ESSB 6001 Stakeholder Committee
October 2, 2007 Meeting
Decision Matrix:
Defining "Permanent" Sequestration

"Permanent" Sequestration:

ESSB 6001 uses the term "permanent" to describe sequestration in the following two sections (*emphasis added*):

Sec. 5(7):
(a) Those emissions that are injected *permanently* in geologic formations;
(b) Those emissions that are *permanently* sequestered by other means approved by the department.

Sec. 5(12)(a):
"…the department shall determine whether sequestration or a plan for sequestration will provide safe, reliable, and *permanent* protection against the greenhouse gases entering the atmosphere from the power plant and all ancillary facilities."

Issue	What concerns are there (e.g. with current law)?	What approaches should be considered?	What is the reflected opinion (recommendation) of the committee?	What complicating factors (or minority opinions) are there?
1) Should the term "permanent" be defined within the rule, as it relates to sequestration?				
The available literature (see references below this table) does not define "permanent" as used with sequestration. Should the rule include a definition for "permanent" as it relates to sequestration?	- How do you prove that you have permanently reduced carbon? - How are you going to actually enforce? - Permanence with respect to what? - Relevant time span - Definition must apply to geologic and other forms of sequestration. -	- Long term reduction - Evidence of leakage over what period of time. - Define containment system on case by case basis. - Percentage (of leakage) over an amount of time and acceptable forms. - IPCC definition - Consider defining emissions - Define emissions as	- something less than 100 percent (need standard) - criteria for monitoring (reliable) - IPCC – expand to include other forms of sequestration - Percentage measured is percentage released into the atmosphere. -	- technology to monitor - IPCC- one percent of what? - How are we measuring it, accounting for it? - Need to consider percent of allowed leakage in respect to area available for sequestration. - Natural occurring CO2 needs to be considered in

Issue	What concerns are there (e.g. with current law)?	What approaches should be considered?	What is the reflected opinion (recommendation) of the committee?	What complicating factors (or minority opinions) are there?
		those coming off the power plant or from another limited pool of power plants. - Consider Natural Gas Storage Industry- 5 percent - Consider a measure for leakage above storage seal - Consider RCW 80.70- one percent of total over life of facility - Define monitoring equipment - Permanence used in selecting an injection site(capability), monitoring for mitigation -		baseline. - Facility may sequester only a certain amount of carbon. - Criteria is only leakage to atmosphere - What does applicant have to demonstrate in order to gain permit. - Reasonable basis that CO2 is going to stay sequestered. - Definition of permanence is more applicable for site selection (not long term monitoring) - Do have monitoring systems.
2) If yes, then how should the term "permanent" be defined?				
Meriam-Webster online dictionary: **per ·ma ·nent:** continuing or enduring without fundamental or marked change; lasting forever		-permit= facility needs to demonstrate viable method of carbon sequestration. - refers to the sequestration of emitted CO2 in a containment system that is capable of retaining "all" Of the "injected" CO2 beyond reasonable doubt over "several" thousands of years, monitored and	- demonstrate viable method of carbon sequestration storing most of emitted CO2 in a containment system over the life of the facility. (with proposed amendments)	- need to include time change in what all means. - injection period over the life of the facility

Issue	What concerns are there (e.g. with current law)?	What approaches should be considered?	What is the reflected opinion (recommendation) of the committee?	What complicating factors (or minority opinions) are there?
		verified according to best available technology and operated according to the defined standards and protocols. - change all to 99 percent		
IPCC Special Report: "It is likely the fraction of stored CO_2 retained is more than 99% over the first 1000 years." Should the rule provide for an "acceptable" amount of leakage (e.g., 1% over the first 1,000 years, or some other percentage that means less than 100% sequestration over a specified period of time)?	IPCC definition only applies geologic sequestration. Doesn't define what is meant by storage. 1% of what? What has actually been injected or what will be injected over life of project?	Definition should include the seal/cap rock and not allow leakage beyond this. Define as some % over life of facility.	IPCC definition good starting point. Expand to include all forms of sequestration.	

What is "permanent" in relation to sequestration?

The Merriam-Webster definition of "permanent" is provided below. Reports and proposed legislation relating to carbon capture and storage are listed following the dictionary definition. Each of these referenced documents uses the term "permanent" when discussing sequestration of CO_2. None of these documents provide a separate definition of "permanent" for the purposes of describing sequestration of CO_2. The IOGCC model statutes and regulations (see #6) use "permanent" to describe geologic storage of carbon dioxide, human occupation of structures, and the cessation of active CSP (CO2 Storage Project) injection operations. The model statute and regulations do not include a definition of permanent. This infers that the generally accepted definition of permanent is applied to all uses of the term throughout the document.

