MEMORANDUM

TO: Public Record for the 2006 Effluent Guidelines Program Plan
EPA Docket Number OW-2004-0032 (www.regulations.gov)

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SUBJECT: Review of Coal Bed Methane for the 2006 Effluent Guidelines Program Plan

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Overview

The purpose of this memorandum is to analyze the Coal Bed Methane industry using the four factors identified in the draft *Strategy for National Clean Water Industrial Regulations* (see 29 November 2002; 67 FR 71165). This memorandum is divided into five sections: one for process description and four for each of the four factors.

I. Description of CWA Section 304(m) Review

EPA reviewed the effluent guidelines for the existing 56 industrial point source categories to determine whether any of these effluent guidelines apply to the CBM industrial sector. In particular, EPA reviewed the applicability of two point source categories, Oil and Gas Extraction category (40 CFR Part 435) and Coal Mining Point Source Category (40 CFR 434). As discussed below, EPA determined that the CBM industry is not now regulated by effluent guidelines.

EPA did not consider CBM production in developing the 1979 national technology-based effluent limitations guidelines for the Onshore and Agricultural and Wildlife Water Use subcategories of the Oil and Gas Extraction category (40 CFR Part 435, Subparts C and E) because there was no significant CBM production in 1979.[1] Additionally, EPA did not consider CBM production in developing the Coal Mining effluent guidelines. EPA established effluent guidelines for coal mine operations based on the use of the "best practicable control technology currently available" (BPT) for existing sources in the Coal Mining Point Source Category (40 CFR 434) on 26 April 1977 (42 FR 21380). These effluent guidelines were revised on 9 October 1985 (50 FR 41296). More recently, EPA revised these ELGs again on 23 January 2002 (67 FR 3370) by adding two new subcategories to address pre-existing discharges at coal remining operations and drainage from coal mining reclamation and other non-process areas in the arid and semi-arid western United States. None of these coal mining rulemakings considered coalbed methane extraction in any of the supporting analyses or records.

[1] Letter from Thomas P. O'Farrell, EPA's Industrial Technology Division, to Constance B. Harriman, Steptoe & Johnson. 1 June 1989. OW-2003-0074, DCN 01191.

To determine whether to review this industrial sector as part of the CWA section 304(m)(1)(A) review or CWA section 304(m)(1)(B) review (i.e., reviewing this industrial sector as a new subcategory of an existing point source category or as a new industrial point source category), EPA reviewed the effluent guidelines for the existing 56 industrial point source categories. EPA generally groups together industry sectors that manufacture similar products or services into point source categories. Within each point source category, EPA generally separates industry sectors into subcategories based on the industrial process and other factors that influence the characteristics of wastewater pollutants and available and affordable treatment technology.

CBM extraction involves industrial operations similar to those performed by facilities subject to the effluent guidelines for Oil and Gas Extraction (40 CFR 435) (i.e., drilling for natural gas extraction which generates produced waters). Consequently, EPA reviewed the Oil and Gas Extraction category to determine whether it may be appropriate to revise its applicability to include limits for CBM extraction (i.e., EPA included this industrial sector in its CWA section 304(m)(1)(A) review for the 2006 Plan.) EPA's assessment to view the CBM industrial sector as producing the same product (natural gas) as conventional natural gas exploration is shared by the Supreme Court's finding that extraction of CBM can be viewed as drilling for natural gas and not coal mining. See Amoco Production Co. v. Southern Ute Indian Tribe, 119 S.Ct. 1719 (1999). ("To the extent Congress had an awareness of [CBM extraction], there is every reason to think it viewed the extraction of CBM gas as drilling for natural gas, not mining coal.").

As discussed in Section 6 of the *Technical Support Document for the 2006 Effluent Guidelines Program Plan*, EPA-821-R-06-018, DCN 3402, EPA currently considers that the CBM industry should be considered a separate subcategory rather than as a part of the onshore oil and gas industry. The following discussion identifies how EPA evaluated the discharges from this industrial sector against the four factors EPA uses in its review of discharges from existing industrial point source categories.

