PAVING THE LEGAL PATH FOR CARBON SEQUESTRATION FROM COAL

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I. INTRODUCTION

Of the many environmental and natural resource challenges that face President Obama, a large one has received scant attention from environmental scholars: coal. In the environmental community, coal—dirty, polluting coal—is more of an epithet than a resource. It has been the bane of environmentalists since the early days of the Clean Air Act,[1] and its reputation has only gotten worse with the recognition that carbon dioxide (CO_2), a major cause of climate change, is produced by coal at a higher ratio per energy output than other fossil fuels.[2] Many environmental organizations propose eliminating coal entirely from our energy mix.[3] However, coal represents forty-nine percent of the Unites States' existing electric-generating capacity, and will likely remain an important source of

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1. Clean Air Act, 42 U.S.C. §§ 7401–7671(q) (2000).

2. BRUCE A. ACKERMAN & WILLIAM T. HASSLER, CLEAN COAL/DIRTY AIR (1981); David Hunter & James Salzman, *Negligence in the Air, the Duty of Care in Climate Change Litigation*, 155 U. PA. L. REV. 1741, 1779 n.145 (2007) (citations omitted).

3. Greenpeace, Project Hotseat: Dangerous Distractions, http://us.greenpeace.org/site/PageNavigator/hotseat/PHS_Dangerous_Distractions (last visited Mar. 16, 2009); Sierra Club, Stopping the Coal Rush, http://www.sierraclub.org/environmentallaw/coal/ (last visited Mar. 16, 2009).

energy in the near and intermediate term.[4] Even more importantly, the Intergovernmental Panel on Climate Change (IPCC) predicts that fossil fuels (primarily coal) will dominate world energy until at least the middle of the next century.[5] Of particular concern is the fact that China, the world's largest emitter of greenhouse gases (GHGs),[6] depends heavily on coal-fired generation, and has relatively more coal than other energy sources to exploit in its continued meteoric growth.[7]

Additionally, in the absence of federal policy on controlling GHGs, much uncertainty surrounds whether and to what extent coal-fired generation can be permitted at all. There have been many instances of state utility regulators, legislators, and governors vetoing the permitting of new coal-fired electricity generating facilities;[8] and the Environmental Protection Agency (EPA) appeals board recently denied a permit for a new coal-fired plant because the permitting region, Region 8, had not set out a reasoned opinion on whether CO_2 is a "pollutant subject to regulation" under the Clean Air Act.[9] While these rejections of coal-fired power may be appropriate responses to the linkage between coal-fired power and GHG production, without being a part of a larger energy plan, they may lead to energy shortages and other unintended consequences. According to the International Energy Agency's *2008 Energy Technology Perspectives Executive Summary*, coal will continue to be part of a future energy mix, and carbon capture and storage will generate approximately nineteen percent of the GHG reductions necessary to stabilize

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4. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ELECTRIC POWER ANNUAL 2007, at 2 (2009), *available at* http://www.eia.doe.gov/cneaf/electricity/epa/epa.pdf.

5. Edward Rubin et al., *Technical Summary*, *in* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE SPECIAL REPORT, CARBON DIOXIDE CAPTURE AND STORAGE 20 (2007), *available at* http://www.ipcc.ch/pdf/special-reports/srccs/srccs_technicalsummary.pdf [hereinafter IPCC, CARBON CAPTURE REPORT].

6. Patricia Ross McCubbin, *China and Climate Change: Domestic Environmental Needs, Differentiated International Responsibilities, and Rule of Law Weaknesses*, 3 U. HOUST. ENVTL. & ENERGY L. & POL'Y J. 200, 201 (2009).

7. Edward H. Ziegler, *China's Cities, Globalization, and Sustainable Development: Comparative Thoughts on Urban Planning, Energy, and Environmental Policy*, 5 WASH. U. GLOBAL STUD. L. REV. 295, 300 (2006).

8. Felicity Barringer, *States' Battles Over Energy Grow Fiercer With U.S. in a Policy Gridlock*, N.Y. TIMES, Mar. 20, 2008, at A18.

9. *In re* Deseret Power Elec. Coop., PSD Permit No. PSD-OU-0002-04.00, PSD Appeal No. 07-03, slip op. at 9–10 (E.A.B. Nov. 13, 2008) (order denying review in part and remanding in part), *available at* http://yosemite.epa.gov/OA/EAB_WEB_Docket.nsf/Filings%20By%20Appeal%20Number/C8C5985967D8096E85257500006811A7/$File/Remand...39.pdf.

atmospheric concentrations of carbon dioxide at 450 parts per million (ppm).[10]

Therefore, it will be imperative for President Obama to figure out what role coal will play in our nation's future energy mix, and what role coal will have in other countries, since coal will continue to impact worldwide emissions of GHGs. Given the "Scylla" of increasing GHGs and the "Charybdis"[11] of the need to replace almost half of the United States' and the world's energy production if coal is banned, it is imperative that the United States move toward either reducing coal usage as quickly as possible around the world by ramping up other cost-effective energy sources, or figuring out a way to continue to produce coal-based electric power while drastically reducing GHG emissions.

The option that has received the most attention is the latter, particularly in finding a way to sequester the carbon dioxide produced by coal-fired emissions and prevent it from entering the atmosphere and contributing to increasing GHGs. This process, referred to as carbon capture and storage (CCS), can potentially remove eighty to ninety-five percent of the CO_2 emitted from electric power plants.[12] Though CO_2 is routinely injected underground to aid in recovery of oil, and though large-scale underground sequestration sites have been identified in the United States,[13] there is not yet a commercial-scale CO_2 sequestration facility attached to a large coal-fired power plant.[14] Therefore, most of the research on this issue has focused on the technical and economic difficulties of cost effective CCS.[15] While this

10. INT'L ENERGY AGENCY, ENERGY TECHNOLOGY PERSPECTIVES IN SUPPORT OF THE G8 PLAN OF ACTION 5 fig.ES.2 (2008),
available at www.iea.org/Textbase/npsum/ETP2008SUM.pdf.

11. Scylla and Charybdis are monsters of the Sicilian Sea in classical mythology, with one on one side and one on the other, creating a difficult path through which to navigate. THE ENCYCLOPEDIA BRITANNICA 519 (Hugh Chisholm ed., 11th ed. 1911).

12. PAUL W. PARFORMAK & PETER FOLGER, CONG. RESEARCH SERV., CARBON DIOXIDE (CO_2) PIPELINES FOR CARBON SEQUESTRATION: EMERGING POLICY ISSUES 1 (2007), *available at* http://ncseonline.org/NLE/CRSreports/07May/RL33971.pdf.

13. *See* NAT'L ENERGY TECH. LAB., U.S. DEP'T OF ENERGY, CARBON SEQUESTRATION ATLAS OF THE UNITED STATES AND CANADA (2008), *available at* http://www.netl.doe.gov/technologies/carbon_seq/refshelf/atlasII/atlasII.pdf.

14. Ann E. Carlson, *Implementing Greenhouse Gas Emissions Caps: A Case Study of the Los Angeles Department of Water and Power*, 55 UCLA L. REV. 1479, 1501–02 (2008).

15. A Google "web scholar" search on December 9, 2008, revealed about 7000 scholarly articles on the economic and technological feasibility of large-scale carbon sequestration, and 2150 articles for a similar search for legal and regulatory feasibility of large-scale carbon sequestration.

is obviously necessary to deploy CCS effectively, there are also legal issues that must be addressed to facilitate the adoption of CCS as a viable technology. These legal issues have received less attention.[16] The most important focus on the regulatory and legal issues to date has come from the work of the Advance Coal Technology Work Group, convened by the EPA.[17] This has culminated in a proposed rule by the EPA to regulate CO_2 sequestration through the Underground Injection Permit program of the Safe Drinking Water Act.[18]

In addition, as of 2005, fourteen states have enacted state carbon sequestration legislation, with numerous other proposals pending.[19] Coal-fired power plants are also regulated by the Federal Electric Regulatory Commission (FERC), and by various state Public Utility Commissions.[20] While the EPA's proposed rule and some of the states' legislation may be a stop-gap way to address CO_2 sequestration, there are many issues, including state and federal regulatory overlap, ownership, and liability, that would be more effectively addressed through new comprehensive federal legislation.[21] If President Obama wishes to accelerate the bringing to market of CCS for use in the United States and other parts of the world, he must focus on legislation that can legally pave the way. This legislation should address licensing of sequestration and electric-generating facilities, ownership and property law, liability,

16. One notable exception is Alexandra Klass & Elizabeth Wilson, *Climate Change and Carbon Sequestration: Assessing a Liability Regime for Long-term Storage of Carbon Dioxide*, 58 EMORY L.J. 103, 107 (2008) (exploring liability issues with respect to adequately protecting the public).

17. *See* ADVANCED COAL TECH. WORK GROUP, U.S. ENVTL. PROT. AGENCY, FINAL REPORT (2008), *available at* http://www.epa.gov/air/caaac/coaltech/2008_01_final_report.pdf [hereinafter COAL FINAL REPORT].

18. Proposed Federal Requirements under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, 73 Fed. Reg. 70,610 (proposed Nov. 21, 2008) (to be codified at 40 C.F.R. pt. 144, 146).

19. MELISSA CHAN & SARAH FORBES, CARBON SEQUESTRATION ROLE IN STATE AND LOCAL ACTIONS 6–7 tbl.1 (2005), *available at* http://www.netl.doe.gov/energyanalyses/pubs/slfinal_1.pdf.

