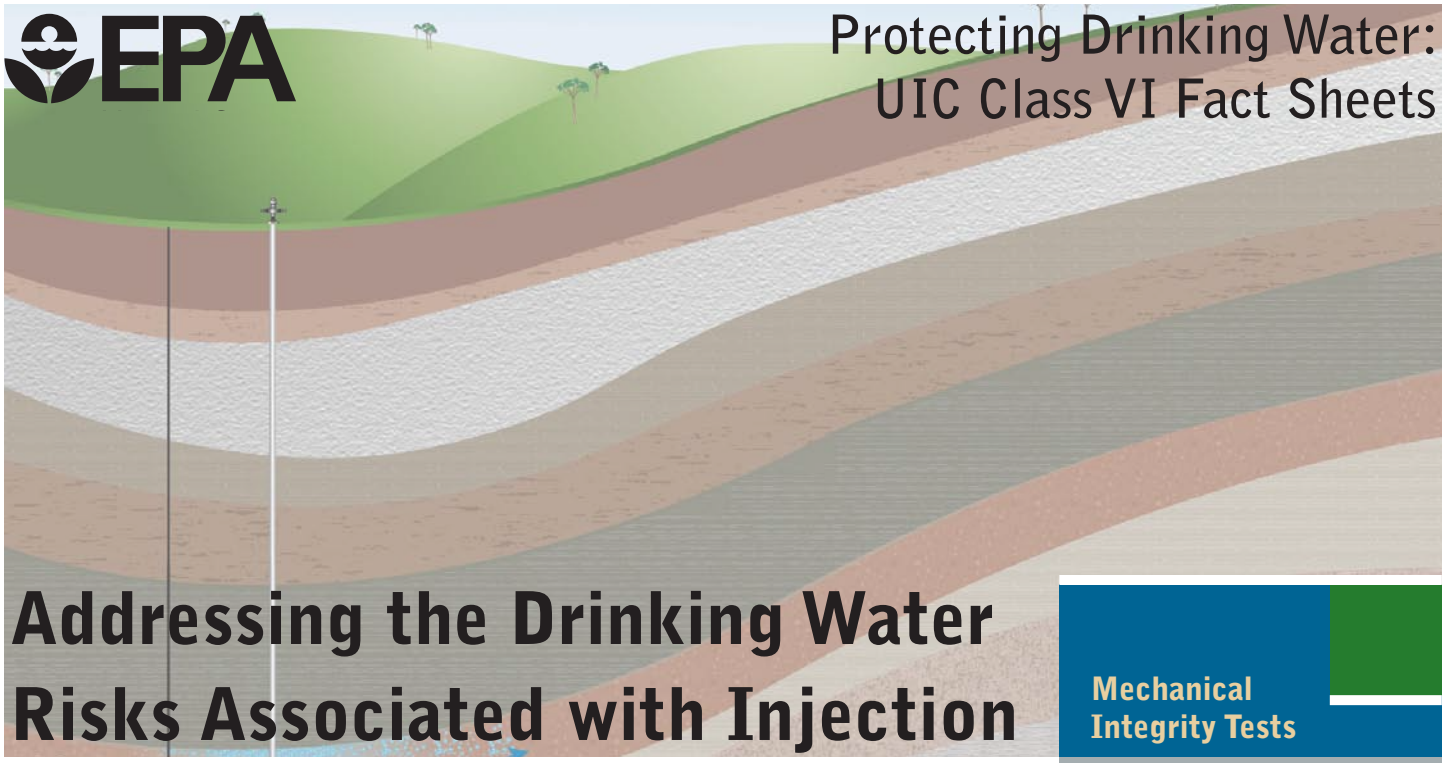


Protecting Drinking Water:
UIC Class VI Fact Sheets

Addressing the Drinking Water Risks Associated with Injection

There are four major pathways through which injected fluids can migrate into underground sources of drinking water (USDWs): the drilled holes ("well bores") of improperly constructed injection wells, improperly plugged nearby wells, transmissive faults or fractures in the surrounding rock formations, and lateral movement into hydraulically-connected USDWs. The Underground Injection Control (UIC) Class VI requirements, for wells used for geologic sequestration (GS), are designed to address these pathways with regard to the injection of carbon dioxide (CO_2). Proper GS project management will appropriately mitigate potential risks of endangerment to USDWs posed by CO_2 injection activities.

Preventing injected fluids from migrating through improperly constructed wells

Improperly constructed wells can become conduits for fluid movement into USDWs. Under the UIC requirements, Class VI wells are required to be constructed with multiple layers of protection using materials that can withstand contact with CO_2 over the life of the GS project. The requirements for cement, surface casing, long-string casing, and tubing and packers for Class VI wells (at 40 CFR 146.86) address the unique physical and chemical characteristics of CO_2.

