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Assessing a Liability Regime for Carbon Capture and Storage

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Abstract

As the private sector and government begin to spend billions of dollars to research and deploy carbon capture and storage (CCS) technology, the question of legal liability for managing short-term and long-term environmental, health and safety risks must be addressed. We examine potential CCS liability within a U.S. context and survey the existing environmental and tort law liability regimes that may affect CCS. We conclude that while existing liability regimes are insufficient on their own to govern the CCS industry, they could provide important risk management tools and serve as safeguards to private parties and governments in the event of harm. We also propose a model for long term stewardship, blending including bonding, insurance, and pooled federal funding into commercial CCS project management to better provide financial security to investors without destroying existing liability protections for those who may suffer harm from CCS. This proposal offers a starting point to develop a model to integrate liability for the nascent CCS industry. A longer version of this paper can be found in the *Emory Law Review,* Fall 2008.

Keywords; carbon capture and storage; liability; common law; federal preemption; bonding; insurance

1. Introduction

Creating a liability regime for CCS must balance the risks and benefits of the technology and will likely influence patterns of CCS deployment. The clarity, certainty and extent of legal liability can heavily affect technology adoption, particularly new technology deployment. Companies considering adopting new technology are adverse to unknown or potentially unlimited liability associated with technological problems new to commercial scale deployment. Stable and certain liability terms help guide company investment as well as shareholder and financial community expectations. Legal liability is also important for government actors wishing to promote a technology because it helps ensure the party with the most information about risks and solutions takes appropriate measures to avoid problematic consequences. And finally, clear and transparent liability regimes help the public understand and have confidence that risks – to human health and their surrounding environment – will be actively managed and, in the event of an accident, effectively remediated and compensated. There are potentially several different kinds of liability associated with CCS projects—here we focus on liability arising from environmental health and safety

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(EH&S) considerations. We recognize that liability linked with CCS and any future climate regime is important, but leave a more in-depth discussion for future work.

EH&S liability is linked to risk and driven by the behaviour of CO_2 in the subsurface: of key import are (1) the volume of CO_2 to be injected—millions of tons per project; (2) initial buoyancy of injected CO_2; and (3) the need for injected CO_2 to remain in the subsurface for hundreds to thousands of years. The risks from CCS are associated both with the sheer volume of injected material, as well as the specific properties of CO_2 and where the CO_2 will be injected [1]. CCS risks will vary through the lifecycle of a CCS project and are affected by local and regional geology, site history, and will likely decrease after injection ceases as formation buoyancy pressures naturally decrease [2, 3].

While experts predict that the injected CO_2 is very likely to remain underground, initially, buoyancy flow could drive CO_2 upward through undetected faults or abandoned well bores, making site selection and characterization particularly important for a successful project. Slow CO_2 seepage into the near subsurface could also harm flora and fauna, and potentially cause local disruptions of ecology or agriculture [4]. Over time persistent leakage could also have compromise CCS's climate efficacy. There are also a number of risks associated with injected CO_2 even if it remains underground, including displacement of brines into potable aquifers, contamination of hydrocarbon resources, pressure changes causing ground heave, and even triggering seismic events—though these risks likely will be small with properly-managed sites [5].

Much of the writing on this topic to date, however, has either implicitly or explicitly argued that policymakers should limit or virtually eliminate project operators' liability associated with stored CO_2 in order to encourage development of this potential technology [6, 7]. Although we recognize that special mechanisms may needed to shield the first dozen CCS projects, we believe liability under federal and state environmental and tort laws can also play an important role in ensuring optimal site selection, increasing overall public acceptance of the technology, and in helping fill in gaps in any future, comprehensive framework to govern the mature CCS industry. Although the U.S. Environmental Protection Agency's (EPA) recently proposed rules for injection and geologic storage are important, the rules are—by necessity of statutory authority—focused on protecting underground sources of drinking water and unable to address liability or many of the risks mentioned above. Here we present an overview of major U.S. environmental and tort considerations and explore what the implications are for future CCS projects.

