CLASS I, CAVERNS, & CLASS V WELLS

*(This handout is provided as a companion to the **Class I, Caverns and Class V Wells** PowerPoint slide presentation.)*

WELL TYPES, REGULATIONS, AND APPLICATION FORMS

(SLIDE NO. 2)

	Class I Non-Haz Waste Injection	Class I Hazardous Waste Injection	Class II Hydrocarbon Storage	Class II E&P Waste Disposal Salt Caverns	Class III Solution Mining	Class V
Statewide Order	29-N-1	29-N-2	29-M	29-M-2	29-N-1	29-N-1
Louisiana Admin Code	LAC 43: XVII.103 Chapter 1	LAC 43: XVII.201 Chapter 2	LAC 43: XVII.301 Chapter 3	LAC 43: XVII.3101 Chapter 31	LAC 43: XVII.103 Chapter 1	LAC 43: XVII.103 Chapter 1
Application Forms	UIC-1	UIC-1	UIC-2 HSW	UIC-43	UIC-3BR	UIC-25

OVERVIEW OF WELL CLASS COMPARISONS

(SLIDE NO. 4)

	Class I Non-Haz	Class I Hazardous	Class II Storage	Class III Solution Mining	Class V
Statewide Order	29-N-1	29-N-2	29-M	29-N-1	29-N-1
Three copies	✔	✔	✔	✔	n/a
Financial Responsibility	✔	✔	✔	✔	n/a
AOR Radius					
Artificial penetrations	2-Mile	> of 2-Mile or COI	1/4 Mile	1/4 Mile	1/4 Mile
Fresh water wells	1/4 Mile	1/4 Mile	1/4 Mile	1/4 Mile	1/4 Mile
Well Construction					
Cemented casings	min. 2	min. 2	min. 2	min. 2	1
Tubings	min. 1	min. 1	min. 1	min. 2	n/a
Screens	n/a	n/a	n/a	n/a	1
Packers	✔	✔	n/a	n/a	n/a

	Class I Non-Haz	Class I Hazardous	Class II Storage	Class III Solution Mining	Class V
Logging and Testing Programs					
Logging Program	✔	✔	✔	✔	n/a
Injectivity Tests	✔	✔	n/a	n/a	n/a
Cement Bonding	✔	✔	✔	✔	n/a
MIT	every 6 mon. *	every 6 mon. *	every 5 years	every 5 years	n/a
Geomechanical studies	n/a	n/a	✔	✔	n/a
Formation Testing	✔	✔	n/a	n/a	n/a
Injection Fluids testing	✔	✔	n/a	✔	n/a
Monitoring & Reporting	✔	✔	✔	✔	n/a
Geology and Hydrology					
Cross sections	✔	✔	✔	✔	✔
Aquifer Evaluation	✔	✔	✔	✔	n/a
Operating Conditions					
Safety Requirements	✔	✔	✔	✔	n/a
Contingency Plans	✔	✔	✔	✔	n/a
Closure	✔	✔ **	✔	✔	n/a
Permit Process					
Duration of Permit	10 years	10 years	No term	No term	10 years
Public Hearing	✔	✔	✔	✔	n/a
Permit to Construct	✔	✔	✔	✔	✔
Permit to Inject	✔	✔	✔	✔	n/a
* Commercial Class I - MITs quarterly					
** Class I Hazardous Wells also with Post-Closure					

PERMIT APPLICATION CONTENT COMMON TO CLASS Is AND SALT CAVERNS

(SLIDE NO. 5)

- Certified Plat
- Regional Geology
- Local Geology
  - Base of USDW
  - Freshwater Aquifers
  - Stratigraphy (Cross Sections)
  - Structure Maps
  - Injection Zone
  - Seismic Activity
  - Flood Areas
- Technical Report
- Monitoring ,Testing & Reporting
- Contingency Plans
- Closure & Post-closure Plans
- Financial Responsibility
- IT Questions
- Adjacent Property Owners' Names & Addresses

CROSS SECTION PROFILES

(SLIDE NOS. 7-12)

