Nuclear Regulatory Commission
The National Mining Association
Uranium Recovery Workshop

Underground Injection Permitting

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Underground Injection and In Situ Leach (ISL) Operations

- Many ISL operations use two types of injection wells
  - Class III ISL recovery wells (all ISL operations)
  - Class I residuals injection wells (many operations)
- Aquifer Exemptions are often needed for the formations into which ISL Class III or Class I wells inject
- NRC has directed staff to meet with EPA and others and to develop groundwater regulations for ISL operations - issues to be resolved are both jurisdictional and technical
- Other UIC regulatory issues that might affect permitting

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ISL Recovery of Uranium

- ISL currently is the most prevalent technique for recovery of uranium
- 80% of the uranium extracted in the US is produced this way
- Injection wells are drilled to the formation containing the mineral salt, which lies within an aquifer
- Production operation wells are divided into three categories with essentially the same type of construction
  - Injection wells
  - Extraction wells
  - Monitoring wells
- All of these are emplaced into the formation containing the mineral

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ISL Recovery of Uranium

The process used for the extraction of the uranium salts includes:

- Injecting a leaching solution, called lixiviant, into the mineral formation
  (Lixiviants for uranium mining commonly consist of oxygenated water and carbon dioxide or sodium bicarbonate, which mobilize uranium)
- Providing sufficient contact of the lixiviant with uranium in the mineral zone;
- Extracting nearly saturated lixiviant;
- Separating the uranium salts from the lixiviant;
- Bleeding off excess fluid (which fluid and other residuals go to disposal);
- Adding chemicals to restore proper concentrations in the lixiviant;
- Re-injecting the lixiviant and repeating the recovery steps

More fluid is extracted than injected to prevent contamination of the surrounding formation of the mining intervals, that in many cases are USDWs.

UIC Program Key Concepts

Aquifer: An underground geologic formation, or group of formations, containing usable amounts of groundwater that can supply drinking water wells or springs

Underground Source of Drinking Water (USDW): An aquifer or portion of an aquifer that

- Supplies any public water system or contains a quantity of ground water sufficient to supply a public water system, and
- Currently supplies drinking water for human consumption, or
- Contains fewer than 10,000 mg/L total dissolved solids and is not an exempted aquifer

Well:

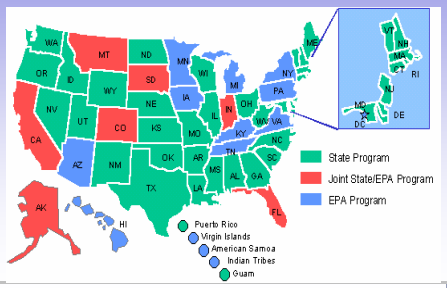
- A bored, drilled or driven shaft whose depth is greater than the largest surface dimension, or
- A dug hole whose depth is greater than the largest surface dimension, or
- An improved sinkhole, or
- A subsurface fluid distribution system

Well Injection: Subsurface discharge of fluids through a well

UIC Program Well Classes

- Class I (~500 wells)
  - Inject hazardous wastes beneath the lowermost USDW
  - Inject industrial non-hazardous liquid beneath the lowermost USDW
  - Inject municipal wastewater beneath the lowermost USDW
- Class II (~147,000 wells)
  - Dispose of fluids associated with the production of oil and natural gas
  - Inject fluids for enhanced oil recovery
  - Inject liquid hydrocarbons for storage (natural gas storage not covered)
- Class III (~17,000 wells)
  - Inject fluids for the extraction of minerals
- Class IV (~40 sites)
  - Inject hazardous or radioactive waste into or above a USDW.
  - This activity is Banned.
  - These wells can only inject as part of an authorized cleanup
- Class V (Range from >500,000 to >685,000)
  - Wells not included in the other classes. Inject non-hazardous liquid into or above a USDW.

