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FILED
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Jim Ruby, Executive Secretary
Environmental Quality Council

**BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
OF THE STATE OF WYOMING**

IN THE MATTER OF THE APPEAL	)	**Docket No. 09-3802**
OF POWDER RIVER BASIN RESOURCE	)	
COUNCIL, BERNADETTE BARLOW,	)	
BERNADETTE BARLOW TRUST,	)	
WILLIAM L. BARLOW TRUST AND	)	
ERIC BARLOW FROM WYPDES	)	
PERMIT NO. WY0052299	)	

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY'S BRIEF IN OPPOSITION TO PETITIONER'S MOTION FOR SUMMARY JUDGMENT

Respondent, Wyoming Department of Environmental Quality ("DEQ"), respectfully submits this brief in opposition to Petitioners' Motion for Summary Judgment. Petitioners' motion should be denied because there are genuine issues of material fact in the above captioned matter.

INTRODUCTION

The DEQ issued renewal permit number WY0052299 to Bill Barrett Corporation ("Barrett") on November 25, 2008. (Ex. 1, at 1 & 5). On January 21, 2009, the Powder River Basin Resource Council ("PRBRC"), through Bernadette Barlow and Eric Barlow ("Barlow"), who are members of the PRBRC, ("Petitioners") appealed WYPDES permit

WY0052299. They alleged that authorized discharges of water that **could** reach the Barlow property would not maintain their water supply at a quality allowing continued use of the water for agricultural purposes without a measurable decrease in their agricultural production. (Pet'r Pet. at 2). Petitioners' further alleged in their petition that the limits in the permit were not derived from an appropriate scientific method and therefore the DEQ's decision to issue the permit had to be reversed. (*Id.* at 2-3). In their motion for summary judgment, Petitioners argue that the limits set by the DEQ in Barrett's permit are wrong because they rely on flawed Tier 2 methodology as concluded in the reports Drs. Hendrickx and Buchanan.[1] (Pet'r. Mot. at 7-8).

The real issue is whether the effluent limits set in Barrett's permit protect agricultural uses. However, Drs. Hendrickx and Buchanan did not examine or present any evidence as to whether there has been a decrease in crop or livestock production on Barlow's property. Because the Hendrickx & Buchanan's reports focus on the science behind Tier 2, rather than what is actually occurring on Barlow's property, they are not relevant to the real issue in this case. As such, even if Tier 2 is flawed, the evidence in this case shows that Barrett's permit is protective of crop or livestock under Chapter 1, Section 20 of the Water Quality Rules and Regulations ("WQRR").

Petitioners admit that they have no evidence to show that the Coal Bed Methane ("CBM") water discharged by Barrett causes or has caused harm to Barlow's crop or

[1] Drs. Hendrickx and Buchanan were hired to determine (after Barrett's permit was issued in 2008) whether the DEQ's Tier 2 methodology to set effluent limits was scientifically valid. (Ex. 2, at 1, and Ex. 3 at 1). The Hendrickx & Buchanan reports concluded that Tier 2 methodology used by the DEQ to set effluent limits for discharge water was neither reasonable nor scientifically valid. (Ex. 2, at iii, and Ex. 3 at ii).

livestock production. (Pet'r Mot. at 6). In fact, the evidence shows that the permit issued by the DEQ set effluent limits and water management requirements that provide real world protection of crop and livestock production on Barlow's property. (Ex. 4, at ¶¶ 5 & 7). Accordingly, Petitioners' motion should be denied, and this matter heard in a contested case hearing.

FACTS

The renewal permit issued in 2008 allows Barrett to discharge produced water into seven on-channel reservoirs located in ephemeral drainages to Dead Horse Creek. (Ex. 1, at 1 & 5). This permit also authorizes Barrett to discharge CBM produced water from outfalls 003, 005, 008, 011, and 013 to on channel reservoirs. (*Id.* at 1). All of these outfalls are located above known irrigation activity in the Dead Horse Creek drainage. (*Id.* at 2).

The permit requires full containment of produced water. (*Id.* at 2-3). The permit only allows discharges of produced water from the lowermost reservoirs during periods of time that natural precipitation events cause the reservoirs to overtop and spill. *Id.* Overtopping of the lowermost reservoirs is limited to forty eight (48) hours. (*Id.* at 2). Because the water is contained in reservoirs, the permit sets the sodium adsorption ratio (SAR) using the formula, SAR $< 7.10 \times EC - 2.48$, at its Irrigation Monitoring Point ("IMP") downstream from Barrett's lowermost reservoirs. (*Id.* at 3). The permit requires daily monitoring below the reservoirs to determine whether produced water reaches the irrigation monitoring point (IMP). *Id.* The DEQ collects and evaluates data at the IMP to assure that any release from the reservoirs from overtopping conforms to SAR. *Id.* If the samples show that water from the reservoirs exceed the SAR limit set by the above formula, the DEQ will add an effluent limit at each of the outfalls. (Ex. 4, at ¶ 13). The DEQ also has a standard provision in Barrett's permit allowing it to re-open and modify the permit to include an SAR effluent limit at the outfall if it is determined one is needed. (*Id*, at ¶ 14).

To be protective of crop and livestock production, and recognizing that the outfalls are above known agricultural practices, the DEQ built in a margin of conservatism in Barrett's permit and set a specific conductance ("EC") effluent limit of 2,315 micromhos/cm. (Ex. 1, at 2). The DEQ set the EC to be protective of crop and livestock production by using soil salinity data collected as a part of a study done in conjunction with the Dead Horse Creek watershed-based permitting effort. (*Id.* at 3). The study was based on Tier 2 methodology and was conducted prior to the issuance of the Hendrickx & Buchanan reports. (*Id.* at 2).

There is evidence to show that Barrett's permit is protective of downstream agricultural uses. The DEQ has conducted its own study to evaluate the potential quality of any water that is discharged as a result of the overtopping of reservoirs. (Ex. 5). That study concludes that SAR levels at IMP's from overtopping events do protect agricultural uses of CBM water. (*Id.* at 1-2). In addition, since Barrett's permit was originally issued in 2005, the DEQ has not received a complaint from any landowner downstream of Barrett's outfalls regarding a decrease in crop or agriculture production based on the quality of the water. (Ex. 4, at ¶ 6). Moreover, crop and livestock production has actually increased in the Dead Horse Creek drainage using Barrett's CBM water despite the effluent limits set by the DEQ in the permit. (Ex. 6, at ¶¶ 4, 5, & 6). Conversely, by Petitioners' own admission, there is no evidence showing a measurable decrease in crop or livestock production as a result of the effluent limits set in Barrett's permit. (Pet'r Mot. at 6).

STANDARD FOR SUMMARY JUDGMENT

Rule 56 of the Wyoming Rules of Civil Procedure governs in cases before the EQC on a motion for summary judgment. (*Dep't of Envrtl. Quality R. of Practice and Procedure*, Ch 2, § 14) and see *Rollins v. Wyoming Tribune-Eagle*, 2007 WY 28, ¶ 6, 152 P.3d 367, 369 (Wyo. 2007). "The moving party bears the initial burden of establishing a prima facia case for a summary judgment. If the movant carries this burden, the opposing party is obligated to demonstrate that a genuine issue of material fact does exist." *Weber v. McCoy*, 950 P.2d 548, 551 (Wyo. 1997) citing *Mize v. N. Big Horn Hosp. Dist.*, 931 P.2d 229, 232 (Wyo. 1997). "The judgment sought shall be rendered forthwith if the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to material fact and that the moving party is entitled to a judgment as a matter of law." *Long v. Daly*, 2007 WY 69, ¶ 7, 156 P.3d 994, 997 (Wyo. 2007). The evidence offered in support of and in opposition to a motion for summary judgment is viewed in a light most favorable to the party opposing the motion. *Id.* "A genuine issue of material fact exists when a disputed fact, if proven, would have the effect of establishing or refuting an essential element of an asserted cause of action or defense." *Id.*

ARGUMENT

Petitioners argue that the Hendrickx & Buchanan reports identify problems with the DEQ's Tier 2 methodology and therefore any permit issued using Tier 2 should be revoked. (Pet'r Mot. at 10-11). In addition, Petitioners argue that Respondents must produce evidence that the CBM water discharged under the provisions of Barrett's permit does not cause a decrease in crop or livestock production. (*Id.* at 17). Petitioners' arguments are misguided as they fail to examine whether there actually is a measurable decrease in agricultural production below Barrett's outfalls. (WQRR, Ch 1, § 20).

Petitioners' motion must fail because the Hendrickx & Buchanan reports do not show that there is a relationship between water quality and a decrease of crop or livestock production under controlled water management practices. The permit issued to Barrett in this case does have effluent limits and water containment terms that protect downstream crop and livestock production on Barlow's property. (Ex. 4, at ¶ 5). The facts in this case show that real world application of the limits and requirements contained in Barrett's permit for its outfalls in Dead Horse Creek are protective of agriculture. (*Id.* and Ex 6, at ¶ 4). Because the genuine issue of fact in this case is whether Barrett's permit protects downstream agricultural uses, Petitioners' motion for summary judgment should be denied so that the EQC can hear evidence on that issue.

Petitioners correctly identify that Chapter 1, Section 20 of the WQRR is at issue in this case. (Pet'r Mot. at 9). The rule requires that "[d]egradation of such waters shall not be of such an extent to cause a measurable decrease in crop or livestock production." (WQRR, Ch. 1, § 20). The DEQ contends that even if Tier 2 is flawed, the effluent limitations set in the Barrett's permit maintain water quality levels that comply with Chapter 1, Section 20 of the WQRR. (Ex. 4, at ¶ 5). Additionally, since the permit was first issued in 2005, the DEQ has never received a complaint from landowners downstream of Barrett's outfalls regarding any decrease in crop or livestock production due to the quality of the water. (*Id.*, at ¶ 6). In fact, Barrett's CBM water used for agricultural purposes under a controlled irrigation management plan has actually resulted in an increase in agricultural production. (Ex. 6. At ¶¶ 5 & 6). Accordingly, the EQC must hear and consider evidence as to whether there has been a measurable decrease in crop or livestock production below Barrett's outfalls. Whether there is a measurable decrease in crop or livestock production is the contested issue in this case. Petitioners' have failed to show that there are no genuine issues of material fact with respect to this issue, and therefore, Petitioners' motion for summary judgment should be denied.

In support of their motion, Petitioners also argue that because Barrett's permit does not contain an end of pipe SAR limit, the produced water is not protective of agricultural uses and the permit should be revoked. (Pet'r. Mot. at 11). The DEQ contends that the requirement in the permit that all discharges must be contained in the lowermost reservoirs (with the exception of rain events), is just the first step in water management that protects downstream agricultural uses negating the need for an end of pipe SAR limit. (Ex. 4, at ¶¶ 7, 8 & 9). Petitioners' argument overlooks the language in the permit that imposes a SAR monitoring requirement, a discretionary provision allowing DEQ to re-open the permit and apply a SAR limit, and an automatic SAR limit if it is shown that produced water is escaping the reservoirs at a SAR level that may be damaging to crop and livestock production. The permit requires daily monitoring below the reservoirs to determine whether produced water reaches the irrigation monitoring point (IMP). (Ex. 1, at 3). The DEQ collects and continuously evaluates data at the IMP to assure that any release from the reservoirs from overtopping conforms to the following formula: SAR < 7.10 x EC – 2.48. *Id.* If the samples show that water from the reservoirs exceed this formula, the automatic SAR limit is triggered and the DEQ will add an effluent limit at each of the outfalls. (Ex. 4, at ¶ 13). The DEQ also retains a standard provision in the permit that allows DEQ to re-open and modify Barrett's permit to include a SAR effluent limit at the outfall, even short of three exceedences per year, such as in the case of a very high single exceedence (*Id*, at ¶ 14).

The DEQ has also conducted studies to evaluate the potential quality of any water that is discharged as a result of the overtopping of the reservoirs. Based on the DEQ's data from in-stream IMP and irrigation compliance point (ICP) locations, the DEQ determined that a SAR limit at Barrett's outfalls was not necessary. (*Id.* at ¶ 9). The data indicates that the vast majority of the water reaching IMP/ICP locations after overtopping protects agricultural uses of CBM water. (*Id.* at ¶ 10 and Ex. 3). Moreover, as mentioned above, the DEQ requires ongoing monitoring at the IMP to confirm its expectation that any overtopping will be compliant the SAR threshold. The Petitioners' argument overlooks the monitoring requirements and automatic SAR limit if it is shown that water is escaping Barrett's lowermost reservoirs at a SAR level that may be damaging to crop and livestock production, and therefore should be disregarded.

Petitioners' argue that the DEQ is **required** to use appropriate scientific methods to establish numeric effluent limits. (Pet'r Mot. at 8). Petitioners rely heavily on the reports of Hendrickx and Buchanan, to argue that the effluent limits set in Barrett's permit are not based on credible science because Tier 2 is flawed. The Hendrickx & Buchanan May 2009 report answered the following questions:

> One, "[w]hether the Tier 2 methodology . . . is reasonable and scientifically valid for determining the EC and SAR of water that can be discharged into an ephemeral drainage in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production."
>
> Two, "[w]hether the method set forth . . . for determining EC and SAR for permitting the discharge of produced water is reasonable, sufficiently defined and scientifically defensible for the conditions in Wyoming, and provides a uniform testing procedure that is reasonably accurate and unbiased for the determination of soil EC from which you can reasonably infer the quality of the water EC and SAR that historically flowed within the drainage that will support the establishment of effluent limits for discharge permits in a given drainage that will not cause a measurable decrease in crop production."

(Ex. 2, at ii). The questions answered in the Hendrickx & Buchanan report focused on discharges of produced water for the protection of crop and livestock production using Tier 2 to determine the EC and SAR of historical water flowing down a drainage. However, at that time, the DEQ was actually determining the composition of the soil in a given drainage, including EC and SAR levels. (Ex. 7, at 24). The DEQ used this information to determine appropriate effluent limits for discharge permits so that produced water applied to the land did not degrade agricultural productivity by degrading the soil. *Id.* The May 2009, Hendrickx & Buchanan report did not address the issue of determining EC and SAR in the existing soil in and around the drainage to determine effluent limits for produced water to be protective of crop and livestock production.

Because of this difference, the DEQ contacted Hendrickx and Buchanan for clarification of their report to the Environmental Quality Council ("EQC"). (Ex. 3, at ii).

After being contacted by the DEQ, Drs. Hendrickx and Buchanan issued a second report in September of 2009. In that report, Drs. Hendrickx and Buchanan found that "no unique relationship exists between irrigation water quality on the one hand and root zone soil salinity and crop productivity on the other." *Id.* However, they still concluded that Tier 2 was not a scientifically valid method for determining the EC of produced waters discharged to waters of the state. *Id.* The report continued on to say that the damage done to crop and livestock production was a result of water-logging that most likely caused an increase in salinity. *Id.* Then the report acknowledged that the true problem was the quantity of water discharged and not the quality of the water discharged. *Id.* The report stated: "The damage done by Tier 2 and Tier 1 starts by creating water logged conditions in the drainages: **the true problem is the quantity of CBM waters rather than its quality**." *Id.* After identifying water quantity as the "true" problem of produced water discharges, the report promoted proper management of CBM water for irrigation to control salinity. *Id.* As such, the Hendrickx & Buchanan report focuses on water quantity and water management issues, not water quality issues, and therefore its conclusions are irrelevant to these proceedings.

Moreover, neither Hendrickx & Buchanan report establishes what specific effect the effluent limitations set in the permit have on the productivity of agriculture below Barrett's outfalls, especially with regard to Barlow's property. It is interesting to note that the Hendrickx & Buchanan report stated that water of any quality can affect the salinity levels in the soil. *Id.* Additionally, the Hendrickx & Buchanan September 2009 report was not conclusive with regard to whether fields water-logged by produced water have an increased salinity by stating that water-logging "**most likely**" causes an increase in salinity. *Id.* The Hendrickx & Buchanan report does not conclude that fields water-logged by produced water **will** cause an increase in salinity. As such, while the Hendrickx & Buchanan reports conclude that Tier 2 is neither reasonable nor scientifically valid, the reports do not show that water discharged under Barrett's permit causes a measurable decrease in crop or livestock production. Accordingly, even if the DEQ utilized potentially flawed methodology in granting permits, that does not mean there are not questions of material fact regarding the actual detrimental effect, if any on Barlow's agricultural operations. The result of Petitioners' failed argument is that the EQC must conduct at a contested case hearing to determine whether the effluent limits and other water management tools set forth in Barrett's permit actually protect Barlow's crop or livestock production.

Petitioners argue that the failure to use scientifically valid methods to determine numeric limits in discharge permits pursuant to Chapter 2, Section 5(c)(iii)(C)(IV) means the permit should be revoked. (Pet'r Mot. at 8-10). However, Petitioners fail to cite any authority which dictates that the remedy for a permit issued with flawed methodology is revocation. Petitioners have pointed to no case, statute or regulation that mandates revocation of Barrett's permit. Instead the pertinent question is whether the substantive water quality standard set forth in Chapter 1, Section 20 of the WQRR is being met under the permit. Chapter 2, Section 5(c)(iii)(C)(IV) states that the DEQ "may" establish numeric effluent limits in permits using an appropriate scientific method. (WQRR, Ch 2, § 5(c)(iii)(C)(IV)). Thus, an EC limit is not mandatory, and therefore a permit containing a flawed EC limit is not inherently invalid. Then the remedy for setting effluent limits based on a flawed scientific method is not necessarily revocation of Barrett's permit. Instead, the appropriate course of action in these circumstances is to determine the factual compliance or non-compliance with the water quality standard set forth in Chapter 1, Section 20 of the WQRR. The Hendrickx & Buchanan reports are not relevant to that determination and are therefore irrelevant.

Determination of whether there is a measurable decrease in crop or livestock production on Barlow's property is the material issue in this case. By their own admission, Petitioners cannot show actual or threatened harm to Barlow's agricultural operations. (Pet'r Mot. at 6). Respondents should have the opportunity to demonstrate compliance with the substantive water quality standard in this case which is whether the effluent limits set in Barrett's permit damage Barlow's crop and livestock production. (WQRR, Ch.1, § 20). Accordingly, the EQC should deny Petitioners' motion for summary judgment.

CONCLUSION

Plaintiffs' have failed to show that summary judgment should be granted in their favor because the Hendrickx & Buchanan reports taken alone do not answer the question as to whether Barrett's permit protects downstream agricultural uses on Barlow's property. This is inherently a question of fact that must be considered in light of the specific effects and particular context of this permit. The effluent limits and water containment terms in the permit create a water management scheme that prevents any measurable decrease in crop or livestock production under Chapter 1, Section 20 of the WQRR. Accordingly, the DEQ requests that the EQC deny Plaintiffs' motion for summary judgment.

Respectfully submitted this 22nd day of April, 2010.

FOR THE DEPARTMENT OF
ENVIRONMENTAL QUALITY

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CERTIFICATE OF SERVICE

I certify that the foregoing document was served by US. Mail, postage prepaid, and addressed correctly, to the following people on the 22nd day of April, 2010:

Kate Fox
Mark Stewart
Davis and Cannon, LLP
422 W. 26th St.
P. O. Box 43
Cheyenne, WY 82003

Jack D. Palma II
Holland & Hart, LLC
P.O. Box 1347
Cheyenne, WY 82003-1347

Wyoming Attorney General's Office

Exhibit 1

Wyoming Department of Environmental Quality
Water Quality Division
WYPDES Program

STATEMENT OF BASIS

MAJOR MODIFICATION

APPLICANT NAME: Bill Barrett Corporation

MAILING ADDRESS: 1901 Energy Ct., Suite 170
Gillette, WY 82718

FACILITY LOCATION: BBC Dead Horse Creek Option 2, which is located in the NENW of Section 2, the SWNW of Section 1, and the NENW of Section 12, all in Township 47 North, Range 75 West; and in the SWNW, and SWSW of Section 6 Township 47 North, Range 74 West in Campbell County. The produced water will be discharged into seven on-channel reservoirs (class 3B) located in ephemeral tributaries (class 3B) to Dead Horse Creek (class 3B), which is tributary to the Powder River (class 2ABWW). The wells at this facility will discharge effluent originating from the Big George and Wyodak coal seams.

NUMBER: **WY0052299**

The following Statement of Basis only includes information that has changed with this modification. For a complete Statement of Basis, please see previously issued modifications or renewals for this permit.

The terms of permit WY0052299 are hereby modified as follows:

1. ***Update irrigation protection limits and monitoring requirements to WDEQ drainage standards.***
2. ***Remove ICP1.***
3. ***Correct outfall 005 to its as-built location.***

With the exception of items explicitly delineated in this major modification, all terms and conditions of Permit No. WY0052299, including Parts II and III of the renewed permit, shall remain unchanged and in full force and effect.

For the on-channel discharges at this facility (outfalls 003,005,008,011, and 013), the permittee will be required to contain all produced water within a series of on-channel reservoirs during "dry" operating conditions. The permittee is authorized to release discharge from upstream on-channel reservoirs only. Water released from the upstream reservoirs will be allowed to cascade down to the lowermost on-channel reservoirs, identified as follows: "Dead Horse" and "35-1". This permit prohibits discharge of effluent from the lowermost reservoirs except during periods of time in which natural precipitation causes the lowermost reservoirs to overtop and spill. Intentional discharges from the lowermost reservoirs will be considered a violation of this permit. Discharge from the lowermost reservoirs is limited by the permit to natural overtopping and shall not extend beyond a 48 hour period following commencement of natural overtopping. Additional release from the lowermost reservoirs as identified above is not authorized. It is the sole responsibility of the operator to adequately demonstrate the circumstances in which reservoir discharges occurred, if requested to do so by the WYPDES Program. Reservoir and/or discharge water is to be released at a rate which does not cause significant erosion to the channel or receiving lands.

Irrigation Use Protection: This permit authorizes discharges from outfalls that are located above known irrigation activity in Dead Horse Creek. In order to monitor and regulate coal bed methane discharge for compliance with Chapter 1, Section 20 of the Wyoming Water Quality Rules and Regulations (protection of agricultural water supply), an end-of-pipe effluent limit for specific conductance (EC) is included in this permit. In addition, this permit requires monitoring for EC and SAR at the established irrigation monitoring point(s) (IMP1).

The Wyoming DEQ has determined that an end-of-pipe specific conductance effluent limit of 2,315 micromhos/cm is appropriate for protection of agricultural uses in the Dead Horse Creek drainage. This effluent limit was derived using soil salinity data submitted as part of a study done in conjunction with the Dead Horse Creek watershed-based permitting effort. As part of the watershed-based permitting process for the Dead Horse Creek watershed, soil sampling data was conducted on naturally irrigated lands located on the Dead Horse Creek mainstem to meet requirements for a Tier 2 study as established under the Agricultural Use Protection Policy. The soil sampling was conducted in August, 2007 by KC Harvey personnel; a representative from the WYPDES Program supervised the soil sampling and managed custody of the samples for delivery to the laboratories.

The end-of-pipe specific conductance limit of 2,315 micromhos/cm was derived through evaluation of the average soil electrical conductivity in the sampled irrigated fields. The average soil EC within the irrigated areas was measured at 4,111 micromhos/cm, with a 95 % confidence interval of +/- 635 micromhos/cm. This means that while the sampled population indicates a mean soil EC of 4,111 micromhos/cm, the actual mean soil EC for all fields likely falls within the range of 3,475 to 4,746 micromhos/cm. For the purpose of introducing a margin of conservatism into the irrigation effluent limit calculations for this permit, the lower value (3,475 micromhos/cm) was assumed to be the actual mean soil EC for the downstream irrigated fields. In calculating an end-of-pipe effluent limit for EC that will maintain a mean soil EC of 3,475 micromhos/cm in the downstream irrigated fields, USDA recommends dividing the soil EC by 1.5 to estimate allowable salinity in the applied water (*Agricultural Salinity and Drainage, Hanson et al., 1999 revision*). This results in an end-of-pipe specific conductance effluent limit of 2,315 micromhos/cm, which is established at each outfall authorized under this permit that is located upstream of irrigation activity, and is effective year-round.