20. *See* 16 U.S.C. § 824 (2000); *see also* LOUIS B. SCHWARTZ ET AL., FREE ENTERPRISE AND ECONOMIC ORGANIZATION: GOVERNMENT REGULATION 32 (6th ed. 1985).

21. In its *Report to Congress: Framework for Geological Carbon Sequestration on Public Land*, the U.S. Department of the Interior recently concluded that existing federal and state legislation is sufficient to handle the sequestration of CO_2 on public lands. U.S. DEP'T OF THE INTERIOR, REPORT TO CONGRESS: FRAMEWORK FOR GEOLOGICAL CARBON SEQUESTRATION ON PUBLIC LAND 13–14 (2009). Nevertheless, the report noted the complexity and possible legal confusion concerning issues of liability, pore space, and transport. *Id.* at 1–2, 13–15.

applicability and possible preemption of federal and state environmental laws, and ancillary issues such as pipeline construction and permitting, and the special case of offshore sequestration. The legislation should also clarify jurisdictional terms, such as "geologic sequestration" and "storage facility." Building on work done by the Program for Interagency Environmental Cooperation at the University of Houston,[22] this article explores some of the major legal issues affecting CCS and proposes policies to address them.

Due to their importance, this article particularly focuses on the need to address jurisdiction (what is CCS and how it should be permitted), liability (who is responsible for any harm), and property rights (who owns the various pieces of a CCS system). This article concludes with other areas that should be addressed in detail by future scholars.

Neither this article nor the work of the Program for Interagency Environmental Cooperation necessarily gives the "best" answer to addressing legal and regulatory barriers, but they do give some answers and focus to the problem.

II. JURISDICTION

One of the most critical concerns in regulatory barriers to CCS deployment is clarifying what qualifies as CCS and, therefore, what CCS legislation should address. Additionally, choices must be made as to how such legislation should be implemented. Specifically, legislation must address whether the federal government or the states should primarily regulate CCS, and what regulatory agency should be assigned, or created, to oversee comprehensive CCS.

A. Definitions

Clearly defining what constitutes CCS, and thus what is to be regulated, is the first jurisdictional step. Carbon dioxide must be defined in terms of purity. In other words, what kind of a gas stream should be sequestered? While pipelines and geologic formations may be able to contain CO_2, they may be less able to contain other air pollutants or toxics.[23] Additionally, the term "geologic sequestration"

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22. *See* University of Houston Law Center, Environment, Energy, and Natural Resources Center, http://www.law.uh.edu/eenrcenter/Interagency.html (last visited May 19, 2009). For more information regarding the Program for Interagency Environmental Cooperation's proposed draft of comprehensive legislation for CCS, see www.law.uh.edu/EENRCenter.

23. *See* Press Release, PR Newswire, Oxyfuel Technology Solutions for Carbon Capture Presented by Air Products at Greenhouse Gas International Conference (Nov. 19, 2008)

must be defined. What constitutes successful sequestration in terms of purity and years stored?[24] Legislation should make this clear. For instance, the term could be defined as "underground storage in a reservoir for at least 1000 years of at least 90% of the carbon dioxide emitted from a capture facility, with a storage failure rate of no more than 1% volume loss in 1000 years."[25] Additional terms that should be defined include "capture facility," "carbon dioxide pipelines," "injection," "reservoir," "site," and "storage facility," as well as words that may need their meaning clarified in this context, such as "operator," "Indian Tribe," or "State."

B. Federal Preemption

There are significant limits on the availability of sites for carbon sequestration. These limitations include both physical constraints on available sites and social constraints on sites based on public opposition.[26] Geologic sequestration is accomplished by injecting CO_2 into encapsulated, porous, geological formations.[27] Porous geological formations that hold, or have previously held, fluids such as natural gas, oil, or brines are potential candidates for CO_2 storage.[28] Saline aquifers and formations, as well as un-minable coal seams, are also possible sequestration locations.[29] While acceptable formations are often found near areas also appropriate for coal-fired power generation, this is not universally true. The net effect is that there are only limited potential sites appropriate for CO_2 geologic sequestration facilities.[30]

(discussing technologies to purify a captured carbon dioxide stream), *available at* http://www.prnewswire.com/cgibin/stories.pl?ACCT=EMAGRCY.story&STORY=/www/story/11-19-2008/0004929254&EDATE=WED+Nov+19+2008,+01:52+PM.

24. The Department of Energy's National Energy Technology Laboratory assumes that sequestration should be "permanent." *See* Nat'l Energy Tech. Lab., Carbon Sequestration, http://www.netl.doe.gov/technologies/carbon_seq/index.html (last visited Mar. 16, 2009).

25. THE PROGRAM TO FACILITATE INTERAGENCY ENVTL. COOPERATION, PROPOSED CARBON GEOLOGIC SEQUESTRATION LEGISLATION 4 (2008), *available at* http://www.law.uh.edu/EENRcenter/documents/CCSProposedLegislation.pdf.

26. *See generally* IPCC, CARBON CAPTURE REPORT, *supra* note 5, at 33–34, 36 (estimating the storage capacity for several geologic storage options and noting that the public tends to view CCS less favorably than other climate change mitigation options).

27. *See id.* at 31.

28. *Id.*

29. Jeffrey W. Moore, *The Potential Law of On-Shore Geologic Sequestration of CO_2 Captured from Coal-Fired Power Plants*, 28 ENERGY L.J. 443, 454 (2007).

30. *See* NAT'L ENERGY TECH. LAB., *supra* note 13.

One possibility for increasing the viable sites for carbon geologic sequestration facilities is to create a new infrastructure, or add to the existing infrastructure, for moving CO_2. Transporting captured CO_2 in small quantities is possible by truck, rail, or ship; however, large-scale CO_2 sequestration may require a dedicated interstate CO_2 pipeline network, which simply does not exist at this time.[31] A recent Congressional Research Report on CO_2 pipelines concluded that developing an "expansive national CO_2 pipeline network . . . could pose numerous new regulatory and economic challenges."[32] Although CO_2 pipeline technology has been employed historically to transport CO_2 for oilfield recovery and CO_2 pipelines operate much the same way as natural gas pipelines, only 5800 kilometers of CO_2 pipeline is currently in operation in the United States.[33] This relatively small regional network is inadequate for massive transportation of CO_2 to distant geologic sequestration locations. Pipelines of the future may gather CO_2 from widespread sources and transport it to a central location for sequestration. However, regulatory uncertainties regarding pipeline authority, as well as the difficulties of securing owners' right of way, combined with the expense and difficulty of creating an extensive CO_2 pipeline network, render it unlikely that full-scale reliance on CO_2 transport through an interstate pipeline network will be an option until well into the future. In the meantime, it seems likely that most CO_2 sequestration will take place very near the point at which CO_2 is captured, limiting location options.[34]

The promotion of sequestration also requires the permitting of new coal-fired power plants and plants that have access to suitable storage sites. Permitting of a power plant typically requires approval from the entities that regulate utilities, which are normally equivalent to public utility commissions, and may also require a "necessity" determination and local environmental review.[35] Additional review occurs at the federal level, including environmental review, and the FERC's analysis of market power and monopolistic behavior.[36]

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31. PARFORMAK & FOLGER, *supra* note 12, at 1.

32. *Id.* at 2.

33. *Id.* at 4–5.

34. *See id.* at 6 (concluding that seventy-seven percent of the total annual CO_2 captured from the major North American sources will likely be stored directly below the sources, and that an additional eighteen percent may be stored within 100 miles of the source).

35. Jeffrey S. Dennis, *Federalism, Electric Energy Restructuring, and the Dormant Commerce Clause*, 43 NAT. RESOURCES. J. 615, 630 (2003).

36. Victor B. Flatt, *What is the Best Formula to Protect the Environment in Electricity Restructuring?*, 1 ENVTL. & ENERGY L. & POL'Y J. 221, 226 (2005); Mark N. Cooper, *The*

Carbon dioxide pipeline permitting similarly requires approval from whatever state and federal entities regulate that type of pipeline approval, as well as environmental, antitrust, and workplace safety approval.[37]

Due to greater concern over climate change, coal-fired power plants have faced significant opposition in recent years, with very few obtaining approval at the state level.[38] Thus, it is imperative to streamline the approval process for appropriately designed coal-fired generating facilities that incorporate capture and sequestration technology. Recent experience suggests that even with advanced capture and sequestration technology incorporated into the coal-fired power plant designs, approval in appropriate locations will be difficult due to overlapping jurisdictions, lack of public awareness of CCS technology, and residual suspicion that CCS will not mitigate the climate change effects of coal fired power plants.[39]

Each entity that has jurisdiction over CCS may have a way to veto a CCS project for reasons unrelated to the original purpose of the legal regime being used, such as necessity, safety, or the environment. Thus, one federal agency, most likely the EPA, should be placed in charge of the permitting of all aspects of CCS. Federal control will eliminate the current system of overlapping and potentially conflicting requirements for CO_2 sequestration facilities.

There is precedent for federal preemption of state site restrictions regarding the geologic storage of CO_2. Liquefied Natural Gas (LNG) terminals allow for the transport and importation of

Failure of Federal Authorities to Protect American Energy Consumers from Market Power and Other Abusive Practices, 19 LOY. CONSUMER L. REV. 315, 393 (2007).

