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Carbon Sequestration: Critical Property Rights and Legal Liabilities — Real Impediments or Red Herrings?

J. Thomas Lane
Britt Freund
H. Hampton Rose
Bowles Rice McDavid Graff & Love LLP
Charleston, West Virginia

Steven M. Carpenter
Advanced Resources International, Inc.
Batavia, Ohio

Synopsis

§ 23.01. Introduction.

The current political debate suggests that greenhouse gases contribute to global warming and climate change and the rate of growth continues at an alarming rate. Accordingly, as the thinking goes, action must be taken to curb emissions. Coal-fired power plants are significant emitters of greenhouse gases, namely, carbon dioxide, and have therefore been targeted to reduce these emissions. Carbon capture and sequestration are seen as the remedy and therefore the hot topic of the day is the ability to capture carbon dioxide and other greenhouse gases at the power plant and to sequester them in subsurface formations.

This chapter addresses three issues: First, the technology for capturing and sequestering carbon dioxide; second, the property rights necessary; and third, the potential liability from sequestration operations.

From a purely legal perspective, we conclude that virtually all activities pertaining to carbon capture and sequestration and the liability that can result occur in other forms and in other applications today. From both a property rights as well as a liability standpoint, we conclude that the old adage "there is nothing new under the sun" applies here.

Further, while catastrophes can occur from the release of carbon dioxide, the actual instances are exceptionally rare, making the potential liability an issue, but not one that should be a significant impediment; thus, we also conclude that liability touted as an impediment is a red herring.

This chapter does not examine or suggest the viability of carbon capture and sequestration as either a workable solution or economically feasible. In fact, as this chapter was being written American Electric Power Company announced in July 2011 the suspension of "one of the most advanced and successful [carbon capture and sequestration projects] in the world" at its Mountaineer Generating Station in New Haven, West Virginia.[1] According to the chairman of AEP, Michael G. Morris, the project was placed "on hold until economic and policy conditions create a viable path before."[2] The demise of the project was attributed to congressional inaction on climate change and the lack of legislation which could have provided financial incentives. More directly, the public regulatory authorities in Virginia and West Virginia denied AEP the ability to recover the costs of its operations, albeit funded 50 percent by the Department of Energy, with the commissions in each state suggesting that the costs needed to be shared by the consumers in all states served by AEP or possibly across the United States, since a successful project would benefit everyone.[3]

Finally, this chapter also does not enter the scientific fray in debating whether global warming or climate change exist nor do we comment on whether, it they exist, either is a result of anthropogenic causes.

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1 Matthew L. Wald and John M. Broder, "Utility Shelves Ambitious Plan to Limit Carbon," *New York Times,* July 14, 2011, at A1.

2 *Id*.

3 *Id*.

§ 23.02. Carbon Capture and Sequestration (CCS) Technical Issues.

[1] — Global Carbon Cycle.

The Global Carbon Cycle is a natural process whereby Greenhouse Gases (GHGs) are naturally emitted and mutually absorbed — creating a somewhat "balanced" process whereby carbon dioxide (the predominant GHG) is "cycled" through a natural progression. Examples of this natural process include plant photosynthesis, respiration and decomposition and ocean-atmosphere exchanges.[4]

The concern and issue relative to the Global Carbon Cycle within the discussion of Carbon Sequestration is an issue of imbalance. When we burn (emit) fossil fuels, there is no corresponding absorption part of the cycle — burning fossil fuels only emits GHGs it cannot absorb GHGs. Carbon capture and storage is the associated man-made or anthropogenic "absorption" piece that balances the emission side of fossil fuel burning.

Much of the discussion surrounding GHG emission focuses on the source of the emission — naturally occurring as described in the Global Carbon Cycle, or anthropogenic as occurs in the burning of fossil fuels. Is the resulting increase in GHG in the earth's atmosphere the result of natural or anthropogenic emissions? This question is not easily addressed. There are many pieces of data, but ultimately the issue comes down to an understanding, resolution and "agreement" of cause and effect.

It is clear that there is a rise in the atmospheric concentration of carbon dioxide over time. It is also clear that there is a rise in the emission of carbon dioxide from anthropogenic sources over the same time period. Charting the increases in emissions from both sources provides a stark comparison.[5] While discussion of a correlation between the rise of GHGs in the atmosphere

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4 *See* Nat'l Oceanic & Atmospheric Admin., *GMD Carbon Cycle Greenhouse Gases Group*, Earth System Research Laboratory, available at http://www.esrl.noaa.gov/gmd/ccgg/ (last visited Sept. 30, 2011).

5 *See* Carbon Dioxide Information Center, available at http://cdiac.esd.ornl.gov/ (last visited Sept. 30, 2011).

and the rise in anthropogenic GHG emissions, and the cause and effect, if any is a valid discussion, we leave it for a scientific analysis and it is not addressed herein.

To move forward with this, and most all other discussions surrounding carbon capture and storage, it is assumed that there is a cause and effect and that a reduction in anthropogenic emission of carbon dioxide will reduce the climate increases identified by scientists. It is this premise that drives the carbon capture and storage technology today.

[2] — Regulatory Framework.

In the United States, the states have taken most of the significant actions to address climate change. In order to address the patchwork of state-enacted climate change rules, emission limits and trading schemes, it is increasingly likely that a federal mandate will be necessary. A key question is whether responsibility for climate change action should rest exclusively with the federal government or exclusively with the states, or some compromise of shared responsibility.

States have historically played a role as effective first-movers on important environmental issues, functioning as policy innovators, testing policies that have later been adopted at the federal level.[6] States also bring an understanding of the unique circumstances within their boundaries and a familiarity with their stakeholders. The federal government provides funding for the first-movers, such as the AEP New Haven project, without which no effort would be undertaken regarding CCS. Federal action also offers a platform for engaging with other nations in forging an international emissions reduction agreement. A national GHG cap-and-trade program could keep costs manageable and drive climate-friendly technological innovation, and could link with other markets around the world, thereby encouraging more first-movers or first-of-a-kind costs to be borne by a select few.[7]

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6 *See* W. Va. Code § 22-11A-1 to -6 (2009).

7 Franz T. Litz, *Toward a Constructive Dialogue on Federal and State Rules in U.S. Climate Change Policy*, World Resources Inst. (2011), available at http://www.pewclimate.org/docUploads/StateFedRoles.pdf.

A federal climate change program will be most successful if it is designed with the relative strengths of each level of government in mind. As such, the following is a non-exhaustive list of the some of the climate-change regulatory framework that is ongoing and may very well be modified as the CCS arena moves forward:

- U.S. Department of Energy — GHG emission monitoring, research and development funding and first-of-a-kind construction funding;[8]
- EPA-Safe Drinking Water Act — Underground Injection Control program — dictates the design, construction, operation and closure of wells used to inject CO_2 as part of CCS;[9]
- EPA-Clean Air Act — Mandatory Greenhouse Gas Reporting Rule — requires facilities (emitters of GHGs) to report annually to the EPA the amount of GHGs emitted;[10]
- U.S. Department of Transportation - Office of Pipeline Safety (OPS) - sets minimum safety standards for pipelines transporting hazardous liquids, including CO_2 ;[11]
- Mineral Leasing Act - CO_2 pipelines may be subject to access and rate conditions imposed by the Department of the Interior's (DOI), Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), when they cross federal lands, and are in any event subject to rate and some siting regulation by individual states;[12]

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8 *See* Nat'l Energy Tech. Lab., *Passive Wireless Acoustic Wave sensors for Monitoring CO_2 Emissions for Geologic Sequestration Sites*, available at http://www.netl.doe.gov/publications/factsheets/project/FE0002138.pdf.

9 40 C.F.R. 144-148.

10 *See* Envtl. Prot. Agency, Greenhouse Gas Reporting Rule, available at http://www.epa.gov/climatechange/emissions/ghgrulemaking.html.

11 Transportation of Hazardous Liquids by Pipeline, 49 C.F.R § 195 (2011); *see* World Resources Inst., *Guidelines for Carbon Dioxide Capture, Transport, and Storage* (2008).

12 *See* World Resources Inst., *supra* note 11.

- Interstate Oil & Gas Compact Commission — an NGO used by federal agencies to prepare draft legislative and regulatory language that may be used for the transportation and storage of CO_2;[13]
- Federal Energy Regulatory Commission — presently regulates the transportation and storage of natural gas and will be seen as a model for replicating to the CCS arena;
- State Regulations - CCS laws & regulation exist in over two dozen states[14] pertaining to CCS incentives, CO_2 transportation, and liability and ownership of CO_2; and
- County and local laws — while too numerous to list, there will be implications and requirements to meet local regulatory requirements, that must be considered.

[3] — Carbon Capture and Storage Process/Technology.

Carbon capture and storage, from a technology/process standpoint is a relatively straightforward undertaking. Remove or capture the greenhouse gases from the emitting sources, package them in some form to be transported to the final destination, and ultimately store or sequester the GHGs on a relatively permanent basis. Developing this three pronged approach — capture, transport and store — is the basis for the commercial deployment of carbon capture and storage as a viable technology for GHG reductions. As you will see, the basis for this technology lies in the replication of existing technologies already in place in the market. Examples of the existing technologies include the removal of other pollutants from flue gas in coal fired power plants such as NO_X and SO_X. The transportation and storage aspects of the technology very closely resemble the natural gas transportation and storage field development.

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13 *See* Interstate Oil & Gas Compact Commission, available at http://www.iogcc.state.ok.us/.

14 Nat'l Conference of State Legislatures, *Carbon Capture and Storage in the States*, available at http://www.ncsl.org/?tabid=22139.

[a] — Carbon Capture.

Carbon capture is the first step in carbon capture and storage process. Fossil fuel GHG emissions from coal fired power plants account for the single largest, "capturable" source of GHGs.[15] There are three main mechanisms or processes by which greenhouse gases can be removed from flue gas in power plants. Those three processes are pre-combustion, post-combustion and oxy-fuel.

[i] — Pre-combustion.

Pre-combustion technologies fall into two categories — physical or solid solvents and membrane technologies. Physical solvents are being developed that readily dissolve CO_2 in the flue-gas stream, that have a high CO_2 adsorption capacity and that are regenerated at higher pressure. It is expected that these solvents will be more applicable to low temperature, high-pressure applications (cooled syngas). Presently the existing solvents are operational at scale, but are not cost effective.

Membranes are being developed which selectively allow H_2 or CO_2 to permeate the membrane while "filtering" out the remaining flue-gas. Membranes are being developed that are capable of operating at higher temperatures and pressures and do not require cooling and reheating of gas streams.[16]

[ii] — Post-combustion.

Post-combustion capture is important because it is compatible with — and can be retrofitted to — the existing coal-fired power plant infrastructure without requiring substantial change in basic combustion technology. It is the leading candidate for gas-fired power plants. Neither the oxy-combustion nor the pre-combustion approaches are well suited for gas plants. Post-combustion offers flexibility. If the capture plant shuts down, the power plant

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15 U.S. Energy Info. Admin., *Annual Energy Outlook 2011* (April 26, 2011).

16 Nat'l Energy Tech. Lab., Carbon Sequestration: Pre-Combustion Capture Focus Area, available at http://www.netl.doe.gov/technologies/carbon_seq/corerd/precombustion.html#solvents.

can still operate. The other two capture options are highly integrated with the power plant: if capture fails, the entire plant must shut down.[17]

[iii] — Oxy-fuel.

Oxy-fuel or oxygen-fuel is a potential alternative to post-combustion technologies. Oxy-fuel combusts the fossil fuel in pure oxygen instead of air, which contains approximately 78 percent nitrogen by volume. The removal of nitrogen allows for a much higher concentration of CO_2 in the flue gas, thereby reducing or eliminating the need for costly CO_2 capture (*e.g.*, pre- or post-combustion). Additionally, NO_X and SO_X emission/removal equipment is also significantly reduced. This process however comes with a large parasitic electrical cost. For a typical 500MW coal-fired power station supplying pure oxygen requires at least 15 percent of the electricity the plant generates annually.[18]

[b] — Carbon Transportation and Infrastructure.

