

# RIVERKEEPER APPENDIX 1

## CASE STUDIES

### IMPACTS AND INCIDENTS INVOLVING HIGH-VOLUME HYDRAULIC FRACTURING FROM ACROSS THE COUNTRY

#### Executive Summary

Since the summer of 2008 Riverkeeper has tracked the prospect of industrial gas drilling in New York State. While gas drilling in New York is not new, what is new is the magnitude, scope, and location of the proposed drilling method of high-volume hydraulic fracturing. Indeed, industrial gas drilling throughout the Marcellus Shale and other shale reserves in New York has the potential to impact the environment and communities dramatically.

To assist in analyzing the DSGEIS and to understand what impacts New Yorkers might expect from this industrial gas drilling activity, the experience from other states where high-volume hydraulic fracturing occurs is very instructive. To that end, Riverkeeper analyzed impacts and incidents that have occurred as a direct result of horizontal drilling using high-volume hydraulic fracturing, the very type of activity the DSGEIS attempts to study. These case studies examine impacts in the Marcellus Shale (Pennsylvania, Ohio, and West Virginia), the Barnett Shale (Texas), and gas drilling activity in Colorado and Wyoming. The case studies rely primarily on the investigations, findings, and statements of *state regulators* from these areas.

The case studies demonstrate that horizontal drilling using high-volume hydraulic fracturing results in significant adverse impacts. These impacts result from improper casing of well bores, over-pressured wells, spills and accidents, gas migration via abandoned wells, the inability of wastewater treatment plants to treat flowback and produced water, underground injection of brine wastewater, improper erosion and sediment controls, truck traffic, compressor stations, and the ordinary operation of high-volume hydraulic fracturing wells.

In Pennsylvania state regulators found that gas drilling using high-volume hydraulic fracturing has caused contaminated drinking water, polluted surface waters, polluted air, and contaminated soils. Specifically, the Pennsylvania Department of Environmental Protection (PA DEP) concluded that in one instance high-volume hydraulic fracturing “caused...gas from lower formations to enter fresh groundwater.” In another instance the PA DEP found that a well using high-volume hydraulic fracturing had “communicated with [an] abandoned gas well”, resulting in natural gas migrating to shallow groundwater and surface soils. In Ohio, state regulators found that inadequate well casing resulted in drinking water contamination and a house exploding. In the Barnett Shale, state regulators found elevated levels of benzene and other toxics in neighborhoods with nearby gas compressors.

The DEC should heed the lessons learned from other states that have experienced high-volume hydraulic fracturing. Through SEQRA, New York has the opportunity to mitigate these impacts before they occur. These case studies highlight specific problems experienced in other states, but also help illustrate areas where the DSGEIS is inadequate.

## MARCELLUS SHALE CASE STUDIES

### **I. Marcellus Shale – Introduction**

The Marcellus shale is a rock formation located approximately 5,000 to 8,000 feet below much of State of Pennsylvania, and portions of southern New York, Ohio and West Virginia.<sup>1</sup> It is believed to contain trillions of cubic feet of natural gas.<sup>2</sup> Until recently, the gas trapped within the Marcellus shale formation was thought prohibitively expensive to access.<sup>3</sup> Rising natural gas prices and advances in drilling technology – namely, the advent of the high-volume hydraulic fracturing process – sparked new interest in tapping the gas within the Marcellus shale.<sup>4</sup> Natural gas companies have used high-volume hydraulic fracturing in Pennsylvania, Ohio and West Virginia. Numerous incidents have occurred either during or after such drilling activities that have resulted in gas migration, water pollution and/or air pollution in these states. Some such incidents are described below.

### **II. Marcellus Shale Case Studies – Water Impacts**

**A. McNett Township, Lycoming County, PA.** On July 27, 2009, the Pennsylvania Department of Environmental Protection (“PA DEP”) discovered a natural gas leak involving a well drilled by East Resources.<sup>5</sup> Two water bodies, tributaries of Lycoming Creek, were affected by the release of methane gas.<sup>6</sup> Methane also impacted numerous private drinking water wells in the area, and one resident was forced to evacuate.<sup>7</sup> Additionally, access roads to the well were closed. According to a subsequent PA DEP report, “[t]he suspected cause of the leak is a casing failure of some sort.”<sup>8</sup> The company took measures to stop the leak at the source, and the area continues to be monitored by PA DEP.<sup>9</sup> Methane continues to be present in some of the private drinking water wells, and one gas extraction device was installed in a residence.<sup>10</sup> According to PA DEP, “the investigation is ongoing.”<sup>11</sup>

#### **B. Dimock Township, Susquehanna County, PA.**

1. In January 2009, there were several reports of methane gas migrating to the surface, and at least one report of a drinking water well exploding along Carter Road in Dimock, PA.<sup>12</sup>

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<sup>1</sup> PA DEP, DEP MARCELLUS SHALE FACT SHEET 1 (2009), *available at* <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-76916/0100-FS-DEP4217.pdf>

<sup>2</sup> *Id.*

<sup>3</sup> *Id.*

<sup>4</sup> *Id.*

<sup>5</sup> PA DEP, BUREAU OF OIL AND GAS MANAGEMENT, DRAFT REPORT STRAY NATURAL GAS MIGRATION ASSOCIATED WITH OIL AND GAS WELLS 3 (2009) [hereinafter “PA DEP DRAFT REPORT”], *available at*, [http://www.dep.state.pa.us/dep/subject/advoun/oil\\_gas/2009/Stray%20Gas%20Migration%20Cases.pdf](http://www.dep.state.pa.us/dep/subject/advoun/oil_gas/2009/Stray%20Gas%20Migration%20Cases.pdf) (last visited Dec. 15, 2009).

<sup>6</sup> *Id.*

<sup>7</sup> *Id.*

<sup>8</sup> *Id.*

<sup>9</sup> *Id.*

<sup>10</sup> *Id.*

<sup>11</sup> PA DEP DRAFT REPORT, *supra* note 5, at 3.

<sup>12</sup> PA DEP, *DEP Continues to Analyze Dimock Water Supplies*, PA DEP Daily News Releases, Mar. 27, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5459> (last visited Dec. 12, 2009).

