



**Public Comment and  
Response Summary  
for the Study on the Potential  
Impacts of Hydraulic Fracturing  
of Coalbed Methane Wells on  
Underground Sources of  
Drinking Water**

**FINAL**

**Office of Water**  
**Office of Ground Water and Drinking Water (4606M)**  
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**June 2004**

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United States Environmental Protection Agency  
Office of Water  
Office of Ground Water and Drinking Water  
Drinking Water Protection Division  
Prevention Branch  
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## LIST OF ACRONYMS AND ABBREVIATIONS

BLM	Bureau of Land Management
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CBM	Coalbed Methane
CCL	Contaminant Candidate List
CFR	Code of Federal Regulations
COGCC	Colorado Oil and Gas Conservation Commission
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency or Agency
FR	Federal Register
GWPC	Ground Water Protection Council
MCL	Maximum Contaminant Level
MOA	Memorandum of Agreement
MSDS	Material Safety Data Sheet
MTBE	Methyl Tert Butyl Ether
NAS	National Academy of Science
PWS	Public Water System
RfD	Reference Dose
SDWA	Safe Drinking Water Act
UCMR	Unregulated Contaminant Monitoring Regulation
UIC	Underground Injection Control Program
USDW	Underground Source of Drinking Water

# **Public Comment and Response Summary for the Study on the Potential Impacts of Hydraulic Fracturing of Coalbed Methane Wells on Underground Sources of Water**

## **I. INTRODUCTION**

The United States Environmental Protection Agency's (EPA's) Office of Ground Water and Drinking Water completed its Phase I study, which assesses the potential for contamination of underground sources of drinking water (USDWs) from the injection of hydraulic fracturing fluids into coalbed methane (CBM) wells. EPA (or the Agency) began collecting information on hydraulic fracturing in the fall of 2000. Based on the information collected and reviewed, EPA has concluded that the injection of hydraulic fracturing fluids into CBM wells poses little or no threat to USDWs and does not justify additional study at this time.

The draft report, titled, "Draft Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs" (hereafter referred to as the draft report), was made available for public comment by an announcement in the *Federal Register* on August 28, 2002.<sup>1</sup> The 60-day public comment period officially ended on October 28, 2002.

The Agency received and reviewed comments from 105 commenters. Several of these were signed by multiple parties (which were counted as one commenter), including a few coalitions of environmental organizations. The commenters include private citizens; environmental and citizen groups; government agencies at the local, state, and national levels; oil and gas companies; trade associations; and four other commenters that do not fit these categories. Table 1 below provides a listing of these commenters.

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<sup>1</sup> US Environmental Protection Agency. 2002. Underground Injection Control (UIC) Program; Hydraulic Fracturing of Coalbed Methane (CBM) Wells Report--Notice. *Federal Register*. Vol. 67, No. 167. p. 55249, August 28, 2002.

<b>TABLE 1: LIST OF PUBLIC COMMENTERS</b>		
<b>Docket ID<sup>1</sup></b>	<b>EdoCKET ID (OW-2001-0002)<sup>2</sup></b>	<b>Organization (State)</b>
<b>Environmental/Citizens Groups</b>		
II-D1.014	045	Bull Mountain Landowners Association (MT)
II-D1.025	055	Land and Water Fund of the Rockies (CO)
II-D1.040	068	Dickenson County Citizens Committee (VA)
II-D1.046	074	Western Organization of Resource Councils and Coalition of 11 Other Environmental/Citizens Groups (DC)
II-D1.055	043	Coalition of 28 Environmental/Citizens Groups (varies)
II-D1.060	085	Oil & Gas Accountability Project and Coalition of 34 Other Environmental/Citizens Groups (CO)
II-D1.072	100	National Resources Defense Council (DC)
II-D1.101	139	San Juan Citizen's Alliance (CO)
II-D1.076; II-D2.001; II-D2.002	106 - 109	Kentucky Resources Council, Inc. (KY)
<b>Private Citizens</b>		
II-D1.004	033	Citizen (AK)
II-D1.050	031	Citizen (AL)
II-D1.012; II-D1.017	041; 048	Citizen (CA - 2)
II-D1.002; II-D1.003; II-D1.006; II-D1.008; II-D1.009; II-D1.011; II-D1.016; II-D1.018; II-D1.022; II-D1.023; II-D1.024; II-D1.026; II-D1.030; II-D1.031; II-D1.032; II-D1.034; II-D1.037; II-D1.038; II-D1.043; II-D1.044; II-D1.049; II-D1.058; II-D1.065; II-D1.067; II-D1.081; II-D1.083; II-D1.084; II-D1.085; II-D1.086; II-D1.087; II-D1.088; II-D1.089; II-D1.093; II-D1.095; II-D1.097; II-D1.099; II-D1.100; II-D1.102; II-D2.008	110; 032; 035; 037; 038; 040; 047; 049; 052; 053; 054; 056; 060; 061; 112; 128; 065; 066; 071; 072; 075; 083; 092; 094; 118; 120; 121; 122; 123; 124; 125; 126; 131; 133; 135; 137; 138; 140; 148	Citizen (CO - 39)
II-D1.015; II-D1.027; II-D1.029; II-D1.041; II-D1.098	046; 057; 059; 069; 136	Citizen (FL - 5)
II-D1.007	036	Citizen (KS)
II-D1.039; II-D1.048; II-D2.007	067; 030; 142	Citizen (MT - 3)
II-D1.005; II-D1.033; II-D1.051	034; 062; 076	Citizen (NM - 3)
II-D1.013; II-D1.019	044; 050	Citizen (NY - 2)
II-D1.042	070	Citizen (UT)
II-D1.028; II-D1.094	058; 132	Citizen (state unknown - 2)
<b>State/Local/Federal Agencies</b>		
II-D1.010	039	Sandia National Laboratories (NM)
II-D1.045	073	San Miguel County Board of Commissioners (CA)
II-D1.047	029	Alabama Oil and Gas Board (AL)
II-D1.057	082	State of New Mexico Energy, Minerals and Natural Resources Department (NM)
II-D1.059	084	Virginia Division of Gas and Oil (VA)
II-D1.061	086	Colorado Geological Survey (CO)
II-D1.062	087; 088	Michigan Department of Environmental Quality (MI)
II-D1.063	089	Pennsylvania Department of Conservation and Natural Resources (PA)
II-D1.064	090	State of Utah Department of Natural Resources, Division of Oil, Gas and Mining (UT)
II-D1.066	093	Alaska Oil and Gas Conservation Commission (AK)

<b>TABLE 1: LIST OF PUBLIC COMMENTERS</b>		
<b>Docket ID<sup>1</sup></b>	<b>Edocket ID (OW-2001-0002)<sup>2</sup></b>	<b>Organization (State)</b>
II-D1.068	095	State of South Dakota (SD)
II-D1.069	096	Ohio Department of Natural Resources (OH)
II-D1.073	101; 102	Conservation Division of the Kansas Corporation Commission (KS)
II-D1.079	116	State of Louisiana, Department of Natural Resources (LA)
II-D1.080	117	Colorado Oil & Gas Conservation Commission (CO)
II-D1.082	119	State of Missouri Department of Natural Resources, Geological Survey & Resource Assessment Division (MO)
II-D1.092	130	Indiana Department of Natural Resources, Division of Oil and Gas (IN)
II-D1.096	134	State of Oklahoma, Office of the Secretary of Energy (OK)
II-D1.103	147	Delta County Commissioners (CO)
II-D2.006	141	Office of Fossil Energy, Department of Energy (DC)
II-D2.009	149	Ohio Department of Natural Resources, Division of Mineral Resources Management (OH)
<b>Oil and Gas Companies</b>		
II-D1.070	097	Halliburton Energy Services (TX)
II-D1.075	105	Chevron Texaco North American Upstream (TX)
II-D1.090	127	Shell Exploration & Production Company (TX)
<b>Trade Associations</b>		
II-D1.035	113	Domestic Petroleum Council (DC)
II-D1.036	064	Independent Petroleum Association (DC)
II-D1.052	077	Interstate Oil and Gas Compact Commission (OK)
II-D1.053	080	Independent Oil & Gas Association of West Virginia (WV)
II-D1.054	042	Coalbed Methane Association of Alabama (AL)
II-D1.056	081	Oklahoma Independent Petroleum Association (OK)
II-D1.071	099	Ground Water Protection Council (OK)
II-D1.074	104	American Petroleum Institute (DC)
<b>Other</b>		
II-D1.020	051	Pace Law School (NY)
II-D1.021	111	University of Montana, Montana Bureau of Mines and Geology, Montana Tech (MT)
II-D1.077	114	Steven Harper, Attorney at Law (CO)
II-D1.078	129	Hansen Environmental Consultants (WA)
<p><sup>1</sup> Docket Identification numbers are assigned by the Water Docket in order to track each public comment with a unique identification number. Note that if a comment has a prefix of "II-D2," it indicates that the comment was received after the October 28, 2002 comment deadline. Comments with the following docket logs were updates, repeats, or clarifications of other comments: II-D1.91; II-D2.03; II-D2.04; and II-D2.05.</p> <p><sup>2</sup> An electronic version of each public comment is available through EPA's electronic public docket and comment system, EPA Dockets at <a href="http://www.epa.gov/edocket/">http://www.epa.gov/edocket/</a>. Each comment begins with the prefix "OW-2001-0002-". Edocket numbers were assigned to comment materials, as well as other relevant background documents in the order they were posted to the edocket Web site.</p>		

The remainder of this document contains summaries of the major public comments and EPA's responses related to the Agency's August 2002 report. The document is divided into seven other major sections as follows:

- **Section II: Scope of the Study** discusses public comments and EPA's responses on areas not included in the study, the literature used for the review, the number of coal basins included in the study, citizen complaints regarding water well contamination, and the peer review panel who reviewed the initial draft of the report.
- **Section III: Fracturing Fluids** describes public comments and EPA's responses related to the components of fracturing fluids, EPA's comparison of the concentration of fracturing fluid constituents to maximum contaminant levels (MCLs), EPA's estimates for the concentrations of fracturing fluid chemicals at the point-of-injection and the edge of the fracture zone, the amount of fracturing fluids that is recovered from CBM reservoirs, the amount of fracturing fluids used in hydraulic fracturing procedures, and the movement of "stranded" fluids in the coalbed formations.
- **Section IV: Fracture Behavior and Practices** discusses comments raised and EPA's responses to these comments regarding fracture growth, multiple fracturing of the same well, the relationship of drinking water wells to hydraulic fracturing activities, and differences in state geology.
- **Section V: Regulation of Hydraulic Fracturing Practices** describes comments and the Agency's responses regarding the states' authority over hydraulic fracturing practices, and the regulation of hydraulic fracturing under the Safe Drinking Water Act (SDWA).
- **Section VI: Language Used in the Report** summarizes specific comments and the Agency's responses related to the use of the term "USDW" in the report, use of scientific terms, and the tone of the language in the report.
- **Section VII: Chapter-Specific Comments** describes comments and the Agency's response regarding the glossary, executive summary, and Chapters 1 through 7 that were not already covered under Sections II through VI of this document.
- **Section VIII: Basin Descriptions** describes comments that pertain to the basin-specific descriptions in Attachments 1 through 11 of the report and EPA's response to these comments. The comments and responses in Section VIII do not include comments that were already discussed in Sections II through VII of this document.

