WORLD RESOURCES INSTITUTE

Workshop Summary

Long Term Liability
Potentially Associated with Carbon Capture and Sequestration
1 November 2007

Summary

WRI conducted a series of workshop discussions on the approaches for managing the risks of Carbon Sequestration/Storage (CS) projects. The emphasis of the discussion was intended to be on long term liability associated with those potential risks. One objective of the workshops was to put the potential long-term risks from CS projects into perspective by describing and ranking them. The discussion confirmed that there is significant inter-relation among the potential risks throughout the life of a CS project because steps taken early in a project are one important means of preventing risks from materializing later in a project's life. The discussion also confirmed that some potential risks are similar in nature to typical project risks from analogous projects such as oil and gas wells, underground natural gas storage projects, and fluid industrial waste disposal, among others. Other potential risks appear to be unique to CS and warrant more detailed consideration.

The group discussion of risk management tools highlighted the notion that layered or portfolio approaches will likely be needed to address the potential risks from CS projects. These approaches should take the regulatory foundation into account and will likely include combinations of insurance; financial instruments such as letters of credit, sureties, bonds and other financial instruments; and some risk taking or "self-insurance" by project developers/operators. The group spent considerable time discussing the types of information that would be needed to develop these risk management tools. There are proposals for addressing the management of these risks during the long term (post-closure) emerging in the policy debate (IOGCC, MIT Study). The group attempted to discuss some of the elements in these approaches but did not do a thorough review. Instead, it was proposed to develop some cases studies based on existing or planned projects in order to suggest options for risk management during the operational and post-closure stages of a project.

Based on these two workshops and side discussions, WRI intends to produce a Workshop Report synthesizing the results of the discussion and outlining next steps. This meeting summary attempts to briefly summarize the main points of discussion from the workshop. It also includes some background information and performs a little of the analysis suggested in the discussion.

1. Review of Priority Ranking of Risks

The purpose of these workshops is to consider the perspective of potential investors in CS projects. Although a primary concern is ensuring that CS projects are safe and protect the public health and environment, an important consideration is ensuring that investors are willing to fund the development of such projects. The potential for long-term liability associated with CS projects has been considered to be an important potential barrier to investment. The WRI workshops thus attempted to explore the potential for long-term liability to be a barrier to investment and options for addressing it as a barrier.

The consensus in the June 2007 workshop was that the risks potentially associated with CS projects were being lumped into a “black box” that needed to be unpacked for further analysis. In an effort to address this request, WRI developed a risk log that categorized and outlined a group of about 60 risks potentially associated with six stages of a CS project: siting, construction, operation, closure, post-closure and long-term maintenance & stewardship.

One way of approaching these risks is to consider the implications for the potential financial responsibility of project investors or owners/operators (note: this is phrased as “potential” because it is not clear where financial responsibility will ultimately lie). Companies that invest in and/or operate CS projects will have responsibility to ensure that those projects are operated in a safe manner. In the event an adverse impact arises, it is likely that the investor and/or owner/operator will be responsible for mitigation. In deciding whether to invest in or operate a CS project, a company is going to consider, among other things, the expected costs; the uncertainty about those expected costs; and, the duration of the investment or exit strategy. The stages in the risk log correspond to a rough set of activities that are likely to be required for CS projects. For example, during siting (stage 1), a project developer will conduct (or hire someone to conduct) a series of detailed technical studies of the geology of the proposed site location; they will have to do significant planning that will include designing the injection wells and monitoring protocols, filing permit applications, and communicating with local stakeholders. It is conceivable that to encourage development of energy resources, states could undertake this and recover costs from subsequent developers. During closure (stage 4), they will have to plug the injection wells according to regulatory specifications, establish continuation of certain monitoring protocols, and undertake other activities. The cost of these activities can be estimated up front for the duration of the project that can be in operation for several decades. However, there are going to be uncertainties about these costs. For example, the cost of cement may rise significantly during the duration of a project. Or, in the course of plugging a well, a leakage pathway may be discovered that will have to be repaired. Project developers will likely be responsible for such uncertainties and will look for ways to both estimate and hedge against the uncertainties. And finally, despite using the best available practices and materials, project developers/operators may still find that unexpected problems arise such as leakage to the surface resulting in defined damages. Investors will be interested in understanding the potential for these risks to occur and the duration of their responsibility for them.

In an effort to explore some of these questions, a group of about 40 workshop participants and additional experts were asked to rank the magnitude of priority and cost for each risk. Sixteen responses were received in time to assess results for the November 2007 workshop. Since the number of responses was relatively small and additional comments on the structure of the risk log were received during the ranking period, the results were presented without much synthesis – a straight average of responses was taken without weighting for the level of expertise and all of the risks were included as originally described in the risk log.

The scales for both the priority and cost rankings are included below. They ranged from a low of 1 to a high of 5. The results from this simple analysis showed that on average no risks were ranked higher than a 3.6 in either priority or cost. The bulk of the priority rankings were well below 3 and a little more than half of the cost rankings were below 3.

