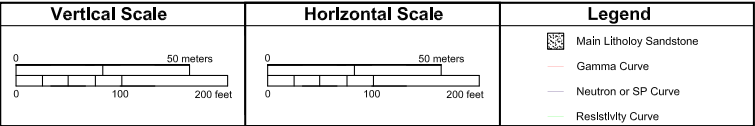
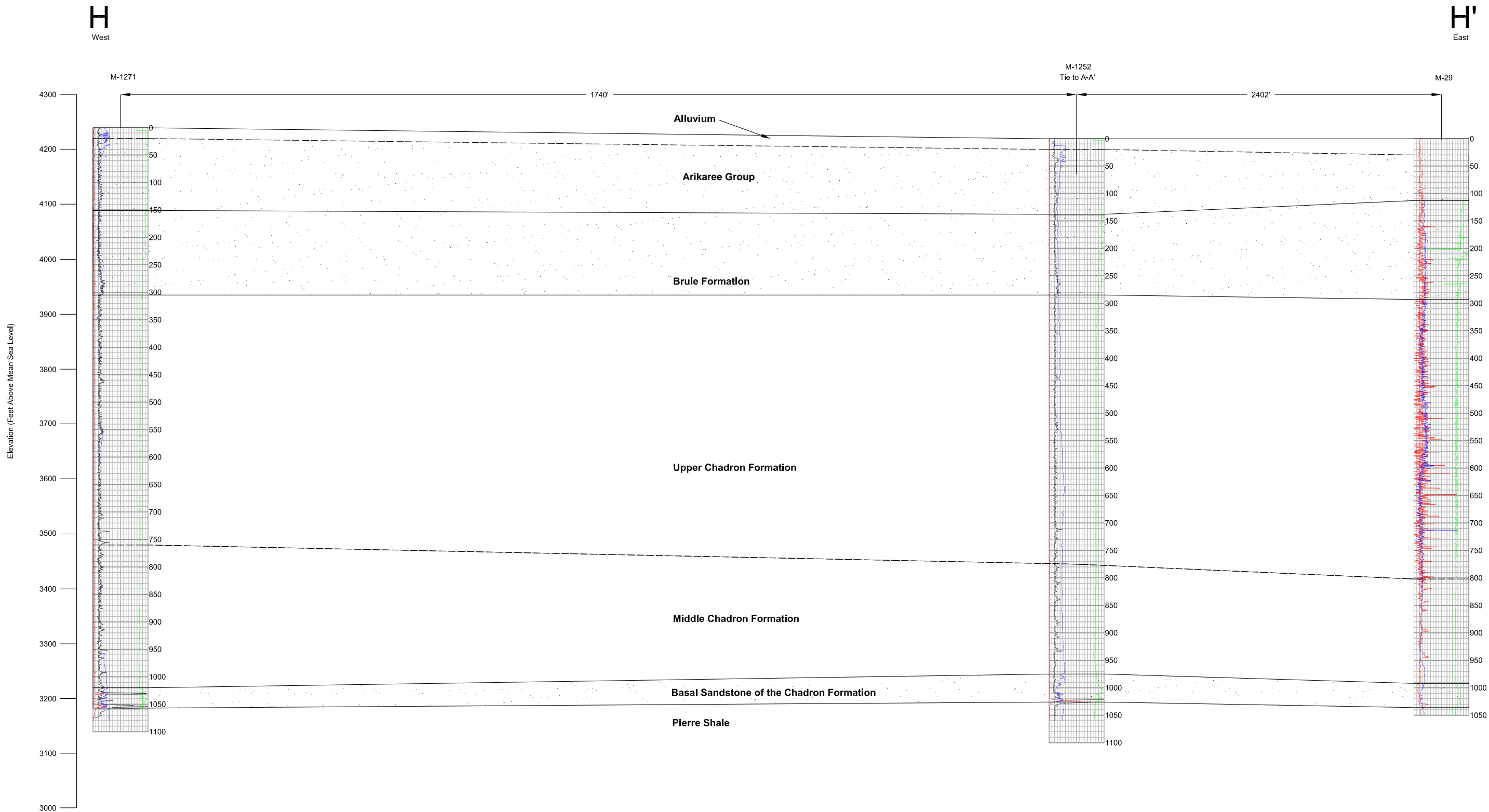



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Source: Cameco Resources, 2013




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**FIGURE 3.3-3h**  
**MARSLAND STRUCTURAL**  
**CROSS-SECTION H-H'**

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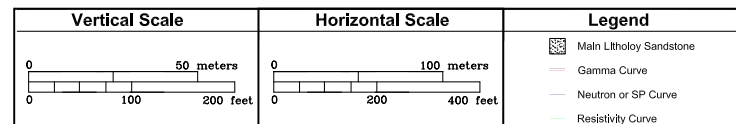
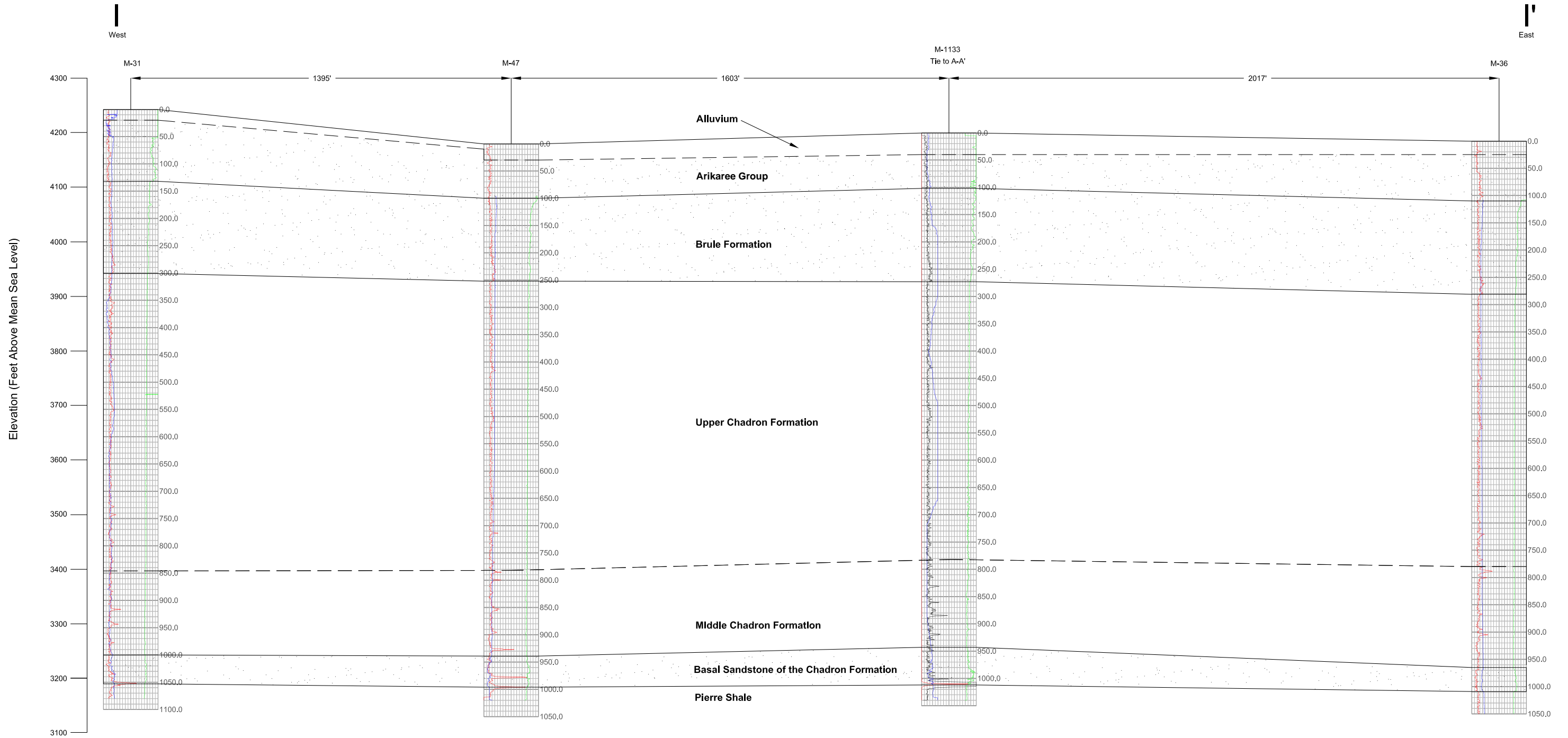
## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-3i Marshland Structural Cross Section I – I'**

PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4\XS I-I.ai @ 10/24/2013 SOURCE FILE: 1\_ACAD\CrossSections\_fromCameco\_Oct2013\Figure E-1-31-I-I.dwg



Source: Cameco Resources, 2013



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**FIGURE 3.3-3i**  
**MARSLAND STRUCTURAL**  
**CROSS-SECTION I-I'**

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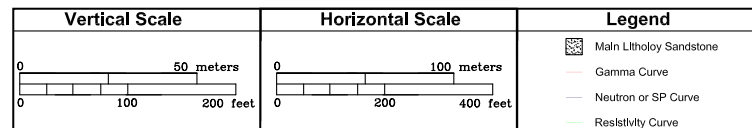
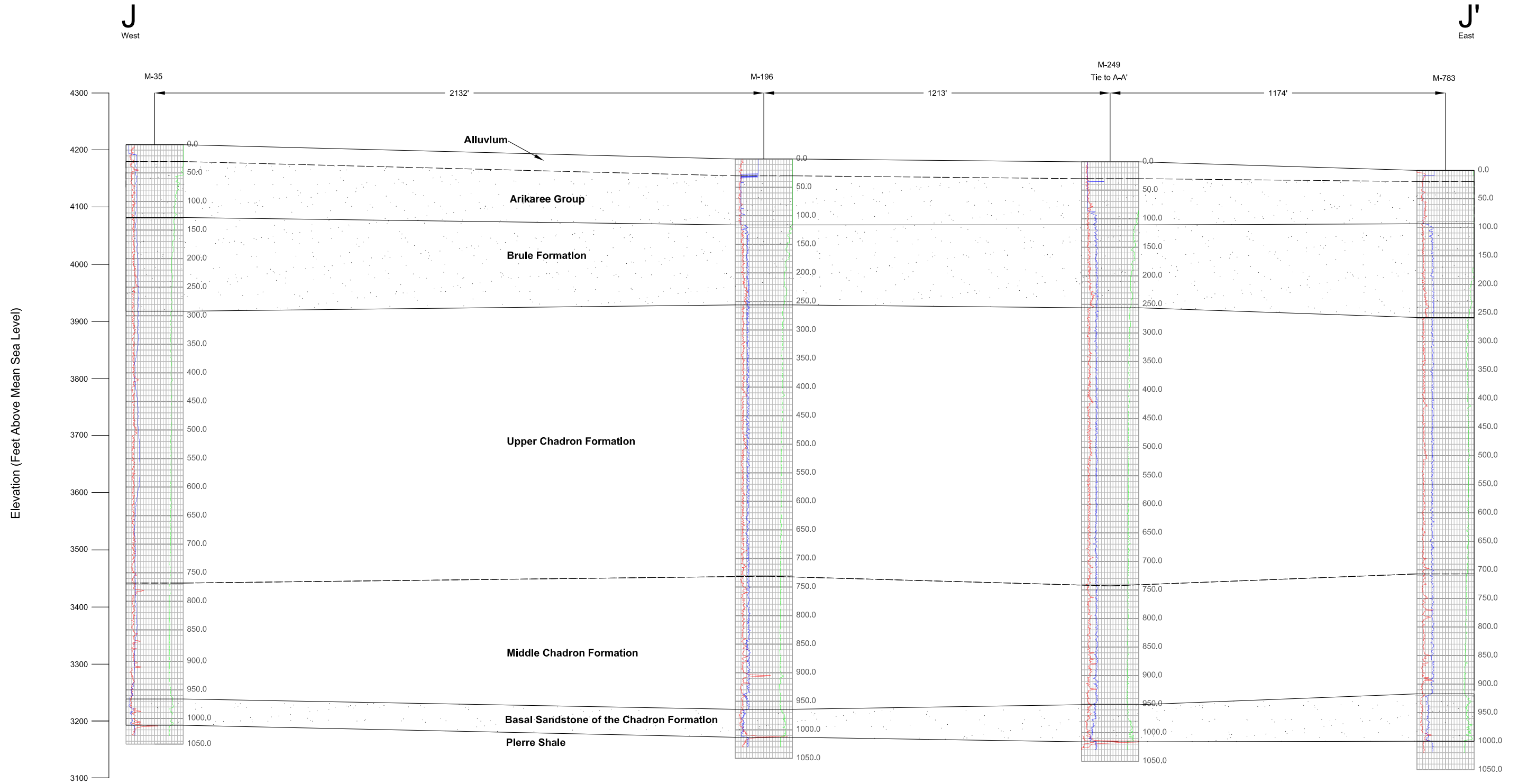
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**Figure 3.3-3j Marshland Structural Cross Section J – J'**



PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4j XS JJ. ai @ 10/24/2013 SOURCE FILE: I:\ACAD\CrossSections\_fromCameco\_Od2013\Figure E 1-3j J-J'.dwg



Source: Cameco Resources, 2013



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**FIGURE 3.3-j**  
**MARSLAND STRUCTURAL**  
**CROSS-SECTION J-J'**

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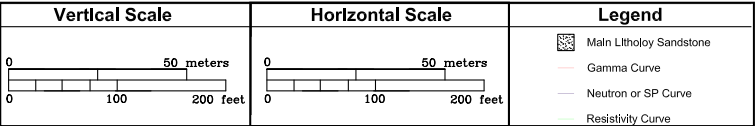
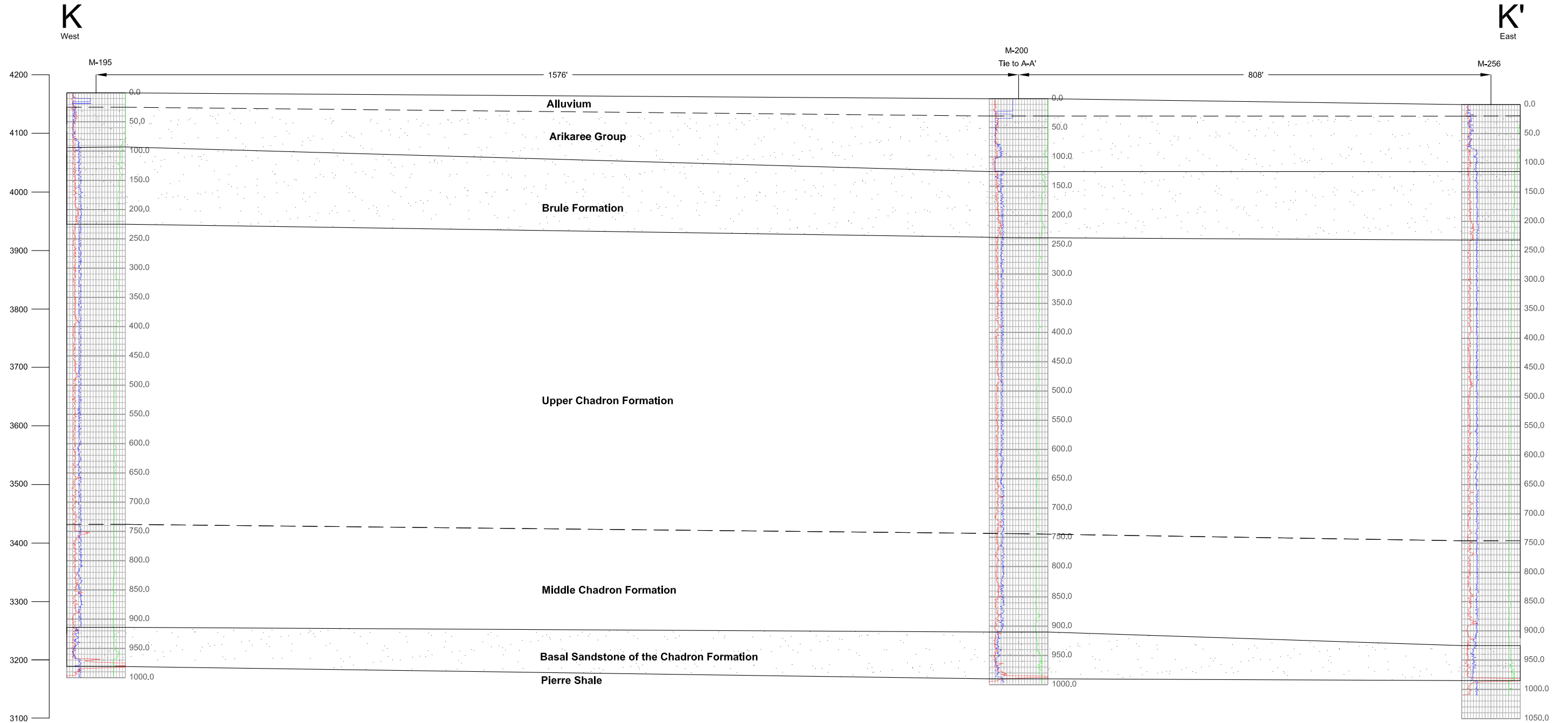
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**Figure 3.3-3k Marshland Structural Cross Section K – K'**

PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4k XS KK.ai @ 10/24/2013 SOURCE FILE: 1\_ACAD\CrossSections\_fromCameco\_Oct2013\Figure E-3k-K-K'.dwg

Elevation (Feet Above Mean Sea Level)



Source: Cameco Resources, 2013




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**FIGURE 3.3-3k**  
**MARSLAND STRUCTURAL**  
**CROSS-SECTION K-K'**

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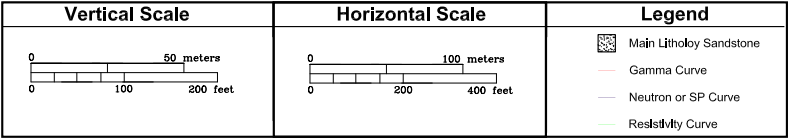
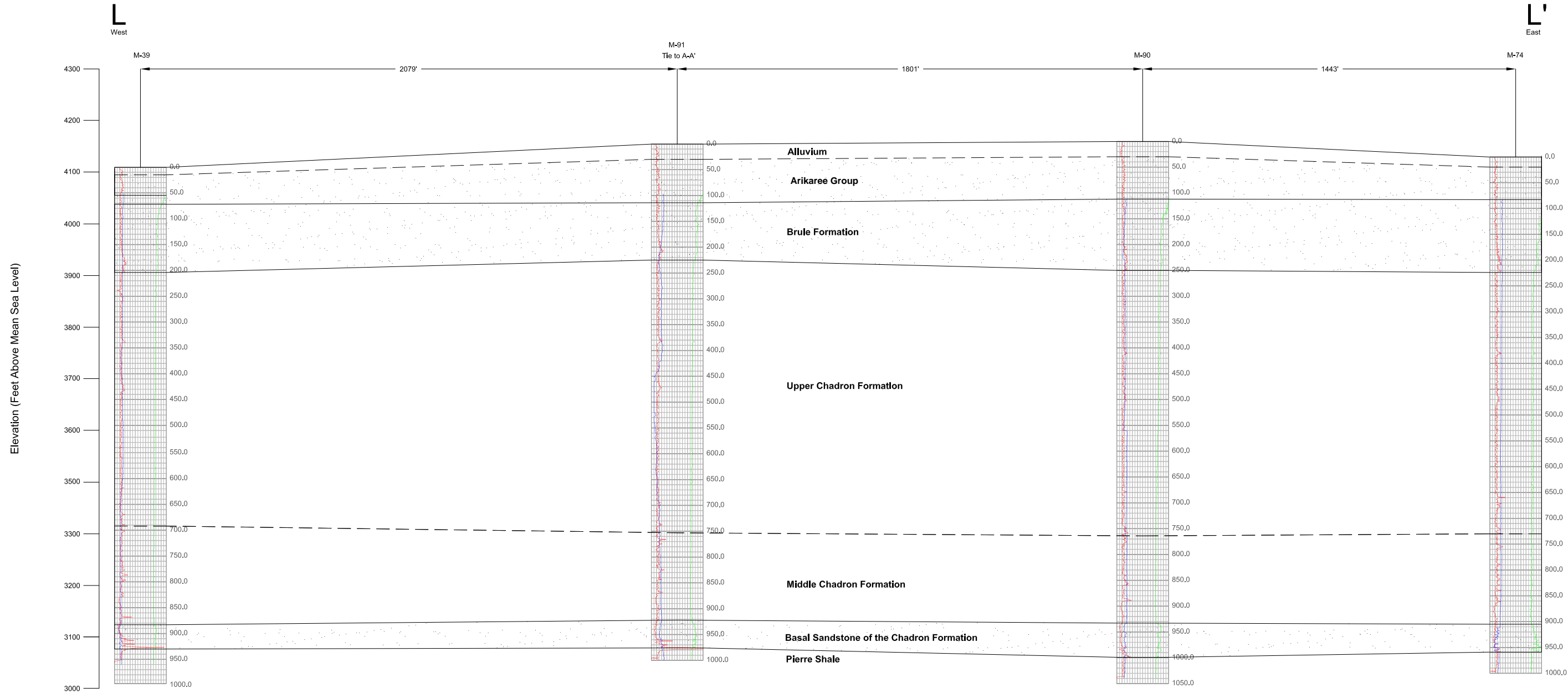
## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-3l Marshland Structural Cross Section L – L'**

PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4\XS.LL.ai @ 10/24/2013 SOURCE FILE: L:\ACAD\CrossSections\_IronCameco\_Oct2013\Figure E-1-3\ L-L.dwg



Source: Cameco Resources, 2013

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**FIGURE 3.3-3I**  
**MARSLAND STRUCTURAL**  
**CROSS-SECTION L-L'**

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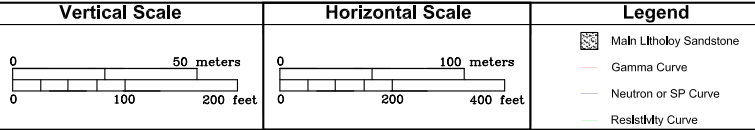
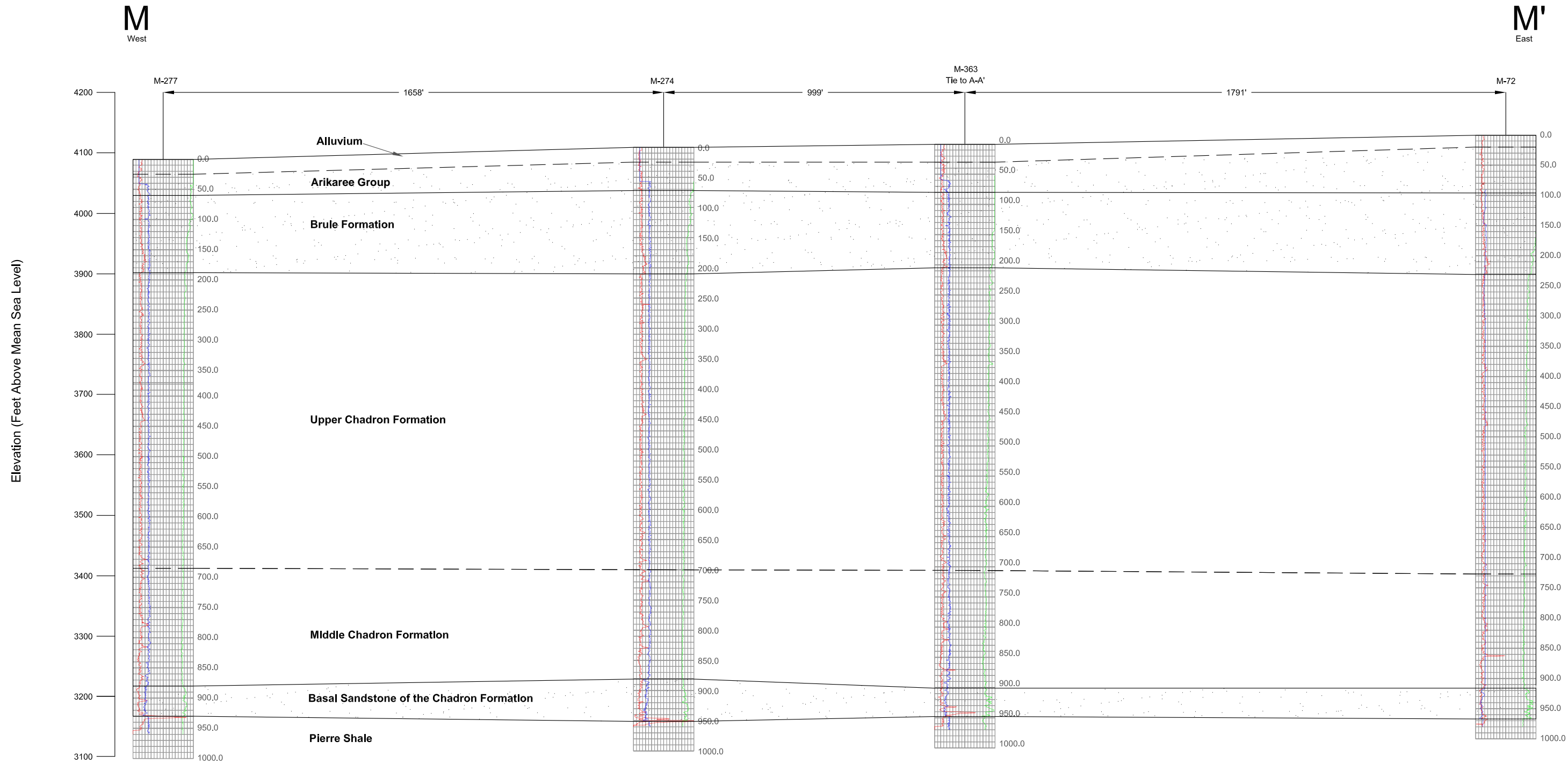
## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-3m Marshland Structural Cross Section M – M'**

PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4m XS MM.ai @ 10/24/2013 SOURCE FILE: I:\ACAD\CrossSections\_fromCameco\_Od2013\Figure E1-3m M-M'.dwg



Source: Cameco Resources, 2013

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**FIGURE 3.3-3m  
MARSLAND STRUCTURAL  
CROSS-SECTION M-M'**

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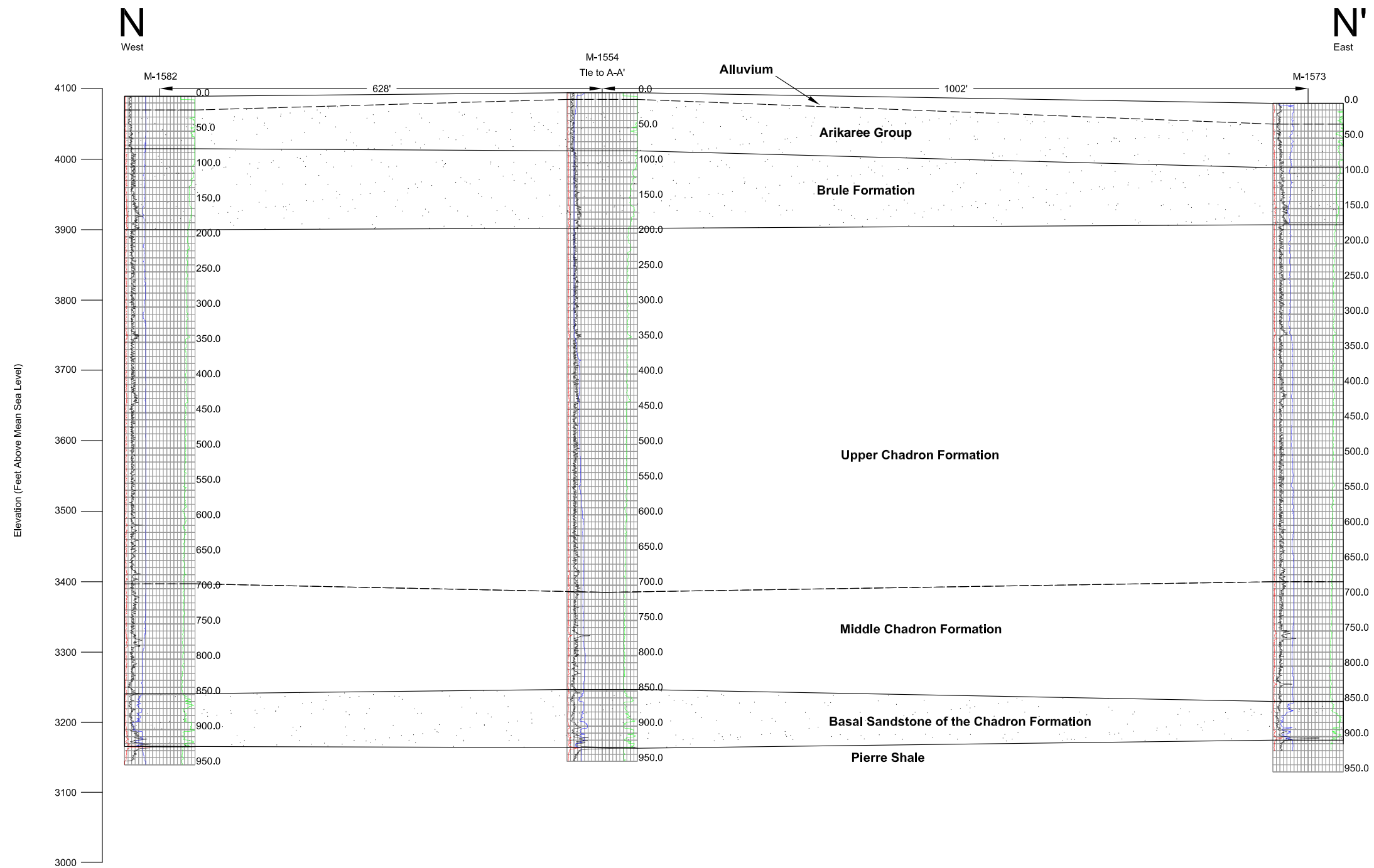
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**Figure 3.3-3n Marshland Structural Cross Section N – N'**



PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-n XS NN. ai @ 10/24/2013 SOURCE FILE: 1\_ACAD\CrossSections\_IronCameco\_Oct2013\Figure E.1-3n N-N'.dwg




Source: Cameco Resources, 2013



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**FIGURE 3.3-3n**  
**MARSLAND STRUCTURAL**  
**CROSS-SECTION N-N'**

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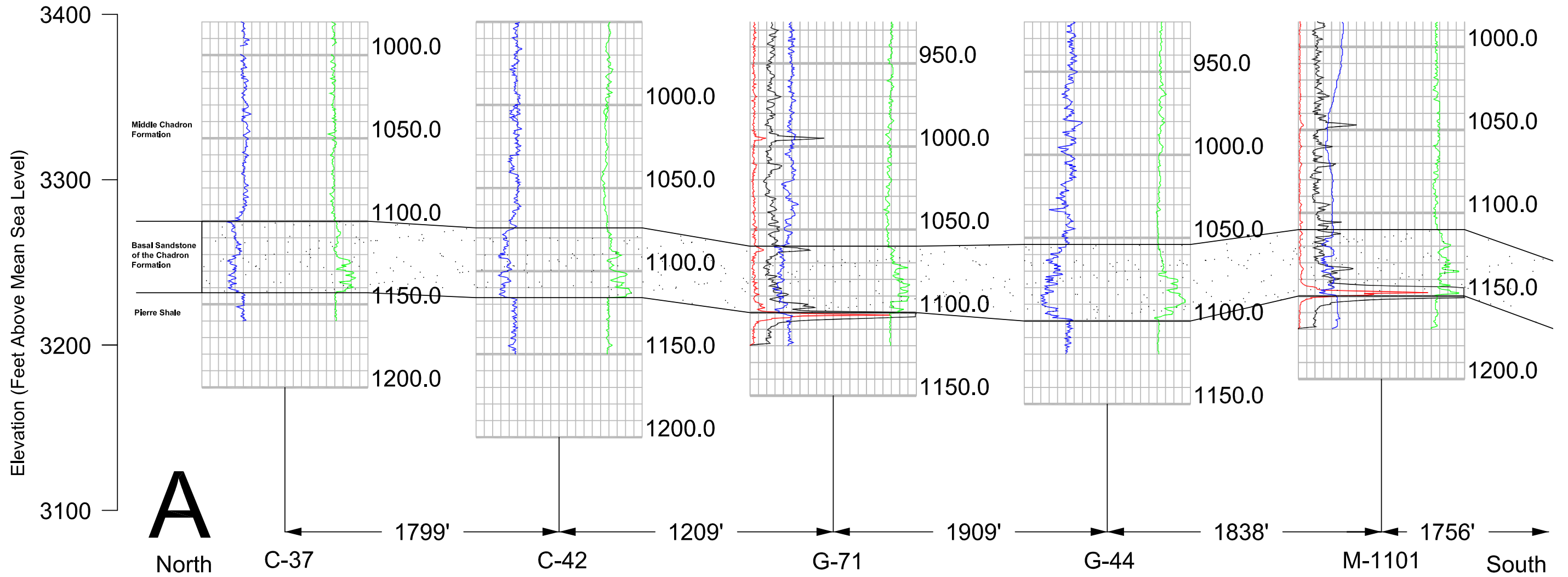
## **Environmental Report Marshland Expansion Area**

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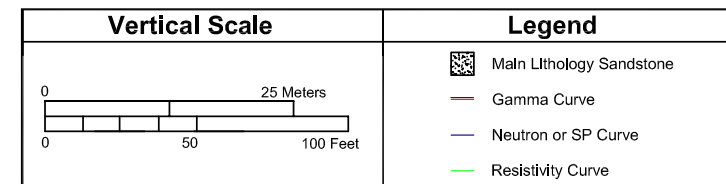
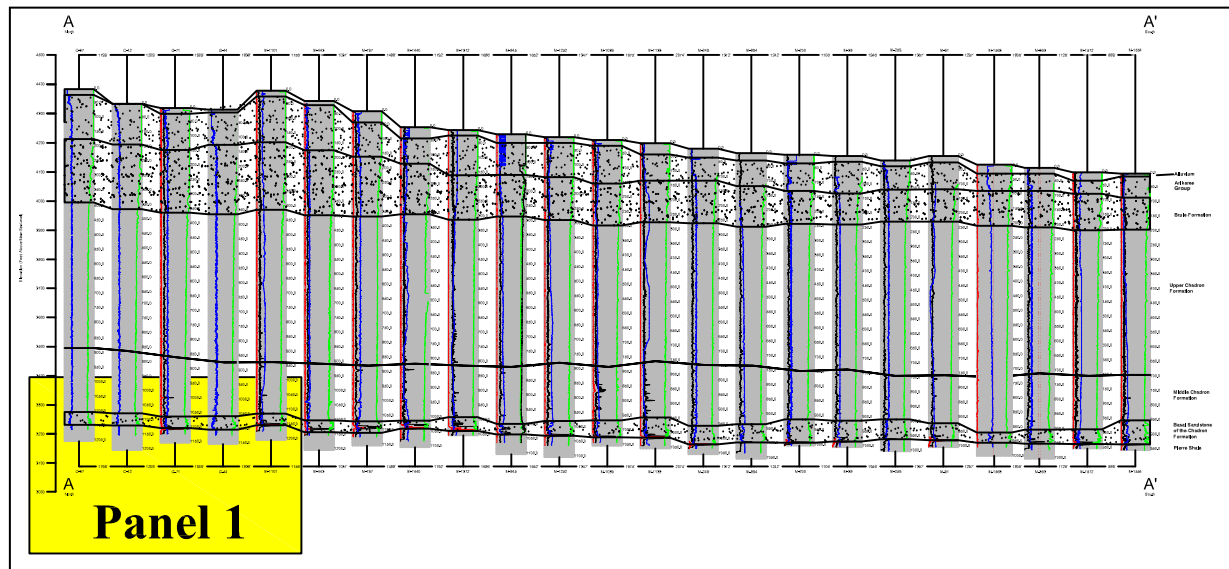


**Figure 3.3-3o Expanded Marshland Structural Cross Section A – A' Panel 1**

PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4o Expanded Marsland Cross Section A-A' Panel 1.ai @ 10/24/2013 SOURCE FILE: L:\ACAD\CrossSections\_Expanded\_Oct182013\Figure E.1-3a\_A-A'ExpandedSections.dwg



CROSS-SECTION PANEL LOCATION



Source: Cameco Resources, 2013



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FIGURE 3.3-3o  
EXPANDED MARSLAND  
CROSS-SECTION A-A'  
PANEL 1

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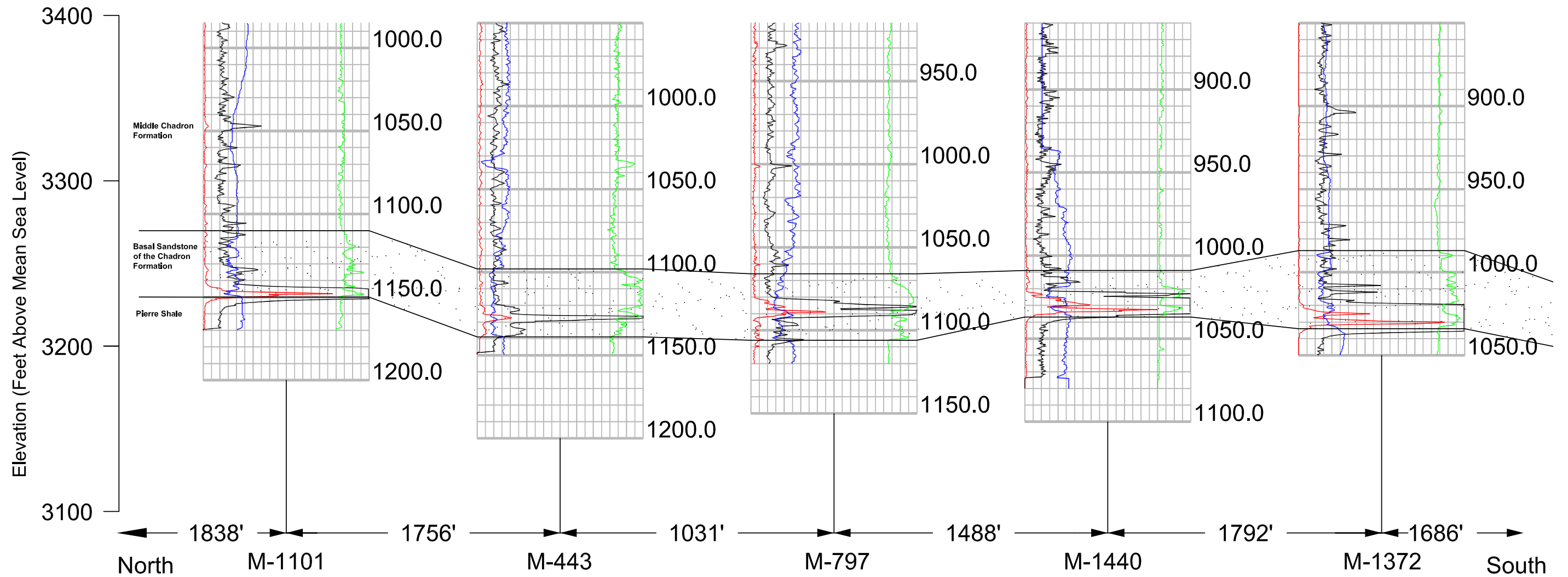
## **Environmental Report Marshland Expansion Area**

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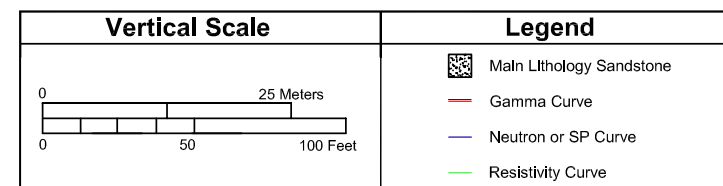
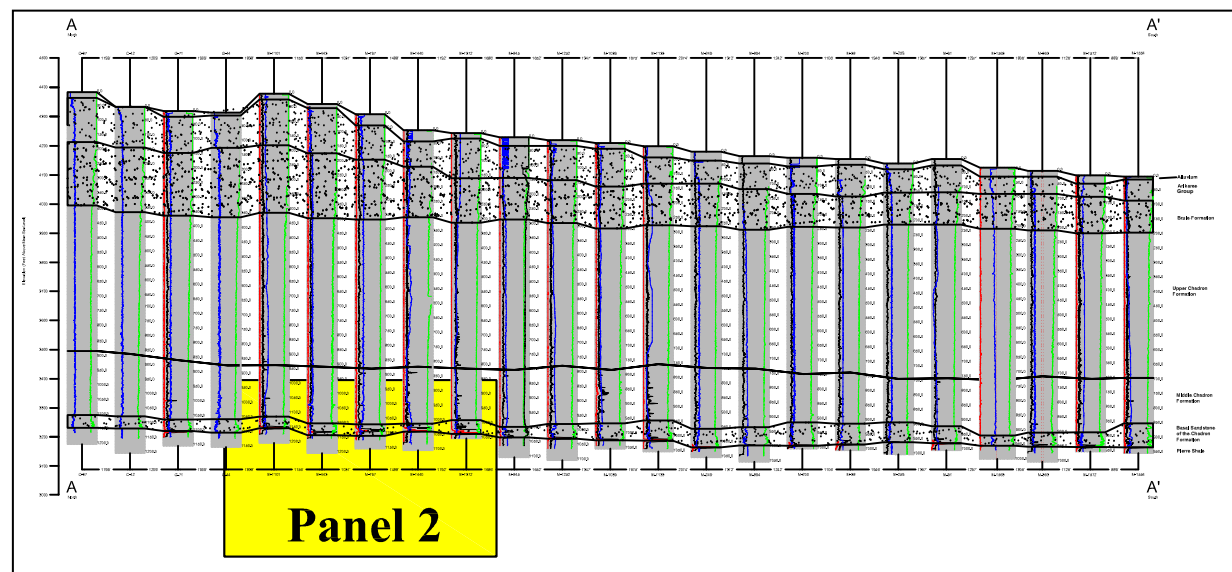


**Figure 3.3-3p Expanded Marshland Structural Cross Section A – A' Panel 2**

PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4p Expanded Marsland Cross Section A-A' Panel 2.ai @ 10/24/2013 SOURCE FILE: L:\ACAD\CrossSections\_Expanded\_Oct182013\Figure E.1-3a\_A-A'ExpandedSections.dwg



