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Advancing Carbon Sequestration Research in an Uncertain Legal and Regulatory Environment

A Study of Phase II of the DOE Regional Carbon Sequestration Partnerships Program

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Advancing Carbon Sequestration Research in an Uncertain Legal and Regulatory Environment: A Study of Phase II of the DOE Regional Carbon Sequestration Partnerships Program

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Abstract

This study examines the legal and regulatory barriers encountered in carbon capture and sequestration (CCS) research, development and demonstration (RD&D) projects under the U.S. Department of Energy's (DOE) Regional Carbon Sequestration Partnerships Program. The study conducts a survey of 19 of the 25 Phase II geologic sequestration projects and examines two of these projects as case studies. The barriers encountered involved liability, consents, and permitting. They created challenges for small-scale RD&D projects that involve little risk, are in the public interest, and are essential to advancing our understanding of CCS if it is to contribute to mitigating climate change on a meaningful scale. To overcome these barriers, this study recommends the federal government adopt policies that provide a legal framework that supports CCS research, specifically a shield from property-related and long-term liabilities associated with sequestration for research organizations and other organizations supporting research; and government indemnity to protect and make whole property rights holders, parties granting consent to projects, and third parties who may be affected by CCS research. The study also recommends that the U.S. Environmental Protection Agency (EPA) consider simplified approval procedures under the Safe Drinking Water Act for small-scale research injections.

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The views expressed within this paper are the author's and do not necessarily reflect those of the Energy Technology Innovation Policy research group, the Belfer Center for Science and International Affairs, or Harvard University. This paper is available at www.belfercenter.org/energy.

Energy Technology Innovation Policy

The overarching objective of the Energy Technology Innovation Policy (ETIP) research group is to determine and then seek to promote adoption of effective strategies for developing and deploying cleaner and more efficient energy technologies, primarily in three of the biggest energy-consuming nations in the world: the United States, China, and India. These three countries have enormous influence on local, regional, and global environmental conditions through their energy production and consumption.

ETIP researchers seek to identify and promote strategies that these countries can pursue, separately and collaboratively, for accelerating the development and deployment of advanced energy options that can reduce conventional air pollution, minimize future greenhouse-gas emissions, reduce dependence on oil, facilitate poverty alleviation, and promote economic development. ETIP's focus on three crucial countries rather than only one not only multiplies directly our leverage on the world scale and facilitates the pursuit of cooperative efforts, but also allows for the development of new insights from comparisons and contrasts among conditions and strategies in the three cases.

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Introduction

Geologic carbon capture and sequestration (CCS) involves the capture of carbon dioxide (CO_2), typically at a power plant or industrial facility, transport, and ultimate injection of the CO_2 into subsurface geologic formations, principally saline formations, depleted oil and gas reservoirs, and deep uneconomically mineable coal seams. CCS can potentially make a significant contribution to mitigating climate change by permanently storing CO_2 produced by coal-fired power plants and other sources underground as opposed to emitting it to the atmosphere.

A growing number of commercial enhanced oil recovery (EOR), enhanced gas recovery (EGR) and permanent sequestration projects have already significantly advanced CCS knowledge. Projects are being undertaken in Europe, Africa, Australia, Japan, China and India.[1] StatoilHydro's Sleipner Field in the Norwegian Sea and its SnØhvit Field in the Barents Sea, the Weyburn CO_2-EOR Enhanced Oil Recovery project in the Weyburn Oil field in Canada, the BP/StatoilHydro In Salah Project in Algeria, and the Vattenfall Schwarze Pumpe power station in Germany are already operating.

Further research and development will be necessary to deploy CCS at the scale necessary to contribute to mitigating climate change. The U.S. Department of Energy (DOE) Office of Fossil Energy sponsors the Regional Carbon Sequestration Partnerships Program, a nationwide multi-phase program to assess the performance, costs, and risks of CCS over a broad range of geologic conditions in order to assess its feasibility at commercial scale. The DOE's partnerships program is a broad and appropriately ambitious research program for assessing and developing CCS as a potential method to address climate change. The International Energy Agency (IEA) recently convened an expert panel that reviewed the program and concluded that it will "significantly advance and accelerate" CCS, and that the size and scope of the program is unmatched throughout the world.[2]

This study surveyed 19 of the 25 Phase II geologic sequestration pilot projects of the DOE Regional Carbon Sequestration Partnerships Program for which data are available, and examined in detail two of these projects as case studies.[3] Appendix A lists the Phase II geologic sequestration projects surveyed in this study.

The survey and case studies reveal that issues surrounding long-term liability have created significant barriers in a number of small-scale research, development and

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[1] IEA Greenhouse Gas R&D Programme (2008). CO_2 Capture and Storage Projects Database, *available at* http://www.co2captureandstorage.info/search.php (accessed March 26, 2008).

[2] IEA Greenhouse Gas R&D Programme (2008). Expert Review of Regional Carbon Sequestration Partnerships Phase III.

[3] Phase II comprises 25 geologic sequestration projects and 11 terrestrial sequestration projects. Of the 25 projects involving geologic carbon sequestration, data were available for 19 projects. The study did not look at the terrestrial sequestration projects.

demonstration (RD&D) projects that are acknowledged to involve little or no risk. Without a clear legal framework governing liability or the ability of research partnerships to indemnify third parties for potential liability, substantial staff time and resources of research organizations were required to address these issues, leading to delays and in one case cancellation of a project. The study also found that permitting requirements under the Safe Drinking Water Act[4] for small-scale research projects have required significant research organization staff time.

The study uses the term "significant" or "substantial" interchangeably, to indicate those barriers that have or have the potential to consume substantial financial or personnel resources of research organizations, to the point that they can delay or block progress in conducting research. Clearing barriers to CCS research is important because this research is in the public interest and essential if we are to assess and develop CCS technology as a potential solution to climate change. The recommendations in this study are not intended to subordinate environmental protections to basic research; instead, they are intended to accommodate CCS research within existing legal and regulatory schemes that are not presently designed to accommodate such research.

To overcome legal and regulatory barriers to CCS research, this study recommends that the federal government provide a shield from property-related and long-term liabilities associated with sequestration for research organizations and other organizations supporting research; and government indemnity to protect and make whole property rights holders, parties granting their consent to projects, and third parties who may be affected by CCS research. The indemnification provision would be limited in scope, amount, and duration. The U.S. Environmental Protection Agency (EPA) should also consider a simplified approval process under the Safe Drinking Water Act (SDWA) for qualifying CCS research.

This study first explains the role that RD&D projects will play in supporting the development of commercial-scale CCS projects. It then briefly discusses the current state of U.S. law and regulation governing CCS as background to the conditions under which CCS research is conducted, and identifies areas of uncertainty due to an incomplete legal framework. Next, it introduces the DOE Regional Carbon Sequestration Partnerships Program, summarizes the results of the survey of 19 of the Phase II pilot projects and examines two case studies. Finally, it analyzes the legal barriers encountered in these projects, and, on the basis of this analysis, proposes policy recommendations for advancing CCS RD&D efforts in the United States.

Need for Continuing Research to Support Commercial-Scale CCS

Research will continue to be important to assessing and developing CCS after the Phase II projects have been completed.

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[4] 42 U.S.C. § 300f et seq. (2008).

Early pilot projects have shown that the most complete understanding of the site-specific behavior of CO_2 has come from monitoring the movement of CO_2 itself.[5] Research experiments have provided important information for studying CO_2 migration in various types of formations. Well-designed test injections could be employed to collect data on response measures to leakage or other contingencies. In a commercial setting, research-scale tests could be used during the assessment phase of a project before a larger investment is made in fully characterizing an area.

Members of the research community and practitioners interviewed for this study widely agreed that continued research will be essential to the development of CCS, even after CCS is deployed in several commercial-scale plants. Just as research in the oil and gas area continues and is increasing as that industry seeks to take advantage of new technologies and overcome increasingly challenging conditions as fields mature, research in various aspects of CCS is likely to be indispensable in such areas as exploring potential new sites, and improving tools for monitoring, measurement, verification and remediation.

CCS research also will be essential for stakeholders to assess various risks, including those relating to health and safety, commercial operations, liability for property and natural resources damage, trespass, and leakage of CO_2. These stakeholders include project developers, investors, lenders, service providers, land and rights owners, regulatory agencies, and insurers. A large and robust database containing multiple data points collected from actual projects over a broad range of geologic and other conditions (e.g., subsurface geophysical, depth, pressure, seismic, climatic) is necessary for developing more accurate metrics for engineering and costs, technological risks, risk assessment of geologic formations and specific sites, and development of early detection monitoring and risk mitigation plans in the event of leakage or unexpected events (e.g., sudden pressure change, increase in CO_2 concentration in soil, seismic events, brine intrusion to drinking water reservoirs).[6]

Incomplete U.S. Legal and Regulatory Framework Governing CCS

The United States currently does not have comprehensive federal law or regulations explicitly designed for CCS. Several regulations apply to different aspects of CCS activities. Most importantly, the EPA regulates underground injections of CO_2 pursuant to its authority under the SDWA, which protects the safety of drinking water supplies. Transportation and worker health and safety regulations also apply to industrial

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[5] Christine Doughty, Barry M. Freifeld, Robert C. Trautz, "Site Characterization for CO_2 Geologic Storage and Vice Versa: The Frio Brine Pilot, Texas, USA as a Case Study," 54 ENVIRONMENTAL GEOLOGY 1635-1656 (2007).

[6] The DOE's NatCarb initiative, which links geological and emission databases from several regional centers into a single interactive mapping system, could play an important role in ensuring that these data are publicly available.

operations involving CO_2. The Resource Conservation and Recovery Act (RCRA)[7] and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[8] also potentially apply to CCS activities. Property and related liability issues fall outside federal regulations governing CCS,[9] and are handled by different state laws, none of which specifically provide for CCS within a coherent legal framework. Appendix B provides a summary of U.S. federal and state laws governing CCS.