Table 1. Priority Ranking Scales

Scale	Priority	Description
1	Very Low	A risk that is very easy to prevent and/or would be very unlikely to occur under standard operating conditions
2	Low	A risk that is easy to prevent and/or would be unlikely to occur under standard operating conditions
3	Medium	A risk that can be prevented and/or would be as likely as not to occur under standard operating conditions
4	High	A risk that requires careful controls to prevent occurrence and/or would be likely to occur without controls/safeguards
5	Very High	A risk for which it is uncertain that prevention is absolutely possible or for which more research will be needed to assure prevention is possible and/or would be almost certain to occur without significant safeguards

Table 2. Cost Scales

Scale	Cost	Description
1	Very Low	Negligible impacts (Costs managed through budget shifts)
2	Low	Minor impact on project time, cost or quality (Requires some additional funding)
3	Medium	Notable impact on project time, cost or quality (Requires significant additional funding)
4	High	Substantial impact on project time, cost or quality (Requires significant allocation of company funds)
5	Very High	Threatens the success of the project (costs > 2-5% of total project costs)

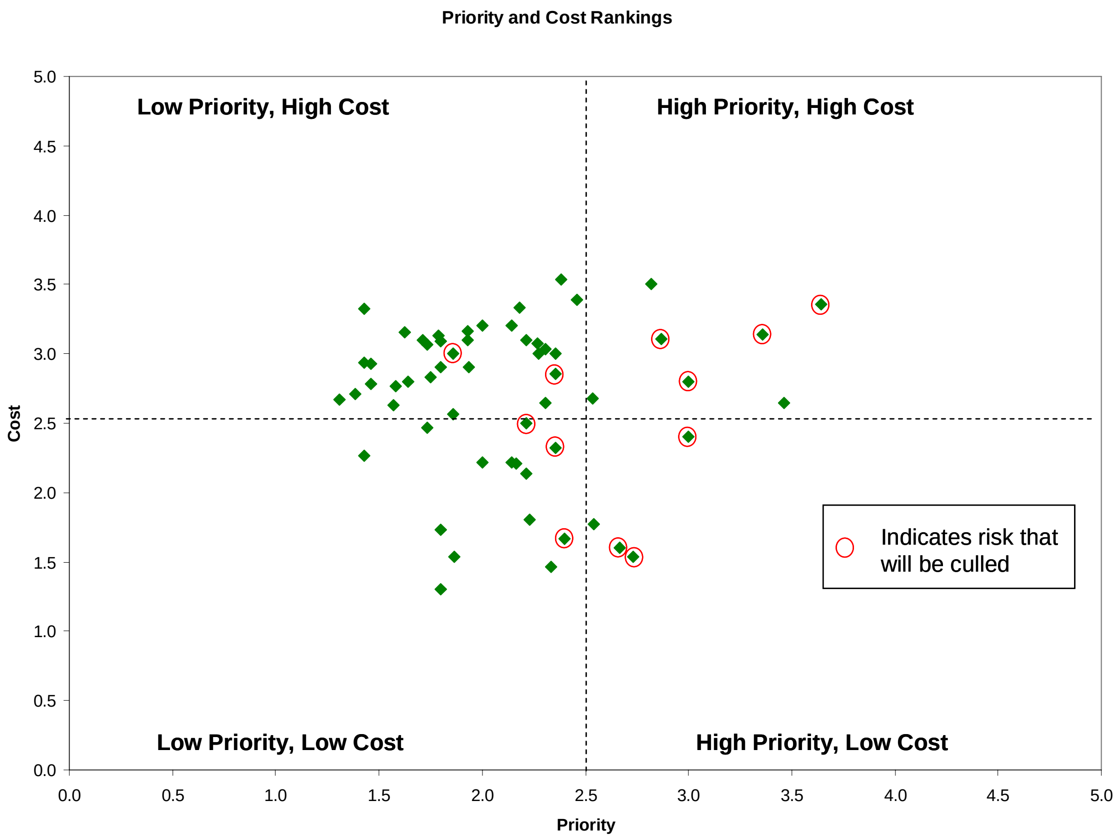
The results were graphed to show the relationships between cost and priority for each risk. This graphing showed some patterns that might form the beginning of risk management approaches. For example, the largest group of risks was ranked as having a low priority (or probability of occurrence) but a relatively high cost for remediation if they did occur. One workshop participant described similar work conducted for DOE that established approaches for addressing risk based on the quadrant in which they fell[1]. Accordingly, low probability but high cost risks might be addressed through a combination of regulatory standards aimed at assuring best practices in order to avoid the risk, adoption of preventive actions by the site developer/operator, private insurance, and pooling of risk. Conceptually, the group was interested in this method of thinking about broad approaches but wanted to first refine the data. The following list indicates the full set of risks, described with abbreviated titles (more detail on each risk is available in the risk log), ranked by priority, cost, and the product of priority and cost (to combine them into one metric). Risks highlighted in grey are described in more detail after Table 3.

