

Class I, Salt Cavern & Class V Wells

Louisiana Department of Natural Resources
Office of Conservation
Injection and Mining Division

CLASS I, SALT CAVERN & CLASS V Wells

	Class I Non-Hazardous Waste Injection	Class I Hazardous Waste Injection	Class II Hydrocarbon Storage	Class II E&P Waste Disposal in a Salt Cavern	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
	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
Permit Application Form	UIC-1	UIC-1	UIC-2 HSW	UIC-43	UIC-3BR	UIC-25

The Application should only refer to the regulations of the specific Class of well for which you are applying.

Note: Class V wells will be discussed separately towards the end of the presentation.

OVERVIEW OF WELL CLASS COMPARISONS

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	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	greater of 2-Mile or Cone of Influence	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
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 I wells and Salt Caverns

- 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



Regional and Local Geology Section

CROSS SECTION PROFILES

- 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

CROSS SECTION PROFILES

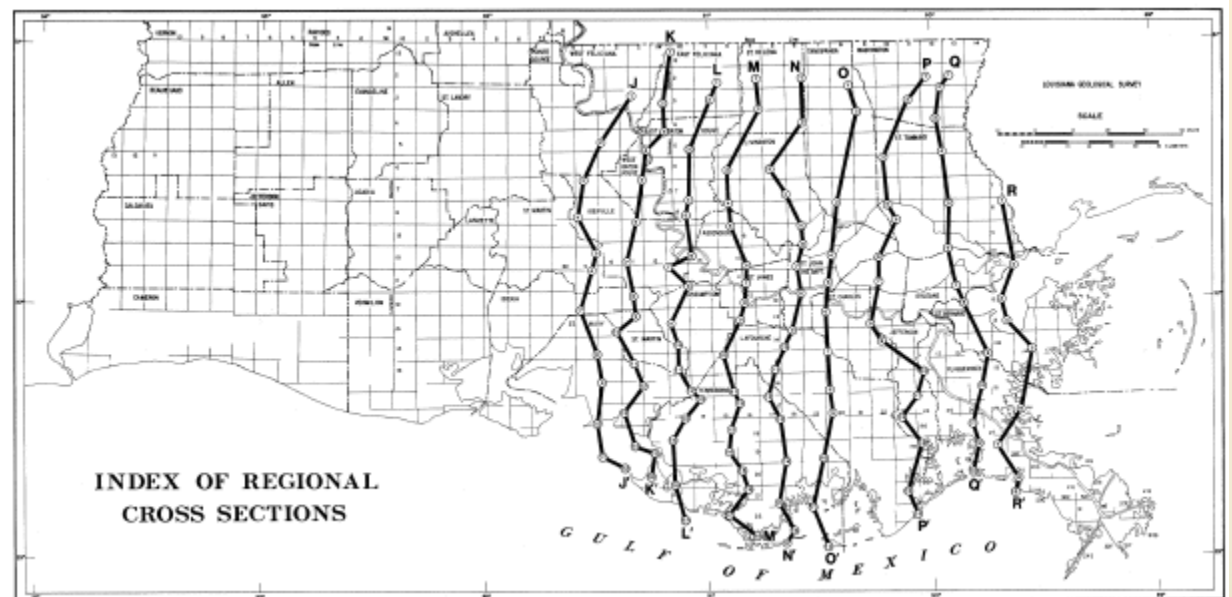
(Continued)

- 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

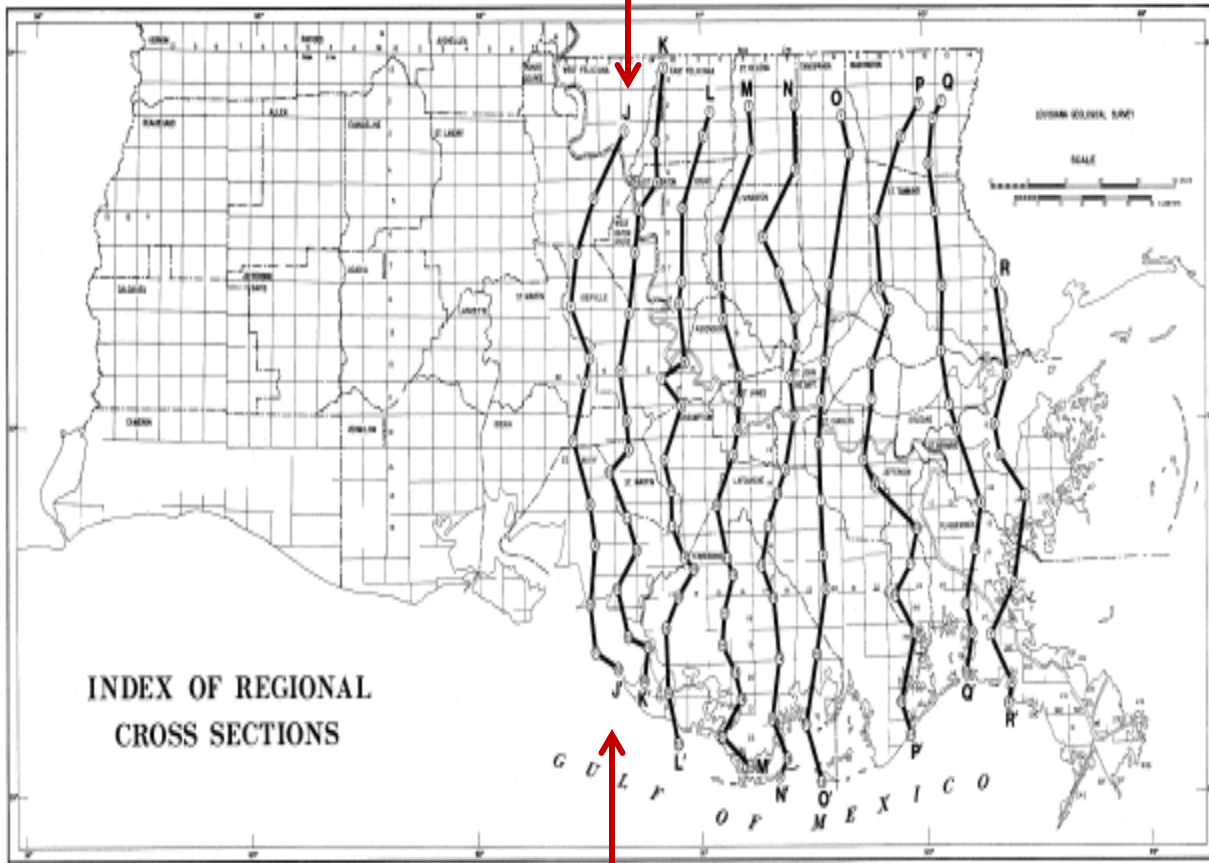
For a complete list of features to include on cross sections, please see the “cross section standards” list.

