solar radiation were obtained for the Scottsbluff area from the U.S. Department of Energy's National Renewable Energy Laboratory (NREL 1990). A flat-plate collector at zero degrees incline from horizontal represents the global solar radiation available at a given location. Wind speed, temperature, and humidity data for the ET calculation were obtained from the Scottsbluff Airport hourly database.

Potential ET values are highest in July, at 10 inches, and lowest in December and January, at 2 inches. Annual ET for this area is projected at 68.6 inches per year.

2.5.3 Site-Specific Analysis

2.5.3.1 Introduction

The site-specific discussion is limited to onsite meteorological data collected for the baseline monitoring period of August 2010 through August 2011. These onsite data are supplemented by meteorological data from the nearby Scottsbluff Airport site, collected during the 15-year period from 1996 through August 2011. The Scottsbluff site is included to incorporate wind monitoring results from a longer period of record and to demonstrate that, for this region, winds during the baseline monitoring period are representative of the longer term. The Scottsbluff site is located 48 miles (77.2 km) south of the MEA, with elevation and topographic features comparable to the project area. In both cases, the surrounding area is characterized by rolling hills and flat plains bordered by small ridges and breaks with ephemeral drainages. With the exception of cultivated land, the vegetation types are mainly confined to native grasses with some sage brush and wooded areas.

2.5.3.2 Temperature

The annual average project site temperature is similar to the regional average temperature at approximately 46° F. The maximum temperature for the baseline monitoring year was 99° F, and the minimum temperature was -28° F.

Figure 2.5-19 shows the monthly average, minimum, and maximum temperatures for the project site. **Table 2.5-5** provides the same data in tabular form. Daily average temperatures range from near 20° F in the winter months to above 70° in the summer months.

Table 2.5-6 provides a meteorological summary for the MEA site for the baseline monitoring year. The averages, maximums, and minimums are specified for each parameter recorded at the site along with the data recovery rate for each. The recovery rates are greater than 97 percent for all parameters.

2.5.3.3 Wind Patterns

Figure 2.5-20 presents a wind rose for the project site during the 12-month baseline monitoring period. **Table 2.5-7** presents the same information in tabular form. The predominant wind direction is north-northwesterly and northwesterly, with the highest wind speeds also coming from those directions. During periods of fair weather, particularly in late spring and summer months, high pressure located over the northern plains produces moderate southeasterly winds in the project area. Synoptic weather systems generally interrupt this pattern, producing high north-northwesterly winds. **Figure 2.5-21** shows seasonal wind roses for the project area. Spring experiences the greatest variability in wind direction with secondary modes as a result of the synoptic scale transition period that occurs during this time. Low pressure regions develop on the lee side of the Rockies, bringing southeasterly winds during storm development. As the low pressure systems form and move off with the general atmospheric flow, winds switch to a north-northwesterly direction.

Figure 2.5-22 presents a diurnal graph of wind speeds at the project site by season. For all seasons, wind speeds peak during the afternoon. Winds during the summer plateau at less than 12 mph, while the rest of the year experiences peak afternoon wind speeds averaging roughly 15 mph. Nighttime winds average 8 to 10 mph throughout the year.

Figure 2.5-23 shows the time distribution of wind speeds at the project site. Half of the time, wind speeds are less than 8 mph, while winds exceed 18 mph 10 percent of the time.

The average wind speed for the project site was 10.6 mph over the 12 months of monitoring, slightly higher than the 8.9 mph long-term average at Scottsbluff. The monthly average and maximum hourly wind speeds at the project site are summarized in **Figure 2.5-24**. The graph shows higher wind speeds in the winter and spring, peaking in April.

Table 2.5-8 provides a breakdown of wind speeds by wind direction. Wind speeds average near or above 12 mph when the wind blows from the northwest quadrant. A secondary maximum occurs for southerly winds, averaging more than 10 mph. For all other directions, wind speeds average less than 10 mph.

The Joint Frequency Distribution (JFD) provides more detail on wind speed distribution by wind direction and atmospheric stability class. The distribution shows the frequencies of hourly average wind speed for each direction based on stability class. **Table 2.5-9** lists the annual JFD for the MEA. **Tables 2.5-10** through **2.5-13** list the seasonal JFDs. A majority of the winds at the project site fall into stability class D, which represents near neutral to slightly unstable conditions. The light winds which accompany stable environments are reflected in the stability class F summary.

2.5.3.4 Precipitation

Figure 2.5-25 shows monthly precipitation at the project site during the baseline monitoring year. Total precipitation was 18 inches, although 10 inches fell during the abnormally wet month of May. Very little precipitation fell during the fall and winter months. Based on long-term records at other weather stations in the region, precipitation recorded during the baseline monitoring year at Marsland is probably not representative of the long term. An annual average precipitation of 15 inches is considered more likely.

2.5.3.5 Evapotranspiration

Daily ET rates were calculated for the project site by applying Penman's equation to recorded solar radiation, wind speed, temperature, and relative humidity data. These calculations were then summed for each month. **Figure 2.5-26** shows projected monthly ET at the project site during the baseline monitoring period. From these calculations, annual ET is computed at approximately 60 inches. This compares favorably to the long-term calculated average of 68 inches at the Scottsbluff Airport site.

2.5.3.6 Justification of Baseline Year as Representative of Long Term

The proposed project is situated in northwest Nebraska. The baseline meteorological monitoring period extended approximately 1 year, from August 24, 2010 through August 29, 2011. To demonstrate that this baseline year is representative of the longer-term wind conditions, the Scottsbluff Airport site was analyzed. Among the weather stations in this region, the Scottsbluff Airport was selected as most representative of the MEA meteorology. Scottsbluff is less than 50 miles (80 km) south of the project site, with an elevation roughly 300 ft lower than the project area. It is also the closest NWS station to the project site that logs hourly wind data. Available hourly data from Scottsbluff span from January 1, 1996 to the present and therefore represent the last 15 years.

Figure 2.5-27 shows wind roses for Scottsbluff. The wind rose on the left reflects 15 years of monitoring (1996 through August, 2011), while the one on the right reflects the MEA baseline monitoring period only. It can be seen that wind speeds and directions are very similar between the 15-year and 1-year monitoring periods.

Figure 2.5-28 compares the wind direction frequency distributions between the 15-year and baseline periods at Scottsbluff. The percent of the time the wind blows from each of the 16 cardinal directions shown is quite similar for the two monitoring periods.

Figure 2.5-29 compares the wind speed frequency distributions of the 15-year and baseline periods at Scottsbluff. The percent of the time the wind speed falls within each of the six wind speed classes shown is quite similar for the two monitoring periods.

In order to quantify this similarity, it is useful to isolate wind speed and wind direction variables in order to correlate short-term and long-term frequency distributions. IML Air Science has developed a statistical methodology for assessing the degree to which the distributions of wind speed class and wind direction frequencies from 1 year of monitoring at a particular location represent the long-term distributions at that same location.

For the joint frequency wind distribution used in the MILDOS-AREA model, wind speeds are divided into six classifications ranging from mild (0 to 3 mph) to strong (> 24 mph) as illustrated in **Table 2.5-9** and on **Figure 2.5-29** above. Likewise, wind directions are divided into 16 categories corresponding to the compass directions illustrated in the wind roses presented above and on **Figure 2.5-28**.

The percent of the time that winds occur in each of the six wind speed categories can be calculated to produce a wind speed frequency distribution. The percent of the time that winds blow from each of the 16 directions can be calculated to produce a wind direction frequency distribution. For each parameter, the 1-year and 15-year distributions can then be compared. Linear regression analysis provides a useful tool to assess the degree of correlation between short- and long-term distributions.

Figure 2.5-30 presents this correlation for the wind speed distributions at Scottsbluff. Each point represents one of the six wind speed classes. The x coordinate corresponds to the percent of the 1-year period during which the wind speed fell in a given class, while the y coordinate corresponds to the percent of the 15-year period during which the wind speed fell in that same class.

The regression line (red) on **Figure 2.5-30** represents the least-squares fit to the six data points. The corresponding R^2 value of 94.5 percent implies very strong linear correlation. The linear slope of 0.98 further implies that short- and long-term wind speed frequencies not only correlate, but are substantially equivalent in magnitude.

A similar analysis can be performed for wind direction frequencies. **Figure 2.5-31** presents this correlation, again for the Scottsbluff Airport site. Each point represents one of the 16 wind direction categories. The x coordinate corresponds to the percent of the 1-year period during which the wind blew from a given direction, while the y coordinate corresponds to the percent of the 15-year period during which the wind blew from that same direction.

The regression line (red) on **Figure 2.5-31** represents the least-squares fit to the 16 data points. The corresponding R^2 value of 97.2 percent implies very strong linear correlation. The linear slope of 1.02 further implies that short- and long-term wind speed frequencies not only correlate, but are substantially equivalent in magnitude.

Figures 2.5-30 and **2.5-31** offer conclusive evidence that the 2010-2011 baseline monitoring year adequately represents the last 15 years at Scottsbluff Airport. Because the 1-year wind data serve as reliable predictors of the long-term wind conditions at Scottsbluff, and because the MEA site experiences similar regional weather patterns, it is proposed here that the 1-year baseline monitoring represents long-term meteorological conditions at the MEA site.

2.5.3.7 Onsite Meteorological Instrument Specifications

Table 2.5-14 lists the meteorological instruments employed at the MEA meteorological monitoring station. The table shows instrument models, accuracy specifications, and instrument heights above the ground. Calibration records for the meteorological instruments are contained in **Appendix B** to this document.

Meteorological data collection, management, and reporting methods at the project site conform to NRC atmospheric dispersion modeling requirements for uranium milling operations, and meet the acceptance criteria established in the NRC's NUREG-1569. The onsite monitoring program was developed according to RG 3.63, "Onsite Meteorological Measurement Program For Uranium Recovery Facilities – Data Acquisition and Reporting." Hourly average values for wind speed, wind direction, sigma theta, temperature, relative humidity, precipitation, and solar radiation are generated by field instruments and recorded by continuous data loggers. Data recovery exceeded 97 percent for the 12-month monitoring period. All hourly data have been downloaded to a relational database for quality assurance, statistical analysis, and reporting purposes.

2.5.3.8 Upper Atmosphere Characterization

Mixing height is the height of the atmosphere above the ground that is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable. Higher mixing heights are associated with greater dispersion, all other parameters being the same. Stable periods have much lower mixing heights and accompanying lapse rates, allowing for less temperature variation. The MILDOS-AREA model uses mixing height, along with other wind parameters, to predict pollutant dispersion. Unstable air leads to more dispersion, which leads to lower predicted impacts on ambient air quality. The default mixing height used by MILDOS-AREA is 100 meters, a very conservative value given that typical mixing heights exceed 1,000 meters.

The nearest upper-air data available from the NWS are from Rapid City, South Dakota, approximately 108 miles (173.8 km) north of the project area. Average mixing heights were derived from the American Meteorological Society (AMS)/U.S. Environmental Protection Agency (EPA) Regulatory Model (AERMOD) calculations used for dispersion modeling, based on hourly data obtained from the NWS stations in Rapid City (upper air). The AERMOD calculation is based on a combination of mechanically and convectively driven boundary layer processes. The results of these calculations are provided for morning and afternoon in **Table 2.5-15**. The annual average mixing height is 1,110 meters.