[1] Andrew Paterson at WNA 2003: http://www.world-nuclear.org/sym/2003/paterson.htm
Andrew Paterson at WEC 2007: http://www.rome2007.it/Congress/Speakers/dettpaper.aspx?codpaper=P001508

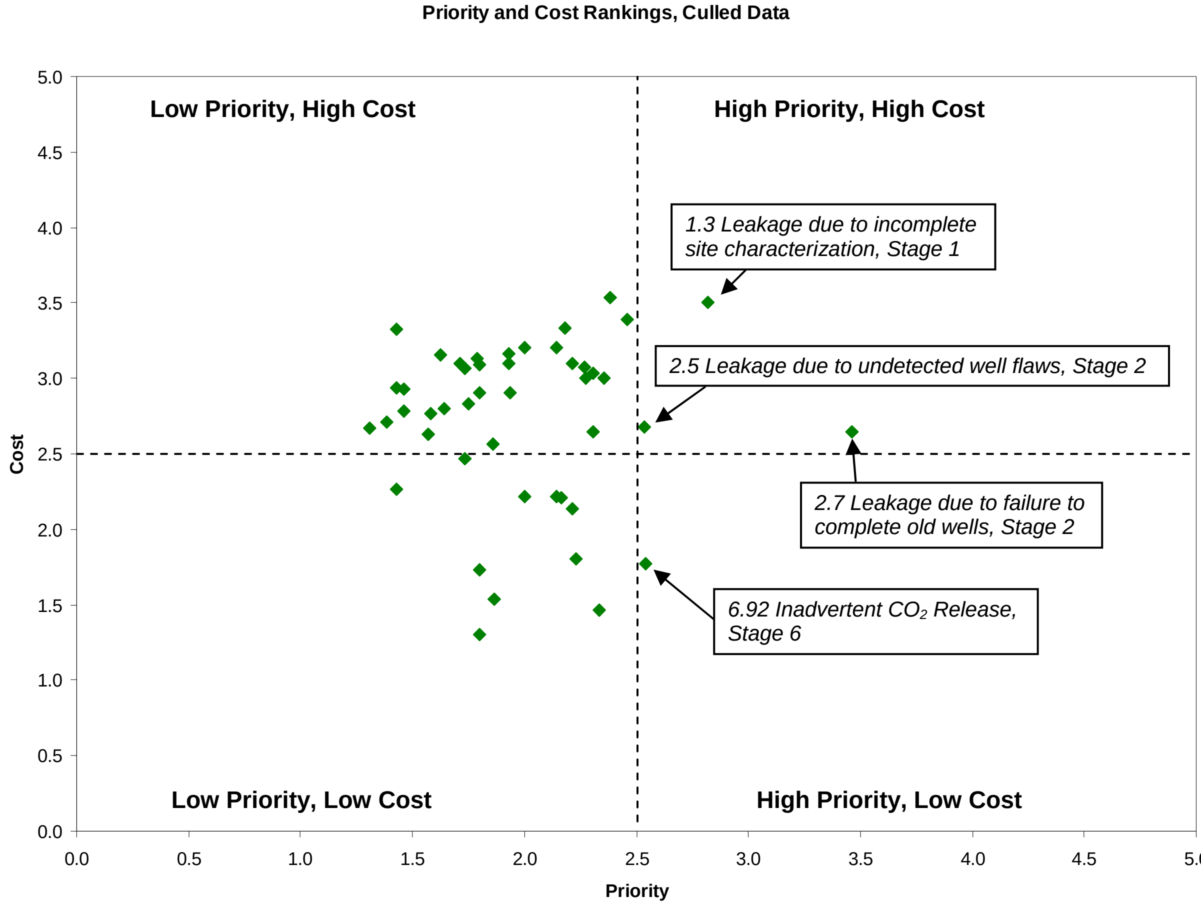
Table 3 – Complete List of Risks and Rankings (Note risk names are abbreviated)

