Carbon Dioxide Sequestration:
Interim Report on Identified Statutory and Regulatory Issues

New Mexico Energy, Minerals, Natural Resources Department
Oil Conservation Division

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Executive Summary

The Governor's Executive Order 2006-69 requires the New Mexico Energy, Minerals, and Natural Resources Department (EMNRD) to coordinate with a stakeholder group to explore and identify statutory and regulatory requirements needed to geologically sequester anthropogenic carbon dioxide.

The purpose of this interim report is to identify the issues and challenges that must be addressed by potential statutory and regulatory changes, to identify questions, concerns and recommendations made by the stakeholder group, and to present preliminary findings and research to date for further policy development.

This interim report is due to the Governor's Climate Change Action Implementation Team on June 27. A final report, with findings and recommendations, is due on December 1.

Geologic sequestration of carbon dioxide has been identified as a technically viable means to significantly reduce anthropogenic emissions of the greenhouse gas carbon dioxide (CO2) over long timescales. Studies suggest that in appropriately selected and managed geologic reservoirs it is very likely that the fraction of stored CO2 will be greater than 99 percent over 100 years, and likely that the fraction of stored CO2 will exceed 99 percent for the first 1,000 years.[1]

Implementation of a regulatory framework for geologic sequestration of CO2 raises numerous property rights, monitoring, verification and liability issues, including the following:

- *Potential Current and Future Conflicts with Subsurface Interests*
  - Potential conflicts with mineral estate interests, pore space/storage owners, surface interests, and groundwater use.
- *Injection of CO2: Disposal Model (waste) or Ownership Model (commodity)?*
  - Should CO2 be treated as a waste or a commodity and how should that conception be reflected in the stringency of the regulatory framework?
- *Ownership of Geologic Formation/Pore Space and the Right to Sequester*
  - How are the diverse interests of the pore space owner and mineral interests to be accommodated for the purposes of long-term sequestration of CO2?
- *Long-term Liability*
  - What is the best means to protect public and private interests against the long-term liability and inherent unknowns (e.g. economic, environmental, carbon dioxide accounting, human health and safety, etc.) of commercial-scale carbon dioxide sequestration projects?
  - Should the state retain long-term liability (monitoring, measurement and mitigation responsibilities) of all projects or a limited number of initial projects to promote industry and commercial participation? Should state take on only those projects demonstrated to be performing as predicted to encourage careful and proper site selection?

[1] *IPCC Special Report on Carbon dioxide Capture and Storage* (2005) p. 246.

- What is the best means to fund the state's long-term liability? Or, should industry retain liability?

To address the potential conflicts and uncertainties outlined above and to ensure the viability and success of any commercial-scale carbon sequestration project, several statutory and regulatory changes would be necessary to address a variety of issues.

Identified Statutory Issues:

- *Authority to Regulate Carbon Sequestration*
  - OCD would need clear authority to regulate the sequestration and accounting of anthropogenic CO2 into all potential geologic reservoirs, not limited to oil and gas, for purposes of long-term/permanent sequestration.
- *Protection of Surface Owner Interests*
  - Make statute applicable to CO2 sequestration operations.
- *Ownership of Geologic Formation/Pore Space*
- *Unitization of Recoverable Hydrocarbons*
  - To account for the enhanced recovery anticipated from injecting CO2 into depleted oil and gas pools, it will be necessary to unitize such pools by voluntary agreement among the pool operators or through a Division order compelling it, to provide a process to equitably allocate costs and production among the various mineral interests.
- *Condemnation of Storage Space and Transportation Corridors by Eminent Domain*
- *Authority to Transfer Liability/Ownership to the State*
- *Authority to Impose Sequestration Fee on Injected CO2 Volumes & Exemptions*
  - Transferred liability to the state could be funded by an industry fee or supported by other funding models based on existing liability programs such as the Price Anderson Act, CERCLA, the Safe Drinking Water Act's Underground Injection Control Program, the Low-Level Radioactive Policy Act or private insurance.
- *Authority to Bond Injection Projects & Facilities*
- *Authority to Enter Land for Inspection*

Identified Regulatory Issues

General

- Enforcement
- Definition of permanent sequestration (99% storage for 1,000 years?)
- Prohibit venting of CO2 (NMED)
- Coordinate CO2 accounting methods with CO2 registry

Siting & Permitting

- Demonstrate property rights/access to pore space
- Proper unitization
- Site/Reservoir characterization (baseline data)
- Public safety/worker emergency response plan
- Public notice

Drilling & Operations

- Injection requirements (monitoring, well casing standards, CO2 purity, etc.)
- CO2 venting/leakage (allowance for equipment failure?)
- Surface Owner's Protection Act (make applicable to CO2 sequestration)

Post Injection & Closure

- Demonstration of site/formation integrity/stability
- Monitoring (soil, wells, groundwater, CO2 plume)
- Plugging & Reclamation of surface and facilities
- Qualifications for transfer of ownership/liability to state (closure report)

Post Closure

- Transfer of liability/ownership (option for injector/operator to retain?)
- Long-term monitoring & mitigation plans

Introduction

The Governor's Executive Order 2006-69 requires EMNRD to "explore requirements needed to … geologically sequester significant amounts of anthropogenic carbon dioxide in the state, including but not limited to geologic surveys, infrastructure, and ownership of liabilities. … In addition, EMNRD shall coordinate with the stakeholder group to develop and propose rules regarding carbon dioxide … storage."

The New Mexico Climate Change Advisory Group in its final report of December 2006 identified the Oil Conservation Division as the likely agency to oversee development and implementation of a regulatory framework for geologic sequestration of CO2 due to its institutional and technical expertise in drilling, deep-well injection, current regulatory oversight of ongoing carbon dioxide injection projects, as well as the anticipated synergies with enhanced oil recovery.