The PA DEP called the event a “significant gas migration,” and both free and dissolved natural gas have been found in numerous wells in the vicinity.<sup>13</sup> Upon preliminary testing, the PA DEP found that four wells in the area contained elevated levels of methane.<sup>14</sup> After further investigation, the agency discovered that nine wells contained methane, four at levels indicating a threat of explosion.<sup>15</sup> The gas migration occurred close to high-volume hydraulic fracturing sites of Cabot Oil & Gas Corporation (“Cabot”). The PA DEP noted that the “area has not experienced previous drilling and recent gas drilling in the vicinity has targeted the Marcellus Shale.” It conducted isotopic analysis in an attempt to discern the source of the stray gas.<sup>16</sup> The PA DEP determined that the gas did indeed originate in the target drilling formation of Cabot, and ruled out the possibility that the gas was produced by bacteria or originated from a shallower gas-bearing formation.<sup>17</sup>

The PA DEP issued Cabot a notice of violation on February 27, 2009, citing the company’s failure to comply with Pennsylvania’s Oil and Gas Act.<sup>18</sup> The Notice also stated that “[PA DEP’s] investigation revealed that Cabot had caused or allowed gas from lower formations to enter fresh groundwater.”<sup>19</sup> In November 2009, the PA DEP and Cabot signed a consent order resolving the violations, which requires Cabot to get PA DEP approval for any future well casing or cementing plans.<sup>20</sup> The PA DEP new release regarding the consent order stated that “DEP inspectors discovered that the well casings on some of Cabot’s natural gas wells were cemented improperly or insufficiently, allowing natural gas to migrate to groundwater.”<sup>21</sup>

2. On September 16, 2009, more incidents in Dimock, PA were linked to Cabot when the two liquid gel spills occurred at the company’s Heitsman natural gas well pad.<sup>22</sup> The spills polluted a wetland and caused a fish kill in Stevens Creek.<sup>23</sup> The PA DEP issued a notice of violation to Cabot for the spills.<sup>24</sup> In response to this event, the PA DEP stated:

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<sup>13</sup> PA DEP DRAFT REPORT, *supra* note 5, at 3.

<sup>14</sup> PA DEP, *DEP Continuing Investigation Into High Methane Levels in Susquehanna County Wells*, PA DEP Daily News Releases, Jan. 23, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5406> (last visited Dec. 12, 2009).

<sup>15</sup> PA DEP, *supra* note 12.

<sup>16</sup> PA DEP, *supra* note 14.

<sup>17</sup> NEW YORK CITY DEP’T OF ENVTL. PROT., RAPID IMPACT ASSESSMENT REPORT: IMPACT ASSESSMENT OF NATURAL GAS PRODUCTION IN THE NEW YORK CITY WATER SUPPLY WATERSHED 53 (2009), available at [http://www.nyc.gov/html/dep/pdf/natural\\_gas\\_drilling/rapid\\_impact\\_assessment\\_091609.pdf](http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/rapid_impact_assessment_091609.pdf) [hereinafter “NYCDEP RAPID IMPACT ASSESSMENT”]; See also Notice of Violation Letter from Craig Lobbins, PA DEP Regional Manager, to Thomas Liberatore, Cabot Oil & Gas Corporation, Vice President (Feb. 27, 2009) (on file with the Pace Environmental Litigation Clinic).

<sup>18</sup> Notice of Violation Letter from Craig Lobbins, Regional Manager of the PA DEP, to Thomas Liberatore, Vice President of Cabot Oil & Gas Corporation (Feb. 27, 2009) (on file with the Pace Environmental Litigation Clinic).

<sup>19</sup> *Id.*

<sup>20</sup> PA DEP, *DEP Reaches Agreement with Cabot to Prevent Gas Migration, Restore Water Supplies in Dimock Township*, PA DEP Daily News Releases, Nov. 4, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5722> (last visited Dec. 13, 2009).

<sup>21</sup> *Id.*

<sup>22</sup> PA DEP, *DEP Issues Violation Notice to Cabot Oil and Gas*, PA DEP Daily News Releases, Sept. 23, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5676> (last visited Dec. 13, 2009).

<sup>23</sup> *Id.*

<sup>24</sup> *Id.*

the notice of violation cites Cabot for an unpermitted discharge of polluting substances, an unpermitted discharge of residual waste, two unpermitted encroachments on Stevens Creek, not containing polluting substances at the well site, and an unpermitted discharge of industrial waste. These were violations of the Pennsylvania Clean Streams Law, Pennsylvania Solid Waste Management Act, the Dam Safety and Encroachments Act, and the Oil and Gas Act.<sup>25</sup>

The two spills involved a lubricant gel used in the high-volume hydraulic fracturing process and totaled over 8,000 gallons.<sup>26</sup> According to Cabot, the releases were caused by failed pipe connections.<sup>27</sup> In addition, a third spill occurred on September 22, 2009 at the same site.<sup>28</sup> This subsequent spill involved 420 gallons of the same lubricant gel.<sup>29</sup>

Following these three spills, on September 25, 2009, PA DEP ordered Cabot to cease all high-volume hydraulic fracturing activities until the company “completes a number of important engineering and safety tasks.”<sup>30</sup> PA DEP fined Cabot \$56,650 and on October 16, 2009, allowed Cabot to resume high-volume hydraulic fracturing activities after it submitted the required documents to PA DEP.<sup>31</sup>

**C. Foster Township, McKean County, PA.** In April 2009, drilling activities conducted by Schreiner Oil & Gas impacted at least seven drinking water supplies along Hedgehog Lane in Foster, PA.<sup>32</sup> Stray gas became evident in numerous wells and residents complained. Two of the affected water supplies contained methane and five had iron and manganese above established drinking water standards.<sup>33</sup> After investigating, the PA DEP found that “the stray gas occurrence is a result of 26 recently drilled wells, four of which had excessive pressure at the surface casing seat and others that had no cement returns.”<sup>34</sup> The PA DEP also issued Schreiner a notice of violation regarding this incident for failing to submit well records.<sup>35</sup> Prior to that notice, the PA DEP

had issued three notices of violation to Schreiner pertaining to drilling on Hedgehog Lane. On November 13, DEP cited Schreiner for over-pressured wells. On February 19, DEP issued a notice of violation for pit violations and failure to

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<sup>25</sup> *Id.*

<sup>26</sup> *Id.*

<sup>27</sup> *Id.*

<sup>28</sup> PA DEP, *supra* note 22.

<sup>29</sup> *Id.*

<sup>30</sup> PA DEP, *DEP Orders Cabot Oil and Gas to Cease All Gas Well Fracking in Susquehanna County*, PA DEP Daily News Releases, Sept. 25, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5678> (last visited Dec. 13, 2009).

<sup>31</sup> PA DEP, *DEP Fines Cabot Oil and Gas Corp. \$56,650 for Susquehanna County Spills*, PA DEP Daily News Releases, Oct. 22, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5705> (last visited Dec. 13, 2009).

<sup>32</sup> PA DEP, *DEP Identifies Responsibility for Bradford Township Gas Migration/Water Supply Problems* PA DEP Daily News Releases, May 5, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5494> (last visited Dec. 12, 2009).

