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March 3, 2011

BY ELECTRONIC MAIL ONLY

Mr. Edward Hanlon
Designated Federal Officer
EPA Science Advisory Board Staff Office (1400R)
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N. W.
Washington, DC 20460

Re: Comments of Halliburton Energy Services, Inc. on
U.S. Environmental Protection Agency Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

Dear Mr. Hanlon:

In response to the Science Advisory Board's February 9, 2011 Federal Register Notice, 76 Fed. Reg. 7,199 [FRL–9264–5], please find attached the written comments of Halliburton Energy Services, Inc. (HESI) on the U.S. Environmental Protection Agency's Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources. These comments have been signed on behalf of HESI's Assistant General Counsel, Stuart Kemp.

Thank you for your assistance

Respectfully,

BAKER BOTTS, L.L.P.

By: J. Barton Seitz
Of Counsel to Halliburton ~~Energy~~ Services, Inc.

JBS:jmd
Enclosure

Comments of Halliburton Energy Services, Inc.

U.S. Environmental Protection Agency Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

March 3, 2011

I. Introduction

Halliburton Energy Services, Inc. ("HESI") welcomes the opportunity to submit these comments to the Science Advisory Board ("SAB") regarding the U.S. Environmental Protection Agency ("EPA") Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources ("Draft Study Plan").

HESI is a leading provider of services to the oil and gas industry and is the global leader with respect to hydraulic fracturing services. HESI helped pioneer the use of hydraulic fracturing in the 1940's and has fraced many hundreds of thousands of wells over the course of the past 60 years. During this time, HESI has conducted independent research on hydraulic fracturing technologies and initiated numerous key innovations for fracturing services. This experience makes HESI particularly well-qualified to comment on the Agency's proposed Study of hydraulic fracturing (the "Study"). We respectfully request that HESI's comments be included in the Agency's administrative record for the Study.

II. Importance of Hydraulic Fracturing

Hydraulic fracturing is the key to accessing and effectively producing the nation's oil and natural gas resources. Recent estimates indicate that the use of hydraulic fracturing technology accounts for 30 percent of U.S. recoverable oil and gas reserves, and to date has been responsible for the production of more than 7 billion barrels of oil and 600 trillion cubic feet of natural gas

that would otherwise have been inaccessible.[1] The National Petroleum Council previously estimated that 60 to 80 percent of all the wells drilled between 2000 and 2010 would require fracturing to meet natural gas demands.[2] A 2009 study estimated that 95 percent of all wells are hydraulically fractured, particularly in unconventional formations.[3] As one expert has stated, as much as 95 percent of the oil and gas wells in the world are now dependent on hydraulic fracturing because the easily-reached petroleum reserves have been used up.[4]

Hydraulic fracturing is particularly critical for recovering natural gas in unconventional shale formations. Indeed, the Ground Water Protection Council ("GWPC") has called hydraulic fracturing the "technological key to the economic recovery of shale gas,"[5] noting that "[b]ecause of the low permeability of [unconventional] formations, it is typically necessary to stimulate the reservoir to create additional permeability [and] [h]ydraulic fracturing is the preferred stimulation method for gas shales."[6] Based on the increased use of hydraulic fracturing in shale plays across the U.S., shale gas has been estimated to account for at least one-third of total U.S. gas reserves.[7]

Given the importance of hydraulic fracturing technology to our nation's energy supply, unwarranted restrictions on its use could have substantial negative economic impacts. Without the use of hydraulic fracturing, most of the new wells across the country would be uneconomical and would be shut down or would never be drilled in the first place – eliminating the jobs,

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[1] *See* http://www.energyindepth.org/about/quick-facts/.
[2] *See* http://www.energyindepth.org/in-depth/frac-in-depth/.
[3] IHS Global Insight, *Measuring the Economic and Energy Impacts of Proposals to Regulate Hydraulic Fracturing* (2009), *available at* http://www.api.org/policy/exploration/hydraulicfracturing/upload/IHG_GI_Hydraulic_Fracturing_Exec_Summary.pdf.
[4] *See* David A. Hill, *Expert: 95 Percent of Oil, Gas Wells Are Fractured*, Colorado Energy News, Dec. 7, 2009, *available at* http://coloradoenergynews.com/2009/12/ expert-95-percent-of-oil-gas-wells-are-fractured.
[5] Ground Water Protection Council, et. al., *Modern Shale Gas Development in the United States: A Primer* at ES-4 (April 2009). The GWPC is an organization that includes state regulators from across the U.S. who are responsible for the protection of groundwater.
[6] *Id.* at 15.
[7] Press Release, Potential Gas Committee, *Potential Gas Committee Reports Unprecedented Increase In Magnitude of U.S. Natural Gas Resource Base* (June 18, 2009).

government revenue and economic activity that they currently generate. Recent reports indicate that without hydraulic fracturing, there would be a 79 percent decrease in the number of wells completed in this country, leading to a 23 percent reduction in oil production and 57 percent reduction in gas production by 2018. These declining production rates would have a powerful impact on the 354,000 Americans the energy industry employs in the exploration and production of domestic oil and natural gas.[8]

In 2007, $226 billion was invested in domestic oil and gas exploration and production activities alone. These investments help to drive economic growth, support local businesses and keep Americans working. Royalties paid by producers totaled $30 billion in 2007, and billions were paid to federal and local governments in the form of severance and income taxes.[9]

III. General Comments

A. The proposed Study scope has improved, but still is overbroad

HESI appreciates the changes that EPA has made to the proposed scope of its Study of hydraulic fracturing operations. As EPA acknowledges in its Draft Study Plan, the U.S. Congress directed EPA to undertake a study concerning "the relationship between hydraulic fracturing and drinking water." Consistent with Congress' directive, the Agency has now identified a number of specific "areas of concern" that are outside the scope of the Study, including such issues as reinjection of produced waters through Class II wells, air emissions, terrestrial and aquatic ecosystem impacts and alleged seismic impacts, and should not be

[8] *See* http://www.energyindepth.org/about/quick-facts/.

[9] *Id. See also* The Perryman Group, *An Enduring Resource: A Perspective on the Past, Present, and Future Contribution of the Barnett Shale to the Economy of Fort Worth and the Surrounding Area* at 27 (March 2009) (Even in a recessionary economy, drilling and production in the Barnett Shale are contributing significantly to local income and tax revenues in the Dallas and Fort Worth area while limiting job losses in the region).

addressed in the proposed Study.[10] HESI agrees that all of these issues do not specifically involve drinking water concerns and need not be included in the Agency's Study Plan.[11]

However, HESI believes that the scope of the Study as set forth in the Draft Study Plan still remains overbroad and continues to encompass issues that are not directly related to hydraulic fracturing and its potential effects on drinking water. Rather than addressing these issues, EPA should instead focus on the concerns that led Congress to request the Study in the first place, namely concerns related to the specific impacts of hydraulic fracturing on drinking water. As Representative Hinchey (D-NY) – the principal sponsor of the congressional language concerning the Study – stated when the House of Representatives approved the appropriations report containing that language, "[t]he study results will put us in a position to take any further steps that are necessary to protect our drinking water supplies from the *chemical* concoctions being *pumped into the ground* by energy companies."[12] Thus, Congress was principally concerned with the hydraulic fracturing fluids being pumped into the subsurface as part of the fracturing process and the potential impacts that these fluids could have on drinking water.

Accordingly, EPA should place its highest priority on studying those areas relating specifically to fracturing fluids and any possible impacts on drinking water wells and aquifers used for drinking water. It is this type of research that will most directly address the issues that motivated the congressional request for the Study.