As stated above, in addition to the end-of-pipe EC limit, this permit requires monitoring for EC and SAR at the designated irrigation monitoring point(s) (IMP1). The Wyoming DEQ has determined that, in this drainage, it is appropriate to establish an EC threshold at the IMP(s) that is equivalent to the calculated average soil EC within the irrigated areas (4,111 micromhos/cm, based on the studies referenced above) divided by 1.5 to estimate allowable salinity in the applied water (based on USDA recommendation cited above). This results in an instream EC threshold of 2,740 micromhos/cm at the IMP(s), which represents the estimated background salinity of the historically-applied irrigation water in the Dead Horse Creek drainage, and therefore is the target water quality value that the Wyoming DEQ has determined should be achieved at the IMP(s). The permittee will be required to monitor at the irrigation monitoring point(s) downstream of the on-channel reservoirs at this facility for compliance with the 2,740 micromhos/cm threshold, as well as for compliance with a chemical relationship between EC and SAR, described in detail below under "Monitoring and Reporting Requirements".

Monitoring and Reporting Requirements: The permit requires daily monitoring on the receiving stream below the outfalls in order to determine whether effluent discharged from the outfalls reaches the established irrigation monitoring point(s) (IMP1, listed in Table 1 of the permit below). Daily monitoring is necessary because the permit establishes different sampling and analysis requirements based on whether the effluent reaches the irrigation monitoring point(s). Once effluent flow at the irrigation monitoring point(s) has been documented within a sampling month, then weekly monitoring of flow at the IMP(s) is required for the remainder of that calendar month. At the beginning of each calendar month, the monitoring frequency will revert to daily until such time as effluent flow occurs at the irrigation monitoring point(s) and a sample is collected to represent effluent quality for irrigation monitoring point constituents. Results are to be reported twice-yearly and if no effluent from this facility reaches the irrigation monitoring point(s) during an entire sampling month, then "no discharge" is to be reported for the IMP that month. The IMP is not a compliance point. It is intended only as a location to gather downstream water quality data.

Data collected at locations IMP1 will be evaluated by WDEQ on an ongoing basis in order to determine if effluent from this facility conforms to the following chemical characteristics at the IMP location:

EC < 2,740 micromhos/cm (= 2.74 dS/m)

and

*SAR < 7.10 x EC – 2.48

(*where "SAR" represents sodium adsorption ratio, and "EC" represents specific conductance of the IMP sample in dS/m).

In the event that overtopping or a release from a reservoir that receives discharges from the permittee's outfall(s) is contributing to flow at station IMP1 or IMP2, and the IMP sample exceeds the SAR threshold listed above, then WDEQ may re-open the permit and add an effluent limit for SAR at the outfall(s) discharging to such reservoir. In any case, where the IMP samples (minimum of 5 samples) exceed the above SAR threshold in 50% or more of the sampled flow events during any continuous 12-month period, then, upon written notification to the permittee, the above SAR threshold (SAR < 7.10 x EC – 2.48) will automatically become an effluent limit at each outfall discharging to such reservoir.

Renewal:
Kathy Shreve
Water Quality Division
Department of Environmental Quality
Drafted: November 3, 2004

Renewal:
Dena Hicks
Water Quality Division
Department of Environmental Quality
Drafted: June 14, 2007

Major Modification:
Bob Alexander
Water Quality Division
Department of Enviromental Quality
Drafted: July 21, 2008

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,

Bill Barrett Corporation

is authorized to discharge from the wastewater treatment facilities serving the

BBC Dead Horse Creek Option 2,

located in

the NENW of Section 2, the SWNW of Section 1, and the NENW of Section 12, all in Township 47 North, Range 75 West; and in the SWNW, and SWSW of Section 6 Township 47 North, Range 74 West in Campbell County

to receiving waters named

seven on-channel reservoirs (class 3B) located in ephemeral tributaries (class 3B) to Dead Horse Creek (class 3B), which is tributary to the Powder River (class 2ABWW)

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

This major 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 this major modification, all terms and conditions of WY0052299, including Part III of the renewed permit, shall remain in full force and effect.**

This permit and the authorization to discharge shall expire November 30, 2010, at midnight .

John F. Wagner
Administrator - Water Quality

Date 11/19/08

John V. Corra
Director - Department of Environmental Quality

Date 11/25/08

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Effective immediately and lasting through November 30, 2010, 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 serial numbers 003, 005, 008, 011 and 013.

1. Such discharges shall be limited as specified below:

Effluent Limits

Effluent Characteristic	Daily Maximum Outfall
Chlorides, mg/l	150
Dissolved Iron, µg/l	1000
pH, standard units	6.5 – 9.0
Specific Conductance, micromhos/cm	2315
Total Recoverable Arsenic, µg/l	8.4
Total Recoverable Barium, µg/l	1800

Note: 1) 'Dissolved' value for metals refers to the amount that will pass through a 0.45 µm membrane filter prior to acidification to 1.5-2.0 with Nitric Acid.

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

For the on-channel discharges at this facility (outfalls 003,005,008,011, and 013), the permittee will be required to contain all produced water within a series of on-channel reservoirs during "dry" operating conditions. The permittee is authorized to release discharge from upstream on-channel reservoirs only. Water released from the upstream reservoirs will be allowed to cascade down to the lowermost on-channel reservoirs, identified as follows: "Dead Horse" and "35-1". This permit prohibits discharge of effluent from the lowermost reservoirs except during periods of time in which natural precipitation causes the lowermost reservoirs to overtop and spill. Intentional discharges from the lowermost reservoirs will be considered a violation of this permit. Discharge from the lowermost reservoirs is limited by the permit to natural overtopping and shall not extend beyond a 48 hour period following commencement of natural overtopping. Additional release from the lowermost reservoirs as identified above is not authorized. It is the sole responsibility of the operator to adequately demonstrate the circumstances in which reservoir discharges occurred, if requested to do so by the WYPDES Program. Reservoir and/or discharge water is to be released at a rate which does not cause significant erosion to the channel or receiving lands.

The permittee may discharge effluent from any authorized well to any permitted outfall, as long as all permit limits and requirements can be met. The produced water being discharged at this facility must originate from the Big George and/or Wyodak coal seams.

Information gathered from the water quality monitoring station and irrigation monitoring point may result in modification of the permit, in accordance with Part III.A.3 of the permit below, 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.

2. Discharges shall be monitored by the permittee as specified below:

If outfalls have already been sampled and analyzed for initial monitoring constituents, the permittee is not required to re-sample and re-analyze the outfalls if results have been obtained for all the constituents listed below and reported to the WDEQ.

a. Monitoring of the initial discharge

Within 60 days of commencement of discharge, a sample shall be collected from each outfall and analyzed for the constituents specified below, at the required detection limits. Within 120 days of commencement of discharge, a summary report on the produced water must be submitted to the Wyoming Department of Environmental Quality and the U.S. EPA Region 8 at the addresses listed below. This summary report must include the results and detection limits for each of the constituents listed below. In addition, the report must include written notification of the established location of the discharge point (refer to Part I.B.11). This notification must include a confirmation that the location of the established discharge point(s) is within 1,510 feet of the location of the identified discharge point(s), is within the same drainage, and discharges to the same landowner's property as identified on the original application form. The legal description and location in decimal degrees of the established discharge point(s) must also be provided. After receiving the monitoring results for the initial discharge, the routine monitoring requirements described in Part I.A.5.b. may be modified to require more stringent monitoring.

Parameter	Required Detection Limit	Sample Type
Dissolved Aluminum	50 µg/l	Grab
Dissolved Cadmium	0.1 µg/l	Grab
Dissolved Calcium	as mg/l	Grab
Chloride	5 mg/l	Grab

Parameter	**Required Detection Limit**	**Sample Type**
Dissolved Copper	1 µg/l	Grab
Dissolved Iron	30 µg/l	Grab
Dissolved Manganese	10 µg/l	Grab
Total Hardness	10 mg/l as $CaCO_3$	Grab
Dissolved Lead	2 µg/l	Grab
Dissolved Magnesium	as mg/l	Grab
Dissolved Mercury	0.06 µg/l	Grab
pH	to 0.1 pH unit	Grab
Total Recoverable Radium 226	0.2 pCi/l	Grab
Total Recoverable Selenium	5 µg/l	Grab
Dissolved Sodium	as mg/l	Grab
Sodium Adsorption Ratio	not applicable	Calculated
Specific Conductance	5 micromhos/cm	Grab
Sulfates	10 mg/l	Grab
Total Alkalinity	1 mg/l as $CaCO_3$	Grab
Total Recoverable Arsenic	1 µg/l	Grab
Total Recoverable Barium	100 µg/l	Grab
Dissolved Zinc	10 µg/l	Grab
Bicarbonate	1 mg/l	Grab
Total Dissolved Solids	5 mg/l	Grab

Initial monitoring reports are to be sent to the following addresses:

Planning and Targeting Program, 8ENF-PT
Office of Enforcement, Compliance, and Environmental Justice
U.S. EPA Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

and

Wyoming Department of Environmental Quality
Water Quality Division
Herschler Building, 4 West
122 West 25th Street
Cheyenne, WY 82002

b. Routine monitoring End of Pipe (003, 005, 008, 011 and 013)

For the duration of the permit, at a minimum, samples for the constituents described below shall be collected at the indicated frequencies. The first routine monitoring for the time frame during which the monitoring of initial discharge occurs will, at a minimum, consist of flow measurements for the duration of the six-month monitoring time frame. Reporting will be based on semi-annual time frames, from January through June, and from July through December.

Parameter	Measurement Frequency	Sample Type
Bicarbonate (mg/l)	Annually	Grab
Dissolved Calcium (mg/l)	Monthly	Grab
Chloride (mg/l)	Annually	Grab
Dissolved Iron (μg/l)	Annually	Grab
Dissolved Magnesium (mg/l)	Monthly	Grab
pH (standard units)	Once Every Six Months	Grab
Dissolved Sodium (mg/l)	Monthly	Grab
Sodium Adsorption Ratio (unadjusted)	Monthly	Calculated
Specific Conductance (micromhos/cm)	Monthly	Grab
Total Alkalinity (mg/l)	Annually	Grab
Total Recoverable Arsenic (μg/l)	Annually	Grab
Total Recoverable Barium (μg/l)	Annually	Grab
Total Flow - (MGD)	Monthly	Continuous

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At the outfall of the final treatment unit which is located out of the natural drainage and prior to admixture with diluent waters.

c. <u>Irrigation Monitoring Point (IMP1)</u>

Effective immediatelyand lasting through permit expiration, at a minimum, samples for the constituents described below shall be collected at the indicated frequencies when water discharged from the outfalls reaches the irrigation monitoring point. Monitoring will be based on monthly time frames and reported semi-annually.

Parameter	Measurement Frequency	Sample Type
Dissolved Calcium, mg/l	Monthly	Grab
Dissolved Magnesium, mg/l	Monthly	Grab
Dissolved Sodium, mg/l	Monthly	Grab
Sodium Adsorption Ratio, unitless – calculated as unadjusted for bicarbonate ratio	Monthly	Calculated

Parameter	Measurement Frequency	Sample Type
Specific Conductance, μmhos/cm	Monthly	Grab
Bicarbonate, mg/l as $CaCO_3$	Monthly	Grab
Flow, MGD	Monthly	Instantaneous

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at the irrigation monitoring point which is located as described in Table 1, Part I.B.12 of the permit.

The permit requires daily monitoring on the receiving stream below the outfalls in order to determine whether effluent discharged from the outfalls reaches the established irrigation monitoring point(s) (IMP1, listed in Table 1 of the permit below). Daily monitoring is necessary because the permit establishes different sampling and analysis requirements based on whether the effluent reaches the irrigation monitoring point(s). Once effluent flow at the irrigation monitoring point(s) has been documented within a sampling month, then weekly monitoring of flow at the IMP(s) is required for the remainder of that calendar month. At the beginning of each calendar month, the monitoring frequency will revert to daily until such time as effluent flow occurs at the irrigation monitoring point(s) and a sample is collected to represent effluent quality for irrigation monitoring point constituents. Results are to be reported twice-yearly and if no effluent from this facility reaches the irrigation monitoring point(s) during an entire sampling month, then "no discharge" is to be reported for the IMP that month. The IMP is not a compliance point. It is intended only as a location to gather downstream water quality data.

Data collected at locations IMP1 will be evaluated by WDEQ on an ongoing basis in order to determine if effluent from this facility conforms to the following chemical characteristics at the IMP location:

EC < 2,740 micromhos/cm (= 2.74 dS/m)

and

*SAR < 7.10 x EC – 2.48

(*where "SAR" represents sodium adsorption ratio, and "EC" represents specific conductance of the IMP sample in dS/m).

In the event that overtopping or a release from a reservoir that receives discharges from the permittee's outfall(s) is contributing to flow at station IMP1, and the IMP sample exceeds the SAR threshold listed above, then WDEQ may re-open the permit and add an effluent limit for SAR at the outfall(s) discharging to such reservoir. In any case, where the IMP samples (minimum of 5 samples) exceed the above SAR threshold in 50% or more of the sampled flow events during any continuous 12-month period, then, upon written notification to the permittee, the above SAR threshold (SAR < 7.10 x EC – 2.48) will automatically become an effluent limit at each outfall discharging to such reservoir.

e. **Water Quality Monitoring Stations TRIB1, UPR, DPR**

For the duration of the permit, at a minimum, samples for the constituents described below shall be collected at the indicated frequencies. Monitoring will be based on monthly time frames, and reported semiannually.

Parameter	Measurement Frequency	Sample Type
Dissolved Calcium (mg/l)	Monthly	Grab
Dissolved Magnesium (mg/l)	Monthly	Grab
Dissolved Sodium (mg/l)	Monthly	Grab
Sodium Adsorption Ratio (calculated as unadjusted ratio)	Monthly	Calculated
Specific Conductance (micromhos/cm)	Monthly	Grab
Flow* (MGD)	Monthly	Instantaneous

*The permittee is only required to monitor and report flow at the tributary monitoring station (TRIB1). The permittee is not required to monitor or report flow data at the mainstem water quality monitoring stations (UPR and DPR), see Table 1, Part I.B.12 for location descriptions.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following locations: designated water quality monitoring stations identified as TRIB1, UPR, and DPR in Table 1 (located at the end of Part I) of the permit below. Established water quality monitoring stations on the mainstem are to be located outside the mixing zone with the tributary and the mainstem. Monthly water quality samples are to be collected at all three water quality monitoring stations when effluent from this CBM facility reaches the TRIB1 station. If flow occurs at the TRIB1 station during a given monthly monitoring period, but this CBM facility did not contribute to that flow, the permittee will report "did not contribute" in the discharge monitoring reports for that monthly monitoring period. Under such circumstances, sampling is not required at the three water quality monitoring stations, and it will be the responsibility of the permittee to demonstrate that the effluent from this facility did not contribute to the flow occurring at the TRIB1 station. If no flow at all occurs at the TRIB1 station for an entire monthly monitoring period, then "no flow" is to be reported and samples need not be collected at the three water quality monitoring stations for that monthly monitoring period.

B. MONITORING AND REPORTING

1. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water, or substance. Monitoring points shall not be changed without notification to and approval by, the permit issuing authority.

2. Reporting

Results of initial monitoring, including the date the discharge began, shall be summarized on a Monitoring Report Form for Monitoring of Initial Discharge and submitted to the state water pollution control agency at the address below postmarked no later than 120 days after the commencement of discharge.

Results of routine end of pipe and water quality station monitoring during the previous six (6) months shall be summarized and reported semiannually on a Discharge Monitoring Report Form (DMR). If the discharge is intermittent, the date the discharge began and ended must be included. The information submitted on the first semiannual DMR shall contain a summary of flow measurements and any additional monitoring conducted subsequent to the submittal of the initial monitoring report. If required, whole effluent toxicity testing (biomonitoring) results must be reported on the most recent version of EPA Region VIII's Guidance for Whole Effluent Reporting. Monitoring reports must be submitted to the state water pollution control agency at the following address postmarked no later than the 15th day of the second month following the completed reporting period. The first report following issuance of this renewal is due by February 15, 2008.

Legible copies of these, and all other reports required herein, shall be signed and certified in accordance with the Signatory Requirements contained in Part II.A.11.

Wyoming Department of Environmental Quality
Water Quality Division
Herschler Building, 4 West
122 West 25th Street
Cheyenne, WY 82002
Telephone: (307) 777-7781

If no discharge occurs during the reporting period, "no discharge" shall be reported. If discharge is intermittent during the reporting period, sampling shall be done while the facility is discharging.

3. **Definitions**

a. The "monthly average" shall be determined by calculating the arithmetic mean (geometric mean in the case of fecal coliform) of all composite and/or grab samples collected during a calendar month.

b. The "weekly average" shall be determined by calculating the arithmetic mean (geometric mean in the case of fecal coliform) of all composite and/or grab samples collected during any week.

c. The "daily maximum" shall be determined by the analysis of a single grab or composite sample.

d. "MGD", for monitoring requirements, is defined as million gallons per day.

e. "Net" value, if noted under Effluent Characteristics, is calculated on the basis of the net increase of the individual parameter over the quantity of that same parameter present in the intake water measured prior to any contamination or use in the process of this facility. Any contaminants contained in any intake water obtained from underground wells shall not be adjusted for as described above and, therefore, shall be considered as process input to the final effluent. Limitations in which "net" is not noted are calculated on the basis of gross measurements of each parameter in the discharge, irrespective of the quantity of those parameters in the intake waters.

f. A "composite" sample, for monitoring requirements, is defined as a minimum of four grab samples collected at equally spaced two hour intervals and proportioned according to flow.

g. An "instantaneous" measurement for monitoring requirements is defined as a single reading, measurement, or observation.

h. A "pollutant" is any substance or substances which, if allowed to enter surface waters of the state, causes or threatens to cause pollution as defined in the Wyoming Environmental Quality Act, Section 35-11-103.

i. "Total Flow" is the total volume of water discharged, measured on a continuous basis and reported as a total volume for each month during a reporting period. The accuracy of flow measurement must comply with Part III.A.1.

4. **Test Procedures**

Test procedures for the analysis of pollutants, collection of samples, sample containers, sample preservation, and holding times, shall conform to regulations published pursuant to 40 CFR, Part 136, unless other test procedures have been specified in this permit.

5. **Recording of Results**

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date and time of sampling;

b. The dates and times the analyses were performed;

c. The person(s) who performed the analyses and collected the samples;

d. The analytical techniques or methods used; and

e. The results of all required analyses including the bench sheets, instrument readouts, computer disks or tapes, etc., used to determine the results.

6. **Additional Monitoring by Permittee**

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form. Such increased frequency shall also be indicated.

7. **Records Retention**

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least three years from the date of the sample, measurement, report or application. This period may be extended by request of the administrator at any time. Data collected on site, copies of Discharge Monitoring Reports and a copy of this WYPDES permit must be maintained on site during the duration of activity at the permitted location.

8. **Penalties for Tampering**

The Act provides that any person who falsifies, tampers with or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by Imprisonment for not more than two years per violation, or both.

9. **Compliance Schedules**

Reports of compliance or noncompliance with, or any progress reports on interim and final requirements contained in any Compliance Schedule of this permit shall be submitted no later than 14 days following each schedule date.

10. **Facility Identification**

All facilities discharging produced water shall be clearly identified with an all-weather sign posted at each outfall, and at the outlet of each receiving reservoir listed in Table 1 below. This sign shall, at a minimum, convey the following information:

a. The name of the company, corporation, person(s) who holds the discharge permit, and the WYPDES permit number;

b. The contact name and phone number of the person responsible for the records associated with the permit;

c. The name of the facility (as identified in this WYPDES permit). In addition, all outfall signs will include the outfall number. Reservoir signs are separate from the outfall signs, and are to be located at the outlet of the reservoir. Reservoir signs must include the information listed in items a and b above, in addition to the reservoir name, as identified in Table 1 below.

11. Identification and Establishment of Discharge Points

According to 40 CFR 122.21(k)(1), the permittee shall identify the expected location of each discharge point on the appropriate WYPDES permit application form. The location of the discharge point must be identified to within an accuracy of 15 seconds. This equates to a distance of 1,510 feet.

In order for the permit not to be subjected to additional public notice, the location of the established discharge point must be within 1,510 feet of the location of the discharge point originally identified on the permit application. In addition, the discharge must be within the same drainage and must discharge to the same landowner's property as identified on the original application form. If the three previously stated requirements are not satisfied, modification of the discharge point location(s) constitutes a major modification of the permit. The permittee shall provide written notification of the establishment of each discharge point in accordance with Part I.A.5.a above.

12. Location of Discharge Points, Irrigation Compliance Points, and Water Quality Monitoring Stations

As of the date of permit issuance, authorized points of discharge were as follows:

SEE TABLE 1 FOR A LIST OF OUTFALLS, IRRIGATION COMPLIANCE POINTS, AND WATER QUALITY MONITORING STATIONS

Table 1: WY0052299 - BBC Dead Horse Creek Option 2

Out-fall	Qtr/Qtr	SEC-TION	TWP (N)	RNG (W)	LATITUDE	LONGITUDE	Drainage / Description	Groundwater Approval Required Prior to Discharge?	Reservoir Bond to WDEQ Required prior to Discharge?
003	NENW	2	47	75	44.08283	-105.84455	Discharges to on-channel "2-1 Reservoir" and "35-1 Reservoir" in *UET to Dead Horse Creek	Yes	No
005	SWNW	1	47	75	44.08071	-105.82803	Discharges to on-channel "P1-2 Reservoir" and "Dead Horse Reservoir" in *UET to Dead Horse Creek	Yes	Yes:Dead Horse
008	NENW	12	47	75	44.07087	-105.82272	Discharges to on-channel "P1-2 Reservoir" and "Dead Horse Reservoir" in *UET to Dead Horse Creek	Yes	Yes:Dead Horse
011	SWNW	6	47	74	44.08114	-105.80740	Discharges to on-channel "6-1 Reservoir" and "Dead Horse Reservoir" in *UET to Dead Horse Creek	Yes	Yes:Dead Horse
013	SWSW	6	47	74	44.07291	-105.80924	Discharges to on-channel "P1-1 Reservoir", "1-1 Reservoir" and "Dead Horse" in *UET to Dead Horse Creek	Yes	Yes:Dead Horse
IMP1	SENE	27	48	75	44.11072	-105.85243	Irrigation Monitoring Point on Dead Horse Creek (Serves outfalls 003, 005, 008, 011 & 013)	NA	NA
TRIB1	NESE	16	49	77	44.21737	-106.11887	Tributary monitoring station on Dead Horse Creek	NA	NA
UPR	SWSW	17	49	77	44.21598	-106.15503	Upstream Powder River monitoring station (above Dead Horse Creek)	NA	NA
DPR	SWSE	32	50	77	44.25689	-106.14790	Downstream Powder River monitoring station (below Dead Horse Creek)	NA	NA

*** UET=Unnamed ephemeral tributary**

The outfalls listed in the above table may be moved from the established location without submittal of a permit modification application provided all of the following conditions are satisfied:

1. The new outfall location is within 2640 feet of the established outfall location.
2. The new outfall location is within the same drainage or immediate permitted receiving waterbody.
3. There is no change in the affected landowners.
4. Notification of the change in outfall location must be provided to the WYPDES Permits Section on a form provided by the WQD Administrator within 10 days of the outfall location change. The form must be provided in duplicate and legible maps showing the previous and new outfall location must be attached to the form.

Moving an outfall location without satisfying the four above listed conditions will be considered a violation of this permit and subject to full enforcement authority of the WQD.

Outfall relocation as described above will not be allowed if the new outfall location is less than one mile from the confluence of a Class 2 waterbody and the dissolved iron limits established in the permit for the outfall are based upon Class 3 standards.

Requests for modification of the above list will be processed as follows. If the requested modification satisfies the definition of a minor permit modification as defined in 40 CFR 122.63 modifications will not be required to be advertised in a public notice. A minor modification constitutes a correction of a typographical error, increase in monitoring and/or reporting, revision to an interim compliance schedule date, change in ownership, revision of a construction schedule for a new source discharger, deletion of permitted outfalls, and/or the incorporation of an approved local pretreatment program.

A request for a minor modification must be initiated by the permittee by completing the form titled Wyoming Pollutant Discharge Elimination System Permit Modification Application for Coal Bed Methane. Incomplete application forms will be returned to the applicant.

