

BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
STATE OF WYOMING

FILED

AUG 17 2006

IN THE MATTER OF THE APPEAL OF)
4W RANCH, ROBERT L. HARSHBARGER)
AND JEAN SHERWIN HARSHBARGER)
AND THEIR OBJECTIONS TO WYPDES)
PERMIT NOS. 0051217, 0051233, 0051373)

Docket No. 04-3801
Terri A. Lorenzon, Director
Environmental Quality Council

DEQ'S PREHEARING MEMORANDUM

The Wyoming Department of Environmental Quality (DEQ), pursuant to the Wyoming Environmental Quality Council's (EQC) June 28, 2006 AMENDED NOTICE OF HEARING AND ORDER and related July 5, 2006 letter, submits this PREHEARING MEMORANDUM.

Witnesses

1. The DEQ will call Becky Peters. Ms. Peters is employed by the DEQ, Water Quality Division, Herschler Building, 4th Floor West, 122 W. 25th Street, Cheyenne, WY 82002, (307) 777-7781. Ms. Peters will testify about the terms, conditions, and issuance of contested WYPDES Permits Nos. WY0051217, WY0051233, and WY0051373.

2. The DEQ may also call Bill DiRienzo and/or Jason Thomas. Both Mr. DiRienzo and Mr. Thomas are employed by the DEQ, Water Quality Division, Herschler Building, 4th Floor West, 122 W. 25th Street, Cheyenne, WY 82002, (307) 777-7781. If called, Mr. DiRienzo and/or Mr. Thomas would testify about issues pertaining to permitting of coal bed methane (CBM) discharges.

3. The DEQ may call any of the other parties' witnesses.

4. The DEQ may call any other witnesses as may be necessary for purposes of impeachment or rebuttal.

Exhibits

The DEQ will or may seek to introduce the following exhibits:

1. Portions of New WYPDES Permit No. WY0051217 issued to Bill Barrett Corporation (Barrett) on April 5, 2004.
2. Portions of New WYPDES Permit No. WY0051233 issued to Barrett on April 5, 2004.
3. Portions of New WYPDES Permit No. WY0051373 issued to Merit Energy Company (Merit) on June 1, 2005.
4. Portions of Modified WYPDES Permit No. WY0051373 issued to Merit on April 10, 2006.
5. Large Map of the Antelope Creek / Cheyenne River Drainage prepared by the DEQ (a copy of which is also Deposition Exhibit #7 to the deposition of Petitioner Robert L. Harshbarger).
6. Portion(s) of the "Report to Accompany NPDES Permit Application for Discharge to Antelope Creek" dated April 16, 2001, Revised August 23, 2001, prepared by WWC Engineering (a copy of which is also Deposition Exhibit #33 to the deposition of Petitioner Robert L. Harshbarger).
7. Portion(s) of the February 2006 Draft Topical Report prepared by RESPEC (a copy of which is also Deposition Exhibit #13 to the deposition of Petitioner Robert L. Harshbarger).
8. Portion(s) of U.S. Department of Interior and USGS "Scientific Investigations Report 2006-5113."
9. Cheyenne River surface water data compiled by the United States Geological Survey (USGS) near Dull Center, Wyoming (site 06365900), which was obtained from the USGS website:

- (a) Mean of daily flow values . . . 1976-1996 (1 p).
 - (b) Mean of daily flow values . . . 1997-2005 (1 p).
 - (c) Spreadsheet of surface water data, 1975-2004 (6 pp).
 - (d) Continuation of spreadsheet of surface water data, 1975-2004 (5 pp).
 - (e) Spreadsheet of surface water data, 2005 (2 pp).
 - (f) Spreadsheet of surface water data, 2006 (2 pp).
10. DEQ figures based on the USGS Cheyenne River Dull Center surface water data:
- (a) Listing of 1975-2006 data on EC at flows < 1 cfs.
 - (b) Figure based on 1975-2006 data on EC at flows < 1 cfs.
 - (c) Figure of EC compared to flow rate.
11. Any other exhibits, including but not limited to deposition transcripts and exhibits and written responses to discovery requests and exhibits, as may be necessary for purposes of impeachment or rebuttal.

Summation of Facts and Legal Issues

The DEQ, Water Quality Division issued new WYPDES Permits Nos. WY0051217 and WY0051233 to Barrett on April 5, 2004. These permits authorize the surface discharge of water from coal bed methane production into drainages tributary to the Cheyenne River, provided the effluent quality is in compliance with the effluent limits established by the permits (including 2000 micromhos/cm for EC, 10 for SAR, and 6.5-8.5 for pH). The DEQ, Water Quality Division originally issued new WYPDES Permit No. WY0051373 to Merit on June 1, 2005. This permit authorized the surface discharge of water from coal bed methane production into drainages tributary to the Cheyenne River, provided the effluent quality is in compliance with the effluent limits established by the permit (including 2000 micromhos/cm for EC, 10 for SAR, and 6.5-8.5 for pH).

Merit Permit No. WY0051373 was subsequently modified, effective April 10, 2006, retaining effluent limits of 2000 micromhos/cm for EC and 10 for SAR, but changing the upper limit for pH from 8.5 to 9.0, in accordance with current Wyoming Water Quality Rules, Chapter 2, Appendix H.

Petitioners Robert L. Harshbarger and Jean Sherwin Harshbarger, by two page letter dated 2 June 2004, appealed these three particular WYPDES Permits (the contested permits), although the original Merit permit (WY0051373), which had gone out for public comment as a draft, was not issued until a year later, in June, 2005. The issues raised by this appeal, as identified in Petitioners' 2 June 2004 letter, primarily involve whether the permit effluent limits (primarily EC, SAR, and pH) protect Petitioners' use of Cheyenne River water for their existing agricultural irrigation, and whether the permitted discharges will "alter the basic stream flow" and cause injury to Petitioners' private property or water rights.

Dated this 17th day of August, 2006.



Mike Barrash
Sr. Assistant Attorney General
123 Capitol Building
Cheyenne, Wyoming 82002
307-777-6946

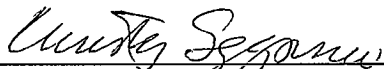
CERTIFICATE OF SERVICE

A true and correct copy of the foregoing DEQ'S PREHEARING MEMORANDUM was served this 17th day of August, 2006 by **e-mail and deposit in the United States mail**, first class postage prepaid, addressed as follows:

Robert L. Harshbarger
Jean Sherwin Harshbarger
4W Ranch
1162 Lynch Road
Newcastle, WY 82701
<harshbarger@agristar.net>

Jack Palma
Hadassah Reimer
Holland & Hart
2515 Warren Ave., Suite 450
P.O. Box 1347
Cheyenne, WY 82003-1347
<hmreimer@hollandhart.com>

John Sundahl
Sundahl, Powers, Kapp & Martin
1725 Carey Avenue
P.O. Box 328
Cheyenne, WY 82003-0328
<jsundahl@spkm.org>



Office of the Wyoming Attorney General



Dave Freudenthal
GOVERNOR

Department of Environmental Quality

Herschler Building • 122 West 25th Street • Cheyenne, Wyoming 82002

ADMINISTRATION	ABANDONED MINES	AIR QUALITY	INDUSTRIAL SITING	LAND QUALITY	SOLID & HAZARDOUS WASTE	WATER QUALITY
(307) 777-7758 FAX 777-7682	(307) 777-8145 FAX 634-0799	(307) 777-7391 FAX 777-5816	(307) 777-7368 FAX 777-6937	(307) 777-7756 FAX 634-0799	(307) 777-7752 FAX 777-5973	(307) 777-7781 FAX 777-5973

STATEMENT OF BASIS

New

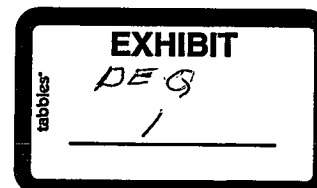
APPLICANT NAME: Bill Barrett Corporation

MAILING ADDRESS: 1901 Energy Court, Suite 170
Gillette, WY 82718

FACILITY LOCATION: Palm Tree Project CBM facility located in the NESW of Section 3, the NENE of Section 4, the SWNW of Section 5, the SESW of Section 6, the NENW, NESE of Section 7, the NWSE, SESE of Section 8, the NWNW of Section 9, the NESW of Section 10, the NENE of Section 15, the NESW of Section 16, the NENW of Section 17, the NESE of Section 18, the SESE of Section 19, the NWSE of Section 20, Township 41 North, Range 74 West; the NESW of Section 32, Township 42 North, Range 74 West, the SWNW of Section 1, the SWSE, SWSW of Section 2, the NENE, NESE, SWNW of Section 12, the SESW of Section 13, the NESW of Section 24, Township 41 North, Range 75 West in Campbell County. The produced water will be discharged to Pine Tree Draw, Ninemile Creek, Simmons Draw, and unnamed ephemeral tributaries (all class 3B water), tributary to Antelope Creek (class 3B water) in the Cheyenne River (class 2ABWW) watershed. The daily maximum permitted discharge flow rate for this facility is 4.4 MGD from the Big George coal seam. There are twenty five outfalls in this permit.

NUMBER: WY0051217

This facility is a typical coal bed methane production facility in which groundwater is pumped from a coal bearing formation resulting in the release of methane from the coal bed. The permit authorizes the discharge to the surface of groundwater produced in this way provided the effluent quality is in compliance with effluent limits that are established by this permit. In developing effluent limits, all federal and state regulations and standards have been considered and the most stringent requirements incorporated into the permit. The EPA Effluent Guidelines and Standards for Oil and Gas Extraction Point Source Category (Part 435, Subpart E) predate the development of coal bed methane extraction technology; however the technology is similar enough to conventional gas extraction that, in the professional judgment of the WDEQ, this effluent limit guideline is appropriately applied to coal bed methane gas production. The guideline limits oil and grease effluent concentrations to less than 35 mg/l and requires that discharges of produced water be used to enhance agricultural production and/or wildlife propagation. In this case, the permittee and landowner(s) have determined that the discharged water will be used for stock watering, irrigation and wildlife propagation. Furthermore, the Water Quality Division has determined that the proposed discharged water is of sufficient quality to support these uses. This permit does not cover activities associated with discharges of drilling fluids, acids, stimulation waters or other fluids derived from the drilling or completion of the wells.



The permittee has chosen option 2 of the coal bed methane permitting options. Under this permitting option, the produced water is immediately discharged to a class 2 or class 3 receiving stream which is eventually tributary to a class 2AB perennial water of the state. The permit establishes effluent limits for the end of pipe, which are protective of all the designated uses defined in Chapter 1 of Wyoming Water Quality Rules and Regulations. This may include drinking water, game and non-game fish, fish consumption, aquatic life other than fish, recreation, agriculture, wildlife, industry and scenic value.

Permit effluent limits are based on federal and state regulations and are effective as of the date of issuance. The daily maximum discharge flow rate for this facility is 4.4 MGD and must be monitored monthly. The permit limits total petroleum hydrocarbons to 10 mg/l and must be monitored yearly. The pH must remain within 6.5 and 8.5 standard units. Effluent limits for total dissolved solids (5,000 mg/l) and sulfates (3,000 mg/l) are included to protect for stock and wildlife watering. These limits are based upon Wyoming Water Quality Rules and Regulations, Chapter 7 and apply to discharge from any permitted outfall. In addition, the permit establishes a radium 226 limit of 1 pCi/l, a dissolved manganese limit of 910 $\mu\text{g/l}$, a total barium limit of 1,800 $\mu\text{g/l}$, a total arsenic limit of 2.4 $\mu\text{g/l}$ and a chlorides limit of 46 mg/l, all of which are to be monitored yearly. These limits are based on standards for class 2AB waters which are intended to protect for the above listed designated uses and reflect the application of the antidegradation provisions required under Chapter 1 of the Wyoming Water Quality Rules and Regulations. A dissolved iron limit of 1,000 $\mu\text{g/l}$ is also included for outfalls that are greater than or equal to one mile from a class 2 stream. This is to protect class 3B waters and is to be monitored yearly.

Results are to be reported twice-yearly and if no discharge occurs then "no discharge" is to be reported. The permit also requires that an initial monitoring of the effluent be conducted within the first 30 days of discharge and the results submitted to WDEQ and the U.S. Environmental Protection Agency within 90 days of the commencement of discharge.

In order to monitor and regulate coal bed methane discharge for compliance with Chapter 1, Section 20 (protection of agricultural water supply), effluent limits for sodium adsorption ratio (SAR) and specific conductance are included in this permit. The Wyoming DEQ has determined that an SAR of 10 and specific conductance of 2,000 micromhos/cm is intended to be protective of agriculture use in the Belle Fourche River and Cheyenne River drainages. The specific conductance limit of 2,000 micromhos/cm is based on the threshold value for alfalfa which is considered to be the most salt sensitive plant irrigated in northeastern Wyoming (USDA George E. Brown Jr. Salinity Laboratory, Salt Tolerance Database, Grasses and Forage Crops). The SAR limit of 10 was determined to not reduce the rate of infiltration relative to ambient water quality in the Belle Fourche and Cheyenne Rivers, given the specific conductance threshold referenced above as ascertained from Figure 3 (page 44) of Agricultural Salinity and Drainage, Hanson et al., 1999 revision. Additionally, a SAR limit of 10 and specific conductance limit of 2,000 micromhos/cm will maintain the baseline C3-S2 irrigation suitability category for these drainages (see Figure 25, of Diagnosis and Improvement of Saline and Alkali Soils, US Dept. of Agricultural Handbook No. 60, 1954). Monitoring will be required for total alkalinity, dissolved calcium, dissolved magnesium, dissolved sodium, bicarbonate, sodium adsorption ratio and specific conductance monthly at the outfall(s) during the irrigation months of April, May, June, July, August and September.