1. **Merriam-Webster online dictionary:**
   http://www.merriam-webster.com/cgi-bin/dictionary

- **per·ma·nent** Function: *adjective*
  continuing or enduring without fundamental or marked change; lasting forever

2. **IPCC Special Report on Carbon Dioxide Capture and Storage:**
   http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm

- Summary for Policymakers:
  Pg. 13: The fraction retained in appropriately selected and managed geological reservoirs is very likely to exceed 99% over 100 years and is likely to exceed 99% over 1000 years.

  Very likely = Probability between 90 and 99% (pg. 13, footnote 25)
  Likely = Probability between 66 and 90% (pg. 11, footnote 19)

- Technical Summary:
  Pg 43: A fraction retained on the order of 90-99% for 100 years or 60-95% for 500 years could still make such impermanent storage valuable for the mitigation of climate change. All studies imply that, if CCS is to be acceptable as a mitigation measure, there must be an upper limit to the amount of leakage that can take place.

- Chapter 5 of full report: Underground geological storage:
  5.7.3.5 Assessing the ability of operational geological storage projects to retain CO2 for long time periods
  Assessment of the fraction retained for geological storage projects is highly site-specific, depending on (1) the storage system design, including the geological characteristics of the selected storage site; (2) the injection system and related reservoir engineering; and (3) the methods of abandonment, including the performance of well-sealing technologies. If the above information is available, it is possible to estimate the fraction retained by using the models described in Section 5.4.2 and risk assessment methods described in Section 5.7.5. Therefore, it is also possible, in principle, to estimate the expected performance of an ensemble of storage projects that adhere to design guidelines such as site selection, seal integrity, injection depth and well closure technologies. Table 5.5 summarizes disparate lines of evidence on the integrity of CO2 storage systems.

  For large-scale operational CO2 storage projects, assuming that sites are well selected, designed, operated and appropriately monitored, the balance of available evidence suggests the following:
  - It is very likely the fraction of stored CO2 retained is more than 99% over the first 100 years.
  - It is likely the fraction of stored CO2 retained is more than 99% over the first 1000 years.

5.7.7 Remediation of leaking storage projects
Geologic storage projects will be selected and operated to *avoid leakage*. (*Emphasis added*)

3. **New Mexico Interim Report:**
http://www.emnrd.state.nm.us/OCD/documents/InterimReportCO2Sequestration.pdf

- Pg. 4:
  Identified Statutory Issues:
  "…for purposes of long term/permanent sequestration."

  Identified Regulatory Issues:
  "Definition of permanent sequestration (99% storage for 1,000 years?)"

- Pg. 21:
  Identified Regulatory Issues:
  - Definition of Permanent Sequestration
    - Maximum leakage rate of 1 percent over 1,000 years?

4. **Ca. Energy Commission:** ***Geologic Carbon Sequestration Strategies for California, The Assembly Bill 1925 Report to the California Legislature***.
http://www.energy.ca.gov/2007publications/CEC-500-2007-100/CEC-500-2007-100-SD.PDF

- Pg. 146: Refers to a "thousand-year well".

Evaluate options and existing capabilities to respond to CCS leakage events, including remediation and mitigation planning.
Even sites with optimal features for CO2 storage will have to be assessed for potential human health and safety and environmental risks during the operational and post-operational phases of a project. Safety procedures to limit these risks and leakage response procedures will be needed. Experience with storing CO2 in geological formations suggests that the inherent risks and potential quantities of CO2 leakage will likely be minimal. However small the risk, CO2 leakage can result from human error, natural hazards, or other unknown factors. Procedures are needed to cover the possibility of CO2 migrating out of the storage formation(s) or other releases that might occur during pipeline transportation or injection activities that could affect public health, the environment, or economic interests. Analogs such as the natural gas storage industry should be studied, as well as the safety practices for EOR, to rigorously evaluate their potential application to geologic sequestration. However, further efforts are needed to address CO2 monitoring, leak detection, and mitigation and remediation at greater spatial and time scales than those that have been needed for EOR operations. Priorities for continued research include procedures for identifying and addressing a failure in

the reservoir seal or cap rock; materials selection and construction procedures to achieve a "*thousand-year well*"; and the cost-effective means for securely reworking or plugging wells in a CO2 storage environment. (*Emphasis added*)