The mixing or inversion heights are entered as inputs to the MILDOS-AREA model for pollutant dispersion modeling. For the MEA project, the MILDOS default value of 100 meters was used for both morning and afternoon mixing heights. Because this is lower than the calculated mixing heights in **Table 2.5-15**, and lower mixing heights lead to less pollutant dispersion, the dosage concentrations calculated by the MILDOS model are conservatively high.

2.5.3.9 Bodies of Water and Special Terrain Features

The only significant body of water near the proposed MEA is the Niobrara River, which flows easterly through a point approximately 4 miles (6.4 km) south of the project site. The average flow rate at this location, however, is only 29 cubic ft/sec (USGS 2009). It is unlikely that the

influence of such a small stream could be measured 4 miles (6.4 km) away with a standard humidity probe.

The nearest mountain ranges to the project site are:

- the Laramie Mountains, approximately 100 miles (160.9 km) to the west
- the Black Hills, approximately 65 miles (104.6 km) to the north

It is believed that, at these distances, the mountain ranges have minimal impact on meteorology in the project area. As discussed above, storms moving eastward from the Rocky Mountains generally relinquish moisture on the windward side of the mountains, creating a drier climate on the leeward side. This is mitigated, however, by occasional moist air masses moving into Nebraska and Wyoming from the Gulf of Mexico.

2.5.4 Conclusion

The proposed MEA near Crawford, Nebraska is located in a semi-arid or steppe climate. The area is characterized by abundant sunshine, low relative humidity, and sustained winds which lead to high evaporative demand. The region has large diurnal and annual variations in temperature.

Thirteen NWS meteorological stations were used to characterize regional weather patterns. The region experiences average daily maximum temperatures near 90° in July and average daily minimum temperatures around 15° F in January. There are large diurnal and annual variations in temperature. The region has cold, harsh winters; hot, dry summers; and relatively warm, moist springs and autumns. Temperature extremes range from roughly -25° F in the winter to 100° F in the summer. The site average temperature is expected to be 46° F with extremes of -30° to +105° F. The region generally receives little precipitation, with annual averages between 13 and 16 inches. Spring and early summer precipitation events are responsible for the majority of the yearly average.

The region is characterized by annual average wind speeds of 9 to 12 mph. Winds at the project site are expected to average 10 to 11 mph annually, with summer averages dipping below 8 mph and winter averages exceeding 12 mph. The predominant wind directions are from the north-northwest and northwest.

The MEA meteorological station and the Scottsbluff Airport meteorological station were both analyzed in the site-specific analysis. The Scottsbluff site is included to validate the temporal representativeness of onsite wind data by incorporating wind monitoring results from a longer period of record. The Scottsbluff site is located 48 miles (77.2 km) south of the MEA, with elevation and topographic features comparable to the project area. The distribution of wind speeds and directions at Scottsbluff during the baseline monitoring period have been shown to closely represent long-term wind speeds and directions.

2.5.5 Air Quality

2.5.5.1 National Ambient Air Quality Standards

The NDEQ regulations are based on federal and/or state law, with the primary source of the authority for air quality regulations being the federal Clean Air Act (NDEQ 2003). The NDEQ adopts the majority of these federal regulations into Title 129 (Nebraska Air Quality of the Nebraska Administrative Code). The basic foundation of the NDEQ air program is the National Ambient Air Quality Standards (NAAQS), which are concentrations of pollutants the EPA has established (and adopted by the NDEQ) as being protective of human health and the environment. The standards are established for six "criteria" pollutants: particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, and lead (**Table 2.5-16**). The State of Nebraska is required to keep areas in compliance with the standards and restore compliance in any areas out of compliance. The NDEQ has several ambient air monitors located throughout the state to measure the concentrations of pollutants in the ambient air (NDEQ 2011). An area may be classified as nonattainment if the concentration of one or more criteria pollutants in an area is found to exceed the regulated or "threshold" level for one or more of the NAAQS. Those areas with concentrations of criteria pollutants that are below the levels established by the NAAQS are considered in attainment or unclassifiable.

On February 14, 2012, the EPA proposed thresholds for classifying nonattainment areas for the 2008 ozone NAAQS promulgated by the EPA on March 12, 2008 (EPA 2012). This proposal also addresses the timing of attainment dates for each classification and revokes the 1997 zone NAAQS 1 year after the effective date of designations for the 2008 ozone NAAQS for transportation conformity purposes only. The February 14, 2012 proposal establishes a necessary step to implement the 2008 NAAQS for ground-level ozone. The EPA set those standards at 0.075 ppm on March 12, 2008. When the rule is finalized, the Omaha/Council Bluffs area may be significantly impacted if its levels of ozone pollution are above the new regulatory limits.

There are no ambient air quality monitoring data for criteria pollutants in the proposed MEA license boundary or AOR. However, there are a limited amount of state and federal monitoring sites in the region of the MEA that can be used as levels representative of the region for the monitored parameters. These monitoring sites are maintained for a variety of purposes, including for regional background purposes by the NDEQ, as per Appendix D of 40 CFR Part 58. However, the parameters measured are limited to particulate and ozone monitoring.

Regional monitoring sites and parameters measured are presented in **Table 2.5-17**. The locations of the monitor sites in western Nebraska are shown on **Figure 2.5-32**. The data available at the time of preparation of this section are summarized in **Tables 2.5-18** through **2.5-25**. The results of this monitoring indicates that the regions being monitored, including the MEA area, are well within compliance of NAAQS standards.

2.5.5.2 Prevention of Significant Deterioration

In addition to the ambient air quality standards, there are national standards for the Prevention of Significant Deterioration (PSD) of air quality (40 CFR 51.166). The PSD program is administered by the States of Nebraska and South Dakota, with their programs designed to protect the air quality in area that are in attainment with the NAAQS and to prevent degradation of air quality in areas below the standard (designated as clean air areas). PSD differs from the

NAAQS in that the NAAQS provides for maximum allowable concentrations of pollutants, while PSD requirements provide maximum allowable increases in concentrations of pollutants for areas already in compliance with the NAAQS. The PSD requirements establish allowable pollution "increments" that may be added to the air in each area while still protecting air quality. The increment is the maximum allowable deterioration of air quality. The maximum allowable increments applicable to Nebraska and South Dakota are shown in **Table 2.5-26.**

The allowable increments vary by location across the states. Those areas characterized as Class I (i.e., National Parks and Wilderness Areas) allow for less incremental pollution increase. Class III areas are planning areas set aside for industrial growth. The areas classified as Class II are essentially all other areas of the state not designated as Class I or Class III. There are no Class I National Park and Wilderness Areas in Nebraska. The Soldier Creek Wilderness Area, located north of Fort Robinson, is not designated as Class I. The State of South Dakota has two Class I Areas: Badlands and Wind Caves National Parks. The Wind Caves National Park is closer to the MEA, at a distance of approximately 75 miles (120.7 km).

No potential impacts to NAAQS parameters or PSD Class I, II, or III areas are expected to occur as the result of the MEA operations. The primary emissions from the proposed MEA will be tailpipe emissions of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), non-methane-ethane volatile organic compounds (VOCs) and particulate matter with a diameter less than ten micrometers (PM_{10}) resulting from vehicle traffic within the MEA. The majority of the emissions generated during construction will be fugitive dust and vehicle combustion emissions. Effects of air emissions and impacts associated with construction and operations are discussed in Section 7.2.1.

2.5.6 References

Cameco Resources. (CBR). 2011. Marsland Expansion Area On-Site Meteorological Monitoring Data. August 24, 2010 through August 29, 2011.

Curtis, J. and K. Grimes, 2007: *Wyoming Climate Atlas.* [Web Page]. Located at: http://www.wrds.uwyo.edu/wrds/wsc/climateatlas/. May 2.Accessd on March 19, 2010.

M. E. Jensen, R. D. Burman, and R. G. Allen. 1990. Evapotranspiration and Irrigation water Requirements , ASCE manuals and Reports on Engineering Practice NO.70 American Society of Civil Engineers NY 1-332.

National Climatic Data Center (NCDC). 2011. *Surface Data, Monthly Extremes.* [Web Page]. Located at: http://gis.ncdc.noaa.gov/website/ims-cdo/extmo/viewer.htm?Box=-110.307738654357:41.4493000825986:-102.349767058746:45.2536595444503. Accessed on: July 5, 2011.

National Renewable Energy Laboratory (NREL). 1990. "Solar Radiation for Flat-Plate Collectors Facing South at a Fixed-Tilt," 30-year (1961-1990) averages for Scottsbluff, Nebraska. [Web Page]. Located at: http://rredc.nrel.gov/solar/old_data/nsrdb/1961-1990/redbook/mon2/24028.txt Accessed on: March 26, 2012.

Nebraska Department of Environmental Quality (NDEQ). 2003. *Environmental Fact Sheet: Establishing Air Quality Regulations in Nebraska.* [Web Page]. Located at: http://www.deq.state.ne.us/. Accessed on: July 5, 2011.

NDEQ. 2011. *NDEQ 2010 Ambient Air Monitoring Network Plan and 5 Year Assessment.* [Web Page]. Located at: http://www.deq.state.ne.us/. Accessed on: November 9, 2011.

South Dakota Department of Environment & Natural Resources (SD DENR). 2011. South Dakota Ambient Air Monitoring Annual Network Plan 2009. [Web Page]. Located at: http://denr.sd.gov/des/aq/aqnews/South%20Dakota%20AP2009.pdf. Accessed on: November 9, 2011.

U.S. Environmental Protection Agency (EPA). 2010a. *Airdata: Access to Air Pollution Data. Monitor Values Report - Criteria Air Pollutants – South Dakota.* [Web Page]. Located at: http://epa.gov/air/data/monvals.html?st~SD~South%20Dakota. Accessed on: March 19, 2010.

EPA. 2010b. *Airdata: Access to Air Pollution Data. Monitor Values Report - Criteria Air Pollutants – Nebraska.* [Web Page]. Located at: http://epa.gov/air/data/monvals.html?st~SD~South%20Dakota. Accessed on: March 19, 2010.

EPA. 2011a. EPA Memorandum from Gina McCarthy, Assistant Administrator to Air Division Directors, Regions I-10 Regarding Implementation of the Ozone National Ambient Air Quality Standard. September 22.

EPA. 2011b. Air and Radiation. National Ambient Air Quality Standards (NAQQS). [Web Page]. Located at: http://www.epa.gov/air/criteria.html. Accessed on: November 9.

EPA. 2012. Implementation of the 2008 National Air Quality Standards for Ozone: Nonattainment Area Classifications Approach. Attainment Deadlines and Revocation of the 1997 Ozone Standards for Transportation Conformity Purposes. Federal Register Volume 77, No. 30, pp. 8197-8209. February 14.

High Plains Regional Climate Center (HPRCC). 2011. [Web Page]. Located at: http://www.hprcc.unl.edu/. Accessed on: March 19, 2010.

United States Geological Survey (USGS). 2009. Geomorphic Segmentation, Hydraulic Geometry, and Hydraulic Microhabitats of the Niobrara River, Nebraska – Methods and Initial Results.

U.S. Nuclear Regulatory Commission (NRC). 1981. MILDOS – A Computer Program for Calculating Environmental Radiation Doses from Uranium Recovery Operations. NUREG/CR-2011 PNL-3767. April 1981.

Western Regional Climate Center (WRCC). 2011. [Web Page]. Located at: http://www.wrcc.dri.edu/. Accessed on: July 5, 2011.