37. Currently, non-natural gas interstate pipelines are regulated for safety and siting by the Department of Transportation Pipeline and Hazardous Materials Administration (PHMA), and intrastate pipelines are regulated for safety and pricing by either public utility commissions or state mining commissions, depending on the eventual use of the carbon dioxide in question (though they may follow certain policies of the PHMA). Depending on where a CCS facility was sited, the utility could require overlapping state and federal approval for pipeline safety, siting, and carrier pricing. Philip M. Marston & Patricia A. Moore, *From EOR to CCS: The Evolving Legal and Regulatory Framework for Carbon Capture and Storage*, 29 ENERGY L.J. 421, 449–50 (2008).

38. Judy Pasternak, *Coal at Heart of Climate Battle: Environmental Groups Go to Court to Stop Each New Power Plant and Force Washington to Address the Issue*, L.A. TIMES, Apr. 14, 2008, at A1.

39. *See* Greg Edwards, *Proposed Coal Plant Denied: Virginia Regulators Say Proposal Neither Reasonable Nor Prudent*, RICHMOND TIMES DISPATCH, Apr. 15, 2008, at B9 (reporting that the Virginia Corporation Commission denied approval for new power plant using coal gasification technology).

natural gas in concentrated liquid formation.[40] Gas in liquefied form can be transported to places that are not connected by a pipeline so that it is not "stranded" in a low-demand market.[41] However, LNG terminals are controversial and many communities have sought to exclude them entirely, despite the benefits.[42] This sentiment has created what lawmakers deem to be unacceptable barriers to the expansion of on-shore LNG terminal capacity.[43] Local and state land use and zoning restrictions were often utilized to resist LNG terminal sites.[44] The Energy Policy Act of 2005 sought to reduce these barriers by modifying the siting process for LNG facilities and preempting local and state siting barriers by declaring that exclusive authority to site LNG facilities rested with the federal government:

> The Commission shall have the exclusive authority to approve or deny an application for the siting, construction, expansion, or operation of an LNG terminal. Except as specifically provided in this chapter, nothing in this chapter is intended to affect otherwise applicable law related to any Federal agency's authorities or responsibilities related to LNG terminals.[45]

This provision has been upheld as a proper exercise of federal power under the Supremacy Clause of the U.S. Constitution.[46]

While this preemption of local authority for siting was initially opposed by environmentalists, closer examination reveals that such preemption may be necessary to increase needed public infrastructure efficiently, without creating unequal burdens on so-called "environmental justice" communities.[47]

Obviously, such preemption (for either LNG or CO_2 sequestration facilities) must be grounded in the notion that the operation of such facilities does not create unacceptable health and safety risks in communities with such sites. Therefore, any

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40. Joshua P. Fershee, *Changing Resources, Changing Market: The Impact of a National Renewable Portfolio Standard on the U.S. Energy Industry*, 29 ENERGY L.J. 49, 57 n.55 (2008).

41. Josh Lute, *LNG Terminals: Future or Folly*, 43 WILLAMETTE L. REV. 621, 630 (2007).

42. *See* Eileen Gauna, *LNG Facility Siting and Environmental (In)Justice: Is it Time for a National Siting Scheme?*, 2 ENVTL. & ENERGY L. & POL'Y J. 85, 98–101 (2007).

43. Angela J. Durbin, Comment, *Striking a Delicate Balance: Developing a New Rationale for Preemption While Protecting the Public's Role in Siting Liquefied Natural Gas Terminals*, 56 EMORY L.J. 507, 509 (2006).

44. Richard J. Pierce, Jr., *Environmental Regulation, Energy, and Market Entry*, 15 DUKE ENVTL. L. & POL'Y F. 167, 176 (2005).

45. Energy Policy Act of 2005, § 311, 15 U.S.C. § 717b(e)(1) (Supp. 2006).

46. AES Sparrows Point LNG, L.L.C. v. Smith, 470 F. Supp. 2d 586, 589 (D. Md. 2007) (striking down a zoning ordinance on LNG siting).

47. Gauna, *supra* note 42, at 106.

preemptive legislation must be explicit about health, safety, and environmental factors that must be met before any permit can be granted, and ensure that existing health, safety, and environmental policies are fully followed. Thus, federal legislation must create a kind of permit system that addresses federal, state, and local concerns.[48]

III. LIABILITY MANAGEMENT

One of the most formidable barriers facing potential CCS operations is the possible liability costs of these operations. If the costs of CCS outweigh the benefits, it should not go forward and, generally, we rely on complex common law liability to send that market signal.[49] However, liability is much more uncertain here, where economic signals do not operate efficiently. Even though studies indicate that the benefits of large-scale CCS operations should be substantial and bring little risk of harm to humans or the environment,[50] differing liability rules and regulations exist, creating an uncertainty that poses a problem in promoting CCS.[51] CCS operators need some assurance that liability costs will not outweigh the benefit derived from implementing CCS operations. Without this predictability, the threat of uncertain liability costs will likely deter a large number of potential operators. Thus, it is necessary to create and adopt a liability scheme that encourages private industry to implement CCS operations, while protecting the public and the public interest.

If liability issues are to be clarified by legislation, this legislation would have to ensure that the purposes of liability—protecting public health and safety, as well as property rights—are preserved. Although unlikely, large surface releases could pose health risks to

48. Even when done in this manner, preemption always poses a risk to local environmental, health, and safety protection. The federal government, even with legal requirements to protect local health, environment, and safety, may not always adequately enforce these laws. To avoid this problem, federal legislation should include a strong citizens' suit provision for enforcement. While this could also be used solely for delay purposes, the trade-off may be necessary to protect the public's interest.

49. *See* Robert Cooter, *Unity in Tort, Contract, and Property: The Model of Precaution*, 73 CAL. L. REV. 1, 7–8 (1985) (noting that relative fault models (negligence with comparative negligent defense) are efficient).

50. *See* SARAH M. FORBES, NAT'L ENERGY TECH. LAB., REGULATORY BARRIERS FOR CARBON CAPTURE, STORAGE AND SEQUESTRATION 1 (2002), *available at* http://www.netl.doe.gov/technologies/carbon_seq/refshelf/reg-issues/capture.pdf.

51. Klass & Wilson, *supra* note 16, at 123.

humans, such as asphyxiation or other effects caused by prolonged exposure to high concentrations of CO_2.[52] Exposure to a 1% to 5% atmospheric CO_2 mixture can result in physical effects including increased breathing; loss of consciousness usually occurs from exposure to greater than 10% atmospheric CO_2; and most CO_2 concentrations above 30% are lethal.[53] Furthermore, CO_2 seepage could harm flora and fauna and potentially ruin nearby ecosystems and agriculture.[54]

With respect to property protection, it is important to account for the nature of CO_2 stored underground. Like water and oil, CO_2 is a "fugitive" substance.[55] Thus, when CO_2 is injected underground, it will naturally migrate throughout the pore space.[56] This natural migration could lead CO_2 to travel upward throughout the reservoir into undetected or abandoned portions of the reservoir, or into portions of the reservoir that are not owned by the operator.[57] Even if it remains underground, CO_2 could cause saline intrusion into potable aquifers, make sources of oil and gas unattainable, create pressure changes causing ground heave, and even trigger seismic events.[58] Even if there were no direct physical harm or trespass, a CO_2 release would increase atmospheric CO_2, which is a leading cause of climate change. Thus, any liability scheme must also ensure that public health and private property rights will be protected and that any harms will be compensated.

This article is not the first to explore the problems that potential liability may pose for the deployment of large-scale CCS. The issue was identified by the Advanced Coal Technology Work Group as a major issue for deployment, and the Interstate Oil and Gas Compact Commission (IOGCC) has proposed releasing operators from long-term liability for CCS. [59] Mark Anthony de Figueredo analyzed

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52. *Id.* at 118.

53. *See* FORBES, *supra* note 50, at 5 (noting the 1986 disaster when CO_2 released from a natural reservoir under Lake Nyos in Africa killed more than 1700 people).

54. *See* Klass & Wilson, *supra* note 16, at 119.

55. *See* Burnham v. Hardy Oil Co., 147 S.W. 330, 335 (Tex. Civ. App. 1912).

56. *See* Mark Anthony de Figueiredo, The Liability of Carbon Dioxide Storage 55 (Jan. 12, 2007) (unpublished Ph.D. dissertation, Massachusetts Institute of Technology), *available at* http://sequestration.mit.edu/pdf/Mark_de_Figueiredo_PhD_Dissertation.pdf.

57. *Id.*; Klass & Wilson, *supra* note 16, at 115–16, 118.

58. *See* Klass & Wilson, *supra* note 16, at 119.

59. *See* COAL FINAL REPORT, *supra* note 17, at 3–4; IOGCC TASK FORCE ON CARBON CAPTURE AND GEOLOGIC STORAGE, STORAGE OF CARBON DIOXIDE IN GEOLOGIC STRUCTURES: A LEGAL AND REGULATORY GUIDE FOR STATES AND PROVINCES 11 (2007),

property rights and liability in his Ph.D. dissertation at MIT,[60] and Alexandra Klass and Elizabeth Wilson have explored liability options for CCS in their article, *Climate Change and Carbon Sequestration: Assessing a Liability Regime for Long-Term Storage of Carbon Dioxide*.[61] Both pieces provide extensive and excellent detail on liability options and issues. This article treads similar ground and agrees and disagrees with some proposals mentioned in the pieces. However, this article focuses more particularly on the economic barriers to deployment due to liability faced by proponents of CCS. Although I agree that the patchwork of liability provisions must also be resolved to ensure protection of the public, I do not delve into this with the detail addressed by Klass and Wilson.