Pursuant to the foregoing Executive Order, EMNRD's Oil Conservation Division (OCD) held a series of public stakeholder meetings with representatives from community and non-governmental organizations, oil and gas exploration and production companies, power generation companies, and industry groups to gather input and recommendations for a proposed statutory and regulatory framework for CO2 sequestration.

The purpose of this interim report is: 1) to identify the issues and challenges that must be addressed through statutory and/or regulatory changes to fully develop a comprehensive regulatory framework for the safe and effective sequestration of carbon dioxide in furtherance of the Governor's Executive Order; 2) identify questions, concerns and recommendations presented to the Division through the stakeholder process; and 3) present findings and research to date for further policy development.

This interim report is scheduled to be presented to the Governor's Climate Change Action Implementation Team – a multi-disciplinary team of representatives from the Departments of Environment; Transportation; Regulations and Licensing; Finance and Administration; Energy, Minerals and Natural Resources; Taxation and Revenue; General Services; Agriculture; Economic Development; the Office of the State Engineer; and the Office of the Governor – on June 27.

A final report with findings, recommendations and proposed statutes and rules is due to be submitted to the Team by December 1, 2007.

Background

Based on current sequestration pilot projects and decades of enhanced oil recovery efforts, evidence suggests that geologic sequestration is a technically viable means to significantly reduce anthropogenic emissions of CO2 and permanently separate it from the atmosphere.

In its December 2006 Final Report, the New Mexico Climate Change Advisory Group (CCAG) included carbon capture and storage/re-use among its greenhouse gas emissions reductions strategies.[2] Governor Richardson directed the CCAG in Executive Order 2005-033 to develop proposals to reduce New Mexico's greenhouse gas emissions to 2000 levels by the year 2012, 10 percent below 2000 levels by 2020, and 75 percent below 2000 levels by 2050 as part of a climate change mitigation strategy.

In recommendation ES-11, focused primarily on the capture and re-injection/re-use of CO2 in the processing of natural gas, the CCAG proposed a CO2 capture and re-injection/re-use target of 7 percent of CO2 emissions every year, based on the prior year's emissions, for a total of 25.1 million metric tons of CO2 equivalent captured and stored/re-used by 2020.[3]

For context, there are currently 70 CO2 injection projects in the United States, injecting more than 35 million tons of CO2 annually, primarily for enhanced oil recovery.[4] In 2000, New Mexico emitted approximately 83 million metric tons of CO2 equivalent,[5] of which 30 million metric tons CO2 equivalent came from the burning of coal.[6] As CO2 is emitted from coal-burning facilities and natural gas processing plants, it is also being mined in Union and Harding counties at the rate of about 8.6 billion cubic feet per month (452,800 metric tons/month on average since January 2006). In 2006, these counties produced more than 104 billion cubic feet (5.5 million metric tons) of CO2, primarily for enhanced oil recovery in southeastern New Mexico.

A recent MIT report concluded that "CO2 capture and sequestration is the critical enabling technology that would reduce CO2 emissions significantly while also allowing coal to meet the world's pressing energy needs."[7] Geologic storage of CO2 is also considered a viable and effective means of successfully sequestering CO2 from the atmosphere over long timescales. Based on decades of studies in analogous hydrocarbon systems, natural gas storage operations and enhanced oil recovery projects, a 2005 Special Report by Intergovernmental Panel on Climate Change reported that "[f]or large-scale operational CO2 storage projects, assuming that sites are well selected, designed, operated and appropriately monitored … [i]t is very likely the fraction of stored CO2 retained is more than 99% over the first 100 years [and that] [i]t is likely the fraction of stored CO2 retained is more than 99% over the first 1000 years."[8]

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[2] New Mexico Climate Change Advisory Group, Final Report (December 2006) http://www.nmclimatechange.us/ewebeditpro/items/O117F10150.pdf
[3] Id. Appendix H-43-H-46.
[4] David Hawkins and George Peridas, "No Time Like the Present: NRDC's Response to MIT's 'Future of Coal' Report," p. 4 (2007).
[5] New Mexico Climate Change Advisory Group, Final Report, Appendix D-5 (December 2006).
[6] Id., Appendix D-20.
[7] MIT Interdisciplinary Study, "The Future of Coal: Options for a Carbon-Constrained World," p. x (2007).
[8] *IPCC Special Report on Carbon dioxide Capture and Storage* (2005) p. 246.

While CO2 has been injected into various geologic formations in New Mexico for decades for enhanced oil recovery purposes and acid gas disposal, the idea of permanent CO2 storage, or sequestration, for the purpose of mitigating global climate change is a fairly novel one with few commercial-scale prototypes upon which to draw guidance in the development of a regulatory framework. To date, there exist no comprehensive regulatory models that address the unique long-term measurement, monitoring and verification requirements, or the liability and property rights issues such a comprehensive and large-scale effort presents. There are, however, numerous useful analogs, mostly developed in the oil and gas fields and by oil and gas regulatory agencies that can serve as models.

Current estimates suggest that New Mexico has a CO2 storage capacity of 6 gigatons in its oil and gas fields and roughly twice that capacity within the state's deep saline aquifers.[9] As a consequence, oil and gas reservoirs, and more specifically enhanced oil recovery, are expected to ultimately play a relatively small role in carbon sequestration. But because the infrastructure for CO2 injection is already largely in place there, and because of the potential market interest and synergy with enhanced hydrocarbon recovery, oil and gas fields will likely be among the first commercial-scale sequestration projects in the state.

Primary considerations in the development of CO2 sequestration regulations are to reduce the effects of climate change by ensuring the permanent geologic sequestration of anthropogenic CO2, to protect human health and the environment, groundwater supplies, property interests, and to avoid disturbing current CO2 injection and enhanced oil recovery practices.

Any CO2 sequestration program must achieve the protection of underground drinking water sources required under the U.S. Environmental Protection Agency's Underground Injection Control Program (UIC), which is managed in the state by the OCD and the New Mexico Environment Department (NMED). OCD will develop proposed regulations tailored to ensure safe and effective CO2 sequestration while complying with EPA's UIC program requirements. OCD contemplates coordinating with appropriate regulatory agencies, both state and federal, to achieve optimal protection of human health and the environment under any proposed CO2 sequestration framework.