At the same time, EPA should place a lower priority on areas of research that would not address this core issue. The Agency recognizes that it will have limited resources that will be

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[10] Draft Study Plan at 54-57.

[11] Previously, EPA had suggested that it planned to study a broad range of ecosystem, habitat and recreational issues that were inconsistent with Congress' specific attention on drinking water. *See* EPA, *Scoping Materials for Initial Design of EPA Research Study on Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources* at 2 (March 2010).

[12] *Congress Gives Final Approval to Hinchey Provision Urging EPA to Conduct New Study on Risks Hydraulic Fracturing Poses to Drinking Water Supplies* (Oct. 28, 2009), *available at* http://hinchey.house.gov/index.php?option=com_content&task=view&id=766&Itemid=69 (emphasis added).

available to conduct the Study and that it must therefore prioritize its research efforts. In fact, the Agency is seeking to leverage its available resources by enlisting the help of others in its research program. HESI believes that some of the research that EPA plans to undertake under the heading of "Well Injection" – particularly some of the field research proposed by the Agency – may be more resource-intensive than EPA expects. As a result, the Agency should be prepared to focus its resources on the key issues identified by Congress and to deemphasize research that will not address these key issues.

For example, EPA is proposing to devote significant resources to researching the potential impacts of withdrawals of water for use in hydraulic fracturing fluids on both the availability of drinking water and on water quality; in fact, water withdrawal is designated in the Draft Study Plan as one of the five general areas of research to be undertaken as part of the Study.[13] HESI recognizes that concerns have been raised regarding the volumes of water required for hydraulic fracturing operations in horizontal wells and the potential impacts that these withdrawals may have on aquatic ecosystems; in fact, HESI has been a leader in developing new fluids and other technologies that will facilitate the reuse of flowback fluid and produced water for future hydraulic fracturing operations, thereby minimizing the amount of fresh water needed. Nevertheless, whatever the impacts of water withdrawals associated with fracturing operations might be, those impacts are entirely unrelated to the concerns that motivated Congress to request the Study. Research regarding the impacts of water withdrawals will not contribute to resolving the drinking water issues of central concern to Congress.

Accordingly, if it is to be conducted at all, research regarding water withdrawals should be accorded a much lower priority than issues associated with the use of hydraulic fracturing fluids during the actual fracturing process. Moreover, any research efforts that are devoted to

[13] Draft Study Plan at 18.

water withdrawal should be limited to water resources that are truly available for drinking water use based on the volume of water available and considerations of accessibility. It would make little sense to devote scarce resources to studying the potential impacts of water withdrawals on water bodies or aquifers where water supply availability is theoretical at best.

HESI also continues to have concerns that EPA has failed to limit the Study to aspects of the oil and gas well development process that are uniquely associated with hydraulic fracturing and instead seeks to devote resources to studying issues that relate to oil and gas drilling operations in general and associated well development process activities. This is particularly true with respect to EPA's proposal to conduct research on both the on-site management of and the ultimate disposal of produced water. Formations that have water naturally associated with them will yield produced water as part of the oil and gas production process. After an initial period when fluids introduced into the formation during the hydraulic fracturing process flow back out of the well, these produced waters will consist predominately or even exclusively of natural formation water. As a result, water treatment issues associated with conventional parameters such as total dissolved solids, bromides, chlorides and other inorganics are not unique to hydraulic fracturing activities but apply to oil and gas production in general. Therefore, research regarding the management of produced water will not yield any insights on the relationship between hydraulic fracturing and drinking water and should not be addressed in the proposed Study.

Likewise, the Draft Study Plan discusses concerns about the ability of publicly-owned treatment works ("POTWs") to "treat hydraulic fracturing wastewaters," citing large quantities of sodium and chlorides that can in turn result in high levels of total dissolved solids ("TDS") in

these wastewaters.[14] However, these high TDS levels are generally associated with naturally occurring formation waters rather than hydraulic fracturing fluids *per se*; for example, the waters found in the Marcellus Shale represent remnants of an ancient inland sea that are naturally high in chlorides. Therefore, research concerning the effectiveness of current treatment methods for produced water as proposed by EPA will again fail to yield relevant information regarding the relationship between hydraulic fracturing and drinking water.

B. The Study should include a conventional human health risk assessment for drinking water exposure pathways

1. A proper risk assessment involves not only toxicity assessment, but also an evaluation of exposure pathways and risk characterization

The Study Plan should clearly articulate how the significance of any potential drinking water quality impacts associated with the hydraulic fracturing process will be evaluated and quantified. Consistent with well-established methodologies for evaluating potential impacts, HESI believes that conducting a human health risk assessment would be an appropriate approach for EPA to take.

The Draft Study Plan contains a variety of statements implying that EPA intends to adopt a risk assessment approach, but the Study Plan should be revised to make the Agency's intent and methods much more explicit. For example, the Executive Summary and Introduction contain the following statements:

> More specifically, the study is designed to examine the conditions that may be associated with the potential contamination of drinking water resources, and to identify the factors that may lead to human exposure and risks.[15]

and

> EPA has identified a set of proposed research activities associated with each stage of the hydraulic fracturing water lifecycle, from water

[14] *Id.* at 40.
[15] *Id.* at i.

> acquisition through the mixing of chemicals and actual fracturing to post-fracturing production, including the management of flowback and produced water and ultimate treatment and disposal. These research activities will identify potential sources and pathways of exposure and will provide information about the toxicity of contaminants of concern. This information can then be used to assess the potential risks to drinking water resources.[16]

The discussion in Section 8 of the Draft Study Plan further indicates that the Agency will evaluate the toxicity of hydraulic fracturing additives, and "combine this with exposure and other relevant data," again implying an intention to perhaps use this information in a risk assessment framework:

> Information developed from this effort to characterize the toxicity and health effects of chemicals will be an important component of understanding the overall risk posed by hydraulic fracturing chemicals that may be present in drinking water resources. When combined with exposure and other relevant data, this information will help EPA characterize the potential public health impacts of hydraulic fracturing on drinking water resources.[17]

While EPA's foregoing statements suggest that risk-based principles might be included in the Study, the Draft Study Plan should be revised to articulate specifically that the Agency will conduct risk assessments for potential hydraulic fracturing impacts to drinking water resources, an approach that HESI supports and firmly believes is necessary in order to produce a valid and credible scientific study.

Well-established federal guidelines direct that risk assessments should evaluate not only chemical toxicity, but also human exposure, both of which are needed to assess the significance of potential hydraulic fracturing impacts to drinking water resources. As the National Research Council has succinctly stated, "[h]uman-health risk assessment entails the evaluation of scientific information on the hazardous properties of environmental agents [chemicals] and on the extent

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[16] *Id.* at 1.
[17] Draft Study Plan at 49.

of human exposure to those agents. The product of the evaluation is a statement regarding the probability that populations so exposed will be harmed, and to what degree."[18] As this statement indicates, there are three fundamental components of a risk assessment:

- Determine the amount of human chemical exposure (*i.e.*, Exposure Assessment);
- Evaluate the hazards associated with particular chemicals (*i.e.*, Toxicity Assessment); and
- Characterize the probability and the magnitude of the harm (*i.e.*, Risk Characterization).

The U.S. EPA Risk Assessment Guidance for Superfund[19] specifically sets forth the methods for each of the three key risk assessment components. However, HESI is concerned that the current Draft Study Plan includes proposals to address the second, Toxicity Assessment element of a risk assessment, but does not indicate whether or how such information will be aptly combined within a quantitative exposure assessment in order to assess potential human health risks. The potential human exposure to hydraulic fracturing fluid constituents must be reliably estimated in order to assess the significance of "potential public health impacts" and the "risks" of hydraulic fracturing on drinking water resources. HESI agrees with the SAB's prior recommendation that the potential health risks ". . . should only be assessed after sources and pathways of possible exposure are much better understood."[20] Consequently, it is recommended that the Study Plan should be revised to state explicitly that the Agency intends to follow established risk assessment methods to assess all of the critical elements of any such examination, including specifically the potential exposure, toxicity, and health risks associated with possible hydraulic fracturing contamination (if any) of drinking water resources.

