FIGURES
Monitoring Well
Montana Bureau of Mines and Geology (MBMG) Well
52SP
AB-21S
AB-24S
AB-23S
AB-22S
53SP
B-7
AB12-S
AB11-S
400
Gauging Station
Capture Well
Approximate Areal Extent of Lithologic Units
Plant Site Area Groundwater Model
CSES-Colstrip, Montana

FIGURE 4

Note: Lithologic extents interpolated from review of approximately 300 well logs, historic USGS topographic maps, aerial photography, and mine reports.

(USGS 1971, Western Energy 2013 A,B,C,D,E,F)

Note: 2013 NAIP Imagery
Note: Contact elevations interpolated from review of approximately 300 well logs, historic USGS topographic maps, aerial photography and mine reports.
(USGS 1971, Western Energy 2013A,B,C,D,E &F)

Note: 2003 NAIP Imagery
Note: Location of cross-section shown on Figure 2 and Figure 3

Hydrostratigraphic Cross Section A-A'  
Plant Site Area Groundwater Model  
CSES-Coalstrip, Montana  
FIGURE 6
Average Monthly Precipitation
Plant Site Area Groundwater Model
Colstrip, Montana
FIGURE 7

Note: Data from Western Regional Climate Center (see Appendix B)
Deviation from Annual Average Precipitation
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 8

Notes:
Data from Wester Regional Climate Center (see Appendix B).
Year excluded if more than 5 days are missing from any one month.
A large time period was allowed (2003 through 2013) to provide adequate spatial coverage. Hydrographs from site wells indicate a slight increase in water levels (between 2 and 5 feet) during this period. At the scale of this potentiometric map, this temporal difference would not greatly impact the gradient or direction of groundwater flow.
Note: McKay is eroded below East Fork Armells Creek.
Monitoring Well and Water Level Data

- 2009
- 1/9/2014, 2/4/19, 10/22/2013

Note: Sparse water level data is available for Deep Sub-McKay wells. A large time period was allowed (2004 through 2014) to provide adequate spatial coverage. Hydrographs from site wells indicate a slight increase in water levels (between 2 and 5 feet) during this period. At the scale of this potentiometric map, this temporal difference would not greatly impact the gradient or direction of groundwater flow.
Vertical Hydraulic Gradients

Plant Site Area Groundwater Model
CSES-Colstrip, Montana

FIGURE 18

Note: 2013 NAIP Imagery

LEGEND

<table>
<thead>
<tr>
<th>Well Pair</th>
<th>Upper Hydrostratigraphic Unit</th>
<th>Lower Hydrostratigraphic Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>100A/99D</td>
<td>Alluvium</td>
<td>Sub-McKay</td>
</tr>
<tr>
<td>104A/103D</td>
<td>Alluvium</td>
<td>McKay</td>
</tr>
<tr>
<td>126SP/125M</td>
<td>Spoils</td>
<td>McKay</td>
</tr>
<tr>
<td>128R/127M</td>
<td>Reservoir</td>
<td>McKay</td>
</tr>
<tr>
<td>129R/128M</td>
<td>Reservoir</td>
<td>McKay</td>
</tr>
<tr>
<td>130M/129D</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>131R/131M</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>13SP/13M</td>
<td>Spoils</td>
<td>McKay</td>
</tr>
<tr>
<td>13SP/13M</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>17M/17D</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>17S/17M</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>18S/18D</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>18SP/18S</td>
<td>Spoils</td>
<td>McKay</td>
</tr>
<tr>
<td>19M/19D-2</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>20S/20M</td>
<td>Alluvium</td>
<td>McKay</td>
</tr>
<tr>
<td>21M/21D</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>21SP-2/21M</td>
<td>Spoils</td>
<td>McKay</td>
</tr>
<tr>
<td>22SP/22M</td>
<td>Spoils</td>
<td>McKay</td>
</tr>
<tr>
<td>35M/35SP</td>
<td>Spoils</td>
<td>McKay</td>
</tr>
<tr>
<td>37SP/37M</td>
<td>Spoils</td>
<td>McKay</td>
</tr>
<tr>
<td>38SP/38M</td>
<td>Spoils</td>
<td>McKay</td>
</tr>
<tr>
<td>39S/39M</td>
<td>Interburden</td>
<td>McKay</td>
</tr>
<tr>
<td>9M/9S</td>
<td>Rosebud</td>
<td>Interburden</td>
</tr>
<tr>
<td>CA-12B/CA-12</td>
<td>Overburden</td>
<td>McKay</td>
</tr>
<tr>
<td>OT-20M/OT-20S</td>
<td>Alluvium</td>
<td>McKay</td>
</tr>
<tr>
<td>OT-21S/OT-21M</td>
<td>Colluvium</td>
<td>McKay</td>
</tr>
<tr>
<td>OT-21S/OT-21M</td>
<td>Colluvium</td>
<td>McKay</td>
</tr>
</tbody>
</table>