Without a comprehensive or consistent legal framework at either the federal or state level, CCS faces legal uncertainty in virtually every aspect of activity, including:[10]

- CO_2 capture (e.g., performance requirements under future regulation)
- CO_2 transportation (e.g., pipeline ownership, safety, regulation and access)
- State property law governing reservoirs, pore space, and injected CO_2
- Liability for leakage of CO_2 (regulatory liability for emissions control, and contractual liability for carbon trading)
- Liability for damage to property (induced seismicity, commingled resources)
- Liability for trespass (multiple users of reservoirs, boundary disputes, including transnational and international waters)
- Liability for CCS activities after transfer of ownership of property
- Liability under RCRA, CERCLA and other environmental statutes
- Health, safety and environmental liability (worker safety, groundwater contamination, flora, fauna) under federal and state regulations
- CCS site selection, permitting, operation and closure
- Long-term monitoring, remediation, and financial responsibility for CCS sites
- Treatment and accounting of CCS as a mitigation measure under voluntary and mandatory climate change regimes

DOE Regional Carbon Sequestration Partnerships Program

The DOE launched the Regional Carbon Sequestration Partnerships Program in 2003 to develop the infrastructure and knowledge base needed to commercialize carbon sequestration technologies. The program comprises three phases: (I) characterization of national CO_2 storage potential in deep oil-, gas-, coal-, and saline-bearing formations; (II) twenty-five geologic sequestration RD&D test injection projects to validate that these different geologic formations have the injectivity, containment, and storage effectiveness

[7] 42 U.S.C. §6901 et seq. (2008).

[8] 42 U.S.C. §9601 et seq. (2008).

[9] See In re Core Energy, LLC, UIC Appeal No. 07-02 (E.A.B., December 19, 2007).

[10] See IEA (2007), Legal Aspects of Storing CO_2 Update and Recommendations for Future Work; Kipp Coddington, Robert Mowrey, Geir Vollsaeter, and Kristin Holloway Jones, CCS Issues under the Safe Drinking Water Act, dated May 10, 2008 (on file with the author).

necessary for long-term sequestration, and eleven terrestrial sequestration projects;[11] and (III) seven commercial-scale geologic sequestration projects to demonstrate the engineering and scientific processes and to validate the long-term safe storage of CO_2 in several major geologic formations capable of storing emissions generated from major point sources, on a cost-effective basis.[12] Appendix A contains a list of the Phase II geologic sequestration projects surveyed in this study.

The program is organized as seven regional partnerships, each tasked with conducting all phases within their region. At the time of writing, the program has substantially completed Phase I for most of the United States, has completed or commenced most of the Phase II projects, and is in the early stages of the Phase III projects.

The 25 Phase II geologic sequestration RD&D projects range in size from 43 tons of CO_2 in a single injection to approximately one million tons of CO_2 injected over a two to three year period, with most projects being a few thousand tones of injected CO_2. Phase III commercial scale demonstration projects will generally be in the range of one to five million tons of injected CO_2 at each site during a period of three to six years.

Legal Barriers Encountered in Phase II Projects

This section reports the legal issues that posed the most common and significant barriers to implementing Phase II projects: long-term liability, consents, and permitting.

Of the 25 Phase II geologic sequestration test injection projects, this study conducted a survey of the 19 projects for which data were available in order to assess the legal issues encountered. The survey questionnaire is presented in Appendix C to this study.

Frequency of Legal Barriers and Impact on Phase II RD&D Projects

Of the 19 pilot projects surveyed, 11 reported significant legal issues. These legal issues consumed substantial financial or personnel resources, to the point that they delayed or blocked research projects. Legal issues relating to liability have caused one project to be cancelled, forcing the lead research organization to locate a new site and start over.

Significantly, legal barriers were encountered in small projects. A majority of the projects in the 2,000 to 10,000 ton range of injected CO_2 and all of the projects above

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[11] Terrestrial carbon sequestration involves changing the management of forests, rangelands, agricultural lands, and wetlands in order to remove more CO_2 or reduce emissions of CO_2 from these ecosystems. This study does not look at the DOE Phase II terrestrial sequestration projects.

[12] U.S. Department of Energy (2008). http://www.fossil.energy.gov/programs/sequestration/partnerships/index.html (accessed on April 5, 2008).

10,000 tons of injected CO_2 reported some kind of significant legal barrier. Only for volumes of 1,000 tons or less of injected CO_2 were legal issues largely absent.

Projects Reporting Legal Barriers by Injection Volume

CO_2 Injection Volume in Tons	**1,000 or Less**	**2,000 to 3,000**	**10,000**	**30,000 to 50,000**	**300,000+**
Number of Projects	5	7	2	2	3
Number Reporting Legal Barriers	1	4	1	2	3

According to survey respondents, the time devoted to non-research functions (legal, permitting, administrative) ranged from 5% to as high as 90% of overall personnel time where significant legal issues were encountered. In no cases were research staff trained to deal with legal issues. In several cases, private parties participating in the various Regional Sequestration Partnerships Program expended substantial resources to assist the research organizations in resolving property rights and legal liability issues, and obtaining consents.

The prevalence of legal barriers for RD&D projects at relatively small injection volumes, even where risks associated with health and safety, property damage and CO_2 leakage were widely acknowledged by stakeholders to be negligible, suggests that future RD&D projects will continue to face significant legal hurdles. The experience gained in Phase II provided important information to identify the regulatory barriers to implementing CCS (which is one of the goals of the DOE program). Research organization staff time and resources devoted to addressing legal issues should be minimized in order to support and advance CCS research in Phase III and future research programs.

Types of Liability

Liability issues appear in different contexts that should be distinguished because only certain types of liabilities posed barriers to CCS research in Phase II. The categories used here are ordinary liabilities associated with the conduct of firms providing commercial services, and longer-term liabilities associated with potential damage to property and life as a result of sequestration activities.

The first category of liability/indemnification issues relating to the conduct of commercial firms providing services, such as drilling and injection services, did not pose a barrier to Phase II research and this study did not produce any evidence that this type of liability will pose a barrier to future research projects. Service providers are already subject to a duty of care defined under tort law and are typically subject to standards of conduct imposed under their contractual arrangements. Companies providing specific services have experience in their industries, and are appropriately subject to liability for worker safety and property damage resulting from their conduct. These companies are best positioned to manage the risks associated with their own conduct and are able to obtain liability insurance for their conduct and workers. In the survey and our case studies, companies were willing to provide services on a commercial basis and generally willing to accept liability for their actions. Accordingly, these types of liabilities are not included within the scope of the liability shield proposed by this study.

The legal barriers encountered in the Phase II projects associated with liability relate to long-term permanent sequestration of CO_2, specifically health and safety risks, potential property damage (land and minerals), leakage of CO_2 and potential tort liability for trespass of CO_2 into other property. Appendix B to this study provides an overview of the health and safety, environmental, property and tort laws that provide the legal basis for the long-term liabilities that are of concern here. Potential long-term liability posed significant barriers for active participants in Phase II projects, as well as passive participants, such as rights holders whose consent is required for a project. Lead research organizations, typically national laboratories or universities, are not appropriate parties to bear these liabilities and in at least some cases are unable to accept such responsibility. These types of liabilities are therefore within the scope of the liability shield and indemnification provision proposed by this study.

Long-Term Liability Issues

For small-scale Phase II projects, stakeholders generally acknowledged that the test injections posed very little risk to health and safety, or of property damage or trespass, due to migration or leakage of CO_2. Nevertheless, in 9 of the 14 projects surveyed for which data was provided on liability issues, long-term liability was an issue of negotiation. Six projects resolved their liability issues because private parties accepted responsibility for potential long-term liability. Inability to resolve liability issues caused one project to be cancelled, forcing the lead research organization to locate a new site and start over. In 5 projects, the liability issue was not raised yet parties are proceeding with those projects. At the time of writing, 2 projects are still negotiating liability issues, two projects have not started negotiating (thus no data are available), and 3 projects declined to comment on the liability issue.

Phase II Projects: Occurrence and Outcome of Long-Term Liability Issues

Outcome	Number of Projects
Liability Assumed by Project Party	6
Liability Not Raised in Negotiations	5
Liability being Negotiated – No Result Yet	2
Project Cancelled Due to Liability	1
Declined to Comment	3
No Data – Negotiations Not Started	2

Where liability issues occurred in Phase II projects, they consumed significant research organization staff time and resources. The liability issues proved to be difficult to resolve because of the inability to demonstrate a limit to liability in amount or time based on past experience, and because the lead research institutions contracted to conduct the Phase II projects were not authorized to, and would not ordinarily be expected to, indemnify third parties for potential liabilities associated with research projects. Significantly, liability issues can be expected to increase in importance for larger Phase III research and commercial CCS projects.

Insurance was sought in at least two Phase II projects as a means to address potential liability; however, long-term insurance is not currently available for CCS activities. For a commercial scale project, insurance is likely to be essential.

Consents

The Phase II projects surveyed appropriately sought consents from surface and subsurface rights holders (mineral rights owners and lessees). None of the projects sought consents from rights holders in neighboring properties because the paths of the CO_2 injection plumes are expected to be within the injection site properties for all projects.

The ability to obtain consents is closely linked to resolving long-term liability issues. In 6 of the 19 projects, rights holders provided consent in return for receiving indemnification to protect them against harm or liability. In one instance, the inability to resolve liability issues resulted in a project being unable to obtain consents and to it being cancelled, requiring researchers to start over at a new site. Two projects are still negotiating for consents, 2 projects have not yet started negotiation, and 3 projects declined to comment on the consents issue.

Six projects reported demands by property rights holders for compensation for the use of, or immediate impact on, their property. These property rights holders included surface and subsurface owners and lessees of the project site. In contrast to long-term liability issues that led to requests for potentially open-ended indemnification, compensation demands were limited in amount and based on market terms (e.g., rental of pad space for injection equipment).

The survey revealed that some of the partnerships experienced significant difficulty obtaining consents from all required parties for Phase II projects. Obtaining consents from the various parties that may hold property rights in a CCS site (e.g., surface owners, mineral rights holders, mineral rights lessees, water users) required considerable time and expense in some cases.