CROSS-SECTION PANEL LOCATION



Source: Cameco Resources, 2013



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FIGURE 3.3-3p  
EXPANDED MARSLAND  
CROSS-SECTION A-A'  
PANEL 2

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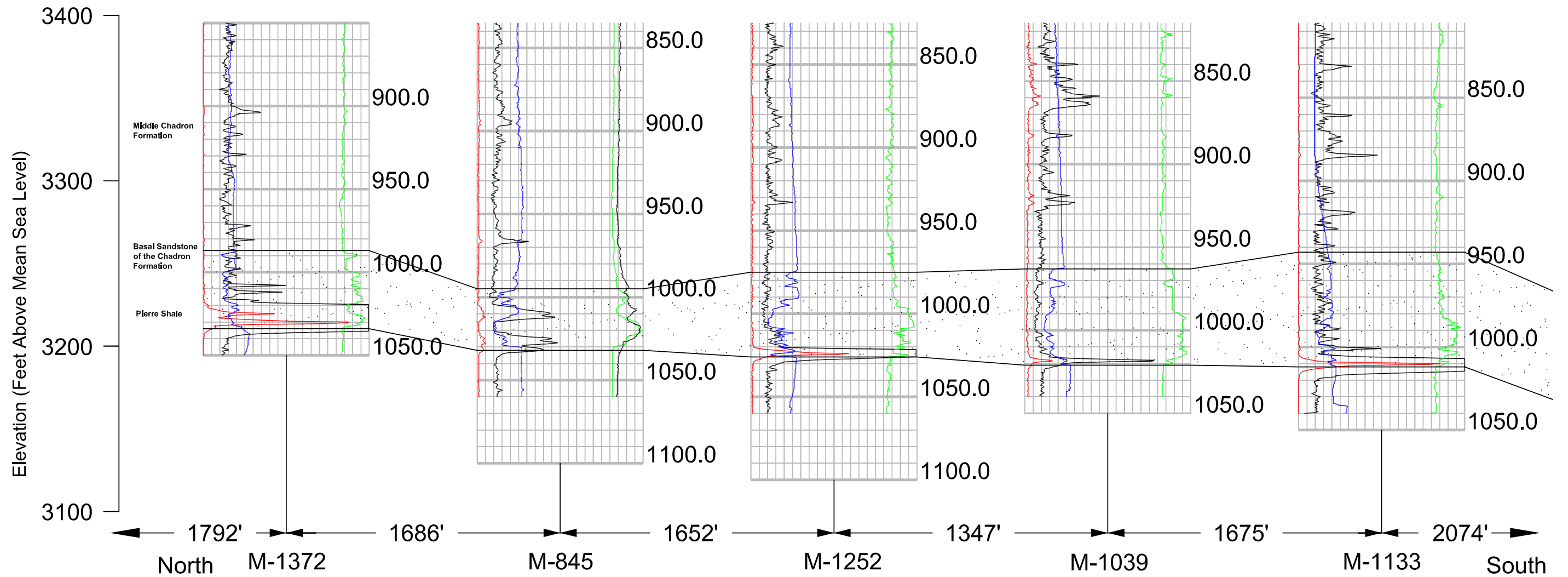
## **Environmental Report Marshland Expansion Area**

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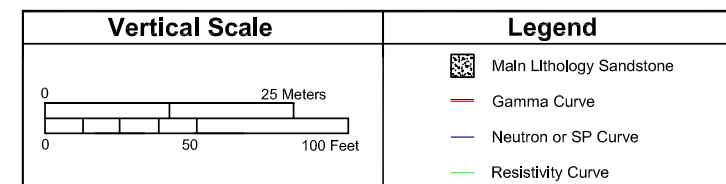
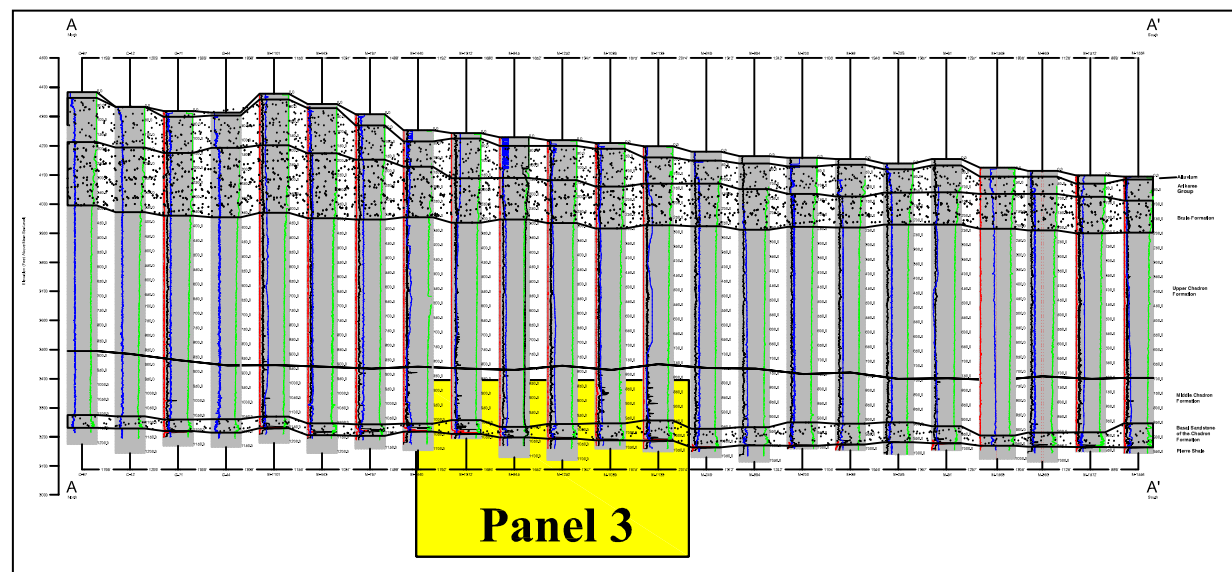


**Figure 3.3-3q Expanded Marshland Structural Cross Section A – A' Panel 3**

PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4q Expanded Marsland Cross Section A-A' Panel 3. at 10/24/2013 SOURCE FILE: L:\ACAD\CrossSections\_Expanded\_Oct182013\Figure E.1-3a\_A-A'ExpandedSections.dwg



CROSS-SECTION PANEL LOCATION



Source: Cameco Resources, 2013



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FIGURE 3.3-3q  
EXPANDED MARSLAND  
CROSS-SECTION A-A'  
PANEL 3

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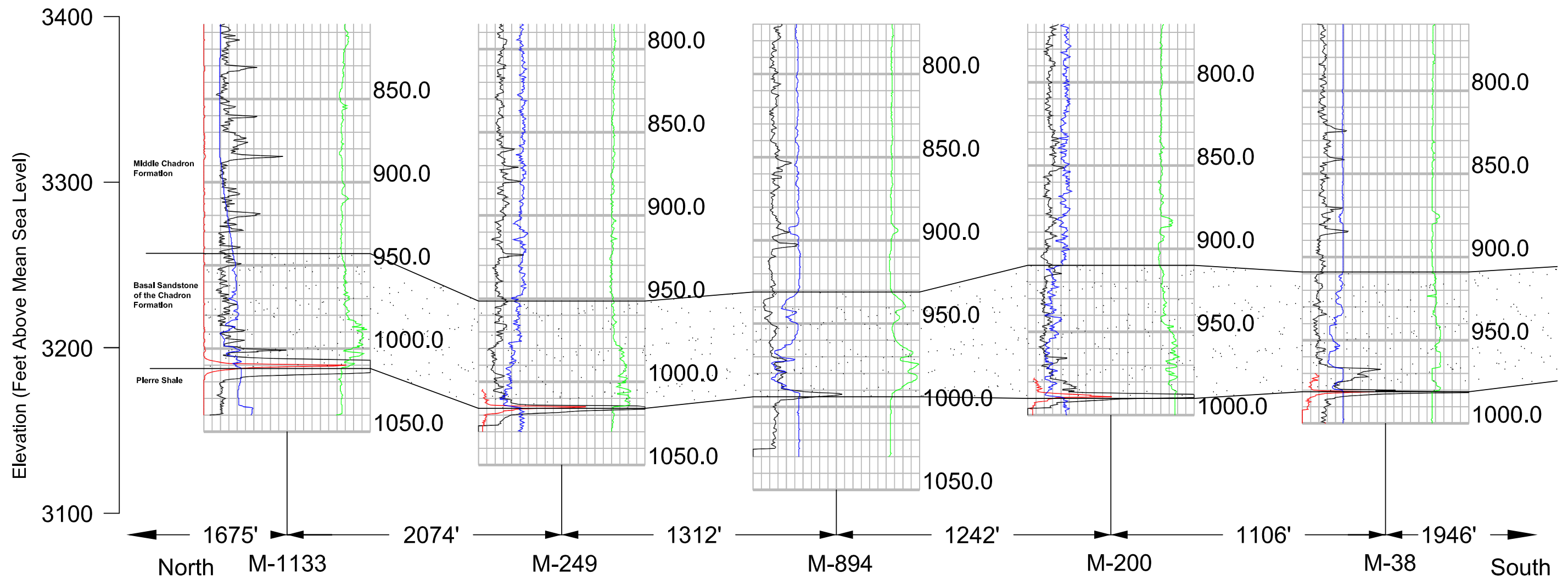
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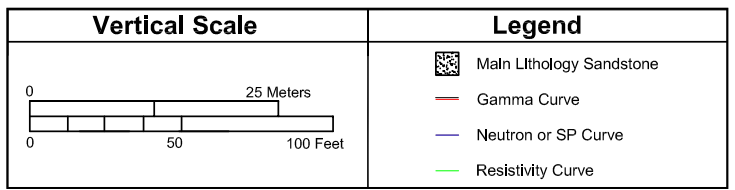
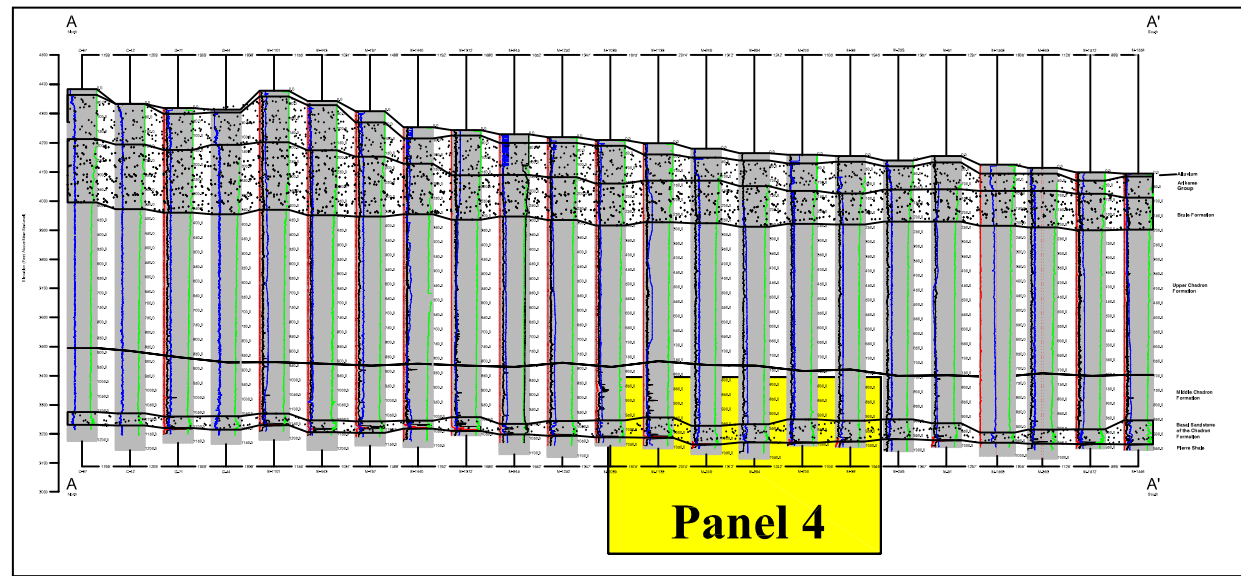
**Figure 3.3-3r Expanded Marshland Structural Cross Section A – A' Panel 4**



PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4r Expanded Marsland Cross Section A-A' Panel 4. ai @ 10/24/2013 SOURCE FILE: 1\_ACAD\CrossSections\_Expanded\_Oct182013\Figure E.1-3a\_A-A'ExpandedSections.dwg



CROSS-SECTION PANEL LOCATION



Source: Cameco Resources, 2013

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**FIGURE 3.3-3r  
EXPANDED MARSLAND  
CROSS-SECTION A-A'  
PANEL 4**

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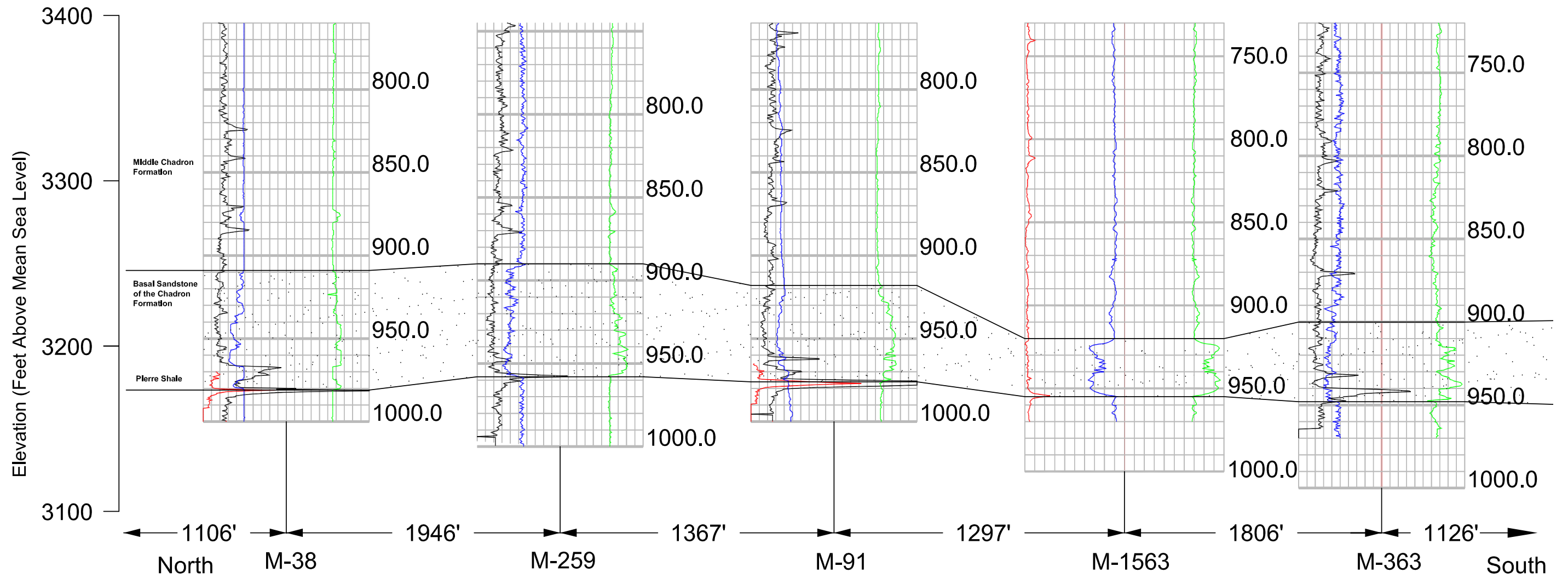
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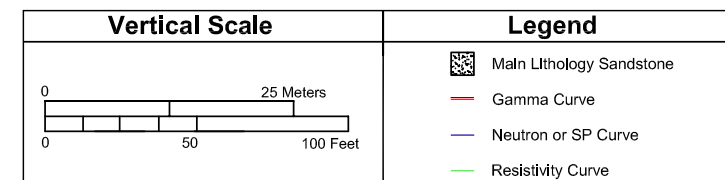
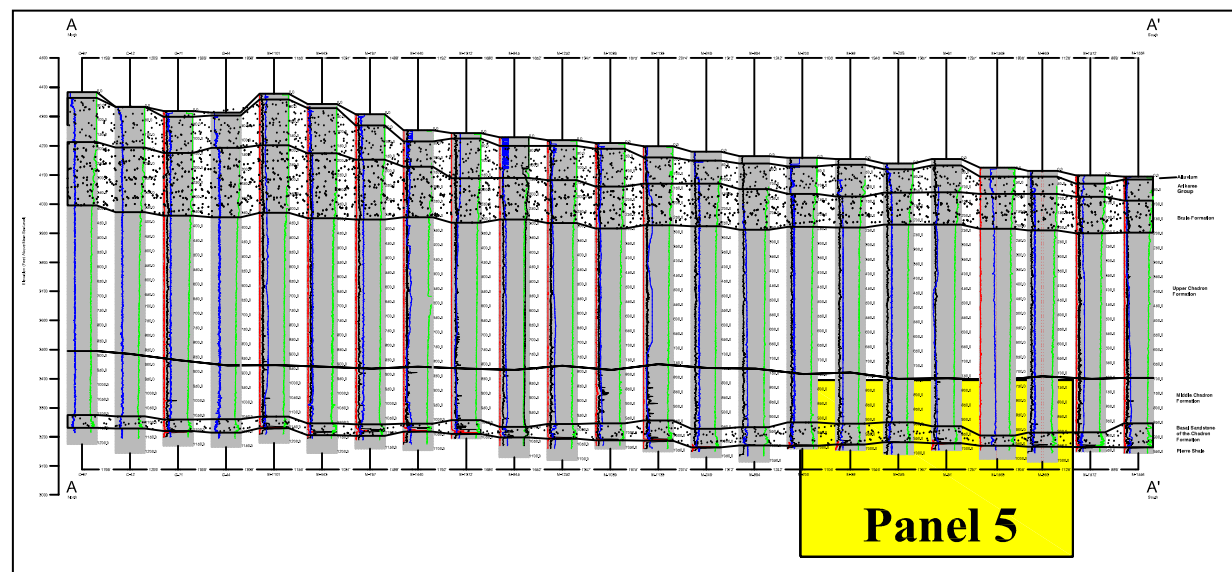


**Figure 3.3-3s Expanded Marshland Structural Cross Section A – A' Panel 5**


PATH: K:\CBR\_P\Projects\CO001636\_Marlsand3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4s Expanded Marlsand Cross Section A-A' Panel 5.ai @ 10/24/2013 SOURCE FILE: L:\ACAD\CrossSections\_Expanded\_Oct182013\Figure E.1-3a\_A-A' Expanded Sections.dwg



CROSS-SECTION PANEL LOCATION




Source: Cameco Resources, 2013

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**FIGURE 3.3-3s**  
**EXPANDED MARSLAND**  
**CROSS-SECTION A-A'**  
**PANEL 5**

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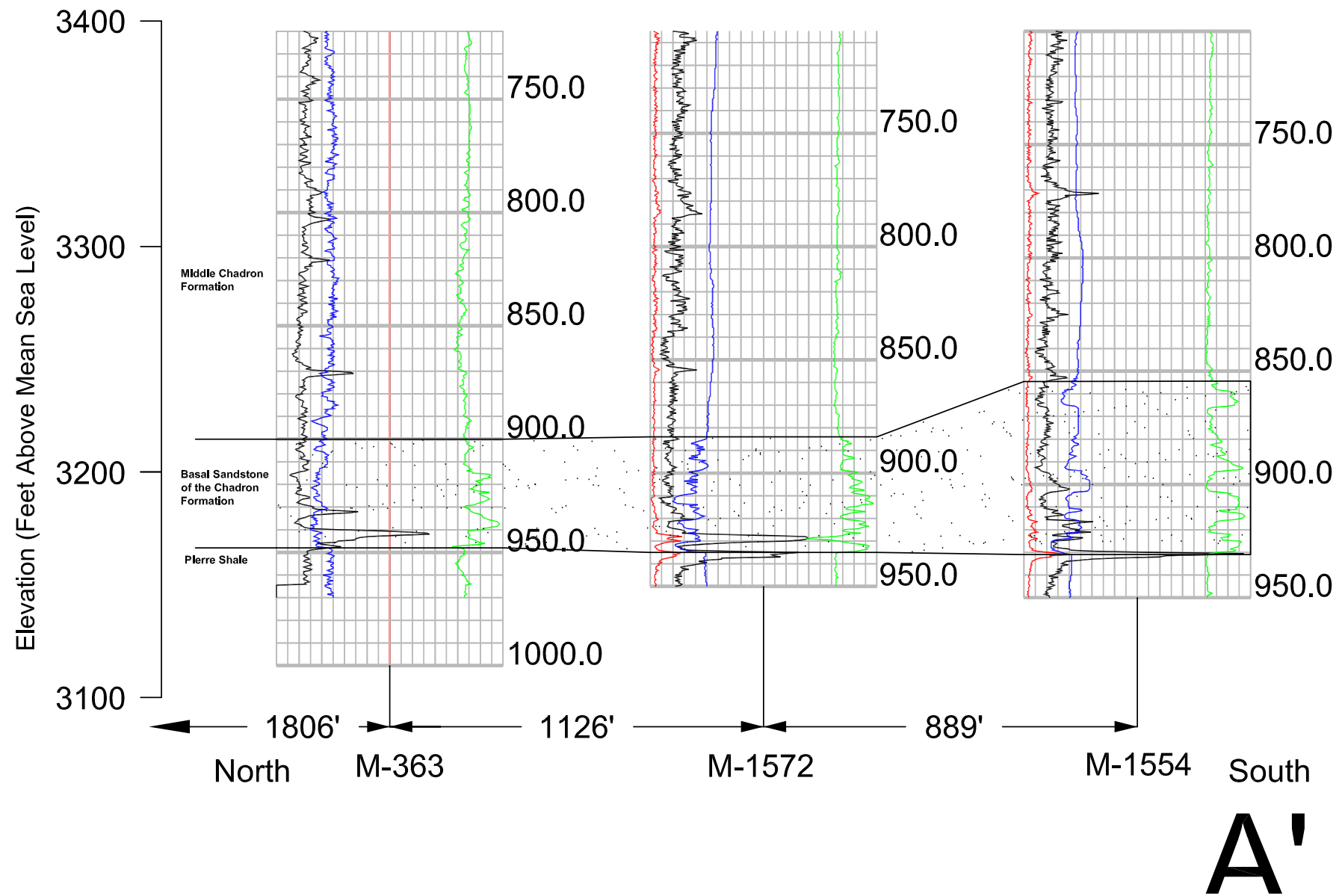
## **Environmental Report Marshland Expansion Area**