Transporting CO_2 from the source of the capture (emission point) to the storage site is an important linking step in the CCS project cycle. Although CO_2 is transported via pipelines, ships, and tanker trucks for enhanced oil recovery and other industrial operations, pipeline transport is considered to be the most cost-effective and reliable method of on-shore transportation.[19] Current CO_2 pipelines are primarily owned privately, and pipeline contracts/capacities are negotiated by the pipeline owner(s)/operator(s). The bulk of existing CO_2 pipelines exist to support the enhanced oil recovery industry which currently supports 4,000 miles of pipelines which move approximately 123,000 tons/day of CO_2.[20]

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17 Howard Herzog. *et al.*, *Advanced Post-Combustion CO_2 Capture*, available at http://web.mit.edu/mitei/docs/reports/herzog-meldon-hatton.pdf.

18 Power Plant CCS, *Oxy Fuel Combustion Method*, available at http://www.powerplantccs.com/ccs/cap/con/of/of.html (last visited Sept. 30, 2011).

19 World Resources Inst., *supra* note 11.

20 Advanced Resources Int'l, Inc., *U.S. Oil Production Potential From Accelerated Deployment of Carbon Capture and Storage*, available at http://www.adv-res.com/pdf/v4ARI%20CCS-CO2-EOR%20whitepaper%20FINAL%204-2-10.pdf.

[c] — Carbon Storage.

Geologic carbon dioxide storage or sequestration involves the injection and storage of CO_2 in geologic formations as opposed to terrestrial carbon dioxide storage that stores the CO_2 in plant material via photosynthesis. The main geologic formations for storage are depleted oil and gas reservoirs, unmineable coal seams, and deep saline reservoirs. These are structures that have stored crude oil, natural gas, brine and CO_2 over millions of years. Many power plants and other large emitters of CO_2 are located near geologic formations that are amenable to CO_2 storage. Further, in many cases, injection of CO_2 into a geologic formation can enhance the recovery of hydrocarbons, providing value-added byproducts that can offset the cost of CO_2 capture and sequestration.[21]

[i] — Oil and Gas Formations.

Production from an oil or natural gas reservoir can be enhanced by pumping CO_2 gas into the reservoir to push out the product, which is called enhanced oil recovery (EOR). The United States is the world leader in enhanced oil recovery technology, using about 32 million tons of CO_2 per year for this purpose. From this perspective enhanced oil recovery represents an opportunity to sequester carbon at low net cost, due to the revenues from recovered oil/gas.[22] Further benefits are realized from the decades of experience derived from the oil and gas industry which has removed, transported and re-injected natural gas into existing geologic formations successfully.

[ii] — Coalbed Methane.

Coal beds typically contain large amounts of methane-rich gas that is adsorbed onto the surface of the coal. The current practice for recovering

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21 Nat'l Energy Tech Lab., *Geologic Storage Formation Classification: Understanding Its Importance and Impacts on CCS Opportunities in the United States* (2010), available at http://www.netl.doe.gov/technologies/carbon_seq/reshelf/ BPM_GeologicStorageClassification.pdf.

22 U.S. Dep't of Energy, *Geologic Sequestration Research*, available at http://fossil.energy.gov/programs/sequestration/geologic/index.html.

coal bed methane, either in advance of mining as a degasification method or as a standalone economic venture is widely practiced in the U. S.

The adsorption rate of CO_2 onto the coal surface (face and butt cleats) is much higher than that of methane. Preferentially, the injection of CO_2 onto a coal seam or coal bed will physically displace the natural gas (methane) while remaining in place in the coal. Similar to the by-product value gained from enhanced oil recovery, the recovered methane provides a value-added revenue stream to the carbon sequestration process, creating a low net cost option. The use of CO_2 to enhance coalbed methane production is known as enhanced coalbed methane or ECBM.

The U.S. coal resources are estimated at six trillion tons, and 90 percent of it is currently unmineable due to seam thickness, depth, and structural integrity. Another promising aspect of CO_2 sequestration in coal beds is that many of the large unmineable coal seams are near electricity generating facilities that can be large point sources of CO_2 emissions. Therefore, limited pipeline transport of CO_2 gas would be required. Integration of coal bed methane with a coal-fired electricity generating system can provide an option for additional power generation with low emissions.[23]

[iii] — Saline Aquifers.

The sequestration potential for CO_2 in deep saline formations or aquifers in the United States is large. It has been estimated that deep saline formations in the United States could potentially store more than 12,000 billion tons of CO_2.[24] Most existing large CO_2 point sources are within easy access to a saline formation injection point, and therefore sequestration in saline formations is compatible with a strategy of transforming large portions of the existing U.S. energy and industrial assets to near-zero carbon emissions via low-cost carbon sequestration retrofits. While storage in saline aquifers does not provide any additional cost/economic benefit as do enhanced coal

23 *Id.*
24 *Id.*

bed methane and enhanced oil recovery operations, deep saline injection does offer some cost benefits that ECBM and EOR do not. Due to the large scale of the formations, the number of injection points (wells) are much less than those required by the other formations. Well construction costs under new EPA UIC regulations[25] will make saline aquifers a key component to the success of CCS in the United States.

[iv] — CO_2-EOR.

Combining carbon capture and storage (CCS) with Enhanced Oil Recovery using CO_2 injection (CO_2-EOR) can help produce more oil from mature oil fields while economically sequestering CO_2. This combination can provide significant benefits, especially if value-added opportunities for productively using captured CO_2 from power generation — the proverbial "low-hanging fruit" — is encouraged and pursued.

Significant expansion of oil production utilizing CO_2-EOR, both in the U.S. and globally, will require volumes of CO_2 that cannot be met by natural CO_2 sources alone.[26] Thus, not only does CCS need CO_2-EOR to help promote economic viability for CCS, but CO_2-EOR needs CCS to ensure adequate CO_2 supplies to facilitate growth in production from CO_2-EOR projects.

The Department of Energy (DOE) has suggested that those in the industry no longer consider CCS without considering the "utilization" of carbon dioxide for the added extraction of additional hydrocarbon recovery — CO_2-EOR. DOE also suggests that CCS is now CCUS — Carbon Capture "Utilization" and Storage.

A recent study by the U.S. Department of Energy/National Energy Technology Laboratory (DOE/NETL) concludes that "next generation" CO_2-EOR can provide 135 billion barrels of additional technically recoverable

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25 *See* UIC Regulations, *supra* note 9.

26 Advanced Resources International, Inc., *U.S. Oil Production Potential From Accelerated Deployment of Carbon Capture and Storage* (March 10, 2010), available at http://www.adv-res.com/pdf/v4ARI%20CCS-CO2-EOR%20whitepaper%20FINAL%204-2-10.pdf.

oil in the U.S.[27] In order to realize this result, some 17 billion metric tons of CO_2 will need to be purchased by CO_2-EOR operators to recover the economically recoverable oil. The CO_2 required to supply this market — 17 billion metric tons — is equivalent to the GHG emissions from 91 large one GW size coal-fired power plants over 30 years.

A recent study by Advanced Resources International for the International Energy Agency Greenhouse Gas Program[28] (IEA GHG) assessed the CO_2-EOR and CO_2 storage potential of the largest 54 oil basins in the world. The assessment concluded that fifty of these basins have reservoirs amenable to miscible CO_2-EOR. Assuming "state-of-the-art" technology, oil fields in just the largest discovered fields in these basins (those greater than 50 million barrels of original oil in place) have the potential to produce 470 billion barrels of additional oil, and store 140 billion metric tons of CO_2.

Enhanced Oil Recovery will continue to lead the way as an early entrant into the CCS project world. CO_2-EOR provides an opportunity to address both climate and energy security. The role of government in the world-view of CCS is very important. Without the financial incentives provided by the governments around the globe, the rollout of numerous large-scale CCS projects is not likely. Promoting CO_2 storage via CO_2-EOR can provide large new revenues to those participants in the value chain.

[v] — Monitoring.

Assuring the environmental acceptability and safety of CO_2 storage is paramount. Determining that CO_2 will not escape from formations and either migrate up to the earth's surface or contaminate drinking water supplies is a

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27 Nat'l Energy Tech. Lab., *Improving Domestic Energy Security and Lowering CO_2 Emissions with "Next Generation" CO_2-Enhanced Oil Recovery (CO_2-EOR)(*July 2011), available at http://netl.doe.gov/energy-analyses/refshelf/PubDetails.aspx?Action=View&Source=Main&PubId=391(prepared by Advanced Resources International).

28 IEA Greenhouse Gas R&D Programme, *CO_2 Storage in Depleted Oilfields: Global Application Criteria for Carbon Dioxide Enhanced Oil Recovery* (August 31, 2009), available at http://www.co2storage.org/Reports/2009-12.pdf (Prepared by Advanced Resources International, Inc. and Melzer Consulting).

key aspect that must be adequately addressed before full scale commercial deployment can be realized.

The major issues to be addressed with a monitoring, verification and closure plan include an understanding of, agreement from, and acceptance by the emitters, the regulators and the public. This is accomplished through a monitoring, reporting and verification plan. Much work is being accomplished through the combined national interests of the U.S. and Canada to develop a bi-national carbon capture and storage standard that can be recognized internationally by governing bodies such as the International Standards Organization (ISO).

[vi] — Long-term Closure.

Addressing the long-term closure issues of CCS is also a key to the success of the technology. Once a geologic storage field (oil and gas formation, saline aquifer, or coal seam) is full and the field will not accept any more CO_2, the field will have to be maintained, much like a closed landfill when it no longer accepts waste. This specific aspect of CCS is unique, in that it will require the post-closure care and long-term liability issues that exist with storing CO_2 permanently.

Work is being completed by many organizations to focus technical expertise on this issue. Two leading organizations and their respective guidance documents are the U. S. DOE-NETL's Best Practices Manual for Monitoring, Verification, and Accounting of CO_2 Stored in Deep Geologic Formations,[29] and the developing Canadian Standards and International Performance Assessment Centre for Geologic Storage of Carbon Dioxide joint effort,[30] American-Canadian carbon capture and storage standard for the geologic storage of carbon dioxide.[31]

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29 Nat'l Energy Tech. Lab., *Best Practices for: Monitoring, Verification, and Accounting of CO_2 Stored in Deep Geologic Formations*, available at http://www.netl.doe.gov%2Ftechnologies%2Fcarbon_seq%2Frefshelf%2FMVA_Document.pdf&ei=pxCGTtTMBJKBsgLW5sSfDw&usg=AFQjCNHxBgCPJn6ArtmQY--fKHuWirIeDg.

30 *See Government of Canada Supports CO_2 Assessment Centre*, available at http://www.wd.gc.ca/eng/77_11804.asp (Jan. 15, 2010).

31 Steven M. Carpenter, "Clean Development Mechanism (CDM) as a Real Option for Carbon Capture & Storage (CCS) — How do we get there?," *Carbon Capture*

[4] — Examples and Costs.

There are currently over two hundred active or planned CCS projects ranging across technologies, project types and sectors at the end of 2010.[32] The majority of the projects are located in the U. S. and Europe.[33] One third of these projects are fully integrated, large-scale CCS projects.[34] In the Central Appalachian Coal Basin, there are two projects within the CCS life cycle. American Electric Power (AEP) implemented a 20 MWe (megawatt equivalent) or about 1.5 percent unit flue gas at the Mountaineer West Virginia facility. As reported above, sequestration at that plant has been suspended. Dominion Power's Virginia Hybrid Energy Center, St. Paul, Virginia is a coal-fired power plant that is designed as a carbon capture capable facility, however, implementation of the capture and sequestration component is delayed.

The costs associated with installing and operating the carbon capture and storage technologies ranges greatly, depending on the specific technology selected and whether or not the technology is applied to a new or existing (*e.g.*, retrofit) facility. Some ranges of costs — required to achieve 90 percent carbon capture at the plant are as follows:

- Current average consumer power cost *increase*: 10.6¢ per kWh;
- New power plant *increased* cost for integrated CC systems: 15-25 percent increase;
- Retrofit *cost* for existing facilities: 20-45 percent increase; and
- CCS entire US Fleet: 40 GW parasitic load.[35]

Journal (June 22, 2011), available at http://www.carboncapturejournal.com/displaynews.php?NewsID=806.

32 Global CCS Institute, *The Global Status of CCS: 2010*, available at http://cdn.globalccsinstitute.com/sites/default/files/publication_20110419_global-status-ccs.pdf.

33 *Id*.

34 *Id*.