- Should include information from literature, seismic data, and facility records.
- Must be prepared to professional geological standards (vertical and horizontal scales, orientation, legend, preparer's name and date of preparation)
- Include an index map to show the cross sections lines
- If logs are available, include the closest wells to the proposed well
- The Operator's name, Well Name and Number, Well Serial Number, and Well Status should be identified above each one of the wells used to construct the cross sections
- Distance between the wells
- Electrical log copies scaled and included in the cross sections
- Indicate the extent of the AOR and property lines
- Indicate the USDW, Aquifer Systems, Age of Major geological units
- Stratigraphic correlations based on particular stratigraphic units should be marked clearly throughout the cross sections
- Proposed perforated interval needs to be marked
- The proposed top and bottom of the injection zone should be marked clearly
- The Confining zone should be marked clearly
- Indicate the horizontal extent of major surface features

DISCUSSION SPECIFIC TO EACH CLASS OF WELL

(SLIDE NOS. 14-22)

CLASS I INJECTION WELLS

CLASS I INJECTION WELLS – isolate hazardous, industrial and municipal, or radioactive wastes from the lowermost formation containing, with ¼ mile radius of the well bore, an underground source of drinking water.

CLASS I NON-HAZARDOUS

- **Area of Review of Artificial Penetration Wells**
  - No less than 2-Miles
- **Area of Review for fresh water wells**
  - ¼ Mile radius
- **Injection Zone Reservoir Properties**
  - Porosity and Permeability
  - Lithology of the Injection Formation
  - Bottomhole Temperature and Pressure
  - Formation Fracture Pressure
- **Waste Stream Characterization**
  - Chemical and Physical properties of the injection fluid
  - Compatibility with Formation
- **Periodic Mechanical Integrity Tests**
  - RTS
  - Temperature Logs
  - Oxygen Activation Logs

CLASS I HAZARDOUS

Essentially the same requirements as Class I Non-Hazardous wells with the addition of the following:

- **Modeling should be done to prove:**
  - That the injection zone has sufficient permeability, porosity, thickness and areal extent to prevent migration of fluids into USDWs or outside of the injection zone.
  - That the confining zone is laterally continuous and free of transecting, transmissive faults or fractures over an area sufficient to prevent the movement of fluids into USDW or outside the injection zone; and
  - Contains at least one formation of sufficient thickness and with lithological and stress characteristics capable of preventing vertical propagation of fractures.
- **Area of Review of Artificial Penetration Wells**
  - 2-Miles around the well OR the calculated cone of influence of the well, whichever is greater
  - <u>For wells within ½ Mile radius of injection well, include</u>:

- Copies of casing and cementing records (including cementing affidavits)
- Copies of plugging and completion records; and
- Schematic diagrams of each well

CLASS II HYDROCARGON STORAGE WELLS

CLASS II HYDOCARBON STORAGE WELLS - inject hydrocarbons in underground formations (such as salt caverns) where they are stored.

- **Structure map showing Top of Salt**
- **Well Construction Requirements**
  - Two strings of casing cemented into the salt
  - Deepest cemented casing at least 300 feet into the salt
- **Storage Cavern Location and Geometry**
  - Maximum development diameter of the storage chamber shall be no less than 100 feet from property lines
  - Distance separation between cavern walls shall be no less than 200 feet as measured in any direction
  - Distance of the cavern to the edge of the salt shall be no less than 300 feet
- **Geomechanical Studies and Modeling**
  - To determine maximum and minimum operating pressure of the storage chamber
- **Subsidence Program** - including semi-annual subsidence surveys for gas storage or annual subsidence surveys for liquid storage
- **Sonar Survey Reports of the mined cavern** (every 5 years)
- **MITs – typically Nitrogen/Brine Tests** (every 5 years)
  - Must include 60-minute casing test and at a minimum a 24-hour cavern system test.

CLASS III SOLUTION MINING WELLS

CLASS III WELLS – inject fluids for extraction of minerals or energy. Currently, all permitted Class III wells in Louisiana are salt SOLUTION MINING WELLS.