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[18] National Research Council, Committee on Risk Assessment and Hazardous Air Pollutants, *Science and Judgment in Risk Assessment* (National Academy Press, 1994).

[19] EPA, Office of Emergency and Remedial Response, *Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part A) (Interim final)*, NTIS PB90-155581; EPA-540/1-89-002 (1989).

[20] SAB, *Advisory on EPA's Research Scoping Document Related to Hydraulic Fracturing*, Enclosure C at 17 (June 24, 2010).

At the same time, the Agency should revise the Study Plan to explicitly define the exposure scenarios and fundamental assumptions to be used in the risk assessment, including more detailed conceptual models defining release mechanisms and pathways to be considered during the hydraulic fracturing lifecycle, and provide more explicit information regarding the exposure assessment methods that will be used. The Agency should therefore revise the Study Plan to identify its conceptual model for the risk assessment (*e.g.*, viable release scenarios, exposure pathways to drinking water resources, *etc.*) and specific risk assessment methods it intends to employ to address this research question. These changes would help EPA satisfy the congressional mandate discussed above and the congressional concerns that gave rise to the Study, by fully addressing potential drinking water exposure pathways.

2. The Agency should rely on readily available studies about hydraulic fracturing

HESI further requests that EPA rely on the numerous existing studies about hydraulic fracturing and its potential impacts that are available from governmental agencies, industry and other organizations. Although the Agency's Draft Study Plan includes citations to a few of these existing studies – such as EPA's 2004 "Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs" ("2004 EPA Report") and the Ground Water Protection Council's April 2009 "Modern Shale Gas Development in the United States: A Primer" report – the Study Plan does not clearly reflect the significant findings from these prior analyses. In addition, there are many other similar studies and related resources that EPA also should review and incorporate as part of the overall Study.

Studies such as the 2004 EPA study of coalbed methane operations and other well-known scientific studies of hydraulic fracturing operations remain valid and relevant and should form the basis for EPA's new Study efforts. The Agency's own 2004 coalbed methane study examined many of the very same issues to be addressed by the new EPA Study. After a

comprehensive review of the existing scientific literature and interviews with dozens of interested parties, EPA concluded that hydraulic fracturing operations in coalbed methane formations do not pose a significant potential threat to underground sources of drinking water ("USDWs") and have not been linked to a single confirmed case of alleged drinking water contamination or well impacts.[21]

Similarly, the 2009 technical report prepared by ICF Incorporated, LLC ("ICF") for the New York State Department of Environmental Conservation ("NYSDEC") provides EPA with further key data and scientific analyses about hydraulic fracturing operations. In its 2009 report,[22] ICF evaluated recent hydraulic fracturing operational practices in the U.S. natural gas industry and how they may affect USDWs. ICF ultimately concluded that hydraulic fracturing "does not present a reasonably foreseeable risk of significant adverse environmental impacts to potential freshwater aquifers" for several key technical reasons, including (1) the physical and geologic separation between the underground shale formations and USDWs by 1,000 feet or more, (2) the relatively short duration of pressurized hydraulic fracturing operations (typically less than one day per stage) whereas it would take many years for frac fluids to migrate to aquifers under even pressurized (much less natural) conditions, (3) some of the hydraulic fracturing additives would be adsorbed by and bound to the shales, and (4) any hydraulic fracturing additives that are left behind in the subsurface after flowback waters are removed would be found at minimal, substantially diluted concentrations.[23] ICF also reaffirmed the conclusions from the 2004 EPA Report, noting that "[t]he historical experience of hydraulic

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[21] 2004 EPA Report at 7-5 to 7-6.

[22] *See* ICF Incorporated, LLC, *Technical Assistance for the Draft Supplemental Generic EIS: Oil, Gas and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low Permeability Gas Reservoirs*, Task 1 Report (Aug. 7, 2009) ("ICF Report").

[23] *Id.* at 34.

fracturing in tens of thousands of wells is consistent with the analytical conclusions. There are no known incidents of groundwater contamination due to hydraulic fracturing."[24]

Furthermore, HESI requests that EPA review and include in its Study the data and conclusions from a set of risk studies recently performed by Gradient in 2009. Two of Gradient's studies included evaluations of (1) the potential human health risks associated with exposures to hydraulic fracturing fluids in the Marcellus Shale region; and (2) the potential effect of flowback water constituents on microbial processes during treatment at POTWs.[25] As part of its human health risk study, Gradient applied conservative assumptions to determine if hydraulic fracturing operations at the surface or subsurface could pose any risks to human health under the following three potential "release" scenarios: (1) release during operations at the surface associated with the pumping of fracturing fluids into the well; (2) release during handling of flowback water; and (3) migration from the subsurface shale production zone.[26] Gradient ultimately concluded that any risks to human health associated with any possible releases of fracturing fluids under these scenarios were insignificant and indeed *de minimis*.[27]

3. The Study Plan should take into account that hydraulic fracturing fluids have limited or no completed pathways of human exposure

While the need to examine exposure factors is discussed above, HESI believes that the available technical evidence already suggests that there are limited or no completed exposure pathways by which fracturing fluids could reach drinking water sources, particularly in the case of shale gas development. This evidence has been identified in several previous studies such as

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[24] *Id.*

[25] A third Gradient study analyzed the NYSDEC's modeling of potential air emissions from surface impoundments used to receive flowback or produced waters.

[26] Gradient, *Human Health Risk Evaluation for Hydraulic Fracturing Fluid Additives Marcellus Shale Formation, New York* at 14 (Dec. 31, 2009) ("Gradient Human Health Risk Evaluation").

[27] *Id.* at 65. Gradient similarly found that discharges of frac fluid constituents to a POTW as part of flowback fluid disposal would be unlikely to cause an upset of the POTW wastewater treatment system. *See* Gradient, *Evaluation of Potential Impacts of Hydraulic Fracturing Flowback Fluid on Microbial Processes in Publicly-Owned Treatment Works* (Dec. 31, 2009).

Gradient's human health risk study described above, which found that there are very few (if any) potentially complete exposure pathways between hydraulic fracturing fluids and drinking water supplies. Indeed, Gradient determined that the potential migration of hydraulic fracturing fluids from the fracture zone into shallow drinking water aquifers via either rock pores or bedrock fractures was highly improbable.[28]

In spite of this well-founded evidence, the Draft Study Plan implies that migration of fracturing fluids from the shale formation itself (*e.g.*, separate from migration *via* a well casing) to overlying aquifers during the fracturing (pumping) phase is a potential pathway of concern.[29] However, HESI is unaware of any data or information which indicates that contamination of overlying aquifers has been caused by fracturing fluid constituents migrating from the underlying shale formation itself (*e.g.*, setting aside hypothetical migration back up the well bore or casing). In fact, it is unclear how these mechanisms would provide a meaningful or "complete" migration pathway from the formation to overlying drinking water aquifers. Shale gas formations, such as the Marcellus Shale formation, are typically separated from overlying aquifers by thousands of feet of bedrock. The implication that the fracturing process could compromise this strata sufficiently to open "new" migration pathways is implausible. NYSDEC, in its Draft Supplemental Generic Environmental Impact Statement, evaluated the likelihood of fracturing fluid migration from the Marcellus Shale formation into overlying aquifers and its analysis indicated that this pathway was implausible.[30] Gradient extended the analysis performed by

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[28] Gradient Human Health Risk Evaluation at 24-27.

