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The Underground Injection Control of Carbon Dioxide

A Special Report to the MIT Carbon Sequestration Initiative

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ABSTRACT

The capture of carbon dioxide and its storage in geologic formations is emerging as a strategy to manage greenhouse gas emissions in the United States. The Underground Injection Control program of the United States Environmental Protection Agency was created to prevent underground injection which endangers drinking water sources, as mandated by the Safe Drinking Water Act. This paper reviews the legislative and regulatory provisions of the Safe Drinking Water Act and Underground Injection Control program, and analyzes the applicability of the regime to the injection and storage of carbon dioxide.

I. INTRODUCTION

The capture and storage of carbon dioxide has been proposed as part of a strategy to manage greenhouse gas emissions in the United States, accompanying proposals to expand the use of renewable energy sources and increase energy efficiency.[1] Potential sources of captured carbon dioxide include electricity generation, industrial processes (e.g., cement and ammonia production), and fuel decarbonization (i.e., producing

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[1] WHITE HOUSE OFFICE OF THE PRESS SECRETARY, PRESIDENT'S STATEMENT ON CLIMATE CHANGE (Jul. 13, 2001), *at* http://www.whitehouse.gov/news/releases/2001/07/20010713-2.html.

hydrogen fuels from carbon-rich feedstocks).[2] Following capture, the carbon dioxide is compressed, transported, and injected into a storage site.[3] Growing attention is being paid to the use of geologic formations as storage reservoirs for captured carbon dioxide.[4] Carbon dioxide is already injected into oil reservoirs to increase the amount of oil that can be produced, a technique known as enhanced oil recovery.[5] Potential geologic sinks for the storage of carbon dioxide include depleted oil and gas reservoirs, unminable coal seams, and deep saline formations.[6]

The Safe Drinking Water Act (SDWA) requires the United States Environmental Protection Agency (EPA) to establish minimum requirements to prevent underground injection which endangers drinking water sources.[7] EPA regulations created the Underground Injection Control (UIC) program, requiring all underground injections to be authorized by permit or rule and prohibiting certain types of injection that may present an imminent and substantial danger to public health.[8] Five classes of injection wells have

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[2] Howard Herzog, *What Future for Carbon Capture and Sequestration?* 35 ENVTL. SCI. TECH. 148A, 149A (2001).
[3] *Id.*
[4] *See*, *e.g.* U.S. DEPARTMENT OF ENERGY, OFFICE OF FOSSIL ENERGY, CARBON SEQUESTRATION TECHNOLOGY ROADMAP AND PROGRAM PLAN 12 (2004).
[5] JASON HEINRICH, HOWARD HERZOG, AND DAVID REINER, ENVIRONMENTAL ASSESSMENT OF GEOLOGIC STORAGE OF CO_2 17 (Massachusetts Institute of Technology Laboratory for Energy and the Environment Special Report No. 2003-002, 2004).
[6] Franklin Orr, *Distinguished Author Series: Storage of Carbon Dioxide in Geologic Formations*, J. PETROLEUM TECH., Sept. 2004, at 90.
[7] 42 U.S.C. § 300h(b)(1) (2004). SDWA was enacted in 1974 and amended in 1977, 1980, 1986, 1988, and 1996. *See* Safe Drinking Water Act, Pub. L. No. 93-523, 88 Stat. 1660 (1974); Safe Drinking Water Act Amendments of 1977, Pub. L. No. 95-190, 91 Stat. 1393 (1977); Safe Drinking Water Act Amendments of 1980, Pub. L. No. 96-502, 94 Stat. 2737 (1980); Safe Drinking Water Act Amendments of 1986, Pub. L. 99-339, 100 Stat. 642 (1986); Lead Contamination Control Act of 1988, Pub. L. No. 100-572, 102 Stat. 2884 (1988); Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, 110 Stat. 1613 (1996). Funding for most programs authorized under SDWA expired in Fiscal Year 2003. EPA and the states are continuing to implement the 1996 Amendments and a broad reauthorization is not expected during the present Congressional session. Note that SDWA programs do not expire as long as they are appropriated funds by Congress. CONGRESSIONAL RESEARCH SERVICE, CRS ISSUE BRIEF FOR CONGRESS: SAFE DRINKING WATER ACT: IMPLEMENTATION AND ISSUES 3 (October 13, 2004).
[8] Underground Injection Control Program, 40 C.F.R. § 144.1 (2004).

been set forth in the regulations, none specific to the underground injection of carbon dioxide.[9]

In this paper, I analyze the potential for carbon dioxide to be regulated under the UIC program. Part II reviews the underground injection provisions of the SDWA and their interpretation by EPA through the UIC regulations. Part III analyzes the applicability of the current UIC regime to the injection and storage of carbon dioxide as related to current injection well classifications. Finally, Part IV looks at the possibility of exempting carbon dioxide from UIC regulations or creating a new UIC classification specifically for the purpose of injection and storage of carbon dioxide.

II. Legislative and Regulatory Authorization for the Control of Underground Injection

State regulation for the underground injection of industrial wastes dates back to 1921, when the Kansas State Corporation Commission was given authorization to regulate brine injection in oil fields.[10] This was followed by the Texas Injection Well Act of 1961, which gave the Texas Railroad Commission authority over the underground injection of oil field wastes and the Texas Board of Water Engineers jurisdiction over the injection of all other wastes.[11] In the 1960s and early 1970s, a number of states established programs regulating underground injection, including Colorado, Michigan, New York, Ohio, and West Virginia.[12] State and/or EPA underground injection programs now exist in every state as a result of federal requirements.[13]

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[9] *Id.* § 144.6.
[10] *See*, *e.g. State v. Lebow*, 280 P. 773, 774 (Kan. 1929).
[11] Tex. Water Code Ann. §§ 27.011 (2004).
[12] Elizabeth Wilson, Timothy Johnson, and David Keith, *Regulating the Ultimate Sink: Managing the Risks of Geologic CO_2 Storage*, 37 ENVTL. SCI. TECH. 3476, 3477 (2003).
[13] *See infra* Figure 1.