## II. SCOPE OF THE STUDY

### A. Areas Not Included in the Review

#### 1. Focus of the Report

Summary of Comments: One commenter indicated that the report should have focused on the possible impacts to human health instead of the hydraulic fracturing process. This commenter added that Chapter 4 of the report should have focused on dose-response curves and not on the properties of hydraulic fracturing fluids. The commenter also stated that EPA should have been able to conduct this analysis because the Agency should have access to research conducted on the toxicity of all constituents used in CBM production.

Another commenter stated that the study did not address the uncertainty in the risk assessment due to omissions and errors in the data used for the study. This commenter indicated that some of the reasons for these omissions and errors could be inadequate reporting by private well owners and counties, inadequate testing, and inadequate enforcement which would result in an underassessment of risk. This commenter also indicated that the report does not address risk resulting from deviations and failures in drilling, fracturing, and monitoring practices, especially for newer wells, or sufficiently address the testing error for volatile chemicals used in hydraulic fracturing.

EPA Response: The Phase I study was not intended to be a risk assessment, but rather, to be a fact-finding effort based primarily on existing literature to assess the potential threat to USDWs from the injection of hydraulic fracturing fluids into CBM wells and to determine based on these findings, whether additional study is warranted. The study is tightly focused on hydraulic fracturing of CBM wells and does not include other aspects of drilling or CBM production. EPA reviewed water quality incidents potentially associated with hydraulic fracturing, as well as evaluated the theoretical potential for hydraulic fracturing to affect USDWs. EPA researched over 200 peer-reviewed publications, interviewed approximately 50 employees from industry and state or local government agencies, and communicated with approximately 40 citizens and groups who are concerned that CBM production affected their drinking water wells.

For the purposes of this study, EPA assessed USDWs impacts by the presence or absence of documented drinking water well contamination cases caused by CBM hydraulic fracturing, clear and immediate contamination threats to drinking water wells from CBM hydraulic fracturing, and the potential for CBM hydraulic fracturing to result in USDW contamination based on two possible mechanisms described below.

1. Direct injection of fracturing fluids into a USDW in which the coal is located, or injection of fracturing fluids into a coal seam that is already in hydraulic communication with a USDW (e.g., through a natural fracture system).
2. Creation of a hydraulic connection between the coalbed formation and an adjacent USDW.

EPA's report includes a discussion of the types of fracturing fluids and additives, and fluid volumes that may be used in hydraulic fracturing operations. This discussion is intended to

provide further background on the hydraulic fracturing process. In addition, the study provides a review of the fate and transport of injected fluids in the subsurface in order to determine whether a detailed risk assessment is warranted.

## *2. Monitoring*

Summary of Comments: Several commenters questioned how EPA could decide whether hydraulic fracturing poses a risk to USDWs without collecting or reviewing monitoring data. Several commenters wanted EPA to proceed to Phase II of the study and to install monitoring wells in areas where hydraulic fracturing of CBM wells was occurring. One commenter recommended that, at a minimum, EPA identify whether any type of monitoring has been conducted by consulting firms, local or state agencies, or members of the academic community, and if this monitoring exists, to include the results in the report.

Another commenter recommended that EPA, in cooperation with the National Academy of Science (NAS), conduct unannounced inspections of hydraulic fracturing projects in order to collect samples of hydraulic fracturing fluids, and observe and measure the total volume of injected hydraulic fracturing fluid. This commenter also recommended that EPA establish reference doses (RfDs) and MCLs for all chemicals currently used in hydraulic fracturing fluids in significant volumes.

EPA Response: EPA has researched and reviewed a variety of monitoring information that may be related to the issue of possible conduits for fracturing fluid transport into USDWs. These data are discussed in Chapter 6 of the report. For example, EPA reviewed a 1999 Bureau of Land Management (BLM) report which focused on monitoring and data interpretation of methane concentrations in groundwater in the San Juan Basin area. EPA reviewed this report to determine if it contained information pertaining to hydraulic fracturing of CBM and its impacts, if any, to the quality of water in drinking water aquifers in this basin.

Chapter 6 of the report provides a detailed discussion of citizen complaints and state responses to their concerns. Complaints were responded to by various state agencies, and many of those responses included testing of water for contaminants. For example, the Virginia Department of Mines, Minerals and Energy is responsible for: responding to environmental issues associated with oil and gas development (including CBM); investigating all reported water problems; and testing water samples for contaminants that may be introduced by drilling (such as chlorides, oil and grease, and volatile organics).

EPA disagrees that monitoring data is needed to determine whether a Phase II study is warranted. As discussed in the previous response, EPA conducted an extensive literature review, conducted numerous interviews, reviewed water quality incidents potentially associated with hydraulic fracturing, and evaluated the theoretical potential for hydraulic fracturing to affect USDWs. EPA's decision that the injection of hydraulic fracturing fluids into CBM wells poses little or no threat to USDWs and does not justify additional study at this time is consistent with the process outlined in the April, 2001 Final Study Design. In its final study design, EPA indicated that the Agency would make a determination regarding whether further investigation was needed after analyzing the Phase I information.

EPA has recently taken a specific and important measure to address one of the primary concerns regarding hydraulic fracturing fluid – the use of diesel fuel. During EPA's research, the Agency realized that diesel is sometimes used a component of fracturing fluids and is of specific concern because it contains BTEX compounds (benzene, toluene, ethylbenzene, and xylenes) for which MCLs have been established under SDWA. Because of the potential problem diesel can cause, EPA requested its removal from hydraulic fracturing fluids. On December 15, 2003, EPA entered into a Memorandum of Agreement (MOA) with three major service companies – BJ Services Company, Halliburton Energy Services, Inc., and Schlumberger Technology Corporation – to voluntarily eliminate diesel fuel from hydraulic fracturing fluids that are injected directly into USDWs for CBM production. If necessary, these companies will select replacements that will not cause hydraulic fracturing fluids to endanger USDWs. Industry representatives estimate that these three companies conduct an estimated 95 percent of the hydraulic fracturing projects in the United States. These three have indicated to EPA that they no longer use diesel fuel as a hydraulic fracturing fluid additive when injecting into USDWs.

EPA, through its Underground Injection Control (UIC) Program, as authorized under SDWA Part C, Sections 1421-1426), is responsible for ensuring that fluids injected into the ground do not endanger USDWs or cause a public water system (PWS) to violate its drinking water standards due to the contamination of a USDW by these injected fluids. Most states have primary enforcement authority (primacy) for implementation of the UIC Program, and thus have the authority under SDWA to place controls on any injection activities that may threaten USDWs. 40 CFR 145.12, Requirements for Compliance Evaluation Programs, requires that authorized states have programs for periodic inspections of injection operations. States may also have additional authorities by which they can regulate hydraulic fracturing. While surprise inspections are not specifically mandated, state programs have a responsibility to conduct inspections, as necessary, to determine compliance with permit conditions, and to verify the accuracy of monitoring data and other information. EPA requires that all UIC inspectors be certified in, and that inspectors be knowledgeable about, proper operation of injection facilities, protection of USDWs, and SDWA requirements.

Regarding the establishment of RfDs and MCLs for all hydraulic fracturing fluid chemicals used in significant volumes, EPA follows an established procedure for identifying the contaminants for which these standards will be set. The Contaminant Candidate List (CCL) and the Unregulated Contaminant Monitoring Regulation (UCMR) are the primary review mechanisms by which EPA identifies drinking water contaminants which pose the most urgent threat to public health. The CCL process uses the best available information on contaminants of concern and emerging contaminants to prioritize according to potential public health threat, and identify candidates for possible regulation. The UCMR provides occurrence information for determining human exposure, establishing the baseline for health effects and economic analyses, contaminant co-occurrence analyses, and treatment technology evaluation (related to the CCL contaminants). After identifying the top priorities for regulatory determination, EPA begins the process of determining RfDs and associated enforceable standards for protection of public health.

### *3. Use of Modeling Results*

Summary of Comments: One commenter recommended that EPA compare the results of hydraulic fracturing after the process to "modeling" conducted before the process to "provide some degree of predictability of the impact of the fracturing before the actual work is done."

This commenter also recommended that any modeling should consider the effect of other existing activities and conditions that could affect the outcome of the model (e.g., existing oil and gas wells, water wells, location and type of surface structures). This commenter also stated that consideration of the impact of these "man induced activities and conditions" should be an integral part of any fracture program and of any analysis of CBM fracturing impact. This commenter stated that the fracturing process and fluids alone may not cause "harm" within the study's parameters, but when coupled with the existing "man induced conditions" could cause "considerable damage and risk."