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Table 2.5-1 Meteorological Stations Included in Climate Analysis

Name	Agency	X	Y	Z (ft)	Years Operation
Alliance	NWS	-102° 54'	42° 6'	3,990	1894 - 2010
Atkinson	NWS	-98° 58'	42° 33'	2,130	1906 - 2010
North Platte	NWS	-100° 41'	41° 8'	2,780	1948 - 2010
Gregory	NWS	-99° 26'	43° 14'	2,160	1906 - 2010
Rapid City	NWS	-103° 4'	44° 3'	3,160	1948 - 2009
Long Valley	NWS	-101° 30'	43° 28'	2,470	1927 - 2010
Lusk	NWS	-104° 29'	42° 45'	5,090	1893 - 2007
Springview	NWS	-99° 45'	42° 49'	2,450	1893 - 2010
Ainsworth	NWS	-99° 52'	42° 33'	2,510	1905 - 2010
Mullen	NWS	-101° 3'	42° 3'	3,250	1893 - 2010
Kimball	NWS	-103° 40'	41° 14'	4,710	1893 - 2010
Newcastle	NWS	-104° 13'	43° 51'	4,410	1906 - 2010
Chugwater	NWS	-104° 49'	41° 45'	5,300	1900 - 2010
Cheyenne	NWS	-104° 49'	41° 09'	6,120	1915 - 2010
Sidney	NWS	-103° 0'	41° 14'	4,320	1908 - 2010
Scottsbluff	NWS	-103° 36'	41° 52'	3,950	1893 - 2010
Valentine	NWS	-100° 33'	42° 52'	2,590	1948 - 2010
Rushville	NWS	-102° 26'	42° 43'	3,760	1941 - 2010
Hay Springs	NWS	-102° 42'	42° 30'	3,810	1951 - 2010
Oelrichs	NWS	-103° 14'	43° 11'	3,350	1893 - 2010
Mt Rushmore	NWS	-103° 27'	43° 53'	5,170	1962 - 2010

Source: National Climate Data Center 2011

Note: NWS = National Weather Service

Table 2.5-2 Annual and Monthly Temperature Statistics for Scottsbluff Airport, NE

Month	Temperature Statistics (° Fahrenheit)				
	Monthly Average	Monthly Maximum	Monthly Minimum	Average Daily High	Average Daily Low
Jan	26.8	69	−28	39.4	12.3
Feb	29.2	74	−22	43.2	15.4
Mar	37.5	81	−7	50.9	22.5
Apr	45.6	86	1	61.5	32.1
May	56.2	99	18	71.3	42.4
Jun	66.6	104	32	82.0	52.1
Jul	74.5	107	32	89.4	58.0
Aug	71.0	103	32	87.5	55.7
Sep	60.8	102	25	78.2	45.2
Oct	46.9	90	1	65.9	33.2
Nov	35.5	79	−13	51.2	21.9
Dec	26.0	72	−26	40.8	13.9

Source: National Climate Data Center 2011, hourly data from 1961 through 2011

Table 2.5-3 Scottsbluff Airport Monthly Wind Parameters Summary

Month	Hourly Average Wind Speeds (mph)		
	Monthly Average	Monthly Maximum	Monthly Minimum
Jan	8.9	39	0
Feb	9.5	44	0
Mar	10.1	43	0
Apr	10.7	43	0
May	10.4	49	0
Jun	9.1	48	0
Jul	7.7	49	0
Aug	7.3	32	0
Sep	7.4	56	0
Oct	8.3	39	0
Nov	8.5	45	0
Dec	8.6	40	0

Source: National Climate Data Center 2011, hourly data from 1996 through 2011

Table 2.5-4 Scottsbluff Airport 15-Year Wind Frequency Distribution

Relative Frequency (% of Recorded Winds) for Wind Rose at Scottsbluff Airport, NE							
11/01/1996 Hr. 1 to 8/31/2011 Hr. 23							
Wind Direction (degrees)	**0.0 – 4.0**	**4.0 – 7.4**	**7.4 – 12.1**	**12.1 – 19.0**	**19.0 – 25.8**	**25.8 – 100.0**	**Row Total**
	mph						
0.0	1.1	1.8	1.4	1.1	0.3	0.1	5.8
22.5	0.6	1.0	1.0	0.6	0.2	0.0	3.4
45.0	0.6	0.9	0.9	0.6	0.1	0.0	3.1
67.5	0.7	1.3	1.0	0.5	0.1	0.0	3.5
90.0	1.5	4.8	3.5	0.7	0.0	0.0	10.5
112.5	0.9	3.2	5.0	2.2	0.2	0.0	11.5
135.0	0.6	1.6	2.5	1.5	0.2	0.0	6.4
157.5	0.4	1.0	1.1	0.9	0.2	0.0	3.6
180.0	0.5	0.8	0.8	0.5	0.1	0.0	2.7
202.5	0.2	0.4	0.3	0.2	0.0	0.0	1.1
225.0	0.2	0.2	0.2	0.1	0.0	0.0	0.8
247.5	0.2	0.3	0.2	0.1	0.0	0.0	0.9
270.0	0.7	1.6	2.0	1.5	0.6	0.2	6.6
292.5	0.9	3.1	4.3	2.8	0.8	0.3	12.2
315.0	1.2	3.8	3.5	2.0	0.8	0.6	11.9
337.5	1.1	2.2	1.5	1.5	0.7	0.3	7.3
TOTAL	**11.3**	**28.0**	**29.3**	**16.7**	**4.3**	**1.6**	**91.2**
0 mph (8.8%) Invalid readings: 4,453							
Number of possible readings: 149,723 Valid readings: 146,270 Data capture: 97.03%							

Source: National Climate Data Center 2011, hourly data from 1996 through 2011

Table 2.5-5 Marsland Expansion Area Maximum, Minimum and Average Monthly Temperatures

Month	Temperature Statistics (° Fahrenheit)		
	Monthly Average	Monthly Minimum	Monthly Maximum
Jan	23.4	−14.4	55.6
Feb	21.9	−27.9	63.4
Mar	35.4	3.1	69.2
Apr	41.9	22.5	78.9
May	49.0	22.1	82.9
Jun	62.7	41.3	92.1
Jul	73.7	50.3	98.6
Aug	72.1	39.7	99.0
Sep	59.7	30.3	90.1
Oct	49.9	18.5	82.7
Nov	33.1	−4.7	72.3
Dec	27.1	−3.3	55.6

Source: Crow Butte Resources, Inc. 2011 data from 8/24/2010 to 8/29/2011

Table 2.5-6 Marsland Meteorological Summary

Meteorological Data Summary 8/24/2010 – 8/29/2011			
Hourly Data			
Parameter	**Average/Total**	**Maximum**	**Minimum**
Wind Speed (mph)	10.6	40.5	0.0
Sigma-Theta (°)	21.6	99.9	0.0
Temperature (°F)	46.3	99.0	–27.9
10m Temperature (°F)	47.1	97.2	–22.3
Relative Humidity (%)	64.5	163.6	6.5
Precipitation (inches)	16.90	0.59	--
Solar Radiation (w/m^{-2})	173.1	939.0	--
Data Recovery			
Parameter	**Possible (Hours)**	**Reported (Hours)**	**Recovery (Percent)**
Wind Speed	8,893	8,708	97.92
Wind Direction	8,893	8,708	97.92
Sigma-Theta	8,893	8,708	97.92
Temperature	8,893	8,884	99.90
10m Temperature	8,893	8,884	99.90
Relative Humidity	8,893	8,884	99.90
Precipitation	8,893	8,884	99.90
Solar Radiation	8,893	8,884	99.90

Source: Crow Butte Resources, Inc. 2011, data from 8/24/2010 to 8/29/2011

Note: Predominant wind direction was from the NNW sector, accounting for 13.0% of the possible winds.

Table 2.5-7 Marsland Expansion Area Meteorological Station

Relative Frequency (% of Recorded Winds) for Wind Rose							
8/28/2010 Hr. 20 to 8/29/2011 Hr. 15							
Wind Direction (degrees)	**0.0 – 4.0**	**4.0 – 7.4**	**7.4 – 12.1**	**12.1 – 19.0**	**19.0 – 25.8**	**25.8 – 100.0**	**Row Total**
	mph						
0.0	1.3	1.6	2.4	2.5	0.7	0.2	8.8
22.5	0.8	0.8	1.5	1.2	0.3	0.1	4.8
45.0	0.7	0.7	0.9	0.8	0.0	0.0	3.3
67.5	0.6	0.9	1.0	0.6	0.0	0.0	3.2
90.0	0.6	1.2	1.4	0.7	0.0	--	3.9
112.5	0.8	1.6	1.8	0.6	0.1	0.0	4.9
135.0	1.0	1.7	1.9	0.7	0.1	--	5.4
157.5	1.0	1.6	1.9	1.6	0.4	0.1	6.6
180.0	1.1	1.3	1.7	1.8	0.5	0.0	6.4
202.5	1.2	1.4	1.4	1.0	0.2	0.0	5.3
225.0	0.8	1.3	1.6	0.7	0.2	0.0	4.7
247.5	0.9	1.5	2.0	1.3	0.4	0.0	6.2
270.0	0.7	0.9	1.5	1.6	0.5	0.3	5.4
292.5	0.7	1.0	1.4	2.4	1.0	0.4	7.0
315.0	0.8	1.5	2.2	3.2	2.3	0.9	10.9
337.5	1.6	2.9	3.0	3.2	1.5	0.7	13.0
TOTAL	**14.8**	**22.1**	**27.6**	**24.1**	**8.3**	**2.8**	**99.7**
0 mph (1.0%) Invalid readings: 186							
Number of possible readings: 8,894 Valid readings: 8,708 Data capture: 97.91%							

Source: National Climate Data Center 2011, hourly data from 1996 through 2011

Table 2.5-8 Marsland Expansion Area Wind Summary

8/24/2010 2:00:00 AM – 8/29/2011 3:00:00 PM			
Hourly Data			
Parameter	**Average**	**Maximum**	**Minimum**
Wind Speed (mph)	10.59	40.51	--
Sigma Theta (°)	21.61	99.90	--
Wind Direction			
N	10.82	32.70	0.16
NNE	10.13	39.89	0.27
NE	8.64	26.80	1.07
ENE	8.16	27.72	0.79
E	8.27	22.53	--
ESE	7.79	29.17	--
SE	7.93	22.80	--
SSE	9.81	28.86	--
S	10.28	29.51	--
SSW	8.41	26.62	0.00
SW	8.52	26.31	0.58
WSW	9.80	32.57	0.87
W	12.01	36.62	0.76
WNW	13.24	40.51	1.04
NW	14.46	39.91	--
NNW	11.89	40.22	--
Data Recovery			
	Possible (Hours)	Reported (Hours)	Recovery (%)
Wind Speed	8,917	8,708	97.66
Sigma Theta	8,917	8,708	97.66
Wind Direction	8,917	8,708	97.66

Source: Cameco Resources, Inc. 2011, data from 8/24/2010 to 8/29/2011

Note: Predominant wind direction was from the NNW sector, accounting for 13% of the winds; the average wind direction was 307°.