Before advancing to statutory and regulatory issues raised by proposed CO2 sequestration, a review of some important concepts will serve as useful background for understanding the policy implications any regulatory framework for the sequestration of carbon dioxide may have.

Potential Current and Future Interference with Subsurface Interests

Sequestration of CO2 in the subsurface geology, while identified as a viable and important means of mitigating climate change and greenhouse gas emissions, will also invariably lead to potential conflicts with other subsurface interests, such as the mineral estate (oil, gas and coal) and associated interests, groundwater users and surface ownership (who are owners of the subsurface geologic formations and pore spaces). Given the areal extent and long timeframes required for sequestration of CO2 – on the order of hundreds to thousands of years –

[9] David Borns, Underground Storage Technology Program Manager, Sandia National Laboratories, personal communication.

consideration must also be given to the future discovery of subsurface minerals or the ascendant value of currently non-economic resources, such as saline waters, that might conflict with CO2 sequestration.

Injection of CO2: Disposal Model (waste) or Ownership Model (commodity)?

If sequestration of carbon dioxide is to be encouraged, any regulatory framework must consider how anthropogenic CO2 is to be defined, giving weight to public attitudes and thresholds for risk or perceived risk and industry concerns for economic burdens.

The definition or characterization of CO2 as either 1) an industrial product or commodity, or 2) a by-product for waste disposal may have significant effects on public acceptance and perception, as well as potential economic consequences affecting project feasibility and liability.

Materials classified under the latter heading are typically subject to more stringent environmental regulations as wastes than the former, e.g. under the U.S. Environmental Protection Agency's Safe Drinking Water Act's Underground Injection Control program (UIC), Class I injection wells (municipal and industrial waste) have more stringent environmental requirements than Class II injection wells (hydrocarbon storage, salt water disposal and enhanced oil recovery).

As an industrial product, anthropogenic CO2 is a commodity, with a value, and is useful and desirable for enhanced oil recovery projects (EOR). As such, the Interstate Oil and Gas Conservation Commission has recommended that CO2 not be classified as a waste product and that its status as a commodity be preserved. At the same time, CO2 is also likely, with contemplated federal regulation addressing climate change, to be ultimately viewed as a by-product or a waste liability. In the case of non-EOR CO2 injection projects, CO2 will likely be viewed primarily as a liability. Also, as more anthropogenic CO2 is captured and becomes available for geologic injection and storage, its value as a commodity will likely diminish over time.

Ownership of Geologic Formation/Pore Space & the Right to Sequester

Related to the concept of CO2 ownership is the property rights issue of the target pore space and the right to sequester CO2. In New Mexico, the law is unsettled as no cases directly test theories of pore space ownership.

There are essentially two competing theories that ultimately define the liability of CO2 injectors in relation to pore space owners.

One legal theory is the "reverse" or "negative rule of capture," which holds that just as an owner may capture such oil or gas that migrates from adjoining property to a well on his own land under the "rule of capture," so may he inject into a formation substances which might migrate to the property of others. Under this rule, liability for the migration of injected substances is essentially limited in preference for polices encouraging enhanced hydrocarbon recovery, or, as in this case, possibly in preference for policies encouraging the mitigation of climate change through sequestration of CO2.

This approach may be justified by positing that sequestration of CO2, and the consequent reduction of greenhouse gas emissions, is a public benefit, or a mitigation of a public nuisance. A likely impediment to this approach is the 5th Amendment of the U.S. Constitution, which provides that no property shall be taken for public use without just compensation. Assuming that the pore space containing the mineral estate is the property of the surface owner and not the mineral estate, this property right presents problems for the application of the negative rule of capture because the non-consensual occupation of space is usually considered a taking.

The alternative, and more widely adopted theory, is that an injector is liable to the surface owner for any provable subsurface trespass or nuisance he may commit. As the majority of states hold that the subsurface geologic structures – including the pore space as distinct from the mineral estate – belongs to the surface property owner, an injector of CO2 must acquire the right to access and sequester CO2 from the appropriate surface owner(s) or face liability for trespass or nuisance actions. Rights to sequester can be acquired either through negotiation, or ultimately through condemnation proceedings pursuant to the state's powers of eminent domain. This concept addresses the important distinction between the rights of the pore space owner and the mineral estate, which are two separate interests, even though they share the same geologic strata. Generally, the mineral interest is limited to the minerals themselves, whereas the pore space interest includes the sand, and gravel, etc., that comprise the geologic formation, but do not extend to the hydrocarbons occupying the interstices.

A minority view is that a severance of the mineral estate should be construed as granting exclusive rights to the subterranean strata for all purposes relating to minerals, whether "native" or "injected," absent explicit language to the contrary in the severance of the mineral estate. This view would eliminate the problem of having to secure storage rights from the surface owner, but it is a minority view.

Long-term Liability

Drawing from current oil and gas practices, the short-term liabilities inherent in any drilling or injection project – whether environmental or economic – can likely be best addressed through the contractual arrangements between generator and injector, as they are now. But liabilities following the injection and closure phases of projects present a unique problem given the anticipated scale, both in terms of time (hundreds to thousands of years) and space, required for successful CO2 sequestration and accurate CO2 inventories. Literature and studies to date on the topic suggest that wells and boreholes will present the most common risk of leakage.

Because of the breadth and depth of the unknowns over such long time scales, transfer of liability to the public sector has been conceived of as one way to encourage the development of sequestration projects by limiting potential liabilities. But this liability model also raises many issues, such as how to control the burden on the public and how to fund monitoring and verification efforts, as well as any potential long-term mitigation that may be required.

Identified Statutory Issues

To address the potential conflicts and uncertainties outlined above, several statutory and regulatory changes are anticipated.