Federal policy for the control of underground injection was first adopted by the Federal Water Quality Administration (FWQA) of the Department of the Interior on October 15, 1970.[14] FWQA opposed the storage or disposal of contaminants "without strict control and clear demonstration that such wastes will not interfere with present or potential use of subsurface water supplies, contaminate interconnected surface waters or otherwise damage the environment".[15] Congress ratified this policy four years later in the SDWA provisions related to underground injection.[16]

Following the adoption of the Federal Water Pollution Control Act of 1972 (also known as the Clean Water Act), EPA sought to regulate underground injection on the federal level.[17] In fact, the Clean Water Act included a directive for information on the control of pollution from "the disposal of pollutants in wells".[18] The Clean Water Act prohibits the "discharge of pollutants into the navigable waters" from a point source without a permit.[19] Navigable waters are defined as "waters of the United States".[20] In December 1973, however, the EPA General Counsel concluded that the discharge of a pollutant into navigable waters did not encompass groundwater pollution from the underground injection of waste.[21]

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[14] FEDERAL WATER QUALITY ADMINISTRATION, POLICY ON DISPOSAL OF WASTE BY SUBSURFACE INJECTION (COM 5040.10, Oct. 15, 1970). FWQA was abolished in December 1970 and its functions were transferred to EPA. Reorganization Plan No. 3 of 1970, 84 Stat. 2083, 2087 (1970).
[15] *Id.*
[16] H.R. REP NO. 93-1185, *reprinted in* 1974 U.S.C.C.A.N. 6454, 6481.
[17] Wilson *et al.*, *supra* note 12, at 3478.
[18] *Id.*
[19] 33 U.S.C. § 1251(a)(1) (2004).
[20] 33 U.S.C. § 1362.
[21] "Under § 502(12) the term 'discharge of a pollutant' is defined so as to include only discharges into navigable waters (or the contiguous zone of the ocean). Discharges into ground waters are not included." Opinion, Office of General Counsel (1973), *reprinted in Exxon Corp. v. Train*, 554 F.2d 1310, 1321 n.21 (5th Cir. 1977).

In 1974, Congress adopted the SDWA to assure that water supply systems serving the public meet minimum national standards for the protection of public health.[22] The SDWA directs the EPA Administrator to establish national drinking water supply standards to protect public health, and minimum requirements for state programs to prevent underground injection that endangers drinking water sources.[23] The SDWA requires that, at minimum, the control of underground injection:

> (1) prohibit unauthorized underground injection effective three years after the enactment of the bill;
>
> (2) require applicants for underground injection permits bear the burden of proving to the state that its injection will not endanger drinking water sources;
>
> (3) refrain from adopting regulations which either on their face or as applied would authorize underground injection which endangers underground sources of water;
>
> (4) adopt inspection, monitoring, recordkeeping, and reporting requirements; and
>
> (5) apply their injection control programs to underground injections by Federal agencies and by any other person whether or not occurring on Federally-owned or leased property.

1974 U.S.C.C.A.N. at 6481.

With respect to underground injection provisions of the SDWA, the EPA Administrator is to designate those states in which a state underground injection control program may be necessary to assure that underground injection will not endanger drinking water sources.[24] Because all states have been listed, the SDWA requires all states to submit a UIC program. States are permitted to assume primary responsibility for the implementation and enforcement of its UIC program upon the timely showing that the

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[22] 1974 U.S.C.C.A.N. at 6454.
[23] 42 U.S.C. §§ 300g(a)(1), 300h(a)(1).
[24] *Id.* § 300h(a)(1).

state program meets the requirements of the UIC regulations promulgated by EPA.[25] In the absence of an approved program, EPA is responsible for regulating the state's underground injection. EPA has discretion whether to require states to use a permit system, rulemaking, or a combination of the two to control underground injection.[26] EPA has delegated primacy to thirty-four states, as shown in Figure 1. A summary of primacy status can be found in the appendix to this paper. State underground injection programs are delegated primacy if they are proven to be at least as stringent as federal UIC standards[27] and/or effective in protecting pollution of underground sources of drinking water.[28]

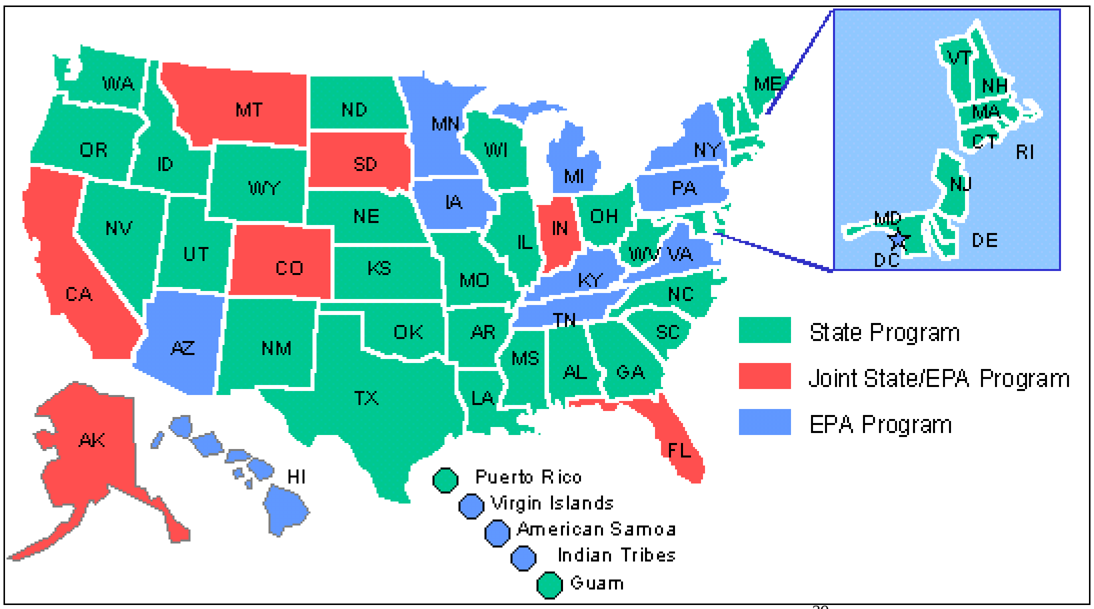

Figure 1: Map of UIC State Primacy Status (EPA) [29]

The 1980 reauthorization of the SDWA exempts the underground injection of fluids which are used in connection with natural gas storage operations.[30] Also, the

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[25] *Id.* § 300h(b)(3).
[26] The purpose was to allow EPA to adopt a program which would be compatible with the permit provisions of the Clean Water Act.
[27] 42 U.S.C. § 300h-1.
[28] 42 U.S.C. § 300h-4. Applies to UIC Class II wells. *See* Table 1 *infra.*
[29] U.S. Environmental Protection Agency, *State UIC Programs, at* http://www.epa.gov/safewater/uic/primacy.html (last modified Nov. 26, 2002).