ID	Risk	Priority	Cost	Product
1.1	Worker safety	2.3	1.5	3.4
1.2	Prop Damage	1.8	1.3	2.3
1.3	Incomplete Site Char	2.8	3.5	9.9
1.4	PublicOpposition	3.6	3.4	12.2
2.1	Worker safety	2.7	1.5	4.2
2.2	Prop Damage	1.9	1.5	2.9
2.3	Damage conf. zone	2.3	3.0	6.8
2.4	Contractor delays	3.0	2.4	7.2
2.5	Well flaws	2.5	2.7	6.8
2.6	Permit delays	2.2	2.5	5.5
2.7	Old wells not completed	3.5	2.6	9.1
2.8	Technical challenges	1.9	3.0	5.6
2.9	Drilling a "dry hole"	2.4	2.3	5.5
3.1	Worker safety – OSHA	2.7	1.6	4.3
3.2	Worker safety – CO2 exposure	1.8	1.7	3.1
3.3	Groundwater: geochemical	2.3	3.1	7.0
3.4	Groundwater: brine	2.4	3.5	8.4
3.5	Confinement zone failure	2.5	3.4	8.4
3.6	Property damage	2.3	3.0	7.0
3.7	Ecosystem degradation	1.8	2.8	5.0
3.8	Sudden Public exposure	1.4	3.3	4.7
3.9	Slow Public exposure	1.7	3.1	5.3
3.91	Atmospheric release	1.9	2.6	4.8
3.92	Business interruption (BI)	2.4	3.0	7.1
3.93	Contingent BI	2.3	2.6	6.1
3.94	Induced seismicity	1.6	3.2	5.1
3.95	Land subsidence	1.6	2.8	4.4
3.96	Lawsuits	3.4	3.1	10.6
3.97	Inadvertent CO2 extraction	2.0	2.2	4.4
3.98	MMV negligence or failures	2.2	1.8	4.0
4.1	Worker safety	2.4	1.7	4.0
4.2	Failure to fully close well	2.1	2.2	4.7
4.3	Failure to adequately maintain MM\	2.2	2.2	4.8
4.4	Quality problems with materials	2.4	2.9	6.7
5.1	Groundwater: geochemical	2.1	3.2	6.9
5.2	Groundwater: brine	2.0	3.2	6.4
5.3	Confinement zone failure	2.2	3.3	7.3
5.4	property damage	2.2	3.1	6.9
5.5	Ecosystem degradation	1.8	2.9	5.2
5.6	Sudden Public exposure	1.7	3.1	5.3
5.7	Slow Public exposure	1.8	3.1	5.6
5.8	Land subsidence	1.5	2.9	4.3
5.9	Atmospheric release	1.7	2.5	4.3
5.91	Lawsuits	2.9	3.1	8.9
5.92	Inadvertent CO2 extraction	2.2	2.1	4.7
5.93	Seismicity	1.4	2.7	3.8
6.1	LT groundwater: geochemical	1.9	3.1	6.0
6.2	LT groundwater: brine	1.9	3.2	6.1
6.3	LT confinement zone failure	1.8	3.1	5.6
6.4	LT property damage	1.9	2.9	5.6
6.5	LT ecosystem degradation	1.6	2.6	4.1
6.6	LT Sudden public exposure	1.4	2.9	4.2
6.7	LT slow public exposure	1.6	2.8	4.6
6.8	LT unanticipated land subsidence	1.3	2.7	3.5
6.9	LT unanticipated atmospheric relea	1.4	2.3	3.2
6.91	LT lawsuits	3.0	2.8	8.4
6.92	LT inadvertent CO2 extraction	2.5	1.8	4.5
6.93	Seismicity	1.5	2.8	4.1

This ranking showed that some of the highest ranked priorities and costs were related to risks that, while very important, were not unique to CS projects and/or needed to be further elaborated. These risks include items like worker safety/OSHA, cost increases due to various construction and permitting delays, potential lawsuits, other technical challenges associated with project construction. They are highlighted in grey in the table above and it was suggested that we cull them from the list for separate analysis. All of the risks are plotted on the following graph which is arranged by quadrant to illustrate a conceptual approach for considering strategies to manage the liability associated with the potential risks. The twelve risks to be culled are marked with red circles.



Once the indicated risks were culled from the list, the remaining data were plotted in a similar graph as indicated below.



When this is done, only four of the identified risks remain in the high priority quadrants of the graph. Three of these are risks of leakage associated with a failure to adequately complete site characterization, failure to complete old wells and failure to detect problems with new wells. These risks might translate into long-term damages, but the cause could take place during the early stages of a project. The fourth high priority risk is inadvertent release of CO_2 long after a project has closed.

Upon further consideration, it seems that the risks potentially associated with CS projects that are also unique to CS projects can be even further simplified. The risk log was broken into six major steps: siting, construction, operation, closure, post-closure, and long-term maintenance & stewardship. Several of these steps take place over relatively confined periods of time and the potential for CS specific risks materializing during that stage (the stage in which the event causing the risk takes place) may be relatively small compared to the potential of risks to arise during other stages. For example, during the siting stage there are potential risks associated with the activities involved in conducting studies, but these risks are routinely managed in similar industries. Also, since no CO_2 is injected during that stage, there is no risk associated with potential CO_2 leakage. During construction and the actual process of closing wells, the risks are similarly bounded. Further, events may occur during these stages that lead to risks at a later stage. For example, the site characterization study may fail to detect all of the old wells in the nearby area, or during closure the cement plug may have tiny flaws, both of which could lead to leakage pathways out in the future. In these examples, the risk does not materialize during the stage in which the action leading to the risk takes place. Based on this assessment, it seems that it would be appropriate to revise the risk log so that it focuses on a simpler matrix of timeframes, causes and damages as indicated in the following table:

Timeframe	**Cause / Pathway**	**Damage**
- Operation - Post-Closure - Long Term Maintenance & Stewardship	- Undetected old wells or faults - Injection well bores - Geomechanical failure of confinement zone - Geochemical failure of confinement zone - Induced seismicity opening up new faults or leading to well bore failure - Naturally occurring seismic activity leading to new faults or well bore failure - Inadvertent release such as through drilling into a CO_2 storage area	- Groundwater contamination - Subsurface property damage - Surface property damage - Ecological damage - Atmospheric release - Public exposure to CO_2 through slow leaks or seeps - Public exposure to CO_2 through sudden releases

It is WRI's intent to consult with experts to refine the risk log accordingly and solicit another round of expert opinions about the probability, and impact (including cost) of specific risks for a given time horizon. .