Authority to Regulate Carbon Sequestration

Issue:
OCD would need to have clear authority to regulate the sequestration of anthropogenic CO2 into all potential geologic reservoirs, not limited to oil and gas, for purposes of long-term/permanent sequestration.

Analysis:
OCD currently has authority under 70-2-6 and 70-2-11 to regulate the injection/sequestration of CO2 into oil and gas reservoirs for the purposes of enhancing hydrocarbon recovery, prevention of CO2 waste, and for disposal. OCD also has the authority under 70-2-12.B(21) to require that CO2 be injected, even after the possibility of enhanced production has elapsed, to prevent the waste of CO2 that would otherwise be vented. Further, OCD also has the authority to regulate naturally occurring CO2 and require sequestration/injection not limited to oil and gas reservoirs if the CO2 is a product of or used in oil and gas operations. However, there exists no clear authority for the Division to regulate anthropogenic CO2 injection for sequestration purposes alone, nor does it have general authority to regulate injection/sequestration of CO2 not produced in oil and gas operations into reservoirs other than those of oil and gas.

Because oil and gas reservoirs are anticipated to ultimately constitute only a small fraction of the total sequestration volumes in New Mexico, clear authority to regulate the sequestration of anthropogenic CO2 into all potential geologic reservoirs, not limited to productive oil and gas reservoirs, for purposes of long-term/permanent sequestration is essential to any regulatory framework for commercial-scale geologic sequestration.

OCD is believed to be the proper entity for such authority given its institutional and technical expertise in drilling, deep-well injection, and its current regulatory oversight of ongoing carbon dioxide injection projects. Further, it is believed that the earliest carbon sequestration projects will probably take place in depleted oil and gas reservoirs given existing infrastructure, knowledge of the target reservoirs and a proven ability to contain gases over geologic timescales, as well as the industry's expertise in injection and CO2.

Protection of Surface Owner Interests

Issue:
The Surface Owners Protection Act applies only to exploration, drilling or production of oil and gas, so it would need to be amended to include activities related to the sequestration of carbon dioxide to adequately protect the interests of surface owners in the same way they are currently protected for oil and gas production.

Ownership of Pore Space/Geologic Formation

Issue:
No statutory language currently exists defining the extent of surface owner property rights with respect to the pore space within the geologic formation. New Mexico law in this area remains undeveloped and uncertain in that ownership of the pore space has not been directly tested in the courts. However, in 1990 the New Mexico Supreme Court indicated in non-binding language its implied preference for the majority view among states that the pore space belongs to the surface owner. A consequence is that any large-scale CO2 sequestration effort will require the acquisition of underground storage rights from surface owners by either negotiation or condemnation proceedings.

Workgroup:

- Is it possible for the state to claim ownership of the pore space as part of the public domain for a beneficial use (e.g. similar to common law rules guiding aquifer recharge)?
- Any proposed regulatory framework should protect the future interests of mineral interest holders – injection of CO2 may impede or prevent future technologies from extracting currently non-economic hydrocarbons, so these future interests must be protected.
- Currently, injection of CO2 for enhanced oil recovery is considered part of the mineral lease operations and does not require the consent of the pore space owner – at what point does CO2 injection become storage and require acquisition of storage space rights?
- Any sequestration regulatory framework must include but not be limited to hydrocarbon reservoirs and contain provisions for injection into other formations, such as saline aquifers.

Analysis:
Pore space for CO2 sequestration has been identified in three major reservoir types, each with similar ownership interests:

- Depleted Oil & Gas Reservoirs

  Where the mineral estate has been severed from the surface estate, the majority view holds that the mineral estate interest is limited to the oil and gas and does not include the pore space of the geologic formation itself, and that once the minerals have been depleted or removed, the mineral estate no longer has any right to the evacuated space, which remains the property of the surface owner. Most jurisdictions similarly hold that only the surface owner has the right to store non-native gases/minerals within the storage space, but can only do so after the mineral reserves have been depleted. A consequence is that any storage of CO2 must be done with the consent of the surface owner or by condemnation of the pore space.

- Deep Saline Aquifers

  In New Mexico, underground waters have been statutorily deemed to be within the public domain (72-12-1 and 72-12-18). However, the aquifer itself, which is the space that contains public waters, is not within the public domain and ostensibly remains the interest

of the surface estate. The state and public entities appear to have the right to use aquifer storage for the purposes of recharging the aquifer without having to pay compensation to the surface owner because such action is simply replacing what was already there for use by the public domain. Other uses may require compensation.

For example, in California there appears to be some precedent that storage of water in depleted aquifer space has been deemed a valid exertion of a water district's police power to generally provide for the public.[10] Whereas in New Mexico, the federal courts recently blocked an action by the Attorney General seeking compensation for resource damage to aquifer storage because "the State as guardian of the public trust has no possessory interest in the sand, gravel, and other minerals that make up the aquifer."[11] That is, the state does not own the aquifer as a "natural resource" in the same sense it owns the public ground waters.[12] A consequence is that any storage of CO2 must be done with the consent of the surface owner or by condemnation of the aquifer storage space.

- Deep Coal Seams

  The third likely reservoir type for sequestration of CO2 are deep coal seams. These have additional technical challenges that must be addressed before any sequestration project is advanced. However, the legal issues with regard to pore space are expected to be highly analogous to those identified for oil and gas reservoirs.

Research questions:

1. At what point does CO2 injection become storage and require acquisition of storage space rights? (Because there are limited CO2 sequestration/storage projects, this question may not have been tested yet in the courts).
2. At what point is a mineral interest considered depleted/non-economic?
3. What is the proper process upon termination of a mineral lease to transition to CO2 sequestration from EOR?
4. What uses of aquifer storage require compensation? Compensation to whom?
5. How will condemnation of pore space for CO2 sequestration affect current acid gas and saline water injection practices?
6. How will condemnation/storage be handled within federally owned pore space?