SDWA authorizes any state to assume primary responsibility for controlling underground injection related to oil and gas recovery and production by demonstrating that its program meets the requirements of the SDWA and represents an "effective" program.[31] The Congressional intent of these provisions was for major oil and gas producing states, most of whom already had underground injection regulations in place, to be able to continue these programs unencumbered by additional federal requirements.[32] In addition, Congress was persuaded that natural gas storage does not pose a threat to drinking water quality and storage operators have an economic incentive to prevent natural gas leakage.[33]

The EPA has implemented the SDWA requirements for the control of underground injection through the establishment of the UIC program. Injection well operators must obtain a permit under one of five classes that have been established by the EPA.[34] A permit will not be granted if the underground injection results in the movement of fluid containing any contaminant into underground sources of drinking water, where the presence of that contaminant may cause a violation of any primary drinking water regulation or may adversely affect public health.[35] If a permit has been granted and if in the course of monitoring it is found that there is movement of any contaminant into the underground source of drinking water, the permit may be modified or terminated.[36] Under the UIC program, a fluid is defined as "any material or substance which flows or

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[30] "The term 'underground injection' means the subsurface emplacement of fluids by well injection. Such term does not include the underground injection of natural gas for purposes of storage." 42 U.S.C. § 300h(d)(1).
[31] *Id.* § 300h(b)(2).
[32] H.R. REP NO. 96-1348, *reprinted in* 1980 U.S.C.C.A.N. 6080, 6084.
[33] *Id.* at 6085.
[34] 40 C.F.R. § 144.6.
[35] *Id.* § 144.12(a). A contaminant means any physical, chemical, biological, or radiological substance or matter in water. *Id.* § 144.3.
[36] *Id.*

moves whether in a semi-solid, liquid, sludge, gas, or any other form or state"[37] and a well is any "shaft" or "dug hole" that is "deeper than its largest surface dimension, where the principal factor of the hole is the emplacement of fluids".[38] An injection well is "any well into which fluids are being injected".[39] Congressional intent of "underground injection" is not limited to the injection of wastes or to injection for disposal purposes.[40]

EPA has established five classes of injection wells, as shown in Table 1. Class I wells are used by operators to inject fluids beneath the lowermost formation containing, within one quarter mile of the well bore, an underground source of drinking water.[41] EPA recognizes three types of Class I wells: wells for the injection of hazardous waste;[42] wells for the injection of radioactive waste;[43] and wells for the injection of all other industrial and municipal waste fluids.[44]

There are 529 active Class I injection wells located at 272 facilities in 19 states.[45] Of these 529 wells, 163 are classified as hazardous waste injection wells and 366 are non-hazardous.[46] The majority of the hazardous injection wells are located in Texas (78) and Louisiana (18), while most of the non-hazardous wells are found in Florida (112) and

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[37] *Id.* § 144.3.
[38] *Id.*
[39] *Id.*
[40] 1974 U.S.C.C.A.N. at 6484.
[41] 40 C.F.R. § 144.6.
[42] The UIC regulations use the definition of hazardous waste defined by the EPA in 40 C.F.R. § 261.3, regulations promulgated under the Resource Conservation and Recovery Act (RCRA). *Id.* § 144.3.
[43] The UIC regulations define radioactive waste as any waste which contains radioactive material in concentrations which exceed those listed in 10 C.F.R. § 20. *Id.*
[44] *Id.* § 144.6.
[45] U.S. Environmental Protection Agency, *Deep Wells (Class I), at* http://www.epa.gov/safewater/uic/classi.html (last modified Nov. 26, 2002).
[46] *Id.*

Table 1: Classifications of Underground Injection Wells (40 C.F.R. § 144.6)

Class	Description
Class I	(1) Wells used by generators of hazardous waste or owners or operators of hazardous waste management facilities to inject hazardous waste beneath the lowermost formation containing, within one-quarter mile of the well bore, an underground source of drinking water.
	(2) Other industrial and municipal disposal wells which inject fluids beneath the lowermost formation containing, within one quarter mile of the well bore, an underground source of drinking water.
	(3) Radioactive waste disposal wells which inject fluids below the lowermost formation containing an underground source of drinking water within one quarter mile of the well bore.
Class II	(1) Wells which inject fluids which are brought to the surface in connection with natural gas storage operations, or conventional oil or natural gas production and may be commingled with waste waters from gas plants which are an integral part of production operations, unless those waters are classified as a hazardous waste at the time of injection.
	(2) Wells which inject fluids for enhanced recovery of oil or natural gas.
	(3) Wells which inject fluids for storage of hydrocarbons which are liquid at standard temperature and pressure.
Class III	Wells which inject for extraction of minerals including: (1) Mining of sulfur by the Frasch process; (2) In situ production of uranium or other metals; this category includes only in-situ production from ore bodies which have not been conventionally mined. Solution mining of conventional mines such as stopes leaching is included in Class V; (3) Solution mining of salts or potash.
Class IV	(1) Wells used by generators of hazardous waste or of radioactive waste, by owners or operators of hazardous waste management facilities, or by owners or operators of radioactive waste disposal sites to dispose of hazardous waste or radioactive waste into a formation which within one-quarter (1/4) mile of the well contains an underground source of drinking water.
	(2) Wells used by generators of hazardous waste or of radioactive waste, by owners or operators of hazardous waste management facilities, or by owners or operators of radioactive waste disposal sites to dispose of hazardous waste or radioactive waste above a formation which within one-quarter (1/4) mile of the well contains an underground source of drinking water.
	(3) Wells used by generators of hazardous waste or owners or operators of hazardous waste management facilities to dispose of hazardous waste, which cannot be classified under paragraph (a)(1) or (d) (1) and (2) of this section (e.g., wells used to dispose of hazardous waste into or above a formation which contains an aquifer which has been exempted pursuant to 40 C.F.R. § 146.04).
Class V	Wells not included in Class I, II, III, or IV.