In Phase III, injections of larger quantities of CO_2 will likely require consents from a greater number of rights holders as the size of the CO_2 plume increases. In turn, this will increase the complexity of obtaining consents for CCS projects.

Evidence from Phase II suggests that resolving long-term liability issues is a necessary step to encouraging rights holders to provide the consents required for RD&D projects. No conclusion can be drawn based on Phase II as to whether further measures, such as the exercise of eminent domain, would be necessary to address the consent issues for the larger scale CCS research projects to be undertaken in Phase III. The study results also suggest that additional financial and personnel resources will be increasingly important to obtain consents for larger projects involving multiple rights holders, although these resources may continue to be provided by private sector research partners.

SDWA Permits

The time and cost associated with preparing SDWA permit applications, and the time required for agency review, have caused delays and can impose burdens on small-scale research projects due to limited personnel and financial resources.

Although the EPA issued guidance recommending that injection permits be issued as Class V experimental Underground Injection Control (UIC) test wells,[13] for the 19 pilot tests surveyed (1 project involving 2 injections at different strata for a total of 20 injections), 12 permits have been issued or are expected to be issued as Class II permits for EOR/EGR injections. Interviews revealed that decisions concerning the class of UIC permit applications were typically based on the type of activity most closely associated with the injection (e.g., EOR/EGR) and the recommendations of partners and the government agencies issuing the injection permits. Interviewees commonly cited greater experience with CO_2 injection under EOR/EGR-related Class II permits and their perception that Class II permits are easier to obtain than Class V permits.

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[13] U.S. Environmental Protection Agency, UIC Program Guidance No. 83, "Using the Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects," March 1, 2007, *available at* http://www.epa.gov/safewater/uic/pdfs/guide_uic_carbonsequestration_final-03-07.pdf.

Phase II Project Wells by Formation Type and UIC Class

	Oil & Gas	Coal	Saline	Total
Class II	7	4	1	12
Class V	1	1	6	8
Total	8	5	7	20

Note: The survey includes the Calpine-Rosetta project as it was originally planned before its cancellation. As planned, it would have involved 2 injections at different levels in a stacked saline aquifer and gas field, requiring two permits, for a total of 20 permits for the 19 projects surveyed.

EPA review of permit applications is generally expected to require between 6 to 9 months based on EPA estimates provided to certain of the partnerships in informal consultations. State agency review under Class II, where available, is expected to require less time, in some cases requiring only 1 to 2 months.

The lack of uniformity inherent in the SDWA UIC program also poses challenges for the research partnerships. Under the UIC program, some states have primacy for all classes of wells, some states have primacy for Class II wells, some states have primacy for all classes of wells except Class II, and some state UIC programs are operated by the regional U.S. EPA office. Where states administer the program, authority is held by oil and gas divisions or environmental protection agencies, depending upon the class of permit. These agencies may take differing approaches to the protection of drinking water under the SDWA. Each project will therefore involve different regulators and permitting strategies depending upon the regulatory framework governing the particular project.

Permitting requirements imposed significant demands on staff time for some of the partnerships, and the uncertain duration of the permitting review process complicated planning decisions for others. The resources required to prepare permits for small-scale research projects could decrease in the future as researchers and regulators gain experience in permitting CCS-related activities. As described below, this study recommends that EPA consider streamlined review procedures for small-scale research projects based on the experience gained in Phase II.

Role of Private Sector and EOR/EGR in Phase II Projects

Private sector parties participated in all of the Phase II projects, demonstrating the important role that the private sector plays in sequestration research. Private sector expertise and resources will continue to be essential in supporting Phase III sequestration projects and in developing capture technologies, many of which are being tested at private sector plants.

The role of the EOR and EGR industries in supporting Phase II projects is particularly significant. For the 19 projects surveyed there were 20 injections (1 project involving 2 injections at different strata), 12 of which are EOR/EGR injections, and an additional 2 are on sites in which EOR or EGR activities are conducted. The predominance of EOR and EGR among Phase II projects reflects the advantage they enjoy compared to saline-formation sequestration due to the low cost of adapting existing commercial infrastructure for EOR and

EGR operations to CCS research, and the abundance of private financial and institutional support available for EOR/EGR-related RD&D.

EOR/EGR partners provided drilling and injection services to the projects. In several cases, they also expended significant resources to resolve legal issues. EOR/EGR mineral rights holders, operating companies, and drilling companies accepted long-term legal liability in all 6 cases in which these issues were raised and have been successfully resolved. In these 6 projects, 4 of the projects involve injection volumes up to 3,000 tons of CO_2 and 2 involve injection volumes over 50,000 tons of CO_2. Five of 6 of these projects, including the 2 larger ones, are EOR/EGR related projects in which the party accepting liability has an economic incentive in the petroleum or gas to be produced or is a service provider. In the one non-EOR/EGR project, a drilling company established in the EOR/EGR field accepted liability. Notably, the 5 projects in which liability was not raised in negotiation are all EOR/EGR projects, which may indicate that liability is not a significant issue for the EOR/EGR industry for the types of injections in Phase II.

Power generators have partnered in 4 of the 7 saline Phase II projects. Like EOR/EGR partners, they have provided resources to resolve legal issues. However, at the time of writing, no generator has accepted liability for their projects.

Case Studies of Two Phase II Projects

The case studies examined in this study provide an example of a successfully completed project and a withdrawn project. These cases show that the resolution of legal issues significantly affects project outcomes.

Both cases are drawn from the DOE Phase II small-scale geologic sequestration test injection projects surveyed in this study: the Otsego County, Michigan pilot test conducted by the Midwest Regional Carbon Sequestration Partnership (MRSCP), and the Calpine-Rosetta injection project operated by the West Coast Regional Carbon Sequestration Partnership (WESTCARB) through the Lawrence Berkeley National Laboratory (LBNL).

Otsego County, Michigan Pilot Test

The Otsego County, Michigan test injection is the first Phase II project in a deep saline formation to be completed under the DOE program. The injection was completed during Spring 2008.

This project is located near Chester Township in Otsego County, Michigan. The purpose of the project is to assess the potential of carbon sequestration in the Bass Island Dolomite and Bois-Blanc layers, an important sequestration target in the Michigan Basin.

This project involves injection of approximately 10,000 tons of CO_2 into a deep saline formation located about 3,190 to 3,515 feet below ground for permanent storage. The plume is expected to be less than 500 feet from the injection site, which is well within the property boundaries.[14] The test site is within a much larger oil and gas production site.[15] Oil production using CO_2 EOR methods is taking place separately on the same property at a depth of about 5,500 feet.

The surface and mineral rights are owned by the Michigan Department of Natural Resources. The mineral rights have been leased to Core Energy, an oil production company, which conducts CO_2 EOR activities on the property and is providing drilling and injection services to the test project.

Battelle Memorial Institute operates the project under contract with the DOE. DTE Energy, a utility, provides financial support to the project and provides the CO_2 for injection collected from its Turtle Lake gas processing plant. Both the EPA and the Michigan Department of Environmental Quality issued permits for the test injection.

The project proponents declined to comment on long-term liability and indemnification issues. The project enjoyed support from those stakeholders directly involved. The Michigan Department of Natural Resources that owns the land was supportive of the project's research goals and viewed the CCS activity as similar in nature to EOR activity that is already occurring on other parts of the property with its approval. As noted above, the mineral rights lessee also supports the project by providing drilling and injection services, and is engaged in EOR on the property.

The only significant legal barriers reported in this case resulted from a challenge to the EPA issuing a Class V UIC permit to Core Energy to undertake the injection.[16] A petitioner who is a resident of Otsego County located about a mile outside the quarter mile regulatory Area of Review opposed the permit, on the grounds that there was an "absence of a clear policy addressing potential liability for any damages that might result from the permitted activity,"[17] and that the permit potentially violates the rights of adjacent property owners because the operation of the well would result in subsurface trespasses.[18]

The Environmental Appeals Board (EAB), which hears challenges to certain EPA actions, denied the petition for review on December 19, 2007, and denied a motion for reconsideration on January 15, 2008. In its first decision, the EAB declined to rule on the liability question on the grounds that it had not been raised during the public comment period and so had not been preserved for appeal. With respect to the property rights claim, it held that EPA does not have authority under SDWA to adjudicate surface,

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[14] Neeraj Gupta, Battelle Memorial Institute, personal communications, May 6, 2008.

[15] Project Facts: Midwest Regional Carbon Sequestration Partnership – Validation Phase, U.S. Department of Energy, National Energy Technology Laboratory, April 2008, *available at* http://www.netl.doe.gov/publications/factsheets/project/proj445.pdf.

[16] See In re Core Energy, LLC, UIC Appeal No. 07-02 (E.A.B., December 19, 2007).

[17] *Id.* at 7.

[18] *Id.* at 9.

mineral, or storage rights when issuing permit decisions. Citing EPA's submission, EAB noted that "Issues relating to property ownership or lessee rights are legal issues between the permittee and property owners. "[19] These property rights issues are governed by state law.

Rosetta-Calpine Carbon Sequestration Project, Thornton, California

The Rosetta-Calpine Carbon Sequestration Project is an example of a project that was cancelled in part due to the legal issues described in this study.

This project was to be located in the Sacramento Valley on a site over an abandoned gas field in Thornton California. Gas production at the site began in the mid 1940s and continued through the late 1980s, producing 53.6 billion cubic feet from 15 production wells.

The purpose of the project was to assess CO_2 storage potential in the Sacramento Valley. The project was located near the partially depleted Rio Vista gas field, which is the largest gas field in California and possesses an estimated 1.7 Gt CO_2 storage capacity alone.[20]

The site was selected from among eight sites assessed in the Southern Sacramento Basin based on safety, technical and logistical criteria, and favorable results from EGR studies. EGR involves a similar CO_2 injection process to EOR, but relies on reservoir repressurization or pressure maintenance and methane displacement to produce additional natural gas.

The project site is zoned for agricultural use and is leased for farming. It is located in a rural location half a mile from the closest residence. The property is bounded by agriculture to the south, east and west, and to the north by the Cosumnes River Preserve, which is operated by The Nature Conservancy, a non-profit conservation group. The preserve is the winter home for migratory birds, including at least one listed as threatened by the state of California.