- **Structure map showing Top of Salt**
- **Evaluation of Groundwater (typically freshwater) Pumpage for Cavern Development**
  - Number of wells to be installed
  - Projected volume of water needed
  - Expected volume of cavern

- Time required to complete the project
- Contact the Environmental Division of the Office of Conservation

- **Groundwater analysis of the source of mining water**
  - The analysis sheet(s) must identify the freshwater well sampled
  - At minimum include measurements of: Chloride and TDS.
- **Sonar Survey Reports of the mined cavern** (every 5 years)
- **MITs – typically Nitrogen/Brine Tests** (every 5 years)
  - Must include 60-minute casing test and at a minimum a 24-hour cavern system test.
- **NOTE:** Class III applications should not refer to regulations in 29-M or 29-M-2 even if the cavern is being developed for storage or E & P Waste Disposal purposes.

TECHNICAL REPORT

(SLIDE NOS. 24-44)

TECHNICAL REPORT REQUIREMENTS FOR CLASS I NON-HAZARDOUS WELLS

- **Proposed Operating Data**
  - Average and maximum daily rate and volume of the injection fluid
  - Average and maximum injection pressure
  - Source and analysis of the chemical, physical and biological characteristics of the injection fluid
- **Proposed Formation Testing Program**
  - To obtain an analysis of the characteristics and properties of the injection zone and the confining zone
- **Proposed Stimulation Program**
- **Proposed Injection Procedures**
  - Include storage and pre-injection treatment of the waste stream and well use schedule
- **Plans (Include Maps)**
  - For meeting the monitoring requirements of LAC 43:XVII.109.A.7 (209.I.1 for Class I Hazardous Wells)
- **Construction Procedures**
  - <u>Include the following</u>:
    - Casing and cementing program

  - Logging procedures and deviation checks
  - Drilling, testing and coring program
- **Contingency Plans**
  - To cope with all shut-ins or well failures in order to prevent fluid migration into the USDW
- **Calculation of The Pressure Increase**
  - In the proposed injection zone for a time period equal to the expected life of the well. May use Matthews and Russell, 1967 *Pressure Buildup and Flow Tests in Wells*, American Institute of Mining, Met. Eng. Monograph, Vol. 1
- **Calculation of Expected Waste Front Travel** – a conservative value can be estimated by using the waste front travel calculation from Warner, D.L. and Lehr, J.H., *An Introduction to the Technology of Subsurface Wastewater Injection*, Robert S. Kerr Environmental Research Laboratory (EPA) Research Report, 1977)

TECHNICAL REPORT REQUIREMENTS FOR CLASS I HAZARDOUS WELLS

Same requirements as Class I Non-Haz with the addition of the following (Items 1-3 below):

- **Data table on all wells which penetrate the proposed zone within a 2-mile Area of Review (AOR) or the calculated cone of influence of the well, whichever is greater**
  - For wells within a ½-mile radius of the injection well, also include the following:
    - Copies of casing and cementing records (include cementing affidavits)
    - Copies of plugging and/or completion records
    - Schematic diagrams of each well
- **Financial Assurance for Closure (P&A) and Post-Closure Care**
  - Through a performance bond or other appropriate means
- **Plans for Closure and Post-Closure Care**

TECHNICAL REPORT REQUIREMENTS FOR CLASS II HSW WELLS

- **Info on manmade structures within the salt stock regardless of use, depth of penetration or distance to the salt cavern**
  - Tabular listing of all salt caverns to include the following:
    - Operator name, well name and number, state serial number and well location
    - Current or previous use of the salt cavern (waste disposal, hydrocarbon storage, solution mining), current status of the salt cavern (active, shut-in, P&A'd), date

the salt cavern well was drilled and the date the current salt cavern status was assigned

- Salt cavern depth, construction, completion (including completion depths), P&A data

- Tabular listing of all conventional (dry or room and pillar) mining activities, whether active or abandoned
  - Include the following:
    - Owner or operator name and address
    - Current mine status (active or abandoned)
    - Depth and boundaries of mined levels
    - Closest distance to the mine in any direction to the salt cavern well and salt cavern

