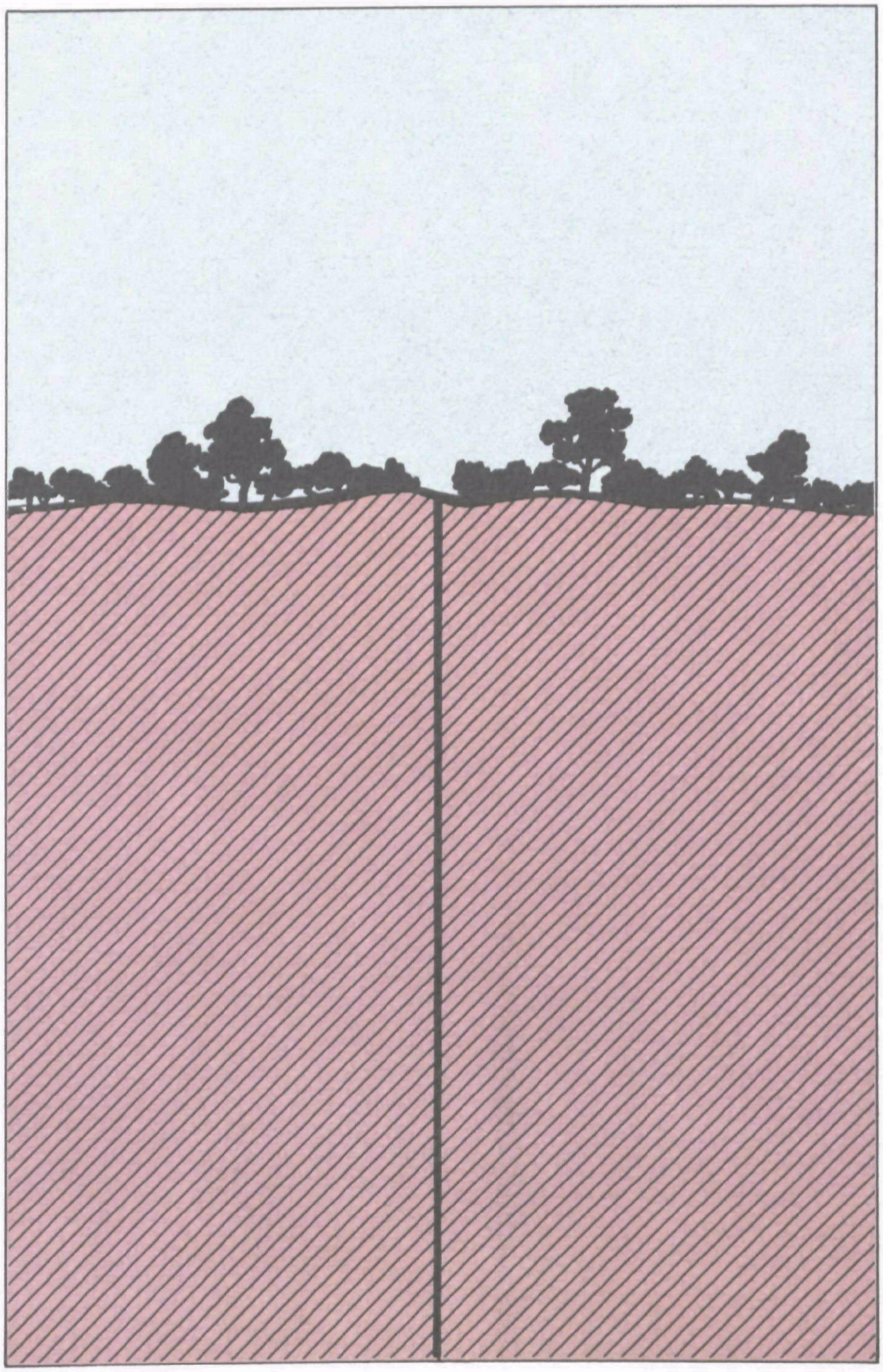
INJECTION WELLS

An Introduction To Their Use, Operation And Regulation



Introduction

Public Awareness: The Key to Protecting Drinking Water

Most Americans are surprised to learn that:

- 50 percent of this nation's drinking water comes from ground water. . .water that is found underground in rock, sand, or gravel.
- 75 percent of our cities derive all or part of their water from underground sources.
- Rural America is 95 percent dependent upon ground water.
- Daily use has increased from 34 billion gallons in 1950 to more than 90 billion gallons a day.

Simply put, ground water is essential to our public water supply systems, economic growth, national agricultural production and the quality of life we all share whether or not we personally rely on it as drinking water.

Estimates place the volume of nationally usable ground water at 100 quadrillion gallons. However, a problem exists. This problem is the potential for ground water contamination. Once a ground water resource has been contaminated, remediation is extremely difficult and sometimes not feasible.

Ground water is extremely susceptible to contamination from a variety of everyday sources, including septic tanks, feed lots, fertilizer, highway de-icing-salts, industrial processes, landfills, underground storage tanks, etc. Also of concern are the approximately 300,000 wells in the United States which inject fluids underground.

Since the passage of legislation in the 1970s that regulates waste disposal into the water, air and landfills, underground injection has grown in importance. In the petroleum industry alone, at least 20 to 30 million barrels of salt water are brought to the surface, along with oil, and then reinjected deep underground each day.

Even though there are federal, state or local regulations affecting all these contaminant sources, each of us should learn how our community might be affected by any of them and if we are, what we can do about it.

Ground Water

Ground water is stored beneath our local communities in formations of saturated rock, sand, gravel, and soil. Unlike surface water, ground water does not flow in a series of lakes and rivers. Instead, the precipitation that seeps into our soil continues its downward journey and eventually fills the pores of rock formations similar to the way water fills a sponge.

Rock formations that contain enough usable amounts of water to feed springs or wells are called aquifers. Two factors determine the amount of water that aquifers can provide: porosity and permeability. Porosity refers to the ability to store or hold water, and permeability refers to the ability to move ground water through rock pores and cracks. Sandstone, a highly porous material, allows water to seep through easily. Some rock formations, including many shales and clays, are extremely non-permeable and act as confining layers which make it possible to dispose of liquids underground into porous intervals while still being very protective of ground water.

Ground water quality generally deteriorates with increased depth. Waters of lesser salinities and mineral content (fresh waters) are usually located nearer the earth's surface. Deeper waters, into which liquid waste disposal takes place, are waters of limited quality or use with high dissolved mineral content. These waters with high salinity are not considered to be potential sources of drinking water.

Underground Injection Wells

The practice of underground injection has become essential to many of today's industries including the petroleum industry, chemical industry, food and product manufacturing companies, geothermal energy development, and many local small specialty plants and retail establishments.