Table 2.5-9 Marsland Annual Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) - One Year (Calm = 1.0%)					
		0 - 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24
A	N	0.001414	0.002357				
	NNE	0.000236	0.001532				
	NE	0.000707	0.001886				
	ENE	0.000825	0.001768				
	E	0.000943	0.001768				
	ESE	0.001296	0.002593				
	SE	0.001061	0.002004				
	SSE	0.002121	0.002121				
	S	0.001768	0.002121				
	SSW	0.003536	0.002593				
	SW	0.001414	0.002239				
	WSW	0.000943	0.004007				
	W	0.001179	0.001179				
	WNW	0.000825	0.001179				
	NW	0.000589	0.002004				
	NNW	0.000589	0.002121				
B	N		0.002004	0.000236			
	NNE		0.002239				
	NE		0.002475	0.000118			
	ENE		0.001768				
	E		0.001768	0.000118			
	ESE	0.000354	0.002475	0.000354			
	SE	0.000118	0.003418	0.000354			
	SSE	0.000471	0.002475	0.000236			
	S	0.000471	0.002357	0.000707			
	SSW	0.000943	0.003182	0.000589			
	SW	0.000118	0.003064				
	WSW		0.002593	0.000471			
	W	0.000118	0.001296	0.000236			
	WNW	0.000118	0.001650	0.000118			
	NW		0.002357	0.000707			
	NNW		0.002121	0.000471			
C	N	0.000118	0.000589	0.010253			
	NNE		0.000589	0.004714			
	NE		0.000589	0.002946			
	ENE		0.000825	0.003418			
	E		0.001179	0.003300			
	ESE		0.001768	0.005539			
	SE	0.000354	0.001886	0.004125			
	SSE	0.000118	0.001532	0.004361			
	S	0.000354	0.001532	0.004950			
	SSW	0.000236	0.001414	0.004361			
	SW	0.000118	0.001886	0.005657			
	WSW		0.000825	0.006600			
	W		0.000707	0.004361			
	WNW		0.000471	0.004714			
	NW		0.000589	0.008132			
	NNW		0.000943	0.007778			

Table 2.5-9 Marsland Annual Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) - One Year (Calm = 1.0%)					
		0 - 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24
D	N	0.000236	0.007307	0.019093	0.017796	0.004125	0.001414
	NNE	0.000236	0.004714	0.010725	0.008603	0.002239	0.000118
	NE		0.001886	0.009193	0.003064	0.000118	
	ENE		0.003064	0.007307	0.002004		0.000118
	E	0.000118	0.005775	0.010371	0.003182	0.000118	
	ESE	0.000471	0.008839	0.009193	0.003064	0.000236	0.000118
	SE	0.000236	0.010489	0.012139	0.003889	0.000354	
	SSE	0.000118	0.007543	0.016500	0.009546	0.003418	0.000118
	S	0.000118	0.005186	0.013082	0.013789	0.002829	0.000118
	SSW	0.000118	0.003889	0.008957	0.006718	0.001179	
	SW	0.000236	0.004832	0.007896	0.003654	0.001414	
	WSW	0.000118	0.005068	0.014614	0.008721	0.002475	0.000236
	W		0.004125	0.012728	0.012610	0.002946	0.002357
	WNW	0.000118	0.003771	0.014850	0.019564	0.007189	0.002946
	NW	0.000118	0.006836	0.019093	0.030053	0.016971	0.005893
	NNW	0.000707	0.013553	0.023689	0.028167	0.012375	0.004478
E	N	0.001532	0.002357	0.000471			
	NNE	0.000707	0.001296	0.000354			
	NE		0.001650	0.000236			
	ENE		0.002004	0.000471			
	E	0.000589	0.001532	0.000589			
	ESE	0.000354	0.003064	0.000236			
	SE	0.000825	0.002004	0.000236			
	SSE	0.000707	0.002475	0.000471			
	S	0.000354	0.002711	0.000236			
	SSW		0.002004	0.000236			
	SW	0.000354	0.002946	0.000589			
	WSW	0.000354	0.002829	0.001061			
	W	0.000118	0.002004	0.000943			
	WNW	0.000707	0.001296	0.000825			
	NW	0.000589	0.003536	0.001414			
	NNW	0.000943	0.009664	0.001886			
F	N	0.009782	0.007071				
	NNE	0.006953	0.002829				
	NE	0.006364	0.001179				
	ENE	0.005421	0.002593				
	E	0.004478	0.003536				
	ESE	0.005186	0.003182				
	SE	0.006718	0.003418				
	SSE	0.006128	0.004832				
	S	0.007543	0.003418				
	SSW	0.006600	0.004950				
	SW	0.005775	0.004361				
	WSW	0.007307	0.004714				
	W	0.005657	0.002946				
	WNW	0.005775	0.005539				
	NW	0.006718	0.004596				
	NNW	0.013318	0.008368				

Source: Crow Butte Resources, Inc. 2011, data from 8/24/2010 to 8/29/2011

Table 2.5-10 Marsland Winter Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) – Winter (Calm = 1.7%)						Row Total
		< 3	4 – 7	8 – 12	13 – 18	19 – 24	> 24	
A	N	0.000512	0.000463					0.000975
	NNE		0.000463					0.000463
	NE	0.001025	0.000463					0.001488
	ENE							
	E	0.001025	0.000926					0.001951
	ESE	0.000512	0.001389					0.001901
	SE	0.001537	0.001389					0.002926
	SSE	0.001025	0.000463					0.001488
	S	0.000512	0.001389					0.001901
	SSW	0.002562	0.001389					0.003951
	SW	0.002050	0.001852					0.003902
	WSW	0.001025	0.001389					0.002414
	W	0.000512	0.001389					0.001901
	WNW	0.000512	0.000926					0.001438
	NW	0.000512	0.002778					0.003290
	NNW	0.000512	0.001852					0.002364
B	N		0.000463					0.000463
	NNE		0.000926					0.000926
	NE		0.001852					0.001852
	ENE		0.000463					0.000463
	E		0.000463	0.000463				0.000926
	ESE	0.001025	0.000926					0.001951
	SE		0.000463					0.000463
	SSE	0.000512	0.001389					0.001901
	S		0.000463					0.000463
	SSW		0.001852	0.000463				0.002315
	SW		0.002315					0.002315
	WSW		0.000463					0.000463
	W		0.001389					0.001389
	WNW		0.002778					0.002778
	NW		0.001852					0.001852
	NNW		0.000926	0.000463				0.001389
C	N		0.000463	0.005093				0.005556
	NNE			0.003704				0.003704
	NE		0.000463	0.001852				0.002315
	ENE			0.000463				0.000463
	E		0.000463	0.000463				0.000926
	ESE		0.001389					0.001389
	SE	0.000512	0.003241	0.001389				0.005142
	SSE		0.000926	0.001852				0.002778
	S	0.000512	0.000926	0.001389				0.002827
	SSW	0.000512	0.000463	0.000926				0.001901
	SW	0.000512	0.001852	0.002315				0.004679
	WSW			0.004630				0.004630
	W		0.000926	0.001389				0.002315
	WNW			0.003704				0.003704
	NW		0.000463	0.005556				0.006019
	NNW		0.000463	0.005556				0.006019

Table 2.5-10 Marsland Winter Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) – Winter (Calm = 1.7%)						Row Total
		< 3	4 – 7	8 – 12	13 – 18	19 – 24	> 24	
D	N	0.000512	0.008333	0.026852	0.014815	0.003241	0.001389	0.055142
	NNE	0.000512	0.005556	0.013426	0.003704			0.023198
	NE		0.001389	0.009259	0.001389	0.000463		0.012500
	ENE		0.003704	0.009259	0.000463		0.000463	0.013889
	E	0.000512	0.005556	0.005556	0.000463			0.012086
	ESE	0.001537	0.009259	0.009259	0.000926			0.020982
	SE		0.007407	0.010648	0.004167	0.000926		0.023148
	SSE		0.004167	0.013889	0.005093	0.002315		0.025463
	S		0.004630	0.011574	0.011111	0.001389		0.028704
	SSW		0.002778	0.007407	0.003704	0.000463		0.014352
	SW		0.003241	0.006944	0.002315	0.000463		0.012963
	WSW	0.000512	0.006944	0.021296	0.012037	0.005093		0.045883
	W		0.008333	0.023148	0.021296	0.006019	0.002778	0.061574
	WNW	0.000512	0.004167	0.025000	0.033796	0.012500	0.002778	0.078753
	NW	0.000512	0.007407	0.023148	0.047222	0.025926	0.003241	0.107457
	NNW	0.000512	0.009259	0.029167	0.036111	0.011111	0.006481	0.092642
E	N	0.000512	0.002315	0.000926				0.003753
	NNE	0.001537	0.000463					0.002000
	NE		0.000926	0.000463				0.001389
	ENE		0.001852					0.001852
	E	0.000512	0.000926	0.000463				0.001901
	ESE		0.000926	0.000463				0.001389
	SE	0.000512	0.001389					0.001901
	SSE	0.000512	0.000926					0.001438
	S	0.000512	0.002778					0.003290
	SSW		0.001389	0.000926				0.002315
	SW	0.000512	0.003241	0.000463				0.004216
	WSW	0.001025	0.004630	0.001389				0.007043
	W		0.002778	0.003241				0.006019
	WNW	0.001537	0.000926	0.001389				0.003852
	NW	0.000512	0.004630	0.001852				0.006994
	NNW	0.001537	0.006019	0.000926				0.008482
F	N	0.013323	0.005556					0.018878
	NNE	0.008199	0.001852					0.010051
	NE	0.006149						0.006149
	ENE	0.005124	0.003241					0.008365
	E	0.004612	0.003241					0.007853
	ESE	0.008199	0.002315					0.010514
	SE	0.007686	0.003241					0.010927
	SSE	0.010248	0.003704					0.013952
	S	0.010761	0.002778					0.013539
	SSW	0.012298	0.004630					0.016928
	SW	0.009736	0.005556					0.015292
	WSW	0.010761	0.005093					0.015853
	W	0.009736	0.005093					0.014829
	WNW	0.005124	0.006944					0.012069
	NW	0.006149	0.005556					0.011705
	NNW	0.012810	0.005093					0.017903

Source: Crow Butte Resources, Inc. 2011, data from 8/24/2010 to 8/29/2011

Table 2.5-11 Marsland Spring Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) - Spring (Calm = 0.6%)						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
A	N	0.001473	0.001836					0.003309
	NNE		0.001836					0.001836
	NE	0.000491	0.001377					0.001868
	ENE	0.000982	0.000918					0.001900
	E	0.000982	0.002295					0.003277
	ESE	0.000491	0.002295					0.002786
	SE		0.002295					0.002295
	SSE	0.001473	0.000918					0.002391
	S	0.001473	0.002754					0.004226
	SSW	0.001473	0.002295					0.003767
	SW	0.000491	0.002295					0.002786
	WSW	0.000491	0.005507					0.005998
	W	0.000982	0.001377					0.002359
	WNW	0.001964	0.002295					0.004258
	NW	0.000491	0.000918					0.001409
	NNW	0.000491	0.002295					0.002786
B	N		0.001836					0.001836
	NNE		0.001836					0.001836
	NE		0.002295					0.002295
	ENE		0.000918					0.000918
	E		0.001836					0.001836
	ESE		0.001377	0.001377				0.002754
	SE		0.003212					0.003212
	SSE	0.000491	0.002295					0.002786
	S	0.000491	0.003671	0.000918				0.005080
	SSW		0.002754	0.000459				0.003212
	SW		0.002754					0.002754
	WSW		0.003212	0.000918				0.004130
	W		0.002295	0.000459				0.002754
	WNW		0.001836					0.001836
	NW		0.002754	0.000459				0.003212
	NNW		0.001836					0.001836
C	N			0.015603				0.015603
	NNE		0.000459	0.007802				0.008261
	NE		0.000459	0.005048				0.005507
	ENE		0.000918	0.006425				0.007343
	E		0.000918	0.003212				0.004130
	ESE		0.001836	0.006884				0.008720
	SE		0.001377	0.005048				0.006425
	SSE		0.001377	0.005507				0.006884
	S		0.002295	0.007343				0.009637
	SSW		0.000459	0.004589				0.005048
	SW		0.001377	0.007802				0.009179
	WSW		0.000459	0.009179				0.009637
	W		0.000459	0.005966				0.006425
	WNW			0.005048				0.005048
	NW		0.000459	0.009637				0.010096
	NNW		0.000918	0.009637				0.010555