Note: Gradients generally calculated using February 2014 water level measurements. Except as follows:
-104A/103D and 100A/99D calculated using October 2013 water level data,
-OT-21S/OT-21M, OT-20S/OT-20M and OT-25R/OT-25M calculated using January 2011 water level data, and
-CA-12B/CA-12 calculated using January 2009 water level data.

Well pairs influenced by pumping are excluded.
Note: Deeper wells are symbolized with dashed and dotted hydrographs. SP = well finished in Spoils, M = well finished in McKay (excluding 9M), R = well finished in Rosebud, D = well finished in Sub McKay, S = well finished in Interburden or Overburden.
Note: Deeper wells are symbolized with dashed and dotted hydrographs.
FIGURE 21

Dissolved Boron in Alluvial Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana

Note: 2013 NAIP Imagery

Baseline screening level (BSL) for Boron in Alluvium = 1.5 mg/L (ARCADIS 2007) as of January 2015

Boron Alluvium
Approximate Extent of Fine Grained Alluvium/Colluvium

Boron Concentration (mg/L)

- > 1.5 to 5.0
- > 5.0 to 20
- > 20
Chloride in Alluvial Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 22

Chloride Alluvium
Approximate Extent of Fine Grained Alluvium/Colluvium
Chloride Concentration (mg/L)

- > 213 to 500
- > 500

Note: Baseline screening level (BSL) for Chloride in Alluvium = 213 mg/L (ARCADIS 2007) as of January 2015

Note: 2013 NAIP Imagery
Specific Conductance in Alluvial Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 23

Note: 2013 NAIP Imagery

Note:
Baseline screening level (BSL) for SC in Alluvium = 5,300 µmhos/cm
(ARCADIS 2007) as of January 2015

Specific Conductance (µmhos/cm)
- > 5,300 to 7,000
- > 7,000 to 10,000
- > 10,000

Approximate Extent of Fine Grained Alluvium/Colluvium

SC Alluvium
Sulfate in Alluvial Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 24
Monitoring Well
Approximate Extent of Spoils
Boron Concentration (mg/L)

- > 1.3 to 5.0
- > 5.0 to 20
- > 20

Baseline screening level (BSL) for Boron in Spoils = 1.3 mg/L (ARCADIS 2007) as of January 2015

Note: 2013 NAIP Imagery

Dissolved Boron in Spoils Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 25
Chloride in Spoils Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 26

Baseline screening level (BSL) for Chloride in Spoils = 73 mg/L (ARCADIS 2007) as of January 2015

Note: 2013 NAIP Imagery
Specific Conductance in Spoils Groundwater

Plant Site Area Groundwater Model
CSES-Colstrip, Montana

FIGURE 27

Note: 2013 NAIP Imagery

Specific Conductance (µmhos/cm)
- > 7,390 to 10,000
- > 10,000

Note:
Baseline screening level (BSL) for SC in Spoils = 7,390 µmhos/cm (ARCADIS 2007) as of January 2015
Sulfate in Spoils Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 28

