Carbon Capture and Storage Project Development

An Overview of Property Rights Acquisition, Permitting and Operational Liability Issues

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Great minds are responding to the global call to reduce carbon emissions. Ideas include increasing the use of renewable energy sources, putting greater focus on reducing demand, and developing innovative technologies to enhance the efficiency of energy usage. However, one fact is unavoidable. Hydrocarbon and carbon fuel sources will remain a part of the world's energy strategy for years to come. Spurred on by industry, environmental non-governmental organizations and concerns of national security, the race is on to "decarbonize" fuels like coal and oil by reducing or capturing their inherent carbon dioxide (CO_2). The term carbon sequestration refers to a variety of mechanisms used to reduce the total atmospheric concentration of carbon dioxide or other greenhouse gases.[1] Sequestration can take a number of forms, including reforestation to increase CO_2 consumption, storage of CO_2 in various forms in the ocean, and use of CO_2 in industrial applications.[2]

Another emerging sequestration method with considerable promise is geological carbon capture and storage (CCS).[3] In CCS, the CO_2 is captured at the point the carbon fuel is used—either after combustion (in the exhaust stack) or before combustion (when fuels are gasified, separating CO_2 from hydrogen or other fuels or feedstocks).[4] The captured CO_2 is transported and injected into deep geological voids such as depleted oil and gas reservoirs, coal bed methane reservoirs, or saline formations.[5] Considerable experience with injecting CO_2 for enhanced oil recovery (EOR) and with natural gas storage confirms the utility of this approach.[6]

Most of the current discussion regarding sequestration centers on the economic and technical aspects of carbon capture, the physical capacity of geological reservoirs, and the legal and regulatory benefits that can be derived (and the penalties that can be avoided) from the resulting reductions in carbon emissions. In contrast, this article discusses the legal issues relating to the practical aspects of developing and permitting a CCS project. To that end, this article covers potential challenges and solutions on such topics as the acquisition of property rights; permitting at both the federal and the state levels; and identification, reduction and transfer of operational and postoperational liabilities. The authors have sought to cover existing principles and anticipated trends with respect to CCS throughout the United States, in general, and with particular reference to the State of Texas.

Property Rights Acquisition

General United States Principles

CCS projects consist of the capture and transportation of CO_2 and the injection of CO_2 into subsurface formations—either into wholly or partially depleted oil, gas, or coal bed methane reservoirs, or into saline formations.[7] In situations in which the real property rights have been divided—with mineral and water rights to the potential reservoir or saline formation being held by persons different than the holders of surface rights or other residual or future interests in the land—the question arises as to which set of owners must convey rights or otherwise consent to the storage of the injected materials. Regardless, surface usage rights are separately needed for the capture, transportation, and injection activities.[8]

The ownership of subsurface formation storage rights in the United States is governed by state laws and is not uniform.[9] These laws do not address the long-term storage of CO_2 specifically, nor does case law exist regarding storage of CO_2 in particular.

The Interstate Oil and Gas Compact Commission (IOGCC) produced a model statute for CO_2 geological storage in late 2007.[10] The model statute was based on IOGCC's conclusion that states and provinces are the most logical and experienced regulators given their experience and expertise in the governance of oil and natural gas production and natural gas storage.[11]

However, some amount of tension exists between the federal and state agencies regarding regulation of potential sequestration projects. Near the end of 2007, the Energy Independence and Security Act was enacted vesting authority for regulating CO_2 injection wells with the Environmental Protection Agency (EPA) and authority over CCS projects on federal lands with the Bureau of Land Management (BLM), within the Department of Interior (DOI).[12] Since both injection well authority and federal lands authority will be important facets of sequestration project development, the new federal law and the state law developments have the potential to create practical conflicts for operators in the future as they seek to permit new projects. Efforts are currently underway in Congress to address state and federal collaboration on this issue and on climate change in general. The eventual resolution may require the development of an interagency task force.[13]

The IOGCC states that a "regulatory program that manages storage . . . should include clear rules about how [ownership interest in subsurface pore space] will be recognized and protected."[14] The IOGCC report concludes that a statute regarding geologic storage (GS) "would best serve the public by clearly declaring that GS is an important activity for the public interest, clearly identifying the surface owner as the person with the right to lease pore space for storage, while protecting other stakeholders from potential damage attributable to sequestration activities."[15]

However, until specific laws for CCS are developed, analysis of the ownership of underground storage rights for long-term storage of CO_2 will depend on current state statutes and on case law in analogous and well-developed commercial applications such as natural gas storage, EOR, and acid gas and hazardous waste injection.[16]

Under current state laws, the ownership of underground storage rights depends on which of two types of geologic formations is proposed as the storage location.[17] The ownership of underground storage rights in mineral-bearing formations, such as depleted oil and gas reservoirs or coal bed methane formations, is generally determined by a state's laws regarding oil, gas, and mineral rights.[18] The ownership of the same rights in saline formations is generally determined by a state's laws regarding water rights.[19]

Mineral-Bearing Formations

The majority of states recognize that legal title to mineral formations resides with the surface interest holder unless otherwise agreed.[20] This standard is referred to as the "American Rule," in contrast to the "English Rule," which a minority of states and the courts in the United Kingdom and Canada follow.[21] The English Rule states that the mineral interest holder is the owner of rights in the mineral formation separate and apart from its rights to remove the minerals.[22]

Although the American Rule may vest title to the formation in the surface interest holder, a party that desires to use the formation for underground storage must recognize that mineral interest holders may continue to have competing property interests in instances in which the formation has arguably not been depleted of minerals.[23] In fact, a mineral formation may never be fully physically depleted of minerals, even if further extraction would be economically impractical.[24] If so, then regardless of the title to the formation, a mineral rights holder might be a potential plaintiff claiming nuisance, trespass, or other causes of action asserting that CO_2 injection and storage has interfered with its lawful use or possession of its own property interest.