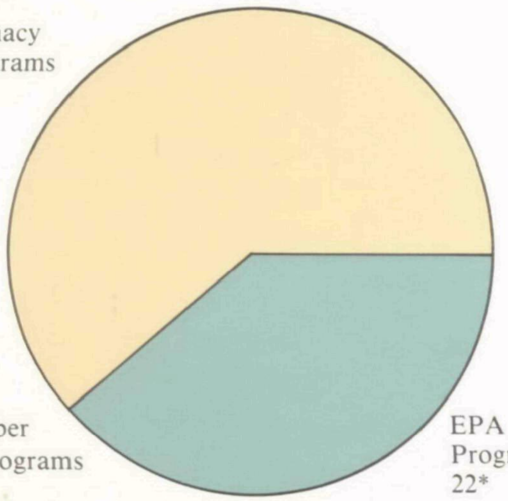
Within the past few decades, the realization that subsurface injection could contaminate ground water has prompted several states to develop programs and methods to protect underground sources of useable water. Additionally, to increase ground water protection, a federal Underground Injection Control (UIC) program has been established under the provisions of the Safe Drinking Water Act (SDWA) of 1974. This federal program establishes minimum requirements for effective state UIC programs. Since ground water is a major source of drinking water in the United States, the UIC program requirements were designed to prevent contamination of Underground Sources of Drinking Water (USDW) resulting from the operation of injection wells. A USDW is defined as an "aquifer or its portion which supplies any public water system or contains a sufficient quantity of ground water to supply a public water system, or contains less than 10,000 milligrams per liter total dissolved solids and is not an exempted aquifer."

Since the passage of the Safe Drinking Water Act, state and federal regulatory agencies have modified existing programs or developed new strategies to protect ground water by establishing even more effective regulations to control the permitting, construction, operation, monitoring and closure of injection wells.

The United States Environmental Protection Agency (USEPA) has delegated primary regulatory authority to those state agencies that have demonstrated an ability to implement UIC programs that meet USEPA requirements promulgated under Section 1422 or 1425 of the SDWA. These states are referred to as Primacy States. In many states more than one state agency has primary regulatory authority for one or more classes of injection wells. In states that have not received primacy, the responsible regulatory agency is the USEPA. These states are referred to as Direct Implementation States. Some states share responsibility with the USEPA.

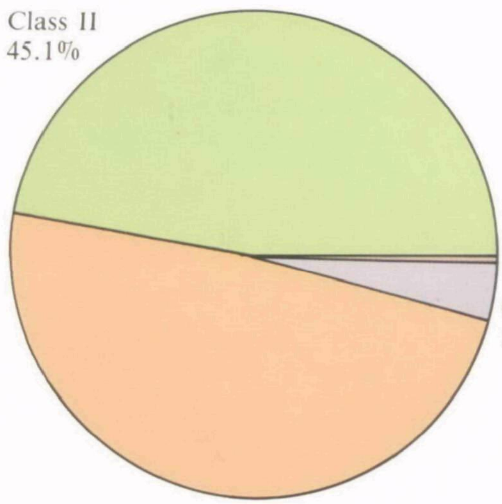
A well, as defined in Title 40 Part 144 of the Code of Federal Regulations, "is either a dug hole or a bored, drilled or driven shaft whose depth is greater than its largest surface dimension." Injection is defined as the subsurface emplacement of fluids in a well, where a fluid is any material that flows or moves whether it is semi-solid, liquid, sludge or gas.