REGIONAL CROSS SECTIONS LOUISIANA GULF COAST (EASTERN PART)

BY
D. G. BEBOUT
AND
D. R. GUTIÉRREZ



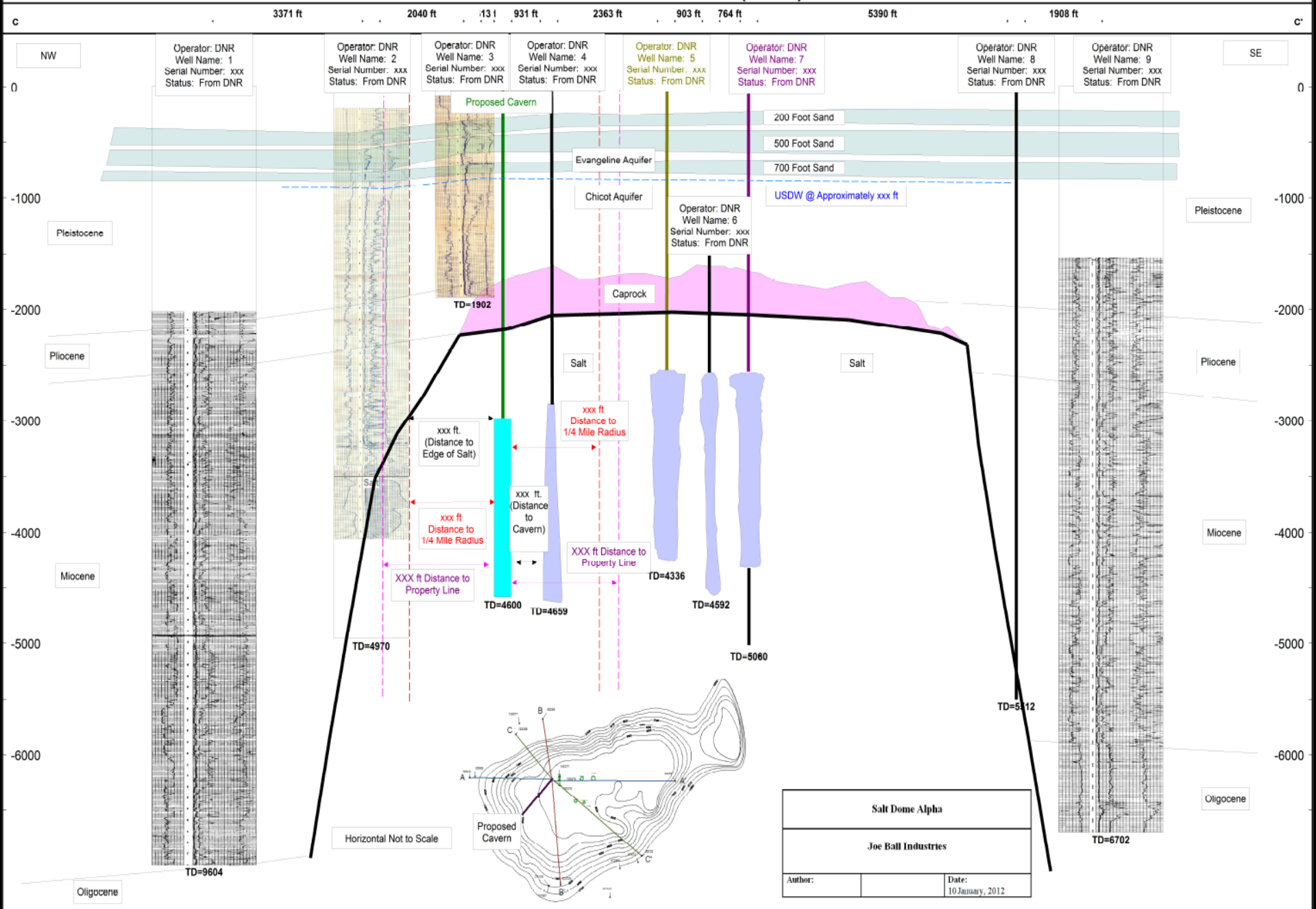
LOUISIANA GEOLOGICAL SURVEY
FOLIO SERIES NO. 6
OCTOBER 1983



INDEX OF REGIONAL
CROSS SECTIONS

LOCAL GEOLOGY – INDEX MAP FOR CROSS-SECTIONS

Northwest to Southeast (C - C')