EPA Response: As discussed in Chapter 3 of the report, operators use a number of techniques to estimate fracture dimensions to design fracture stimulation treatments. Operators have a financial incentive to keep the hydraulically induced fracture generally within the target coal zone, so that expenditures on hydraulic horsepower, fracturing fluids, and proppants are minimized. For precise and statistically reliable measurements, however, fracture height and length can be measured (as opposed to modeled) accurately by microseismic monitoring. Tiltmeter measurements can also provide fracture height and length measurements somewhat accurately. The results of hydraulic fracturing "after the process" have also been investigated in the mined-through studies by the U.S. Bureau of Mines and others. These studies provide important, directly-measured characteristics of hydraulic fracturing in coal seams and surrounding strata. In addition, paint tracer studies conducted as part of mined-through studies can provide lower bound estimates on the extent of fluid movement.

During its analysis of the threat of CBM fracturing practices on USDWs, EPA considered the impact of human activities (such as improperly sealed or abandoned wells). Chapter 6 of the report summarizes citizen complaints and resulting investigations by state agencies into possible impacts of hydraulic fracturing on drinking water wells and surface waters. In some cases, improperly sealed gas wells have been remediated, resulting in decreased concentrations of methane in drinking water wells.

## **B. Literature Used for the Study**

Summary of Comments: Some commenters indicated that the literature used for the study was outdated. Another commenter questioned whether the search terms that the Agency used to find references for the report would locate "health-related" literature. This commenter also questioned whether the acronym "USDW" and/or "underground sources of drinking water" was used as a search term. Another commenter stated that the report was "simply a compilation of existing data, with no new information, references, or conclusions."

EPA Response: The search terms used by the Agency did not include health-related terms because the study's goals did not include conducting a human-health risk assessment or conducting a new investigation into the toxicity of any of the components of hydraulic fracturing fluids.

As stated in the study design (66 FR 39396)<sup>2</sup>, EPA focused the study on a review of existing data. EPA's literature search included publications and documents that were publically available as of December 2000/January 2001. EPA reviewed over 200 peer-reviewed publications. Much of the appropriate literature comes from the mid-1990s when funding was available for this kind of research. EPA also reviewed additional studies recommended by commenters and the peer review panelists, and incorporated information from these documents into the study, when appropriate. Further, EPA obtained information for the study through interviews with approximately 50 employees from industry and state or local government agencies, and communication with approximately 40 citizens and groups who are concerned that CBM production affected their drinking water wells.

### **C. Basins Included in the Study**

Summary of Comments: One commenter questioned why EPA's report only included 11 basins. This commenter indicated that there are 16 separate basins considered to have CBM resources in the lower 48 states. Further, the commenter stated that the Illinois Basin, which was not discussed in the study, is a major coal-bearing region in the central Midwest.

EPA Response: EPA's literature search did not find any CBM activity or hydraulic fracturing in the Illinois Basin. Other basins which have little or no current CBM production activity (e.g., Alaska) were also omitted from the study.

### **D. Citizen Complaints/Instances of Water Well Contamination**

Summary of Comments: Many commenters stated that EPA and state agencies have not done an adequate job of investigating citizen complaints related to contamination of water wells near hydraulically fractured CBM wells. Some commenters also stated that the Agency disregarded these complaints by concluding in its draft report that hydraulic fracturing of CBM wells poses a low risk. Some commenters also believed that the volume of complaints was enough to warrant the need for the Agency to continue its study. One commenter criticized the Agency for only having a 30-day collection period associated with the July 30, 2001 *Federal Register* notice in which the Agency requested information on groundwater contamination incidents that could be due to hydraulic fracturing of CBM wells. This commenter added that EPA's outreach efforts were unlikely to have reached the general public, and also recommended that EPA set up hotlines and make resources available to "allow immediate, comprehensive investigations of citizen complaints related to hydraulic fracturing impacts on USDWs."

Conversely, others commenters indicated that based on the volume of hydraulic fracturing activities, that if the threat to public health from hydraulic fracturing of CBM wells were significant, confirmed instances of water well contamination would exist. Some of these

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<sup>2</sup> US Environmental Protection Agency. 2001. Underground Injection Control; Request for Information of Ground Water Contamination Incidents Believed To Be Due to Hydraulic Fracturing of Coalbed Methane Wells. *Federal Register*. Vol. 66, No. 146. p. 39396, July 30, 2001.

commenters indicated that EPA's report should acknowledge the 1998 study conducted by the Ground Water Protection Council (GWPC), "Survey Results On Inventory and Extent of Hydraulic Fracturing in Coalbed Methane Wells in the Producing States," GWPC (December 15, 1998) because this survey of state oil and gas regulators provides further support for EPA's study conclusions.

EPA Response: The response of state agencies and EPA to citizen complaints are documented in Chapter 6. EPA has responded to complaints, particularly at the Regional level. For instance, in the Powder River Basin, located in Wyoming and Montana, citizen complaints dealt primarily with water quantity issues, which were beyond the scope of this study. EPA Region 8 is participating in a study that addresses the environmental effects of all aspects of CBM development and not just hydraulic fracturing. In response to citizen complaints, the Alabama Department of Environmental Management and EPA Region 4 also conducted independent sampling on wells in the Black Warrior Basin. Water analyses indicated that the wells had not been contaminated as a result of the hydraulic fracturing activities.

In some regions responses to citizen complaints are made primarily at the state level. For example, the Colorado Department of Health and the Colorado Oil and Gas Conservation Commission (COGCC) responds to many complaints. In Colorado, the primary response of the COGCC to citizen complaints has been the remediation of old, improperly sealed gas wells. The remediation of such wells has reduced methane concentrations in approximately 27 percent of the water wells sampled. Reduction of methane concentrations in many of the additional wells is expected over time due to the COGCC's efforts.

Regarding public outreach efforts need improvement, EPA has made considerable efforts to ensure its outreach and communications reach the general public. In addition to making the August 2002 draft available for public comments, EPA's outreach steps included:

- Publishing *Federal Register* notices (EPA's primary mechanism for communicating with the public):
  - requesting comment on how an EPA study should be structured (65 FR 45774)<sup>3</sup>;
  - requesting information on any impacts to groundwater believed to be associated with hydraulic fracturing (66 FR 39396) (see footnote 2) including a mailing to over 200 county agencies making them aware of the *Federal Register* notice; and
  - requesting comments on the August 2002 draft of the study (67 FR 55249) (see footnote 1).
- Holding a public meeting on August 24, 2000, to obtain additional stakeholder input on the study. Several of these commenters recommended that EPA's study include accounts of personal experiences with regard to CBM impacts on drinking water wells. These experiences are discussed in Chapter 6.

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<sup>3</sup> US Environmental Protection Agency. 2000. Underground Injection Control (UIC) Program; Proposed Coal Bed Methane (CBM) Study Design. *Federal Register*. Vol. 65, No. 143. p. 45774, July 25, 2000.

- Providing periodic updates for stakeholders, including citizens groups, in the form of written communication; and
- Maintaining a Web site where stakeholders can view the project documents; get updates on the progress of the project (including announcements of the release of *Federal Register* notices); and provide information to EPA.

Regarding the comment that EPA only provided 30 days for the public to provide information on CBM-related groundwater contamination incidents following the July 30, 2001 *Federal Register* notice, note that the Agency has considered all complaints received from the public, regardless of the time at which EPA received them. In addition, EPA's Web site [www.epa.gov/safewater/uic/cbmstudy.html](http://www.epa.gov/safewater/uic/cbmstudy.html) has a link to a form that allows people to submit information on the potential effects of hydraulic fracturing.

In response to the commenter's suggestion regarding hotlines, EPA has its Safe Drinking Water Hotline, which callers within the United States may reach at (800) 426-4791. Citizens are welcome to contact EPA or the states regarding these issues.

Regarding the comment about the volume of CBM activities and lack of confirmed instances of water well contamination, during its review, EPA found no confirmed cases that are linked to fracturing fluid injection into CBM wells or subsequent underground movement of fracturing fluids. Although thousands of CBM wells are fractured annually, EPA did not find confirmed evidence that drinking water wells have been contaminated by hydraulic fracturing fluid injection into CBM wells. EPA has included language to that effect in its final report, "Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs", June 2004, EPA document number: EPA 816-R-04-003 (hereafter referred to as final report).

## **E. Peer Review Panel**

**Summary of Comments:** Many commenters questioned the composition of EPA's peer review panel, who reviewed the initial draft report. These commenters stated that this panel was heavily biased toward industry that has a stake in the outcome of the study. These commenters recommended that EPA convene a panel that is free of conflict of interest. Some recommended using members of the NAS as panelists.

One commenter indicated that he could not ascertain the composition of the panel although Appendix B of the report is supposed to contain a table with the list of the peer review panel. Another commenter stated that EPA made it very difficult for the public to obtain a copy of the peer review report, and that these comments were not attached in an appendix as originally promised.

**EPA Response:** EPA has a formal Agency Peer Review Policy that establishes the criteria and requirements for independent evaluation of scientific and technical studies and documents. Consistent with that policy, the Agency established a seven-member technical expert peer review panel, who performed a technical review of the study. Panel members were selected by identifying individuals with scientific or technical expertise in hydraulic fracturing through

reviewing peer-reviewed publications in scientific journals and through communications with professional societies, trade and business associations, state organizations, and other federal agencies. EPA considered over 20 candidates before selecting 7 individuals based on their experience in the fields of hydraulic fracturing, rock mechanics, and/or natural gas production, and for their varying perspectives (industry, state government, academia, and a national laboratory). The charge to this committee was to review the report to determine if: 1) the report is complete, thorough, and accurate; and 2) the scientific/technical studies reviewed are applied in a sound, unbiased manner.