5. FutureGen Project

- **State of Illinois, HB 1777:** Creates the Clean Coal FutureGen for Illinois Act for the purpose of providing the FutureGen Alliance with adequate liability protection, land use rights, and permitting certainty to facilitate the siting of the FutureGen Project in Illinois.
  http://www.ilga.gov/legislation/fulltext.asp?DocName=&SessionId=51&GA=95&DocTypeId=HB&DocNum=1777&GAID=9&LegID=30606&SpecSess=&Session=

  Section 15 Definitions: "Carbon capture and storage means the process of capturing and injecting sequestered gas for permanent storage." *(The bill does not define permanent)*

- **State of Texas, SB 1461:** Allows the governor to contract with an organization that is exempt from federal income taxation for a purpose related to implementing a clean coal power plant project. This bill also designates land for the disposal of sequestered carbon dioxide and requires that the attorney general provide legal representation for a state agency in a legal proceeding that arises from an escape or migration of carbon dioxide captured or sequestered in connection with a clean coal project.

  Sec. 119.0025. MONITORING OF SEQUESTERED CARBON DIOXIDE. Requires the Bureau of Economic Geology of The University of Texas at Austin to monitor, measure, and verify the permanent status of sequestered carbon dioxide in which the Railroad Commission of Texas has acquired the right, title, and interest under Section 119.002. *(The bill does not define permanent)* http://www.capitol.state.tx.us/tlodocs/80R/billtext/pdf/SB01461F.pdf

- **FutureGen Draft EIS:**
  http://www.netl.doe.gov/technologies/coalpower/futuregen/EIS/Volume%20I.pdf
  Pg. 1-3: Geologic Sequestration is the placement of CO2 or other GHGs into a geologic formation in such a way that it remains *permanently* stored. (*Emphasis added*)

  Pg. 2-40: The separated (i.e., captured) CO2 would be *permanently* sequestered. (*Emphasis added*)

  Pg. 2-45: Geologic sequestration is the storage of CO2 in a suitable subsurface formation with the capability to contain it *permanently*. (*Emphasis added*)

  Pg. 2-47: An objective of the FutureGen Project is to inject between 1.1 and 2.8 million tons (1 and 2.5 MMT) per year of CO_2 into a deep saline reservoir, providing *permanent* storage of the CO_2 underground. (*Emphasis added*)

Pg. 2-53: MM&V encompasses the process for ensuring the safe and *permanent* storage of sequestered gases. (*Emphasis added*)

Pg. 2-70: A closure plan would be developed at the time that the power plant was to be *permanently* closed. (*Emphasis added*)

Pg. 10-5: Monitoring, Mitigation, and Verification- Capability to measure the amount of CO_2 stored at a sequestration site, monitor the site for leaks, to verify that the CO_2 is stored in a way that is *permanent* and not harmful to the host ecosystem, and to respond to CO_2 leakage or ecological damage in the unlikely event that it should occur. Monitoring, mitigation, and verification (MM&V) applies to geologic sequestration and terrestrial sequestration. (*Emphasis added*)

6. **Interstate Oil and Gas Compact Commission: Storage of Carbon Dioxide in Geologic Structures - A Legal and Regulatory Guide for States and Provinces**
http://www.iogcc.state.ok.us/docs/MeetingDocs/Master-Document-September-252007-FINAL(2).pdf

- Model Statute:

Pg. 1: Footnote 2- The purpose of this section is to make clear that the primary goal is to *permanently* store carbon dioxide to mitigate its impacts on global climate change;… (*Emphasis added*)

Pg. 2: (f) Geologic storage. *Permanent* or short-term underground storage of carbon dioxide in a reservoir. (*Emphasis added*)

- General Rules and Regulations:

Pg. 1: (f) **CSP Closure Period** means that period of time (10 years unless otherwise designated by the State Regulatory agency {SRA}) from the *permanent* cessation of active CSP injection operations until the expiration of the CSP performance bond, unless monitoring efforts following the operational period demonstrate to SRA that a different time frame is appropriate. (*Emphasis added*)

Pg. 4: (ii) All manmade surface structures that are intended for temporary or *permanent* human occupancy within the GSU and within one mile of the outside boundary of the GSU; (*Emphasis added*)