There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause formation of visible deposits of iron, hydrocarbons or any other constituent on the bottom or shoreline of the receiving water. In addition, erosion control measures will be implemented to prevent significant damage to or erosion of the receiving water channel at the point of discharge.

The discharge of wastewater and the effluent limits that are established in this permit have been reviewed to ensure that the levels of water quality necessary to protect the designated uses of the receiving waters are maintained and protected. An antidegradation review has been conducted and verifies that the permit conditions, including the effluent limitations established, provide a level of protection to the receiving water consistent with the antidegradation provisions of Wyoming surface water quality standards.

Self monitoring of effluent quality and quantity is required on a regular basis with reporting of results semiannually. The permit is scheduled to expire on February 28, 2009.

Becky Peters
Water Quality Division
Department of Environmental Quality
December 23, 2003

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, (hereinafter referred to as "the Act"), and the Wyoming Environmental Quality Act,

Bill Barrett Corporation

is authorized to discharge from the wastewater treatment facilities serving the

Palm Tree Project CBM facility

located in

the NESW of Section 3, the NENE of Section 4, the SWNW of Section 5, the SESW of Section 6, the NENW, NESE of Section 7, the NWSE, SESE of Section 8, the NWNW of Section 9, the NESW of Section 10, the NENE of Section 15, the NESW of Section 16, the NENW of Section 17, the NESE of Section 18, the SESE of Section 19, the NWSE of Section 20, Township 41 North, Range 74 West; the NESW of Section 32, Township 42 North, Range 74 West, the SWNW of Section 1, the SWSE, SWSW of Section 2, the NENE, NESE, SWNW of Section 12, the SESW of Section 13, the NESW of Section 24, Township 41 North, Range 75 West in Campbell County

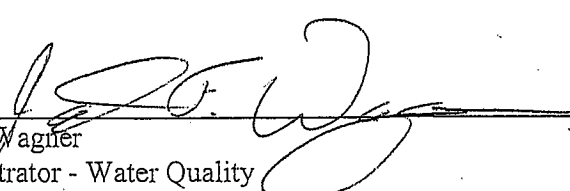
to receiving waters named

Pine Tree Draw, Ninemile Creek, Simmons Draw, and unnamed ephemeral tributaries (all class 3B water), all tributary to Antelope Creek (class 3B water) in the Cheyenne River (class 2ABWW) watershed

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II and III hereof.

The permit shall become effective on the date that it is signed below by the Director of the Department of Environmental Quality below.

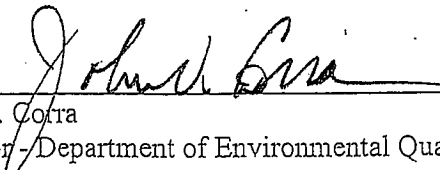
This permit and the authorization to discharge shall expire at midnight, February 28, 2009.



John F. Wagner
Administrator - Water Quality

4/3/04

Date



John V. Cotra
Director - Department of Environmental Quality

4/3/04

Date

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Effective immediately and lasting through February 28, 2009, the quality of effluent discharged by the permittee shall, at a minimum, meet the limitations set forth below. The permittee is authorized to discharge from outfalls(s) serial number(s) 001 - 025.

- Such discharges shall be limited as specified below:

Effluent Limits

Effluent Characteristic	Daily Maximum
Chlorides, mg/l	46
Dissolved Iron, µg/l	1000
Dissolved Manganese, µg/l	910
pH, su	6.5 - 8.5
Sodium Adsorption Ratio	10
Specific Conductance, micromhos/cm	2000
Sulfates, mg/l	3000
Total Arsenic, µg/l	2.4
Total Barium, µg/l	1800
Total Dissolved Solids, mg/l	5000
Total Flow, MGD**	4.4
Total Petroleum Hydrocarbons (TPH), mg/l*	10
Total Radium 226, pCi/l	1

*Acceptable methods for this parameter are 1664 in the latest edition of Standard Methods for the Examination of Water and Wastewater and EPA SW846 Method 8015 (modified) for Total Extractable Petroleum Hydrocarbons.

**This shall be the combined flow from outfall(s) 001 - 025.

The daily maximum permitted discharge flow rate for this facility is 4.4 million gallons per day (MGD). The effluent discharged at this facility will originate from the Big George coal seam.

The pH shall not be less than 6.5 standard units nor greater than 8.5 standard units in any single grab sample.

Information gathered from the water quality monitoring stations may result in modification of the permit to protect existing uses on the tributary and the mainstem.

There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause formation of a visible sheen or visible hydrocarbon deposits on the bottom or shoreline of the receiving water.



Dave Freudenthal
GOVERNOR

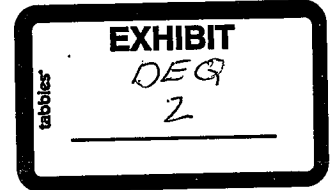
Department of Environmental Quality

Herschler Building • 122 West 25th Street • Cheyenne, Wyoming 82002

ADMINISTRATION	ABANDONED MINES	AIR QUALITY	INDUSTRIAL SITING	LAND QUALITY	SOLID & HAZARDOUS WASTE	WATER QUALITY
(307) 777-7758 FAX 777-7682	(307) 777-6145 FAX 634-0799	(307) 777-7391 FAX 777-5616	(307) 777-7398 FAX 777-6937	(307) 777-7756 FAX 634-0799	(307) 777-7752 FAX 777-5973	(307) 777-7781 FAX 777-5973

STATEMENT OF BASIS

New



APPLICANT NAME: Bill Barrett Corporation

MAILING ADDRESS: 1901 Energy Court, Suite 170
Gillette, WY 82718

FACILITY LOCATION: Big Porcupine Project CBM facility located in the NESW of Section 19, the NWSE of Section 20, Township 42 North, Range 70 West; the SESW of Section 23, the NWSW of Section 26, Township 42 North, Range 71 West in Campbell County. The produced water will be discharged to Porcupine Creek, Boss Draw and unnamed ephemeral tributaries (all class 3B water), tributary to Antelope Creek (class 3B water) in the Cheyenne River (class 2ABWW) watershed. The daily maximum permitted discharge flow rate for this facility is 3.4 MGD from the Wyodak coal seam. There are four outfalls in this permit.

NUMBER: WY0051233

This facility is a typical coal bed methane production facility in which groundwater is pumped from a coal bearing formation resulting in the release of methane from the coal bed. The permit authorizes the discharge to the surface of groundwater produced in this way provided the effluent quality is in compliance with effluent limits that are established by this permit. In developing effluent limits, all federal and state regulations and standards have been considered and the most stringent requirements incorporated into the permit. The EPA Effluent Guidelines and Standards for Oil and Gas Extraction Point Source Category (Part 435, Subpart E) predate the development of coal bed methane extraction technology; however the technology is similar enough to conventional gas extraction that, in the professional judgment of the WDEQ, this effluent limit guideline is appropriately applied to coal bed methane gas production. The guideline limits oil and grease effluent concentrations to less than 35 mg/l and requires that discharges of produced water be used to enhance agricultural production and/or wildlife propagation. In this case, the permittee and landowner(s) have determined that the discharged water will be used for stock watering, irrigation and wildlife propagation. Furthermore, the Water Quality Division has determined that the proposed discharged water is of sufficient quality to support these uses. This permit does not cover activities associated with discharges of drilling fluids, acids, stimulation waters or other fluids derived from the drilling or completion of the wells.

The permittee has chosen option 2 of the coal bed methane permitting options. Under this permitting option, the produced water is immediately discharged to a class 2 or class 3 receiving stream which is eventually tributary to a class 2AB perennial water of the state. The permit establishes effluent limits for the end of pipe, which are protective of all the designated uses defined in Chapter 1 of Wyoming Water Quality Rules and Regulations. This may include drinking water, game and non-game fish, fish consumption, aquatic life other than fish, recreation, agriculture, wildlife, industry and scenic value.

Permit effluent limits are based on federal and state regulations and are effective as of the date of issuance. The daily maximum discharge flow rate for this facility is 3.4 MGD and must be monitored monthly. The permit limits total petroleum hydrocarbons to 10 mg/l and must be monitored yearly. The pH must remain within 6.5 and 8.5 standard units. Effluent limits for total dissolved solids (5,000 mg/l) and sulfates (3,000 mg/l) are included to protect for stock and wildlife watering. These limits are based upon Wyoming Water Quality Rules and Regulations, Chapter 7 and apply to

discharge from any permitted outfall. In addition, the permit establishes a radium 226 limit of 1 pCi/l, a dissolved manganese limit of 910 $\mu\text{g/l}$, a total barium limit of 1,800 $\mu\text{g/l}$, a total arsenic limit of 2.4 $\mu\text{g/l}$ and a chlorides limit of 46 mg/l, all of which are to be monitored yearly. These limits are based on standards for class 2AB waters which are intended to protect for the above listed designated uses and reflect the application of the antidegradation provisions required under Chapter 1 of the Wyoming Water Quality Rules and Regulations. A dissolved iron limit of 1,000 $\mu\text{g/l}$ is also included for outfalls that are greater than or equal to one mile from a class 2 stream. This is to protect class 3B waters and is to be monitored yearly.

Results are to be reported twice-yearly and if no discharge occurs then "no discharge" is to be reported. The permit also requires that an initial monitoring of the effluent be conducted within the first 30 days of discharge and the results submitted to WDEQ and the U.S. Environmental Protection Agency within 90 days of the commencement of discharge.

In order to monitor and regulate coal bed methane discharge for compliance with Chapter 1, Section 20 (protection of agricultural water supply), effluent limits for sodium adsorption ratio (SAR) and specific conductance are included in this permit. The Wyoming DEQ has determined that an SAR of 10 and specific conductance of 2,000 micromhos/cm is intended to be protective of agriculture use in the Belle Fourche River and Cheyenne River drainages. The specific conductance limit of 2,000 micromhos/cm is based on the threshold value for alfalfa which is considered to be the most salt sensitive plant irrigated in northeastern Wyoming (USDA George E. Brown Jr. Salinity Laboratory, Salt Tolerance Database, Grasses and Forage Crops). The SAR limit of 10 was determined to not reduce the rate of infiltration relative to ambient water quality in the Belle Fourche and Cheyenne Rivers, given the specific conductance threshold referenced above as ascertained from Figure 3 (page 44) of Agricultural Salinity and Drainage, Hanson et al., 1999 revision. Additionally, a SAR limit of 10 and specific conductance limit of 2,000 micromhos/cm will maintain the baseline C3-S2 irrigation suitability category for these drainages (see Figure 25, of Diagnosis and Improvement of Saline and Alkali Soils, US Dept. of Agricultural Handbook No. 60, 1954). Monitoring will be required for total alkalinity, dissolved calcium, dissolved magnesium, dissolved sodium, bicarbonate, sodium adsorption ratio and specific conductance monthly at the outfall(s) during the irrigation months of April, May, June, July, August and September.

There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause formation of visible deposits of iron, hydrocarbons or any other constituent on the bottom or shoreline of the receiving water. In addition, erosion control measures will be implemented to prevent significant damage to or erosion of the receiving water channel at the point of discharge.

The discharge of wastewater and the effluent limits that are established in this permit have been reviewed to ensure that the levels of water quality necessary to protect the designated uses of the receiving waters are maintained and protected. An antidegradation review has been conducted and verifies that the permit conditions, including the effluent limitations established, provide a level of protection to the receiving water consistent with the antidegradation provisions of Wyoming surface water quality standards.

Self monitoring of effluent quality and quantity is required on a regular basis with reporting of results semiannually. The permit is scheduled to expire on February 28, 2009.

Becky Peters
Water Quality Division
Department of Environmental Quality
January 13, 2004

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, (hereinafter referred to as "the Act"), and the Wyoming Environmental Quality Act,

Bill Barrett Corporation

is authorized to discharge from the wastewater treatment facilities serving the

Big Porcupine CBM facility

located in

the NESW of Section 19, the NWSE of Section 20, Township 42 North, Range 70 West; the SESW of Section 23, the NWSW of Section 26, Township 42 North, Range 71 West in Campbell County.

to receiving waters named

Porcupine Creek, Boss Draw and unnamed ephemeral tributaries (all class 3B water), tributary to Antelope Creek (class 3B water) in the Cheyenne River (class 2ABWW) watershed

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II and III hereof.

The permit shall become effective on the date that it is signed below by the Director of the Department of Environmental Quality below.

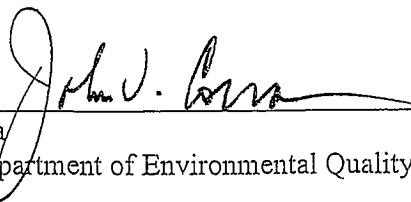
This permit and the authorization to discharge shall expire at midnight, February 28, 2009.



John F. Wagner
Administrator - Water Quality

4/2/04

Date



John V. Corra
Director - Department of Environmental Quality

4/15/04

Date

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Effective immediately and lasting through February 28, 2009, the quality of effluent discharged by the permittee shall, at a minimum, meet the limitations set forth below. The permittee is authorized to discharge from outfalls(s) serial number(s) 001 - 004.

- Such discharges shall be limited as specified below:

Effluent Limits

Effluent Characteristic	Daily Maximum
Chlorides, mg/l	46
Dissolved Iron, µg/l	1000
Dissolved Manganese, µg/l	910
pH, su	6.5 - 8.5
Sodium Adsorption Ratio	10
Specific Conductance, micromhos/cm	2000
Sulfates, mg/l	3000
Total Arsenic, µg/l	2.4
Total Barium, µg/l	1800
Total Dissolved Solids, mg/l	5000
Total Flow, MGD**	3.4
Total Petroleum Hydrocarbons (TPH), mg/l*	10
Total Radium 226, pCi/l	1

*Acceptable methods for this parameter are 1664 in the latest edition of Standard Methods for the Examination of Water and Wastewater and EPA SW846 Method 8015 (modified) for Total Extractable Petroleum Hydrocarbons.