EPA posted the list of these reviewers and their qualifications on its Web site at [www.epa.gov/safewater/uic/cbmstudy.html](http://www.epa.gov/safewater/uic/cbmstudy.html). EPA inadvertently omitted the table that identifies the peer reviewers in Appendix B of the draft report. This table is included in the final report.

### III. FRACTURE FLUIDS

#### A. Components of Fracturing Fluids

##### 1. Health Effects

Summary of Comments: Many commenters were concerned about the amount and health effects of certain chemicals used in hydraulic fracturing fluids and cited these concerns as reasons to continue the study. Some argued that very small quantities of toxic chemicals, such as benzene or methyl tert butyl ether (MTBE), could contaminate millions of gallons of groundwater.

Other commenters were concerned about the way in which the constituents of fracturing fluids and their potential health effects were presented in the draft report. For example, one commenter wanted the report to clearly convey the following: a wide variety of fracturing fluids exist, the health effects identified in the report apply to only some of the constituents that may or may not be present in the fracturing fluid, the health effects are associated with the product in its "pure form," and all the fluids additives are greatly diluted during fracturing operations.

EPA Response: As discussed in section II.A.2, EPA has recently entered into agreements with three major service companies to voluntarily eliminate diesel fuel from hydraulic fracturing fluids injected directly into USDWs for CBM production. Compounds such as benzene are components of diesel. These agreements will significantly reduce the use of diesel fuel in hydraulic fracturing fluids that are injected directly into USDWs for CBM production.

Chapter 4 of the final report provides a general description of the fate and transport processes which would minimize potential exposure to chemicals used in hydraulic fracturing fluids. Based on a 1991 fracturing fluid recovery study conducted in coal by Palmer et al., as much as 68 to 82 percent of the fracturing fluids may be removed when the methane is extracted.<sup>4</sup> This study is discussed in Chapter 3 of the report. As detailed in Chapter 4 of the report, the

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<sup>4</sup> Palmer, I.D., Fryar, R.T., Tumino, K.A., and Puri, R. 1991. Comparison between gel-fracture and water-fracture stimulations in the Black Warrior basin; Proceedings 1991 Coalbed Methane Symposium, University of Alabama (Tuscaloosa), pp. 233-242).

unrecovered fluids will undergo processes that may limit their availability, concentration, and movement. These fluids may be significantly diluted and dispersed as they are transported through the subsurface. They may also interact chemically or physically with geologic material which may retard their movement and further disperse their concentrations.

EPA identified fluids and fluid additives commonly used in hydraulic fracturing through literature searches, reviews of relevant material safety data sheets (MSDSs) provided by service companies, and discussions with field engineers, service company chemists, and state and federal employees. The draft and final reports provide a discussion of the wide variety of hydraulic fracturing fluids that may be used. Table 4-1 of the report lists components that may be contained in fracturing fluids based on MSDSs. The final report emphasizes that not all fracturing fluid constituents, identified in Table 4-1 of this report, may be present in fracturing fluids, that the potential human health effects presented in the table apply to these compounds in their pure form, and that these compounds are significantly diluted prior to use.

An environmental impact statement (EIS) prepared by the BLM also identified MTBE as a compound that may be found in fracturing fluid (U.S. Department of the Interior, CO State BLM, 1998).<sup>5</sup> However, EPA was unable to find any indications in the literature, on MSDSs, or in interviews with service companies that MTBE is used in fracturing fluids to stimulate CBM wells.

## 2. Diesel Fuel

Summary of Comments: Several commenters supported EPA's recommendation that the industry use "water-based" alternatives in lieu of hazardous constituents such as diesel fuel. Some argued that EPA should make this a requirement and not a recommendation. Some of these commenters pointed to EPA's recommendation to "remove any threat whatsoever" from hydraulic fracturing fluid as a contradiction to the study's conclusions and as a reason to continue the study.

Conversely, several commenters indicated that there are valid reasons for using certain chemicals to enhance CBM production and that in choosing alternatives, the CBM well operators must take into account the specific geologic conditions of the site. These commenters recommended that EPA "encourage flexibility" with respect to the production of methane. One of these commenters noted that the draft report suggests that water-based alternatives are: currently available, feasible, and acceptable substitutes for diesel-based gels. This commenter indicated that the report findings should recognize that more research is needed on these potential alternatives. This commenter added that not all of the potential alternatives to the use of diesel may be water-based, citing polymer-based alternatives as one possibility. This commenter recommended that the term "water-based alternatives" be changed to read "non-diesel-based alternatives."

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<sup>5</sup> U.S. Department of the Interior, Bureau of Land Management, Colorado State Office. 1998. Glenwood Spring Resource Area: Oil & Gas Leasing Development, Draft Supplemental Environmental Impact Statement, June 1998.

One commenter indicated that in the State of Alabama, diesel is not used nor is it approved for hydraulic fracturing. The commenter added that service companies in his state primarily use a linear gel composed of guar gum, a surfactant, and silica.

EPA Response: The discussion of potential alternatives to the use of diesel is not included in the final report because it is outside the scope of the study. Instead, the report highlights the MOA with three major service companies to voluntarily eliminate the use of diesel fuel in hydraulic fracturing fluids injected directly into USDWs for the purpose of CBM production and if necessary, select replacements that will not cause hydraulic fracturing fluids to endanger USDWs (see the response to comment in section II.A.2).

Regarding the comment on the use of diesel in the State of Alabama, Table A2-1 in Attachment 2 of the draft and final report indicates that diesel is not used in that state.

### 3. *MTBE*

Summary of Comments: Several commenters were concerned about the use of MTBE in fracturing fluids. Many of them included the following statement in their comments: "only 28 tablespoons of MTBE could contaminate millions of gallons of groundwater."

One commenter indicated that the report contains several inconsistent statements regarding MTBE as a component of fracturing fluids. This commenter noted that in Chapter 4 of the draft report, EPA states that, based on its literature reviews and interviews with service companies, the Agency did not find any evidence that MTBE is used in fracturing fluids. This commenter also indicated that later in the same chapter, EPA states that "some gelling agents can contain hazardous substances including . . . [MTBE.]," and cites as its source a Supplemental EIS issued by BLM. This commenter provided arguments why he believed that the supplemental EIS was in error in listing MTBE as a potential component in fracturing fluids. This commenter further recommended that EPA should not have used this EIS as a source for identifying constituents in fracturing fluids or at a minimum, should have indicated the shortcomings associated with using this type of document to determine the components of fracturing fluids. This commenter provided a detailed discussion of some of the problems with using this particular EIS.

EPA Response: As stated in the response to comment in section III.A.1, an EIS prepared by the Colorado State BLM (1998) identified MTBE as a compound that may be found in fracturing fluid. EPA found no information in the literature, MSDSs, or through interviews with service companies indicating that MTBE is used in fracturing fluids to stimulate CBM wells. MTBE is not used during the manufacture of diesel fuel. It is generally only added to gasoline. However, in an effort to be fully inclusive of all the Agency's literature search findings, EPA included the information found in the EIS and noted that EPA was not able to confirm MTBE use in fracturing fluids.

## **B. Comparison of Concentrations of Hydraulic Fracturing Fluid Components to MCLs**

Summary of Comments: A few commenters questioned the appropriateness of EPA's use of MCLs to compare the projected concentrations of fracturing fluids that may be injected into

USDWs. The commenters argued that MCLs apply to "treated water" and that the water associated with the formations in which hydraulic fracturing occurs would not be suitable for drinking water without first being treated.

EPA Response: Under the mandate of SDWA, EPA establishes MCLs as enforceable maximum permissible levels for contaminants in drinking water, to ensure the safety of public drinking water supplies. Because the concern about contamination relates to USDWs, which are actual or future supplies of drinking water for human consumption, MCLs are used in this study as standard reference points to compare calculated or anticipated levels of contaminants in hydraulic fracturing fluids and in the subsurface. MCLs provide a context for discussions regarding the concentrations of individual contaminants.

## **C. Concentrations of Constituents in Fracturing Fluids/Fluid Recovery Rates**

### *1. Estimates of Concentrations of Constituents in Fracturing Fluids*

Summary of Comments: EPA received several comments on its estimates of the concentrations of the constituents of concern in fracturing fluids that may be present at the point-of-injection and at the edge of the fracture zone. Many commenters were alarmed about the estimated concentrations of some of these constituents such as benzene because they were above the MCL. Further, some were concerned that EPA had revised its estimates since publication of the report. Conversely, other commenters indicated that EPA had overstated these concentrations. Each of these comments is discussed in more detail below.

One commenter indicated that EPA's estimates for the constituents of concern at the edge of the fracture zone, which assume a dilution factor of 30, still exceed drinking water standards for benzene, aromatics, 1-methylnaphthalene, and methanol. This commenter added that EPA estimated high concentrations for the estimated point-of-injection for some chemicals for which drinking water standards have not yet been developed. This commenter acknowledged that these concentrations will be reduced as they mix with groundwater; however, he stated that very small amounts of some chemicals like benzene and MTBE can contaminate millions of liters of groundwater. Further, this commenter noted that most CBM wells are hydraulically fractured more than once, and therefore, "the groundwater in which it resides," will receive multiple doses of the fracturing fluids chemicals. The commenter stated a figure from the report that between 50,000 and 350,000 gallons of fracturing fluids are typically used in coalbed fracture treatments. Another commenter indicated that the report does not recognize that some of the constituents in fracturing fluids may affect human health at very low concentrations. This commenter added that with the potentially thousands of CBM wells being developed, the problem is magnified.

Several commenters claimed that EPA revised its calculations after the draft report was released. Some of these commenters indicated that EPA changed its scientific and policy conclusions under pressure from industry. One commenter provided detailed comments on the revised calculations. This commenter argued that EPA changed some of the parameters that were used in the draft report (such as length and height of a fracture, volume of injected hydraulic fracturing fluids, percentage of unrecovered hydraulic fracturing fluids) and they resulted in smaller estimated concentrations, including a revised estimate for benzene that does not exceed the MCL. This commenter questioned the basis for EPA's revising its estimates.