This project would have injected approximately 2,000 tons[21] of CO_2 into a saline formation located approximately 3,500 feet to 5,000 feet underground. A second test of

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[19] *Id.* at 9.

[20] Robert Trautz, Sally Benson, Larry Myer, Curtis Oldenburg, Ed Seeman, Eric Hadsell, and Ben Funderburk, "The Rosetta Resources CO_2 Storage Project – A WESTCARB Geologic Pilot Test" (January 30, 2006). Lawrence Berkeley National Laboratory. Paper LBNL-59655, *available at* http://repositories.cdlib.org/lbnl/LBNL-59655.

[21] This is the amount of CO_2 generated by a typical 1,000-megawatt (MW) coal-fired power plant in approximately 2.2 hours. CO_2 is highly compressible, its density influenced by pressure and temperature. At injection depths, pressure is approximately 1,500 pounds per square inch (102 atmospheres) and the temperature is approximately 130˚F. Under these conditions, 2,000 tons of CO_2 would have a volume of about 200,000 cubic feet or about the size of a football field 3.5 feet deep. Lawrence Berkeley National

an additional 2,000 tons of injected CO_2 into a depleted natural gas reservoir formation located above the saline formation at approximately 3,000 feet below ground was also contemplated.

A single injection well, cased in cement and perforated to permit fluid flow into and out of the formation, was to be used for injection into both the saline formation and the depleted gas reservoir. A separate observation well was to be fitted with monitoring equipment. Following drilling, the geologic features of the wells would be logged in open hole and cased condition, and baseline conditions characterized including fluid sampling, geophysics, soil gas survey, and reservoir pressure. Upon completion of the project, the wells would be abandoned in accordance with California State law and the site would then be restored.

The site landowner is a state government entity. A multinational insurance and financial company owns the subsurface rights, which in turn leased these rights to Calpine Corporation, a publicly-traded independent power producer. Calpine entered into an agreement to undertake and support the pilot project by contributing drilling and other services. Calpine later transferred its subsurface property rights to Rosetta Corporation, a gas exploration and production company, along with the obligation to support the project. LBNL provided technical leadership for carrying out the project, including conducting modeling, monitoring and verification of the pilot tests, and assisting in preparing permit applications. A private third party company would provide injection and project management services.

Consents were sought from the rights holders of the property on which the injection site was located. The injected CO_2 was not expected to migrate across the property boundaries. Both the state government landowner and the mineral rights holder sought indemnification for any liabilities that could occur in connection with the project. The mineral rights owner also sought full indemnification, including for potential damages to its mineral rights. Rosetta and the injection services company, both of which are experienced companies in the gas industry, were both willing to conduct drilling and injection activities without indemnification for those specific activities.

EPA Region IX has jurisdiction over most SDWA approvals in California, except for the California State Department of Oil, Gas and Geothermal Resources (DOGGR), which retains jurisdiction over extraction or injection involving oil and gas reservoirs. LBNL had planned to prepare and file a Class V UIC permit application with EPA Region IX for the injection into the saline formation, and to prepare and submit an injectivity permit application within the Class II permit regulations for the injection into the depleted natural gas reservoir. The project was cancelled before an application was prepared and submitted to EPA or DOGGR for permits, however, the project parties had informally consulted these agencies in advance.

Laboratory (2008), Project Description: Arizona Utilities CO_2 Storage Pilot Project (Draft dated March 2008) (on file with the author).

Several of the stakeholders expressed the view that injection of 2,000 tons of CO_2 does not present any significant health and safety risks. Although the risks were widely viewed as minimal, the liability issues proved to be a significant barrier to this project. No private party partner possessed the economic incentive, and LBNL and DOE lacked authority, to indemnify project participants for potential liabilities. Without the ability to resolve these issues, key participants in the project withdrew, ultimately causing the project to be cancelled.

Permitting did not appear to be a major obstacle, although there was concern about the amount of research organization staff time and other resources required to obtain permits.

LBNL is now working with new partners at a new test location in the Sacramento Valley to develop a Phase II injection project to replace the Calpine-Rosetta project.

Recommendations for Advancing CCS Research

The Phase II pilot projects involved very little risk to health and safety, or of property damage or trespass, due to migration or leakage of CO_2, yet they encountered significant legal barriers, sometimes requiring substantial commitments of personnel time and financial resources to resolve. Long-term liability issues appear to be the primary barrier to advancing CCS RD&D research. The experience gained in Phase II strongly suggests that liability issues will pose significant barriers to advancing CCS research in Phase III.

In all 6 Phase II projects in which liability issues have been raised and resolved, EOR/EGR mineral rights holders, operating companies, and drilling companies that had an economic interest in the petroleum or gas produced or in providing services accepted long-term liability. These were relatively small projects under 3,000 tons or larger projects in which the injection of CO_2 was for EOR/EGR purposes and the economic incentives were substantial.

In Phase III, CO_2 injection volumes increase significantly and saline formation projects are the focus of research. Private parties may not continue to voluntarily accept liability in Phase III saline-formation projects that do not involve strong economic incentives such as those associated with EOR/EGR projects. In the absence of strong private economic incentives, saline formation research is an appropriate priority for government support because saline formation capacity is estimated to represent as much as 84% of geologic storage capacity in the United States.[22]

Policies such as cap-and-trade and carbon taxes can generate support for various greenhouse gas mitigation technologies, including CCS. However, in the absence of or in

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[22] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, EPA-HQ-OW-2008-0390 FRL-8695-3, July 15, 2008, 73 Fed. Reg. 43492 (July 25, 2008).

addition to such economy-wide policies, government policies specifically addressing the barriers to CCS RD&D are necessary to promote maturation of the CCS industry. Once a commercial CCS industry exists, policies such as a carbon tax or cap-and-trade system would then promote market adoption of CCS technologies.

Government can advance CCS by providing a legal framework that addresses the barriers to CCS RD&D identified in this study. Most importantly, this study recommends a shield protecting research organizations and other organizations supporting research; and government indemnity to protect and make whole property rights holders, parties granting consent to projects, and third parties who may be affected by CCS research. It also recommends that EPA provide a simplified approval process under the SDWA for qualifying small-scale injections.

Liability Shield and Government Indemnification for CCS RD&D Projects

A statute shielding research organizations and organizations supporting research from legal liability would provide important support for the further development of CCS. Where research organizations and supporting organizations either lack a commercial motivation or they are not permitted to accept liability (as is frequently the case for research institutions), shielding these parties from liability will be essential.

A liability shield should be coupled with government indemnification to protect and make whole property rights holders, parties granting consent to projects, and third parties who may be affected by CCS research. The liability shield and indemnification provisions would be limited in scope, dollar amount and duration.

The scope of the liability shield and government indemnification provision could be limited in a number of ways. They should cover only CCS RD&D activities (e.g., test injections, monitoring, measurement and verification, demonstration) that result in public disclosure and dissemination of data. The liability shield and government indemnification provision should only cover long-term and property-related liabilities because these liabilities pose potentially significant barriers to CCS research. The provision of commercial services, such as drilling and injection services, would not be included within the scope of the liability shield and indemnification provision proposed here. Only RD&D-phase liabilities would be covered; if a RD&D project is converted to commercial sequestration, the liability provisions should no longer be available. The liability shield and indemnification provision could also be limited to non-EOR/EGR sequestration, in particular saline formations which lack the economic incentives associated with EOR/EGR applications.

Qualifying projects could also be subject to a number of technical conditions designed to protect health and safety, and to reduce government exposure to potential liability under an indemnification provision. These requirements could include limits on volume of injection, depth of injection, purity of injectate, and proximity to underground sources of drinking water, human settlements, or ecologically sensitive areas. The DOE possesses resources in the national laboratories to provide guidance for establishing appropriate technical conditions.[23] Other prudential conditions for a project to qualify for the liability shield and government indemnity could include management by a recognized national laboratory, university, or private entity approved by the DOE; and DOE project approval.

The private sector possesses important capabilities and resources that are necessary to support CCS research. The liability shield and indemnification provision should extend to protect private parties to the extent they participate in a qualified research program for long-term liabilities associated with sequestration. However, as noted above, this coverage should not relieve commercial service providers of potential liability for their conduct based on legal and contractual duties of care. The precise balance between these two principles would need to be established in legislation.

The duration of the liability shield and government indemnification would be limited to projects initiated during the period authorized by Congress. The protections provided by the liability shield and indemnification provisions should be available indefinitely to qualifying projects. As noted above, however, if a RD&D project is converted to commercial sequestration, the liability provisions should cease to be available.

Finally, the indemnification provision proposed here would be limited in dollar amount. The specific amount authorized for the government indemnification provision are beyond the scope of this study and would require further evaluation of future CCS research needs, including the Phase III RD&D projects. However, it is important to note that the amount should be limited and need not compete with supporting other priorities, such as renewable energy. Congress possesses several funding options that do not necessarily compete with other priorities, including imposing a charge on industry that would employ CCS technology in the event of a claim against the government indemnification provision, an allocation of allowances or credits under a cap-and-trade system that would provide revenues to support a special fund, or funding from general tax revenues in the event a claim is made.

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[23] See Curtis M. Oldenburg and Steven L. Bryant, Certification Framework for Geologic CO_2 Storage, Sixth Annual Conference on Carbon Capture and Sequestration, National Energy Technology Laboratory, Pittsburgh, PA, May 7-10, 2007 available at www.netl.doe.gov/publications/proceedings/07/carbon-seq/data/papers/tue_062.pdf; Curtis M. Oldenburg, Steven L. Bryant, Jean-Philippe Nicot, and Ying Zhang, Certification Framework for Geologic Carbon Sequestration Based on Effective Trapping, Seventh Annual Conference on Carbon Capture and Sequestration, National Energy Technology Laboratory, Pittsburgh, PA, May 5-8, 2008; Curtis M. Oldenburg, Steven L. Bryant, Jean-Philippe Nicot, Certification Framework for Geologic Carbon Sequestration Based on Effective Trapping (forthcoming 2009).