- **Corrective Action Plan** – for "deficient" manmade structures within the Area of Review (AOR) that penetrate the salt stock but are not properly constructed, completed or P&A'd
- **Surface Site Diagram(s)** – drawn to scale to include details and locations of the entire salt cavern hydrocarbon storage facility layout
  - Include the following:
    - Surface pumps, piping and instrumentation
    - Controlled access roads, fenced boundaries
    - Hydrocarbon offloading, storage, treatment and processing areas
    - Field office, monitoring and safety equipment and location of such equipment
    - Required curbed or other retaining wall heights, etc.
- **Detailed plans & procedures to operate the well and related facilities in accordance with the following requirements:**
  - Cavern and Surface Facility Design Requirements including:
    - Cavern spacing requirements
    - Cavern coalescence
  - Operating Requirements including:
    - Cavern roof restrictions
    - Blanket material
    - Remedial work
    - Well recompletion

- Multiple well caverns
- Cavern allowable operating pressure and rates
- Cavern displacement fluid management

- Safety Requirements including:
  - Emergency action plan
  - Controlled site access
  - Facility identification
  - Personnel
  - Wellhead protection and identification
  - Valves and flowlines
  - Alarm systems
  - Emergency shutdown valves
  - Vapor monitoring and leak detection
  - Gaseous vapor control
  - Fire detection and suppression
  - Systems test and inspections
  - Surface facility retaining walls and spill containment
  - Contingency plans to cope with all shut-ins or well failures to prevent fluid migration into the USDW
- Monitoring Requirements and Equipment Requirements including:
  - Pressure gauges
  - Pressure sensors
  - Flow sensors
  - Continuous recording instruments
  - Leak detection
  - Subsidence monitoring
  - Description of methods that will be taken to monitor salt cavern growth due to under-saturated fluid injection
- Pre-Operating Requirements including:
  - Submission of a completion report and required information prior to accepting, storing or otherwise initiating storage activities
- Mechanical Integrity Pressure and Leak Test Requirements including:

- Frequency of tests
- Test methods
- Submission of pressure and leak test results
- Notification of test failures

- Cavern Configuration and Capacity Measurement Procedures including:
  - Sonar caliper surveys
  - Frequency of surveys and submission of survey results
- Inactive Cavern Requirements
- Record Retention Requirements
- Closure Requirements including:
  - Closure plan requirements
  - Standards for closure
- Any other information pertinent to operation of the salt cavern storage facility

TECHNICAL REPORT REQUIREMENTS FOR CLASS III WELLS

- **Proposed Operating Data**
  - Average and maximum daily rate and fluid volume to be injected
  - Average and maximum injection pressure
  - Qualitative analysis and ranges in concentrations of all constituents of injected fluids
- **Proposed Formation Testing Program** – to obtain the information required by LAC 43:XVII.109.B.4.c and d
- **Proposed Stimulation Program**
- **Proposed Injection Procedure**
- **Plans (include maps)** – for meeting the monitoring requirements of LAC 43:XVII.109.B.7
- **Financial Assurance** – through a performance bond or other appropriate means, the resources necessary to close or P&A the well as required by LAC 43:XVII.109.B.10 and 107.C
- **Corrective Action Plan** – for wells within the AOR which penetrate the injection zone but are not properly completed or plugged

A BRIEF DISCUSSION OF CLASS V INJECTION WELLS

INTRODUCTION

(SLIDE NOS. 46-47)

Under Provisions of the Safe Drinking Water Act of 1974, the U.S. Environmental Protection Agency (EPA) delegated Louisiana with full permitting and enforcement authority of the State's UIC Program in March 23, 1982.

In Louisiana, regulations for Class V well are included under the Statewide Order 29-N-1, more specifically under LAC 43:XVII, Chapter 1.

EXAMPLES OF CLASS V WELLS

(SLIDE NO. 48)

There are over 20 well subtypes that fall into the Class V category. Some examples are:

- Air conditioning return flow wells used to return to the supply aquifer the water used for heating or cooling in a heat pump;
- Large capacity cesspools that receive sanitary wastes serving more than 20 persons a day;
- Cooling water return flow wells used to inject water previously used for cooling;
- Recharge wells used to replenish the water in an Aquifer; etc.