<sup>33</sup> *Id.*

<sup>34</sup> *Id.*

<sup>35</sup> *Id.*

post a well permit. On March 20, DEP cited Schreiner for new over-pressured wells and failure to submit well records.<sup>36</sup>

**D. Hamlin Township, McKean County, PA.** In September 2007, a migration of natural gas caused “a change in water quality and a minor explosion in a community water well.”<sup>37</sup> Additionally, combustible gas was discovered in several private water wells within Kushequa village.<sup>38</sup> The PA DEP determined through an investigation that a specific over-pressured gas well was the cause of the stray gas release.<sup>39</sup> Also, “additional production casing was placed in the suspect well to permanently resolve the problem.”<sup>40</sup> The responsible party was issued a Consent Order and Civil Assessment and must plug 15 orphan wells adjacent to the affected water wells.<sup>41</sup> PA DEP has stated that “[a] small percentage of abandoned wells leak oil or acidic water from mines, which contaminates streams and drinking water supplies.”<sup>42</sup>

**E. Knox Township, Jefferson County, PA.** On April 18, 2009, fugitive gas began escaping from a domestic drinking water well in Knox, PA.<sup>43</sup> An investigation ensued and the PA DEP also discovered combustible gas in an adjacent drinking water well.<sup>44</sup> The PA DEP believes that the likely cause of the fugitive gas migration is a recently drilled neighboring gas well.<sup>45</sup> The PA DEP is also investigating three additional reports of water quality issues that could be associated with the recent high-volume hydraulic fracturing activities in the area.<sup>46</sup>

**F. Liberty Township, McKean County, PA.** In January 2008, PA DEP responded to a complaint regarding fugitive gas in a domestic drinking water well in Liberty, PA.<sup>47</sup> Further investigation revealed that two nearby recently drilled gas wells were over-pressured, “exceeding the amount of allowable pressure on the casing seat.”<sup>48</sup> The operator of the wells “placed packers and additional production casing . . . thereby eliminating pressure on the casing seat. The water well was aggressively pumped and over time the amount of combustible gas in the well bore decreased significantly.”<sup>49</sup> When the amount of gas decreased to an allowable amount, the wells were brought back into production.<sup>50</sup>

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<sup>36</sup> *Id.*

<sup>37</sup> PA DEP DRAFT REPORT, *supra* note 5, at 4.

<sup>38</sup> *Id.*

<sup>39</sup> *Id.*

<sup>40</sup> *Id.*

<sup>41</sup> *Id.*

<sup>42</sup> PA DEP, *Governor Rendell Says PA Protecting Communities, Miners from Abandoned Oil, Gas Wells – Says \$2.3 Million Will Plug 150 Abandoned Wells, Safeguard Public Health, Drinking Water*, PA DEP Daily News Releases, Sept. 19, 2007, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=4748> (last visited Dec. 15, 2009).

<sup>43</sup> PA DEP DRAFT REPORT, *supra* note 5, at 4.

<sup>44</sup> *Id.*

<sup>45</sup> *Id.*

<sup>46</sup> *Id.*

<sup>47</sup> PA DEP DRAFT REPORT, *supra* note 5, at 5.

<sup>48</sup> *Id.*

<sup>49</sup> *Id.*

<sup>50</sup> *Id.*

**G. Hamlin Township, McKean County, PA.** In June 2006 the PA DEP responded to two water quality and diminution complaints in Hamlin, PA.<sup>51</sup> It found that “a change in water quality was evident.”<sup>52</sup> The PA DEP also noted that “over-pressured conditions” had been present at a recently drilled nearby gas well.<sup>53</sup> Subsequently, the operator drilled new drinking water wells for the impacted residents; however, gas was encountered during the drilling process.<sup>54</sup> When the operator then placed additional production casing into the gas well, the PA DEP noted a marked decrease in the amount of gas in the recently drilled water wells.<sup>55</sup> The problem has since diminished.<sup>56</sup>

**H. Alexander Investigation, Washington County, PA.** In September 2006, a migration of natural gas impacted several private drinking water supplies and surface soils in Washington County, PA.<sup>57</sup> PA DEP determined that a well that had been recently drilled using high-volume hydraulic fracturing had “communicated with [an] abandoned gas well.”<sup>58</sup> As a result, the natural gas migrated to shallow groundwater and surface soils in the area.<sup>59</sup> Investigation by the PA DEP revealed that fracturing activity at the recently drilled well had “created [a] pathway to [the] abandoned well and [caused] further migration into the shallow groundwater system.”<sup>60</sup>

**I. Howe Township, Forest County, PA.** In June 2005, stray natural gas entered two springs that serve as domestic water supplies to residents of Howe, PA.<sup>61</sup> The area has a long history of oil and gas drilling activity.<sup>62</sup> PA DEP discovered that the gas migration began close to the same time when two gas wells, located more than 3000 feet away, were being drilled using high-volume hydraulic fracturing.<sup>63</sup> According to the PA DEP, the “new gas wells are in regulatory compliance and additional measures were taken to prevent a gas migration.”<sup>64</sup> All efforts to more definitively identify the cause of the migration have been unsuccessful.<sup>65</sup>

**J. Monongahela River, TDS violations:** On October 11, 2008 the PA DEP first determined that the levels of total dissolved solids (“TDS”) in the Monongahela River exceeded federal and state water quality standards.<sup>66</sup> On October 22, 2008, the PA DEP announced that it would begin

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<sup>51</sup> PA DEP DRAFT REPORT, *supra* note 5, at 6.

<sup>52</sup> *Id.*

<sup>53</sup> *Id.*

<sup>54</sup> *Id.*

<sup>55</sup> *Id.*

<sup>56</sup> *Id.*

<sup>57</sup> PA DEP DRAFT REPORT, *supra* note 5, at 7-8.

<sup>58</sup> *Id.*

<sup>59</sup> *Id.*

<sup>60</sup> PA DEP DRAFT REPORT, *supra* note 5, at 8.

<sup>61</sup> *Id.* at 12.

<sup>62</sup> *Id.*

<sup>63</sup> *Id.*

<sup>64</sup> PA DEP DRAFT REPORT, *supra* note 5, at 12-13.

<sup>65</sup> *Id.* at 13.

