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CLIMATE CHANGE, CARBON SEQUESTRATION, AND PROPERTY RIGHTS

*Alexandra B. Klass**
*Elizabeth J. Wilson***

This Article considers the role of property rights in efforts to sequester underground hundreds of millions of tons of carbon dioxide (CO_2) per year from power plants and other industrial facilities in order to mitigate climate change. This technology, known as carbon capture and sequestration (CCS), could provide deep emission cuts, particularly from coal power generation, on a worldwide basis. In order to widely deploy this technology, future CCS operators must be able to access millions of acres of deep subsurface "pore space" roughly a kilometer below the earth's surface to sequester the CO_2 for hundreds to thousands of years. This Article explores questions relating to ownership of subsurface pore space, physical takings, regulatory takings, and just compensation that will necessarily accompany the implementation of CCS in the United States. In order to accommodate the full range of property rights and takings issues that will arise with CCS, this Article proposes a regulatory framework based in part on the Natural Gas Act to address these issues in connection with subsurface CO_2 sequestration.

INTRODUCTION

In February 2009, President Obama signed the $787 billion economic stimulus package known as the American Recovery and Reinvestment

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Act.[1] At that time, representatives from industry, government, and non-profit groups in the energy and natural resources field focused immediately on the $80 billion in spending, loan guarantees, and tax incentives geared toward promoting energy efficiency, renewable energy, and new technologies to reduce emissions from the use of coal and other fossil fuels.[2] On their own, these investments constitute the biggest energy bill in history.[3] Notably, this $80 billion includes $3.4 billion for carbon capture and sequestration (CCS) demonstration projects, an increase in federal support for this technology in the United States by 70 percent to over $8 billion.[4]

CCS involves capturing CO_2 from power generation and industrial processes, transporting the CO_2 to an area with suitable geology, and injecting it into deep geologic formations, sequestering the CO_2 underground for long periods of time.[5] Geological formations suitable for CO_2 sequestration include oil and gas fields, saline aquifers, and possibly deep coal seams.[6] Natural analogs, such as geologic formations containing crude oil, natural gas, and CO_2, have demonstrated that these fluids can be securely held for millions of years.[7] CCS technologies take advantage of the sequestration capability of geologic formations to store injected CO_2 and reduce CO_2 emissions going into the atmosphere in an effort to mitigate climate change.[8]

This Article considers the role of property rights in efforts to develop CCS. In an earlier Article, we discussed the potential environmental and tort liability associated with CCS.[9] In that Article, we argued that environmental and tort liability could serve an important role within a federal framework of CCS regulation to ensure proper site selection and monitoring as well as provide compensation for harm to governments and private parties caused by escaping CO_2.[10] We then proposed an adaptive governance model at the federal level for integrating several

1. American Recovery and Reinvestment Act of 2009, H.R. 1, 111th Cong. (2009) (enacted).

2. *See* Editorial, *An $80 Billion Start*, N.Y. TIMES, Feb. 18, 2009, at A26; Linda Roeder & Janice Valverde, *Economic Stimulus*, 40 Env't Rep. (BNA) No. 8, at 365 (Feb. 20, 2009).

3. *An $80 Billion Start*, *supra* note 2.

4. *Flurry of U.S. State, Federal Policies Advance CCS*, CARBON CAPTURE J., Feb. 20, 2009, http://www.carboncapturejournal.com/displaynews.php?NewsID=344&PHPSESSID=1043389bcbaec9b35c510344a0524b43&PHPSESSID=1043389bcbaec9b35c510344a0524b43.

5. Stephanie M. Haggerty, Note, *Legal Requirements for Widespread Implementation of CO_2 Sequestration in Depleted Oil Reserves*, 21 PACE ENVTL. L. REV. 197, 200–01 (2003).

6. *Id.* at 201.

7. *See* Sally Benson et al., *Underground Geological Storage*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE 195, 210 (Bert Metz et al. eds. 2005), http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf [hereinafter IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE] (noting that in the Pisgah Anticline, near Jackson, Mississippi, 200 metric tons of naturally occurring CO_2 is thought to have been stored for over 65 million years without leakage).

8. Paul Freund et al., *Introduction*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note 7, at 51, 53.

9. Alexandra B. Klass & Elizabeth J. Wilson, *Climate Change and Carbon Sequestration: Assessing a Liability Regime for Long-Term Storage of Carbon Dioxide*, 58 EMORY L.J. 103 (2008).

10. *Id.* at 178–79.

different compensation mechanisms, including bonding, insurance, and pooled federal funding, into commercial CCS project management to better provide financial security to investors without destroying existing liability protections for those who may suffer harm from CCS.[11]

In this Article, we turn to property rights in the context of geologic sequestration of CO_2 in the deep subsurface. To "geologically sequester" CO_2, the gas is compressed to a supercritical fluid and injected a kilometer or deeper into the microscopic "pore space" in the deep subsurface rock matrix, displacing the *in situ* brine.[12] Injected CO_2 flows through and fills the pore spaces in permeable layers of the rock matrix and, while more buoyant than the native brines, its upward migration is prevented by less permeable rock layers.[13] In order to widely implement CCS, geologic sequestration project operators and state and federal governments must be able to access millions of acres of deep subsurface pore space roughly a kilometer below the earth's surface to sequester the CO_2 for hundreds to thousands of years. Who currently owns that pore space? Are any rights to the pore space vested in the owner of the surface lands above the pore space? What if the mineral rights have been severed and transferred to a third party, as is the case in many states where CO_2 sequestration is being proposed?[14] Or does the federal government own the pore space because it is so far beneath the surface that neither the surface owner nor the mineral owner has ever had a reasonable expectation that it would make use of that space? If rights to the pore space are in fact vested in a surface owner or mineral owner, can the federal government exercise the power of eminent domain to implement CCS as a "public use" under the Fifth Amendment? If so, what constitutes "just" compensation? If the government restricts private surface or subsurface use of property to protect the integrity of a nearby CO_2 sequestration reservoir, does that restriction constitute a regulatory taking giving the surface owner or mineral owner a right to just compensation?

Here, we explore these questions associated with subsurface property rights and CCS and provide a range of options for policymakers and judges who undoubtedly will be forced to grapple with these questions if efforts to implement CCS move forward. In general, while the courts have regularly found that government-authorized physical use or invasion of private surface lands constitutes a per se taking, the courts have just as often taken a more cautious and nuanced approach to private property rights in both the airspace above and the subsurface below private lands.[15]

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11. *Id.* at 158.

12. Edward Rubin et al., *Technical Summary*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note 7, at 17, 31.

13. *Id.*

14. *See* Benson et al., *supra* note 7, at 256.

15. *See infra* Part III.

A review of the existing case law involving property rights in airspace, the surface, and the subsurface reveals that there is precedent available to reach legal conclusions in favor of a strong protectable property interest in the subsurface, a weak or nonexistent protectable property interest in the subsurface, and various points in between.[16] As a result, legislative declarations by Congress or the Administration on the public necessity of CCS as one solution to reduce greenhouse gases (GHGs), as well as public opinion on that topic, may play a significant role in determining the extent to which courts will recognize a protectable property interest in the subsurface. Ultimately, policymakers and judges will need to balance the extent to which they wish to recognize and protect private property rights in the subsurface against a desire to facilitate CCS in part through creating easy access to subsurface pore space. This Article attempts to give lawmakers and judges a framework in which to make these difficult decisions.

In resolving these issues, the government or CO_2 injectors may argue that just as surface owners could no longer claim rights to the airspace far above their property after the advent of airplanes, surface owners and mineral rights owners can no longer assert rights to the deep subsurface in the face of cutting-edge technologies that would make real use of that subsurface for the public goal of combating climate change.[17] There is an equally strong argument, however, that property rights in the subsurface have a completely different legal history than rights to the airspace, and thus there are protectable property interests in pore space that are vested in the surface owner, the mineral owner, or both. Indeed, three states—Montana, North Dakota, and Wyoming—have already declared as a matter of statute that subsurface pore space ownership is vested in the surface owner.[18] As a result, existing and future creation or modification of subsurface property rights ultimately may be in tension with federal policies attempting to implement CCS with minimal property acquisition costs.

Part I begins with an introduction to CCS technology, its potential role in addressing climate change on a global basis, recent federal, state, and industry efforts to promote CCS technology, and how implementation of CCS technology may intersect with subsurface property rights.[19] Part II introduces takings jurisprudence and then explores the extent to which surface and mineral owners have protectable property rights in the subsurface pore space. In this Part, we provide a range of options based on available precedent in areas involving rights in the airspace, the surface, and the subsurface.

16. *See infra* Part II.

17. *See* John G. Sprankling, *Owning the Center of the Earth*, 55 UCLA L. REV. 979, 1022–25 (2008).

18. *See infra* notes 131–39 and accompanying text.

19. In this Article, we concentrate our analysis on the "sequestration" part of CCS.

In Part III, we explore more fully the extent to which CCS operations may result in either a physical taking or a regulatory taking. In this area, there are arguments to be made that to the extent the implementation of CCS results in a permanent, physical occupation of the subsurface pore space, there is a per se physical taking that requires just compensation, and the only significant question is whether that compensation will be nominal or significant. There is also precedent to support an alternative conclusion, however, namely that where physical occupation of CO_2 takes place far below any existing or reasonably foreseeable economic uses, no physical taking has occurred. In other situations, CO_2 sequestration may not result in a physical occupation of the subsurface but may still modify, limit, or prohibit existing or future uses of that subsurface because of regulatory limits imposed to protect the integrity of a nearby CO_2 sequestration reservoir. In those circumstances, courts would conduct a regulatory takings analysis that would balance the character of the government's action, the severity of the economic impact, and the extent to which the regulation interferes with the property owner's distinct, investment-backed expectations. Based on this analysis, we conclude that in most cases, actions to sequester CO_2 to address climate change goals would outweigh most regulatory restrictions on nearby subsurface use, assuming such restrictions do not eliminate all economic value relating to the property owner's surface and subsurface use. Part III concludes with a discussion of the issue of "just compensation" and factors that may play a role in determining the value of subsurface pore space within the parameters of existing takings law.

Finally, in Part IV we consider a federal legislative proposal for CCS that would be similar to that used for interstate natural gas pipelines and natural gas storage under the Natural Gas Act. This adapted structure would require the government or CCS operators to negotiate with surface owners or mineral rights owners if CCS operations physically interfere with existing, protectable property interests (or if regulation rises to the level of a taking) and if negotiations break down, that eminent domain would be authorized as a public use to obtain the subsurface pore space in question. Part IV first discusses why taking subsurface property for CO_2 sequestration to address climate change likely will be a "public use" that authorizes the use of eminent domain under the U.S. Constitution. It then provides some preliminary ideas on what this structure would look like and discusses the issue of how just compensation and other statutory compensation to surface owners or mineral owners could be implemented.

I. CLIMATE CHANGE, THE USE OF COAL, AND CCS

Concern over the potential effects of climate change continues to grow, making the issue a major focus among policymakers, industry, and

nonprofit organizations worldwide.[20] Scientists have concluded that immediate measures to control GHG emissions are necessary to avoid "severe and irreversible changes to natural ecosystems," and that impacts of climate change are likely to impose significant costs.[21] These costs are related to potentially significant impacts on public health, agriculture, food supply, forests, ecosystems, biodiversity, coastal zones, sea levels, water resources, energy production and use, and public lands and recreation.[22]

The election of President Barack Obama has already brought about significant changes in federal climate change policy. During the Bush Administration, the United States Environmental Protection Agency (EPA) refused to take any major action with regard to GHG emissions that would include mandatory caps on emissions, despite the growing body of scientific evidence linking GHG emissions, particularly CO_2 emissions, and climate change.[23] This was true even after the Supreme Court in 2007 directed the EPA to either regulate GHG emissions from motor vehicles as an "air pollutant" under the Clean Air Act (CAA) or provide a reasonable explanation for failing to do so.[24] During that time, the EPA also refused to allow California to set its own more restrictive limits on automobile tailpipe emissions to address climate change, as the state is authorized to do if it receives a federal waiver from the EPA under the CAA.[25]

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20. According to the Environmental Protection Agency (EPA), the term "climate change," which is often used synonymously with the term "global warming," refers to "any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer)." *See* U.S. Environmental Protection Agency, Climate Change, Basic Information, http://www.epa.gov/climatechange/basicinfo.html (last visited Dec. 15, 2009) [hereinafter EPA, Basic Information].

21. *See* Massachusetts v. EPA, 549 U.S. 497, 521 (2007) (quoting MacCracken Decl. ¶ 5(d)); Richard B. Alley et al., *Summary for Policymakers*, *in* IPCC FOURTH ASSESSMENT REPORT: CLIMATE CHANGE 2007, THE PHYSICAL SCIENCE BASIS 1, 2–5, 10 (Susan Solomon et al. eds., 2007), http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf [hereinafter WORKING GROUP 1 REPORT].

22. *See* U.S. Environmental Protection Agency, Climate Change, Health and Environmental Effects, http://www.epa.gov/climatechange/effects/index.html (last visited Dec. 15, 2009).

23. Ken Alex, *A Period of Consequences: Global Warming as Public Nuisance*, 26 STAN. ENVTL. L.J. 77, 82–84 (2007) (describing the federal government's lack of response to global warming); J.R. DeShazo & Jody Freeman, *Timing and Form of Federal Regulation: The Case of Climate Change*, 155 U. PA. L. REV. 1499, 1517 n.54 (2007) (describing state climate change initiatives as arising "against the background of a relative vacuum of policy responses at the federal level" and detailing the Bush Administration's policy positions on the issue); David Hunter & James Salzman, *Negligence in the Air: The Duty of Care in Climate Change Litigation*, 155 U. PA. L. REV. 1741, 1741–43 (2007) (describing federal government's failure to take meaningful action with regard to climate change as compared to the significant activity at the state and local levels).

24. *Massachusetts*, 549 U.S. at 533.

25. California State Motor Vehicle Pollution Control Standards; Notice of Decision Denying a Waiver of Clean Air Act Preemption for California's 2009 and Subsequent Model Year Greenhouse Gas Emission Standards for New Motor Vehicles, 73 Fed. Reg. 12,156 (Mar. 6, 2008); John M. Broder & Felicity Barringer, *E.P.A. Says 17 States Can't Set Greenhouse Gas Rules for Cars*, N.Y. TIMES, Dec. 20, 2007, at A1 (reporting on EPA's denial of California's CAA waiver request); Letter from Stephen L. Johnson, U.S. Envtl. Protect. Agency, to Arnold Schwarzenegger, Governor of Cal. (Dec. 19, 2007) (informing California Governor of EPA's decision to deny California waiver request), http://www.epa.gov/otaq/climate/20071219-slj.pdf.

In January 2009, however, President Obama directed EPA Administrator Lisa Jackson to reconsider the Agency's prior decision denying California's waiver request.[26] At that time, at least seventeen states had adopted or were considering adopting the California standards, which would mean that granting the waiver would result in stricter limits on auto emissions in a significant portion of the country.[27] In April 2009, pursuant to the Supreme Court's 2007 directive in *Massachusetts v. EPA*, the EPA issued a proposed "endangerment" finding under the CAA that GHGs in the atmosphere, including CO_2, "threaten the public health and welfare of current and future generations."[28] Then, in May 2009, President Obama announced that the Administration had reached an agreement with the auto industry, the State of California, and other stakeholders for setting new national auto emission standards that will increase fuel economy and impose the first-ever national greenhouse gas emission standards on cars and trucks.[29] Moreover, as part of the effort to address climate change, the economic stimulus package enacted in February 2009 contains $80 billion in spending and tax incentives for renewable energy, energy efficiency, and new coal and fossil fuel technologies.[30] While it remains to be seen what the new climate change and energy policies will actually look like, the Administration's focus on climate change, renewable energy, and more environmentally friendly approaches to the use of existing fossil fuels is significant.

One important piece of the Administration's plan to change the way we generate energy and deal with the associated emissions is the development of CCS technology. Energy Secretary Steven Chu has stated that developing CCS technology "is critically important for reducing

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26. Ken Bensinger & Jim Tankersley, *Obama Makes Move on Emissions*, L.A. TIMES, Jan. 26, 2009, at A1; *see also* Editorial, *New Day on Climate Change*, N.Y. TIMES, Jan. 26, 2009, at A30.

27. Bensinger & Tankersley, *supra* note 26.

28. U.S. ENVTL. PROTECT. AGENCY, OVERVIEW OF EPA'S PROPOSED ENDANGERMENT AND CAUSE OR CONTRIBUTE FINDINGS FOR GREENHOUSE GASES UNDER THE CLEAN AIR ACT (Apr. 17, 2009), http://epa.gov/climatechange/endangerment/downloads/Determination.pdf. The EPA issued the final endangerment findings in December 2009. *See* Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. I); U.S. Environmental Protection Agency, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under the Clean Air Act, http://www.epa.gov/climatechange/endangerment.html (last visited Jan. 29, 2010).

29. *See* U.S. ENVTL. PROTECT. AGENCY, EPA WILL PROPOSE HISTORIC GREENHOUSE GAS EMISSIONS STANDARDS FOR LIGHT-DUTY VEHICLES (May 2009), http://www.epa.gov/otaq/climate/regulations/420f09028.pdf; Colin Sullivan, *Vow of Silence Key to White House-Calif. Fuel Economy Talks*, N.Y. TIMES, May 20, 2009, http://www.nytimes.com/gwire/2009/05/20/20greenwire-vow-of-silence-key-to-white-house-calif-fuel-e-12208.html; Press Release, White House, President Obama Announces National Fuel Efficiency Policy (May 19, 2009), *available at* http://www.whitehouse.gov/the_press_office/President-Obama-Announces-National-Fuel-Efficiency-Policy/; Josh Voorhees & Robin Bravender, *Obama Unveils Dual Standard for Fuel Economy, Emissions*, GREENWIRE, May 19, 2009, http://www.eenews.net/Greenwire/2009/05/19/1. The EPA granted California's waiver request on June 30, 2009, but because the new federal standards are substantially similar to the California standards, California agreed to defer to the national standards through 2016. News Release, U.S. Envtl. Protect. Agency, EPA Grants California GHG Waiver (June 30, 2009) (EPA news releases are available on its Web site, http://www.epa.gov/newsroom/newsreleases.htm).

30. *See supra* note 2.

greenhouse gas emissions in the U.S. and around the world," and the Department of Energy (DOE) has committed billions of dollars to CCS research and development.[31] While the individual technologies in CCS are well understood, there are few commercial-scale integrated projects operating, none of which capture CO_2 from power plants, and the technology is prohibitively expensive without a significant price on CO_2 emissions.[32] However, the promise of CCS is that, under the appropriate conditions, it can allow society to dramatically reduce CO_2 emissions while still using inexpensive fossil fuels.[33] This Part discusses the potential role of CCS in combating climate change by significantly reducing CO_2 emissions from coal-fired power plants. Section A explains the current role of coal in providing electricity in the United States and worldwide and introduces the arguments for and against CCS as a means of continuing to use coal while reducing its harmful climate effects. Section B explains more precisely how CCS technology works, how it has been implemented to date, and the potential risks associated with CCS. Last, Section C explores how CCS implementation may come into conflict with existing subsurface property rights and surveys existing federal and state legislation on that topic to date.

A. Electric Power, Industrial Sources, and Greenhouse Gas Emissions

Any potential solution to address climate change must include reducing GHG emissions from the electric power and industrial sectors. The U.S. electric power sector was responsible for roughly 42 percent of CO_2 emissions from fossil fuel combustion and 34 percent of total GHG emissions in the United States in 2007.[34] Almost 80 percent of the 2.4 billion metric tons of GHG emissions associated with the electric power sector each year are from coal-fired electric plants.[35] Coal-fired electric power plants play an important role in our energy infrastructure, providing inexpensive base-load electricity generation[36] that amounts to roughly

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31. *See* Steven D. Cook, *Carbon Capture, Storage to Get $2.4 Billion in Recovery Funds, Secretary Chu Announces*, 40 Env't Rept. 1164 (BNA) (May 22, 2009); Bob Secter, *New Life for Clean-Coal Plan*, CHI. TRIB., June 13, 2009, at 4 (discussing Department of Energy's commitment to CCS as well as its decision to revive the "FutureGen" project which the Bush Administration had canceled based on alleged cost overruns that a congressional auditor later said were based on false projections).

32. *See* INT'L ENERGY AGENCY, CARBON CAPTURE AND STORAGE: FULL-SCALE DEMONSTRATION PROGRESS UPDATE 3–4 (2009), http://www.iea.org/G8/docs/ccs_g8july09.pdf.

33. *Id.*

34. *See* U.S. ENVTL. PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2007, at ES-9, ES-16 (2009), http://www.epa.gov/climatechange/emissions/downloads09/GHG2007entire_report-508.pdf.

35. DEP'T OF ENERGY & ENVTL. PROTECT. AGENCY, CARBON DIOXIDE EMISSIONS FROM THE GENERATION OF ELECTRIC POWER IN THE UNITED STATES 3 (2000), http://www.eia.doe.gov/cneaf/electricity/page/co2_report/co2emiss.pdf.

36. Electricity cannot be stored and must be generated to meet demand. Because electricity demand varies both throughout the day and across different seasons, plants typically are run as either base load or peaking plants. Base load generating plants are plants that run almost continuously. Typically, base load plants—traditionally nuclear or coal—are inexpensive to operate, but more ex-

half the total U.S. generation.[37] Coal resources are plentiful in the United States[38] and worldwide,[39] and coal is inexpensive relative to other fuel sources.[40] Coal is a key energy resource in countries like China, India, South Africa, and Germany, as well as in the United States.[41]

Despite the Obama Administration's focus on climate change,[42] the fact remains that GHG emissions continue to increase as much of the growing global energy demand is satisfied with coal-based electric power. Currently the United States emits roughly two billion tons of CO_2 per year from coal combustion in electric power plants.[43] Fossil fuels are predicted to remain a "mainstay" in energy production in the U.S. and around the world for decades to come, thereby steadily increasing atmospheric concentrations of CO_2.[44] More important, putting aside the use of coal-fired electric power in the United States, rapid growth in developing countries, particularly China and India, is significantly escalating CO_2 emissions.[45] Indeed, by 2030, the combined coal consumption of China and India is expected to account for nearly 70 percent of the incremental demand worldwide.[46]

Effectively dealing with climate change will require a fundamental transition in how societies throughout the world produce and use energy. Moreover, it is important to recognize that stabilizing atmospheric concentrations of GHGs is fundamentally different than stabilizing concentrations of traditional criteria air pollutants like sulfur dioxide (SO_2) or oxides of nitrogen (NO_x).[47] Most GHGs have long atmospheric life-

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pensive to build. *See generally* Stratford Douglas, *Measuring Gains from Regional Dispatch: Coal-Fired Power Plant Utilization and Market Reforms*, 27 ENERGY J. 119 (2006).