**This shall be the combined flow from outfall(s) 001 - 004.

The daily maximum permitted discharge flow rate for this facility is 3.4 million gallons per day (MGD). The effluent discharged at this facility will originate from the Wyodak coal seam.

The pH shall not be less than 6.5 standard units nor greater than 8.5 standard units in any single grab sample.

Information gathered from the water quality monitoring stations may result in modification of the permit to protect existing uses on the tributary and the mainstem.

There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause formation of a visible sheen or visible hydrocarbon deposits on the bottom or shoreline of the receiving water.

STATEMENT OF BASIS

New

APPLICANT NAME: Merit Energy Company

MAILING ADDRESS: 13727 Noel Road, Suite 500
Dallas, TX 75240

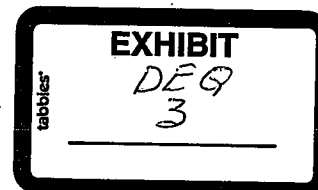
FACILITY LOCATION: Tuit Draw CBM facility located in the NENW, SWSE, NESW, SWSW of Section 34, the NWNW of Section 35, Township 43 North, Range 72 West in Campbell County. The produced water will be discharged to Little Porcupine Creek and its unnamed ephemeral tributaries (class 3B water), in the Cheyenne River (class 2ABWW) watershed. The daily maximum permitted discharge flow rate for this facility is 0.86 MGD from the Wyodak coal seam. There are 5 outfalls in this permit.

NUMBER: WY0051373

This facility is a typical coal bed methane production facility in which groundwater is pumped from a coal bearing formation resulting in the release of methane from the coal bed. The permit authorizes the discharge to the surface of groundwater produced in this way provided the effluent quality is in compliance with effluent limits that are established by this permit. In developing effluent limits, all federal and state regulations and standards have been considered and the most stringent requirements incorporated into the permit. The EPA Effluent Guidelines and Standards for Oil and Gas Extraction Point Source Category (Part 435, Subpart E) predate the development of coal bed methane extraction technology; however the technology is similar enough to conventional gas extraction that, in the professional judgment of the WDEQ, this effluent limit guideline is appropriately applied to coal bed methane gas production. The guideline limits oil and grease effluent concentrations to less than 35 mg/l and requires that discharges of produced water be used to enhance agricultural production and/or wildlife propagation. In this case, the permittee and landowner(s) have determined that the discharged water will be used for stock watering. Furthermore, the Water Quality Division has determined that the proposed discharged water is of sufficient quality to support this use. This permit does not cover activities associated with discharges of drilling fluids, acids, stimulation waters or other fluids derived from the drilling or completion of the wells.

The permittee has chosen option 2 of the coal bed methane permitting options. Under this permitting option, the produced water is immediately discharged to a class 2 or class 3 receiving stream which is eventually tributary to a class 2AB perennial water of the state. The permit establishes effluent limits for the end of pipe, which are protective of all the designated uses defined in Chapter 1 of Wyoming Water Quality Rules and Regulations. This may include drinking water, game and non-game fish, fish consumption, aquatic life other than fish, recreation, agriculture, wildlife, industry and scenic value.

Permit effluent limits are based on federal and state regulations and are effective as of the date of issuance. The daily maximum discharge flow rate for this facility is 0.86 MGD and must be monitored monthly. The permit limits total petroleum hydrocarbons to 10 mg/l and must be monitored yearly. The pH must remain within 6.5 and 8.5 standard units. Effluent limits for total dissolved solids (5,000 mg/l) and sulfates (3,000 mg/l) are included to protect for stock and wildlife watering. These limits are based upon Wyoming Water Quality Rules and Regulations, Chapter 7 and apply to discharge from any permitted outfall. In addition, the permit establishes a radium 226 limit of 1 pCi/l, a dissolved manganese limit of 910 µg/l, a total barium limit of 1,800 µg/l, a total arsenic limit of 2.4 µg/l and a chlorides limit of 46 mg/l, all of which are to be monitored yearly. These limits are based on standards for class 2AB waters which are intended to protect for the above listed



designated uses and reflect the application of the antidegradation provisions required under Chapter 1 of the Wyoming Water Quality Rules and Regulations. A dissolved iron limit of 1,000 $\mu\text{g/l}$ is also included for outfalls that are greater than or equal to one mile from a class 2 stream. This is to protect class 3B waters and is to be monitored yearly.

Results are to be reported twice-yearly and if no discharge occurs then "no discharge" is to be reported. The permit also requires that an initial monitoring of the effluent be conducted within the first 60 days of discharge and the results submitted to WDEQ and the U.S. Environmental Protection Agency within 120 days of the commencement of discharge.

In order to monitor and regulate coal bed methane discharge for compliance with Chapter 1, Section 20 (protection of agricultural water supply), effluent limits for sodium adsorption ratio (SAR) and specific conductance are included in this permit. The Wyoming DEQ has determined that an SAR of 10 and specific conductance of 2,000 micromhos/cm is intended to be protective of agriculture use in the Belle Fourche River and Cheyenne River drainages. The specific conductance limit of 2,000 micromhos/cm is based on the threshold value for alfalfa which is considered to be the most salt sensitive plant irrigated in northeastern Wyoming (USDA George E. Brown Jr. Salinity Laboratory, Salt Tolerance Database, Grasses and Forage Crops). The SAR limit of 10 was determined to not reduce the rate of infiltration relative to ambient water quality in the Belle Fourche and Cheyenne Rivers, given the specific conductance threshold referenced above as ascertained from Figure 3 (page 44) of Agricultural Salinity and Drainage, Hanson et al., 1999 revision. Additionally, a SAR limit of 10 and specific conductance limit of 2,000 micromhos/cm will maintain the baseline C3-S2 irrigation suitability category for these drainages (see Figure 25, of Diagnosis and Improvement of Saline and Alkali Soils, US Dept. of Agricultural Handbook No. 60, 1954). Monitoring will be required for total alkalinity, dissolved calcium, dissolved magnesium, dissolved sodium, bicarbonate, sodium adsorption ratio and specific conductance monthly at the outfall(s) during the irrigation months of April, May, June, July, August and September.

There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause formation of visible deposits of iron, hydrocarbons or any other constituent on the bottom or shoreline of the receiving water. In addition, erosion control measures will be implemented to prevent significant damage to or erosion of the receiving water channel at the point of discharge.

The discharge of wastewater and the effluent limits that are established in this permit have been reviewed to ensure that the levels of water quality necessary to protect the designated uses of the receiving waters are maintained and protected. An antidegradation review has been conducted and verifies that the permit conditions, including the effluent limitations established, provide a level of protection to the receiving water of Wyoming surface water quality standards.

Self monitoring of effluent quality and quantity is required on a regular basis with reporting of results semiannually. The permit is scheduled to expire on March 31, 2009.

Becky Peters
Water Quality Division
Department of Environmental Quality
January 29, 2004

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, (hereinafter referred to as "the Act"), and the Wyoming Environmental Quality Act,

Merit Energy Company

is authorized to discharge from the wastewater treatment facilities serving the

Tuit Draw CBM facility

located in

the NENW, SWSE, NESW, SWSW of Section 34, the NWNW of Section 35, Township 43 North, Range 72 West in Campbell County

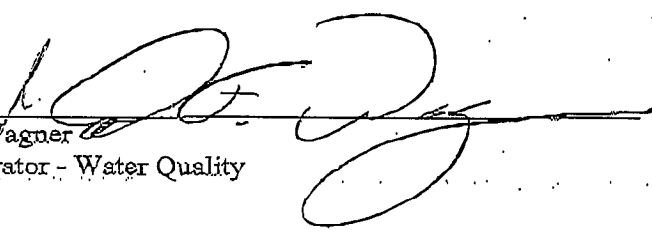
to receiving waters named

Little Porcupine Creek and its unnamed ephemeral tributaries (class 3B water), in the Cheyenne River (class 2ABWW) watershed

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II and III hereof.

The permit shall become effective on the date that it is signed below by the Director of the Department of Environmental Quality below.

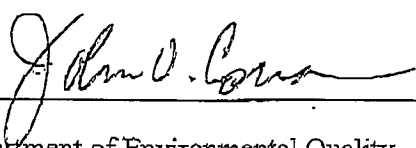
This permit and the authorization to discharge shall expire at midnight, March 31, 2009.



John F. Wagner
Administrator - Water Quality

6/1/05

Date



John V. Corra
Director - Department of Environmental Quality

6/1/05

Date

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Effective immediately and lasting through March 31, 2009, the quality of effluent discharged by the permittee shall, at a minimum, meet the limitations set forth below. The permittee is authorized to discharge from outfalls(s) serial number(s) 001 - 005.

- Such discharges shall be limited as specified below:

Effluent Limits

Effluent Parameters	Daily Maximum
Chlorides, mg/l	46
Dissolved Iron, $\mu\text{g/l}$	1000
Dissolved Manganese, $\mu\text{g/l}$	910
pH, su	6.5 - 8.5
Sodium Adsorption Ratio	10
Specific Conductance, micromhos/cm	2000
Sulfates, mg/l	3000
Total Arsenic, $\mu\text{g/l}$	2.4
Total Barium, $\mu\text{g/l}$	1800
Total Dissolved Solids, mg/l	5000
Total Flow, MGD**	0.86
Total Petroleum Hydrocarbons (TPH), mg/l*	10
Total Radium 226, pCi/l	1

*Acceptable methods for this parameter are 1664 in the latest edition of Standard Methods for the Examination of Water and Wastewater and EPA SW846 Method 8015 (modified) for Total Extractable Petroleum Hydrocarbons.

**This shall be the combined flow from outfall(s) 001 - 005.

The daily maximum permitted discharge flow rate for this facility is 0.86 million gallons per day (MGD). The effluent discharged at this facility will originate from the Wyodak coal seam.

The pH shall not be less than 6.5 standard units nor greater than 8.5 standard units in any single grab sample.

Information gathered from the water quality monitoring stations may result in modification of the permit to protect existing uses on the tributary and the mainstem.

There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause formation of a visible sheen or visible hydrocarbon deposits on the bottom or shoreline of the receiving water.

All waters shall be discharged in a manner to prevent erosion, scouring, or damage to stream banks, stream beds, ditches, or other waters of the state at the point of discharge. In addition, there shall be no deposition of substances in quantities which could result in significant aesthetic degradation, or degradation of habitat for aquatic life, plant life or wildlife; or which could adversely affect public water

Wyoming Department of Environmental Quality
Water Quality Division
WYPDES Program



STATEMENT OF BASIS

MAJOR MODIFICATION

APPLICANT NAME: Merit Energy Company

MAILING ADDRESS: 13727 Noel Road, Suite 500
Dallas, TX 75240

FACILITY LOCATION: Tuit Draw CBM facility located in the NENW of Section 34, the NENE and NWSW Section 33, Township 43 North, Range 72 West, the NWNW, SWSW and SWSE of Section 3, and the NWNW of Section 1, Township 42 North, Range 72 West in Campbell County. The produced water will be discharged to Little Porcupine Creek and its unnamed ephemeral tributaries (Class 3B), Porcupine Creek and its unnamed ephemeral tributaries (Class 3B), Antelope Creek and its unnamed ephemeral tributaries, Cripple Creek (Class 3B), and Rattlesnake Draw (Class 3B) in the Cheyenne River (Class 2ABWW) watershed. The daily maximum permitted discharge flow rate for this facility is 0.605 MGD from the Wyodak coal seam. There are 7 outfalls in this permit.

NUMBER: WY0051373

- Upon approval of this major modification, the terms of permit WY051373 are hereby modified as follows:*
- 1. In accordance with current WDEQ policy, the effluent limit and monitoring requirements for total petroleum hydrocarbons (TPH) are removed.*
 - 2. Add 5 outfalls.*
 - 3. Relocate outfalls 001 and 002.*
 - 4. Delete outfalls 003, 004 and 005.*
 - 5. Update the list of contributing wells.*
 - 6. pH values are updated.*
 - 7. The radium²²⁶ effluent limit is updated to reflect current WDEQ permitting approaches.*

With the exception of items explicitly delineated in the major modification, all terms and conditions of permit WY0051373, including Parts II and III of the original permit, shall remain unchanged and in full force and effect.

This facility is a typical coal bed methane production facility in which groundwater is pumped from a coal bearing formation resulting in the release of methane from the coal bed. The permit authorizes the discharge to the surface of groundwater produced in this way provided the effluent quality is in compliance with effluent limits that are established by this permit. In developing effluent limits, all federal and state regulations and standards have been considered and the most stringent requirements incorporated into the permit. The EPA Effluent Guidelines and Standards for Oil and Gas Extraction Point Source Category (Part 435, Subpart E) predate the development of coal bed methane extraction technology; however the technology is similar enough to conventional gas extraction that, in the professional judgment of the WDEQ, this effluent limit guideline is appropriately applied to coal bed methane gas production. The guideline limits oil and grease effluent concentrations to less than 35 mg/l and requires that discharges of produced water be used to enhance agricultural production and/or wildlife propagation. In this case, the permittee and landowner(s) have

determined that the discharged water will be used for stock watering. Furthermore, the Water Quality Division has determined that the proposed discharged water is of sufficient quality to support this use. This permit does not cover activities associated with discharges of drilling fluids, acids, stimulation waters or other fluids derived from the drilling or completion of the wells.