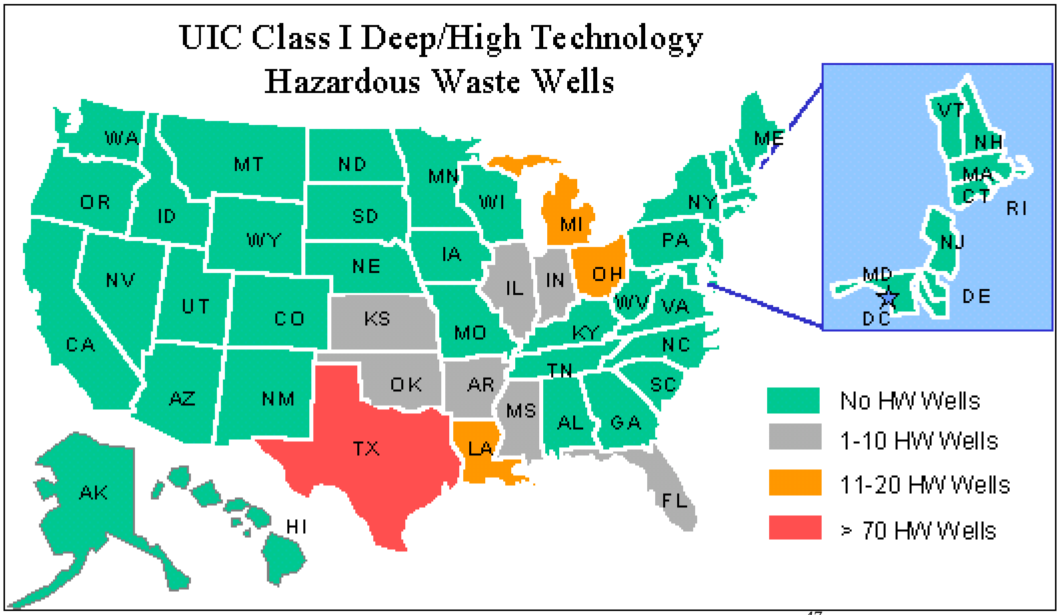

Figure 2: Map of UIC Class I Injection Wells (EPA) [47]

Texas (110).[48] Florida is the only state with Class I municipal wells (104).[49]

Class I wells inject waste into brine-saturated formations or non-freshwater zones.[50] In the Great Lakes region, these depths range from 1,700 to 6,000 feet, while in the Gulf Coast region, these depths range from 2,200 to 12,000 feet.[51] Class I wells must be located in geologically stable areas that are free of transmissive fractures or faults through which injected fluids could travel to drinking water sources.[52] In addition, operators must demonstrate internal and external mechanical integrity of the well.[53]

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[47] U.S. Environmental Protection Agency, *supra* note 45.
[48] *Id.*
[49] *Id.* Florida's Class I municipal wells inject non-hazardous, secondary-treated effluent from wastewater treatment plants. Florida Department of Environmental Protection, *Underground Injection Control Program*, *at* http://www.dep.state.fl.us/water/uic/ (last modified June 16, 2004). *See also* Wilson *et al.*, *supra* note 12, at 3480.
[50] U.S. Environmental Protection Agency, Class I Underground Injection Control Program: Study of the Risks Associated with Class I Underground Injection Wells 12, (EPA-816-R-01-007, 2001).
[51] *Id.* at 12.
[52] *Id.* at 18.
[53] *Id.* at 13.

Class I wells must be cased and cemented to prevent the movement of fluids.[54] They are continuously monitored and must maintain a pressure that will not initiate new fractures or propagate existing fractures.[55] EPA regulations provide for an area of review of one-quarter mile for non-hazardous and municipal wells, and two miles for hazardous wells.[56]

Class I hazardous wells have additional requirements. Operators seeking to inject hazardous waste must demonstrate via a no-migration petition that hazardous constituents will not migrate out of the injection zone for 10,000 years.[57] They must also demonstrate that injection of hazardous waste will not induce earthquakes or increase the frequency of naturally occurring earthquakes.[58] There are additional construction requirements and the well design must be approved by the UIC program before construction.[59] Finally there are additional monitoring requirements, including alarms and devices that must be installed in the event that injection parameters are exceeded.[60]

Operators of Class I injection wells are expected to provide financial assurance in case they cease operation.[61] Operators must certify financial assurance on an annual basis.[62] Financial assurance can be shown through trust funds, surety bonds, letters of credit, and insurance.[63] The amount of financial assurance required to be shown depends on the estimated cost of the plugging and abandonment of the well.[64] The adequacy of

[54] *Id.* at 22.
[55] *Id.* at 23.
[56] *Id.* at 19. Note that states may specify a larger area of review for non-hazardous and municipal wells.
[57] *Id.* at 20.
[58] *Id.* at 18.
[59] *Id.* at 22.
[60] *Id.* at 23.
[61] 40 C.F.R. § 144.63.
[62] *Id.*
[63] *Id.*
[64] *Id.*

Class I financial assurance requirements was questioned in a 2003 GAO report.[65] In particular, GAO was concerned that current financial assurance requirements may not ensure adequate resources to close an injection well in the event of owner bankruptcy or if the well ceases operations.[66]

Class II wells inject fluids related to the production of hydrocarbons.[67] EPA recognizes three types of Class II wells: wells which inject fluids which are brought to the surface in connection with natural gas storage operations, or conventional oil or natural gas production; wells which inject fluids for the enhanced recovery of oil or natural gas; and wells which inject fluids for the storage of hydrocarbons which are liquid at standard temperature and pressure.[68]

There are 167,000 Class II oil and gas wells, most of which are located in Texas (53,000), California (25,000), Oklahoma (22,000), and Kansas (15,000).[69] Class II wells that inject fluids for the production of oil and gas are called enhanced recovery wells and are designated as Class II-R.[70] Wells that inject fluids for the purpose of disposal are called disposal wells and designated as Class II-D.[71] Wells used for the storage of liquid hydrocarbons or hydrocarbon products are designated Class II-H wells.[72] Of Class II wells, approximately 21% are Class II-D, 78% Class II-R, and 1% Class II-H.[73]

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[65] *See* U.S. GENERAL ACCOUNTING OFFICE, DEEP INJECTION WELLS: EPA NEEDS TO INVOLVE COMMUNITIES EARLIER AND ENSURE THAT FINANCIAL ASSURANCE REQUIREMENTS ARE ADEQUATE (GAO-03-761, 2003).
[66] *Id.* at 17.
[67] 40 C.F.R. § 144.6.
[68] *Id.*
[69] *Id.*
[70] U.S. Environmental Protection Agency, *Introduction to the Underground Injection Control Program* (Jan. 2003), *at* http://www.epa.gov/safewater/dwa/electronic/presentations/uic/uic.pdf.
[71] *Id.*
[72] *Id.*
[73] *Id.*

