US EPA Region 8

Powder River Watershed
Stream Water Quality
Pre- and Post-CBM Development

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Powder River Watershed Questions

1. What is the water quality of the permitted CBM discharge?

2. What is the ambient stream water quality?
   - What is the time period that represents “natural” background?
   - What impact has the drought had on water quality?
   - What are the relationships between flow and water quality?

3. What has been the impact of CBM discharge on stream water quality?
MT WQS for EC & SAR

- Powder River
  - EC: Irrigation Season
    - Average: 2000
    - Maximum: 2500
  - SAR: Irrigation Season
    - Average: 5.0
    - Maximum: 7.5

EC at $25^\circ$C = specific conductance (SpC).
Figure 2. Location of streamflow-gaging stations and stream-water-quality sites in the Powder River Basin, Wyoming and Montana.
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CBM Water Quality

- CBM Production
- SpC (= EC at 25°C)
- SAR
- SpC - SAR Relationship
CBM Water Production
Discharge Locations

Legend
- Tongue and Powder River HUC8 Rivers
- Major Water
- Cities
- CBM Production Discharge Locations

Powder River Watershed
Powder River Basin
CBM Water Production
Powder River Basin

Data Source: WY Oil & Gas Commission
CBM Water Quality
SpC

Data Source: WY DEQ DMR
CBM Water Quality
SAR

Data Source: WY DEQ DMR
CBM Produced Water Quality
SpC – SAR Relationship

Data Source: WY DEQ DMR

CBM Produced Water
Powder River Watershed

MT WQ Std Max
Irrigation Season

Data Source: WY DEQ DMR
CBM Water Quality
Data Summary

- **SpC:**
  - Median: 1900
  - Range (5% - 95%): 1000 to 4300
  - Lowest concentrations occur in southeast portion of basin.
  - Concentrations generally increase to northwest.

- **SAR**
  - Median: 20
  - Range (5% - 95%): 8 – 35
  - Lowest concentrations occur in southeast portion of basin.
  - Concentrations increase to northwest.
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Ambient Stream Water Quality

- USGS long term stations
- SpC, SAR, SpC & SAR relationships
- Time series analysis
- Flow versus concentration relationships
- Month statistics
- Comparison to MT WQ Stds
Powder River Watershed
Powder River Basin
Tea Pot: < Feb 1990
Wet: 1990 – 1999 (No O&G Discharge)
CBM: >= 2000 (CBM Production)
Tea Pot: < Feb 1990
Wet: 1990 – 1999 (No O&G Discharge)
CBM: >= 2000 (CBM Production)

Data Source: http://water.usgs.gov/nwis/
What is the time period that represents “natural” background?
Powder River at Moorhead
SpC Statistics 1990-1999 by Month

Powder River at Moorhead
Mar 1990 - Dec 1999

SpC (uS/cm)

Min
25th
Median
75th
Max
MT Ave Std
MT Max Std

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
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Powder River at Moorhead
SpC Statistics by Month

HED: March 2007
What is the time period that represents “natural” background?

Data Source: http://water.usgs.gov/nwis/
What impact has the drought had on water quality?

Data Source: http://water.usgs.gov/nwis/
Flow vs SpC
Powder River at Moorhead

What are the relationships between flow and water quality?

Flow (cfs) vs SpC (umho/cm)

Data Source: http://water.usgs.gov/nwis/
Flow-Adjusted Concentration

Technical Approach

1. Apply regression analysis to unambiguously, un-impacted, “wet” time period data.

2. Calculate predicted and residual (flow-adjusted) concentrations for all time periods using regression equation fit to “wet” time period data.


4. Evaluate flow-adjusted concentrations using parametric and non-parametric statistical tests to compare data from different time periods.
Flow Adjusted SpC
Powder River at Moorhead

SC vs Time

Discharge vs Time

Flow Adjusted SC vs Time

SC vs Discharge
SAR?

(Not analyzed 1990-99 at Powder River at Moorhead)
DRAFT: Preliminary Observations

SpC vs Calcium & Sodium
Powder River at Sussex & Arvada

Data Source: http://water.usgs.gov/nwis/
Powder River at Moorhead
Monthly Mean SpC

Monthly Mean SpC

Spc (us/cm)

No O&G
CBM
MT STD Avg

Error bars = Mean ± 95% UCL

DRAFT: Preliminary Observations

HED: March 2007
Powder River at Moorhead
Monthly Mean Flow Adjusted SpC

Error bars = Mean ± 95% UCL
Because of varying climate conditions and historical oil and gas operations in the basin, the available data do not allow an unambiguous determination of the impacts of CBM discharge on SpC and SAR in the Powder River at Moorhead.

When the data are considered in aggregate, existing discharge and SpC relationships appear to suggest that there has been no statistically significant impact from CBM operations on SpC in the Powder River at Moorhead.

Also, when the data are considered in aggregate, existing SAR and SpC relationships appear to suggest there has been no significant impact from CBM operations on SAR in the Powder River at Moorhead.

When monthly flow adjusted SpC statistics for the Powder River at Moorhead are considered, most months show no statistically significant impact from CBM operations. The exception is April, where flow adjusted SpC since CBM operations commenced is statistically greater than that of the period 1990-1999 when there was no discharge due to oil & gas operations.

The quality of discharge from CBM activities in the Powder River may deteriorate as development moves west and north, due to increased salinity in groundwater, and therefore may impact stream water quality in the future.