The permittee has chosen option 2 of the coal bed methane permitting options. Under this permitting option, the produced water is immediately discharged to a class 2 or class 3 receiving stream which is eventually tributary to a class 2AB perennial water of the state. The permit establishes effluent limits for the end of pipe, which are protective of all the designated uses defined in Chapter 1 of Wyoming Water Quality Rules and Regulations. This may include drinking water, game and non-game fish, fish consumption, aquatic life other than fish, recreation, agriculture, wildlife, industry and scenic value.

Permit effluent limits are based on federal and state regulations and are effective as of the date of issuance. The daily maximum discharge flow rate for this facility is 0.605 MGD and must be monitored monthly. The pH must remain within 6.5 and 9.0 standard units. Effluent limits for total dissolved solids (5,000 mg/l) and sulfates (3,000 mg/l) are included to protect for stock and wildlife watering. These limits are based upon Wyoming Water Quality Rules and Regulations, Chapter 2 and apply to discharge from any permitted outfall. In addition, the permit establishes a dissolved manganese limit of 910 $\mu\text{g/l}$, a total barium limit of 1,800 $\mu\text{g/l}$, a total arsenic limit of 2.4 $\mu\text{g/l}$ and a chlorides limit of 46 mg/l, all of which are to be monitored yearly. These limits are based on standards for class 2AB waters which are intended to protect for the above listed designated uses and reflect the application of the antidegradation provisions required under Chapter 1 of the Wyoming Water Quality Rules and Regulations. A dissolved iron limit of 1,000 $\mu\text{g/l}$ is also included for outfalls that are greater than or equal to one mile from a class 2 stream. This is to protect class 3B waters and is to be monitored yearly.

This permit originally established a total radium 226 limit of 1 pCi/l and total petroleum hydrocarbons (TPH) limit of 10 mg/l at the end of pipe. Based upon water quality data collected by WDEQ since the time this permit was originally issued, a permitting approach for establishing total radium limits in coal bed methane permits has been developed. This approach is based upon the distance of the outfall from a class 2 water. The removal of the originally established total radium 226 limit is based on this permitting approach. In addition, a review of discharge monitoring report data for this facility and other CBM facilities in Northeast Wyoming indicates that the maximum reported concentrations for total petroleum hydrocarbons (TPH) in the discharge were well below the water quality standard of 10 mg/l established in Chapter 1 of the Wyoming Water Quality Rules and Regulations. Therefore, WDEQ has removed the effluent limit and monitoring requirements for TPH in this permit. Based on evaluation of the available data, it is WDEQ's determination that modifying the total radium 226 and removing total petroleum hydrocarbons limits from this permit conforms to the anti-backsliding requirements established in Section 402(o).2.B.4 of the Clean Water Act.

Results are to be reported twice-yearly and if no discharge occurs then "no discharge" is to be reported. The permit also requires that an initial monitoring of the effluent be conducted within the first 60 days of discharge and the results submitted to WDEQ and the U.S. Environmental Protection Agency within 120 days of the commencement of discharge.

In order to monitor and regulate coal bed methane discharge for compliance with Chapter 1, Section 20 (protection of agricultural water supply), effluent limits for sodium adsorption ratio (SAR) and specific conductance are included in this permit. The Wyoming DEQ has determined that an SAR of 10 and specific conductance of 2,000 micromhos/cm is intended to be protective of agriculture use in the Belle Fourche River and Cheyenne River drainages. The specific conductance limit of 2,000 micromhos/cm is based on the threshold value for alfalfa which is considered to be the most salt sensitive plant irrigated in northeastern Wyoming (USDA George E. Brown Jr. Salinity Laboratory, Salt Tolerance Database, Grasses and Forage Crops). The SAR limit of 10 was determined to not reduce the rate of infiltration relative to ambient water quality in the Belle Fourche and Cheyenne Rivers, given the specific conductance threshold referenced above as ascertained from Figure 3 (page 44) of Agricultural Salinity and Drainage, Hanson et al., 1999 revision. Additionally, a SAR limit of 10 and specific conductance limit of 2,000 micromhos/cm will maintain the baseline C3-S2 irrigation suitability category for these drainages (see Figure 25, of Diagnosis and Improvement

of Saline and Alkali Soils, US Dept. of Agricultural Handbook No. 60, 1954). Monitoring will be required for total alkalinity, dissolved calcium, dissolved magnesium, dissolved sodium, bicarbonate, sodium adsorption ratio and specific conductance monthly at the outfall(s) during the irrigation months of April, May, June, July, August and September.

There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause formation of visible deposits of iron, hydrocarbons or any other constituent on the bottom or shoreline of the receiving water. In addition, erosion control measures will be implemented to prevent significant damage to or erosion of the receiving water channel at the point of discharge.

The discharge of wastewater and the effluent limits that are established in this permit have been reviewed to ensure that the levels of water quality necessary to protect the designated uses of the receiving waters are maintained and protected. An antidegradation review has been conducted and verifies that the permit conditions, including the effluent limitations established, provide a level of protection to the receiving water of Wyoming surface water quality standards.

Self monitoring of effluent quality and quantity is required on a regular basis with reporting of results semiannually. The permit is scheduled to expire on March 31, 2009.

Becky Peters
Water Quality Division
Department of Environmental Quality
January 29, 2004
Major Modification – Bob Alexander – December 15, 2005

AUTHORIZATION TO DISCHARGE UNDER THE
WYOMING POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, (hereinafter referred to as "the Act"), and the Wyoming Environmental Quality Act,

Merit Energy Company

is authorized to discharge from the wastewater treatment facilities serving the

Tuit Draw CBM facility

located in

the NENW of Section 34, the NENE and NWSW Section 33, Township 43 North, Range 72 West, the NWNW, SWSW and SWSE of Section 3, and the NWNW of Section 1, Township 42 North, Range 72 West in Campbell County

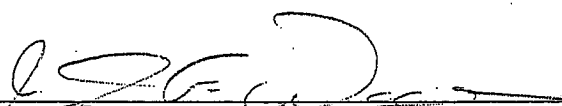
to receiving waters named

Little Porcupine Creek and its unnamed ephemeral tributaries (Class 3B), Porcupine Creek and its unnamed ephemeral tributaries (Class 3B), Antelope Creek and its unnamed ephemeral tributaries, Cripple Creek (Class 3B), and Rattlesnake Draw (Class 3B) in the Cheyenne River (Class 2ABWW) watershed

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II and III hereof.

The original permit became effective on June 1, 2005. This modification shall become effective on the date of signature by the Director of the Department of Environmental Quality. With the exception of items explicitly delineated in the major modification, all terms and conditions of permit WY0051373 including Parts II and III of the original permit, shall remain unchanged and in full force and effect.

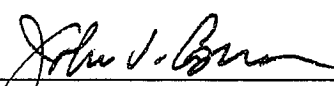
This permit and the authorization to discharge shall expire at midnight, March 31, 2009.



John F. Wagner
Administrator - Water Quality

4/3/06

Date



John V. Corra
Director - Department of Environmental Quality

4/10/06

Date

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Effective immediately and lasting through March 31, 2009, the quality of effluent discharged by the permittee shall, at a minimum, meet the limitations set forth below. The permittee is authorized to discharge from outfall(s) serial number(s) 001, 002 and 006 - 010.

- Such discharges shall be limited as specified below:

Effluent Limits

Effluent Characteristic	Daily Maximum
Chlorides, mg/l	46
Dissolved Iron, µg/l	1000
Dissolved Manganese, µg/l	910
pH, su	6.5 - 9.0
Sodium Adsorption Ratio	10
Specific Conductance,	2000
Sulfates, mg/l	3000
Total Arsenic, µg/l	2.4
Total Barium, µg/l	1800
Total Dissolved Solids, mg/l	5000
Total Flow, MGD*	0.86

*This shall be the combined flow from outfall(s) 001, 002 and 006 - 010.

The daily maximum permitted discharge flow rate for this facility is 0.605 million gallons per day (MGD). The effluent discharged at this facility will originate from the Wyodak coal seam.

The pH shall not be less than 6.5 standard units nor greater than 9.0 standard units in any single grab sample.

Information gathered from the water quality monitoring stations may result in modification of the permit to protect existing uses on the tributary and the mainstem.

There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause formation of a visible sheen or visible hydrocarbon deposits on the bottom or shoreline of the receiving water.

All waters shall be discharged in a manner to prevent erosion, scouring, or damage to stream banks, stream beds, ditches, or other waters of the state at the point of discharge. In addition, there shall be no deposition of substances in quantities which could result in significant aesthetic degradation, or degradation of habitat for aquatic life, plant life or wildlife; or which could adversely affect public water supplies or those intended for agricultural or industrial use.

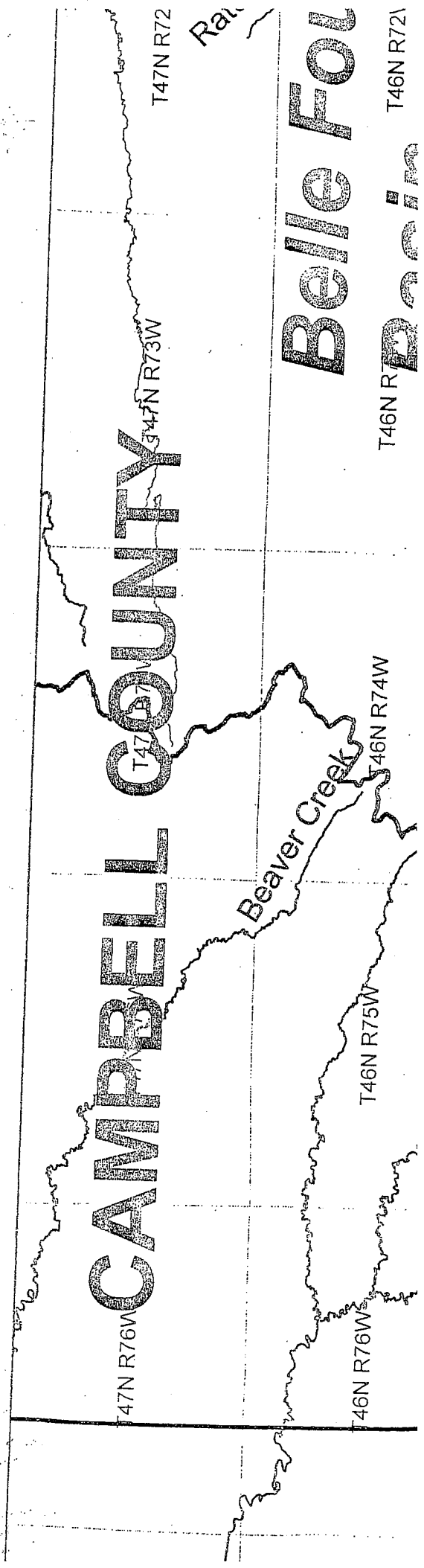
- Discharges shall be monitored by the permittee as specified below:

tabbles®
EXHIBIT
DEQ
5



Cheyenne River Basin, CBM DC

July 25, 2006

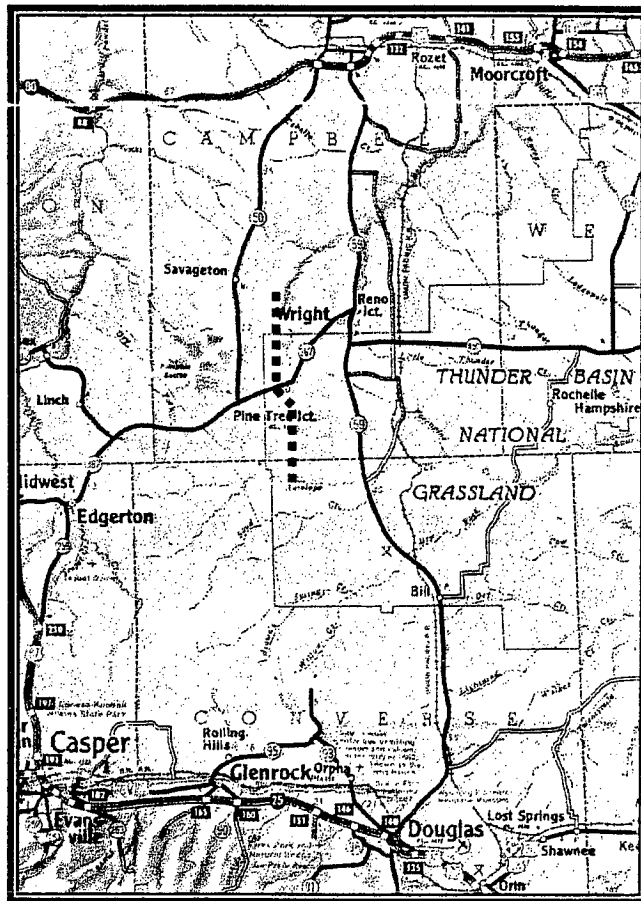




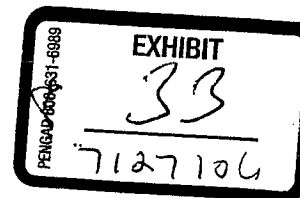
NPDES PERMIT APPLICATION FOR DISCHARGE TO ANTELOPE CREEK

April 16, 2001

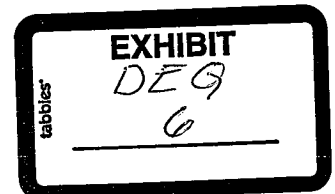
Revised July 12 and August 22, 2001



Submitted by Phillips Petroleum Company
800 Werner Court, Suite 205
Casper, Wyoming



Submitted to Wyoming Department of Environmental Quality
Water Quality Division
Herschler Building
122 West 25th Street
Cheyenne, Wyoming



REPORT TO ACCOMPANY NPDES PERMIT APPLICATION FOR DISCHARGE TO ANTELOPE CREEK

April 16, 2001
Revised August 23, 2001

Prepared for:

PHILLIPS PETROLEUM COMPANY
800 Werner Court, Suite 205
Casper, Wyoming 82601

Prepared by:



Civil Environmental Mining Water Resources

A Division of Western Water Consultants, Inc.