When the ownership of underground storage rights has been litigated in the context of natural gas, courts have often held that conveyances or consents from mineral rights holders as well as surface rights holders are required or useful to eliminate the prospect of title or tort claims. For example, a prominent Michigan case held that the property rights and interests required to operate an underground field for storage purposes include: "(1) access to the surface, (2) the container—that is to say, that portion of the underground area within which the gas will be stored and, (3) the contents of the container (whatever native gas and oil may remain in the container)."[25]

In discussing rights to be acquired in connection to the use of a mineral formation for natural gas storage purposes, University of Oklahoma law professor, Eugene Kuntz, noted that "[b]ecause the cases on the subject are few in number and are not in harmony, when a subsurface stratum is acquired for storage purposes, the grant should be taken from the person having the rights to extract the particular substance to be stored, the surface owner and the owner of any other mineral rights."[26] Kuntz further observed that "prudence also dictates that grants be secured from mineral owners of any separate strata not acquired whose rights of access might be impaired, from owners of various surface interests, and from owners of easements or other similar interests whose rights might be impaired in some way."[27] If the applicable reservoir has been unitized or is subject to unitization, further consideration should be given to seeking rights from the operator of the unit or the unit working interest owners themselves.[28]

Saline Formations

The majority of states recognize that a surface interest owner has the right to make use of a saline formation situated below its property.[29] However, a party that desires to operate a saline formation as a storage facility must also consider the ownership of the water in the saline formation and the right to extract and use that water, which may be subject to one of several property rights rules.[30] The five major rules that are applicable depend on the state in question and are commonly referred to as "absolute dominion," "reasonable use," "correlative rights," "the Restatement rule," and the "prior appropriation rule."[31]

At the risk of oversimplification, the rules with respect to saline formations may be summarized for CCS purposes as follows. Under "absolute dominion," the surface interest owner owns the water beneath its property and has the absolute right to extract or otherwise use that groundwater without any liability for damage to an adjoining owner.[32] The "reasonable use" rule holds that the use of groundwater is unrestricted so long as it is reasonable and beneficial and takes place on the land overlying the aquifer.[33] Under the "correlative rights" rule, surface owners may use groundwater in proportion to their land ownership.[34] Under the "Restatement rule," a surface rights owner may use groundwater in a reasonable manner, but is not restricted as to where it may use that water.[35] Finally, the "prior appropriation rule" gives whoever is "first in time" the first right to use the water.[36]

Depending on the rule used in the particular state, it may be prudent to obtain conveyances or consents not only from the surface rights owner and water rights owner, but also from any current appropriator of the water and any surface rights owner capable of accessing the saline formation.

Summary of Rights to be Acquired for Geological Storage of CO_2

While the property rules described above have not yet been applied in the context of long-term CO_2 storage, these rules are likely to apply until such time as new rules are adopted.[37] Therefore, at present, a party desiring to obtain underground storage rights for long-term CO_2 storage with respect to either mineral or saline formations must not only acquire the rights of the owner of the formation itself, but should also consider the rights of any other mineral or water interest holder.

Case law in analogous situations such as natural gas storage and hazardous waste injection "suggests that both surface and mineral owners will have a legitimate claim to subsurface strata used for [geological CO_2 storage]."[38] Depending on the particular circumstances of the storage operation, adjacent surface, mineral, and water interest holders may also have interests that are impacted and thus, the consent of such persons may also be desired to avoid tort claims.[39]

A final consideration is that the duration of mineral rights is frequently limited to such time as the minerals are producing in paying quantities. However, CO_2 sequestration projects typically proceed only once a site has ceased producing in paying quantities. Consequently, the grant of storage rights by a mineral rights holder may not be of secure duration. For all of the reasons discussed above, consents would ordinarily be sought from both the mineral and surface estate holders.

Texas Principles

Texas follows the American Rule with respect to the determination of the ownership rights of the underground storage rights in existing mineral formations.[40] Ownership of land in fee simple is deemed to include not only the surface and mineral estates, but also the underlying earth and reservoir storage space.[41] Mineral interests are considered part of the realty and are subject to ownership, severance, conveyance, and lease, just as are surface estates.[42] If the mineral and surface interests have been severed, the mineral estate is considered dominant over the surface estate. However, one case has held that the surface estate continues to own the storage rights after severance due to the doctrine of absolute dominion.[43] Another Texas case held that the mineral rights owner who created salt cavern space had exclusive rights to the storage, but such manmade space would not be the preferred storage location for CCS projects.[44]

Texas applies the absolute dominion rule with respect to groundwater, meaning that a fee simple titleholder owns everything above, on, and below the surface.[45] This rule is derived from common law and the seminal Texas case of *Houston & Texas Central Railway Co. v. East* held that the following doctrine applied in Texas: "'the person who owns the surface may dig therein and apply all that is there found to his own purposes, at his free will and pleasure; and that if, in the exercise of such right, he intercepts or drains off the water collected from the underground springs in his neighbor's well, this inconvenience to his neighbor falls within the description of *damnum absque injuria*, which cannot become the ground of an action.'"[46] Courts have since refined this theory to explicitly require that the use be non-wasteful, but have otherwise left this doctrine intact.[47] It is possible, however, for water rights to be given to a party by the landowner in the event of an express contract between the parties for the same.[48]

It should be recognized that, in addition to the common law principles and century's worth of case law described above, a complex and evolving regulatory scheme also governs the rights to and use of groundwater in Texas. Consequently, any CCS project that may impact water quality or otherwise impact or interfere with groundwater will be subject to regulatory oversight and (potentially) a separate permitting regime to address any potential impact on water quality.