Discussion:

Although activities that are analogous to CS have been carried out for decades, there are some key differences between CS and these analog activities. There is also a new group of developers and investors becoming involved in CS who do not have a long background in oil/gas drilling or other analogous activities. The workshop discussion revealed potential real and perceived concerns or gaps in data, all of which could serve as barriers to investment. The discussion during the November workshop attempted to address these issues in relation to the risk log. The key points stemming from the discussion that are not reflected in the above presentation of the risk log were as follows:

- CCS has a lot of similarities to current oil industry practices, but some key differences include the much larger volume of injection expected for CS and the need for virtually permanent sequestration. Since CO_2 forms carbonic acid, a mild acid when combined with water, or in the case of CS, injected into brines, additional measures to protect the equipment involved in injection and storage will be necessary over the long term. Similar maintenance procedures are already practiced in the EOR industry.

- Like oil and gas, CO_2 is buoyant and will accumulate at the top of the storage reservoir. It is slightly acidic nature may have some affect on carbonaceous materials in the cap rock or seal, as well as on the cement sealing the space around the well casing, over time.
- It is important to recognize that analogous activities take place all around the country and the risks are well managed in those cases. For example, the underground natural gas storage fields serving the Chicago area are located, by necessity and without problem, close enough to the city that they can be used to regulate the availability of natural gas on a daily basis.
- The importance of risk perception cannot be underestimated at this juncture in the development of CS. Potential CS risks for which the perceived risk is higher than the measured risk may be difficult to insure or otherwise mitigate. It is also important to note perception of various risks will likely evolve over time as we gain more concrete experience with CS.
- On a related note, the issue of the public perception of CS and its impact on investor perception of CS risk was discussed. Some suggested that public perception will have a strong influence on investor perception and others were not as convinced.
- Someone questioned whether the status of CO_2 as a waste or a commodity would have an impact on the risk assessment. The general reaction was that it would not.
- Since there are "gate-keeping" decisions implied in the stages, some thought it was important to draw attention to the process that companies would undertake in deciding whether to commit capital to CS projects. Corporate risk management processes could have a role in helping to ensure that projects only move forward when they demonstrate high likelihood of avoiding the risks outlined in the log. Questions were asked about how they fit with this process. WRI will endeavor to identify specific gate-keeping decisions in the context of the risk log.
- The version of the risk log used for this workshop represented a good start of describing and reviewing the risks potentially associated with CS projects. However, upon further consideration, there are important changes that need to be made to the risk log before it is used to solicit a larger number of responses.

Suggestions for moving forward with the risk log:

- Transparency in the discussion process is very important, the steps and findings need to be documented and explained.
- A detailed review of the risk log suggested modifications as described above that would put aside certain risks to be further elaborated (lawsuits) or addressed through more conventional risk management strategies. While these risks are important, it was felt that they could be addressed through other means, whereas the risks that appear to be unique to CS should be the focus of this effort. In addition, it was suggested that the process of site selection and characterization is more detailed than indicated in the risk log. Several of the activities listed under the construction stage would take place during siting and be completed before a company would make a "go/no go" decision on a specific site. And finally, it was suggested that some of the timelines associated with the stages be

modified. WRI will make these changes in consultation with workshop participants and outside experts.

- Obtain a larger sample of responses.

2. Insurability Assessment

As discussed earlier in the previous section, a working hypothesis of the workshop is that investors and project developers/operators are likely to heavily consider the extent to which they can estimate the potential costs and the uncertainties around those costs associated with CS projects, as well as the extent to which they can hedge the risk that costs will be significantly different than those estimated. There are a number of mechanisms that can be used alone or in combination to mitigate financial risk, and it seems likely that a portfolio or layered approach will be necessary for most of the risks potentially associated with CS projects.

Several financial assurance mechanisms are used under the current UIC program[2]:

a. A Surety Bond issued by an approved surety company that guarantees that the obligations (i.e. plugging) listed on the bond will be performed. There are two types of surety bonds: Financial Guarantee Bonds and Performance Bonds.

b. Letter of Credit from a regulated bank or other financial institution.

c. A Trust Fund operated by a regulated third party.

d. A Standby Trust Fund, which is a Trust Fund that is not fully funded and is used under certain conditions to support Surety Bonds or Letters of Credit.

There are several kinds of insurance that are used to cover environmental risks. These include:

a. Environmental (impairment liability (EIL) insurance / Pollution Liability Coverage) – can cover 3rd party claims for property damage, resulting financial loss (legal defense costs) and in some cases pure named financial losses.
b. First Party Clean Up Cost Insurance – covers insured's cost for cleanup of personal property due to unanticipated contamination (say from fire or discovered over time).
c. Cost Cap Policies (Stop Loss), – can protect against cost overruns during remediation / immediate response action.
d. Secured Lender Policies – can limit the risk of investors for liability for damages.
e. Finite Risk Policies – can be used to cap future liability for clean up costs (insurer assumes risk if future clean up costs more than agreed policy amount).
f. Contractors Pollution Liability Policies – can be used to insure general contractors against third party property damage, bodily injury, and environmental cleanup claims.
g. Errors and Omissions (also known as Professional Liability coverage) -- can be used to insure against claims for mistakes and negligent acts for engineers, lawyers, consultants, laboratories and other professionals.
h. Owner-Controlled Policies – can be used to protect developer in event insurance held by contractors and service providers is insufficient (supplemental)?