We recognize existing statutory and common law not specific to CCS as sub-optimal tools for assigning fault or rapidly compensating parties damaged by CCS projects, we believe they could be viewed as a secondary backstop behind a future comprehensive federal framework for CCS. With this in mind, we explore the use of several federal liability management mechanisms (bonding, insurance, or pooled funds) that could ensure injured parties are compensated for damages and simultaneously create operator incentives for good CCS site selection and management. We present a proposal for an adaptive management framework at the federal level that would integrate site-specific performance data into risk pricing and management of project liability.

2. Existing Federal and State Environmental Liability Framework

CCS will be deployed into an existing framework of laws, regulations and legal precedent which will vary significantly across different jurisdictions. Overarching U.S. federal legislation may impact CCS in several different ways. Since the 1970s, Congress and state legislatures have enacted far-reaching legislation to reduce or eliminate air and water pollution, govern the generation, storage, and disposal of solid and hazardous waste, and create a regulatory system to review, classify, and regulate a host of pollutants and hazardous chemicals. While we do not provide a comprehensive discussion of existing environmental laws that may govern CCS [8], we focus on the two statutes that have the most direct application for CO_2 storage, the Resource Conservation and Recovery Act ("RCRA")[2] and the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA").[3] If

[2] 42 U.S.C. § 6901-6992k.
[3] 42 U.S.C. §§ 9601-9675.

CO_2 is classified as a "waste" or "hazardous substance", these laws may act as important gap-fillers in any federal regulatory system governing CCS.

RCRA was enacted in 1976 to provide, among other things, a comprehensive "cradle-to-grave" regulatory system for identifying, listing, and tracking hazardous wastes; setting standards for the generation, handling, storage, and disposal of hazardous wastes; and assisting states with the management of solid wastes from active facilities [9]. Section 7002 of RCRA authorizes suits by any person to restrain anyone who has contributed or is contributing to the past or present handling of any solid or hazardous waste that endanger human health or the environment.[4] RCRA's provisions may provide liability for harm arising from the long-term storage of CO_2, if stored CO_2 is determined to be a solid or a hazardous waste and may also impose stringent handling, storage, and disposal requirements on the CCS process. RCRA defines solid waste as including "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid or contained gaseous materials, resulting from industrial, commercial, mining, and agricultural operations, and from community activities."[5] This definition likely includes stored CO_2 in connection with CCS operations because the CO_2 is arguably "discarded material," is in "gaseous" or "liquid" form, and results from industrial or commercial activities. Hazardous waste is essentially defined as that which exhibits a hazardous characteristic (such characteristics includes ignitability, corrosivity, reactivity, and toxicity) or is listed by the EPA as hazardous [9].[6] CO_2 is not currently a listed hazardous waste and it seems unlikely that CO_2 alone would be considered a hazardous waste, although co-injection with other waste stream constituents (e.g. hydrogen sulfide (H_2S)) could cause it to be defined so.[7] It is also possible EPA would exclude stored CO_2 from the definition of hazardous waste, as it has done with incinerator ash and, more applicably, for wastes produced during the exploration, development, and production of crude oil, natural gas, and geothermal energy [9]. Furthermore the industry has made some effort to encourage the classification of CO_2 as a "commodity," which would bring it outside the scope of RCRA by avoiding a classification as a "waste," [10].

CERCLA, also known as "Superfund"[8] was enacted in 1980 to create a federal framework to address the problems associated with the existence of hazardous substances in the environment [11]. Unlike other environmental laws that govern the generation, management, and disposal of hazardous materials and waste, CERCLA provides a cost-recovery vehicle for the federal government, state and local governments, and private parties to recover costs associated with contamination that occurred in the past. Liability under CERCLA is retroactive, joint, and several and is imposed on current as well as past owners and operators of "facilities" where there has been a release of a hazardous substance, as well as on those who have generated or transported hazardous substances [9].[9] It, however, only allows recovery by private parties for money spent on the investigation and remediation of a release of hazardous substances; it does not allow private parties to recover damages associated with lost profits, diminution in value to property, personal injury, lost rents, punitive damages, or other damages associated with contamination of property or the environment, although some state superfund statutes do.