37. *See* U.S. ENERGY INFO. ADMIN., NET GENERATION BY ENERGY SOURCE (2009), http://www.eia.doe.gov/cneaf/electricity/epm/table1_1.html (ranging from 49 percent to 53 percent in the years beginning with 1995 and ending with 2007).

38. U.S. Energy Information Administration, Coal Explained, http://tonto.eia.doe.gov/energyexplained/index.cfm?page=coal_reserves (last visited Dec. 23, 2009).

39. Coal reserves are especially prominent in North America, Europe, and Asia. *See* BRITISH PETROLEUM, BP STATISTICAL REVIEW OF WORLD ENERGY 32 (2009), http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2009_downloads/statistical_review_of_world_energy_full_report_2009.pdf.

40. For a good summary of the above sources, see ENERGY INFO. ADMIN., ANNUAL ENERGY REVIEW 2008 (2009), http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf. *Compare* U.S. Energy Information Administration, Petroleum Price & Data Analysis, http://tonto.eia.doe.gov/dnav/pet/pet_pri_top.asp (last visited Dec. 15, 2009), *with* U.S. Energy Information Administration, Coal News and Markets, http://www.eia.doe.gov/cneaf/coal/page/coalnews/coalmar.html (last visited Dec. 15, 2009).

41. *See* BRITISH PETROLEUM, *supra* note 39, at 35.

42. *See* Press Release, Barack Obama, President, Statement by the President on House Passage of the American Clean Energy and Security Act (June 26, 2009), *available at* http://www.whitehouse.gov/the_press_office/Statement-By-The-President-On-House-Passage-Of-The-American-Clean-Energy-And-Security-Act.

43. U.S. ENVTL. PROTECT. AGENCY, *supra* note 34, at 3-5 tbl.3-5.

44. Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, 73 Fed. Reg. 43,491, 43,495 (proposed July 25, 2008) (to be codified at 40 C.F.R. pts. 144, 146) [hereinafter EPA Proposed Rule].

45. *See* MASS. INST. TECH., THE FUTURE OF COAL 17 (2007), http://web.mit/edu/coal/The_Future_of_Coal.pdf.

46. *See id.* at 63.

47. *See generally* Rubin et al., *supra* note 12, at 20.

times—decades to thousands of years—compared to hours or days for most criteria air pollutants.[48] According to the United Nations Framework Convention on Climate Change, deep GHG emissions reductions—roughly 50 to 80 percent below 2000 levels[49]—will be necessary to stabilize atmospheric concentrations of GHG at 450 to 490 parts-per-million and, hopefully, avoid some of the most dangerous impacts from climate change.[50]

While many energy technologies are available to make near-term reductions in GHG emissions, it will be necessary to deploy a full portfolio of all available low-carbon technologies to address the immense scale of the cuts required to combat climate change.[51] CCS is emerging as a potentially promising but potentially contentious technology that could enable the continued use of fossil fuels while still allowing society to dramatically reduce accompanying GHG emissions. This technology could be deployed to reduce CO_2 emissions from upstream natural gas processing, industrial operations, and, importantly, coal-fired electric generation.

The Intergovernmental Panel on Climate Change (IPCC) published a comprehensive report on CCS technology in 2005.[52] This report outlines sources of CO_2,[53] capture technologies,[54] transportation modes,[55] and

48. Greenhouse gases include carbon dioxide, methane, nitrous oxide, and fluorinated gases. Piers Forster et al., *Changes in Atmospheric Constituents and in Radiative Force*, *in* WORKING GROUP 1 REPORT, *supra* note 21, at 129, 212 tbl.2.14, http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf; EPA, Basic Information, *supra* note 20.

49. *See* Terry Barker et al., *Summary for Policymakers*, *in* IPCC FOURTH ASSESSMENT REPORT: CLIMATE CHANGE 2007, MITIGATION OF CLIMATE CHANGE 15 tbl.SPM.5 (Bert Metz et al. eds., 2007), http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-spm.pdf.

50. *See* United Nations Framework Convention on Climate Change art. 2, *opened for signature* May 9, 1992, 1771 U.N.T.S. 107, http://unfccc.int/resource/docs/convkp/conveng.pdf ("The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."). The United States is a signatory to the UNFCCC, but not to the later Kyoto Protocol, which establishes targets for GHG emission reductions.

51. *See, e.g.*, ENERGY TECH. ASSESSMENT CTR., ELEC. POWER RESEARCH INST., THE POWER TO REDUCE CO_2 EMISSIONS: THE FULL PORTFOLIO 2009, at 5-1 (2009), *available at* http://my.epri.com/portal/server.pt?Abstract_id000000000001020389; James A. Edmonds et al., *Modeling Greenhouse Gas Energy Technology Responses to Climate Change*, 29 ENERGY 1529, 1531 (2004); Stephen Pacala & Robert Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 SCIENCE 968, 969–71 (2004).

52. IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note 7. The IPCC is a scientific body created under the auspices of the United Nations Environment Programme and the World Meteorological Organization to provide scientific, technical, and socioeconomic information on climate change for policymakers. *See* Intergovernmental Panel on Climate Change, Organization, http://www.ipcc.ch/organization/organization.htm (last visited Dec. 15, 2009).

53. John Gale et al., *Sources of CO_2*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note 7, at 75, 75–103.

54. Kelly Thambimuthu et al., *Capture of CO_2*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note 7, at 105, 105–78.

geologic sequestration and risks;[56] covers economic potential and cost;[57] and describes how CCS could fit within a larger GHG reduction effort.[58] Ultimately, it concludes that CCS could play a significant role in lowering the overall costs of deep emissions reductions.[59]

B. CCS Technology

CCS technology assembles existing technologies that have been developed within the chemical, oil, and natural gas industries to capture and sequester large volumes of CO_2.[60] CCS involves capturing CO_2 during fossil fuel use,[61] transporting the CO_2 to a location with suitable geologic formations (typically by pipeline), and injecting the CO_2 into deep geologic formations at least one kilometer below the surface.[62] The goal is to avoid the atmospheric release of CO_2 by sequestering the captured CO_2 emissions deep underground for hundreds to thousands of years. CO_2 sequestration could take place in depleted oil or gas fields, saline formations, and, potentially, deep coal seams.[63] During CO_2 injection, the pressure of CO_2 at the well bottom exceeds the pressure of fluid in the formation, and CO_2 is forced into microscopic spaces in the rock matrix, displacing brine (or oil and gas) that originally occupied the pore space.[64] CO_2 will flow through and fill the pore spaces in permeable layers of the rock and be prevented from migrating upwards by less permeable rock layers.[65] CO_2 will typically be sequestered as a dense, supercritical fluid.[66] While CO_2 density depends on the reservoir temperature and pressure, in almost all circumstances (except deep ocean subsurface se-

55. Richard Doctor et al., *Transport of CO_2*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note 7, at 179, 179–93.

56. Benson et al., *supra* note 7, at 195–276.

57. Howard Herzog et al., *Cost and Economic Potential*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note 7, at 339, 339–62.

58. Balgis Osman-Elasha et al., *Implications of Carbon Dioxide Capture and Storage for Greenhouse Gas Inventories and Accounting*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE, *supra* note 7, at 363, 363–79.

59. Herzog et al., *supra* note 57, at 341.

60. Rubin et al., *supra* note 12, at 40–41.

61. The CCS process could also be applied to other industrial processes that have CO_2 emissions streams, like ethanol plants or other industrial facilities. We focus on fossil fuel operations here because they are critical to any climate change effort.

62. *See* Doctor et al., *supra* note 55, at 181; Rubin et al., *supra* note 12, at 17, 31–36; *see also* Sam Holloway, *An Overview of the Underground Disposal of Carbon Dioxide*, 38 ENERGY CONVERSION & MGMT. S193, S193 (Supp. 1997); Sam Holloway, *Storage of Fossil Fuel-Derived Carbon Dioxide Beneath the Surface of the Earth*, 26 ANN. REV. ENERGY & ENV'T 145, 149 (2001) [hereinafter Holloway, *Storage of Fossil Fuel-Derived Carbon Dioxide*].

63. *See* Holloway, *Storage of Fossil Fuel-Derived Oriented Carbon Dioxide*, *supra* note 62, at 148–49, 158.

64. *Id.* at 149–50.

65. *Id.* at 150.

66. A supercritical fluid exists when a substance is above its critical temperature and critical pressure. When a fluid is at its critical point, it exists as a gas and liquid in equilibrium, giving it unique properties. CO_2 is considered a supercritical fluid at temperatures greater than 31.1 degrees Celsius and 7.38 MPa (critical point). *See* CRC HANDBOOK OF CHEMISTRY AND PHYSICS 6-39 (David R. Lide ed., 88th ed. 2008).

questration, not discussed here) CO_2 will be less dense than the brine present in the reservoir.[67]

Because injected CO_2 will initially be more buoyant than the brine in the geological formation, injected CO_2 will have the tendency to move upwards and spread laterally within the subsurface.[68] This behavior is important when considering subsurface property rights. Due to differences in site geology, subsurface CO_2 will behave differently at different sites. Importantly, after injection of CO_2 ceases, CO_2 trapped in the rock matrix will gradually become less mobile and more secure as CO_2 dissolved in the brine and slow geochemical reactions convert it to minerals like calcium carbonate.[69] Thus, an effective geologic sequestration site will keep large volumes of a buoyant fluid underground for centuries to millennia, effectively occupying the pore space in perpetuity.

Natural geologic analogs, such as geologic formations containing crude oil, natural gas, and CO_2, prove that CO_2 can be retained underground for millions of years.[70] CCS technologies would attempt to take advantage of this geologic capacity to reduce CO_2 emissions to the atmosphere. Several CCS projects are underway in Norway, Algeria, and Canada, and more are planned in the United States, China, Australia, and other European countries.[71] There are currently four active CCS projects, each injecting roughly one million metric tons of CO_2 per year.[72] For example, the Dakota Gasification Company plant in Beulah, North Dakota captures and transports CO_2 by pipeline over 200 miles across an international border to the Canadian Weyburn oil field for enhanced oil recovery.[73] The DOE has funded seven regional carbon sequestration partnerships with the aim of long-term research and development of the technology as well as six of seven anticipated large scale pilot projects to store 1 million tons or more of CO_2 in various geologic formations across

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67. *See* Stefan Bachu, *Sequestration of CO_2 in Geological Media: Criteria and Approach for Site Selection in Response to Climate Change*, 41 ENERGY CONVERSION & MGMT. 953, 957 (2000); Rubin et al., *supra* note 12, at 31.

68. Rubin et al., *supra* note 12, at 31–32.

69. William D. Gunter et al., *The Role of Hydrogeological and Geothermal Trapping in Sedimentary Basins for Secure Geological Storage of Carbon Dioxide*, *in* GEOLOGICAL STORAGE OF CARBON DIOXIDE 129, 135–36 (S. J. Baines & R. H. Worden eds., 2004) (asserting that mineralization with carbonates take just days where the same with silicates can take hundreds to thousands of years); Karsten Pruess et al., *Numerical Modeling of Aquifer Disposal of CO_2*, 8 SOC'Y PETROLEUM ENGINEERS J. 49, 52–53 (2003).

70. *See* Gunter et al., *supra* note 69, at 135.

71. *See* Rubin et al., *supra* note 12, at 19, 33 tbl.TS.5.

72. *See* INT'L ENERGY AGENCY, *supra* note 32, at 4–5. Three current CCS projects capture and inject the CO_2 produced from natural gas production projects. Sleipner in the North Sea and Snøvhit in the Barents Sea injects CO_2 captured from produced natural gas deep below the seafloor. *Id.* at 5. In Salah, in Algeria, injects the captured CO_2 into a deep gas formation. *Id.* The third project, in Saskatchewan, injects and monitors CO_2 for the Weyburn enhanced oil recovery project in Beulah, North Dakota. *Id.*

73. *See id.*; *see also* Dakota Gasification Company, Pipeline Information, http://www.dakotagas.com/CO2_Capture_and_Storage/Pipeline_Information/index.html (last visited Dec. 16, 2009); International Energy Agency, CO_2 Capture and Storage, R, D & D Projects Database, http://www.co2captureandstorage.info/project_specific.php?project_id=119 (last visited Dec. 16, 2009).

the country.[74] As mentioned earlier, the American Recovery and Reinvestment Act will provide an additional $3.4 billion for CCS demonstration projects, increasing federal support for CCS by 70 percent to over $8 billion.[75] A DOE report estimates that geological resources are likely sufficient to allow sequestration of more than 3300 billion metric tons of CO_2 from power plants and other industrial sources across the U.S. and Canada.[76] Thus, the available sequestration capacity could prove to be quite large when compared with the two billion tons of CO_2 emitted from coal-fired power plants annually in the United States.[77] Some electric power industry representatives believe that CCS "could reduce power plant emissions by about one-quarter in 2030."[78]

Although the idea of injecting CO_2 into the subsurface for the purpose of controlling GHG emissions may be new, the practice of injecting CO_2 into the subsurface for other purposes is not. For decades, oil producers have injected CO_2 into the subsurface to increase oil production. This process, known as "enhanced oil recovery" or EOR, is in widespread use in the Permian Basin in western Texas, where approximately 30 million tons of CO_2 are injected into the ground annually, resulting in a total of 600 million tons injected—though not formally "sequestered"—in that area since 1985.[79] These amounts, however, pale in comparison to the massive scale of injection required to implement CCS for climate change purposes, foreshadowing the property rights issues associated with CCS.[80] Indeed, for CCS to have a real impact on climate change, individual projects must sequester millions of tons of CO_2 per

74. U.S. Department of Energy, Fossil Energy, Carbon Sequestration Regional Partnerships, http://fossil.energy.gov/sequestration/partnerships/index.html (last visited Dec. 16, 2009).

75. *See supra* note 4 and accompanying text.

76. *See* U.S. DEP'T OF ENERGY, CARBON SEQUESTRATION ATLAS OF THE UNITED STATES AND CANADA 15 (2007), http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlas/ATLAS.pdf; Lawrence J. Speer, *DOE Finds Large Capacity for Storing Carbon Dioxide Across U.S., Canada*, Daily Env't Rep. (BNA) No. 60, at A-5 (Mar. 29, 2007); *see also* Eric Williams et al., *Carbon Capture, Pipeline and Storage: A Viable Option for North Carolina Utilities?* (Nicolas Inst. for Envtl. Pol'y Solutions & Ctr. on Global Change, Duke Univ. Working Paper No. 07-01, 2007), http:\\www.nicholas.duke.edu/institute/carboncapture.pdf.

77. *See* Klass & Wilson, *supra* note 9, at 112; *see also* EPA Proposed Rule, *supra* note 44, at 43,496 ("Worldwide, there appears to be significant capacity in subsurface formations both on land and under the seafloor to sequester CO_2 for hundreds, if not thousands of years.").

78. Steven D. Cook, *Power Industry Officials Disagree on Future, Feasibility of Carbon Capture, Storage*, Daily Env't Rep. (BNA) No. 186, at A-1 (Sept. 26, 2007).

79. RICHARD C. MAXWELL ET AL., THE LAW OF OIL AND GAS 13–14 (8th ed. 2007) (discussing enhanced recovery technology); Steven D. Cook, *Researchers Optimistic on Prospects for Successful Carbon Capture, Storage*, Daily Env't Rep. (BNA) No. 94, at A-1 (May 16, 2007) (discussing the use of enhanced oil recovery in Texas as a current example of subsurface injection of CO_2); *see also* Memorandum from Cynthia C. Dougherty, Dir., Office of Ground Water & Drinking Water, and Brian McLean, Dir., Office of Atmospheric Programs, to the Water Mgmt. Div. Dirs. & Air Div. Dirs. of EPA Regions I to X (Mar. 11, 2007), http://www.epa.gov/safewater/uic/pdfs/guide_uic_carbonsequestration_final-03-07.pdf. ("While injection of fluids, including CO_2 into the subsurface, e.g., for enhanced oil recovery (EOR) and enhanced gas recovery (EGR), is a long-standing practice, injection of CO_2 for [CCS] is an experimental application of this existing technology.").

80. MASS. INST. TECH., *supra* note 46, at ix ("If 60% of the CO_2 produced from U.S. coal-based power generation were to be captured and compressed to a liquid for geologic sequestration, its volume would about equal the total U.S. oil consumption of 20 million barrels per day.").

year and keep the injected CO_2 underground for hundreds to thousands of years. Depending on the formation geology and the depth and permeability of the injection zone, sequestered CO_2 from a single project could potentially spread over tens to hundreds of square kilometers, and subsurface pressure effects—affecting brine displacement—could be felt over even greater distances.[81]

Despite its significant potential to have a real impact on climate change, like any technology, CCS is not without risks. These include the risks to human health and the environment associated with the unintended release of CO_2 during transportation by pipeline to sequestration sites, injection of CO_2 into the subsurface, or leakage of CO_2 to the surface or into overlying sources of drinking water.[82] These risks can arise from problems associated with improper transportation, leaking wells, unanticipated issues with the subsurface geology in which CO_2 is injected, or a failure to properly monitor and manage CO_2 once it is injected into the subsurface.[83] There are also climate risks associated with CCS. If CCS becomes a part of forthcoming state or federal CO_2 cap-and-trade systems, incorporating CCS into industrial operations will result in credits for reducing CO_2 through CCS technology.[84] It is very possible, however, that if significant quantities of CO_2 injected into the subsurface prematurely leak back into the atmosphere, it could limit the long-term climate benefit.[85]

CCS has both its detractors and supporters within the environmental nonprofit community. Greenpeace released a report in May 2008 entitled "False Hope," in which it contends that CCS wastes energy, creates unacceptable risks of leakage, is too expensive, undermines funding for more sustainable solutions to potential climate change, carries significant liability risks, and cannot be implemented in time to avoid dangerous climate change.[86] Greenpeace argues instead for investing in renewable energy technologies and increasing energy efficiency that can begin to reverse climate change today.[87] Other environmental nonprofit groups, however, such as the Environmental Defense Fund, Natural Resources Defense Council, World Resources Institute, and The Nature Conservancy, see CCS as a necessary technology to help mitigate the effects of

81. Pruess et al., *supra* note 69, at 52–53.

82. *See* Klass & Wilson, *supra* note 9, at 117–19 (discussing risks to human health and the environment associated with the release of CO_2 from CCS projects). With regard to property rights, CCS-related risks include hydrocarbon contamination and potential water degradation.

83. *See* Alexandra B. Klass & Elizabeth J. Wilson, *Carbon Capture and Sequestration: Identifying and Managing Risks*, 8 ISSUES L. SCHOLARSHIP 1, 1 (2009).

84. *Id.* at 27–28.

85. *Id.* at 1–2.

86. *See* GREENPEACE, FALSE HOPE: WHY CARBON CAPTURE AND STORAGE WON'T SAVE THE CLIMATE 5 (2008).

87. *Id.*

climate change.[88] As one environmental nonprofit representative has stated, CCS "is a terrible idea that we desperately need."[89] Outside the environmental nonprofit community there is an equally significant range of views on the merits of CCS. Those who deny the fact of climate change may see CCS and other climate change technologies as an unnecessary expenditure of government and private resources.[90] Some in industry view CCS as a way to acknowledge the problem of climate change while allowing the world to continue to use coal long into the future.[91] Others see it as a transition technology that allows the world to make dramatic reductions in CO_2 emissions—and broker politically viable climate agreements—while alternatives to coal and fossil fuels are developed.[92] Yet others oppose CCS because of potential risks to human health and the environment, the moral and ethical issues associated with injecting pollutants into the earth, and the fact that CCS enables the continued use of coal and may reduce the incentives and funding needed to transition to a more sustainable energy future.[93]

Our objective in this Article is not to argue in favor of or against the development of CCS as a technology to reduce GHG emissions in response to climate change. We recognize that the position one takes on a range of CCS-related issues—from property rights, to takings, to who should be responsible for the risks associated with CCS—depends significantly on whether one wants to encourage or discourage the development of CCS as a temporary or permanent solution to climate change. Our goal here is to illustrate a range of approaches available to address the subsurface property rights issues CCS raises and discuss the policy implications that flow from them. As a result, the remainder of this Article explores how CCS may intersect with existing interests in subsurface property, as well as methods policymakers and courts may employ to resolve any conflicts.

C. Potential Intersection of CCS and Subsurface Property Rights

For CCS to enable continued use of fossil fuels and simultaneous deep emission reductions, it must be widely deployed. To do this, the technology must be integrated into a larger industrial, legal, and regulatory scheme. Of key import are (1) the amount of the CO_2 to be injected—a 1000 megawatt coal-fired power plant produces roughly four-

88. Gabrielle Wong-Parodi et al., *Environmental Non-Government Organizations' Perceptions of Geologic Sequestration*, ENVTL. RESEARCH LETTERS, at 1, 3 tbl.3 Apr.–June 2008, http://www.iop.org/EJ/abstract/1748-9326/3/2/0240071.

89. *Id.* at 3.

90. *See, e.g.*, Nicholas Dawidoff, *The Civil Heretic*, N.Y. TIMES MAG., Mar. 29, 2009, at 32 (profiling Institute for Advanced Study physicist Freeman Dyson, who has voiced doubts about both climate change and its potential for significant adverse effects on the planet).

91. *See* Wong-Parodi, *supra* note 88, at 4.

92. *See id.* at 5–6.

93. *See id.* at 5.

to-six million tons of CO_2 per year; (2) the size of the area injected CO_2 will occupy—tens to hundreds of square kilometers; (3) the fact that CO_2 will migrate in the subsurface and initially be more buoyant than the subsurface saline formation water; and (4) the need for injected CO_2 to remain in the subsurface for hundreds to thousands of years, effectively occupying the subsurface pore space in perpetuity.