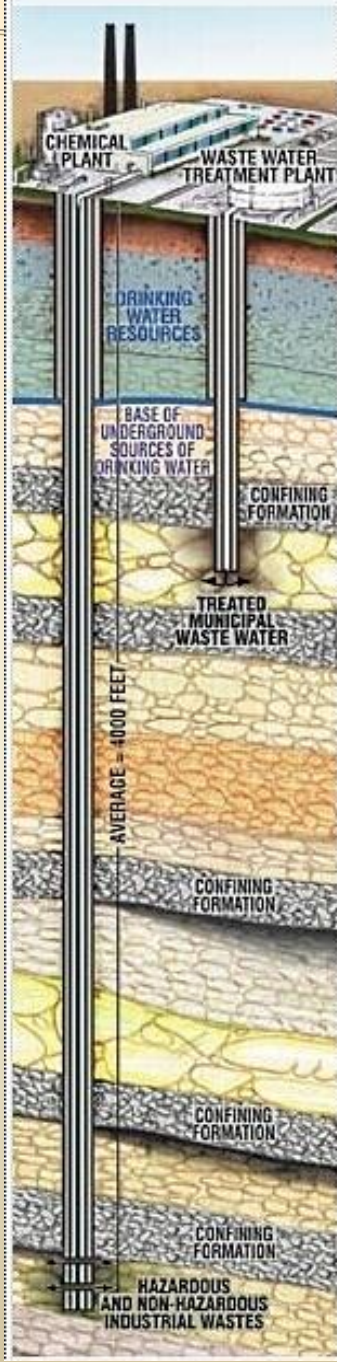


Salt Dome Alpha	
Joe Ball Industries	
Author:	Date:
	10 January, 2012



**Some areas of Discussion that are
specific to each Class of well**

Class I Wells



Class I Injection Wells isolate hazardous, industrial and municipal, or radioactive wastes from the lowermost formation containing, within $\frac{1}{4}$ 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 TEST
 - 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:

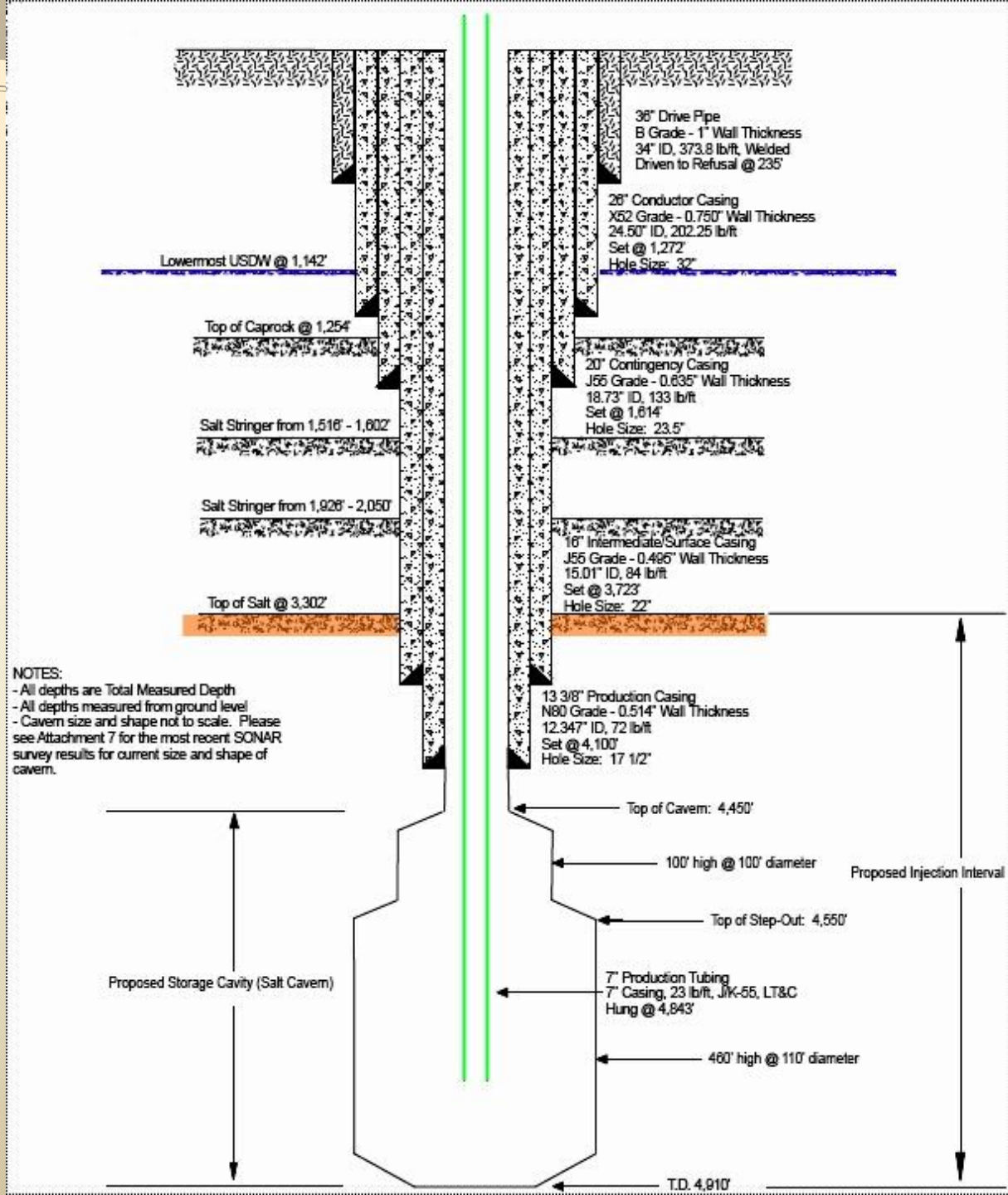
- ❖ The following must be proven through modeling:
 - That the injection zone has sufficient permeability, porosity, thickness & areal extent to prevent migration of fluids into USDWs or outside of the injection zone.
 - That the confining zone is laterally continuous and free of transecting, transmissive 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.