Unitization of Recoverable Hydrocarbons

Issue:
In order to account for the enhanced recovery anticipated from injecting CO2 into depleted oil and gas pools it will be necessary to unitize such pools. That is, by either voluntary agreement among the pool operators or through a Division order compelling it, depleted oil and gas fields subject to CO2 sequestration/injection will need to be operated as a unit in order to equitably

[10] Tara L. Taguchi, "Whose Space is it, Anyway: Protecting the Public Interest in Allocating Storage Space in California's Groundwater Basins," 32 Sw. L. Rev. 117 (2003).
[11] *New Mexico v. General Elec. Co.*, 335 F.Supp.2d. 1185 (D.N.M. 2004), aff'd *New Mexico v. General Elec. Co.*, 467 F.3d 1223 (10th Cir. 2006).
[12] *New Mexico v. General Elec. Co.*, 467 F.3d 1223 (10th Cir. 2006).

allocate costs and production among the various interests. Distinguishing between the pore space interests and the mineral interests, such unitization will apply only to the mineral interests.

In anticipation of the scale of commercial CO2 sequestration, it is expected that most, if not all, depleted oil and gas fields in the state will be evaluated for sequestration and may therefore require unitization on a large scale.

Analysis:
The authority granted by the Statutory Unitization Act (70-7-1 et seq.), provides for voluntary or compulsory unitization of a pool or part of a pool. The Act requires that the plan of unitization, whether voluntary or compulsory, be ratified by three-quarters of the working interest, royalty interest and overriding royalty interest owners. The consequence is that OCD can only compel unitization against the minority interest. This may prove to provide an unacceptable means of blocking planned sequestration projects, as minority interests could refuse to ratify unitization orders, making operation of the unit as a sequestration field difficult. Non-unitized interests may have available to them legal remedies such as nuisance and trespass actions for any provable interference with their mineral production. It may, however, be desirable for injectors to have acquired some level of voluntary agreement for unitization among mineral interests before enabling compulsory unitization by Division order.

Under an effective CO2 sequestration program it is anticipated that OCD would need to unitize larger areas than is now the practice. The language in 70-2-11 may be flexible enough to allow OCD to properly unitize pools of adequate size.

The Act also requires OCD to find that unitization will "substantially increase the ultimate recovery of oil and gas from the pool or unitized portion thereof." 70-7-5. Because increased recovery may not always result in a program designed primarily for the sequestration of CO2, this language may pose a barrier.

The Act further requires OCD to find "that the estimated additional costs, if any, of conducting such operations will not exceed the estimated value of the additional oil and gas so recovered plus a reasonable profit." 70-7-6.A(3). Interpreted to mean the costs of production of additional hydrocarbons (CO2 separation and re-injection/cycling, etc.) as opposed to the costs of the entire sequestration project, this language should not pose a barrier.

Statutory continuation of expiring leases may be considered to facilitate planning and implementation of CO2 sequestration projects.

Unitization of federal minerals with non-federal minerals is provided for in the federal "Mineral Leasing Act," 30 USC Code, Chapter 3A, Subchapter 1 § 184a: "…any State owning lands or interests therein acquired by it from the United States may consent to the operation or development of such lands or interests, or any part thereof, under agreements approved by the Secretary of the Interior made jointly or severally with lessees or permittees of lands or mineral deposits of the United States or others, for the purpose of more properly conserving the oil and gas resources within such State. Such agreements may provide for the cooperative or unit operation or development of part or all of any oil or gas pool, field, or area; for the allocation of production and the sharing of proceeds from the whole or any specified part thereof regardless of

the particular tract from which production is obtained or proceeds are derived; and, with the consent of the State, for the modification of the terms and provisions of State leases for lands operated land developed thereunder, including the term of years for which said leases were originally granted, to conform said leases to the terms and provisions of such agreements…"

Research Questions:

1. Does the unitization of federal minerals allowance conflict with the purpose of CO2 sequestration? How to handle sequestration units that include strata with federal minerals?
2. What is the effect of Indian ownership on unitization?

Condemnation of Storage Space and Transportation Corridors by Eminent Domain

Issue:
Subsurface sequestration space and surface easements for pipelines and injection facilities will be necessary for a large-scale sequestration program.

OCD does not have the power under existing law to provide for the acquisition by eminent domain of subsurface pore space for the purposes of CO2 sequestration. Authority to condemn subterranean storage space, similar to provisions in 70-6-1 through 70-6-8 authorizing the condemnation of underground storage space for natural gas, would be necessary for CO2 sequestration operators to acquire the storage rights from property owners who have not reached an agreement.

Compensable parties may not be limited to the target pore space owners, however, as there may be room for mineral interests to argue that since oil and gas reservoirs may never be fully depleted, CO2 sequestration constitutes interference with their estate and requires just compensation if interference or harm is provable. Currently, New Mexico law prohibits the condemnation of storage space for gas storage in strata capable of producing oil in payable quantities through any known recovery method. Likewise, no strata capable of producing gas in payable quantities can be condemned unless the recoverable volumes of native gas are substantially depleted and unless the formation has greater value or utility as a storage reservoir.

The state currently has authority under 70-3-5 to condemn surface land for pipeline construction, including CO2 pipelines. This provision applies only to trunk lines, or primary transportation lines, and not to gathering lines. 70-3A-1 et seq. establishes the means by which easements for smaller disposal lines and gathering lines may be acquired across private property.

All condemnation proceedings must be done in accord with and pursuant to 42-1-1 to 42A-1-33.

Workgroup:

- Will the size and scale of the units/formations make condemnation difficult or cost prohibitive?
- If the goal is to condemn only the target storage space/interval/strata, what's the effect on the other intervals? Can hydrocarbon exploration/production continue in other intervals?

- What's the method of valuation for condemnation?
- Compensation to the pore space owner should be offset by the value of any liability assumed by the state that would otherwise reside with the pore space/surface owner

Analysis:
70-6-1 et seq. can either be amended to include condemnation for CO2 sequestration or condemnation provisions may be included in a separate statute, but because the target pore space and geologic formations are the property interests of the surface owner, a process for the condemnation of the pore space for CO2 storage must be established to accommodate situations where surface owners and injectors are unable to agree on sequestration terms.