<sup>66</sup> PA DEP, *Total Dissolved Solids in Monongahela River Drop Significantly Below State, Federal Limits*, PA DEP Daily News Releases, Jan. 21, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5404> (last visited Dec. 12, 2009).

investigating the source of these “unusually high” levels of TDS.<sup>67</sup> In order to immediately address the problem, the PA DEP directed

all sewage treatment plants accepting gas well drilling wastewater, and which discharge to the Monongahela River or its tributaries, to drastically reduce the volume of gas well drilling wastewater they accept to one percent of their daily flow. Currently gas well drilling wastewater constitutes up to 20 percent of those plants daily flow. The restrictions will reduce the volume of drilling wastewater treated by 90 to 95 percent.<sup>68</sup>

PA DEP traced the high TDS levels to “delivery of highly mineralized wastewater to municipal wastewater treatment plants from natural gas drilling operations.”<sup>69</sup> A New York City DEP report noted that “[w]ater samples analyzed downstream of several wastewater treatment plant discharges in the Monongahela indicated TDS levels nearly twice the allowable limit and nearly five times average levels.”<sup>70</sup>

On August 7, 2009, the PA DEP announced that TDS levels in the Monongahela River again exceeded drinking water quality standards.<sup>71</sup> And again on October 14, 2009, the PA DEP made the same announcement.<sup>72</sup>

**K. Cogan House Township and Mifflin Township, Lycoming County, PA.** On May 30, 2008 the PA DEP ordered Range Resources – Appalachia, LLC and Chief Oil and Gas, LLC to cease their surface water withdrawals from local streams due to violations of Pennsylvania’s Clean Streams Law.<sup>73</sup> PA DEP’s Regional Office Director stated that “[high-volume hydraulic fracturing] can often times consume millions of gallons of water. In the course of their operations, neither Range Resources nor Chief Oil and Gas have taken the necessary precautions to protect nearby streams from pollution or impairment during the drilling process.”<sup>74</sup> The companies were within the jurisdiction of the Susquehanna River Basin Commission, and were required to obtain water withdrawal permits, but failed to do so.<sup>75</sup> The cease orders remain in effect until each company acquires all necessary permits.<sup>76</sup>

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<sup>67</sup> PA DEP, *DEP Investigates Source of Elevated Total Dissolved Solids in Monongahela River*, PA DEP Daily News Releases, Oct. 22, 2008, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5337> (last visited Dec. 12, 2009).

<sup>68</sup> *Id.*

<sup>69</sup> NYCDEP RAPID IMPACT ASSESSMENT, *supra* note 17, at 54.

<sup>70</sup> *Id.*

<sup>71</sup> PA DEP, *DEP Detects Elevated Levels of Total Dissolved Solids in Monongahela River*, PA DEP Daily News Releases, Aug. 7, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5619> (last visited Dec. 12, 2009).

<sup>72</sup> PA DEP, *DEP Detects Total Dissolved Solids Over Standards in Monongahela River*, PA DEP Daily News Releases, Oct. 14, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5694> (last visited Dec. 12, 2009).

<sup>73</sup> NYCDEP RAPID IMPACT ASSESSMENT, *supra* note 17, at 55.

<sup>74</sup> PA DEP, *DEP Orders Partial Shutdown of Two Natural Gas Drilling Operations in Lycoming County* PA DEP Daily News Releases, May 30, 2008, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5079> (last visited Dec. 12, 2009).

<sup>75</sup> *Id.* NYCDEP RAPID IMPACT ASSESSMENT, *supra* note 17, at 55.

<sup>76</sup> PA DEP, *supra* note 74.



**L. Athens Township, Bradford County, PA.** In January 2005, Columbia Natural Resources, LLC violated Pennsylvania environmental regulations when it failed to implement proper erosion and sedimentation control measures along a road it constructed in connection with its natural gas drilling activities.<sup>77</sup> This resulted in contamination of two waterways and a wetland in Athens, PA.<sup>78</sup> Columbia also filled a portion of the wetland without obtaining a permit from PA DEP, another violation.<sup>79</sup> On June 24, 2005, PA DEP fined the company \$6,500 for its violations.<sup>80</sup>

**M. Bainbridge Township, Geauga County, OH.** On December 15, 2007 an explosion occurred inside a home in Bainbridge, OH.<sup>81</sup> Two residents in the home were not injured but the structure was damaged significantly.<sup>82</sup> After investigation, the Ohio Department of Natural Resources (“Ohio DNR”) determined that nearby high-volume hydraulic fracturing operations, conducted by Ohio Valley Energy Systems Corp. (“OVESC”), caused the explosion.<sup>83</sup> According to an April 16, 2009 Order from the Ohio DNR, OVESC began drilling the English No. 1 natural gas well in the area on October 18, 2007.<sup>84</sup> The investigation further revealed that:

Accumulation and confinement of deep, high-pressure gas in the surface-production casing annulus of the English No. 1 well, between November 16 and December 15, 2007, resulted in over-pressurization of the annulus. This over-pressurized condition resulted in the invasion, or migration of natural gas from the annulus of the well into natural fractures in the bedrock below the base of the cemented surface casing. This gas migrated vertically through fractures into the overlying aquifers, discharged or exited the aquifers through local water wells, and entered some inhabited structures in the area in varying concentrations through groundwater.<sup>85</sup>

In addition to the explosion, the drilling operations led to significant water contamination in the area. According to the Ohio DNR, this specific event contaminated “22 domestic and one public water supply.”<sup>86</sup> A letter from the Ohio Department of Health regarding well sampling in

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<sup>77</sup> PA DEP, *DEP Fines West Virginia Company \$6,500 For Environmental Violations in Bradford County* PA DEP Daily News Releases, June 24, 2005, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=3503> (last visited Dec. 13, 2009).

<sup>78</sup> *Id.*

<sup>79</sup> *Id.*

<sup>80</sup> *Id.*

<sup>81</sup> Letter from John F. Husted, Chief of the Ohio Department of Natural Resources, Division of Mineral Resource Management (Aug. 28, 2008), available at [http://www.dnr.state.oh.us/Portals/11/bainbridge/cover\\_letter.pdf](http://www.dnr.state.oh.us/Portals/11/bainbridge/cover_letter.pdf). See also OHIO DEP’T OF NATURAL RES., DIVISION OF MINERAL RES. MGMT., REPORT ON THE INVESTIGATION OF THE NATURAL GAS INVASION IN BAINBRIDGE TOWNSHIP OF GEauga COUNTY OHIO 3 (2008), available at <http://www.dnr.state.oh.us/Portals/11/bainbridge/report.pdf> [hereinafter “REPORT ON BAINBRIDGE INVESTIGATION”].

<sup>82</sup> REPORT ON BAINBRIDGE INVESTIGATION, *supra* note 81, at 3.

<sup>83</sup> See Ohio DNR, Order by the Chief to Ohio Valley Energy Systems Corp., Apr. 14, 2008, available at <http://ohiodnr.com/portals/11/bainbridge/2009-order-by-chief.pdf>. See also Ohio DNR, Order by the Chief to Ohio Valley Energy Systems Corp., Apr. 16, 2008, available at <http://ohiodnr.com/portals/11/bainbridge/2009-order-by-chief-2.pdf>. See also REPORT ON BAINBRIDGE INVESTIGATION, *supra* note 81, at 3.

<sup>84</sup> ODNR, Order by the Chief to Ohio Valley Energy Systems Corp., Apr. 16, 2008, *supra* note 83, ¶ 2.

<sup>85</sup> *Id.* ¶ 4.