Examples of Government Indemnification for Third Party Liability

There is no government-wide legislation providing for indemnification of federal government contractors for third-party liability. In certain cases, however, the U.S. federal government does indemnify contractors for third party liability for research and development contracts. These examples provide precedent for a government indemnification provision for CCS-related RD&D activities.

Congress has authorized certain departments and agencies to indemnify contractors for certain types of risks. These authorizations are typically for hazardous activities or the national defense. Examples include the National Defense Contracts Act[24] that provides for indemnification for unusually hazardous or nuclear risks under defense contracts; Armed Forces procurement law that provides for indemnification for unusually hazardous defense research and development activities;[25] the Federal Aviation Act[26] that provides for indemnification for aircraft operations in carrying out U.S. foreign policy; and the National Aeronautics and Space Act[27] that provides for indemnification for the launch, operation or recovery of space vehicles.

The Atomic Energy Act, as amended by the Price-Anderson Act of 1957, provides for mandatory indemnification of contractors for activities involving the risk of a substantial nuclear incident up to an aggregate limit of $10 billion.[28] The indemnification provision has been extended periodically, most recently by the Energy Policy Act of 2005 for another 20 years. Nuclear operators are required to obtain the maximum amount of insurance against nuclear related incidents available in the insurance market; claims above insured amounts would then be satisfied by the government indemnification provision up to the statutory limit, which is financed by contributions from the nuclear reactor operators in the event of an accident.

The Price-Anderson Act indemnification provision covers DOE contractors and their subcontractors for nuclear RD&D projects. DOE has issued indemnification language to be included in its contracts, which specifies that the contractor shall be indemnified for personal injury and property damage claims as a result of negligence or other bases of liability, excluding willful misconduct.[29]

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[24] 50 U.S.C. § 1431 et seq. (2008), as implemented by Executive Order 10789.

[25] 10 U.S.C. § 2354 (2008).

[26] 49 U.S.C. § 1531 et seq (2008).

[27] 42 U.S.C. § 2458b et seq (2008).

[28] 42 U.S.C. § 2210(d).

[29] 48 C.F.R. § 952.250-70.

Streamlined Review under SDWA

The time and cost associated with preparing SDWA permit applications, and the time required for agency review, have caused delays and imposed burdens on Phase II projects due to limited financial and staff resources.

The EPA's proposed rule for CCS injections under the SDWA released in July 2008 contains no provision for small-scale test injections performed prior to full permitting for purposes of research or characterizing the geology of a proposed well.[30] The preamble to the proposed rule does, however, provide that Class V experimental well classification will remain available for those pilot-projects that continue to qualify under Class V guidelines.[31]

This study's survey results suggest that the Class V experimental well provision was disfavored by Phase II project proponents who sought permits under Class II where available. Also, the lack of uniformity inherent in the SDWA UIC program posed challenges for the research community.

EPA should evaluate how research needs are currently handled under existing SDWA permit arrangements, and consider research provisions in its final rule for permitting CO_2 injections for CCS. This study suggests that streamlined provisions for permitting small-scale CCS research and test injections under the SDWA could help facilitate research and development efforts. Streamlined permitting procedures would focus regulatory resources appropriately on large-scale injections, rather than on small injections that pose little or no risk to the environment.

Notably, the State of Washington's UIC program allows streamlined permitting under Class V for small-scale pilot injections of under 1,000 metric tons or larger volumes by application.[32] Australia has adopted a phased permitting process, which includes an assessment permit.[33] Other U.S. environmental laws also have adopted a streamlined review and permitting approach in non-CCS contexts.[34]

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[30] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, EPA-HQ-OW-2008-0390 FRL-8695-3, July 15, 2008, 73 Fed. Reg. 43492 (July 25, 2008).

[31] U.S. Environmental Protection Agency, UIC Program Guidance No. 83, "Using the Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects," March 1, 2007, *available at* http://www.epa.gov/safewater/uic/pdfs/guide_uic_carbonsequestration_final-03-07.pdf.

[32] Wash. Admin. Code, 173-218-115(4)(b).

[33] Nigel Bankes and Jenette Poschwatta, *Australian Legislation on Carbon Capture and Storage: A Canadian Perspective* (June 2008), *available at* www.iseee.ca/files/iseee/bankes_research_paper.pdf.

[34] For example, the Toxic Substances Control Act (TSCA), 15 U.S.C. § 2601 et seq. (2008), which governs the manufacture, processing, use, distribution in commerce, and disposal of chemical substances and mixtures, provides for varying levels of expedited review and exemption from regulations for qualifying research, low volume commercial production, and low release low exposure commercial production. See

A common feature of streamlined permitting schemes is a quantified limit, which in the case of CCS, would likely be a volume limit. The advantages of a quantified volume limit include that it provides greater certainty for research organizations. While no specific volume limit is suggested here, if EPA were to adopt such an approach, EPA should consider several factors for setting such a limit. A volume limit should be differentiated base on type of formation, site pressure, and other site-specific conditions. Such a limit could change (likely increase) along with our knowledge of a particular formation and experience with CO_2 injections for purposes of permanent sequestration. Finally, in addition to considerations relating to protection of drinking water sources, a volume limit should be based on the needs of advancing research and the risks to health and safety, including the general population, flora and fauna. CCS assessment models have been developed by our national laboratories specifically to address these kinds of risks.[35]

The Phase II projects have provided valuable experience about the CCS permitting process for small-scale CCS research projects. EPA should take account of this experience and consider providing an improved permitting regime for small-scale research projects in order to facilitate future CCS research and development efforts.

Conclusions

This study examined the legal and regulatory barriers to the Phase II projects of the U.S. Department of Energy's Regional Carbon Sequestration Partnerships Program. The barriers involved long-term liability, obtaining consents, and to a lesser extent Safe Drinking Water Act permitting. To overcome these barriers, this study recommends the federal government provide a legal framework that supports CCS research, specifically a liability shield for research organizations and organization that support research, and government indemnity for third parties including property rights holders, parties granting consent to projects, and those who may be affected by CCS research projects. It also recommends that the U.S. EPA consider adopting a simplified approval process under the Safe Drinking Water Act for research injections.

Elizabeth Brown et al., A Practitioner's Guide to the Toxic Substance Control Act, Environmental Law Institute, 1999.

[35] See Curtis M. Oldenburg and Steven L. Bryant, Certification Framework for Geologic CO_2 Storage, Sixth Annual Conference on Carbon Capture and Sequestration, National Energy Technology Laboratory, Pittsburgh, PA, May 7-10, 2007 available at www.netl.doe.gov/publications/proceedings/07/carbon-seq/data/papers/tue_062.pdf; Curtis M. Oldenburg, Steven L. Bryant, Jean-Philippe Nicot, and Ying Zhang, Certification Framework for Geologic Carbon Sequestration Based on Effective Trapping, Seventh Annual Conference on Carbon Capture and Sequestration, National Energy Technology Laboratory, Pittsburgh, PA, May 5-8, 2008; Curtis M. Oldenburg, Steven L. Bryant, Jean-Philippe Nicot, Certification Framework for Geologic Carbon Sequestration Based on Effective Trapping (forthcoming 2009).

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Appendix A: Phase II Geologic Sequestration Projects Included in Survey

Partnership	Name	Location	Formation
BigSky	Basalt Field Test	Walula, WA	Basalt
MGSC	Huff-Puff	Fayette County, IL	Sandstone
MGSC	Tanquary	Wabash County, IL	Coal Bed
MGSC	Imiscible Gas	Western, KY	Sandstone
MRCSP	Appalachian Basin	Shadyside, OH	Saline
MRCSP	Cincinnati Arch	Rabbithash, KY	Saline
MRCSP	Michigan	Otsego, MI	Saline
PCOR	Lignite	Bowbells, ND	Coal Seam
PCOR	Williston Basin	TBD	Carbonate
PCOR	ZAMA	Alberta, CA	Carbonate
SECARB	Cranfield	Cranfield, TX	Saline
SECARB	Appalachian	Russell County, VA	Coal Seam
SECARB	Black Warrior	Tuscaloosa AL	Coal Seam
SECARB	Plant Daniel	Escataba, MI	Saline
Southwest	Aneth	Blaning, UT	Carbonate
Southwest	San Juan	Farmington, NM	Coal
Southwest	SACROC	Snyder, TX	Carbonate
WESTCARB	Rosetta	Thornton CA	Saline
WESTCARB	Arizona	Flagstaff AZ	Saline

Appendix B: U.S. Federal and State Law Potentially Governing CCS Activities

This section briefly describes the SDWA and other major federal and state laws which could be interpreted to apply to various aspects of CCS, including RCRA, CERCLA, the Occupational Safety and Health Act (OSHA),[36] state laws governing health and safety, state law that governs property rights and tort liability, and federal government laws regarding indemnification of contractors for third party liability.

Safe Drinking Water Act

The SDWA[37] is intended to protect public drinking water supplies, including potential underground drinking water sources. The EPA has established through its UIC regulations that underground sources of drinking water are underground aquifers with less than 10,000 milligrams per liter (mg/L) total dissolved solids (TDS) and which contain a sufficient quantity of ground water to supply a public water system.[38]

The SDWA directs EPA to establish regulations setting minimum requirements for state water quality. States with permitting programs that meet EPA requirements are eligible to retain primary enforcement responsibility under SDWA. EPA administers SDWA in states that do not adopt an approved UIC program. With the exception of 10 state programs administrated by EPA and 7 states that administer their programs jointly with EPA,[39] all other states retain primary authority for administering SDWA.

SDWA requires applicants to obtain a permit to conduct an "underground injection" of substances under the UIC program. Permit applicants must demonstrate that the proposed underground injection will not endanger drinking water sources.[40] The statute provides that underground injection endangers drinking water sources,

> [i]f such injection may result in the presence in underground water which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons.[41]

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[36] 15 U.S.C § 651 et seq. (2008).

[37] 42 U.S.C. § 300f et seq.

[38] 40 CFR 144.3. Section 1421(b) (3)(A) of the Act also provides that EPA's UIC regulations shall "permit or provide for consideration of varying geologic, hydrological, or historical conditions in different States and in different areas within a State."