Delegated Programs vs EPA Implementation



*Does not include Federal programs on Indian lands

Distribution of Active Injection Wells



Injection Well Classification Chart

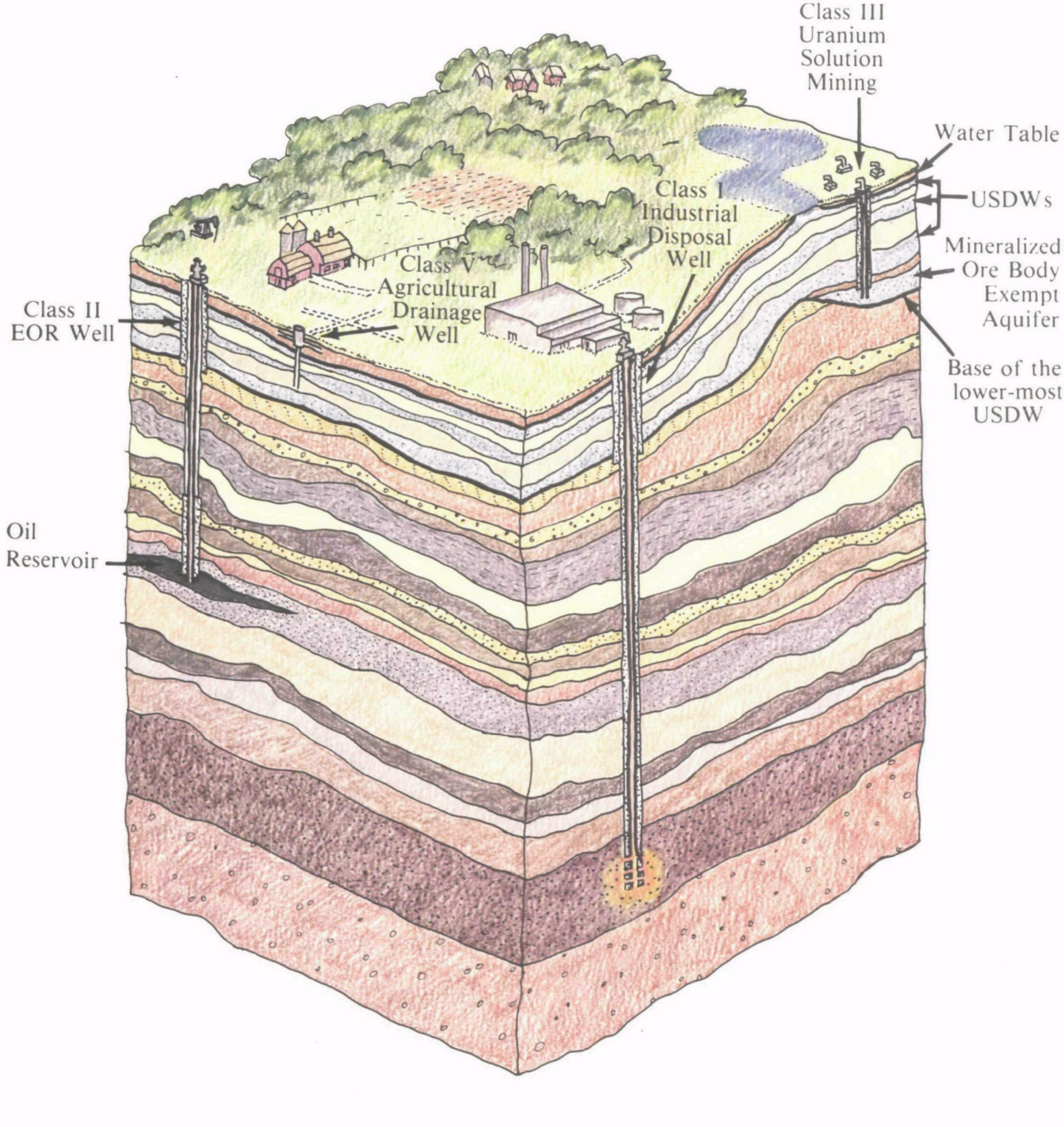
Table 1

USEPA CLASSIFICATION	INJECTION WELL DESCRIPTION	1989 EPA ACTIVE INVENTORY
CLASS I	Wells used to inject liquid hazardous wastes beneath the lowermost USDW.	245
	Wells used to inject industrial non-hazardous liquid wastes beneath the lowermost USDW.	233
	Wells used to inject municipal waste waters beneath the lowermost USDW.	76
CLASS II	Wells used to dispose of fluids associated with the production of oil and natural gas.	38,152
	Wells used to inject fluids for enhanced oil recovery.	121,086
	Wells used for the storage of liquid hydrocarbons.	918
CLASS III	Wells used to inject fluids for the extraction of minerals.	21,027[1]
CLASS IV	Wells used to dispose of hazardous or radioactive wastes into or above a USDW. **[EPA has banned the use of these wells.]**	20
CLASS V	Wells not included in the other classes used to generally inject non-hazardous fluid into or above a USDW.	173,159[2]

[1] Located in 192 Facilities

[2] Inventory from EPA Class V Report to Congress

Injection Well Relationship to USDWs



Well diameter enlarged to show detail.

Class I Injection Wells

Injection Wells Related to Hazardous, Industrial Nonhazardous, and Municipal Wastewater Disposal Below USDWs

Some waste is an unavoidable by-product of a myriad of manufacturing processes that create thousands of the products we use in the course of everyday living. While industry continues to reduce waste by recycling and improving manufacturing processes, there are still wastes that require disposal. There are many environmentally safe ways to do this job, including incineration, biological or chemical treatment, landfilling in properly located and constructed sites, and disposal through injection wells. Injection wells penetrate many thousands of feet below the earth's surface into rock formations where the waste cannot contaminate underground sources of drinking water.

The suitability of this disposal method depends on the availability of appropriate underground rock formations that have the natural ability to accept and confine the wastes. It is this long-term confinement that makes deep-well disposal an environmentally sound waste disposal method. This same natural ability of subsurface rock formations to confine liquids is the very characteristic that has permitted the entrapment and containment of naturally occurring oil and gas deposits for millions of years. These deposits have been held in place, moving little, if at all, for eons.

Class I injection wells can be subdivided by the types of waste injected: hazardous, nonhazardous, and municipal.

Hazardous Class I Injection Wells

Hazardous wastes are those industrial wastes that meet the definition in 40 CFR Part 261.3 under Section 3001, of Subtitle C of the Solid Waste Disposal Act, as amended by the 1976 Resource Conservation and Recovery Act. Class I hazardous waste wells are located in 15 states. A high concentration of these wells is located along the Texas-Louisiana Gulf Coast because this area offers a combination of suitable injection zones and large numbers of waste generators. The Great Lakes region also has a high concentration of Class I hazardous wells for the same basic reasons.

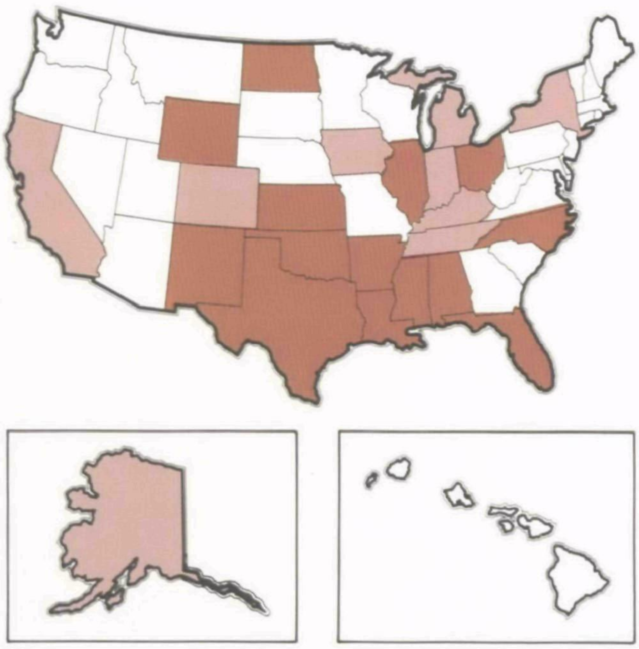
Nonhazardous Industrial Class I Injection Wells

Nonhazardous wastes are any other industrial wastes that do not meet the legal definition of hazardous wastes. Texas and Kansas have the greatest number of wells in this category because these states have specific industries that generate large quantities of nonhazardous, liquid wastes. Nonhazardous industrial Class I wells are located in 19 states.

Municipal Class I Injection Wells

Municipal wastes, which are not specifically defined in the federal regulations, are wastes associated with sewage effluent that has received a minimum of secondary treatment. Disposal of municipal (treated sewage effluent) waste through injection wells is currently practiced only in Florida. In Florida, this waste-disposal practice is chosen more and more often due to a shortage of available land, strict surface-water discharge limitations, extremely permeable injection zones and cost effectiveness.

States With Class I Injection Wells



Primacy States with Class I Injection Wells

Direct Implementation States with Class I Wells

States with no Class I Wells

Site Selection and Distribution

Site selection for a Class I disposal well is dependent upon geologic and hydrogeologic conditions, and only certain areas are suitable. Most favorable locations are generally in the mid-continent, gulf-coast, and great lakes regions of the country.

The process of selecting a site for a Class I disposal well involves evaluating many conditions. Paramount in the consideration, is the determination that the underground formations possess the natural ability to contain and isolate the injected waste. An important part of this determination is the evaluation of the history of earthquake activity. A well would not be located in an area of geologic instability. Also the existence of abandoned wells, mineral resources and underground sources of drinking water are identified and evaluated.

A detailed study is conducted to determine the suitability of the underground formation for disposal. The receiving formation must be far below any usable ground waters and be separated from them by confining layers of rock, which prevent fluid migration into the ground water. The injection zone in the receiving formation must be of sufficient size and have sufficient pore space to accept and maintain the injected wastes. The region around the well must be geologically stable, and the injection zone should not contain recoverable mineral resources such as ores, oil, coal, or gas.