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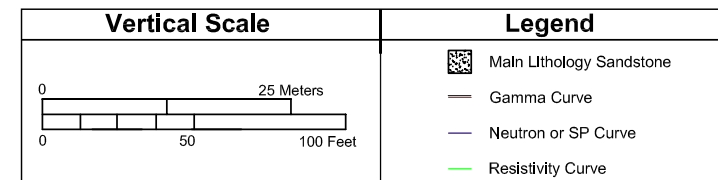
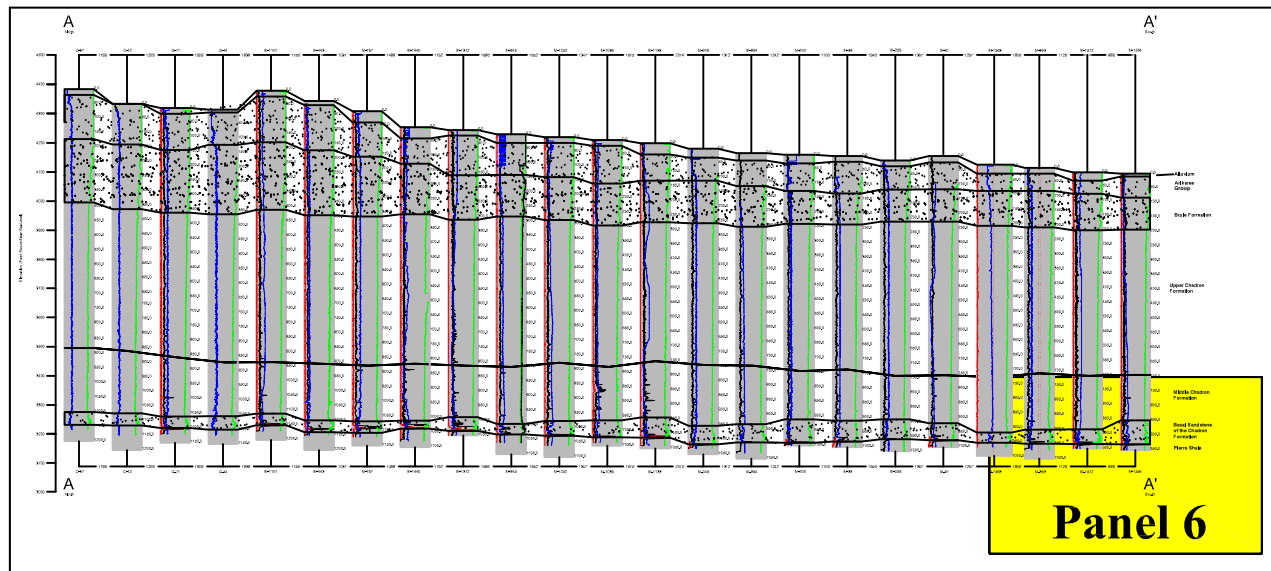


**Figure 3.3-3t Expanded Marshland Structural Cross Section A – A' Panel 6**

PATH: K:\CBR\_P\Projects\CO001636\_Marsland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4t Expanded Marsland Cross Section A-A' Panel 6.ai @ 10/24/2013 SOURCE FILE: 1\_ACAD\CrossSections\_Expanded\_Oct182013\Figure E.1-3a\_A-A'ExpandedSections.dwg



CROSS-SECTION PANEL LOCATION



Source: Cameco Resources, 2013



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**FIGURE 3.3-3t**  
**EXPANDED MARSLAND**  
**CROSS-SECTION A-A'**  
**PANEL 6**

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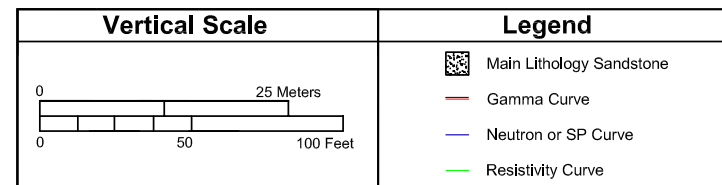
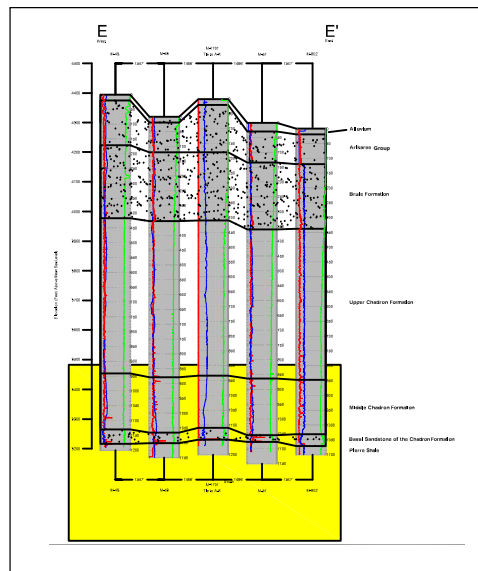
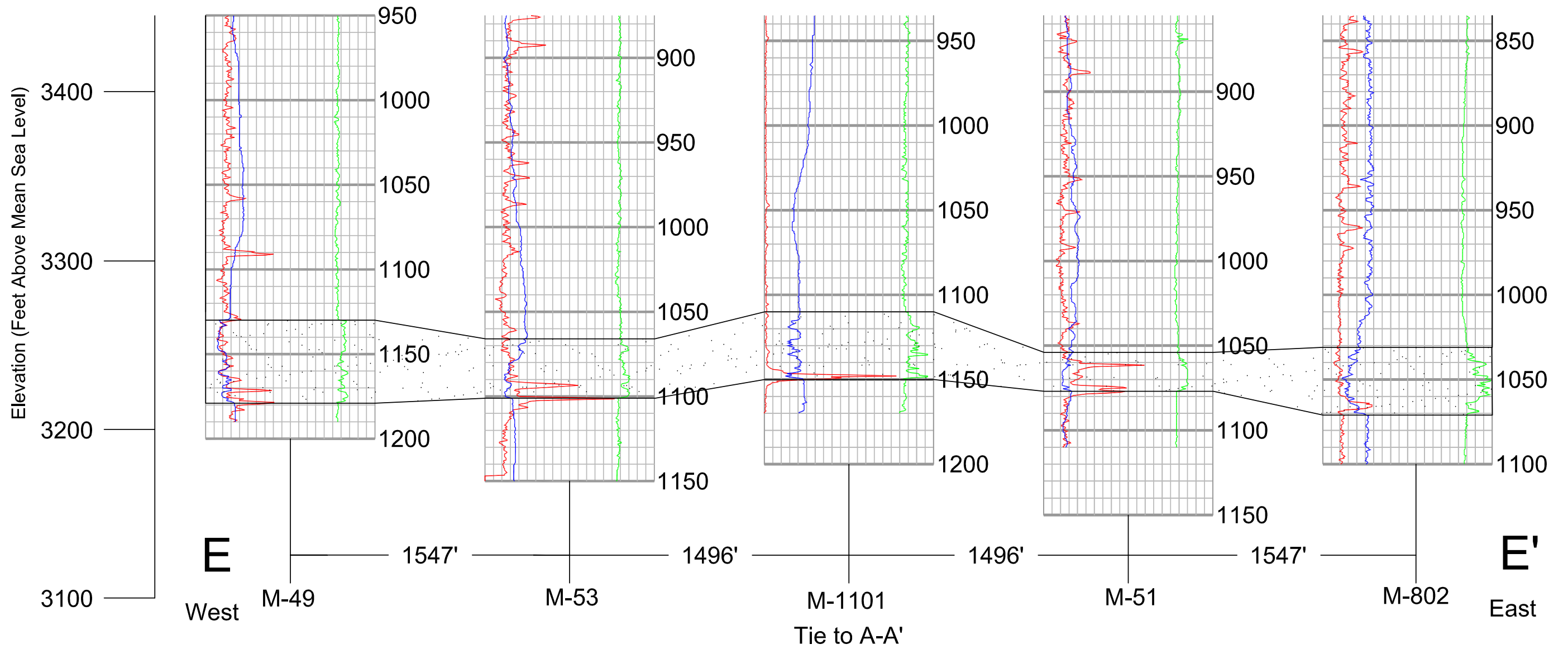
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**Figure 3.3-3u Expanded Marshland Structural Cross Section E – E' Panel**



PATH: K:\CBR\_P\Projects\CO001636\_Marland3\_IMAGES\Illustrator\CrossSections\AEP\_Figure 3-4u Expanded Marland Cross Section E-E'.ai @ 10/24/2013 SOURCE FILE: 1\_ACAD\CrossSections\_Expanded\_Oct 82013\Figure E-1-3a\_A-A'ExpandedSections.dwg



Source: Cameco Resources, 2013



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FIGURE 3.3-3u  
EXPANDED MARLAND  
CROSS-SECTION E-E' PANEL

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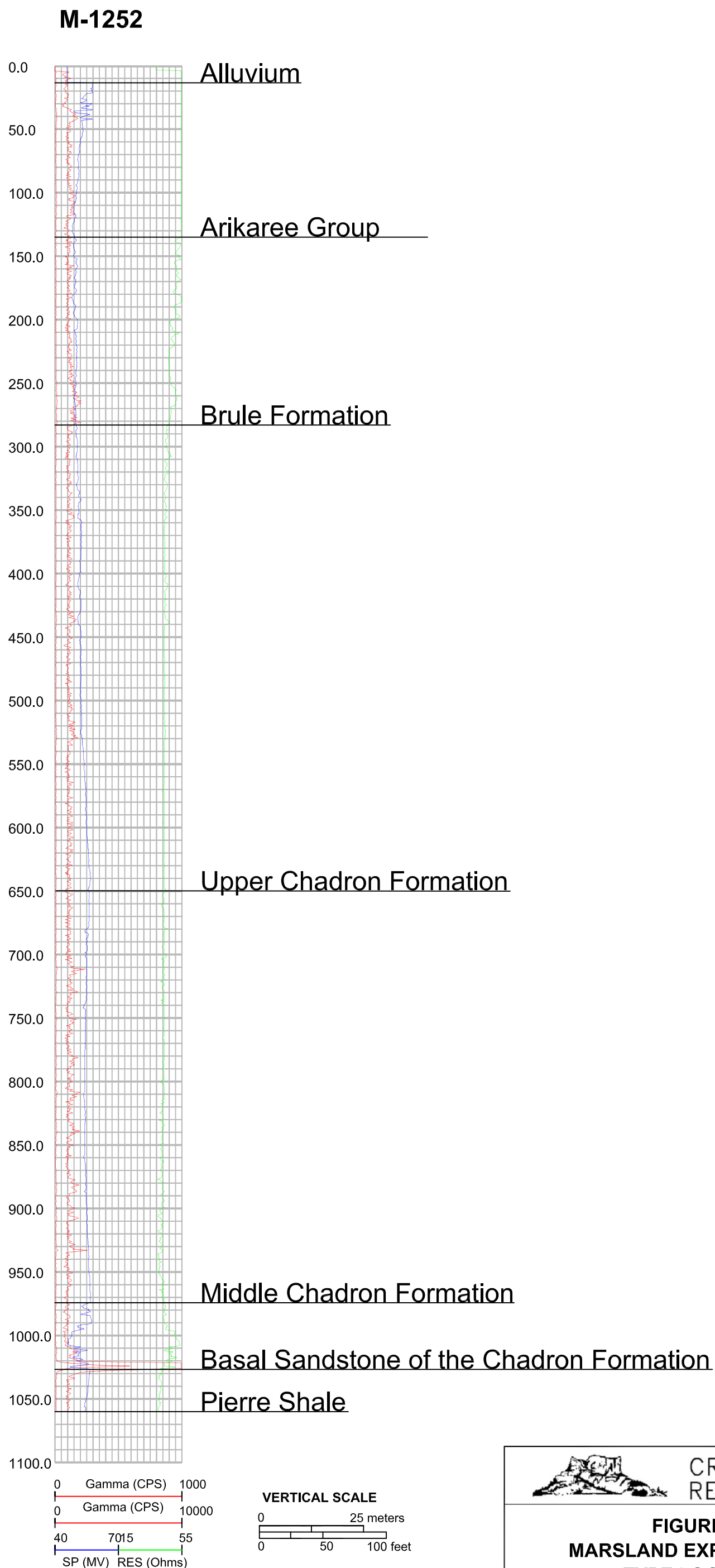
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**Figure 3.3-4 Marshland Expansion Area Type Log (M-1252)**





Source: Cameco Resources, 2011



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**FIGURE 3.3-4**  
**MARSLAND EXPANSION AREA**  
**TYPE LOG (M-1252)**

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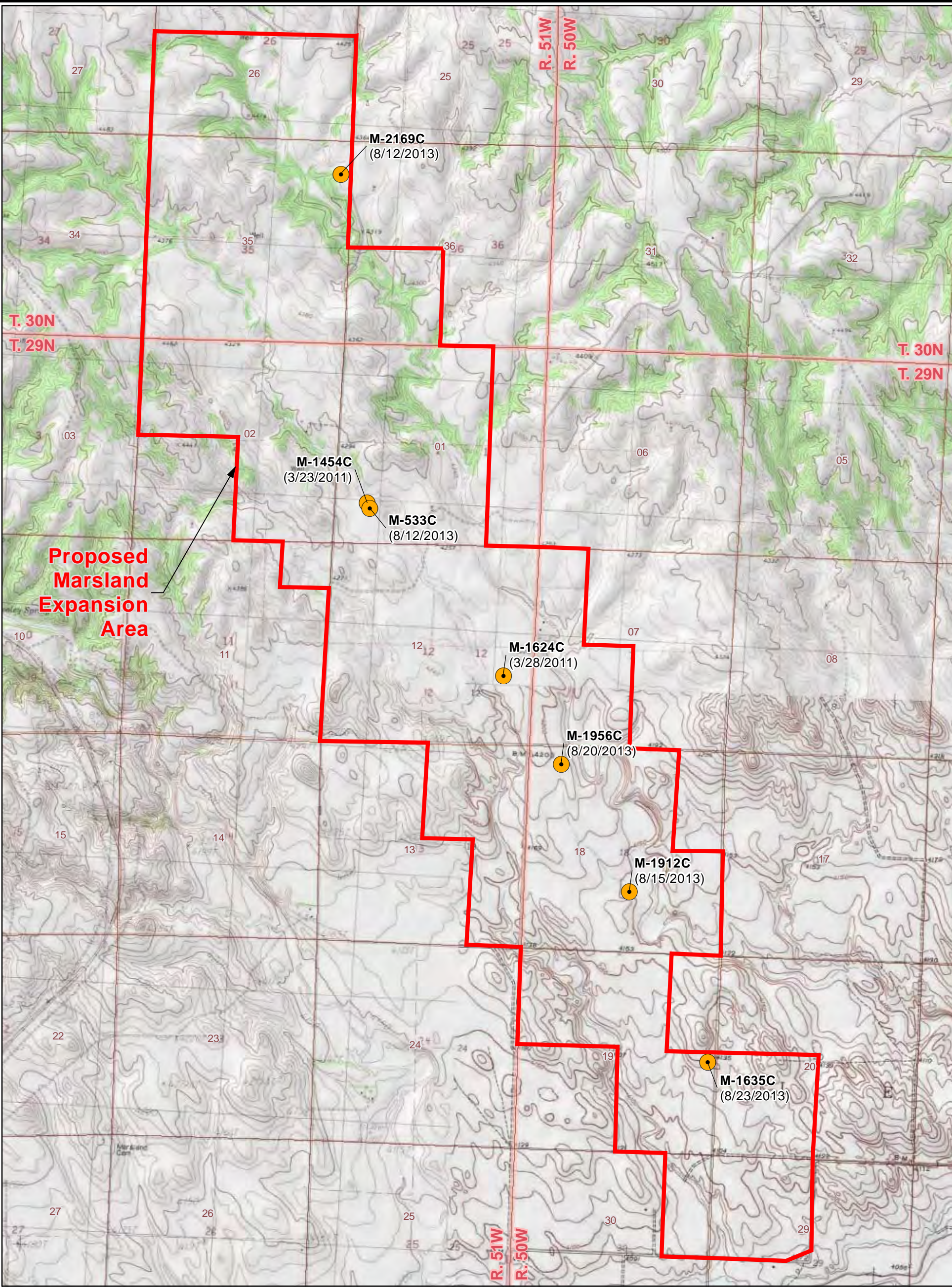
## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-5 Marshland Expansion Area Coring Location**





LEGEND

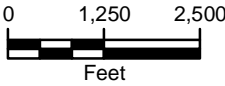


Coring Location



Proposed Marland Expansion Area

**M-1635C** Location ID  
(8/23/2013) Date of Collection



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



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FIGURE 3.3-5  
MARSLAND EXPANSION AREA  
CORING LOCATIONS

PROJECT: CO001636      MAPPED BY: JC      CHECKED BY: JEC



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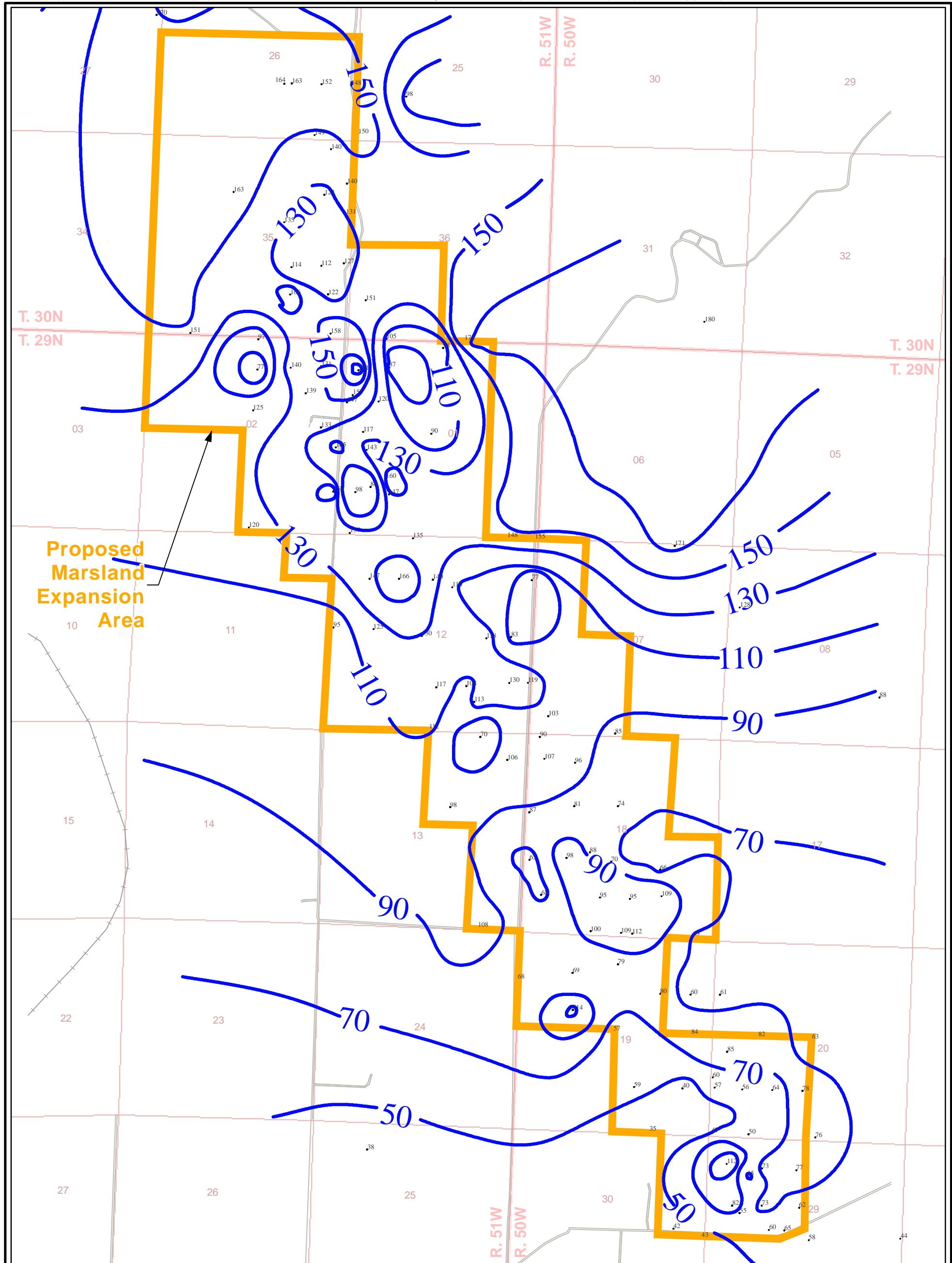
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## **Environmental Report Marsland Expansion Area**