35 Sources: Energy Information Administration, National Energy Technology Laboratory, and Intergovernmental Panel on Climate Change.

[5] — Conclusions.

In conclusion, the technologies required to implement carbon capture and storage already exist. The EOR and ECBM industry have been implementing similar — and in some cases the exact technologies — for decades. There is however a general lack of geological homogeneity, lack of time in grade regarding duration of monitoring (*e.g.*, 50 to 100 years), and a lack of federal and international standardization. In the face of these shortcomings, work is progressing toward insurance, bonding, regulation, and pore space ownership that, once overcome, will afford the CCS industry the opportunity to grow and flourish.

§ 23.03. Property Use for Carbon Sequestration.

[1] — Infrastructure Generally.

A carbon capture and sequestration project has three critical components: a plant which will separate carbon dioxide and other pollutants from the waste stream of a plant (this aspect of the operation is discussed in section 23.02 above); a transportation component to move CO_2 from the capture plant to a storage field; and storage field operations which will involve injection wells, compressors and monitoring wells.

The transportation and storage field operations will resemble oil and gas operations from a property use standpoint. In fact, a sequestration operation will be nearly identical to gas storage operations today where gas is injected into or withdrawn from an underground formation capable of containing the gas with transportation through a pipeline system on the surface. The primary difference, and perhaps uniqueness, of a carbon sequestration effort will be the goal of containing the gas in formation in perpetuity. From a geologic standpoint the challenge will be to locate an underground structure with no fissures, old wells or fracturing which could allow the carbon dioxide to migrate to other formations and possibly the surface where the gas could escape into the atmosphere, the exact thing which sequestration is attempting to prevent. The infrastructure required for these operations will be exactly the same as currently exist for the transportation of gas, or for that matter oil and other fluids. Injection wells, monitoring wells and compressor facilities will similarly resemble the facilities currently in use with oil and gas operations.

[2] — Transportation.

From the point carbon dioxide is captured at a power plant, it must be transported either in a gaseous or liquid state to the storage field. This will require pipelines and compression and these in turn will require associated roads and easements. The transportation component of a sequestration operation will look exactly like oil and gas transportation facilities currently in existence across the United States and anywhere oil and gas are produced.

In fact, carbon dioxide pipelines and facilities already exist in many parts of the country.[36] Most notably, these pipeline systems have been installed and are currently used to inject carbon dioxide into oil-producing horizons to enhance oil production. In other applications carbon dioxide can be used for industrial purposes and in these cases pipeline systems have been constructed to transport from the place of production or manufacture to an end-user. In these instances carbon dioxide is transported, just like natural gas, oil and other products are currently piped across land.

Accordingly, securing property rights for carbon dioxide transportation will be no different for a sequestration operation than currently exists for other transportation purposes. In order to secure rights, the options are simple: either buy or, given the public purpose,[37] condemn the strip of land or easement necessary for the pipeline.

[3] — Wells, Sites and Meters.

In order to inject carbon dioxide physically, both injection and monitoring wells must be drilled, and associated with these will be roads, well sites, compression facilities and meters, and possibly other similar facilities. The physical acts and rights necessary are no different than currently take place with gas storage fields, injections wells for deposition of brine and other products, and other similar operations.

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36 *See* Kinder Morgan, *Asset Map*, available at http://www.kne.com/asset_map/KM_System_Map_B_12-27-10.pdf.

37 *See* W. Va. Code § 22-11A-1(a)(12)(2009).

[4] — Storage Rights Akin to Natural Gas Storage.

Natural gas as a commodity for public consumption whether for residential, commercial or industrial use requires certain critical components: production from wells in the field, gathering lines to transport gas to major pipelines, major pipelines, utility service lines and end-users. Consumption has significant peaks and valleys and a critical additional component in having a reliable delivery of natural gas is storage in underground reservoirs. In most areas of the eastern United States, geologic formations which have certain physical characteristics and oftentimes which are depleted gas formations have been transformed into storage fields. These fields can range in size from 20 square miles to 100 square miles and exist commonly along major transportation lines.[38]

Storage fields function like cushions so that when demand for natural gas is low, injection wells are used to inject gas into formation, and when demand is high, wells withdraw the gas with the result being that a dependable supply of gas always exists. The function of natural gas storage from a property use and ownership standpoint would be virtually the same for carbon sequestration, the primary difference being that with carbon sequestration there would be permanent storage with no withdrawal. In either case monitoring is essential to insure that gas is not lost. Conceptually, the use of pipelines, compressors, injection wells and use of an underground space would be virtually identical. Thus, from a property use and rights standpoint the injection of carbon dioxide for storage purposes, albeit permanent, leads to the conclusion "there is nothing new under the sun."

[5] — Effect on Other Development.

A carbon sequestration project involving pipelines, compressors, wells and subsurface horizons will have impacts on the owners of the land and their ability to use and develop the affected areas. Pipelines, compressors, wells and other similar facilities will obviously require long-term use of the

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38 *See* U.S. Energy Info. Admin., Underground Natural Gas Storage, available at http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/undrgrnd_storage.html.

surface and will render the affected areas incapable of development and most other uses.

Wells which are drilled through subsurface formations can also affect subsurface development. Most significantly, wells which penetrate minable coal seams sterilize areas of coal around the wellbore. In West Virginia, statutes prohibit mining within 500 feet of a wellbore without consent, and even with consent, mining will be prevented within a 200-foot radius of the wellbore. The sterilization of blocks of coal in this fashion can have a material impact on conventional mining and in the case of longwall mining can have a serious and costly impact.

Finally, sequestration involves permanent storage in a subsurface geologic formation. Accordingly, any horizon, and likely those above and below for a certain distance, will be permanently taken for the exclusive use of sequestration and will of necessity preclude other development, such as deep oil or gas drilling, and in particular, fracturing or completion of wells in such a way as to jeopardize the sequestration operation.

§ 23.04. Ownership and Use of Underground Space.

Use of land for carbon dioxide sequestration purposes is a concept which has very recent origins. Accordingly, deeds which create property rights will not, except perhaps in a very rare instance, provide for property rights for carbon sequestration. It is simply not a use which anyone would have considered until very recently. Thus, a central question we address is who will own the property right to carbon sequestration, and the extended question, whether it is a private property right or public right.

In some respects, if the debate emerges over use of land for sequestration purposes, and in particular where severed ownership in minerals exists, that debate will resemble the one which occurred over coalbed methane ownership beginning in the early 1980s with a landmark decision by the Pennsylvania Supreme Court in *U.S. Steel v. Hoge*.[39] In that case the court held coalbed methane which exists in a coal seam is owned by the coal owner. It is fair to

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[39] U.S. Steel v. Hoge, 468 A.2d 1380 (Pa. 1983).

say that prior to that decision, the smartest lawyers in the country in drafting deeds and transaction documents virtually never mentioned, specifically, who would own the gas existing in coal seams, despite the fact that gas in coal seams has long been known to exist.[40] The same can be said for carbon sequestration as a property right, particularly where severed ownership exists. The coalbed methane litigation which was spawned by *Hoge* occurred on a state by state basis and resulted in widely disparate results. The experience there argues in favor of a statutory scheme which could facilitate use of land for sequestration purposes on a uniform basis.[41]

The analysis which follows will attempt to take existing precedent and determine if conclusions can be reached on ownership of subterranean formations capable of sequestration and, importantly, who will have the right to use formations for sequestration, to drill wells and inject gas and otherwise install facilities for sequestration purposes. Our analysis begins with rudimentary principles of land ownership, the ability to sever ownership of different parts of the land, and the rights which are appurtenant to different ownerships.

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40 McGinley, "Legal Problems Relating to Ownership of Gas Found in Coal Deposits," 80 *W. Va. L. Rev.* 369 (1978); Bowles, "Coalbed Gas, Present Status of Ownership Issue and Other Legal Considerations," 1 *E. Min. L. Inst.* Ch. 7 (1980).

41 For years after the *Hoge* decision. the Energy & Mineral Law Foundation and other groups sponsored special educational seminars focused on the ownership issue and, given the intellectual challenge in sorting out the issues, these occurred on an annual basis for many years. The disparate results from the state by state litigation has resulted in some states siding with the *Hoge* decision in holding that the coal owner owns the gas existing in the coal seam (*See* NCNB Texas Nat'l Bank, N.A. v. West, 631 So. 2d 212(Ala. 1993) and Vines v. McKenzie Methane Corp., 619 So. 2d 1305 (Ala. 1993)); other states holding that the gas owner owns gas because it is gas (*See* Carbon County v. Union Reserve Coal Co. v. Florentine Exploration & Prod., Inc., 898 P.2d 680 (Mont. 1995) and Amoco Prod. Co. v. Southern Ute Indian Tribe, 526 U.S. 865 (1999)); and still others suggesting that deeds pre-existing the *Hoge* decision simply did not contemplate coalbed methane and accordingly it would remain with the landowner (*see* Energy Devel. Corp. v. Moss, 591 S.E.2d 135 (W. Va. 2003)). *See generally*, Jeff Lewin, *et al.*, "Unlocking the Fire: A Proposal for Legislative Determination of the Ownership of Coalbed Methane," 94 *W. Va. L. Rev.* 369 (1992).

[1] — Ownership of Land — General Principles.

The study of real property law teaches that private ownership of property, personal and real, is a fundamental right in the United States and that this right is an essential part of the constitutions and laws of the various states. From an early age we learn that property may be owned, protected and possessed, and that remedies exist for injuries to it or encroachments upon it. This ownership includes a well-recognized bundle of rights, so that property can be put to nearly unlimited uses. The elementary limitations on use can be summed up in three general categories: first, an owner of property cannot use it in such a way as to injure his neighbor; second, all ownership is subject to reasonable governmental restrictions such as zoning, land use, and with respect to mineral ownership, regulations which govern the manner in which minerals can be developed; and, third, ownership can be limited by the right of the public to eminent domain.

Each owner of land has certain inherent legal protections and remedies against the unauthorized use, encroachments or taking of land, so that an owner can recover damages and enjoin an unlawful action.

Among the bundle of rights which go with property ownership are the right to use, enjoy, develop, lease and sell. Each of these in turn can be parsed into an infinite variety of ways to enjoy, ways to develop, ways to lease and ways to sell. Included in the right to sell is the right to subdivide the land into different parts. Subdivisions can occur both horizontally and vertically, so that land can be divided on the surface into housing subdivisions, business parks and other similar uses. The right also exists to subdivide the land into different horizontal strata so that ownership of any part of the land can be severed from another. This inherent right of the ability to subdivide results in conveyances of surface, minerals, coal, oil and gas, salt, water, iron and a near infinite variety of minerals and other substances which can be found underneath the land.

Typically in the eastern United States and mineral-producing regions we see subdivisions involving combinations of surface, oil and gas, and coal (with possible different ownerships of separate coal seams) and possibly other minerals and strata. These subdivisions or severances can occur in an almost infinite variation of ways and, without any specified format for deeds, the language employed from the earliest mineral severances in the 1700s to the present has varied and in all too many cases has been done in a highly confusing way, leading to ambiguities and conflicting claims of ownership. Case law interpreting deeds is nearly endless, but this is a topic for a different chapter. It is fair to say, however, that mention of the ownership of "space" or right to use land for storage or sequestration purposes, particularly in old deeds, is virtually unheard of.

When ownership of land is severed into different parts, each owner of a part of land is deemed to own the whole bundle of rights applicable to land ownership. Thus, the owner of the coal, the owner of the oil and gas, the owner of the surface, and the owner of any other interest in the land will each have the whole panoply of rights associated with property ownership and these include the ability to enjoy, develop, lease, sell and subdivide. Each is entitled to protections against the unauthorized use or entry onto its property, and each is limited in use by the basic rule that no owner can use his or her property in a way that causes injury to another and each is subject to reasonable governmental regulations which may limit and restrict the use of the property.

[2] — Rights Appurtenant to Severed Ownership.

Where land ownership is severed between the surface and subsurface (or any combination of minerals or substances or spaces), the subsurface owners will have reasonable use of the surface for access and development of the subsurface and this often leads to tension and sometimes conflict as each owner attempts to use and enjoy the same land for competing purposes. Moreover, when the issue turns to storage, and now sequestration, the property right, absent an express provision in a deed, will be guided, first, by the nature of the severance, and, second, by basic rules which define the rights associated with mineral or any subsurface ownership.