Several methods of valuation have been analyzed by the courts for determining the fair market value of pore space for storage of natural gas that may be applicable to valuation of sequestration space for CO2:

- Comparable agreements/rentals/sales
- Capitalization of rental income: multiply acreage rental by comparable storage rights to arrive at present worth of the future income stream, using filing date of condemnation as start date and termination of storage field as end date. Fair market value is equated to a capital sum which, when invested as of the date of the filing, would earn income equal to comparable storage rentals for the future.
- Depreciation in the fair market value of condemned tract as a whole by reason of the taking of the storage easement: based on the difference in the fair market value of the entire condemned tract before and after the taking.
- Viewpoint of value: just compensation should be measured from the point of view of the landowner (what the landowner has lost, not what the petitioner (injector) has gained), e.g., if there are still quantities of native oil or gas in the storage easement not in paying quantities (having no effect on the tract's market value), then these volumes would not be taken into account in the valuation.

On the issue of whether compensation is necessary for the mineral estate interests, CO2 sequestration might be sufficiently distinguishable from the storage of natural gas in that it does not preclude later or even concurrent production of hydrocarbons, and may be anticipated to generate, facilitate or increase such production. Unlike the situation for storage of natural gas which essentially precludes concurrent hydrocarbon recovery, there may be no ostensibly negative impact or interference with the production of the mineral estate beyond the cost of segregating the CO2 from production volumes (which production is expected to be enhanced by the CO2) and re-injecting/cycling it back into the formation.

Research Questions:

1. Must mineral interests be compensated for the use/condemnation of pore space?
2. More on compensable parties and valuation methods
3. Valuation of non-recoverable/non-economic minerals

Authority to Transfer Liability/Ownership to State

Issue:
The various forms of liability (e.g. economic and environmental) inherent in proposed sequestration projects and how they will be addressed within a given regulatory framework are perceived as being significant factors in making sequestration projects feasible on the industry side, but also as being crucial for advancing public acceptance of the technologies, processes and regulations.

Short-term liabilities inherent in any drilling or injection project – whether environmental or economic – can likely be best addressed through the contractual arrangements between CO2 generator and injector, as such liabilities are currently handled. But liabilities following the injection and closure phases of the projects present a unique problem given the long-term economic and environmental unknowns and the anticipated scale of sequestration projects, both in terms of time and space, required for successful CO2 mitigation.

Nearly all of the sequestration literature assumes that long-term liability must be transferred to the public sector to maintain economic viability and to encourage industry participation. Because the lifespan of sequestration projects after closure, which would include continuous monitoring, measurement and verification (MMV) of the reservoir integrity, is contemplated to endure for possibly hundreds to thousands of years, the public sector (because of the longevity of public institutions and the ease of transferability of institutional knowledge) is seen as the only viable entity capable of maintaining these projects over the long term. An alternative would be for the state to accept liability for a limited number of projects (e.g. the first enhanced oil recovery project, the first deep saline project, the first deep coal project, etc.) or for a limited time frame (e.g. first 5 years of CO2 sequestration).

Considerations:

- Is transfer of liability and ownership of CO2 to the public sector the proper model?
- Should there be a limit to the liability that is transferred? Should the state be indemnified against claims or mitigation costs above a certain amount?
- Should the state accept liability for only a certain number of projects (e.g. the first enhanced oil recovery project, the first several deep saline projects, the first deep coal projects, etc.) or should the state accept liability for those projects initiated within a limited time frame (e.g. first 5 years of CO2 sequestration)?
- If liability is transferred to the public sector, how shall the costs be funded – a fee program based on volume of CO2 injected?
- Should the generator or injector retain any liability – environmental, economic or for CO2 accounting purposes?
- Should CO2 generators/injectors have the choice to transfer liability to the public sector and pay a long-term liability fee or maintain liability with bonding to cover insolvency or abandonment?

Workgroup:

- Will the state be liable for mitigation/damages after transfer? Should state liability beyond the amount covered by the fee pool be protected as a sovereign immunity?
- Texas proposes to accept liability only for FutureGen sites.
- If there is a fee, it should be used only for mitigation, long-term monitoring, and verification of sequestration projects (i.e. protected against other legislative appropriations).
- State should only take on ownership/liability of projects where monitoring following cessation of injection/operations indicates the project is performing as predicted.
- State should only take on ownership/liability of projects with a demonstrated leakage rate of less than TK (1 percent?)
- How will parties/individuals injured be able to recover? Through industry fund?
- An alternative to a sequestration fee is to fund the long-term monitoring, measurement, verification and mitigation through a portion of the severance taxes collected on the enhanced recovery made possible by the CO2 injections.
- Having the state take on the long-term liability makes the project more appealing – the sooner the state takes on liability the more appealing the project
- If there is a transfer of liability, the state must have the right to enter private land and plug/re-plug problem wells within the sequestration unit to ensure field/storage integrity.
- Is/will CO2 be considered a "hazardous substance" under federal CERCLA/RCRA laws and how might that impact liability for generators, transporters and disposers/injectors?

Authority to Impose Sequestration Fee on Injected CO2 Volumes & Exemptions

Issue:
If there is a transfer of liability and ownership of sequestered CO2 to the public sector, it is contemplated that there should be some fund available to cover the monitoring, measurement, verification (MMV) and mitigation costs associated with long-term management of sequestration projects following operational and post-closure phases.

Such a fund could be managed by the state and based on a fee assessed per volume sequestered, or there could be a requirement that CO2 injectors/generators purchase insurance in the private market, or some variation based on a pre-existing model of environmental project management, such as CERCLA (Superfund), RCRA (hazardous waste) or the Price Anderson Act (nuclear power industry model).