<sup>86</sup> REPORT ON BAINBRIDGE INVESTIGATION, *supra* note 81, at 4.



the area after the event stated that “of the 78 wells sampled, 45 had measurable levels of dissolved methane in the water. Many of the 78 wells sampled had iron, manganese, and less commonly aluminum and total dissolved solids, at levels exceeding U.S. EPA Secondary Maximum Contaminant Levels.”<sup>87</sup> In response to this incident, the Ohio DNR directed OVESC to (i) remedy inadequate primary cementing of the production casing of English Well No. 1; (ii) isolate the deep high-pressure gas zones that were the source of the overpressurization of the aquifers; and (iii) eliminate the confinement of annular gas which caused the build-up of pressure.<sup>88</sup> The Ohio DNR’s report on this event states that:

[r]emedial cementing operations completed by OVESC in mid-December, 2007 have effectively isolated and sealed deep, high-pressure gas bearing zones. As a result, natural gas from deep formations can no longer migrate up the surface-production casing annulus of the English #1 well and migrate into local aquifers.<sup>89</sup>

**N. Dunkard Creek, Monongalia County, WV.** On September 1, 2009 a substantial fish kill in Dunkard Creek, along the West Virginia- Pennsylvania border, was reported to the West Virginia Department of Environmental Protection (“WV DEP”).<sup>90</sup> According to PA DEP over “30 stream miles” in PA and WV were “impacted by a discharge, originating from West Virginia, and contains high levels of total dissolved solids (TDS)”; “at least 16 species of freshwater mussels and at least 18 species of fish were killed by this pollution event in Dunkard Creek.”<sup>91</sup> Agencies in both West Virginia and Pennsylvania investigated the incident, which was traced to a bloom of golden algae in the creek.<sup>92</sup> The Creek is in a heavy oil and gas drilling area, and the WV DEP has received numerous complaints from residents who suspect that companies are illegally dumping oil and gas drilling waste into the waterway.<sup>93</sup>

### III. Marcellus Shale Case Studies – Air and Soil Impacts.

**A. McCalmont Township, Jefferson County, PA.** In April 2008 PA DEP was informed of “a large fugitive expression” in Little Sandy Creek in McCalmont, PA.<sup>94</sup> Amounts of combustible natural gas were discovered in the basement of a nearby residence upon

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<sup>87</sup> Letter from Robert C. Frey, Ph.D., Chief of the Health Assessment Section of the Ohio Bureau of Environmental Health, Ohio Department of Health to Scott Kell, Deputy Chief of the Ohio Department of Natural Resources Division of Mineral Resource Management (Sept. 10, 2008), *available at* <http://www.dnr.state.oh.us/bainbridge/tabid/20484/Default.aspx> (last visited Dec. 16, 2009) and [http://www.dnr.state.oh.us/Portals/11/bainbridge/10-31-08\\_resident\\_mailing\\_odh\\_letter.pdf](http://www.dnr.state.oh.us/Portals/11/bainbridge/10-31-08_resident_mailing_odh_letter.pdf) (last visited Dec. 16, 2009).

<sup>88</sup> REPORT ON BAINBRIDGE INVESTIGATION, *supra* note 80, at 5.

<sup>89</sup> *Id.*

<sup>90</sup> News Release, WV DEP, DEP Actively Investigating Dunkard Creek Fish Kill (Sept. 21, 2009), *available at* [http://www.wvdep.org/Docs/18246\\_Sept\\_21\\_2009\\_press\\_release.pdf](http://www.wvdep.org/Docs/18246_Sept_21_2009_press_release.pdf).

<sup>91</sup> PA DEP, *DEP, Fish and Boat Commission Monitoring Dunkard Creek Fish Kill*, PA DEP Daily News Releases, Sept. 18, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5671> (last visited Dec. 13, 2009).

<sup>92</sup> News Release, WVDEP, Update on Dunkard Creek Fish Kill Investigation (Oct. 5, 2009), *available at* [http://www.wvdep.org/Docs/18245\\_October\\_5\\_2009\\_press\\_release.pdf](http://www.wvdep.org/Docs/18245_October_5_2009_press_release.pdf). *See also* Patrick Campbell, WV DEP Presentation on “Dunkard Creek Aquatic Wildlife Kills, September, 2009” (Oct. 9, 2009) *available at* [http://www.wvdep.org/Docs/18239\\_dunkardaqlkillpvc.pdf](http://www.wvdep.org/Docs/18239_dunkardaqlkillpvc.pdf).

<sup>93</sup> PA DEP, *supra* note 90.

<sup>94</sup> PA DEP DRAFT REPORT, *supra* note 5, at 4.

investigation.<sup>95</sup> PA DEP determined that the gas was entering the house “through an un-sealed sump opening in the concrete floor of the basement.”<sup>96</sup> Additionally, the investigation revealed “two recently drilled gas wells were over-pressured and were producing from different geologic strata.”<sup>97</sup> PA DEP conducted isotopic analysis of the wells which indicated that one of the wells was the probable source.<sup>98</sup> The residence continued to be monitored and the amount of gas in the sump was determined to be decreasing.<sup>99</sup>

**B. Dimock Township, Susquehanna County, PA.** There have been two reports of “diesel fuel leaking from tanks at high-volume hydraulic fracturing drilling operations run by Cabot Oil & Gas Corp. near Dimock Township in northeastern Pennsylvania.”<sup>100</sup> The first leak was caused by “a loose fitting on a tank and resulted in approximately 800 gallons of diesel entering a wetland located approximately 350 feet from the tank.”<sup>101</sup> The second leak resulted in “approximately 100 gallons of diesel resulting in soil contamination.”<sup>102</sup> PA DEP directed that the soil be removed and “indicated there was no suspected groundwater contamination.”<sup>103</sup>

**C. Millcreek Township, Erie County, PA.** A gas migration episode in November and December of 2007 caused residents of Walnut Creek in Millcreek, PA to be evacuated from their homes for over two months.<sup>104</sup> Fugitive gas was discovered in the soil and “natural gas levels in and around homes . . . were found to be at explosive levels.”<sup>105</sup> PA DEP investigations and isotopic analysis of the gas revealed that recently drilled gas wells in the area caused the migration.<sup>106</sup> PA DEP assessed a \$32,000 civil penalty against First Alliance Church for this gas migration, which kept five families out of their homes for 39 days. First Alliance Church had hired a contractor to drill for natural gas on its property.<sup>107</sup>

#### **IV. Marcellus Shale Case Studies – Permit/Regulatory Violations.**

**A. U.S. Energy Cease & Desist Order.** On July 10, 2009, PA DEP issued a cease and desist order against U.S. Energy Development Inc. “for persistent and repeated violations of environmental laws and regulations.”<sup>108</sup> The order prohibits U.S. Energy “from conducting all earth disturbance, drilling and hydro-fracturing operations.”<sup>109</sup> The basis of the order is the

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<sup>95</sup> *Id.*

<sup>96</sup> *Id.*

<sup>97</sup> *Id.*

<sup>98</sup> *Id.*

<sup>99</sup> *Id.*

<sup>100</sup> NYCDEP RAPID IMPACT ASSESSMENT, *supra* note 17, at 54.