Thus, Texas applies rules that would tend to vest legal title to the geologic formation itself in the surface rights owner. However, the interests of the mineral or water rights holder should be considered in determining what consents would be required for geological CCS and it should be recognized that separate permitting issues may come in to play with respect to interference with groundwater.

Permitting Requirements

Current Injection Well Regulatory Status

Permitting for geological CCS projects can generally be divided into four categories: capture, transport, injection, and storage.[49] The specific permit requirements will depend on the project. Permit requirements associated with capture and transport of carbon would perhaps include air pollution permits for the processes by which carbon is generated and pipeline permits for transportation. Some persons argue that even these requirements may have some intricacies particular to carbon dioxide.[50] Injection and storage of carbon present entirely novel permitting questions.

For the past 20 years, the EPA's underground injection control program has categorized UIC wells into five different classes, each with its own set of qualifications, restrictions and obligations. Class I wells are used for injection of hazardous wastes, industrial non-hazardous liquids, and municipal wastewater; Class II wells are used for injection in oil and gas operations, including injection for EOR; Class III wells are used for in situ or "solution" mining for minerals; Class IV wells are used for groundwater remediation projects; and Class V is a general category for "experimental" or "other" non-hazardous injection wells. Importantly, under the Safe Drinking Water Act (SDWA), individual states and tribes can apply to the EPA to obtain primary authority to administer the UIC program; and to be granted such primacy, the state program must be at least as stringent as the federal requirements.[51]

Until now, the resolution of how wells for injection of CO_2 for geologic sequestration would be classified under the SDWA was highly uncertain. CO_2 injection wells with EOR applications were presumed to fall within Class II, while other wells were thought to fit nowhere but the catch-all Class V. Indeed, interim guidance that the EPA issued in March 2007 indicated that pilot-stage CO_2 injection wells should be regulated under Class V. At the same time, states have been making their own determinations and developing their own regulations on the subject.[51] Now, under the proposed rule, the EPA would establish a new category of UIC wells, Class VI wells, which category is specifically for the injection of CO_2 for CCS. In issuing this proposed rule, the EPA has taken an important first step toward resolving the current uncertainty over the regulation of underground injection wells used for CCS.

Proposed Well Regulations

Given the early stage of development of CCS projects, the permitting requirements have not been well-defined. The UIC program modifications that are contained in the proposed regulations are intended to address some of the unique challenges presented by the injection of CO_2 for long-term geologic sequestration.[53] These challenges include: the relative buoyancy of CO_2, its corrosivity when present with water, potential impurities that may be entrained in the captured CO_2, the mobility of CO_2 in underground formations, and the very large injection volumes that are anticipated once CCS technology is fully deployed. The main elements of the proposed regulations are summarized below.

- **Scope of the Rule.** As indicated, the proposed regulations would establish a new class of UIC wells—Class VI wells—that are used for the "long-term containment of a gaseous, liquid or supercritical carbon dioxide stream in subsurface geologic formations." The regulations would specify that the owner or operator of a proposed Class VI well must apply for and obtain a permit before operating the well.
- **Content of Permit Application.** The rule would require submission of extensive information regarding a proposed injection well as part of the Class VI permit application. In all, the applicant would have to address 25 separate categories of information including maps, a site specific "Area of Review" (AoR) determination, a delineation of the potentially affected underground source of drinking water (USDW), testing results, and several distinct operating plans and procedures—all of which the Director must review and approve.[54] Key components of a permit application include the following:
  - *Corrective Action Plan.* As part of the permit application, the applicant would be required to submit a Corrective Action Plan that identifies all wells within the AoR (a region surrounding the sequestration project, defined through computer modeling) and that specifies actions to be taken to protect the USDW from the migration of CO_2 and formation fluids. If site monitoring indicates an endangerment to the USDW, the responsible agency must be notified and injection operations must cease. In addition, the corrective action requirements would apply to all known wells penetrating the injection zone of the proposed Class VI well, and measures would be required to ensure that any substandard wells in the AoR do not threaten any existing USDWs.
  - *Emergency and Remedial Response Plan.* The permit applicant must also submit an Emergency and Remedial Response Plan that identifies the actions that will be taken to address any movement of injection or formation fluids that may cause an endangerment to an USDW during all phases of the life of the well. In addition, if the owner or operator obtains evidence that the injected CO_2 stream and associ-

ated pressure front may cause an endangerment to an USDW, the owner or operator must immediately cease injection, provide a 24-hour notice to the Director and implement the Emergency and Remedial Response plan.