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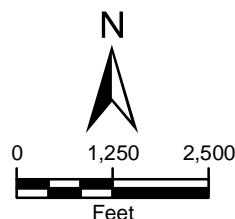


**Figure 3.3-6 Marsland Isopach Map - Arikaree Formation**



## LEGEND

-  Proposed Marsland Expansion Area
- 38 Borehole Location and Unit Thickness Reading (Feet)
-  Isopach Contour (Feet)
-  Railroad
-  Road



PROJECTION: NAD 1927, STATE PLANE  
NEBRASKA NORTH, FIPS 2601



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**FIGURE 3.3-6  
MARSLAND ISOPACH MAP  
ARIKAREE GROUP**

PROJECT: CO001636

MAPPED BY: JC

CHECKED BY: MS



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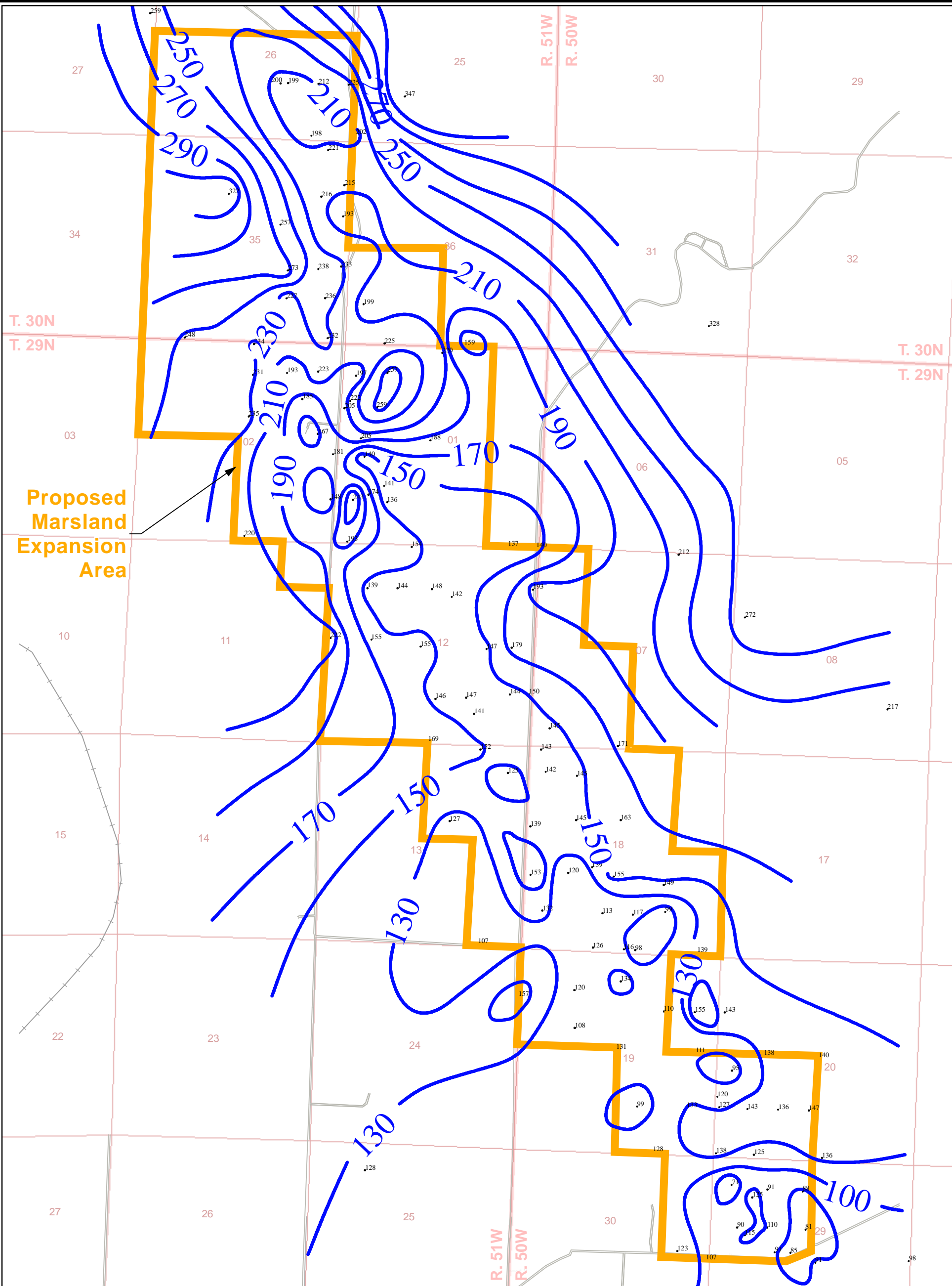
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## **Environmental Report Marsland Expansion Area**






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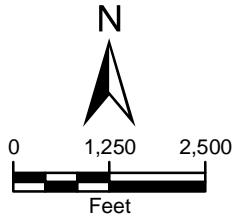


**Figure 3.3-7 Marsland Isopach Map - Brule Formation**



LEGEND

-  Proposed Marstrand Expansion Area
-  Borehole Location and Unit Thickness Reading (Feet)
-  Isopach Contour (Feet)
-  Railroad
-  Road



PROJECTION: NAD 1927, STATE PLANE  
NEBRASKA NORTH, FIPS 2601



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FIGURE 3.3-7  
MARSLAND ISOPACH MAP  
BRULE FORMATION

PROJECT: CO001636      MAPPED BY: JC      CHECKED BY: MS



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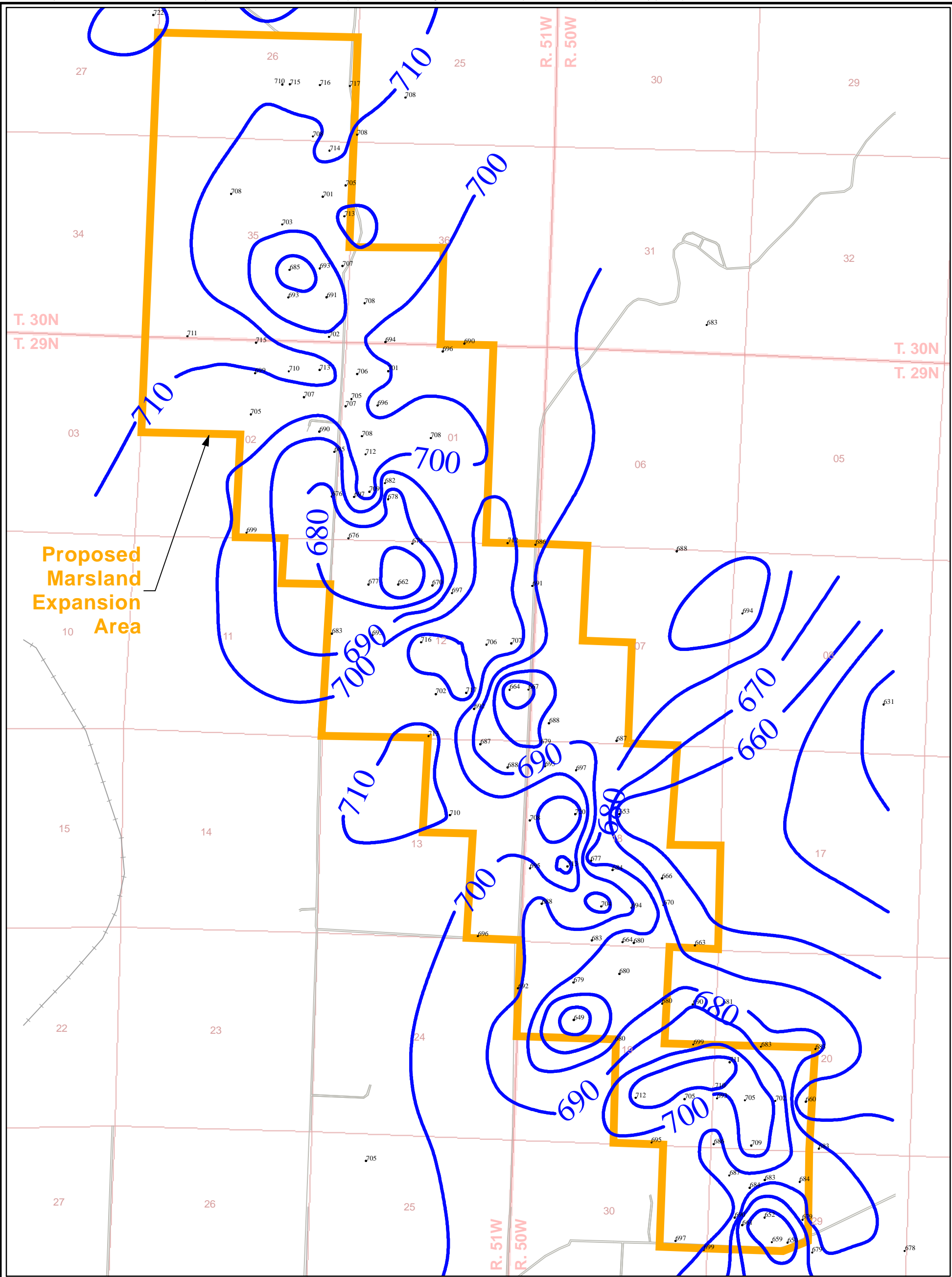
## **Environmental Report Marsland Expansion Area**

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





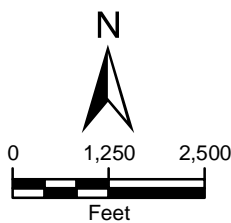
**Figure 3.3-8 Marsland Isopach Map - Chadron Formation**





#### LEGEND

-  Proposed Marmland Expansion Area
-  Borehole Location and Unit Thickness Reading (Feet)
-  Isopach Contour (Feet)
-  Railroad
-  Road



PROJECTION: NAD 1927, STATE PLANE  
NEBRASKA NORTH, FIPS 2601



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#### FIGURE 3.3-8 MARSLAND ISOPACH MAP UPPER AND MIDDLE CHADRON FORMATION

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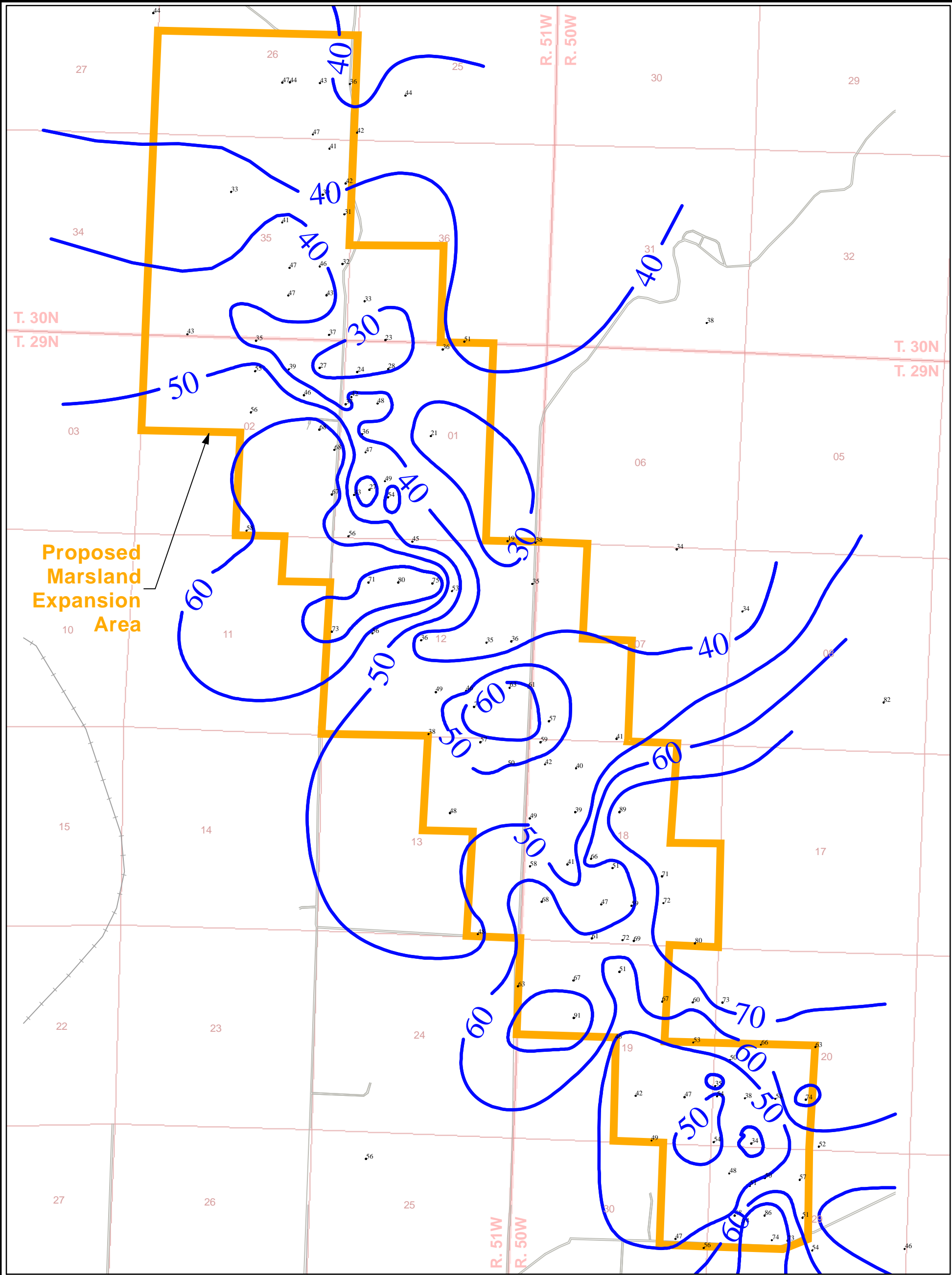
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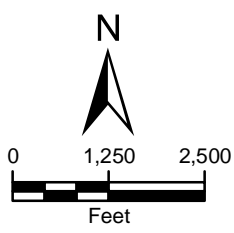


**Figure 3.3-9 Basal Sandstone of the Chadron Formation**



LEGEND

- Proposed Marsland Expansion Area
- Borehole Location and Unit Thickness Reading (Feet)
- Isopach Contour (Feet)
- Railroad
- Road



PROJECTION: NAD 1927, STATE PLANE  
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FIGURE 3.3-9  
MARSLAND ISOPACH MAP  
BASAL SANDSTONE OF  
THE CHADRON FORMATION

PROJECT: CO001636      MAPPED BY: JC      CHECKED BY: MS



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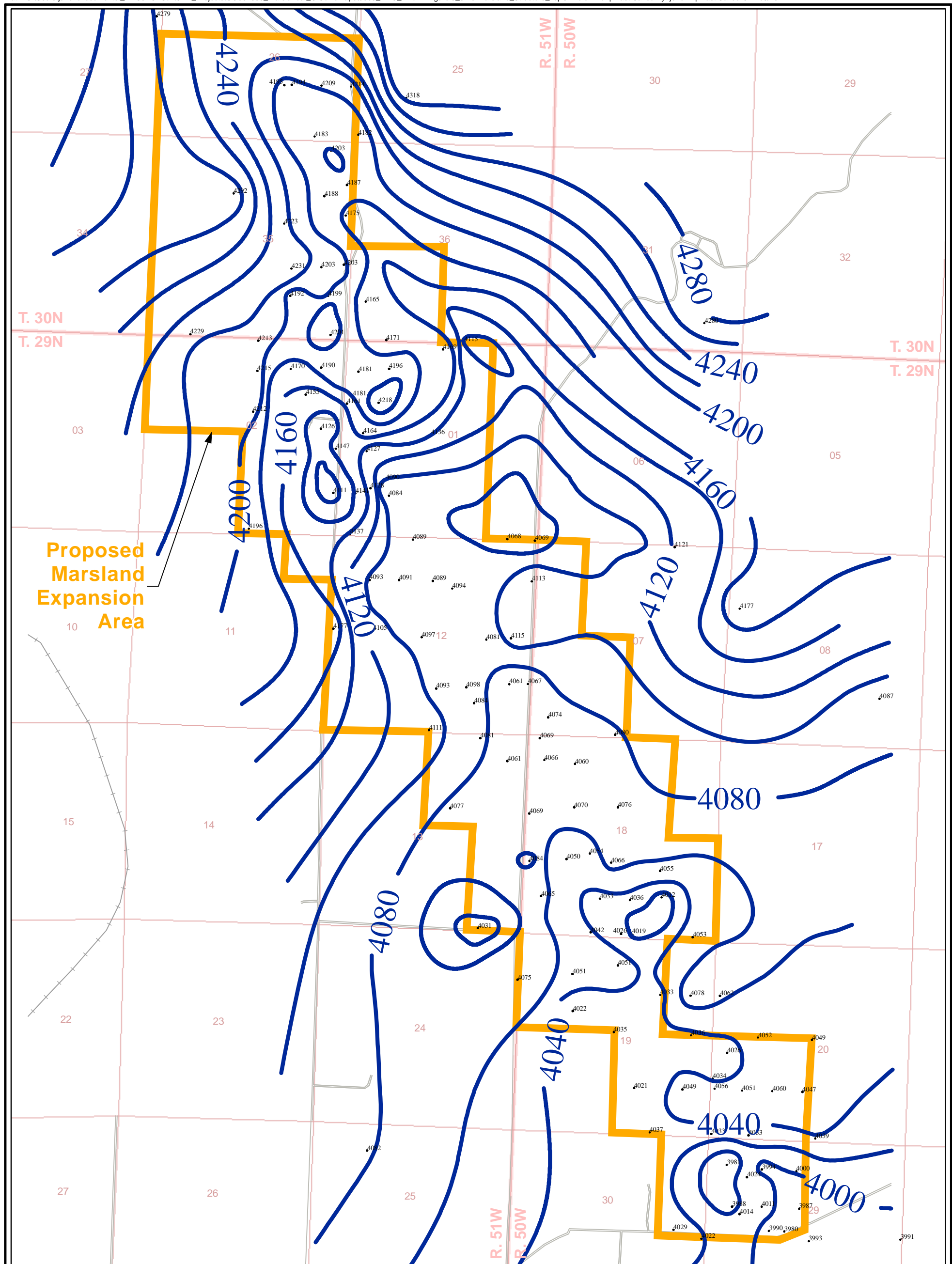
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## **Environmental Report Marshland Expansion Area**





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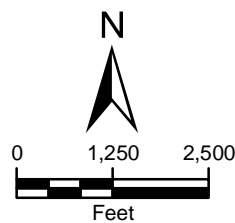
**Figure 3.3-10 Top of the Brule Formation**



## LEGEND

-  Proposed Marsland Expansion Area
- 4021 Borehole Location and Elevation - Top of Brule Formation (FT-AMSL)
-  Elevation Contour - Top of Brule Formation (FT-AMSL)
-  Railroad
-  Road

FT-AMSL = Feet Above Mean Sea Level



PROJECTION: NAD 1927, STATE PLANE  
NEBRASKA NORTH, FIPS 2601



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**FIGURE 3.3-10  
MARSLAND STRUCTURE MAP  
TOP OF BRULE FORMATION**

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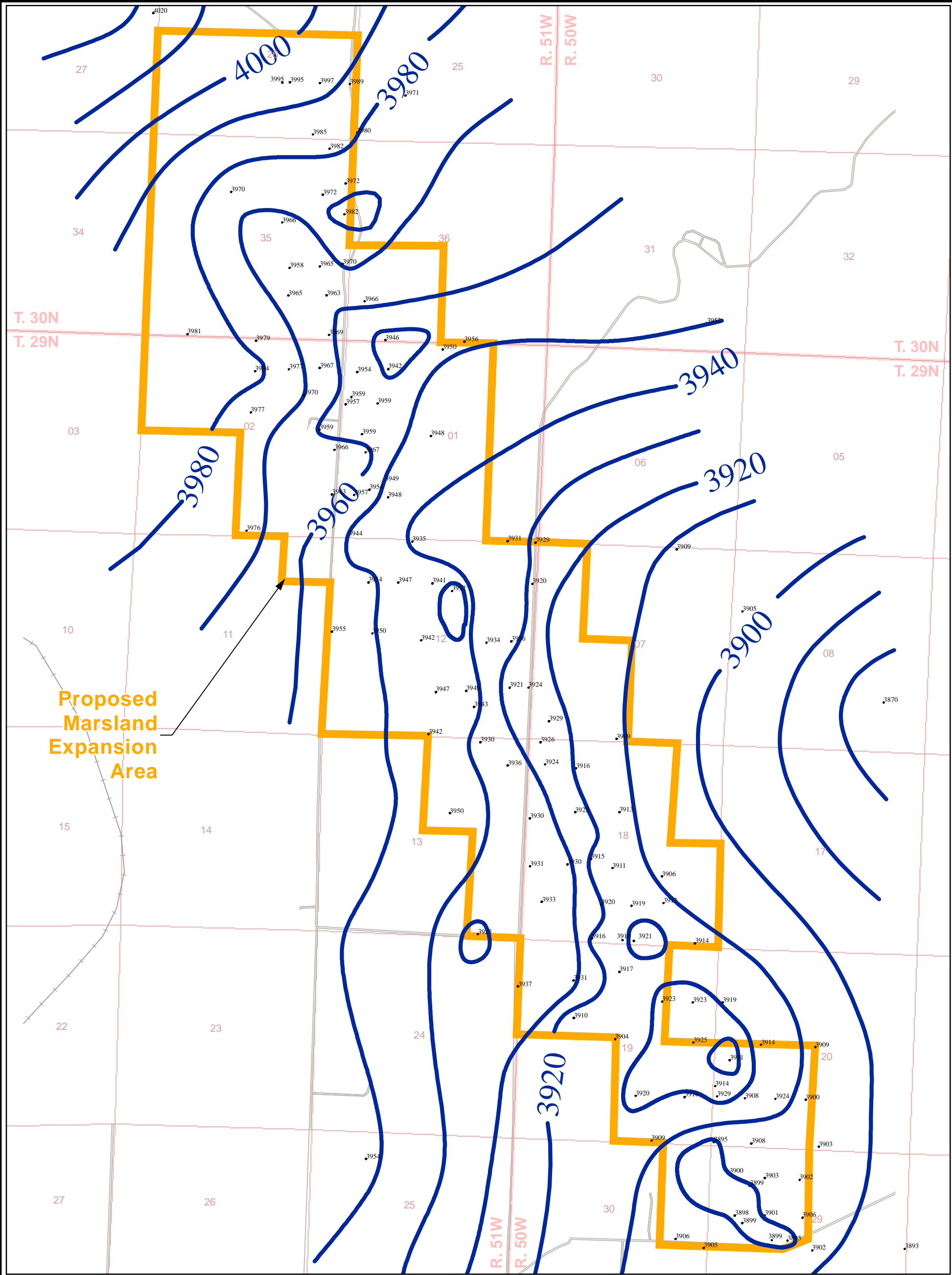
## **Environmental Report Marsland Expansion Area**