II. Amount and Toxicity of the Pollutants in an Industrial Category's Discharge (Factor 1)

CBM extraction requires removal of large amounts of water from underground coal seams before CBM can be released. CBM wells have a distinctive production history characterized by an early stage when large amounts of water are produced to reduce reservoir pressure which in turn encourages release of gas; a stable stage when quantities of produced gas increase as the quantities of produced water decrease; and, a late stage when the amount of gas produced declines and water production remains low (see DCN 03070). The quantity and quality of water that is produced in association with CBM development will vary from basin to basin, within a particular basin, from coal seam to coal seam, and over the lifetime of a CBM well. For example, CBM produced water volumes range from 1,000 to 17,000 gal/day-well in the San Juan and Powder River Basins, respectively (see DCN 3402). Currently there are approximately 28,000 CBM producing wells in the Nation (see DCN 3402).

Pollutants often found in these wastewaters include chloride, sodium, sulfate, bicarbonate, fluoride, iron, barium, magnesium, ammonia, and arsenic. Total dissolved solids (TDS) and electrical conductivity (EC) are bulk parameters for quantifying the total amount of dissolved solids in a wastewater and also used to quantify the amount of pollutants in CBM produced waters (see DCN 03159 and 3297). All of these parameters can potentially cause environmental impacts as well as affect potential beneficial uses of CBM produced water. The following are typical ranges of TDS concentrations reported in the major CBM basins:

- San Juan Basin, Colorado and New Mexico: 15,000 mg/L;
- Raton Basin, Colorado and New Mexico: 310 to 3,349 mg/L;
- Piceance Basin, Colorado: 1,000 to 6,000 mg/L;
- Powder River Basin, Montana and Wyoming: 244 to 8,000 mg/L, with values up to 50,000 mg/L;
- Wind River Basin, Wyoming: 2,000 to 11,000 mg/L;
- Green River Basin, Wyoming: 10,000 mg/L and above;
- Uinta Basin, Utah: 1,000 to 5,000 mg/L;
- Black Warrior Basin, Alabama: 10,000 mg/L and above; and
- Central Appalachian Basin: 30,000 mg/L (central Appalachian basin) (see DCN 3402 and 3489).

Equally important in preventing environmental damage is controlling the sodicity of the CBM produced waters. Sodicity is often quantified as the sodium adsorption ratio (SAR), which is expressed as the ratio of sodium ions to calcium and magnesium ions, and is an important factor in controlling the produced water's suitability for irrigation and its potential for degrading soils (see DCN 3156, 3272, 3273, 3274, 3066). The higher the SAR value the greater the potential for adverse environmental impacts including impacts to agricultural lands, which when degraded can negatively affect water quality.

Generally, SAR values greater than 6 have an increasing potential to cause riparian soil damage with a decreasing ability for use in agriculture. For example, the mean SAR levels of CBM produced waters in the Powder River Basin range from 34 to 51 (see DCN 2491). The Montana Department of Environmental Quality (MDEQ), in a Final Environmental Impact Statement analyzing CBM extraction, warns that “clayey” soil, like that in the Tongue River Valley, is vulnerable to damage from high SAR water (see DCN 3148).

Impacts to surface water from discharges of CBM produced waters can be severe depending upon the quality of the CBM produced waters. Saline discharges have variable effects depending on the biology of the receiving stream. Some waterbodies and watersheds may be able to absorb the discharged water while others are sensitive to large amounts of low-quality CBM water. For example, large surface waters with sufficient dilution capacity or marine waters are less sensitive to saline discharges than freshwater surface waters. Discharge of these CBM produced waters may also cause erosion and in some cases irreversible soil damage from elevated TDS concentrations and SAR values. This may limit future agricultural and livestock uses of the water and watershed. For example, the MDEQ FEIS cautioned that unregulated discharge of CBM water would cause “[s]urface water quality in some watersheds [to] be slightly to severely degraded, resulting in restricted downstream use of some waters," (see DCN 3148).