– *Financial Responsibility.* Under proposed Section 146.85, the applicant would be required to demonstrate and maintain "Financial Responsibility" for corrective action, well plugging, post-injection site care, and the costs of emergency and remedial response. While Financial Responsibility requirements have been a long-time component of the EPA's RCRA hazardous waste management program, under the proposed Class VI UIC program this concept would be applied to the management of something other than a regulated hazardous waste. The cost estimates that make up the Financial Responsibility requirement would be site-specific; and the EPA indicates that further guidance on financial surety requirements will be forthcoming.

- **Closure Plan & Long Term Monitoring.** Under the proposed regulations, the Class VI permit holder would be required to prepare and implement a post-injection site care and site closure plan, which would define post-injection monitoring locations, monitoring methods, and proposed monitoring frequency. The proposed plan would have to be included as part of permit application. The proposed regulations would require the sequestration site to be monitored following cessation of operations, for a presumed period of 50 years, until the sequestration project no longer poses any endangerment to an USDW. The Director may authorize site closure before the end of the 50-year period if the facts demonstrate that the project no longer poses a threat of endangerment to an USDW. On the other hand, according to the proposed rule's preamble discussion, the monitoring period could be extended to "100 years (or longer)" if the Director concludes this time frame is necessary. Under the proposed regulations, "Site Closure" would be defined as that point in time when the owner or operator of the Class VI well is released from the duty to provide post-injection site care.

  After the site has been closed, a closure report would have to be submitted within 90 days. In addition, the owner or operator of the Class VI well would be required to record a notation in the relevant property records that would inform any future purchaser of the land that a CO_2 sequestration operation was conducted on the property, the volume of CO_2 injected, and the period of time in which the injection took place. Records generated during the site closure would have to be maintained for three years.

- **Technical Requirements.** The proposed regulations also contain a number of technical requirements relating to the construction and operation of a Class VI well. These requirements include the following:

– The regulations would establish construction requirements to ensure that a Class VI well, once operational, will not facilitate the movement of fluids into or between an USDW, or into an unauthorized zone. In addition, the Director would be authorized to designate site-specific casing and cementing requirements for the well.

– The owner or operator of the well would be required to conduct appropriate surveys and tests during the drilling and construction of the well to assure conformance with the construction requirements, and to establish "baseline data" against which future measurements applicable to the operation of the well will be made. These tests will also measure the mechanical integrity of the well.

– The regulations would also specify various operating requirements. For example, the injection pressure in the well would not be permitted to cause the movement of fluids in such a way as to endanger an USDW; certain types of injection practices would be prohibited; and the loss of mechanical integrity would be grounds to shut down or terminate a CO_2 injection operation.

– The regulations would establish testing and monitoring requirements, as well as the requirement to prepare a testing and monitoring plan. This plan would have to include provisions for continuous monitoring and recording devices, corrosion monitoring, monitoring of the CO_2 plume that is created by the injection operations, and periodic monitoring of ground water quality.

– The permit holder would be subject to semi-annual and monthly reporting requirements. Semi-annual reports to the Director would have to include information relating to changes in the relevant characteristics of the injected CO_2 stream, and monthly average, maximum and minimum values for injection pressure, flow rate and volume, and annulus pressure, and a description of "any event" that exceeds the permit's operating parameters or triggered the activation of a shutdown device. The monthly report would have to include information on mechanical integrity tests and well work over or maintenance results.

– Finally, the regulations would establish well plugging standards and would require the preparation of a site-specific well plugging plan that includes specific information on the plugging materials and techniques that will be used.

Issues for Stakeholders

Although the proposed rule provides a solid first step toward defining the regulatory parameters for geologic carbon sequestration, they also raise a number of important issues that stakeholders should consider as they evaluate the potential impacts of this new program. For example:

- The EPA proposes that every Class VI well must go below any underground drinking water source, even if thousands of feet of rock are present between the injection zone and the USDW. The preamble cites several situations in which this limitation is inappropriately strict, including most coal bed methane formations, and suggests that the Director could be given the discretion to waive this requirement or to exempt lower USDWs from SDWA protection. But, such discretion is not found in the proposed regulations. It is not clear if a half-mile depth is also being used as a surrogate test, though the preamble disclaims that such a depth is being used to assure the EPA that the CO2 will be kept in a supercritical fluid state.

- The presumptive 50 years of site care and monitoring, and accompanying financial responsibility requirement, is considerably longer than that suggested by other agencies, such as the IOGCC, which proposed a period of 10 years. Some stakeholders are calling for either the government or private enterprise to relieve the well operator from its obligations and liabilities after the passage of some appropriate time period, either by law or by a privately funded insurance, trust, or indemnity arrangement. In the preamble, the EPA recognizes that as between the facility operator and some trust fund or indemnitor, the fund or indemnitor may shoulder this burden. But, under its SDWA authority, the EPA feels it must impose this lengthy duty on the well operator for that period.

- In addition, the proposed rule raises a number of questions, for which the EPA has specifically solicited comments from affected stakeholders. These questions include the following:

  – Should CO_2 injection for EOR purposes still be regulated as traditional Class II wells, rather than in the new Class VI category;

  – Should already existing and permitted Class I-V wells be "grandfathered" under the new regulations if they are going to be converted to Class VI wells;

  – Should the EPA prohibit injection into coal seams and organic rich shales when they are above the lowermost USDW (proposal prohibits coal seems);

  – Should the new regulations prohibit the injection of hazardous waste in Class VI wells;

  – Under what circumstances may injected and/or stored CO_2 contain a hazardous substance, such that a release could result in CERCLA release reporting;

  – Should the Director be allowed to require owner to identify additional confining/containment zones in addition to the primary zone;

  – Should the AoR be reevaluated on periodic basis, and under what conditions, 10 year minimum reevaluation;

  – Should aquifer exemptions be given for Class VI injection, and under what conditions;

  – Should the rules have a minimum injection depth requirement, rather than requiring injection to occur below the lowermost USDW; and

– Should financial responsibility adjustments be required as proposed?