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**Figure 3.3-11 Top of the Chadron Formation**

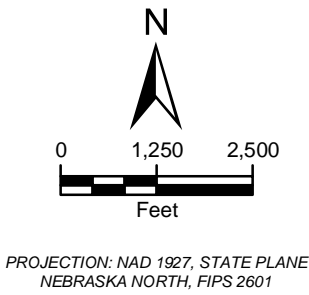




LEGEND

- Proposed Marland Expansion Area
- Borehole Location and Elevation - Top of Chadron Formation (FT-AMSL)
- Elevation Contour - Top of Chadron Formation (FT-AMSL)
- Railroad
- Road

FT-AMSL = Feet Above Mean Sea Level



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FIGURE 3.3-11  
MARSLAND STRUCTURE MAP  
TOP OF CHADRON FORMATION

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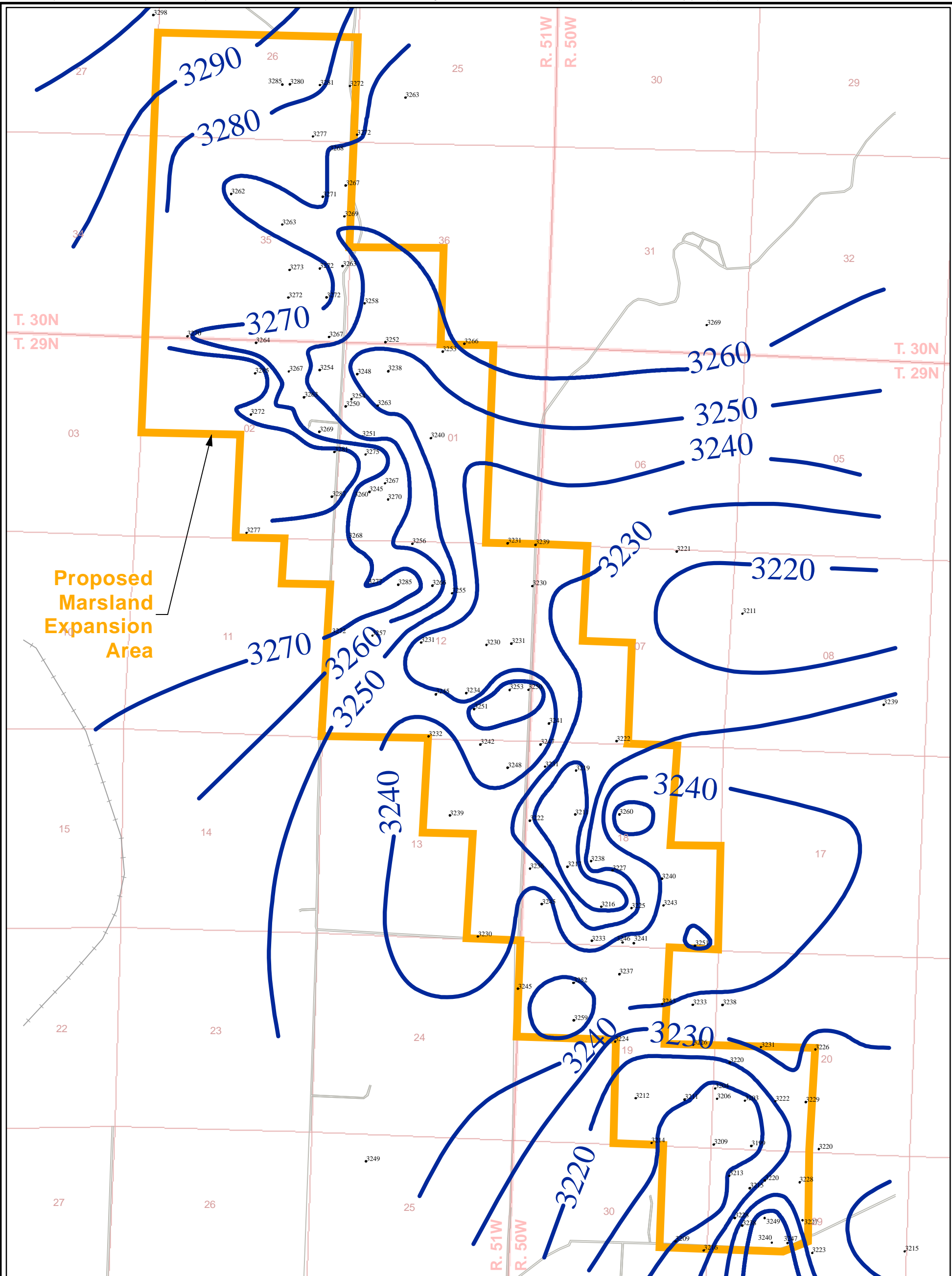
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## **Environmental Report Marsland Expansion Area**

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**Figure 3.3-12 Top of the Basal sandstone of the Chadron Formation**



**LEGEND**

- Proposed Marland Expansion Area
- Borehole Location and Elevation - Top of Basal Sandstone (FT-AMSL)
- Elevation Contour - Top of Basal Sandstone (FT-AMSL)
- Railroad
- Road

FT-AMSL = Feet Above Mean Sea Level

Feet  

PROJECTION: NAD 1927, STATE PLANE  
NEBRASKA NORTH, FIPS 2601

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**FIGURE 3.3-12**  
**MARSLAND STRUCTURE MAP**  
**TOP OF BASAL SANDSTONE OF**  
**THE CHADRON FORMATION**

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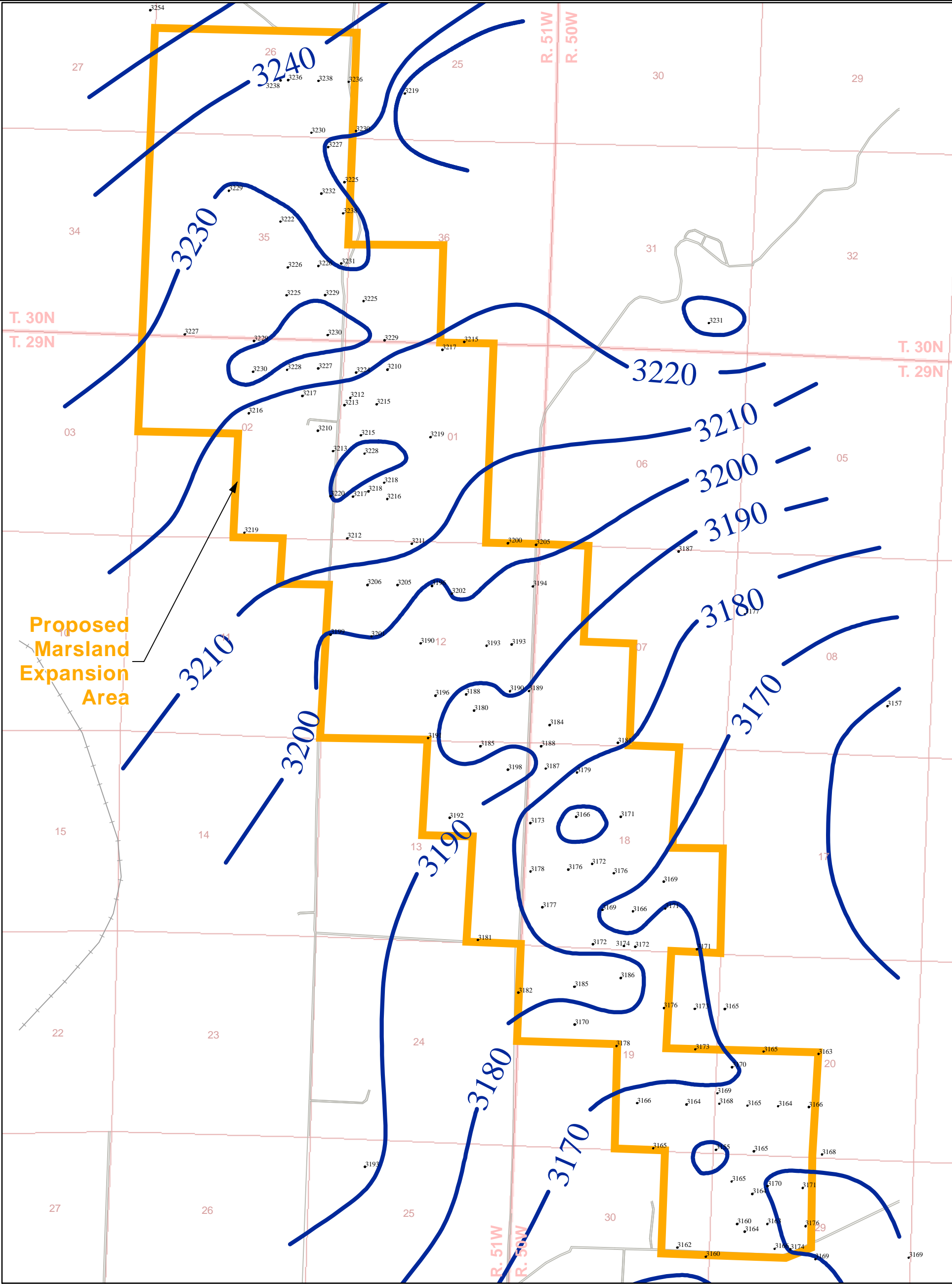
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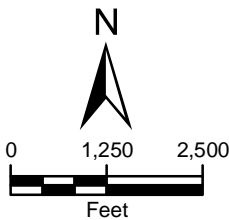
**Figure 3.3-13 Top of Pierre Shale**



LEGEND

- Proposed Marmland Expansion Area
- 3193 Borehole Location and Elevation - Top of Pierre Shale (FT-AMSL)
- Elevation Contour - Top of Pierre Shale (FT-AMSL)
- Railroad
- Road

FT-AMSL = Feet Above Mean Sea Level



PROJECTION: NAD 1927, STATE PLANE  
NEBRASKA NORTH, FIPS 2601



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FIGURE 3.3-13  
MARSLAND STRUCTURE MAP  
TOP OF PIERRE SHALE

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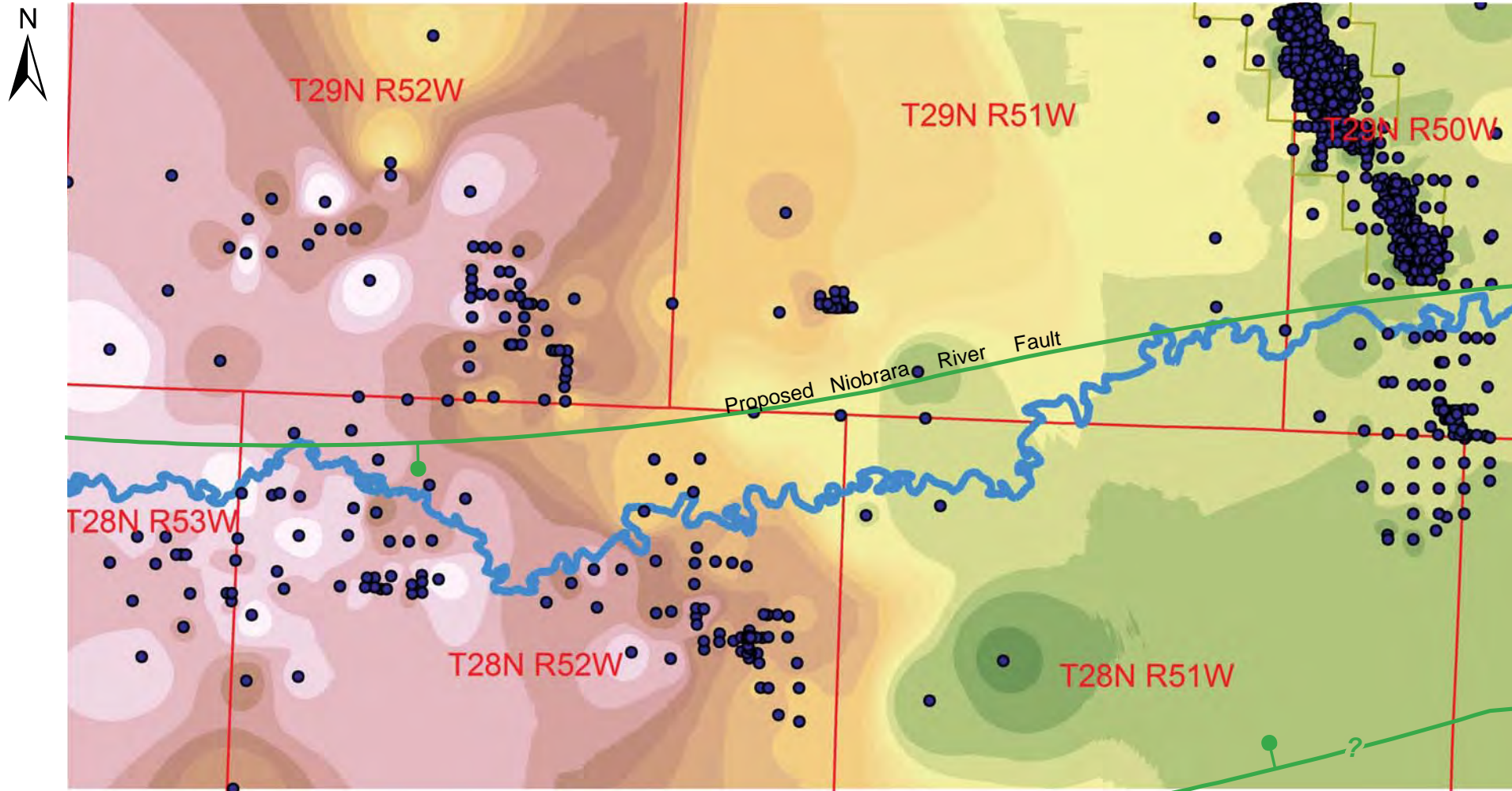
## **Environmental Report Marsland Expansion Area**

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**Figure 3.3-14 Marsland Structure Map - Top of Pierre Shale**





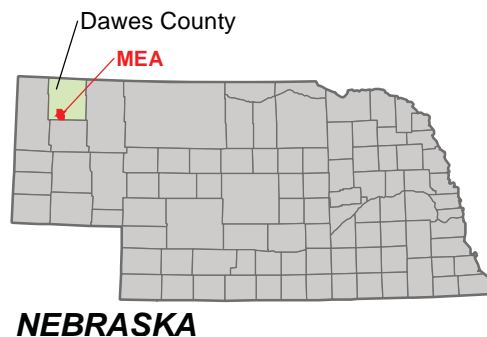
## LEGEND

- Boring Locations Used for Structural Interpretation
- Proposed Marland Expansion Area (MEA)
- Niobrara River

### Elevation - Top of Pierre Shale (FT-AMSL) (Structural contour interval is 20 feet)

3,100 - 3,120	3,220 - 3,240	3,340 - 3,360
3,120 - 3,140	3,240 - 3,260	3,360 - 3,380
3,140 - 3,160	3,260 - 3,280	3,380 - 3,400
3,160 - 3,180	3,280 - 3,300	3,400 - 3,420
3,180 - 3,200	3,300 - 3,320	3,420 - 3,440
3,200 - 3,220	3,320 - 3,340	

- Fault Interpretations by DeGraw (1971)  
(Ball on downthrown side; ? denotes inferred)



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## FIGURE 3.3-14 REGIONAL STRUCTURE CONTOUR MAP - TOP OF PIERRE SHALE

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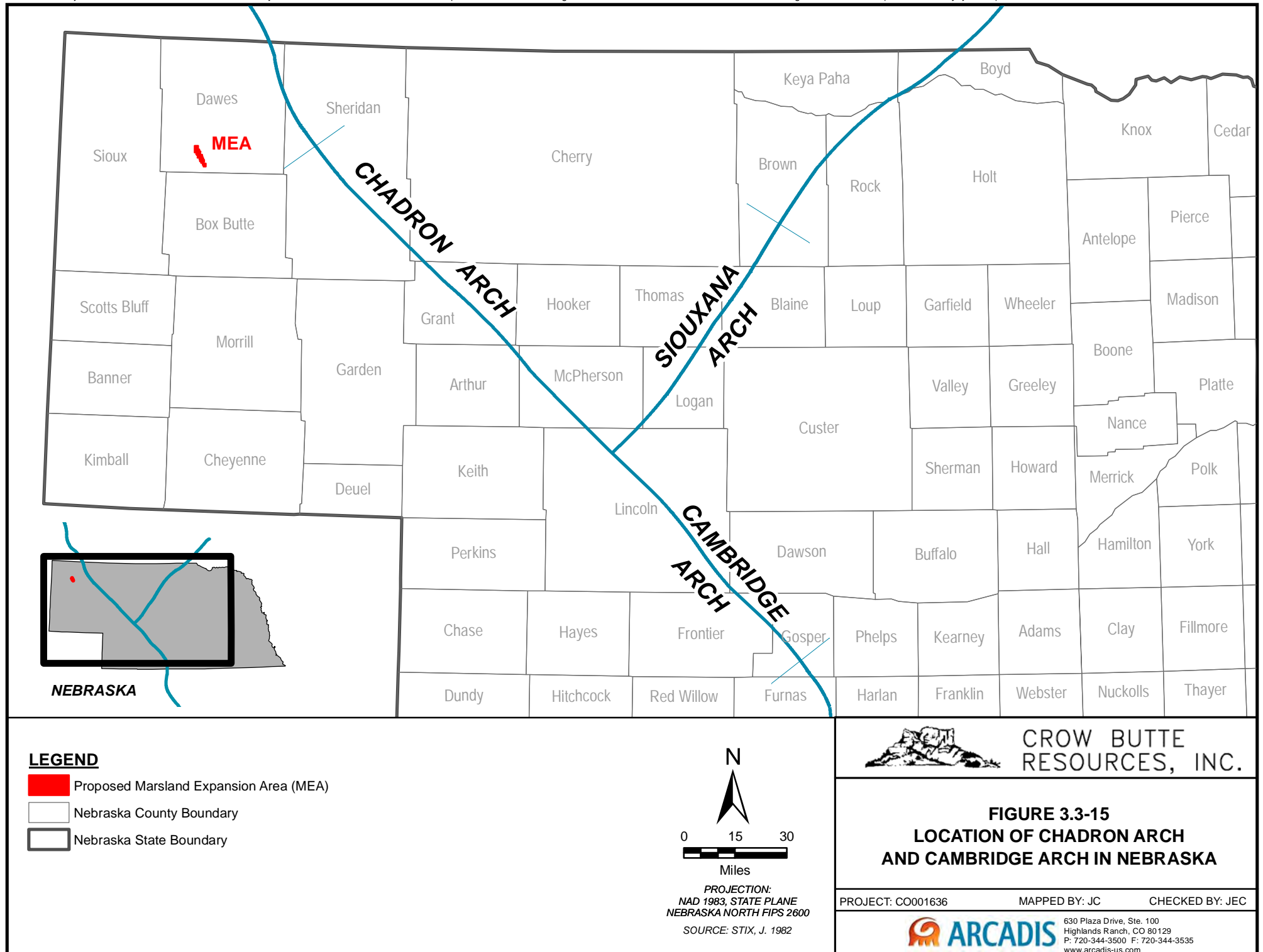
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## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-15 Location of Chadron Arch and Cambridge Arch in Nebraska**