CLASS I HAZARDOUS

(continued)

- ❖ Area of Review of Artificial Penetration Wells
 - 2-Miles around the well **OR** the calculated cone of influence of the well, whichever is greater
 - For wells within $\frac{1}{2}$ Mile radius of injection well, include:
 - Copies of casing and cementing records (including cementing affidavits)
 - Copies of plugging and completion records; and
 - Schematic diagrams of each well

Class II Hydrocarbon Storage Wells inject hydrocarbons in underground formations (such as salt caverns) where they are stored.



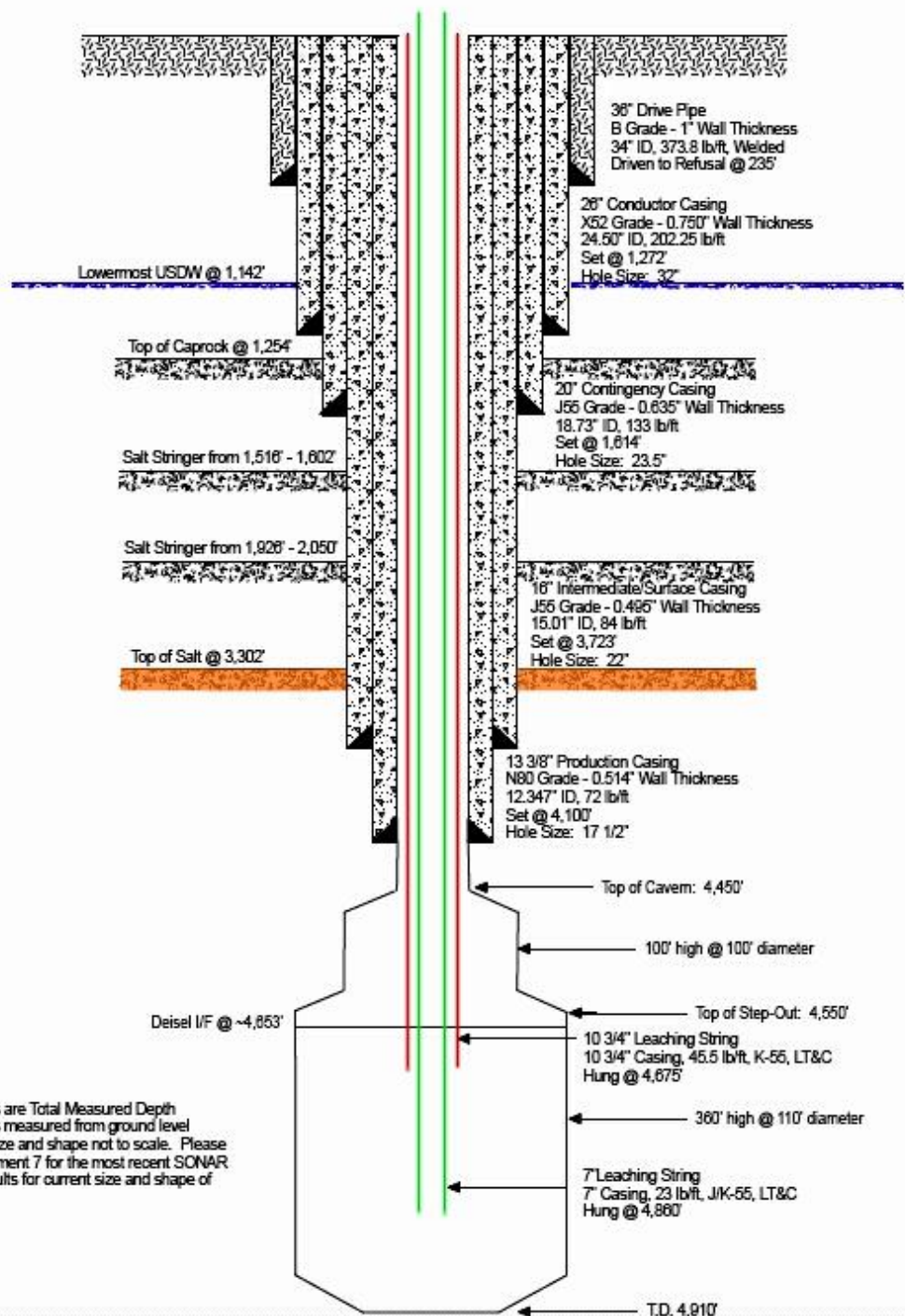
Class II Hydrocarbon Storage

- ❖ 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

Class II Hydrocarbon Storage

- ❖ 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 wells inject fluids for extraction of minerals or energy. Currently, all permitted Class III wells in Louisiana are salt solution mining wells.