Finally, given the complexity and significance of these issues, it will be critical to assess whether a primacy state or the EPA will enforce the new regulations and make determinations as to hazardous material content, permitted injection zones, and postinjection site care and monitoring time periods. A total of 33 states have achieved primacy for the existing UIC wells; and we can expect a similar number to seek primacy for the Class VI wells.

Other Regulatory Issues

Another important issue is whether the carbon being stored would be characterized as a hazardous waste under either federal or state law. Depending on the concentration and form of the carbon involved in any particular project, classification as a hazardous waste might apply.[55] Such a classification would affect transportation as well as injection, storage, or disposal requirements, but it should not present an insurmountable barrier to a project.

The first question in making a hazardous waste determination is whether the material is actually a "waste." It is not clear whether CO_2 that is intended to be entirely sequestered (as opposed to used for EOR) will be treated as a commodity (as is the case in EOR) or as a waste. However, the U.S. Supreme Court recently held in *Massachusetts v. Environmental Protection Agency* that the Clean Air Act authorizes the EPA to regulate greenhouse gas emissions from motor vehicles as an "air pollutant."[56] Some observers believe that this holding will result in the classification of CO_2 as a waste, rather than as a commodity, for purposes of CCS.[57]

If CO_2 is treated as a waste, the next question is whether it is classified as hazardous or non-hazardous.[58] Currently CO_2 is not listed as hazardous under EPA regulations implementing the Resource Conservation and Recovery Act (RCRA), which is the federal law governing hazardous waste.[59] Nor does CO_2 exhibit the characteristics that would render it hazardous under RCRA (i.e. ignitability, corrosiveness, reactivity, or toxicity).[60] Nevertheless, CO_2 could be classified as hazardous pursuant to RCRA if it is a "waste. . . which because of its quantity, concentration, or physical, chemical, or infectious characteristics may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed."[61] This distinction is also important for UIC classification purposes, because more stringent requirements are being imposed upon hazardous waste disposal wells.[62]

Potential Texas Permitting Requirements

Although no definitive permitting requirements have yet been identified for CCS projects, this chart identifies permits that may be required for each stage of a CCS project. It also identifies additional permits that may be required depending upon the nature of the project. Should any particular CCS project be identified, a comprehensive permitting review should be conducted for each stage of a CCS project in the State of Texas. *Please refer to the Geological CCS Potential Permitting Requirements in Texas table at the conclusion of this paper.*

Operational Liabilities

Liabilities associated with CO_2 transport and injection activities are known and managed by oil and gas companies in the context of EOR. Below, we provide a summary of potential post-injection operational liabilities specifically associated with longterm CO_2 storage.

Overview of Potential Liabilities

While liabilities associated with long-term CO_2 storage are uncertain due to the lack of experience with storage of CO_2 in the quantities and for the time periods contemplated, a number of studies have identified the likely types and categories of such liabilities. One such study identifies five major categories of risk: "toxicological effects, environmental effects, induced seismicity, sub-surface trespass, and climate effects."[63] These risk categories relate to two general types of post-injection liabilities: "*in situ* liability of harm to human health, the environment, and property," and "climate liability related to leakage of CO_2 from geological reservoirs and the effect on climate change."[64]

- ***In Situ* Liability.**
  – *Toxicological Effects.* While the chances of a deadly release from a properly managed geological formation are generally low, the

toxicological effects of upwellings and seeps of naturally occurring CO_2 worldwide are widely documented and have caused human deaths in addition to ecosystem damage.[65] Releases could also occur from improperly abandoned wells or newly drilled wells, seismic activity, or migration of the gas from the protected reservoir to other reservoirs with active wells.[66] These exposures suggest the importance of locating CCS operations over formations that are determined not to have increased risks of such failures.

- *Environmental Effects.* Leakage from underground CO_2 storage facilities may result in risks to both surface and subsurface soil and aquatic ecosystems including acidification of soils and water.[67]
- *Induced Seismicity.* While induced seismicity has not been observed in connection with CCS, minor seismic events have been observed (or alleged) in connection with other injection activities in seismically active areas.[68]
- *Subsurface Trespass.* Failure to obtain rights from mineral or water-rights holders whose properties or activities are impacted by the storage activities may lead to trespass or related actions if the CO_2 escapes from the intended reservoir system.[69]

• **Climate Liability.** Leakage from the storage formation into the atmosphere would be treated as an emission subject to applicable regulations. However, without any relevant agency determinations on these issues, presently it is impossible to determine which regulatory regime would ultimately be applied.[70] It is expected that CCS projects will be pursued to qualify parties for exemptions from carbon emissions ceilings or related obligations or to obtain carbon credits or other trading rights.[71] The possibility of CO_2 leakage may impair the initial qualification of CCS projects for those regulatory benefits and any actual leakage could result in revocation or reduction of those benefits.