C. RESERVOIR / IMPOUNDMENT REQUIREMENTS

1. Groundwater Monitoring Beneath Impoundments:

Table 1 of the permit above identifies which outfalls (if any) are designed to discharge into impoundments that are subject to groundwater monitoring requirements established in the latest version of the Water Quality Division guideline *"Compliance Monitoring for Groundwater Protection Beneath Unlined Coalbed Methane Produced Water Impoundments."* These specified outfalls are not authorized to discharge until a written groundwater compliance approval has been granted by the Groundwater Pollution Control Program of the Water Quality Division. A groundwater compliance approval will consist of either a final approved groundwater compliance monitoring plan, or written authorization for an exemption thereof. Once an impoundment has been granted a written groundwater compliance approval, the contributing outfall(s) to that reservoir may commence discharge.

2. Reclamation Performance Bonds for On-Channel Reservoirs:

Table 1 of the permit above also identifies which outfalls (if any) are designed to discharge into impoundments that are subject to WDEQ bonding requirements, as set forth in the latest version of the Water Quality Division guideline *"Implementation Guidance for Reclamation and Bonding of On-Channel Reservoirs That Store Coalbed Natural Gas Produced Water."* These specified outfalls are not authorized to discharge until the associated reservoir reclamation bond is approved by WDEQ. Once the reservoir reclamation bond is approved by WDEQ, the contributing outfall(s) to that reservoir may commence discharge.

Any discharge into an above-listed impoundment which has not been secured by the required WDEQ-approved bond, or which has not been granted the required groundwater compliance approval, will constitute a violation of this permit, and may result in enforcement action from the Water Quality Division.

Exhibit 2

EXPERT SCIENTIFIC OPINION ON THE TIER-2 METHODOLGY

Report to the Wyoming Environmental Quality Council

Jan M.H. Hendrickx
New Mexico Tech
Socorro, NM 87801

Bruce A. Buchanan
Buchanan Consultants, Ltd.
Farmington, NM 87499

May 2009

EXECUTIVE SUMMARY

All Wyoming surface waters are protected to some extent for agricultural uses. The primary agricultural uses are stock watering or irrigation. The uses are protected under the AGRICULTURAL USE PROTECTION POLICY (AUPP) which was finalized August 2006 in conjunction with the Triennial Review of the Chapter 1 Surface Water Standards. The policy is contained in Chapter 1, Section 20 of the AUPP. This policy is under consideration by the Wyoming Environmental Quality Council (WEQC) for adoption as an Appendix to the Chapter 1 rules. Until a final decision is rendered on the rulemaking, the provisions of the policy remain in effect for establishing effluent limits on discharges that may affect agricultural use.

The purpose of this report is to provide an expert, scientific opinion regarding the methods proposed for estimation of the EC (Electrical Conductivity) and SAR (Sodium Adsorption Ratio) of produced Coal Bed Methane (CBM) water. These produced waters are discharged into ephemeral drainages in Wyoming such that degradation of the receiving water will not affect crop production.

Chapter 2 lists the services to be provided by the contractors and specifically formulates two specific questions by the Council: *Question A.* Whether the Tier 2 methodology as set forth in Appendix H section c(vi)(B) is reasonable and scientifically valid for determining the EC and SAR of water that can be discharged into an ephemeral drainage in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production. *Question B.* Whether the method set forth in Appendix H section c(vi)(B) for determining EC and SAR for permitting the discharge of produced water is reasonable, sufficiently defined and scientifically defensible for the conditions in Wyoming, and provides a uniform testing procedure that is reasonably accurate and unbiased for the determination of soil EC from which you can reasonably infer the quality of the water EC and SAR that historically flowed within the drainage that will support the establishment of effluent limits for discharge permits in a given drainage that will not cause a measurable decrease in crop production.

Chapter 3 educates the reader on the causes of soil salinity focusing on the relation between soil salinity and the quality of irrigation water. Major causes for soil salinity are soil characteristics, ground water table depth, climate, presence of saline seepages, and irrigation management but not the quality of the irrigation water. No evidence has been found in the peer-reviewed literature in support of the assumption on which Tier 2 is based: "soil salinity in artificially and naturally irrigated lands in ephemeral drainages is *entirely* determined by pre-existing background water quality".

In Chapter 4 a succinct review of the testimony to the Council is discussed under three headings: Assumption for Tier 2 Methodology, Soil Testing Procedure for Unbiased Determination of Soil EC and SAR, and Managed and Unmanaged Irrigation with CBM Waters.

Finally, in Chapter 5 the expert scientific opinions are presented in answer to the two questions A and B by the Council. *Scientific Expert Opinion A.* The Tier 2 methodology as set forth in Appendix H section c(vi)(B) is not reasonable nor scientifically valid for determining the EC and SAR of water that can be discharged into an ephemeral drainage in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production. *Scientific Expert Opinion B.* The method set forth in Appendix H section c(vi)(B) for determining electrical conductivity (EC) and sodium adsorption ratio (SAR) for permitting the discharge of produced water is not reasonable nor sufficiently defined nor scientifically defensible for the conditions in Wyoming. It does not provide a uniform testing procedure that is reasonably accurate and unbiased for the determination of soil EC from which you can reasonably infer the quality of the water EC and SAR that historically flowed within the drainage that will support the establishment of effluent limits for discharge permits in a given drainage that will not cause a measurable decrease in crop production.

Scientific Expert Opinion on Way Forward. Since it is not scientifically defensible to use Tier 2, the question is how to move forward. The use of Tier 1 can be continued since it is conservative and has been accepted by the community. If the water quality requirements of Tier 1 cannot be met, the Irrigation Waiver seems the preferred alternative since it requires an irrigation management plan that provides reasonable assurance that the lower quality water will be confined to the targeted lands. In this manner, the Irrigation Waiver will deal with the issue of water quantity. Given the large scale on which CBM water is produced it seems justifiable to implement an aggressive applied and basic research program to develop guidelines on how to use CBM water in a beneficial manner.

TABLE OF CONTENTS

1. PURPOSE

All Wyoming surface waters are protected to some extent for agricultural uses. The primary agricultural uses are stock watering or irrigation. The uses are protected under the AGRICULTURAL USE PROTECTION POLICY (AUPP) which was finalized August 2006 in conjunction with the Triennial Review of the Chapter 1 Surface Water Standards. The policy is contained in Chapter 1, Section 20 of the AUPP. This policy is under consideration by the Wyoming Environmental Quality Council (WEQC) for adoption as an Appendix to the Chapter 1 rules. Until a final decision is rendered on the rulemaking, the provisions of the policy remain in effect for establishing effluent limits on discharges that may affect agricultural use.

The purpose of this AUPP report is to provide an expert, scientific opinion regarding the methods proposed for estimation of the EC (Electrical Conductivity) and SAR (Sodium Adsorption Ratio) of produced water. These produced waters are discharged into ephemeral drainages in Wyoming such that degradation of the receiving water will not affect crop production.

This report contains five chapters. Chapter 1 discusses the purpose of this report. Chapter 2 describes the services to be provided by the contractor and is followed by Chapter 3 that educates the reader on the causes of soil salinity focusing on the possible effects of EC and SAR of precipitation, irrigation, and flood waters. Chapter 4 presents highlights of the submittals and testimony presented to the Council while Chapter 5 presents the contractors' expert scientific opinions.

2. SERVICES TO BE PROVIDED BY CONTRACTOR

Drs. Buchanan and Hendrickx have been contracted to review the AGRICULTURAL USE PROTECTION POLICY and basically determine if making the policy a rule is reasonable and scientifically valid. Three specific services have been requested by the Wyoming Environmental Quality Council.

Service One:

Review the following:

A. Appendix H Section c(vi)(B) of the Rule as proposed by the DEQ on 11/20/2008 (see Appendix A).

B. Transcripts of the testimony received by the Council on October 24th and 28th, 2008.

C. Section 20 of the Rule as proposed by DEQ on November 11, 2008 (see Appendix A).

D. Written submittals, responses to comments, and other documents submitted to the Council under Docket No. 08-3101.

Service Two:

Based upon Contractor's training, education, and work experience provide, in written form, a report outlining Contractor's expert scientific opinion regarding:

A. Whether the Tier 2 methodology as set forth in Appendix H section c(vi)(B) is reasonable and scientifically valid for determining the EC and SAR of water that can be discharged into an ephemeral drainages in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production.

B. Whether the method set forth in Appendix H section c(vi)(B) for determining EC and SAR for permitting the discharge of produced water is reasonable, sufficiently defined and scientifically defensible for the conditions in Wyoming, and provides a uniform testing procedure that is reasonably accurate and unbiased for the determination of soil EC from which you can reasonably infer the quality of the water EC and SAR that historically flowed within the drainage that will support the establishment of effluent limits for discharge permits in a given drainage that will not cause a measurable decrease in crop production.

Service Three:

Consult with DEQ to the degree necessary to achieve the goals of Section 2 of the Contract. Communicate any suggested improvements or procedures to EQC and DEQ.

Drs. Buchanan and Hendrickx have reviewed all documents listed under Service One and present a review summary in Chapter 4. They have made one consultation with DEQ in the form of eight questions on the subject of the permitting process. The clear response by Mr. John Wagner of DEQ to these questions was very helpful. Their expert scientific opinions are presented in Chapter 5.

The basic processes of soil salinization are reviewed in Chapter 3 since they are the scientific basis of the opinion. Moreover, these processes need to be understood –at least a conceptual level– in order to successfully implement the expert scientific opinion into a fair and balanced system for discharge permits of produced waters into ephemeral drainages in Wyoming.

3. WHAT CAUSES SOIL SALINITY?

Soil salinity is the amount of soluble salts in a soil (Soil Science Glossary Terms Committee, 2008)[1] but the term is often used in the sense that the salt content of the soil is too high for satisfactory crop production[2]: the soil is saline or salty. Important natural sources of salts in arid and semi-arid regions are atmospheric deposition (wet and dry) (Bresler et al., 1982; Scanlon, 1991), mineral weathering (Bresler et al., 1982; Rhoades et al., 1974), "fossil" salts (built up in poorly drained flood-plain or playa sediments) (Bresler et al., 1982; Carter and Robbins, 1978), seepage from uplands (Stephanie J. Moore, 2008), and upwelling from deep ground water brines (Hogan et al., 2007; Phillips et al., 2003; Stephanie J. Moore, 2008). Four common anthropogenic salt sources are: irrigation water (Rhoades et al., 1973; Rhoades et al., 1974), fertilizers (Darwish et al., 2005), discharge of treated sewage water (Gonçalves et al., 2007; Mills, 2003), and discharge of saline waters during coalbed methane (Ganjegunte et al., 2005) or oil and gas extraction (Hendrickx et al., 2005a). Most soil salinity is caused by mineral weathering and application of waters containing salt on irrigated lands. The importance of each source of salinity depends on soil type, climate and irrigation management (Bresler et al., 1982; Keren, 2000).

Salinity is common in arid and semi-arid areas where evapotranspiration exceeds annual precipitation as is the case in Wyoming. Evapotranspiration is defined as the evaporation of water from soil combined with the transpiration of water from plants. Since salts do not vaporize at atmospheric pressure, they are left behind during the processes of evapotranspiration and accumulate in the soil. Soil salinity will affect crop growth when the concentration of soluble salts in the root zone exceeds a critical threshold level (Hanson et al., 2006). For the purpose of this report three common scenarios of salt accumulation in the root zone of semi-arid lands will be described: soil water chloride profiles in semi-arid uplands with deep ground water tables where the only source of

[1] Scientific references are listed in Appendix xx.
[2] http://waterwiki.net/index.php/Soil_salinity on May 8, 2009.

water is precipitation, soil salinity in semi-arid riparian lands with shallow ground water tables, and soil salinity in irrigated fields.

Scenario I: Soil Salinity in Semi-arid Uplands with Deep Ground Water Tables. Figure 1 shows the chloride distribution with depth in two desert soil profiles in southern New Mexico. Although the chloride concentration of the incoming precipitation is the same for both profiles, the chloride content at depth is 1000 times larger in the profile that does not receive run-on water. Similar differences do occur due to changes in land use (Hendrickx and Walker, 1997; Stephens, 1995), soil and bedrock characteristics (Heilweil and Solomon, 2004), or geomorphic setting (Hendrickx and Walker, 1997; Johnston, 1987; Scanlon, 1991; Scanlon, 1992). For example, in Australia the chloride concentration in soil profiles beneath native *Eucalyptus* vegetation is about 4000 mg/l versus 1000 mg/l under fields cleared from native vegetation 12 years previously. The lower water use of the crops that replaced the native vegetation lead to an increased recharge and salt leaching (Walker et al., 1991). Thus, **in semi-arid uplands with deep ground water tables no unique relationship exists between salt concentration of precipitation and soil salinity.**

Scenario II: Soil Salinity in Semi-arid Riparian Lands with Shallow Ground Water Tables. In riparian areas soil salinity is often variable and can change over short distances (Amezketa and Lersundi, 2008; Hendrickx et al., 1994; Hendrickx et al., 1997; Sheets et al., 1994). For example, in the Horse Creek riparian area on the Rottman Ranch, Hawk Springs, Wyoming, soil samples indicated an "extremely high variability" of soil salinity depending on soil age and texture, topography, and depth to ground water[3]. Salinization in these areas is caused by discharge of groundwater to the atmosphere, a process that can result from three different mechanisms: (i) deep-rooted plants tap directly into the ground water to acquire water for transpiration, (ii) capillary rise from

[3] http://wsare.usu.edu/pro/fieldrep_00/pdf/refinal/aw96014.pdf on May 15, 2009.

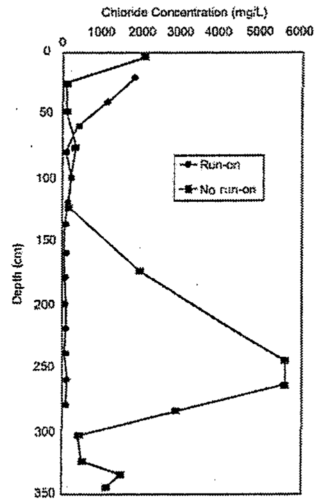

Figure 1. Soil water chloride profiles in two nearby loam soil profiles with a deep ground water table in southern New Mexico receiving precipitation with a chloride concentration of less than 5 mg/liter (Eppes and Harrison, 2003; Hogan et al., 2007). Despite the low chloride concentration of the precipitation the maximum chloride concentration in the "no run-on" profile exceeds 5000 mg/liter.

the ground water table to the soil surface where the water evaporates, or (iii) capillary rise to the bottom of the root zone where it becomes available for transpiration by vegetation. The dissolved salts in the evaporated and transpired water are left behind and accumulate in the soil. The rate of salt accumulation depends on the quantity or rate of ground water discharge as well as the quality or salt concentration of the ground water (Rose, 2004).

A dry sponge in contact with water will suck up the water and even make it flow upwards due to capillary forces. In the same way, water can flow from the ground water table to the soil surface or the bottom of the root zone. The resulting discharge rate depends on the depth of the ground water, the texture and sequence of different soil horizons, and the rooting depth (Hoffman and Durnford, 1999; Weeks et al., 1987). For example, during a seven year study near Buckeye, Arizona, the annual evapotranspiration of salt cedar varied from 2150 mm with ground water level at 1.5 m to less than 1000 mm with ground water level at 2.7 m (Van Hylckama, 1974). A computer simulation based on field observations during the 1999 growing season in the Bosque del Apache (Socorro, New Mexico) evaluated the effect of soil texture, ground water depth, and rooting depth on ground water discharge. The average discharge in a virtual homogeneous clay profile was 49 cm versus 19 cm in a virtual homogeneous sand profile; the average discharges from ground water depth 100, 200, and 500 cm were 66, 31, and 5 cm; the average discharges with rooting depths 30 and 300 cm were 21 and 47 cm, respectively (Moayyad et al., 2003). Several authors have shown that discharge from ground water tables less than 5 m (15 feet) deep can be considerable (Hendrickx et al., 2003; Jolly et al., 1993; Moayyad et al., 2003) while it typically can be ignored when the ground water table falls below 10 m[4] but not always (Hoffman and Durnford, 1999).

During a soil reclamation project in a riparian area close to Albuquerque (Caplan et al., 2001), the authors of this report evaluated soil salinity dynamics in a non-flooded riparian area combining a detailed soil salinity survey using electromagnetic induction (Hendrickx and Kachanoski, 2002; Hendrickx et al., 1994; Sheets et al., 1994), extensive soil descriptions and laboratory analyses of representative riparian soils, ground water depth measurements, ground water quality measurements, and simulations with the forward model for prediction of electromagnetic induction responses (Borchers et al., 1997; Hendrickx and Kachanoski, 2002; Hendrickx et al., 2002) as well as simulations with the model HYDRUS1D for prediction of soil water contents and soil water salt concentrations (Šimůnek et al., 2008). Although all soils in this riparian area received their water from the river (salt concentration about 200-400 ppm) and precipitation, the soil salinity profiles are widely different (Hong, 2002). Figure 2 shows Profile 1 with almost no salt accumulation while Profile 6 has accumulated a considerable amount of salts since the construction of Cochiti reservoir around 1970 that prevented flooding of our riparian study area. The difference in soil salinity is caused by the interaction between soil texture, capillary rise, and ground water level fluctuations. Thus, this case study is strong evidence that no unique relationship exists between the historic salt concentrations in the Rio Grande and current soil salinity profiles in riparian areas with shallow ground water tables. Soil salinity depends on soil texture and ground water table depth rather than on historic water quality in the Rio Grande. Similar trends are observed in the River Murray region of Australia[5]. Thus, **in semi-arid riparian areas with**

[4] http://www.clw.csiro.au/research/rivers/flows/floodplain/timescales.html on May 15, 2009.
[5] http://www.clw.csiro.au/research/rivers/flows/floodplain/timescales.html on May 15, 2009.

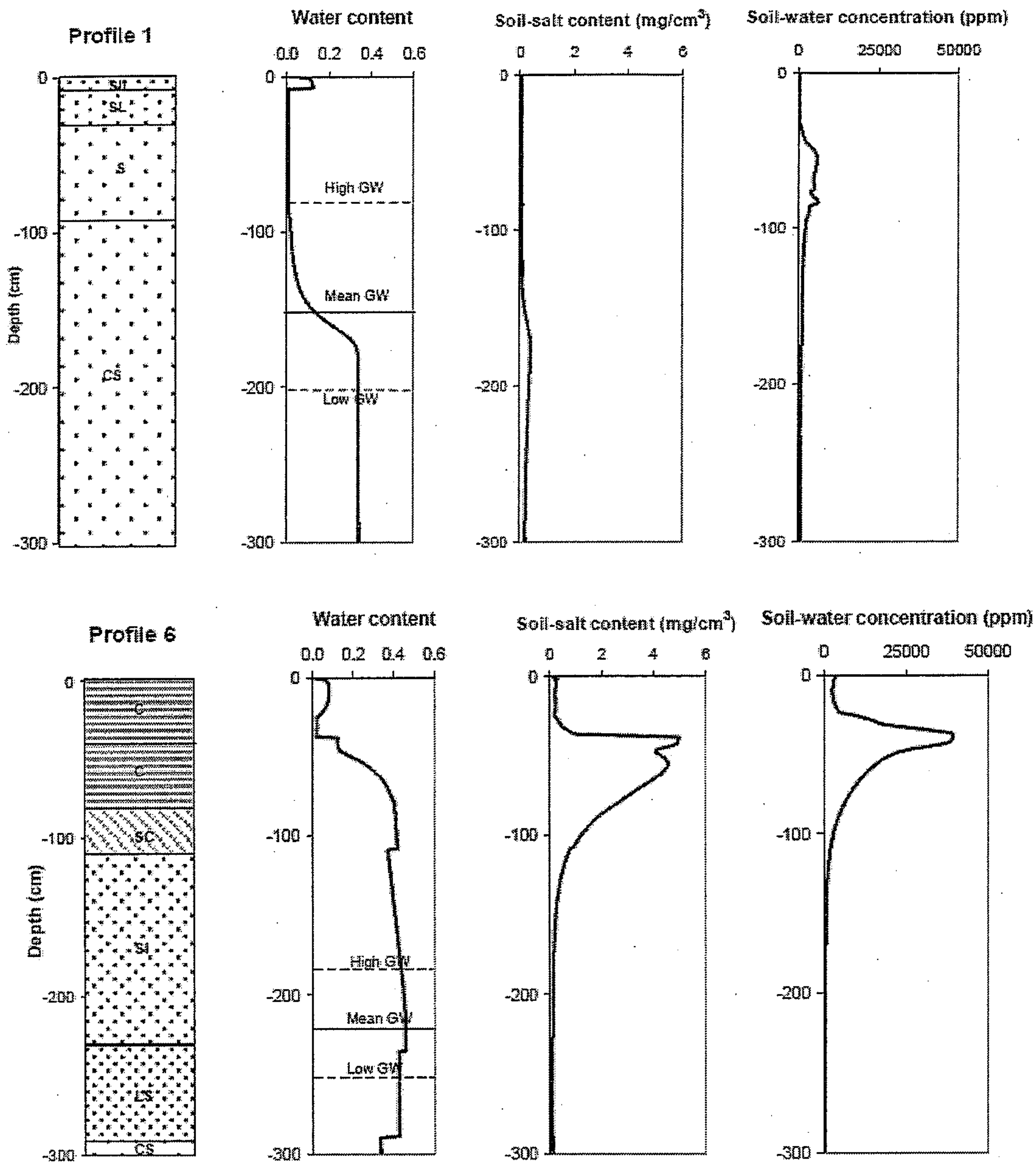

Figure 2. Soil stratigraphy and texture of representative profiles 1 and 6 with the simulated profiles of the water content, soil-salt content, and soil-water concentration. Initial ground water and time-independent bottom solute boundary conditions are 200 ppm. (SIL: silty loam, SL: sandy loam, S: sand, L: loam, LS: loamy sand, CS: coarse sand). The simulated salinity profiles have been confirmed in the field with electromagnetic induction measurements (Hong, 2002).

shallow ground water tables no unique relationship exists between historic salt concentration in the river and soil salinity.

Scenario III: Soil Salinity in Irrigated Fields. The purpose of irrigation is to provide sufficient water to agricultural lands in arid and semi-arid regions to meet crop water requirements during the growing season. Since even good-quality irrigation waters contain some salts, soil salinization will be certain unless sufficient water is supplied to leach the salts below the root zone. As a matter of fact 100 cm of good-quality irrigation water, i.e. a typical amount normally applied in a single irrigation season, contains about 5 tons of salt per hectare which is sufficient to salinate an initially salt-free soil (Hillel, 1998). Therefore, leaching of salt at the bottom of the root zone should be adequate to prevent salt accumulation in the root zone. Most irrigation projects need a drainage infrastructure to accomplish the leaching necessary to keep the root zone at salt levels that are tolerable for the crops (Hoffman and Durnford, 1999).

The soil salinity of irrigated fields depends mainly on the farmer's management. For a given irrigation water quality the farmer can regulate salinity conditions in the root zone by adjusting the leaching fraction which equals the volume of water drained from the field divided by the volume of water applied by irrigation. The larger the leaching fraction, the more water is drained, and the more salts are removed from the root zone (Hanson et al., 2006; Hillel, 1998; Hoffman and Durnford, 1999; Rose, 2004). For example, the senior author of this report used electromagnetic induction for the assessment of soil salinity in a 37 ha representative experimental drainage area located 35 km southwest of Faisalabad in the Punjab Province of Pakistan. Although the site received the same quality irrigation water on all fields, it had a wide range of salinity conditions from 269 dS/m on abandoned fields to 20 dS/m on pepper fields. Excluding the abandoned fields, the range of mean salinity values for different land uses went from 90 dS/m on fallow fields with irrigation inlet structures to 56 dS/m on fodder fields to 38 dS/m on rice fields and then to 20 dS/m on the pepper fields. These mean values are significantly different at the 5% level (Hendrickx et al., 1992) and demonstrate that irrigation management influences soil salinity to a much greater extent than irrigation water quality. Thus, on irrigated lands **no unique relationship exists between the water quality in the rivers that supply the irrigation canals and soil salinity.**

Relevance for Tier 2. Tier 2 is based on the assumption that soil salinity in artificially and naturally irrigated lands in ephemeral drainages is entirely determined by pre-existing background water quality. However, the three typical scenarios for causing soil salinity in semi-arid lands described above do not support this assumption. On the contrary, pre-existing background water quality appears to be a minor factor or none at all. Major causes for soil salinity are soil characteristics, ground water table depth, climate, presence of saline seepages, and irrigation management (Hillel, 1998; Hoffman and Durnford, 1999; Hogan et al., 2007; Rose, 2004). No evidence has been found in the peer-reviewed literature in support of the assumption on which Tier 2 is based. We welcome to be informed of any scientific evidence in support of this assumption.