[39] U.S. Environmental Protection Agency, State UIC Programs, http://www.epa.gov/safewater/uic/primacy.html (accessed on August 7, 2008).

[40] See 42 U.S.C. § 300h(b)(1)(B).

[41] 42 U.S.C. § 300h(d)(2).

Although carbon dioxide that is injected into a properly sited and regulated formation is anticipated not to come into contact with underground sources of drinking water, the potential exists that carbon dioxide may cause acidification of drinking water, displace brine which could then come into contact with drinking water, or carry with it metals and other sediments that can contaminate drinking water. Even rendering water unpalatable can be cause for finding a substance to be a contaminant, as unpalatable water may cause people to seek unsafe sources of water.[42]

UIC permits for underground injections are classified based on the type of injection. Classes I, II and V are candidates for CO_2 injection wells:

- Class I injection wells are used to dispose of hazardous waste, non-hazardous industrial waste, municipal wastewater, and deep radioactive waste.[43]
- Class II injection wells are used for injections of fluids for disposal that are associated with oil and natural gas activities and injections for EOR/EGR.
- Class III injection wells inject fluids for mineral extraction.
- Class IV injection wells are used for hazardous or radioactive waste within a quarter mile of, into or above, underground safe drinking water.[44]
- Class V covers injections that are not covered by the other classifications, including experimental wells.[45]

In March 2007, EPA issued preliminary guidance under the UIC program for permitting demonstration CCS projects. The guidance encourages use of the Class V experimental well category, and provides guidelines for site selection, the appropriate "area of review," operational and monitoring procedures, and site closure.[46] The specific requirements for CCS research wells under the Class V category are being developed as regulators receive and review applications filed by the DOE partnerships.

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[42] Kipp Coddington, Robert Mowrey, Geir Vollsaeter, and Kristin Holloway Jones, CCS Issues under the Safe Drinking Water Act, dated May 10, 2008 (on file with the author), citing legislative history of the SDWA at 41 Fed. Reg. 36730, 36733 (August 31, 1976).

[43] There are no known radioactive waste disposal wells operating in the United States. See http://www.epa.gov/ogwdw000/uic/wells_class1.html#what_is (accessed October 12, 2008).

[44] In 1984, EPA banned the use of Class IV injection wells for disposal of hazardous or radioactive waste. These wells may now only be operated as part of an EPA- or state-authorized ground water clean-up action. There are approximately 32 waste clean-up sites with Class IV wells in the United States. See http://www.epa.gov/ogwdw000/uic/wells_class4.html#what_is (accessed October 12, 2008).

[45] 40 C.F.R. § 144.6.

[46] U.S. Environmental Protection Agency, UIC Program Guidance No. 83, "Using the Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects," March 1, 2007, *available at* http://www.epa.gov/safewater/uic/pdfs/guide_uic_carbonsequestration_final-03-07.pdf.

In July 2008, following its review of the UIC permitting program in relation to CCS, EPA issued a proposed rule for commercial CCS injection wells under the SDWA UIC program. The proposed rule would create a Class VI injection well for permanent geologic sequestration of certain carbon dioxide streams. The proposed rule includes the following elements:

- Geologic site characterization to ensure that sequestration wells are appropriately sited;
- Requirements to construct wells with injectate-compatible materials in a manner that prevents fluid movement into unintended zones;
- Periodic re-evaluation of the area of review around the injection well to incorporate monitoring and operational data and to verify that the CO_2 is moving as predicted within the subsurface;
- Testing of the mechanical integrity of the injection well, ground water monitoring, and tracking of the location of the injected CO_2 to ensure protection of underground sources of drinking water;
- Extended post-injection monitoring and site care to track the location of the injected CO_2 and monitor subsurface pressures;
- Financial responsibility requirements to assure that funds will be available for well plugging, site care, closure, and emergency and remedial response; and
- Recordkeeping and reporting.[47]

Under the proposed rule, EPA proposes to retain availability of Class II injection well treatment for EOR/EGR activities provided these wells are still producing oil or gas. The proposed rule will also grandfather the construction of existing wells that have been permitted under Classes I, II or V, but will impose additional Class VI conditions on these wells and operations if they are later used for permanent carbon sequestration purposes.

To qualify under the new Class VI category, eligible CCS projects must: meet specific geologic requirements for the injection and confining zones (e.g., presence of cap rock, depth, absence of faults and fractures, pressure); include an analysis of projected path of injection plume; and include a detailed characterization of the injection formation in advance of permitting. The proposed rule calls for extensive pre-injection characterization and periodic post-injection monitoring for a 50-year default period or until the plume stabilizes.

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[47] U.S. Environmental Protection Agency, Office of Water, "EPA Proposes New Requirements for Geologic Sequestration of Carbon Dioxide." EPA 816-F-08-031. July 2008, *available at* http://www.epa.gov/safewater/uic/pdfs/fs_uic_co2_proposedrule.pdf.

RCRA, CERCLA, and NEPA

Carbon sequestration will also implicate several major federal environmental laws. This section briefly reviews RCRA and CERCLA because these laws are potentially directly applicable to carbon sequestration activities. The National Environmental Policy Act (NEPA)[48] is also reviewed here as it is applicable to CCS activities where there is federal involvement.[49] OSHA is also broadly applicable to CCS activities and is covered in its own section below. Other laws such as the Clean Water Act (which governs surface waters), the Clean Air Act, the Toxic Substances Control Act, the Pollution Prevention Act, the Endangered Species Act, the National Historic Preservation Act (where sites contain landmarks or archeologically significant items) could also potentially be applicable to a carbon sequestration project.

Currently, no U.S. federal law or regulation classifies CO_2 as a “waste”.[50] However, in its 2008 proposed rule on SDWA, EPA noted that whether a CO_2 injection in a CCS project will trigger potential liability under RCRA or CERCLA will depend upon whether the CO_2 stream could contain other substances that are hazardous and could cause the CO_2 stream to be hazardous waste for purposes of RCRA, or contain hazardous substances or react to become a hazardous substance under CERCLA.[51]

RCRA[52] creates the framework for the cradle to grave management of hazardous and nonhazardous solid waste. RCRA established three programs: (a) the solid waste program, which encourages states to develop comprehensive plans to manage nonhazardous industrial solid waste and municipal solid waste, sets criteria for municipal solid waste landfills and other solid waste disposal facilities, and prohibits the open dumping of solid waste; (b) the hazardous waste program, which establishes a system for controlling hazardous waste from the time it is generated until its ultimate disposal; and (c) the underground storage tank program, which regulates underground storage tanks containing hazardous substances and petroleum products.

CERCLA,[53] commonly known as the Superfund law, authorizes the federal government to take action to clean up releases or threatened releases of hazardous

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[48] 42 U.S.C. § 4321 et seq. (2008).

[49] State environmental protection laws similar to NEPA may also apply where there is significant state or local government involvement in, or approval of, a CCS project.

[50] Massachusetts v. Environmental Protection Agency, 549 U.S. 497 (2007), declared atmospheric emissions of CO2 to be an “air pollutant” under the Clean Air Act.

[51] U.S. Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells, EPA-HQ-OW-2008-0390 FRL-8695-3, July 15, 2008, 73 Fed. Reg. 43492 (July 25, 2008).

[52] 42 U.S.C. § 6901 et seq.

[53] 42 U.S.C. § 9601 et seq.

substances that may endanger human health or the environment. CERCLA references four other federal statutes to designate over 800 substances as hazardous and to identify many more as potentially hazardous due to their characteristics and the circumstances of their release. CERCLA enables EPA to clean up sites contaminated with hazardous substances and seek compensation from responsible parties, or compel responsible parties to cleanup sites themselves. CERCLA liability potentially extends to current owners and operators of a facility, past owners and operators at the time hazardous wastes were disposed of, and generators and transporters of hazardous wastes. A responsible party may be able to avoid liability through specifically enumerated defenses, including that a release qualifies as a "federally permitted release" as defined under CERCLA.[54]

NEPA requires federal agencies to conduct assessments of major federal actions that may significantly affect the human environment. NEPA involves three levels of analysis. At the first level, an undertaking may be categorically excluded from a detailed environmental analysis if it meets certain criteria that a federal agency has previously determined as having no significant environmental impact. At the second level of analysis, a federal agency prepares a written Environmental Assessment (EA) to determine whether or not a federal undertaking would significantly affect the environment. If the EA results in a finding that a significant impact on the environment could occur, NEPA then requires a detailed Environmental Impact Statement (EIS). The EIS must include analysis of the environmental impact of the proposed action, unavoidable adverse environmental impacts, alternatives (including no action), short-term uses of the environment and its long-term preservation, and secondary and cumulative effects of implementing the action. Most of the Phase II projects received a categorical exclusion during the NEPA process based on determinations that they would have no significant environmental impact. However, the Phase III projects are all required to complete Environmental Assessments or Environmental Impact Statements due to the nature and scope of the actions.

Public and Workplace Health and Safety Laws

Exposure to carbon dioxide in high concentrations poses risks to human health, animals, and vegetation. For small-scale research projects, the safety of workers is probably the most immediate concern as workers engaged in drilling and injection activities have the greatest potential exposure to CO_2.