Abandoned wells of any type which penetrate the proposed injection zone are investigated in an area of review within a specified radius of the injection well to assure that they were properly plugged to prevent escape of injected materials.

Construction and Monitoring Requirements

The primary concern in the construction of a Class I injection well is the protection of ground water by assuring containment of the injected wastes through a multilayer protection system. A Class I injection well is constructed in stages, the first stage being the drilling of a hole to a depth below the lowermost USDW. A steel casing or surface pipe is installed the full length of the borehole and cement is placed outside of the casing from the bottom to the top of the hole. This provides a barrier of steel and cement to protect drinking water.

The second phase is to continue drilling below the surface casing down to the intended injection zone. A second protective casing string is installed from the surface down through the injection zone and again cemented in place the entire length of the casing to seal the space outside of the casing. A smaller pipe, called injection tubing, is installed inside the protective casing string. The tubing is secured with a wellhead at the surface and a packer at the bottom. The space between the tubing and the protective casing is known as the annulus and it is filled with a noncorrosive fluid. The fluid in the annulus is monitored as a continuous check on the mechanical integrity of the downhole system. Should a leak develop, a change in the annulus pressure would occur and the well could be shut down prior to contamination of a USDW.

Class I injection wells are continuously monitored and controlled with sophisticated equipment. Pressure recording inside and outside of the injection tubing and routine mechanical integrity testing of the components of the well insure containment of the injected fluids.

Closure

When a Class I well is retired from service, the borehole and casing must be securely plugged to prevent any movement of the waste. A properly sealed well, using cements and other materials, permanently confines the waste within the injection zone as well as prevents any movement of high salinity water into a USDW. Thus, a Class I disposal well is secured — not abandoned.

Properly located, designed, constructed, operated and monitored — Class I wells have proven to be an environmentally and technically sound method for the disposal of many liquid wastes which could not be safely disposed of otherwise.

Class II Injection Wells

Injection Wells Related to Oil and Gas Activity

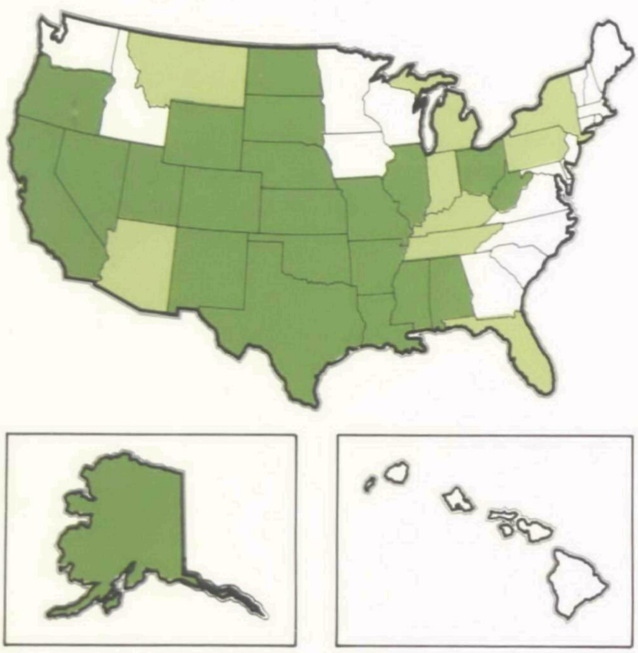
Class II injection wells have been used in oil field related activities since the 1930s. Today there are approximately 170,000 Class II injection wells located in 31 states. All class II injection wells are regulated by either a state agency which has been granted regulatory authority over the program or by the USEPA directly. Class II wells are subject to a regulatory process which generally requires a technical review to assure adequate protection of drinking water and an administrative review defining operational guidelines.

Class II injection wells are categorized into three subclasses. They are salt water disposal wells, enhanced oil recovery (EOR) wells, and hydrocarbon storage wells.

Salt Water Disposal Well

As oil and gas are brought to the surface they are quite often mixed with salt water. On a national average, approximately 10 barrels of salt water are produced with every barrel of crude oil. Approved geologic formations receive the produced waters that are reinjected through disposal wells and EOR wells. One of the common forms of liquid waste disposal by the oil and gas industry is through injection into geologic formations that do not contain hydrocarbons. These disposal wells have been used extensively to return salt water associated with oil and gas production to the subsurface. Approximately 30 percent of salt water produced with oil and gas onshore in the United States is disposed of via salt water disposal wells.

States With Class II Injection Wells



Primacy States with Class II Injection Wells

Direct Implementation States with Class II Wells

States with no Class II Wells

Enhanced Oil Recovery Wells

Enhanced Oil Recovery (EOR) injection wells are used to increase and prolong oil production from depleting oil producing fields. SECONDARY RECOVERY is an EOR process, commonly referred to as waterflooding. In this process salt water co-produced with oil and gas is reinjected into the oil producing formation to drive oil into pumping wells, resulting in the recovery of additional oil. TERTIARY RECOVERY is an EOR process that is used after secondary recovery methods become inefficient or uneconomical. Tertiary recovery methods include the injection of gases, enhanced waters and steam in order to maintain and extend oil production. Approximately 60 percent of salt water produced with oil and gas onshore in the United States is injected into EOR wells.

Hydrocarbon Storage Wells

These wells are used for the underground storage of crude oil, liquified petroleum gas (LPG), and other liquid hydrocarbon products in naturally occurring rock formations. The same wells are often designed for both injection and removal of the stored hydrocarbons.

Construction Requirements

Construction of Class II injection wells is subject to either State or Federal regulation. Construction design must adequately confine injected fluids to the authorized zone as well as prevent the migration of fluids into USDWs. Through the permitting process, site specific regulations can be imposed to meet any unusual circumstances.

Injection wells are drilled and cased with steel pipe which is cemented in place to prevent the migration of fluids into USDWs. Surface casing in conventionally constructed wells is set and cemented back to surface, preventing fluid movement. Cement is also placed behind the production casing to confine injected fluids to the authorized zone of injection. A typical salt water disposal injection well also has an interior string of pipe called tubing through which injection takes place. A packer is commonly used to isolate the injection zone from the annular space between the tubing and production casing above the packer.

Operations

Typically, the oil, gas and salt water are separated at the oil and gas production facilities. The salt water is then either piped or trucked to the injection site for disposal or EOR operations. There, the salt water is transferred to holding tanks and pumped down the injection well. For EOR, the salt water may be treated or augmented by other fluids prior to injection. Fresh water or fresh water converted to steam is injected to maximize oil recovery in some EOR operations.