In order for CERCLA to apply to any releases of CO_2, the stored CO_2 must be considered a "hazardous substance." As mentioned before, CERCLA nor any other federal environmental statute defines CO_2 as a hazardous substance, although the EPA has stated that if the injected stream contains mercury or other hazardous substances or were to react with groundwater to create hazardous substances, it might be subject to CERCLA liability.[10] Given CO_2 is non-toxic at low concentrations and is not a listed waste, CERCLA likely does not apply to current CO_2 injection activities unless recognized hazardous substances are present. If CCS is associated with hydrocarbon production, it might fall under the CERCLA "petroleum exclusion" which states that petroleum and natural gas are not hazardous substances. Finally, CERCLA typically does not apply to hazardous substances sold as "useful products" (as

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[4] 42 U.S.C. § 6972(a).
[5] 42 U.S.C. § 6903(27).
[6] 42 U.S.C. § 6904(5)
[7] 73 Fed. Reg. 43492, (July 25, 2008)
[8] The term "Superfund" is from the five-year, $1.6 billion Hazardous Substances Response Trust Fund created to finance cleanups at CERCLA's inception. *See* 28 U.S.C. § 9507 (establishing fund).
[9] *See* 42 U.S.C. § 9607(a).
[10] 73 Fed. Reg. 43492, 43504 (July 25, 2008).

opposed to those for disposal) which would mean that CERCLA might not cover stored CO_2 if it was classified as a "commodity" rather than a waste [12].

Table 1: Different common law doctrines that could affect CCS

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	Description	Elements	Tests	Example/ Precedents	Application to CCS
Trespass	Property based tort: interferance with a plaintiff's possessory interest in his personal property (land or chattels)	The plaintiff must show that the 1) defendant acted voluntarily or with an intent to commit the act (not necessarily the effects of the act), 2) that the plaintiff did not consent to the trespass in any way and 3) that harm was suffered by the plaintiff.		Oil and gas: where courts had treated migration of resource as analagous to wild animals or 'fugitive resources', meaning it belonged to no one until captured. Once efficient use of the resource became a priority for public policy, the courts began weighing the costs and benefits of storage.	Public policy favoring GHG reductions may weigh in favor of applying liability sparingly although the sheer volumes of CO2 to be injected might raise caution.
Negligence	Common law tort: Conduct liable because it failed to take the care that a reasonable person would to protect another from foreseeable harm	The plaintiff must show the defendant 1) had a duty of care, 2) breached that duty, 3) the breach was the cause (actual and proximate) of the plaintiffs harm and 4) demonstrate damages.	Every negligence case involves a balancing of social costs and benefits associated with the defendant's conduct.		It may be difficult to establish the appropriate standard of care or the duty or breach of that duty with a new technology and new industry. Establishing the causal link between the injected CO2 and the harm may also be difficult, particularly where several parties are simultaneously injecting into the same formation.
Negligence per se	Common law tort where a statute is substituted for the 'reasonable person standard' in a negligence action.	The plaintiff must show (1) the defendant violated a statute, (2) the resulting harm or injury was of the kind the statute intended to prevent, and (3) the plaintiff was of the class of persons intended to be protected by the statute.	The statute must be read by the court to have intended to prevent the kind of harm from happening to the particular plaintiff bringing the action.	Since the 1970s, courts have used newly enacted state and federal environmental statutes and regulations to help define the duty in an array of environmental negligence and negligence per se cases.	The body of state and federal statutes that could provide the basis for a common law, negligence per se action is just developing.
Private Nuisance	Property based tort: interference with a plaintiff's private use and enjoyment of his land	To show PRIVATE nuisance, a plaintiff must show an intentional and unreasonable (but not necessarily illegal) or an unintentional but reckless or highly dangerous action by the defendant which intereferes with the use and enjoyment of the plaintiffs land.	Once established, the court generally balances the benefits fo the alleged nuisance activity with the harm caused and other equitable factors to determine whether the defendant should pay damages or be enjoined from actions causing the nuisance	The doctrines have been used by parties to obtain both injunctive and monetary relief from air, water, soil and noise pollution resulting from an array of industrial and commercial activities such as landfills, sewage treatment plants, oil refineries, quarries and the like.	The doctrine of nuisance could apply to an operator complying fully with regulations and statutes governing behavior if they activity never-the-less still interferred substantially with a plaintiff's use of his land. However, a balancing test might find the public benefit from mitigating climate change outweighs the harm or cost of the action.
Public Nuisance	Property based tort: interference with a right common to the general public	To show PUBLIC nuisance a public body must show an unreasonable interference with a right common to the general public, or a private party must show he or she suffered unique injury by the same that differentiates him/her from the rest of the general public.	Similar to private nuisance	Similar to private nuisance but generally brought by public entities such as state attorneys general.	Similar to private nuisance but where the activity interefered with a right common to the public like the right to clean air or water.
Strict Liability	Common law tort: Imposes liability regardless of intent where defendant is in the best position to bear the loss or avoid the risk and usually where enganging in abnormally dangerous enterprise.	The plaintiff must show the existence of a high degree of risk, likelihood the harm will be great, the inability to eliminate harm through reasonable care, the extent to which the activity is not common, the inappropriateness of resonable care, and the extent to which the value of the activity is outweighed by the risk.	Unlike other doctrines, under strict liability the plaintiff does not need to show the defendant intended to act or interfere with a legally protected interest.	Courts have held defendants strictly liable for a broad range of related activities including: the release of petroleum or oil contaminating groundwater; the seeping of salt water contaminating a water supply; the release of pollutants during oil drilling; and the percolation of pollution from oil wells.	States vary considerably in the application of strict liability for different activities. Similarly the level of associated risk varies greatly between the geology of different potential formations across the country.