[2] For more description of these instruments see the EPA UIC website at: http://www.epa.gov/region5/water/uic/finmech.htm

In addition, newer financial instruments such as derivatives and other hedging tools have been developed over the last few years. One such example is a weather derivative through which a company hedges against the risk of losses related to weather. The company selling the derivative bears the risk of the weather-related loss in exchange for the premium, or fee, paid by the company who wishes to manage the risk. If the weather event occurs, for example, rain falling before a certain time of day, the company managing the risk files a claim with the company selling the derivative. If the weather event does not happen, the company selling the derivative keeps the premium. Tools such as this can help a company to better manage the uncertainty of potential financial impacts due to weather, and have been made possible because of increasing market sophistication and computerization. A decade ago, weather derivatives were rare if they existed at all. In a similar fashion, it is expected that new financial instruments that have not yet been designed will emerge to help manage some of the risks potentially associated with CS projects.

Another type of risk management tool is based on regulatory performance standards or requirements. For example, under the UIC program, the mechanical integrity test (MIT) requirements for Class I and Class II wells differ in some key areas. Given the importance of the early steps in a CS project to ensure long-term storage integrity of CS projects, a regulatory requirement that imposes appropriately rigorous MIT requirements could help to mitigate the risk associated with undetected well flaws.

Another type of potential risk management tool is government policy. As described in the June 2007 workshop, there are several government programs that establish limits on the financial responsibility of various entities (typically in combination with other financial assurance requirements that those same entities must meet). One of the most frequently discussed program is the Price Anderson Act, which establishes tiered requirements for nuclear energy companies to obtain insurance coverage and also includes a 3rd tier of government indemnification of certain potential liabilities. Other programs include the National Flood Insurance Program and the National Vaccination Injury Compensation Program. At least two proposals have emerged to address the long term liability associated with the potential for CO_2 leakage and associated damages from CS projects. The first is contained in the model rule and statute proposed by the IOGCC [http://www.iogcc.state.ok.us/docs/MeetingDocs/Master-Document-September-252007-FINAL-(2).pdf]. The second is contained in the thesis of a PhD candidate from MIT and is incorporated in the Massachusetts Institute of Technology Future of Coal Study [www.mit.edu/coal]. These two proposals differ in important respects, however both propose the long-term liability be transferred to a public entity at some point after post-closure and based on certain conditions demonstrating that the risk from a project has been minimized.

As a way of beginning to evaluate the applicability and efficacy of the various risk management options for addressing the risks potentially associated with CS projects, the project team developed a straw assessment of the potential insurability of the various risks contained in the risk log. This straw assessment is based on an understanding of commonly available insurance and is not meant to definitively assert that insurance will be available to cover the risks. In developing this assessment, it became clear that while certain risks might be conceptually insurable, specific issues related to classes of projects or individual projects might prevent underwriters from offering insurance (or offering insurance at acceptable rates) for those classes or individual projects. For example, insurers might be more comfortable offering insurance to hedge against the risk of CO_2 leakage from a site that is very well documented (e.g., an oil field) than it would be in offering similar insurance for a project located in an area that is not well documented (e.g., a saline reservoir).

The scale used for assessing insurability is as follows:

Rank	**Scale**	**Likelihood of insurability**
1	Very Low	Unlikely to obtain insurance
2	Low	Very limited scope of coverage or capacity
3	Medium	Only specialty insurers will insure
4	High	Available from many insurers
5	Very High	Generally available coverage

In developing this straw assessment, the project team envisioned a “zone of insurability” concept. Risks rated with a 4 or 5 are in the highest or most-likely-to-be-insurable zone. For these risks, it seems likely that insurance providers would be able to work with project developers to develop insurance instruments for hedging risks. Risks rated in the 2-3 zone might possibly be “bumped” up into the more insurable zone by either developing better data about the potential for the risk to occur, or by developing layered risk management approaches utilizing not only insurance but also some of the financial assurance mechanisms discussed above. Risks rated in the 1 zone potentially fall into two categories. Some risks are typically borne by the company. For example, oil companies engaged in exploration often bear the risk that they will drill a “dry” well. Some of the risks assessed in the 1 zone are similarly expected to be borne by the company developing or operating a CS project. The remaining risks ranked in the 1 zone will require additional consideration. Some may be able to be “bumped” into higher zones of insurability through layered approaches to risk management. Certain others might require government response.

The straw assessments are presented below.