Other commenters were concerned that EPA did not adequately explain the assumptions used to generate its calculations. For example, one commenter indicated that it was unclear whether EPA based its estimates at the edge of the fracture zone on a specific fracture length or fracture radius. Some commenters also stated that EPA did not consider factors that would influence the availability and decrease the concentrations of the constituents at the edge of the fracture zone. These factors included: the recovery of the majority of the fracturing fluid, the relatively low permeability of coalbed formations will limit the movement of groundwater away from the wellbore, the coal will adsorb some of the constituents onto its surfaces, acids react with certain rock constituents and become spent, and some fracturing fluid constituents such as benzene will biodegrade. Some commenters also recommended that EPA's report should further emphasize that any constituents of concern in fracturing fluids are present only in very minimal amounts.

One commenter indicated that EPA had "significantly mischaracterized the nature of its estimates at both the point-of-injection and the edge of the fracture zone" because EPA had used a "worst case" scenario for estimating these concentrations. The commenter stated that, although the report indicates that EPA used mid-range values, the Agency used the maximum amount of diesel fuel that service companies reported to EPA instead of an average value. This commenter also explained why he believed that some of the point-of-injection concentrations that were presented in Table 4-2 of the draft report, such as that estimated for methanol, appeared to be inconsistent with the discussion in the text. Further, this commenter also recommended that EPA include its newer calculations in the report.

EPA Response: The values presented in the draft report are oversimplified estimates based on dilution alone and are not accurate enough to predict that a 30 times decrease is above or below the MCL. In the final report, EPA has revised its procedure for assessing the potential effect of fracturing fluid constituents on USDWs from that presented in the August 2002 draft as follows:

- The draft report included point-of-injection calculations for all constituents that may be contained in fracturing fluids. The final report focuses only on those constituents for which MCLs are established (i.e., BTEX compounds).
- EPA has revised the fraction of BTEX compounds in diesel used to estimate the point-of-injection concentrations from a single value to a documented broader range of values for the fraction of BTEX in diesel fuel. For example, the fraction of benzene in diesel was revised from  $0.00006 \text{ g}_{\text{benzene}}/\text{g}_{\text{diesel}}$  to a range with a minimum value of  $0.000026 \text{ g}_{\text{benzene}}/\text{g}_{\text{diesel}}$  and a maximum value of  $0.001 \text{ g}_{\text{benzene}}/\text{g}_{\text{diesel}}$ . If the maximum value for benzene in diesel is used to estimate the concentration of benzene at the point-of-injection, the resulting estimate is 17 times higher than that presented in the draft report.
- In the final report, EPA used more current values for two of the parameters used to estimate the point-of-injection concentrations of BTEX compounds. Specifically, the estimates in this report use a density of the diesel fuel-gel mixture of  $0.87 \text{ g/mL}$  compared to  $0.84 \text{ g/mL}$  in the draft report, and a fraction of diesel fuel in gel of  $0.60 \text{ g}_{\text{diesel}}/\text{g}_{\text{gel}}$  compared to  $0.52 \text{ g}_{\text{diesel}}/\text{g}_{\text{gel}}$  in the draft report. The use of these more current values does not affect the order of magnitude of the revised point-of-injection calculations.

- The August 2002 draft report included estimates of the concentration of benzene at an idealized, hypothetical edge of the fracture zone located 100 feet from the point-of-injection. Based on new information and stakeholder input, EPA concluded that the edge of fracture zone calculation is not an appropriate model for reasons including:
  - Mined-through studies reviewed by EPA indicated that hydraulic fracturing injection fluids had traveled several hundred feet beyond the point-of-injection.
  - The assumption of well-mixed concentrations within the idealized fracture zone is insufficient. One mined-through study indicated an observed concentration of gel in a fracture that was 15 times the injected concentration, with gel found to be hanging in stringy clumps in many fractures. The variability in gel distribution in hydraulic fractures indicates that the gel constituents are unlikely to be well mixed in groundwater.
  - Based on more extensive review of the literature, the width of a typical fracture was estimated to be much thinner than that used in the draft report (0.1 inch versus 2 inches). The impact of the reduced width of a typical fracture is that the calculated volume of fluid that can fit within a fracture is less. After an initial volume calculation using the new width, EPA found that the volume of the space within the fracture area may not hold the volume of fluid pumped into the ground during a typical fracturing event. Therefore, EPA assumes that a greater volume of fracturing fluid must "leakoff" to intersecting smaller fractures than what was assumed in the draft report, or that fluid may move beyond the idealized, hypothetical "edge of fracture zone." This assumption is supported by field observations in mined-through studies, which indicate that fracturing fluids often take a stair-step transport path through the natural fracture system.
- In the draft report, EPA approximated the edge of fracture zone concentrations considering only dilution. Based on new information and stakeholder input on the draft report, EPA does not provide estimates of concentrations beyond the point-of-injection in the final report. Developing such concentration values with the precision required to compare them to MCLs would require the collection of significant amounts of site-specific data. This data in turn would be used to perform a formal risk assessment, considering numerous fate and transport scenarios. These activities are beyond the scope of Phase I of this study.
- In Chapter 4 of the final report, EPA provides a qualitative evaluation of the fate and transport of unrecovered fracturing fluids on residual concentrations of BTEX in groundwater. EPA describes in Chapter 4 how subsurface flow would significantly disperse and dilute BTEX compounds in groundwater, minimizing potential exposure to these constituents. BTEX compounds may also interact chemically or physically with geologic material which may retard their movement and further disperse their concentrations.

See also EPA's response to comment in section III.A.1 of this document.

No data or conclusions in the final report or in any previous draft were altered to accommodate any industry parties, states, environmental groups, or others. This study was a thorough and transparent data collection and technical evaluation exercise. The report and its conclusions were prepared by career technical staff at EPA.

The study was designed based upon a transparent process including public comment on the conceptual study design which included comments from state drinking water and oil and gas agencies, industry, environmental groups, and private citizens. EPA consulted with experts in the United States Geological Survey and the Department of Energy. Consistent with principles of good science, a draft of the study was subjected to a technical peer review from hydraulic fracturing experts. The conclusions of the study were not submitted for review to any private sector parties.

## *2. Fluid Recovery Rates*

Summary of Comments: Many commenters were concerned that a large percentage of fracturing fluid remains behind and is available to potentially migrate into USDWs, citing these concerns as a reason to continue EPA's study. Some commenters indicated that EPA was inconsistent in the recovery percentages that the Agency cited in the report. Two commenters noted that the recovery experiment that is referenced in the report only ran for 19 days and that additional fracturing fluids may be recovered after that time. Another commenter stated that one fluid recovery rate (i.e., 61 percent) should not be "indiscriminately applied to over 14,000 CBM wells."

Some commenters cited a study by three Amoco scientists in which the study found "that a significant volume of fracturing fluids is not withdrawn." These commenters explained that the scientists found that the gelling agents used in the fracturing fluids remained in the coal samples although they had been flushed with water and strong acids. The commenters argued that, since these chemicals are not fully recovered, they could "serve as continuous sources of groundwater contamination."

EPA Response: Section III.A.1 provides a discussion of processes that can limit the availability, concentration, and movement through groundwater of unrecovered fracturing fluids. EPA has ensured that the recovery percentages cited in the report are both internally consistent and consistent with the literature reviewed. Three studies on recovery rates of hydraulic fracturing fluids were reviewed in Chapter 3 of the report. Only one of these studies, Palmer et al., 1991, involved hydraulic fracturing of coalbeds (refer to footnote 1 for the study reference). Thus, the Palmer study was considered the most relevant of the three studies for the purposes of this report. The final report clarifies that the recovery rate of 61 percent was based on a 19-day flowback period. Palmer et al., 1991, predicted recovery rates as high as 82 percent over a longer recovery period.

Regarding the study by three Amoco scientists, EPA contacted one of the commenters to obtain a copy of the study to review.<sup>6</sup> The commenter was unable to provide the study and EPA's additional library research efforts were also unsuccessful at obtaining this study.

### *3. Amount of Fracturing Fluids*

Summary of Comments: Some commenters were concerned about the volume of fracturing fluids used in a "typical fracturing job" and cited the following statement from the report, "Coalbed fracture treatments typically use 50,000 to 350,000 gallons of various fracturing fluids, and from 75,000 to 320,000 pounds of sand as proppant... ." Others questioned the accuracy of the quantities of fracturing fluid and proppant cited in the report, stating that these figures were more consistent with a massive hydraulic fracture. Another commenter stated that the unique properties that make many coal formations effective receptacles for methane also allow them to hold large quantities of water. This commenter stated that injection of hydraulic fracturing fluids into USDWs risks permanent contamination of these USDWs because fracturing fluids often contain large amounts of toxic chemicals.

EPA Response: EPA has clarified in the final report that more typical injection volume may be closer to a maximum of 150,000 gal/well, and a median value of 57,500 gal/well. These values are based on average injection volume data provided by Halliburton for six CBM locations.

Refer to section III.A.1 regarding factors that would influence the availability, concentration, and movement of fracturing fluids and their constituents.

### *4. Movement of Fracturing Fluids*

Summary of Comments: Some commenters stated that unrecovered fracturing fluids will flow toward the well because of the pressure gradients. Others noted that this was only true while the well was in production. These commenters argued that once pumping stops, the aquifer will attempt to resume a normal flow pattern and the remaining hydraulic fracturing fluids will move freely within the coalbed formation.

EPA Response: Chapter 4 of the final report has been expanded to more clearly explain:

- hydraulic gradients that occur during injection versus those during fluid recovery;
- the significance of the capture zone of the production well on fracturing fluid recovery (i.e., the portion of the aquifer that contributes water to the well); and
- the movement of fracturing fluids (and what influences their movement) both inside and outside the capture zone.