Injection well operations must be directed in such a manner as to prevent the contamination of USDWs and to ensure fluid emplacement and confinement within the authorized injection zone. Primacy states have adopted regulations, which have been approved by the USEPA as protective of USDWs, concerning Class II injection well operations. These regulations address injection pressures, mechanical integrity testing, pressure monitoring and reporting. Direct Implementation states must meet operational guidelines as set out by the USEPA.

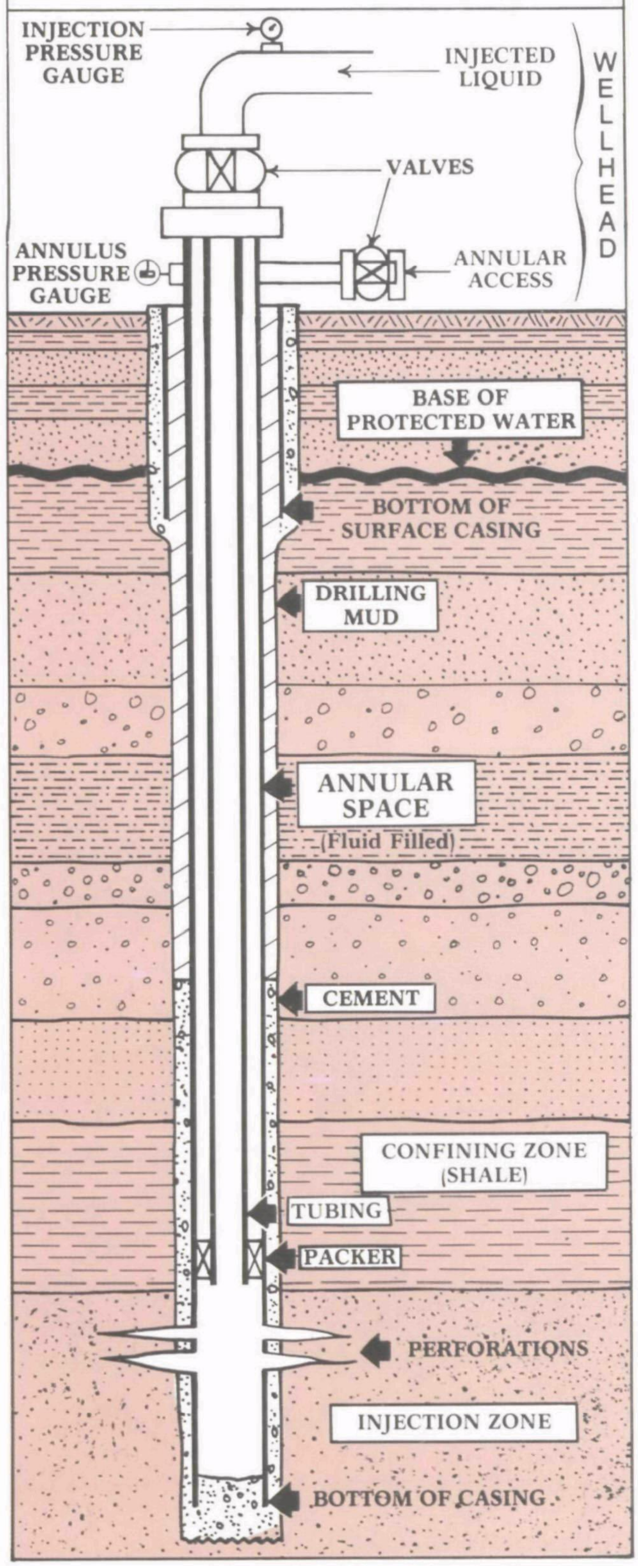
Closure of Class II injection wells must be conducted in a manner as to protect USDWs. Although regulations vary slightly from state to state, commonly a cement plug is required to be placed in the wellbore across the injection zone, with additional plugs set across the base of the lowermost USDW and a final near surface plug.

Testing and Monitoring

After placing Class II injection wells in service, ground water protection is accomplished by testing and monitoring the wells. Injection pressures and volumes are monitored as a valuable indicator of well performance. Effective monitoring is important since any downhole problems can normally be recognized and corrective action can be taken quickly to prevent endangerment of USDWs.

Mechanical integrity tests (MITs) are required prior to initial injection and at a minimum of once every five years thereafter. Variations of acceptable tests and frequencies greater than once per five years are determined on a test by test basis and are rigorously reviewed by the USEPA. These tests evaluate the operational integrity of the well so that USDWs will not be endangered.

A TYPICAL
CLASS II INJECTION WELL



Class III Injection Wells

Injection Wells Related to Mineral Extraction

Class III injection wells are located in 16 states. Every Class III injection well, whether located in a primacy or a direct implementation state, is subject to a permitting requirement through the authorized regulatory agency. The operating permit will require the well to meet any regulations the state has adopted to assure the protection of USDWs. The permits may include specific well construction, monitoring, mechanical integrity testing, maximum allowable injection pressure, and reporting requirements. Proper closure or plugging of all Class III injection wells must be conducted in a manner to protect USDWs from potential contamination.

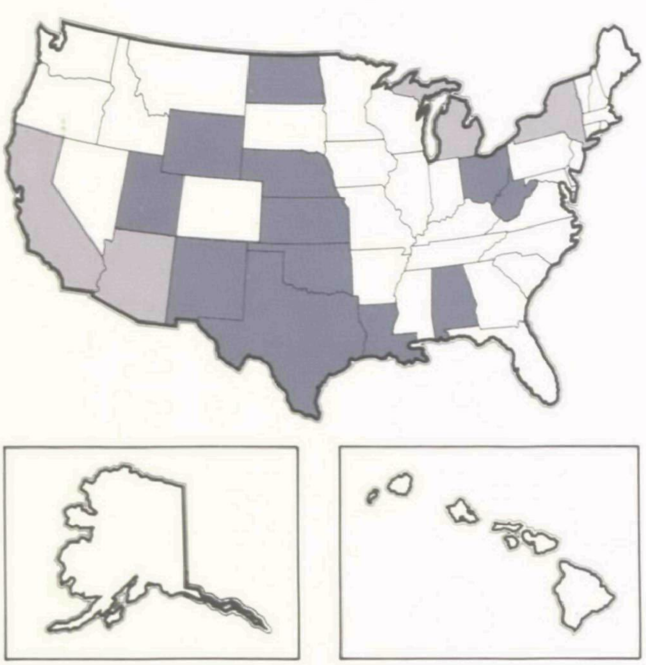
The techniques these wells use for mineral extraction may be divided into two basic categories: solution mining of salts and sulfur; and in situ (in place) leaching for various minerals such as uranium, gold or copper.