Table 2.5-11 Marsland Spring Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) - Spring (Calm = 0.6%)						Row Total
		< 3	4 - 7	8 - 12	13 - 18	19 - 24	> 24	
D	N		0.005048	0.020193	0.033043	0.005048		0.063332
	NNE		0.005507	0.013768	0.012391	0.004130		0.035796
	NE		0.002754	0.012850	0.006884			0.022487
	ENE		0.002754	0.006884	0.004130			0.013768
	E		0.005048	0.015603	0.009179	0.000459		0.030289
	ESE		0.008720	0.010096	0.006425	0.000459		0.025700
	SE	0.000491	0.011014	0.011473	0.006425			0.029403
	SSE		0.006884	0.019734	0.010555	0.009637	0.000459	0.047269
	S		0.003671	0.010096	0.012850	0.007343	0.000459	0.034419
	SSW		0.005507	0.010096	0.010555	0.003212		0.029371
	SW	0.000491	0.004130	0.007343	0.001377	0.000918		0.014259
	WSW		0.001377	0.013768	0.008261	0.001836	0.000918	0.026159
	W		0.001836	0.010096	0.015603	0.003212	0.006425	0.037173
	WNW		0.002295	0.018816	0.014227	0.008720	0.003671	0.047728
	NW		0.006884	0.019275	0.033961	0.013309	0.008261	0.081689
	NNW		0.007343	0.024782	0.032584	0.015603	0.003212	0.083525
E	N	0.000491	0.001377	0.000459				0.002327
	NNE	0.000491	0.000918	0.000459				0.001868
	NE		0.002754					0.002754
	ENE		0.001836					0.001836
	E	0.000491	0.002754	0.001377				0.004621
	ESE		0.003671	0.000459				0.004130
	SE	0.000982	0.002295					0.003277
	SSE	0.000491	0.002754					0.003245
	S	0.000491	0.002295					0.002786
	SSW		0.000459					0.000459
	SW	0.000491	0.002295	0.000459				0.003245
	WSW		0.001377					0.001377
	W		0.000459					0.000459
	WNW	0.000982	0.002295					0.003277
	NW	0.000491	0.001377	0.000918				0.002786
	NNW	0.000491	0.005048	0.001377				0.006916
F	N	0.004418	0.005507					0.009926
	NNE	0.004909	0.001836					0.006745
	NE	0.003928	0.000918					0.004845
	ENE	0.001473	0.002295					0.003767
	E	0.003437	0.003671					0.007108
	ESE	0.003437	0.004589					0.008026
	SE	0.004418	0.002295					0.006713
	SSE	0.004909	0.004130					0.009040
	S	0.004909	0.002754					0.007663
	SSW	0.000982	0.005048					0.006030
	SW	0.002946	0.002295					0.005240
	WSW	0.002455	0.002754					0.005208
	W	0.001964	0.002754					0.004717
	WNW	0.004418	0.002754					0.007172
	NW	0.006873	0.003671					0.010545
	NNW	0.007364	0.004130					0.011494

Source: Crow Butte Resources, Inc. 2011, data from 8/24/2010 to 8/29/2011

Table 2.5-12 Marsland Summer Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) – Summer (Calm = 0.2%)						Row Total
		< 3	4 – 7	8 – 12	13 – 18	19 – 24	> 24	
A	N	0.002875	0.004710					0.007585
	NNE	0.000958	0.003297					0.004256
	NE		0.004710					0.004710
	ENE	0.001438	0.005181					0.006619
	E	0.001438	0.002826					0.004264
	ESE	0.001438	0.005181					0.006619
	SE	0.000958	0.003768					0.004727
	SSE	0.002875	0.005652					0.008527
	S	0.003833	0.003297					0.007131
	SSW	0.005750	0.005652					0.011403
	SW	0.001917	0.002355					0.004272
	WSW	0.000958	0.005652					0.006611
	W	0.001917	0.001413					0.003330
	WNW		0.000942					0.000942
	NW	0.000958	0.002355					0.003314
	NNW		0.003297					0.003297
B	N		0.004239	0.000942				0.005181
	NNE		0.005181					0.005181
	NE		0.005652	0.000471				0.006123
	ENE		0.005652					0.005652
	E		0.003768					0.003768
	ESE	0.000479	0.007537					0.008016
	SE		0.008008	0.000942				0.008950
	SSE	0.000479	0.005652	0.000942				0.007074
	S	0.000479	0.005181	0.001413				0.007074
	SSW	0.000479	0.003768	0.000942				0.005189
	SW		0.003768					0.003768
	WSW		0.003768	0.000942				0.004710
	W	0.000479	0.001413	0.000471				0.002363
	WNW	0.000479	0.001413	0.000471				0.002363
	NW		0.002826	0.001884				0.004710
	NNW		0.003768	0.001413				0.005181
C	N	0.000479	0.000471	0.013660				0.014610
	NNE		0.000471	0.006123				0.006594
	NE		0.000471	0.003768				0.004239
	ENE		0.001884	0.005652				0.007537
	E		0.002355	0.008008				0.010363
	ESE		0.003297	0.015073				0.018370
	SE		0.002355	0.009421				0.011776
	SSE		0.003297	0.007537				0.010834
	S		0.000942	0.009421				0.010363
	SSW		0.002826	0.007537				0.010363
	SW		0.002355	0.008008				0.010363
	WSW		0.002355	0.010363				0.012718
	W		0.000471	0.007537				0.008008
	WNW		0.001884	0.007065				0.008950
	NW		0.001413	0.007065				0.008479
	NNW		0.000471	0.008479				0.008950

Table 2.5-12 Marsland Summer Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) – Summer (Calm = 0.2%)						Row Total
		< 3	4 – 7	8 – 12	13 – 18	19 – 24	> 24	
D	N		0.005652	0.014131	0.009892	0.002826	0.000942	0.033443
	NNE	0.000479	0.005181	0.009421	0.010834	0.002355	0.000471	0.028741
	NE		0.001413	0.012718	0.002355			0.016486
	ENE		0.005181	0.009421	0.003297			0.017899
	E		0.008950	0.013660	0.002826			0.025436
	ESE	0.000479	0.009421	0.013660	0.003768			0.027328
	SE	0.000479	0.015073	0.016957	0.003297			0.035807
	SSE		0.008950	0.014131	0.009892	0.001413		0.034385
	S		0.007065	0.015544	0.021196	0.000942		0.044748
	SSW		0.005652	0.012247	0.009421	0.000942		0.028262
	SW		0.004239	0.010834	0.005181	0.001413		0.021667
	WSW		0.005181	0.007537	0.005181	0.001413		0.019312
	W		0.001413	0.006594	0.001884	0.000471		0.010363
	WNW		0.001884	0.000471	0.002826			0.005181
	NW		0.002826	0.003297	0.013189	0.003768		0.023081
	NNW	0.000958	0.009892	0.016486	0.016015	0.004239	0.000942	0.048533
E	N	0.000958	0.003297	0.000471				0.004727
	NNE		0.001884					0.001884
	NE		0.000942					0.000942
	ENE		0.002826	0.000942				0.003768
	E		0.001884					0.001884
	ESE		0.002826					0.002826
	SE	0.000479	0.003297					0.003776
	SSE	0.000958	0.004239	0.000942				0.006140
	S		0.003768	0.000942				0.004710
	SSW		0.004239					0.004239
	SW		0.003768					0.003768
	WSW	0.000479	0.002826	0.000471				0.003776
	W		0.002355					0.002355
	WNW		0.000471					0.000471
	NW	0.000479	0.003297	0.000471				0.004247
	NNW		0.010363	0.002826				0.013189
F	N	0.008625	0.011305					0.019930
	NNE	0.006229	0.002826					0.009056
	NE	0.007667	0.001884					0.009551
	ENE	0.005750	0.002355					0.008105
	E	0.003833	0.006123					0.009957
	ESE	0.004792	0.003768					0.008560
	SE	0.008146	0.005181					0.013327
	SSE	0.003354	0.008008					0.011362
	S	0.007188	0.004710					0.011898
	SSW	0.007667	0.005181					0.012848
	SW	0.003833	0.003297					0.007131
	WSW	0.005750	0.004710					0.010460
	W	0.005271	0.001884					0.007155
	WNW	0.004792	0.005652					0.010444
	NW	0.006229	0.003297					0.009527
	NNW	0.012938	0.008950					0.021887

Source: Crow Butte Resources, Inc. 2011, data from 8/24/2010 to 8/29/2011

Table 2.5-13 Marsland Fall Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) – Fall (Calm = 1.7%)						Row Total
		< 3	4 – 7	8 – 12	13 – 18	19 – 24	> 24	
A	N	0.001028	0.002364					0.003392
	NNE		0.000473					0.000473
	NE	0.001541	0.000946					0.002487
	ENE	0.001028	0.000946					0.001973
	E	0.000514	0.000946					0.001459
	ESE	0.003083	0.001418					0.004501
	SE	0.002055	0.000473					0.002528
	SSE	0.003596	0.001418					0.005015
	S	0.001541	0.000946					0.002487
	SSW	0.005138	0.000946					0.006083
	SW	0.001541	0.002364					0.003905
	WSW	0.001541	0.003310					0.004851
	W	0.001541	0.000473					0.002014
	WNW	0.001028	0.000473					0.001500
	NW	0.000514	0.001891					0.002405
	NNW	0.001541	0.000946					0.002487
B	N		0.001418					0.001418
	NNE		0.000946					0.000946
	NE							
	ENE							
	E		0.000946					0.000946
	ESE							
	SE	0.000514	0.001891	0.000473				0.002878
	SSE	0.000514	0.000473					0.000987
	S	0.001028		0.000473				0.001500
	SSW	0.003596	0.004255	0.000473				0.008325
	SW	0.000514	0.003310					0.003823
	WSW		0.002837					0.002837
	W							
	WNW		0.000473					0.000473
	NW		0.001891	0.000473				0.002364
	NNW		0.001891					0.001891
C	N		0.001418	0.006147				0.007565
	NNE		0.001418	0.000946				0.002364
	NE		0.000946	0.000946				0.001891
	ENE		0.000473	0.000946				0.001418
	E		0.000946	0.001418				0.002364
	ESE		0.000473					0.000473
	SE	0.001028	0.000473	0.000473				0.001973
	SSE	0.000514	0.000473	0.002364				0.003351
	S	0.001028	0.001891	0.001418				0.004337
	SSW	0.000514	0.001891	0.004255				0.006660
	SW		0.001891	0.004255				0.006147
	WSW		0.000473	0.001891				0.002364
	W		0.000946	0.002364				0.003310
	WNW			0.002837				0.002837
	NW			0.009929				0.009929
	NNW		0.001891	0.007092				0.008983