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<sup>6</sup> Puri, R., G.E. King, and I.D. Palmer, 1991, "Damage to Coal Permeability During Hydraulic Fracturing," Society of Petroleum Engineers Proceedings from Rocky Mountain Regional Meeting and Low-Permeability Reservoirs Symposium, Denver, CO, p. 109-115, (SPE #21813).

## IV. FRACTURE BEHAVIOR AND PRACTICES

### A. Fracture Growth

Summary of Comments: EPA received many comments on the statements in its report that, "Vertical fracture heights in coalbeds have been measured in excess of 500 feet and lengths can reportedly reach up to 1,500 feet." Some of these commenters stated that these distances indicate the potential for communication with and contamination of USDWs. Other commenters believed that these measurements were incorrect. Some commenters also discussed whether confining layers act as barriers to vertical fracture growth.

One commenter described in detail why he believed that confining layers above and below the hydraulically fractured coal formations would also be fractured and permeated by fluids. This commenter noted that the fracture heights cited in the report exceed the thickness of the thickest coal formations identified in the report. In addition, this commenter noted that the report indicates that some of the coal seams are bounded by sandstone and conglomerate (which have different lithological properties, and therefore different fracturing properties, than shale). Further, he indicated that the report supports his position that the risk for migration of fracturing fluids into adjacent USDWs is significant because it indicates that "Stimulation fluids in coal penetrate from 50 to 100 feet away from the fracture and into the surrounding formation. In these and other cases, when stimulation ceases and production resumes, these chemicals may not be completely recovered and pumped back to the CBM well, and, if mobile, may be available to migrate through an aquifer." This commenter also noted that the report shows that many of the coal formations are located in mountainous regions such as the Rocky Mountains and Appalachian Mountains. The commenter stated that the rock formations in these regions, including the coal formations, have been subjected to intense orogenic and tectonic stress resulting in regional, systematic fractures and faults. The commenter argued that it is likely that coal formations, and other rocks above and below them, are characterized by cracks and fractures, and that because of these deformation features, rates of groundwater transport tend to be higher.

One commenter indicated that the report's description of how fractures travel is incorrect (i.e., they travel horizontally vs. vertically). This commenter added that there is some vertical expansion as the fracture moves horizontally but that this is not the primary direction of fracturing. This commenter stated that their state geologists estimate vertical fracture heights at 50 to 60 feet. Another commenter provided detailed comments on the studies that were conducted on fracture height growths. This commenter indicated that he had been involved in numerous fracture experiments (in all types of reservoirs) where the fracture height has actually been measured (using microseismic or downhole tiltmeter), as well as in mineback tests where hydraulic fractures have been excavated. Based on his experience, the fracture height has always been less than or equal to the height that would be predicted by just using stresses in the various layers (which the commenter indicated was the only factor considered in all the references used in the draft report). The commenter reported that in some cases, the differences were factors of two or three. This commenter also provided detail on factors that influence fracture height growth, such as horizontal stress in the coal, the horizontal stress in the surrounding layers, the characteristics of the layering, and the type of hydraulic fracturing fluids being pumped.

Another commenter noted that the discussion on fracture dimensions in the report was based on literature from 1993 and earlier, but acknowledged that there were "virtually no post-1993 published reports on hydraulic fracturing." The commenter recommended that EPA contact operators, service companies, and state regulatory agencies for current practices and models. Further, this commenter noted that newer data based on more sophisticated FracPro models are available for many basins. He added that, in his state, model results indicate that fracture height is "generally less than 100 feet, whereas fracture half length is typically between 150 and 700 feet." This commenter also noted that the report should state that the fracture heights have been "modeled" not "measured" because vertical fracture heights have never been fully measured in the field.

EPA Response: EPA has revised Chapter 3 to provide clarification on the characterization of fracturing behavior during hydraulic stimulations. The statement that fractures have been "measured in excess of 500 feet and lengths can reach up to 1,500 feet" has been removed because it refers to modeled estimates, rather than direct measurements. Instead, the results of 22 mined-through studies have been summarized, because they provide direct measurements of the dimensions of hydraulic fractures, as well as lower bounds on the extent of fracturing fluid movement. Chapter 3 has also been revised to better distinguish between fracture characterizations based on modeling vs. those that are directly measured.

In addition, EPA has revised Chapter 3 to clarify the issue of hydraulic barriers and barriers to fracture growth above coalbeds. EPA agrees with the commenter that when shales overlying targeted coals are extensively fractured, they may not act as barriers to hydraulic fracture growth or as hydraulic barriers. On the other hand, thick, relatively unfractured shale may present a barrier to upward fracture growth because of the stress contrast between the coalbed and the overlying shale. Deep vertical fractures can propagate vertically to shallower depths and develop a horizontal component. In the formation of these "T-fractures," the fracture tip may fill with coal fines or intercept a zone of stress contrast, causing the fracture to turn and develop horizontally, sometimes at the contact of the coalbed and an overlying formation.

## **B. Multiple Fractures**

Summary of Comments: Some commenters raised concern over the statement in the draft report that "each well, over its lifetime is fractured several times" and urged EPA to continue to Phase II of the study. Others questioned the accuracy of EPA's statement that wells are fractured multiple times. One commenter indicated that in their state, most wells have not been re-fractured multiple times but that instead, two to four coal groups were generally fractured in each well.

EPA Response: EPA has revised the statements regarding multiple stimulations in Chapter 3. In the draft report EPA stated that "many coalbeds are refractured at sometime after the initial treatment." The text has been revised to indicate that the literature on refracturing that was reviewed pertains only to the Black Warrior Basin. EPA's extensive literature review did not find any information indicating that wells are fractured multiple times in any basin other than the Black Warrior Basin.

## **C. Relationship of Drinking Water Wells to Hydraulic Fracturing Activities**

Summary of Comments: Some commenters were concerned about the potential for fracturing fluids to contaminate USDWs due to the high occurrence of coal reservoirs within USDWs. One commenter cited a statement from the report "if coalbeds are located within USDWs, then any fracturing fluids injected into coalbeds have the potential to contaminate the USDW." The commenter added that the report indicates that as much as 91 percent of U.S. coal reservoirs may be located within USDWs.

Two commenters indicated that hydraulic fracturing activities take place at depths far below groundwater sources used as drinking water sources. One of these commenters added that his company's records show that it conducts hydraulic fracturing at shallow depths, (i.e., less than 300 feet below ground surface), in less than one percent of all hydraulic fracturing jobs. This commenter provided this as one reason that he believed that hydraulic fracturing is unlikely to pose a threat to drinking water.

EPA Response: EPA found that 10 of the 11 coal basins, included in the study, may lie, at least in part, within USDWs. Given the concerns associated with the use of diesel fuel and the introduction of BTEX constituents into USDWs, EPA negotiated an MOA with three major hydraulic fracturing service companies for the voluntary elimination of diesel fuel in hydraulic fracturing fluids injected directly into USDWs for the purpose of CBM production. Nevertheless, even when fracturing fluids are injected directly into coalbeds located in USDWs, fracturing fluid components are likely to be significantly diluted and dispersed, as well as subject to other fate and transport processes (discussed in Chapter 4) which are likely to lower their concentrations or prevent their mobility underground. Also see the response to comment in section III.A.1.

#### **D. Differences in State Geology**

Summary of Comments: Several commenters indicated that the report did not adequately address the variability present in the different geologic formations that are subject to hydraulic fracturing, and therefore, did not address the possible impacts associated with that variability regarding regional groundwater flow and/or the occurrence and distribution of CBM resources, on assessing the potential threat of hydraulic fracturing on USDWs. One commenter indicated that to accurately represent the threats to USDWs, risk levels should be "differentiated based on modeling and actual data on similar geologic conditions."

EPA Response: EPA agrees that variability of geologic formations and regional groundwater flow are key to the assessment and understanding of the potential threat to USDWs posed by hydraulic fracturing. The study findings and conclusions are based on literature from each of the 11 major coal basins in the United States. In addition, the draft and final report contains separate attachments which discuss basin-specific geologic and hydrogeologic investigations related to each of the 11 basins. The discussions provided were intended to characterize regional coal basin methane production with respect to its effect on USDWs and to supplement the generalized information provided within the body of the report. EPA also agrees that if modeling risk levels, the variability of geologic conditions should be considered. However, such a modeling exercise is beyond the scope of the current study.

## V. REGULATION OF HYDRAULIC FRACTURING PRACTICES

### A. States' Authority

Summary of Comments: Several commenters recommended that EPA expand its discussion in the final report of the states' role in regulating hydraulic fracturing. Others suggested clarifying the language from the draft report regarding states' authority to regulate hydraulic fracturing. For example, one commenter indicated that EPA's statement, "States with primacy for their UIC program enforce and have the authority to place controls on any injection activities that may threaten USDW's" implies that state UIC Programs can or would regulate hydraulic fracturing. The commenter recommended that EPA add clarifying language that removes the implication that hydraulic fracturing is commonly regulated under UIC Programs.

One commenter stated that the report was inaccurate in its description of Virginia's authority to place restrictions on the depth at which hydraulic fracturing can occur. The commenter indicated that the "restrictions" are instead voluntary procedures. The commenter also clarified the purpose of these procedures.

EPA Response: EPA did not conduct a systematic review of state regulations of hydraulic fracturing and, therefore, has no basis for expanding its discussion of the state's role in the regulation of hydraulic fracturing. However, the Agency added clarifying language regarding the state's ability to regulate hydraulic fracturing. EPA also added clarifying wording to the report regarding Virginia's voluntary program.