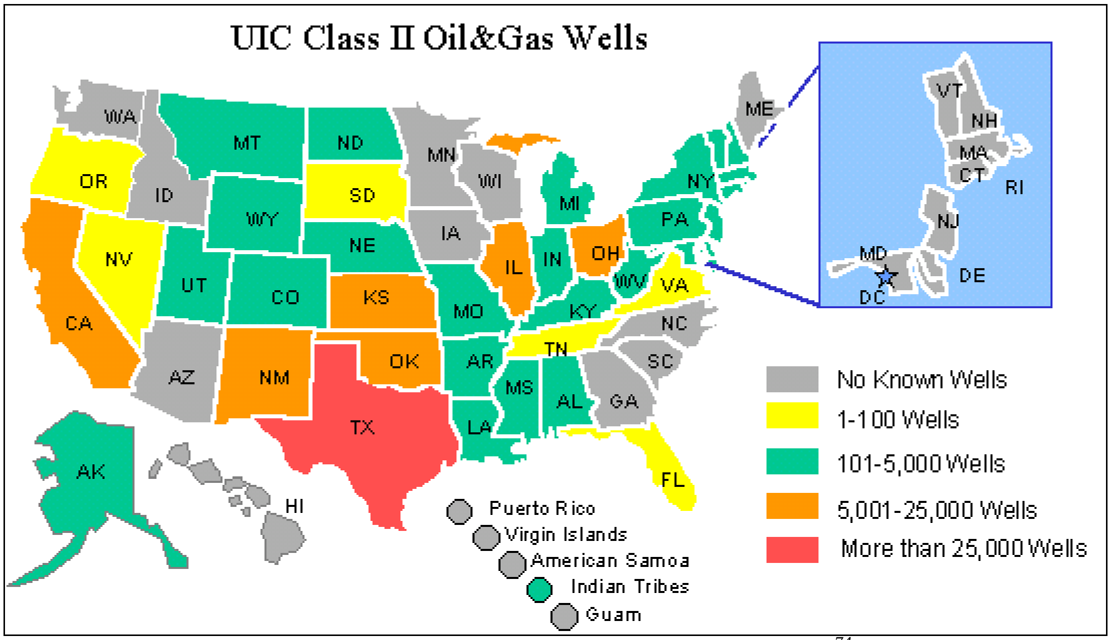

Figure 3: Map of UIC Class II Injection Wells (EPA) [74]

Requirements for Class II well construction are relaxed compared to the requirements for other UIC well classes. Class II well operators need only make a demonstration that the State has an effective program to prevent underground injection which endangers drinking water sources.[75] These relaxed requirements were intended to assure that constraints on energy production activities would be kept limited in scope while assuring the safety of present and potential sources of drinking water.[76]

Class III injection wells are used for the extraction of minerals.[77] There are approximately 19,000 Class III wells.[78] Examples of uses for Class III wells include salt solution mining (pumping water into a salt formation to extract salt), in-situ leaching of

[74] U.S. Environmental Protection Agency, *Oil and Gas Injection Wells (Class II), at* http://www.epa.gov/safewater/uic/classii.html (last modified Nov. 26, 2002).
[75] 42 U.S.C. § 300h(b)(2). If a state proves that its UIC program is effective in preventing pollution of underground sources of drinking water, it is grated primacy for Class II wells under SDWA § 1425. 42 U.S.C. § 300h-4. A listing of these states can be found in the appendix to this paper.
[76] 1980 U.S.C.C.A.N. at 6085.
[77] 40 C.F.R. § 144.6.
[78] U.S. Environmental Protection Agency, *supra* note 70.

uranium (injecting a fluid to leach out uranium salts, from which uranium is subsequently extracted), and sulfur production.[79] The construction requirements for Class III wells depend on the type of mineral being extracted.[80] Area of review ranges from 1/4 mile to 2-1/2 miles.[81]

Class IV wells are used for the injection of hazardous or radioactive waste where the waste is injected into a formation or above a formation which within one-quarter mile of the well contains an underground source of drinking water.[82] These wells are prohibited unless the wells are used to inject contaminated groundwater that has been treated and is being injected into the same formation from which it was drawn.[83] In general, Class IV wells are prohibited unless they are used as part of a remediation program pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or the Resource Conservation and Recovery Act (RCRA).[84]

Finally, Class V wells are defined as injection wells not included in Class I, II, III, or IV.[85] Class V wells are subject to the same statutory and regulatory requirements as other UIC classifications, i.e. the prohibition against endangerment of underground sources of drinking water.[86] Class V wells are typically shallow injection wells, such as for storm water drainage or septic systems, but they may be deep wells, such as for geothermal reinjection.[87] There are more than 650,000 Class V wells in the United

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[79] U.S. Environmental Protection Agency, *Mining Wells (Class III)*, *at* http://www.epa.gov/safewater/uic/classiii.html (last modified Nov. 26, 2002).
[80] U.S. Environmental Protection Agency, *supra* note 70.
[81] *Id.*
[82] 40 C.F.R. § 144.6.
[83] *Id.*
[84] 40 C.F.R. § 144.13.
[85] *Id.* § 144.6.
[86] U.S. Environmental Protection Agency, *Shallow Injection Wells (Class V)*, *at* http://www.epa.gov/safewater/uic/classv.html (last modified Nov. 26, 2002).
[87] *Id.*

States, and Class V wells can be found in every state.[88] In December 1999, EPA established rules for two types of Class V wells: motor vehicle waste disposal wells and large-capacity cesspools.[89] EPA announced a final determination for all other types of Class V wells in June 2002.[90]

III. Applicability of an Underground Injection Control Regime to Carbon Dioxide

At present, it is unclear how the injection and storage of carbon dioxide would be regulated in a UIC regime. The issue is being presently considered by the EPA and the Interstate Oil and Gas Compact Commission (IOGCC).[91] EPA held a stakeholder meeting in February 2004 to obtain input from relevant stakeholders and regulators.[92] IOGCC is developing model state regulations for carbon dioxide storage, and argues that storage activities should be regulated on the state level by building upon existing enhanced oil and gas recovery regulations.[93] A report is expected in early 2005, along with the creation of a follow-on task force called the IOGCC Carbon Capture and Storage Task Force whose role will be to refine policy frameworks and facilitate cooperation among IOGCC member states.[94]

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[88] U.S. Environmental Protection Agency, *Final Determination Fact Sheet*, *at* http://www.epa.gov/safewater/uic/fact6-7-02text.pdf (last viewed Jan. 11, 2005).