1849 Terra Avenue

Sheridan, Wyoming 82801

k:\phillips\99241\05\mpdes\antelope\newantelopecreek1.doc

OTHER LOCATIONS

107 East First Street
Gillette, Wyoming 82716
(307) 682-1880
FAX (307) 682-2257
infoflt@wwcengineering.com

611 Skyline Road
Laramie, Wyoming 82070
(307) 742-0031
FAX (307) 721-2913
infoLAR@wwcengineering.com

701 Antler Drive, Suite 233
Casper, Wyoming 82601
(307) 473-2707
FAX (307) 237-0828
infoCSP@wwcengineering.com

7 West Sixth Avenue, Suite 4E
Helena, MT 59601
(406) 443-3962
FAX (406) 447-4255
infoHln@wwcengineering.com

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performed for each of the study cases and the results are presented in Table 10-6 and Appendix D.

Table 10-6. Calculated Minimum Flows in the Cheyenne River at which Flow Occurs to Selected Irrigation Facilities.

Permit No./Name	Diversion Type	Minimum Flow at Which Irrigation Occurs (cfs)
P21903D (Sherwin No. 2 Ditch)	Temporary Earthen Berm	137
P18815D (Hurtt Ditch)	Pump	52
P10103D (White No. 1 Ditch)	Pump	167
P5422D (WH Pearson Ditch)	Pump	133

Summary printouts from the HEC-RAS analysis are provided in Appendix D. The plotted cross sections clearly illustrate the fact that a discharge of 50 cfs in the Cheyenne River is small relative to channel capacity and could be accommodated at a shallow flow depth (1.0 to 2.1 feet) and a low velocity (1.0 to 1.3 ft/sec).

The results of this analysis indicate that irrigation from the main channel of the Cheyenne River downstream of the confluence with Antelope Creek occurs infrequently and only when the discharge rate in the stream exceeds about 52 cfs.

At a background flow rate of 52 cfs and conservatively assuming 17 cfs CBM water loss above this location, Phillips' CBM water would comprise about 39% of the total flow in the stream. The next section describes how it was determined that when the CBM water is diluted to this extent by natural runoff, the resulting water quality will have no deleterious effects on soils when used for irrigation. Therefore, existing irrigation practices will be protected.

10.3.4 Cheyenne River Irrigation Water Quality Impacts

In order to assess the irrigation impacts to the Cheyenne River, WWC Engineering performed mixed SAR and salinity calculations at two locations: the Wyoming location requiring the least amount of flow to divert and the Angostura Reservoir in South Dakota. The results of each investigation are presented below.

EXHIBIT

— DRAFT 30 —

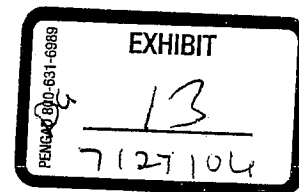
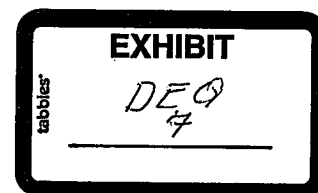
**CHEYENNE RIVER WATERSHED
NIOBRARA COUNTY 319
IMPLEMENTATION PROJECT**

Topical Report RSI-1818

prepared for

Niobrara Conservation District
P.O. Box 659
Lusk, Wyoming 82225

February 2006



Topical Report RSI-1818

by

Cory S. Foreman
Dr. Scott Kenner
Fanuel Banda

RESPEC
P.O. Box 725
Rapid City, South Dakota 57709

prepared for

Niobrara Conservation District
P.O. Box 659
Lusk, Wyoming 82225

February 2006

— DRAFT —

EXECUTIVE SUMMARY

Project Title: Cheyenne River – Niobrara County 319 Project	
Project Start Date: 04/01/03	Project Completion Date: 09/30/05
Funding: \$221,388	Total Budget: \$230,681.96
Total EPA Budget: \$132,500	
Total Expenditures of EPA Funds: \$132,500	
Total Section 319 Match Accrued: \$98,181.97	
Budget Revisions:	
Total Expenditures: \$230,618.96	

Niobrara Conservation District (NCD) received a 319 Project Implementation grant from the Wyoming Department of Environmental Quality for the Cheyenne River in Wyoming in spring of 2003. The grant was used within Niobrara, Converse, and Campbell Counties to develop an environmental inventory and assessment of potential impacts from the ongoing and proposed coal bed methane development. Specific impacts for monitoring included changes in flow; Sodium Absorption Ratio (SAR); Cation/Anion balance; impacts to stream morphology, and resultant impacts on beneficial uses, including riparian habitat and irrigation uses.

In November of 2003, historic discharge, precipitation, and water quality data were collected at several stations. These stations are identified in Table E-1. Data from these stations were used to characterize historic conditions for flow and water quality. Monthly and annual stream flow and precipitation characteristics were described using this analysis throughout the watershed. Relationships between gauging stations were developed while major contributors to stream discharge at the downstream gauge on the Cheyenne River were identified. Historic water quality was described, specifically for chemical balances of ions. Sampling frequency and distribution of previous water quality sampling were evaluated. From this evaluation, a monitoring and sampling plan, including water quality monitoring and stream physical habitat assessment, was drafted and implemented.

Grab sampling for water quality took place throughout the 2003, 2004, and 2005 sampling season. Real-time data sampling stations were installed at three sites in 2004 and one site in 2005. Included at the three monitoring stations were automated event-driven samplers that collected 24 individual samples when a runoff event occurred. The stations gave an opportunity to see the system's response to storm events. The data show that the system response is based on a local and a regional scale. The local response showed a slight

Table E-1. Historic Water Quality Analysis Site Identification Summary Table

USGS ID	Description	Symbol	Streamflow Data		Water Quality Data		Drainage Area (sq. mi.)
			Start	End	Start	End	
06365300	Dry Fork Cheyenne River near Bill, WY	DF01	11/1/1976	9/30/1987	2/22/1977	10/2/1987	128.0
06364700	Antelope Creek near Teckla, WY	AC01	9/8/1977	9/30/1981	10/3/1977	9/2/2002	959.0
06365900	Cheyenne River near Duil Center, WY	CR01	4/1/1976	9/30/1987	11/4/1975	10/1/1987	1527.0
06375600	Little Thunder Creek near Hampshire, WY	LT01	9/7/1977	12/31/1997	9/30/1977	5/28/1997	234.0
06376300	Black Thunder Creek near Hampshire, WY	BT01	10/1/1972	9/30/1990	5/7/1980	9/9/2002	535.0
06378300	Lodgepole Creek near Hampshire, WY	LP01	9/7/1977	9/30/1981	3/23/1978	5/19/1981	354.0
	Upper Cheyenne North Niobrara County Border, WY	CR06	—	—	8/23/1999	7/3/2003	
06386000	Lance Creek near Riverview, WY	LC01	5/1/1948	9/30/1983	5/13/1971	7/16/2003	2,070.0
06386400	Cheyenne River near Riverview, WY	CR02	—	—	10/22/1980	Ongoing	5,160.0
06386500	Cheyenne River near Spencer, WY	CR03	10/1/1948	9/30/1974	9/13/1999	7/23/2002	5,270.0
06392900	Beaver Creek at Mallow Camp, near Four Corners, WY	BC01	10/1/1974	Ongoing	—	—	10.3
06392950	Stockade Beaver Creek near Newcastle, WY	BC02	10/1/1974	Ongoing	—	—	107.0
06394000	Beaver Creek near Newcastle, WY	BC03	10/1/1944	12/31/1997	10/30/1946	5/12/1986	1,320.0
06394500	Beaver Creek near Burdock, SD	BC04	4/19/1929	6/30/1932	—	—	1,540.0
06395000	Cheyenne River at Edgemont, SD	CR04	7/1/1903	Ongoing	6/27/1967	Ongoing	7,143.0

response to storm events with a fraction of an inch increase in stage and a lag time of a few hours. The regional response showed a stage increase in excess of a foot and a lag time of almost a day.

Several storm and base flow grab samples were collected and analyzed at Energy Laboratories, Inc. in Rapid City, South Dakota. The parameters tested are listed in Table E-2. The results showed that Little Thunder and Spring Creek are carbonate systems; whereas, sites on the Cheyenne River are sulfate systems.

Table E-2. List of Parameters Analyzed in Samples Collected

Alkalinity, Total as CaCO ₃
Bicarbonate as HCO ₃
Calcium
Carbonate as CO ₃
Chloride
Hardness as CaCO ₃
Hardness as CaCO ₃ - Grains
Magnesium
Nitrogen, Ammonia as N
Potassium
Sodium
Solids, Suspended Sediment SSC @ 105 C
Solids, Total Dissolved TDS @ 180 C
Solids, Total Suspended TSS @ 105 C
Sulfate

Eighteen sites were selected for assessment based on landowner permission, site accessibility, and location in relation to Coal Bed Methane (CBM) production areas. Final site selection was done in collaboration with the NCD staff. Site selection took into account existing United States Geological Survey (USGS) gauging stations and land use characteristics. The upstream-most sites are located on Porcupine, Spring, and Antelope Creeks at Wyoming Highway 59. The downstream-most site was selected at Spencer, Wyoming, near the border with South Dakota. The work conducted included physical habitat assessment, stream classification, and biological sampling. Table E-3 defines the site names and site identification used in this report. Figure E-1 shows the Cheyenne River Watershed above Angostura Reservoir in South Dakota with locations of the physical habitat sampling sites along with the historic gauge station locations.

The physical habitat assessment showed that the Cheyenne River Watershed has very little variability. The sites were divided into three categories based on their standing in relation to the mean of any given metric. The different metrics considered showed that most of the sites sampled fell within one standard deviation of the mean for most metrics. This report explains why some sites fall outside one standard deviation of the mean.

Three categories of streams were identified and grouped by the amount of water present at the site. Three of eighteen sites were dry and represented one category. The second category was sites representing intermittent streams with little water. The third category was sites with abundant water, either at the downstream portions of the watershed or in the areas of CBM discharge.

The sampled sites were classified using both Schumm's Channel Evolution Model (CEM) and the Rosgen's Level II classification scheme. This report details the reasoning behind each classification and summarizes the results. Fourteen of the eighteen sites sampled were classified as either Stage IV or Stage V of the 5-stage channel evolution model. Stage IV represents the onset of quasi equilibrium state, while Stage V is quasi equilibrium state. These two stages represent the natural state of the basin. Two sites, DF01 and LT02, were classified as Stage II because of pronounced incision at the sites. LT03 exhibited both Stage II and Stage III characteristics and was classified as a Stage II/III.

Fifteen of the eighteen sites were classified as either type "E" or type "C" streams in the Rosgen classification scheme. Type "E" streams are described as slightly entrenched; with the entrenchment ratios greater than 2.2 and very low width-to-depth ratios less than 12. Type "C" streams are described as slightly entrenched with entrenchment ratios greater than 2.2 and a moderate to high width-to-depth ratios (>12). DF01 and BT01 were both classified as type "G" which are described as entrenched systems having entrenchment ratios less than 1.4 and low width-to-depth ratios (<12). Lastly, PP02 was classified as a type "B" stream described as being moderately entrenched with entrenchment ratios of 1.4-2.2 and width-to-depth ratios greater than 12. Most sites within the watershed appear to be in a stable and natural condition. However, based on Rosgen's stream classification, streams types found within the Cheyenne River Watershed are prone to rapid degradation in response to disturbance. Sites on Dry Fork and Black Thunder show the potential for large-scale incision to occur within the watershed.

Five sites were selected for biological assessment, which included benthic macro-invertebrates and periphyton sample collection and data analysis. An index of biological integrity (IBI) was created for both benthic macroinvertebrate and periphyton data. The IBI was created using a multimetric approach using seven metrics for the benthic IBI and eleven metrics for the periphyton IBI. The IBI scores showed CR01 had the highest IBI and LT04 had the lowest IBI.

7.0 FUTURE ACTIVITY RECOMMENDATION

This project set baseline conditions for stream morphology and physical habitat on which future projects can build on. The large amount of data collected on this project gives insight to level of natural variability within the watershed. In order to get a full understanding of the processes in the watershed, it is necessary to conduct more studies in areas outlined below.

Recommendations for future projects include better defining opportunities for irrigation, better defining the extent of CBM effects downstream, characterizing surface water and groundwater interactions, and better defining biological effects and developing recommended CBM discharge BMPs. Each of these areas is describe in further detail below.

7.1 DEFINE OPPORTUNITIES FOR IRRIGATION

The data collected using the sondes have shown that specific conductance and SAR are reduced at the onset of storms and remain low for more than 24 hours. Further monitoring needs to be conducted in order to refine the estimate of the "window of opportunity" to irrigate. Specifically, a better understanding of the relationship between SAR and specific conductance in runoff originating on different parent geology would greatly increase the confidence in real-time monitoring of SAR, using specific conductance, and allow for more reasonable decisions to be made in relation to when SAR is low enough to allow irrigation.

7.2 DEFINE THE EXTENT OF COAL BED METHANE EFFECTS DOWNSTREAM

From the 2004 sampling season, sufficient data were not collected to determine the downstream extent of CBM impacts. This was clearly evident at AC01 where physical habitat and riparian characteristics were similar to conditions found in CBM areas. It is likely that conditions found at AC01 were due to natural ponding of water along the site length; however, a definitive statement of water origin could not be drawn. Grab samples collected during the last few sampling seasons demonstrated that CBM water can easily be identified based on the ion balance of the samples.