In many ways, in comparison to federal environmental statutes, state law, and particularly state common law, has the potential to provide non-federal actors more comprehensive relief from harm related to the long-term storage of CO_2, but also is at risk of preemption by any forthcoming federal regulatory framework on CCS. Unlike the federal environmental statutes, which either do not give states or private parties the right to seek monetary recovery or, in the case of CERCLA, allow only for recovery of response costs, the state common law claims are available to private parties, local governments, and states to recover for a fuller range of harms associated with leakage from stored CO_2. Potential claims of trespass, negligence, nuisance, and strict liability, along with potential damages, offer the possibility for compensatory and punitive damages and injunctive relief not available under most federal and state environmental statutes [13]. The range of applicable common law doctrines are illustrated in Table 1.

3. Statutory Developments, Competition, and Limitations on Liability

Even though EPA's statutory authority does not allow it to address issues associated with long-term liability, property rights, [11] federal and state legislators are keenly aware of the importance of defining property rights and tort liability in advance of implementing CCS and long-term storage of CO_2. Deployment of the first dozen or so CCS projects will provide a real-world experience for risk identification and management and to help establish appropriate mechanisms for assigning liability and funding to address potential harm.

Arguments over whether existing federal legislation should preempt liability under state law are based on principles of constitutional law, federalism, statutory interpretation, and, in some cases, deference to agency positions arguing in favor of preemption [14]. In the case of CCS, however, Congress will likely consider and perhaps adopt broad federal legislation to govern many aspects of the CCS process in addition to whatever legislation is enacted at the state level. If and when Congress considers such legislation, there undoubtedly will be arguments by industry, and perhaps federal agencies, that any such legislation should preempt state tort remedies in order to provide more settled-expectations to industry and avoid multiple liability standards.

We caution against such an approach, as Congress has generally not acted to preempt state law in enacting environmental health and safety legislation, even when that legislation is intended to cover nationwide issues such as the regulation of air pollution, water, or waste [9]. Even though CCS is new and will require significant federal, state, and private resources to become viable, as the technology matures, it can look to existing and future liability and funding frameworks to create a reasonable certainty of investment without compromising public health, safety, and environmental protection. Such frameworks can be structured to enhance incentives for proper site selection and management for CCS projects. Ensuring that existing liability frameworks are in place for CCS is particularly important at a time when federal agencies often do not have the resources to enforce their own regulations, creating an enforcement vacuum that had historically been filled by state tort law.

4. Ensuring Financial Responsibility and Managing Liabilities for CCS

Provisions for financial responsibility and liability during post-closure care and long-term stewardship of CCS projects must balance global and local risks with the climate benefit of CCS deployment. If long-term stewardship and liability considerations are too onerous, firms may choose not to invest in CCS; if they are too lax, public and ecological health could be compromised and public confidence in CCS may suffer. As the time-line for CCS projects (hundreds of years to thousands of years) is incongruous with the lifetime of private firms, legislators and regulators must develop institutional structures to manage CCS risks over the long term. Such structures will likely be temporally segmented, with responsibility passing from private firms to public management for long-term stewardship. While such risks are expected to be small, ensuring adequate funds are available during the post-closure and long-term stewardship phases could follow several different formulae, but any approach must guarantee resources are available to cover public monitoring and potential remediation costs and avoid CCS projects becoming an unfunded public mandate [7, 15].