### B. Regulation of Hydraulic Fracturing under SDWA

Summary of Comments: Several commenters wanted EPA to regulate hydraulic fracturing of CBM wells under SDWA and did not believe that recommended measures such as using "water-based alternatives" instead of diesel were sufficient. One commenter stated that based on *Legal Environmental Assistance Foundation, Inc. v. U.S. E.P.A.*, 118 F.3d 1467, 1470 (11th Cir. 1997), EPA is to decide how to regulate hydraulic fracturing under SDWA, and not to determine whether "further investigation was necessary to evaluate any potential threats" before EPA acts. Another commenter was concerned whether EPA was using the presence of documented cases of "health harm from non-regulation" as the criterion for determining whether to regulate hydraulic fracturing injection activities under SDWA. This commenter argued that the purpose of the UIC Program is "to forestall and prevent such harm by isolating the injected fluids from aquifers that are or could be developed as USDWs"; and therefore, using proven harm as a regulatory threshold goes against the purpose and intent of the law.

Conversely, other commenters indicated that EPA should "recognize the need for industry to be allowed reasonable flexibility in the means that it uses to produce CBM." These commenters also indicated that under 42 U.S.C. § 300h(b)(2), Congress intended that EPA not impose restrictions through the UIC Program that interfere with or impede activities related to oil and gas development unless such restrictions are essential for preventing endangerment of drinking water sources. Another commenter specifically recommended that UIC permits not be required for hydraulic fracturing practices.

EPA Response: Based on the information collected and reviewed, EPA has determined that the injection of hydraulic fracturing fluids into CBM wells poses little or no threat to USDWs. Continued investigation under a Phase II study is not warranted at this time. The lack of confirmed incidents of drinking water well contamination due to hydraulic fracturing fluid injection from past hydraulic fracturing activities was one among many factors EPA considered. If threats to USDWs from hydraulic fracturing of CBM wells were significant, EPA would expect to have found confirmed instances of drinking water well contamination from the practice. Although thousands of CBM wells are fractured annually, EPA did not find confirmed evidence that drinking water wells have been contaminated by the injection of hydraulic fracturing fluids into CBM wells.

EPA's recent agreements with three major service companies, discussed in section II.A.2, will significantly reduce the use of diesel fuel in hydraulic fracturing fluids that are injected directly into USDWs for CBM production.

It is important to note that states with primary enforcement authority (primacy) for their UIC Programs implement and enforce their regulations, and have the authority under SDWA to place additional controls on any injection activities that may threaten USDWs. States may also have additional authorities by which they can regulate hydraulic fracturing. With the expected increase in CBM production, the Agency is committed to working with states to monitor this issue.

## **VI. LANGUAGE USED IN THE REPORT**

### **A. Use of the Term "USDW"**

Summary of Comments: Some commenters indicated that EPA used the term "USDW" too broadly. In particular, one commenter indicated that the report "carelessly utilizes the USDW term in the context of hydrocarbon bearing formations." This commenter added that these hydrocarbon-bearing aquifers subjected to hydraulic fracturing are unlikely to be used for drinking water, especially without treatment for two reasons: 1) the high total dissolved solids level of the waters in these formations; 2) the waters in these formations may be considered an "exempted aquifer" under SDWA because the aquifer is mineral, hydrocarbon, or geothermal energy producing, or can be demonstrated to be commercially producible. This commenter also stated that the inferences in the report, that some risks may be attributed to hydraulic fracturing, conflict with "the reality that such a formation would not be used for water supply without treatment, if it were ever to be used."

EPA Response: EPA disagrees that it has applied the term "USDW" too broadly in the report. SDWA mandates the protection of USDWs from injection activities – "if such injection may result in the presence in underground water which supplies or can reasonably be expected to supply any PWS of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons." The broad definition of a USDW by Congress was to ensure that future USDWs would be protected, even where those aquifers were not currently used as a drinking water source or could not be used without some form of water treatment such

as desalination. It is also important to note that an exempted aquifer is a USDW, but is exempt from regulation.

## **B. Use of Scientific Terms**

Summary of Comments: A few commenters provided corrections to some of the terminology used in the report. One commenter felt that there was a general misuse of geologic terminology in the report, and specifically indicated that the geologic terms "system," "formation," and "seams" should not have been used interchangeably. This commenter provided other specific clarifications or corrections to some of the discussions in the report (e.g., Section 3.1 regarding the depositional history of coal-bearing rocks in the United States).

EPA Response: EPA appreciates the careful review of the report by many of the commenters. EPA has revised some of the terminology used in the report and incorporated some of the clarifications suggested by the commenters.

## **C. Use of Qualifying Language**

Summary of Comments: Both the commenters that supported EPA's conclusions and those who opposed it indicated that the tone of the language used throughout the report conflicted with EPA's conclusions. Commenters cited examples of this language that included the following:

- "Based on the information collected, the potential threats to USDWs posed by hydraulic fracturing *appear to be low* and do not justify additional study.";
- ..."*the apparent risk* to public health from hydraulic fracturing is not compelling enough to warrant expending resources on a phase II effort"; and
- "*the apparent threat* to public health from hydraulic fracturing."

One of the commenters indicated that this language showed "a weak articulation of EPA's confidence in its own report." Many of the commenters who were opposed to EPA's findings, pointed to EPA's qualified statements as a reason to continue the study.

Another commenter, who supported EPA's findings, stated that the primary definition of the word, "apparent," is, "something that is clearly seen or understood, obvious, self-evident, glaring." This commenter, among others who supported the Agency's findings, recommended that EPA replace all uses of the word "apparent" when describing the threat posed to USDWs by hydraulic fracturing with words that more accurately describe the low likelihood of this threat.

EPA Response: In the final report, EPA has eliminated the use of the word "apparent" and "appears" to describe its study conclusions and has made the language more consistent with the report's results.

## **VII. CHAPTER-SPECIFIC COMMENTS**

This summary of chapter-specific comments focuses mainly on those comments that have not been summarized within the issue-specific Sections II through VI of this document. Comments were received on almost every chapter of the document, ranging from minor editorial suggestions, to factual corrections. EPA appreciates the thorough comments that were submitted regarding the contents of the hydraulic fracturing report. The Agency has considered all comments, researched the accuracy of some comments (where necessary), and incorporated comments where appropriate.

## **A. Glossary**

Summary of Comments: One commenter submitted recommended changes to the list of acronyms and abbreviations, and the glossary pertaining to "M"; "KCl"; "pad"; and the phrase, "wells that have been 'screened-out' cannot be used for gas production."

EPA Response: After reviewing and checking on the accuracy of the above comments, EPA incorporated changes to the glossary and list of acronyms, where appropriate.

## **B. Other Executive Summary Comments**

Summary of Comments: EPA received many comments that were specific to the executive summary of the report, including recommendations for revising the text, tables, and figures. A few commenters suggested that the language regarding the findings and conclusions of the study needs to be clearer and stronger (e.g., qualifiers such as "appear to be low" and "persuasive evidence" weakens the conclusions). Another suggested that, in general, the executive summary and the main document need to point out that not all USDWs are currently being used nor will they ever be used as sources of drinking water. Some commenters felt that the executive summary was inappropriately long and provided suggestions for making the section shorter, including eliminating all tables from this section. Many commenters provided specific editorial comments.

A few commenters expressed concern regarding the "graphic language" in Table ES-2 (*Summary of MSDSs for Hydraulic Fracturing Fluid Additives*) used to describe the health effects of fracturing fluids, and noted that they felt it may be unnecessarily alarming, and potentially misleading to readers (i.e., it does not clarify that the health effects only pertain to some constituents that may or may not be present in the fracturing fluids). Commenters added that Table ES-2 suggests that linear gel delivery systems always contain diesel and does not indicate that fluid additives are greatly diluted. One commenter felt that the information provided in Table ES-4 (*Evidence in Support of Coal-USDW Co-Location in U.S. Coal Basins*) was too general, and believed that the information should just be presented in the more detailed sections from which it was summarized. Other commenters were concerned that the information provided in Table ES-5 (*Summary of Reported Incidents that Associate Water Quality/Quantity with Coalbed Methane (CBM) Activity*) could be misleading to the public.

One commenter felt that the executive summary figures in general were "confusing and misleading." Other commenters questioned the accuracy and clarity of Figure ES-2 (*Graphical Representation of the Hydraulic Fracturing Process in Coalbed Methane Wells*), which depicts

drinking water wells drawing down into coal seams. One commenter questioned the accuracy of the illustrations in Figures ES-3 (*Direct Fluid Injection into a USDW (Coal within USDW)*) and ES-4 (*Fracture Creates Connection to USDW*) regarding the depth of the water wells and the direction of fluid migration (i.e., fracturing fluids are shown to be flowing away from the well bore toward the drinking water wells). The commenter pointed out that the descriptive text on page ES-10 conflicts with the depiction of fluid migration in Figure ES-4.

EPA Response: EPA has reviewed and considered all comments regarding the executive summary of the document. The Agency originally designed the executive summary to be a stand-alone document. Because many readers of such a document (such as Congress or the leaders of various stakeholder organizations) may have limited time to dedicate to the review of a large technical document, EPA included essential summary information, including tables and figures, in the executive summary. However, based on the comments received, EPA has pared down the executive summary by taking out most of the tables and summarizing key information from these tables in narrative form. EPA incorporated many of the specific suggestions related to the figures (e.g., decreasing the depth of drinking water wells), and in some instances, provided clarifying language to explain the figures.

### **C. Other Chapter 1 Comments (Introduction)**

Summary of Comments: A few commenters provided comments regarding the Introduction to the hydraulic fracturing report. Comments included questions about the accuracy of the figures, and how they were depicted: groundwater flow; the relation between well depths and coal seams; and the point-of-injection for the fracturing fluids. One commenter objected to the statement that the study was "based on a high level of interest of stakeholders..." when it was the commenters' understanding that it was based only on a "handful" of complaints.

EPA Response: The statement that the study was "based on a high level of interest of stakeholders..." is an accurate statement but the term "stakeholders" was vague. To be more descriptive, Chapter 1 of the final report indicates that a reason for conducting the study was "concerns voiced by individuals who may be affected by coalbed methane development. . ." The Agency addressed each of the other comments by either incorporating suggested language or making relevant clarifications in the document language and figures.