Other economic uses of the subsurface—water recovery, hydrocarbon production, natural gas storage, or liquid waste disposal—could coincide with subsurface CCS injection.[94] Throughout the United States, subsurface activities vary extensively, as do depths of other economic interests and target CCS formations. Every CCS injection site will be geologically unique, and establishing an effective monitoring program will vary across geologic formations and across sites within a particular formation. Indeed, state legislators, particularly in oil and gas producing states, are attempting to write CCS legislation that best avoids conflict with other productive subsurface activities.[95]

As an initial matter, subsurface formations with hydrocarbon reservoirs are often already well-characterized,[96] and are often stacked between non-hydrocarbon bearing saline formations.[97] Currently oil and natural gas developers operate wells at average depths of 1720 and 1750 meters (5600 and 5700 feet), respectively, which is similar to the depths of potential CO_2 sequestration projects.[98] The possibility of developing a CO_2 sequestration site above or below oil or natural gas reservoirs may have advantages in reduced characterization and capital costs, but may also create potential interference between projects.[99] The potential subsurface impacts of CO_2 injection are varied. In a reservoir with active hydrocarbon resources, particularly natural gas, migrating CO_2 could comingle directly with the resource and require additional removal efforts.[100] Soluble CO_2 can cause the precipitation of carbonate minerals and associated plugging of pore space, potentially affecting the extraction

94. *See* U.S. DEP'T OF INTERIOR, REPORT TO CONGRESS: FRAMEWORK FOR GEOLOGICAL CARBON SEQUESTRATION ON PUBLIC LAND 1 (June 3, 2009), http://www.doi.gov/news/09_News_Releases/EISA_Sec._714_Report_to_Congress_V12_Final.pdf ("[C]arbon sequestration may potentially conflict with other land uses including existing and future mines, oil and gas fields, coal resources, geothermal fields, and drinking water sources.").

95. April Reese, *Climate: States Moving to Clarify Landowners' Rights over CO_2 Storage Space*, LAND LETTER, Feb. 26, 2009, http://www.eenews.net (subscription required for access) (noting that some states are also trying to write clauses in the legislation that protect existing resources and property interests); *see also infra* notes 138–39 and accompanying text (discussing state legislation).

96. *See, e.g.*, Christine Doughty & Karsten Pruess, *Modeling Supercritical Carbon Dioxide Injection in Heterogeneous Porous Media*, 3 VADOSE ZONE J. 837 (2004).

97. Carl L. Brassow, Use of Solution—Mined Salt Caverns for the Disposal of Non-Hazardous Oil and Gas (NOW) Waste (Nov. 2001), http://ipec.utulsa.edu/Conf2001/brasso2_131.pdf.

98. U.S. Energy Information Administration, Average Depths of Crude Oil and Natural Gas Wells, http://tonto.eia.doe.gov/dnav/pet/pet_crd_welldep_s1_a.htm (last visited Dec. 16, 2009).

99. *See* Benson et al., *supra* note 7, at 234 (stating that the presence of CO_2 in the basin can lead to corrosion problems and can change the composition of oils such that plugging, erosion, and processing problems arise).

100. *See id.*

efficiency for existing natural gas facilities.[101] The pressure effects from the injection operation, particularly if multiple sites are used to inject CO_2 into a single basin, could adversely impact other injection operations by potentially altering injectibility, plume size and shape, and associated monitoring changes.[102]

Hydrocarbon extraction also produces large amounts of waste water that needs to be disposed. When oil is produced it is mixed with water (an average of seven gallons of water produced for each gallon of oil), and the produced water must be separated and disposed of, usually by underground injection.[103] In the United States each year, over 750 billion gallons of oil-produced waters[104] are injected into the subsurface through 150,000 disposal wells.[105] This volume of produced water corresponds to roughly the volume that two gigatonnes (Gt) of CO_2 would occupy at one kilometer depth, potentially requiring coordination with future CO_2 sequestration operations.[106] The waste water is generally handled on site, with roughly one-quarter of it being injected back into the oil producing formation, in part to help in the oil recovery process.[107] Other operators inject into non-producing formations at varying depths where porous and permeable formations are present.[108] Some waste water disposal wells inject below the hydrocarbon formation and others inject above it.[109] In Texas, produced water is injected into non-producing formations varying in depth from approximately 300 to 3000 meters (1000 to 10,000 feet), with 60 percent of these wells a kilometer or more deep.[110] Both the practice and scale of handling produced water are similar to the expected practices for injecting CO_2.[111]

Underground natural gas storage is another area where CCS use of the subsurface may require coordination. Underground natural gas storage has helped balance supply and demand fluctuations around the globe for nearly 100 years and, in many ways, is a useful analog for se-

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101. Sally M. Benson & David R. Cole, *CO_2 Sequestration in Deep Sedimentary Formations*, 4 ELEMENTS 325, 328 (2008); *see also* Gunter et al., *supra* note 69, at 136–38.

102. SARAH FORBES ET AL., WORLD RES. INST., CCS GUIDELINES 62–63 (2008), http://pdf.wri.org/ccs_guidelines.pdf; JOHN VEIL ET AL., ARGONNE NAT'L LAB., A WHITE PAPER DESCRIBING PRODUCED WATER FROM PRODUCTION OF CRUDE OIL, NATURAL GAS, AND COAL BED METHANE 17 (2004), http://www.ead.anl.gov/pub/doc/ProducedWatersWP0401.pdf.

103. VEIL ET AL., *supra* note 102, at 47.

104. Produced water is the industry term for brine that is extracted as part of oil or gas production.

105. Benson et al., *supra* note 7, at 212; *see also* M. G. PUDER & J. A. VEIL, ARGONNE NAT'L LAB., OFFSITE COMMERCIAL DISPOSAL OF OIL AND GAS EXPLORATION AND PRODUCTION WASTE: AVAILABILITY, OPTIONS, AND COSTS 39 (2006), http://www.evs.anl.gov/pub/doc/ANL-EVS-R-06-5.pdf.

106. Benson et al., *supra* note 7, at 212.

107. *See* VEIL ET AL., *supra* note 102, at 49.

108. *See id.* at 49–50.

109. *See id.* at 34.

110. Melisa Pollak, Produced Water Disposal: Comparison to Geological Sequestration of CO_2 1 n.3 (Jan. 29, 2009) (on file with authors).

111. Benson et al., *supra* note 7, at 234.

questration of CO_2.[112] Similar to sequestration of CO_2, depleted hydrocarbon fields and saline aquifer formations are commonly used for natural gas storage.[113] Because injected CO_2 is readily mixed with natural gas, if natural gas storage and CO_2 sequestration projects operated in close proximity within the same basin, the two substances might comingle and degrade the quality of the natural gas.[114] Today there are roughly 133 operators storing between 1200 and 3300 billion cubic feet (BCF) of natural gas through a series of roughly 300,000 wells in the United States.[115]

In addition, long-standing and new uses of the subsurface for activities wholly unrelated to hydrocarbon production may take place in formations and depths similar to CO_2 sequestration. EPA Underground Injection Control (UIC) Program Class I waste injection wells, for example, aim to inject waste below the lowest underground source of drinking water.[116] These waste injection wells are located in basins where the freshwater is protected from the injection zone by an impermeable caprock or confining layer, much like what would be used for CO_2 sequestration.[117] Injection zones typically range from slightly over 500 meters to more than 3000 meters in depth.[118] There are roughly 550 Class I wells in the United States, mostly located in the sedimentary basins of the Gulf Coast and Great Lakes regions.[119] While approximately 48 percent of the Class I wells are for nonhazardous waste, another 30 percent of the wells are dedicated to municipal wastewater disposal in Florida.[120] The EPA recently changed its guidelines for Class I wells for Florida wastewater to prevent adverse effects from the noticeable upward migration of the disposed waters into underground sources of drinking water.[121]

Finally, compressed air storage and aquifer storage and recovery have both become increasingly attractive technologies that use the subsurface. Compressed air storage could help manage complications with the intermittency of large-scale wind produced energy. Wind energy that

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112. *Id.* at 211.

113. *Id.*

114. Bachu, *supra* note 67, at 964.

115. U.S. Energy Information Administration, Weekly Natural Gas Storage Report, http://www.eia.doe.gov/oil_gas/natural_gas/ngs/ngs.html (last visited Dec. 16, 2009) (follow the "History" hyperlink); William Trapmann, U.S. Weekly Natural Gas Storage Data, slide 4 (Sept. 28, 2007), *available at* http://www.eia.doe.gov/pub/oil_gas/natural_gas/presentations/2007/ngsdata/ngsdata_files/frame.html.

116. VEIL ET AL., *supra* note 102, at 34.

117. For a discussion of the EPA's UIC Program, see *infra* notes 126–30 and accompanying text.

118. U.S. ENVT'L PROTECT. AGENCY, CLASS I UNDERGROUND INJECTION CONTROL PROGRAM: STUDY OF THE RISKS ASSOCIATED WITH CLASS I UNDERGROUND INJECTION WELLS 12 (2001), http://www.epa.gov/ogwdw000/uic/pdfs/study_uic-classl_study_risks_classl.pdf.

119. U.S. Environmental Protection Agency, Industrial & Municipal Waste Disposal Wells (Class I), http://www.epa.gov/safewater/uic/wells_classl.html (last visited Dec. 16, 2009).

120. *Id.*

121. *See* Underground Injection Control Program—Revision to the Federal Underground Injection Control Requirements for Class I Municipal Disposal Wells in Florida, 70 Fed. Reg. 70,513 (Nov. 22, 2005) (codified at 40 C.F.R. § 146 (2005)); David W. Keith et al., *Regulating the Underground Injection of CO_2*, 39 ENVTL. SCI. & TECH. 499A, 501A (2005).

would otherwise flow to the electric grid would be used to compress air that would then be pumped and stored in deep geologic reservoirs for later use in making natural gas turbines more efficient.[122] A compressed air storage operation in Germany has been compressing roughly 300,000 cubic meters of air in a natural gas storage reservoir roughly 650 to 800 meters below the surface.[123] Additionally, the Battelle Memorial Institute has suggested that future United States compressed air storage projects should be located in formations roughly 650 to 850 meters below the surface and at least 100 meters away from any dissimilar geologic formation.[124] Aquifer storage and recovery involves injecting water into deep underground reservoirs for later retrieval.[125] The subsurface formation essentially acts as a "water bank" for future withdrawals.

Thus, there is the real potential for CCS operations to interfere with actual or reasonably foreseeable uses of subsurface pore space and, consequently, subsurface property rights. Currently, there is little federal or state statutory authority governing subsurface property rights issues in the context of CCS, and many of these activities are managed within different federal and state agencies. The federal Safe Drinking Water Act (SDWA) gives the EPA authority to manage the UIC program, which regulates underground injection activities and enhanced oil recovery but not natural gas storage.[126] The EPA has determined that its authority under the UIC program confers the authority to regulate geologic sequestration of CO_2.[127] In July 2008, the EPA released for comment a draft CCS-specific rule under the UIC program.[128] The proposed rule includes provisions for on-site characterization, well construction and operation, post-injection monitoring, and post-closure care.[129] The EPA has stated, however, that the SDWA does not give the agency any authority to address CCS-specific property rights concerns, and thus these issues are not addressed by the new rule.[130]

Recently, several states have also begun to develop regulatory frameworks to manage geologic sequestration of CO_2, with increasing at-

122. *See* Paul Denholm & Ramteen Sioshansi, *The Value of Compressed Air Energy Storage with Wind in Transmission-Constrained Electric Power Systems*, 37 ENERGY POL'Y 3149, 3149–50 (2009).

123. *See* Fritz Crotogino et al., *Huntorf CAES: More than 20 Years of Successful Operation* (Mar. 22, 2009), http://www.uni-saarland.de/fak7/fze/AKE_Archiv/AKE2003H/AKE2003H_Vortraege/AKE2003H03c_Crotogino_ea_HuntorfCAES_CompressedAirEnergyStorage.pdf.

124. R. D. ALLEN ET AL., BATELLE MEMORIAL INST., GEOTECHNICAL ISSUES AND GUIDELINES FOR STORAGE OF COMPRESSED AIR IN EXCAVATED HARD ROCK CAVERNS, at xiii (1982), http://www.osti.gov/energycitations/servlets/purl/5437632-pQfu9J/5437632.pdf.

125. State of Washington Department of Ecology, Aquifer Storage and Recovery, http://www.ecy.wa.gov/programs/wr/asr/asr-home.html (last visited Dec. 22, 2009).

126. 40 C.F.R. §§ 144–146 (2008).

127. *See* Safe Drinking Water Act, 42 U.S.C. § 300(h)(d) (2006); *see also* U.S. Environmental Protection Agency, Underground Injection Control Program, http://www.epa.gov/OGWDW/uic/wells_sequestration.html (last visited Dec. 16, 2009).

128. Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, 73 Fed. Reg. 43,492 (proposed July 25, 2008).

129. *Id.*

130. *Id.* at 43,495.

tention to the issue of pore space ownership. As shown in Table 1, Wyoming, Montana, and North Dakota have passed legislation explicitly defining pore space ownership.[131] Wyoming H.B. 89 addresses property rights by stating that "[t]he ownership of all pore space in all strata below the surface lands and waters of this state is declared to be vested in the several owners of the surface above the strata."[132] In 2009, the Wyoming governor signed into law H.B. 57, which amends the pore space provision in H.B. 89 and clarifies that the mineral estate is still dominant over the surface estate.[133] In 2009, North Dakota S.B. 2139 similarly proclaimed that "[t]itle to pore space in all strata underlying the surface of lands and waters is vested in the owner of the overlying surface estate."[134] North Dakota's bill further attaches pore space rights to the surface estate by prohibiting severance of pore space from the title to the overlying surface real property.[135] Montana S.B. 498 creates a presumption that the surface owner owns subsurface pore space if deeds or other severance documents do not demonstrate otherwise.[136] Like Wyoming and North Dakota, Montana's new statute explicitly does not interfere with common law or the dominance of the mineral estate. West Virginia's new legislation creates a working group that will make recommendations to the legislature on pore space ownership by 2011.[137]

This assignment of subsurface property rights in Wyoming, Montana, and North Dakota—and perhaps in other states in the future—has the potential to create a direct conflict between state subsurface property interests and any future federal or state efforts to facilitate the widespread underground sequestration of CO_2. The number of states moving to adopt similar legislation has recently increased considerably as legislators anticipate future carbon limits and try to settle potential property rights disputes to create a more stable environment for future project development.[138] The nature of subsurface property rights in general and the potential conflict between state-created subsurface property rights and future federal policies are discussed below in Parts II and III.

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131. *See* S.B. 498, 61st Leg., Reg. Sess. (Mont. 2009) (codified at MONT. CODE ANN. § 82-11-180 (2009)); S.B. 2319, 61st Leg. Assem., Reg. Sess. (N.D. 2009) (codified at N.D. CENT. CODE § 47-31-01-08 (2006 & Supp. 2009)); H.R. 89, 59th Leg., Budget Sess. (Wyo. 2008) (codified at WYO. STAT. ANN. § 34-1-152 (2009)).

132. Wyo. H.R. 89 (codified at WYO. STAT. ANN. § 34-1-152(a)).

133. WYO. STAT. ANN. § 34-1-152(a); H.R. 57, 60th Leg., Gen. Sess. (Wyo. 2009).

134. N.D. S.B. 2319 (codified at N.D. CENT. CODE § 47-31-04).

135. *Id.* (codified at N.D. CENT. CODE § 47-31-05, -06 (2009)).

136. S.B. 498, 61st Leg., Reg. Sess. (Mont. 2009) (enacted at MONT. CODE ANN. § 82-11-180 (2009)).

137. H.B. 2860, 79th Leg., 1st Sess. (W. Va. 2009) (enacted in pertinent part at W. VA. CODE § 22-11A-6 (2009)).

138. *See* TASK FORCE ON CARBON CAPTURE & GEOLOGIC STORAGE, INTERSTATE OIL & GAS COMPACT COMM'N, STORAGE OF CARBON DIOXIDE IN GEOLOGIC STRUCTURES: A LEGAL AND REGULATORY GUIDE FOR STATES AND PROVINCES 16–22 (2007); Owen L. Anderson, *Geologic CO_2 Sequestration: Who Owns the Pore Space?*, 9 WYO. L. REV. 97, 99 (2009); Reese, *supra* note 95. However, several states have authorized significant regulations, such as permitting rules for CO_2 sequestration, without explicitly addressing property rights issues.

TABLE 1

EXISTING STATE LEGISLATION AND REGULATION RELATING TO PROPERTY RIGHTS AND CO_2 SEQUESTRATION[139]

	Regulatory Authority	Pore Space Ownership	Eminent Domain	Unitization	Mineral Rights Primacy
Louisiana H.B. 661 (2009); H.B. 1220 (2008); H.B. 1117 (2008)	Office of Conservation, Department of Natural Resources	Not addressed.	CO_2 Sequestration declared to be in the public interest. Public and private entities may exercise eminent domain, subject to certain findings.	Not addressed.	Not addressed.
Montana S.B. 498 (2009)	Board of Oil and Gas Conservation, with comments from Board of Environmental Review	Surface owner, severance allowed.	Not addressed.	Owners of 60% or more of pore space storage capacity may apply to the Board of Oil and Gas to have the area treated as a unit.	Common law and dominance of mineral estate not altered.
North Dakota S.B. 2095 (2009); SB 2139 (2009); N.D. Admin. Code 42-02-04.1 (proposed)	Industrial Commission	Surface owner, severance not allowed.	CO_2 Sequestration declared to be in the public interest.	Owners of 60% or more of pore space capacity must approve.	Common law and dominance of mineral estate not altered.
Oklahoma S.B. 610 (2009); S.B. 1765 (2008)	Corporation Commission (for fossil fuel-bearing formation); Dep't of Environmental Quality for all others.	Not addressed.	CO_2 Sequestration declared to be in the public interest.	Corporation Commission will be the regulatory authority if a unitization process is adopted.	Common law and dominance of mineral estate not altered.
West Virginia H.B. 2860 (2009)	Department of Environmental Protection	CO_2 Sequestration Working Group will make recommendations in 2011.	CO_2 Sequestration declared to be in the public interest.	Not addressed.	Common law and dominance of mineral estate not altered.

(*Continued on next page*)

139. Updated from Melisa F. Pollak & Elizabeth J. Wilson, *Regulating Geologic Sequestration in the United States: Early Rules Take Divergent Approaches*, 43 ENVTL. SCI. & TECH. 3035, 3036–38 (2009), *available at* http://pubs.acs.org/doi/pdfplus/10.1021/es803094f, and Melisa F. Pollak & Sarah Johnson Phillips, State Policy on Geologic Sequestration: 2009 Update, at 10 (2009) (on file with authors).

TABLE I—*Continued*

	Regulatory Authority	Pore Space Ownership	Eminent Domain	Unitization	Mineral Rights Primacy
Wyoming H.B. 57 (2009); H.B. 58 (2009); H.B. 80 (2009); H.B. 89 (2008); Water Qual. Rules & Regs. chap. 24 (proposed)	Department of Environmental Quality	Surface owner, severance allowed.	Not addressed.	Any interested person may apply to treat an area as a unit; Oil and Gas Conservation Commission may approve if owners of at least 80% of pore space approve.	Dominance of the mineral estate affirmed.

II. THE SKIES, THE EARTH, AND THE SUBSURFACE: DEFINING PROTECTABLE PROPERTY INTERESTS

The Fifth Amendment Takings Clause states that private property shall not "be taken for public use, without just compensation."[140] The Constitution does not create or define the scope of property interests protectable under the Fifth Amendment, but instead requires compensation in the event of an interference with those property interests that amounts to a taking.[141] Thus, in determining whether a protectable property interest exists, courts look to "existing rules or understandings" and "background principles" derived from independent sources such as state law, federal law, or common law.[142] Although property interests are often defined by state law, state-created property interests may be limited by federal law, even in the area of real property.[143] The Supreme Court has stated that the Takings Clause "was designed to bar Government from forcing some people alone to bear public burdens which, in all fairness and justice, should be borne by the public as a whole."[144]

Once a protectable property interest is established, a court must decide whether to analyze the government action in question as a physical taking or as a regulatory taking.[145] A physical taking occurs when the

140. U.S. CONST. amend. V.

141. *See* Phillips v. Wash. Legal Found., 524 U.S. 156, 164 (1998) ("[T]he Constitution protects rather than creates property interests . . . .").

142. *See* Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1030 (1992); Klamath Irrigation Dist. v. United States, 67 Fed. Cl. 504, 515 (Fed. Cl. 2005).

143. *See Lucas*, 505 U.S. at 1032 n.18 (stating that state-law definitions of private property rights must be based on "an objectively reasonable application of relevant precedents" (emphasis omitted)); *Klamath*, 67 Fed. Cl. at 515 n.15 (stating an objective basis in defining property rights is "vital if the integrity of the Takings Clause is to be preserved as against entirely novel and unprincipled definitions of property designed artificially to defeat or buttress a takings claim") (citing Webb's Fabulous Pharmacies, Inc. v. Beckwith, 449 U.S. 155, 164 (1980)).

144. Armstrong v. United States, 364 U.S. 40, 49 (1960).

145. Lingle v. Chevron U.S.A. Inc., 544 U.S. 528, 538 (2005).

government engages in a permanent physical occupation of private property or authorizes a third party to engage in such occupation.[146] In the case of physical invasions, "no matter how minute the intrusion, and no matter how weighty the public purpose behind it," a taking has occurred and just compensation is required.[147] Even if there is no physical occupation of private property, a "regulatory taking" can occur if government regulation places too great a burden on the owner's use of the property.[148] A regulatory taking can take place under two circumstances.[149] First, a regulatory action can be a "per se" taking when the regulation completely deprives an owner of all reasonably beneficial use of her property.[150] Second, in the absence of a complete deprivation of all economic use of the property, courts generally consider whether the regulatory restriction has risen to the level of a compensable taking under the multifactor balancing test set out in *Penn Central Transportation Co. v. New York City*.[151] This test considers (1) the character of the government action; (2) the severity of the economic impact; and (3) the extent to which the regulation interferes with the property owner's distinct, "investment-backed" expectations.[152] Finally, even if the government engages in a physical taking or a regulatory taking of private property, a violation of the Fifth Amendment only occurs if the taking is without "just compensation."[153] As a result, if a court determines that the property owner's net loss as a result of the taking is zero, the compensation due under the Constitution is also zero.[154]

Based on this framework, this Part considers the threshold question of whether a landowner (or a mineral owner) has a sufficient interest in the subsurface pore space to implicate the Takings Clause in the first place. There is little dispute that, subject to reasonable regulation, the surface owner of property has significant rights to use her property as she sees fit and, just as important, has the right to exclude others from making use of her property. If the state or federal government wishes to use that property, take that property, or allow other private parties to use or

146. *Id.*; Loretto v. Teleprompter Manhattan CATV Corp., 458 U.S. 419, 426 (1982) (holding that state regulation requiring landlords to allow television cable companies to place cable facilities in their apartment buildings constituted a taking even though the facilities occupied at most only one and one-half cubic feet of the landlord's property).