Responsible Parties

The parties potentially responsible for operational liabilities include the person whose activities generated the CO_2, the injector of the CO_2, the owner of the CO_2, and possibly the surface or mineral rights owner whose subsurface formation is being used for storage. The IOGCC proposes that during the period commencing when the injection wells have been plugged and continuing for some to-be-determined period of time after injection activities cease, the operator will be responsible for potential liabilities and required to maintain the operational bond and individual or blanket well bonds (with individual well bonds released as the wells are plugged).[72]

The complexity of this topic derives from liabilities arising in further post-operational phases. Recognizing the difficulty of assigning storage-related liability to individual creditworthy private parties given the long-term nature of the proposed projects, the IOGCC proposes that a trust fund supported by taxes or other impositions on injected volumes of CO_2 finance any monitoring activities and liability exposures for stored gas ten years following cessation of injection activity.[73] However, this proposal is only a model statute, and it is possible that the desired release of liability will be conditioned on the adoption of some industry-level or publicly administered fund, insurance scheme (akin to the Price-Anderson Act for nuclear energy utilization), or similar measures.[74]

Conclusion

CCS is a rapidly developing field and is subject to changes in domestic and international practices, laws, and public policies. We encourage interested parties to monitor developments, including changes in treatment of the matters discussed in this article. Concerted efforts on the part of all stakeholders—regulatory agencies, coal and gas producers, EOR operators, utilities, pipeline companies, storage facility operators, carbon emissions traders and technology licensors—will be necessary to make CCS project development a reality.

Geological CCS Potential Permitting Requirements in Texas

Permit	Agency
Capture	
Air permits, possibly including Title V permits	Texas Commission on Environmental Quality (TCEQ)
Transport	
Encroachment permit	City or County public works departments, reclamation districts
Right-of-way permit	Texas General Land Office
Permit to construct	Railroad Commission of Texas
Authority to construct/permit to operate	Railroad Commission of Texas
Injection	
Authority to construct/permit to operate	Texas Commission on Environmental Quality for Classes I, V
UIC injection permit	Texas Railroad Commission for Classes II, V; Texas Commission on Environmental Quality for Classes I and V (when not regulated by the Railroad Commission of Texas)
Hazardous waste disposal permit	Texas Commission on Environmental Quality
Storage	
UIC injection permit	Texas Railroad Commission for Classes II, V; Texas Commission on Environmental Quality for Classes I and V (when not regulated by the Railroad Commission of Texas)
Operation permit	Railroad Commission of Texas
Additional Permits, Depending on Project	
Environmental impact statement (NEPA)	Designated federal lead agency or permitting agency
Section 404 Clean Water Act (CWA) and Section 10 Rivers and Harbors Act permits	U.S. Army Corps of Engineers Texas General Land Office, which has certain powers related to Rivers and Harbors Act
Section 7 or Section 10 Endangered Species Act Consultation	U.S. Fish and Wildlife Service or National Marine Fisheries Service
Confined space permit and other OSHA requirements	U.S. Occupational Safety and Health Administration
NPDES discharge permits and Section 401 CWA certification/ waiver	Texas Commission on Environmental Quality
Steambed and lake alteration agreements	Texas Parks and Wildlife Department
Endangered species consultation	Texas Parks and Wildlife Department
Hazardous materials release response plan	City or County environmental health department
Domestic well and septic system permit	City or County environmental health department
Building permits	City or County environmental health department
Encroachment approval	Reclamation district

Endnotes

[1] U.S. Dep't of Energy, Fossil Energy, Carbon Sequestration R&D Overview, http://www.fossil.energy.gov/sequestration/overview.html (last visited Feb. 26, 2008).

[2] See U.S. Dep't of Energy, Fossil Energy, Terrestrial Sequestration Research, http://www.fossil.energy.gov/sequestration/terrestrial/index.html (last visited Feb. 26, 2008); see also U.S. Dep't of Energy, Fossil Energy, Geologic Sequestration Research, http://www.fossil.energy.gov/sequestration/geologic/index.html (last visited Feb. 26, 2008); see also U.S. Dep't of Energy, Fossil Energy, Novel Carbon Sequestration Concepts, http://www.fossil.energy.gov/sequestration/novelconcepts/index.html (last visited Feb. 26, 2008).

[3] U.S. Dep't of Energy, Geologic Sequestration Research, supra note 2.

[4] *See id.*

[5] *Id.*

[6] *See id.*

[7] *Id.*

[8] Interstate Oil and Gas Compact Comm'n, Task Force on Car bon Capture and Geologic Storage, Storage of Carbon Dioxide in Geologic Structures: A Legal and Regulatory Guide for States and Provinces 15 (2007) (on file with authors) [hereinafter IOGCC Regulatory Guide for States].

[9] See Interstate Oil and Gas Compact Comm'n, CO2 Storage : A Legal and Regulatory Guide for States (2007), http://iogcc.myshopify.com/ (stating the need for a model law regarding CO2 storage); see also IOGCC Regulatory Guide for States, *supra* note 8, at 1.

[10] IOGCC Regulatory Guide for States, *supra* note 8, at 1.

[11] Id. at 13.

[12] Energy Independence and Security Act of 2007, PL 110-140, 121 Stat 1492.