The illustration on the next page demonstrates the construction requirements for a Class VI well. The tubing and packer, in combination with the surface casing and long-string casing, provide multiple-barrier protection for USDWs. Cements and other materials used in Class VI wells must be compatible with injected fluids and have sufficient structural strength to prevent CO_2 leakage for the entire life of the GS project. In addition, Class VI wells must have alarms and automatic surface or down-hole shut-off systems. These devices will alert operators and close the well if the well is in danger of losing mechanical integrity (see the box to the right for more information on mechanical integrity).

Image of CO_2 injection courtesy of CO2CRC (© CO2CRC).

Mechanical Integrity Tests

Mechanical integrity (MI) is the absence of significant leakage inside and outside the well.

Mechanical integrity tests (MITs) are a means of measuring the adequacy of the construction of an injection well and a way to detect problems within the well system before leaks occur.

Periodic well MITs will ensure that a well maintains internal and external MI.

Internal MI will be verified within the injection tubing and casing system. External MI will be verified by establishing the absence of significant fluid movement along the outside of the casing.

Addressing the Drinking Water Risks Associated with Injection (continued)

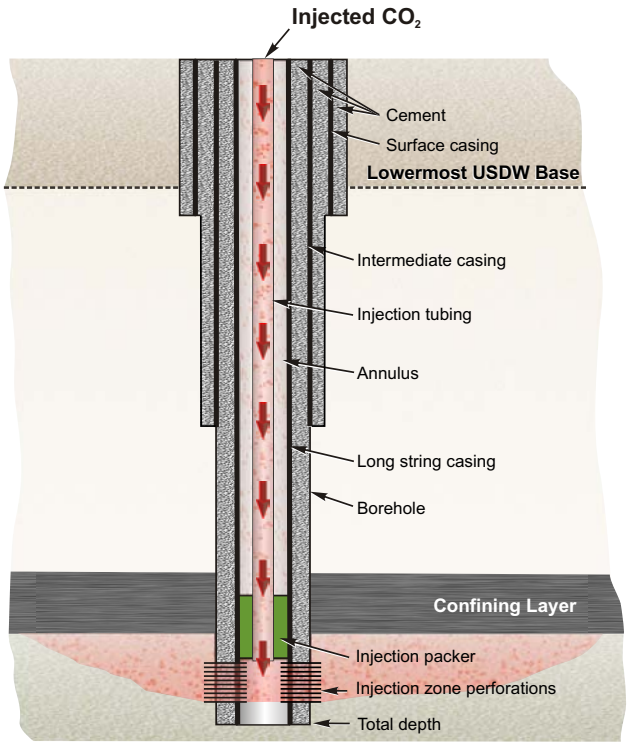
Preventing injected fluids from migrating into nearby wells

Fluids from the pressurized area in the injection zone may be forced upward through wells in the area of review (AoR). The AoR is the region surrounding the GS project where USDWs may be endangered by the injection activity. The owners or operators of a Class VI well must identify the wells in the AoR that need corrective action to prevent the movement of CO_2 or other fluids into or between USDWs, and must perform corrective action to address deficiencies in any wells (regardless of ownership) that are identified as potential conduits for fluid movement into USDWs.

Wells that penetrate the injection zone must be properly constructed to prevent fluid migration up these wellbores. Owners and operators are responsible for performing corrective action to ensure that wells within the AoR do not serve as conduits for the movement of fluids into USDWs.

Preventing injected fluids from migrating through faults or fractures in confining strata

Fluids may be forced upward out of the injection zone through transmissive faults or fractures in the confining zone. Under the GS Rule, owners or operators of Class VI wells must conduct extensive geologic investigations to demonstrate that injection sites have appropriate injection and confining zones that can store and contain the injected CO_2. In addition, the owners or operators must verify the absence of transmissive faults or fractures that could allow fluids to move between formations. The UIC Program Director may require owners or operators to identify and characterize additional confining zones that will impede vertical fluid movement. (For additional information on siting criteria, see 40 CFR 146.83.)



Components of a Class VI well (not to scale).

Injection pressures are limited such that pressure in the injection zone may not exceed 90% of the fracture pressure of the injection zone, and that injection may not initiate new fractures or propogate existing fractures in the injection or confining zones. The calculated fracture pressures and injection pressure limits are based on site-specific geologic and geomechanical data collected during the site characterization process. (For additional information on injection pressure limitations, see 40 CFR 146.88.)

Preventing native fluids from lateral displacement into hydraulically-connected USDWs

Once injected, CO_2 may move laterally in the injection zone, and there is also a risk of lateral displacement of native fluids into connected USDWs, depending on the proximity of USDWs to the Class VI well in the AoR. When an injection well is sited, permit information regarding the proximity of USDWs to underground injection wells is considered by the permitting authority. Well operators are required to control injection pressure and conduct monitoring and testing to track migration of fluids.