Workgroup:

- Will the fee apply only to CO2 injected for sequestration purposes and not to EOR projects?
- How will the state handle out-of-state CO2 generators sequestering in state? Will out-of-state generators be assessed a fee at the state line? Or at the point of injection?
- EOR associated with sequestration should be subject to an increased severance tax, reflecting the benefit conferred to interest owners by the recovery of otherwise non-economic resources, reserving the proceeds in a Superfund-type account to address potential future environmental remediation.
- The possibility of exemptions/financial incentives was not discussed to any great extent.

Analysis:
CO2 sequestration literature has proposed various funding models to cover the unknown costs of long-term monitoring, measurement, verification and mitigation:

- Injection Fee
  - Mandatory contributions by injection operators to a fund managed by the state, to be used exclusively for the long-term monitoring, measurement, verification and mitigation of CO2 storage once liability transfers to the state.
- Alternative methods
  - Price Anderson (nuclear industry model)
    - Requires nuclear power plant licensees to purchase the maximum amount of commercial liability insurance available on the private market ($200 million per plant) and to participate in an industry-wide fund; but liability is limited and licensees are not financially responsible for the cost of any accident that exceeds these two layers of insurance (government assumes liability above this threshold).
  - CERCLA (Superfund)
    - Imposes standard of strict liability (joint and several liability)
    - Ties type/degree of liability to party type (e.g., owner/operator, past owner/operator, generators, transporters)
    - Types of liabilities include cost for government cleanup, damages to natural resources, costs of certain health assessments
  - Private insurance
    - Private insurers may not be willing to cover this new industry for the period necessary given the unknowns
  - State assumes liability (e.g. Low-Level Radioactive Waste Policy Act 1985)
    - States are responsible for LLRW generated within their borders
  - SDWA UIC/RCRA model (injectors demonstrate financial responsibility)
    - Surety bonds, letters of credit, trust funds, financial statements, etc.

Exemptions:

Texas has proposed a tax-exemption provision for anthropogenic CO2 use (H.B. 3431):

- Producer of oil or gas recovered through an enhanced recovery project is entitled to a reduction in severance tax rate if recovery of oil uses carbon dioxide that is from an anthropogenic source, would otherwise be released to the atmosphere, and is ultimately sequestered (per OCD definition) in one or more geological formations
- Qualification for tax reduction is granted following certification by regulatory agency
- Certification requires demonstration based on substantial evidence that there is a reasonable expectation that sequestration will result in at least 99 percent of CO2 remaining sequestered for at least 1,000 years
- Monitoring and verification for a period sufficient to demonstrate whether the sequestration is performing as expected
- Tax reduction does not apply if measuring and verification determine a different amount is being stored

Authority to Bond Injection Projects & Facilities

Issue:
Aside from the costs associated with post-closure MMV and potential mitigation, are the costs associated with reclaiming project sites and facilities following injector abandonment or insolvency. The state would need to ensure that injectors provide adequate financial assurance to cover the cost of any necessary plugging, reclamation or mitigation required as a result of abandonment or insolvency.

Workgroup:

- Should bonds be required for a project and surface facilities, as well as for individual wells.
- Excessive bonding will discourage operators from undertaking sequestration projects and make them cost prohibitive given the range of cost unknowns already contemplated.

Authority to Enter Land for Inspection

Issue:
The state will need clear authority to enter surface estates to inspect facilities and the integrity and functioning of injection wells and other bore holes that may penetrate the CO2 sequestration zone. And in the event of the transfer of ownership/liability to the state, the Division will require authority to enter surface properties to plug abandoned wells and reclaim sequestration surface facilities.

Workgroup:
This topic was not raised.

Identified Regulatory Issues

General

- Statement of Division's General Authority

- Enforcement/Penalties
  - Violation of OCD rules (70-2-31)
    - Maximum of $1,000/day/violation
    - Some provision for criminal penalties
  - Prevent operator from selling product
  - OCD can seize and sell product
  - OCD can revoke permit
  - OCD can shut in production/injection wells
  - Prohibit the degradation of groundwater (UIC)

- Prohibit venting of CO2
  - Provide for emergency venting provisions?
  - Allowance for equipment failure?

- Definition of Permanent Sequestration
  - Maximum leakage rate of 1 percent over 1,000 years?

- CO2 Registry
  - Mesh CO2 sequestration accounting requirements with state registry program?
  - Ensure proper accounting of net anthropogenic CO2 sequestration

Siting & Permitting

- Property Rights
  - Injector must demonstrate sufficient/adequate property rights
    - Pore space
      - Agreement/rentals with surface owners
      - Condemnation via eminent domain
    - Mineral interests
      - Unitization (voluntary or compelled)
        - Guidelines for compelling unitization of CO2 sequestration zone
        - Parties to unitization
          - Provide for contractual relationship
        - Procedure for federal/Indian minerals
        - Notice to surface owners and mineral interests within unit and extending to a defined distance beyond (1 mile?)
          - Opportunity to contest/protest unitization through hearing process
        - Provision to allocate costs when not covered by contract (compelled unitization)
          - What costs included?
            - Cycling/re-injecting CO2?
            - Costs of original CO2 injection?
              - Capital costs
              - Operating costs
            - Transportation of CO2 to site?
        - Allocation of production

- Mineral Leases
  - Existing
    - Injector (not well owner/operator) must ensure the integrity of existing wells penetrating the storage zone; injector takes on liability of old well bores in storage zone
  - New
    - Can drill through storage zone if successfully demonstrate that drilling won't impact storage reservoir integrity
    - Require new wells to analyze strata above and below storage unit for CO2 and report findings