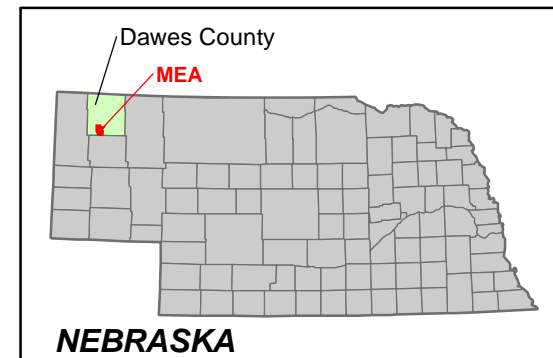
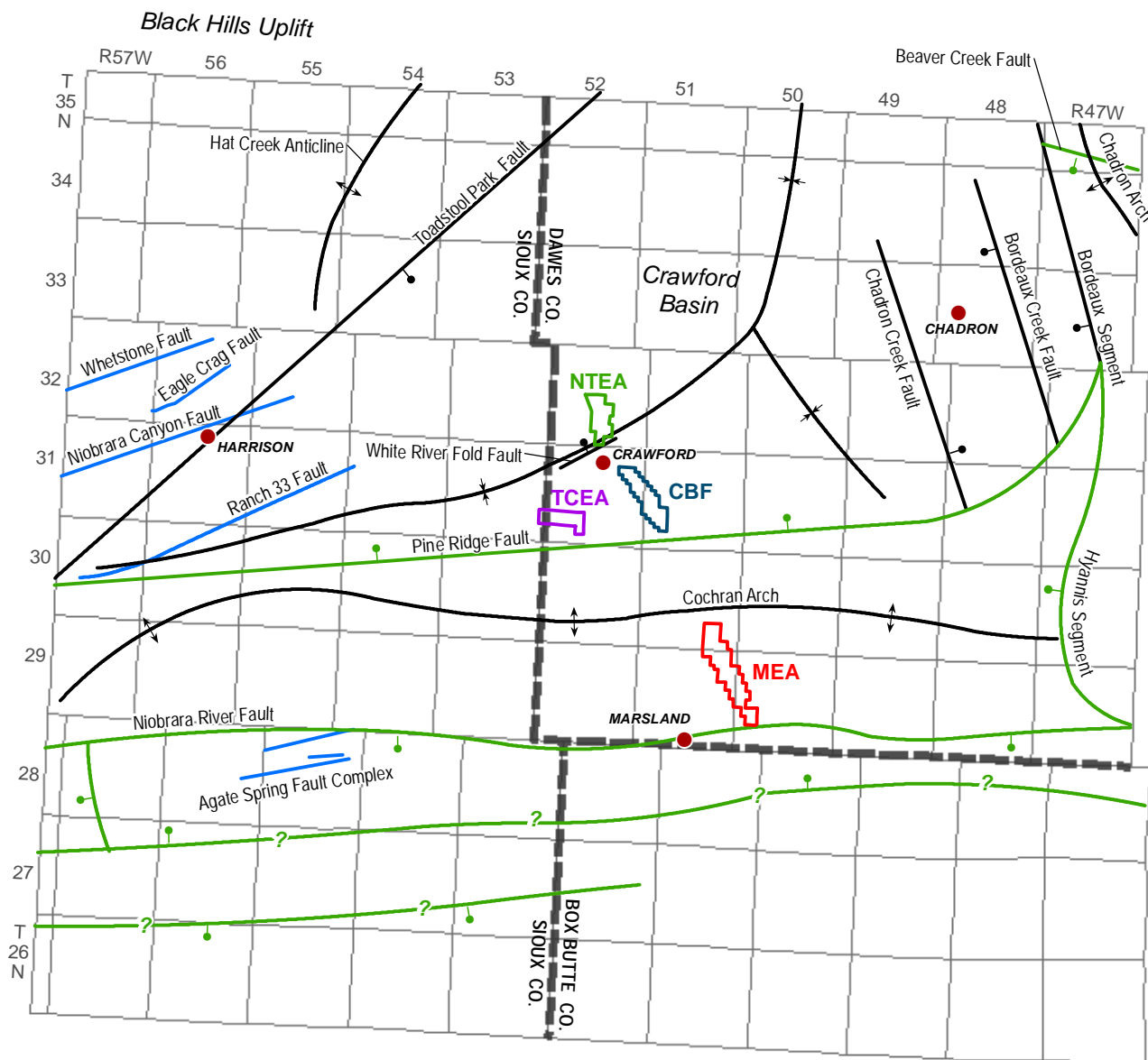
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## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-16 Structural Features Map of the Crawford Basin**



### LEGEND

- City/Town
- Fault (Ball on downthrown side)
- Fault Interpretations by DeGraw (1971) (Ball on downthrown side; ? denotes inferred)
- Fault Interpretations by Hunt (1990)
- ↕ Anticline
- ↕ Syncline
- County Boundary
- Proposed Marsland Expansion Area (MEA)
- Crow Butte Facility (CPF) Permit Area
- Proposed North Trend Expansion Area (NTEA)
- Proposed Three Crow Expansion Area (TCEA)

Source:  
Modified from DeGraw, 1969;  
WFC-White River Fault only (Collings & Knode, 1984)



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**FIGURE 3.3-16  
STRUCTURAL FEATURES MAP OF  
THE CRAWFORD BASIN**

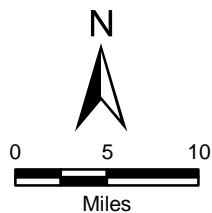
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PROJECTION:  
NAD83, UTM ZONE 14N

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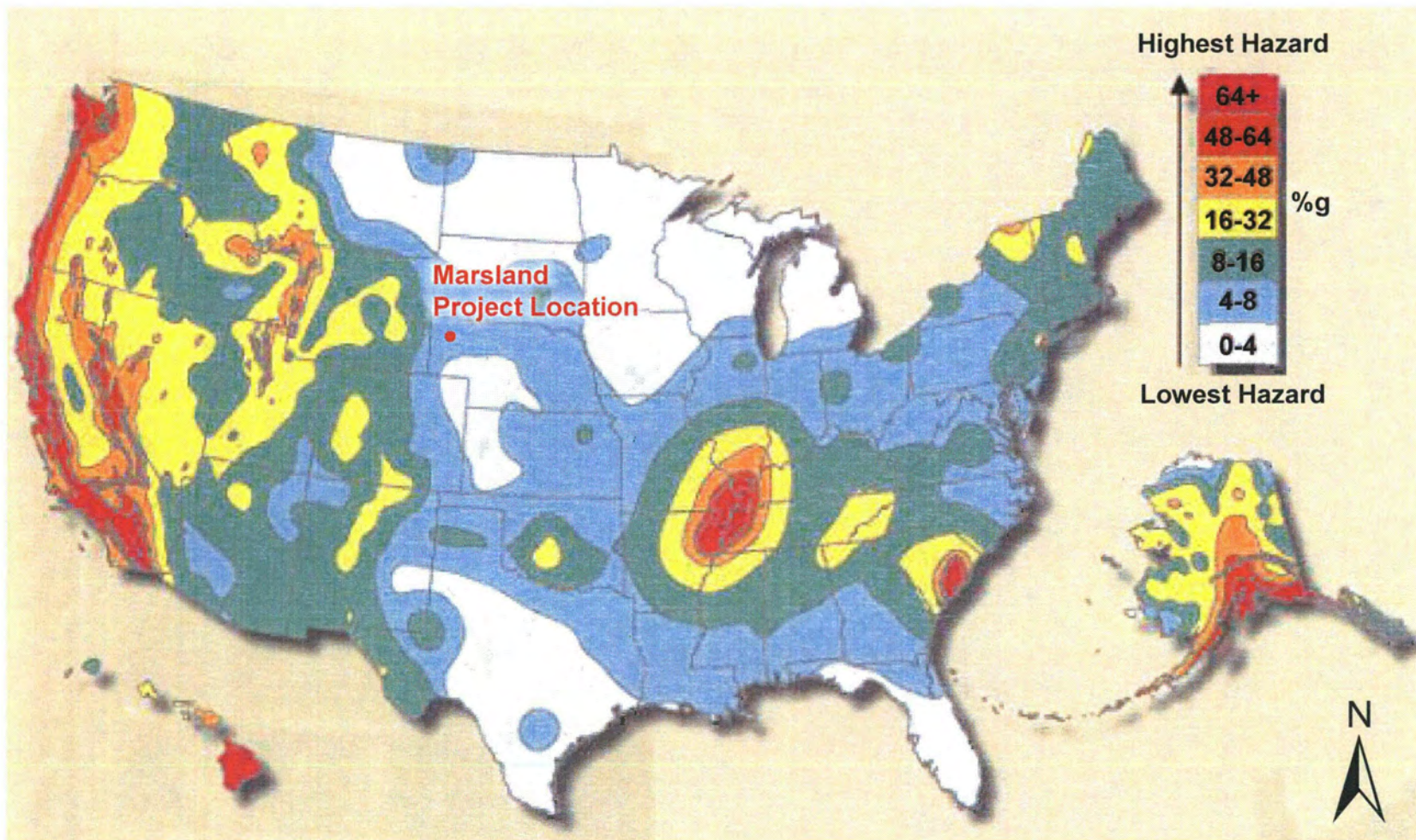
## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-17 Earthquake Hazard Ranking in the U.S.**





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**FIGURE 3.3-14  
EARTHQUAKE HAZARD RANKING  
IN THE U.S.**

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SOURCE: USGS 2009g.

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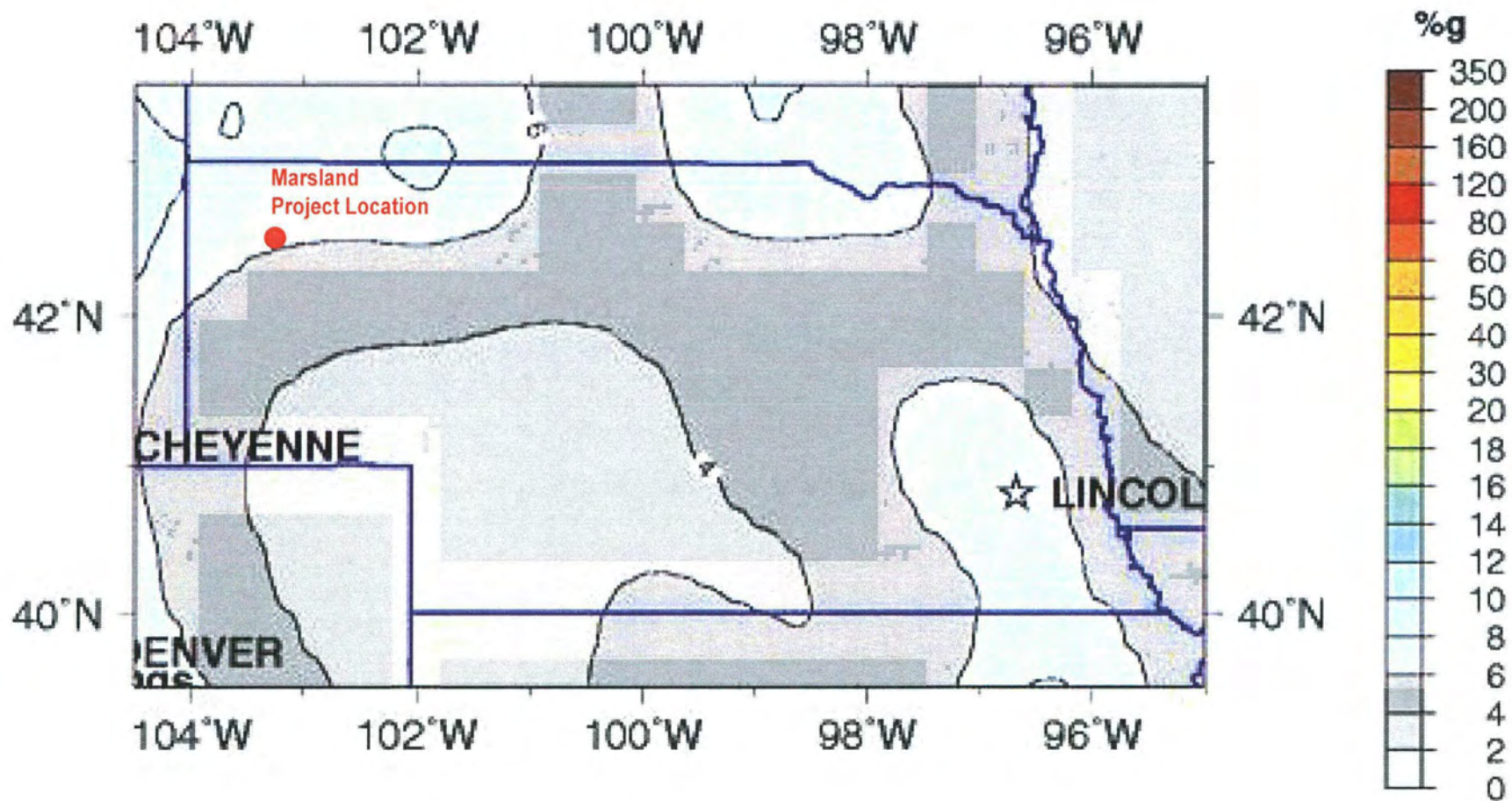
## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-18 Seismic Hazard Map for Nebraska (2008)**





Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years  
 Site: NEHRP B-C boundary  
 National Seismic Hazard Mapping Project (Peterson, M.D. 2008)



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**FIGURE 3.3-15  
 SEISMIC HAZARD MAP  
 FOR NEBRASKA (2008)**

PROJECT: CO0016 6.00001

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SOURCE: USGS 2009a

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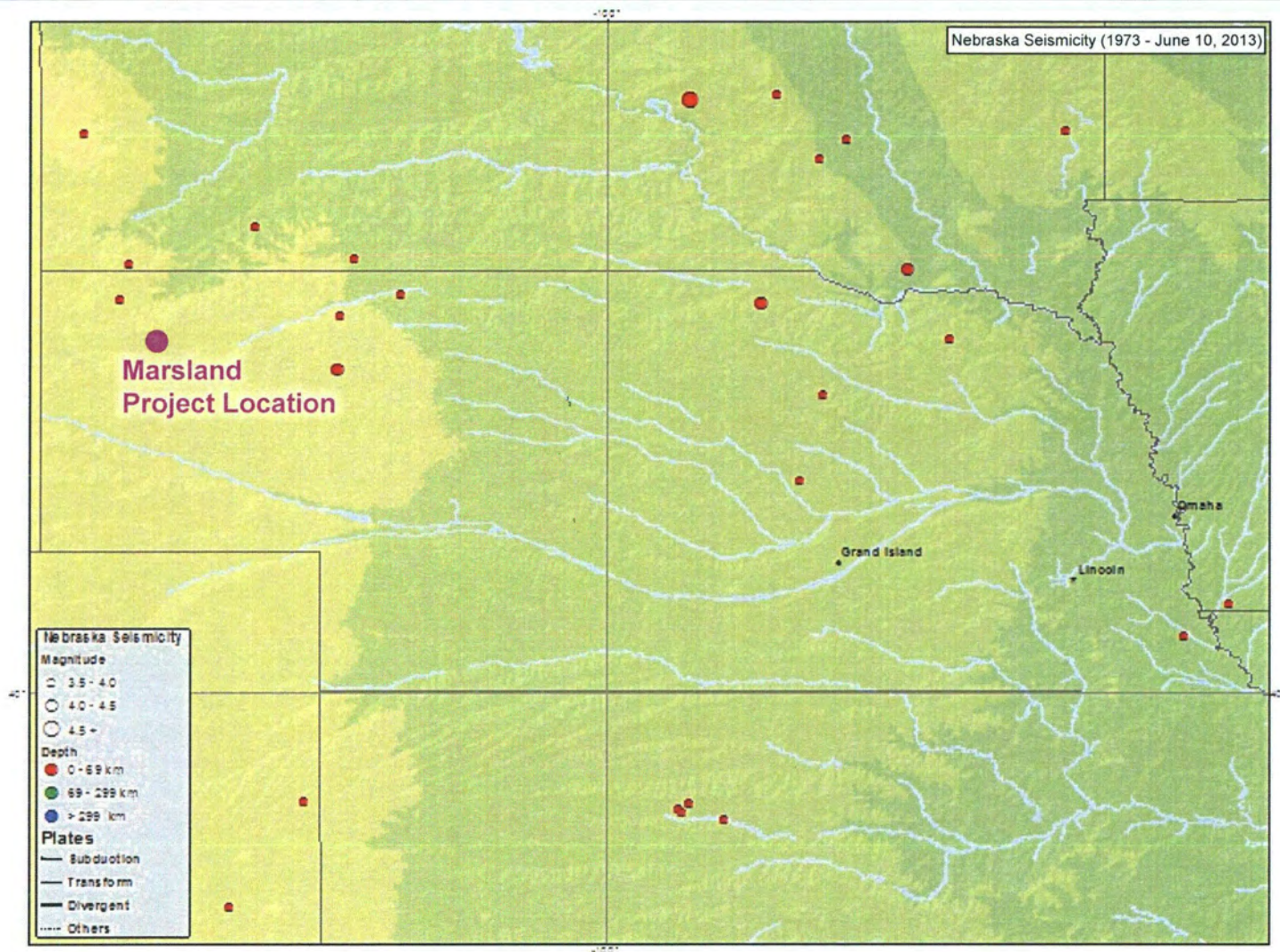
## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-19 Seismicity of Nebraska 1990-2006**





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**FIGURE 3.3-16**  
**SEISMICITY OF NEBRASKA**  
**1973 - 2013**

Source: <http://earthquake.usgs.gov/earthquakes/states/nebraska/seismicity.php>

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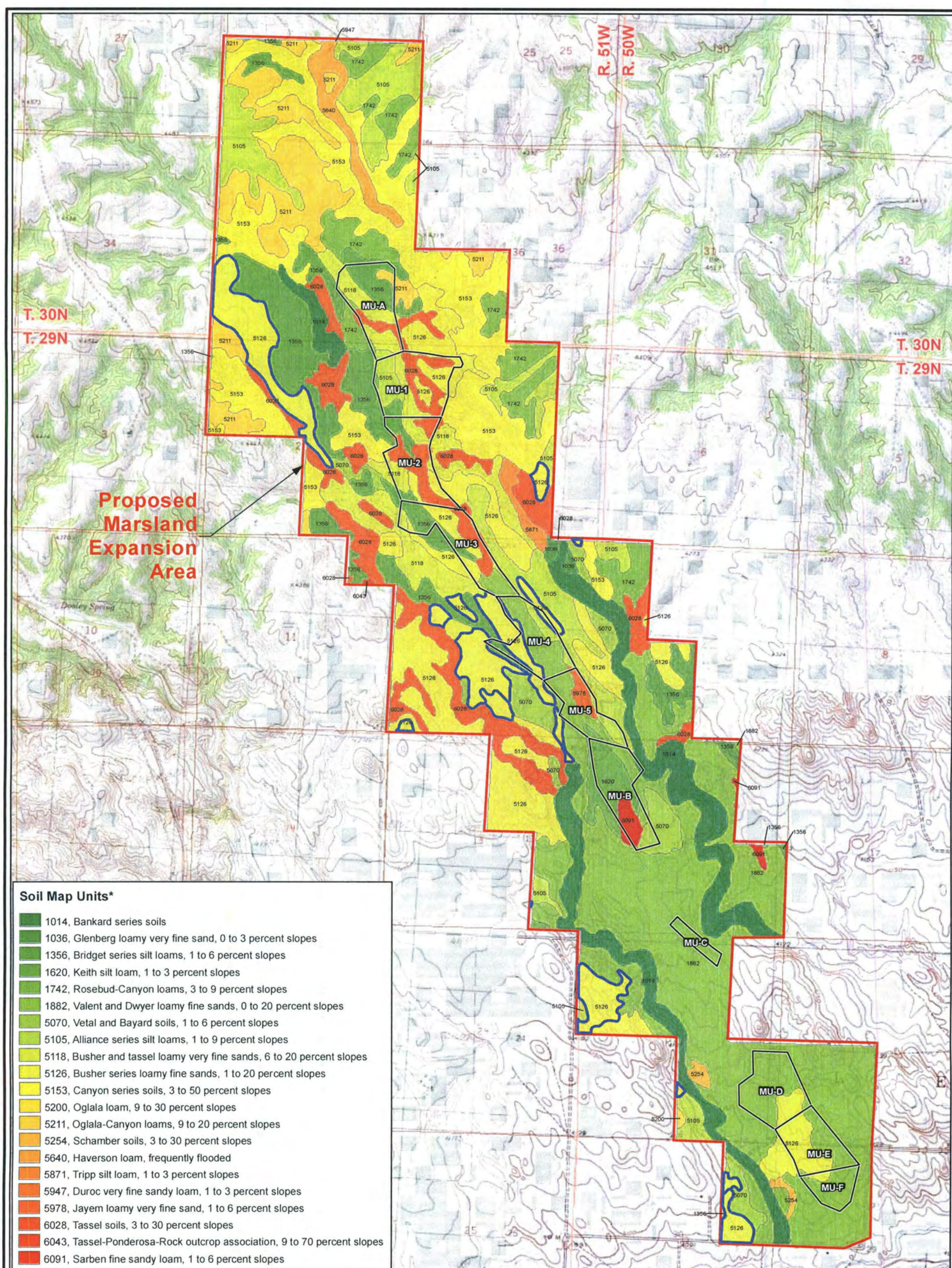
## **Environmental Report Marshland Expansion Area**

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**Figure 3.3-20 Soils**

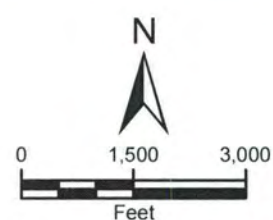




#### LEGEND

- Mine Unit
- Soil units mapped by NRCS as exhibiting prevalent erosion
- Proposed Marsland Expansion Area

\* Soil map units 1014, 1356, 1882, 5105, 5126, and 5153 represent combined NRCS map units. The map number represents the NRCS map unit with the greatest extent within the Proposed Marsland Expansion Area. See text for complete description of soil map units.