Solution Mining

Solution mining techniques are used primarily for the extraction of salts and sulfur. For common salt, the solution mining process involves injecting water, which dissolves the underground salt formation. The resulting brine is pumped to the surface either through the tubing-casing annulus of the injection well or through production wells.

The technique for solution mining of sulfur is known as the Frasch process. This process consists of injecting superheated water down the tubing-casing annulus of the injection well and into the sulfur-bearing formations to melt the sulfur. The molten sulfur is extracted from the subsurface through tubing within the injection well with the aid of compressed air, which mixes with the liquid sulfur and airlifts it to the surface.

States With Class III Injection Wells



Primacy States with Class III Injection Wells

Direct Implementation States with Class III Wells

States with no Class III Wells

In Situ Leaching

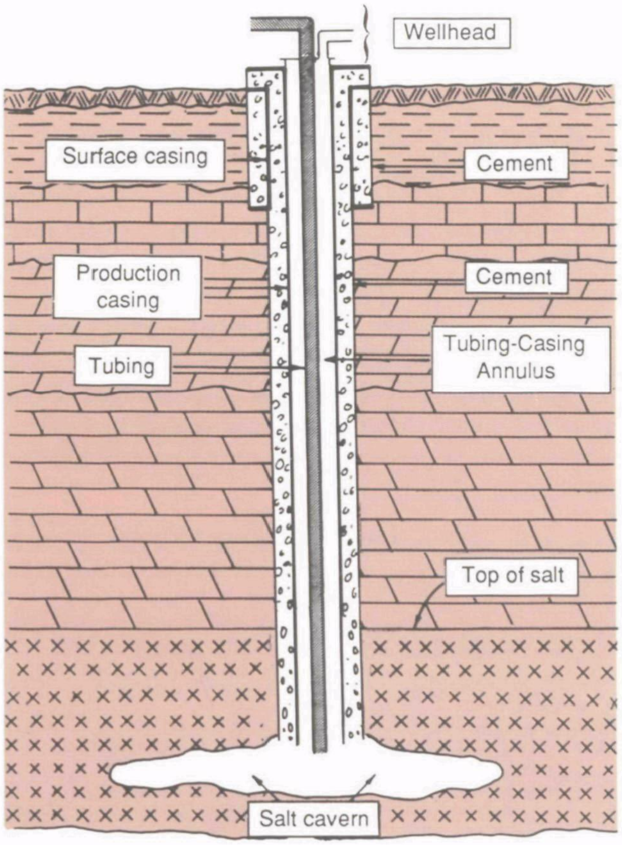
In situ leaching is commonly used to extract uranium, gold, and copper. Uranium is the predominate mineral extracted by this technique. The uranium in situ leaching process involves injection of a neutral ground water solution containing non-toxic chemicals (e.g. oxygen and carbon dioxide) down injection wells. This fortified water is circulated through an underground ore body or mineral zone to dissolve or leach the uranium particles that coat the sand grains of the ore body. The resulting uranium-rich solution is then pumped to the surface where the uranium is extracted from the solution, and the leaching solution is recycled back into the ore body through the injection wells. This same general technology is employed for in situ leaching of other minerals, with the only difference being the type of fluid used for injection.

The typical life of an in situ leaching well is less than five years. At the end of the in situ leaching operations, UIC regulations require restoration of the mined aquifer to its original quality.

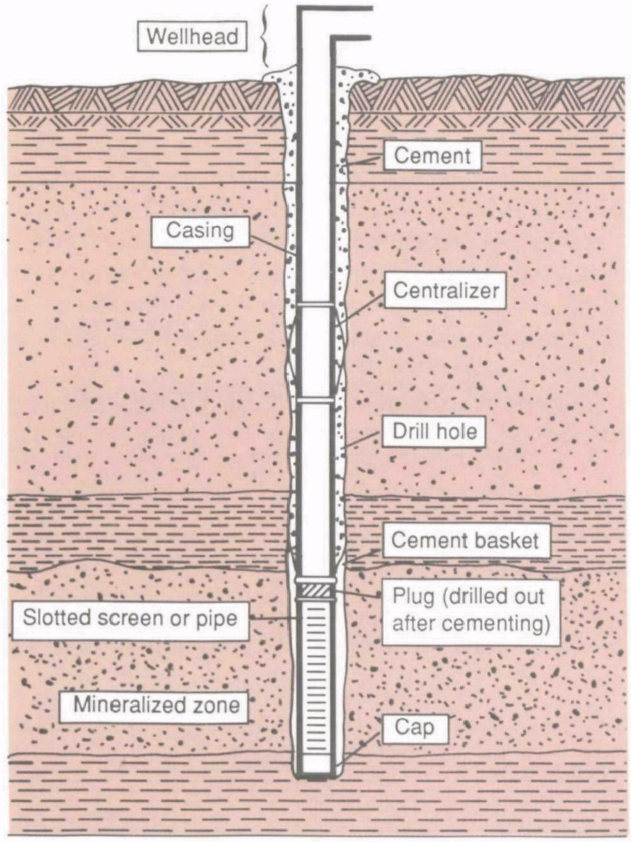
Construction and Testing Requirements

Construction standards for Class III injection wells are designed to confine injected fluids to the authorized injection zone and prevent migration of these fluids into USDWs. Class III injection wells are drilled into mineralized rock formations and are cased with pipe which is cemented in place to prevent fluid migration into USDWs. Construction materials and techniques vary and depend upon the mineral extracted and the nature of the injected fluids.

Typical Salt Solution Well Completion



Typical In Situ Leaching Well Completion



Mechanical integrity tests are required prior to initial operation of Class III injection wells. Several different tests have been approved, however, in each case the tests are required to determine that there are no leaks in the tubing, casing or packer (if used) and there is no significant fluid movement into a USDW. In situ leaching wells also require that the ore body be surrounded by monitoring wells to detect horizontal migration of the mining solutions. Additionally, overlying and underlying aquifers must be monitored to detect any vertical migration of these same fluids.

Class IV Injection Wells

Injection Wells Related to Hazardous and Radioactive Wastewater Disposal Into or Above USDWs

These wells have been identified by the EPA as a threat to human health and environment. The EPA has banned the use of these wells. As these wells are identified by State and Federal UIC regulatory agencies they are subject to corrective action which may include remediation as well as permanent closure.