NOTES:
 - All depths are Total Measured Depth
 - All depths measured from ground level
 - Cavern size and shape not to scale. Please see Attachment 7 for the most recent SONAR survey results for current size and shape of cavern.

Class III Solution Mining

- ❖ 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

Technical Report

The purpose of the Technical Report is to describe the proposed project as a whole and must explain:

- Regional and Local Geology
- overall well operating ranges,
- system monitoring,
- safety procedures and equipment,
- financial responsibility,
- Closure and post closure plans, etc.

The bulk of these application packages is located in the Technical Report. Each Class well is required to include certain content within the Technical report. We will discuss content that is specific for the Engineering and Geological reviews for each type well.



**Components to include in the Technical
Report for Class I Non-Hazardous
(Non-Haz) Wells**

Technical Report for Class I **Non-Haz** Wells

- ❑ **Proposed operating data**: average & maximum daily rate & volume of the injection fluid; average & maximum injection pressure; source & analysis of the chemical, physical & biological characteristics of the injection fluid;
- ❑ **Proposed formation testing program**: to obtain an analysis of the physical & chemical characteristics of the receiving formation;
- ❑ **Proposed stimulation program**;
- ❑ **Proposed injection procedures**: including storage & pre-injection treatment of the waste stream, and well use schedule;

Technical Report (for Class I **Non-Haz Wells**) - continued

- ❑ **Plans (including maps)**: for meeting the monitoring requirements of Lac 43:XVII.109.A.7 (209.I.1 for *Class I Hazardous Wells*);
- ❑ **Construction procedures**: including a cementing & casing program, logging procedures, deviation checks & a drilling, testing & coring program;
- ❑ **Contingency plans**: to cope with all shut-ins or well failures to prevent the migration of the contaminating fluids into underground sources of drinking water (USDW);

Technical Report (for Class I **Non-Haz Wells**) - continued

- ❑ **Calculation of the pressure increase**: in the proposed injection zone for a time period equal to the expected life of the well. You 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 calculated by using the following formula (*see next slide*).

Technical Report (for Class I **Non-Haz** Wells)

- continued

□ Calculation of expected waste front travel:

$$r = \sqrt{\frac{v}{\pi b \phi}}$$

where:

r = radial distance of wastewater front from well;

v = cumulative volume of injected wastewater;

b = effective reservoir thickness;

ϕ = average effective porosity;

(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)

**Components to include in the Technical
Report for Class I Hazardous
(Haz) Wells**

Technical Report (for Class I **Haz** Wells)


Essentially, the *same* requirements as Class I **Non-Haz** wells with the addition of the following:

- ❑ Table of data 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 - you must also include:
 - ❑ Copies of casing & cementing records (including cementing affidavits);
 - ❑ Copies of plugging &/or completion records; and
 - ❑ Schematic diagrams of each well.

Technical Report (for Class I **Haz** Wells)

- continued

- ❑ **Proposed formation testing program**: to obtain an analysis of the chemical, physical & radiological characteristics of & other information on both the injection zone and the confining zone;
- ❑ **Construction procedures**: should include a cementing and casing program (include cementer's recommendation), well material specifications & their life expectancy, logging procedures, deviation checks and a drilling, testing & coring program;
- ❑ **Financial assurance**: through a performance bond or other appropriate means, the **resources necessary to close, P&A the well & for post-closure care** as required under LAC 43:XVII.207.C & 209.O;
- ❑ **Applicant's plans for closure (P&A) and post-closure care** of the well (information required under LAC 43:XVII.209.L.1 & M.1).



**Components to include in the Technical
Report for Class II Hydrocarbon Storage
(HSW) Wells**

Technical Report (for Class II HSW wells)

- ❑ Information on manmade structures within the salt stock regardless of use, depth of penetration, or distance to the salt cavern well or salt cavern being the subject of the application:
 - ❑ A tabular listing of all salt caverns to include:
 - ❑ Operator name, well name & number, state serial number & 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, & the date the current salt cavern status was assigned;
 - ❑ Salt cavern depth, construction, completion (including completion depths), P&A data;

Technical Report (for Class II HSW wells) - continued

- ❑ A tabular listing of all conventional (dry or room and pillar) mining activities, whether active or abandoned. The list must include the following minimum items:
 - ❑ Owner or operator name & address;
 - ❑ Current mine status (active, abandoned);
 - ❑ Depth & boundaries of mined levels;
 - ❑ The closest distance of the mine in any direction to the salt cavern well & salt cavern.