[29] *See* Draft Study Plan at 31 ("In the case of leakoff, the fluid may flow into the micropore or pore spaces within the formation, existing natural fractures in the formation, or small fractures opened into the formation by the pressure in the induced fracture. . . . Fluid leakoff during hydraulic fracturing . . . may result in fluid migrating into drinking water aquifers").

[30] NYSDEC, *Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program* at 5-148 (Sept. 30, 2009) ("Draft SGEIS") ("currently proposed approaches to hydraulic fracturing will not have reasonably foreseeable adverse environmental impacts on potential freshwater aquifers due to subsurface migration of fracturing fluids").

NYSDEC and in a 2009 report again demonstrated the implausibility of this pathway as noted above.[31]

Despite the implausibility of a complete migration pathway, Section 6.3.6.2 of the Draft Study Plan suggests that the Agency intends to use mathematical models to explore the potential for fracturing fluid constituents to migrate from the formation to overlying aquifers. For example, the Draft Study Plan indicates that "physics-based modeling tools" will be used to explore "near-field short term" and "far-field long-term" impacts.[32] Given the implausibility of this pathway, HESI questions the utility of spending limited resources on elaborate modeling efforts for this research issue and recommends that empirical data be used wherever possible.

C. EPA's case studies should be based on accurate, representative conditions

To assist in carrying out the Study Plan, the Agency has indicated that it intends to rely on retrospective and prospective case studies to generate data and information to help EPA assess hydraulic fracturing's potential impacts (if any) on drinking water resources. As EPA moves forward, Halliburton urges the Agency to ensure that its Study – and the proposed case studies in particular – focus on the extensive, already-available body of data for hydraulic fracturing operational conditions that are truly representative of real-world industry practices and regulatory requirements. This Study should take a "forward-looking" posture given the rapidly changing technological environment for hydraulic fracturing operations. Furthermore, given the tens of thousands of frac jobs that are performed each year without incident, it is critical that the Agency make sure that its case studies reflect typical, state-of-the art industry practices and do not focus solely on "worst-case" scenarios where drinking water impacts have allegedly occurred.

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[31] *See* Gradient Human Health Risk Evaluation.
[32] Draft Study Plan at 36.

1. The Agency's proposal to examine a limited number of retrospective case study sites is unlikely to yield meaningful insights; EPA should broaden its analysis to include the wide range of existing data for hydraulic fracturing and oil and gas operations

EPA has established an ambitious set of objectives for its Study by stating that the Agency will "examine conditions that may be associated with the potential contamination of drinking water resources, . . . identify the factors that may lead to human exposure and risks,"[33] and assess the "frequency and severity of well failures, as well as the factors that contribute to them."[34] However, to achieve these objectives EPA seemingly will not be reviewing the substantial body of data that already exists for the hundreds of thousands of oil and gas wells and frac jobs that have been completed during the past decade and longer, but rather will principally investigate only five retrospective case study sites and then perform certain limited "scenario evaluations." In essence, Halliburton is concerned that EPA's approach is unlikely to yield meaningful insights into the actual drinking water risks associated with hydraulic fracturing – which have been shown to be minimal at most – and therefore EPA's proposed Study could misdirect the available research funds in an ineffective and unsatisfactory manner.

Halliburton urges the Agency to instead refocus its research and consider a comprehensive examination of the statistically significant body of existing data available from State oil and gas well drilling records, federal and state spill reports and similar sources. Numerous databases and related information sources are available that provide valuable empirical data (and a sufficiently large sample size) for EPA to review and incorporate into its Study. For historical data these sources include, for example, the following:

- Information compiled by state oil and gas commissions and environmental regulators in connection with oil and natural gas well drilling operations;

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[33] *Id.* at vii.
[34] *Id.* at 35.

- Additional databases maintained by these state agencies that involve groundwater and/or surface water quality, such as the water well quality database compiled by the Colorado Oil and Gas Conservation Commission ("COGCC") and the Pennsylvania Department of Environmental Protection's ("PADEP") collection of groundwater quality data;
- The National Response Center's database of spills and releases of hazardous substances, petroleum and other materials,[35] and similar state databases such as those maintained by New York, Pennsylvania, Texas and others; and
- Surface water quality data collected by EPA and state agencies as part of their identification and assessment of "impaired" water bodies under Section 303(d) of the federal Clean Water Act.

HESI believes that these data sources should be carefully reviewed for identifiable trends in the rate and significance of incidents – if any – that are truly associated with hydraulic fracturing operations. Without this much more comprehensive retrospective examination, EPA is unlikely to effectively respond to its express congressional directive to study the relationship between hydraulic fracturing and drinking water resources – and the Agency's Study would instead merely raise new unresolved questions that are unrelated to hydraulic fracturing. Moreover, unless EPA carefully reviews the available empirical data, the Agency will not achieve its stated research outcome of determining the "frequency and severity of well failures, as well as the factors that contribute to them."[36]

2. The retrospective case studies should include sites where hydraulic fracturing has been performed without incident, instead of focusing only on "worst-case" circumstances

In the Draft Study Plan, EPA has proposed to conduct retrospective case studies at three to five sites in unconventional geologic formations that will be selected from among the following five "finalist" sites: (1) Bakken Shale – Killdeer and Dunn County, ND; (2) Barnett Shale – Wise and Denton Counties, TX; (3) Marcellus Shale – Bradford and Susquehanna

[35] At its website, the National Response Center indicates that it "makes all oil and chemical spill data reported to the Center available via the World Wide Web." *See* http://www.nrc.uscg.mil/foia.html.
[36] Draft Study Plan at 35.

Counties, PA; (4) Marcellus Shale – Wetzel County, WV; Green/ Washington Counties, PA; and (5) Raton Basin – Los Animas County, CO. According to the Agency, these five finalist geographic locations were identified because they have potential drinking water contamination allegedly caused by natural gas drilling operations, and EPA wishes to evaluate whether hydraulic fracturing operations have contributed to the contamination at these sites.[37]

Regardless of which geologic locations are addressed, HESI submits that EPA's proposed retrospective study approach must be based on an approach that is fully representative of recent oil and gas development. A comprehensive and accurate study of the risks related to hydraulic fracturing should take a balanced look at the typical well settings and geologic conditions at any of the designated sites and assess the long track record of actual hydraulic fracturing performance. In order to capture a comprehensive range of data and information, HESI believes that EPA's case study criteria should ensure that the sites selected for case studies include not only the more vulnerable hydrogeologic and well site settings in closest proximity to water sources, but also the more typical well settings and conditions.

Indeed, HESI's experience has confirmed what several independent studies have shown: the typical well site settings and geologic conditions in which hydraulic fracturing is used involve wells that are properly constructed under industry standards and carefully targeted production zones. These production zones have been hydraulically isolated from overlying shallow aquifers for hundreds of millions of years, with many intervening layers of low permeability shales, siltstone and limestone lying between the shallow aquifers and the production zones thousands of feet below.[38] EPA's 2004 study of the most shallow formations where hydraulic fracturing is typically utilized – coalbed methane reservoirs – fully supports this

[37] *Id.* at 44.
[38] *See, e.g.,* ICF Report at 34.

view and found no confirmed cases of contamination due to underground movement of gases or fluids.[39]

Moreover, the responsible state oil and gas commissions and other key authorities have already investigated the alleged prior incidents to be assessed by EPA in its five retrospective study sites that have been initially targeted by the Agency, and have uniformly determined that subsurface hydraulic fracturing operations were not responsible. Surprisingly, EPA makes no mention of any of these prior state investigations throughout the Draft Study Plan and the Agency apparently intends to conduct again its own independent review of the these alleged incidents. For example, one of EPA's proposed retrospective sites would be located in Susquehanna County, Pennsylvania, where there have been allegations that water wells were contaminated by fluids used to hydraulically fracture several natural gas wells in the area. However, PADEP – the state agency that regulates oil and gas activities in Pennsylvania – has already thoroughly investigated this incident and specifically concluded that hydraulic fracturing activity has not impacted local water wells. Halliburton therefore urges the Agency to fully acknowledge and incorporate into its Study the results of PADEP's and other similar state investigations of alleged hydraulic fracturing impacts which have uniformly found that hydraulic fracturing has not impacted USDWs, or at the very least identify and study other representative frac projects in these areas as well.[40]

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[39] *See* 2004 EPA Report.