[89] Revisions to the Underground Injection Control Regulations for Class V Injection Wells, 64 Fed. Reg. 68546 (Dec. 7, 1999) (to be codified at 40 C.F.R. pts. 9, 144, 145, and 146).

[90] Notice of Final Determination for Class V Wells, 67 Fed. Reg. 39583 (June 7, 2002) (to be codified at 40 C.F.R. pt. 144).

[91] ADAM SMITH, REGULATORY ISSUES CONTROLLING CARBON CAPTURE AND STORAGE 35 (2004) (S.M. thesis, Massachusetts Institute of Technology), *available at* http://sequestration.mit.edu/pdf/Adam_Smith_thesis_June2004.pdf.

[92] *Id.*

[93] INTERSTATE OIL AND GAS COMPACT COMMISSION, IOGCC MEETING ON LONG-TERM STORAGE OF CO_2 IN GEOLOGIC FORMATIONS WORKSHOP REPORT (July 17-19, 2002), *available at* http://www.iogcc.oklaosf.state.ok.us/ISSUES/CO2%20Sequestration/Workshop%20Report%20(Final).doc.

[94] INTERSTATE OIL AND GAS COMPACT COMMISSION, RESOLUTION 04.102: CONTINUING POLICY ON THE ISSUE OF CARBON CAPTURE AND STORAGE IN UNDERGROUND GEOLOGICAL FORMATIONS (2004), *available at* http://www.iogcc.oklaosf.state.ok.us/MISCFILE/resolutions_2004.htm.

Although carbon dioxide is a naturally occurring gas, it likely would not come under the UIC exemption for natural gas storage. In 1993, the U.S. Court of Appeals for the Tenth Circuit concluded that "neither the language of the SDWA, nor the relevant legislative history reveals a clear congressional intent to treat carbon dioxide as 'natural gas' within the meaning of the Act."[95] Note that the decision did not deal with carbon dioxide storage in the context of greenhouse gas mitigation. In the case before the court, ARCO Oil and Gas Co. operated a well for wastes connected with the extraction of carbon dioxide.[96] EPA designated the disposal well as a Class I well.[97] ARCO argued that the wastes were Class II as they were brought to the surface in connection with natural gas production.[98] EPA countered that the definition of natural gas for the purposes of UIC included only energy-related hydrocarbons, such as methane and butane, not carbon dioxide.[99] In reviewing the legislative history, the court found that Congress did not reveal whether it considered the production of carbon dioxide to be one of the protected energy production activities.[100] The court deferred to the agency's expertise in excluding carbon dioxide from the definition of natural gas.[101] Note, however, that the Tenth Circuit upheld defining carbon dioxide as "natural gas" for the purposes of issuing a right-of-way across federal land for a carbon dioxide pipeline.[102] Thus the Tenth Circuit's logic has been that carbon dioxide is not necessarily "natural gas" and one must look to Congressional intent to determine whether the storage of carbon dioxide is

[95] *ARCO Oil and Gas Co. v. EPA*, 14 F.3d 1431, 1436 (10th Cir. 1993).
[96] *Id.* at 1431.
[97] *Id.*
[98] *Id.*
[99] *Id.* at 1433.
[100] *Id.* at 1435.
[101] *Id.* at 1436.
[102] *Exxon Corp. v. Lujan*, 970 F.2d 757, 763 (10th Cir. 1992) (affirming a decision of the Bureau of Land Management to issue a right-of-way for a carbon dioxide pipeline under the Mineral Leasing Act, rather than under the Federal Land Policy and Management Act).

encompassed within natural gas storage legislation. The end result in the Tenth Circuit is that carbon dioxide is "natural gas" for the purposes of pipeline and transportation, but not "natural gas" for the purposes of underground injection.

There are two potential UIC frameworks for carbon dioxide. One would be to allow states to regulate carbon dioxide injection and storage according to the injection well classifications that they see fit. The second would be for federal regulators to specify the UIC classification that carbon dioxide would come under through rulemaking or guidance documents. Carbon dioxide could come under three potential classifications: Class I non-hazardous injection wells; Class II enhanced oil recovery wells; and Class V experimental wells.

Class I non-hazardous injection wells would likely encompass carbon dioxide injected into deep brine aquifers or unminable coal seams. Carbon dioxide is not among the materials excluded from waste regulation under 40 C.F.R. § 261.4, however, it has also not been listed as a hazardous waste under 40 C.F.R. § 261.3. Therefore, carbon dioxide still needs to be characterized to show that it is not a hazardous waste and therefore suitable for a Class I non-hazardous injection well.[103] A waste is a characteristic waste if it displays the properties of ignitability, corrosivity, reactivity, or toxicity as defined by 40 C.F.R. §§ 261.21-261.24.

Several commentators have argued that carbon dioxide storage should come under a Class I regime.[104] One argument is that a Class I regime is appropriate because carbon dioxide might be stored for long time periods (thousands of years) and hazardous

[103] U.S. Environmental Protection Agency, s*upra* note 50, at 1.
[104] *See* Smith, *supra* note 91, at 36.

injection wells are required to demonstrate no migration for a period of 10,000 years.[105] However, the non-migration petition is based on criteria for hazardous waste injection wells, and carbon dioxide would be regulated under a non-hazardous waste classification. Tsang *et al.* argue that Class I injection wells are the most relevant to carbon dioxide injection into brine formations.[106] They assume that carbon dioxide will likely be stored at depths greater than 800 meters to keep carbon dioxide in a supercritical state, and most drinking water aquifers are shallower than 800 meters.[107] Note that this argument is specific to brine formations, as Class II injection wells, where carbon dioxide is injected for enhanced oil recovery, could also include depths greater than 800 meters.

A Class II regime would be appropriate where carbon dioxide is injected in conjunction with the production of oil or natural gas. The regulatory requirements for Class II injection wells are less stringent as compared with Class I wells. The injection of carbon dioxide for enhanced oil recovery is already regulated under a Class II regime.[108] However, it is unclear whether a Class II regime would apply to the injection and storage of carbon dioxide in depleted oil and natural gas reservoirs. Class II wells are defined to be used for fluids injected in connection with conventional oil and gas production, enhanced recovery of oil or natural gas, and the storage of hydrocarbons.[109] Injection unrelated to the recovery or storage of hydrocarbons is not encompassed under a Class II regime. This is complicated by the fact that although an oil and gas reservoir may be deemed "depleted", there may still be hydrocarbons in the reservoir, albeit unrecoverable

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[105] *Id.*
[106] C.-F. Tsang, Sally Benson, Bruce Kobelski, and Robert Smith, *Scientific Considerations Related to Regulation Development for CO_2 Sequestration in Brine Formations* 4, First National Conference on Carbon Sequestration (2001), *available at* http://www.netl.doe.gov/publications/proceedings/01/carbon_seq/p33.pdf.
[107] Id.
[108] U.S. Environmental Protection Agency, *supra* note 69.
[109] 40 C.F.R. § 144.6.

hydrocarbons. In addition, carbon dioxide may be injected into a reservoir for the purpose of enhanced recovery of oil or gas; instead of the carbon dioxide being blown out, the well may be plugged and the carbon dioxide stored in that same reservoir.