The Tier 2 assumption is scientifically flawed for several reasons: (i) effluent water quality that is better than the pre-existing background water quality could still cause severe soil salinity (Hillel, 1998), (ii) effluent water quality that is worse than the pre-existing background water quality may be used beneficially on artificially irrigated lands (Rhoades, 1999; Tanji, 1997), and (iii) soil salinity varies with time and can even change suddenly when riparian areas flood or when farmers irrigate fallow or abandoned lands. Therefore, a Tier 2 analysis will not result in a scientifically defensible assessment of water quality (EC and SAR) that can be released in an ephemeral drainage without irrigation management.

4. REVIEW OF TESTIMONY AND SUBMITTALS TO THE COUNCIL

The testimony and submittals to the Council have been an important source of information on the history of Section 20 of the AUPP as well as the issues faced by industry and landowners to deal with CBM water. In this section we will highlight and comment on relevant testimony for the formulation of our expert scientific opinion on the Tier 2 methodology as set forth in Appendix H section c(vi)(B). Our review and discussion is organized under three headings: Assumption for Tier 2 Methodology, Soil Testing Procedure for Unbiased Determination of Soil EC and SAR, and Managed and Unmanaged Irrigation with CBM Waters.

Assumption for Tier 2 Methodology. Tier 2 is based on the assumption that soil salinity in artificially and naturally irrigated lands in ephemeral drainages is entirely determined by pre-existing background water quality. Several testimonies consider this assumption flawed. Dr Paige testifies: "we cannot determine background water quality for measuring soil EC and SAR" and "my real problem is with trying to back out background water quality from soil EC and salinity within the soil". Later in the hearing Chairman Boal asks Dr. Munn "I think you're are telling me that it is not a good idea to use soil samples to come up with those [background water quality] numbers" and his answer is "That is my professional assessment".

On the other hand Mr. Harvey's testimony is in support of the Tier 2 methodology. He states "The relationships amongst salinity, sodicity, water, plants, and especially the soil are dynamic. They are very complex and dynamic systems, and we need flexibility in a rule ... to deal with this" and "the proposed rule, ... I believe is conservative and protective. I'm ... here to support it." He explains "There is no Tier 2 comparison between managed irrigation with coal-bed natural gas water and WYPDES discharge scenarios. ... Managed irrigation scenarios ... do not fall under the Tier 2 process ... It is a different environment. We're applying water in a managed manner evenly over a field using separate center pivot equipment or other such equipment. Discharge into channel, it's just a different situation". He continues "The Tier 2 process ... is meant to derive conservative limits for unmanaged irrigation after discharge to the channel".

Since 2005 Mr. Harvey has been involved in "most of the Section 20 reports and analyses that are used to derive EC and SAR effluent limits". His method for deriving pre-existing background water quality from current soil salinity is based on the assumption "that the 1.5 concentration factor from water to soil EC is appropriate and conservative in the rule, and I am supporting DEQ's use of it". He adds "the 1.5 concentration factor was agreed to by all parties the first day of drafting this policy, that now is a proposed rule ... It's been the basis of all of the Tier 2-based WYPDES permits to date". Mr. Harvey's testimony did not provide scientific support for the number 1.5 to be used as the concentration factor for artificially and naturally irrigated lands in Wyoming's ephemeral drainages. However, Dr. Munn stated "the idea [of Tier 2] is ... we can use relationships from managed irrigation fields ... to back-calculate background water [quality] and the number chosen is 1.5" and "1.5 is an arbitrary number based on an assumption of an arbitrary leaching fraction ... in irrigated fields in southern California as a conversion between the applied water salinity and what you will see [i.e. soil salinity] in the root zone".

Experts' Opinion. In Chapter 3 scientific evidence has been presented that pre-existing water quality in a drainage cannot be derived from current soil salinity. The testimony to the Council has been mixed with Paige and Munn recognizing that no link exists between back-ground water quality in an ephemeral drainage and soil salinity while Harvey makes the case that such a relationship does exist and can be used for prediction of back-ground water quality. However, no scientific evidence was found to support the latter position.

In 1976, Ayers and Westcott published the first edition of a FAO (Food and Agriculture Organizations of the United Nations) Irrigation and Drainage Paper (Ayers and Westcot, 1994)[6] as a field guide for evaluating the suitability of water for irrigation. Two of their recommendations have

[6] http://www.fao.org/docrep/003/T0234E/T0234E00.HTM on May 16, 2009.

Leaching Fraction (LF)	Applied Water Needed (Percent of ET)	Concentration Factor [2] (X)
0.05	105.3	3.2
0.10	111.1	2.1
0.15	117.6	1.6
0.20	125.0	1.3
0.25	133.3	1.2
0.30	142.9	1.0
0.40	166.7	0.9
0.50	200.0	0.8
0.60	250.0	0.7
0.70	333.3	0.6
0.80	500.0	0.6

Table 1. Concentration factors for predicting root zone soil water salinity from irrigation water salinity and the leaching fraction from Ayers and Westcott (1994) (Ayers and Westcot, 1994).

been used for the development of Tier 2: (i) the concentration factors for predicting root zone soil salinity from irrigation water salinity and the leaching factor (Table 3 of Ayers and Westcott) and (ii) the relative rate of water infiltration as affected by salinity (EC) and sodium adsorption ratio (SAR) (Figure 21 of Ayers and Westcott (1994) as adapted from Rhoades (1977) (J.D., 1977) and Oster and Schroer (1979) (Oster and Schroer, 1979)). Table 1 presents Table 3 of Ayers and Westcott; it presents concentration factors as a function of leaching factors.

The concentration factors (*X*) have been developed by Ayers and Westcott to calculate average root zone soil salinity (EC_{soil}) from irrigation water salinity (EC_w):

$$EC_{soil} = EC_w \times X \quad [1]$$

In Tier 2 Eq. [1] has been inversed as

$$EC_w = \frac{EC_{soil}}{X} \quad [2]$$

Eq. [1] is based on several assumptions: (i) the crop water use pattern is such that 40 percent of the water is taken up from the upper quarter of the root zone, 30 percent from the next quarter, 20 percent from the next, and 10 percent from the lower quarter, (ii) actual crop evapotranspiration is known so that the water manager can determine the irrigation application for a desired leaching fraction, and (iii) no capillary rise from a shallow ground water table. The crop water use pattern in the root zone and the absence of capillary rise are reasonable assumptions for managed irrigated lands in California but are uncertain assumptions in the artificially and naturally irrigated lands in ephemeral drainages in Wyoming. Not knowing past actual evapotranspiration rates and water applications from the ephemeral drainages to the irrigated lands makes it next to impossible to estimate a leaching fraction. An irrigator who knows the crop water use pattern and the actual evapotranspiration can use Table 1 and Eq. [1] to estimate the unknown leaching fraction necessary to maintain a favorable root zone soil water salinity. In other words, Eq. [1] is used to estimate one unknown variable, the leaching fraction. On the other hand, a regulator who only knows the root zone soil water salinity will face great difficulties using Eq. [2] to estimate the pre-existing back-ground water quality in the drainage. Instead of one unknown, the regulator must estimate three unknowns: crop water use pattern in the root zone of the heterogeneous artificially and naturally irrigated lands of an ephemeral drainage, the average amount of water delivered by the drainage to the irrigated land, and the average actual evapotranspiration of the crop during those deliveries. An error in any of these estimates will lead to an error in the concentration factor and, therefore, the pre-existing back-ground water quality. Even when capillary rise is ignored the regulator is faced with the problem of solving one equation with three unknowns. For all these reasons, the use of Eq. [2] in Tier 2 cannot be scientifically defended; it is incorrect.

Tier 2 also depends on Figure 21 of Ayers and Westcott (1994) as adapted from Rhoades (1977) (J.D., 1977) and Oster & Schroer (1979) (Oster and Schroer, 1979) that estimate how salinity (EC) and sodium adsorption ratio (SAR) affect the relative rate of water infiltration. This figure is known as the "Hanson" diagram to the Council. Use of this figure has resulted in protecting the infiltration capabilities of the soils in ephemeral drainages but its use has little impact on root zone soil water salinity. The latter factor depends on soil type, climate, ground water table depth, and irrigation management as discussed in the previous sections.

Dr. Vance has expressed concern about using Figure 21 of Ayers and Westcott (1994) to assess how the relative infiltration rate of soils with smectitic clays is affected. Since these clays have low infiltration rates under the best conditions, a relative decrease will have much more impact on soil salinization than a relative decrease in soils with higher infiltration rates. The validity of Figure 21 for soils containing smectitic clays should be further explored.

Soil Testing Procedure for Unbiased Determination of Soil EC and SAR

Different testimonies referred to different procedures of soil sampling in the ephemeral drainages. The experts did not agree on one most optimal method for salinity surveys in the drainages. None referred to the new salinity monitoring approach that is increasingly used all over the world: this approach is based on a continuous survey of the entire area using electromagnetic induction followed by soil coring at selected validation sites.

Experts' Opinion. In the previous section we explained that the prediction of pre-existing back-ground water quality in the drainage using soil salinity samples is scientifically not correct. Yet, for the management of CBM waters on artificially and naturally irrigated lands it will be necessary to conduct salinity surveys that result in reliable soil salinity maps.

The proposed procedure in Appendix H section c(vi)(B) for determining EC and SAR is ambiguous since samples are taken at semi-random sites meaning that within specific terrain zones soils will be randomly sampled. The term *terrain zone* is not defined in any way and could be interpreted to mean a number of different landscape characteristics. The examples given range from units identified by landscape characteristics (channel bottom, first terrace, etc) and land use characteristics (sub and non-sub irrigated reaches). Another issue is the proposed number of required soil sample sites (from 3 to 7 depending on acreage) that would make it very difficult to characterize the soil landscape or to evaluate the natural variation of soil properties. Use of the proposed procedure by different capable soil scientists would yield different salinity maps and cause a challenge for the regulatory agencies. Therefore, we recommend the use of a continuous highdensity survey method based on electromagnetic induction that will leave no ambiguity in the final soil salinity map and is transparent for all stakeholders.

Currently, three basic procedures are available for the measurement of soil salinity: (i) soil extraction for measurement of the soil salinity as grams of salt over grams of dry soil, (ii) soil water extraction for measurement of the soil water salinity as grams of salt over grams of water, and (iii) indirect measurement of the soil water salinity by measuring the apparent electrical conductivity of the soil. Since soil extraction and soil water extraction methods are time consuming and expensive, faster indirect methods for measurement of soil salinity have been developed. These methods measure the apparent soil electrical conductivity and need a calibration function for determination of the salinity of soil water (Hendrickx and Kachanoski, 2002).

Electrical conductivity methods have been used for several decades (Rhoades and Halvorson, 1977; Rhoades and Oster, 1986; Rhoades et al., 1976) but advances in equipment, computers, and Global Positioning Systems have all come together now into a system that allows the measurement of soil apparent electrical conductivity at a reasonable cost (Hendrickx and Kachanoski, 2002). Of special interest is the electromagnetic induction method since it doesn't require contact with the soil (McNeill, 1980) and allows for quick and reliable measurements either on foot in difficult terrain (Hendrickx et al., 1997; Hendrickx et al., 1992; Sheets and Hendrickx, 1995) or on a vehicle in flat agricultural lands (Corwin and Lesch, 2003) (Figure 3). The method has been successfully used for the detection of produced oil-and-gas waters in the arid vadose zones of New Mexico (Hendrickx, 2003; Hendrickx et al., 1994; Hendrickx et al., 2005b). Often the electromagnetic induction (EMI) measurements alone are sufficient to prepare maps of soil salinity. Taking measurements at different heights above the soil surface and using inverse methods, it is even possible to determine the depth profile of apparent soil electrical conductivity (Borchers et al., 1997; Hendrickx et al., 2002). However, for regulatory purposes or for the management of lands irrigated with challenging water qualities it is necessary to relate the EMI measurements to EC and/or SAR. Therefore, the U.S. Salinity Laboratory in Riverside CA has developed a software

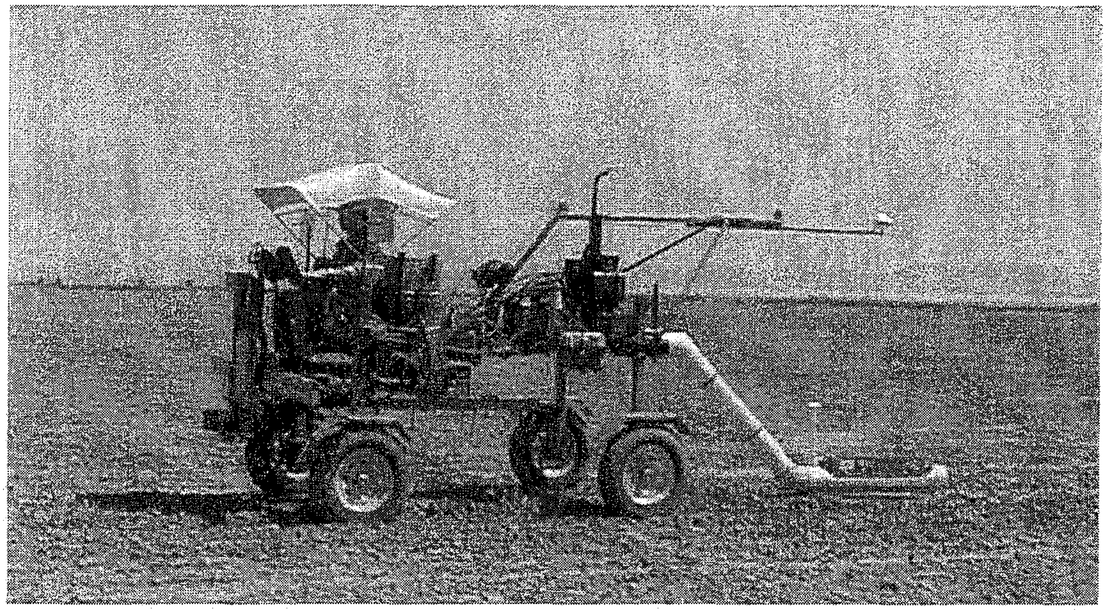

Figure 3. Mobile dual-dipole electromagnetic induction equipment for the continuous measurement of apparent soil electrical conductivity (Corwin and Lesch, 2003).

package, ESAP-95, to select optimal sites for calibration of the relationship between the apparent soil electrical conductivity measured with EMI and the EC of the soil water at different depths measured in the laboratory (Lesch et al., 2000). The soil samples can be easily taken with a soil coring device in the back of a 1-ton pickup with a 2-inch diameter device that can go down 4 to 6 feet or deeper if soil conditions permit. The theoretical background of ESAP-95 is presented by Lesch and his colleagues (Lesch et al., 1995a; Lesch et al., 1995b). Several applications of this software have been reported in the scientific literature (Amezketa, 2007; Amezketa and Lersundi, 2008; Corwin and Lesch, 2003; Corwin et al., 2006) as well as by consulting companies[7].

Managed and Unmanaged Irrigation with CBM Waters

In several testimonies reference was made to unmanaged and managed irrigation. Mr. Harvey summarizes best the management aspect of Tier 2: "The Tier 2 process ... is meant to derive conservative limits for unmanaged irrigation after discharge to the channel" while Chairman Boal expresses succinctly the idea on which Tier 2 is based:

[7] Soil and Water West, Inc. personal communication March 2009.

"Tier 2 is the option that if we know the water quality, the background water quality, then the discharge can be no worse than the known".

The testimony of landowners typically refers to water quantity rather than water quality. Ms. West states: "We have as much water as we want, and way more water than we want. ... We have had a great deal of flooding. We have lost 80 acres of prime hay meadow. ... Please do not implement this Tier 2". Ms. Barlow states: "In 2003 a large reservoir above my property contained CBM water, upper flowed and flooded the bottomland of my property for three months. ... The carpet of native grass was replaced for the first three years by bare soils, and now there is a few unpalatable weeds". Mr. Swartz quantifies: "June 2008 they dumped water at 102 to 136 cubic feet per second. ... DEQ likes to say ... We are not concerned with quantity. We're only concerned with quality. State engineer says we aren't concerned with quality, we're only concerned with quantity. And I'm getting the runaround and I don't like it". These statements confirm Dr. Munn's observation "In many cases, you're are going from ephemeral to a perennial flowing system".

Landowners who don't have to deal with damage by flooding are quite positive. Mr. Brug states: "I'd like to see the regulations surely not get any stiffer, because if it was, some of these instances I wouldn't be able to use more water". Mr. Litton observes: "We've got eight miles of bottomlands, which we hayed at one time. We don't anymore. But it has some methane water running the length of it, and spreads out for some places a quarter of a mile wide. And yet over this past seven years that we've been letting water on there, we still see no signs of salt showing up. Just a point of the quality of water that we have". Ms. Faye Mackey testifies: "I'm here to speak not only for my ranch, but the 581,250 acres, landowners represented here on the map in blue. ... These ranches use our water beneficially for our livestock, wildlife habitat, irrigation, and even some domestic water. ... There is no waste of water here. ... This water, and my ability to direct its use on my ranch, is essential to my current agriculture operation. ... There's no one-size-fits-all solution. We, as ranchers, know our soil types. We look at whether we can irrigate on a mister or pivot system, and industry has been very helpful in this, testing the soils and ...

taking water samples at different intervals ... There have been studies by industry in these areas of irrigation that the native grass is approximately five times thicker with CBM produced water than without the application of this water. Mr. Eitel's opinion: "If you set up real stringent rules, that one-size-fits-all, it just doesn't work in our area". Mr. Shepperson states: "I am in favor, as a landowner, of your Tier 2 regs. ... There's so much variability in the sites, ...So the variabilities of sites, you've got to have the flexibility to deal with these things site by site. And keep that in the regs, please. ... keep the negotiations between the landowner and industry open. Allow for that. Let us negotiate with industry on our ranches, but, boy, keep your oversight, too, on your rules".

Experts' Opinion. Several landowners clearly have suffered flood damage by unmanaged releases of CBM water and not recognizing the duration and volume of CBM waters to be received. Although these issues are serious, they can be resolved by proper engineering of CBM water release infrastructure and by developing management plans for the use of CBM water on artificially and naturally irrigated lands. As a matter of fact, the landowners who are enthusiastic about receiving CBM waters express a common concern against stiffer regulations that would prevent them to manage their CBM water in a flexible manner adapting to the natural variability of their ranches.

The amount of CBM water in Wyoming and other states is very large. For example, the Bureau of Land Management forecasts 51,000 wells in the Powder River Basin operating and producing gas and water by 2010. These 51,000 wells are expected to produce nearly 700 million gallons of CBM water per day[8]. These water supplies are sufficient to irrigate about 75,000 acres. However, to realize the potential benefits of CBM water it is necessary to manage both water quality and water quantity on the artificially and naturally irrigated lands receiving this water. There is general agreement that beneficial use of marginal waters for irrigation is possible if principles and strategies of salinity management are considered at on-farm and project-levels (Ayers and Westcot, 1994; Rhoades, 1999; Tanji, 1997). Mr. Harvey has presented some nice examples how marginal water can be made productive in Wyoming on managed irrigated lands.

[8] Petition 05-3102 before Wyoming Environmental Quality Council by the Wyoming Outdoor Council.

The most beneficial use of CBM waters can only be realized by managed irrigation taking into account both the quality and quantity of the produced waters. Managed irrigation needs to balance the supply from the CBM wells with the crop water requirements during the year taking into account quality and quantity of the produced waters. This will be a great challenge for engineers in the petroleum industry, landowners, soil and water resource consultants, researchers at the University of Wyoming, and regulators at DEQ. However, the hearings have shown that a large pool of dedicated professionals is ready to face this challenge. Given the broad range of experiences with existing use of produced waters in Wyoming, progress with irrigation management plans and regulations shouldn't take too long.

5. EXPERT SCIENTIFIC OPINIONS

In Chapter 2 expert scientific opinions are requested on two questions A and B. In this chapter we will respond to these questions and formulate a short opinion on the way forward that we consider relevant for the policy contained in Chapter 1, Section 20 of the AUPP.

Question A. Whether the Tier 2 methodology as set forth in Appendix H section c(vi)(B) is reasonable and scientifically valid for determining the EC and SAR of water that can be discharged into an ephemeral drainage in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production.

Scientific Expert Opinion A. The Tier 2 methodology as set forth in Appendix H section c(vi)(B) is not reasonable nor scientifically valid for determining the EC and SAR of water that can be discharged into an ephemeral drainage in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production.

Clarification A. Tier 2 is based on the option that if the background water quality in an ephemeral drainage is known, the quality of the discharge of CBM produced water can be no worse. Tier 2 is based on the erroneous belief that a measurable decrease in crop production only will occur if the quality of the discharge of CBM produced water is worse than the background water quality. In Chapter 3, we have explained that root zone soil salinity does not depend directly on the quality of the irrigation water; it depends on soil characteristics, climate, depth of ground water table, and more importantly irrigation management. The scientific literature provides examples where marginal irrigation water is successfully used for crop production.

Question B. Whether the method set forth in Appendix H section c(vi)(B) for determining EC and SAR for permitting the discharge of produced water is reasonable, sufficiently defined and scientifically defensible for the conditions in

Wyoming, and provides a uniform testing procedure that is reasonably accurate and unbiased for the determination of soil EC from which you can reasonably infer the quality of the water EC and SAR that historically flowed within the drainage that will support the establishment of effluent limits for discharge permits in a given drainage that will not cause a measurable decrease in crop production.

Scientific Expert Opinion B. The method set forth in Appendix H section c(vi)(B) for determining EC and SAR for permitting the discharge of produced water is not reasonable nor sufficiently defined nor scientifically defensible for the conditions in Wyoming. It does not provide a uniform testing procedure that is reasonably accurate and unbiased for the determination of soil EC from which you can reasonably infer the quality of the water EC and SAR that historically flowed within the drainage that will support the establishment of effluent limits for discharge permits in a given drainage that will not cause a measurable decrease in crop production.

Clarification B. See first Clarification A. As explained in Chapter 4 the proposed soil testing procedure would result in ambiguous soil maps. We refer to the recent science literature how an accurate soil salinity map can be made without spending too much.

Scientific Expert Opinion on Way Forward. Since it is not scientifically defensible to use Tier 2, the question is how to move forward. The use of Tier 1 can be continued since it is conservative and has been accepted by the community. Of course, as explained in Chapter 3 using Tier 1 CBM water can still result in increased soil salinity and reduced crop yields if not managed well. The latter aspect is of special importance when the quantity of available water is substantial. Current research in Wyoming and surrounding states may result in a relaxation of the crop threshold values that are currently based on California conditions. Mr. Harvey's testimony suggests that these threshold values may be too strict for Wyoming conditions.

If the water quality requirements of Tier 1 cannot be met, the Irrigation Waiver seems the preferred alternative since it requires an irrigation management plan that provides reasonable assurance that the lower quality water will be confined to the targeted lands. In this manner, the Irrigation Waiver will deal with the issue of water quantity. Given the large scale on which CBM water is produced it seems justifiable to implement an aggressive applied and basic research program to develop guidelines on how to use CBM water in a beneficial manner.

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Exhibit 3

EXPERT SCIENTIFIC OPINION ON THE TIER-2 METHODOLGY

Report to the

Wyoming Department of Environmental Quality

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September 2009

EXECUTIVE SUMMARY

At the invitation of the Department of Environmental Quality we have spent four days in the Powder River Basin to visit drainages around Gillette in the summer of 2009. During this period we have been briefed by the Department of Environmental Quality on the Tier 1, 2, and 3 methodology. In addition, we have had ample opportunities to talk with landowners as well as representatives of the industry and the Powder River Basin Resource Council. This report is based on our field observations, the scientific literature, and the wealth of information provided to us by all stakeholders.