147. *Lucas*, 505 U.S. at 1015; *see also* Brown v. Legal Found. of Wash., 538 U.S. 216, 233–34 (2003) (discussing rules regarding per se physical takings and holding that the state's requirement that interest earned on certain client trust accounts be transferred to law-related charitable and educational purposes should be subject to analysis under the per se physical taking test); *Loretto*, 458 U.S. at 426.

148. *See* Tahoe-Sierra Pres. Council, Inc. v. Tahoe Reg'l Planning Agency, 535 U.S. 302, 326 (2002).

149. *Lingle*, 544 U.S. at 538.

150. *See Lucas*, 505 U.S. at 1029 (holding regulations that prohibit all economically beneficial use of land are just as much of a taking requiring compensation as permanent physical occupations of land).

151. 438 U.S. 104 (1978).

152. *Id.* at 124.

153. *See* Brown v. Legal Found. of Wash., 538 U.S. 216, 235 (2003).

154. *Id.* at 237.

take that property for a public purpose, the government can do so by virtue of its eminent domain power but must pay "just compensation" to the property owner.[155] Thus, the question arises as to how far up into the sky and down into the earth do those rights extend? Most law students in their first-year property course are taught the maxim "*cujus ejus est usque ad coelum et ad infernos*" (translated as "the rights of the surface owner extend upwards to the heavens [*ad coelum*] and downward to the center of the earth [*ad infernos*]"). Students are also taught, however, that with the advent of air travel in the 1930s, courts did away with the *ad coelum* doctrine with regard to ownership of airspace high above the ground. But what of the doctrine's continued application to the subsurface far below the ground?

Section A provides a brief history of the *ad coelum* doctrine and how courts modified the doctrine with regard to airspace after the rise of air travel in the early twentieth century. Section B considers whether property rights and takings jurisprudence involving private property in surface lands can be applied directly to subsurface rights in general and subsurface pore space rights in particular. Section C then proceeds to analyze case law in the areas of oil and gas development, underground waste injection, and subsurface natural gas storage to show the different approaches courts have taken to the issue of subsurface ownership. These cases show that courts have taken a fairly nuanced approach to subsurface property rights, rejecting many claims for technical trespass, recognizing rights to recover for actual damage or interference with use, and recognizing the need for compensation in cases of physical occupation of the subsurface in some circumstances. Thus, instead of vesting absolute ownership of the subsurface in one party or another, courts appear to allow regulated use of the subsurface (by either the government or private parties) when the use is in the public interest without always requiring compensation for surface owners or mineral owners in the absence of actual harm or loss. Finally, Section D uses the case law discussed in the prior Sections to analyze various approaches courts and policymakers can potentially use to resolve claims involving property rights and takings in the context of subsurface pore space and CO_2 sequestration.

A. Breaking Apart the Ad Coelum *Doctrine from the Top Down*

With regard to airspace, until the early part of the twentieth century, courts and commentators continued to invoke the *ad coelum* doctrine, stating that common law ownership of land "extended to the periphery of the universe."[156] These statements, even in dicta, however, were

155. *See infra* Part III.A.

156. United States v. Causby, 328 U.S. 256, 260–61 (1946) ("It is ancient doctrine that at common law ownership of the land extended to the periphery of the universe—*Cujus est solum ejus est usque ad coelum*." (citing 1 COKE, INSTITUTES, ch. 1, § 1(4a) (19th ed. 1832); 2 BLACKSTONE, COMMENTARIES

put to rest with regard to airspace by the Supreme Court's 1946 decision in *United States v. Causby*.[157] In that case, the Court found that the plaintiff farmers could recover just compensation for a taking of an easement on their farm by the federal government's frequent, low-level military flights over the farm, which significantly interfered with their use and enjoyment of the land and destroyed their ability to continue to use the property as a commercial chicken farm.[158] In reaching that decision, however, the Court contrasted the interference caused by the low-level flights at issue in the case with the general principle that the *ad coelum* doctrine "has no place in the modern world."[159] Instead, "the air is a public highway" and "private claims to the airspace would clog [those] highways, seriously interfere with their control and development in the public interest, and transfer into private ownership that to which only the public has a just claim."[160]

It is important to note that the Court was able to declare that the national airspace was a "public highway" despite the historic *ad coelum* doctrine because of Congress's enactment of the Air Commerce Act of 1926.[161] In summarizing the government's position in the case, the Court quoted heavily from that Act, which provided in part that the United States has "complete and exclusive sovereignty" of the airspace over the lands and water of the United States, that "navigable airspace shall be subject to a public right of freedom of interstate and foreign air navigation," and that the airspace is recognized and declared to exist in behalf of any citizen of the United States a public right of freedom of transit in air commerce through the navigable airspace of the United States.[162]

The Court then made some attempt to distinguish between a landowner's protectable property interest in the airspace above the surface of his or her lands and the "public highway" above that airspace.[163] The Court recognized that to have full enjoyment of the land, a landowner "must have exclusive control of the immediate reaches of the enveloping atmosphere" or else he or she could not plant trees or construct buildings or fences.[164] Thus, a landowner owns as much space above the ground as he or she "can occupy or use in connection with the land."[165] Even if the landowner does not actually occupy that space by erecting a building, the intrusion by an airplane or another structure, even if it did not touch the

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18 (Lewis ed. 1902); 3 KENT, COMMENTARIES 621 (Gould ed. 1896))); *see also* Sprankling, *supra* note 17, at 1000 ("American courts repeatedly advanced this expansive view of airspace rights—until the invention of the airplane sparked litigation, especially in the 1930s.").

157. 328 U.S. at 256.

158. *Id.* at 259, 265.

159. *Id.* at 261.

160. *Id.*

161. *Id.* at 260 (citing Air Commerce Act of 1926, 49 U.S.C. §§ 176(a), 180, 403 (1946)).

162. *Id.*

163. *Id.* at 261–62.

164. *Id.* at 264.

165. *Id.*

surface, "is as much an appropriation of the use of land as a more conventional entry upon it."[166] With regard to airplanes, the Court held that an airplane flight over land is lawful unless it is at such a low altitude as to interfere with "then existing use to which the land or water, or the space over the land or water, is put by the owner."[167] The Court concluded this discussion by noting that the airplane is "part of the modern environment of life," the inconveniences it causes are not normally compensable under the Fifth Amendment, and the airspace (apart from that immediately above the land) is part of the "public domain."[168]

The Court expressly declined to determine the precise line that divided the public domain of airspace from its lower reaches that were within the realm of private property.[169] Instead, it held simply that "[f]lights over private land are not a taking, unless they are so low and frequent as to be a direct and immediate interference with the enjoyment and use of land."[170] Thus, *Causby* and subsequent cases involving airspace rights[171] show that once there developed a significant public interest in airspace, and once Congress explicitly recognized and protected that public interest by federal statute, courts responded by modifying the *ad coelum* doctrine. Such modification served to limit a landowner's protectable property interests to the part of the airspace that could reasonably be used "in connection with the land."[172] The case consequently eliminated trespass and takings claims relating to airspace except in cases, like *Causby*, where there was "a direct and immediate interference with the enjoyment and use of land."[173] It is this requirement that any interest in airspace be tied to reasonable use of the surface of the land that is potentially applicable to the discussion that follows on the extent of protectable property interests in the subsurface.

As shown in Section C below, courts deciding subsurface property rights cases do look to *Causby* and other airspace cases for precedent in some circumstances.[174] It is important to note at the outset, however, that the case law in the area of subsurface rights is much more complicated than that involving airspace. This complication arises from three main factors that potentially distinguish the precedent involving airspace rights from the precedent involving subsurface rights. The first distinction is that unlike airspace rights, subsurface rights have been carved up, con-

166. *Id.* at 264.
167. *Id.* at 266.
168. *Id.*
169. *Id.*
170. *Id.*
171. *Id.*; *see, e.g.*, United Masonry, Inc. v. Jefferson Mews, Inc., 237 S.E.2d 171, 181 (Va. 1977) (stating that the common law *ad coelum* doctrine "has been modified so that now the landowner is generally held to own only that amount of airspace he can reasonably use").
172. *Causby*, 328 U.S. at 264.
173. *Id.* at 264–66 ("The superadjacent airspace at this low altitude is so close to the land that continuous invasions of it affect the use of the surface of the land itself.").
174. *See infra* notes 215–21.

veyed, used, bought, sold, and developed by private parties and federal, state, and local governments since nearly the founding of the country. This has resulted in ownership, use, and exploitation of the subsurface in a manner far more tangible than ever existed for airspace rights. The second distinction is that in the airspace cases there was a single and very strong "public interest"—national airspace travel—competing against surface interests. In cases involving subsurface rights, by contrast, the surface owners' rights come up against multiple competing rights in the public interest such as oil and gas development, subsurface groundwater use, underground injection of hazardous waste, and underground natural gas storage. All of these competing uses of the subsurface are arguably in the public interest, they often conflict with each other, and all are subject to a federal or a state regulatory system designed to promote one or more public interests. A third distinction is Congress's early declaration that "airspace shall be subject to a public right of freedom of interstate and foreign air navigation"[175] as compared to the long history of subsurface rights being bought, sold, and privatized by the federal government, the states, and private parties. While Congress may in the future enact legislation to create a public right of freedom in the subsurface to facilitate CCS and other technological developments that are in the public interest, the fact remains that such legislation will exist against a backdrop of significantly more expectation of private property rights in the subsurface (at least in some parts of the country) than existed with regard to airspace at the time Congress created a public highway in airspace.

So there are good arguments that the judicial and legislative precedent that has limited private property rights in airspace may not be completely dispositive in deciding cases involving subsurface property rights in general and subsurface pore space rights in particular. The next question is whether the rich body of case law involving traditional property rights in the land's surface is dispositive on the question of property rights in the subsurface, or whether there are relevant distinctions there as well. The question is analyzed below in Section B.

B. Ownership and Occupation of Surface Lands Versus Ownership and Occupation of Subsurface Lands

The bulk of cases involving property rights, takings, and trespass involve, of course, ownership and use of the surface of the land. This precedent was mentioned in the introduction to Part II and is discussed more fully below in Part III. At this point, however, it is important to consider whether this body of case law applies without distinction to questions involving use and occupation of the subsurface. The leading Supreme Court case on the physical occupation of the surface is *Loretto*

175. *See* 49 U.S.C. § 180 (1946) (cited in *Causby*, 328 U.S. at 260).

v. Teleprompter Manhattan CATV Corp.[176] In that case, the issue was whether a New York law requiring a landlord to permit installation of private cables on rental properties to facilitate cable television access was a taking without just compensation.[177] The Supreme Court held that the state statute did work a taking of a portion of the plaintiff's property (approximately one and one-half cubic feet on the outside of the rental building) for which she was entitled to just compensation under the Fifth Amendment.[178] In reaching its decision, the Court, citing *Causby*, distinguished between the government's permanent, physical occupation of property, which constitutes a "per se" taking in most cases, and a "regulation that merely restricts the use of property."[179] The Court found that to the extent the government permanently occupies property (or grants another party the right to do so), it effectively destroys the right to "possess, use, and dispose" of property and will always work a taking.[180] The Court found that in applying this per se taking rule for physical occupations, the size of the area occupied is irrelevant, as is whether the plaintiff had previously occupied the space in question.[181] The Court also cited *Causby* once again for the proposition that "[a]n owner is entitled to the absolute and undisturbed possession of every part of his premises, including the space above, as much as a mine beneath."[182]

In light of the sweeping language of *Loretto*, an initial question is whether *Loretto* applies in all cases of physical use of subsurface pore space. There is certainly language in the case that supports that conclusion, particularly the declaration that the size of the area is irrelevant, that the plaintiff need not have previously occupied the space in question, and that there is a right of "undisturbed possession" of every part of the premises including the space above and the "mine beneath."[183] On the other hand, *Causby*, on which *Loretto* relies heavily, clearly limited property interests in the skies above to that portion of the airspace that was necessary to enjoy the surface of the land and did not include the public highway in the airspace established by Congress.[184] This limitation arguably would protect interests in the subsurface that are necessary to the reasonable use of the surface or are in existing economic use, but

176. 458 U.S. 419 (1982).

177. *Id.* at 421.

178. *Id.* at 441. On remand, the lower court determined that just compensation was only one dollar, and that ruling was affirmed on appeal. *Loretto v. Teleprompter Manhattan CATV Corp.*, 446 N.E.2d 428, 435 (N.Y. 1983).

179. *Loretto*, 458 U.S. at 430 (citing *Causby*, 328 U.S. at 261); *see also* Brown v. Legal Found. of Wash., 538 U.S. 216, 240 (2003) (holding that a state law requiring that client funds that could not otherwise generate net earnings for the client be deposited into account where such earnings are used for law-related charitable and educational purposes was not a "regulatory taking," but that a law requiring that the interest on those funds be transferred to a different owner for a legitimate public purpose could be a per se physical taking akin to the occupation of a small amount of rooftop space in *Loretto*).

180. *Loretto*, 458 U.S. at 435.

181. *Id.* at 436, 438 n.16.

182. *Id.* at 437 n.13 (quoting Causby, 328 U.S. at 256 n.10).

183. *Id.*

184. *Causby*, 328 U.S. at 266.

perhaps would not protect all subsurface areas, particularly those far below the surface of the earth. Thus, just as airspace rights end at some point not far above the surface of the earth, perhaps pore space rights end at some point not far below the surface of the earth. Once again though, using *Causby* to support a more limited view of subsurface property rights must be tempered by the real distinction between the historical use and regulation of subsurface and the use and regulation of the airspace discussed in Section B.

Ultimately, courts will need to grapple with *Causby*, *Loretto*, and the case law specific to subsurface property rights, discussed below in Section C, whether or not Congress and the states attempt to increase or limit property rights in subsurface pore space in connection with CCS or other new technologies. Any legislative efforts to define or limit subsurface property rights to facilitate CCS will likely be subject to takings challenges. While the Supreme Court has not yet decided any cases specific to subsurface pore space, some state courts have done so in connection with oil and gas development, underground waste injection, and natural gas storage.[185] While these cases are not always consistent with each other, there are some notable themes that emerge, which are discussed below in Section C.

C. *Ownership of Space Versus Ownership of Resources and the Role of the Public Interest*

Despite the lack of clear judicial precedent on a national level involving subsurface pore space rights, there is a rich body of state case law involving subsurface property rights in a range of circumstances, some involving ownership of resources and others involving ownership of subsurface space itself. We find the most applicable cases to be those that arise from the following three situations: (1) regulatory creation of unitized oil fields and secondary oil and gas recovery that interferes with neighboring subsurface rights, (2) regulatory approval for subsurface waste injection, and (3) regulatory approval for subsurface natural gas storage. In each of these situations, courts balance private surface interests, private subsurface interests, and the public interest in various ways, based on the resource or use at issue.

These situations, like CO_2 sequestration, are arguably different from the numerous judicial decisions involving subsurface water rights, oil and gas rights, hard-rock mining rights, or coal-bed methane (CBM) gas ownership, which are the other categories of subsurface rights that are regularly litigated today.[186] In those cases, courts are called upon to re-

185. *See, e.g.*, Phillips Petroleum Co. v. Stryker, 723 So. 2d 585 (Ala. 1998); Chance v. BP Chems., Inc., 670 N.E.2d 985 (Ohio 1996); Mapco, Inc. v. Carter, 808 S.W.2d 262 (Tex. App. 1991).

186. For a succinct discussion of how courts have historically resolved ownership disputes in each of these areas, see Sprankling, *supra* note 17, at 1005–13; Elizabeth J. Wilson & Mark A. de Figueire-

solve disputes over who is entitled by common law, statute, or contract (in the case of a conveyance or reservation of mineral or oil and gas interests) to own, extract, or develop a valuable resource. For instance, subsurface water rights require the resolution of multiple and competing claims to a finite and valuable resource—water—that is subject to a complex regulatory regime that differs from state to state, depending on the water availability and needs of that state.[187] In the CBM cases, courts are called upon to determine whether the surface owner, coal owner, or natural gas owner has the right to develop and sell CBM gas under government land patents or private conveyance documents that did not anticipate the technology that recently created a commercial use for CBM gas.[188] Thus, instead of involving the use of *space* in the subsurface, these

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do, *Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law*, 36 Envtl. L. Rep. (Envtl. Law Inst.) 10,114, 10,116–18 (2006).

187. *See* S.W. Sand & Gravel, Inc. v. Cent. Ariz. Water Conservation Dist., 212 P.3d 1, 10 (Ariz. Ct. App. 2008) (holding that water district's right to divert water into a river abutting company's land was not limited by doctrine of non-injurious use, company did not have power to preclude district from diverting water into the river, and company could not prevail on claims for negligence, trespass, nuisance, or inverse condemnation); W. Maricopa Combine, Inc. v. Ariz. Dept. of Water Res., 26 P.3d 1171, 1175 (Ariz. Ct. App. 2001) (holding that statutorily authorized diversion of water over private property was not a government taking or trespass based in part on the fact that "Arizona is an arid desert" and has a "policy predating statehood that encourages the full and beneficial use of scarce water resources"); Alameda County Water Dist. v. Niles Sand & Gravel Co., 112 Cal. Rptr. 846, 853 (Cal. Ct. App. 1974) (denying excavation company's claim for inverse condemnation against water district on grounds that flooding of excavation pit under district's water replenishment program constituted a taking of property and discussing California's rejection of the *ad coelum* doctrine based on the "realities of the underground water situation in California" and its replacement with the "correlative rights doctrine," which limits the rights of each surface owner to reasonable use of percolating waters in correlation with those of other users); Bd. of County Comm'rs v. Park County Sportsmen's Ranch, L.L.P., 45 P.3d 693, 706 (Colo. 2002) (holding landowners did not have a property right under the *ad coelum* doctrine to require that the ranch obtain their consent before recharging aquifer, the ranch was not required to pay compensation, and basing its decision on the "Colorado doctrine," which established that water is a public resource; the right to water includes the right to cross the land of others; and natural, water-bearing formations within the state may be used for the transport and retention of water); McNamara v. City of Rittman, 838 N.E.2d 640, 646 (Ohio 2005) (holding that landowners have a property interest in the groundwater underlying their land and governmental interference with that right can be an unconstitutional taking based in part on Ohio's "unique water resources and water needs"); State v. Michels Pipeline Constr., Inc., 217 N.W.2d 339 (Wis. 1974) (rejecting doctrine of correlative rights because water is not scarce in Wisconsin and adopting an approach modeled on RESTATEMENT (SECOND) OF TORTS § 858 (1977), which places no restrictions on the taking of groundwater so long it is used in a reasonable and beneficial manner on the extractor's land); *see also* RESTATEMENT (SECOND) OF TORTS § 858 (stating a landowner who withdraws groundwater from the land and uses it for a beneficial purpose is not liable for interference with the use of water by another unless the withdrawal unreasonably causes harm to neighboring landowners by lowering the water table or reducing pressure, the withdrawal exceeds the landowner's reasonable share of the annual supply or total supply of groundwater, or the withdrawal of groundwater has a "direct and substantial effect upon a watercourse or lake" and unreasonable causes harm to a person entitled to use of its water); JOSEPH L. SAX ET AL., LEGAL CONTROL OF WATER RESOURCES 364–65 (3d ed. 2000) (summarizing the different legal regimes that states apply to groundwater rights); Wilson & de Figueiredo, *supra* note 186, at 10,117 (discussing various doctrines states have created to resolve property rights disputes over groundwater, including the absolute dominion doctrine, reasonable use doctrine, correlative rights doctrine, Restatement rule, and prior appropriation doctrine).

188. *See* Amoco Prod. Co. v. S. Ute Indian Tribe, 526 U.S. 865, 878 (1999) (holding that surface owner, not tribe holding equitable title to reserved coal in lands patented under Coal Lands Acts of 1909 and 1910, owned CBM gas contained in the coal, based in part on grounds that Congress did not "appear to have given consideration to the possibility that CBM gas would one day be a profitable

cases involve the use of valuable *resources* to be taken from the subsurface for commercial gain. The subsurface water, CBM, and other mineral rights cases involve disputes over ownership of a valuable commodity found within the subsurface rather than disputes over ownership of the subsurface itself, which can be used to store either a waste product (like the underground waste injection cases) or a valuable commodity (like the natural gas storage cases). Said another way, both the subsurface pore space below and the airspace above provide valuable space for competing uses such as airplanes and buildings above and oil, gas, water, and CBM below. As a result, the cases focusing on ownership of the *space* for the resource, commodity, or development may be more helpful than cases focusing on ownership of the resource, commodity, or development itself, although the latter group of cases may still be instructive in some circumstances. For the remainder of this Article, however, we put aside the subsurface water, CBM, and mineral rights cases and focus on judicial decisions in the areas of oil and gas development, underground waste injection, and subsurface natural gas storage.

In cases involving secondary oil recovery and subsurface waste injection, courts have modified the *ad coelum* doctrine and limited surface owner rights to recover for trespass or to establish a taking as a result of federal or state regulation authorizing the invasive activity at issue to promote the public interest.[189] On the other hand, in cases involving subsurface natural gas storage, operators have proceeded under the Natural Gas Act to take subsurface property by eminent domain, thus implicitly recognizing (or at least not expressly challenging) the existence of a protectable property interest deserving of at least some compensation.[190] It is not a stretch for future courts to look to these cases for guidance in defining the rights of surface owners or mineral owners to prevent access to the deep pore space beneath the surface for CO_2 sequestration in the absence of compensation.[191] These cases are discussed below.

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energy source developed on a large scale"); Carbon County v. Union Reserve Coal Co., 898 P.2d 680, 687 (Mont. 1995) (holding CBM gas was not part of the coal estate granted by the county and thus could be severed from the coal estate); U.S. Steel Corp. v. Hoge, 468 A.2d 1380, 1388 (Pa. 1983) (holding that CBM gas belongs to the owner of the coal estate so long as the gas physically remains in the coal itself and does not migrate to surrounding property); Newman v. RAG Wyo. Land Co., 53 P.3d 540, 550 (Wyo. 2002) (holding that deed from landowners to coal operator granting coal and minerals comingled with the coal but reserving all "oil, gas, and other minerals" did not convey the landowners' ownership of CBM gas).

189. *See* Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 11 (Tex. 2008).

190. *See infra* notes 261–62 and accompanying text.