Injection Wells not Included in the Other Classes

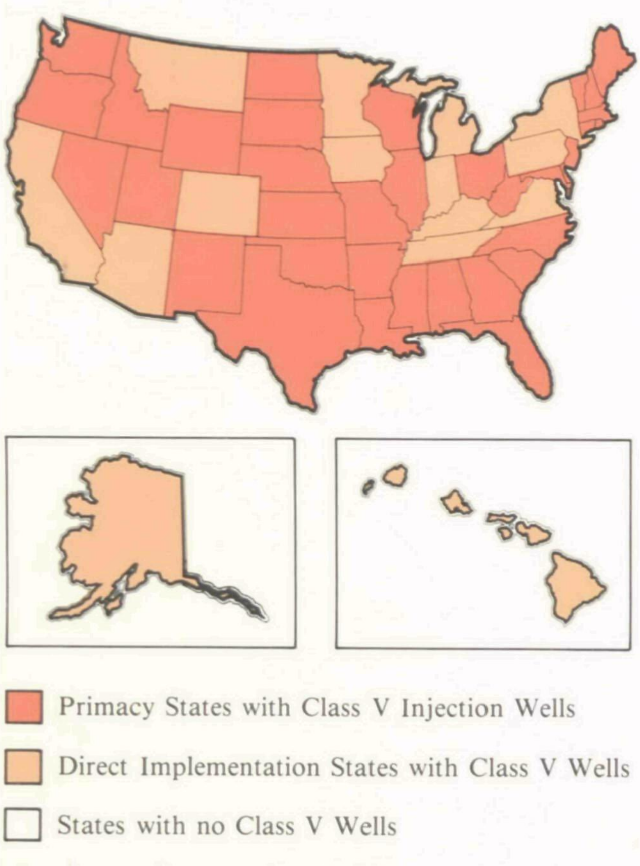
Class V — Simple to Complex

If a well does not fit into the first four classes of injection wells and still meets the definition of an injection well, it is considered a Class V well. Class V injection practices recognized by the USEPA include 30 individual types of wells, which range in complexity from simple cesspools that are barely deeper than they are wide, to sophisticated geothermal reinjection wells that may be thousands of feet deep.

It should be noted that not all Class V wells are used for disposal. Examples of Class V practices which are not disposal related include: Aquifer Recharge, Fossil Fuel Recovery and Mineral Recovery wells. Table 2 describes all of the subclasses of Class V wells, the potential contaminants, and the ground water contamination potential.

As seen in Table 2, the Class V injection well category is very large and diverse. Class V injection practices can be divided into two general categories, "high-tech" and "low-tech." "Low-tech" wells generally have simple casing designs and surface equipment and inject into shallow formations by gravity flow or low volume pumps. In contrast, "high-tech" wells typically have multiple casing strings, sophisticated well head equipment to control and measure pressure and inject fluids into deep saline formations that are separated from aquifers by impermeable confining layers or rock.

States With Class V Injection Wells



Class V Injection Systems and Your Drinking Water

Class V wells injecting below the lowermost USDW have the least potential for contaminating ground water. Class V injection directly into USDWs is potentially more harmful to the water quality than discharges above the water table. This is because some contaminants can be removed from the waste by attenuation, adsorption and degradation as they move through shallow soils and some rock formations.

Based on inventories conducted by the states, it is estimated that there are approximately 170,000 Class V wells in the United States and its Territories and Possessions. This number is only an estimate and the actual number is considerably higher. There are seven major categories of Class V injection wells, which comprise 30 individual well types. About 83 percent of all Class V wells belong to two categories: drainage wells (57 percent) and sewage related wells (26 percent).

The USEPA is currently developing a strategy for dealing with Class V injection wells. State and local government, as well as public involvement is essential. Many states have already adopted regulations and ordinances for oversight of certain Class V wells. The USEPA is looking closely at Class V wells which pose the greatest environmental risks as candidates for federal regulation and enforcement. Two groups of particular interest are the industrial disposal wells (5W20) and automobile service station disposal wells (5X28) as discussed in Table 2.