- ❑ **Corrective action plan:** for wells or other manmade structures within the AOR that penetrate the salt stock but are not properly constructed, completed or P&A'd;

Technical Report (for Class II HSW wells) - continued

- ❑ **Surface site diagram(s)**: drawn to scale to include details & locations of the entire salt cavern hydrocarbon storage facility layout (surface pumps, piping & instrumentation, controlled access roads, fenced boundaries, hydrocarbon offloading, storage, treatment & processing areas, field office, monitoring & safety equipment & location of such equipment, required curbed or other retaining wall heights, etc.;
- ❑ **Detailed plans & procedures to operate the salt cavern well, salt cavern & related surface facilities** in accordance with the following requirements:

Technical Report (for Class II HSW wells) - continued

- ❑ **Cavern & surface facility design requirements:** including but not limited to cavern spacing requirements & cavern coalescence;
- ❑ **Operating requirements:** including but not limited to cavern roof restrictions, blanket material, remedial work, well recompletion, multiple well caverns, cavern allowable operating pressure & rates and cavern displacement fluid management;

Technical Report (for Class II HSW wells) - continued

- ❑ **Safety requirements:** including but not limited to an emergency action plan, controlled site access, facility identification, personnel, wellhead protection & identification, valves & flowlines, alarm systems, emergency shutdown valves, vapor monitoring & leak detection, gaseous vapor control, fire detection & suppression, systems test & inspections & surface facility retaining walls & spill containment, as well as contingency plans to cope with all shut-ins or well failures to prevent the migration of contaminating fluids into underground sources of drinking water;

Technical Report (for Class II HSW wells) - continued


- ❑ Monitoring requirements including but not limited to equipment requirements such as pressure gauges, pressure sensors and flow sensors, continuous recording instruments, leak detection, subsidence monitoring, as well as a description of methods that will be undertaken to monitor salt cavern growth due to under-saturated fluid injection;
- ❑ Pre-operating requirements specifically the submission of a completion report & the information required therein, prior to accepting, storing or otherwise initiating storage activities;

Technical Report (for Class II HSW wells) - continued

- ❑ Mechanical integrity pressure and leak test requirements including but not limited to frequency of tests, test methods, submission of pressure & leak test results, notification of test failures;
- ❑ Cavern configuration & capacity measurement procedures including but not limited to sonar caliper surveys, frequency of surveys & submission of survey results;

Technical Report (for Class II HSW wells) - continued

- ❑ Requirements for inactive caverns;
- ❑ Closure requirements including but not limited to closure plan requirements, standards for closure; and,
- ❑ Any other information pertinent to operation of the salt cavern storage facility.



Components to include in the Technical Report for Class III Wells

Technical Report (for Class III wells)

- ❑ **Proposed operating data**: average & maximum daily rate & volume of fluid to be injected; average & maximum injection pressure; and qualitative analysis & ranges in concentrations of all constituents of injected fluids;
- ❑ **Proposed formation testing program**: to obtain the info required by LAC 43:XVII.109.B.4.c & d;
- ❑ **Proposed stimulation program**;
- ❑ **Proposed injection procedure**;

Technical Report (for Class III wells)

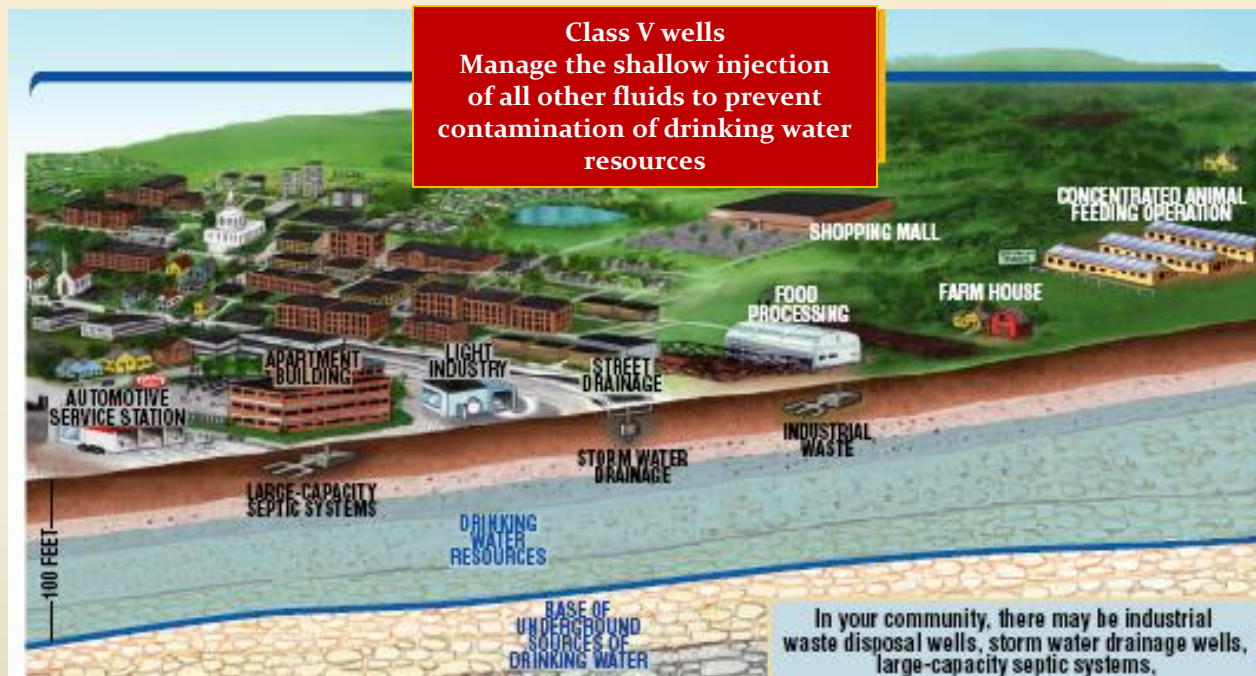
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- ❑ **Plans (including maps)**: for meeting the monitoring requirements of LAC 43:XVII.109.B.7;
- ❑ **Expected changes in pressure, native fluid displacement and the direction of movement** of injection fluid;
- ❑ **Financial assurance**: through a 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 & 107.C; and,
- ❑ **Corrective action proposed to be taken under 109.B.3**: for wells within the AOR which penetrate the injection zone but are not properly completed or plugged.