UIC Program Primacy



Underground Source of Drinking Water (USDW)

- The U.S. Environmental Protection Agency (EPA) permits injection wells for uranium ISL operations under the 40 CFR Parts 144-146
- Section 144.3 of Title 40 of the Code of Federal Regulations defines an underground source of drinking water as:

  Underground Source of Drinking Water (USDW) means an aquifer or its portion: (a)(1) ***Which supplies any public water system****; or*
  (2) Which contains sufficient quantity of ground water to supply a public water system; and
  (i) ***Currently supplies drinking water for human consumption****; or*
  (ii) Contains fewer than 10,000 mg/l total dissolved solids; and
  (b) Which is ***not an exempted aquifer****.*
- This definition is very protective and includes a large number of aquifers in the US.

Prevention of Endangerment

"Underground injection endangers drinking water sources if such injection may result in the presence in underground water which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons."

SDWA § 1421(d)(2); 42 U.S.C. § 300h(d)(2).

Regulatory Definition of Class III Wells

40 CFR section 144.6

(c) **Class III**. Wells which inject for extraction of minerals including:

* * *

(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.

UIC Permitting Requirements

- For a new Class I, II or III well, the owner/operator must file an application with the UIC Director with the specific information listed in 40 CFR 146 or in the applicable State program.
- Applicant must demonstrate that USDWs will be protected.
- The key areas of information are:
  1. geological considerations used in the well siting and design, including information on all USDWs penetrated by the injection well;
  2. structural integrity of the well;
  3. specific operational considerations used in well design;
  4. information on the status of wells in the area of review that penetrate the injection zone; and
  5. the proposed monitoring plan for the facility.

Common UIC Permitting Requirements

- The monitoring program must consider quantity and quality of injected fluids and existing reservoir conditions.
- Applicants must submit data on all existing and abandoned wells that penetrate the injection zone within the area of review (AOR) of proposed injection wells.
- Casing and cementing information for all wells in the AOR
- Director uses this information to determine if any wells in the AOR require corrective action prior to commencement of injection.
- Information to calculate the injection pressure curve
- Applicants must also provide an appropriate demonstration of financial responsibility for operation and closure of the facility.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class I Operating Requirements - 1

- All new injection wells require a Permit prior to construction.
- Area of review is a minimum of 1/4 mile, except for some Indian Country.
- Injection between the outermost casing and the wellbore is prohibited.
- All injection wells must be tested for mechanical integrity prior to operation. This includes both a pressure test to demonstrate the absence of casing, tubing, or packer leaks and a valid temperature, oxygen activation or noise log (or approved alternative log) to demonstrate the absence of vertical fluid movement.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class I Operating Requirements -2

- Permits are issued for up to ten years.
- Injection pressure must be limited so that no fracturing of the injection zone occurs except for stimulation.
- Area Permits are allowed for nonhazardous injection wells.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class I Monitoring Requirements - 1

- Continuous monitoring of annulus pressure, injection pressure, flow rate, and volume is required.
- An annual pressure falloff test of the injection reservoir must be performed in each Class I injection well. The results must be analyzed, including a comparison with previous tests, for major reservoir characteristics to determine if significant changes are occurring within the reservoir, especially immediately adjacent to the wellbore.
- Class I hazardous waste injection wells require a written waste analysis plan.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class I Monitoring Requirements - 2

- UIC Director may require Class I well applicants to obtain, interpret and submit seismic data for the site.
- UIC Director may require Class I wells to have ground-water monitoring in the 1st aquifer overlying the injection zone with quarterly sampling.
- Nonhazardous waste injection wells must demonstrate mechanical integrity at least once every five years unless the Director waives the requirement.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class I Reporting Requirements

- Any noncompliance with UIC regulations must be reported orally to EPA within 24 hours of discovery and in writing within five (5) days.
- Submit Quarterly Report (EPA Form 7520-11 is suggested) containing:
  1. the physical, chemical and other relevant characteristics of injected fluid;
  2. observations of monthly average, maximum and minimum values for injection pressure, flow volume and rate and the pressure on the casing/tubing annulus; and
  3. the results of any on-site groundwater monitoring.
- The first quarterly report after completion must include the results of periodic MIT, any well workover, and any other tests required by the Director.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class I Hazardous Waste Well Requirements