ID	Risk	Ins rank	ID	Risk	Ins rank
1.1	Worker safety	5	1.4	PublicOpposition	1
1.2	Prop Damage	5	2.4	Contractor delays	1
2.1	Worker safety	5	2.6	Permit delays	1
2.2	Prop Damage	5	2.7	Old wells not completed	1
3.92	Business interruption (BI)	5	2.8	Technical challenges	1
3.1	Worker safety – OSHA	4	2.9	Drilling a “dry hole”	1
3.2	Worker safety – CO2 exposure	4	3.5	Confinement zone failure	1
3.93	Contingent BI	4	3.6	Property damage	1
4.1	Worker safety	4	3.7	Ecosystem degradation	1
3.8	Sudden Public exposure	3	3.91	Atmospheric release	1
4.4	Quality problems with materials	3	3.97	Inadvertent CO2 extraction	1
5.6	Sudden Public exposure	3	3.98	MMV negligence or failures	1
5.9	Atmospheric release	3	5.3	Confinement zone failure	1
3.9	Slow Public exposure	2 to 3	5.4	property damage	1
5.7	Slow Public exposure	2 to 3	5.5	Ecosystem degradation	1
6.7	LT slow public exposure	2 to 3	5.92	Inadvertent CO2 extraction	1
6.9	LT unanticipated atmospheric release	2 to 3	5.93	Seismicity	1
2.3	Damage conf. zone	2	6.1	LT groundwater: geochemical	1
2.5	Well flaws	2	6.2	LT groundwater: brine	1
3.3	Groundwater: geochemical	2	6.3	LT confinement zone failure	1
3.4	Groundwater: brine	2	6.4	LT property damage	1
3.94	Induced seismicity	2	6.5	LT ecosystem degradation	1
3.95	Land subsidence	2	6.6	LT Sudden public exposure	1
4.2	Failure to fully close well	2	6.8	LT unanticipated land subsidence	1
4.3	Failure to maintain MMV system	2	6.92	LT inadvertent CO2 extraction	1
5.1	Groundwater: geochemical	2	6.93	Seismicity	1
5.2	Groundwater: brine	2	3.96	Lawsuits	Range
5.8	Land subsidence	2	5.91	Lawsuits	Range
1.3	Incomplete Site Char	1 to 3	6.91	LT lawsuits	Range

This presentation resulted in considerable discussion of various issues surrounding the concept of insurability, and the relationship between insurability and other risk management mechanisms. It also circled back to discussions about what is known or not known about the potential risks from CS. While the discussion did not result in a consensus view on the insurability of various risks or of the potential efficacy/applicability of the other mechanisms under discussion, it did lead to some concrete ideas for using case studies from existing and/or planned projects to develop a better understanding of the kinds of information the financial risk management industry would need to evaluate in order to consider offering various risk management tools for CS projects. The discussion also led to a greater appreciation of the temporal needs for risk management. While the initial workshop focus had been primarily on long-term liability, the discussion during the November workshop highlighted the interconnectedness of risk management as a continuum throughout a project’s life. What follows is a summary of additional points, raised during the discussion, that have not been included above or warrant additional emphasis.

a. Financial risk management involves more than just insurance and should be described as a portfolio or approach:
    - The regulatory backdrop, specifically whether there are significant carbon constraints or not, will have an impact on the availability of financial risk management mechanisms.

- It was suggested that the risks be mapped to a grid and that best approaches to risk management might emerge from that mapping. It was suggested that management decisions/policies might be useful for managing those risks in the low probability/low cost quadrant; it was suggested that insurance and warranties might be useful for those risks in the low probability/high cost quadrant; it was suggested that regulation, industry standards and potentially government backing/indemnification might be useful for managing those risks in the high probability/low cost quadrant; and, finally, it was suggested that those risks in the high probability/high cost quadrant would need to be reviewed and might lead to some kind of negotiated response.

b. Insurance is an important option among the tools for financial risk management:
    - The insurance industry has the advantage of helping companies to pool and transfer risk, as a result, companies may experience the benefits of tax efficiency, and increased legal and technical expertise as a result of this pool.

c. The insurance industry and insurance policies are not monolithic:
    - While some types of risks potentially associated with CS may be conceptually or categorically "insurable," that does not mean that individual insurance companies will offer policies related to CS or that each CS project will be able to find the same terms of coverage.
    - There are structures within the insurance industry that may be more applicable to CS, especially in the early stages of demonstration. One such structure is known as an industry mutual and involves the creation of an insurance company that is owned by its shareholders for the purpose of providing insurance to those shareholders.
    - Although the nuclear industry insurance practices may be applicable to CCS, the statutory structure may not be applicable.
    - CS may require the development of mechanisms to address an evolving or evolutionary risk profile. In other words, a single project may become more or less risky based on the performance and findings about the project in its early stages of operation.

d. The discussion did not focus on approaches that project owners/operators might consider to help mitigate financial risk. For example, in some cases companies have formed joint ventures to develop new types of projects in order to distribute the risk potentially associated with those new projects among a large number of interested companies.

e. Additional data requirements for consideration by the insurance industry in determining whether to underwrite insurance policies would include, among other things:
    - For defined risks, identify frequency, severity and cost with much greater certainty
    - Develop maximum probable and maximum potential loss estimates
    - A clearer demarcation of risks will be useful for insurance industry so that they can decide which available mechanisms can be applied to CCS with confidence and what needs to be created.