Worker health and safety is regulated under both federal and state law. OSHA requires employers to provide a workplace free from serious recognized hazards and to comply with occupational safety and health standards. The Act authorizes states to establish their own safety and health programs provided standards are at least as strict as

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[54] 42 U.S.C. § 9607 governs liability under CERCLA. Specifically, 42 U.S.C. § 9607(b) provides general enumerated defenses to liability, and other provisions of section 9607 provide defenses available to specific classes of parties and activities.

federal standards. Twenty-three states operate OSHA-compliant programs covering private sector workers as well as state and local government employees.[55]

Research on the impact of exposure levels of CO_2 on human health show that relatively low concentrations of approximately 5% for extended periods can cause adverse physiological effects.[56] Pursuant to OSHA, the National Institute for Occupational Safety and Health sets workplace exposure guidelines for chemicals, including CO_2. OSHA regulations limit CO_2 exposure in the workplace to an average of less than 5,000 parts per million (0.5%) for a 40-hour workweek.[57]

Tort laws described further below also define public and workplace standards of care in the areas of worker health and safety. Laws governing transportation of CO_2 (e.g., by pipeline, rail and truck), injection into high-pressure CO_2 formations, and experience in CO_2 injection for EOR/EGR will provide guidance to courts in determining standards of care for workplace safety for carbon sequestration operations.[58] Design, installation and operation safety regulations set by various federal and state agencies will influence courts in setting the standard of care, and compliance with such regulations will be an important factor in determining whether a judicial standard of care has been met if litigated in tort cases.[59]

The liabilities associated with worker health and safety, transportation and other operations such as drilling for which we have long experience are already largely addressed within existing tort law and regulatory frameworks. Contractors are willing to accept legal liability for their conduct in these areas. Accordingly, these types of liabilities are not included within the scope of the liability shield proposed by this study.

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[55] Occupational Safety & Health Administration, http://www.osha.gov/dcsp/osp/index.html (accessed August 12, 2008).

[56] Sally M. Benson, Robert Hepple, John Apps, Chin-Fu Tsang, and Marcelo Lippmann, Lessons Learned from Natural and Industrial Analogues for Storage of Carbon Dioxide in Deep Geological Formations (Lawrence Berkeley Nat'l Lab. Report LBNL-51170, 2002) *available at* http://repositories.cdlib.org/lbnl/LBNL-51170/.

[57] Occupational Safety & Health Administration, Carbon Dioxide (Revised Sept. 20, 2001), *at* http://www.osha.gov/dts/chemicalsampling/data/CH_225400.html.

[58] Research into the safety record of EOR operations suggests that adequate steps are being taken to protect worker safety. Sally M. Benson, Stanford University, personal communications, March 18, 2008. See also Gary Adams, Health and Safety Handbook for Enhanced Oil Recovery, The MITRE Corporation, August 1983 (noting that "Since CO_2 is neither toxic nor flammable, the increased hazard associated with CO_2 is minimal compared with the hazards which exist at conventional oil production sites.").

[59] See, e.g., 49 CFR 191-199, which sets safety and reporting requirements for the design, installation, operation and maintenance of interstate pipelines transporting carbon dioxide. States with jurisdiction over intrastate pipelines have either incorporated these same standards by reference or adopted similar or even more stringent provisions.

Property Laws Governing Carbon Capture and Storage

State property laws control the ownership of subsurface pore space, the rights to access and use that space, and liability concerning its use. In turn, these rights determine whose consents are necessary or desirable before proceeding with a CCS project.

At the time of this writing, Wyoming is the only state that has adopted property laws relating to the long-term storage of CO_2. In the absence of specific legislation governing property rights in relation to CCS, state property laws determine ownership of underground pore space and injected CO_2. Because different types of geologic formations are generally governed by different bodies of property law, property laws governing CCS projects differ depending upon the type of formation. Oil and gas reservoirs are typically governed by state property law regarding oil, gas and mineral rights. Saline formations are generally governed by state water laws.[60]

State Mineral Laws

For mineral-bearing formations, a majority of states follow the "American Rule" which vests legal title to the formation in the surface rights holder unless these rights are severed. Where a separate mineral rights holder exists, the mineral rights holder's interest is dominant over the surface estate as long as minerals remain on the property. Minerals are typically never completely exhausted, so the mineral rights holder will generally continue to retain an interest following the completion of active mining activities under the American Rule.[61] The "English Rule" followed by a minority of the states vests the mineral rights holder with the ownership of the mineral formation even following completion of mining activities.

State Water Laws

For saline formations, state water law controls ownership and the rights of other parties who use subsurface water. The five major rules in the United States are the absolute dominion rule, reasonable use rule, correlative rights rule, Restatement rule, and prior appropriation rule.[62] Under the absolute dominion rule, the surface interest owner owns and can use all water beneath the property without liability to others.[63] The reasonable use rule allows a landowner to use groundwater in reasonable amounts for

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[60] Mark A. de Figueiredo, Howard J. Herzog, Paul L. Joskow, Kenneth A. Oye, and David M. Reiner, Regulating Carbon Dioxide Capture and Storage, MIT Center for Energy and Environmental Policy Research Working Paper 07-003 (2006) *available at* http://tisiphone.mit.edu/repec/mee/wpaper/2007-003.pdf.

[61] Orpha A. Merrill, Note and Comments, *Oil and Gas: Substratum Storage Problems*, 7 OKLA. L. REV. 225, 227 (1954).

[62] Mark A. de Figueiredo, *Property Interests and Liability of Geologic CO_2 Storage: A Special Report to the MIT Carbon Sequestration Initiative* (Sept. 2005), *available at* http://sequestration.mit.edu/pdf/defigueiredo_property_interests.pdf.

[63] *Bristor v. Cheatham*, 255 P.2d 173, 178 (Ariz. 1953).

beneficial uses on the land above the aquifer. Under the correlative rights rule, landowners may extract water from a common aquifer in proportion to their land area.[64] In California, application of the correlative rights rule also takes into account reasonableness of use based on custom, social utility, safe yield, and need.[65] Under the Restatement rule, a surface rights owner may use groundwater for any purpose or location (including off the property) in a reasonable manner. The prior appropriation rule grants water use rights to prior users (the "first in time" rule).

Tort Theories of Liability

This section focuses on tort theories of liability potentially applicable to carbon sequestration activities. These are trespass, negligence, nuisance and strict liability. Seismic activity induced by CCS or leakage of CO_2 affecting public health or damaging property are examples of the kinds of occurrences that might support a claim under one or more of these theories. In all cases, however, a plaintiff must show that the CCS activity actually caused the plaintiff harm.

Trespass

Trespass is the unauthorized entry upon land. Trespass can occur on the surface or subsurface levels.[66] The common law distinguishes between willful or intentional trespass and mistaken or inadvertent trespass.[67] Under the traditional rule of trespass, damages are not required to be proven on the theory that intent is adequate to show damages.

Although presently no trespass cases involving CCS have been litigated, cases involving subsurface trespass resulting from other underground injection activities suggest that a successful trespass claim would likely require a showing of actual damages, as would be expected in any tort case. At least one jurisdiction has required a showing of actual damages to support a claim of trespass for cases involving subsurface injections. In *Chance et al. v. BP Chemicals, Inc.*, the court held that without a showing of physical damage or interference with the use of the neighboring property, the subsurface lateral migration of injection fluid onto a neighboring property from a properly permitted deep well injection under the UIC program that was non-negligently maintained would not give rise to liability under theories of trespass. In reaching its decision, the court limited the surface owner's rights to "the right to exclude invasions of the subsurface property that actually interfere with appellants' reasonable and foreseeable use of the subsurface." Significantly, the court noted that there appears to be no cases in any jurisdiction

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[64] Earl Finbar Murphy, The Recurring State Judicial Task of Choosing Rule for Groundwater Law: How Occult Still?, 66 NEB. L. REV. 120, 134 (1987).

[65] *City of Pasadena v. City of Alhambra*, 207 P.2d 17, 33 (Cal. 1949) *cert. denied*, 339 U.S. 937 (1950).

[66] Owen Anderson et al., Hemingway Oil and Gas Law and Taxation §§ 4.1 and 4.2 (4th ed. 2004).

[67] W.L. Summers, The Law of Oil and Gas § 2.7 (3rd ed. 2004).

imposing liability in the absence of actual damages for permitted, non-negligent deep-well disposal.[68]

The potential for CO_2 to migrate across property boundaries or to escape to the atmosphere could give rise to claims for trespass and damages if it can be shown that a surface or subsurface property right is infringed that causes actual damages. CO_2 injection for permanent storage that prevents a landowner from exploiting its property, such as extraction of mineral resources, could produce actual damages. Similarly, if CCS becomes commonplace and a value is placed on storage space, damages could be awarded for migration of CO_2 across property boundaries that interferes with other property owners' ability to use their underground pore space for carbon sequestration.

Other legal theories that may be employed to seek recovery where a trespass is proven include conversion, implied contract, unlawful appropriation of trade secrets,[69] assumpsit (for rental value of occupied land), and confusion of goods.[70]

Negligence

Liability for negligence arises where a plaintiff can show that a defendant owed a duty of care to the plaintiff, the defendant failed to meet the required standard of care, the negligent acts or omissions caused harm to the plaintiff (actual cause), resulting in damages, and it was reasonably foreseeable that plaintiff's breach of the duty could have caused such harm (proximate cause).[71]

In the context of CCS, virtually every aspect of a CCS project will involve a duty of care owed to one or more groups, including surface and subsurface rights owners, neighboring property rights owners, workers and other invitees onto land, and residents in the vicinity of a CCS operation. These duties will arise at every step of the CCS project, including site selection and assessment, drilling, injection, transportation, well closure, monitoring, and reporting. Standards of care for CCS projects will be shaped in part by experience in the oil and gas industry, CO_2 handling and transport, and enhanced oil and gas recovery operations.

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[68] *Chance et al. v. BP Chem., Inc*., 77 Ohio St.3d 17, 670 N.E.2d 985 (Ohio 1996).

[69] Unlawful appropriation of trade secrets could be argued where a trespass results in disclosure of information about subsurface conditions that adversely affects the market value of property. Owen Anderson et al., Hemingway Oil and Gas Law and Taxation § 4.1(B). (4th ed. 2004). See generally *City of Northglenn v. Grynberg*, 846 P.2d 175, 183 (Colo. 1993), *cert. denied*, 510 U.S. 815 (1993) (collecting seismic information without permission could constitute misappropriation of a trade secret, but holding that information was already publicly known in particular case so was not a trade secret).

[70] Owen Anderson et al., Hemingway Oil and Gas Law and Taxation § 4.1(B)-(C). (4th ed. 2004); 15A C.J.S. Confusion of Goods § 1.

[71]*Palsgraf v. Long Island R.R. Co.*, 248 N.Y. 339, 162 N.E. 99 (N.Y. 1928).