- Hazardous waste injection wells must have surface casing set through all USDWs. This casing must be cemented to the surface.
- The minimum Area of Review for HW wells is 2 miles
- Hazardous waste injection wells must have an annual Radioactive Tracer Survey (RTS) to demonstrate integrity of bottom-hole cement.
- Hazardous waste injection wells are subject to the land disposal restrictions.
- Class I hazardous waste injection wells require a written waste analysis plan.
- Class I hazardous waste injection wells must have a casing inspection log whenever there is a well workover.
- Hazardous waste injection wells must demonstrate internal mechanical integrity (pressure test to demonstrate no leaks in casing, tubing, or packer) once per year
- Class I hazardous wells are subject to post-closure monitoring requirements.
- For all hazardous waste injection wells, the Director must be notified within 24 hours of any well alarm or well shutdown.

Class III Operating Conditions - 1

- All new operations require a permit.
- Permit may be for up to the life of the well or project.
- UIC Director must review the Permit at least once every five years.
- Area permits may be issued for multi-well projects.
- Area of review is a minimum of 1/4 mile from the boundary of the permitted project area or wellbore if this is not an area permit.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class III Operating Conditions - 2

- Operator must monitor overlying or underlying underground sources of drinking water, if injection occurs into a formation containing water with a TDS of less than 10,000 mg/liter (See 40 CFR 146.32(e)).
- New injection wells must demonstrate mechanical integrity.
- Injection wells constructed with PVC casing (used primarily for shallow uranium solution mining) may demonstrate part II of mechanical integrity, the absence of significant flow adjacent to the casing, by circulating cement to the surface.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class III Monitoring Requirements

- Operator must obtain a sample of the injection fluid and analyze it for specified parameters with sufficient frequency to yield representative data on its characteristics, and thereafter when changes are made to the injection fluid.
- Operator shall observe the injection pressure and flow rate or volume, semimonthly or metering and daily recording of injected and produced fluid volumes as appropriate.
- Operator must monitor ground-water monitoring wells quarterly.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class III Reporting Requirements - 1

- Operator must report any noncompliance with UIC regulations orally to EPA within 24 hours of discovery and in writing within five (5) days.
- Submit quarterly Monitoring Report (EPA Form 7520-11 or State equivalent) on required monitoring to the UIC Director.
- If a change of ownership occurs for rule-authorized wells, the operator must notify EPA within 30 days of such transfer. Permitted wells require 30 days notice in advance of the proposed transfer date. An Application to Transfer Permit (EPA Form 7520-7or State equivalent).
- Notify the UIC Director of company change of address at least 15 days prior to the effective date.
- Submit Well Rework Record (EPA Form 7520-12 or State equivalent) within 60 days of any well workover.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Class III Reporting Requirements - 2

- Notify EPA at least 30 days prior to performing a mechanical integrity test (MIT). Shorter notice is permissible if sufficient time is allowed for EPA to witness the test.
- Operator must provide the UIC Director with test results within 30 days, unless MIT failure occurs (pressure change of 10% or greater within 30 minutes), in which case notification must be within 5 days.
- Notify the UIC Director at least 45 days prior to initiating plugging and abandonment of a well. A shorter notice is permissible if sufficient time is allowed for the UIC Director to witness the operation.
- Submit a Plugging Record (EPA Form 7520-13 or State equivalent) within 60 days of plugging and abandonment of a well, specifying the manner in which the well was plugged.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

Permitting Procedures

- Following a completeness review, the applicant will be notified of the items needed for a complete application, if any.
- When the application is complete, a technical review will be conducted and decision to issue or deny the permit will be prepared and published with appropriate public notice and participation.
- The public notice period is a minimum of 30 days.
- Anyone may request that the Director hold a public hearing to provide opportunity for commentors to prsent objections or information regarding the proposed permit.
- If the Director determines that there is sufficient reason for a hearing, a notice of the hearing must be issued for minimum period of 30 days.
- Any comments received during this period will be addressed in the final permit decision.
- When the Final Permit is prepared, it may be issued effective immediately if there have been no adverse comments during the Public Comment period.