For CCS, augmenting statutory and common law liability within a tailored regulatory structure is a crucial component of risk management. Shortcomings of relying solely upon general statutory and common law liability are: (1) the ability to detect and assign blame for harm—especially in areas where many operators may be injecting into the same basin [16]; (2) the potential lack of necessary resources for firms injecting CO_2 to address potential harms; and (3) the time horizon between cause (injection of CO_2) and effect of any damages [17-19]. As a result of these shortcomings, we examine different approaches which can supplement liability frameworks and provide a compensation mechanism where liability is imposed [8]. The following table (Table 2) describes four financial mechanisms for compensation in cases of injury – bonding, insurance, a special fund, and a blended mechanism using private insurance and a pooled fund.

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[11] *See* 73 Fed. Reg. 43492, 43495 (July 25, 2008)

Table 2. Mechanisms to Finance Post Closure and Long-Term Stewardship for CCS

	Bonding	Insurance	Special Fund	Blended Approach--Insurance and Pool
Description	Allows for the internalization of future damages by requiring an up-front commitment to offset costs of potential future pollution - often in the form of cash, a letter of credit, a surety bond, or a trust fund or escrow account. For bonds to be effective, the time frame they cover must be specified.	Serves to allocate risk through classifying the risk and pricing it, the use of policy exclusions and deductibles and the creation of 'surrogate regulation' where inspection, risk assessment and risk management act as de facto impetus towards better management.	A special fund for certain types of harm can allow prompt payment of claims but retain the ability of claimants to seek damages beyond the funding limits from responsible parties through the tort system.	Provides an alternative to the tort process by displacing (or preempting) tort law and setting caps on damages available from the fund. Proponants argue they help manage uncertain risks, protect industry from large jury awards and unnecessary lawsuits and provide a climate for private investment while still compensating injured parties.
Mechanics	The bond is posted up front, but if the firm does not comply, it is forfeited and remediation funds are immediately available.The burden of proof is shifted from the regulator to the operator and provides public protection up to the amount posted (but not necessarily the amount of damages).	Conventional rules of insurability include: 1) a sufficient number of similar and uncorrelated events to allow for risk pooling; 2) clearly calculable losses; 3) loss occuring within a well established time period; 4) frequent enough losses to calculate premiums and 5) insured party has no incentive to cause loss.	Operators pay into the fund based on an agreed metric, based on use or potential damage.	In addition to insurance requirements up to a level the private insurance industry is able to provide, a special industry fund is collected in case of a larger accident. These approaches are often coupled with a federal backstop and limit on liability.
Application for CCS	For bonding to be effectively used for long-term stewardship in a CCS project, several conditions would need to be met: 1) the time frame covered by the bond must be clearly established; 2) the party responsible for the damages myst be identified; and 3) cost estimates - for monitoring, verifying and remediating damage - are needed to set the bond amount.	CCS might violate many of the conventional rules of insurability. The lack of experience with large-scale CCS and inherent geologic heterogeneity creates problems for rules 1, 2 and 4. The long time frames required for CCS may prove problematic for Rule 3.Insurers, however, believe they have the required experience to manage all environmental risks associated with CCS (with the possible exception of climate risk) primarily through a relatively recent insurance product, environmental impairment liability (EIL).	Operators could pay into a fund based initially on tons of CO2 injected and in later years pay at increased or decreased rates based on a risk-rated ton charge which incorporates site operational data and the risk of leakage after monitoring data has been gathered at the injection site and surrounding areas. The funds could be collected during active site injection, aligning income from injection with long-term care fund collection.	Like the early nuclear industry, CCS highlights the importance of the interplay between encouraging technology deployment, protecting human health and the environment, and balancing the role of state and federal law. The blending of site specific insurance and pooled industry funds could provide both site-tailored risk management and ensure that adequate funds are available to cover damage in the post-closure period.
Time Frame	The role of bonding is inextricably linked to future regulation governing the operator's duration and scope of responsibility. If the post-closure period for site care is a fixed time period (as opposed to performance-based) bonding could be a useful tool. Bonding works well for short time frames, but over the 15 to 50 years required for post-closure financial responsibility, bonding could tie up capital and prove less efficient than insurance-based instruments.	EIL policies are claims-made and 'backward looking' in that they pay claims made on environmental damages that occurred in the past.	Allows for immediate relief for injured parties, but leaves room for assigning additional liability in court. A lowered liability cap within a strict liability federal fund for the first dozen or so full-sized CCS projects could help industry to gain confidence and experience. Care should be taken, however, to ensure such a cap does not become permanent as - in addition to removing normal incentives for responsible behavior - it could create a public backlash adversely affecting future CCS project siting.	
Examples	Bonding is currently used in the EPA's Underground Injection Control (UIC) program to ensure that wells are properly plugged and abandoned.	Both RCRA and CERCLA use pollution liability insurance as a tool to control environmental pollution. EIL provides experience with all risks posed by a CCS project - with the exception of climate-related risks - and is tailored to site-specific risks, which is important for linking geologic variability within a risk management framework.	The Trans-Alaska Pipeline Liability Fund (TAPL), creates a fund for quick payout of claims and allows claimants to seek damages in excess of the fund's maximum from liable parties under tort law. The Oil Pollution Act (OPA) reconciles existing regulatory standards and incorporates liability and risk management according to the location of the damage. OPA also includes a savings clause providing that nothing in it should be construed as preempting state or federal liability or obligations.	Congress has created specialized funds to displace the standard tort process for certain types of workplace injuries, the federal childhood vaccine program and nuclear power plants. For example, the Price-Anderson Fund requires each nuclear reactor over 10 MW to have $300M in insurance and any additional claims are paid from an industry-pooled fund, with each company contributing up to $98.5M if a nuclear accident occurs--currently about $10B. Any claims beyond this amount would be covered by funds raised by the Nuclear Regulatory Commission (NRC).