191. Recent white papers and articles have analyzed whether, in the first instance, the surface owner or the mineral owner on split-estate land has property rights in the pore space. While most of these papers and articles conclude that the surface owner would prevail over the mineral owner in most cases, the issue is far from resolved. *See* Anderson, *supra* note 138, at 99–101 (stating that Texas and other jurisdictions have not specifically determined who owns subterranean pore space as between a mineral owner and a surface owner but, based on existing case law and legal doctrine, the most "likely" owner of the pore space is the surface owner); Wilson & de Figueiredo, *supra* note 186, at 10,121–22 (stating that most courts have held that after the removal of underground minerals, oil, or gas, the surface owner retains the right to use the remaining space for storage but that mineral rights holders

1. *Oil and Gas Operations: Secondary Oil Recovery and Field Unitization*

For decades, oil producers have injected fluids into the subsurface to increase oil production from nearly depleted fields.[192] When using waters, this process is known as "secondary recovery," and it adds pressure to the reservoir to enhance oil and gas recovery.[193] Secondary recovery can also result in migration of the injected fluids, or the native oil and gas, to a neighboring oil and gas lease, affecting that owner's ability to recover the resource.[194] Most secondary recovery activities take place in a field that has been "unitized" pursuant to state regulatory board orders.[195] With "field unitization," the oil or gas leases for development are combined, and production and profits are shared by the unit members.[196] For those areas that are not unitized or where neighboring owners have not joined the unit, trespass claims and other disputes arise when secondary recovery operations invade those oil and gas leases that are not part of the unit.[197]

For the most part, courts have rejected claims for trespass in these cases on the grounds that secondary recovery is authorized by state regulation, results in the most efficient recovery of the resource, or otherwise is in the public interest.[198] For instance, in *Railroad Commission of Texas v. Manziel*,[199] the Texas Supreme Court in 1964 rejected a trespass claim by a mineral owner against the Texas Railroad Commission for its approval of a secondary recovery project where the injection of salt water could potentially migrate across the property lines and damage the plaintiff's producing well.[200] In dismissing the claim, the court did not determine whether the injecting operator would be liable for actual damages to the adjoining property or whether the Commission's authorization of such secondary recovery operations would instead throw "a protective cloak" around the injecting operator.[201] Instead, the court decided only the question of "whether a trespass is committed when secondary recov-

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often retain some rights to access the pore space for continued exploration or extraction of minerals in other areas); *see also* DAVID COONEY, IOGCC TASK FORCE ON CARBON CAPTURE AND GEOLOGIC STORAGE, PART 2: ANALYSIS OF PROPERTY RIGHTS ISSUES RELATED TO UNDERGROUND SPACE USED FOR GEOLOGIC STORAGE OF CARBON DIOXIDE (2007) (surveying case law from various states that addresses rights relating to natural gas storage).

192. *See* MAXWELL ET AL., *supra* note 79, at 13–14 (discussing secondary oil recovery technology).

193. Enhanced Oil Recovery (EOR), by contrast, refers to tertiary recovery (often using CO_2) to enhance oil production and recovery. *Id.*

194. SEAN MCCOY, CCSREG PROJECT, POLICY BRIEF: GOVERNING ACCESS TO AND USE OF PORE SPACE FOR DEEP GEOLOGICAL SEQUESTRATION 13 n.17 (2009), http://www.ccsreg.org/pdf/PoreSpace_07132009.pdf.

195. Wilson & de Figueiredo, *supra* note 186, at 10,118.

196. *Id.*

197. *See id.*

198. *Id.* at 10,118–19.

199. 361 S.W.2d 560 (Tex. 1962).

200. *Id.* at 566–69.

201. *Id.* at 566–67.

ery waters from an authorized secondary recovery project cross lease lines."[202] On that question, the court found that "[t]he 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."[203] To apply the general rules of surface invasions would interfere with the public policy considerations behind secondary recovery operations which, the court found, should be encouraged as a matter of "public necessity."[204]

The Alabama Supreme Court reached a similar decision in *Phillips Petroleum Co. v. Stryker*,[205] where secondary recovery through injection of dry gas within a unitized oil and gas field allegedly drained the plaintiff's oil reserves.[206] In reversing a jury award of $26.9 million to the plaintiff based on claims of trespass, negligence, fraud, and nuisance, the court found that to hold the defendant liable in the case would be against the state's policy of promoting secondary recovery in order to prevent oil and gas waste.[207] Instead of suing for damages, the plaintiff should have engaged in his own recovery operations or sought to participate in the unit.[208]

The Louisiana Supreme Court has similarly allowed the public interest in field unitization to trump any absolute property rights. In *Nunez v. Wainoco Oil & Gas Co.*,[209] the court rejected a landowner's trespass claim against a well operator that drilled a well which allegedly bottomed out on the plaintiff's property two miles below the surface.[210] Notably, the plaintiff's property was within a drilling unit created by the Commissioner of Conservation, but the plaintiff had declined to lease his land to a defendant that had received approval for the unit.[211] In rejecting the trespass claim, the court recognized that Louisiana law historically allowed claims of subsurface trespass where a well bottoms out on the land of another without his or her consent.[212] Here, though, the court found that the state's creation of the Conservation Commission and the state policy of ensuring that "an irreplaceable natural resource should not be subjected to avoidable waste" created "a qualification of sorts in one's rights in private property."[213] In light of these statutory developments and the current regulatory structure favoring unitization as the method to reconcile the correlative rights of resource owners in a com-

202. *Id.*
203. *Id.* at 568.
204. *Id.*
205. 723 So. 2d 585 (Ala. 1998).
206. *Id.* at 586–87.
207. *Id.* at 588.
208. *Id.* at 591.
209. 488 So. 2d 955 (La. 1986).
210. *Id.* at 956, 964.
211. *Id.* at 956.
212. *Id.* at 958.
213. *Id.* at 960–62.

mon pool, the court found there was no legally actionable trespass in the case.[214]

The Texas Supreme Court again addressed the ability of a mineral owner to sue for trespass as a result of secondary recovery operations in 2008. In *Coastal Oil & Gas Corp. v. Garza Energy Trust*,[215] the court considered whether a defendant well operator engaging in "fracing" (stimulating a natural gas well by pumping fluid down the well at high pressure in order to create cracks in the rock to allow oil and gas to flow) would be liable for trespass if "proppants" (sand, ceramic beads, or bauxite that follow the fluid and prop open the cracks in the rock) used in the process migrated to the plaintiff's land two miles below the surface and drained the oil and gas from the plaintiff's property.[216] In that case, the plaintiff sought damages equal to the value of the royalty on the gas that would be drained from the land.[217] The court began its discussion by noting that if the defendant had "caused something like proppants to be deposited on the *surface* of [the plaintiff's land], it would be liable for trespass."[218] The court noted, however, that just as the Supreme Court in *Causby* found the *ad coelum* doctrine had no place "in the modern world" with regard to airspace two miles above the ground, the doctrine also no longer applied two miles below the ground.[219] The court then stated that the plaintiff might have a claim for damages if he could show the defendant's fracing operations damaged the plaintiff's wells or the formation beneath his property.[220] The plaintiff could not show that, however, and simply alleged the trespass of proppants would result in gas flowing from the plaintiff's property to the defendant's wells.[221]

The plaintiff's claim, the court found, was prevented by the rule of capture, which holds that the plaintiff does not own the oil and gas under his property until he has "captured" it.[222] Thus, the gas the plaintiff alleged he would lose "simply [did] not belong to him."[223] Instead, his remedy under the rule of capture was to drill an offset well to protect against the drainage or, if that was not effective, to make an offer to pool the re-

214. *Id.* at 963–64.
215. 268 S.W.3d 1 (Tex. 2008).
216. *Id.* at 7, 9.
217. *Id.* at 8.
218. *Id.* at 11.
219. *Id.*
220. *Id.* at 13.
221. *Id.* at 12–13.
222. *Id.* In Texas, "a mineral rights owner has a real interest in oil and gas in place," but that right does not extend to any particular gas beneath the property. *Id.* at 15. Instead, ownership must "be considered in connection with the law of capture which is recognized as a property right." *Id.* (quoting Texaco, Inc. v. R.R. Comm'n, 583 S.W.2d 307, 310 (Tex. 1979)). Today, states where oil and gas are commercially produced are primarily divided by whether they follow the rule of capture or recognize ownership of oil and gas in a manner similar to how they recognize ownership of hard minerals. In practice, however, states have adopted remedial legislation putting oil and gas interests in substantially the same position regardless of which rule is followed. *See* OWEN L. ANDERSON ET AL., HEMMINGWAY OIL AND GAS LAW AND TAXATION 29–36 (4th ed. 2004).
223. *Coastal Oil & Gas Corp.*, 268 S.W.3d at 13.

sources or apply to the Railroad Commission for forced pooling.[224] The court reasoned that "[t]he rule of capture makes it possible for the Commission to enact and enforce rules governing the spacing, density, and allowables of wells, to protect correlative rights of owners with interests in the same mineral deposits while securing 'the state's goals of preventing waste and conserving natural resources.'"[225] Moreover, allowing litigation over recovery for draining resulting in fracing would force judges and juries to make difficult factual determinations based on proof "hidden below miles of rock" and make decisions without taking into account "social policies, industry operations, and the greater good," which are important in determining whether fracing should or should not be against the law.[226] Thus, the court held that subsurface draining of oil and gas through fracing was not actionable in tort, but non-draining damages to wells or the oil and gas formation might be.[227]

In all of these cases, the courts placed great emphasis on the state's statutory policy of encouraging secondary recovery operations to promote the efficient use and development of natural resources, which was in the public interest. The courts focused on the existence of a state regulatory body to balance the needs of the various rights-holders and refused tort recovery for those who declined to participate in unitization or otherwise capture or exploit resources on their lands in a manner consistent with state policy and regulation. Also in these cases, though, there is at least the recognition that future plaintiffs may be able to recover where there is actual damage to a plaintiff's wells, formation, or other tangible property, rather than simply a technical trespass of fluid or other materials. This supports the idea that if there is actual interference with commercial use of the subsurface, some recovery under tort law may be warranted even if the defendant's operations are authorized under state law. This is consistent with case law in other states that allows plaintiffs to be compensated for actual damages resulting from secondary recovery.[228] Allowing recovery in tort for actual damage to property is different, however, than finding the plaintiff in these cases has the type of "property" right in the subsurface that would allow the plaintiff to exclude others from invading the property with fluids, proppants, or other substances in connection with resource development. It is this type of absolute ownership doctrine that courts seem to have rejected in the secondary recovery and field unitization cases and which acts as a potential

224. *Id.* at 14.

225. *Id.* at 14–15 (quoting Seagull Energy E & P, Inc. v. R.R. Comm'n, 226 S.W.3d 383, 389 (Tex. 2007)).

226. *Id.* at 16.

227. *Id.* at 17.

228. *See* Greyhound Leasing & Fin. Corp. v. Joiner City Unit, 444 F.2d 439, 440, 444 (10th Cir. 1971) (granting recovery based on private nuisance for damage caused by salt water encroachment associated with secondary recovery operations); Boyce v. Dundee Healdton Sand Unit, 560 P.2d 234, 238 (Okla. Civ. App. 1975) (granting recovery for nuisance claim for damages caused by water flooding).

precedent in future cases involving sequestration of CO_2 for CCS purposes,[229] particularly in states that now provide for CO_2 unitization.[230]

2. *Underground Waste Injection*

Judicial decisions in the area of underground waste injection also provide helpful precedent in determining the extent to which courts recognize and protect surface owners' rights to the subsurface. Since the 1930s, oil producers have disposed of brine and other oil-producing waste by injecting it underground into deep, subsurface rock formations.[231] Chemical companies began using the process a few decades later to dispose of nonhazardous and hazardous industrial wastes.[232] Today, the EPA and delegated state agencies regulate the underground injection of wastes under the UIC program by creating "classes" of injection wells and setting standards for injection to protect underground sources of drinking water.[233] There are approximately 260 nonhazardous and 120 hazardous waste Class I wells operating in nineteen states, with most injecting at average depths of 1400 meters (4500 feet).[234]

Like in the secondary recovery and field unitization cases, courts faced with attempts by surface owners to prevent waste disposal below the surface of their properties have not been successful without establishing harm to their actual use of that subsurface. For instance, in *Chance v. BP Chemicals, Inc.*,[235] the Supreme Court of Ohio rejected the plaintiff property owners' claims of trespass, strict liability, nuisance, negligence, and fraud for damage allegedly caused by lateral migration of hazardous waste refining products more than 790 meters (2600 feet) below the surface that were produced in connection with the defendant's deep well injection technology.[236] The defendant operated the injection wells pursuant to permits and regulatory practices of both the U.S. EPA and Ohio EPA.[237] As part of their claim, the plaintiffs contended that they owned everything below the surface of their property, including the geologic

229. In these cases, courts can be seen as creating a "liability rule" as opposed to a "property rule" that protects property owners. *See* Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1092 (1972) (reasoning that some entitlements are protected by a "property rule" (i.e., an injunction) which permits violation of the entitlement only with permission of the property owner while other entitlements are protected by a "liability rule" (i.e., damages) which permits violation of the entitlement without permission of the owner so long as the violator pays damages).

230. *See supra* Table 1.

231. *See* U.S. Environmental Protection Agency, Underground Injection Control Program, Basic Information About Injection Wells, http://www.epa.gov/OGWDW/uic/basicinformation.html (last visited Dec. 17, 2009).

232. *Id.*

233. *Id.*

234. *See* Elizabeth J. Wilson et al., *Regulating the Ultimate Sink: Managing the Risks of Geologic CO_2 Storage*, 37 ENVTL. SCI. & TECH. 3476, 3478 tbl.2 (2003).

235. 670 N.E.2d 985 (Ohio 1996).

236. *Id.* at 986–89.

237. *Id.* at 987.

formations into which the hazardous waste was being injected, and that they had the right to exclude the defendants from their properties.[238]

The court began its discussion by noting that even though the defendants were operating pursuant to valid state and federal permits, that in itself did not shield them from liability.[239] In reviewing the plaintiffs' claims for relief, however, the court placed weight on the fact that the plaintiffs had no specific evidence the defendants' wells were causing any problems, only "opinion testimony that problems may arise in the future."[240] That left primarily the trespass claim and the argument that plaintiffs had the right to exclude the injectate from their property under the *ad coelum* doctrine.[241] The court rejected strict application of the doctrine, finding that "ownership rights in today's world are not so clear-cut as they were before the advent of airplanes and injection wells."[242] It found that "[j]ust as a property owner must accept some limitations on the ownership rights extending above the surface of the property . . . there are also limitations on property owners' subsurface rights."[243] Thus, the court found that although the plaintiffs did have a property interest in the subsurface containing the injectate, it was a "potentially limited one."[244] As a result, it rejected the idea of "presumed" damages as would be available in cases of surface trespass, and instead held that there must be some type of physical damage or interference with use for the plaintiffs to recover for subsurface trespass.[245]

In *FPL Farming, Ltd. v. Texas Natural Resource Conservation Commission*,[246] the Texas Court of Appeals conducted a similar analysis when faced with a landowner's claim that the Texas Natural Resource Conservation Commission's grant of two nonhazardous Class I permits for injection of waste 2200 to 2500 meters (7350 to 8200 feet) below the surface into a saline formation under the plaintiff's property constituted a taking of private property without just compensation.[247] First, the Court expressly rejected the *ad coelum* doctrine and refused to accept the plaintiff's argument that migration of the waste plume under the plaintiff's property, without some measure of harm, could constitute a trespass.[248] Instead, it deferred to the Commission's expertise in the geological effects of subsurface migration of injectates and its conclusion in the administrative proceeding below that the injection would not impair

238. *Id.*
239. *Id.* at 990.
240. *Id.*
241. *Id.* at 991.
242. *Id.* at 992.
243. *Id.*
244. *Id.*
245. *Id.* at 993.
246. No. 03-02-00477-CV, 2003 WL 247183 (Tex. App. Feb. 6, 2003).
247. *Id.* at *1.
248. *Id.* at *3–4.

any existing rights and would be in the public interest.[249] Although the plaintiff had testified in the proceedings that it was now prohibited from acquiring its own permit to store saltwater or subsurface waste on its property because of the permit that had already been granted for that area, the court found there was no evidence that the existing permits would hamper the plaintiff's ability to use the deep subsurface in the same manner in the future.[250]

As for the takings claim itself, the court rejected the idea that approval of the injection constituted a "permanent, physical occupation of property" of the type the Supreme Court of the United States held was a per se taking requiring just compensation in *Loretto v. Teleprompter Manhattan CATV Corp.*[251] The court found that *Loretto* did not apply because the plaintiff could not show that migration of the waste plume would prevent it from engaging in a brine mining operation or conducting its own injection well, and thus could not show it had lost the right to use the property.[252] The court concluded, however, that if the waste plume did migrate to the plaintiff's property and did cause harm, the plaintiff could then seek damage from the well operator because, under state statute, the existence of a permit did not relieve a party of civil liability for harm.[253]

Finally, the District Court for the Eastern District of Louisiana reached a similar conclusion in *Raymond v. Union Texas Petroleum Corp.*[254] In that case, the defendant injected saltwater into a disposal well on neighboring property that allegedly migrated and invaded the subsurface of the plaintiffs' property.[255] The plaintiffs did not seek to enjoin the injection or challenge the state-issued disposal permit, but instead sought to be paid rentals for the disposal of saltwater under their land just as one of their neighbors had been paid.[256] In rejecting the trespass claim, the court relied upon the Louisiana Supreme Court's decision in *Nunez*, which held that "traditional property concepts like trespass[] must yield to the important interest of conserving the natural resources of the state."[257] It concluded that based on *Nunez*, there was no legally action-

249. *Id.* at *4.

250. *Id.*

251. *Id.* at *5 (citing Loretto v. Teleprompter Manhattan CATV Corp., 458 U.S. 419, 435 (1982)); *see also infra* Part III.

252. *FPL Farming, Ltd.*, 2003 WL 247183, at *5. Notably, the Supreme Court in *Loretto* found that the property owner need not show actual use of the property in question in order to support a claim for a per se physical taking. *See Loretto*, 458 U.S. at 438 n.16 ("It is constitutionally irrelevant whether appellant (or her predecessor in title) had previously occupied this space, since 'a landowner owns at least as much of the space above the ground as he can occupy or use in connection with the land.'" (citing United States v. Causby, 328 U.S 256, 264 (1946))). Arguably though, the holding in *Loretto* could be read to limit the plaintiff's interest to reasonable occupation of the space in question as opposed to actual occupation.

253. *FPL Farming, Ltd.*, 2003 WL 247183, at *5.

254. 697 F. Supp. 270, 274 (E.D. La. 1988).

255. *Id.* at 271.

256. *Id.* at 273.

257. *Id.* at 274; *see also supra* notes 209–14 and accompanying text.

able trespass, but that *Nunez* did not preclude a landowner from recovering compensation for damage to property or measurable inconvenience.[258] The court found that the rentals paid to the neighbor were compensation for *surface* use of the property and any inconvenience caused by the disposal operations, but that there was no evidence the underground disposal of saltwater damaged the subsurface formation, fresh water, or mineral-bearing strata, or that it caused any surface or subsurface inconvenience to the plaintiff.[259]

The underground waste injection cases—hazardous, nonhazardous, and hydrocarbon associated water—show that courts have rejected any form of the *ad coelum* doctrine when it comes to surface owner efforts to prevent the underground migration of waste on their property in the absence of actual harm when the injection of waste is conducted pursuant to federal or state permits. In each case, the court placed great weight on the public interest and regulatory approval associated with the underground injection of waste products and modified existing doctrines relating to subsurface property rights accordingly. At the same time, however, each of the courts held open the possibility that a plaintiff could recover if it could show actual damage or actual interference with use of either the surface or the subsurface. Thus, the courts refused any absolute property rights in the deep subsurface, but retained limited property rights that would allow surface owners to seek damages or just compensation for a condemnation in case of actual interference or harm.

3. *Subsurface Natural Gas Storage*

The last set of cases relevant to the issue of property rights and CO_2 sequestration are those that have resolved disputes over property rights and the subsurface storage of natural gas. "Natural gas is stored underground in depleted oil and gas reservoirs, salt caverns, or suitable natural aquifers to provide for the increased demand for natural gas during the winter months."[260] Domestic natural gas storage capacity is approximately 230 billion cubic meters (8.1 trillion cubic feet).[261] Under the Natural Gas Act and judicial decisions interpreting the Act, natural gas operators that have obtained a "certificate of public convenience and necessity" from the Federal Energy Regulatory Commission (FERC) have the power of eminent domain to take land and create not only interstate natural gas pipelines, but also associated underground natural gas storage facilities.[262] Not surprisingly, courts have been forced to resolve disputes

258. *Raymond*, 697 F. Supp. at 274.

259. *Id.* at 274–75; *see also* Mongrue v. Monsanto Co., 249 F.3d 422, 425 (5th Cir. 2001) (holding that wastewater injected by defendant on its property that migrated under the plaintiff's property did not constitute a taking without just compensation).

260. Wilson & de Figueiredo, *supra* note 186, at 10,121.

261. *Id.*

262. *See* 15 U.S.C. § 717f(h) (2006); Columbia Gas Transmission Corp. v. Exclusive Gas Storage Easement, 776 F.2d 125, 128 (6th Cir. 1985); Steven D. McGrew, Note, *Selected Issues in Federal Con-*

over ownership and valuation of the pore space in which the natural gas is stored when that pore space also is in potential or actual use by surface owners or mineral rights owners.

As an initial matter, numerous courts have held that after the removal of underground minerals, oil, or gas, the surface owner retains the right to use the remaining space for storage, although mineral rights holders have also been found to have some retained interest in the storage space if they held exploratory rights or constructed the storage space.[263] Thus, in developing natural gas storage rights, natural gas companies often have included both the surface owner and mineral owner in condemnation actions, providing just compensation to both sets of interests.[264] Accordingly, although the rest of this Section refers to disputes between natural gas owners and surface owners, mineral owners may also have subsurface rights that come into conflict with natural gas storage efforts.