U.S. EPA Technical Program Overview: Underground Injection Control Regulations, Appendix (2001).

UIC Aquifer Exemptions

Aquifer Exemptions

- In addition to obtaining UIC permits and meeting restoration requirements, ISL operators must obtain USDW exemptions.
- Through the UIC aquifer exemption process, EPA and its delegated Primacy States determine if an aquifer or part of an aquifer is exempt from protection as an underground source of drinking water during the mining process.
- Approval of this exemption is necessary before a UIC permit may be issued for ISL mineral extraction wells
- EPA requires, however, that non-exempted groundwater sources be protected from contamination. It is permanent.

Underground Source of Drinking Water (USDW)

- Section 144.3 of Title 40 of the Code of Federal Regulations defines a USDW as:

  Underground Source of Drinking Water (USDW) means an aquifer or its portion: (a)(1) Which supplies any public water system; or
  (2) Which contains sufficient quantity of ground water to supply a public water system; and
  (i) Currently supplies drinking water for human consumption; or
  (ii) Contains fewer than 10,000 mg/l total dissolved solids; and
  (b) Which is not an exempted aquifer.

- This definition is very protective and includes a large number of aquifers in the US.

Aquifer Exemptions

- Most, if not all, Class III ISL operations will take place in USDWs.
- These aquifers must be exempted in accordance with 40 CFR §146.04 in order for these operations to be legal.
- All information necessary for EPA to approve the exemptions can be included in an initial UIC State program approval application
- This includes a demonstration that the aquifer is not currently used and that it meets one of the criteria of §146.4(b).
- The aquifer must also be identified in terms of areal extent and depth.
- Exemptions can be granted subsequent to approval of the State program under 40 CFR §144.7(b)(3).

Exemption Criteria §146.4(b)(1)

- Aquifer cannot now and will not in the future serve as a source of drinking water because:
  - it is mineral, hydrocarbon, or geothermal energy producing

  or
  - can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible

Aquifer Exemptions

- Following EPA approval of a State UIC program, the State will from time to time make program changes which will constitute revisions to the approved program.
- The UIC regulations differentiate between "substantial" revisions which are rulemaking and must be approved by the Administrator and "non-substantial" revisions which can be approved by a letter to the Governor.
- "Substantial" revisions include proposed exemptions of an aquifer containing water of less than 3,000 mg/l TDS which is: (a) related to any Class I well; or (b) not related to action on a permit, except in the case of enhanced recovery operations authorized by rule.

Exemption Process

- A state can also designate (and request approval from EPA for) some aquifers that meet the criteria for USDW as exempted from this definition if they don't serve as a source of drinking water and they will never serve as a source in the future.
- Exemptions are granted for aquifers that contain commercial minerals (such as oil, gas, uranium and table salt) or for the purpose of injection.
- EPA makes the final determination on all exemptions.
- EPA also offers a chance for a public hearing, if the water in the aquifer has less than 3,000 mg/l concentration of dissolved solids.
- Final exemption removes the specified portion of the aquifer from definition and regulation as a USDW

Solution Mining Exemption

- To demonstrate producibility the applicant for a Class III injection well permit may provide a map and general description of the mining zone, analysis of the amenability of the mining zone to the proposed mining method, and a production timetable.
- Applicants for an exemption for a Class II injection well may demonstrate producibility by providing information such as logs, core data, drill stem test information, a formation description, and oil data for the well in question or surrounding wells.