A. Current Liability Schemes That Might Apply without Legislative Changes

There are four general causes of action that may arise in the event of a CO_2 release. These claims contain similar elements, but some claims may be better suited for particular sets of facts. In addition, there exists the possibility of claims of harm arising from climate change.

1. Negligence

The most likely cause of action would be a general negligence claim that could cover a wide variety of harms.[62] A negligence claim could be used to address harm to human and environmental health, and to property.[63] In order to prove a negligence claim, a plaintiff would have to prove four elements: duty, breach, causation, and damages. The plaintiff would have to show that the operator had a duty of care over the CCS operation, that the operator breached that duty, and that the plaintiff's injuries were caused by that breach.[64] Damages could be in the form of either property damage or damage to plaintiff's health.[65]

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available at http://www.gwpc.org/e-library/documents/co2/IOGCC%20Master%20CO2%20Regulatory%20Document%209-2007.pdf [hereinafter IOGCC TASK FORCE].

60. De Figueiredo, *supra* note 56.

61. Klass & Wilson, *supra* note 16.

62. *See* Melanie R. Kay, *Environmental Negligence: A Proposal for a New Cause of Action for the Forgotten Innocent Owners of Contaminated Land*, 94 CAL. L. REV. 149, 168–69 (2006).

63. *See* de Figueiredo, *supra* note 56, at 56.

64. *See* Kay, *supra* note 62, at 170 (quoting Newhall Land & Farming Co. v. Superior Court, 19 Cal. App. 4th 334, 349 (Cal. Ct. App. 1993)).

65. *See* de Figueiredo, *supra* note 56, at 55.

2. Trespass

Another claim could be a trespass claim. As discussed previously, CO_2 will naturally migrate throughout any reservoir.[66] This could lead to the CO_2 migrating into pore space that is not owned by the operator, giving rise to a trespass cause of action. The plaintiff owner would need to show that the unauthorized entry of the CO_2 into her property prevented her from making use of that pore space.[67] The remedy for trespass is usually an injunction, payment for the loss of property value, and/or costs of restoration.[68]

3. Nuisance

Another possible cause of action is nuisance. The difference between a nuisance claim and a trespass claim is that a nuisance claim arises from an interference in the enjoyment of one's property, while a trespass claim arises from an invasion of one's property.[69] Damages for nuisance and trespass are virtually identical.[70]

4. Strict Liability

Another possible claim could be a strict liability claim. Strict liability claims are reserved for abnormally dangerous activities under sections 519 and 520 of the Restatement (Second) of Torts.[71] Under strict liability, an operator can be found liable even if she used "all possible preventive measures."[72]

5. Climate Change

The purpose of CCS operations is to reduce the amount of CO_2 emitted into the atmosphere, as GHG emissions are the primary cause of atmospheric warming.[73] Thus, one other perceived harm that could arise from CCS operations is that a major release of CO_2 would contribute to climate change. While damage from climate change

66. *Id.*

67. *See id.*

68. *See id.*

69. *Id.* at 56; G. Nelson Smith, III, *Nuisance and Trespass Claims in Environmental Litigation: Legislative Inaction and Common Law Confusion*, 36 SANTA CLARA L. REV. 39, 54 (1995).

70. *See* de Figueiredo, *supra* note 56, at 56.

71. Klass & Wilson, *supra* note 16, at 141–42.

72. De Figueiredo, *supra* note 56, at 58.

73. *See, e.g.*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT, SUMMARY FOR POLICYMAKERS 5 (2007).

harm is a somewhat novel legal concept, it is a possible uncertainty in CCS.

B. What Should Comprehensive Legislation Look Like?

Liability regulation in comprehensive legislation should be limited to physical harm to humans, animals, and plant life. Because property issues from migration would be similar to existing migratory issues for natural gas, which are currently handled under state law, claims of property damage in the form of trespass and nuisance should probably be left to state law (though consistency at the state level would be important in this area).

With respect to a possible federal liability scheme for health and environmental damages, some statutory plan based on requiring "reasonable" behavior should be adopted. A strict liability regime should not be adopted for CCS operations, in that it would greatly increase the risk of liability costs for CCS operators without commensurate benefit to the public.

If operators take on the burden of implementing CCS operations, they should not also be held liable for climate change claims. If liability could be imposed on CCS operators for a CO_2 release that did not cause any harm other than increasing atmospheric CO_2 levels, an unlikely occurrence given the correct initial standard, this scheme would fail to reach the goal of encouraging implementation of CCS. The climate change protections should be specified and set out in the original standard. It seems counterproductive to impose climate change liability on operators who have undertaken demonstrated efforts to reduce harm from CO_2 emissions, and who have also complied with government mandated standards designed to avoid such harm. If operators are held liable for their contribution to climate change because of a CO_2 release, they will have much less incentive to implement CCS.

What federal statutory schemes would work? There are several options.

<u>1. Insurance</u>

The most commonly used method for managing liability is insurance. Insurance serves three related, but separate, functions.

> First, insurance transfers risk from parties who are comparatively risk averse to enterprises more willing to bear risk. Second, insurance spreads risk by combining individual risks [into a general pool]. . . . Third, insurance performs a risk-allocation function by

> charging premiums that reflect the level of risk posed by each individual . . . that is insured.[74]

Essential to setting proper premium prices and setting aside the proper funds in case of an accident for CCS is knowledge of the likely frequency and severity of a CCS disaster. Because CCS is a very new technology and there has been no real opportunity to assess the frequency and severity of CCS events, CCS is not well suited, at least at this point, for actuarial models.[75] If private insurance companies set premium prices too low, they may be unable to cover the damages that stem from a CCS accident. On the other hand, if insurance companies set premiums too high, this could deter possible operators, who would otherwise provide a cost effective benefit, from entering into the CCS business. Without a working knowledge of the frequency and/or severity of CCS accidents, a private insurance scheme, standing alone, would be little more than guesswork and probably would not adequately reach both the goals of encouraging private industry to implement CCS while protecting public health and welfare.

2. Liability Cap

Another liability scheme that has worked in other areas is a liability cap. The Price-Anderson Act,[76] adopted in 1957, regulates liability for the nuclear power industry in the United States. This act allows for a limited liability shield, in that each nuclear plant operator must obtain primary insurance coverage up to $300 million.[77] In the event that damages from a nuclear accident were to exceed the primary insurance coverage, recovery could be sought from a secondary insurance source, for which each nuclear operator would "contribute up to $95.8 million per unit[,] . . . payable in annual installments of $15 million or less."[78] If the damages of a nuclear accident were ever to exceed both the primary and secondary insurance coverage, the nuclear operators would be shielded from any amount over the secondary coverage, and the federal government would take on the remaining liability.[79]

74. *E.g.*, Kenneth S. Abraham, *Environmental Liability and the Limits of Insurance*, 88 COLUM. L. REV. 942, 945–46 (1988).

75. *See id.* at 960; de Figueiredo, *supra* note 56, at 62.

76. 42 U.S.C. § 2210 (2000).

77. 10 C.F.R. § 140.11(a)(4) (2008).

78. AM. NUCLEAR SOC'Y, THE PRICE-ANDERSON ACT: BACKGROUND INFORMATION 2 (2005), *available at* http://www.ans.org/pi/ps/docs/ps54-bi.pdf.

79. *See* 42 U.S.C. § 2210(e)(2) (2000).

3. Liability Shield

Another possible scheme would be to grant a complete liability shield under other statutes to all CCS operators that have followed certain safety rules and regulations as set out by the appropriate federal agency.[80] Under this scheme, as long as the operator followed all CCS safety regulations, a rough equivalency to "acting reasonably," the operator could be completely exempt from all claims arising under other statutes.[81] This scheme would encourage private industry to implement CCS technology by removing the liability costs associated with CCS. This scheme, however, would deprive possible victims of necessary compensation unless the federal government agreed to take on the liability that would have been borne by the CCS operators. Furthermore, even if the federal government agreed to assume this liability, it may not adequately protect the public welfare, as CCS operators would have less incentive to follow the aforementioned safe practices in implementing CCS. Thus, while a partial liability shield may be plausible with the federal government making the claimant whole, a complete liability shield would not be the best method to reach the twofold goal of encouraging private investment and adequately protecting human and environmental health.

4. Bonding

Another possibility is bonding. Typically, the operator or a third party would post the bond as a promise of compliance with federal regulations.[82] The bond would then be released back to the original payor when its promise of compliance was fulfilled.[83] The main issue in this context would be the length of time that the operator would be required to comply before his promise would be deemed fulfilled.[84] If compliance was incomplete or insufficient, the bond would be forfeited and used to finance any claims arising from these

80. This scheme has been used in other environmental statutes, namely CERCLA. *See* 42 U.S.C. § 9607(j) (2000).

81. The language used to avoid imposing CERCLA liability on those who have met other statutory mandates is: "Recovery by any person (including the United States or any State or Indian tribe) for response costs or damages resulting from a federally permitted release shall be pursuant to existing law in lieu of this section." *Id.*

82. DAVID GERARD & ELIZABETH J. WILSON, ENVIRONMENTAL BONDS AND THE PROBLEM OF LONG-TERM CARBON SEQUESTRATION 2 (2006), *available at* www.ecy.wa.gov/laws-rules/wac173407_218/Gerard%20Wilson%20Bonding.pdf.