Ownership of any severed interest in land will include, as part of the bundle of rights associated with ownership, the special rights which are necessary for enjoyment and use. In the case of subsurface ownership, most commonly, coal, oil, gas, possibly all minerals, the subsurface ownership will carry with it the right to use the land, particularly the surface, for access to and development of the minerals. Where not expressed in a deed, the rights will be implied by law. The major test for the existence of implied rights, established in a long line of cases, is a rule holding that a mineral owner will have those rights which are "reasonable and necessary."[42] These words form a two-prong test: first, the proposed use must be "reasonable." This prong of the test measures the imposition of the subsurface owner's proposed use against the surface owner's interest in the land. In general where the mineral burden is deemed excessive in its effect on the surface it will be deemed unreasonable and therefore not implied. The second prong of the test, "necessity," is measured from the standpoint of the mineral owner with the question being: is the proposed right "necessary" or better stated "reasonably necessary" for development of the minerals?

Express rights are contrasted with implied rights because they are in fact expressed in a deed or other instrument affecting property rights. As a general rule express rights are recognized by the courts and given effect as written.

[3] — Fee Simple Ownership and Rights.

Applying the above principles on land ownership and rights associated with ownership, we analyze cases and principles which will guide the question on sequestration rights.

Where land is owned in fee simple, the historical principle for ownership was *cujus est solum, ejus est usque ad coelum et ad inferos*, generally known as the "*ad coelum*" principle. In short, it means that the ownership of land runs from the heavens above to the core of the earth beneath. Within this space the owner of land is generally considered to own all substances and spaces together with the full panoply of rights which are described above.

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42 Squires v. Lafferty, 121 S.E. 90 (W. Va. 1924); Adkins v. United Fuel Gas Co., 69 S.E.2d 633 (W. Va. 1950); Justice v. Pennzoil Co., 598 F.2d 1339 (4th Cir. 1979); Ross Coal Co. v. Cole, 249 F.2d 600 (1957); Buffalo Mining Co. v. Martin, 267 S.E.2d 721 (W. Va. 1980).

The *ad coelum* principle, however, has been eroded in cases pertaining to air rights and to a limited extent with subsurface formations.[43] We are aware of no case law, however, which directly addresses the issue of the right to sequester carbon dioxide in subsurface formations. Thus, we start with the proposition that *ad coelum* will apply and a fee simple owner will be deemed to own all formations and spaces beneath the surface. Current science[44] suggests three candidate formations for sequestration: coal seams, depleted oil and gas formations, and deep saline aquifers. While the science may change and other formations become candidates, we will focus on the presently identified candidates.

Absent case law which provides direct precedent on the right of a fee simple owner of land to use subterranean strata for sequestration or storage, we look to cases involving severed ownership where similar issues have been addressed. The analysis of these cases appears below, and from them, we conclude that both case law and actual use of land recognizes the property right to inject and store gases and other substances into the earth, and accordingly, where land is owned in fee simple, the fee simple owner will own the spaces underground and the right to store gas and other substances in them. When ownership is severed, it becomes difficult in many instances to sort out the exact rights which go with the different ownership in the same land.

[4] — Severed Title.

Cases which address subsurface horizons and spaces and the right to use spaces for a variety of ways severance can occur. Where such severed title exists important distinctions are found in the variety of ways frequently involve land where ownership is severed in one of the almost infinite manner the land is divided. Accordingly, our analysis addresses these cases in separate categories.

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43 *See* discussion *infra* § 23.04[05].

44 *See supra* § 23.02.

[a] — Horizontal Division.

Among the myriad ways in which land can be subdivided, one is where a horizontal boundary is created. Such a boundary can be at the surface,[45] a specified coal seam,[46] a rock formation[47] or any other identifiable subsurface strata. Cases involving such horizontal boundaries generally conclude that each owner has the right to use the land, including spaces, for any purpose with the basic caveat that the use cannot injure an adjoining (upper) owner. In holding that the subsurface owner can use space for any purpose, a conclusion which can be drawn that the right to use constitutes ownership of the space.

Perhaps the most common instance of the creation of a horizontal boundary occurs when the surface only is granted or reserved, so that the land is divided between the surface and subsurface. While the word "surface" has been the subject of differing interpretations,[48] in those instances where it is interpreted to include surface only, the horizontal boundary will exist at the surface, or at least not too far from it.

In *Drummond v. White Oak Fuel Co.*,[49] the surface only was conveyed by deed and when the owner of the subsurface developed the coal, mining caused subsidence. The effects of the subsidence were limited to subsurface strata, and while underground water was diverted from the surface owner's water well, the surface was not injured. Under the facts, the court held there could be no recovery because there was no injury to the surface and the diversion of underground water was not recoverable. While the opinion of the court does not directly address the ownership of subsurface space, the inference is that the subsurface owner has the right to use the subsurface for any purpose that does not injure the adjacent, or surface, owner.

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45 Drummond v. White Oak Fuel Co., 140 S.E. 57 (W. Va. 1927); Williams v. South Penn Oil Co., 43 S.E. 214 (W. Va. 1902).

46 Ross Coal Co. v. Cole, 249 F.2d 600 (4th Cir. 1957).

47 Robinson v. Wheeling Steel & Iron Co., 129 S.E. 311 (W. Va. 1925).

48 *Compare* Williams v. South Penn Oil Co., 43 S.E. 214 (W. Va. 1902), with Ramage v. South Penn Oil Co., 118 S.E. 162 (W. Va. 1923).

49 Drummond v. White Oak Fuel Co., 140 S.E. 57 (W. Va. 1927).

In *Robinson v. Wheeling Steel* and *Ross Coal Co. v. Cole*, horizontal boundaries were created, respectively, at a "cement rock" formation[50] and the Island Creek coal seam.[51] The essence of the holdings in both cases was that the owner of the lower strata had the right to use the voids in the coal mines in question for transportation purposes. The indication, particularly in *Robinson*, was that owner of the subsurface space could use its land for any purpose it wished, so long as it did not injure the upper owner.

Where horizontal boundaries such as these are created, it is logical to conclude that the *ad coelum* principle will apply and that the respective owners will each own all formations, substances **and** spaces within their respective boundaries. We conclude that in these instances each owner will own the spaces underground and will have the right of use for storage, sequestration or any other purpose. The critical question, however, will be the rights which the lower owner may exercise over and through the upper owner. In cases where the severance deed expresses limited rights which can be exercised, the expression might limit use or ownership.[52] Conversely, where broad rights are expressed, other compatible uses might be inferred.[53]

[b] — Surface and Minerals.

In cases where severance deeds divide the land between "surface" and "minerals" or, possibly, between the "surface" and certain minerals such as coal or oil and gas, an inherent ambiguity exists. In these instances the deeds do not expressly provide for rock or other formations which are not "minerals," or for that matter any other substance or space which exists. In these instances the courts have tended to give the word "surface" an expanded meaning to include all of the land, other than the minerals or the mineral expressly stated.[54] If "surface" is given a limited meaning, our analysis in

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50 *Robinson*, 129 S.E. at 312.

51 Ross Coal Co. v Cole, 249 F.2d 607 (4th Cir. 1957).

52 Rock House Fork Land Co. v. Raleigh Brick and Tile Co., 97 S.E. 684 (W. Va. 1918).

53 Buffalo Mining Co. v. Martin, 267 S.E.2d 721 (W. Va. 1980).

54 *See* Dolan v. Dolan, 73 S.E. 90 (W. Va. 1911); Ramage v. South Penn Oil Co., 118 S.E. 162 (W. Va. 1923).

[a] above applies, and if given an expanded definition our analysis in [c] below applies.

[c] — Land and Minerals.

In cases where land ownership is divided between all of the land and either "all minerals" or certain minerals, such as coal, oil and gas, salt or other, the cases consistently hold that the owner of the mineral has the exclusive right to use space either where the mineral exists, such as a porous sandstone containing oil or gas, or the space created by removal of the mineral in the case of a solid mineral. In some instances this right is qualified and the fact that it is qualified leads to the implication that the landowner, as opposed to the mineral owner, owns the container space, but subject to the rights of the mineral owner.

An examination of these cases is instructive. The early leading cases come from Pennsylvania where the court held in *Lillibridge v. Lackawanna Coal Co.*,[55] as modified in *Webber v. Vogel*[56] that a coal owner will have the right to use the space created by removal of coal, but only so long as coal reserves remain and mining is conducted with diligence.[57] The Pennsylvania rule with its qualification was followed in West Virginia in *Fisher v. West Virginia Coal & Transp. Co.*,[58] but rejected initially in Virginia.[59] In Virginia, however, the legislature modified the court made law by statute.[60]

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55 United States v. 43.42 Acres of Land, 22 A. 1035 (Pa. 1891).

56 Webber v. Vogel, 159 Pa. 235, 28 226 (1893)(reported as *Vogel v. Webber* in the *Atlantic Reporter*).

57 The qualifications in this rule were criticized by Judge Robert Donley, a long-time professor of coal, oil and gas at West Virginia University College of Law, and we agree with Judge Donley. *See* Donley, "Use of Containing Space After the Removal of Subsurface Minerals," 55 *W. Va. L. Qrtly*. 202 (1953).

58 Fisher v. West Virginia Coal & Transp. Co., 73 S.E.2d 633 (W. Va. 1952).

59 Clayborn v. Camilla Red Ash Coal Co., 105 S.E. 117, 119 (Va. 1921); Webber v. Vogel, 28 A. 226 (Pa. 1893); Lillibridge v. Lackawanna Coal Co., 22 A. 1035 (Pa. 1891); *See also* James Simenton, "Rights of Fee Simple Owner of Subjacent Mineral Stratum in the Containing Space," 32 *W. Va. L. Qrtly*. 242 (1925-1926).

60 Va. Code Ann. § 55-154.2 (West 1981).

The key principle of these cases is that the coal owner has the right to use mine spaces for the transportation of coal, men and supplies from other property, in essence, using one tract (at least the void beneath the tract) to aid in the development of other lands, a use which could not occur on the surface.[61]

In *Pittsburg & Midway Coal Min. Co. v. Shepherd*,[62] the court considered the right of the coal owner to use spaces for injection of refuse material from a cleaning plant. The coal from the mine in question needed processing and the refuse area was reaching capacity. A critical factor leading to the court's conclusion was that coal mining would be restricted without using the mine void for refuse disposal. On these facts the court held that the use of the space for disposal was reasonably necessary for the mining operation and that the coal owner could use the space for these purposes.[63]

In *Tate v. United Fuel Gas Co.*,[64] a gas owner attempted to use a depleted gas formation for gas storage purposes. The court concluded that the gas owner had rights to use the land for the extraction and production of minerals, but not for storage purposes. This decision was heavily influenced by the severance deed language which expressly provided that sandstone formations (one of which was the target of the storage operation) were owned by the landowner, not the mineral owner.

In *International Salt Co. v. Geostow*,[65] the landowner sought to use vacant space in a salt cavern for storing incinerator ash, and the New York court held that so long as the salt owner had active operations in the mine, the salt owner had exclusive right to the spaces.

In *Emery v. United States*,[66] the federal government contended that in acquiring a lease for "mining and operating for oil and gas" and to "produce,

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61 *Ross Coal Co.* at 600.

62 Pittsburg & Midway Coal Min. Co. v. Shepherd, 888 F.2d 1533 (11th Cir. 1989).

63 *See* Ernest and Illingsworth, "Underground Disposal of Slurry in Mine Voids: Does the Coal Owner / Lessee Have the Legal Right to Dispose of Slurry and Coal Refuse in the Mine Voids?" 28 *Energy & Min. L. Inst.* Ch. 11 (Energy & Min. L. Found. 2007).