Two main types of disputes arise in subsurface natural gas storage cases. The first is where the natural gas company obtains a certificate of public convenience and necessity from FERC and then attempts to contract with the surface owner to obtain the necessary storage rights, and, if they are unable to reach agreement, the company exercises the power of eminent domain to take the subsurface within the area covered by the certificate.[265] In these cases, there may be disputes surrounding valuation of the storage space, but the access rights are settled. The second type of dispute is where the natural gas company fails to obtain all of the storage rights within the area in which it intends to operate, creating a "window" in the storage field.[266] In such a case, the owner of a window property may attempt to sue for trespass once storage operations begin or, when a window owner threatens to drill into the storage field or surrounding area, the gas company may file a condemnation action to prevent the owner from either withdrawing the company's stored gas or damaging the integrity of the storage field.[267] At that point, the window owner may counterclaim for trespass and seek an injunction, compensatory damages, and punitive damages.[268] Courts in these cases have reached mixed conclusions on the issue of property rights.

For instance, landowners in Kansas sued Northern Natural Gas Company asserting claims of trespass and unjust enrichment related to

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demnation for Underground Natural Gas Storage Rights: Valuation Methods, Inverse Condemnation, and Trespass, 51 CASE W. RES. L. REV. 131, 138–41 (2000).

263. *See* Mapco, Inc. v. Carter, 808 S.W.2d 262, 277–78 (Tex. App. 1991); Alan Stamm, *Legal Problems in the Underground Storage of Natural Gas*, 36 TEX. L. REV. 161, 165–68 (1957); Wilson & de Figueiredo, *supra* note 186, at 10,121–22; *see also* Anderson, *supra* note 138, at 105–06 (discussing *Mapco* and how far its holding extends).

264. Wilson & de Figueiredo, *supra* note 186, at 10,122.

265. *See* McGrew, *supra* note 262, at 138–40.

266. *See* Wilson & de Figueiredo, *supra* note 186, at 10,122.

267. *Id.*

268. *See* McGrew, *supra* note 262, at 142.

the migration of gas to the Simpson formation underlying their land.[269] A federal jury "found in favor of the landowners on both claims and awarded $100.00 per acre as fair rental value of the property for the period in question."[270] By contrast, in a Michigan case, the federal district court held that the underground movement of native gas from the company's storage field to the area under the plaintiffs' property was not the type of physical intrusion that would support a claim for inverse condemnation, particularly without a showing of actual harm.[271]

This precedent raises the issue of whether a landowner always has a property interest in the subsurface sufficient to require the gas company to condemn the subsurface rights prior to using it for gas storage, and, if the company fails to do so, whether the surface owner can sue for trespass and seek not only compensatory damages (if any) but also punitive damages based on the technical trespass.[272] The gas company could certainly argue that just as courts have recognized that surface owners have no absolute rights to the airspace above their property, they should have no absolute rights to the subsurface below their property. While as a practical matter natural gas companies have generally paid the surface or mineral owner for the subsurface space necessary to store the gas, that does not mean there are not arguments against the existence of subsurface property rights in this context that are available based on the unitization and waste injection cases.[273]

D. Conclusion

Based on the analysis in the preceding Sections, there are two main themes in the cases that may be relevant to subsurface sequestration of CO_2 in connection with CCS. First, as shown in the oil and gas development and underground waste injection cases,[274] a federal or state regulatory program can authorize some invasions of the subsurface and can serve to protect against claims of takings or trespass when the invasion is

269. Beck v. N. Natural Gas Co., 170 F.3d 1018, 1021 (10th Cir. 1999).

270. *Id.*

271. ANR Pipeline Co. v. 60 Acres of Land, 418 F. Supp. 2d 933, 940 (W.D. Mich. 2006).

272. *See id.* at 946 (discussing claims for damages in subsurface trespass cases); Alexandra B. Klass, *Punitive Damages and Valuing Harm*, 92 MINN. L. REV. 83, 105–07 (2007) (discussing availability of punitive damages in surface trespass cases). To the extent a property is in split estate, and the natural gas storage interferes with the mineral rights owner's ability to develop the oil or gas, then the mineral rights owner may also have a claim for trespass or a right to just compensation resulting from condemnation.

273. *But see* McGrew, *supra* note 262, at 176–79 (arguing that surface owners should be able to sue for trespass when natural gas companies fail to use condemnation authority to obtain storage rights and thus recognizing an inherent property right regardless of any showing that the owner had an alternative reasonable use for the storage space).

274. *See* Raymond v. Union Tex. Petroleum Corp., 697 F. Supp. 270 (E.D. La. 1988); Phillips Petroleum Co. v. Stryker, 723 So. 2d 585 (Ala. 1998); Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955 (La. 1986); Chance v. BP Chems., Inc., 670 N.E.2d 985 (Ohio 1996); Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1 (Tex. 2008); R.R. Comm'n of Tex. v. Manziel, 361 S.W.2d 560 (Tex. 1962); FPL Farming, Ltd. v. Tex. Natural Res. Conservation Comm'n, No. 03-02-00477-CV, 2003 WL 247183 (Tex. App. Feb. 6, 2003).

incidental, the landowner had an opportunity to participate in the regulatory program, or the landowner cannot show actual harm to its use or enjoyment of the surface or subsurface. Thus, while courts have rejected any absolute rights to the subsurface on the part of the landowner, they have retained limited landowner rights to use and exploit the subsurface and recover for actual harm caused by subsurface invasions.[275] In many ways, this is similar to what courts have done with airspace rights near the surface, as opposed to airspace rights miles above.[276] In recent years, courts have been quite willing to allow landowners to sue for trespass and nuisance when airborne particles and pollution invade the landowner's airspace and cause harm.[277] While landowners cannot sue for just any invasion of particles, courts routinely allow such suits upon a showing of harm.[278] Thus, in the airspace pollution cases, the court looks to see whether the invasion is actually interfering with the plaintiff's use and enjoyment of the property and has caused actual harm.[279] In the subsurface invasion cases, as shown above, the courts are looking at almost precisely the same factors and reaching similar conclusions.[280] Second, Congress has chosen to recognize some property rights in the subsurface for takings purposes in the natural gas storage cases by setting up a statutory system, whereby natural gas companies are given authority to take subsurface storage space by eminent domain and pay just compensation if a voluntary contractual agreement cannot be reached.[281] In doing so, Congress chose not to declare a "public highway" in the subsurface or otherwise limit private interests in the subsurface.

How then should this precedent apply to the subsurface sequestration of CO_2? We conclude that there are multiple approaches to property rights courts and policymakers can pursue based on this precedent, ranging from (1) recognizing very limited private property rights in subsurface pore space and requiring compensation only in cases of actual harm or where ongoing economic uses in the subsurface are destroyed; (2) recognizing private property rights in subsurface pore space in cases where there is ongoing use of the subsurface or such use is reasonably foreseeable; and (3) recognizing private property rights in the subsurface

275. *See supra* note 274.

276. *See* United States v. Causby, 328 U.S. 256 (1946).

277. *See, e.g.*, Davis v. Georgia-Pacific Corp., 445 P.2d 481, 483 (Or. 1968) (holding that intrusion of fumes, gases, and microscopic particles on the property of another can constitute a trespass in addition to a nuisance); JAMES A. HENDERSON, JR. ET AL., THE TORTS PROCESS 402–03 (7th ed. 2007) (discussing how some courts have allowed claims for trespass, in addition to nuisance, for claims based on the intrusion of smoke, gases, or odors).

278. *See* HENDERSON ET AL., *supra* note 277, at 386, 389 (discussing requirement of harm to prevail on claims for nuisance and unintentional trespass with no showing of harm required for intentional trespass cases); *see also* RESTATEMENT (SECOND) OF TORTS §§ 826–829A (1977) (setting forth harm component of nuisance claim).

279. HENDERSON ET AL., *supra* note 277, at 400–01.

280. *See supra* note 229 and accompanying text (discussing courts' use of a "liability rule" rather than a "property rule" in these cases).

281. *See supra* note Part II.C.3.

in all cases, regardless of use or reasonably foreseeable use, with the only remaining question being the value of the property for purposes of determining just compensation.[282]

1. Limited Private Property Rights in the Subsurface

As shown above, numerous courts have held that a surface owner's interest in the subsurface is "limited" at best, relying on *Causby* and other cases limiting the surface owner's rights to control the airspace.[283] Arguably, even if states expressly provide by statute that a surface owner has a property right in the pore space, as Wyoming, North Dakota, and Montana have done, such a state-created property interest may be limited by the judicial application of *Causby* to subsurface rights that places "objective" limits on rights to the subsurface.[284] In other words, the argument would be that just as Wyoming could not vest in surface owners the right to the airspace far above their property as a result of the objective, background principles expressed in *Causby*, Wyoming cannot vest in surface owners the right to the deep subsurface as a result of courts' application of *Causby* to the subsurface.[285]

This argument would be consistent with a 2008 article by John Sprankling in the *UCLA Law Review* entitled *Owning the Center of the Earth*.[286] In that article, Sprankling takes the position that private property rights to land should not extend more than 300 meters (1000 feet) below the surface of the earth, and the subsurface beneath that threshold should belong to the federal government.[287] The article did not focus on CCS specifically but instead focused on the issue of subsurface ownership in connection with today's technological ability to develop various energy and climate change technologies, including CCS and enhanced geothermal systems, that must make use of the subsurface in ways not contemplated in the past.[288] Sprankling contends that based on case law involving subsurface water, oil and gas development, and hazardous waste injection, among others, American law has never determined whether a landowner's rights extend more than two miles below the surface and that even case law within two miles of the surface is largely inconsistent.[289] He then concludes that property owners should have some rights below the surface to accommodate foundations, trees, and other

282. With the third option, for many properties just compensation may be zero because there is no value lost to the surface owner. *See, e.g.*, Brown v. Legal Found. of Wash., 538 U.S. 216, 240 (2003) (holding that the state's taking of private property did not violate the Fifth Amendment because the value of the property, measured by the owner's pecuniary loss, was zero).

283. *See, e.g.*, Chance v. BP Chems. Inc., 670 N.E.2d 985, 992 (Ohio 1996); *supra* Part II.

284. *See* Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 11 (Tex. 2008); *Chance*, 670 N.E.2d at 992; *see also supra* notes 131–39.

285. *See supra* Part II.A.

286. Sprankling, *supra* note 17.

287. *Id.* at 982.

288. *Id.* at 1029–32.

289. *Id.* at 1020.

normal surface facilities, but those rights should not extend more than 1000 feet below the surface.[290] Following that argument, Congress could enact legislation declaring a "public highway" in the subsurface at a specified depth below the surface of the earth just as has been done with navigable airspace.[291] Such action could establish a system for compensating for existing uses of the subsurface below that depth (or existing rights or leases that have already been conveyed) and cut off the establishment of future private property rights and expectations going forward.[292] While such an approach would certainly facilitate the development of CCS by reducing acquisition costs associated with subsurface pore space, it would almost just as certainly invite takings challenges, creating uncertainty surrounding total costs of CCS implementation and leaving the issue for the courts.

2. *Property Rights in the Subsurface Based on Existing Use and Reasonable Investment-Backed Expectations*

While limiting subsurface property rights has appeal as a means to facilitate new technologies like CCS, it arguably fails to recognize the realities of how the subsurface has historically been used and is used today. As discussed in Part III, in many regions of the country, subsurface property rights below 1000 feet are used, bought, sold, condemned, and valued. Underground activities at depths below 1000 feet, or roughly 300 meters, include coal production; oil and natural gas exploration, production, and storage; produced waters injection; hazardous and municipal waste water injection; and potentially aquifer storage and recovery and compressed air storage.[293] Congress has chosen to implicitly recognize those property rights under some circumstances through the eminent domain provisions of the Natural Gas Act, and courts have recognized those rights by allowing for claims of trespass and nuisance in cases of actual interference or harm.[294] Courts also have created mechanisms to determine just compensation when subsurface areas are needed for a public use such as natural gas storage.[295] Thus, the country's history of the use of the subsurface is in fact different than its use of airspace.

Moreover, there is a two-fold problem with a declaration that surface owners have no more property rights in the deep subsurface than they have in airspace. First, even though there may be federal background principles (e.g., *Causby*) that would prevent the vesting of prop-

290. *Id.* at 1026–28, 1031.

291. *See* 42 U.S.C. § 171 (2006).

292. Sprankling does recognize the potential need to acknowledge and honor "all existing rights to extract specific valuable minerals, at least to the extent appropriate to ensure a reasonable return on prior investments." Sprankling, *supra* note 17, at 1037–38.

293. *See supra* Part I.B.

294. *See supra* note 262 and accompanying text.

295. *See* Columbia Gas Transmission Corp. v. Exclusive Natural Gas Storage Easement, 962 F.2d 1192, 1199 (6th Cir. 1992).

erty rights in the airspace other than those used in connection with the surface, the same is far less true with regard to the subsurface.[296] To date there has been no federal declaration of a "public highway" in the subsurface as there has been with airspace, and any future declaration along those lines would come into conflict with vested economic interests in the subsurface in many areas of the country.[297] Economic use of the subsurface may end at a certain depth, for instance, any deeper than necessary for existing and future natural gas storage, waste injection, and oil and gas exploration. But to the extent that CO_2 sequestration will be at depths that are currently subject to existing or reasonably foreseeable economic use (and it appears that it will be),[298] there do not appear to be any background principles of statutory or common law that would prevent states from vesting those property rights in surface owners or mineral owners if they choose to do so, or preventing courts from recognizing such rights as a matter of common law or constitutional law.[299]

Second, to the extent CO_2 sequestration occurs at the same depths and in the same locations as natural gas or other storage, there may be circumstances where the surface owner (or mineral owner) can no longer use the subsurface for any other economic purpose. When analyzing a physical taking, the size and scope of the physical invasion is immaterial to whether a taking has occurred.[300] Thus, some precedent would appear to support the idea that CO_2 sequestration, at least at depths that are at the same level as existing uses or those uses subject to reasonable, investment-backed expectations (for instance, a property owner with a state or federal permit to develop or use the deep subsurface for natural gas storage or waste injection but where the activity has not yet occurred) would interfere with a protectable property interest.[301] This argument would be even stronger in states like Wyoming that have expressly vested subsurface pore space rights in the surface owner or the mineral owner.

An approach based on existing and reasonably foreseeable subsurface uses would likely result in the existence of subsurface property rights in some regions of the country but not in others, based on whether the geology is suitable for CO_2 sequestration and whether that might compete with oil and gas development, natural gas storage, and the like.

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296. *See* Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1029 (1992) (looking to "background principles" of the state's law of property and nuisance as an exception to the per se takings rule for regulations that deprive a landowner of all economic use of property); Bair v. United States, 515 F.3d 1323, 1327–28 (Fed. Cir. 2008) (recognizing that "state-created property interests may be limited by federal laws" and that federal law can constitute "background principles" that can prevent a per se takings claim).

297. *See supra* text accompanying notes 293–95 (discussing difference in historic use of airspace and historic use of subsurface).

298. *See supra* Part II.

299. *See Lucas*, 505 U.S. at 1029 (discussing "background principles").

300. *See* Tahoe-Sierra Pres. Council, Inc. v. Tahoe Reg'l Planning Agency, 535 U.S. 302, 322 (2002).

301. *See, e.g., id.*

Recognizing subsurface property rights based on existing and reasonably foreseeable use would provide a middle ground approach to property rights that makes CCS somewhat more expensive to implement but would also recognize, value, and compensate for competing economic uses, both those in existence and those that are subject to reasonable, investment-backed expectations. Under such an approach, CCS legislation could create a presumption of no property interest in the deep subsurface, but allow property owners to rebut that presumption with evidence of existing uses or reasonable, investment-backed expectations to establish a property interest.[302]

3. *Expansive Private Property Rights in the Subsurface*

Last, an approach that applies *Loretto* squarely to subsurface property rights could arguably result in a determination that all surface owners (or in some cases mineral owners) have a private interest in subsurface pore space. Such a property interest would not be limited by the amount of space at issue, whether the owner had used the space in the past, or whether there are reasonably foreseeable future uses.[303] Instead, existing and reasonably foreseeable use would be relevant only in determining the amount of just compensation due.[304] As a legislative matter, this would be similar to what Congress has done with the Natural Gas Act, namely, assuming the existence of private property in the subsurface that operators must acquire through contractual agreements or by eminent domain with payment of just compensation. This would likely result in more money needed to acquire the pore space necessary for CO_2 sequestration and an administrative structure to address a larger number of claims than would exist under the other two options because there will be more potential claimants. The nature and extent of the money and infrastructure necessary will depend on how widely CCS is deployed and how central it becomes to our future approach to limiting GHG emissions. On balance though, the case for a direct application of *Loretto* to the subsurface, without any of the qualifications and limitations that exist in the case law governing trespass associated with oil and gas and waste injection operations, seems to expand property rights in the deep subsurface beyond what is legally supportable or necessary to protect existing subsurface interests. Indeed, it is possible to theorize that just as *Causby* confirmed that federal legislation cut off property interests in the higher airspace, legislation authorizing the use of the deep subsurface for CO_2 sequestration could similarly cut off property interests in the deep sub-

302. *See, e.g.*, MCCOY, *supra* note 194, at 1 (proposing a regulatory structure for CO_2 sequestration that provides notice and a window of time for property owners to assert claims associated with existing or near-term economic use of the subsurface but that any interests not asserted within that time frame be subject to CO_2 storage without compensation).

303. *See* Loretto v. Teleprompter Manhattan CATV Corp., 458 U.S. 419, 436–38 (1982).

304. For a discussion of approaches to determine value and just compensation, see *infra* Part III.C.

surface, except in connection with those uses that are currently in existence or subject to reasonable, investment-backed expectations.

III. CO_2 SEQUESTRATION AND TAKINGS

Now that we have explored a range of options with regard to defining property rights in Part II, we turn in this Part to the issue of takings. Even under the most restrictive option with regard to recognizing subsurface property rights discussed in Part II, any widespread implementation of CCS will likely implicate at least some protectable property interests in the portions of the country where there are existing economic uses of the subsurface at depths where CO_2 sequestration is proposed. Building off that premise, this Part discusses a range of issues relating to physical takings and regulatory takings in the context of subsurface CO_2 sequestration. With regard to a physical taking, as explained in Part II, the first question is whether the landowner (or mineral owner) has a sufficient interest in the subsurface pore space to implicate the Takings Clause.[305] Assuming that is the case, a physical taking could occur if a private or government CCS operator (1) injects CO_2 directly into the subsurface underlying the owner's property for permanent sequestration or (2) injects the CO_2 nearby in such a manner that CO_2 or displaced brine migrates and permanently invades the pore space underlying the landowner's property. Under those circumstances, a court would be called on to determine whether such actions constitute a permanent, physical occupation of that property, which would require just compensation for any reduction in property value. As for regulatory takings, there may be some circumstances where there is no physical injection of CO_2 under the landowner's property and no migration from a neighboring sequestration basin, but the federal or state regulatory authority has enacted regulations that prevent the landowner or mineral owner from conducting a range of subsurface operations relating to oil and gas development or natural gas storage in order to ensure the integrity of a nearby CO_2 sequestration basin. Section A considers the issue of physical takings, and Section B addresses regulatory takings.

A. Physical Takings

To the extent there are at least limited private property rights in subsurface pore space, any action by the government or private parties to inject and sequester large amounts of CO_2 in that pore space could be a per se physical taking requiring just compensation. In *Loretto v. Manhattan CATV Corp.*, the Court held that a state law requiring landlords to allow television cable companies to place cable facilities in their apartment buildings constituted a taking, even though the facilities occupied

305. *See supra* Part II.

at most only one and one-half cubic feet of the landlord's property.[306] In its analysis, the Court found the cable legislation's purpose—to promote rapid development of communication—was in the public interest, but held that the state action authorizing the permanent invasion of private land by a third party so frustrated the property interest that a taking had occurred.[307] Even though the just compensation owed to the plaintiff was ultimately determined to be only one dollar,[308] the decision is significant in its ruling that any regulation that results in a permanent physical invasion or occupation, no matter how small and without regard to the owner's historic use of the property, constitutes a per se taking.[309] Moreover, both before and after *Loretto*, the Court has distinguished between a "permanent" physical invasion, which will always constitute a taking, and a temporary physical invasion, which will sometimes (but not always) constitute a taking.[310]

The Court has held many things to be a physical intrusion on land (e.g., telephone lines, pipes, and rails), but these are typically concrete invasions of the surface estate.[311] Likewise, in the context of water rights, the Court has found in some circumstances that diversion of water onto or away from the plaintiffs' property to accomplish public purposes—such as supporting the war effort or building dams—can constitute a per se physical taking requiring just compensation.[312] Is the injection and se-

306. *Loretto*, 458 U.S. at 438.

307. *Id.* at 425.

308. *See* Loretto v. Teleprompter Manhattan CATV Corp., 446 N.E.2d 428, 435 (N.Y. 1983) (sustaining compensation for the taking at one dollar).

309. *Loretto*, 458 U.S. at 437–38.

310. *Id.* at 428 ("Since these early cases, this Court has consistently distinguished between flooding cases involving a permanent physical occupation, on the one hand, and cases involving a more temporary invasion, or government action outside the owner's property that causes consequential damages within, on the other. A taking has always been found only in the former situation."); *see also* City of St. Louis v. W. Union Tel. Co., 148 U.S. 92, 99 (1893) (holding the installation of telephone poles are in the public interest but noting that the action "effectually and permanently dispossesses the general public as if it had destroyed that amount of ground"); McKay v. United States, 199 F.3d 1376, 1381–83 (Fed. Cir. 1999) (holding that the installation by federal agencies of groundwater monitoring wells extending into the plaintiffs' mineral estate for several years interfered with their mining prospects because it was a physical occupation of private property by the government, and distinguishing other cases involving test hole borings which did not interfere with the mineral estate and were discrete, transitory invasions rather than a permanent invasion).

311. *Loretto*, 458 U.S. at 430 ("Later cases, relying on the character of a physical occupation, clearly establish that permanent occupations of land by such installations as telegraph and telephone lines, rails, and underground pipes or wires are takings even if they occupy only relatively insubstantial amounts of space and do not seriously interfere with the landowner's use of the rest of his land.").