83. *Id.*

84. *See id.* at 14–15.

operations.[85] Bonding has been used as a liability measure in coal mining and hard-rock mining projects.[86]

Bonding is less favorable to private investment than a partial liability shield because the bond shifts the injured party's burden of proof from proving that the operator was harmed to proving that compliance criteria were met.[87] At the same time, the public sector is only protected up to the amount of the bond posted—not necessarily for the full amount of potential damages.[88] However, if the operator remains solvent after forfeiting its bond, harmed parties may seek additional remedies through the court system.[89]

5. Compensation Fund

The final possibility would be to establish a compensation fund. In this scheme, those that create the risk, the CCS operators, would make payments into a fund that would be used to address any harm caused by CCS operations.[90] The compensation fund would be beneficial to injured parties in that the injured parties would not necessarily have to trace their injury to a specific operator. Instead, they would only need to show that their injuries resulted from the negligence of any CCS operator in order to be awarded damages from the fund.

Under this scheme, one major issue would be determining how much each operator should contribute to the fund. Payment could be based on several factors, including amount of CO_2 stored, the injection site's proximity to population centers, and the physical characteristics of the reservoir.[91]

For several policy reasons, comprehensive CCS legislation should probably adopt this strategy. Under a compensation fund scheme, the federal government could collect fees from CCS operators to provide funding for injuries resulting from the release of CO_2. Any uncertainty with respect to total risk would then be borne by the government, rather than the CCS operator. The legislation would have to address three major issues in designing an appropriate compensation fund: (1) the method of financing the fund, (2) the

85. *Id.* at 3.
86. *Id.* at 3 n.6.
87. *Id.* at 8.
88. *Id.*
89. *Id.*
90. De Figueiredo, *supra* note 56, at 70.
91. *Id.* at 71.

events that are compensable, and (3) the amount of compensation awarded to each injured party.[92]

With respect to financing, one possibility would be to consider the amount of CO_2 stored—for instance, the more you inject, the more you pay. Another possibility is a risk-based contribution.[93] Under this model, each operator's contribution to the fund would be determined by: (1) an analysis of the severity of damages that a CO_2 release would cause based on the amount of CO_2 stored and its proximity to populations centers, and (2) consideration of the likelihood of a CO_2 leak based on the physical characteristics of the reservoir. De Figueiredo proposes this type of scheme, wherein the operator of the site pays a different amount based on the risk of leakage and failure.[94]

While the risk-based model may seem to be the most fair and would most closely align incentives, it faces particular problems in this context. First, it requires extensive scientific analysis and calculation, making administration more costly and difficult. Though de Figueiredo assumes that such calculations can be done,[95] risk analysis over CCS time periods becomes even more difficult. Such difficulty in administration may not even provide much more in the way of incentives to operators. It should be noted that every injection site will be subject to the same regulations and safety standards. Thus, using the likelihood of a release as a factor in determining each operator's contribution could be a redundant exercise in risk evaluation. If every site is subject to the same safety standards, then the amount of CO_2 stored, a determination easily made administratively, could be the basis of each operator's contribution. In other words, operators that stored similar volumes of CO_2 would pay the same amount to the fund, regardless of physical characteristics and proximity to population centers.

While this option may prove to be more efficient from an administrative point of view, it would not encourage the use of the most safe injection sites. It is possible that proximity to population centers could also be converted into a formula for ease of administration. In an effort to establish a contribution model that accurately reflects the risk imposed by each operator, contributions

92. Kenneth S. Abraham, *Individual Action and Collective Responsibility: The Dilemma of Mass Tort Reform*, 73 VA. L. REV. 845, 886 (1987).

93. *See id.* at 890.

94. De Figueiredo, *supra* note 56, at 399.

95. *Id.*

should be based on the amount of CO_2 injected with an additional risk analysis related to proximity to an affected population. With CO_2, due to its quick dispersal, this would be a much smaller factor than trying to calculate effects of toxic release on the public.

With respect to determining which events are compensable and what the amounts should be, this should probably be designated to regulatory discretion. The types of injuries that could possibly occur are not completely understood, and thus we cannot understand necessary compensation either. The EPA has particular expertise in determining environmental safety risks and has specifically addressed the effects of CO_2 on human health.[96] Thus, based on sound environmental and actuarial science, both determinations should be delegated to the EPA.

IV. PROPERTY RIGHTS

The injection of carbon dioxide into geologic formations is not new; it has been used for decades in enhanced oil recovery operations.[97] However, because of the vast quantities of CO_2 that will be injected and the long-term storage that is required, CCS technology faces several novel challenges, particularly in the area of subsurface property rights.[98]

A. Ownership Issues Related to CCS Technology

Geologic storage of immense amounts of carbon dioxide for hundreds, or perhaps thousands, of years presents very complex property issues. Carbon dioxide can be sequestered in a number of different geologic formations, including depleted oil and gas reservoirs, saline aquifers, coal seams, and deep sub-seabed formations.[99] The geologic formation subject to injection will dictate the property rights that are implicated. MIT's recent study on the *Future of Coal* notes that "[b]ecause of their large storage potential

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96. *See* OFFICE OF AIR & RADIATION, ENVTL. PROT. AGENCY, CARBON DIOXIDE AS A FIRE SUPPRESSANT: EXAMINING THE RISKS app. B (2000); *see also* 29 C.F.R. § 1910.1000 (2007) (setting forth OSHA regulations regarding human exposure to air contaminants, including CO_2).

97. NAT'L ENERGY TECH. LAB., U.S. DEP'T OF ENERGY, CARBON SEQUESTRATION THROUGH OIL RECOVERY 1 (2008), *available at* www.netl.doe.gov/publications/factsheets/program/Prog053.pdf.

98. *See* Elizabeth J. Wilson & Mark A. de Figueiredo, *Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law*, 36 ENVTL. L. REP. 10114, 10116–18 (2006).

99. *Id.* at 10114.

and broad distribution, it is likely that most geological sequestration will occur in saline formations."[100] However, the study also concludes that most initial carbon sequestration projects will likely utilize depleted oil and gas reservoirs because of their availability, the quality of existing subsurface data, and the potential for economic return.[101] Additionally, whether sequestration takes place on-shore or off-shore further impacts the legal framework at issue.[102] Finally, because there is already legal precedent governing the injection of carbon dioxide for enhanced oil recovery operations, if the CO_2 were initially injected for this purpose it is likely that it would be governed by that body of law.[103]

1. Depleted Oil and Gas Reservoirs

The injection of carbon dioxide into oil and gas reservoirs implicates a number of property interests, including surface owners, mineral owners, lessees of solid minerals, oil and gas lessees, owners of non-operating interests, owners of future interests, and the rights of adjacent property owners.[104] In most of the world, subsurface minerals and pore space is the property of the central government, simplifying consideration of property issues for carbon sequestration.[105] However, in the United States, mineral rights and subsurface pore space ownership on private land are commonly held by private parties, adding great complexity to the property rights equation.

The IOGCC Geologic Carbon Dioxide Sequestration Task Force has "identified three working models that can provide technological and regulatory guidance for [geologic storage]: (1) injection of CO_2 into underground formations for enhanced oil recovery (EOR) operations, (2) storage of natural gas in geologic reservoirs, and (3) injection of acid gas into underground formations."[106] According to the IOGCC Taskforce, the law governing short-term storage of natural gas is the most useful for the consideration of CCS.[107]

100. MASS. INST. OF TECH., THE FUTURE OF COAL: OPTIONS FOR A CARBON-CONSTRAINED WORLD 44 (2007), *available at* http://web.mit.edu/coal/The_Future_of_Coal.pdf.

101. *Id.*

102. INT'L ENERGY AGENCY, PROSPECTS FOR CO_2 CAPTURE AND STORAGE 190 (2004).

103. Wilson & de Figueiredo, *supra* note 98, at 10117–18.

104. IOGCC TASK FORCE, *supra* note 59, at 15.

105. *See* INT'L RISK GOVERNANCE COUNCIL, REGULATION OF CARBON CAPTURE AND STORAGE 13 (2008).

106. IOGCC TASK FORCE, *supra* note 59, at 15.

107. *See id.* at 15–16.

However, each of these legal paradigms should be examined because each adds to the understanding of the complexity of the property rights at issue.

a. Enhanced Oil Recovery Operations (EOR)

Through enhanced oil recovery operations, CO_2 is injected into an oil and gas reservoir in order to re-pressurize the reservoir and increase oil and gas recovery (termed secondary and tertiary recovery).[108] EOR operations have raised a number of legal questions regarding the operator's liability to adjacent property owners. While the operator has "the right to a fair share of the oil and gas in place and a duty to protect the common source of supply[,]" physical invasion of a neighboring mineral estate with a substance injected to enhance recovery is forbidden.[109] As a result, EOR operations will generally only take place in a field that has been unitized.[110] "With 'field unitization,' oil or gas field leases for resource development are combined, thereby creating a field-wide operation; liability is removed as a driving concern because production and profits are shared by all unit members, and the field is managed in order to optimize resource recovery."[111] In EOR operations that have not been unitized, liability has been imposed on the operator for mineral loss on the basis of trespass and nuisance.[112]

In the case of secondary recovery operations, the power of state regulatory boards to grant permits for forced unitization has been consistently upheld.[113] The unitization method may be of particular interest in the regulation of CCS given the uncertainty of where the CO_2 will travel once it is injected into a reservoir. For example, in *Phillips Petroleum Co. v. Stryker*, the Alabama Supreme Court reversed a finding of damages to a landowner's reservoir that

108. Wilson & de Figueiredo, *supra* note 98, at 10118.

109. *Id.*

110. The use of field unitization in oil and gas operations is widespread. Only Texas, the largest oil and gas producing state in the United States, does not have a compulsory unitization law. Jacqueline Lang Weaver, *The Tragedy of the Commons from Spindletop to Enron*, 24 J. LAND RESOURCES & ENVTL. L. 187, 187 (2004) ("Such a statute is universally recognized as necessary to assure the maximum efficient recovery of oil and gas while also allocating fair shares of a field's bounty to the different operators of leases overlying a common reservoir.").