In Louisiana, most Class V Injection Wells are shallow wells installed to inject trademark products to enhance the remediation of impacted soil and groundwater conditions.

CLASS V WELL APPLICATIONS (FORM UIC-25)

(SLIDE NO. 51)

Class V Well Applications (Form UIC-25) should include the following:

- Location Plat for a single well or group of wells
- Well construction details
- Injection Fluids Description
- Letter from the LDEQ Agency approving the Remediation Work Plan

CLASS V WELL CONSTRUCTION

(SLIDE NO. 50)

- Well Casing above OR below ground with flush mount protective cover
- Well Depth usually between 2 to 40 feet below ground

CLASS V REQUIREMENTS

(SLIDE NO. 51)

- Injection without a permit is a violation of Statewide Order No. 29-N-1, and is subject to enforcement action and fines
- Operator Name, Serial Number and Well Name should be inscribed, stamped or otherwise permanently affixed to the well
- An original signed completed Well History & Work Resume Report (FORM UIC-42) must be submitted after completing the injection well

CROSS SECTION STANDARDS

The purpose of drawing geological cross sections is to give a two dimensional view of three-dimensional geological features below ground. In order for there to be some consistency in the Geological Section, please use the following list of items as a reference when reviewing cross sections.

1. Geological cross sections should be constructed from data collected from all available information including literature, boreholes, wells, seismic data, etc ., and must be prepared to professional geological standards which at a minimum shall indicate: Vertical and horizontal scales, orientation (i.e. N-S or W-E), legend, the preparer's name, and date of preparation.

2. The legend should include and define all symbols used in the drawings.

3. All cross sections submitted with the same application should use the same scales in order to facilitate their review and comparison.

4. An index base map should be included so that the orientation of the cross sections can be identified as well as the wells used to construct the cross sections.

5. Wells closest to the proposed location should be included as a part of one (or more) cross section line. It should be apparent from the cross sections that the operator has geological control of the area. Wells and boreholes within one-mile radius of the proposed well or cavern should be considered to have the best log control of the area to draw representative cross sections. At a minimum two cross sections oriented North- South and West-East must be submitted; however, additional cross sections may be required in order to gain a better understanding of geological structural features below ground.

6. Each well used to construct the cross sections must be identified with Operator's name, Well name and number, Well Serial Number, Well status (i.e., plugged and abandoned, active, etc), and if available a reference elevation (i.e., RKB, GL, or SS) of the wells. A separate page can be included to detail this information.

7. The distance between the wells used to construct the cross sections should be indicated.

8. Readable scaled copies of electrical logs of the wells used to construct the cross sections should be included on the cross sections to support stratigraphic correlations among the wells. Dashed lines can represent wells that are not in the same plane of the cross section but may provide lateral control to the geologic mapping of the flank of the salt. Solid vertical lines can be used to represent proposed well locations.

9. On the cross sections, the horizontal extent should be indicated for any major topographic features.

10. On the cross sections, the appropriate AOR should be indicated.

11. Faults, shear zones, unconformities, or any other geological feature, if present or inferred, should be indicated on the cross sections.

12. On the cross sections the occurrence of the base of the Underground Source of Drinking Water (USDW), as well as Aquifer Systems present (top and bottom of the units) should be properly correlated and marked across the cross sections. If the values used are inferred, a dashed line should be used to illustrate this provision. Also, the injection zone and proposed injection intervals (if required) should be correlated across the cross sections.

13. Include on all cross sections, the age of major geological units (i.e.., Pleistocene, Pliocene, Miocene, etc). Usually this information is indicated next to the depth scale on one side of the cross sections.

14. Stratigraphic correlations based on particular stratigraphic units (Groups, Formations or Members) should be marked clearly throughout the cross sections.

15. Cross sections drawn to portray the position and shape of a salt dome should correlate to structure maps drawn for the top of the salt and the top of caprock.

16. Proposed perforations need to be marked on converted wells or new drills.

Cross-Section Example

Northwest to Southeast (C - C')