- Site & Reservoir characterization and mapping (baseline data)
  - Reservoir
    - Type
      - Depleted oil
        - Water drive
        - Depletion drive
      - Depleted gas
      - Deep coal seam
      - Saline aquifer
    - Original reservoir pressure
      - Injection pressures should not exceed fracture pressure and reservoir pressure should not exceed the original reservoir pressure unless the injector can demonstrate otherwise through a formal hearing process
    - Determine Reservoir size and areal extent (final storage volume)
    - Depth (average depth) and volume of proposed storage reservoir
    - Groundwater/drinking water sources (depth/height to source)
      - Include deepest groundwater source
  - Map faults
  - Seismic/tectonic history and activity
  - Regional pressure gradients
  - Baseline measurements
    - Groundwater chemistry
    - Surface soils
    - Connate fluids
  - Wells (determine location and status of all wells within unit and buffer zone)
  - Trapping mechanism (geochemical, stratigraphic, etc.)
    - Stratigraphic position and thickness of all confining strata
    - Determination of confinement mechanism to prevent CO2 mobility
    - Stratigraphic discontinuities/spill points and likely potential leakage points

- Injection
  - Proposed pressures
    - Above supercritical?
  - Proposed volumes
  - Demonstrate Fracing gradient (frac pressure limits)
  - Proposed monitoring and modeling methods for injected CO2 plume

- Radius of Influence/Area of Review
  - Locate all wells (water, oil and gas, plug & abandoned)
    - Determine if properly cased/plugged to prevent leakage/seepage of CO2 into other formations or to surface
  - Areal extent of monitoring defined

- Proposed public safety and emergency response plan
  - Worker safety and training plan
  - Corrosion monitoring and prevention plan

- Leak detection and monitoring plan for all wells and surface facilities within the areal extent of unit

- Siting
  - OCD/Commission to approve proposed injection well site and containment/reservoir modeling

- Bonding
  - Establish independent bonding requirements (separate from oil and gas production bonding) to cover abandoned CO2 injection projects and surface facilities
  - Bonding for individual wells
  - Effect on CO2 generator? Need some bail out if contractual injector fails to meet contractual agreement?

- Notice Requirements
  - Surface owners within x distance (1 mile) beyond unit area
  - Mineral interests within unit area
  - Interests within a buffer zone beyond areal extent of unit (1 mile?)
  - Include legal description of permit area, date, time and place of hearing for permit

- Permit conditions
  - Fully revocable by OCD
  - Monthly reporting
    - Injected volumes
    - Reservoir pressures
    - Groundwater monitoring
  - 5-year major permit review
    - Injector demonstrates full permit compliance

- Procedure and Requirements for Transfer/Sale of Sequestration Project
  - Require permit review at time of transfer if prior to post-closure period?
  - Allow for modification of permit at time of transfer?
  - Allowing full permit review at transfer may impose too many uncertainties

Drilling & Operations

- OCD Right of Entry
  - Monitoring
  - Inspection
  - Plug/re-plug problem/abandoned wells

- Casing requirements
  - Ensure protection against acid degradation with proper casing
  - Demonstrate well is cemented to adequately confine injectate

- CO2 purity

- 90-95 percent? (90 percent recommendation by Southwest Regional Partnership; 95 percent in Bingaman's bill)

- Re-circulation of CO2
  - Account for volumes circulated (mass balance, how much CO2 is circulated in EOR projects; avoid double sequestration credit)

- Right of Entry
  - Injection operator has right to enter and properly plug wells within project area to ensure integrity of sequestration project

- Monitoring during injection
  - Injection well integrity
    - Corrosion monitoring
  - Integrity of unit wells
    - casings
  - groundwater
  - surface soils
  - formation pressure
  - Distributed observation wells?
  - CO2 plume
    - OCD to approve monitoring/modeling proposal
  - CO2 leakage (out of formation/target zone) and seepage (to the surface)
    - Measure/trap CO2 emissions from surface facilities (plants/compressors)
  - CO2 purity

- CO2 safety
  - Public and worker safety and emergency response plans
    - Demonstrate adequate worker training
    - Posted contact info at all surface facilities and wells within unit area?
  - Contingency plans
    - Individual wells and project
  - Venting prevention
    - Allowable leak rate
      - From injection well?
      - From formation?

- Injured Parties – Remedies and Recovery
  - Short-term
    - Contractual between the injector and generator
    - Surface Owner's Protection Act applies
  - Long-term
    - Option to transfer ownership/liability to state
    - Limit state liability?

Post-Injection & Closure

- 10-year demonstration of reservoir and well integrity after cessation of injection phase before evaluation for potential transfer of ownership/liability? Or however long it takes to demonstrate integrity after injection phase (when formation pressures stabilize)?
    - Demonstrate site/formation stability (Gorgon/Australia)
    - Alternative: set up a closure/transfer window – transfer/closure shall occur no sooner than TK and no later than TK
    - Demonstrate integrity of wells (both injection and those perforating unit)
    - Can petition Commission to shorten demonstration period
    - Allowable leak rate/percentage?
    - Disallow blowdown of formation in CO2 sequestration projects (without re-injection of CO2)
    - Transfer liability of only those projects that meet expectations/minimum leak rates?

- Monitoring
    - Well
        - Inject N2 at end of injection phase for monitoring/safety (Dr. Lee)
    - Soil?
    - Groundwater
        - Groundwater monitoring wells
            - 1 up-gradient, 3 down-gradient (gradient may change over long time spans)? Adequate for areal extent?
    - Status/behavior of CO2 plume over time?
        - Proposed monitoring/modeling to be approved by OCD

- Plugging
    - Within a certain time of termination of injection phase, all injection wells must be plugged
    - State inspector on site at time of well closure/plugging

- Reclamation/Restoration of surface
    - All surface facilities to be removed and surface reclaimed

- Qualifications for transfer
    - Closure report
        - Final assessment of operations
        - Volumes injected/extracted
            - CO2 purity
        - Chemical analyses of injectate/groundwater
        - Summary of monitoring
        - Current position and characteristics of areal extent of CO2 plume
        - Model and predicted behavior of plume

Post-Closure

- Transfer of liability
  - Option for injector/operator to retain ownership/liability
- Long-term monitoring plan
- Mitigation plan