64 Tate v. United Fuel Gas Co., 71 S.E.2d 65 (W. Va. 1952).

65 International Salt Co. v. Geostow, 878 F.2d 570 (2d Cir. 1989).

66 Emery v. United States, 188 Ct. Cl. 1024, 412 F.2d 1319 (Ct. Cl. 1969).

save, and take care of said products" it had acquired the right to store gas produced elsewhere in the depleted formation.[67] The U.S. Court of Claims disagreed, holding that the right to store alien gas in the formation had not been granted, a result consistent with the West Virginia decision in *Tate*.[68]

In *United States v. 43.42 Acres of Land*,[69] a mineral estate owner argued that because salt was a mineral, the mineral estate owner had the right to receive compensation for the depleted salt cavern's use for oil storage purposes.[70] A Louisiana federal district court instead held that a mineral estate owner has no ownership interest in minerals in place, following a codified 'non ownership' theory[71] that is applicable in some states to oil and gas. Under this theory minerals are owned only when "reduced to possession."[72] Upon this holding the court ruled that the mineral owner did not have the right to use the salt cavern for storage purposes.[73]

In *Ellis v. Arkansas Louisiana Gas Co.*,[74] a mineral estate owner argued that a conveyance of all the minerals included the right to store oil and gas in a depleted field.[75] An Oklahoma federal district court disagreed, holding that the stratum of rock surrounding the oil and gas reserve are only severed from the surface estate when explicitly done so.[76] Again, the oil and gas owner did not have the right of storage.

An extension of the right to use underground space is seen in the cases involving enhanced oil or gas recovery where the courts have recognized the right of a mineral owner to inject various substances in natural gas or oil reservoirs for the purpose of enhanced recovery projects.[77] While the practice

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67 *Emery*, 412 F.2d at 1322.
68 *Id*. at 1324.
69 United States v. 43.42 Acres of Land, 520 F. Supp. 1042 (W.D. La. 1981).
70 *Id*. at 1044.
71 La. Rev. Stat. Ann. § 31:5 (1975).
72 *Id*. at 1045-1046.
73 *Id*.
74 Ellis v. Arkansas Louisiana Gas Co., 450 F. Supp. 412 (E.D. Okla. 1978).
75 *Id*. at 418.
76 *Id*. at 422.
77 *See* Raymond v. Union Texas Petroleum Corp., 697 F. Supp. 270 (E.D. La. 1988); Wiser Oil Co. v. Conley, 346 S.W.2d 718 (Ky. 1960); Nunez v. Wainoco Oil & Gas Co., 488 So. 2d

seems to be widespread enough that a challenge would in most instances be difficult, the court in *Wiser Oil Co. v. Conley*, found that the technique was not contemplated in the early oil lease in question, but nevertheless allowed use of the land for enhanced recovery subject to payment for any actual damage caused to the property.[78]

The *Wiser Oil* case suggests an additional consideration in determining property rights, particularly where severed title exists and implied rights are questioned, is what rights or burdens were or could have been contemplated by the parties at the time of a deed. It is fair to say that throughout history carbon sequestration has not been a property right expressed in deeds, and until recently, has not been a use contemplated. Thus, if the concept of sequestration could not have been contemplated at the time a deed was written, a question is raised whether the right could be implied, particularly with a severed mineral owner.

Early surface mining cases introduced this concept in resolving whether the extensive burden of surface mining could be implied where a deed did not expressly provide for surface mining.[79] The analysis from a substantive standpoint should focus on the burden imposed, such as *Wells v. AEP*,[80] where the court held that longwall mining might not have been contemplated at the time the deed in question was written, but that the burden, subsidence, clearly was. Accordingly, the exercise of the right was allowed.

If the logic of the *Wells* court is applied to carbon sequestration, the question of carbon sequestration rights should turn on whether the burdens of carbon sequestration were contemplated, not so much whether the particular use was. So examined, the question will be whether the surface can be used

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955 (La. 1986); and Bordeaux v. Jefferson Island Storage & Hub, LLC, 255 F.3d 271 (5th Cir. 2001).

78 *Id*.

79 West Virginia-Pittsburgh Coal Co. v. Strong, 42 S.E.2d 46 (W. Va. 1947); Fox v. Phillips, 458 S.E.2d 327 (W. Va. 1995); Skivolocki v. East Ohio Gas Co., 313 N.E.2d 374 (Ohio1974), *but compare with* Akers v. Baldwin, 736 S.W.2d 294 (Ky. 1987), and the line of Kentucky cases which were overruled.

80 Wells v. AEP, 548 N.E.2d 995 (Ohio App. 1988).

for injection wells, pipelines and related facilities and whether subsurface strata can be penetrated and used for sequestration. We conclude from the above cases that an owner of minerals will have rights associated with the development of the minerals, but will not have rights to use the land for unrelated purposes, such as storage or sequestration.

[5] — Limiting the *Ad Coelum* Principle

Cases involving air travel in the mid-twentieth century addressed the common law doctrine of *cujus est solum, ejus est usque ad coelum et ad inferos*, and focused on the *ad coelum* portion. The essential determination of the cases was that a property owner's interest in the space above land is limited and beyond the point of actual use, the airspace is in the public domain.[81] What has not yet been fully explored is the *ad inferos* portion of the doctrine, and the question lingers whether some subsurface formations might be considered to be in the public domain.

In *U.S. v. Causby*,[82] the Supreme Court held, in dicta, that a property owner's interest in the skies above property is not infinite.[83] In *Causby* a chicken farmer asserted a "takings" claim against the federal government based on the use of an adjacent airport as a heavy bomber airbase.[84] Army Air Corps bombers from the base flew at low altitudes over the farmer's land causing hysteria among the chickens which flung themselves against the chicken coop walls, killing themselves.[85] The farmer claimed that even though the bombers did not physically touch his property, their constant low-level flights constituted a "taking" of his property and he demanded "just compensation," as required by the Fifth Amendment.[86]

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81 John G. Sprankling, "Owning the Center of the Earth," 55 *UCLA L. Rev.* 979, 982-983 (2008)(citing William Blackstone, 2 Commentaries 18).
82 U.S. v. Causby, 328 U.S. 256 (1946).
83 *Id.* at 260-261.
84 *Id.* at 258.
85 *Id.*
86 *Id.*

While the Court ultimately decided that the low level flights constituted a taking, it opined that the *ad coelum* doctrine "has no place in the modern world,"[87] at least insofar as air rights are concerned. Limiting the *ad coelum* principle, the Court stated that "[t]he landowner owns at least as much of the space above the ground as [the landowner] can occupy or use in connection with the land. . . . The airspace, apart from the immediate reaches above the land, is part of the public domain."[88]

In reaching its decision, the Court, in part, based its holding on the Ninth Circuit decision in *Hinman v. Pacific Transport*.[89] In *Hinman*, the Ninth Circuit decided a case brought by a landowner who alleged that two commercial airlines had "disturbed, invaded, and trespassed upon the ownership and possession of [the landowner's] tract" by flying over his property daily at varying altitudes, sometimes as low as one hundred feet.[90] The court held that a literal application of the *ad coelum* principle "would be . . . utterly impracticable and would lead to endless confusion."[91] The court refused to "foist any such chimerical concept of property rights upon the jurisprudence of this country."[92] The court created a standard for airspace ownership, holding "[w]ithout possession, no right in [property] can be maintained. The air, like the sea, is by its nature incapable of private ownership, except in so far as one may actually use it."[93] While *Causby*, based on the reasoning set forth in *Hinman*, limited *ad coelum* ownership above the surface, neither the Supreme Court nor the Ninth Circuit addressed the *ad inferos* portion of the doctrine. In both *Causby* and *Hinman*, the Supreme Court and the Ninth Circuit held that the ability to reduce property to possession was indicative of ownership.

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87 *Id*. at 261.
88 *Id*. at 264 (quoting Hinman v. Pacific Air Transport, 84 F.2d 755 (9th Cir. 1936)).
89 *Hinman* at 755.
90 *Id*. at 756.
91 *Id*. at 758.
92 *Id*.
93 *Id*.

[6] — An Inverse Rule of Capture?

From the early days of oil and gas development it was known that oil and gas exist in formation under pressure, and when a well is drilled into formation a release for the pressure exists and the oil and gas move to the well. It is much like tapping a beer keg. Left alone the beer remains contained; however, when tapped the pressure is released and the beer escapes. Eventually all beer in the keg moves to the top and is "produced." While oil and gas do not exist in open containers underground, the rock formations in which they are contained are typically measured by the ability to allow movement, their porosity, and it became well known that oil and gas can migrate through formation, so that a well on one tract of land may cause the migration of oil or gas from neighboring lands, so that the owner of property might produce oil and gas from his neighbors' property.

When tested through litigation, courts across the county followed the lead of Pennsylvania in *Barnard v. Monongahela Natural Gas Co.*,[94] in holding that the capture of minerals in this fashion would not subject the owner of the well to liability, and from this we have the rule of capture. All states have adopted the rule of capture in the sense of non-liability, so that the owner of the oil and gas, or the entity with exclusive rights to produce, can drill and operate without liability to adjoining landowners for any migration of oil and gas which may be caused. Thus, while exceptions to the rule exist in cases of negligence,[95] development on one tract may not only cause a migration of minerals, but possibly production of the oil and gas which formerly existed under adjacent property. The remedy for the drained owner is 'go and do likewise.'

For carbon sequestration, the question is presented in reverse: what liability exists if carbon dioxide is introduced into a formation under pressure and it migrates to surrounding property?

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94 Barnard v. Monongahela Natural Gas Co., 65 A. 801 (Pa. 1907).

95 Elliff v. Texon Drilling Co., 210 S.W.2d 558 (Tex. 1948).

One leading oil and gas treatise suggests a "negative rule of capture":

> Just as under the rule of capture a land owner may capture such oil or gas as will migrate from adjoining premises to a well bottomed on his land, so also may he inject into a formation substances which may migrate through the structure to the land of others, even if it thus results in the displacement under such land of more valuable with less valuable substances.[96]

In *Railroad Commission of Texas v. Manziel*,[97] the Supreme Court of Texas considered whether the migration of salt water, injected as part of a secondary recovery project, outside of the lease boundaries constituted an actionable trespass.[98] The court recited the Williams and Meyers' definition of the "negative rule of capture" in its decision and distinguished a surface trespass from a subsurface trespass:

> The orthodox rules and principles applied by the courts as regards surface invasions of land may not be appropriately applied to subsurface invasions as arise out of the secondary recovery of natural resources. If the intrusions of salt water are to be regarded as trespassory in character, then under common notions of surface invasions, the justifying public policy considerations behind secondary recovery operations could not be reached in considering the validity and reasonableness of such operations.[99]

The court balanced the interests between the private interest of having free use and enjoyment of real property and the public interest of maximizing natural resource production.[100] As the pressure in a gas field drops, thus necessitating secondary recovery projects, the *Manziel* court held that

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96 *Williams and Meyers: Oil and Gas Law* § 204.5, n. 1.

97 Railroad Comm'n of Texas v. Manziel, 361 S.W.2d 560 (Tex. 1962).

98 *Id*. at 566-567. For a more thorough discussion of liability for trespass *see infra* § 23.05[2][c].

99 *Id*. at 569.

100 *Id*.

the public interest in secondary recovery trumps any competing private interest.[101]

In the context of carbon sequestration, the reasoning in these cases indicates that the extent of ownership beneath the surface of property might not be related to a particular depth *ad inferno* but rather to the utility of a particular geologic formation. The overarching consideration will be whether the public interest trumps private property interests. Thus, with carbon sequestration, we predict that where property owners have no reasonable and foreseeable use for subsurface space **and** where a clear public interest in carbon sequestion is articulated,[102] an argument can be advanced that the public domain extends to such formations. A unique aspect of any debate will be the important fact that the only purpose for carbon sequestration is a public one. Even so, if sequestration is deployed, the countervailing proposition will be advanced that property uniquely suited for sequestration will have unique value, and the question of "forseeable use" may become defined by value for sequestration purposes, albeit forced by governmental edict.

[7] — Conclusions.

Unless a determination is made that use of subsurface space for carbon sequestration purposes is a public right which trumps private property rights, we offer the following conclusions.

Where land is owned in fee simple, the owner will have all rights for use of the land, including ownership of subsurface strata and spaces with the right to use space for storage and sequestration.

Where title is divided by a horizontal boundary, each owner will have all rights of a fee simple owner to their respective portions and each owner will own all strata and space with the right to use for carbon sequestration; however, a question will exist with respect to the right of the lower owner to use the surface and upper strata for development, such as drilling wells,

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101 *Id*.

102 W. Va. Code § 22-11A-1(a)(12)(2009).

installing pipelines and other facilities in connection with a sequestration operation. The answer to this question will turn on the rights stated or which can be implied with the subsurface ownership.