Table 2.5-13 Marsland Fall Joint Frequency Distribution

Stability Class	Wind Direction	Wind Speed (mph) – Fall (Calm = 1.7%)						Row Total
		< 3	4 – 7	8 – 12	13 – 18	19 – 24	> 24	
D	N	0.000514	0.009929	0.014184	0.012293	0.005201	0.003310	0.045431
	NNE		0.002364	0.005674	0.007092	0.002364		0.017494
	NE		0.001891	0.001418	0.001418			0.004728
	ENE		0.000473	0.003310				0.003783
	E		0.003310	0.006147				0.009456
	ESE		0.007565	0.003310	0.000946	0.000473	0.000473	0.012766
	SE		0.008038	0.008983	0.001418	0.000473		0.018913
	SSE	0.000514	0.009929	0.017494	0.012293			0.040230
	S	0.000514	0.005674	0.014657	0.009456	0.001418		0.031719
	SSW	0.000514	0.001418	0.005674	0.002837			0.010443
	SW	0.000514	0.007565	0.006147	0.005674	0.002837		0.022736
	WSW		0.006619	0.015130	0.008983	0.001418		0.032151
	W		0.004728	0.010402	0.010875	0.001891		0.027896
	WNW		0.006619	0.014184	0.026478	0.007092	0.005201	0.059574
	NW		0.009929	0.029787	0.024113	0.024113	0.011820	0.099764
	NNW	0.001541	0.027423	0.023168	0.026478	0.017967	0.007092	0.103669
E	N	0.004624	0.002364					0.006988
	NNE	0.001028	0.001891	0.000946				0.003864
	NE		0.001891	0.000473				0.002364
	ENE		0.001418	0.000946				0.002364
	E	0.001541	0.000473	0.000473				0.002487
	ESE	0.001541	0.004728					0.006269
	SE	0.001541	0.000946	0.000946				0.003433
	SSE	0.001028	0.001891	0.000946				0.003864
	S	0.000514	0.001891					0.002405
	SSW		0.001891					0.001891
	SW	0.000514	0.002364	0.001418				0.004296
	WSW		0.002364	0.002364				0.004728
	W	0.000514	0.002364	0.000473				0.003351
	WNW	0.000514	0.001418	0.001891				0.003823
	NW	0.001028	0.004728	0.002364				0.008120
	NNW	0.002055	0.017021	0.002364				0.021440
F	N	0.015413	0.005674					0.036053
	NNE	0.010276	0.004728					0.030110
	NE	0.009248	0.001891					0.019538
	ENE	0.010789	0.002364					0.009591
	E	0.007193	0.000946					0.011140
	ESE	0.005652	0.001891					0.011165
	SE	0.008221	0.002837					0.009100
	SSE	0.007707	0.003310					0.017032
	S	0.009248	0.003310					0.014060
	SSW	0.007193	0.004728					0.011682
	SW	0.008221	0.006147					0.012097
	WSW	0.012331	0.006147					0.011656
	W	0.007707	0.001891					0.013519
	WNW	0.010276	0.006619					0.018945
	NW	0.009248	0.005674					0.021865
	NNW	0.023634	0.015130					0.041199

Source: Crow Butte Resources, Inc. 2011, data from 8/24/2010 to 8/29/2011

Table 2.5-14 Marsland Onsite Meteorological Station Description

Equipment	Description
10-meter town	Free-standing 10-meter (or 33-foot) aluminum town, which is self supporting with typical sets of instruments at wind levels up to 110 miles per hour (mph).
Model 034B wind sensor	Model 034B wind sensor combines wind speed and direction measurements into a single sensing unit. The sensor is constructed of aluminum and stainless steel. Specifications: 1. Wind Speed • Range: 0 to 167 mph (0 to 75 meters/second [m/s]) • Starting threshold: 0.9 mph (0.4 m/s) • Accuracy : <22.7 mph (0.25 mph [0.1 m/s]) • Accuracy: >22.7 mph (± 1.1 percent of true) 2. Wind Direction • Range: Mechanical: 0 to 360° Electrical: 0 to 356° • Starting threshold: 0.9 mph (0.4 m/s) • Accuracy: 0.4° • Damping ratio: 0.25 standard (0.4 to 0.6 optional) • Resolution: <0.5° 3. Temperature Range • –30 °C to +70 °C (minimal icing conditions) 4. Output Signal • Wind speed: Pulsed contact closure • Wind direction: Potentiometer output (0 to 10 kohms)
Air temperature sensor	Met One Model 062 MP Specifications: 1. General • Sensing element: Multi-stage state thermistor, highly linearized • Time constant: Less than 10 seconds in still air • Self-heating: None 2. Housing: 3/8 in (9.5 mm) x 6 in (152.4 mm) 3. Range: –50 °C to +50 °C 4. Accuracy: ±0.05 °C, PSD compliant 5. For a system range of: Maximum Error/Degree of Maximum Error differential temperature: / over range: –5 °F to +5 °F: 0.02 °F / 0.05 °F –5 °C to +5 °C: 0.02 °C / 0.05 °C –5 °F to +10 °F: 0.02 °F / 0.1 °F –5 °C to +10 °C: 0.02 °C / 0.1 °C –10 °F to +20 °F: 0.02 °F / 0.2 °F
Relative humidity and temperature probes; solar radiation shield	Model HMP45AC Specifications: 1. Operating temperature range: –40 to +60 °C (–40 to +140 °F) 2. Storage temperature range: –40 to +80 °C (–40 to +176 °F) 3. Supply voltage: 7 to 35 VDC 4. Settling time: 500 m/s

Table 2.5-14 Marsland Onsite Meteorological Station Description

Equipment	Description
	5. Power consumption: <4 milliamperes (mA) 6. Relative humidity: • Measuring range: 0.8 to 100% RH • Output scale: 0 to 100% RH equals 0.1 VDC • Accuracy at +20 °C (+68 °F) (including nonlinearity and hysteresis) against calibration against references: ±1% RH field calibration against references: ±2% RH (0 to 90% RH) ±3% RH (90 to 100% RH) • Typical long-term stability: <1% RH/year • Temperature dependence: ±0.05% RH/°C (±0.03% RH/°F) • Response time (90% at +20 °C): 10 seconds with membrane filter • Humidity sensor: HUMICAP 180 7. Temperature • Measurement range: –39.2 to +60 °C (–32 to +140 °F) • Output scale: –40 to +60 °C (–40 to +140 °F) equals 0 to 1 VDC • Accuracy at +20 °C (+68 °F)
Solar radiation	LiCor 200 Pyranometer Designed for field measurement if global solar radiation. Specifications: 1. Sensitivity: Typically 90 microamperes (μA) per 1000 W m^{-2} 2. Linearity: maximum deviation of 1% up to 3000 W m^{-2} 3. Stability: <± 2% change over a 1-year period 4. Response time: 10 microseconds (μs) 5. Temperature dependence: 0.15% per °C maximum 6. Cosine correction: cosine corrected up to 80° angle of incidence 7. Azimuth: <±1% error over 360° at 45° elevation 8. Operating temperature: –40 to 65 °C 9. Relative humidity: 0 to 100%
Datalogger	Campbell Scientific CR 1000 programmable control and data acquisition system Provides direct communications and telecommunications, reduces data, controls external devices, and stores data and programs in on-board, non-volatile storage. Sensor data can be directly downloaded from the datalogger. Specifications: 1. Analog inputs: 16 single-ended or 8 differential, individually configured 2. Pulse counters: 2 3. Switched voltage excitations: 3 4. Control/digital ports: 8 5. RS-232 port: 1 6. CS I/O port: 1 7. Scan rate: 100 Hz 8. Burst mode: 1500 HZ 9. Programming: CR Basic 10. Data storage: Table

Table 2.5-14 Marsland Onsite Meteorological Station Description

Equipment	Description
Tipping bucket rain gage	Texas Electronics TE525WS tipping bucket rain gage Specifications: 1. Orifice diameter: 8 inches (20.3 cm) 2. Rainfall per tip: 0.01 inch (0.254 mm) 3. Accuracy: • Up to 1 inch/hr: ±1% • 1 to 2 inches/hr: +0, –2.5% • 2 to 3 inches/hr: +0, –3.5% 4. Temperature: 0 °C to +50 °C 5. Resolution: 1 tip 6. Magnetic reed switch

Source: Cameco Resources, Inc.

Table 2.5-15 Rapid City Mixing Heights

Time Period (Filtered)	Average Mixing/Inversion Height
Morning (2 a.m. – 6 a.m.)	333 meters
Afternoon (12 p.m. – 4 p.m.)	1,547 meters

Table 2.5-16 EPA National Ambient Air Quality Standards (NAAQS)

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3-month average	0.15 μg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution [71 FR 61144, Oct 17, 2006]	$PM_{2.5}$	primary and secondary	Annual	15 μg/m^3	Annual mean, averaged over 3 years
			24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
[38 FR 25678, Sept 14, 1973]		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Source: EPA 2011b.

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 μg/m^3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, for which the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Table 2.5-17 Nebraska and South Dakota Ambient Air Monitoring Network Near Marsland Expansion Area

Site	Operating Agency	Location			Parameters Monitored	Monitoring Objective	Distance from MEA [c]
		State	County	Coordinates [o]			
Wind Cave National Park	SD DENR	SD	Custer	UTM Zone 13, NAD 83 E 622,471.56 N 4,823, 856.93	PM_{10} $PM_{2.5}$ SO_2 NO_2 Ozone	Background (Regional) Pollutant Transport	70 miles
Badlands National Park	SD DENR	SD	Jackson	UTM Zone 14, NAD 83 E 263, 173.81 N 4,847, 799.95	PM_{10} $PM_{2.5}$ SO_2 NO_2 Ozone	$PM_{2.5}$: Regional Others: Background (Regional) and Pollutant Transport	107 miles
Black Hawk	SD DENR	SD	Meade	UTM Zone 13, NAD 83 E 634,683.07 N 4,890, 309.65	PM_{10} Ozone	PM_{10}: Population and Urban Background Ozone: Population and High Concentration	110 miles
Agate Fossil Beds [a]	National Park Service	NE	Sioux	42.429300 -103.729400	Ozone	Background (regional)	23 miles
Scottsbluff (Library) [b]	NDEQ	NE	Scotts Bluff	41.865000 -103.664444	$PM_{2.5}$	Background (Regional) Population (Closed)	45 miles
Scottsbluff (Senior High School)	NDEQ	NE	Scotts Bluff	40.942099 -98.364967	$PM_{2.5}$	Background (Regional) Population	45 miles
Rapid City National Guard	SD DENR	SD	Pennington	UTM Zone 13, NAD 83 E 638,543.08 N 4,882, 373.72	PM_{10}	Population High Concentration	105 miles
Rapid City Credit Union	SD DENR	SD	Pennington	UTM Zone 13, NAD 83 E 638,199.75 N 4,882, 811.92	$PM_{2.5}$ PM_{10}	Background (Regional) Population	105 miles

Sources: NDEQ 2009; SD DENR 2011

[a] data not suitable for NAAQS compliance determination – only for general trend information.

[b] closed May 11, 2009; replaced by monitors at Scottsbluff Senior High School

[c] Distances are approximate measured to the nearest license boundary of the Marsland Expansion Area.