[40] *See, e.g.,* PADEP, Press Release, *DEP Continues to Analyze Dimock Water Supplies* (March 27, 2009).

3. The prospective case study sites should evaluate hydraulic fracturing operations that are being conducted consistent with recently-implemented state requirements and industry practices that are likely to be followed in the coming years, and should include background sampling of underground aquifers and surface water bodies prior to drilling

In addition to addressing representative projects as part of the retrospective case studies, Halliburton requests that the prospective case study process should fully take into account recently-adopted regulatory controls and industry management practices as the Agency selects and implements these case studies. As EPA knows, hydraulic fracturing and other oil and gas operations have been carefully regulated by state agencies for many decades. These existing programs have established important health and environmental protection requirements while still assuring that critically important energy resources can be effectively recovered.

In recent years, several key oil- and gas-producing states have taken further steps to strengthen existing state regulations in order to incorporate updated best practices for well construction and hydraulic fracturing operations. For example, in 2008 the COGCC promulgated amended rules that included extensive requirements on well construction standards, water protection and waste management.[41] Similarly, during 2010 PADEP adopted a comprehensive update to its oil and gas regulations to specify additional requirements for well design, construction practices, gas migration prevention, and hydraulic fracturing.[42] EPA's assessment of potential drinking water impacts during the prospective case study process should expressly acknowledge the applicability of these state regulatory requirements and account for the impacts that these controls will achieve as future prospective projects are undertaken.

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[41] Colorado Oil and Gas Conservation Commission, *Statement of Basis, Specific Authority, and Purpose* at 1-2 (2008), *available at* http://cogcc.state.co.us/ (follow link to "Final Amended Rules"; then follow link under "Final Statement of Basis and Purpose").

[42] Pennsylvania Independent Regulatory Review Commission, *Approval Order, Regulation No. 7-459: Environmental Quality Board Oil and Gas Wells* (Nov. 18, 2010), *available at* http://www.irrc.state.pa.us/Documents/SRCDocuments/Regulations/2857/IRRC/Document-20520.pdf.

At the same time, HESI requests that EPA's Study fully reflect the application of up-to-date industry best management practices that are specifically designed to protect drinking water supplies, as well as the fact that hydraulic fracturing technology continues to rapidly evolve and achieve higher performance goals. Having long recognized the importance of human health and environmental protection, the oil and gas industry has been working to continually improve its operations by adopting standards/practices which help assure that hydraulic fracturing would not pose unacceptable risks to human health or the environment. These measures have included, for example, a series of American Petroleum Institute ("API") guidance documents that contain recommended practices for various aspects of operations associated with hydraulic fracturing.[43] In one recent key API guidance, the oil and gas industry has emphasized the importance of using effective well construction practices:

> [m]aintaining well integrity is a key design principle and design feature of all oil and gas production wells . . . . Although there is some variability in the details of well construction because of varying geologic, environmental and operational settings, the basic practices in constructing a reliable well are similar . . . [and] are the result of operators gaining knowledge based on years of experience and technology development and improvement.[44]

This API guidance additionally indicates that the casing used in wells that will be hydraulically fractured should meet specified API standards covering the design, manufacture, testing and transportation of casing in order to ensure that the well will be able to withstand the anticipated hydraulic fracturing pressure as well as the expected production pressures and corrosive conditions.[45] These standards call for, among other things, cementing the annulus of the conductor and surface casing from the bottom of the casing to the ground surface. The specific

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[43] *See* API, *Guidance Document HF1, Hydraulic Fracturing Operations – Well Construction and Integrity Guidelines* (1st Ed. 2009) ("API HF1"); API, *Guidance Document HF2, Water Management Associated with Hydraulic Fracturing* (1st Ed. 2010) ("API HF2"); API, *Guidance Document HF3, Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing* (1st Ed. 2011) ("API HF3").

[44] API HF1 at 1.

[45] *Id.* at 4-5.

role of the surface casing is to isolate USDWs. An intermediate casing is installed to provide borehole stability and isolate subsurface zones of anomalous high pressure. The intermediate casing annulus is cemented to a height above any petroleum- or gas-producing zone and USDW zone. Finally, the production casing is cemented in place to isolate the production zone from all other subsurface formations.[46]

API guidelines further contain detailed recommendations concerning the selection of cement and cementing practices as well as logging and other diagnostic procedures to ensure the integrity of the cement job.[47] For example, the cement used in these wells should conform to the standards set forth in API Specification 10A and API Recommended Practice 10B-4.[48] The foregoing industry standards and best management practices help assure that zonal isolation effectively prevents the materials in the wellbore (including hydraulic fracturing fluids) from coming into contact with shallow formations that may contain drinking water aquifers.

HESI itself has been working to continually enhance the performance of fracturing technology. To effectively perform hydraulic fracturing requires an understanding of the geologic, petrophysical and reservoir parameters of the hydrocarbon-bearing formation and its surrounding layers. HESI devotes significant resources to researching these parameters and developing programs that successfully stimulate production formations, but at the same time isolate and protect the integrity of the production and water-bearing zones. HESI invests substantial research and development efforts to formulate custom stimulation fluid systems to perform within the geological and technical conditions unique to each well and formation. These research efforts include significant work in developing stimulation fluid systems that can be

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[46] *Id.* at 5.
[47] *Id.* at 9-10.
[48] *See* API, *Specification 10A: Specification for Cements and Materials for Well Cementing* (2002); API, *Recommended Practice 10B-4/ISO 10426-4, Recommended Practice on Preparation and Testing of Foamed Cement Slurries at Atmospheric Pressure* (2004).

effectively and safely used in conventional and unconventional oil and gas wells, including coalbed methane, shales and tight sands.

HESI's innovative technology is not limited solely to those that directly increase oil and gas production for its customers. HESI also invests substantial resources in developing effective solutions to issues raised by the industry with respect to other aspects of the hydraulic fracturing process, solutions that often have key environmental benefits. HESI's CleanSuite™ Technologies include products and services aimed at achieving both production objectives and environmental benefits. For example, HESI's CleanStream® Service is an ultraviolet light bacteria control process that uses a mobile unit capable of treating fracturing fluid at rates up to 100 barrels per minute. The CleamStream® Service enables operators to significantly reduce the volume of biocides used to treat for aerobic and anaerobic (sulfate reducing) bacteria. If wellsite logistics permit the utilization of the CleanStream® Service on-the-fly, biocide use in the stimulation process can be substantially reduced.