We present scientific evidence that no unique relationship exists between irrigation water quality on the one hand and root zone soil salinity and crop productivity on the other. Therefore, we conclude that the **Tier 2 and Tier 1 methodology** as set forth in Appendix H section C(vi)(B) **is not reasonable nor scientifically valid for determining the EC of water that can be discharged into an ephemeral drainage in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production.**

We have observed in the field that the **Tier 2 and Tier 1 methodology has caused a rise of the ground water table that resulted in both "waterlogging and –most likely– increased soil salinity"**. Had a monitoring program be in place since the beginning of CBM water releases, it is almost certain that a decrease in crop production would have been measured due to waterlogging and/or increased soil salinity. The damage done by Tier 2 and Tier 1 starts by creating water logged conditions in the drainages: **the true problem is the quantity of CBM waters rather than its quality.**

Prominent agricultural salinity experts state "The successful use of saline ... waters for irrigation requires **appropriate management practices to control salinity**, not only within the irrigated fields, but also within the associated irrigation project and geo-hydrologic system" (Rhoades, 1999) and "**adequate control of soil salinity** changes requires that the farmer has access to multiple and dependable supplies of irrigation water where at least one supply is of good quality" (Maas and Grattan, 1999). The **Tier 2 and Tier 1 methodology results in uncontrolled and**

unmanageable releases of CBM waters since the farmers receive at unknown times, unknown volumes of water of unknown quality from hundreds of outlets controlled by different companies.

We recommend that **comprehensive monitoring of soils, ground water, and surface waters** is undertaken in all drainages that have received and are receiving CBM waters. The objectives are: (1) to determine where the salts are accumulating in the hydrologic system; (2) to assess where and when the salts will leave the system; (3) to design restoration measures for naturally and artificially irrigated lands that already have been affected or will be affected by "waterlogging and soil salinity".

We have observed in the field that Tier 3 and the "irrigation waiver" are viable alternatives for the Tier 2 and Tier 1 methodology. Under Tier 3 the CBM waters are managed in a proper manner and used for increased crop production to the satisfaction of the landowners. Therefore, **we recommend to abandon uncontrolled releases of CBM water into the drainages by Tier 2 and Tier 1 methodology in favor of the Tier 3 methodology that relies on appropriate management practices to control salinity.**

Tier 3 is best implemented over deep vadose zones so that the saline drainage waters percolating from the root zone enter the ground water gradually and minimize salt load to the Powder River.

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1. PURPOSE

In May 2009, the report "Expert Scientific Opinion on the Tier-2 Methodology" (Hendrickx and Buchanan) was presented to the Wyoming Environmental Quality Council. The findings and opinion from that report were the Tier 2 methodology as set forth in Appendix H section C(vi)(B) is not reasonable nor scientifically valid for determining the EC and SAR of water that can be discharged into an ephemeral drainage in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production.

The Wyoming Department of Environmental Quality (WDEQ) then contracted Hendrickx and Buchanan to visit Wyoming, review field conditions in the Gillette area and provide evaluation and clarification as to the use of the Tier 2 Method. The purpose of this report is to provide opinion regarding the Tier 2 Method.

The report includes general comments about the relationships of irrigation waters to affected crops and soils, the application of the Tier 2 methodology, and opinion of its validity in representative conditions found in the Powder River Basin (PRB).

The project included two visits to the PRB, one in July and one in August. The visits included field reviews of properties, discussions with landowners, industry, PRBRC and the DEQ.

2. SERVICES TO BE PROVIDED BY CONTRACTOR

Drs. Buchanan and Hendrickx have been contracted to provide further clarification on the report entitled "Expert Scientific Opinion on the Tier-2 Methodology" and discuss in more detail the DEQ permitting program as it pertains to agricultural use protection. The contractors shall provide advice to DEQ regarding their approach to permitting surface discharges of produced water.

The following tasks and questions were formulated during our two field visits:

1. Clarification of the Tier-2 evaluation.
2. Evaluate the application of the Tier system in the Powder River Basin. Provide a description of how different quality CBM waters are handled in the current system and how it is working.
3. Discuss the Tier-2 approach and how it should be modified.
4. Provide direction regarding existing Tier-2 permits.
5. Discuss other questions that consultants deem important.

3. HOW SALINE IRRIGATION WATER AFFECTS CROP PRODUCTIVITY

Three criteria are used to judge irrigation water quality as it affects crop productivity: (1) The possible toxicity of specific solutes in the irrigation water on plant growth; (2) Combined effect of Sodium Adsorption Ratio (SAR) and salt concentration or electrical conductivity (EC) of irrigation water on soil permeability; and (3) The salinity or EC of the irrigation water (Hanson et al., 2006; Maas and Grattan, 1999; Rhoades, 1999). Toxicity will not be discussed in this report due to time constraints. The SAR and EC of irrigation water are important since applications of irrigation water, with a relatively low EC and high SAR value, can substantially reduce infiltration rates of the soil. Since the SAR and EC thresholds used by the Wyoming Department of Environmental Quality are protective of soil infiltration rates, we will not address the issue of soil infiltration rates in this report but instead focus on the salinity or EC of the CBM waters.

Saline irrigation water affects crop growth and yield by osmotic influences that interfere with root water uptake. In plants, the concentration of solutes in root cells is higher than in soil water. This concentration difference allows water to move from the soil (low concentration) into the plant roots (high concentration). When the salinity of soil water increases the concentration difference becomes small; thus less water will move into the plant roots. The plant counteracts by increasing the solute concentration in its root cells by either accumulating salts or synthesizing organic compounds such as sugars and organic acids so that water movement into its roots is –at least partly– restored. Since these processes use energy that otherwise could have been used for crop growth, plants are smaller but otherwise often appear healthy in all other aspects concluding that **salinity is hard to detect by visual observations** (Bresler et al., 1982; Hanson et al., 2006; Lambers et al., 2008; Maas and Grattan, 1999).

During root water uptake, salts generally cannot move into the roots of agricultural crops and remain behind in the soil. Since the total amount of salt remains the same while soil water content decreases, the salt concentration of soil water is increasing when the soil dries out and crops growing on saline soils often appear to be suffering from drought (Bresler et al., 1982). Except under extreme levels of salinity, **salt-affected crops appear normal but yield losses**

from osmotic stress caused by saline soil water can be significant before any foliar injury occurs (Bresler et al., 1982; Maas and Grattan, 1999). Visual observations that relate crop appearance and "salt patches" to the salt content near or at the soil surface are quick and economical, but have the disadvantage that salinity development is detected after crop damage has occurred. Soil salinity measurements combined with established salt tolerance data are needed to diagnose salt problems well before major yield reductions occur (Bresler et al., 1982; Hendrickx et al., 1992; Rhoades, 1999).

During the last 100 years the salt tolerance of crops has been studied in the field and laboratory in many parts of the world (Kijne, 2003; Ulery et al., 1998). The salt tolerance bibliography of the US Salinity Laboratory contains 6,256 literature references[1] that have been used for the derivation of salt tolerance thresholds for agricultural crops (Maas and Hoffman, 1977; Maas and Grattan, 1999; Steppuhn et al., 2005a). It was found that a graph of crop yield versus irrigation water salinity often exhibit large variability, while crop yield versus root zone soil salinity yields stable graphs. For example, Figure 1 shows typical plots of wheat yield versus, respectively, irrigation water quality and root zone soil salinity in the Fordwah-Eastern Sadiqia Project of Pakistan (Kijne, 2003). The reason for the large variability of yield versus irrigation water quality is that there is no relationship between the salt content of irrigation water and root zone salinity as has been explained in our report to the Wyoming Environmental Quality Council (Hendrickx and Buchanan, 2009). As a matter of fact, most current salinity problems throughout the world occur in areas that are blessed with "good-quality" irrigation waters with low salt contents (Rhoades, 1999). Rhoades, who is one of the most prominent agricultural salinity experts in the world, states "The successful use of saline ... waters for irrigation requires an adequate understanding of how salts affect waters, soils and plants. But, the sustainability of a viable agriculture requires much more. It requires the implementation of appropriate management practices to control salinity, not only within the irrigated fields, but also within the associated irrigation project and geo-hydrologic system" (Rhoades, 1999).

[1] http://www.ars.usda.gov/Services/docs.htm?docid=8908 accessed on August 30, 2009.

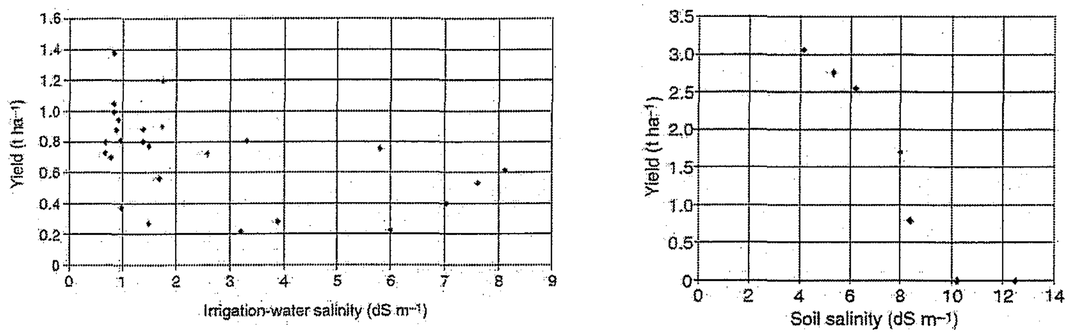

Figure 1. Typical plots of wheat yield versus irrigation water salinity (left) and root zone soil salinity (right). (Kahlown et al., 1998; Kijne, 2003).

In the next two sections we will first discuss crop productivity as a function of root zone soil salinity and then best irrigation management practices to optimize crop productivity when irrigation water is saline.

Crop Yield Response Functions

Crop salt tolerance provides a measure of the ability of plants to survive and produce economic yields under adverse conditions caused by root zone salinity (Bresler et al., 1982; Hanson et al., 2006). The salt tolerance of agricultural crops is expressed in terms of yield reductions while appearance is a more relevant measurement for ornamental plants. A common approach for agricultural crops is to compare yields on saline versus non-saline soils and to plot relative yields against mean root zone salinity (Maas and Hoffman, 1977; Maas and Grattan, 1999). The relative yield is found by dividing the absolute yield by the maximum yield obtained under non-saline optimal soil conditions. The absolute yields represent samples from fields with different root zone soil salinities or experimental plots.

For most crops the crop yield response function follows a sigmoidal relationship (Fig. 2). However, before the ubiquitous presence of computers it was much easier to represent the response function by two line segments: one with a zero slope at the maximum relative yield, and the second, a concentration-dependent line whose slope indicates the yield reduction per unit increase in salinity (Fig. 3) (Maas and Hoffman, 1977). In this report we prefer the sigmoidal curve since it fits the experimental data better than the two-piece linear model and it captures the variable rate of decrease in relative yield with increasing root zone soil salinity

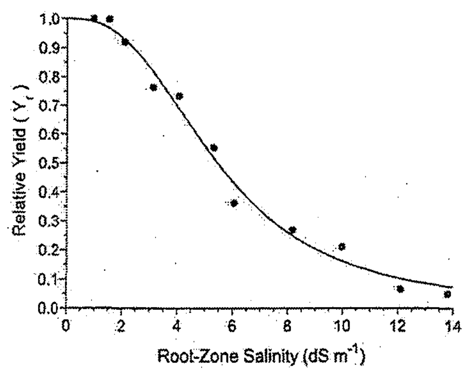

Figure 2. Sigmoidal function applied to Biggar spring wheat data (Steppuhn et al., 2005b).

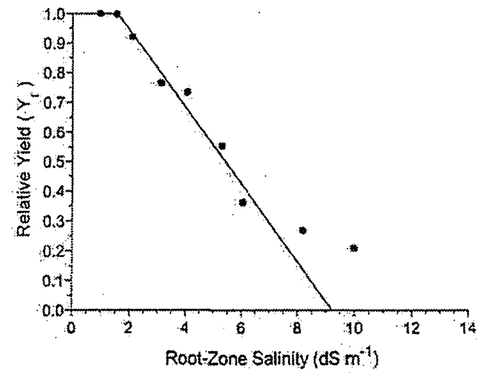

Figure 3. Two-piece linear function applied to Biggar spring wheat data (Steppuhn et al., 2005b).

(Steppuhn et al., 2005a; Steppuhn et al., 2005b). In addition, field observations indicate that yields can decline at much lower values of root zone soil salinity than predicted by the thresholds inherent in the two-piece linear functions (Katerji et al., 2000; Kijne, 2003; Shalhevet, 1994).

Two crop response functions for Alfalfa are available in the scientific literature (Steppuhn et al., 2005a). These functions are based on experiments conducted in the period 1943 through 1999 (Bernstein and Francois, 1973; Berstein and Ogata, 1966; Bower et al., 1969; Brown and Hayward, 1956; Gauch and Magistad, 1943; Hoffman et al., 1975; Steppuhn et al., 1999). Considering the memorandum of January 6, 2008, by Mr. Mark Majerus of the Natural Resources Conservation Service at Bridger Plant Materials Center in Montana we have selected the Alfalfa-Steppuhn response function for this report (Fig. 4). Mr. Majerus states that he and Dr. Harold Steppuhn agree that a threshold EC value of 4 dS/m in the root zone is an acceptable level for Alfalfa in Wyoming and "would best represent Alfalfa's response to salinity in our region".

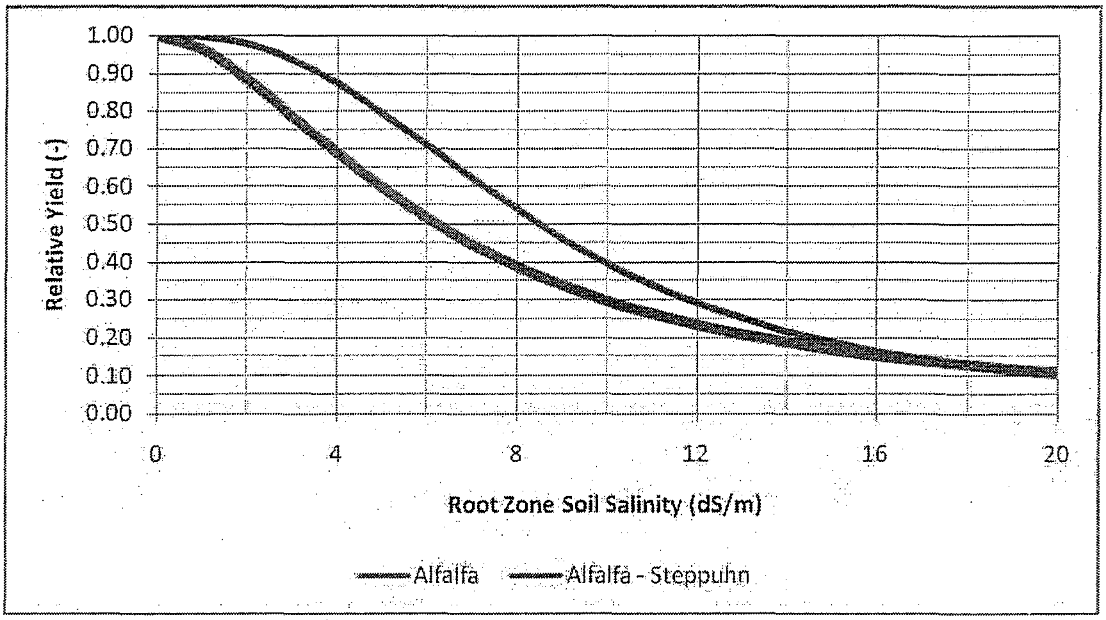

Figure 4. Two Alfalfa yield response functions to root zone salinity. The Alfalfa-Steppuhn response function is based upon field research in Canada and is selected for this report (Steppuhn et al., 2005a).

The Quality Standards for Wyoming Surface Water, Chapter I, §20, state:

> "All Wyoming surface waters which have the natural water quality potential for use as an agricultural water supply shall be maintained at a quality which allows continued use of such water for agricultural purposes. Degradation of such waters shall not be of such an extent to cause a measurable decrease in crop production".

The key phrase is "*measurable* decrease in crop production". A threshold EC value of 4 dS/m coincides with approximately 13% yield reduction on the sigmoidal response curve in Figure 4 and could, therefore, be interpreted to be an infringement of the Quality Standards for Wyoming Surface Water. However, one needs to take into account that this average curve is based on true yields that have an inherent natural variability. See, for example, Fig. 3 where the average response curve for wheat at 2 dS/m falls a little below the true yield sample measured in the field. Since the inherent natural variability of crop yields makes it very difficult to prove or disprove that a ±10% yield reduction has truly occurred, we support an EC of 4 dS/m[2] as the regulatory threshold value for Alfalfa root zone soil salinity in the Powder River Basin. The measurement of root zone soil salinity in the field is straightforward and well understood (Borchers et al., 1997; Corwin et al., 2006; Hendrickx et al., 1994; Hendrickx et al., 1992; Hendrickx et al., 2002; Lesch et al., 1995a; Lesch et al., 1995b; Lesch et al., 2000; Rhoades et al., 1999) so that regulators, land owners, and industry can easily inspect whether threshold values have been respected.

Management of Root Zone Soil Salinity

In the previous section we have shown how in a scientific manner an unambiguous threshold value for root zone soil salinity can be determined for Alfalfa and other crops. However, the Department of Environmental Quality needs an end-of-pipe salt concentration for its regulatory Tier 2 process. Therefore, we will discuss in this section the link between irrigation water salinity and root zone soil salinity.

As explained in our May 2009 report to the Wyoming Environmental Quality Council, major causes for soil salinity are soil characteristics, ground water table depth, climate, presence of saline seepages, and water management but not the quality of the irrigation water. No evidence has been found in the peer-reviewed literature (Bresler et al., 1982; Corwin et al., 2007; Kijne, 2003; Letey and Feng, 2007; Rhoades, 1999) in support of the assumption on which Tier 2 is based: soil salinity in artificially and naturally irrigated lands in ephemeral drainages is entirely determined by pre-existing background water quality. Since for any artificially or naturally irrigated land in the Powder River Basin soil characteristics, ground water table depth, climate, and presence of saline seepages are beyond control of the landowners, the critical link between the salinity of irrigation water and root zone soil salinity is water management. Not only management on the field scale by landowners but also the overall institutional management structure.

[2] The Department of Environmental Quality uses µmho/cm to express electrical soil and water conductivity. In this report we use the generally accepted unit of dS/m (Hanson et al., 2006).
1 dS/m = 1 mmho/cm = 1000 µmho/cm.

In irrigated agriculture there is only one economical way to control root zone soil salinity: ensure a net downward flow of water (drainage) through the root zone to leach out the salts. If leaching is inadequate, salts can accumulate in the root zone within a few seasons to harmful levels that decrease crop yields (Hoffman and Durnford, 1999). The leaching fraction is a critical management parameter for root zone soil salinity control since it determines the relationship between irrigation water salinity and root zone soil salinity. In its simplest form the leaching fraction, *LF*, for steady state conditions can be defined as

$$LF = \frac{D_d}{D_a} \qquad [1]$$

where D_d is the volume of water draining from the root zone expressed as an equivalent depth (inch or mm) and D_a is the volume of water applied to the land and entering the root zone. For example, if LF=0.2 the volume of drainage water will be equal to 0.2 times the volume of applied water or in other words 20% of the volume of applied water will leave the root zone. The higher the leaching fraction the less likely that the root zone soil salinity will rise to harmful levels since the drainage waters remove salts from the root zone. Farmers try to manage irrigations in such a way that the leaching fraction is sufficient to keep root zone soil salinity at a level that will not reduce yields.

Tables and graphics have been developed that present the relationships between root zone soil salinity, irrigation water salinity, and the leaching fraction (Hoffman and van Genuchten, 1983; Hoffman and Durnford, 1999; Rhoades, 1982; Rhoades, 1999). These tables have been used for almost thirty years for the successful management of saline irrigation waters. Table 1 presents the relationship between the leaching fraction and the ratio of root zone soil salinity (expressed as the electrical conductivity of the saturation extract EC_e) to that of irrigation water salinity (expressed as the electrical conductivity of the water) developed by Rhoades (1999) for conventional irrigation management and high-frequency irrigation management. Figure 5 presents the same information but in the form of graphics. This visual presentation of the information in Table 1 immediately demonstrates that no unique relationship exists between irrigation water salinity and root zone soil salinity. The root zone soil salinity resulting from a

Table 1. Relationship between the ratio of average root zone EC_e (dS/m) and the *EC* of irrigation water ($R_{soil/water}$) and the leaching fraction (*LF*) (Rhoades, 1982; Rhoades, 1999).

	$R_{soil/water}$					
	Leaching Fraction (*LF*)					
	0.05	0.10	0.20	0.30	0.40	0.50
Low-frequency Irrigation Management	2.79	1.88	1.29	1.03	0.87[#]	0.77
High-frequency Irrigation Management	1.79	1.35	1.03	0.87	0.77	0.70

[#] Ratio values less than 1.0 are not an indication that the quality of the drainage water has become better than that of the irrigation water; it is impossible. In order to relate irrigation water salinity directly to crop response functions the average root zone soil salinity is expressed as the EC of the saturation extract, EC_e. Since the water content at which EC_e is determined is about twice the soil water content at field capacity, the EC of the soil water at field capacity just after irrigation is about twice the value of EC_e (Pratt and Suarez, 1990).

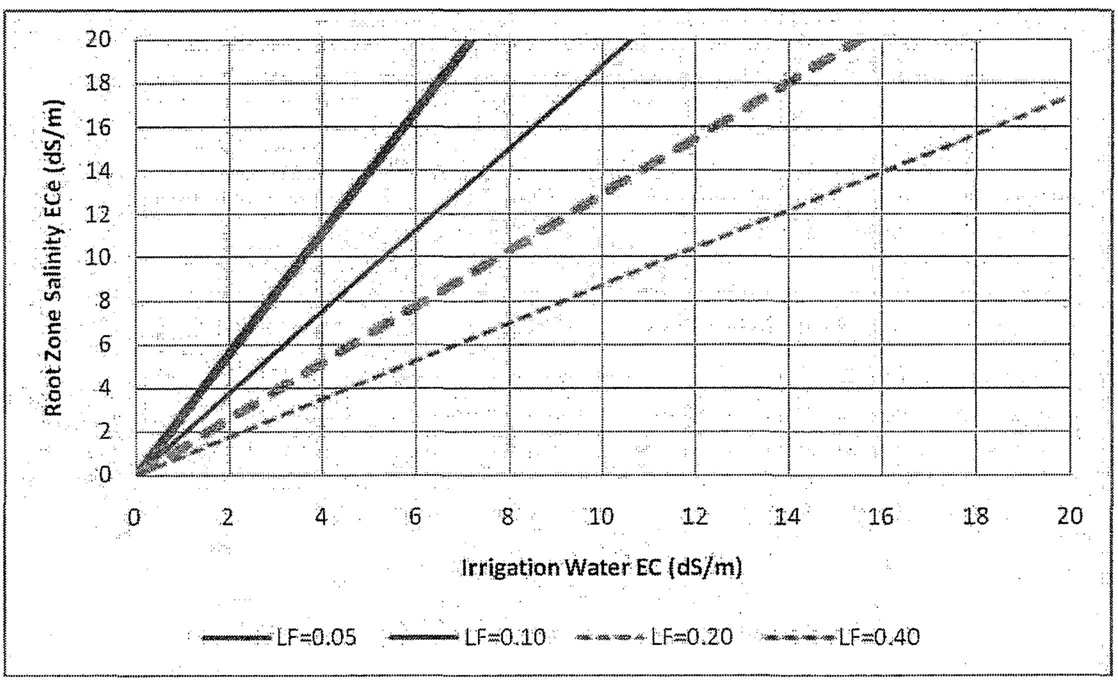

Figure 5. Relationships between leaching fraction (*LR*), average root zone salinity (EC_e, dS/m) and irrigation water salinity (*EC*, dS/m) under conventional (low frequency) irrigation management (Rhoades, 1999).

given irrigation water salinity depends on the leaching fraction. For example, irrigation water with EC of 2.0 dS/m can result in root zone salinities of 2 to 6 dS/m when leaching factors vary from 0.4 to 0.05 . Thus, irrigation water of reasonable quality can result in zero or 30 percent crop yield reduction (Fig. 4) depending on the leaching fraction, i.e. irrigation water management.