Table 2: Mechanisms to Manage Long-term Financial Responsibility

5. Managing Liability and Ensuring Long-Term Financial Responsibility

The lifetime of private firms is much shorter than the period necessary to ensure public and environmental health protection in CCS projects, a transfer of responsibility from a single firm to a pooled fund held by a private or public entity must occur. Under the current regulatory authority—the Safe Drinking Water Act, the site operator is indefinitely responsible for the CCS site, but this arrangement may not be suitable to balance public stewardship and operator interests. One potential structure would be to adopt a post-closure care program of graduated responsibility which ensures that the CCS project operator is responsible for CCS care for a defined time period after closure. Over the first post-closure phase, the project operator would bear full responsibility for all liability and be required to provide some type of financial assurance. Over the longer-term, stewardship of CCS projects—and funds to ensure remediation—would be transferred to a public or private organization with a pool of resources to ensure public and environmental health are managed over the long term. Bonds, insurance, and selective damage caps (for early pilot projects and the long-term stewardship periods only) could all help ensure CCS risk is managed over the long-term. We assume the CCS life-cycle will follow a pattern of active injection, site closure, post-closure, and long-term stewardship, with monitoring, remediation, and liability responsibility shifting from private to third-party (public or possibly a public-private hybrid) ownership with post-closure to long-term stewardship transition. Here we posit that the regulatory framework must clarify how to transition ownership and responsibility from a private

operator CCS project to a public entity for long-term stewardship. There could be a fixed time period of operator monitoring and responsibility (e.g., up to and including 15 or 30 years of post-closure care or even 50 years under the EPA Proposed Rules—though these rules require monitoring but do not have any provisions for a transfer of responsibility), at which time project responsibility would be passed to a public entity or a performance-based measure. The proposed EPA rules also explore a possibility that "post-injection site care will continue until the plume is stabilized and cannot endanger USDWs," (p 43519). A similar provision could be adopted to initiate the transfer of CCS site responsibility.