With severed mineral title, the mineral owner has the exclusive right to use subterranean spaces which contain the minerals for mining or development of the minerals, and may exclude the landowner from any competing use. The coal cases qualify the right to use so long as the mineral is being developed and is not exhausted, although we question the legitimacy of the qualifications. The inference of the cases is that mineral ownership includes only the minerals and the container space is owned by the landowner. As a general rule the use of space by a mineral owner is limited to development of the minerals, and if use is for a different purpose, such as carbon sequestration, both the mineral owner and land owner will have rights.

A mineral owner is generally recognized to have the right to inject water and other substances, including carbon dioxide for enhanced oil, gas and coalbed methane recovery.

Where minerals are depleted, the landowner has the best argument for ownership of the cavern or space which was occupied by the minerals and will have the right of use and this includes, arguably, the use of pore spaces for carbon sequestration.

An argument that carbon sequestration rights are in the public domain, at least with respect to strata which do not have a reasonable and foreseeable use, will require strong legislation that articulates the public need.

§ 23.05. Risk and Liability.

[1] — The Horribles from Release.

For some time now, commentators, scholars, lawyers and the like have been discussing the potential liability related to the widespread and long-term storage of CO_2 in geological formations. Just as the ownership of the pore space has been a hot topic of articles, symposiums, and the like, so have the liability issues. We examine below the various "horribles" of the potential escape of stored CO_2 from its sequestration and, just as was concluded above, recognize that, except for the speculative and unknown aspects of the proposed sequestration, systems for dealing with the potential for liability would be largely the same as what has been done before in related areas.

Widespread long-term storage of CO_2 underground does raise a range of potential risks and associated liability. These risks can be broken into several major categories: (i) groundwater contamination; (ii) induced seismic activity; (iii) toxicological effects, including from a catastrophic escape of CO_2; (iv) environmental effects; and (iv) subsurface trespass.

Carbon dioxide stored underground could both migrate within the subsurface or find its way to the surface. In its Special Report on Carbon Dioxide Capture and Storage, the Intergovernmental Panel on Climate Change (IPCC) documents potential pathways for CO_2 escape, including leakage through the pores of low-permeability caprocks should the carbon dioxide be injected at too high a pressure, migration via faults and openings in caprock, as well as its most likely escape occurring through poorly completed injection wells.[103]

Liability associated with the potential migration of CO_2 from the geological formation selected to contain it, especially in consideration of the longevity of a sequestration project, is inescapable. This section analyzes the liability associated with post-injection CCS and applies existing legal theory to address the potential harm to human health, the environment, and damage to property that could, even if not likely, be caused from it.

[a] — Groundwater.

When carbon dioxide interacts with water it forms carbonic acid — *i.e.*, the water becomes "carbonated." Should mass quantities of stored CO_2 find its way to a drinking water aquifer, the CO_2 would contaminate the water supply.[104]

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103 IPCC, *Special Report on Carbon Dioxide Capture and Storage* 3, Bert Metz, Ogunlade Davidson, Heleen de Coninck, Manuela Loos and Leo Meyer (Eds.) Cambridge University Press, UK; 2005.

104 Mark Anthony de Figueiredo, *The Liability of Carbon Dioxide Storage* at 169 (Feb. 2007), (submitted to Massachusetts Institute of Technology) *available at* http://sequestration.mit.edu/pdf/Mark_de_Figueiredo_PhD_Dissertation.pdf.

In addition to a direct contamination of drinking water, CO_2 could displace *in situ* brine of the geological formation where it is stored, and the brine could eventually come into contact with drinking water.[105] Similarly, injected CO_2 could cause sulphates, chloride or toxic metals within the selected geological storage formation to circulate into a drinking water supply source.[106]

[b] — Seismic Activity.

Another potential risk of large-scale underground CO_2 sequestration is that it could induce seismic activity.[107] A correlation between the underground injection of waste materials and earthquakes was first documented in Denver, Colorado in the 1960s.[108] Although, the majority of the induced earthquakes were very small in magnitude, three relatively large earthquakes were recorded in the Denver area in 1967.[109] U.S. Geological Survey (USGS) scientists, concerned that pressure increases from the injection of waste fluids caused the Denver earthquakes, conducted a field experiment at the Rangely oil field in Colorado by increasing and decreasing fluid pressure via subsurface injection and measuring for corresponding seismic activity.[110] The general conclusion drawn from the experiment was that seismic activity could be induced by varying fluid pressure in a seismically active zone.[111] Notably, in the context of carbon dioxide sequestration, since the time that the Rangely experiment was concluded, both CO_2 and pressurized water have been injected into the same formation for EOR and there has not been a report of any seismic activity associated with the CO_2 injection.[112]

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105 IPCC, *supra* 105 at 248.
106 *Id*. at 247.
107 Figueiredo, *supra* note 105, at 155.
108 J.H. Healy *et al*., "The Denver Earthquakes," *Science*, Sept. 27, 1968 at 1301.
109 *Id*. at 156.
110 C.B. Raleigh *et al*., "An Experiment in Earthquake Control at Rangely," *Colorado Science*, March 26, 1976 at 1230.
111 Figueiredo, *supra* note 105, at 157.
112 *Id*. at 158.

[c] — Human Health.

According to the National Institute for Occupational Safety and Health (NIOSH), carbon dioxide acts as an asphyxiant, a respiratory stimulant, and a central nervous system stimulant and depressant.[113] Chronic exposure to CO_2 adversely affects human health under three general situations: (i) low concentration exposures for prolonged periods of time, (ii) intermediate exposures in environments lacking in oxygen, and (iii) high concentration exposures for short periods of time.[114]

The well-known, and perhaps only, catastrophic CO_2 release occurred at Lake Nyos along the Cameroon Volcanic Line in 1986. The Lake Nyos release killed over 1,200 people who lived in nearby villages.[115] Lake Nyos is believed to have been formed by a volcanic eruption centuries ago. Over time, the lake became supersaturated with CO_2 that seeped in from deposits of magma beneath the lakebed. Some have concluded that the catastrophic release occurred because of the slow and continuous accumulation of CO_2, that in due course exceeded the storage capacity of the lake. In contrast though, carbon dioxide that is sequestered in an underground geological formation should tend to diffuse over time.[116]

[d] — Environment.

Although carbon dioxide plays a critical role in plant life, a release of stored CO_2 into the environment at high concentrations can be harmful to both plants and animals. Limited studies exist as to the effects of high concentration of CO_2 on plant life. However the USGS concluded that

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113 *See* Nat'l Inst. For Occupational Safety & Health, *Occupational Health Guideline for Carbon Dioxide* 1 (HEW Publication No. (NIOSH) Aug. 1976).

114 *See* Figueiredo, *supra* note 105, at 185 (citing studies which indicate that prolonged acute exposures of CO_2 above five percent concentration can lead to mental impairment, above 10 percent can lead to unconsciousness, and above 30 percent can lead to death, and chronic exposures of even small amounts of CO_2 can lead to changes in respiration and blood ph, headaches and decreased respiratory response).

115 Tom Clarke, "Taming Africa's Killer Lake," *Nature*, Feb. 1, 2001 at 554.

116 Figueiredo, *supra* note 105, at 185.

roots of trees on Mammoth Mountain (a young volcano located in eastern California) were being killed by high concentrations of CO_2 in the soil.[117] The scientists discovered that numerous earthquakes occurred beneath Mammoth Mountain in 1989 causing a small body of magma to rise through a fissure beneath the mountain and increase the concentration level of CO_2 in the soil. The abnormally high level of CO_2 denied tree roots of oxygen and nutrients, which led to the recent 100 acres or more of tree kill.[118]

Animals have a significantly lower tolerance for CO_2 than plants. The ability of an animal to withstand elevated concentrations depends on physiology. Air breathing animals have the least tolerance to CO_2 exposure. For air-breathing animals, prolonged exposure to concentrations of 20-30 percent CO_2 can be lethal. Insects can withstand slightly higher concentrations than air-breathing animals, and single-celled organisms can survive in concentrations of up to 50 percent CO_2.[119]

[e] — Subsurface Trespass.

Although the potential damage would not be as detectable or, for that matter, as tragic as in a Lake Nyos type surface release of stored CO_2, a migration of CO_2 from its sequestered formation into subsurface property owned by another could be actionable as a legal trespass upon neighboring property. In addition to the risk of an underground intrusion of injected carbon dioxide into another's property, another form of subsurface trespass would be the drainage of carbon dioxide or other gas from a neighboring unowned formation or storage field. For example, should a CO_2 storage operation cause injected CO_2 to displace native gas or commingle with gas

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117 U.S. Geological Survey, *Invisible CO_2, Gas Killing Trees at Mammoth Mountain, California* (U.S. Geological Survey Fact Sheet 172-96, June 2001), available at http://pubs.usgs.gov/fs/fs172-96/ (last visited Sept. 24, 2011).

118 *Id.*

119 Figueiredo, *supra* note 105, at 190 (citing Sally Benson *et al.*, *Lessons Learned From Natural and Industrial Analogues for Storage of Carbon Dioxide in Deep Geological Formations* (Lawrence Berkeley Nat'l Lab. Report LBNL_51170, 2002)).

from a reservoir where production rights have not been obtained, liability could be imposed. As surmised in Section 23.04 [6], *supra,* however, future policy may establish that subterranean space for which a landowner has no foreseeable use may be deemed to belong to the general public and as such could not be the subject of a private trespass claim.

[2] — Theories of Liability.

Although various regulatory frameworks to govern CO_2 sequestration operations are being enacted in many states, only a handful of the statutes contain provisions related to liability for the long-term risks posed by the geological sequestration of carbon dioxide.[120] Most existing CO_2 sequestration demonstration programs have been permitted under the Underground Injection Control (UIC) Program. By way of example, in West Virginia (where the AEP Mountaineer plant is located), the recently enacted carbon sequestration statute[121] requires that regulation be promulgated for the creation of subclasses of wells within the existing UIC Program.[122] The UIC Program was created under the federal Safe Drinking Water Act of 1974[123] — but clearly not developed for the purpose of governing CO_2 sequestration. Although enforcement mechanisms exist under the UIC Program in the form of civil and criminal penalties and administrative orders, they were not designed to address the "parade of horribles" discussed in the previous

120 According to the National conference of State Legislatures, Illinois, Kansas, Louisiana, Montana, North Dakota, Oklahoma, Pennsylvania, Texas and Wyoming have laws that address CO2 liability and ownership issues and Louisiana and Texas have set up trust funds for their carbon storage sites to pay for long-term regulation, monitoring and remediation. Nat'l Conference of State Legislatures, Carbon Capture and Storage in the States, available at http://www.ncsl.org/?tabid=22139.

121 *See* W. Va. Code § 22-11A-1, *et seq.* (2009).

122 W. Va. Code § 22-11A-4 (4).

123 42 U.S.C. § 300h(b)(1)(The SWDA was enacted in 1974 and amended in 1977, 1980, 1986, 1988 and 1966. The UIC program regulates underground injection operations for the purpose of preventing underground injection which endangers drinking water sources. The Act allows for individual states to assume the primary responsibility of its implementation within their borders, provided the state's program meets EPA minimum regulatory requirements).

section.[124] Hence, we look to common law tort theories as the most complete existing legal framework for addressing the long term risks and imposing liability for the potential, albeit unlikely, harm that CO_2 sequestration poses to the environment, human health and property interests.

[a] — Strict Liability.

Although generally the notion that there is "never any liability without fault" permeates the common law of torts, in certain circumstances the common law imposes liability upon an actor even though he has not departed from a reasonable standard of intent or care.[125] In other words, under the right circumstances a defendant will be held strictly liable.

The leading case from which the doctrine of strict liability developed is *Rylands v. Fletcher.*[126] The defendants in *Rylands* were mill owners in the coal mining area of Lancashire, England, who constructed a reservoir on their land. Water from the reservoir broke through the filled-in shaft of an abandoned coal mine and flooded connecting passageways into the plaintiff's nearby mine, damaging the mine. The trial court found in favor of the defendants, but on appeal, the Exchequer Chamber reversed the lower court and announced, "that the person who for his own purposes brings on his lands and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and, if he does not do so, is prima facie answerable for all the damage which is the natural consequence of its escape."[127] In the House of Lords this statement was limited in that it was said to apply only to a "non-natural" use of the defendant's land.[128] Thus,

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124 For example, section 5 of the recent West Virginia carbon sequestration statute (discussed above) provides for the termination of any applicable UIC permit "if an excursion cannot be controlled or mitigated"; however, further liability provisions do not exist. W. Va. Code § 22-11A-5(13).