312. *See* Dugan v. Rank, 372 U.S. 609, 620–21 (1963) (holding that federal construction of dam that resulted in diversion of plaintiffs' riparian water rights used for irrigation was a physical taking); United States v. Gerlach Live Stock Co., 339 U.S. 725, 752 (1950) (same); Int'l Paper Co. v. United States, 282 U.S. 399, 404–05, 408 (1931) (holding U.S. requisition order diverting all the hydroelectric power of the Niagara Falls Power Company to increase power production for third-party use in connection with war effort constituted a taking of water from International Paper, which had a lease for a portion of that water). *But see* Hudson County Water Co. v. McCarter, 209 U.S. 349, 357–58 (1908) (holding that New Jersey statute that barred a company with riparian water rights from diverting water was not a taking because state law did not create any rights to the diversion). Outside the context of land, the Court has found that a state requirement that interest on certain lawyer trust accounts be

questration of CO_2 in the deep subsurface comparable to these other physical occupations? Certainly, the occupation of the subsurface appears to be "permanent" in that there is an expectation the CO_2 will remain in the subsurface for hundreds to thousands of years. On the other hand, following the reasoning of the secondary recovery and underground waste injection cases, one can argue that placing an odorless, colorless gas nearly a mile below the surface is less like the tangible, physical invasion of a cable wire, telephone line, or water, and is therefore less likely to so completely "frustrate" the owner's interest in either the surface or mineral estate in the absence of actual harm. The rejoinder to that, of course, is that storage of massive amounts of CO_2 below the surface of earth may pose different risks, and certainly more uncertain risks, to surface owners than does the more tangible placement of various cables, telephone lines, or impounded water on the surface.

Ultimately, the question may come down to the property owner's reasonable expectations with regard to the subsurface. Currently, there is no reasonable expectation among property owners that they can control the airspace far above their property as they can the surface of their property. Is the same true with regard to the subsurface? For many property owners, it is, as they have never expected to use and control the subsurface in the same way as the surface of their property. For other surface and mineral owners, however, they are already making economic use of the subsurface at the same depths as proposed CO_2 sequestration, or such uses are subject to reasonable, investment-backed expectations. These property owners may have stronger arguments to support a claim that there is a physical taking of those rights if the government acts to place CO_2 in that subsurface in perpetuity.

Likewise, a surface owner or mineral owner affected not by the injected CO_2, but by the associated displaced brines from nearby CO_2 sequestration, might have a similar physical takings claim. In such a case, however, the owner may need to show actual or reasonably foreseeable interference with use of the subsurface, and that the displaced brines are sufficiently tied to the government authorization or are a reasonably foreseeable consequence of the government action.[313] While the Court has found the permanent flooding of the surface to be a physical taking,[314] it is unclear whether the same analysis would apply to underground flooding or migration of subsurface waters, particularly based on the oil and gas and underground waste injection cases discussed in Part II. Thus, where such an invasion from nearby CO_2 sequestration operations occurs and where no economically valuable resources are affected, there may be no physical taking. If, however, displaced brines actually interfere with

transferred to a foundation for law-related charitable and educational purposes was a physical taking akin to the rooftop space taken in *Loretto*. Brown v. Legal Found. of Wash., 538 U.S. 216, 235 (2003).

313. *See, e.g.*, Jan G. Laitos & Elizabeth H. Getches, *Multi-Layered, and Sequential, State and Local Barriers to Extractive Resource Development*, 23 VA. ENVTL. L.J. 1, 26–29 (2004).

314. *See supra* note 310 and accompanying text.

existing and reasonably foreseeable subsurface operations, such an invasion may constitute a physical taking, resulting in just compensation as well as any actual damages. As mentioned above, Congress could establish a presumption that CO_2 sequestration does not constitute a physical taking but then give property owners the opportunity to rebut that presumption by showing interference with actual economic use of the subsurface or interference with reasonable, investment-backed expectations with regard to the subsurface.

B. Regulatory Takings

As stated earlier, even if there is no physical occupation of private property, a regulatory taking can occur if government regulation places too great a burden on the owner's use of the property. A regulatory taking can take place under two circumstances. First, a regulatory action can be a per se taking just like a physical occupation when the regulation completely deprives an owner of all reasonably beneficial use of her property.[315] In the absence of a complete deprivation of all economic use of the property, courts generally consider whether the regulatory restriction has risen to the level of a compensable taking under the multifactor balancing test set out in *Penn Central Transportation Co. v. New York City*,[316] which considers (1) the character of the government action; (2) the severity of the economic impact; and (3) the extent to which the regulation interferes with the property owner's distinct, "investment-backed" expectations.[317]

Although it is uncertain at this point what regulations governing subsurface CO_2 sequestration will look like, it is highly likely that CCS implementation will be accompanied by regulations prohibiting certain activities that might interfere with the safety and permanent sequestration of CO_2 in a given basin. Notably, surface and mineral estate owners both within the sequestration basin area and near the basin area might be limited in their ability to drill through the confining layer in such a way that penetrates or compromises the CO_2 sequestration area. Thus, the first question is whether such a regulatory prohibition would deprive a surface owner or mineral owner of all economic value of the property. If not, the next question is whether under the *Penn Central* balancing test the extent of the deprivation unreasonably interferes with the owner's distinct, investment-backed expectations for economic use of that property.

To answer these questions, it is necessary to consider the nature of the property interest. If a court were to determine that the pore space is

315. *See* Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1029 (1992) (holding regulations that prohibit all economically beneficial use of land require compensation just as if it were a permanent physical occupation of land).

316. 438 U.S. 104 (1978).

317. *Id.* at 124.

a property interest separate and distinct from either the surface interest or the mineral interest, it would be possible to conclude that regulations restricting use of or access to that pore space would be a complete deprivation of economic use, resulting in a per se taking.[318] The Supreme Court precedent in this area is somewhat mixed, particularly in the area of subsurface rights that have arisen with regard to the regulation of coal mining operations.

For instance, in *Pennsylvania Coal Co. v. Mahon*,[319] the plaintiffs owned the surface rights under their home but not the mineral rights, which had been severed and conveyed to the defendant coal company.[320] A state law, the Kohler Act, prohibited the mining of anthracite coal within city limits in such a manner as would cause the subsidence of any dwelling or other building.[321] When the plaintiffs sued to enjoin further mining of coal under their property pursuant to the Kohler Act, the defendant contended application of the law amounted to an unconstitutional taking of its property (the coal) without just compensation.[322] In an opinion by Justice Holmes, the Court found that application of the law was a taking.[323] In reaching the decision, Justice Holmes balanced the extent of the defendant's deprivation against the private interest of the homeowners rather than the state's interest in preventing a public nuisance, which had been a defense to similar regulatory takings claims in the past.[324] The Court found that the extent of the deprivation was "great" because the law purported to abolish the entire "support" estate in coal—a separately defined estate under state law.[325] The Court concluded with its now-famous line, stating that "while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking."[326]

Several decades later, however, in *Keystone Bituminous Coal Ass'n v. DeBenedictis*,[327] the Court revisited the issue of subsurface takings related to the regulation of coal mining in Pennsylvania, but reached a different result. In *Keystone Bituminous*, coal companies challenged the Pennsylvania Subsidence Act, which required 50 percent of the coal be-

318. *See Lucas*, 505 U.S. at 1029.
319. 260 U.S. 393 (1922).
320. *Id.* at 394–95.
321. *Id.* at 412–13.
322. *Id.* at 412.
323. *Id.* at 414 ("To make it commercially impracticable to mine certain coal has very nearly the same effect for constitutional purposes as appropriating or destroying it.").
324. *Id.* at 413 (focusing on the fact that this is a case "of a single private house" and not a public nuisance); *id.* at 417–18 (Brandeis, J., dissenting) (stating that Kohler Act did not work an unconstitutional taking of property because the restriction "is merely the prohibition of a noxious use" and citing precedent that such legislation is not a taking even if it deprives the owner of all economic use of the property).
325. *Id.* at 414; JESSE DUKEMINIER ET AL., PROPERTY 989 (6th ed. 2006) ("Pennsylvania law recognizes three separate estates in mining property: in the surface, in the minerals, and in support of the surface.").
326. *Mahon*, 260 U.S. at 415.
327. 480 U.S. 470 (1987).

neath surface structures to be left in place to provide surface support.[328] In finding that the law did not result in an unconstitutional taking, the Court distinguished *Mahon* and applied the *Penn Central* balancing test.[329] In finding that *Mahon* did not apply, the Court focused on the important public purpose of the law in promoting public health and safety and found that when balanced against the extent of deprivation, the regulation did not go "too far" and did not result in a taking.[330]

More important, departing from *Mahon*, the Court refused to consider the support estate as a separate estate in property in determining the extent of the deprivation.[331] The Court found that the 27 million tons of coal owned by the plaintiffs that would need to be left in place under the law did not "constitute a separate segment of property for takings law purposes."[332] Instead, the regulation limiting the extraction of coal was no different than a requirement that a building occupy no more than a specific percentage of the lot on which it is located; zoning setback requirements; the Court's decision in *Penn Central* itself, which refused to sever the company's "air rights" from the remainder of its property; or other restrictions in the public interest that place limits on the property owner's right to make profitable use of some segments of his or her property.[333] Relying on the lower court's decision, the Court reasoned that even though Pennsylvania law recognized the support estate as a separate property interest, that estate could not be used profitably by one who does not also possess either the mineral estate or the surface estate, and thus it must be considered together with those other estates for purposes of conducting the takings analysis.[334]

Since the decision in *Keystone Bituminous*, the Court has continued to struggle with how to define property interests for purposes of determining whether a regulation works a complete elimination of economic use of property resulting in a per se taking, as well as for determining the extent of deprivation under the *Penn Central* balancing test.[335] In *Lucas v. South Carolina Coastal Council*,[336] the Court announced its controversial per se regulatory takings rule in cases where the government denies all economic use of property unless "background principles" of nuisance and property law would have precluded the activity in question.[337] Since *Lucas*, however, the Supreme Court and lower courts generally have declined to apply the per se regulatory takings rule. Instead, courts either

328. *Id.* at 476–77.
329. *Id.* at 481–82.
330. *Id.* at 485–93.
331. *Id.* at 501.
332. *Id.* at 498.
333. *Id.* at 498–99.
334. *Id.* at 501.
335. DUKEMINIER ET AL., *supra* note 325, at 989, 1022 (discussing continuing uncertainty over the idea of "conceptual severance" in regulatory takings jurisprudence).
336. 505 U.S. 1003 (1992).
337. *Id.* at 1028–32.

have declined to sever property interests in space or time in a way that would result in a denial of all economic value of the property, or relied on the "background principles" exception in *Lucas* to uphold the regulation in question.[338] In sum, although the Court has been less than consistent in its approach to this issue, the trend among courts in recent years appears to be away from allowing the property owner to define discrete rights in property in either time or space in a way that favors per se regulatory takings claims.

In the context of CO_2 sequestration, it would appear to be very difficult for a surface owner or mineral owner to show that a regulatory restriction or even outright prohibition on deep subsurface use would eliminate all economically beneficial use of the property and result in a per se regulatory taking under *Lucas*. With regard to severance, while the authority in the area would seem to argue against the idea that a "pore estate" could be reasonably severed from the rest of the surface or mineral estate for purposes of a federal takings analysis, state laws in Montana and Wyoming now allow for such severance.[339] For extraction operations, the pore space contains the extractable resource. This relationship is not unlike that in *Keystone Bituminous*, where the Court determined the support estate had value only with regard to its relation to the other estates.[340] Although recent lower courts have split over whether coal bed methane gas is part of the coal estate or the surface estate, all courts have held it to be part of one or the other, at least with regard to disputes between surface owners and mineral owners.[341] Indeed, even if one accepts severability for related resources that can be physically separated, it is even more difficult to assert that the pore space should be separated

338. *See, e.g.*, Tahoe-Sierra Pres. Council v. Tahoe Reg'l Planning Agency, 535 U.S. 302 (2002) (holding that moratorium imposed on development as part of land use planning was not a per se taking on grounds that after moratorium was lifted, claimants could pursue their development rights); Esplanade Props., LLC v. City of Seattle, 307 F.3d 978 (9th Cir. 2002) (holding that city's denial of a shoreline development permit application was not a taking based on the "background principles" of Washington law, which restricted the type of development at issue under the public trust doctrine); Palazzolo v. Rhode Island, No. WM 88-0297, 2005 WL 1645974 (R.I. Super. Ct. July 5, 2005) (finding that state's denial of permit to fill eighteen acres of salt marsh was not a per se taking based on background principles of state law including the public trust doctrine); *see also* DUKEMINIER ET AL., *supra* note 325, at 1022 (finding that state courts generally appear to reject conceptual severance and instead consider the impact of land use regulation on a property owner's entire parcel rather than its impact on just the regulated part, but noting that the Court of Federal Claims and Federal Circuit often tend to go in the opposite direction); Michael C. Blumm & Lucus Ritchie, Lucas*'s Unlikely Legacy: The Rise of Background Principles as Categorical Takings Defenses*, 29 HARV. ENVTL. L. REV. 321, 325–26 (2005) (discussing *Lucas* and arguing that courts have interpreted the "background principles" of nuisance and property law expansively to avoid per se regulatory takings claims).

339. *See supra* Table 1.

340. Keystone Bituminous Coal Ass'n v. DeBenedictis, 480 U.S. 470, 501 (1987).

341. *Compare* Carbon County v. Union Reserve Coal Co., 898 P.2d 680, 687 (Mont. 1995) (holding that coalbed methane was not a constituent part of the coal), Harrison-Wyatt LLC v. Ratliff, 593 S.E.2d 234, 238 (Va. 2004), *and* Newman v. RAG Wyo. Land Co., 53 P.3d 540, 545 (Wyo. 2002) (holding CBM was not a mineral mined in association with coal but rather a separate process), *with* Vines v. McKenzie Methane Corp., 619 So. 2d 1305, 1308 (Ala. 1993). *See also* Laitos & Getches, *supra* note 313, at 6.

from the rock formation as there quite literally is no "pore" without the surrounding rock.

If, however, the surface estate and mineral estate are in separate ownership, and restrictions on use of the subsurface completely prohibit the ability of a mineral owner to access or use the entire mineral estate, that would appear to provide a better basis for arguing that the regulation has resulted in a reduction of all economic value of the mineral owner's property. Thus, the impact of the regulation on the mineral owner will be critical. If the mineral owner's property interest is limited, and the regulation eliminates its economic value entirely, there might be a per se takings claim under *Lucas*. On the other hand, if the mineral owner's subsurface holdings are extensive, as was the case in *Keystone Bituminous*, it is more likely that a court would use a *Penn Central* balancing test rather than finding a per se taking. In sum, it is unlikely a court would find that restrictions on subsurface use and exploration for purposes of preserving the integrity of the CO_2 reservoir would constitute a per se taking, except in the case where the regulations completely prevent a mineral owner from accessing all of her mineral holdings.

If regulations protecting the CO_2 reservoir are found to deprive a surface or mineral owner of some but not all of the economic value of the surface or mineral estate, courts will then conduct a takings analysis using the *Penn Central* balancing factors: (1) the character of the government action; (2) the severity of the economic impact; and (3) the extent to which the regulation interferes with the property owner's distinct, "investment-backed" expectations.[342] With regard to the character of the government action, the purpose of any regulation meant to protect the integrity of the CO_2 sequestration basin would be to facilitate the deployment of a critical technology to address climate change. The regulations would also be intended to promote public health and safety by ensuring that stored CO_2 does not cause harm to resources outside the sequestration area or escape into the atmosphere and cause harm to human health or nearby surface and subsurface resources.

As to the severity of the economic impact, it remains uncertain precisely how the use of pore space and the surrounding area will be allocated and regulated. It is likely, however, that surface owners and mineral owners may be limited or prohibited from drilling through a confining layer in a way that punctures or compromises the sequestration area.[343] For some property owners, these restrictions will have a minimal impact on their existing or reasonably foreseeable surface or subsurface operations, but for others, the impact may result in additional restrictions or costs.

342. Penn Cent. Transp. Co. v. New York City, 438 U.S. 104, 124 (1977).

343. *See, e.g.*, KAN. ADMIN. REGS. §§ 82-3-1100–82-3-311a (proposed Jan. 2009) (regulations for the underground storage of CO_2 that include provisions on permitting, monitoring, and leakage reporting, as well as requirements for drilling through a CO_2 storage facility); *see also supra* Table 1.

Finally, the weight of the third factor—interference with reasonable, investment-backed expectations—will depend in large part on the extent to which the surface owner or mineral owner currently makes use of the subsurface or could reasonably expect to do so in the future.[344] Those owners already using the pore space for underground waste injection or natural gas storage may have a cognizable investment-backed expectation free from CCS-related regulation, whereas the vast majority of surface owners will have a difficult time establishing current or even plausible uses for the pore space a kilometer underground that is harmed by future CCS-related regulations. More important, this issue comes down to not only the landowner's existing or reasonably foreseeable use of the property, but also the landowner's expectations at the time of the purchase or investment with regard to using that space free of CCS or other related regulation. Like all takings issues considered under the *Penn Central* balancing test, this will be a factually intensive inquiry, taking into account the time of purchase, the expectations at that time, and whether those expectations were reasonable.

Ultimately, unless a court finds there is a deprivation of all economic use of the property, it is unlikely a court would find that regulations restricting some portion of the surface or subsurface would constitute a taking under the *Penn Central* balancing factors. This would be in large part because of the critical importance of addressing climate change as well as the important public health and safety concerns associated with preventing the re-release of CO_2 into the atmosphere after injection. In any particular case, however, there is the possibility that if regulatory restrictions interfere substantially with existing uses of the surface or subsurface, a court may find that the extent of deprivation is so great as to constitute a taking on grounds that the regulation has gone "too far" and the government must pay its way.[345]

C. Just Compensation and Determining Value

As noted earlier, even if a court finds that the government has taken private property, there is no violation of the Fifth Amendment unless the taking is without payment of just compensation. The Supreme Court has held that "just compensation required by the Fifth Amendment is measured by the property owner's loss rather than the government's gain."[346] As Justice Holmes has stated, "[T]he question is what has the owner lost,

344. *See Penn Central*, 438 U.S. at 130.

345. Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1014 (1992) ("[W]hile property may be regulated to a certain extent, if any regulation goes too far it will be recognized as a taking." (quoting Pa. Coal Co. v. Mahon, 260 U.S. 393, 415 (1992))).

346. Brown v. Legal Found. of Wash., 538 U.S. 216, 235–36 (2003) (internal quotations omitted); *see also* United States v. Toronto, Hamilton & Buffalo Navigation Co., 338 U.S. 396, 404 (1949) ("We take it that in the valuation of readily salable articles, price at the market nearest the taking is, at least in the usual case, a practical rule of thumb, and one that is most likely to place the claimant in the pecuniary position he occupied before the taking.").

not what has the taker gained."[347] As a result, if a court determines that the economic loss to the owner is zero, the compensation is also zero and there is no taking in violation of the Fifth Amendment.[348] Assessing the value or worth for any specific item of property, however, can be a difficult enterprise. As a result the Court generally has used a more practical measure in the form of the concept of "fair market value," or "what a willing buyer would pay in cash to a willing seller," even though this measure "does not necessarily compensate for all values an owner may derive from his property."[349] In other words, if there is a prevailing market price at the time of the taking,[350] that price is just compensation.[351] Fair market value is also recognized as a way to strike a fair "balance between the public's need and the claimant's loss" in takings cases.[352]

The Court, however, "has refused to designate market value as the sole measure of just compensation,"[353] and even in cases where there is an established market, there is not necessarily a fixed method for determining the market value.[354] Although the best evidence of market value may be recent sales, courts also have found that any "fair and nondiscriminatory" method of determining a "fair and realistic value" is acceptable.[355] While the fair market value measure becomes somewhat problematic when there is no willing seller in a takings case, it becomes even more problematic in the situation where there is not only no willing seller but also no established market at all.[356] Thus, the Court has recognized that in some circumstances, it simply may be impossible to determine a market value, particularly in cases where there have been too few sales to credibly predict a future price.[357]

Turning once again to eminent domain actions brought under the Natural Gas Act, determining just compensation in those cases is often

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347. Boston Chamber of Commerce v. City of Boston, 217 U.S. 189, 195 (1910).

348. *See Brown*, 538 U.S. at 237.

349. United States v. 564.54 Acres of Land, 441 U.S. 506, 511 (1979) (internal quotations omitted).

350. Olson v. United States, 292 U.S. 246, 255 (1934) ("That equivalent is the market value of the property at the time of the taking contemporaneously paid in money."); *see also* Yancey v. United States, 915 F.2d 1534, 1543 (Fed. Cir. 1990) ("Fair market value under the Fifth Amendment is normally ascertained at the date the governmental restrictions are imposed, which is the date of the taking.").

351. United States v. New River Collieries Co., 262 U.S. 341, 344 (1923).

352. *564.54 Acres of Land*, 441 U.S. at 512 (internal quotations omitted).

353. *Id.*

354. Allied Corp. v. Town of Camillus, 604 N.E.2d 1348, 1350 (N.Y. 1992).

355. *Id.* ("The ultimate purpose of valuation, whether in eminent domain or tax certiorari proceedings, is to arrive at a fair and realistic value of the property involved so that all property owners contribute equitably to the public fisc. Any fair and nondiscriminating method that will achieve that result is acceptable." (citations omitted)).

356. United States v. Toronto, Hamilton & Buffalo Navigation Co., 338 U.S. 396, 407 (1949) (Frankfurter, J., concurring) ("Resort to the conventional formulas for ascertaining just compensation for the taking of property rarely bought and sold, and having therefore no recognized market value, does not yield fruitful results. The variables are too many to permit of anything except an informed judgment.")

357. *Id.* at 402 (majority opinion).

difficult because subsurface gas storage rights are not commonly traded on the public market in the same way as surface rights.[358] As a result, comparative sales and other valuation methods are difficult to determine. In one Ohio case, *Columbia Gas Transmission Corp. v. Exclusive Natural Gas Storage Easement*,[359] the United States Court of Appeals for the Sixth Circuit held that state law governing just compensation should apply to federal condemnation of natural gas storage easements.[360] In so finding, the court paid particular attention to the express language in the Natural Gas Act[361] that directs federal courts to look to the practice and procedure of the state in which the property parcel is located.[362] More generally, the court also asserted that the presumption that state law should be incorporated into federal law is heightened when parties "have entered legal relationships with the expectation that their rights and obligations would be governed by state-law standards."[363]

When the issue of just compensation was certified to the Supreme Court of Ohio, the state court adopted the federal district court's instructions to the condemnation commission regarding the factors to be taken into account when setting just compensation.[364] These factors were (1) comparable sales (if available);[365] (2) any probable revenues to the landowner associated with commercially recoverable natural gas under the property; (3) the fair market value of the storage easement based upon a capitalization of retail income from the right to store gas; (4) depreciation in the fair market value of the condemned tract as a whole by reason of the taking of the storage easement; (5) the existence of any mineral leases on the property; and (6) the value of the property from the landowner's perspective (not the value of the storage easement to the natural gas company).[366]

The judicial principles governing just compensation in general, and for subsurface natural gas storage in particular, could guide any valuation of CO_2 sequestration areas in potential eminent domain actions for owners with a protectable property interest. If evidence of comparable sales

358. McGrew, *supra* note 262, at 154.

359. 962 F.2d 1192 (6th Cir. 1992).