<sup>101</sup> *Id.*

<sup>102</sup> *Id.*

<sup>103</sup> *Id.*

<sup>104</sup> PA DEP DRAFT REPORT, *supra* note 5, at 5.

<sup>105</sup> PA DEP, *DEP Assesses Penalty for 2007 Gas Migration That Forced Evacuation in Erie County*, PA DEP Daily News Releases, July 8, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5569> (last visited Dec. 13, 2009).

<sup>106</sup> PA DEP DRAFT REPORT, *supra* note 5, at 5-6.

<sup>107</sup> PA DEP, *supra* note 104.

<sup>108</sup> PA DEP, *DEP Orders U.S. Energy to Cease Drilling Operations Throughout Pennsylvania*, PA DEP Daily News Releases, July 10, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5574> (last visited Dec. 12, 2009).

<sup>109</sup> *Id.*

company's 302 violations since August 2007, 197 of which remain unresolved.<sup>110</sup> The violations included "failure to implement measures to prevent accelerated erosion, unpermitted discharges, failure to restore well sites, encroachments into streams and wetlands without obtaining required permits, and failure to plug abandoned wells."<sup>111</sup> The cease and desist order was later lifted when a consent agreement was signed in which PA DEP assessed U.S. Energy a \$200,000 civil penalty and required it to work under an environmental management plan.<sup>112</sup>

**B. Revocation of Permits Issued to Ultra Resources Inc. and Fortuna Energy Inc.** On October 28, 2009, PA DEP revoked three erosion and sedimentation control permits issued to Ultra Resources Inc. and Fortuna Energy Inc. because of technical deficiencies.<sup>113</sup> The deficiencies, namely the failure to provide for best management practices and some inaccurate calculations, were discovered after the permits had been approved.<sup>114</sup> The Chesapeake Bay Foundation challenged the permits, causing PA DEP to re-examine and subsequently revoke them.<sup>115</sup>

**C. Synd Enterprises and Vertical Resources Cease & Desist Order.** On December 12, 2006, PA DEP issued a cease and desist order to the owners of Synd Enterprises, Inc. and Vertical Resources.<sup>116</sup> The companies had "continued and numerous violations" of Pennsylvania law and had "shown a lack of ability or intention to comply with the provisions of the commonwealth's environmental laws."<sup>117</sup> Additionally PA DEP sought civil penalties of \$657,040 to perform cleanup activities and plug wells.<sup>118</sup> Among the violations cited in the order were "over-pressured wells that cause gas migration and contaminate groundwater; failure to implement erosion and sedimentation controls at well sites which has caused accelerated erosion; unpermitted discharges of brine onto the ground; and encroachments into floodways and streams without permits."<sup>119</sup>

On June 15, 2007, the PA DEP and Synd entered into a consent agreement whereby the owners of Synd had to pay a \$400,000 civil penalty and "must refrain from owning or operating any future oil and gas operations in the commonwealth and must dissolve their other active companies here."<sup>120</sup>

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<sup>110</sup> *Id.*

<sup>111</sup> *Id.*

<sup>112</sup> PA DEP, *DEP Reaches Agreement with U.S. Energy*, PA DEP Daily News Releases, Aug. 12, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5624> (last visited Dec. 12, 2009).

<sup>113</sup> PA DEP, *DEP Revokes Erosion and Sedimentation Control Permits for Two Gas Companies*, PA DEP Daily News Releases, Oct. 28, 2009, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5710> (last visited Dec. 12, 2009).

<sup>114</sup> *Id.*

<sup>115</sup> *Id.*

<sup>116</sup> PA DEP, *DEP Seeks \$657,040 Civil Penalty Against New York Company For Environmental Damage in Allegheny National Forest*, PA DEP Daily News Releases, Jan. 11, 2007, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=4367> (last visited Dec. 13, 2009).

<sup>117</sup> *Id.*

<sup>118</sup> *Id.*

<sup>119</sup> *Id.*

<sup>120</sup> PA DEP, *DEP Fines Oil and Gas Operator \$400,000 For Violations*, PA DEP Daily News Releases, June 15, 2007, <http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=4549> (last visited Dec. 13, 2009).

## **BARNETT SHALE CASE STUDIES**

### **I. Introduction**

The Barnett Shale is substantially similar geologically to the Marcellus Shale formation. The Barnett Shale underlies the cities of Dallas and Fort Worth and surrounding counties, covering approximately 5,000 square miles.<sup>121</sup> Because the Barnett Shale underlies the city of Fort Worth, Texas, the impact of drilling and exploration is felt somewhat differently than the effects of Marcellus drilling, which occurs in more rural areas. There are approximately 12,000 gas wells and 1,300 natural gas compressors operating in the Barnett Shale.<sup>122</sup> Since large-scale horizontal drilling began in the Barnett in 2002, there have been reports of water pollution, air pollution, geological disturbances, and impact on human health and wildlife linked to high-volume hydraulic fracturing drilling practices.<sup>123</sup>

### **II. Barnett Shale Case Studies – Water Impacts**

**A. City of Midland, Midland County, TX.** In April 2009, a private well in Midland, Texas, was confirmed to be contaminated with fifty times the acceptable level of hexavalent chromium.<sup>124</sup> The Texas Commission on Environmental Quality (TCEQ) has tested about 240 wells and added filters to 42, where hexavalent chromium levels were found to exceed safe levels.<sup>125</sup> The source of this chromium-6 contamination has not been determined, but the TCEQ is investigating a link to natural gas drilling in the area.<sup>126</sup> Specifically, TCEQ made a connection to Schlumberger gas facilities in the area. In a press statement, the company denied that a source had been determined, but stated that the source was likely an adjacent operation. The TCEQ held public meetings in May and July 2009 to provide information on remediation to residents, but still has not identified a source.<sup>127</sup> The TCEQ has referred the area to the EPA for inclusion on the National Priorities List.<sup>128</sup>

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<sup>121</sup> Texas Commission on Environmental Quality, Barnett Shale Geological Area, <http://www.tceq.state.tx.us/implementation/barnettshale> (last visited Dec. 14, 2009).

<sup>122</sup> *Health Issues Follow Natural Gas Drilling in Texas*, NPR, Nov. 3, 2009, <http://www.npr.org/templates/story/story.php?storyId=120043996> (last visited Nov. 13, 2009).

<sup>123</sup> Until recently, drilling in the Barnett Shale was limited to bigger regional and national energy companies. On December 14, 2009, Exxon Mobil Corp. announced that it would acquire Texas-based XTO Energy in a \$31 billion deal. <http://www.eenews.net/cw/2009/12/15/1> (last visited Dec. 15, 2009).