If any transition to public responsibility of CCS projects is to occur, it must be accompanied by sufficient funds to cover costs of long-term stewardship. In addition to stimulating early CCS demonstration projects through the use of trust funds, a variety of funding models could ensure resources are available for post-closure and long-term stewardship phases of the CCS life-cycle [20]. We propose development of a three-tiered payment system that covers: (1) the active CO_2 injection phase; (2) the post-closure period; and (3) long-term stewardship. During Phase 1 active CO_2 injection, the CCS project operator holds insurance and site liability and pays a charge into a central fund, as pre-payment for long-term stewardship. In Phase 2, the post-closure period, the operator is still responsible for site monitoring, verification, and necessary remediation, and is fully liable for damages. During Phase 2, bonding or private insurance mechanisms could be used to cover monitoring and necessary remediation. These could be held at a project level—again to encourage responsible site operation by the owner/operator, or pooled across different projects if care were taken to manage any moral hazard. An industry-funded pool created, potentially at the basin or federal level, could ensure risk sharing and compensation for damages above individual operator liability caps. To transition to Phase 3—public assumption of responsibility, the CCS site must meet pre-determined performance based measures. During Phase 3, the long-term stewardship phase, necessary monitoring, remediation and damages would be funded from the federal pool, financed during the active injection phase. This Phase 3 fund could conceivably be administered by a public or semi-private entity and would be responsible for ensuring long-term data storage and site management for CCS injection sites. The advantage of having this pool financed at the federal, as opposed to state or geologic basin level is two-fold. First, risks of leakage or damage may be correlated with certain geologic formations, and this approach would spread the risk more widely. Second, if this pool were linked to a site-specific damage cap, federal standards would provide a regulatory "floor" for environmental and technical standards.

Separate from this phased liability and funding approach is the issue of how to encourage the development of the first CCS "pilot" projects. For those projects, Congress could create a special federal fund with a damage cap that allows claimants to recover on a strict liability basis with the operator paying only the lowered damage cap and the federal government paying the rest. By carefully structuring a path towards CCS commercialization—*and ensuring that temporary systems to manage liability for pilot projects do not become permanent*—Congress could help chart a path toward commercial CCS deployment. After the first dozen or so projects have been built, CCS project caps would be raised to the risk-based site specific caps described above, and operators would be regulated under a set of federal standards and subject to existing tort and environmental statutory liability (along with liability under any CCS-specific legislation), coupled potentially with other instruments like pooled federal funding, insurance, and bonding. As a result, the federal government would take on a larger compensation burden in cases of harm in pilot projects throughout the CCS life-cycle, and for the long-term stewardship phase of all CCS projects. This graduated and risk-based structure is designed to both encourage CCS development and ensure safe site-selection and project operation as well as compensate those who may be harmed by CO_2 storage.

6. Conclusions

Existing statutory environmental laws and common law doctrines are crude tools for governing the complicated policy and regulatory issues associated with CCS and are no substitute for a comprehensive state and federal regulatory framework. CCS-specific laws can consider the unique features of CCS, create regulatory safeguards to guide development, and create a permitting and compliance structure unique to CCS. This does not mean, however, that the existing statutory and common law liability framework is not relevant. RCRA and CERCLA are powerful environmental statutes that have been used to address a wide range of issues relating to waste and contamination since they were enacted over 20 years ago. Common law, for its part, can evolve in a reasoned manner somewhat more insulated from interest groups than the political process; reach decisions based on sworn, scientific testimony

rather than the generalities often presented in legislative hearings; and can base decisions on individualized factual circumstances.

The framework presented here could begin to address liability and funding issues associated with the long-term storage of CO_2. We propose a system that uses existing tort and statutory liability for harm associated with CCS as a backstop to comprehensive federal regulations and then places on top of it a funding system consisting of insurance, bonding, selected damage caps (for early pilot projects only) and pooled federal funding to provide protection both for CCS operators and for those potentially harmed by CCS. Such a system can go a long way toward decreasing the risks of climate change while managing the local risks of CCS. How liability is structured is important. While the first dozen or so CCS projects may require additional tools to manage uncertain liabilities in the earliest stages of development, we caution against blanket state absorption of liability and blanket pre-emption for commercial CCS projects. Such proposals have the potential to eliminate important incentives for good site selection and responsible management, and do not address issues of compensation for potential damages from CCS projects. Indeed, until a comprehensive federal framework is developed, existing environmental law and tort liability can help manage liability and encourage good site selection and project management.

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