Note: 2013 NAIP Imagery

Note: Baseline screening level (BSL) for Sulfate in Spoils = 5,000 mg/L (ARCADIS 2007) as of January 2015

Figure does not include "Deep Sub-McKay Water Quality because there are no "Deep Sub-McKay" monitoring wells in the Plant Site Area

Monitoring Well
Approximate Extent of Spoils
Sulfate Concentration (mg/L)
- > 5,000 to 10,000
- > 10,000

0 Feet 800

Note: 2013 NAIP Imagery

Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 28

Baseline screening level (BSL) for Sulfate in Spoils = 5,000 mg/L (ARCADIS 2007) as of January 2015

Figure does not include Deep Sub-McKay Water Quality because there are no "Deep Sub-McKay" monitoring wells in the Plant Site Area

Monitoring Well
Approximate Extent of Spoils
Sulfate Concentration (mg/L)
- > 5,000 to 10,000
- > 10,000

0 Feet 800

Note: 2013 NAIP Imagery

Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 28
Note: Baseline screening level (BSL) for Boron in Bedrock = 1.2 mg/L (ARCADIS 2007) as of January 2015.

Figure does not include Deep Sub-McKay Water Quality because there are no "Deep Sub-McKay" monitoring wells in the Plant Site Area.

Includes Water Quality from Wells Screened in McKay Coal.

Note: 2013 NAIP Imagery

Monitoring Well

Boron Concentration (mg/L)

- > 1.2 to 5.0
- > 5.0 to 20
- > 20

Dissolved Boron in Bedrock Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 29
FIGURE 30

Monitorig Well

Chloride Concentration (mg/L)

- > 48 to 200
- > 200

Note: 2013 NAIP Imagery

Note:
Baseline screening level (BSL)
for Chloride in Bedrock = 48 mg/L
(ARCADIS 2007) as of January 2015

Figure does not include Deep Sub-McKay
Water Quality because there are no
"Deep Sub-McKay" monitoring wells in
the Plant Site Area
Includes Water Quality from Wells
Screened in McKay Coal

Chloride in Bedrock Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 30
Specific Conductance in Bedrock Groundwater
April 2014
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 31

Note: 2013 NAIP Imagery

Figure does not include Deep Sub-McKay Water Quality because there are no "Deep Sub-McKay" monitoring wells in the Plant Site Area. Includes Water Quality from Wells Screened in McKay Coal.

Note: Baseline screening level (BSL) for SC in Bedrock = 3,940 µmhos/cm (ARCADIS 2007) as of January 2015.

Specific Conductance (µmhos/cm)

- > 3,940 to 7,000
- > 7000

Legend:
- Monitoring Well

Note:
- 0 Feet - 1,000 Feet
- 1,000 Feet - 2,000 Feet
- 2,000 Feet - 3,000 Feet
- 3,000 Feet - 4,000 Feet
- 4,000 Feet - 5,000 Feet
- 5,000 Feet - 6,000 Feet
- 6,000 Feet - 7,000 Feet
- 7,000 Feet - 8,000 Feet
- 8,000 Feet - 9,000 Feet
- 9,000 Feet - 10,000 Feet

Monitoring Well
Specific Conductance (µmhos/cm)
- > 3,940 to 7,000
- > 7000
Note:
Baseline screening level (BSL) for Sulfate in Bedrock = 2,310 mg/L (ARCADIS 2007) as of January 2015

Figure does not include Deep Sub-McKay Water Quality because there are no "Deep Sub-McKay" monitoring wells in the Plant Site Area
Includes Water Quality from Wells Screened in McKay Coal

Monitoring Well

Sulfate Concentration (mg/L)
- > 2,310 to 6,000
- > 6,000

Note: 2013 NAIP Imagery
New Model

Cross Section Location shown on Figure 35
New Model

Cross Section Location shown on Figure 35

FIGURE 38

Model Cross Section C-C'
Plant Site Area Groundwater Model
CSES Colstrip, Montana

FIGURE 38
Note: 2013 NAIP Imagery

Boundary Conditions Layer 1, 2 and 3
Plant Site Area Groundwater Model
CSES-Colstrip, Montana

FIGURE 39

Note: In 2003 the Southern Model Boundary is a General Head Boundary in Layers 3 and 4. This difference is due to the lack of dewatering in Area B of the Rosebud Mine Cut.
Note: In 2003 the Southern Model Boundary is a General Head Boundary in Layers 3 and 4. This difference is due to the lack of dewatering in area B of the Rosebud Mine Cut.