111. Wilson & de Figueiredo, *supra* note 98, at 10118.

112. *Id.* Note that this is not the case in Texas under the "negative rule of capture" established in *Railroad Commission of Texas v. Manziel*, in which the Texas Supreme Court held that technical rules of trespass could not defeat a secondary recovery project. 361 S.W.2d 560, 574 (Tex. 1962).

113. Wilson & de Figueiredo, *supra* note 98, at 10118.

bordered a unitized EOR project, holding that under Alabama law the adjacent landowner could have petitioned for inclusion into the unitized project in order to protect his underlying reservoir.[114] In coming to this conclusion, the court stressed the importance of state administrative power to create and protect unitization projects.

b. Hazardous Waste Injection

Underground injection wells dispose of about fifty percent of the liquid hazardous waste produced in the United States; however, this amount is very small compared to the enormous quantities of carbon dioxide that will be stored in conjunction with CCS projects.[115] Leading case law in this area—premised on trespass, negligence, and nuisance—affirms the liability of operators for the intrusion of hazardous waste into the pore space of adjacent landowners.[116] However, these cases limit the adjacent landowner's likelihood of recovery by placing the burden of proof on the plaintiff and holding that claims for subsurface invasions "are only valid as long as the invasions actually interfere with 'reasonable and foreseeable' use of the subsurface."[117] In other words, the adjacent land owner must show that its own mineral operations are actually impacted, or that an expectation of profit from the use of pore space storage is impaired.

c. Natural Gas Storage

Natural gas is injected into shallow formations for temporary storage to maintain reserves.[118] The storage of natural gas in depleted reservoirs is not entirely analogous to the storage of carbon dioxide, as natural gas is generally stored for very short periods of time to provide for increased demand in winter months.[119] In addition, because natural gas itself is a valuable commodity, unlike hazardous wastes or CO_2 in this context, ownership of the injected gas has also been an issue. Thus, there are actually two separate issues to consider

114. *Id.* (citing Phillips Petroleum Co. v. Stryker, 723 So. 2d 585 (Ala. 1998)).

115. *Id.* at 10119.

116. *Id.* at 10119–20 (citing Mongrue v. Monsanto, 249 F.3d 422 (5th Cir. 2001); Chance v. BP Chem., Inc., 670 N.E.2d 985 (Ohio 1996)).

117. *Id.* at 10120.

118. Moore, *supra* note 29, at 461. Note that natural gas can also be stored in suitable salt caverns and natural aquifers. Wilson & de Figueiredo, *supra* note 98, at 10121.

119. Also, note that natural gas injection is exempt from regulation under the Underground Injection Control (UIC) program. Moore, *supra* note 29, at 462. However, the EPA and U.S. courts have held that CO_2 is not a "natural gas" under the UIC program or the Safe Water Drinking Act. *Id.* (citing Arco Oil & Gas Co. v. Envtl. Prot. Agency, 14 F.3d 1431, 1436 (10th Cir. 1993)).

when examining the law of natural gas storage: (1) the ownership of the injected gas, and (2) the ownership of the associated pore space.

i. Ownership of the Injected Natural Gas

State law has held that the natural gas injected into underground reservoirs remains the property of the injecting operator.[120] This has been found to be the case even where the injected natural gas migrated to an adjacent property owner's reservoir where the operator had not obtained storage rights:[121] "The storing party was found to have retained ownership rights even though the gas had migrated to production wells that were on the third party's land not within the designated storage area."[122]

ii. Ownership of the Pore Space

The property law of each state will control ownership of the depleted oil and gas reservoir pore space. There is no clear consensus on whether the ownership of the pore space lies with the surface estate or the mineral estate, and consideration of these rights varies significantly from state to state.[123] The two primary theories governing pore space ownership are termed the American Rule and the English Rule.

Under the American Rule, once subsurface minerals have been removed from the pore space, the surface owner—and not the mineral owner—retains the right to use the depleted space for storage.[124] In essence, the mineral estate owner only has the right to the actual minerals, not to the reservoir containing those minerals. This view has been adopted by a number of states, including Oklahoma, Louisiana, and Michigan.[125] However, a Michigan court was careful to note that any oil or natural gas that remains in the pore space can serve to preclude the surface owner from using the reservoir for storage.[126] Because certain amounts of oil and natural gas typically remain in formations even after recovery operations are completed, use of pore space for CCS may be complicated even in states where ownership clearly lies with the surface owner. The

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120. Wilson & de Figueiredo, *supra* note 98, at 10121.

121. *Id.* (citing Natural Gas Co. v. Mahon & Rowsey, Inc., 786 F.2d 1004 (10th Cir. 1986); Lone Star Gas Co. v. Murchison, 353 S.W.2d 870 (Tex. Ct. App. 1962)).

122. *Id.*

123. IOGCC TASK FORCE, *supra* note 59, at 16–19.

124. Wilson & de Figueiredo, *supra* note 98, at 10121.

125. IOGCC TASK FORCE, *supra* note 59, at 17–18.

126. *Id.* (citing Dep't of Transp. v. Goike, 560 N.W.2d 365 (Mich. Ct. App. 1996)).

owner of the mineral estate (and of any leased, operating, or future interests thereto) would retain an interest in the pore space for which he would have to be compensated.

Conversely, under the English Rule, which is followed in much of Canada as well as Kentucky, the mineral owner retains the rights to the subsurface pore space even after all minerals are extracted.[127] Complicating matters further, there are a number of states where the ownership of pore space has not been addressed or remains unsettled. This is of particular concern in Texas, where there is no clear general rule on pore space ownership unless it has been specified by contract.[128]

Legal commentators have also failed to come to any consensus as to the rightful ownership of pore space as between the mineral and surface estates. In their article entitled *Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law*, authors Elizabeth J. Wilson and Mark A. de Figueiredo conclude that while a majority of states adopt the view that the surface owner has rights to the spent reservoir space, mineral owners often retain a valid interest, so it is in the best interest of the entity who wishes to obtain rights to the pore space to compensate all estate owners.[129] In contrast, Williams and Meyers argue in their treatise on oil and gas law that the mineral estate, as the dominant estate, should retain ownership of the associated pore space, even after the minerals are depleted.[130]

2. Saline Formations

The property rights concerning saline aquifers are dependent on a separate legal regime governing groundwater rights.[131] Wilson and de Figueiredo have explored this legal system extensively.[132] While there is a developed body of law on the use of depleted oil and gas reservoirs for natural gas storage, there is virtually no case law on the use of saline aquifers for storage and associated property rights.[133] Rather, water law has focused on property rights concerning the use

127. Wilson & de Figueiredo, *supra* note 98, at 10121; IOGCC TASK FORCE, *supra* note 59, at 18–19.

128. IOGCC TASK FORCE, *supra* note 59, at 16.

129. Wilson & de Figueiredo, *supra* note 98, at 10123.

130. IOGCC TASK FORCE, *supra* note 59, at 20 (citing PATRICK H. MARTIN & BRUCE M. KRAMER, 1 WILLIAMS & MEYERS OIL & GAS LAW § 222 (2006)).

131. Wilson & de Figueiredo, *supra* note 98, at 10117.

132. *See* Wilson & de Figueiredo, *supra* note 98.

133. *Id.* at 10117.

of groundwater for consumption.[134] "In general, states follow one of five major doctrines with respect to ownership of groundwater rights: (1) absolute dominion, (2) reasonable use, (3) correlative rights, (4) the [R]estatement rule, or (5) prior appropriation."[135]

Pursuant to the absolute dominion rule, the owner of the surface estate has "absolute dominion" over all resources on, above, or below his property, including any underlying aquifer.[136] The "absolute dominion" owner may make any use of the underlying aquifer without risk of liability to an adjoining landowner.[137]

The next three doctrines are all essentially variants of the reasonable use rule. The reasonable use owner may also use underlying groundwater without restriction, as long as that use is reasonable and beneficial to the land itself.[138] The correlative rights rule is similar, except that owners over an aquifer are held to have apportioned shares of the aquifer dependent upon the amount of their land that overlies the resource.[139] The Restatement rule, based on section 858 of the Restatement (Second) of Torts, is very similar to the reasonable use rule with the exception that it allows use of the groundwater outside of the land overlying the aquifer.[140] An owner will be liable to adjacent property owners for unreasonable use that harms the aquifer.[141]

Finally, under the prior appropriation rule, which is used throughout most of the American West, the first person to make beneficial use of a water source establishes precedence over its continued use. However, some states have imposed a reasonable use requirement on this doctrine.[142]

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134. *Id.*

135. *Id.*

136. *Id.*

137. *Id.*

138. Judith Royster, *Indian Tribal Rights to Groundwater*, 15 KAN. J.L. & PUB. POL'Y 489, 499 (2006).

139. A. Dan Tarlock & Sarah B. Van de Wetering, *Western Growth and Sustainable Water Use: If There Are No "Natural Limits," Should We Worry About Water Supplies?*, 27 PUB. LAND & RESOURCES L. REV. 33, 51 (2006).

