RCSP Water Working Group

Carbon Capture and Storage: Protecting Freshwater Resources

Introduction

The overall goal of carbon capture and storage (CCS) is to inject carbon dioxide (CO_2) that has been captured from a point source, such as a power plant, into a deep underground storage formation and ensure that it remains there. Maintaining the security of that CO_2 is crucial to protecting our water resources. This fact sheet identifies the keys to successfully protect water resources during CCS and introduces the evolving regulatory framework set up for that purpose.

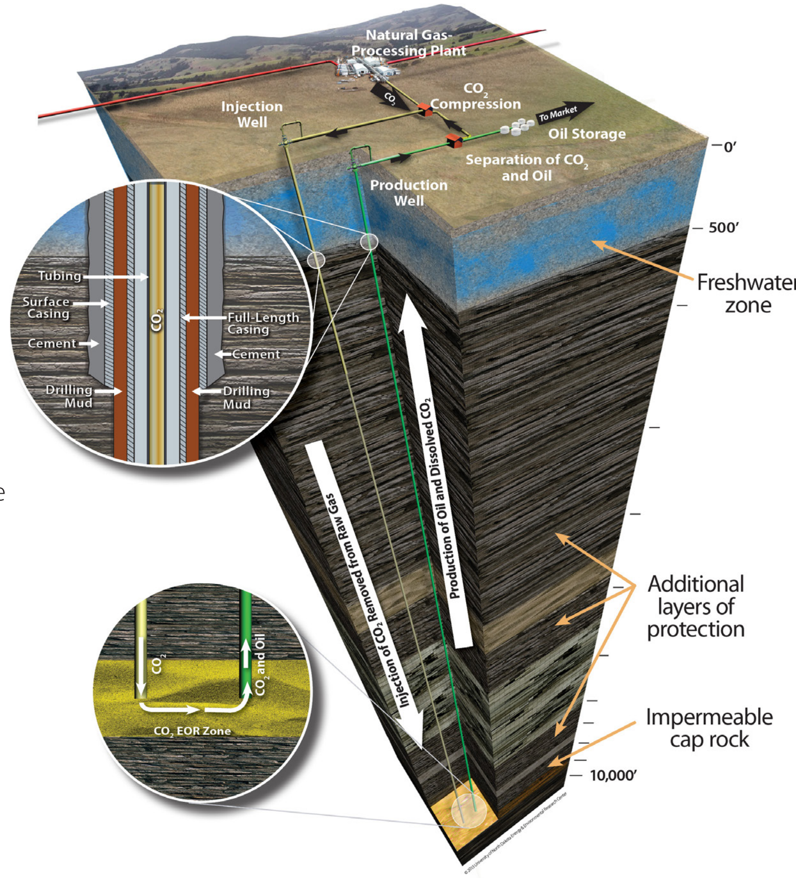

Figure 1. Illustrative example of CO_2 injection into a deep storage reservoir during CCS (image not to scale).

CCS and CO_2 Containment

The commercial geologic injection of fluids has been done safely in the United States for decades and currently occurs under the Underground Injection Control Program, which is directed by state and federal regulatory agencies. Each day, large volumes of fluids are injected for waste disposal, enhanced oil recovery (EOR), and liquid hydrocarbon and natural gas storage (Table 1). The subsurface systems encountered during CCS (Figure 1) are similar to those encountered during the deep injection activities identified in Table 1.

Keys to Successful Protection of Water Resources

The keys to water resource protection during CCS include detailed site characterization, sound well construction and operation protocols, and comprehensive monitoring and

Table 1. Injection Well Types in the United States[1–3]

Well Type/Class	Number of Wells	Comments[a]
Oil and Gas-Related Injection Wells (Class II) Includes Brine Disposal and the Injection of CO_2 and Other Fluids/Gases for EOR	~150,000	Over 2 billion gallons of brine injected/day; 80% associated with EOR, the other 20% at natural gas/oil production facilities. As of March 2010, 11 TCF (560 million metric tons) of CO_2 has been consumed by the U.S. CO_2 EOR industry.
Natural Gas Storage	400 active storage facilities in the lower 48 states	5000 to 7000 BCF of natural gas in storage/month.
Liquid Hydrocarbon Storage (Class II)	100	Part of U.S. Strategic Petroleum Reserve.
Hazardous Waste Disposal (Class I) as Defined by RCRA[b]	120	Generally located at industrial facilities.
Nonhazardous Industrial Waste Disposal (Class I)	260	Currently operate in 19 states, primarily Texas, Wyoming, Kansas, and Louisiana.
Municipal Wastewater Disposal (Class I)	160	Primarily in Florida; large diameter and gravity-fed.

[a] BCF = billion cubic feet and TCF = trillion cubic feet.
[b] Resource Conservation and Recovery Act.

mitigation strategies. Good site selection based on a detailed characterization of the subsurface geology at the storage site is the first line of defense in preventing unwanted migration of the CO_2 and formation brines. Through the Regional Carbon Sequestration Partnership (RCSP) Program, the U.S. Department of Energy (DOE) is conducting comprehensive research to determine best practices to ensure that 1) the geologic formation of interest has sufficient capacity to store the desired volume of CO_2 and 2) the characteristics (e.g., permeability) and number of seals (e.g., shale layers) between the storage unit and the targeted water resources are sufficient to contain the CO_2.