A Brief Discussion on Class V Wells

Safe Drinking Water Act

Underground Injection Control (UIC) Program Protecting Public Health and Drinking Water Resources

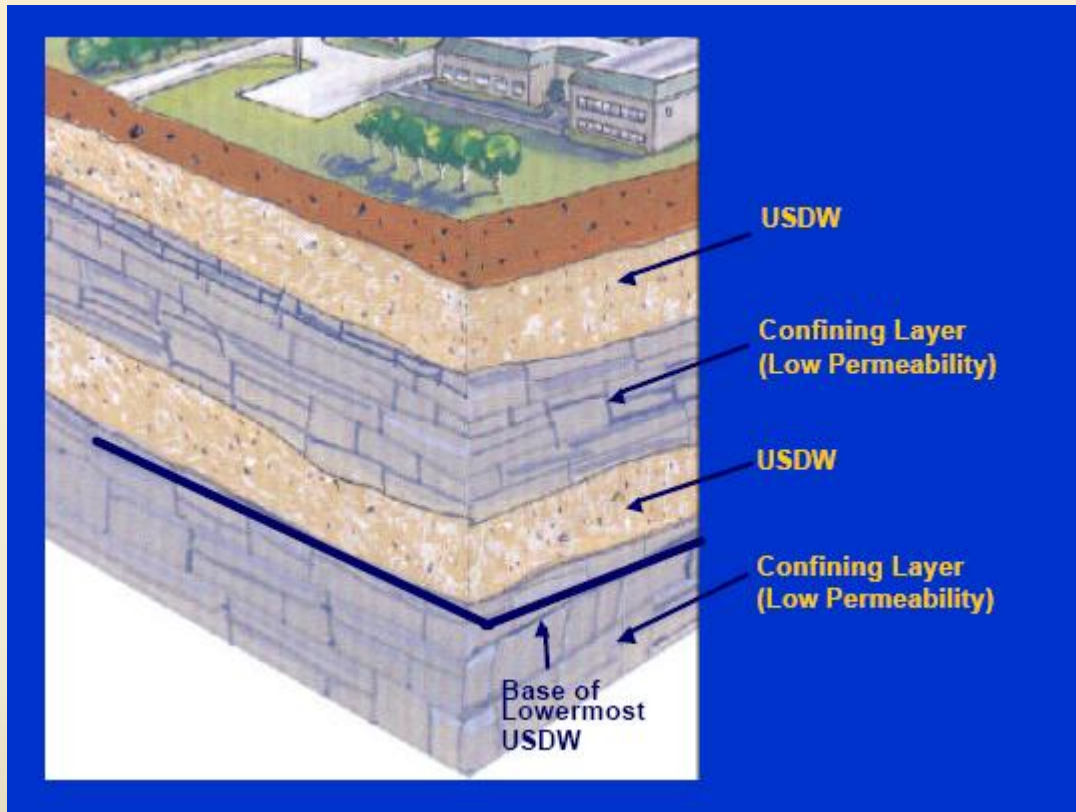


In March 23, 1982 EPA delegated the State of Louisiana with full permitting and enforcement authority of the State's UIC Program

Class V Permitting

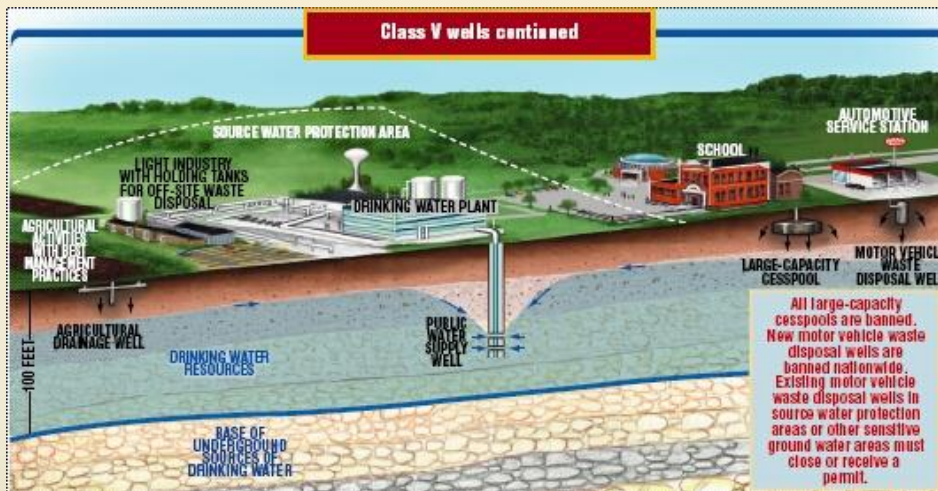
Class V	
Statewide Order	29-N-1
	LAC 43: XVII.103 Chapter 1
Permit Application Form	UIC-25

USDW MUST BE PROTECTED



Safe Drinking Water Act

Underground Injection Control (UIC) Program Protecting Public Health and Drinking Water Resources