[13] In fact, the Energy Independence and Security Act began to lay the framework for this type of collaboration at the federal level by requiring agencies including the Department of Energy, the DOI, and the EPA to work together with respect to assessments of sequestration capacity and developing a framework for sequestration activities occurring on public lands. *Id.* at Sec. 711 and 714. See also, "Who Should Take the Lead on Regulating CCS?", Environmental Science & Technology Online News, http://pubs.acs.org/subscribe/journals/esthag-w/2007/dec/policy/cc_sequestration.html (discussing Senator John Kerry's proposed bill requiring the development of an interagency task force to develop regulations pertaining to carbon sequestration technologies and activities).

[14] IOGCC Regulatory Guide for States, *supra* note 8, at 22.

[15] *Id.*

[16] Jeffrey W. Moore, *The Potential Law of On-Shore Geologic Sequestration of CO_2 Captured From Coal-Fired Power Plants*, 28 Energy L. J. 443, 447–48 (2007).

[17] Mark A. de Figueiredo, *Property Interests and Liability of Geologic Carbon Dioxide Storage: A Special Report to the MIT Carbon Sequestration Initiative 5* (2005), http://sequestration.mit.edu/pdf/deFigueiredo_Property_Interests.pdf; see IOGCC Regulatory Guide for States, *supr*a note 8, at 16–17.

[18] See de Figueiredo, *supra* note 17, at 5.

[19] *Id.*

[20] See IOGCC Regulatory Guide for States, *supra* note 8, at 19.

[21] de Figueiredo, *supra* note 17, at 6.

[22] de Figueiredo, *supra* note 17, at 6; see also Jack Lyndon, *The Legal Aspects of Underground Storage of Natural Gas—Should Legislation Be Considered Before the Problem Arises?*, 1 Alberta L. Rev. 543, 545 (1961).

[23] See IOGCC Regulatory Guide for States, supra note 8, at 19; see also de Figueiredo, *supra* note 17, at 7.

[24] Orpha A. Merrill, *Note and Comments, Oil and Gas: Substratum Storage Problems*, 7 Okla . L. Rev. 225, 227 (1954); de Figueiredo, *supra* note 17, at 8.

[25] *Mich. Consol. Gas Co. v. Muzeck*, 154 N.W.2d 448, 450 (Mich. 1967).

[26] 1 Eugene Kuntz, *A Treatise on The Law of Oil and Gas* § 2.6(c) (1987).

[27] *Id.*

[28] See de Figueiredo, *supra* note 17, at 20 (discussing types of geophysical subsurface trespass in relation to unitized oil fields).

[29] William R. Walker & William E. Cox, *Deep Well Injection of Industrial Wastes: Government Controls and Legal Constraints* 131 (1976); de Figueiredo, *supra* note 17, at 9.

[30] de Figueiredo, *supra* note 17, at 9.

[31] *Id.*

[32] *Bristor v. Cheatham*, 255 P.2d 173, 178 (Ariz. 1953); de Figueiredo, *supra* note 17, at 9.

[33] de Figueiredo, *supra* note 17, at 10.

[34] Id. at 10; Earl Finbar Murphy, *The Recurring State Judicial Task of Choosing Rule for Groundwater Law: How Occult Still?* 66 NEB. L. REV. 120, 134 (1987).

[35] de Figueiredo, *supra* note 17, at 11.

[36] *Id.*

[37] *Id.* at 15.

[38] Elizabeth J. Wilson & Mark A. de Figueiredo, *Geologic CO_2 Sequestration: An Analysis of Subsurface Property Law*, 36 Envtl. L. Rep. 10114, 10123 (2006), available at http://web.mit.edu/defig/www/publications.html.

[39] *Id.*

[40] *Humble Oil & Refining Co. v. West*, 508 S.W.2d 812 (Tex. 1974).

[41] *Id.* at 815.

[42] *Stephens Cty. v. Mid-Kansas Oil & Gas Co.*, 113 Tex. 160, 254 S.W. 290 (Tex. 1923).

[43] *Emeny v. United States*, 412 F.2d 1319, 1323 (Ct. Cl. 1969).

[44] *Id.* at 1319. For a recent overview of the question of who owns the storage space where CO_2 will be stored and how to acquire storage rights, see Bill Jeffery, *"What 'Carbon Capture and Storage' Means for Oil and Gas Attorneys"*, Texas State Bar Oil, Gas & Energy Resources Law Journal, vol. 32, no. 4, at 79 (2008).

[45] *Fain v. Great Spring Waters of America, Inc.*, 973 S.W.2d 327, 328 (*Tex. App.–Tyler* 1998, pet. denied) (citing *Houston & Tex. Cent. Ry. Co. v. East, 98 Tex.* 146, 81 S.W. 279 (Tex. 1904)).

[46] *Houston & Tex. Cent. Ry. Co. v. East*, 98 Tex. 146, 81 S.W. 279 (Tex. 1904) (citing *Acton v. Blundell*, 12 Mees. & W. 324).

[47] *Pecos Cty. Water Control and Imp. Dist. V. Williams*, 271 S.W.2d 503, 505 (*Tex. Civ. App.–El Paso* 1954, writ ref'd n.r.e.).

[48] *Texas Co. v. Giddings*, 148 S.W. 1142 (T*ex. Civ. App.–Dallas* 1912, no writ).

[49] See generally The Midwest Regional Carbon Sequestration P'ship, Phase I Final Report (2005), http://216.109.210.162/userdata/Phase%20I%20Report/MRCSP_Phase_I_Final.pdf.