7.3 CHARACTERIZE SURFACE WATER AND GROUNDWATER INTERACTIONS

This project did not specifically address groundwater. Evidence was seen that CBM water generally only travels a short distance down stream channels before being lost to infiltration and/or evapotranspiration. It is not clear to what extent impacts are occurring in subsurface flow in stream channels or what the impacts to groundwater resources may be. Future projects

should attempt to characterize the quantity and quality of groundwater and the mechanism through which groundwater interacts with the surface water in the Cheyenne River Watershed.

7.4 BETTER DEFINE BIOLOGICAL EFFECTS AND DEVELOP RECOMMENDED COAL BED METHANE DISCHARGE BEST MANAGEMENT PRACTICES

The significance of a healthy biological system can not be overemphasized. The presence or absence of periphyton (primary producers) affects the presence of macroinvertebrate which in turn affect fish populations. A poor biological condition may signal an overall poor ecological state. The biological effect of CBM water on the system is not clearly understood and needs further investigation. If the effect of CBM discharges to stream aquatic ecology is negative, BMPs will need to be identified to lessen the negative impacts. This project showed some positive and some negative impacts to the biological community from CBM discharges. In future projects, it would be beneficial to increase the number of sites where biological and water quality data would be collected. The increased number of samples would help to increase the confidence in the statistical integrity of the data while providing a better understanding of the true impacts to ecology.

7.5 CONCLUSIONS

Historical water quality data show a consistent pattern throughout the watershed. The general water quality tends to be sulfate (SO₄) dominated with a balance between sodium (Na) and calcium (Ca) cations. There is an increase in calcium and bicarbonate at BC03, which reflects the upstream geological characteristics found on Beaver Creek. The effects of Beaver Creek are seen in water quality at CR04. Water quality at LP01 tends to have higher SAR levels. LP01 is completely dominated by sodium and sulfate. Based on the analysis of SAR from water quality samples collected on this project, it is clear that the elevated SARs may be a function of soil types and ultimately geology found within LP01. However, storm sampling has not been conducted efficiently in the Lodgepole Creek Watershed. It is possible that the elevated SARs found at LP01 may be a function of the water quality sampling regime.

An evaluation of flows at which historical water quality sampling were conducted indicates that a majority of water quality sampling has occurred during low flow. Thus historical water quality data do not reflect high flow conditions well. Additionally, evaluation of precipitation data shows that most of the runoff is generated by snowmelt or precipitation occurring as short-duration high intensity events. The focus of future sampling needs to be focused on event sampling throughout the watershed in order to gain a better understanding of the true water quality conditions in the watershed.

Event sampling during the monitoring program shows a significant reduction in specific conductance (dissolved solids) and potentially SAR during runoff events. Flow during runoff events is applicable for irrigation and could be pumped and stored for later use.

Historical water quality data compared to recent water quality grab samples at SC01 and LT01 indicate possible effects from CBM discharges. The ability to evaluate these effects is limited due to water quality sampling duration and frequency. The general change is seen as a shift from a sulfate dominated system to a bicarbonate system.

Morphological and biological effects of CBM discharges are indicated locally. The duration and frequency of discharges does tend to cause an acceleration of stream continuum. CBM discharges tend to accentuate the deep pocket scour holes common to arid intermittent streams [Lowham and Smith, 1993]. Evidence of this was seen at LT02 where active incision was evident. Rosgen's Level II Classifications indicate that stream types common in the Cheyenne River Watershed are prone to rapid degradation in response to disturbance. DF01 and BT01 also show the potential for large-scale incision to occur within the watershed.

Both positive and negative biological affects are indicated. Where CBM discharges are active and flow is dynamic, biological IBIs indicate characteristics similar to downstream locations. At site LT04, where flow is stagnate, there is a negative biological effect. It is suspected that location of small detention facilities, such as in channel stock dams, limits the downstream effects of CBM discharges.

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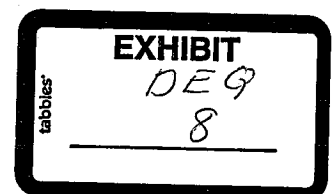
**Water-Quality Characteristics, Including
Sodium-Adsorption Ratios, for Four Sites
in the Powder River Drainage Basin,
Wyoming and Montana,
Water Years 2001-2004**

By Melanie L. Clark and Jon P. Mason

Prepared in cooperation with the Wyoming Department of Environmental Quality

Scientific Investigations Report 2006-5113

U.S. Department of the Interior
U.S. Geological Survey



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Clark, M.L., and Mason, J.P., 2006, Water-quality characteristics, including sodium-adsorption ratios, for four sites in the Powder River drainage basin, Wyoming and Montana, water years 2001-2004: U.S. Geological Survey Scientific Investigations Report 2006-5113, 22 p.

Summary

The U.S. Geological Survey, in cooperation with the Wyoming Department of Environmental Quality, monitors streams throughout the Powder River structural basin in Wyoming and parts of Montana in response to concerns over coalbed natural gas development. Because coalbed waters may have specific conductance values and sodium-adsorption ratio (SAR) values that are larger than the stream waters that may receive discharge waters, continuous water-quality instruments for specific conductance were installed and discrete water-quality samples were collected to characterize water quality during water years 2001-2004 at four sites in the Powder River drainage basin: the Powder River at Sussex, Wyoming; Crazy Woman Creek near Arvada, Wyoming; Clear Creek near Arvada, Wyoming; and the Powder River at Moorhead, Montana.

During water years 2001-2004, the median specific conductance of 2,270 microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S}/\text{cm}$) in discrete samples from the Powder River at Sussex, Wyoming, was larger than the median specific conductance of 1,930 $\mu\text{S}/\text{cm}$ in discrete samples downstream on the Powder River at Moorhead, Montana. The median specific conductance was smallest in discrete samples from Clear Creek (1,180 $\mu\text{S}/\text{cm}$), which has a dilution effect on the specific conductance for the Powder River at Moorhead, Montana. The daily mean values for specific conductance from continuous water-quality instruments during the irrigation season showed the same spatial pattern as discrete values from samples. Specific conductance values may have been elevated in some samples collected at all four sites owing to drought conditions during water years 2001-2004.

Dissolved sodium, SAR values, and dissolved solids generally showed the same spatial pattern as specific conductance. The largest median sodium concentration (274 milligrams per liter) and the largest range of SAR values (3.7 to 21) were measured in samples from the Powder River at Sussex, Wyoming. Although the Powder River at Sussex, Wyoming is upstream from coalbed natural gas development, the site receives inputs from Salt Creek. Conventional gas and oil development occur in the Salt Creek drainage basin. Median concentrations of sodium and SAR values were substantially smaller in Crazy Woman Creek and Clear Creek, which tend to decrease sodium concentrations and SAR values at the Powder River at Moorhead, Montana. Dissolved-solids concentrations in discrete samples were closely correlated with specific conductance values; Pearson's correlation coefficients were 0.98 or greater for all four sites.

Regression equations for specific conductance and SAR were statistically significant (p -values <0.001) at all four sites. The strongest relation ($R^2=0.92$) was at the Powder River at Sussex, Wyoming. Relations on Crazy Woman Creek ($R^2=0.91$) and Clear Creek ($R^2=0.83$) also were strong. The relation between specific conductance and SAR was weakest ($R^2=0.65$) at the Powder River at Moorhead, Montana.

These data indicate that values for specific conductance from continuous water-quality instruments are useful for estimating sodium-adsorption ratios in real time.

A regression model called LOADEST was used to estimate dissolved-solids loads for the four sites. The average daily mean dissolved-solids loads varied among the sites during water year 2004. The largest average daily mean dissolved-solids load was calculated for the Powder River at Moorhead, Montana. Although the smallest concentrations of dissolved solids were in samples from Clear Creek, the smallest average daily mean dissolved-solids load was calculated for Crazy Woman Creek. The largest loads occurred during spring runoff, and the smallest loads occurred in late summer, when streamflows typically were smallest. Dissolved-solids loads may be smaller than average during water years 2001-2004 as a result of drought conditions.

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Converse County, Wyoming Hydrologic Unit Code 10120103 Latitude 43°25'45", Longitude 105°02'43" NAD27 Drainage area 1,527.00 square miles	Output formats <input type="button" value="HTML table of all data"/> <input type="button" value="Tab-separated data"/> <input type="button" value="Reselect output format"/>
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2	0.15	0.35	2.3	7.2	5.3	19	13	16	17	39	0.31	0.17
3	0.15	0.43	2.7	8.0	6.9	15	18	6.4	1.9	31	0.34	0.19
4	0.14	0.41	5.1	11	7.1	17	6.9	4.4	0.60	5.4	0.31	0.19
5	0.15	0.35	15	17	6.8	11	78	11	0.35	2.4	0.32	0.16
6	0.15	0.36	18	15	8.8	11	43	23	0.24	1.5	0.42	0.15
7	0.14	0.39	27	12	15	13	19	8.7	0.13	1.2	0.58	0.15
8	0.13	0.41	62	10	43	120	56	3.5	0.11	1.1	0.49	0.16
9	0.12	0.45	98	9.6	37	33	62	36	0.11	0.98	0.26	0.15
10	0.12	0.44	119	9.3	21	63	12	13	0.12	0.79	0.23	0.15
11	0.17	0.52	36	9.2	15	26	7.5	24	0.10	0.68	0.23	0.18
12	0.22	0.61	30	9.6	21	13	4.5	4.1	0.10	0.60	0.21	0.20
13	0.26	0.78	21	9.3	21	13	2.9	1.5	0.10	0.49	0.23	0.21
14	0.20	0.99	15	8.8	14	42	2.3	1.1	0.10	0.40	0.22	0.22
15	0.14	1.3	13	8.3	11	56	1.9	53	0.10	0.36	0.22	0.23
16	0.11	1.5	12	8.1	32	15	1.7	34	0.10	0.28	0.32	0.24
17	0.11	1.9	12	7.8	351	9.4	1.5	23	0.10	0.26	0.38	0.23
18	0.12	5.9	18	7.7	1,210	8.0	4.2	19	0.12	0.24	0.31	0.22
19	0.13	13	17	7.4	409	23	16	14	0.11	0.26	0.40	0.20
20	0.15	10	12	7.9	127	12	17	5.9	0.11	0.30	0.36	0.20
21	0.15	7.0	12	8.1	72	61	228	2.6	0.11	0.30	0.57	0.21
22	0.16	4.5	12	7.5	46	28	122	1.6	0.12	0.31	0.35	0.21
23	0.17	3.1	10	6.8	36	21	28	7.0	18	0.27	0.31	0.22
24	0.16	2.7	9.5	6.2	35	16	11	35	3.8	0.27	0.27	0.21
25	0.16	3.0	8.6	5.7	61	11	11	2.3	0.75	0.28	0.21	0.20
26	0.16	3.8	8.3	5.3	21	22	25	1.4	0.17	0.29	0.19	0.20
27	0.19	5.5	8.1	5.1	33	55	4.8	14	0.14	0.30	0.17	0.20
28	0.21	3.9	8.2	5.0	25	23	14	6.0	0.17	0.30	0.17	0.19
29	0.19	5.0	7.6	19	35	62	5.6	2.1	0.15	0.31	0.18	0.19
30	0.21		7.7	16	132	29	13	1.7	0.14	0.30	0.17	0.17
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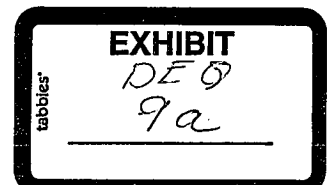
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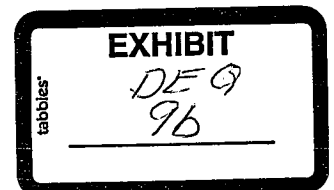
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00060, Discharge, cubic feet per second,												
Day of month	Mean of daily mean values for each day for 2 years of record in, cfs (Calculation Period From:1997-01-01 , To:2005-09-03)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.04	0.05	0.03	0.03	0.01	0.07	0.01	0.01	0.01	0.01	0.05	0.02
2	0.03	0.05	0.03	0.04	0.01	0.04	0.01	0.01	0.01	0.01	0.05	0.03
3	0.04	0.05	0.03	0.03	0.02	0.04	0.01	0.00	0.01	0.01	0.05	0.03
4	0.04	0.05	0.03	0.03	0.02	0.04	0.01	0.01	0.01	0.00	0.04	0.03
5	0.04	0.05	0.03	0.03	0.01	0.03	0.01	0.01	0.01	0.00	0.04	0.03
6	0.04	0.05	0.03	0.03	0.01	0.03	0.01	0.01	0.01	0.00	0.04	0.03
7	0.04	0.05	0.02	0.03	0.07	0.02	0.01	0.01	0.01	0.00	0.04	0.03
8	0.04	0.05	0.03	0.03	0.29	0.02	0.01	0.01	0.01	0.01	0.04	0.03
9	0.04	0.05	0.03	0.04	0.07	0.02	0.01	0.01	0.01	0.01	0.04	0.04
10	0.04	0.05	0.03	0.04	0.10	0.02	0.01	0.01	0.01	0.01	0.04	0.03
11	0.04	0.05	0.02	0.03	0.45	0.05	0.01	0.01	0.01	0.01	0.04	0.04
12	0.03	0.05	0.03	0.03	0.54	0.07	0.01	0.01	0.01	0.01	0.03	0.03
13	0.02	0.05	0.03	0.03	0.05	0.96	0.00	0.01	0.01	0.01	0.05	0.03
14	0.02	0.05	0.03	0.03	0.02	0.12	0.00	0.01	0.01	0.01	0.03	0.03
15	0.02	0.05	0.04	0.03	0.02	3.0	0.00	0.01	0.01	0.01	0.04	0.03
16	0.03	0.04	0.03	0.03	0.02	2.2	0.00	0.01	0.01	0.01	0.03	0.04
17	0.05	0.05	0.03	0.03	0.02	0.08	0.00	0.01	0.01	0.02	0.03	0.03
18	0.05	0.05	0.04	0.03	0.02	0.02	0.00	0.01	0.01	0.02	0.03	0.03
19	0.06	0.05	0.03	0.03	0.05	0.00	0.00	0.01	0.01	0.02	0.04	0.03
20	0.06	0.05	0.03	0.03	0.05	0.00	0.00	0.01	0.01	0.02	0.04	0.04
21	0.07	0.05	0.04	0.05	0.04	0.00	0.00	0.01	0.01	0.02	0.03	0.03
22	0.06	0.04	0.04	0.16	0.04	0.00	0.00	0.01	0.00	0.03	0.03	0.03
23	0.05	0.04	0.04	0.04	0.04	0.00	0.01	0.01	0.00	0.03	0.04	0.04
24	0.05	0.04	0.05	0.02	0.04	0.00	0.00	0.01	0.00	0.03	0.04	0.04
25	0.05	0.04	0.05	0.02	0.08	0.00	0.00	0.01	0.00	0.03	0.04	0.04
26	0.05	0.04	0.04	0.01	0.05	0.00	0.00	0.01	0.00	0.04	0.03	0.04
27	0.05	0.04	0.04	0.02	0.05	0.00	0.00	0.01	0.01	0.04	0.03	0.03
28	0.05	0.03	0.04	0.02	0.03	0.00	0.00	0.01	0.00	0.04	0.02	0.04
29	0.05		0.03	0.01	0.03	0.00	0.01	0.01	0.00	0.05	0.02	0.04
30	0.05		0.04	0.01	0.06	0.00	5.0	0.01	0.01	0.05	0.02	0.04
31	0.05		0.04		0.13		0.20	0.01		0.05		0.04