PROJECTION: NAD 1927, STATE PLANE  
NEBRASKA NORTH, FIPS 2601  
SOURCES: US TOPO MAPS, SERVICED  
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#### FIGURE 3.3-17 SOILS

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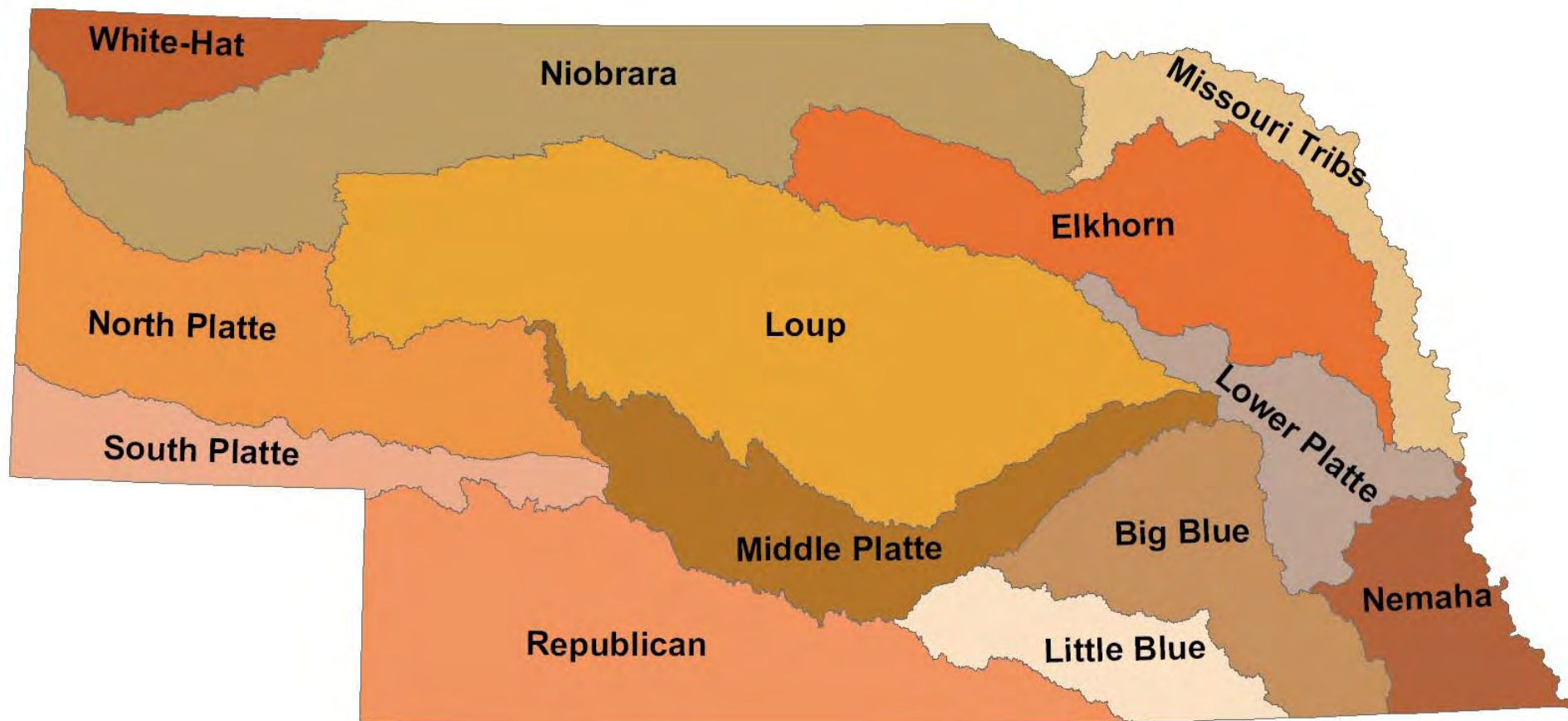
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**Figure 3.4-1 Nebraska's Major River Basins**



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**FIGURE 3.4-1  
NEBRASKA'S MAJOR RIVER BASINS**

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Source: NDEQ, 2010

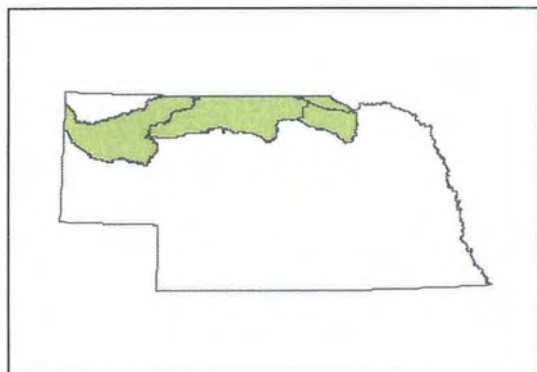
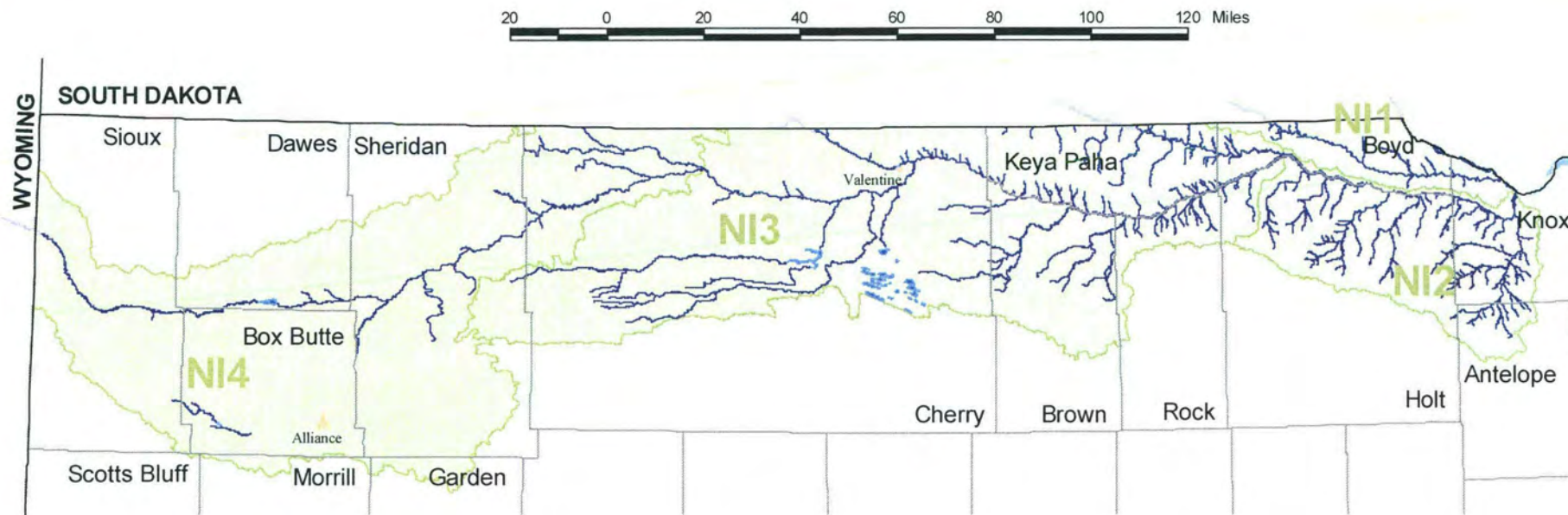
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**Figure 3.4-2 Niobrara River Basin (and Subbasins)**



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**FIGURE 3.4-2  
NIOBRARA RIVER BASIN  
(AND SUBBASINS)**

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Source: NDEQ, 2010

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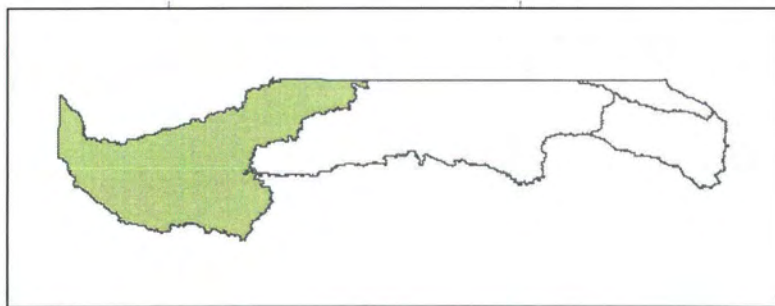
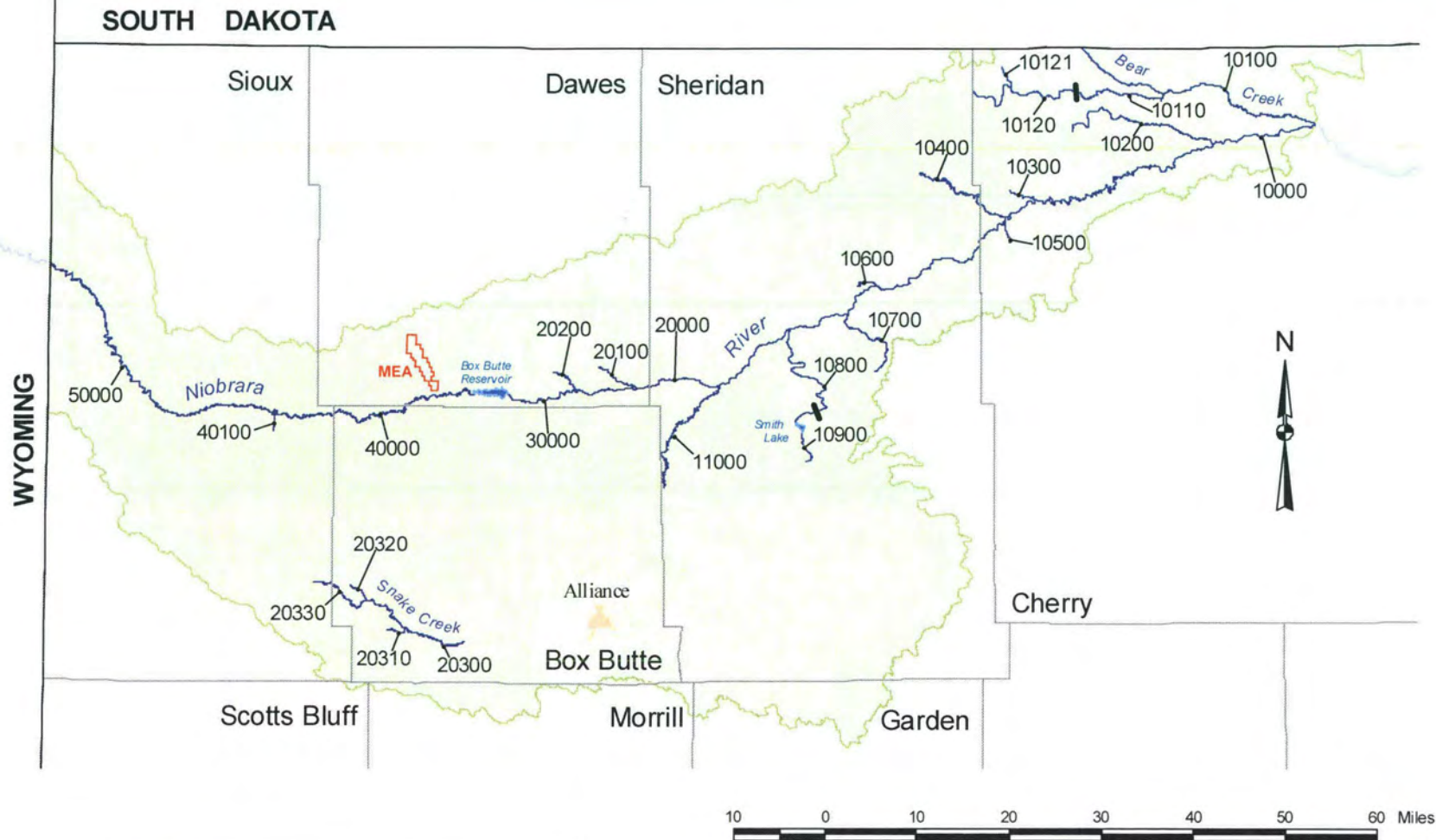
## **Environmental Report Marshland Expansion Area**

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**Figure 3.4-3    Niobrara River Subbasin N14**





Source: NDEQ, 2010

Revised July 2013



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**FIGURE 3.4-3**  
**NIOBRARA RIVER SUBBASIN N14**

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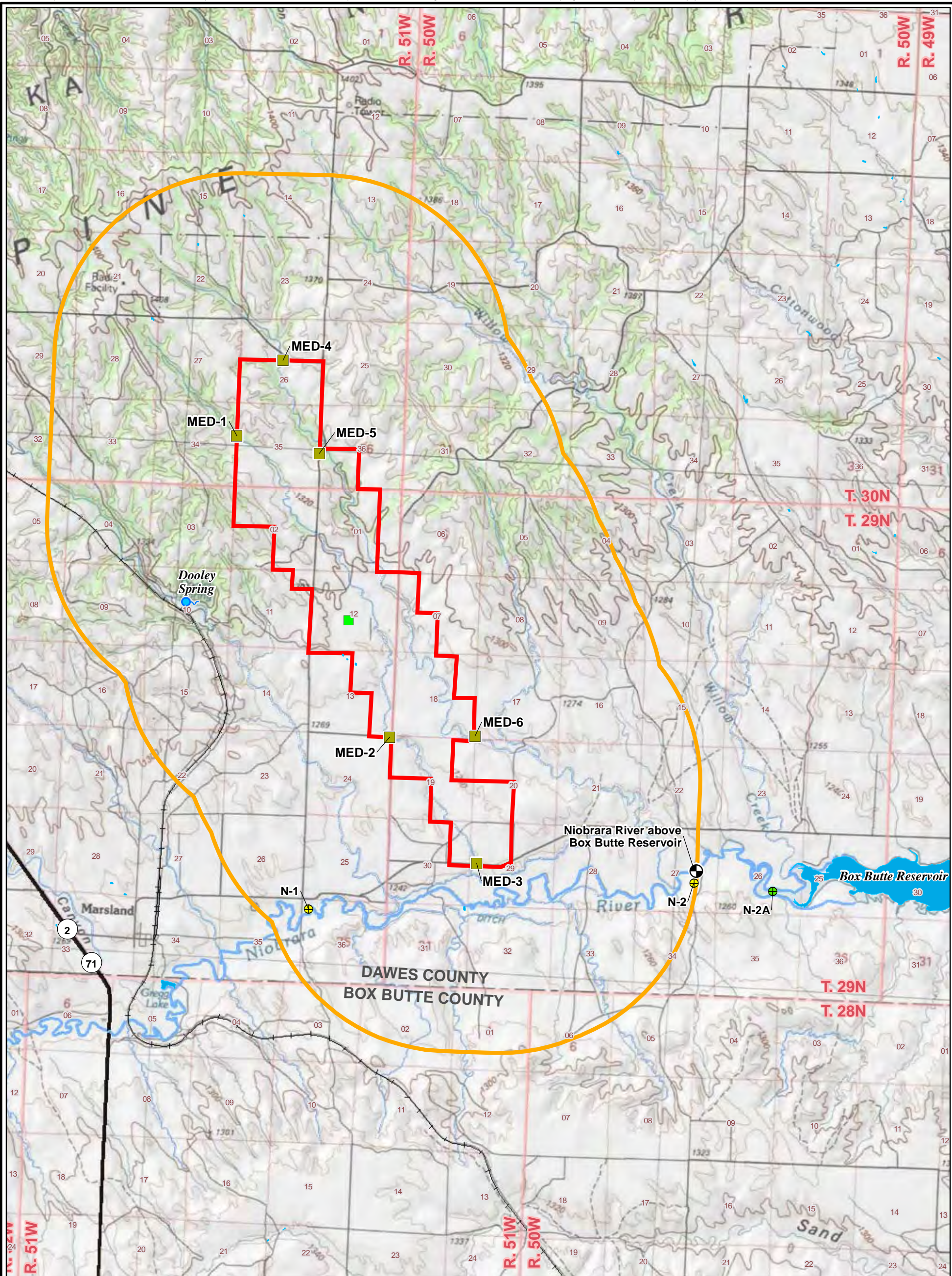
## **Environmental Report Marshland Expansion Area**

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**Figure 3.4-4 Marshland Expansion Area Surface Water Sampling Locations**

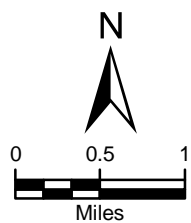




LEGEND

- |  |   |  |                     |
|--|---|--|---------------------|
|  | Proposed Marsland Expansion Area                        |  | Natural Spring      |
|  | Area of Review (AOR)                                    |  | Reservoir/Lake/Pond |
|  | Proposed Marsland Satellite Facility Site               |  | Perennial River     |
|  | CBR Surface Water/ Sediment Sampling Location           |  | Ephemeral Drainage  |
|  | CBR Sampling Point Abandoned as of 3/2013               |  | Railroad            |
|  | Marsland Ephemeral Drainage (MED)                       |  | State Highway       |
|  | Sediment and Surface Runoff Sampling Point              |  |                     |
|  | USGS/NDNR 06454500 and NDEQ SNI4NIOBR402 Gaging Station |  |                     |

Note: Fish sampling for radiological analysis occurs in headwaters of Box Butte Reservoir.



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



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FIGURE 3.4-4  
SURFACE WATER AND  
SEDIMENT SAMPLING LOCATIONS

PROJECT: CO001636      MAPPED BY: JC      CHECKED BY: JEC



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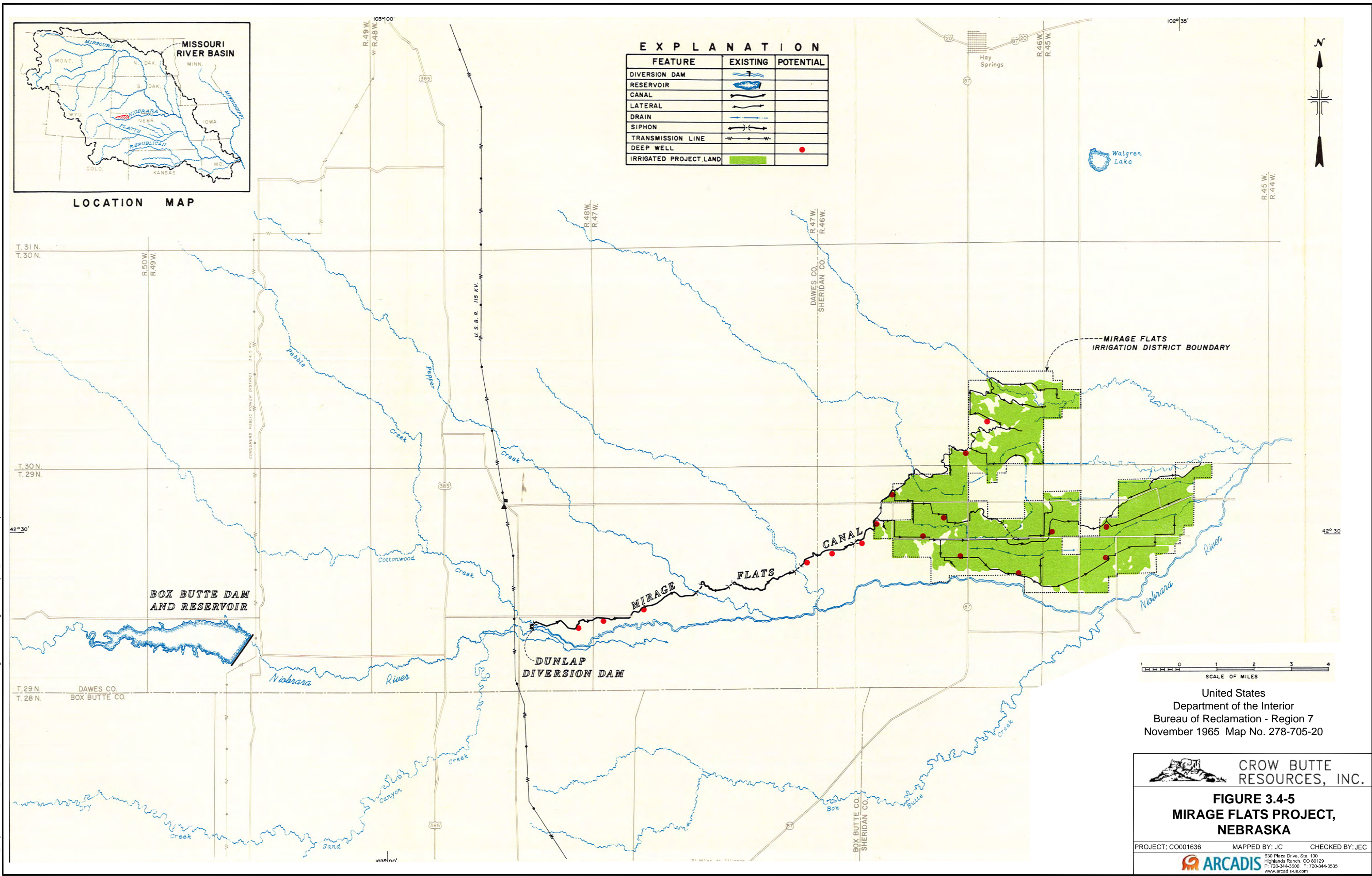
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**Figure 3.4-5    Mirage Flats Project, Nebraska**



K:\CBR\_Projects\CO001636\_Marland\3\_IMAGES\Illustrator\TR Figure 2.7-5 Mirage Flats Project\_11x17Landscape.ai @ 10/15/2011





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## **Environmental Report Marshland Expansion Area**

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**Figure 3.4-6 Major Surface Features/Structures Within AOR as per Title 122,  
Chapter 11, Section 006.09**