Figure 5 clearly demonstrates that no unique relationship exists between average root zone soil salinity and historic irrigation water quality which is the conceptual basis for Tier 2. For example, using the Tier 2 approach an average root zone salinity of 4 dS/m would lead to the conclusion that the historic water EC in the creek was 4/1.5=2.7 dS/m. However, Fig. 5 demonstrates that historic water EC could have fluctuated between approximately 1.5 and 5 dS/m depending on the leaching fraction. Fig. 5 also demonstrates that allowing releases of CBM water with an EC of 2.7 dS/m could result in average root zone soil salinities between approximately 2 and 8 dS/m depending on the leaching fraction. Thus, CBM water with an EC of 2.7 dS/m can result in zero to 45% yield reduction (Fig. 4).

We repeat our previous findings and opinion that the **Tier 2 methodology** as set forth in Appendix H section C(vi)(B) **is not reasonable nor scientifically valid for determining the EC of water that can be discharged into an ephemeral drainage in Wyoming** so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production (Hendrickx and Buchanan, 2009). Based on the current scientific analysis we conclude that the **Tier 2 methodology can cause degradation of the receiving water to such an extent to cause a considerable measurable decrease in crop production.**

4. EVALUATION OF THE TIER SYSTEM IN THE POWDER RIVER BASIN

Since crop yield reductions due to soil salinity cannot be observed visually until severe damage has occurred, it is a common strategy on agricultural lands at risk to implement monitoring programs for soil salinity as well as surface and ground water salinity. The data from such monitoring programs indicate whether salinity risks are increasing or decreasing and can guide prevention and restoration programs (Kaddah and Rhoades, 1976; Rhoades et al., 1999). Unfortunately, few comprehensive salinity data sets are available for the Powder River Basin and, therefore, we are grateful that the Department of Environmental Quality (DEQ) has invited us to visit the field in order to become familiar with the physical environment of the Powder River Basin and how the Tier 2 policy was implemented to regulate water quality. We have observed the basin from the air during a 45 minutes over-flight, visited several watersheds near Gillette during four field days, and through discussions with DEQ, land owners, and representatives of industry and the Powder River Basin Resource Council we have become accustomed with site conditions and water management practices.

In this chapter we will distill our field observations, information provided in reports and the literature, and comments by industrial and farmer water managers into a conceptual model that explains how CBM waters are likely to affect the watersheds in the Powder River Basin. But first we have to explain the "twin menace of water logging and soil salinity" that has challenged irrigation water managers for more than six thousand years (Hillel, 2000).

Waterlogging and Soil Salinity

The environmental conditions of arid and semi-arid watersheds change considerably when irrigation waters are introduced. A typical scenario is that water tables rise due to excessive irrigation, canal seepage, and inadequate natural drainage. Then, the soils become waterlogged while evapotranspiration depletes the applied water but leaves the salts behind which leads to increased salinity in the root zone and the shallow ground water. Upward capillary water flow occurs from shallow ground water and crop yields decrease due to a combination of inadequate aeration and high salinity levels in the root zone (Figure 6). These problems do not occur

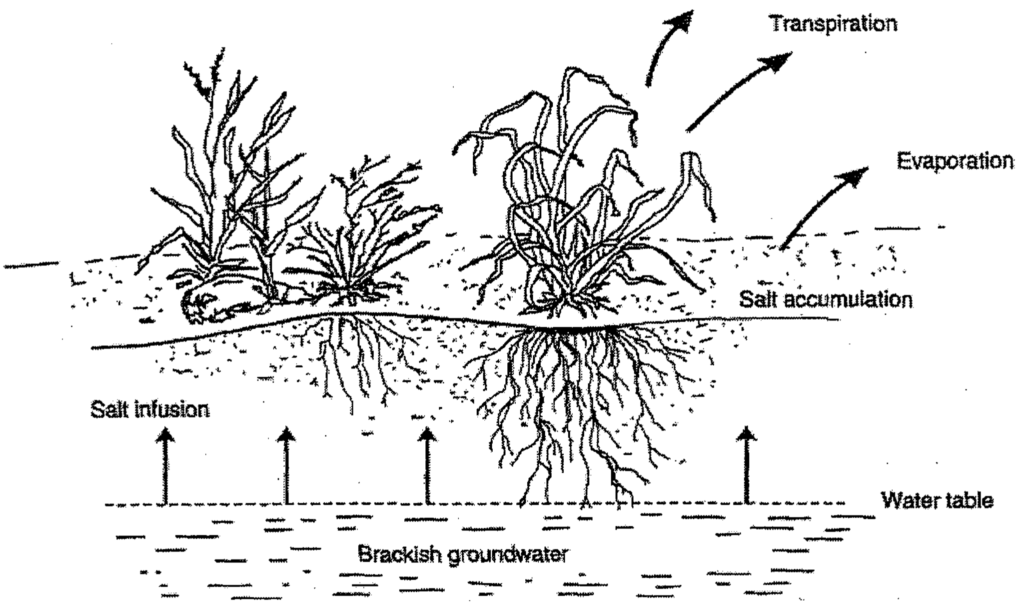

Figure 6. The process of waterlogging and soil salinity (Hillel, 2000). When irrigation waters are introduced in semi-arid systems the water table rises, capillary upward fluxes increase, and salts accumulate in the root zone unless sufficient leaching water is available. Salt accumulation will occur even if the irrigation and groundwater have low salt contents.

immediately after the start of irrigation but take time to develop. Sometimes it takes a decade as in Fallon, Nevada, or twenty years as in the Imperial Valley of California or more than fifty years as in the Indus Valley of Pakistan and India (Hoffman and Durnford, 1999).

One major exception is the irrigated lands of ancient Egypt that thrived for several millennia without developing root zone salinity problems. Before the construction of the Aswan High Dam in 1970, in the autumn the river Nile crested and inundated the flood plain as seepage naturally raised the ground water table. As the river discharge diminished water levels dropped and the ground water tables went down well below the soil surface. Due to this annual fluctuation of the ground water table under a free-draining floodplain the salts were leached from the root zone and carried away by the Nile itself (Hillel, 2000). A similar salt leaching mechanism has been observed by Hendrickx and his students in the Middle Rio Grande Basin (Hong, 2002).

The amount of water and salts that move with capillary rise from a shallow ground water table into the root zone depends on the soil texture and the depths of the root zone and the ground water table. For example, for a root zone with depth 0.5 m underlain by a water table at 1.0 m below the land surface the capillary flux that rises over a height of 0.5 m from 1.0 to 0.5 m height is critical. Under shallow ground water tables the volume of water entering the root zone by capillary rise can be of the same order of magnitude as that of annual precipitation. Figure 7 demonstrates that a capillary flux of 2 mm/day can be maintained in a clay loam over a height of about 2.4 m (8 feet) while such a flux in a sand soil will hardly reach 0.15 m (0.5 foot). For this report it is of more importance to consider how much the capillary rise can change due to a change of ground water table depth. Table 2 demonstrates that a rise of 30 cm (1 foot) of the ground water table can increase the capillary flux considerably. For example, in sandy loam (1) the capillary flux from a ground water table 91 cm (3 feet) below the bottom of the root zone will increase from 0.01 cm/day to 0.1 cm day when the water tables rises to 61 cm (2 feet) or from 0.1 cm/day at 61 cm depth to 0.6 cm/day at 32 cm depth. Thus, Table 2 indicates that a one foot rise in ground water table depth can result in a large increase in capillary upward water flow into the root zone and –as a consequence– a large increase in root zone salinity as well as a decrease in aeration due to waterlogging. Since the processes described in this section have been so often observed in arid and semi-arid watersheds when additional water is introduced one speaks about the "twin menace of water logging and soil salinity".

One relevant case study on the agricultural impacts of irrigation induced waterlogging and soil salinity is found in the Lower Arkansas river valley (Houk et al., 2006) with historic water qualities similar to those found in the Powder River and Little Powder River[3]. As a consequence of rising ground water levels since 1870 saline water tables began to develop by the early part of the 20th century. In 1999, the average water table depth of the study area was 2.1 m below the surface, with approximately 25% of the region's water table depth less than 1.5 m (Gates et al., 2002) while the minimum drain depth for salinity control in semi-arid regions is about 2.0 m (Hoffman and Durnford, 1999). Houk and his colleagues estimated the impact of both soil salinity and waterlogging on crop production. For Alfalfa in the Lower Arkansas river valley

[3] http://pubs.usgs.gov/fs/fs166-97/ accessed on September 12, 2009.

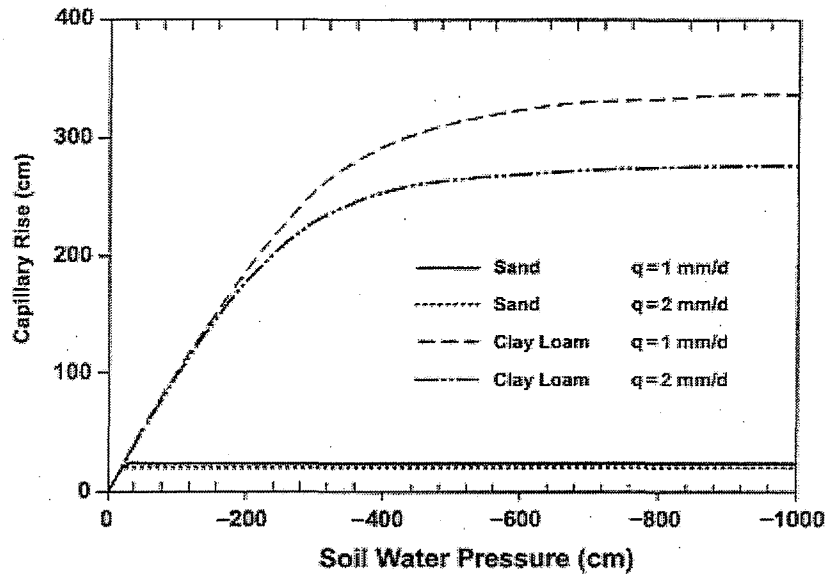

Figure 7. The height of capillary rise in homogeneous sand and clay loam profiles as a function of soil water pressure for evaporation fluxes of 1 and 2 mm/day (Hendrickx et al., 2003).

Texture	Capillary flux (cm day^{-1})									
	3	2	1	0.8	0.6	0.4	0.2	0.1	0.1	0.01
Sand[1]	14	15	17	18	19	20	23	26	29	37
Sand[2]	35	40	48	51	55	61	73	87	103	152
Loamy sand[1]	16	17	20	21	22	24	28	32	37	51
Loamy sand[3]	133	151	185	197	213	237	282	334	394	572
Sandy loam[1]	20	23	28	30	32	36	43	51	61	91
Sandy loam[2]	37	44	59	64	72	84	107	135	169	277
Loam[1]	21	26	35	38	43	50	65	82	103	171
Loam[2]	32	41	60	66	78	95	130	176	234	425
Clay loam[1]	10	14	23	27	32	40	58	82	112	219
Clay loam[3]	106	126	165	179	197	226	279	342	415	639

Table 2. Maximum height of capillary rise (cm) for ten fluxes in homogeneous soil profiles with different soil textures taken from the literature (Hendrickx et al., 2003). 1) (Carsel and Parrish, 1988); 2) (Wösten and Van Genuchten, 1988); 3) (Van Genuchten, 1978).

they estimated that relative yields decline about 11% for each one foot decrease in ground water table depth if the ground water table depth is shallower than 1.34 m (4.5 feet) due to lack of aeration caused by waterlogging. They estimated the relative yield due to root zone salinity using the Alfalfa response function with a threshold value of 2 dS/m (blue line in Fig. 4). The combined impact of waterlogging and root zone salinity was estimated by multiplying the relative yields estimated for, respectively, waterlogging and root zone salinity. For example, the total relative yield of Alfalfa on a field with a shallow ground water table of 1.0 m and a root zone salinity of 6 dS/m is estimated as follows: (1) water logging reduces yield by 11% for each 30 cm decrease of ground water table depth from the threshold depth of 1.34 m so that a ground water table depth of 1.00 m results in a relative yield of 0.89 due to waterlogging; (2) the relative yield due to soil salinity is 0.7 (brown line in Fig. 4); (3) the relative yield due to waterlogging and root zone salinity is 0.89 times 0.7 which equals 0.62.

The study by Houk and his colleagues is relevant for this report since it provides the tools to quantify independently the effects of waterlogging and root zone salinity for Alfalfa in a river valley with conditions somewhat similar to those in the creeks of the Powder River Basin.

In summary, adding water to a semi-arid watershed will often lead to a rise of ground water tables toward the land surface. If the water tables come within 3 to 1 m of the land surface, waterlogging and/or root zone salinity can occur even if the quality of the irrigation water is excellent. There is no relationship between irrigation water quality and the extent of waterlogging and/or root zone salinity and, therefore, there is no scientific basis for Tier 2 and even Tier 1. Tier 1 and Tier 2 permits are no guarantee that landowners will not suffer a measurable decrease in crop production. Since both Tier 2 and Tier 1 add water to a semi-arid hydrologic system they have the potential to cause more harm than good.

Conceptual Model of CBM Water and Salt Movement in the Powder River Basin

In Chapter 3 and the previous section of this Chapter we have explained the basic hydrologic principles of water and salt movement through semi-arid systems together with relevant examples from the literature. The purpose of this section is to develop a conceptual model of CBM water and salt movement in the Powder River Basin and to use this model to develop guidelines for environmentally safe disposal practices that will not lead to measurable decreases in crop production. Due to time constrains this section is written in a qualitative manner and all points discussed need more in-depth study before used for policy making or developing monitoring programs.

Historic Water and Soil Quality in the Powder River Basin.

The watersheds that we have visited in the Powder River Basin are located in the Gillette area with an average annual precipitation of about 14 to 16 inches (350 to 400 mm). Annual pan evaporation is estimated somewhere between 44 and 70 inches (1100 and 1800 mm). As a consequence deep aquifer recharge rates are estimated to vary from 0.5 to 2.0 mm per year (Puckett, 2008) which is characteristic for many arid and semi-arid regions (Hendrickx and Walker, 1997). Therefore, salinity is expected to be an integral part of the landscape. Historic water quality measurements by the USGS show that water quality in the Powder River varies from high EC at low discharge rates to low EC at high discharge rates[4] which reflects low salt contents during runoff of snowmelt and rainstorms but high salt contents when only saline seeps contribute to the flow in the river. In the field Mr. James Wolff showed us a saline seepage that was not caused by CBM waters but by the practice of leaving uphill dry land farm fields fallow during one year. Then, no plant roots will take up precipitation, water accumulates in the soil and percolates to deeper depths. At locations where soluble salts are present in the subsoil such as in geological layers formed in marine environments, the percolating water will dissolve salts and transport those downward. When the water finally daylights at the toe of a hill, a saline seepage will result; or the saline water can discharge into one of the creeks. This may explain relatively high EC's in creek water when snowmelt or storm runoff are absent.

Since the creeks in the Powder River Basin meander through small sloping valleys surface water and ground water will be well mixed and the water quality of the surface water in the creek is expected to be quite similar to the water quality of the ground water. As a result of the elevated EC of ground water, soil salinity is expected to occur in some of the valley soils, especially the higher ones that are not inundated on a regular basis.

Thus, saline soils and saline seepage waters as well as high quality snow melt and precipitation waters are all part of the semi-arid hydrologic system in the creeks of the Powder River Basin. The landowners of the Powder River Basin have been able to make these lands productive since the late 1800's and were able to overcome salinity and an extremely short growing season. They know when and where to put spreader dikes to make their challenging environment produce a

[4] http://pubs.usgs.gov/wri/wri014279/pdf/figs3-4.pdf accessed on September 13, 2009.

decent crop yield. Just as the Egyptian farmers in the floodplain of the Nile, the farmers of the Powder River Basin depend on snowmelt and storm runoff to crest their creeks, inundate their bottom lands, irrigate their hay meadows, and –most of all– wash their salts away when water levels fall. Without this annual cycle of high creek flow to wet the lands and low creek flow to pull the salts away, the system will not be viable.

Effect of CBM Waters on Creek Watershed Hydrology

Finding a new source of water in a semi-arid environment creates expectations and with good reason. Many are the testimonies of land owners who use CBM waters for managed live stock watering and advanced Tier 3 highly managed productive irrigation projects. However, where CBM waters have been released in the fragile creek system under the false assumption that "good" water cannot result in "bad" soils and crop yield reductions, the twin menace of waterlogging and salinity has appeared.

As in many other arid and semi-arid locations of the world, adding CBM waters to the Powder River Basin creeks almost immediately resulted in prolonged flooding due to inadequate natural drainage and ice dams. Although ice dams can be prevented by timing of CBM water releases, inadequate natural drainage is not so easy to adjust. Too much drainage may convert productive bottom lands and hay meadows in dry range lands while too little drainage may salinize the soils. The most extreme case is the property of Mr. Clabaugh that is frequently inundated for long periods of time. He is right: waterlogging and increasing soil salinity are reducing the productivity of his land. Restoration should start as soon as possible to prevent more permanent damage.

More subtle and much less visible are the lands where the ground water table has risen but stayed below the land surface. This is the case in all creeks that have converted from ephemeral to permanent streams. When an ephemeral stream loses its water, the ground water level has fallen below the bottom of the stream; when a stream doesn't lose its water anymore, the ground water level has not fallen below the bottom of the stream and is located above the bottom of the stream. Then, as explained above the process of soil salinization and crop yield reduction start due to the shallow ground water tables, even when the quality of the water added to the system is good. A clear example is the property of Mr. Tooter Rodgers where the surface water in the SA creek is piped around his property during the summer period. Yet, the creek is still flowing due to the fact that the ground water table has risen. The quality of the creek has now become equal to the quality of the saline ground water and is measured to be around 6 dS/m. This ground water quality is a result of historic water quality, CBM salts, and lack of leaching after the creek converted from an ephemeral into a permanent creek due to shallower ground water table levels.

In summary: there is no doubt that CBM waters have resulted in shallower ground water tables. This in turn will have increased capillary upward fluxes, soil salinization, crop yield depression, and ground water salinity. Since no systematic monitoring is conducted in the basin, it is difficult to quantify these increases but there is no doubt about the overall process.

CBM Waters and Tier 2

As the Tier 3 farmers demonstrate there is a successful way to manage CBM waters for crop production. However, whereas Tier 3 farmers have a clear agreement with industry, are assisted by experts, and know when, how much, and what quality water they will receive, a Tier 2 farmer is in a completely different position. For example, Mr. Swartz who manages about 300 acres of irrigated land does not know when he will have irrigation water, how much irrigation water he will receive, nor what the quality of his irrigation water will be. His water comes from about 150 outlets operated by about 10 different companies, his water quality is regulated by DEQ that sets an end-of-pipe CBM water quality limit, and his water quantity is regulated by the State Engineer's Office. TIER 2 is an impediment against farmer water management and puts out salts without any control or monitoring because adequate control of soil salinity changes requires that the farmer has access to multiple and dependable supplies of irrigation water where at least one supply is of good quality (Maas and Grattan, 1999)

In Ivy Creek CBM water discharged in the creek and never makes it to the downstream landowner. This is considered a success but is it? Where did the water and the salts go? Nobody knows since monitoring is not part of a Tier 2 or Tier 1 permit. The water is probably decreasing the depth of an existing water table and will sooner or later reach the root zone and result in soil salinization. Or the saline waters may start seeping towards the downstream landowner.

5. EXPERT SCIENTIFIC OPINIONS

We have presented scientific evidence that no unique relationship exists between irrigation water quality on the one hand and root zone soil salinity and crop productivity on the other. Therefore, we conclude that the **Tier 2 and Tier 1 methodology** as set forth in Appendix H section C(vi)(B) **is not reasonable nor scientifically valid for determining the EC of water that can be discharged into an ephemeral drainage in Wyoming so that degradation of the receiving water will not be of such an extent to cause a measurable decrease in crop production.**

We have observed in the field (Clabaugh, Swartz, Rodgers) that the **Tier 2 and Tier 1 methodology has caused a rise of the ground water table that resulted in both "waterlogging and –most likely– increased soil salinity"**. Had a monitoring program be in place since the beginning of CBM water releases, it is almost certain that a decrease in crop production would have been measured due to waterlogging and/or increased soil salinity. The damage done by Tier 2 and Tier 1 starts by creating water logged conditions in the drainages: **the true problem is the quantity of CBM waters rather than its quality**.

Prominent agricultural salinity experts state "The successful use of saline ... waters for irrigation requires **appropriate management practices to control salinity**, not only within the irrigated fields, but also within the associated irrigation project and geo-hydrologic system" (Rhoades, 1999) and "**adequate control of soil salinity** changes requires that the farmer has access to multiple and dependable supplies of irrigation water where at least one supply is of good quality" (Maas and Grattan, 1999). The **Tier 2 and Tier 1 methodology results in the uncontrolled and unmanageable release of CBM waters** since the farmers receive at unknown times, unknown volumes of water of unknown quality from hundreds of outlets controlled by different companies.

We recommend that **comprehensive monitoring of soils, ground water, and surface waters** is undertaken in all drainages that have received and are receiving CBM waters. The objectives are: (1) to determine where the salts are accumulating in the hydrologic system; (2) to assess where and when the salts will leave the system; (3) to design restoration measures for naturally and artificially irrigated lands that already have been affected or will be affected by "waterlogging and soil salinity".

We have observed in the field (Creswell, Werner, Williamson) that Tier 3 and the "irrigation waiver" are viable alternatives for the Tier 2 and Tier 1 methodology. Under Tier 3 the CBM waters are managed in a proper manner and used for increased crop production to the satisfaction of the landowners. Therefore, **we recommend to abandon uncontrolled releases of CBM water into the drainages by Tier 2 and Tier 1 methodology in favor of the Tier 3 methodology that relies on appropriate management practices to control salinity.**

Tier 3 is best implemented over deep vadose zones so that the saline drainage waters percolating from the root zone enter the ground water gradually and minimize salt load to the Powder River (Hendrickx et al., 2005).

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Exhibit 4

John S. Burbridge, # 5-2856
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Attorney for the Department
of Environmental Quality

**BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
OF THE STATE OF WYOMING**

IN THE MATTER OF THE APPEAL OF POWDER RIVER BASIN RESOURCE COUNCIL, BERNADETTE BARLOW, BERNADETTE BARLOW TRUST, WILLIAM L. BARLOW TRUST AND ERIC BARLOW FROM WYPDES PERMIT NO. WY0052299	)	**Docket No. 09-3802**

AFFIDAVIT OF JASON THOMAS IN SUPPORT OF THE WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY'S BRIEF IN OPPOSITION TO PETITIONERS' MOTION FOR SUMMARY JUDGMENT

Jason Thomas, being first duly sworn, deposes and says as follows:

1. I am over the age of 21 and am competent to make this affidavit.

2. The facts and matters stated herein are within my personal knowledge, and are true and correct.

3. I am employed with the Wyoming Department of Environmental Quality Water Quality Division (DEQ) where I am an Environmental Manager of the coal bed methane (CBM) permitting program. I have held this position for approximately 8 years.

4. I was involved with the issuance and establishment of effluent limits for the major modification of WYPDES permit WY0052299 to the Bill Barrett Corporation on November 25, 2008.

5. Even if Tier 2 is flawed, the effluent limitations in WYPDES permit WY0052299 are protective of downstream agricultural uses.

6. Since WYPDES permit WY0052299 was first issued in 2005, the DEQ has never received a complaint from landowners downstream of the outfalls regulated by Barrett's permit regarding any decrease in crop or livestock production due to the quality of the produced water.

7. WYPDES permit WY0052299 requires that Barrett contain its produced water in reservoirs which is the first step in CBM water management.

8. In the case of WYPDES permit WY0052299, the DEQ did not impose an end of-pipe limit for SAR. Instead, the DEQ required the permittee to contain all discharges in reservoirs and monitor any release from the reservoirs for SAR.

9. For permits where containment of discharges is required, the DEQ does not generally put an SAR limit at the outfall. Based on our past data from in-stream irrigation monitoring points (IMP) and irrigation compliance points (ICP) locations below these types of reservoirs, the DEQ has determined that an SAR limit at the outfall above a reservoir is generally not necessary.

10. DEQ's data indicates that the vast majority (95+ %) of the water reaching IMP/ICP locations after overtopping falls within the protective range for water quality on the Hanson chart for SAR.

11. This data serves as our reasonable potential analysis under the federal regulations because it takes into account other sources of the pollutant, variability of the pollutant in the effluent, and available dilution.

12. Coupled with our reliance on the past DEQ data, the DEQ requires ongoing monitoring at the IMP's to confirm that our assumptions are still valid and that the SAR is in compliance with the Hanson chart upon overtopping.