140. R. Timothy Weston, *Harmonizing Management of Ground and Surface Water Use under Eastern Water Law Regimes*, 11 U. DENV. WATER L. REV. 239, 252 (2008).

141. Wilson & de Figueiredo, *supra* note 98, at 10117.

142. *Id.*

a. Condemnation and Compensation

Given the implications of subsurface trespass law outlined above, establishing a reservoir for use in CCS will almost certainly require the purchase of all property rights that could be impacted by the project or the use of some sort of unitization process. The creation of such a geologic storage unit could potentially take months or years of negotiation, and some property interests will likely be adverse to use of their pore space for storage at all. The solutions to these problems are at least partially addressed by consideration of condemnation under natural gas law.

The Natural Gas Act of 1938[143] "provides for eminent domain for the construction of interstate natural gas pipelines," a power which the courts have held extends to the construction of underground storage facilities.[144] "Thus, if a gas company is unable to directly contract with property owners for storage rights, it can still obtain subsurface rights for storage by initiating condemnation procedures in a state or federal court."[145] If a reservoir is not interstate, then corresponding state condemnation laws must be used.

Most state statutes also provide for voluntary and involuntary unitization procedures. While these laws are currently focused on unitization for the purpose of mineral extraction, they could be useful in the establishment of a reservoir for CCS operations. Under involuntary unitization, once a certain percentage of owners in the field agree to unitization (anywhere from fifty to eighty-five percent), an application may be submitted to the state oil and gas or natural resources commission, and if the application is approved, a unit is created.[146] Thereafter, the remaining property interests will be compelled to participate in the unitized project, and are entitled to receipt of a portion of the proceeds.

Methods for compensation for natural gas storage remain uncertain. This issue was explored in depth in *Columbia Gas Transmission Corp. v. An Exclusive Gas Storage Easement*.[147] The

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143. 15 U.S.C. § 717 (2006).

144. Wilson & de Figueiredo, *supra* note 98, at 10122 (citing Columbia Gas Transmission Corp. v. Exclusive Gas Storage Easement, 776 F.2d 125, 128 (6th Cir. 1985); Steven D. McGrew, *Selected Issues in Federal Condemnations for Underground Natural Gas Storage Rights: Valuation Methods, Inverse Condemnation, and Trespass*, 51 CASE W. RES. L. REV. 131, 138–40 (2000)).

145. Wilson & de Figueiredo, *supra* note 98, at 10122.

146. *Id.* at 10119 (citing U.S. OFFICE OF TECH. ASSESSMENT, ENHANCED OIL RECOVERY POTENTIAL IN THE UNITED STATES 234 (1978)).

147. *Id.* at 10122 (citing *Exclusive Gas Storage Easement*, 776 F.2d at 128).

Sixth Circuit's analysis suggested that an award of "fair market value" could be based on any of the following methods:

> comparable sales of easements for natural gas in the particular formation; present value calculation (if sufficient natural gas exists for commercial recovery) of the "foreseeable net income flow from the property for its foreseeable life"; capitalization of rental income for the right to store gas, calculated by multiplying the area to be rented with the value of comparable storage rights; calculation of the depreciation of the entire tract from the taking of the easement used for storage; calculating the difference of the market value of the property before and after the taking; mineral lease value, and viewpoint value, i.e. the value calculated from the point of view of the landowner.[148]

While this case served to clarify the method of awarding fair market value for natural gas storage in subsurface formations in Ohio, the law of valuation remains unclear in most states and is largely undecided.[149]

b. Spectrum of Property Rights at Issue

As evidenced by the above discussion, the property rights at issue for any CCS project will depend upon both the geologic formation in which the CO_2 is injected, as well as the state law governing the particular type of formation. Any legal and regulatory framework for the promotion of CCS would have to take into account, at a minimum, the following property interests.

(1) Ownership of subsurface rights
- a. Storage in oil and gas reservoirs
- b. Storage in saline aquifers (separate legal regime)
- c. Storage in sub-seabed formations
- d. Pore space ownership issues
- e. Trespass and liability issues

(2) Ownership of surface rights
- a. Pore space ownership issues (overlap with subsurface rights)
- b. Access and construction of facilities

(3) Severed Estate Issues
- a. Lessees of solid minerals
- b. Oil and gas lessees
- c. Owners of non-operating interests

148. *Id.* (citation omitted).
149. *Id.*

d. Owners of future interests
e. Rights of adjacent property owners
(4) Condemnation and unitization
a. Condemnation
b. Voluntary unitization
c. Compulsory unitization
(5) Short-term ownership and liability issues
(6) Long-term ownership and liability issues

B. How Comprehensive Federal Legislation Should Deal with Ownership Issues

Due to the spectrum of property interests at issue, the diversity of treatment of these interests between the states and the reliance upon the states of these regimes governing existing CO_2 injection sites, federal law should not completely preempt this area of state property law as part of any comprehensive CCS federal legislation. Of particular concern is the risk of takings claims from each of these diverse property interests if federal law were to preempt in this area. Also of concern is the large extent of well-developed state property law that would be preempted through federal legislation, and how this preemptive legislation would interact with non-preempted state property law.

Furthermore, the IOGCC Task Force report, which has been widely cited by commentators, specifically recommends that "given the jurisdiction, experience, and expertise of states and provinces in the regulation of oil and natural gas production and natural gas storage in the United States and Canada, the states and provinces would be the most logical and experienced regulators of the geologic storage of carbon dioxide."[150] In keeping with this recommendation, the Task Force further recommended that rather than imposing a legal property framework on the states for the promotion of CCS technology, "control of the necessary storage rights should be required as part of the initial [Geological Storage Unit (GSU)] site licensing to promote orderly development and maximize utilization of the GSU," thus essentially leaving the question of site ownership to established state law.[151]

150. IOGCC TASK FORCE, *supra* note 59, at 3.
151. *Id.* at 27.

Rather than completely preempting this area of property law, federal legislation could include limited federal statutory authority for certain key elements and propose a type of model state legislation that could be adopted by states with less developed or unclear rules in order to better facilitate the proposed federal scheme. Such a model state legislation could be based on the more robust property regimes of the states that have examined this area. This preserves existing state law, but ensures that CCS operators in states without developed law would have a guide or proposal for moving ahead. An example of model legislation is provided in the Appendix. It addresses a number of factors that are of particular concern to subsurface property rights and should help to facilitate CCS deployment, including ownership of subsurface pore space and impacts on surface and mineral estates, state condemnation provisions, a post-closure ownership scheme, and unitization procedures.[152]

Federal legislation could address some aspects of CCS without preempting state law. Federal legislation should provide that no sequestration project may be permitted without ownership of all necessary property rights. If an operator could not secure all necessary property rights after legitimate and fair negotiations, federal legislation could further provide for condemnation proceedings for interstate projects modeled after the Natural Gas Act of 1938.[153] Under this statute, if eminent domain powers are exercised, the federal legislation provides for compensation of the property owner at fair market value.[154] The EPA, as the proposed CCS regulatory agency, could promulgate regulations establishing the method for determination of fair market value.

Federal legislation should also clearly provide that any right of eminent domain granted pursuant to the statute will not prejudice the owners of the land to other uses of the property not acquired for the storage facility. A similar condemnation procedure for intra-state reservoirs is also provided for in the model state statute.[155]

With a proposed liability scheme, federal legislation could also adopt a long-term ownership transfer and release of liability scheme that should help address concerns about long-term storage liability issues that are inherent to CCS. Under the laws governing natural

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152. This statutory language borrows heavily from similar statutes recently passed in Wyoming. *See, e.g.*, WYO. STAT. ANN. §§ 34-1-152, 34-1-202, 30-5-501, 35-11-313 (2008).

153. 15 U.S.C. § 717 (2006).

154. *Id.*

155. IOGCC TASK FORCE, *supra* note 59, app. 1.

gas storage, it is apparent that the injecting operator will retain ownership rights of the injected carbon dioxide, even if it were to migrate outside the designated receiving reservoir. This retention of ownership raises important issues regarding long-term monitoring and liability for the stored CO_2. Commentators have noted that the only entities that are likely equipped to reliably handle the long-term storage requirements of carbon dioxide are state and federal governments.[156]

Given these issues, federal legislation should adopt the post-closure property transfer and release of liability provisions (in primary part) proposed by the IOGCC Task Force in their 2007 report on *Storage of Carbon Dioxide in Geologic Structures*, to the extent it is consistent with overall provisions on liability. The Task Force, which was sponsored by the Department of Energy, included members from the IOGCC, state agencies, federal agencies from both the United States and Canada, industry representatives, academic and professional representatives, and environmental advocates. This diverse membership suggested a framework for long-term liability and property ownership that appears to be a workable solution for the promotion of CCS technology. The primary components are summarized as follows:

> Closure is proposed to be divided into a Closure Period and Post-Closure Period. The Closure Period is defined as that period of time when the plugging of the injection wells (excluding wells to be used as observation wells as agreed upon between the [CO_2 Storage Project (CSP)] Operator and the [State Regulatory Agency]) is completed and continuing until a future date is reached, defined as some period of time (10 or 29 years, etc.) after injection activities and the injection wells are plugged. During this Closure Period, the operator of the CSP would be the responsible party and be required to maintain the CSP operational bond and individual or blanket well bonds specified in Section 4. The individual well bonds will be released as the wells are plugged. At the conclusion of the Closure Period, the operational bond would be released and the liability for ensuring that the CSP remains a secure storage site during the Post-Closure Period would transfer to the state.
>
> During the Post-Closure Period the financial resources necessary for the state or a state contracted entity to engage in future monitoring, verification, and remediation activities would be provided by a state-administered trust fund.[157]

156. INT'L RISK GOVERNANCE COUNCIL, *supra* note 105, at 23.
157. IOGCC TASK FORCE, *supra* note 59, at 29.

The IOGCC scheme could be modified somewhat to conform to other liability elements in federal legislation. For example, during the Post-Closure Period, ownership could transfer to the United States, instead of a state, under a comprehensive liability scheme.