FIGURE 40

P:\Colstrip\04 GIS\Projects\PlantSite_Plumes\FIGURE 40 - Boundary.mxd

Note: 2013 NAIP Imagery

Well Package
FWLS Well Package
General Head
No Flow
Model Grid

Boundary Conditions Layer 4, 5 and 6
Plant Site Area Groundwater Model
CSES-Colstrip, Montana
FIGURE 41

Recharge Zones

1. Background
2. Units 1 & 2 Pond A
3. Units 1 & 2 Bottom Ash Ponds
4. South Cooling Tower Blowdown Pond C
5. Weco Pond PO-10
6. Weco Sediment Ponds Including PO-151
7. Units 3 & 4 Bottom Ash Pond
8. Units 3 & 4 Wash Tray Pond
9. Weco Pond PO-10A
10. Clay of Colstrip Sewer Lagoons
11. Cimarron Drainage
12. Clinker Infiltrating Recharge
13. Units 1 & 2 Plant Leak
14. Units 1 & 2 Plant Leak
15. North Cooling Tower Blowdown Pond C
16. Lawn Irrigation
17. Units 3 & 4 Bottom Ash Pond
18. Units 3 & 4 Bottom Ash Pond
19. Units 3 & 4 Bottom Ash Pond
20. Units 3 & 4 Bottom Ash Pond
21. Units 3 & 4 Bottom Ash Pond
22. Units 3 & 4 Bottom Ash Pond
23. Weco Pond PO-10B
24. Broken water line around well 12-R3 (Transient)
25. Lined Units 1 & 2 Pond B Brine Pond
26. Impervious Surface Area of Plant Site
27. Units 3 & 4 Drain Collection Pond
28. Former Brine Pond Area D4
29. Former Brine Pond Area D4
30. Un-vegetated Area of Plant Site
31. Brine Pond Area D1, 2, and 3 Pond
32. Sediment Retention Pond
33. Units 3 & 4 Bottom Ash Pond Area
34. Weco Pond
35. Weco Pond
36. Weco Pond
37. Weco Pond
38. Weco Pond
39. Units 3 & 4 Wash Tray Pond
40. Stormwater Retention Pond

Legend:
- Background
- Clinker Infiltrating Recharge
- Impervious
- Lawn Irrigation Infiltration
- Ponds Seepage
- Unvegetated Infiltration Recharge
- Model Domain

Note: 2003 NAIP Imagery
Calibrated Hydraulic Conductivity Distribution - Layer 1
Plant Site Area Groundwater Model
CSES-Coalstrip, Montana
FIGURE 42

Note: Kx and Ky values in Appendix K

Calibrated Hydraulic Conductivity Distribution - Layer 1
Plant Site Area Groundwater Model
CSES-Coalstrip, Montana
FIGURE 42

Note: Kx and Ky values in Appendix K
Note:  Kx and Ky values in Appendix K
Note: Kx and Ky values in Appendix K
Calibrated Hydraulic Conductivity Distribution - Layer 4
Plant Site Area Groundwater Model
CSES-Coalstrip, Montana
FIGURE 45

Note: Kx and Ky values in Appendix K

Note: 2013 NAIP Imagery

Hydraulic Conductivity Zone

Model Domain
0 2,000 Feet
Note: Kx and Ky values in Appendix K

Note: 2013 NAIP Imagery

Hydraulic Conductivity Zone

Model Domain

Calibrated Hydraulic Conductivity Distribution - Layer 5
Plant Site Area Groundwater Model
CSES-Coalstrip, Montana
FIGURE 46