A Class V well would be appropriate for the injection and storage of carbon dioxide for experimental purposes, or where carbon dioxide is not injected below the lowermost underground source of drinking water and is not injected in conjunction with enhanced oil recovery operations. Scientists affiliated with the Gulf Coast Carbon Center received a Class V permit from Texas regulators for an experiment injecting carbon dioxide into the Frio brine formation in Texas.[110] The group was advised that they would be ineligible for a Class II permit because the carbon dioxide was not intended for enhanced oil production or the disposal of pre-refinery oil field waste.[111]

IV. Possibilities for an Exemption or New Classification/Sub-Classification

Some commentators have noted the UIC regime, as currently constructed, may not meet the needs of carbon dioxide injection and storage.[112] Wilson notes that there are no federal requirements for monitoring actual fluid movement in an injection zone, or for monitoring leakage in overlying zones, with the exception of Class I hazardous wells.[113] Morgan argues that UIC regulations are procedurally-based rather than performance-

[110] *See* Smith, *supra* note 91, at 36. The Gulf Coast Carbon Center is a regional industry-academic partnership affiliated with University of Texas, and a member of the U.S. Department of Energy's Southeast Regional Partnership. U.S. Department of Energy, *Southeast Regional Carbon Sequestration Partnership, at* http://www.fe.doe.gov/programs/sequestration/partnerships/2003sel_southeast.html (last modified Aug. 2, 2004). U.S. Department of Energy, *Fossil Energy Techline: Frio Formation Test Well Injected with Carbon Dioxide* (Nov. 19, 2004), *at* http://www.fossil.energy.gov/news/techlines/2004/tl_frio_injection.html.

[111] Susan Havorka, Mark Holtz, Shinichi Sakurai, and Paul Knox, Report to the Texas Commission on Environmental Quality to Accompany a Class V Application for an Experimental Technology Pilot Injection Well: Frio Pilot in CO2 Sequestration in Brine-Bearing Sandstones 4, (2003), *available at* http://www.beg.utexas.edu/environqlty/co2seq/pubs_presentations/friopilotapplication.pdf.

[112] *See* Smith, *supra* note 91, at 36.

[113] Wilson, *supra* note 12, at 3479.

based, and that a performance-based regulation, such as mandating a maximum leakage rate, would be more appropriate for carbon dioxide injection wells.[114] UIC regulations do not specify a containment time for injected waste, with the exception of Class I hazardous wells, which mandate no migration within the geologic formation for at least 10,000 years.[115]

If carbon dioxide injection and storage is not regulated under the current UIC regime, there are two other possibilities. The first would be for Congress to exempt carbon dioxide from underground injection regulations, similar to what has been done for natural gas storage. The second would be to create a separate classification or a sub-category with a current injection well class, specifically for carbon dioxide.

Exempting carbon dioxide from the current underground injection regime would require an act of Congress. In the 1980 reauthorization of the Safe Drinking Water Act, Congress exempted the underground storage of natural gas.[116] The House Committee on Interstate and Foreign Commerce noted that "sufficient evidence does not exist indicating that natural gas storage poses a threat to drinking water quality and that storage operators have an economic incentive to prevent gas leakages".[117]

One could envision a similar argument made for carbon dioxide storage. Note that the House Committee argument focused on the effect of natural gas storage on drinking water quality and not the effect of natural gas on drinking water. There are two components to the argument: (1) whether storage poses a threat to drinking water quality; and (2) whether there is an economic incentive to prevent leakage. It would be useful to

[114] Smith, *supra* note 91, at 36 (summarizing personal communication with Dr. Granger Morgan, Carnegie Mellon University, regarding suitability of UIC program for geologic carbon storage).
[115] Wilson, *supra* note 12, at 3481.
[116] 42 U.S.C. § 300h(d)(1).
[117] 1980 U.S.C.C.A.N. at 6085.

investigate the differences in the threat to drinking water quality posed by carbon dioxide storage as compared with natural gas storage. Natural gas has economic value as a commodity. If a carbon tax or an equivalent "cap and trade" mechanism was instituted, carbon dioxide storage operators could have an incentive to prevent leakage. However, issues of federalism and legal consistency might arise from the use of state-by-state regulation of underground injection within a carbon dioxide market. Even if both prongs of the House Committee's argument were shown to be true for carbon dioxide storage, Congressional action would still be required to exempt carbon dioxide storage from the SDWA and UIC regulations.

Sub-categories are already used by the UIC program. EPA defines sub-categories if operating and construction practices warrant such.[118] For example, as noted in the discussion of Class II well sub-categories, UIC distinguishes between disposal wells, wells used for enhanced oil recovery, and wells used for hydrocarbon storage. It would be a logical extension of current regulations to create a new sub-category under a Class I or Class V regime. Although the UIC program has created sub-categories of wells, EPA has not created new classes of wells. In either case, specific guidance would address some of the uncertainties and possible inconsistencies in the regulation of carbon dioxide injection wells, such as addressing regulatory discrepancies between storage in depleted oil and gas reservoirs versus storage following enhanced oil recovery.

[118] *See, e.g.* U.S. ENVIRONMENTAL PROTECTION AGENCY, STATEMENT OF BASIS AND PURPOSE: UNDERGROUND INJECTION CONTROL REGULATIONS 6 (National UIC Docket Control Number D01079, 1989) (responding to comments that Class III wells be sub-categorized), *available at* http://www.epa.gov/safewater/uic/pdfs/statement_of_basis_and_purpose_uic_1980.pdf.