13. The requirement includes a provision for an automatic assignment of an SAR effluent limit at the outfall in the event that the SAR at the IMP shows a pattern of non-compliance. The DEQ would impose this requirement if the monitoring data showed three (3) exceedences in a year.

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14. The DEQ also retains the standard re-opener provision for any case where the DEQ might choose to re-open and modify the permit to include an SAR effluent limit at the outfall, even short of three exceedences per year (in the case of a very high single exceedence for example).

Dated this 20th day of April, 2010

Jason Thomas
Coal Bed Methane Permitting Supervisor

STATE OF WYOMING)
) ss.
County of Laramie)

Subscribed and sworn before me by Jason Thomas on the 20th day of April, 2010.

Witness my hand and official seal.

Donna Behounek
Notary Public

My commission expires: April 28, 2012

DONNA BEHOUNEK - NOTARY PUBLIC
COUNTY OF LARAMIE
STATE OF WYOMING
MY COMMISSION EXPIRES APR. 28, 2012

Exhibit 5

Instream Values for SAR and EC Sampled Downstream of Naturally Overtopping CBM Reservoirs in Ephemeral Drainages of the Powder River Basin

WYPDES Reasonable Potential Review Document A

Purpose: Pursuant to 40 CFR 122.44(d), the discharge permitting authority must determine whether a given pollutant within a discharged effluent will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including narrative criteria for water quality. If the permitting authority determines that the pollutant in the discharge will cause, have the reasonable potential to cause, or contribute to an instream excursion of the applicable standard, then the permitting authority must include an effluent limit for that pollutant in a discharge permit. If the permitting authority finds that no such potential exists, then no effluent limit is necessary. In making such a determination, the permitting authority must consider the variability of the pollutant, other sources of the pollutant in the watershed, and available dilution. The purpose of this particular review is to determine whether or not an effluent limit for Sodium Adsorption Ratio (SAR) is generally necessary for discharges that are managed in on-channel reservoirs.

Applicability: In order to protect irrigation uses below permitted discharges, WDEQ sets an instream target for SAR at: SAR < 6.67 EC (dS/m) – 3.33. This function is derived from Ayers and Westcot FAO Paper 29; 1985 (re-published in "Agricultural Salinity and Drainage," UC Davis, Hanson; 2006). By setting this as the instream target for SAR, WDEQ is intending to maintain no reduction in the rate of infiltration for irrigated soils.

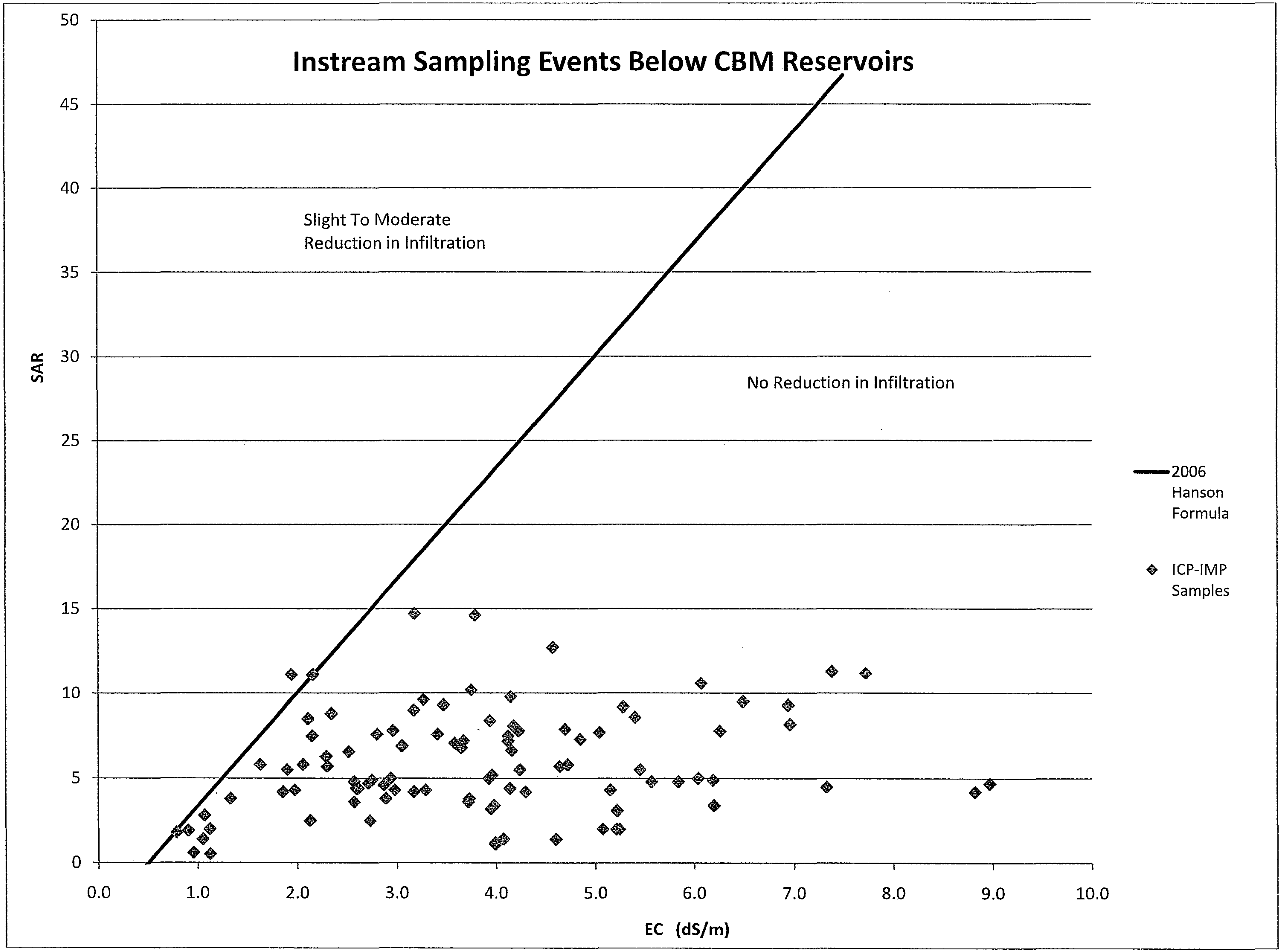
WDEQ has accumulated a body of SAR and EC data from instream locations which are downstream of CBM reservoirs, and upstream of irrigation uses on ephemeral tributaries of the Powder River (See Table below). The subject reservoirs are located on-channel, and are permitted to passively overtop in response to upstream storm events. This is a particular water management option available in WYPDES CBM discharge permits. The collected data is from natural overtopping events, representing a variety of field conditions over large project areas from storm events that occurred over a number of years. The data itself adequately accounts for multiple sources of SAR as a pollutant in the subject watersheds, the inherent variability of SAR as it occurs in the reservoirs themselves prior to overtopping, and the available dilution from storm events that cause overtopping. Therefore, this data meets the necessary considerations for a reasonable potential review under 40 CFR 122.44(d).

Findings: The data below indicates that 99% of the sampled events did not exceed the above instream threshold for SAR. Of the 97 overtopping events sampled, 96 complied with the threshold. The single sample that did exceed the above instream threshold for SAR contained an SAR level of 11. The threshold for that event was 10. Therefore the data suggests that the risk of exceeding the instream target for SAR is very low under this water management scenario; and the risk of a significant exceedence appears to be even lower. Based on this data, WDEQ has determined that CBM effluent managed in on-channel reservoirs, which passively overtop in response to natural storm events, does not have a reasonable potential to cause or contribute to an excursion above the instream target for SAR. Therefore, unless otherwise demonstrated, an effluent limit for SAR is not necessary at an outfall flowing into such a reservoir.

Conditions:

1) Where new instream data is gathered below CBM reservoirs (at an irrigation monitoring point) and it does not conform with the established threshold for SAR, then WDEQ retains the re-opener authority to establish an effluent limit for SAR at any outfall contributing to such an exceedence.

2) Where a reservoir release is requested upon a showing of available salt and sodium credits under the "Powder River Assimilative Capacity Allocation and Control" Program, and the reservoir is located upstream of a tributary irrigation use as identified in the permit, the release will only be authorized by WDEQ if the water residing in the reservoir at the time of the release request meets the SAR threshold above. No release will be authorized from a reservoir above an irrigation use if the SAR of the water in the reservoir exceeds the above threshold.


Instream Sampling Events Below CBM Reservoirs
Slight To Moderate
Reduction in Infiltration
No Reduction in Infiltration
SAR
EC (dS/m)
0
5
10
15
20
25
30
35
40
45
50
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
2006 Hanson Formula
ICP-IMP Samples

WYPDES Permit #	Station Name	Permittee	FacilityName	SAR	EC (dS/m)	EC (µmhos/cm)	Sample Month Begin	Sample Month End	Hanson SAR limit (2006 Formula)	Instream SAR Exceeds Standard?
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	2	0.783	783	02/01/07	02/28/07	2	No
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	3	2.13	2130	05/01/07	05/31/07	11	No
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	5	2.57	2570	06/01/05	06/30/05	14	No
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	3	2.73	2730	06/01/07	06/30/07	15	No
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	5	2.87	2870	05/01/05	05/31/05	16	No
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	4	3.72	3720	03/01/07	03/31/07	21	No
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	3	3.95	3950	06/01/08	06/30/08	23	No
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	3	3.984	3984	05/01/08	05/31/08	23	No
WY0037362	ICP	Yates Petroleum Corporation	Store Draw CS State #1 CBM Wells	5	5.57	5570	04/01/07	04/30/07	34	No
WY0038164	ICP1	Lance Oil and Gas Company, Inc.	Carson and Reed	5	7.33	7330	06/01/07	06/30/07	46	No
WY0038164	ICP1	Lance Oil and Gas Company, Inc.	Carson and Reed	4	8.82	8820	04/01/07	04/30/07	55	No
WY0038164	ICP1	Lance Oil and Gas Company, Inc.	Carson and Reed	5	8.97	8970	05/01/07	05/31/07	56	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	2	1.12	1120	02/01/07	02/28/07	4	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	4	2.89	2890	03/01/07	03/31/07	16	No

WYPDES Permit #	Station Name	Permittee	FacilityName	SAR	EC (dS/m)	EC (µmhos/cm)	Sample Month Begin	Sample Month End	Hanson SAR limit (2006 Formula)	Instream SAR Exceeds Standard?
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	15	3.18	3180	10/01/05	10/31/05	18	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	15	3.79	3790	11/01/05	11/30/05	22	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	10	4.15	4150	06/01/05	06/30/05	24	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	13	4.57	4570	12/01/05	12/31/05	27	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	9	5.28	5280	04/01/06	04/30/06	32	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	11	6.07	6070	03/01/05	03/31/05	37	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	10	6.49	6490	04/01/05	04/30/05	40	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	9	6.94	6940	05/01/07	05/31/07	43	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	11	7.38	7380	01/01/06	01/31/06	46	No
WY0038377	ICP1	Devon Energy Production Company, LP	Spotted Horse Creek CBM Operations	11	7.72	7720	02/01/06	02/28/06	48	No
WY0039152	ICP1	Patriot Energy Resources, LLC	South Kitty - S Bar Creek	1	1.05	1050	03/01/08	03/31/08	4	No

WYPDES Permit #	Station Name	Permittee	FacilityName	SAR	EC (dS/m)	EC (µmhos/cm)	Sample Month Begin	Sample Month End	Hanson SAR limit (2006 Formula)	Instream SAR Exceeds Standard?
WY0040371	ICP3	Lance Oil and Gas Company, Inc.	Lazy B CBM Operation	2	0.902	902	03/01/08	03/31/08	3	No
WY0040371	ICP1	Lance Oil and Gas Company, Inc.	Lazy B CBM Operation	8	5.04	5040	06/01/08	06/30/08	30	No
WY0040371	ICP1	Lance Oil and Gas Company, Inc.	Lazy B CBM Operation	8	6.26	6260	05/01/08	05/31/08	38	No
WY0042048	ICP-2	Yates Petroleum Corporation	Felix CS State Lease CBM Wells	4	5.15	5150	03/01/08	03/31/08	31	No
WY0042048	ICP-2	Yates Petroleum Corporation	Felix CS State Lease CBM Wells	5	5.84	5840	05/01/08	05/31/08	36	No
WY0042048	ICP-2	Yates Petroleum Corporation	Felix CS State Lease CBM Wells	5	6.04	6040	04/01/08	04/30/08	37	No
WY0046213	ICP	Pinnacle Gas Resources, Inc.	Bobcat CBM Project	4	4.14	4140	04/01/03	04/30/03	24	No
WY0046213	ICP	Pinnacle Gas Resources, Inc.	Bobcat CBM Project	4	4.3	4300	05/01/03	05/31/03	25	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	4	1.33	1330	06/01/07	06/30/07	6	No
WY0048241	ICP2	Lance Oil and Gas Company, Inc.	Gas Draw Unit	6	1.63	1630	04/01/06	04/30/06	8	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	6	1.9	1900	11/01/07	11/30/07	9	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	6	2.06	2060	12/01/07	12/31/07	10	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	6	2.29	2290	01/01/08	01/31/08	12	No

WYPDES Permit #	Station Name	Permittee	FacilityName	SAR	EC (dS/m)	EC (µmhos/cm)	Sample Month Begin	Sample Month End	Hanson SAR limit (2006 Formula)	Instream SAR Exceeds Standard?
WY0048241	ICP2	Lance Oil and Gas Company, Inc.	Gas Draw Unit	6	2.3	2300	07/01/05	07/31/05	12	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	4	2.59	2590	05/01/06	05/31/06	14	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	4	2.61	2610	04/01/06	04/30/06	14	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	5	2.71	2710	04/01/07	04/30/07	15	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	5	2.75	2750	05/01/07	05/31/07	15	No
WY0048241	ICP2	Lance Oil and Gas Company, Inc.	Gas Draw Unit	5	2.94	2940	06/01/06	06/30/06	16	No
WY0048241	ICP2	Lance Oil and Gas Company, Inc.	Gas Draw Unit	4	2.98	2980	04/01/07	04/30/07	17	No
WY0048241	ICP2	Lance Oil and Gas Company, Inc.	Gas Draw Unit	4	3.29	3290	05/01/07	05/31/07	19	No
WY0048241	ICP2	Lance Oil and Gas Company, Inc.	Gas Draw Unit	4	3.73	3730	06/01/07	06/30/07	22	No
WY0048241	ICP1	Lance Oil and Gas Company, Inc.	Gas Draw Unit	3	5.22	5220	07/01/05	07/31/05	31	No
WY0048321	ICP1	Williams Production RMT Company	Schoonover Road Unit 11	1	0.957	957	05/01/07	05/31/07	3	No
WY0048321	ICP1	Williams Production RMT Company	Schoonover Road Unit 11	1	1.124	1124	06/01/07	06/30/07	4	No

WYPDES Permit #	Station Name	Permittee	FacilityName	SAR	EC (dS/m)	EC (µmhos/cm)	Sample Month Begin	Sample Month End	Hanson SAR limit (2006 Formula)	Instream SAR Exceeds Standard?
WY0048933	ICP1	Williams Production RMT Company	Lone Tree #1	4	1.976	1976	06/01/07	06/30/07	10	No
WY0048976	ICP	Williams Production RMT Company	Kitty Unit	4	1.857	1857	05/01/07	05/31/07	9	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	9	2.34	2340	07/01/03	07/31/03	12	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	7	2.516	2516	04/01/07	04/30/07	13	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	8	2.96	2960	06/01/05	06/30/05	16	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	7	3.05	3050	04/01/05	04/30/05	17	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	9	3.17	3170	06/01/03	06/30/03	18	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	10	3.27	3270	07/01/04	07/31/04	18	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	8	3.41	3410	05/01/06	05/31/06	19	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	9	3.47	3470	06/01/04	06/30/04	20	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	7	3.584	3584	08/01/07	08/31/07	21	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	7	3.65	3650	04/01/06	04/30/06	21	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	7	3.67	3670	04/01/03	04/30/03	21	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	10	3.752	3752	06/01/07	06/30/07	22	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	8	3.939	3939	09/01/03	09/30/03	23	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	7	4.12	4120	05/01/05	05/31/05	24	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	8	4.12	4120	04/01/04	04/30/04	24	No

WYPDES Permit #	Station Name	Permittee	FacilityName	SAR	EC (dS/m)	EC (μmhos/cm)	Sample Month Begin	Sample Month End	Hanson SAR limit (2006 Formula)	Instream SAR Exceeds Standard?
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	7	4.157	4157	05/01/07	05/31/07	24	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	8	4.23	4230	05/01/03	05/31/03	25	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	8	4.694	4694	06/01/06	06/30/06	28	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	7	4.848	4848	07/01/07	07/31/07	29	No
WY0049166	ICP	Jim's Water Service, Inc.	East Kingsbury CBM Unit	9	5.4	5400	05/01/04	05/31/04	33	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	11	1.946	1946	07/01/06	07/31/06	10	Yes
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	9	2.108	2108	09/01/05	09/30/05	11	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	8	2.15	2150	07/01/04	07/31/04	11	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	11	2.158	2158	08/01/06	08/31/06	11	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	8	2.801	2801	09/01/06	09/30/06	15	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	5	3.93	3930	04/01/04	04/30/04	23	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	5	3.962	3962	04/01/07	04/30/07	23	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	8	4.177	4177	04/01/06	04/30/06	25	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	6	4.24	4240	06/01/06	06/30/06	25	No

WYPDES Permit #	Station Name	Permittee	FacilityName	SAR	EC (dS/m)	EC (µmhos/cm)	Sample Month Begin	Sample Month End	Hanson SAR limit (2006 Formula)	Instream SAR Exceeds Standard?
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	6	4.64	4640	05/01/04	05/31/04	28	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	6	4.723	4723	05/01/06	05/31/06	28	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	6	5.45	5450	06/01/07	06/30/07	33	No
WY0049689	ICP	Devon Energy Production Company, LP	South Kitty #2	5	6.19	6190	05/01/07	05/31/07	38	No
WY0049701	ICP2	Lance Oil and Gas Company, Inc.	Spotted Horse Store Unit	4	2.57	2570	05/01/07	05/31/07	14	No
WY0049701	ICP1	Lance Oil and Gas Company, Inc.	Spotted Horse Store Unit	1	3.99	3990	03/01/07	03/31/07	23	No
WY0049701	ICP1	Lance Oil and Gas Company, Inc.	Spotted Horse Store Unit	1	3.99	3990	04/01/07	04/30/07	23	No
WY0049701	ICP1	Lance Oil and Gas Company, Inc.	Spotted Horse Store Unit	1	4.07	4070	06/01/07	06/30/07	24	No
WY0049701	ICP1	Lance Oil and Gas Company, Inc.	Spotted Horse Store Unit	1	4.6	4600	05/01/07	05/31/07	27	No
WY0049859	ICP2	Lance Oil and Gas Company, Inc.	South Spotted Horse Unit	2	5.07	5070	05/01/07	05/31/07	30	No
WY0049859	ICP2	Lance Oil and Gas Company, Inc.	South Spotted Horse Unit	2	5.21	5210	04/01/07	04/30/07	31	No
WY0049859	ICP2	Lance Oil and Gas Company, Inc.	South Spotted Horse Unit	2	5.24	5240	06/01/07	06/30/07	32	No

WYPDES Permit #	Station Name	Permittee	FacilityName	SAR	EC (dS/m)	EC (µmhos/cm)	Sample Month Begin	Sample Month End	Hanson SAR limit (2006 Formula)	Instream SAR Exceeds Standard?
WY0049859	ICP2	Lance Oil and Gas Company, Inc.	South Spotted Horse Unit	3	6.2	6200	03/01/07	03/31/07	38	No
WY0051012	ICP1	Pennaco Energy, Inc.	Wild Horse Creek-Kingsbury Project	3	1.07	1070	02/01/08	02/29/08	4	No
WY0051306	ICP	Yates Petroleum Corporation	Ucross CS Federal	4	3.17	3170	06/01/07	06/30/07	18	No
WY0051306	ICP	Yates Petroleum Corporation	Ucross CS Federal	8	6.96	6960	05/01/07	05/31/07	43	No

Exhibit 6

BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
STATE OF WYOMING

IN THE MATTER OF THE APPEAL OF POWDER RIVER BASIN RESOURCE COUNCIL, BERNADETTE BARLOW, BERNADETTE BARLOW TRUST, WILLIAM L. BARLOW TRUST AND ERIC BARLOW FROM WYPDES PERMIT NO. WY0052299	))))))))	Docket No. 09-3802

AFFIDAVIT OF GIB BELL

I, Gib Bell, being first duly sworn upon my oath, state as follows:

1. My name is Gib Bell. I am over the age of 21 and am competent to testify to the matters I state in this Affidavit. I give this Affidavit based on personal knowledge. I reserve the right to supplement my testimony in future proceedings.

2. I own a company called Riata Ranch LLC (Riata). Riata conducts ranching operations in a joint venture with the Nisselius Ranch Co. (joint venture) on the Nisselius Ranch located in Campbell County approximately 23 miles southwest of Gillette, Wyoming. I am responsible for day to day operations on this ranch. I reside on this ranch and I have 25 years experience in ranching.

3 Bill Barrett Corporation (BBC) discharges coal bed natural gas (CBNG) water on this ranch under Permit No. WY0052299 (BBC Dead Horse Creek) and has done so for the past three and a half years.

4. I have <u>not</u> found CBNG water discharged under WY0052299 to cause a measurable decrease in crop or livestock production on the ranch.

5. I have actually noted a measurable <u>increase</u> in crop and livestock production from the CBNG water discharged under WY0052299.

6. The Nisselius Ranch Co. owns and the joint venture operates a twenty (20) acre subsurface drip irrigation system (SDI) during the April-September irrigation season and an extensive year-round stock watering system with approximately 32,000' of buried pipeline. Both these systems were installed after BBC started discharging water under WY0052299. The stock watering system is used for an intense grazing management system. The joint venture has invested a considerable amount of time and money into these systems. The joint venture depends on the water produced under WY0052299 for these systems.

FURTHER AFFIANT SAYETH NOT.

DATED this 15 day of April, 2010.

Gib Bell
Riata Ranch LLC

STATE OF WYOMING)
) ss.
COUNTY OF Campbell)

The foregoing Affidavit was signed and sworn to before me this 15 day of April, ~~2006~~ 2010, by Gib Bell.

Witness my hand and official seal.

Rachel L. Garcia - Notary Public
County of Campbell State of Wyoming
My Commission Expires 10-13-2012

NOTARY PUBLIC in and for the State of Wyoming.

My appointment expires: 10-13-2012.

Exhibit 7

BEFORE THE ENVIRONMENTAL QUALITY COUNCIL

OF THE STATE OF WYOMING

IN THE MATTER OF THE APPEAL OF CLABAUGH RANCH, INC., FROM WYPDES PERMIT NO. WY0049697

Docket No. 08-3802

DEPOSITION OF JOHN WAGNER
Taken on behalf of Petitioner

1:17 p.m., Wednesday
June 17, 2009

PURSUANT TO NOTICE, the deposition of JOHN WAGNER, was taken in accordance with the applicable Wyoming Rules of Civil Procedure at the Yellowstone Room, 122 West 25th Street, Cheyenne, Wyoming, before Margie R. Dauster, Registered Professional Reporter, Certified Realtime Reporter, and a Notary Public.

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APPEARANCES

For Petitioner Clabaugh Ranch: MR. TOM C. TONER
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EXHIBITS

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JOHN WAGNER,

called for examination by the Petitioner, being first duly sworn, on his oath testified as follows:

EXAMINATION

Q. (BY MR. TONER) State your name, please.
A. John Wagner.
Q. What is your position with the Department of Environmental Quality?
A. I'm the administrator of the Water Quality Division.
Q. How long have you held that position?
A. Since October 2003.
Q. What's your educational background?
A. I have a bachelor's in biology from University of Wyoming; a master's in water resources from the University of Wyoming.
Q. And when did you obtain those?
A. Bachelor's was in '70; the master's in '71.
Q. And can you give me a brief work history from your graduation from college?
A. I went to work for the State right after I got my master's. So I went to work for -- at that time there was no DEQ. I went to work for the Health Department. It was called Sanitary Engineering Services. It was the water pollution control agency for the State at that time.