### **D. Other Chapter 2 Comments (Methodology)**

*No substantive comments received on this chapter.*

### **E. Other Chapter 3 Comments (Characteristics of CBM Production and HF Practices)**

Summary of Comments: EPA received several comments regarding the information in Chapter 3. In particular, several commenters questioned the study's assumptions regarding recovery rates and fracture heights. A more detailed summary of the comments received on these topics can be found in sections III.C.2 and IV.A, respectively. One commenter had several specific questions regarding statements made in this chapter, including: the meaning of the term "conventional coal mines"; statements regarding the number of CBM wells in Alabama; the discussion of the

origin of CBM; the statement that "coal has very little natural permeability"; contradictions between the discussion of fluids migration in this chapter compared to that shown in Figures ES-4 and 1-3; accuracy and clarity of statements regarding the rate of fluid recovery; and the statement that many CBM wells are re-fractured.

EPA Response: EPA appreciates the detailed comments that were submitted regarding Chapter 3 of the hydraulic fracturing report. The Agency made several editorial corrections and clarifications to this chapter based on these comments. A more detailed response regarding recovery rates, fracture heights, and re-fracturing of the same wells can be found in sections III.C.2, IV.A, and IV.B, respectively.

#### **F. Other Chapter 4 Comments (HF Fluids)**

Summary of Comments: Comments specific to Chapter 4 of the report included questions about the calculation of the constituents of concern at the point-of-injection, and other editorial comments and suggestions.

EPA Response: In response to comments received on Chapter 4, EPA has incorporated clarifying language regarding its calculations of BTEX compounds at the point-of-injection. Other editorial corrections and clarifications have also been incorporated. For a discussion of how EPA revised its procedure for assessing the potential effect of fracturing fluid constituents on USDWs from that presented in the draft report, refer to section III.C.1.

#### **G. Other Chapter 5 Comments (Basin Descriptions)**

Summary of Comments: Several comments were received regarding the basin descriptions, including updates from a few states on the numbers of wells in the applicable basins. One commenter suggested additional references that should be used to correct some of the statements regarding the Pottsville Formation. The other four commenters each provided specific editorial suggestions on one of the following four basins: the Central Appalachian Basin, the Northern Appalachian Basin, the Uinta Basin, and the Powder River Basin.

EPA Response: EPA has incorporated the updated well information provided by states. All other editorial comments were considered, and most were incorporated. Other basin-specific issues are discussed in section VIII of this document.

#### **H. Other Chapter 6 Comments (Water Quality Incidents)**

Summary of Comments: Several comments were received regarding the water quality incidents chapter of the report. Commenters made specific editorial suggestions, and provided clarifications about specific complaints, additional information about how their state investigates complaints, and information about state-specific hydraulic fracturing regulations. One commenter stated that the discussion of the Pottsville, Allegheny, Conemaugh, and Monongahela Groups were "oversimplified" and questioned the conflicting use of the terms "cyclothem" and "complex" when describing the depositional environments of the Allegheny Group.

A few commenters expressed concern that the descriptions of public complaints (including the information summarized in Table 6-2) are presented in the report as if the information was factual, without linking the complaints to actual findings following the state and EPA investigations. One commenter indicated that EPA does not present any data from state agencies, which suggests to the commenter that no real scientific studies were conducted. Commenters recommended that the complaints be immediately followed by a summary of the evaluation and resolution of the complaint. One recommendation was that, if kept in the report, the information be moved to an appendix.

Finally, some commenters felt that EPA was contradictory regarding the question of whether hydraulic fracturing of CBM wells threaten USDWs. For example, one commenter indicated that EPA had concluded in Chapter 6 that there is insufficient evidence to determine if there is a link between fracturing and USDW contamination. However, elsewhere in Chapter 6, EPA states that "water quality problems might be associated with some of the variety of production activities common to CBM extraction. These production activities include... methane migration through conduits created by drilling and fracturing practices..."

EPA Response: In response to stakeholder's comments on EPA's original study methodology, EPA compiled citizen complaints and reported incidences of CBM impacts on drinking water wells and included these accounts in Chapter 6 of the report. In the final report, EPA has clarified the rationale for including citizen complaints in its report.

The final report also clarifies that many of the reported impacts (such as impacts to water supply quantities and effects of discharge of groundwater extracted in the CBM production process) included in Chapter 6 are outside of the scope of SDWA and beyond the scope of the Phase I study. The goal of the Phase I study was to assess the potential for contamination of USDWs due to the injection of hydraulic fracturing fluids into CBM wells, and to determine based on these findings if further study is warranted. EPA also incorporated information that was provided by states regarding incident reports, and state-specific regulations. Finally, the Agency took Table 6-2 out of the document because, as suggested by some commenters, summarizing citizen complaints in a tabular format oversimplified this information, and created a potential for misinterpretation. The information in Table 6-2 is presented in detail in the main body of Chapter 6.

See also EPA's response to comment in section II.D of this document regarding other issues pertaining to water contamination incidents and citizen complaints.

## **I. Other Chapter 7 Comments (Conclusions and Recommendations)**

Summary of Comments: Most comments received regarding Chapter 7 of the report also relate back to prior report chapters. Several commenters had specific suggestions or questions regarding the conclusions and recommendations section of the report. Some of these commenters agreed with the conclusions of the study, but recommended that EPA put more emphasis on the conclusions, and include information about the findings of the study earlier in the document. Specifically, commenters suggested that, at the beginning of the document, EPA include a statement clarifying that: "EPA finds no evidence of harm from hydraulic fracturing

while investigating the reported incidents that spurred the study." These commenters felt that EPA's findings that Phase II of the study is unnecessary, and that little or no public health threat is posed by hydraulic fracturing should be more strongly stated in the conclusions of the report.

Note that commenter opinions regarding Chapter 7 of the report do not reflect the overall commenter perspectives regarding the outcome and conclusions of the study. Most of the commenters expressed opinions regarding the study's conclusions, but did not state them within the context of Chapter 7.

EPA Response: EPA has reviewed all commenter suggestions regarding Chapter 7, and incorporated the majority of these comments where appropriate. Other revisions to Chapter 7, which relate back to changes in previous chapters, have been made in order to ensure internal consistency within the document.

## **VIII. BASIN DESCRIPTIONS**

This summary of basin-specific comments focuses mainly on those comments that have not been summarized within the issue-specific Sections II through VI of this document. Many comments were received that provided minor editorial suggestions and factual corrections regarding basin descriptions. The Agency has considered all comments, researched the accuracy of some comments (where necessary), and incorporated public comments where appropriate.

### **A. San Juan Basin**

Summary of Comments: One commenter provided suggested edits and corrections pertaining to the San Juan Basin geology, hydrology and USDW identification, and CBM production activity. This commenter also provided additional references.

EPA Response: EPA reviewed and considered all suggested edits and corrections and has incorporated revisions to the San Juan Basin descriptions. EPA also reviewed the additional references provided by the commenter, and incorporated additional pertinent information.

### **B. Black Warrior Basin**

Summary of Comments: One commenter provided a variety of editorial comments and factual clarifications regarding the Black Warrior Basin. Examples of information the commenter questioned include: coal thickness; total dissolved solids levels; number of active Class II wells in this area; fracture height vs. length; and chemical components of fracturing fluids.

EPA Response: EPA has incorporated into the final report the majority of the commenter's suggestions regarding the description of the Black Warrior Basin.

### **C. Piceance Basin**

Summary of Comments: One commenter provided a brief description of the activities and progress of the pilot program in the White River Dome field.

EPA Response: The final report contains the information provided by the commenter.

#### **D. Uinta Basin**

Summary of Comments: One commenter indicated that the information on the Castlegate Field is out of date. The commenter clarified that the field is currently in production, and explained why he believes that cross-contamination from the Blackhawk to the Castlegate Sandstone and Star Point Sandstone (as indicated in the report) is unlikely.

EPA Response: EPA has made revisions to the basin description based on this information.

#### **E. Powder River Basin**

Summary of Comments: *No substantive comments were submitted on this section.*

#### **F. Central Appalachian Basin**

Summary of Comments: One commenter provided clarifications and corrections regarding CBM activity, regulations, and drinking water sources in Virginia.

EPA Response: EPA has incorporated many of the commenter's clarifications into the basin description.

#### **G. Northern Appalachian Basin**

Summary of Comments: One commenter provided information on the square mileage and number of CBM wells in this basin, with associated references. This commenter, who is the individual that was interviewed for some of the information provided in this attachment, provided edits to the interview summary. Another commenter suggested several editorial corrections pertaining to the location of specific coal groups, the use of the term "group," and the use of the term "separated laterally" vs. "vertical separation."

EPA Response: EPA has incorporated all appropriate information into the basin description.

#### **H. Western Interior Basin**

Summary of Comments: This commenter questioned the accuracy of the statement that "coal seams could be coincident with a USDW" within the Cherokee Basin. The commenter discussed the aerial extent to which various coal seams in the Cherokee Basin coincide with USDWs, and recommended that EPA also review a 1997 paper entitled "Kansas coal resources and their potential for coalbed methane."

EPA Response: EPA has modified the report to indicate that "all or part of targeted coal seams could be coincident with a USDW," thereby clarifying the summary of the data provided in Table A8-2, which presents the relative depths of coal seams and USDWs.

### **I. Raton Basin**

Summary of Comments: *No comments were submitted on this section.*

### **J. Sand Wash Basin**

Summary of Comments: One commenter pointed out that in the Sand Wash Basin, the pilot at Craig Dome was abandoned "due to excessive water production." This commenter also believed that EPA's findings that hydraulic fracturing poses very little potential threat to USDWs does not account for proximity or overlap with natural fault lines. The commenter stated that: "if a fracture propagates into and along a fault plane, it may contaminate a USDW."

EPA Response: EPA has incorporated the commenter's information into Attachment 10 of the final report.

### **K. Washington Coal Regions (Pacific and Central)**

Summary of Comments: *No comments were submitted on this section.*