Salinization and sodication may adversely impact native soils by creating seals or crusts on the soil surface that reduce soil permeability. Native vegetation would be adversely impacted by changes in the soil structure that make water less available to native plants and more salt-tolerant species may replace native salt intolerant species. Irrigated crops and land may be adversely affected by changes in the soil structure that inhibit or kill crops or by loss of agricultural soil resulting from increased runoff and erosion (see 3069, 3066, 3067, 3272, 3273, 3274). Soils with high clay content, especially the smectite clays (e.g., montmorillonitic clays) and vermiculite clays, or soils with poor drainage are most vulnerable to these impacts (see DCN 3272). Waters with TDS over 500 mg/L and SARs over 6 have decreased utility for cropland irrigation and an increased potential for degrading soils (see DCN 3064). Also, irrigation requirements and environmental protection may require more stringent controls on SAR in CBM produced waters at the point of discharge. Elevated concentrations of bicarbonate in CBM produced waters (e.g., Powder River Basin) can lead to precipitation of calcite after the point of discharge. This precipitation reduces the concentration of dissolved calcium ions and increases the SAR of CBM produced waters after the point of discharge (see DCN 3031). Disposal of the quantities of CBM produced water into stream channels and on the landscape can poses a risk to the health and condition of existing riparian and wetland areas. High salinity and sodium levels in CBM produced water can alter riparian and wetland plant communities and cause replacement of salt intolerant species with more salt tolerant species. For example, in the Powder River Basin salt tolerant species (e.g., salt cedar, Russian olive, leafy spurge, slew grass) are replacing salt intolerant species due to the enhanced saline conditions from CBM discharges (see DCN 3066, 3067, 3204).

Aquatic communities can be adversely impacted (e.g., decrease in species diversity, density) by the constituents in CBM produced waters (e.g., TDS, bicarbonate, chloride, metals, organics) (see DCN 3063, 3071, 3072). CBM discharges may adversely impact water quality and aquatic organisms. For example, soil colloids suspended in runoff may sorb and mobilize metals, soil nutrients, pesticides and other organic contaminants[2]. Also, the ions that compose TDS (e.g., chloride) can be toxic to freshwater organisms if present in sufficiently high concentrations (see DCN 3135, 3136, 3208, 3555, 3424). Some macroinvertebrates in freshwater systems appear to be quite sensitive to increasing TDS concentrations. Sensitivity will vary with the species of aquatic organism and the ionic composition of the TDS. As in-stream TDS concentrations increase, sensitive aquatic species are eliminated while more TDS-tolerant species increase in abundance. Thus, while the overall abundance of macroinvertebrates may not change, the diversity, or taxa richness, of the aquatic community may change.

There is very limited discharge monitoring information in PCS and TRI for this industrial sector. Consequently, EPA estimated pollutant discharge estimates for this industrial sector from projected CBM produced water volumes and pollutant concentrations (see EPA-HQ-OW-2003-0074-0489). EPA used this information in the current effluent guidelines review.

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[2] See Sumner, ME and R. Naidu. 1998. Sodic Soils: Distribution, Properties, Management, and Environmental Consequences. Oxford University Press.

III. Available Technology, Process Change, or Pollution Prevention Options (Factor 2)

Available options for disposal include discharge to land or surface water bodies, re-injection, or one of many beneficial use options (e.g., stock watering, irrigation). Treatment options for removal of pollutants include counter-current ion exchange, ultrafiltration, and reverse osmosis.

Injection wells, which require suitable formations for disposal, are the preferred method of disposal in the San Juan Basin and central Appalachian basin (see DCN 3451, 3478), whereas discharge into surface streams, after treatment in ponds to meet water-quality regulations, occurs in the Black Warrior basin (see DCN 3402, 3451). Direct discharge of CBM produced waters also occurs in the Powder River, Raton, and Wind River basins. EPA evaluated and estimated costs associated with some of the major technology options for CBM produced waters in the 2004 Plan Technical Support Document (see EPA-HQ-OW-2003-0074-1346 through 1352) and used this information in the current effluent guidelines review. For example, EPA estimated CBM produced water treatment costs for various sizes of CBM projects. These unit CBM produced water treatment costs range from $0.10 to $1 per barrel of produced water for treatment (reverse osmosis, counter-current ion exchange) and surface discharge (TDS target of 500 mg/L) to $0.13 to $1.23 per barrel of produced water for zero discharge (storage ponds/impoundments, re-injection disposal) (see DCN 3402).

Piping costs for transferring CBM produced water are a significant portion of the produced water management costs and is required regardless of disposal method to transport the produced water to the disposal location. In general, there is an inverse relationship between the cost per barrel treatment costs for CBM produced water and the size of the CBM project. The collection of produced water from multiple CBM wells decreases the treatment costs for CBM produced water. Consequently, it is much easier to plan and minimize piping costs for new and larger CBM projects with treatment than to retro-fit existing CBM projects with multiple outfall locations.