Aquifer Exemption Process

- For all aquifer exemptions, the EPA Regions should notify OGWDW
- If the exemption constitutes a substantial program revision, or requires OGWDW concurrence, as much of the supporting material as feasible should be sent along.
- Aquifer exemptions that constitute “substantial revisions” will be handled as a rulemaking.
- Where OGWDW concurrence for non-substantial revision is necessary it will be in the nature of a telephone call from
- Approval will be confirmed later by a memorandum.

EPA UIC Guidance 34.

Other Aquifer Exemptions

An aquifer or portion thereof, meeting the definition of a USDW, can be exempted for the **purpose of injection** if it meets the following criteria:

a) It does not currently serve as a source of drinking water; and

b) It cannot now and will not in the future serve as a source of drinking water because:

- 1) It is mineral, hydrocarbon, or geothermal energy producing;
- 2) It is situated at a depth or location which makes recovery of water economically or technologically impractical;
- 3) It is so contaminated that it would be impractical to make the water fit for consumption;
- 4) It is located over a Class III well mining area subject to subsidence or catastrophic collapse; or

c) The total dissolved solids content of the ground water is more than 3000 mg/liter and less than 10,000 mg/liter and it is not reasonably expected to serve a public water system.

Prevention of Endangerment

"Underground injection endangers drinking water sources if such injection may result in the presence in underground water which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons."

SDWA § 1421(d)(2); 42 U.S.C. § 300h(d)(2).

Ground Water Restoration

Monitoring and Restoration for Protection of USDWs

- Class III Permit includes restoration standards for USDW after mining
- Operator conducts baseline monitoring to determine initial ground water quality
- Operator posts bond and is required to restore the USDW to approximately its pre-mining quality
- Operators of Class III mining projects are usually required to monitor the boundaries of the mined area for fluid excursions and correct them
- For wells completed in USDWs, semi-monthly monitoring of the injection zone and overlying USDWs is generally required
- Class III well owners and operators must report well data annually

Ground Water Protection and Restoration

- EPA groundwater protection standards issued under authority of UMTRCA are required to be followed by ISR licensees of the NRC or its Agreement States.
- Remediation of groundwater in the wellfield must be conducted to return the groundwater and other systems to as close to pre-extraction conditions, or EPA drinking water maximum contaminant levels (MCLs) where possible or practical.
- If that is not possible, alternate concentration limits (ACL's) in terms of the presence of metals, organics, pH level, and radioactivity, may be approved by the NRC or its Agreement States, with EPA concurrence.
- In addition to those requirements, ISL operators also must comply with the EPA Underground Injection Control (UIC) regulations.

EPA Regulations

- EPA's regulations issued under UMTRCA authority appear in 40 CFR Part 192 and provide the principal standards for uranium ISR operations and groundwater protection, while the UIC regulations are considered additional requirements for ISR operations.
- Under UIC permits the Agency usually exempts that portion of an aquifer constituting the well field from meeting drinking water standards.
- However, under EPA standards established under UMTRCA authority, the operator of the ISR restores the well field to either background, or EPA drinking water maximum contaminant limit levels where possible or practical.
- When this cannot be accomplished, alternate concentration limits (ACL's) in terms of the presence of metals, organics, pH level, and radioactivity, may be approved by the NRC or its Agreement States, with EPA concurrence.

EPA, Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining 2-10 (2006).

Applicable EPA Requirements

- Not every ISR operation generates large quantities of these wastes, as the quantities are determined by the ore body's geochemical characteristics and its interactions with the leachate solutions.
- Data collected by EPA in 2000, from reports on files at the NRC and the state agencies in Texas and Wyoming, showed radium-226 in the wastewater can range from background levels to 2,119 pCi/L (78.4 Bq/L), whereas total uranium may be as high as 1,100 mg/L (see Appendix V).
- NRC and state licensing and permits at uranium solution mining sites require cleanup of all surface wastes.
- Aquifer restoration may or may not be required by the regulating agencies depending upon its geologic and hydrologic conditions.

EPA, Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining 3-22 (2006).