Note: Clarification of mining objectives:

- **Background Level** monitoring is used to determine general background levels of air pollutants. This can be applied to regions, neighborhoods, and urban areas.
- **High Concentration** monitoring is conducted at sites to find the highest concentration of an air pollutant in an area within a given monitoring network. A monitoring network may have multiple high concentration sites as a result of varying meteorology, source area variability, etc.
- **Population Exposure** monitoring is conducted to represent the air pollutant concentrations to which a populated area is exposed.
- **Pollutant Transport** is the movement of pollutant(s) between air basins or areas within an air basin. Pollutant transport monitoring is used to assess and address sources from upwind areas when those transported pollutant(s) affect neighboring downwind areas. Transport monitoring can also be used to determine the extent of regional pollutant transport.

Table 2.5-18 Comparison of Ambient Particulate Matter (PM_{10}) Monitoring Data for Regional Monitoring Sites

Site	2006	2007	2008	2009	2010	3-Year Average	Attainment with NAAQS[a]
PM_{10} Annual Averages for Monitoring Sites							
Wind Cave, SD	7	7	10	9	8	9	[b]
Badlands, SD	9	9	12	7	8	11	[b]
Black Hawk, NE	15	16	18	16	14	16	[b]
Rapid City, SD (National Guard)	27	29	32	26	30	28	[b]
Second Highest 24-Hour Concentration							
Wind Cave, SD	26	43	47	141	67	80	Yes
Badlands, SD	30	40	56	32	31	40	Yes
Black Hawk, NE	47	42	36	34	29	33	Yes
Rapid City, SD (National Guard)	91	89	84	65	73	74	Yes

Source: SD DENR 2011.

[a] Standard of 150 $\mu g/m^3$ is not to be exceeded more than once per year on average over 3 years.

[b] Annual PM_{10} standard was revoked by the USEPA in 2006 and later removed by the states of Nebraska and South Dakota.

Table 2.5-19 PM_{10} Annual Average Monitoring Data for South Dakota Monitoring Sites

Year	Wind Cave		Badlands		Black Hawk		Rapid City (National Guard)	
	Annual Average	Maximum 24-Hour Average	Annual Average	Maximum 24-Hour Average	Annual Average	Maximum 24-Hour Average	Annual Average	Maximum 24-Hour Average
	$\mu g/m^3$							
1992	--	--	--	--	--	--	37	No Data
1993	--	--	--	--	--	--	34	No Data
1994	--	--	--	--	--	--	39	No Data
1995	--	--	--	--	--	--	33	No Data
1996	--	--	--	--	--	--	35	No Data
1997	--	--	--	--	--	--	41	No Data
1998	--	--	--	--	--	--	31	87
1999	--	--	--	--	--	--	28	117
2000	--	--	12	39	--	--	32	97
2001	--	--	12	48	21	70	35	82
2002	--	--	10	26	19	77	34	105
2003	--	--	16	74	21	77	36	92
2004	--	--	10	24	20	42	35	72
2005	7	32	9	40	15	52	27	94
2006	7	28	9	30	16	50	29	124
2007	10	44	12	50	18	42	32	93
2008	9	47	11	56	16	36	26	124
2009	9	141	7	32	16	34	26	124
2010	8	67	8	31	14	29	30	97

Source: EPA 2011a; SD DENR 2011.
Note: Standard of 150 $\mu g/m^3$ is not to be exceeded more than once per year on average over 3 years.

Table 2.5-20 $PM_{2.5}$ Annual Average Monitoring Data for Regional Monitoring Sites

Year	Wind Cave		Badlands		Black Hawk		Rapid City (National Guard)		Scottsbluff	
	Annual Average	Maximum 24-Hour Average	Annual Average	Maximum 24-Hour Average	Annual Average	Maximum 24-Hour Average	Annual Average	Maximum 24-Hour Average	Annual Average	Maximum 24-Hour Average
	$\mu g/m^3$									
1998	--	--	--	--	--	--	--	--	--	--
1999	--	--	--	--	--	--	--	--	8.17	32.0
2000	--	--	5.38	13.9	--	--	7.94	29.5	6.31	21.8
2001	--	--	5.60	12.7	6.09	23.2	8.44	24.5	6.21	16.9
2002	--	--	5.15	15.1	6.29	35.5	7.73	26.7	5.69	19.8
2003	--	--	5.77	24.0	6.38	26.6	7.71	21.2	6.10	23.0
2004	--	--	5.25	13.5	6.29	24.4	8.09	13.6	5.69	15.4
2005	5.4	16.2	5.35	15.4	--	--	8.6 [a]	--	5.28	20.1
2006	5.3	16.5	5.38	15.7	--	--	9.3 [a]	--	5.76	27.3
2007	6.2	22.4	5.49	18.7	--	--	8.3 [a]	--	7.10	19.8
2008	4.9	41.6	5.2	51.2	--	--	7.7 [a]	--	6.77	31.1
2009	4.7	--	4.0	--	--	--	6.7 [a]	--	5.13	--
2010	4.7	--	3.9	--	--	--	6.6 [a]	--	5.27 [b]	--

Source: NDEQ 2011; SD DENR 2011; EPA 2011a and b.

-- data not available.

[a] New monitor location for determination of $PM_{2.5}$ compliance in Rapid City, SD (Rapid City Credit Union).

[b] Scottsbluff site was relocated from 1809 3rd Street (shut down on 5/11/2009) to Scottsbluff High School at Highway 26 and 5th Street (start-up on 5/13/2010). Combined data for both sites is presented here.

Table 2.5-21 Comparison of Ambient Particulate Matter ($PM_{2.5}$) Monitoring Data for Regional Monitoring Sites

Site	2006	2007	2008	2009	2010	3-Year Average	Attainment with NAAQS
	$\mu g/m^3$						
Comparison of 98th Percentile, 24-Hour Concentrations for $PM_{2.5}$ to NAAQS [a]							
Wind Cave, SD	12.2	17.5	10.8	9.6	12.4	14.0	Yes
Badlands, SD	12.2	12.4	12.8	10.4	13.6	13.0	Yes
Scottsbluff, NE	19.0	17.7	19.3	12.0	14.0	15.1	Yes
Rapid City, SD (Credit Union)	--	--	18.7	14.3	14.0	15.7	Yes
Comparison of 3-Year Annual Averages for $PM_{2.5}$ to NAAQS [b]							
Wind Cave, SD	5.3	6.2	4.9	4.7	4.7	5.5	Yes
Badlands, SD	5.3	5.5	5.2	4.0	3.9	5.3	Yes
Scottsbluff, NE [c]	5.76	7.10	6.77	5.13	5.27	6.68	Yes
Rapid City, SD (National Guard)	--	--	--	--	--	--	--

[a] To determine attainment status, the 3-year average of the annual 98th percentile value is compared to the 35 $\mu g/m^3$ NAAQS. The 98th percentile value is higher than 98 percent of 24-hour values for the year.

[b] To determine attainment status, the 3-year average of the annual averages is compared to the 15 $\mu g/m^3$ NAAQS.

[c] Scottsbluff site was relocated from 1809 3rd Street (shut down on 5/11/2009) to Scottsbluff High School at Highway 26 and 5th Street (start-up on 5/13/2010). Combined data for both sites is presented here.

Table 2.5-22 Comparison of Sulfur Dioxide Values for Wind Cave and Badlands, SD Monitor Sites

Monitor Site	SO_2 Annual Average Concentration	SO_2 1-Hour Design Values (Effective in 2010)		
		99th Percentile Concentration	3-Year Average	Attainment Status
	parts per billion (ppb)			
Wind Cave				
2005	0.4	--	--	
2006	0.8	--	--	
2007	0.4	--	--	
2008	0.2	3	6	Yes
2009	0.5	10		
2010	2.6	5		
Badlands				
2005	3.0			
2006	2.1			
2007	2.4			
2008	1.3	5	6	Yes
2009	0.8	5		
2010	3.3	9		

SD DENR Standards: 1-hour standard at 75 ppb; 24-hour and annual SO_2 standards revoked. Note: Compliance is met when the 99th percentile daily maximum 1-hour SO_2 concentration, averaged over 3 years, does not exceed 70 ppb. The 3-year averages shown above are used to evaluate compliance with the sulfur dioxide standard.

Table 2.5-23 Comparison of Nitrogen Dioxide 1-Hour 98th Percentile Concentrations for Wind Cave and Badlands, SD

Site	98th Percentile Concentration	3-Year Average	Attainment Status
	parts per billion (ppb)		
Wind Cave			
2008	3	3	Yes
2009	3		
2010	3		
Badlands			
2008	4	4	Yes
2009	4		
2010	5		

Source: SD DENR 2011

Table 2.5-24 Comparison of Nitrogen Dioxide Annual Average Values for Wind Cave and Badlands, SD Monitor Sites

Monitoring Site	2005	2006	2007	2008	2009	2010
	parts per billion (ppb)					
Wind Cave	0.8	0.9	1.1	0.2	0.6	0.2
Badlands	1.3	1.2	0.5	0.8	0.5	0.5

SD DENR Standards: Nitrogen Dioxide: 0.053 ppm (annual mean)

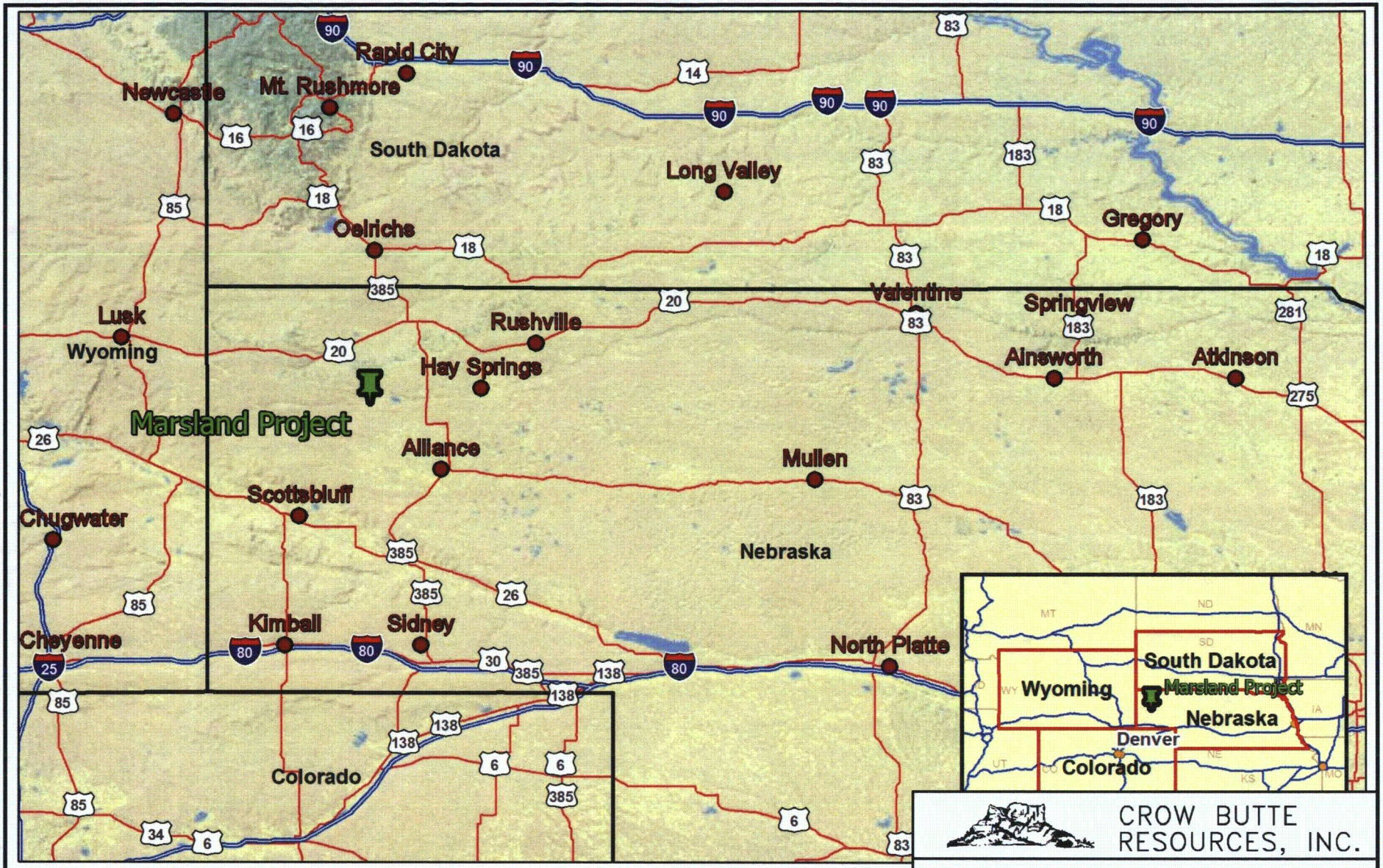
Table 2.5-25 Ozone Yearly 4th Highest 8-Hour Averages for Regional Monitoring Sites [a, b]