3. Putting the Pieces Together – A Review of Emerging Policy Options.

There are several proposals that have begun to emerge to address long term liability. These include proposals in the IOGCC model rule and statute, suggestions in the Future of Coal study, and treatment of the potential liability associated with FutureGen by the Texas and Illinois State Legislatures. A common approach in these policies is that at some point in time, and under specific conditions, government takes on responsibility for ensuring the integrity of CS projects. The implied benefits of such an approach are, among others, that it provides a mechanism for long-term monitoring and maintenance of CS projects (long-term in this case being a period of time that exceeds the expected lifetime of a typical corporation) and removes the uncertainty of long-term liability as a barrier to investment. The implied risk is that integrity of a CS project may erode over the long-term. During the afternoon discussion, the group reviewed the culled list of risks and straw man compendium of the emerging policy options for addressing long term liability. The discussion yielded some interesting points for considering aspects of these policy options, but fell short of a comprehensive review. It was felt that additional ground work in detailing key risks, exploring insurance and other risk management tools, and considering policy frameworks would be needed to conduct a methodic review of policy options.

What follows is a summary of the key points from the discussion. It is important to note that discussing certain aspects is not meant to imply support for those provisions. For example, there was no agreement that long-term liability should be transferred to the government at some point after a CS project is closed yet the group still reflected on certain considerations if such a policy were put in place.

a. Regarding concern about liability as a barrier to investment:

- Some expressed a view that as we learn more about CS, it's likely that long-term liability will not be a large problem. Today, it seems equally the case that the lack of policy or economic drivers is a primary barrier to investment. Carbon control programs resulting in carbon prices of $70 per ton, for example, would likely drive CS projects.
- Others contend that the early projects / first movers bear a large risk – this is true in both the case of the owner/operator and the host community. For example, this is a growing concern for the DOE Regional Carbon Sequestration Partnerships as they negotiate the Phase III projects. It was suggested that a structure may be needed to address demonstration projects that involve rigorous project controls and some liability management.
- Still others opined that long-term liability was likely to remain a barrier to investment even after several large scale demonstrations were in place.
- In discussing whether it made sense to focus on two approaches, one for demonstration projects and a second for other projects, the group was reminded of the history of nuclear energy development. It was suggested that the Price Anderson act was originally intended as a short-term measure to help get through the project demonstration phase and yet it has grown into a program that is defended rigorously as necessary for keeping nuclear power plants running. The

point being made was that it may be difficult to successfully bifurcate a liability system that treats demonstration projects differently than other projects.

b. Regarding a timeline for liability transfer:

- It was felt that not enough is know to determine a fixed period of time before liability transfer would take place. The proposals mentioned include a transfer at the point of injection as well as transfer 10 years after closure. Others have suggested that the timeline be based on the number of years of injection. Still others suggest that rules need to be determined to test when project risk has stabilized or declined.
- The group was reminded that Subtitle D landfill (non-hazardous) program is an important analog. The rule established a 30 yr transfer period, and ultimately it was found that this wasn't long enough for some landfills.
- It was suggested that Measurement, Monitoring and Verification (MMV) should be used to evaluate project quality and to determine whether the project meets certain criteria before transfer to the public sector.

c. Regarding private sector vs. public sector assumption of liability:

- It was suggested that the marketplace should be allowed to address as much risk as it can bear and the government should be asked to cover the gap.
- There was concern that the current statutory framework is insufficient to foster private insurance or to enable the government to assume long-term liability. Legislative limits on CS liability are an example of statutory response that could be helpful in facilitating private insurance to offer coverage.
- Some expressed the view that even if certain aspects of CS appear to be uninsurable, state or federal indemnity is not the only option that might be applicable.
- Transferring the risk to the public does not come without costs. It is expected that in order for the government to accept any long-term liability, there will be a greater up-front burden on projects as the public may demand more assurance than the private sector would.

d. Regarding potential risk management models:

- A "mutual" liability model was discussed through which policyholders have ownership in the insurance company. It was thought that a privately owned mutual would encourage good risk management and act as a vehicle for a balance of liability between public and private sector.
- Storage funds were discussed. It was suggested that there could be multiple storage funds bidding for liability and that these could be sanctioned at the state or federal level. Some expressed concerns that state or federally managed funds might not encourage good projects. Others thought the discussion of a carbon storage fund was premature given lack of knowledge about costs and requirements.

4. Discussion of Next Steps

It seems that the following steps are warranted to further the discussion of liability:

1. Revise the risk log and obtain a larger sample of expert responses.

2. Conduct small discussions around case studies involving CS experts and insurance industry representative to develop models for risk management and to detail the project information that may be necessary for risk management.

3. In order to facilitate long-term risk management, develop recommendations for regulatory requirements affecting the early and operational stages of implementation of CS projects.

WRI intends to convene small working groups to complete these tasks; it will share results of these discussions in a liability paper; and it will also assess how this work integrates with the rest of its CS guidelines efforts.

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Appendix A
Proposed Agenda for Nov 1

8:30 – 9:00	Introductions
9:00 – 9:30	Recap of June 5 workshop and recent activities – Jonathan Pershing, WRI
9:30 – 10:45	Review of priority ranking of risks – Sarah Wade, AJW
11:00 – 12:30	Insurability Assessment – Gary Meggs, Southern Company
12:30 – 1:30	Lunch – Informal Discussion
1:30 – 3:30	Presentation of straw man approach to address high ranked, low insurability risks – Sarah Wade, AJW
3:45 – 4:30	Review group "findings" and discuss paper proposal – develop review group and process

Appendix B
Participant List

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