V. Conclusion

The regulatory issues surrounding the capture and storage of carbon dioxide need to be clarified to facilitate large-scale implementation. EPA's UIC program will likely form the basis for the regulation, and could very well become the regulatory regime for carbon dioxide injection and storage. It is unclear how UIC will be interpreted with respect to carbon dioxide. Under the current UIC regime, one could interpret the regulations to provide three classifications for carbon storage: a regime for experiments (Class V wells), a regime carbon dioxide injection and storage for enhanced oil recovery (Class II wells), and a regime for the injection of carbon dioxide into all other geologic formations (Class I wells). In the alternative, there may be precedent for advancing legislation that would exempt carbon dioxide from the current underground injection regime, or regulatory clarity could be provided by creating a separate classification regime for carbon dioxide injection wells.

APPENDIX

PRIMACY STATUS OF STATES [119]

State	Type [120]	Classes	Effective Date	Federal Register Reference
Alabama	1425	II	August 2, 1982	47FR33268
Alabama*	1422	I, III, IV, V	August 25, 1983	47FR38640
Alaska**	1425	II	May 6, 1986	51FR16683
Arkansas	1422	I, III, IV, V	July 6, 1982	47FR29236
Arkansas*	1425	II	March 26, 1984	49FR11179
CNMI*	1422	I - V	July 17, 1985	50FR28942
California**	1425	II	March 14, 1983	48FR6336
Colorado**	1425	II	April 2, 1984	49FR13040
Connecticut*	1422	I - V	March 26, 1984	49FR11179
Delaware*	1422	I - V	April 5, 1984	49FR13525
Florida**	1422	I, III, IV, V	February 7, 1983	48FR5556
Georgia*	1422	I - V	April 19, 1984	49FR15553
Guam*	1422	I - V	May 2, 1983	48FR19717
Idaho*	1422	I - V	June 7, 1985	50FR23956
Illinois	1425	II	February 1, 1984	49FR3990
Illinois*	1422	I, III, IV, V	February 1, 1984	49FR3991
Indiana**	1425	II	August 19, 1991	56FR41072
Kansas	1422	I, III, IV, V	December 2, 1983	48FR54350
Kansas*	1425	II	February 9, 1984	49FR4735
Louisiana*	1422/25	I - V	April 23, 1982	47FR17487
Maine*	1422	I - V	August 25, 1983	48FR38641
Maryland*	1422	I - V	April 19, 1984	49FR15553
Massachusetts*	1422	I - V	November 23, 1982	47FR52705
Mississippi	1425	II	September 28, 1983	54FR8734
Mississippi**	1422	I, III, IV, V	August 25, 1983	48FR38641
Missouri	1425	II	December 2, 1983	48FR54349

[119] U.S. Environmental Protection Agency, *Responsibility for the UIC Program, at* http://www.epa.gov/safewater/uic/primacy2.html (last modified June 1, 2004). (* means the state has full primacy for UIC, ** means the state shares primacy with EPA)

[120] Refers to the SDWA provision under which EPA has delegated authority. States delegated under SDWA § 1422 (42 U.S.C. § 300h-1) have shown that the state UIC program is at least as stringent as standards in 40 C.F.R. § 144-148. States delegated under SDWA § 1425 (42 U.S.C. § 300h-4) have shown that the state program is effective in preventing pollution of underground sources of drinking water, as specified by 40 C.F.R. §144.3. SDWA § 1425 applies only to Class II wells. *Id.*

PRIMACY STATUS OF STATES (CONT'D)

State	Type	Classes	Effective Date	Federal Register Reference
Missouri*	1422	I, III, IV, V	July 17, 1985	50FR28941
Montana	1425	II	November 19, 1996	61FR58933
Nebraska	1425	II	February 3, 1984	48FR4777
Nebraska*	1422	I, III, IV, V	June 12, 1984	49FR24134
Nevada	1422	I - V	October 5, 1988	53FR39089
New Hampshire*	1422	I - V	September 21, 1982	47FR41561
New Jersey*	1422	I - V	July 15, 1983	48FR32343
New Mexico	1425	II	February 5, 1982	47FR5412
New Mexico*	1422	I, III, IV, V	July 11, 1983	48FR31640
North Carolina*	1422	I - V	April 19, 1984	49FR15553
North Dakota	1425	II	August 23, 1983	48FR38237
North Dakota*	1422	I, III, IV, V	September 21, 1984	49FR37065
Ohio	1425	II	August 23, 1983	48FR38238
Ohio*	1422	I, III, IV, V	November 29, 1984	49FR46896
Oklahoma	1425	II	December 2, 1981	46FR58488
Oklahoma*	1422	I, III, IV, V	June 24, 1982	47FR27273
Oregon*	1422/25	I - V	September 25, 1984	49FR37593
Rhode Island*	1422	I - V	August 1, 1984	49FR30698
South Carolina*	1422	I - V	July 10, 1984	49FR28057
South Dakota**	1425	II	October 24, 1984	49FR42728
Texas	1422	I, III, IV, V	January 6, 1982	47FR618
Texas*	1425	II	April 23, 1982	47FR17488
Utah	1425	II	October 8, 1982	47FR44561
Utah*	1422	I, III, IV, V	January 19, 1983	48FR2321
Vermont*	1422	I - V	June 22, 1984	49FR25633
Washington*	1422	I - V	August 9, 1984	49FR31875
West Virginia*	1422/25	I - V	December 9, 1983	48FR55127
Wisconsin*	1422	I - V	September 30, 1983	48FR44783
Wyoming	1425	II	November 22, 1982	47FR52434
Wyoming*	1422	I, III, IV, V	July 15, 1983	48FR32343

CATEGORIES OF CLASS V WELLS [121]

- Large-capacity cesspools
- Motor vehicle waste disposal wells
- Agricultural Drainage
- Storm Water Drainage
- Carwashes
- Large-Capacity Septic Systems
- Food Processing Disposal
- Sewage Treatment Effluent
- Laundromats without dry cleaning facilities
- Spent Brine Return Flow
- Mine Backfill
- Aquaculture
- Solution Mining
- In-Situ Fossil Fuel Recovery
- Special Drainage
- Experimental
- Aquifer Remediation
- Geothermal Electric Power
- Geothermal Direct Heat Return Flow
- Heat Pump/Air Conditioning Return Flow
- Salt Water Intrusion Barrier
- Aquifer Recharge/Recovery
- Noncontact Cooling Water
- Subsidence Control

[121] *See* 1 U.S. ENVIRONMENTAL PROTECTION AGENCY, THE CLASS V UNDERGROUND INJECTION CONTROL STUDY 13-14 (EPA/816-R-99-014a, 1999), *available at* http://www.epa.gov/safewater/uic/classv/pdfs/volume1.pdf.