IV. Affordability Or Economic Achievability Of The Technology, Process Change, Or Pollution Prevention Options (Factor 3)

The CBM industrial sector is a newly growing part of the Nation’s domestic source of natural gas. For example, only 5% of WY CBM reserves have been produced (see DCN 3402). EIA expects CBM production to grow from the current production of 1.7 TCF/yr (2004) to 8.1 TCF/yr (2015) and 9.1 TCF/yr (2025) (see DCN 3402). Based on BLM and States projections this will likely increase the current estimated 28,000 CBM wells to over 100,000 CBM wells (see DCN 3402). The growth in the CBM industrial sector can be explained by the decrease in drilling and transmission costs in getting the CBM to market, clarity of gas ownership, and the increase of long-term natural gas prices.

New techniques for CBM well completions were developed in 1997 and significantly reduced drilling costs, which increased the profitability of CBM drilling (see DCN 3486). Transmission infrastructure has also recently been installed, which increases the potential profitability of CBM wells. Lower transmission costs may spur CBM development as they more closely align the CBM well head price (amount realized by the CBM operator) with the market price of natural gas (amount realized by the natural gas distributor to end-users). For example, installation of the 24-inch, 110 mile Fort Union Pipeline, 24-inch, 63 mile Fort Union Expansion, and other major pipelines in the Powder River Basin helped promote CBM production (see DCN 02991). More recently, the schedule of a 1,323-mile, $3 billion, natural-gas pipeline from Wyoming to Ohio was announced with construction expected to start in spring 2007 (see DCN 3582). This will likely further encourage CBM production due to lower transmission costs in getting gas to additional markets.

The profitability of the CBM industry also increased in 1999 after a U.S. Supreme Court decision favorable to CBM production (see DCN 3486). See Amoco Production Co. v. Southern Ute Indian Tribe, 119 S.Ct. 1719 (1999). This decision clarified that methane in coal seams is not part of the coal and is not subject to coal royalty payments .The reduction in royalty payments has resulted in increased profitability for CBM projects.

Finally, another major factor spurring CBM development is the long-term price of natural gas. EIA does not expect the price of natural gas to return to historic levels in the $2/MMBtu range . EIA predicts that natural gas will range from $4 to $6/MMBtu in 2004 dollars over the next 25 years (see DCN 3414). This doubling or tripling in natural gas prices over historic long-term averages will likely spur operators to explore new CBM development across the Nation. Areas previously unexplored may see a renewed interest in development due to the profitability of CBM projects.

V. Implementation and Efficiency Considerations (Factor 4)

As previously discussed, EPA determined that the CBM industry is not now regulated by effluent guidelines. In the absence of applicable effluent guidelines for the discharge or pollutant, technology-based limitations are determined by the permit writer on a case-by-case basis, in accordance with the statutory factors specified in CWA §§ 301(b)(2) and 304(b), 33 U.S.C. §§ 1311(b)(2), (3), 1314(b), 1342(a)(1). These site-specific, technology-based effluent limitations reflect the best professional judgment (BPJ) of the permit writer under 40 CFR 125.3(c)(2) taking into account the same statutory factors EPA would use in promulgating a national categorical rule, but considering unique factors relating to the applicant.

Currently there exists a patchwork of regulatory controls for CBM produced waters that vary from State to State and permit to permit (see DCN 3204, 3205, 04079). This inconsistent regulatory framework may contribute to significant delays in and suppression of some CBM production. For example, "after a decade of steady growth in the number of CBM wells and CBM gas production in the Powder River Basin (including dramatic growth from 1998 to 2003), production dropped about 5% from 2003 to 2004…[A]ccording to industry representatives, this reduction was apparently due in part to difficulties in managing and disposing of CBM [produced] water. Partly as a consequence of these difficulties, industry is now considering other disposal options including injection and more expensive water treatment methods. But if difficulties in disposing and/or permitting CBM [produced] water discharges were, in fact, the root causes of reduced production in 2004, additional acceptable options for managing the water will be needed or production may continue to level off or decline." (see DCN 3486).