HESI's CleanSuite™ Technologies also include other innovative solutions such as CleanStim™, which is one of the most environmentally safe fluid systems ever developed. This innovative fracturing fluid system is comprised of ingredients sourced from the food industry, which provides further protection during the frac job. HESI's ADP™ Advanced Dry Polymer Blender also serves to minimize the use of chemicals in the hydraulic fracturing process. The ADP™ Advanced Dry Polymer Blender allows HESI to bring the gelling agent (typically guar) to the well site in dry form and mix it with the frac fluids without the use of a liquid gel concentrate ("LGC"), thereby eliminating the use of LGCs and reducing the amount of chemicals requiring transport to the well site.[49]

[49] Complete information about HESI's CleanSuite™ Technologies is available at http://www.halliburton.com/public/projects/pubsdata/Hydraulic_Fracturing/CleanSuite_Technologies.html.

In addition to conducting a thorough review of the applicable regulatory controls and industry practices as part of the prospective case study process, the Agency should collect a comprehensive set of background data. Obtaining adequate baseline data representing aquifer and formation conditions prior to hydraulic fracturing operations is paramount for these case studies to provide meaningful information. For example, obtaining *in situ* water chemistry data for drinking water aquifers and, where practicable, underlying shale formation waters is critical. In addition, the properties of these strata that control water movement in the aquifer (porosity, hydraulic conductivity, hydraulic head, *etc.*) should also be determined.

IV. Specific Comments

A. EPA's hypothetical fracture propagation discussion significantly overstates the potential dangers of uncontrolled fractures (pp. 30-31 of the Study Plan)

EPA has claimed in its Draft Study Plan that hydraulic fracturing operations can cause uncontrolled fractures in subsurface geological formations, which allegedly can serve as potential pathways for contamination of shallow drinking water.[50] However, contrary to the Agency's claims, previous studies have already considered these issues and found that hydraulic fracturing operations are unlikely to result in uncontrolled fractures, for the following reasons:

- In-situ stress (compressive far-field stress) in the shales will tend to close fractures. Shales are generally somewhat ductile and tend to creep, thus keeping fractures closed;[51]
- Hydraulic fracturing pressures, which could potentially drive fluid through a fracture from a gas-bearing shale into an overlying aquifer thousands of feet above, are generally only applied for 1-2 days. The time for fluid to flow under those pressures may be measured in months to years, depending upon the properties of the stratigraphic units above a gas-bearing shale;[52]
- Pressures are carefully monitored during hydraulic fracture propagation by the fracturing contractor. If a propagated fracture intersects a natural fracture, the

[50] Draft Study Plan at 30-31.
[51] Gradient Human Health Risk Evaluation at 26.
[52] ICF Report at 34.

contractor would notice an anomaly due to the inability to maintain fracturing pressure;[53]

- Flowback will immediately relieve the pressure differential caused by induced pressure on the hydraulic fracturing fluids. As such, there would be no driving force or gradient for upward flow beyond the short duration of the hydraulic fracturing stimulation;[54]
- Gas production will lead to pressure reduction in the gas-bearing shale formation, which will create pressure gradient towards the production well, negating potential upflow through propagated or natural fractures;[55] and
- Micro-seismic equipment and tiltmeters are used to map the actual fractures propagated by hydraulic fracturing. In addition, numerical models have been created that can help predict fracture length. These tools are often used in initial hydraulic fracturing in an area to help ensure fractures are not extending beyond the target gas-bearing shale.[56] Propagation of fractures beyond the target formation can have significant effect on the cost of development.

Based on the low potential risk of contamination to shallow drinking water posed by uncontrolled fractures in deep shale hydraulic fracturing as described above, the Study should recognize the role of <u>other</u> potential contaminant sources that are unrelated to hydraulic fracturing. For example, with respect to potential methane migration through uncontrolled fractures into shallow drinking water sources, the Study needs to take into account that there are multiple other causes and sources of methane contamination that are independent of hydraulic fracturing operations. The Study Plan should therefore be revised to explain how these other potential causes/sources will be accounted for in the Study including, among others: (1) anthropogenic methane; (2) shallow coal seams; (3) old, conventional production wells with casing or cement failures; (4) pipelines; (5) septic tanks and fields; (6) old landfills; and (7) other releases of organic materials, such as oil.

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[53] *Id.* at 32.

[54] T. Engelder, The Pennsylvania State University, Department of Geosciences, *Over 1,000,000 Hydraulic Fracturing Stimulations Within the USA Without Compromising Fresh Groundwater: True or False?,* Presentation before the Global Shale Gas Water Management Initiative Conference, Dallas, Texas at 45 (2010).

[55] *Id.* at 46.

[56] S.C. Maxwell, T.I. Urbancic, N. Steinsberger, and R. Zinno, *Microseismic Imaging of Hydraulic Fracture Complexity in the Barnett Shale*, Society of Petroleum Engineers Publication Number 77440 at 1-2 (2002).

B. The draft Study Plan contains inaccurate assumptions and comments about mechanical integrity and alleged wellbore failures (pp. 29-34)

Sections 6.3.1.2 through 6.3.4 of the Draft Study Plan contain various inaccurate assumptions and comments about mechanical integrity and alleged wellbore failures. For example, the Draft Study Plan greatly exaggerates the risks associated with well integrity and does not reflect the industry successes at well completions, current best practices or recent changes to regulations and standards that ensure well integrity. However, well integrity and zonal isolation have been the subject of industry attention since the early part of the 20th century.[57] Early concerns focused largely on preventing formation water from entering the reservoir. Subsequently, well construction practices have evolved and improved to prevent cross-zonal protection of USDWs.

Best management practices are an evolving process achieved through the professional interaction of design engineers, drillers, field service companies and operators in conjunction with state-mandated regulations. It should be emphasized that API and various state regulators have evaluated well integrity issues and developed effective standards and recommended practices for well integrity and state regulators provide enforcement to assure compliance with applicable standards. As noted above, in 2009 API released a full set of well construction guidelines embodied in API HF1. API is an American National Standards Institute-accredited standards-developing organization, operating with approved standards development procedures and undergoing regular audits of its processes.[58] The standards and recommended practices

[57] Ground Water Protection Council, et al., *State Oil and Natural Gas Regulations Designed to Protect Water Resources* at 12 (May 2009).
[58] *See* http://www.api.org/Standards/.

developed by API are designed to ensure zonal isolation between formations, especially the full isolation of groundwater.[59]

Numerous state agencies also have established zonal isolation and well integrity requirements as part of their oil and natural gas regulatory programs. NYSDEC was one of the first state agencies to require cementing for zonal isolation in 1986, through the issuance of New York's Generic Environmental Impact Statement.[60] In addition, NYSDEC's draft SGEIS provides an exhaustive review of natural gas development within that state, and has specifically verified the success of well cementing techniques in New York, noting that:

> There are 482 oil and gas wells located within the boundaries of 14 Primary Aquifers and 2,413 oil and gas wells located within the boundaries of Principal Aquifers. Another 1,510 storage, solution brine, injection, stratigraphic, geothermal, and other deep wells are located within the boundaries of the mapped aquifers. The remaining regulated oil and gas wells likely penetrate a horizon of potable freshwater that can be used by residents or communities as a drinking water. No documented instances of groundwater contamination are recorded in the NYSDEC files from previous horizontal drilling or hydraulic fracturing projects in New York. No documented incidents of groundwater contamination in public water supply systems were reported by the NYSDOH central office and Rochester district office (NYSDOH, 2009a; NYSDOH, 2009b). References have been made to some reports of private well contamination in Chautauqua County in the 1980s that may be attributed to oil and gas drilling (Chautauqua County Department of Health, 2009; NYSDOH, 2009a; NYSDOH, 2009b; Sierra Club, undated). The reported Chautauqua County incidents, the majority of which occurred in the 1980s and which pre-date the current casing and cementing practices and fresh water aquifer supplementary permit conditions, could not be substantiated because pre-drilling water quality testing was not conducted, improper tests were run which yielded inconclusive results and/or the incidents of alleged well contamination were not officially confirmed.[61]

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[59] API HF1 at 5.