[50] *Id.* at 198-999. See also Moore, *supra* note 16, at 458–459 and Phillip M. Marston and Patricia A. Moore, *From EOR to CCS: The Evolving Legal and Regulatory Framework for Carbon Capture and Storage*, 29 Energy L. J. 421 (2008).

[51] See 42 U.S.C. § 300h-4 (c)(2).

[52] As recently as June 30, 2008, the Washington State Department of Ecology promulgated UIC rules intended to fit CO_2 injection wells within Class V.

[53] The EPA had the proposed rule published in the July 25, 2008 *Federal Register*. 73 Fed. Reg. 43,492. The EPA held hearings on September 30 and October 2, 2008 to receive oral comments on the rule and written comments were to be submitted no later than November 24, 2008.

[54] The regulatory authority is referred to as "the Director" in the regulations because these wells may be regulated by the EPA or an authorized state agency.

[55] 40 C.F.R. § 261.11 (2008).

[56] *Mass. v. Envtl. Protection Agency*, 549 U.S. 497 (2007).

[57] See Statement of Kipp Coddington, Esq., Partner Alston & Bird LLP, before the U.S. S. Comm. on Energy and Natural Resources, at 6-7 (Apr. 16, 2007), http://energy.senate.gov/public/_files/CoddingtonTestimony.DOC; see also Steven Milloy, *Junk Science: Breath is Toxic Waste?*, Fox News, Mar. 6, 2008, http://www.foxnews.com/story/0,2933,335748,00.html.

[58] Moore, *supra* note 16, at 471.

[59] 40 C.F.R. § 261.31-33 (2008).

[60] 40 C.F.R. §261.21-24 (2008) (provides descriptions of each characteristic; however, while pure CO_2 may be free of these characteristics, the characteristics may be present in sequestered CO_2).

[61] 42 U.S.C. § 6903(5)(B).

[62] See generally 40 C.F.R. Parts 144 and 261.

[63] Mark de Figueiredo et al., *The Liability of Carbon Dioxide Storage*, at 2, http://sequestration.mit.edu/pdf/GHGT8_deFigueiredo.pdf.

[64] Mark de Figueiredo et al., *The Liability of Carbon Dioxide Storage*, presented at the Eighth International Conference on Greenhouse Gas Control Technologies, Trondheim, Norway (2006), available at http://web.mit.edu/defig/www/publications.html.

[65] Janet Wilson, *Team Hopes to Drill Its Way to Global Warming Solution*, L.A. Times, Oct. 25, 2006.

[66] de Figueiredo et al., *supra* note 64.

[67] Edward Vine, *Regulatory Constraints to Carbon Sequestration in Terrestrial Ecosystems and Geologic Formations: A California Perspective*, in Mitigation and Adaptation Strategies for Global Change, Vol. 9: 77, 89 (2004).

[68] de Figueiredo et al., *supra* note 64.

[69] 69 de Figueiredo et al., *supra* note 64.

[70] Some persons suggest that the EPA has considered the issue of leakage as part of the proposed rule regarding the creation of a Class VI UIC well, but considers that regulatory issue to be outside of its legislative authority under the Safe Drinking Water Act. See, 73 Fed. Reg. 43,492, at 43,497-43,498. Therefore, it remains to be seen how any of these leakages will be addressed. It is possible that they may be handled through a regime similar to that used for fugitive emissions from different point sources. For examples of how fugitive emissions are regulated, see generally, 40 C.F.R. Part 60.

[71] The deliberations of the intergovernmental Carbon Sequestration Leadership Forum (CSLF), and the U.S. Supreme Court's recent decision regarding motor vehicle emissions in *Massachusetts v Environmental Protection Agency* (Apr. 2, 2007) will likely result in regulatory activity addressing CO_2 emissions from sources that can employ geological CCS. See also *MIT Study on the Future of Coal* (MIT 2007). In addition, as previously noted, the Supreme Court's decision may result in CO_2 being classified as a waste, rather than as a commodity, for purposes of CCS. Government entitlements such as the permits addressed in Section 2 above likely will contain authorizations for CCS projects that qualify for these benefits, and will govern the manner in which qualifying projects will be designed, built and monitored.

[72] IOGCC, Regulatory Guide For States, *supra* note 8, at 29.

[73] Id. at 30.

[74] For example, in 2006, Texas Governor Rick Perry signed into law HB 149. This bill facilitated the FutureGen Industrial Alliance—which, until suspension of the large-scale project in January 2008, planned to build a near-zero emissions fossil fuel energy facility that would generate electricity, produce hydrogen and provide for CCS. The Alliance would be shielded from CCS liability by authorizing the University of Texas System and Permanent University Fund to enter into a lease for permanent CO_2 storage with the Railroad Commission of Texas or a project owner or operator, but requiring adequate indemnification of the System and the Fund by the Railroad Commission or the owner or operator of a clean coal project against claims resulting from CO_2 migration or escape. A number of other states have passed, or are considering, bills that address liability as well as other issues related to CCS. One example is Wyoming, which has already enacted two statutes on the CCS issue. One statute vests pore space ownership with the surface owner, and the other creates the legislative and regulatory framework for regulating CCS. See generally, Wyoming H.B. 89 (Mar. 4, 2008), available at http://legisweb.state.wy.us/2008/Enroll/HB0089.pdf and Wyoming H.B. 90 (Mar. 4, 2008), available at http://legisweb.state.wy.us/2008/Enroll/HB0090.pdf.

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