125 W. Page Keeton *et al*., *Prosser And Keeton on Torts* §75 (Fifth Ed. 1984).

126 Fletcher v. Rylands, 1865, 3 H. & C. 774,159 Eng. Rep. 737, *reversed* in Fletcher v. Rylands, 1866, L.R. 1 Ex. 265, affirmed in Rylands v. Fletcher, 1868, L.R. 3 H.L. 330.

127 Fletcher v. Rylands, 1866, L.R. 1 Ex. 265, 279-80.

128 Rylands v. Fletcher, 1868, L.R. 3 H.L. 330, 338.

the rule from *Rylands* is that an actor may be held liable when he damages another by a thing or an activity that is unduly dangerous and inappropriate to the place where it occurs.[129]

Although the doctrine of *Rylands* was for a long period rejected by a number of American courts, presently it is accepted in the majority of U.S. jurisdictions.[130] The conditions and activities to which the rule has been applied include the large collection of water in a dangerous place; explosives and flammable liquids stored in quantity in an urban area; pile driving; crop dusting; fumigation of a building with cyanide gas; drilling oil wells in populated areas, and so on.[131]

In *Weaver Mercantile Co. v. Thurmond*,[132] the West Virginia Supreme Court stated in its syllabus, "[a] man is bound to use his premises so as not to injure his neighbor's property."[133] The defendant in *Weaver* owned a hotel that was supplied with water from a large wooden tank erected on the side of a hill above the hotel and other businesses in the town. The tank burst and water flowed down the hill and into the storeroom where the plaintiff operated his mercantile business.[134]

The Supreme Court affirmed the lower court's verdict in favor of the plaintiff stating that "the liability of [the] defendant does not depend on negligence in construction, but upon negligence in not keeping the water confined."[135] The *Weaver* court did not require proof of the defendant's breach of a standard of care in this instance, but rather discussed the *Rylands* case for the proposition that *res ipsa loquitur* applied.[136]

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129 Keeton *et al.*, *supra* note 127 § 78.
130 *Id*.
131 *Id*.
132 Weaver Mercantile Co. v. Thurmond, 70 S.E. 126 (W. Va. 1911).
133 *Id*. at 126.
134 *Id*. at 127.
135 *Id*.
136 *Id*. at 128. In Foster v. City of Keyser, 501 S.E.2d 165 (W. Va. 1997)(discussed *infra)*, the West Virginia Supreme court later distinguished the doctrine of *res ipsa loquitur* (an evidentiary standard under a negligence theory) from that of strict liability (a non-fault or non-negligence theory). Here though, the West Virginia court stated that it's holding was premised on *res ipsa*, but clearly applied a strict liability standard.

We are not aware of any cases where a plaintiff suffered injuries due to CO_2 storage leak and pursued an action under a strict liability theory. However, there are a couple of noteworthy cases dealing with injuries suffered from the storage of natural gas and gasoline.

In *McLane v. Northwest Natural Gas Co.*,[137] the Supreme Court of Oregon applied the *Reynold's* doctrine and overturned a judgment that sustained a demurrer to the complaint, when stored natural gas that escaped from the defendant's control and entered into a liquefied gas storage tank, exploded and killed a man. The *McLane* court's holding was predicated on its finding that the storage of gas poses a risk to others, "which cannot be alleviated and which arises from the extraordinary, exceptional, or abnormal nature of the activity."[138] One of the defenses asserted was that, as a natural gas utility, the defendant was authorized by the state to store and distribute natural gas and, therefore, enjoyed immunity from absolute liability for carrying on the public duty imposed upon it.[139] The court did not, however, agree with the defendant's contention: "We do not believe the fact that the state has authorized defendant to engage in the abnormally dangerous activity in question demonstrates any intention to predetermine where responsibility should lie in the case of a non-negligent miscarriage of the activity."[140] The court held that the doctrine of strict liability applied.

In *Rosenblatt v. Exxon Co., U.S.A.*,[141] the Maryland Supreme Court held that the storage of gasoline in underground tanks was not an abnormally dangerous activity unless the property is bordered by residential property. The plaintiff, a lessee of property that had formerly been leased to the defendant for the purpose of operating a gasoline station, urged the court to hold the defendant strictly liable for leakage related to its underground gasoline storage tanks. The Maryland Supreme Court, however, declined to apply the doctrine and stated:

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137 McLane v. Northwest Natural Gas Co., 467 P.2d 635 (Or. 1970).
138 *Id*. at 638.
139 *Id*. at 640.
140 *Id*. at 641.
141 Rosenblatt v. Exxon Co., U.S.A., 642 A.2d 180 (Md. 1994).

> In *Yommer*, we found the leakage of gasoline to be abnormally dangerous when the tank from which it leaked was located adjacent to a residential water supply. 255 Md. at 227, 257 A.2d 138. Gasoline leakage may not, however, be considered abnormally dangerous on another site, such as a commercial site which is not bordered by residential property.[142]

One has to wonder then, if the storage of gasoline is not considered to be abnormally dangerous (and to impose strict liability) unless it occurs near a residential area, what would it take for CO_2 storage operations to be abnormally dangerous.

The Restatement of Torts adopts the principle of *Rylands v. Fletcher*, but only in instances of "ultrahazardous activity."[143] Restatement (Second) of Torts, Chapter 21, Section 520 states:

> In determining whether an activity is abnormally dangerous, the following factors are to be considered:
>
> (a) existence of a high degree of risk of some harm to the person, land or chattels of others;
>
> (b) likelihood that the harm that results from it will be great;
>
> (c) inability to eliminate the risk by the exercise of reasonable care;
>
> (d) extent to which the activity is not a matter of common usage;
>
> (e) inappropriateness of the activity to the place where it is carried on; and
>
> (f) extent to which its value to the community is outweighed by its dangerous attributes.

Several of the Restatement of Torts (Second) "abnormally dangerous" factors are met with CO_2 storage: (a) High degree of risk — Although the

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142 *Id*. at 187.

143 Restatement (Second) of Torts §§ 519-520.

Lake Nyos catastrophe did not involve the intentional injection and storage of carbon dioxide, it does demonstrate the extraordinary harm that can result from a massive and uncontrolled escape of carbon dioxide; (b) Likelihood of great harm — the likelihood that harm could result from CO_2 sequestration is largely speculative as it has not been done on the scale contemplated, however the Lake Nyos example, again, demonstrates potentially catastrophic results; (c) Inability to eliminate risk — should CO_2 storage eventually be undertaken at the scale contemplated, it is safe to assume that numerous studies will have been conducted to ensure risks are eliminated, if then a catastrophe were to occur, it is likely that this element would also be met; (d) Uncommon activity — clearly large scale CO_2 sequestration is not commonplace; (e) Inappropriateness to the location — would depend on the facts of the situation; (f) Value to community outweighs its dangerous attributes — mass scale CO_2 sequestration will only be undertaken as a public service and hence this factor cuts against the imposition of strict liability.

Thus, although many of the Restatement's strict liability factors could be present, the *Rosenblatt* case demonstrates that a critical finding for the application of the doctrine would be that the activity were inappropriate for the place where it were carried on. Additionally, should the doctrine apply, the public utility of CO_2 sequestration cuts against the application of strict liability, but as discussed in the *McLane* case, the public purpose exception to strict liability for an abnormally dangerous activity, unless it expressly appeared in legislation, may not be recognized.

[b] — Negligence.

Regardless of whether the doctrine of strict liability were available, a negligence action could be brought for damages caused by CO_2 leakage. In *Foster v. City of Keyser,*[144] the West Virginia Supreme Court overturned the application of strict liability by the lower court after a house was damaged in a natural gas transmission explosion. The West Virginia court noted, though,

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144 Foster v. City of Keyser, 501 S.E.2d 165 (W. Va. 1997).

the high standard of care which must be observed in the transmission of natural gas:

> It is a tribute to human ingenuity generally . . . that in spite of this combination of factors which renders transmitting natural gas a particularly and inherently dangerous activity, relatively few natural gas explosions occur, considering how widely gas is transmitted and used. Nevertheless, explosions do occur, and law books in every jurisdiction are amply stocked with cases involving the sorting out of who should pay for the injuries . . . . In many such cases, this court (and others) have recognized and discussed the high duty of care to which an enterprise in transmitting natural gas through transmission lines must adhere.[145]

The *Foster* court further noted that "[i]t is the duty of a company transporting and supplying natural gas, to so construct and maintain its pipe lines as to prevent the escape of gas in a manner that will injure the person or property of another."[146]

Additionally, the court discussed the distinction between the *Rylands* type doctrine of strict liability and the evidentiary rule of *res ipsa loquitur*, under which a plaintiff's negligence can be inferred.

> [I]n res ipsa cases as well as in [Rylands v. Fletcher, L.R. 3 H.L. 330 (1868) strict liability], negligence need not be proven. When we speak in res ipsa terms, we are speaking of negligence: because of the res ipsa rule of circumstantial evidence, negligence is presumed until the defendant rebuts the presumption. On the other hand, in Rylands-type cases, the basis of the liability is not negligence, but rather the defendant's intentional behavior in exposing others to a risk.[147]

145 *Id*. at 176.
146 *Id*.
147 *Id*. at 178 (citing *Peneschi*, 170 W. Va. at 517, 295 S.E.2d at 7).

The *Foster* court held that in light of the high degree of care required in the activity which caused the plaintiff's injuries coupled with the availability of *res ipsa loquitur*, it should ordinarily be unnecessary to apply the doctrine of strict liability in cases involving explosions caused by leaking natural gas transmission lines.

In another natural gas explosion case, *Hayes Sight & Sound, Inc. v. ONEOK, Inc.*,[148] natural gas migrated eight miles from a storage field near Hutchinson, Kansas, and exploded. The fires damaged local businesses and a trailer park and resulted in two fatalities. The Yaggy storage field consisted of 70 caverns, also referred to as wells. Prior to the development of the natural gas storage field, the caverns had been used for propane storage and then plugged. The defendants increased maximum storage pressures above their regulatory allowance in order to increase the volume of gas stored in the same space. This increase over and above that of the maximum allowance caused the stored gas pressure to be greater than what the geology of the structure could contain and a rupture in one of the wells allowed large volumes of gas to escape.[149] On appeal, the defendant's liability under a negligence theory was uncontested and the defendants were not successful in their argument that a punitive damages award of over $5.2 million dollars was a violation of their substantive due process rights.[150]

In light of the above cases and the applicability of the doctrine of *res ipsa loquitur* to negligence actions, it is foreseeable that a similar jurisprudence might be applied to a negligence claim involving the injection and storage of carbon dioxide. Hence, even where strict liability were not available, it is predictable that a plaintiff, who had suffered injuries from stored CO_2 leakage, would argue that the abnormally dangerous nature of the activity required a heightened standard of care and/or that the doctrine of *res ipsa loquitur* relieved him of the burden to prove that the defendant breached a standard of care.

148 Hayes Sight & Sound, Inc. v. ONEOK, Inc., 136 P.3d 428 (Kan. 2006).
149 *Id*. at 434-37.
150 *Id*. at 428.

[c] — Trespass.

Generally, the intentional use of another's real property, without authorization and without a privilege to do so, is actionable as a trespass without regard to harm.[151] This common law action is based on the notion that a landowner maintains an exclusive right to the use of his property, which necessarily implies the correlative right to exclude others from use of the property even though another's use may pose no interference or damage to the landowner.[152] It therefore follows that the intrusion of CO_2 into subsurface property to which rights were not acquired, under the traditional notion of trespass, would be actionable even if the migrating gas caused no damage to the other's property or interfered with his use of it.

As discussed in the previous section regarding subterranean ownership, in the context of *cujus est solum, ejus est usque ad coelum et ad inferos,* a landowner may only have the right to exclude others from his property in "as much of the space above the ground as [the landowner] can occupy or use in connection with the land."[153] Additionally, courts have begun to limit the landowner's right to exclude another from the use of his property below the ground.