ISR Restoration Requirements

- When ISL process is completed, the ore body and aquifer are placed in a restoration phase, as required by mine permits, NRC and Agreement State regulatory programs.
- Typically, the aquifer must be restored to background or EPA drinking water maximum contaminant limit levels where possible or practical, or to alternate concentration limits (ACL's) in terms of the presence of metals, organics, pH level, and radioactivity, approved by the NRC and its Agreement State s, with EPA concurrence.
- Therefore, in some cases, restoring it to the preoperation level does not necessarily make it potable.
- EPA groundwater protection standards issued under authority of UMTRCA are required to be followed by ISL licensees of the NRC and its Agreement States.

EPA, Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining 2-10 (2006 supp).

NRC Ground Water Protection Rule

NRC Ground Water Protection Rule

- Beginning in 2003, NRC pursued MOUs to defer ground water protection at ISRs to non-Agreement states [those lacking authority to regulate 11e(2) material] with UIC Program Primacy
- In January 2006, NRC decided to change approach and develop ground water protection regulations to eliminate dual regulation
- NRC would retain jurisdiction over production wellfield and ground water under Atomic Energy Act
- NRC would defer active regulation of underground injection wells and ground water programs to EPA or Primacy states under UIC program
- For current licensees, enforcement discretion would be used to allow compliance with state GW requirements in lieu of license conditions

"Milling of Uranium"

- NRC claims jurisdiction and licensing authority over "the milling of uranium" (as defined in 10 CFR 40.4).
- NRC concludes that this gives it regulatory authority over the extraction portion of ISR operations, unless
  - either a State enters into an agreement with the NRC which provides for the discontinuance of the NRC's regulatory authority over the activities associated with uranium and thorium recovery facilities pursuant to section 247b. of the Atomic Energy Act of 1954, as amended (AEA),
  - or a statutory change is made

NRC Ground Water Protection Program

- The processes involved in ISL mining of uranium from an underground ore zone chemically alter the groundwater quality relative to the conditions that existed before the onset of operations.
- After the completion of uranium recovery in a particular mining area, licensees are required to restore the affected groundwater to established standards to assure the protection of public health, safety, and the environment.
- Because the most significant impact of ISL mining is the chemical alteration of the groundwater in the ore zone of interest, the groundwater restoration elements of the NRC's groundwater protection program are the most important aspects of the NRC's program for ISL facilities.

Source: NRC SECY-05-0123, July 8, 2005 (p. 2)

UIC REGULATORY ISSUES

UIC Program Facing Demands

- UIC program demands also increasing
  - Class V program implementation pressures continue
  - Drinking Water Treatment Residuals (Classes I, II, V)
  - Aquifer Storage and Recovery programs
  - Greenhouse Gas Geological Sequestration
- Increased emphasis on source water protection
- EPA OGWDW also faces significant Drinking Water Program demands for Public Water Systems
- Resources are flat with pressures to reduce funding

Carbon Capture and Geologic Sequestration

- Substantial increase in interest
- Legislative developments
  - Principal immediate focus on increased funding for demonstration projects on commercial scale
  - MIT Report on the Future of Coal
  - Increasing appropriations from $79 MM to $279 MM
  - Climate change legislation and hearings highlighting GS

Recent Database Developments

- EPA to create national UIC Program database by the end of this year
- This is a high priority for the national UIC program
- Getting closer to having acceptable working system
  - States were having problems with EPA's approach
  - Recent EPA adjustments have addressed many of the concerns
  - Greatest concerns over potential misinterpretation of data – especially data types that differ from one state to another

Texas Regulatory Action

- The commissioners of the Texas Commission on Environmental Quality (TCEQ) have directed the staff to review all rules pertaining to Class III wells
- A new rulemaking to revise these rules is anticipated
- Legislation may be enacted by the current session of the Texas Legislature that will affect this rulemaking for Class III wells

Underground Injection Technology Group (The UIT Group)

- Member association of injection well operators
- Primarily Class I industrial injection well operators
- Includes companies operating other classes of wells

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