360. *Id.* at 1199.

361. 15 U.S.C. § 717f(h) (2006) ("The practice and procedure in any action or proceeding for that purpose in the district court of the United States shall conform as nearly as may be with the practice and procedure in similar action or proceeding in the courts of the State where the property is situated . . . .").

362. *Columbia Gas*, 962 F.2d at 1197.

363. *Id.* at 1196 (citations omitted).

364. Columbia Gas Transmission Corp. v. Exclusive Natural Gas Storage Easement, 620 N.E.2d 48, 49–50 (Ohio 1993).

365. It was reported that in 1993, "Columbia routinely paid four dollars per acre per year for the right to store gas beneath a property" while the East Ohio Gas Company paid "five dollars per acre per year." McGrew, *supra* note 262, at 153. These transactions are rentals and thus must be converted and reduced to present value in cases where the gas company wishes to obtain a permanent easement. Moreover, because there is no real market for this property other than gas storage, the gas company essentially has a monopoly, which casts doubt on these amounts as fair market value. *Id.*

366. *Columbia Gas*, 620 N.E.2d at 49–50.

or rental payments are not easy to identify, as is likely with regard to the right to sequester CO_2 hundreds or thousands of feet underground, parties will look to other factors to establish just compensation. For instance, a landowner who can establish the existence of commercially recoverable resources may attempt to calculate the probable revenues and costs of extracting the resource to determine just compensation,[367] although this approach is somewhat controversial because future revenues often are thought to be too speculative.[368] More specifically the Court has held that elements affecting value that depend upon events or occurrences which, "while within the realm of possibility, are not fairly shown to be reasonably probable, should be excluded from consideration, for that would be to allow mere speculation and conjecture to become a guide for the ascertainment of value."[369] Avoiding such speculation and conjecture in just compensation valuation has since come to be known as the "reasonable possibility" or "reasonable probability" standard.[370]

Parties also may show a depreciation or loss in the whole property value due to the taking at issue, a measure commonly used in partial takings cases.[371] For instance, "[i]n general, the ultimate measure of the permanent damages sustained by an owner from the establishment of a pipeline easement across his premises is the difference between the fair market value of the whole premises immediately before the taking and the fair market value thereof immediately afterward."[372] One complication with this method for both partial and complete takings situations is that the mere announcement of government intent to regulate or condemn can affect the property value before the taking.[373] In some cases, this can lead to "condemnation blight," which often occurs when a governmental entity announces its intent to condemn property for a park, a road, or other development, resulting in a dramatic reduction of the property's marketability.[374] By the time the government condemns the project years later, "its fair market value will be significantly less than if the government had never [undertaken] the project in the first place."[375] In other cases, however, the government's announcement of its intent to condemn can result in an increase in property values, such as when a new

367. *Id.* at 49 (noting that the full amount must also be reduced by the interest enjoyed by a one-time payment).

368. *See* McGrew, *supra* note 262, at 156.

369. *See* Olson v. United States, 292 U.S. 246, 257 (1934).

370. *See, e.g.*, St. Genevieve Gas Co. v. Tenn. Valley Auth., 747 F.2d 1411, 1413 (11th Cir. 1984).

371. *See* McGrew, *supra* note 262, at 158–59.

372. Am. La. Pipe Line Co. v. Kennerk, 144 N.E.2d 660, 665 (Ohio Ct. App. 1957) (recognizing that in Ohio there is a distinction between damages and compensation).

373. *See* Christopher Serkin, *The Meaning of Value: Assessing Just Compensation for Regulatory Takings*, 99 NW. U. L. REV. 677, 696–99 (2005) (discussing how the prospect of an imminent government eminent domain action can have either a positive or a negative effect on the value of the property subject to condemnation).

374. *Id.* at 696–97.

375. *Id.* at 697.

road will be constructed that will increase property values in the area.[376] The question then becomes whether the government must pay for that increase in value at the time of the actual condemnation. At least twenty-nine states have enacted valuation laws that outline how to calculate the timing of the taking and the property value before and after the taking.[377] Notably, some of the laws are written to require an adjustment in valuation recognizing the impact of the government announcement to condemn or regulate.[378]

In the context of an eminent domain action to acquire subsurface pore space for CO_2 sequestration, the "timing of condemnation" issue could potentially increase or decrease the value of the property. With regard to subsurface pore space already in economic use for oil and gas operations, natural gas storage, or other economic use, an eminent domain announcement could reduce the market value of the subsurface property for these existing economic uses. On the other hand, with regard to subsurface pore space not already in economic use (or reasonably foreseeable economic use apart from CCS), an eminent domain announcement could increase the value of that subsurface property because the announcement would create an economic use for that property and other subsurface pore space in the area. This would be particularly true if the eminent domain actions took place over numerous years and during that time created market value for subsurface pore space for CO_2 storage that did not exist prior to the initial set of actions.

Particularly in situations where the taking is something less than an actual permanent, physical occupation, some courts have begun using the concept of "option value" as a method of valuation for just compensation purposes.[379] At least one state, New Jersey, has codified the concept, defining just compensation for a temporary restriction to be the fair market value of an option to purchase the land reserved for the period of reservation.[380] In so doing, the court assumes the state has taken an option to buy the property from the landowner for the period of the taking and then attempts to determine what a freely bargained-for option would cost on the market.[381] This option value is similar to the price one would pay for a negative covenant, or the requirement that the landowner refrain from activities on his land.[382] In New Jersey, prior to codification of the valuation principle, the New Jersey Supreme Court held that the op-

376. *Id.* at 698.

377. Christopher A. Bauer, Note, *Government Takings and Constitutional Guarantees: When Date of Valuation Statutes Deny Just Compensation*, 2003 BYU L. REV. 265, 278.

378. *Id.*

379. *See, e.g.*, Jay Harris Rabin, Note, *It's Not Just Compensation, It's a Theory of Valuation as Well: "Just Compensation" for Temporary Regulatory Takings*, 14 COLUM. J. ENVTL. L. 247, 257 (1989); *see also* J. Margaret Tretbar, Comment, *Calculating Compensation for Temporary Regulatory Takings*, 42 U. KAN. L. REV. 201, 226–27 (1993).

380. *See* N.J. STAT. ANN. § 40:55D-44 (West 2008).

381. *See* Rabin, *supra* note 379, at 257.

382. *Id.* at 265.

tion price should include, among other things, taxes accrued for the period, and that the full "sum can be established by expert advice and opinion."[383] Even in the case where the only loss the plaintiff can demonstrate is the loss of selling prospects because of the restrictive zoning, New Jersey courts have held that the plaintiff is entitled to reasonable damages in the form of recovery of the option value, regardless of how difficult it is to measure.[384] Although CO_2 sequestration in most cases will be permanent rather than temporary, the concept of option value could be helpful in determining just compensation for subsurface pore space. For instance, option value could be applied to regulatory takings in the absence of condemnation proceedings if a court ever determined that CCS regulatory measures deprived the owner of all beneficial use of the property or the ability to sell the property to another party.[385]

Ultimately, to the extent CO_2 sequestration is sought in private subsurface areas in which there are already private commercial uses for natural gas storage, oil and gas development, or other uses, the costs of obtaining rights to the subsurface by eminent domain may be significant. In other cases though, where the geologic formation is appropriate for CO_2 sequestration but is not appropriate for other, existing commercial uses, the costs associated with acquiring that property may be no more than the one dollar ultimately awarded to the apartment owners in *Loretto*,[386] or even zero.[387] Thus, even if one assumes that all surface owners have protectable property interests to the center of the earth, the amount of compensation owed may be next to nothing or nothing in some of those cases. As a result, there may well be a sliding scale of compensation for subsurface pore space based not on the existence of a property right, but on the value of that right based on the existing or reasonably foreseeable uses of the pore space. One option is for Congress to create a presumption regarding just compensation similar to that suggested above for defining a property right in the first place. Thus, Congress could create a presumption that subsurface pore space has no value, and consequently no compensation is due, but give property owners the opportunity to rebut that presumption by showing the economic value of the deep subsurface associated with existing uses or reasonable, investment-backed expectations regarding use.

383. Lomarch Corp. v. Mayor of Englewood, 237 A.2d 881, 884 (N.J. 1968).

384. Sheerr v. Twp. of Evesham, 445 A.2d 46, 75 (N.J. Super. Ct. Law Div. 1982).

385. *But see* Rabin, *supra* note 379, at 259 (arguing that the option value method suffers from some of the same difficulties as other valuation methods where the "market value for an option to purchase a particular piece of undeveloped property is haunted by speculation and inaccuracies" and courts wind up engaging in "a guessing game as to what a similarly bargained-for option would be worth").

386. *See* Loretto v. Teleprompter Manhattan CATV Corp., 446 N.E.2d 428, 432–33 (N.Y. 1983). A significant amount of CO_2 sequestration could also take place on federal public lands in the west, which presumably would avoid the costs of just compensation under the Fifth Amendment entirely.

387. *See* Brown v. Legal Found. of Wash., 538 U.S. 216, 240 (2003) (holding that the state's taking of private property did not violate the Fifth Amendment because the value of the property, measured by the owner's pecuniary loss, was zero).

IV. FEDERAL LEGISLATION AND ACCESS TO SUBSURFACE PORE SPACE

If policymakers ultimately decide to encourage widespread deployment of CCS to combat climate change, it will be important to consider a federal regulatory structure to address subsurface pore space access issues for CO_2 sequestration projects. State regulation, while certainly possible, will have difficulty addressing problems related to sequestration under federal lands, sequestration in geologic basins that cross state lines, and other interstate issues relating to the transport and injection of CO_2 into the subsurface on the massive scale necessary to address global climate change. Because of the government and private investment that will be necessary to create and implement such a regulatory system, how much money CO_2 operators or the government will actually have to pay to obtain pore space and the complexity of the underlying transactions are important questions.

As discussed in Part II, even under the most restrictive approach to property rights, widespread implementation of CCS will likely interfere with at least some protectable property interests in subsurface pore space.[388] To account for these cases, or an even greater number of cases if policymakers or courts opt for a more expansive approach to subsurface property rights, policymakers should implement a federal process for resolving these claims. To do so, Congress can create a regulatory structure that provides a means for CO_2 operators to take subsurface property by eminent domain if it is necessary, assuming that lawmakers deem CO_2 sequestration to be a more important public use than the current use of the subsurface. The remainder of this Part considers more fully the idea of public use as well as a framework for implementing such a regulatory structure.

A. Eminent Domain Authority and Public Use

If policymakers wish to pursue CCS as a major part of the nation's response to climate change, it will be necessary to create a means to acquire the pore space necessary to store billions of tons of CO_2. This will potentially require obtaining property rights from thousands of surface owners and mineral owners, any one of which could hold up a CCS project if the government and CCS operators do not have the power of eminent domain.[389] Any federal legislation authorizing eminent domain would need to declare that CO_2 sequestration for purposes of addressing climate change is a "public use" under the U.S. Constitution, as well as grant eminent domain authority to private parties to facilitate CO_2 se-

388. *See supra* Part II.B.

389. Anderson, *supra* note 138, at 108–09 (explaining that eminent domain authority is necessary to prevent any owner, whether surface or mineral, from blocking a sequestration project and that eminent domain authority can be particularly useful in situations where estates may have been highly severed and would otherwise require separate consent from each individual interest holder).

questration upon receipt of a permit or certificate authorizing the sequestration basin.[390]

The EPA and states with delegated authority currently regulate and permit injection of substances, including CO_2, pursuant to the UIC Program administered under the Safe Drinking Water Act.[391] In order to implement large-scale injection and sequestration of CO_2 to reduce GHG emissions, however, there will likely need to be federal legislation that specifically authorizes such injection and sequestration into designated underground basins that cover multi-state areas. Based on the analysis above, at least some of the subsurface area within those sequestration basins will lie beneath private property. As a result, any federal legislation governing large-scale CO_2 sequestration should include provisions that authorize the federal government, state governments, and/or private parties to exercise the right of eminent domain.

As discussed in Part II, under the Fifth Amendment to the U.S. Constitution, the government has the power to take private property by eminent domain so long as it is taken for "a public use" and "just compensation" is paid.[392] Courts have broadly interpreted "public use" to include not only the use of property for schools, railroads, post offices and the like that will be put into "use by the public," but also a wide range of more controversial "public purposes" connected to land development, such as the government transfer of private property from one private owner to another to develop the property in a way that will eliminate blight or simply increase the tax base for the community.[393] Establishing that the sequestration of CO_2 to reduce GHG emissions is a "public purpose" that justifies the use of eminent domain consistent with the Fifth Amendment will be made easier by the growing recognition of the dangers of climate change. There is now broad consensus that climate change poses a significant threat to human health and the environment.[394] The use of private property to aid in addressing that threat would appear to be in the public interest, for a public benefit, and for a public purpose, and thus is likely constitutional so long as just compensation is paid.

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390. For a discussion of the Supreme Court's jurisprudence on the Public Use Clause of the Fifth Amendment, see *infra* notes 392–400 and accompanying text.

391. *See supra* notes 126–30 and accompanying text.

392. U.S. CONST. amend. V.

393. *See* Kelo v. City of New London, 545 U.S. 469, 484–86 (2005) (finding that City of New London's exercise of its eminent domain power to take private residences in connection with development of a corporate headquarters for Pfizer Corporation to increase the city's tax base and spur development in an economically distressed area was a "public purpose" consistent with the Fifth Amendment).

394. *See, e.g.*, Rais Akhtar, et al., *Human Health*, *in* IPCC FOURTH ASSESSMENT REPORT, CLIMATE CHANGE 2007: IMPACTS, ADAPTATIONS AND VULNERABILITY 393 (Martin Parry et al. eds., 2007), http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter8.pdf; *see also* Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. I); U.S. Environmental Protection Agency, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under the Clean Air Act, http://www.epa.gov/climatechange/endangerment.html (last visited Jan. 29, 2010).

Moreover, in *Kelo v. City of New London*,[395] the Supreme Court reaffirmed a very broad interpretation of the public use clause, confirming that it was not limited to "use by the public" but included any purpose of public benefit, public interest, or value to the community.[396] Thus, in *Kelo*, the Court held that the City of New London's actions to take a private residence to facilitate development of a new corporate headquarters for Pfizer Corporation and increase the community's tax base was a "public use" that supported the exercise of eminent domain authority with payment of just compensation.[397] Likewise, courts have upheld the use of eminent domain authority in connection with the creation of subsurface natural gas storage basins and held that secondary recovery, field unitization, and subsurface waste injection are all a benefit to the community and in the public interest.[398] Currently, the Obama Administration has declared that implementing CCS will be major part of its approach to addressing climate change.[399] Based on that policy and the judicial precedent in the area of public use, it is likely courts will find that sequestration of CO_2 for purposes of combating climate change is a public use. Indeed, at the current time climate change is seen as one of the country's most pressing environmental needs, and thus there is a very strong argument that implementing a technology to address that need is a public use, particularly if such sequestration is carried out pursuant to federal or state legislation declaring it a public use and supporting that declaration with the appropriate scientific findings and data.[400]

B. The Natural Gas Act Model

To the extent the federal government wishes to enlist private CCS operators in implementing large-scale CO_2 sequestration, Congress will need to enact legislation that not only establishes that such sequestration is a public use, but also specifically grants the power of eminent domain to such private actors. One model for granting such authority and regulating its use is the Natural Gas Act.[401] Under the Natural Gas Act, a natural gas company that wishes to construct an interstate natural gas pipeline or obtain subsurface property for natural gas storage must obtain a certificate of public convenience and necessity from FERC.[402] After the company submits an application for a certificate that describes the project and establishes why the project is required and is in the public in-

395. *Kelo*, 545 U.S. 469.
396. *Id.* at 485–89.
397. *Id.* at 483–85.
398. *See supra* Part II.C.
399. *See, e.g.*, Press Release, White House, Press Briefing in the Trip of the President to Canada (Feb. 17, 2009), *available at* http://www.whitehouse.gov/the_press_office/Press_Briefing-2/17/09/.
400. *See Kelo*, 545 U.S. at 483–84 (focusing on comprehensiveness of city's plan and thoroughness of deliberations in upholding city's determination of public use); *id.* at 493 (Kennedy, J., concurring) (same).
401. 15 U.S.C. §§ 717–717z (2006).
402. *Id.* § 717f(c)(1)(a).

terest, FERC files a public notice of the application in the Federal Register, solicits public comment, and conducts a public hearing on the application.[403] As part of its evaluation, FERC must, among other things, investigate the environmental consequences of the project under the National Environmental Policy Act.[404] At the end of the process, FERC issues a certificate if it finds that the proposed project "is or will be required by the present or future public convenience and necessity."[405]

Once FERC has issued the certificate, the Natural Gas Act empowers the certificate holder to exercise "the right of eminent domain" to obtain easements and other property interests needed for the project if such property interests cannot be obtained through voluntary contractual negotiations.[406] Moreover, although the Natural Gas Act itself does not provide for a "quick-take" process whereby the certificate holder can obtain possession of the property prior to the determination of just compensation, numerous courts have authorized certificate holders to obtain such immediate possession through the equitable remedy of a preliminary injunction.[407] As a result, after depositing an amount of money with the court equal to the appraised value of the property and establishing sufficient financial viability to pay any additional amounts awarded by the court, the certificate holder can begin construction of the pipeline or natural gas storage area while the amount of compensation owed is still being litigated.[408]

This structure under the Natural Gas Act for reviewing projects and authorizing the right of eminent domain can serve as a partial model for CCS legislation. Congress could enact CCS legislation that creates a comprehensive regulatory, geologic, and environmental review process to determine whether a CCS sequestration project is in the public interest. This process, which could be conducted by FERC or another agency with mandatory input or consultation from the EPA and other federal agencies, would be subject to public notice, comment, geologic review, environmental review, and other expert review. A determination that the project is in the public interest would result in FERC, or whichever federal agency is granted authority over such review, issuing a certificate that indicates the project is in the public interest. The CCS operator holding the certificate would then be authorized to exercise the power of

403. *Id.* § 717(f)(c)(1)(b); 18 C.F.R. § 157.1 (2008).

404. 18 C.F.R. § 157.9(b); *see also* National Environmental Policy Act, 42 U.S.C. §§ 4331–4335; E. Tenn. Natural Gas Co. v. Sage, 361 F.3d 808, 818 (4th Cir. 2004) (describing the process of obtaining a certificate of public convenience and necessity under the Natural Gas Act).

405. 15 U.S.C. § 717f(e).

406. *Id.* § 717f(h).

407. *See E. Tenn. Natural Gas Co.*, 361 F.3d at 827 (granting immediate possession to natural gas company after issuance of order recognizing right of eminent domain under the Natural Gas Act but before determination of just compensation and citing other cases granting similar immediate possession). *See generally* Jim Behnke & Harold Dondis, *The* Sage *Approach to Immediate Entry by Private Entities Exercising Federal Eminent Domain Authority Under the Natural Gas Act and the Federal Power Act*, 27 ENERGY L.J. 499 (2006).

408. Behnke & Dondis, *supra* note 407, at 530.

eminent domain to obtain any necessary property interests if it cannot obtain such interests through voluntary contractual negotiations. Congress could also specifically grant "quick-take" authority to the certificate holder so that project implementation may begin before the final determination of just compensation.

As discussed earlier, simply because a private party owns land above a proposed CO_2 sequestration basin does not mean that private party has a "property interest" in the subsurface that can be acquired only by eminent domain. In cases where Congress, the states, or the courts have recognized a property interest, however, the CCS operator would be able to exercise the right of eminent domain to obtain these subsurface property rights with payment of just compensation.

Such federal legislation authorizing eminent domain to obtain subsurface pore space for CO_2 sequestration may or may not also create a structure for payment of compensation. The Natural Gas Act does not create such a structure for payment of compensation, choosing instead to implicitly assume the existence of property rights in the subsurface and allow the courts to address any disputes over the amount of just compensation using the principles of state law.[409] Another option, though, as stated above, would be to create a presumption that any private pore space property is of no value or of nominal value, but give surface or mineral owners an opportunity to present evidence in an administrative proceeding that current or reasonably foreseeable non-CCS uses will be impaired by CO_2 sequestration, and that the value of the property is reduced as a result.[410] Any administrative decision on this issue could then be made appealable to federal or state district court.

In addition to creating a structure to assess the value of the subsurface property in any statutory eminent domain proceeding, another issue that needs to be addressed is whether the government or private CCS operators should be required to compensate surface owners up front for the fact that their land will be located above significant amounts of injected CCS for hundreds to thousands of years. While experts believe the risks associated with such sequestration are small, the fact remains that those surface owners with CO_2 beneath their land will bear those risks far more heavily than the remainder of the population, all of whom will benefit equally from reduced CO_2 in the atmosphere.[411] While the jurisprudence regarding valuation of property under the Constitution for just compensation purposes cannot easily take that increased risk to human health and the environment into account, Congress could establish a

409. *See* 15 U.S.C. § 717f(h) (stating that practice and procedure for Natural Gas Act condemnation actions shall conform as much as possible to the state law where the property is situated).

410. *See* MCCOY, *supra* note 194, at 9 (distinguishing the need for compensation in natural gas storage cases from CO_2 storage cases because natural gas storage is often displacing developable oil and gas resources, and arguing that compensation for use of pore space for CO_2 storage should only be required where the property owner shows impairment of a pre-existing economic interest).

411. Klass & Wilson, *supra* note 83, at 13.

payment system separate and apart from just compensation to reflect that risk.

CONCLUSION

This Article explores the role of property rights in current efforts to develop the technology to transport, inject, and store underground millions to billions of tons of CO_2 per year as a means to reduce atmospheric CO_2 emissions and address climate change. Ultimately, we conclude that precedent supports a range of options that policymakers and courts can adopt when it comes to determining private property rights in the subsurface. Assuming that CO_2 sequestration will implicate at least some private property interests, we propose a federal statutory framework for acquiring deep subsurface pore space rights and paying any compensation owed. We conclude sequestration of CO_2 will likely be found to be a "public use" under the Fifth Amendment because of its potentially important role in combating climate change, and thus an eminent domain action would be lawful. Ultimately, CCS is a promising technology that may play a major role in efforts to address climate change. Before it can be implemented on a large scale, however, policymakers and courts must identify, analyze, and begin to resolve these important property rights issues. This Article is an effort to provide a roadmap to assist in that end.