<sup>124</sup> *EPA grants extension for further testing of chromium contaminated area*, Midland Reporter-Telegram, Dec. 3, 2009, [http://www.mywesttexas.com/articles/2009/12/03/news/top\\_stories/epa\\_grants\\_extension\\_for\\_testing\\_of\\_chromium.txt](http://www.mywesttexas.com/articles/2009/12/03/news/top_stories/epa_grants_extension_for_testing_of_chromium.txt) (last visited Dec. 16, 2009).

<sup>125</sup> Texas Commission on Environmental Quality, *Cleanup in Midland County: West County Road 112, Midland, TX*, <http://www.tceq.state.tx.us/remediation/sites/cr112.html> (last visited Dec. 16, 2009).

<sup>126</sup> Texas Commission on Environmental Quality, *West County Road-112 Groundwater Plume Midland County, Texas, Site Update September 2009*, <http://www.tceq.state.tx.us/assets/public/remediation/variousremediationsites/westcr112/092409meeting.pdf> (last visited Dec. 16, 2009).

<sup>127</sup> Texas Commission on Environmental Quality, *TCEQ Holds Public Meeting on Water Well Contamination*, [http://www.tceq.state.tx.us/comm\\_exec/communication/media/05-09midlandmeeting.html](http://www.tceq.state.tx.us/comm_exec/communication/media/05-09midlandmeeting.html) (last visited Dec. 16, 2009); Texas Commission on Environmental Quality, *TCEQ Holds Public Meeting on Water Well Contamination*,

### III. Barnett Shale Case Studies – Air Impacts

**A. Town of DISH, Denton County, TX.** Reports of human illness and animal deaths led the town of DISH, Texas to spend 15% of its \$70,000 annual budget on an air quality study of the effects of gas wells and compressor stations within the town and just across town lines.<sup>129</sup> The study, conducted in August 2009 by an independent environmental consulting firm, found the “presence in high concentrations of carcinogenic and neurotoxin compounds in ambient air near and/or on residential properties.”<sup>130</sup> The compounds found “were in excess of what would normally be anticipated in ambient air” in communities like these.<sup>131</sup> These compounds included benzene, xylene, carbon disulfide, naphthalene, dimethyl disulphide, methyl ethyl disulphide, and pyridine metabolites.<sup>132</sup> Many of the compounds were found in levels that exceeded either short or long term Effects Screening Levels established by the TCEQ.<sup>133</sup>

**B. Dallas-Fort Worth, Denton and Dallas Counties, TX.** The Dallas-Fort Worth area has seen a dramatic impact on its air quality from natural gas drilling in the Barnett Shale. A report by Al Amendariz of Southern Methodist University, and now EPA Region 6 Regional Administrator, found that the pollutant emissions from natural gas drilling activities per day surpassed those produced by all of the vehicle traffic in the Dallas-Fort Worth region.<sup>134</sup>

In addition to the independent study undertaken by Dish, the Texas Commission on Environmental Quality (TCEQ) is conducting a large-scale air monitoring program.<sup>135</sup> The initial results of that study found benzene levels in the air around Fort Worth to exceed short-term limits. Because benzene is a human carcinogen and the Barnett Shale gas is thought to be fairly “dry” the excessive levels are alarming to regulators. While the TCEQ is continuing its monitoring, officials have referred the findings to the EPA. The TCEQ met with the eight biggest operators in the Barnett Shale, and asked them to

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[http://www.tceq.state.tx.us/comm\\_exec/communication/media/06-09midlandchrome2.html](http://www.tceq.state.tx.us/comm_exec/communication/media/06-09midlandchrome2.html) (last visited Dec. 16, 2009).

<sup>128</sup> EPA, *Search Superfund Site Information, West CR 112 Groundwater*, <http://cfpub.epa.gov/supercpad/cursites/csinfo.cfm?id=0606992> (last visited Dec. 16, 2009).

<sup>129</sup> *State Tests Air Around Drilling And Pipeline Sites*, KERA, Oct. 14, 2009, <http://www.publicbroadcasting.net/keranews/newsmain/article/0/1/1566121/North.Texas/State.Tests..Air.Around.Drilling.And.Pipeline.Sites> (last visited Nov. 12, 2009).

<sup>130</sup> Wolf Eagle Environmental, *DISH Air Study Results*, Sept. 15, 2009 at 9, available at, [http://www.townofdish.com/objects/DISH\\_Air\\_Study.pdf](http://www.townofdish.com/objects/DISH_Air_Study.pdf) (last visited Nov. 12, 2009).

<sup>131</sup> *Id.*

<sup>132</sup> *Id.*

<sup>133</sup> *State Tests Air Around Drilling and Pipeline Sites*, KERA.

<sup>134</sup> Al Amendariz, *Emissions from Natural Gas Production in Barnett Shale Area and Opportunities for Cost-Effective Improvements*, Jan. 26, 2009, [http://www.edf.org/documents/9235\\_Barnett\\_Shale\\_Report.pdf](http://www.edf.org/documents/9235_Barnett_Shale_Report.pdf) (last visited Nov. 13, 2009).

<sup>135</sup> *Cancer-causing toxin found in air near gas facilities*, WFAA, Oct. 30, 2009, [http://www.wfaa.com/sharedcontent/dws/wfaa/latestnews/stories/wfaa091029\\_mo\\_drilling.2669d39e4.html](http://www.wfaa.com/sharedcontent/dws/wfaa/latestnews/stories/wfaa091029_mo_drilling.2669d39e4.html) (last visited Nov. 13, 2009).

voluntarily reduce emissions from drilling operations after the TCEQ investigation found hydrocarbon vapors escaping from drilling machinery and storage tanks, and significant levels of benzene in some locations.<sup>136</sup> The TCEQ is expected to release the results of the study in late 2009 or early 2010.<sup>137</sup>

The TCEQ Toxicology Division issued a memo on October 27, 2009 reviewing the health effects documented in the DISH report.<sup>138</sup> The memo “strongly” recommended additional sampling in the area.<sup>139</sup> While the memo stated that the monitored concentrations of benzene in DISH did not exceed short-term limits, it also concluded that “the monitored concentrations of benzene at several of the sampling locations could pose a long-term health risk to residents if representative of normal and prolonged ambient conditions.”<sup>140</sup>

The City of Fort Worth has been inquiring into the effects of drilling activity on the air quality around Fort Worth. Most recently, on December 8, 2009 the TCEQ and Fort Worth Department of Environmental Management presented information regarding ongoing investigative efforts to the Fort Worth City Council.<sup>141</sup>

#### **IV. Barnett Shale Case Studies – Geological Impacts**

**A. City of Cleburne, Johnson County, TX.** In addition to the effects on air quality and related health impacts, gas drilling in the Barnett has been linked to minor earthquakes in the Fort Worth region.<sup>142</sup> Since the beginning of 2008, the Dallas-Fort Worth area has experienced at least 18 earthquakes. In the town of Cleburne, less than thirty miles from Fort Worth.