In *Railroad Commission of Texas v. Manziel*,[154] the plaintiffs asked the Supreme Court of Texas to set aside an order of the Texas Railroad Commission that allowed for a deviation from regulatory spacing for injection wells in a secondary recovery program on the basis that the injection of salt water would cause a subsurface invasion of the plaintiff's adjoining mineral estate. In this landmark case, the Texas court was asked to decide the issue of whether a trespass was committed when secondary recovery waters

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151 Keeton *et al*., *supra* note 127 §13.

152 *Id*.

153 *Causby,* 328 U.S. at 264 (citing *Hinman v. Pacific Air Transport*, 84 F.2d 755 (9th Cir. 1936)).

154 Railroad Comm'n of Texas v. Manziel, 361 S.W.2d 560 (Tex. 1962) discussed *supra* § 23.04[06].

crossed lease lines. As discussed in the previous section, the court held that the encroaching recovery waters would not constitute a trespass.[155]

More recently, in August of 2011, the Texas Supreme Court revisited its' *Manziel* holding, but in the context of whether subsurface trespass liability exists for permitted wastewater injection wells. In *FPL Farming Ltd. v. Environmental Processing Systems, L.C.*,[156] the plaintiff, a landowner, sued the defendant, a permittee of two deep wastewater injection wells, in tort for physical trespass based on subsurface migration of waste injected via the defendant's wells. The Texas Commission on Environmental Quality (TCEQ) (the permitting authority) had reviewed data which demonstrated that the defendant's waste plume was projected to migrate into the deep subsurface of the formation and encroach upon the plaintiff's property and still issued the permits. When challenged in state court, the lower court held that the plaintiff could not recover for trespass damages because the wells were authorized by the TCEQ permit.[157]

On appeal, the Texas Supreme Court held that securing a permit does not immunize the permit holder from the tortious consequences of its actions arising out of activity authorized by the permit.[158] The Texas Supreme court noted that the lower court erred in its interpretation that the *Manziel* case stood for the proposition that where a state agency authorized injections, no trespass could occur when the injected substance migrated across property lines.[159] The *FPL* court declined to apply the doctrine of negative capture and advised that "injecting substances to aid in the extraction of minerals serves a different purpose than does injecting wastewater."[160] The case was

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155 *Manziel* at 568 (stating: "orthodox rules and principles applied by the courts as regards surface invasions of land may not be appropriately applied to subsurface invasions as arise out of the secondary recovery of natural resources").

156 FPL Farming Ltd. v. Envtl. Processing Sys., L.C., No. 09-1010 (Tex. Aug. 26, 2011), available at http://www.supreme.courts.state.tx.us/historical/2011/aug/091010.pdf.

157 *Id*., slip op. at 2.

158 *Id*. at 7.

159 *Id*. at 11.

160 *Id*. at 13 (citing Tex. Water Code § 27.011).

remanded to the lower court for a determination of, among other things, "whether the jury charge should have included an instruction that injury is not a necessary element of trespass."[161]

In a 1996 case before the Supreme Court of Ohio, *Chance v. BP Chemicals, Inc.*,[162] a class of property owners sought damages for trespass from BP Chemicals, who had injected waste materials in brine aquifers at a depth below the surface of greater than 2,430 feet.[163] The plaintiffs offered expert testimony that the waste had migrated laterally from beneath the defendant's property to that of the plaintiffs.[164] The defendants argued that the Supreme Court of Texas' rule from *Manziel* should be applied. The *Chance* court, however (similar to what the Texas Supreme Court would later hold in *FPL* (discussed *supra*)), distinguished the facts presented in the case from that of *Manziel* and other oil and gas cases, stating:

> We find that the situation before us is not analogous to those present in the oil and gas cases. . . . the injection in . . . [the *Manziel*] case was directly related to oil and gas extraction, and was fundamentally dissimilar to the unique situation before us, which involves the injection of waste byproducts from the production of industrial chemicals. Since the appellee's injection well operation has nothing to do with the extraction or storage of oil or gas, we find the negative rule of capture inapplicable to our consideration of this case.[165]

The court additionally addressed the question of whether the plaintiffs had an absolute ownership in the depths below the surface of their property (*i.e.*, the right to exclude another regardless of a lack of foreseeable use of

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161 *Id*. at 15.

162 Chance v. BP Chems., Inc., 670 N.E.2d 984 (Sup. Ct. of Ohio 1996).

163 *Chance* at 986.

164 *Id*.

165 *Chance* at 991.

the property or actual damage to it).[166] The Ohio Supreme Court, relying on *Causby*, stated:

> We do not accept appellants' assertion of absolute ownership of everything below the surface of their properties. Just as a property owner must accept some limitations on the ownership rights extending above the surface of the property, we find that there are also some limitations on property owners' subsurface rights. . . . [G]iven the unique facts here we find that appellants' subsurface rights in their properties include the right to exclude invasions of the subsurface property that *actually interfere with appellants' reasonable and foreseeable use of the subsurface*." (emphasis added).

Thus, the *Chance* court modified the common law of trespass, with regard to the subsurface property at issue by holding that the plaintiffs could not recover for trespass absent proof of actual interference with a foreseeable use of their property.[167]

In the context of CO_2 injection and sequestration then, it follows that, although CO_2 injection for the purpose of secondary recovery (*i.e.*, production) that has migrated, would likely not be a trespass under the negative rule of capture; CO_2 injected underground purely for storage (as a waste product for example from coal-fired electricity) that has migrated laterally from its geological storage boundaries to unowned property, would give rise to a tort action for trespass, unless the notion of absolute ownership were limited as in the *Chance* case.

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166 *Id*. at 991-92 ("[j]ust as a property owner must accept some limitations on the ownership rights extending above the surface of the property, we find that there are also some limitations on property owners' subsurface rights," quoting Hinman v. Pacific Air Transport, 84 F.2d 755 (9th Cir. 1936)).

167 *Id*. at 993 ("[e]ven assuming that the injectate had laterally migrated to be in an offending concentration under some of the appellants' properties, we find that some type of physical damages or interference with use must have been demonstrated for appellants to recover for a trespass").

In light of the U.S. Supreme Court's holding in *Causby*, the *Chance* court's analysis may likely find majority support in the context discussed. In other words, since, as of now, property owners have no reasonable and foreseeable use for deep saline aquifers or likely for other geologic formations where CO_2 sequestration would occur, they would have no absolute ownership interest and, thus, no right to exclude carbon dioxide injection or migration within those formations. Additionally, just as the negative rule of capture were applied to negate an incidental trespass from waters injected to stimulate oil production — an activity held to be in the public interest (*i.e*., the economical development of natural resources), so too might public policy considerations related to CO_2 sequestration be held to negate a trespass caused by migrating CO_2.

On the other hand, should a CO_2 intrusion result in subsurface damage to another's property or should the production of natural gas, oil, CO_2 or other commodity from unowned property result from it, a tort claim for trespass could likely be maintained. Further, as noted in the recent Texas Supreme Court holding in *FPL*, a permit for the injection/storage activity would not *per se* shield the permittee from civil tort liability that may result from actions governed by the permit. It is submitted, though, that the public policy considerations related to CO_2 sequestration may likely lead to legislation that would shield the activity from such liability.

[d] — Nuisance.

Where trespass is a physical invasion in the plaintiff's exclusive possession of his land, nuisance is an interference with his use and enjoyment of it.[168] The *Restatement of Torts* defines nuisance to encompass all claims arising from "a non-trespassory invasion of another's interest in the use and enjoyment of land."[169] The invasion giving rise to liability can be either "intentional and unreasonable" or "unintentional and otherwise actionable

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168 Keeton *et al*., *supra* note 127 §87.

169 Restatement of Torts §822 (1939); Restatement (Second) of Torts § 821D (1977).

under the rules governing liability for negligent or reckless conduct, or for abnormally dangerous conditions or activities."[170] Importantly, the invasion must result in a substantial interference with a plaintiff's use and/or constitute an unreasonable interference with plaintiff's use of his land (*i.e.*, damages). The substantial interference requirement is to satisfy the need for a showing that the plaintiff's land is reduced in value because of the defendant's conduct.[171]

There is no reason to believe that sequestered CO_2 would interfere with an adjoining property owner's use or cause a substantial impairment to the value of his land, provided it stays sequestered. Thus, only if the stored CO_2 leaks would a claim for nuisance possibly arise. In such an instance the carbon dioxide release would have to substantially impair the plaintiff in his use of the property or significantly diminish the value of his property. In the case of a release where the CO_2 actually enters the land of another, the legal claim would be cognizant as a trespass; only damages caused to another's property from CO_2 that does not physically reach another's property would constitute nuisance. In any such event, like the other theories discussed above, the causation and damages elements would be a critical component to the maintenance of a nuisance action and even then, public policy considerations may trump the ability of the aggrieved landowner to obtain his relief.

[3] — Conclusions.

The long-term risks associated with CO_2 sequestration present a unique set of challenges due to the mass scale carbon capture and storage required if it is to have any impact on climate change concerns. However, the types of risks associated with CO_2 sequestration have each, in related enterprises, been addressed in the past. The liability associated with the type of harm that CO_2 sequestration presents has likewise been addressed via the development of the common law of torts. Essentially, there is nothing new under the sun — or in this case — under ground.

170 Restatement (Second) of Torts § 821D.

171 Restatement (Second) of Torts § 821F, cmt. C.

Those unique challenges that CO_2 sequestration does pose are predicated on two issues:

1. Due to the longevity of the proposed sequestration, the risks could manifest themselves virtually in perpetuity; and
2. The whole enterprise of CCS is driven solely by public policy and is not motivated by financial gain.

In light of the above two premises, an exclusively private solution to the risks posed by CO_2 sequestration, although (as demonstrated) are in existence, will likely not be sufficient. In contrast to the activities addressed in the cases discussed above (primarily natural gas storage, production and transportation), the liability associated with CO_2 sequestration would be ongoing. For example, although natural gas storage is analogous to CO_2 sequestration, under mass scale CO_2 sequestration there will be larger injection rates and longer timeframes for the carbon dioxide to remain underground. It is possible and even likely that with the prospect of the CO_2 being sequestered underground for hundreds of years, the injectors and entities responsible for the storage operations will no longer exist if/when a harm manifests. To whom then, could an injured party turn? Even if a proper defendant could be identified, there could still be the hurdles associated with statutes of limitation, and so forth.

Additionally, the entire enterprise of CCS is premised on public policy and not on profitability. Undoubtedly, financial incentives will be present for those that play a role in carbon sequestration development, and CO_2 can and is injected as part of a scheme to produce natural resources. But — at its core — carbon capture and storage does not produce wealth. No product is created. The service being provided is solely for the good of the public and is not motivated by financial profit. As discussed in the introduction of this article, one of the most successful demonstration projects in the world was recently put on hold due to financial considerations. The AEP Mountaineer project was halted midway due to the inability of AEP to recover its costs, even when its project received 50 percent funding from the DOE. If then, liability were to be fully borne by the private sector, the potentially unbounded exposure to it could create an additional hurdle and effectively keep others from embarking on the undertaking in spite of government grants and other incentives.

In light of the foregoing, undoubtedly, common law tort theory would develop "public policy" exceptions for the long-term liability associated with CO_2 sequestration. Additionally, legislation can and would be developed to address the unique challenges that the long-term risks pose. But this may not be enough.

Clearly, CCS will not occur without government action to constrain carbon dioxide emissions or mandate CCS innovations. With respect to long-term liability, because government will be forcing the private sector to act by imposing these constraints, it stands to reason that the government will assume some if not all of the responsibility and thus lessen industry's exposure to the liability.

Many commentators have suggested that the solution to the long-term liability associated with CO_2 sequestration would be a hybrid arrangement where the private sector would bear liability for storage in the short term (as private operators need to have some financial responsibility for potential harm or damage to ensure that adequate precautions are taken) and long term responsibility would reside with the government (to avoid the issues discussed above). This hybrid approach seems most likely and expedient: Common law liability regimes would be imposed on private actors, but limited by public policy via court decisions and legislation; longer term risks could be managed with the availability of both public and private insurance; and, at some point, the public in general, who most directly benefits from the enterprise, would bear the responsibility for potential liability via its government.