There are over 20 subtypes of Class V Wells , nationwide

In Louisiana, most Class V wells are permitted to inject non-hazardous fluids to remediate soil and/or groundwater conditions

Class V Well Applications Should Include:

- ❖ LOCATION PLAT FOR A SINGLE WELL OR GROUP OF WELLS
- ❖ WELL CONSTRUCTION DETAILS
- ❖ DESCRIPTION OF INJECTION FLUIDS
(i.e., Ozone, OxyTek-L[®], Organicide[®], etc.)
- ❖ PROOF THAT THE REMEDIATION SITE IS UNDER MANAGEMENT OF LDEQ AGENCY

CLASS V – Well Construction

Figure 1

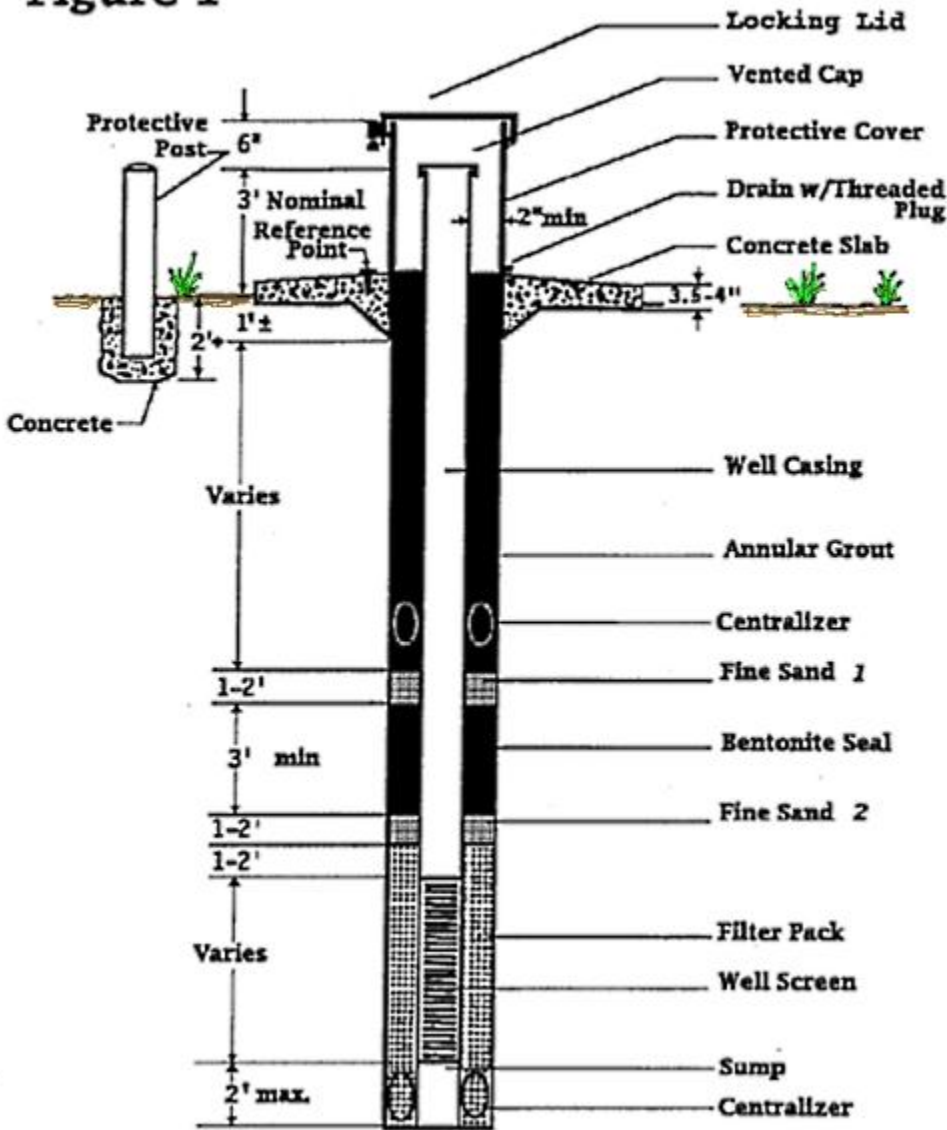
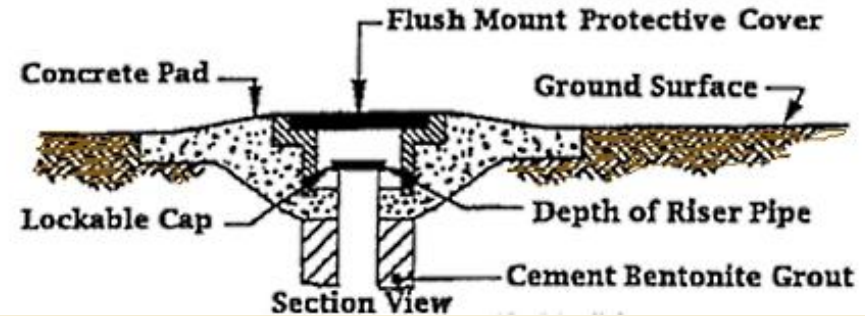


Figure 2

SURFACE MOUNT DETAIL



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

CLASS V REQUIREMENTS

- ❖ 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
- ❖ A work permit (FORM UIC-17) must be approved before any work is performed on the well