Class V Injection Well Subclasses

Table 2

Name of Well Type and Description	Ground Water Contamination Potential	Potential Contaminants	EPA Well Code
DRAINAGE WELLS (a.k.a. DRY WELLS) Agricultural Drainage Wells — receive irrigation tailwaters, other field drainage, animal yard, feedlot, or dairy runoff, etc.	High	Pesticides, nutrients, pathogens, metals transported by sediments, salts.	5F1
Storm Water Drainage Wells — receive storm water runoff from paved areas, including parking lots, streets, residential subdivisions, building roofs, highways, etc.	Moderate	Heavy metals (Cu, Pb, Zn) organics, high levels of coliform bacteria. Contaminants from streets, roofs, landscaped areas, Herbicides, Pesticides.	5D2
Improved Sinkholes — receive storm water runoff from developments located in karst topographic areas.	High-Moderate	Variable: pesticides, nutrients, coliform bacteria.	5D3
Industrial Drainage Wells — wells located in industrial areas which primarily receive storm water runoff but are susceptible to spills, leaks, or other chemical discharge.	High-Moderate	Usually organic solvents, acids, pesticides, and various other industrial waste constituents. Similar to storm drainage wells but usually higher concentrations.	5D4
Special Drainage Wells — used for disposing water from sources other than direct precipitation. Four types were reported: landslide control drainage wells (Montana), potable water tank overflow drainage wells (Idaho), swimming pool drainage wells (Florida), and lake level control drainage wells (Florida)	Moderate-Low	Chlorinated and treated water, pH imbalance, algaecides, fungicides, muriatic acid.	5G30
GEOTHERMAL REINJECTION WELLS Electric Power Reinjection Wells — reinject geothermal fluids used to generate electric power — deep wells.	Moderate	pH imbalance, minerals and metals in solution. (As, Bo, Se), sulfates.	5A5
Direct Heat Reinjection Wells — reinject geothermal fluids used to provide heat for large buildings or developments — deep wells.	Moderate	Hot geothermal brines with TDS between 2,000 to 325,000 mg/l. Co_3, $CaSO_4$, Sr and Ba, As.	5A6
Heat Pump/Air Conditioning Return Flow Wells — reinject groundwater used to heat or cool a building in a heat pump system — shallow wells.	Low	Potable water with temperatures ranging from 90° to 110° F., may have scale or corrosion inhibitors.	5A7
Groundwater Aquaculture Return Flow Wells — reinject groundwater or geothermal fluids used to support aquaculture. Non-geothermal aquaculture disposal wells are also included in this category (e.g. Marine aquariums in Hawaii use relatively cool sea water).	Moderate	Used geothermal waters which may be highly mineralized & include traces of arsenic, boron, fluoride, dissolved & suspended solids, animal detritus, perished animals and bacteria.	5A8
DOMESTIC WASTEWATER DISPOSAL WELLS Untreated Sewage Waste Disposal Wells — receive raw sewage wastes from pumping trucks or other vehicles which collect such wastes from single or multiple sources. (No treatment)	High	Soluble organic & inorganic compounds including household chemicals. Raw sewage with 99.9% water and .03% suspended solid. May contain pathogenic bacteria & viruses, nitrates, ammonia.	5W9
Cesspools — including multiple dwelling, community, or regional cesspools, or other devices that receive wastes and which must have an open bottom and sometimes have perforated sides. Must serve greater than 20 persons per day if receiving solely sanitary wastes. (Settling of solids)	High	Soluble organic & inorganic compounds including household chemicals. Raw sewage with 99.9% water and .03% suspended solid. May contain pathogenic bacteria & viruses, nitrates, ammonia.	5W10
Septic Systems (Undifferentiated Disposal Method) — used to inject the waste or effluent from a multiple dwelling, business establishment, community, or regional business establishment septic tank. Must serve greater than 20 persons per day if receiving solely sanitary wastes. (Primary Treatment)	High-Low	Varies with type of system: fluids typically 99.9% water (by weight) and .03% suspended solids: major constituents include nitrates, chlorides, sulfates, sodium, calcium, and fecal coliform.	5W11
Septic Systems (Well Disposal Method) — examples of wells include actual wells, seepage pits, cavitettes, etc. The largest surface dimension is less than or equal to the depth dimension. Must serve greater than 20 pesons per day if receiving solely sanitary wastes. (Less treatment per square area than 5W32)	High-Low	Varies with type of system: fluids typically 99.9% water (by weight) and .03% suspended solids: major constituents include nitrates, chlorides, sulfates, sodium, calcium, and fecal coliform.	5W31
Septic System (Drainfield Disposal Method) — examples of drainfields include drain or tile lines, and trenches. Must serve more than 20 persons per day if receiving solely sanitary wastes. (More treatment per square area than 5W31)	High-Low	Varies with type of system: fluids typically 99.9% water (by weight) and .03% suspended solids: major constituents include nitrates, chlorides, sulfates, sodium, calcium, and fecal coliform.	5W32
Domestic Wastewater Treatment Plant Effluent Disposal Wells — dispose of treated sewage or domestic effluent from small package plants up to large municipal treatment plants. (Secondary or further treatment)	High-Low	Lower levels of organics and bacteria than other septic systems and cesspools.	5W12
MINERAL AND FOSSIL FUEL RECOVERY RELATED WELLS Mining, Sand, or Other Backfill Wells — used to inject a mixture of water and sand, mill tailings, and other solids into mined out portions of subsurface mines whether what is injected is a radioactive waste or not. Also includes special wells used to control mine fires and acid mine drainage wells.	Moderate	Acidic waters	5X13
Solution Mining Wells — used for in-situ solution mining in conventional mines, such as stopes leaching.	Moderate-Low	2.4% sulfuric acid, pH less than 2 for copper & ferric cyanide solution for gold or silver.	5X14
In-situ Fossil Fuel Recovery Wells — used for in-situ recovery of coal, lignite, oil shale, and tar sands.	Moderate	Steam, air, solvents, igniting agents.	5X15
Spent-Brine Return Flow Wells — used to reinject spent brine into the same formation from which it was withdrawn after extraction of halogens or their salts.	Low	Variable	5X16

Table 2 (continued)

Name of Well Type and Description	Ground Water Contamination Potential	Potential Contaminants	EPA Well Code
INDUSTRIAL/COMMERCIAL/UTILITY DISPOSAL WELLS Cooling Water Return Flow Wells — used to inject water which was used in a cooling process, both open and closed loop processes.	Low-Moderate	Anti-sealing additives, thermal pollution, potential for industrial spills reaching ground water.	5A19
Industrial Process Water and Water Disposal Wells — used to dispose of a wide variety of wastes and wastewaters from industrial, commercial, or utility processes. Industries include refineries, chemical plants, smelters, pharmaceutical plants, laundromats and dry cleaners, tanneries, carwashes, laboratories, etc. *Industry and waste stream must be specified* (e.g. Petroleum Storage Facility—storage tank condensation water; Electric Power Generation Plant—mixed waste stream of laboratory drainage, fireside water, and boiler blowdown; Car Wash—Mixed waste stream of detergent, oil and grease, and paved area washdown; Electroplating Industry—spent solvent wastes; etc.).	High	Potentially any fluid disposed by various industries, suspended solids, alkalinity, sulfate volatile organic compounds.	5W20
Automobile Service Station Disposal Well — repair bay drains connected to a disposal well. Suspected of disposal of dangerous or toxic wastes.	High	Heavy metals, solvents, cleaners, used oil and fluids, detergents, organic compounds.	5X28
RECHARGE WELLS Aquifer Recharge Wells — used to recharge depleted aquifers and may inject fluids from a variety of sources such as lakes, streams, domestic wastewater treatment plants, other aquifers, etc.	High-Low	Variable: water is generally of good quality	5R21
Saline Water Intrusion Barrier Wells — used to inject water into fresh water aquifers to prevent intrusion of salt water into fresh water aquifers.	Low	Varies: advanced treated sewage, surface urban and agricultural runoff, and imported surface waters.	5B22
Subsidence Control Wells — used to inject fluids into a non-oil or gas producing zone to reduce or eliminate subsidence associated with overdraft of fresh water and not used for the purpose of oil or natural gas production.	Low	No specific type of injected fluid noted, similar to aquifer recharge wells.	5S23
MISCELLANEOUS WELLS Radioactive Waste Disposal Wells — all radioactive waste disposal wells other than Class IV wells.	Unknown	Low-level radioactive wastes.	5N24
Experimental Technology Wells — wells used in experimental or unproven technologies such as pilot scale in-situ solution mining wells in previously unmined areas.	Low-Moderate	Varies depending on project.	5X25
Aquifer Remediation Related Wells — wells used to prevent, control, or remediate aquifer pollution, including but not limited to Sueprfund sites.	Unknown	Nutrients used in Biodegradation of organics, oil/grease, phenols, toluene.	5X26
Abandoned Drinking Water Wells — used for disposal of waste.	Moderate	Potentially any kind of fluid, particularly brackish or saline water, hazardous chemcials and sewage.	5X29
Other Wells — any other unspecified Class V wells: *Well type/purpose and injected fluids must be specified.*	Unknown	Variable	5X27

Protecting Drinking Water

The UIC program addresses only a part of the overall threat to underground sources of drinking water. State, federal and local UIC programs integrated with careful planning, good management and other ground water protection initiatives can significantly reduce the threat of contamination to our drinking water supplies from all classes of injection well activities.

For additional information contact the USEPA, Office of Drinking Water at (202) 382-5530 or the Underground Injection Practices Council at (405) 525-6146.

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