Questions about data?
 Feedback on this web site
 Surface Water data for Wyoming: USGS Surface-Water Daily Statistics
<http://waterdata.usgs.gov/wy/nwis/dvstat?>

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 Explanation of terms

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Water Quality Samples for Wyoming

USGS 06365900 CHEYENNE RIVER NR DULL CENTER WY

Available data for this site **Water-Quality: Field/Lab samples** **GO**

Output formats

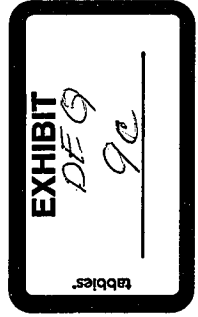
Parameter Group data summary
 Inventory of available water-quality data
 Inventory of water-quality data with retrieval
 Tab-separated ASCII file, serial order
 Tab-separated ASCII file, wide order
 Reselect output format

Converse County, Wyoming
 Hydrologic Unit Code 10120103
 Latitude 43°25'45", Longitude 105°02'43" NAD27
 Drainage area 1,527.00 square miles

SAMPLE DATE/TIME	MEDIUM CODE	Temperature, water, deg C (00010)	Temperature, air, deg C (00020)	Barometric pressure, mm Hg (00025)	Agency collecting sample, code (00027)	Agency analyzing sample, code (00028)	Instantaneous discharge, cfs (00061)	Number of sampling points, count (00063)	Cage height, feet (00065)	Turbidity, Jtu (00070)	Turbidity, NTU (00076)	Color, water, Pt-Co units (00080)	Specific conductance, wat uS/cm 25 degC (00095)	Dissolved oxygen, mg/L (00300)	Dissolved oxygen, percent of saturation (00301)	BOD, water, unfiltrd 5 day, degC (00310)	pH, water, unfiltrd field, std units (00400)	pH, water, unfiltrd lab, std units (00403)	Carbon dioxide, water, unfiltrd mg/L (00405)	ANC, unfixed end pt, mg/L as CaCO3 (00410)	Bicarbonate, water, unfixed end pt, mg/L (00440)	Carbonate, water, unfixed end pt, mg/L (00445)	Periphyton biomass, ash weight, g/m2 (00572)	
1975-11-04 13:45	9	14.0					E.20			20			3200	9.8			8.1		4.4	285	347		.0	
1975-12-02 15:00	9	3.5					E.50			6			3000	10.4			7.8		9.2	298	363		.0	
1976-01-06 14:00	9						.00																	
1976-02-03 14:00	9	.5					E.40			10			3200	10.6			7.7		13	326	397		.0	
1976-05-04 13:45	9	16.5					.18			25			3500	9.2			8.0		5.2	267	326		.0	
1976-05-23 13:50	9	9.0					41																	
1976-05-31 12:05	9	17.0					283																	
1976-06-09 15:15	9	28.0					4.0			20			2000	7.1			8.1		3.5	227	277		.0	
1976-07-08 11:30	9	24.0					5.7			110			1500	7.4			7.9		4.3	176	214		.0	

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7/24/2006



2004-09-07 08:45	9	13.0	14.0	641	1028	80020	.03	1.30	4830	5.0	7.4	7.6
Water Quality Remark Code												
Description												
<												
B												
Estimated value												
M												
Presence of material verified but not quantified												
U												
Material specifically analyzed for but not detected												

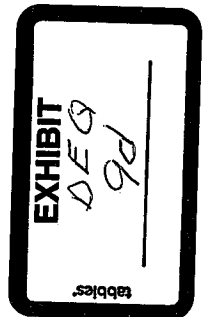
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 Water Quality Samples for Wyoming: Sample Data
<http://waterdata.usgs.gov/wy/nwis/qwvdata/>

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Table 1

Site	nitrate water unfird mg/L as N (00630)	nitrate water fird mg/L as N (00631)	Phos- phosphate water unfird mg/L (00650)	Phos- phosphate water fird mg/L (00660)	Phos- phosphate water unfird mg/L as P (00665)	Phos- phosphate water fird mg/L as P (00666)	Organic carbon, water, fird, mg/L (00681)	carbon, suspended sediment total, mg/L (00689)	carbon, bed sediment total, g/kg (00693)	Cyanide water unfird mg/L (00720)	Hardness, water, mg/L as CaCO3 (00900)	Hardness, water, fird, mg/L as CaCO3 (00902)	Calcium water, fird, mg/L (00915)	Magnesium, water, fird, mg/L (00925)	Sodium, water, fird, mg/L (00930)	Sodium adsorption ratio (00931)	Sodium, percent (00932)	Sodium, water, fird, mg/L as Na (00933)
49	.010				.030					1	1200	880	270	120	320	4	37	
05	.030				.010					2	1100	780	250	110	280	4	36	
67	.060				<.010					3	1100	780	260	110	290	4	36	
	.040				.040					4	1200	920	260	130	320	4	37	
										5								
										6								
										7								
68	.050				.050					8	760	530	180	75.0	200	3	36	
61	.100				.050					9	610	430	150	57.0	130	2	31	
72	.010				.070					10	1100	810	240	110	290	4	37	
97	.100				.060					11	1100	850	240	110	280	4	36	
84	.040				.070					12	1100	800	250	110	310	4	38	
										13								
22	<.100				.010					14	1100	780	250	110	290	4	37	
35	.010				.020					15	1200	850	270	120	320	4	37	
53	.100				.020					16	1800	1300	400	200	500	5	37	
										17								
06	.010				.060					18	1200	860	270	120	290	4	35	
71	.070				.050					19	1200	900	270	120	320	4	37	
90	.040				.040					20	1200	900	270	120	310	4	36	
10	.030				.050					21	1300	1100	300	140	420	5	40	
84	.030				.040					22	990	770	230	100	280	4	38	
11	.150				.080					23	340	220	80.0	33.0	90.0	2	36	
75	.090				.060					24	640	450	150	65.0	160	3	35	
44	.010				.020					25	1200	920	290	120	280	4	33	X
										26								



Print Page 3
 (Header Page 2)
 Table P. 2

Ortho-phosphate, water, filtered, mg/L (00660)	Phosphorus, water, filtered, mg/L (00665)	Phosphorus, water, filtered, mg/L as P (00671)	Ortho-phosphate, water, filtered, mg/L (00681)	Organic carbon, suspended sediment, total, mg/L (00689)	Total carbon, bed sediment, total, g/kg (00693)	Cyanide, water, unfiltered, mg/L (00720)	Hardness, water, mg/L as CaCO3 (00900)	Noncarbohydrate, water, unfiltered, mg/L as CaCO3 (00902)	Calcium, water, filtered, mg/L (00915)	Magnesium, water, filtered, mg/L (00925)	Sodium, water, filtered, mg/L (00930)	Sodium adsorption ratio (00931)	Sodium, percent (00932)	Sodium + potassium, water, filtered, mg/L as Na (00933)	Potassium, water, filtered, mg/L (00935)	Chloride, water, filtered, mg/L (00940)	Sulfate, water, filtered, mg/L (00945)
.020		Page 2		Live 1			530	370	190	13.0	170	3	41	10.0	17.0	840	
.070				2			760	520	180	75.0	180	3	34	8.70	20.0	820	
.030				3			710	520	160	75.0	170	3	34	9.60	17.0	820	
.100				4			990	760	230	100	270	4	37	15.0	25.0	1200	
				5													
				6													
				7													
				8													
				9													
.040				10			1000	750	240	100	280	4	37	300	15.0	23.0	1300
				11													
.010				12			470	330	120	42.0	120	2	46	130	10.0	14.0	570
.010							990	730	240	95.0	240	3	34	260	15.0	21.0	1400
.000	.000		6.9	1.4			1200	940	290	120	310	4	36	310	1.70	32.0	1500
.000							1200	860	280	110	340	4	51	360	17.0	27.0	1600
.010	.010		11.0				1200	930	290	120	310	4	35	320	14.0	24.0	1500
.000	.000		19.0	.2		.00	1200	870	240	140	370	5	57	390	15.0	25.0	1500
.010	.000						1400	1000	310	150	370	4	36	390	15.0	32.0	1800
.090	.010		7.4	.5		.00	780	560	190	73.0	190	3	34	200	9.60	18.0	960
.050	.010		8.9	.3			960	720	230	94.0	240	3	35	250	13.0	21.0	1100
.010	.000		8.1	.2	25		1000	810	250	100	290	4	37		18.0	24.0	1300

X

00	280	170	71.0	26.0	72.0	2	35	9.70	7.0	330
50	990	710	230	100	280	4	38	18.0	28.0	1300

Table P. 2

Ortho-phosphate, water, filtered, mg/L (00660)	Phosphorus, water, filtered, mg/L (00665)	Phosphorus, water, filtered, mg/L as P (00671)	Organic carbon, water, filtered, mg/L (00681)	Organic carbon, suspended sediment, total, mg/L (00689)	Total carbon, bed sediment, total, g/kg (00693)	Cyanide, water, unfiltered, mg/L (00720)	Hardness, water, mg/L as CaCO3 (00900)	Noncarbon hardness, water, field, mg/L as CaCO3 (00902)	Calcium, water, filtered, mg/L (00915)	Magnesium, water, filtered, mg/L (00925)	Sodium, water, filtered, mg/L (00930)	Sodium adsorption ratio (00931)	Sodium, percent (00932)	Sodium + potassium, water, filtered, mg/L as Na (00933)	Potassium, water, filtered, mg/L (00935)	Chloride, water, filtered, mg/L (00940)	Sulfate, water, filtered, mg/L (00945)
	.020	1							280	130	330			130	28.0	1600	
	.040	2							230	92.0	230			11.0	20.0	1100	
	.700	3							72.0	30.0	81.0			6.60	7.0	360	
	.070	4							190	75.0	190			9.20	19.0	880	
	.340	5							110	47.0	120			8.60	11.0	550	
	.630	6							78.0	31.0	67.0			8.40	7.9	370	
	.770	7							71.0	27.0	68.0			5.90	6.8	320	
	.060	8							210	91.0	250			140	23.0	1200	
	.020	9							320	130	370			17.0	26.0	1700	
	.110	10							200	120	350			17.0	29.0	1700	
		11															
		12															
		13							438	181	562			13.2	30.9	2550	
		14							469	191	570			13.2	32.5	2670	
		15							427	180	546			12.7	30.6	2620	
		16															

Table P. 3



06365900 Cheyenne River near Dull Center WY

Return to [Index to Surface-Water-Quality Data for Water Year 2005](#)

WARNING--PROVISIONAL DATA, SUBJECT TO REVISION

Station number	Date as yyyyymmdd	Sample start time	Discharge, instantaneous, cubic feet per second	Barometric pressure, millimeters of mercury	Dissolved oxygen, water, unfiltered, milligrams per liter	Dissolved oxygen, water, unfiltered, percent of saturation
06365900	20041005	0845	.01	652	5.3	56
06365900	20041103	0805	.05	652	8.0	70
06365900	20041207	0815	.03	644	7.9	65
06365900	20050111	0830	.04	645	7.8	64
06365900	20050208	0840	.05	650	8.4	69
06365900	20050307	0845	.02	651	9.1	78
06365900	20050413	0845	.04	652	7.7	73
06365900	20050519	1535	.05	647	5.6	87
06365900	20050606	0900	.03	644	6.8	85
06365900	20050712	0830	.00			
06365900	20050809	0815	.00			
06365900	20050907	0820	.00			

Remarks:

< = Actual value is known to be less than the value shown.

> = Actual value is known to be greater than the value shown.