[60] NYSDEC, *Generic Environmental Impact Statement* (1992), *available at* http://www.dec.ny.gov/energy/45912.html.

[61] NYSDEC, Draft SGEIS at 2-25 (emphasis added).

EPA should rely on and incorporate into its Study these and similar findings by NYSDEC and other state regulatory agencies which have confirmed that hydraulic fracturing operations have not impacted drinking water resources.

C. EPA should not rely on misstatements about historical diesel use in hydraulic fracturing (p. 25)

The Draft Study Plan includes certain allegations about the products that have been used in hydraulic fracturing operations, and relies on a recent congressional letter to suggest that large quantities of diesel fuel are still being used in frac jobs.[62] However, contrary to EPA's assertions, the allegations about diesel use set forth in a January 31, 2011 letter from U.S. Representatives Waxman, Markey and DeGette to EPA all rely on old, out-of-date data. In fact, HESI has been taking steps to phase out its use of diesel in fracing operations since it signed a Memorandum of Agreement with EPA in 2003 in which it agreed not to use diesel in fracing coalbed methane wells where the frac fluids were being pumped into a USDW. Halliburton's use of diesel in frac fluids has declined substantially since 2005 and has been quite limited since at least 2007.

D. EPA's "chemical mixing" research should focus on realistic scenarios involving chemical mixtures in a dilute form that are representative of actual industry practices and site conditions (pp. 25-27)

EPA's proposed research approach for understanding the "possible impacts of releases of hydraulic fracturing fluids on drinking water resources" during surface operations – referred to as "chemical mixing" in the proposed Study Plan – consists of understanding the chemical composition of hydraulic fracturing fluids, defining the toxicity of hydraulic fracturing additives, and determining the likelihood of impacts to drinking water resources using a combination of

[62] Draft Study Plan at 25.

available data and literature regarding environmental fate and transport of surface spills as well as retrospective/prospective case studies.

However, the Study Plan does not provide adequate detail on how EPA will answer the key "chemical mixing" study question, *i.e.*, how will the Agency "determine the likelihood that surface spills will result in the contamination of drinking water resources"?[63] To address this question, it appears that EPA is merely planning to rely heavily on the findings from only a limited number of retrospective case studies. In fact, the Draft Study Plan states that the Agency will select at least one retrospective case study where accidental surface releases have been reported.[64] In spite of these statements, it is unclear how EPA will use information from one or a few case studies to draw conclusions regarding the likelihood of impacts to drinking water resources as a result of accidental surface spills, given the multiple variables involved (*e.g.*, spill volume, hydraulic fracturing fluid composition, hydrogeological conditions, *etc.*).

In order to properly address this issue, HESI submits that the Study should use a human health risk assessment framework to evaluate the likelihood of impacts to drinking water resources, as previously discussed above in Section III.B. For the reasons described previously in these comments, the Study should utilize realistic scenarios that reflect current industry practices and fully leverage available data. Specifically, the Study should account for state and federal spill prevention and control regulations and best management practices used to minimize and manage accidental releases, such as the industry standards issued by API;[65] utilize typical diluted (or water and proppant-blended) concentrations of hydraulic fracturing additives in the analysis; and incorporate the data from spill-related databases maintained by various states (*e.g.*, Pennsylvania, Colorado, New Mexico) to better understand the frequency and magnitude of

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[63] *Id.* at 27.
[64] *Id.* at 26.
[65] *See, e.g.,* API HF3 (Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing).

hydraulic fracturing-related accidental surface releases during the chemical mixing process. HESI believes that a study design which incorporates these elements, together with a human health risk assessment, would more accurately reflect true, "real-world" operations and help ascertain the likelihood (if any) of potential impacts to drinking water resources.

In any event, as the Agency obtains additional information about the constituents contained in "chemical mixtures" at the well site – such as hydraulic fracturing additives – EPA should ensure that it provides full protection for all proprietary and trade secret information associated with these additive constituents and formulations. HESI and other oil and gas companies have made substantial research and development investments in their proprietary hydraulic fracturing products, and EPA should reaffirm that all proprietary and trade secret information provided to the Agency will be subject to the legal protections afforded to confidential business information under the federal EPA regulations at 40 C.F.R. Part 2, Subpart B.

E. The well "injection" research should rely on empirical data wherever available; modeling should be performed only with current, up-to-date models and technically-proven assumptions (pp. 32-35)

Just as HESI has encouraged the use of empirical data to evaluate historical hydraulic fracturing operations (rather than focusing on a limited set of retrospective case studies), HESI recommends that empirical data be used to evaluate the impacts of pumping operations and that modeling approaches should be pursued only where appropriate and based on valid assumptions. The Draft Study Plan currently indicates that the Agency intends to research potential well injection impacts using "physics-based computer modeling tools."[66] While the use of up-to-date models that are appropriately selected, validated, and calibrated to fit the physical conditions

[66] Draft Study Plan at 34.

being modeled (fractured bedrock flow) is not unreasonable,[67] the Study should provide a clearer definition of the scope of any such modeling scenarios. Based on the text in Section 6.3.3, and the information in the flow chart in Figure 7 of the Draft Study Plan, it appears that the Agency intends to model several scenarios: (i) fluid migration *via* an improperly sealed well casing (including both hydraulic fracturing fluid during downhole pumping operations and flowback/production fluid), and (ii) hydraulic fracturing and/or formation water migration directly from the formation through overlying strata and into shallow drinking water aquifers. However, of these two postulated pathways, migration directly from the formation through overlying strata is highly implausible and modeling of such migration would represent a questionable expenditure of resources for the reasons noted above.[68]

The Draft Study Plan also discusses modeling Areas of Evaluation ("AOEs"),[69] and superimposing the aerial footprint of AOEs over geographical areas containing drinking water resources:

> Within [the AOE], drinking water resources could be affected by the migration of hydraulic fracturing fluids and liberated gases outside the injection zone, as well as the displacement of native brines within the subsurface. Maps of the AOEs for multiple injection operations can be overlaid on regional maps to evaluate cumulative impacts…The AOE may also be used to support contamination fate and transport hypothesis testing in retrospective case studies.[70]

Geospatial information system ("GIS") methods may be useful tools to help identify areas where drinking water aquifers overlay areas of natural gas development at different scales (watershed,

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[67] The Draft Study Plan is not specific about what models would specifically be used, instead listing a number of options in Appendix H. MODFLOW, which is included Appendix H as an option for groundwater transport, is not suitable for modeling fractured bedrock flow from deeply buried shale formations.

[68] For example, EPA itself has previously concluded that "the injection of hydraulic fracturing fluids into [coalbed methane] wells poses little or no threat to underground sources of drinking water USDWs and does not justify additional study at this time." 2004 EPA Report at ES-1. The Study Plan presents no information that calls into question the validity of EPA's earlier finding.

[69] The so-called AOE represents the aerial footprint of the underground fracture zone, superimposed on a map of overlying aquifers (and topography).

[70] Draft Study Plan at 34.

basin, *etc.*), in order to select areas of focused study as recommended by the SAB. However, unless there is a demonstrated fluid migration pathway from the shale formation through the overburden to overlying aquifers, superimposing AOEs on local or regional aquifer maps has questionable merit or utility. The proposed AOE modeling will not address the research issue the Agency posed in regard to the question of migration directly from the formation, which is to "[i]dentify the key conditions that increase or decrease the likelihood of the interactions of existing pathways with hydraulic fractures."[71] The usefulness of modeling AOEs and using GIS tools to overlay them on regional aquifer maps should be reconsidered to assess whether the suggested approach will provide meaningful information.