At least seven earthquakes were documented in Cleburne alone between June and July 2009, with another possible earthquake reported on September 30, 2009. While a formal link has not been established, it is suspected that there is a link between disposing of gas drilling wastewater and the quakes.<sup>143</sup> The town of Cleburne had not registered an

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<sup>136</sup> *State worried about air pollution near Barnett Shale wells*, Fort Worth Star-Telegram, Nov. 22, 2009, <http://www.star-telegram.com/804/story/1782464.html> (last visited Nov. 22, 2009).

<sup>137</sup> *Id.*

<sup>138</sup> Texas Commission on Environmental Quality, *Health Effects Review of Ambient Air Monitoring Data Collected by Wolf Eagle Environmental Engineers and Consultants for DISH, TX*, October 27, 2009, [http://www.tceq.state.tx.us/assets/public/implementation/barnett\\_shale/healthEffectsReview.pdf](http://www.tceq.state.tx.us/assets/public/implementation/barnett_shale/healthEffectsReview.pdf) (last visited Dec. 14, 2009).

<sup>139</sup> *Id.*

<sup>140</sup> *Id.*

<sup>141</sup> Fort Worth City Council, *Pre-Council Agenda*, Dec. 8, 2009.

[http://www.fortworthgov.org/council\\_packet/create\\_precouncil\\_agenda.asp?mode=V](http://www.fortworthgov.org/council_packet/create_precouncil_agenda.asp?mode=V) (last visited Dec. 14, 2009) Video of the meeting is available at [http://fortworthgov.granicus.com/ViewPublisher.php?view\\_id=2](http://fortworthgov.granicus.com/ViewPublisher.php?view_id=2) (last visited Dec. 15, 2009).

<sup>142</sup> *Is Drilling to Blame for Texas Quakes?*, NPR, June 30, 2009, <http://www.npr.org/templates/transcript/transcript.php?storyId=106059425> (last visited Nov. 13, 2009).

<sup>143</sup> *Cleburne quakes probably related to gas drilling, expert says*, Dallas Morning News, June 8, 2009, <http://www.dallasnews.com/sharedcontent/dws/dn/latestnews/stories/060909dnmetquakes.40620de.html> (last visited Nov. 13, 2009).



earthquake in its 142-year history, prior to the June quakes.<sup>144</sup> A research team at Southern Methodist University is monitoring seismic activity around the Cleburne area. It is suspected that the quakes may be linked to the underground injection of wastewater from the hydraulic fracturing process. Chesapeake Energy closed two of its salt water disposal wells in the area after the quakes.<sup>145</sup>

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<sup>144</sup> *Temblors Rattle Texas Town*, Wall Street Journal, June 12, 2009

<http://online.wsj.com/article/SB124476331270108225.html>. (last visited Nov. 13, 2009).

<sup>145</sup> *Chesapeake shuts two re-injection wells down as a precaution*. Cleburne Times-Review. Aug. 14, 2009, [http://www.cleburnetimesreview.com/local/local\\_story\\_226123755.html](http://www.cleburnetimesreview.com/local/local_story_226123755.html). (last visited Nov. 13, 2009).

## WYOMING AND COLORADO CASE STUDIES

### **I. Wyoming and Colorado Case Studies – Water Impacts**

**A. Pavillion, Fremont County, WY.** In response to complaints of foul odors and taste in residential wells, EPA Region 8 funded an investigation into the source and nature of the contamination.<sup>146</sup> The report considered data collected from residential and municipal wells in Pavillion, Wyoming in March and May 2009. The report found heightened levels of hazardous contaminants in a number of drinking water wells, including the same chemicals used in a nearby hydraulic fracturing operation.<sup>147</sup> EPA found that oil and gas activity in the region was a potential source of contamination, and that the agency would be working with gas producer EnCana in the area to mitigate the effects of drilling on the water supply.<sup>148</sup> The Pavillion area is currently being considered for addition to the National Priorities List.<sup>149</sup>

**B. Garfield County, CO.** A report prepared for Garfield County, CO found a correlation between increased levels of methane and chloride in groundwater in areas proximate to gas drilling activity.<sup>150</sup> The report elaborated that the positive correlation between drilling activity and increased levels of dissolved methane in the groundwater suggested, “drilling and production activities are the cause.”<sup>151</sup>

The Colorado Oil and Gas Conservation Commission (COGCC) reports an ongoing problem with ground water contamination in Garfield County.<sup>152</sup> The COGCC has required EnCana, the gas producer in that region, to remediate this contamination and provide quarterly reports on the state of the groundwater. The COGCC reports that methane and BTEX (benzene, toluene, ethylbenzene, and total xylenes) have been the principal forms of contamination.<sup>153</sup>

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<sup>146</sup> URS Operating Services, Inc., Site Inspection – Analytical Results Report, Pavillion Area Groundwater Investigation Site. CERCLIS ID# WYN000802735. Aug. 2009, [http://www.earthworksaction.org/pubs-others/EPA\\_2009\\_Pavillion\\_Groundwater\\_Report.pdf](http://www.earthworksaction.org/pubs-others/EPA_2009_Pavillion_Groundwater_Report.pdf) (last visited Dec. 16, 2009).

<sup>147</sup> *Id.*

<sup>148</sup> EPA Region 8, *Pavillion Groundwater Investigation, Pavillion Wyoming, Phase I Sampling Results* (PowerPoint Presentation) Aug. 11, 2009, [http://www.earthworksaction.org/pubs-others/EPA\\_2009\\_Pavillion\\_Groundwater.ppt](http://www.earthworksaction.org/pubs-others/EPA_2009_Pavillion_Groundwater.ppt) (last visited Dec. 15, 2009).

<sup>149</sup> EPA, *Search Superfund Site Information, Pavillion Area Ground Water Study*, <http://cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0802735> (last visited Dec. 16, 2009).

<sup>150</sup> Review of Phase II Hydrogeologic Study, Prepared for Garfield County. Geoffrey Tyne. Dec. 20, 2009. <http://www.garfield-county.com/Index.aspx?page=1143> (last visited Dec. 15, 2009).

<sup>151</sup> *Id.*

<sup>152</sup> Colorado Oil and Gas Conservation Commission, *FY 2008-2009 Report to the Water Quality Control Commission and Watery Quality Control Division of the Colorado Department of Public Health and Environment*, Nov. 2009, [http://cogcc.state.co.us/Library/WQCC\\_WQCD\\_AnnualReports/WQCC08\\_09RPT.pdf](http://cogcc.state.co.us/Library/WQCC_WQCD_AnnualReports/WQCC08_09RPT.pdf) (last visited Dec. 16, 2009).

<sup>153</sup> *Id.*