V. CONCLUSION

Jurisdiction, liability, and property rights are not the only issues that must be addressed in a comprehensive CCS statutory scheme. Other regulatory barriers need to be addressed as well. For instance, what regimes should govern Tribal Lands managed in the Federal Indian Trust System for which states may not have the right to regulate minerals?[158] Sequestering CO_2 offshore is also a viable economic option for CCS. But since offshore sequestration involves different jurisdictional issues, those must be addressed as well. Last, the potential for other state and federal laws to impede deployment of CCS must be examined as well. Many policy decisions would need to be addressed and the Environment, Energy, and Natural Resources Center at the University of Houston Law Center has attempted to address some of them through its research and draft legislative proposal for comprehensive CCS legislation.

There are genuine differences in how the policy questions of liability burden and property rights should be addressed. The approach taken in this article is not the only one. However, it is clear that there are serious regulatory questions that must be addressed to reduce the uncertainties facing those who would be the first adopters of CCS. Because of the importance of CCS to reducing GHG emissions, this statutory undertaking should be one of President Obama's most important natural resource priorities.

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158. *See* Assiniboine & Sioux Tribes v. Bd. of Oil & Gas Conservation, 792 F.2d 782, 796 (9th Cir. 1986) (noting that the Bureau of Land Management may preclude states from managing mineral resources on Indian Trust land).

APPENDIX

MODEL STATE/TRIBAL LEGISLATION

SECTION 1: OWNERSHIP OF PORE SPACE

Subchapter I. As used in this section, the term "pore space" is defined to mean subsurface space which can be used as storage space for carbon dioxide or other substances.

Subchapter II. The ownership of all pore space below surface lands and waters of the state is declared to be vested in the owner of the surface estate.

Subchapter III. A conveyance of the surface estate shall be a conveyance of the pore space in all strata below the surface of such real property unless the ownership interest in such pore space previously has been severed from the surface ownership or is explicitly excluded in the conveyance.

Subchapter IV. The ownership of pore space in strata may be conveyed in any manner provided by law for the transfer of mineral interests in real property. No agreement conveying mineral or other interests underlying the surface estate shall act to convey ownership of any pore space unless the agreement explicitly conveys that ownership interest.

Subchapter V. Nothing in this section shall be construed to change or alter the state or common law as it relates to the rights belonging to, or the dominance of, the mineral estate.

Subchapter VI. All instruments which transfer the rights to pore space under this section shall describe the scope of any right to use the surface estate. The owner of any pore space right shall have no right to use the surface estate beyond that set out in a properly recorded instrument.

Subchapter VII. Transfers of pore space rights made after ________________ (date of enactment) are null and void at the option of the owner of the surface estate if the transfer instrument does not contain a specific description of the location of the pore space being transferred. The description may include, but is not limited to, a subsurface geologic or seismic survey or a metes and bounds description of the surface lying over the transferred pore space. In the event a description of the surface is used, the transfer shall be deemed to include pore space at all depths underlying the described surface area unless specifically excluded. The validity of pore space rights under this paragraph shall not affect the respective liabilities of any party, and such liabilities shall operate in the same manner as if the pore space transfer were valid.

Subchapter VIII. Nothing in this section shall alter, amend, diminish or invalidate rights to the use of subsurface pore space that were acquired by contract or lease prior to ___________ (date of enactment).

Subchapter IX. It is the intent of the legislature to clarify the ownership of pore space underlying the surface of the lands and waters of this state. All conveyances of interests in real property on and after _________________ (date of enactment) shall be subject to the provisions of this Act. All conveyances of real property made prior to __________________ (date of enactment) shall be construed in accordance with the provisions of this act unless a person claiming an ownership interest contrary to the provisions of this act establishes such ownership by a preponderance of the evidence in an action to establish ownership of such interest.

SECTION 2: EMINENT DOMAIN AUTHORITY

(a) When any owner or operator of a sequestration project that has been licensed in accordance with the Act, cannot acquire by contract, or is unable to agree with the owner of property as to the compensation to be paid, all surface and subsurface property rights and interests necessary for construction and operation of the sequestration project, including, but not limited to, all necessary rights-of-way to construct, operate and maintain all pipelines, compressor stations, pressure apparatus, or other stations or necessary equipment or facilities, the owner or operator may acquire the same by the exercise of the right of eminent domain in the state courts.

(b) Owners of property subject to eminent domain authority shall be compensated at fair market value. The State environmental regulatory agency may promulgate regulations establishing the method for determination of fair market value.

(c) The right of eminent domain granted in this section shall not prejudice the rights of the owners of said land or other rights or interests therein as to all other uses not acquired for the storage facility.

SECTION 3: UNITIZATION

(a) The State Regulatory Agency, upon its own motion, or upon the petition by any interested party, shall conduct a hearing to consider the need for the operation as a unit of an entire pool or any portion thereof, in order to facilitate the use of the pore space for the storage of carbon dioxide or other substances.

(b) The State Regulatory Agency shall issue an order requiring unit operations, if it finds that:

1. Operation of the pool or any portion thereof is necessary to prevent waste, to facilitate use of the pore space for carbon dioxide or other substances, to avoid the drilling of unnecessary wells, and to protect the correlative rights of the property owners;

2. The unit operation of the pool or any portion thereof is reasonably necessary in order to carry on proper development, maintenance or other operations.

(c) The order issued by the State Regulatory Agency shall be upon terms and conditions that are just and reasonable for unit operations and shall include:

1. A description of the pool or portion thereof, to be so operated, termed the unit area;

2. A statement of the nature of the operations contemplated;

3. A just and reasonable allocation to the separately owned tracts in the unit area for the injection of all carbon dioxide or other substances into the unit area;

4. A provision for the credits and charges to be made in the adjustment among the owners in the unit area for their interest in wells, tanks, pumps, machinery, materials, and equipment contributed to the unit operations;

5. The time when the unit operations shall commence, and the manner in which, and the circumstances under which, the unit operations and the unit shall terminate and be dissolved;

6. Such additional provisions that are found to be appropriate for carrying on the unit operations, and for the prevention of waste and protection of correlative rights.

(d) General Provisions:

1. The State Regulatory Agency may approve additions to the unit portions of pools not previously included within the unit and may extend the unit area as necessary. The State Regulatory Agency may approve reductions to the unit area as necessary. An order

adding to or deleting from the unit area shall be upon terms that are just and reasonable.

2. A property owner not included in the original unit may petition for inclusion into the unit area.

3. All operations, including, but not limited to, the commencement, drilling, or operation of a site upon any portion of the unit area shall be deemed for all purposes the conduct of such operations upon each separately owned tract in the unit area by the several owners thereof.

4. The State Regulatory Agency, upon its own motion, or upon the petition by any owner, may for good cause terminate unit operations and dissolve the unit.

SECTION 4: TRUST FUND, LIABILITY RELEASE, AND TRANSFER OF OWNERSHIP

(a) Establishment of Trust Fund. There is hereby established a Carbon Dioxide Storage Facility Trust Fund to be administered by the State Regulatory Agency. There is hereby levied on the Owner or Operator a fee equal to ____ for each ton of carbon dioxide injected for storage for the purposes of funding the Carbon Dioxide Geologic Storage Trust Fund. The Trust Fund shall be utilized solely for the long-term monitoring and maintenance of the site and storage facility, including, but not limited to, maintenance and monitoring of remaining surface facilities and wells, remediation of mechanical problems associated with remaining wells and surface infrastructure, repairing mechanical leaks at the site, and plugging and abandoning remaining wells under the jurisdiction of the State Regulatory Agency for use as observation wells. The Trust Fund shall be administered by the Administrator.

(b) Liability Release/Transfer of Ownership. Ten years, or some other timeframe as established by rule, after cessation of operations, the State Regulatory Agency shall issue a Certificate of Completion of Injection Operations, upon a showing by the Owner or Operator that the reservoir is reasonably expected to retain mechanical integrity and remain emplaced, at which time ownership to the remaining project, including the stored carbon dioxide, transfers to the State.

(c) Upon issuance of the Certificate of Completion of Injection Operations, the owner or operator, and all generators of any injected carbon dioxide, shall be released from all further liability associated with the project. This section shall have no impact on the

Compensation Fund and associated regulations, which Fund will remain in effect at all times regardless of ownership of the pore space and stored carbon dioxide.