E = Estimated value

M = Presence of material verified but not quantified

U.S. Department of the Interior, U.S. Geological Survey

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	pH, water, unfiltered, field, standard units	Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	Temperature, air, degrees Celsius	Temperature, water, degrees Celsius	Hardness, water, unfiltered, milligrams per liter as calcium carbonate	Calcium, water, filtered, milligrams per liter	Magnesium, water, filtered, milligrams per liter	Potassium, water, filtered, milligrams per liter	Sodium adsorption ratio, water, number	Sodium, v filtered, millig liter
	7.3	4780	4.5	10.0	2000	479	199	13.2	6	595
	7.5	3690	7.5	2.5	1400	314	159	20.7	5	438
	7.5	3990	.5	.0	1700	396	182	23.1	5	483
	7.4	3770	1.0	.0	1600	370	172	18.8	4	418
	7.7	3620	-10.0	.5	1400	332	150	16.3	5	412
	7.9	3870	2.0	2.0	1500	347	161	16.2	5	429
	7.6	4020	12.5	8.0	1700	385	172	20.2	5	508
	8.0	3270	26.0	28.5	1200	246	133	18.6	5	382
	7.7	3580	23.0	17.0	1300	252	155	20.0	5	395



06365900 Cheyenne River near Dull Center WY

Return to [Index to Surface-Water-Quality Data for Water Year 2006](#)

WARNING--PROVISIONAL DATA SUBJECT TO REVISION

Station number	Date as yyyyymmdd	Sample start time	Discharge, instantaneous, cubic feet per second	Barometric pressure, millimeters of mercury	Dissolved oxygen, water, unfiltered, milligrams per liter	Dissolved oxygen, water, unfiltered, percent of saturation	pH unfiltered
06365900	20051011	0835	.00				
06365900	20051107	0855	.00				
06365900	20051207	0900	.02	662	5.1	41	
06365900	20060110	0850	.04	651	9.2	75	
06365900	20060207	0850	.40	658	8.5	68	
06365900	20060307	0840	.01	646	6.5	59	
06365900	20060411	0900	.01	647			
06365900	20060509	0930	.05	651	8.8	87	

Remarks:

< = Actual value is known to be less than the value shown.

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	pH, water, unfiltered, field, standard units	Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius	Temperature, air, degrees Celsius	Temperature, water, degrees Celsius	Hardness, water, unfiltered, milligrams per liter as calcium carbonate	Calcium, water, filtered, milligrams per liter	Magnesium, water, filtered, milligrams per liter	Potassium, water, filtered, milligrams per liter	Sodium adsorption ratio, water, number	Sodium, water, filtered, milligram per liter
	7.5	4880	-2.5	.0	2100	468	226	28.1	5	575
	7.8	3280	-2.0	.0						
	7.6	3520	-2.0	.0	1500	333	154	17.1	5	409
	7.5	4130	11.0	4.0						
	8.5		8.5	8.0						
	8.0	4220		7.5						

USGS Cheyenne River Dull Center Data
 1975-2006 EC at flows less than 1 cfs

Sample Date	Flow (cfs)	EC (umhos/cm)
11/4/1975	0.2	3200
12/2/1975	0.5	3000
2/3/1976	0.4	3200
5/4/1976	0.18	3500
8/3/1976	0.43	3000
9/1/1976	0.02	3000
9/28/1976	0.11	3200
11/5/1976	0.07	3000
12/8/1976	0.12	3000
2/4/1977	0.04	3500
3/31/1977	0.13	3200
4/28/1977	0.17	3200
5/25/1977	0.07	3200
7/7/1977	0.05	3500
8/2/1977	0.07	2800
11/9/1977	0.1	2600
12/30/1977	0.18	3500
2/1/1978	0.07	2800
8/30/1978	0.76	2500
9/13/1978	0.07	3400
10/11/1978	0.26	3600
10/15/1978	0.17	3700
11/8/1978	0.26	3500
7/18/1979	0.37	2600
9/11/1979	0.17	2500
10/3/1979	0.2	2960
11/13/1979	0.24	2920
12/5/1979	0.26	3160
2/7/1980	0.18	3350
7/9/1980	0.14	3150
8/13/1980	0.09	2930
9/24/1980	0.17	2900
10/23/1980	0.23	3120
11/18/1980	0.18	3580
12/17/1980	0.17	3030
1/13/1981	0.11	3220
2/19/1981	0.56	2140
2/26/1981	0.12	2900
3/15/1981	0.18	3100
4/15/1981	0.12	3190
5/19/1981	0.66	3000
6/17/1981	0.16	3130
7/8/1981	0.04	3420
9/9/1981	0.1	2650
1/5/1987	0.26	3400
7/23/1987	0.11	3380
8/27/1987	0.13	2720

Outliers

8/30/1977	0.07	910
9/29/1977	0.01	1500

Post CBM Data

Date	Flow	EC
7/13/2004	0.01	4880
8/9/2004	0.01	4740
9/7/2004	0.03	4830
10/5/2004	0.01	4780
11/3/2004	0.05	3690
12/7/2004	0.03	3990
1/11/2005	0.04	3770
2/8/2005	0.05	3620
3/7/2005	0.02	3870
4/13/2005	0.04	4020
5/19/2005	0.05	3270
6/6/2005	0.03	3580
6/27/2005	0.04	3070
12/7/2005	0.02	4880
1/10/2006	0.04	3280
2/7/2006	0.4	3520
3/7/2006	0.01	4130
5/9/2006	0.05	4220

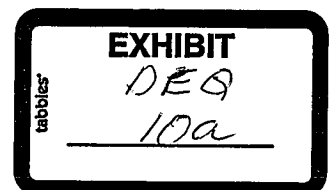


Figure based on USGS Cheyenne River
Dull Center Data 1975-2006

Flow and EC, Pre- and Post-CBM at Low Flows (<1 cfs)

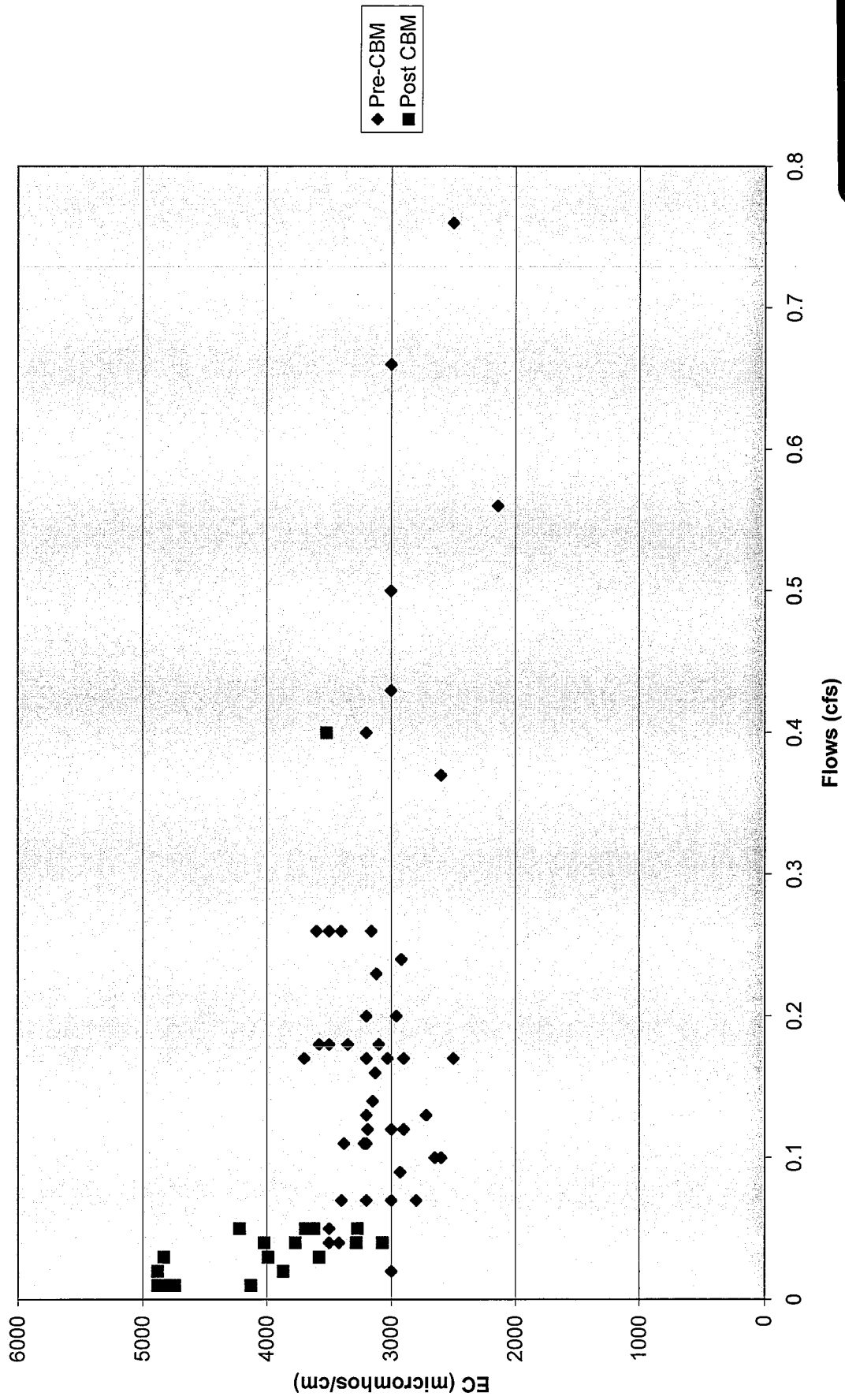
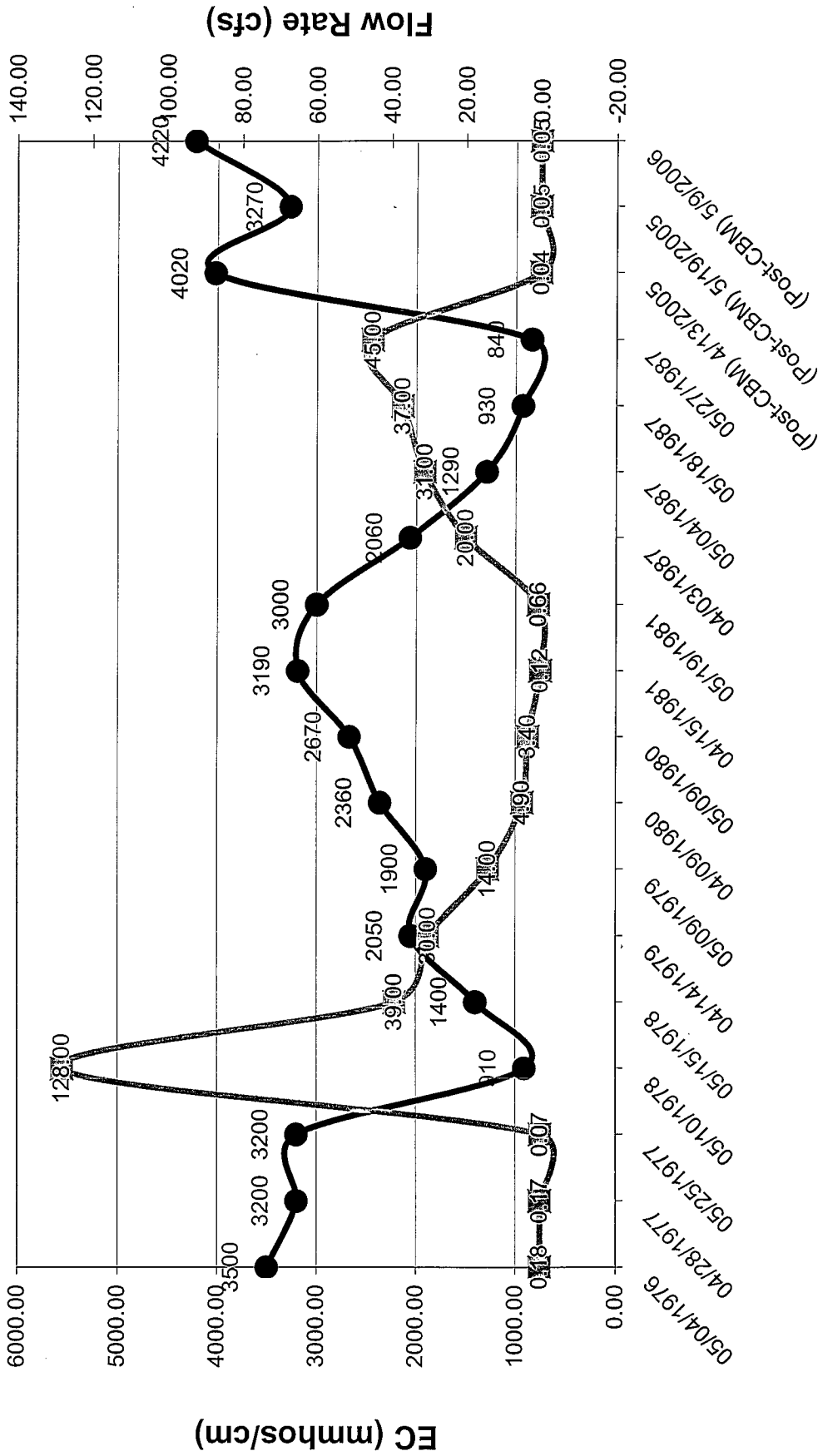


EXHIBIT
DEQ
106

EC Compared To Flow Rate

Source: USGS Surface Water Quality Data (Cheyenne River, Near Dull Center, Wyoming)



● EC Value ■ Flow Rate (cfs)

EXHIBIT
 PEG
 10C