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DEQ was created in 1973. And fairly early in my career -- and I don't remember exactly when -- I was put in charge of the discharge permitting program for the State, as well as the water quality standards. And I did basically that job until 1996.
In 1996 I transferred to the Land Quality Division of DEQ. I was in the Land Quality Division until I was promoted to the water quality administrator.
Q. I'll show you Deposition Exhibit 24. It's already been marked. And is that a letter that you wrote to the Wyoming Environmental Quality Council Members?
A. Yes, it is.
Q. On the second page of that letter, under the heading Group 3, you refer to a University of Wyoming study. And you say: The report (copy attached) provided by Dr. Raisbeck and his colleagues provided exactly the information requested. We believe it provides the most up-to-date summary of the information currently available on the subject of water quality for livestock.
Do you still believe that Dr. Raisbeck's report provides the most up-to-date summary of information currently available on the subject of water quality for livestock?
A. Yes, I do.
Q. Now, on the fourth page there's a summary of four groups. Could you give me an explanation of what those groups represent?

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A. I can. Group 1 are the effluent limitations that we have used for livestock protection since 1977, I believe. Those numbers are in -- are in rule.
Group 2 are some additions to the limits that are in rule, and they're additions to the Group 1 that are set by policy or had been set by policy over the years.
Group 3 is a summary of the recommendations that came from the University of Wyoming report. And then Group 4 is the list of limits that we propose to the advisory board.
Q. I have a couple of questions. The University of Wyoming report for sulfates sets a short-term exposure limit of 1,800 and a chronic exposure limit of 1,000. And the DEQ's recommendation is 2,000.
A. That's correct.
Q. Would you explain to me why that difference?
A. Yeah. As I explained to both the Environmental Quality Council and the advisory board, the sulfate limit that we had been using for -- since 1977 was 3,000 milligrams per liter.
We had no reason to think that that 3,000 milligram per liter number was causing any kind of a problem. And, as a matter of fact, we had extensive testimony from the

agricultural community, during the advisory board process, indicating that they thought 3,000 was a good number.

However, the University of Wyoming was suggesting a number lower. And, quite honestly, it was a compromise between the two.

Q. Okay. How about the sodium limit? The University of Wyoming recommended 4,000 milligrams per liter dissolved short-term exposure; 1,000 milligrams per liter dissolved long-term exposure. And you've recommended 1,000 milligrams per liter dissolved?

A. Correct.

Q. And is that just to follow the University of Wyoming report?

A. Yeah, we never had -- we never -- we never regulated sodium before. Something that came out of the University of Wyoming report that was very useful to us was: Hey, you haven't been regulating sodium in the past. We think probably you should be, and we think the long-term criteria ought to be 1,000.

And so we accepted that.

Q. And are you imposing that on permits that are currently being written?

A. We're not.

Q. Why is that, if you --

A. Because the rule was -- has never been passed. The

advisory board, when they -- when the advisory board heard this particular part of the rule, the advisory board recommended no change to -- the advisory board -- let me go back.

The advisory board heard all the arguments, heard the presentation by the University of Wyoming, heard our recommendations. As I -- as it says here, Group 4 was recommended to the advisory board. The advisory board chose to stick with Group 1 and Group 2.

Q. Okay. Group 2, those are policy limits not imposed by a rule, correct?

A. That's correct.

Q. And so at some point the DEQ made a determination that those various parameters ought to be regulated?

A. We did. Yes.

Q. And that was based on, what, scientific information that you received?

A. That's correct. As information became available, we -- you know, we may have learned at one time, hey, cadmium may be of concern. Therefore, we started regulating cadmium.

Q. With Dr. Raisbeck's study providing the most up-to-date summary of information currently available on the subject of water quality for livestock, why aren't you imposing a sodium limit like you would any other parameter

under Group 2?

MR. CRANK: Object as to the form of the question. You can answer if you can.

A. The reason we're not doing it is because the advisory board told us not to, and the Environmental Quality Council has not yet made a ruling on it.

Q. (BY MR. TONER) Are you asking that the sodium limit be put into a rule?

A. That's correct. The ag use protection policy, which is before the council now, has two parts. One part is the irrigation part. The second part is the livestock criteria. And they have not ruled one way or the other on either part of that, so --

Q. This advisory board, I'm not clear on what sort of statutory power that has. Can you explain that for me?

A. Yes. The statute says that all rules that are adopted by the department originate with the department, but then they go through a process which includes the advisory board up front, and then the advisory board makes recommendations to the Environmental Quality Council.

And so we're at the point where the advisory board has made a recommendation, which was not our recommendation, but it was a recommendation to the Environmental Quality Council. The council has not yet taken action.

Q. So in the DEQ's opinion, the best science available

right now would indicate you should be regulating sodium to protect livestock?

A. Well, the best science may say that. But, certainly, our advisory board did not agree with us and, therefore, we are -- our advisory board said use Group 1 and Group 2. And so we are not -- we're not going against what the advisory board recommended.

Q. But as far as the DEQ is concerned, the best science indicates that sodium should be regulated?

A. Our recommendation to the advisory board was that there should be a limit of 1,000 to protect livestock.

Q. And that's because that's what the best science indicates?

A. That's what the University of Wyoming reports said and suggested.

Q. And you've indicated that's the best -- the most up-to-date summary of information currently available on the subject of water quality for livestock?

A. That's correct.

Q. So in the permit in question here, the Echeta Road permit, is that why dissolved sodium is not regulated, is because the Water Quality Advisory Board didn't recommend it?

A. Yeah, if there's no -- no sodium limit in there -- and I've got to admit, I'm not familiar with the permit itself.

We have not been issuing discharge permits with sodium limits to protect livestock at this point, and we have never put sodium limits in permits to protect livestock for as long as I've worked for the agency.

Q. Okay. Now, is the dissolved sodium that's referred to -- I guess you heard the testimony about the number of pounds of dissolved sodium that's authorized to be issued under this permit.

A. I did, yes.

Q. Is that the same sodium we're talking about in the recommendation that the DEQ made?

A. It's the same element, yes.

Q. I'd like to ask you a couple of questions about this Bridger Technical Note 26. You were here when Mr. Thomas testified about a memo that you wrote concerning inquiries made to the author of that report?

A. Yes.

Q. Did you personally talk to the author of that report?

A. No.

Q. Was Mr. Thomas the only one, as far as you know, from the DEQ that was instructed to talk to the author of that report?

A. That's my understanding, yes.

Q. And was it your understanding that the author of that report recommended that it not be used for regulatory purposes?

A. That's what Mr. Thomas reported.

Q. I'd like to ask you a few questions about the report that Dr. Hendrickx and Dr. Buchanan prepared. Let's see, what is that? Is that Exhibit --

MR. CRANK: 14.

MR. TONER: 14. Thank you.

Q. (BY MR. TONER) Have you reviewed that report?

A. I've read it once.

Q. Read it once, okay.

A. Mm-hum.

Q. Did you give any instructions to any DEQ employees to prepare a response to that report?

A. I have not.

Q. Is there any reason you have not done so?

A. I can't remember exactly when that report came out. I think it was earlier this month. Or maybe it was late May. I can't really remember. But the Environmental Quality Council was meeting soon after that report came out. And we, frankly, were waiting for the Environmental Quality Council to give some guidance as to how they were going to handle the report.

Were they going to put it out there for public

comment? Were they going to want the agency to respond, just the agency? We didn't really know where they were going to go with that. So we, frankly, were waiting for the council to make a decision. And my understanding is -- I wasn't at the council's meeting. But my understanding is, is the council has decided to leave the hearing record open until late September.

And so our assumption is, is that the department, and anybody else, will be free to comment on that report clear up until the end of September.

Q. And you haven't assigned anyone that task yet?

A. No.

Q. Are you familiar with the conclusions of the report?

A. Yes.

Q. Do you agree or disagree with the conclusions of the report?

A. It depends on what the question -- how you frame the question. I think the report answered the question adequately if the question is: Can you use soil quality to back-calculate background water quality?

They say you cannot do that. And after reading their report, I -- I see where they're coming from. And I -- I tend to agree with their -- their conclusions. That's not quite the question that we want answered though.

The question that we want answered is: What methodology can you use to set an effluent limit that will not cause harm to the soils? And: Can you use soil quality to make that decision?

And so that question, I don't think, has been answered.

Q. Do you have an opinion on that?

A. My opinion is that, yes, you can use -- you can use soil quality data to make some reasonable judgements as to the quality of the water that you can discharge onto that land.

If the land is salty, then you can be less conservative about the water quality that you can put on it. On the other hand, if the land or the soils are not very salty, then you have to be very conservative, and you don't want to put additional salts on it.

So I think it makes sense to use soil quality to make some determinations on discharge quality.

Q. Any other opinions in the report that you would disagree with or you think you would qualify in some way?

A. No.

MR. CRANK: Pretty broad. I'll object as to the form. You can answer if you can.

Q. (BY MR. TONER) Does the DEQ intend to hire other consultants to evaluate Dr. Buchanan and Dr. Hendrickx'

report?
A. We've thought about that, but no conclusions have been made as to whether or not we should do that.
Q. Did you investigate the background of Dr. Hendrickx or Dr. Buchanan and determine whether they're good scientists or not?
A. No. I'll point out that the department had no role in choosing them at all.
Q. That was totally done by the Environmental Quality Council?
A. That's correct.
Q. Do you understand what process they went through to select these gentlemen?
A. I don't.
Q. But were you present at the telephone conference where they interviewed these gentlemen before they hired them?
A. No.
Q. Have you read the transcript of that interview?
A. No.
MR. CRANK: Is there a transcript of that?
MR. TONER: Yes.
MR. CRANK: Is it posted on the website?
MR. TONER: I don't know. I have a copy of it. If you'd like it, I can send it to you.

MR. CRANK: That would be great.
MR. TONER: Let me write that down. In fact, I might even have it here.
(Discussion off the record.)
(Deposition Exhibit Number 27 was marked for identification.)
Q. (BY MR. TONER) I'll hand you a document that's been marked Deposition Exhibit 27. As the water quality administrator, does your jurisdiction extend to quality standards for Wyoming groundwater?
A. It does.
Q. This exhibit is a copy of Chapter 8, Quality Standards for Wyoming Groundwater. And if you'd take a look at the section the fourth page over where it's defining the classes of groundwater of the state.
A. Yes.
Q. And under Paragraph (d)(ii), it says: Class II Groundwater of the State. This water is suitable for agricultural use where soil conditions and other factors are adequate. The ambient quality of underground water of this suitability does not have a concentration in excess of any of the standards for Class II Groundwater of the State (see Table I, Page 9.)
So we go over to Table I on the Underground Water Class and Use Suitability under Category II for agriculture,

and we drop down to SAR. It has a limit of 8.
Do you see that?
A. Yes.
Q. So if I read these groundwater regulations correctly, if the ambient quality of underground water has an SAR in excess of 8, it is not a Class II groundwater and is not deemed suitable for agricultural use; is that true?
A. That's correct.
Q. Yet if you have water with an SAR of, say, 25 coming out of a coalbed methane well, is it possible for the DEQ to say that water is suitable for agricultural use?
A. Yes.
Q. Do you see any conflict between those positions?
A. Well, on the surface it kind of looks like it's contradictory. And keep in mind that these things were published in the 1980's some time, so they're getting kind of long in the tooth.
And the purpose of the groundwater standards is to simply set the classifications of the stream or -- or classification of the groundwater. It doesn't go to the next step saying: Okay, in these particular circumstances, in these particular soils, these particular individual conditions, an SAR of 8 is okay.
Because as you're well aware, sometimes SAR of 8 would be too -- too high. Sometimes it would be too low.

It can vary tremendously. So it -- I'm not sure that they relate quite as cleanly or as clearly as some people would like to imply that they do.
Q. Well, is there some move to update Chapter 8 of the Quality Standards for Wyoming Groundwater to increase or decrease the SAR concentration of groundwater that's suitable for agriculture?
A. No. Certainly not a high priority at all.
Q. I just want to see if I understand this classification correctly. Let's say we have a coal seam aquifer and the SAR in that coal seam aquifer is 15. That would not be classified as suitable for agriculture; is that right?
A. Correct. It would kick it to a Class III groundwater.
Q. And that would mean that it's, what, suitable for livestock?
A. Correct.
Q. You heard the discussion this morning with Mr. Thomas about the formula that relates SAR to EC?
A. Yes.
Q. Do you know why the DEQ changed that formula?
A. DEQ did not change the formula.
Q. All right. Why the DEQ started using a different formula in the permits that it's issuing?

A. Yes.
Q. And why did they do that?
A. My understanding is -- I think it was the 1990 version of the Hanson document had the Ayers and Westcot formula in it. And subsequent to that, in 2006 I believe it was, whoever edited the Hanson document, when they came out with the new version, changed the slope slightly so that it is a slightly more conservative number now than it was.
When we -- when we became aware of the fact that the slope had changed slightly, we then started incorporating the new -- new numbers, because we -- evidently, whoever the editor of that document is felt that the new slope was a better -- a better slope.
Q. Well, the slope that Hanson published in 1999 was supposed to be the Ayers and Westcot slope, right?
A. Yeah, they're both Ayers and Westcot slopes.
Q. So when Hanson -- when it was published in the 1999 version of Hanson, they got it wrong, correct?
A. Evidently, somebody -- somebody decided that that 1999 version was incorrect, and they updated it and corrected it.
Q. In 2006, when they re-published the Hanson agricultural salinity text, they updated it and corrected it to the correct Ayers and Westcot slope?
A. That's correct. Yes.

Q. Okay.
(Deposition Exhibit Number 28 was marked for identification.)
Q. (BY MR. TONER) I'll show you a document that's been marked as Exhibit 28. And is that a copy of a letter that you sent to the Environmental Quality Council relating to questions that had been asked by Dr. Hendrickx and Dr. Buchanan?
A. That's correct.
Q. And can you tell me what process the DEQ went through in order to prepare the answers to those questions?
A. Yes. As I recall, Mr. Ruby, I believe, brought us these questions and asked us to go over them and provide to the council our response to these. And it was a collaborative effort; primarily myself, Mr. DiRienzo and Mr. Thomas, and probably Mr. Waterstreet as well.
Q. What was Mr. Waterstreet's role?
A. Mr. Waterstreet is the -- in our water -- in our watershed program. His responsibility is with the water quality standards. It's a little confusing, so maybe I can give you a little background.
Q. Sure.
A. Mr. Bill DiRienzo was in that position until around 2005. At that time Mr. DiRienzo was transferred to head of our permitting section, and then Mr. Waterstreet came in

behind Mr. DiRienzo and took Mr. DiRienzo's old position.
The permitting and the water quality standards are very integrated. They have to -- they have to work together very, very closely. And so that's why you'll see Mr. DiRienzo and Mr. Waterstreet. They're both involved in this a lot, so . . . HERE?
Q. Okay. After receiving the report from Dr. Hendrickx and Dr. Buchanan, did you feel that there was any information that the DEQ should have given them but didn't?
A. As I mentioned earlier, I'm not sure that we've done a good job of framing the question. I'm afraid that there's confusion about back-calculating the background water quality data from soils data, and that that is where everybody's emphasis is when that's not really the question we need answered.
Q. Did the DEQ participate in formulating the question that Dr. Buchanan and Dr. Hendrickx were to answer?
A. I'm hesitating because I'm trying to remember just exactly if -- whether we had any involvement and if we had any involvement. And I believe Mr. Ruby may have sent us a draft of the scope of work that was the -- or the draft contract with the -- with the consultants, and we may have commented to Mr. Ruby about that. But I've got to admit, I don't remember for sure.

Q. Well, on Exhibit 14, which is the report from Dr. Hendrickx and Dr. Buchanan, on Page 2, they -- they outline the services to be provided by the contractor. And they set forth on Page 2 and the top of Page 3 two questions that they were supposed to answer. Did the DEQ participate in formulating those questions?
A. We definitely did not write these. But whether we commented on them or not, I can't tell you. But I'll also tell you this, and that is that even the way the ag use policy is currently crafted, I think it makes -- I think it's not clear that we're not trying to get to the background water quality in the receiving stream from the soils data. In other words, I don't think even in our ag use policy that we have done a good job of crafting the question.
Q. Do you know if the Environmental Quality Council changed the scope of work for Dr. Hendrickx and Dr. Buchanan after the DEQ comment?
A. Number one, I'm not even -- I'm not even positive that we did comment. And, number two, whether they did or not, I don't know.
Q. I would like to ask you some questions about this agricultural use protection policy, which is Exhibit 17. On Page 59 under the heading Tier 2 - Background Water Quality, it says: If sufficient data is available to demonstrate or

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calculate that the pre-existing background water quality at the points of diversion is worse than the effluent quality, EC and SAR effluent limits may be based upon those background conditions rather than tolerance values for the most sensitive crop.

So then it states there are two possible ways of doing that. One is measured data, and the other is calculated background, where you don't have the pre-discharge water quality data available.

And it says: In that event -- in the event that soil studies are used as a means to estimate baseline water quality for a given drainage, the following requirements apply.

So is it correct that in a Tier 2 situation where you don't have measured background quality that you then try to back-calculate the baseline water quality based on soil samples?

A. That's what it says. And like I said, that's where I've -- I think we've -- I think we need to craft this better. Because I -- that's not what we're trying to get to. We're not trying to get to what the background water quality is. We're trying to get to what should the effluent limits be and what is safe water to apply to the land through irrigation.

Q. But, in fact, that is the methodology that is being

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followed. Your permit writers are back-calculating to come up with what they think is the background water quality.

A. No. What they're calculating is what's acceptable to put on the land.

Q. So you don't think that when your permit writers are doing this calculation based on soil samples and concentration factor that they're trying to determine what the baseline water quality is?

A. What they're -- what's in their mind, I can't say. But I -- I can tell you that what we're attempting to do is to ensure that the quality of water that we allow to be applied to the land is, number one, of a sufficient quality that we don't get degradation of the agricultural activity; in other words, no loss of productivity; but, number two, that we are not setting limits that are so stringent -- unnecessarily stringent so that the operator is spending money and resources treating when it's not necessary. So we're trying to do that balance.

Q. Where in the permit writing process is there a calculation of the expense to the operator of doing the treatment?

A. Well, there's -- there's not. But the statute is petty clear that when we -- when we develop standards, we have to take into account the reasonableness of the pollution and so on and so forth. In other words, it would

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be very easy for us to go out and write discharge permits -- everybody's got to put distilled water out the end of the pipe.

If we did that, we would be certain that we would be protected. But would it be reasonable? And so we have to balance those two.

Q. (BY MR. TONER) But the permit writers are not instructed to engage in that kind of a balancing, are they?

A. They're not instructed to look at the economics, but they are -- they are -- they need to be protective, but they -- they are also instructed not to be overprotective.

Q. Well, coming back to Exhibit 17 on Page 57 under the heading Establishing Effluent Limits, it says there: Tier 2 refers to a process whereby the default limits may be refined to equal background water quality conditions and is intended to be used in situations where the background EC and SAR is worse than the effluent quality.

Is that a correct statement when the Tier 2 process is to be used?

A. Let me read it again.

Q. Sure.

A. And maybe -- maybe read the whole paragraph in context. Yeah, I would -- I quibble somewhat when we start saying that we're trying to calculate the background water

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quality. I think a better way to phrase that would be something to the effect where we're attempting to calculate effluent limits that are protective of the lands.

Q. All right. How about that sentence, though, I asked you about? Is that an accurate description of when the Tier 2 process is to be used?

MR. CRANK: Object as to the form. You can answer if you can.

A. Well, what happens is an application comes in. And if a Tier 1 approach -- if the company cannot meet the Tier 1 limits, they really have two choices. They can treat to meet the Tier 1 limits, which are, of course, the most conservative limits.

They can conduct a Tier 2 analysis, which is basically look at the soil quality. Or I guess there's a third alternative, and that is try to cut a deal with a downstream landowner to, you know, apply poor quality water on that landowner's land.

So the Tier 2 approach is an attempt to look at what the quality of the soils are and ensure that we're not going to put water on those particular soils that are going to cause damage. But on the other hand, we're not going to put -- make the limits so stringent that we are unnecessarily restricting the operator.

Q. (BY MR. TONER) Okay. Well, this sentence says:

Tier 2 is intended to be used in situations where the background EC and SAR is worse than the effluent quality.

Is that a correct statement of when the Tier 2 process is to be used?

MR. CRANK: Object as to the form of the question. You can answer if you can.

A. If you say if -- the background EC -- if you say the background EC and SAR in the soils, I would agree with it, yes.

Q. (BY MR. TONER) Well, wait a minute. You recognize there's a concentration factor, right?

A. You're going to have to be more clear.

Q. You realize that the -- there's an equation that the DEQ has been using about the salinity in the soil is equal to the salinity in the water times a concentration factor? You're aware of that, right?

A. Yes. Yes.

Q. So when you try to make a distinction about referring to the EC and the SAR in the soil being worse than the effluent quality, are you saying that the soil EC and the soil SAR has to be worse than the quality of the effluent water?

A. No.

Q. Okay.

A. Obviously, yeah, there's -- that calculation has to

take place, but --

Q. Well, were you aware that the DEQ in this particular permit used Tier 2 even though the SAR -- the background SAR was not worse than the effluent quality?

MR. CRANK: Object as to the form of the question. You can answer if you can.

A. I'm not familiar enough with this individual permit to answer that question.

Q. (BY MR. TONER) Now, you say you quibble a little bit about the use of the phrase "calculating background water" in the Tier 2. But if we look at Page 59 of the agricultural use protection under Paragraph a(2), it's headed Calculated Background, isn't it?

A. Let me make sure I'm with you. Page 59?

Q. Yes.

A. Item A?

Q. Subparagraph 2. The heading on that is Calculated Background, right?

A. I'm aware of what it says. It doesn't necessarily mean that I completely agree with it.

Q. But that's what your permit writers are doing, isn't it?

A. Again, what they're doing is they're calculating numbers on effluent quality that is protective of the soils.

I think it's -- I think it's mistaken to say that

we are back-calculating to background water quality.

Q. Maybe I'm being particularly dense. What does the phrase "calculated background" mean then in this agricultural use policy?

A. What I'm telling you is the way we have written this ag use policy, I believe, needs to be refined. Because I don't -- I don't think it adequately or accurately reflects what we're really doing.

Q. And has your position about the agricultural use protection policy not accurately reflecting what the permit writers are doing been communicated to the Environmental Quality Council?

A. No.

Q. Mr. Wagner, let me just take a few minutes on my notes, and I might be done with you here.

(Deposition Exhibit Number 29 was marked for identification.)

Q. (BY MR. TONER) I'll hand you a document that's been marked as Exhibit 29. And can you tell me what this is and how it was created?

A. The Environmental Quality Council had -- as is typical, asked the department to review the comments that come in on a proposed set of rules. And this is our review and comment on those -- or our analysis of those comments.

Q. Who created this analysis?

A. David Waterstreet was the primary person that answered this. He undoubtedly got some help from Mr. DiRienzo probably, and probably Mr. Thomas as well.

Q. Did you review this exhibit before it was submitted?

A. I may have reviewed pieces of it, but I don't believe I reviewed the whole document.

Q. And was this exhibit provided to the Environmental Quality Council?

A. To the best of my knowledge it was, yes.

MR. TONER: That's all I have. Thank you.

MR. BURBRIDGE: I have no questions.

MR. CRANK: I have no questions.

(Deposition proceedings concluded 2:06 p.m., June 17, 2009.)

DEPONENT CERTIFICATE

I, JOHN WAGNER, do hereby certify that I have read the foregoing transcript of my testimony given on June 17, 2009, and that the same is a full, true and correct record of my deposition.

____

JOHN WAGNER

( ) No changes ( ) Changes attached

Subscribed and sworn to before me this _____ day of ____________________, 2009.

____

Notary Public

My commission expires: ________________

CERTIFICATE

I, MARGIE R. DAUSTER, a Registered Professional Reporter, Certified Realtime Reporter, and a Notary Public of the State of Colorado, do hereby certify that the aforementioned witness was by me first duly sworn to testify to the truth, the whole truth, and nothing but the truth;

That the foregoing transcript is a true record of the testimony given by said witness, together with all other proceedings herein contained.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my Notarial Seal this 26th day of June, 2009.

Margie R. Dauster

____

MARGIE R. DAUSTER
Registered Professional Reporter
Certified Realtime Reporter

My commission expires January 16, 2011.