Location	2003	2004	2005	2006	2007	2008	2009	2010	3-Year Average (2008–2010)	Attainment Status [c]
	parts per million (ppm)									
Wind Cave, SD	ND	ND	0.070	0.073	0.069	0.059	0.062	0.059	0.060	Yes
Badlands, SD	0.067	0.063	0.069	0.071	0.064	0.053	0.055	0.058	0.055	Yes
Black Hawk, SD	ND	ND	ND	ND	0.053	0.060	0.058	0.057	0.058	Yes
Agate Fossil Beds [d]	ND	ND	ND	ND	0.066	0.067	0.062	ND	0.066	--

[a] The design value is the 3-year average of the 4th highest maximum for each year. The 4th highest 8-hour average is used to evaluate compliance with the ozone standard.
[b] NAAQS = 0.075 ppm (8-hour average). Standard promulgated 3/27/2008. The EPA has proposed new standards for ozone that are expected to lower the standards to between 60 and 70 ppb (action is currently pending).
[c] Attainment status is for the current standard of 0.075 ppm.
[d] The ozone monitor at the Agate Fossil beds operated by the National Park Service does not generate data acceptable for determinations of NAAQS compliance (for general reference only).
ND = No data

Table 2.5-26 Prevention of Significant Deterioration (PSD) of Air Quality Allowable Increments

Pollutant	Averaging Time	PSD Increment µg/m3	
		Class I	Class II
Particulate Matter (PM_{10})	24-Hour Maximum	8	30
	Annual Arithmetic Mean	4	17
Sulfur Dioxide (SO_2)	24-Hour Maximum	5	91
	3-Hour Maximum	25	512
	Annual Arithmetic Mean	2	20
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	2.5	25



Climate Met Stations

NWS ASOS/COOP

Project Site

0 15 30 60 Miles

N W E S

Source: Inter-Mountain Lab (IML) Air Science, 2011

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FIGURE 2.5-1
MARSLAND PROJECT
MET STATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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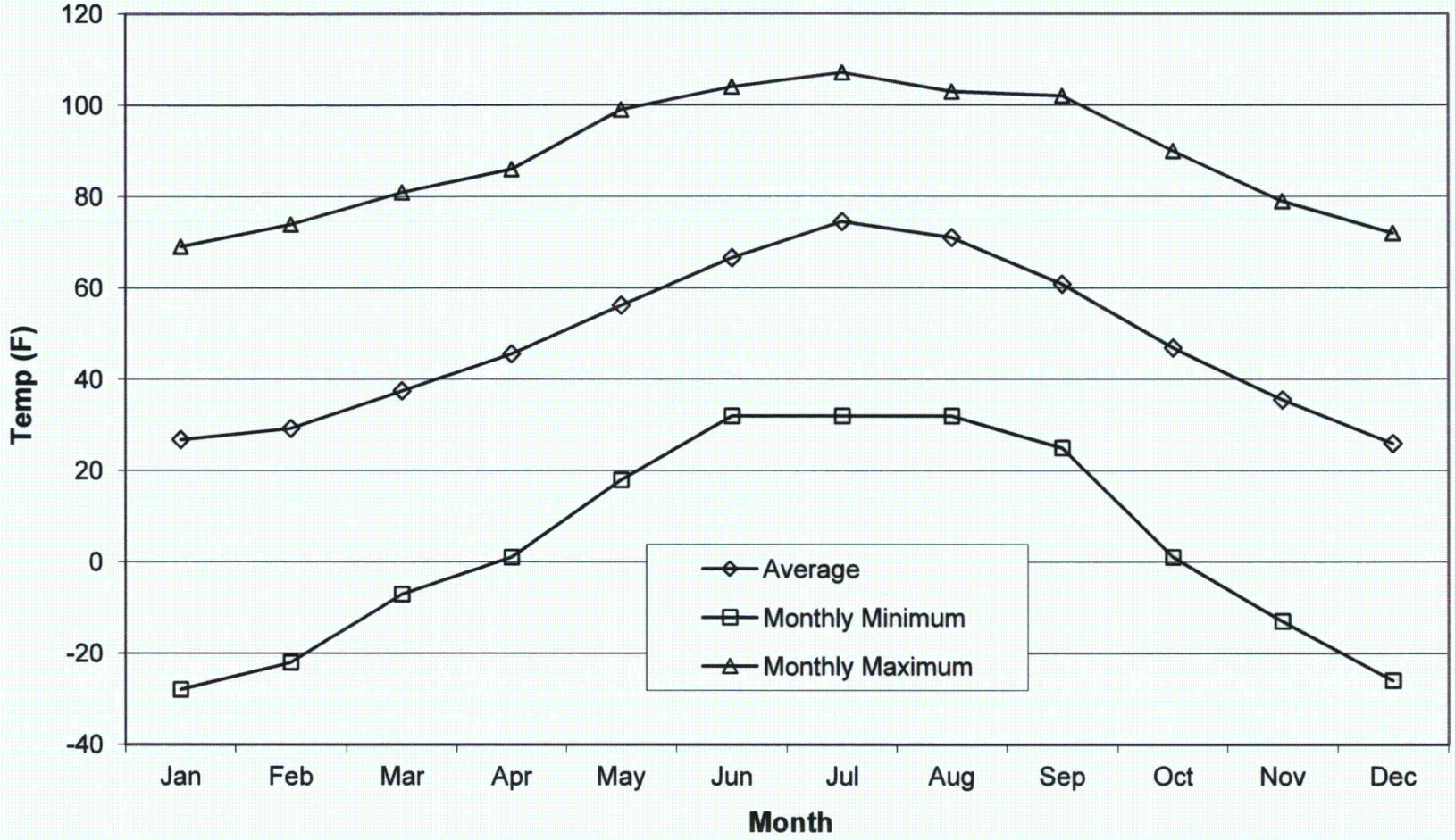
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_5-1 Marsland Project Met Stations.ai @ 10/17/2011



Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

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FIGURE 2.5-2
SCOTTSBLUFF AP
MONTHLY TEMPERATURES

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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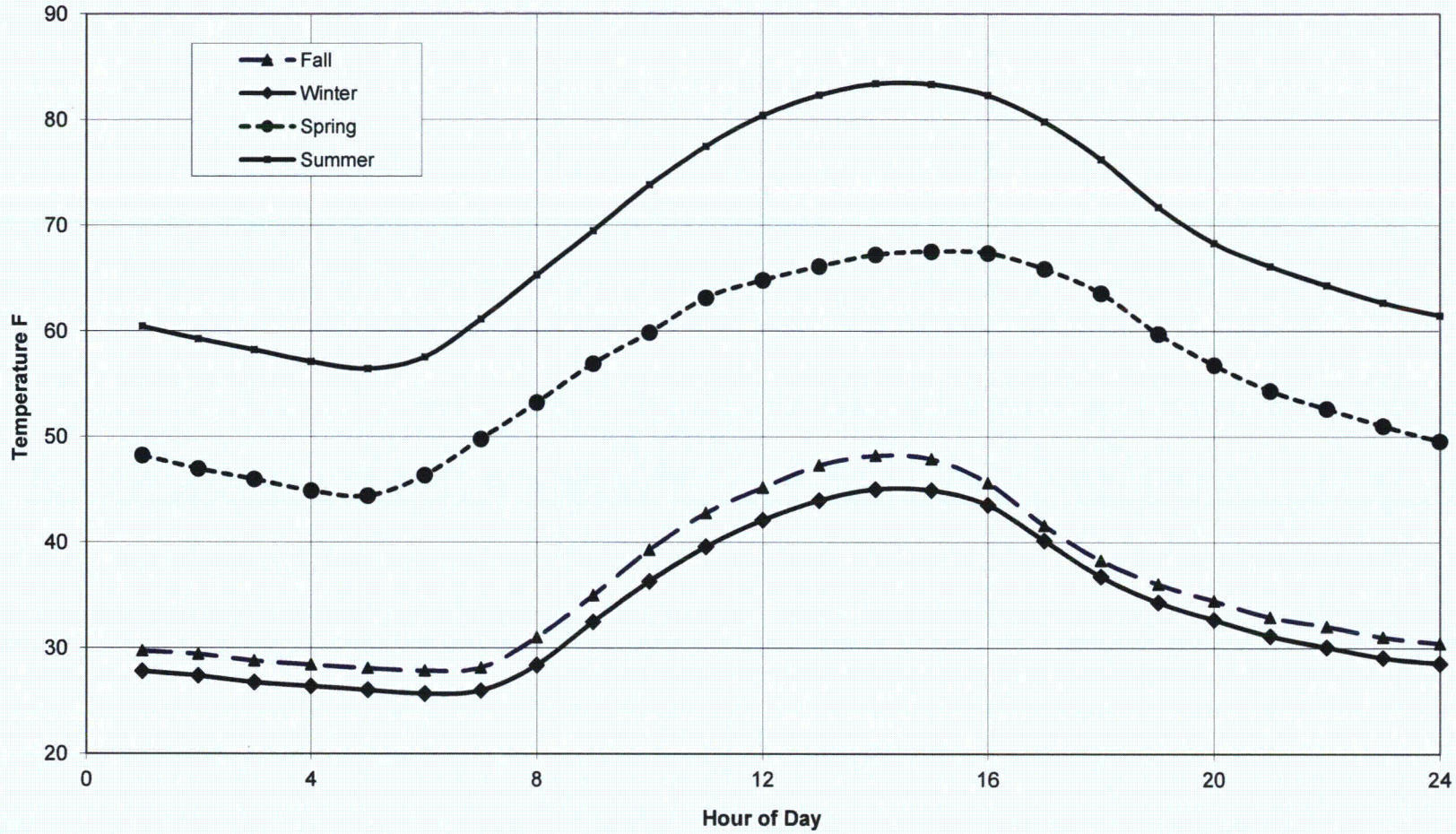
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_5-2 Scottsbluff AP Monthly Temp.ai @ 11/08/2011



Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

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FIGURE 2.5-3
SCOTTSBLUFF AP SEASONAL DIURNAL TEMPERATURE VARIATIONS

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K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_5-3 Scottsbluff AP Seasonal Diurnal Temp Variation.ai @ 11/08/2011