Nuisance

Persons in possession of real property (either land owners or tenants) are entitled to the quiet enjoyment of their lands. Hazards, pollution, smells, and sounds that interfere with the quiet enjoyment of real property may bring a claim of nuisance. Normal, reasonable uses of property that may affect one's enjoyment of property will not give rise to a nuisance claim. Nor does nuisance include trespass.

There are two types of nuisance: private and public. A private nuisance is an unreasonable interference with a property owners' quiet enjoyment of land. A public nuisance is an unreasonable interference with the public's right to property, including interference with public health, safety, peace or convenience. Often, a public nuisance will also violate law, such as zoning laws or laws protecting public health and safety. A private nuisance that affects many people will often be treated as public nuisance.

Remedies for nuisance include payment of damages and injunction against the activity. In one influential case, the court allowed a cement plant that produced air pollution affecting neighboring residences to continue to pollute but to pay permanent damages reflecting the net present value of the diminution in value caused by its activities.[72]

Strict Liability

Strict liability generally applies to hazardous or inherently dangerous activities. Strict liability often applies to product liability claims and the use of explosives. Under the doctrine of strict liability, a person is liable for damages and losses caused by his or her acts and omissions regardless of whether the person acted negligently or possessed intent to cause harm. Under strict liability, the plaintiff need only prove that the tort occurred and that the defendant was responsible. A defendant's taking all possible precautions is not a valid defense to strict liability.

State Authority to Adjust Property Rights for Public Use

Under the U.S. Constitution and applicable state constitutions, each state is vested with power to adjust private property rights. Eminent domain and unitization are two legal methods that could be employed to adjust property rights to facilitate the development of CCS.

Eminent Domain

Eminent domain is "[t]he inherent power of a government entity to take privately owned property, especially land, and convert it to public use, subject to reasonable

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[72] *Boomer v. Atlantic Cement Co*., 26 N.Y.2d 219, 309 N.Y.S.2d 312 (N.Y. 1970) (The court's judgment was based on the fact that the cost of closing the plant or installing pollution abatement equipment would have been far greater than the damages caused to the plaintiffs).

compensation for the taking."[73] In the United States, the Fifth Amendment prohibits taking of private property without "just compensation." The Fourteenth Amendment extends these Fifth Amendment protections to eminent domain actions taken by the states.[74]

The power of eminent domain has been exercised on behalf of, and even delegated to, private companies where there is a public use. The public use requirement has been broadly interpreted to include virtually any aspect of the common welfare, including economic development, health or safety. In Kelo et al. v. City of New London, the Supreme Court upheld a city government's exercise of eminent domain on behalf of private developers in a condemnation action on private residences where "the city has carefully formulated a development plan that it believes will provide appreciable benefits to the community, including but not limited to, new jobs and increased tax revenue."[75]

The Natural Gas Act of 1938[76] grants private companies engaged in interstate transportation of natural gas the right to exercise federal eminent domain powers to obtain property for transportation facilities.[77] Federal court decisions later extended the Natural Gas Act's grant of eminent domain power to natural gas storage.[78] To exercise eminent domain power, a company is required to engage in good faith negotiations with property holders, and in the event negotiations fail, obtain a certificate of public convenience and necessity from the Federal Energy Regulatory Commission following a public hearing.[79]

The exercise of eminent domain under the Natural Gas Act provides precedent that could be relevant to the potential use of this doctrine in the context of CCS projects. In Columbia Gas Transmission Corporation v. An Exclusive Natural Gas Storage Easement, the Ohio Supreme Court provided valuation guidelines for subsurface natural gas storage space in an eminent domain action under the Natural Gas Act. The court held that the fair market value and just compensation for an easement could be determined by comparable sales of storage space, the rental income for the right to store gas, the value of any commercially recoverable gas and oil deposits that could not be exploited by a

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[73] Black's Law Dictionary, 7th Edition, West Group, St. Paul, Minnesota, 1999. See also Eminent Domain, 26 Am.Jur.2d, 2004.

[74] *Chicago Burlington & Quincy R.R. v. Chicago*, 166 U.S. 226 (1897).

[75] *Kelo et al. v. City of New London, Conn. et al.*, 545 U.S. 469 (2005).

[76] 15 U.S.C. § 717 et seq. (2008)

[77] 15 U.S.C. §717f(h).

[78] *Columbia Gas Transmission Corp. v. An Exclusive Natural Gas Storage Easement*, 776 F.2d 125, 128 (6th Cir. 1985).

[79] 15 U.S.C. §717f(c). See also Steven D. McGrew, Note: Selected Issues in Federal Condemnations for Underground Natural Gas Storage Rights: Valuation Methods, Inverse Condemnation, and Trespass, 51 CASE WES. RES. L. REV. 131 (2000).

landowner as a result of the gas storage facility, and the diminution in value of the property as a result of the exercise of eminent domain.[80]

Unitization Laws

Field unitization is the common management, including profit and loss sharing, of oil producing properties within a formation in order to maximize the field's production and resolve competing claims for production.[81] Most oil producing states have some form of unitization law, either on a purely voluntary or a compulsory basis when a statutorily specified percentage of ownership in a field petitions for the arrangement.

The degree of consent required for mandatory unitization in different U.S. states ranges from a single owner representing any percentage to as high as 85% of the land in a field.[82] Although Texas has a voluntary unitization arrangement, the Texas Railroad Commission which regulates oil production in that state will approve unitization arrangements among field owners seeking unitization, omitting those that do not consent.[83]

Unitization has proven to be an effective method to address property rights issues in oil production areas. Unitization could be employed in the CCS context to overcome property rights and legal liability issues associated with operating a large carbon sequestration project involving many property holders.

State Efforts to Develop CCS Legislation

The Interstate Oil and Gas Compact Commission (IOGCC), which comprises 38 U.S. states, has issued a model statute and regulations for CCS, which includes property rights and liability rules.[84] It calls for state governments to take title to, and release operators from liability for, CCS reservoirs that have ceased injection for a period of 10-years or other time frame established by statute, and are certified to be reasonably expected to retain mechanical integrity and remain emplaced. The IOGCCC model law

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[80] *Columbia Gas Transmission Corporation v. An Exclusive Natural Gas Storage Easement*, 67 Ohio St.3d 463, 620 N.E.2d 48 (1993).

[81] A. Allen King, Pooling and Unitization of Oil and Gas Leases, 46 MICH. L. REV. 311, 313 (1948); Jacqueline Lang Weaver & David F. Asmus, Unitizing Oil and Gas Fields Around the World: A Comparative Analysis of National Laws and Private Contracts, 28 HOUS. J. INT'L. L. 3, 12 (2006).

[82] U.S. Office of Technology Assessment, Enhanced Oil Recovery Potential in the United States 24 (NTIS PB-276594, 1978), *available at* http://www.princeton.edu/nota/disk3/1978/7807/7807.pdf.

[83] Paula C. Murray & Frank B. Cross, *The Case for a Texas Compulsory Unitization Statute*, 23 ST. MARY'S L.J. 1099, 1153 (1992).

[84] Interstate Oil and Gas Compact Commission Task Force on Carbon Capture and Geologic Storage, <u>Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces</u> (September 25, 2007) *available at* http://www.southwestcarbonpartnership.org/_resources/pdf/2008-co2-storage-legal-and-regulatory-guide-for-states-full-report.pdf.

contains an eminent domain provision allowing for state and private parties to acquire property rights in order to conduct CCS activities.

The State of Wyoming is the first state to enact dedicated comprehensive statutes governing CO_2 injection and storage,[85] including rules for property rights.[86] The Wyoming CCS legislation integrates the state's existing SDWA UIC program.

At the time of writing, over half a dozen states are contemplating CCS legislation or rulemaking, including actions such as studies, developing CCS incentive programs, and mandating use of CCS. [87]

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[85] Carbon Capture and Sequestration Act, Ch. 30, 2008 Wyo. Sess. Laws 48 *available at* http://legisweb.state.wy.us/2008/Enroll/HB0090.pdf; WYO. STAT. ANN. §34-1-152 (2008).

[86] Ownership of Subsurface Pore Space Act, Ch. 29, 2008 Wyo. Sess. Laws 47, *available at* http://legisweb.state.wy.us/2008/Enroll/HB0089.pdf; WYO. STAT. ANN. §34-1-152 (2008).

[87] These include Idaho, Illinois, Kansas, Montana, Ohio, Oklahoma, Texas, Utah, Washington, and Wyoming. Kristin Holloway Jones, Alston & Bird, State CCS Legislative & Regulatory Developments, Alston & Bird, May 6, 2008.

Appendix C: Survey Form

REGIONAL CARBON SEQUESTRATION PARTNERSHIP: NAME OF SURVEY RESPONDENT:						
Project Description	Parties (Circle applicable)	Of the parties, which are private entities? (Circle applicable)	Has anyone requested Indemnity? (Circle applicable)	Has anyone refused to grant rights? (Circle applicable)	Please indicate if you are seeking property rights from neighboring properties? If so, describe who, why and whether there are any barriers or difficulty in obtaining necessary rights.	Please describe any difficulty experienced or anticipated to obtain government permits? (e.g., public opposition, cost, resources)
Project Name: Location: Type of Formation: Tons CO_2: Site Area: Status of project: EOR: Unitized: EIS Required?	Site Land Owner Site Subsurface Owner Site Mineral Lessee Site Water rights holder Drilling/ Injection Company	Site Land Owner Site Subsurface Owner Site Mineral Lessee Site Water rights holder Drilling/ Injection Company	Site Land Owner Site Subsurface Owner Site Mineral Lessee Site Water rights holder Drilling/ Injection Company	Site Land Owner Site Subsurface Owner Site Mineral Lessee Site Water rights holder Drilling/ Injection Company	Y/N: From who are you seeking? Adjacent Land Owner Adjacent Subsurface Owner Adjacent Site Mineral Lessee Adjacent site water rights Why seeking consents? Barriers to obtaining consents?	
Has any rights holders sought compensation for their consent?						
Please describe any other barriers you have encountered in these projects:						
Percentage Time Consumed: Non-Research (Legal/Administrative) % Research (including characterization) %						

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