F. Research involving flowback waters should reflect the most recent industry best management practices and applicable regulatory controls (pp. 38-40)

The Study Plan proposes to investigate potential impacts to drinking water resources from flowback waters using the following methods:

- Retrospective case study analysis of existing data relating to (i) flowback/produced water chemical composition, and (ii) literature review of past releases of flowback waters;
- Prospective case studies to determine flowback water chemistry;
- Prospective case studies of surface impoundment storage practices, integrity, and post closure conditions to assess surface chemical release potential; and
- Modeling (scenario evaluation) of flowback water release from an improperly sealed section of borehole or well.[72]

To the extent retrospective studies (literature review) may provide useful information, the Agency should focus on conditions and management practices that most accurately reflect current best management practices and State requirements for hydraulic fracturing wells. Research on past spills from natural gas production sites that does not reflect current hydraulic

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[71] *Id.* at 35.

[72] While this release scenario is mentioned in Section 6.4.5.2, it is not mentioned as a potential "research outcome" in Section 6.4.6, which mentions surface releases. The Study Plan should be internally consistent and unambiguous in all the research priorities.

fracturing practices may provide little value. In addition, consistent with the congressional mandate, any such studies should focus on hydraulic fracturing-specific issues, and not be diverted to investigate produced water issues that relate to oil and gas operations in general, as noted above.

The Draft Study Plan indicates that for the prospective case studies, the Agency will "draw samples [of flowback/produced water] as part of the full lifecycle monitoring at sites" and that "flowback and produced water will be sampled periodically following the completion of the injection of fracturing fluids into the formation."[73] However, in order to yield the most unambiguous and useful information, the prospective case studies must first establish the "baseline" water chemistry conditions of the formation water by collecting samples prior to the downhole pumping of hydraulic fracturing fluids. In addition, in conducting these prospective studies EPA should have an understanding of the chemical makeup of the hydraulic fracturing fluids being used at a site so that the Agency can determine which constituents in the flowback may be derived from the frac fluids. By comparing the information concerning the constituents of the frac fluid with the background sampling results, EPA also can determine which flowback constituents may be derived from the naturally-occurring formation water. With this information, EPA can focus its research efforts on those flowback constituents that may be associated with hydraulic fracturing operations.

The Draft Study Plan proposal to leverage research by the U.S. Department of Energy ("DOE") National Energy Technology Laboratory ("NETL") on possible unique stable-isotope "signature" compounds from the Marcellus shale formation is a good suggestion. Identifying unambiguous indicator compounds to identify the source of chemicals in flowback/production water is a vital component of the prospective studies.

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[73] *Id.* at 38.

G. Any analysis of frac fluid constituents should be appropriately prioritized (pp. 47-49; Appendix D)

EPA has compiled an extensive list of more than 400 frac fluid constituents using information obtained from a number of sources.[74] In order to understand the potential human health effects associated with these constituents, it is critical that EPA utilize a prioritization framework to streamline its evaluation. Toxicity should be one of the key factors in establishing priorities for further research concerning these constituents. Chronic toxicity factors developed by EPA or other entities are available for a number of frac fluid constituents, whereas for some constituents toxicity can be inferred based on the uses of the constituents (*e.g.*, a number of the frac fluid constituents are relatively benign compounds, which are classified as "Generally Regarded as Safe" by the U.S. Food and Drug Administration, and some are used as food additives). HESI believes that EPA should use this type of information to establish priorities among the list of the constituents.

For compounds with no readily available toxicity data, EPA may need to apply other factors to determine research priorities. An assessment of these chemicals based on toxicity would potentially require the development of toxicity factors – an onerous task. Accordingly, HESI believes that EPA should prioritize such constituents based on their relative persistence and mobility (*e.g.*, aqueous solubility and affinity to sorb to solids). Constituents that are persistent and relatively mobile (*i.e.*, highly water soluble and with a low affinity to solids) should be accorded a higher priority in assessing potential drinking water exposure.

In addition to constituent prioritization, EPA should consider other approaches for streamlining its evaluation of frac fluid constituents. For example, although the list of frac fluid constituents is long, a relatively small number of additives (and constituents) are used in a given

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[74] *Id.*, App. D.

frac job. The choice of additives is based on site-specific conditions and is dependent on a number of factors. Therefore, EPA should consider defining a few representative "model" fluids that include the different additive categories (*e.g.*, friction reducer, breaker, *etc.*) required to successfully complete a frac job. Such an approach would not only enable EPA to simulate typical fracing scenarios, but also could greatly streamline the evaluation and focus it on selected, representative constituents. The NYSDEC effectively utilized such an approach in its draft SGEIS.

H. The Study should carefully adhere to Congress' requirements for quality assurance and quality control

One of Congress' express requirements for the proposed Study is that it "should be prepared in accordance with the Agency's quality assurance principles."[75] Consistent with this directive, HESI requests that EPA's Study process should fully adhere to the Agency's quality assurance and quality control procedures that have been set forth in various applicable EPA guidance materials.[76] More specifically, HESI submits that the Agency should assure that the Study will rely on substantiated data and be conducted in a fully transparent and balanced manner. In addiiton, EPA's analysis of hydraulic fracturing should not rely on mere anecdotal assertions of alleged impacts from hydraulic fracturing, of the kind referenced by EPA several times in the Draft Study Plan.[77] The Agency should instead apply its quality assurance principles so that the Study's conclusions are based on legitimate, scientifically-valid data and decision-making. Furthermore, in order to ensure that the Study is conducted in a technically sound

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[75] U.S. Congress, *Fiscal Year 2010 Department of the Interior, Environment, and Related Agencies Appropriation Act*, H. Rept. 111-316 at 109 (111th Congress, Oct. 28, 2009).

[76] *See, e.g.*, EPA, *Guidance for Quality Assurance Plans*, EPA QA/G-5 (Dec. 2002), *available at* http://www.epa.gov/QUALITY/qs-docs/g5-final.pdf.

[77] For example, the Draft Study Plan contains an allegation that "a fish kill was linked to a spill of hydraulic fracturing fluid that contaminated a stream" in Pennsylvania, citing an August 26, 2009 article by Abrahm Lustgarten posted at the Scientific American website. Draft Study Plan at 56. However, this article – found at http://www.scientificamerican.com/article.cfm?id=chemicals-found-in-drinking-water-from-natural-gas-drilling – contains no such allegations about any Pennsylvania fish kills.

manner with a full understanding of the currently applied hydraulic fracturing technologies, HESI strongly encourages EPA to actively seek input from the oil and gas industry throughout the Study process and draw upon HESI's substantial experience with hydraulic fracturing operations.

V. Conclusion

HESI appreciates the opportunity to submit these comments on EPA's Draft Study Plan. HESI supports EPA's goal of conducting the proposed Study in a transparent, scientific manner with a clear emphasis on assessing the relationship between hydraulic fracturing and drinking water.

At the same time, HESI respectfully requests that the Agency make certain key changes in EPA's Draft Study Plan to assure that the Study adheres to the limited scope established by the U.S. Congress and incorporates an appropriate human health risk assessment of possible drinking water exposure pathways. HESI also recommends that the Agency Study should make full use of the existing studies and data that are available from a broad range of technical, scientific and state regulatory sources. In a similar fashion, EPA should perform its Study with a careful review of the well-documented state oil and gas regulatory programs and existing industry well construction practices that already comprehensively protect drinking water supplies.

HESI looks forward to working with EPA on the continued design, execution, and review of the Agency's Study. If you have any questions regarding these comments, please do not hesitate to contact Stuart H. Kemp, Assistant General Counsel for Halliburton, at (713) 839-4539.