Regulatory Framework

State and federal regulators have been successfully managing CO_2 injection associated with oil and gas activities for decades through the existing Class II well-permitting process. In addition, there are evolving federal[4] and state regulations under development for permitting CO_2 injection wells for long-term CO_2 storage. In both cases, injection wells are constructed and injection operations are managed so that CO_2 stays in the injection horizon and drinking water is protected. Of primary consideration is the prevention of fluid migration through wellbores of abandoned wells in the storage system (Figure 2). If migration were to occur, it would most likely be through wellbore cement or at interfaces between the cement and well casing or the cement and formation rock. Migration prevention through operational controls includes active monitoring to prevent overpressurization of the storage formation.

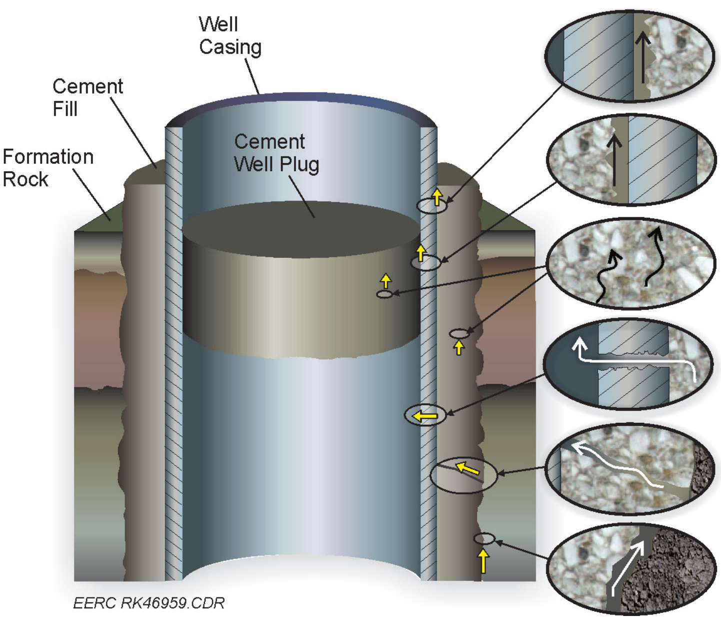

Figure 2. Potential migration pathways along existing wellbores.[5] Risks associated with existing wellbores have long been recognized and remain an active area of CCS-related research.

One example of how states might proceed with regulations was addressed in a 2008 Interstate Oil and Gas Compact Commission (IOGCC) study, where a model CO_2 storage statute and a set of model rules and regulations governing CO_2 storage are presented.[6]

Path Forward

There is confidence that the successful commercial deployment of CCS is achievable given that 1) many of the subsurface injection technologies needed for CCS have been field tested (Figure 1) and 2) many similarities exist between the operations and management of current commercial subsurface injections and CCS (Table 1). During this commercial deployment, protection of water resources from the migration of injected CO_2 and formation brines can be assured by careful site selection, adequately characterizing sealing formations, and properly managing injection operations. Furthermore, monitoring will ensure compliance with injection limits and will track the movement of the injected CO_2 as well as the in-place formation brines. In the unlikely event that unintended migration is detected, active mitigation techniques are available that can be implemented to prevent harm to the ecosystem. Lastly, as part of this commercialization effort, the unique aspects of CCS in the areas of characterization, injection, monitoring, and mitigation, are being investigated by DOE and others to ensure that there are no unforeseen risks to water resources associated with this evolving carbon management strategy.

References

1 U.S. Environmental Protection Agency, 2012, http://water.epa.gov/type/groundwater/uic/ (accessed December 2012).

2 U.S. Energy Information Administration, 2012, www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/storagebasics/storagebasics.html (accessed December 2012).

3 U.S. Department of Energy National Energy Technology Laboratory, 2010, Carbon dioxide enhanced oil recovery.

4 U.S. Environmental Protection Agency, 2012, http://water.epa.gov/type/groundwater/uic/class6/gsclass6wells.cfm (accessed December 2012).

5 Nordbotten, J.M., Celia, M.A., Bachu, S., and Dahle, H.K., 2005, Semi-analytical solution for CO_2 leakage through an abandoned well: Environmental Science and Technology, v. 39, no. 2, p. 602–611.

6 Interstate Oil and Gas Compact Commission, 2008, CO_2 storage—a legal and regulatory guide for states.

The Water Working Group (WWG) consists of members from all of the RCSPs who serve as a team of experts representing government, academia, and industry. The goal of the WWG is to address stakeholder concerns regarding emerging CCS technology and its potential interactions with local and regional water resources. The WWG is organized by the Plains CO_2 Reduction (PCOR) Partnership, which is a group of public and private sector stakeholders working together to better understand the technical and economic feasibility of storing CO_2 emissions from stationary sources in the central interior of North America. The PCOR Partnership is led by the Energy & Environmental Research Center at the University of North Dakota and is one of seven regional partnerships under DOE's National Energy Technology Laboratory (NETL) RCSP Initiative. To learn more, contact:

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