KDHE OVERVIEW OF THE KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT UNDERGROUND INJECTION CONTROL PROGRAM ADDRESSING CLASS III INJECTION WELLS

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This document is for use only as an overview of that part of the KDHE UIC program addressing Class III injection wells. It is not intended to be an all inclusive listing of requirements or conditions for Class III injection wells. This document may not be used in a court of law. Many of the requirements listed have been taken from the official Kansas Administrative Regulations publication. The permit application, permits, policies, guidance, statutes and rules and regulations establish the specific requirements for Class III injection wells and are available from KDHE.

INTRODUCTION

Bedded salt deposits in Central Kansas have been mined for many years by solution mining methods. Historical records indicate solution mining for the extraction of brine has occurred in Kansas since the 1880’s.

When fresh water or unsaturated brine is injected into a Class III solution mining well, the water contacts the salt deposits and dissolves the salt. The resulting saturated brine is then brought to the surface through a well for evaporation or other uses at salt or chemical plants.

KDHE REGULATORY HISTORY

After several Salt Solution Mining Well cavern collapses and subsidence incidents in the late 1970’s in Kansas resulting in contamination of groundwater and damage to property, the KDHE promulgated regulations in 1979 at Article 43, governing salt solution mining wells. KDHE in 2010 revoked Article 43 and moved the regulations for salt solution mining wells, including modifications and several new regulations, to existing Article 46, Underground Injection Control Regulations. Article 46 includes regulations addressing the permitting, construction, financial assurance, testing, monitoring and plugging of salt solution mining wells.

In addition, nationally, a number of pollution incidents in the 1970s were traced to the use of injection wells. It was realized that injection activities could contaminate groundwater if not conducted under strict controls. This realization prompted Congress to develop the Federal UIC program as part of the Safe Drinking Water Act (SDWA). The Environmental Protection Agency (EPA) has delegated primary regulatory authority for the federal program to those states agencies that have demonstrated an ability to implement a UIC program that meets EPA requirements promulgated under the SDWA. These states are referred to as Primacy States. The KDHE received primacy from EPA in December, 1983, to administer the Federal UIC program in Kansas for Class I, III, IV, and V wells. As stated previously, the State of Kansas has regulated salt solution mining wells since the late 1970’s. Kansas Administrative Regulations 28-46-1 through 28-46-44 found at Article 46 govern these classes of UIC wells in Kansas, including Class III salt solution mining wells. The Article 46 regulations can be found at: http://www.kdheks.gov/uic/index.html#Regulations.

The purpose of the KDHE UIC program is to protect the public health and safety and to prevent contamination of fresh and usable groundwater supplies by injection activities. In Kansas, approximately 90% of the water used is supplied from groundwater. The major contamination problems in Kansas are from sources associated with human activity. The groundwater supply
can be lost for use if not adequately protected from contamination. The most effective method of protecting groundwater supplies is to prevent contamination. Prevention is much more cost effective, and has better results than cleanup activities.

DEFINITIONS

It is necessary to define several terms before proceeding. These terms are as follows:

**A well** means a dug hole or bored, drilled or driven shaft whose depth is greater than its largest surface dimension or an improved sinkhole, or a subsurface fluid distribution system.

**Well Injection** means the subsurface emplacement of fluids through a well.

**Injection well** is a well into which fluids are injected.

**A fluid** is defined as any material that flows or moves, whether it is semi-solid, liquid, sludge or gas.

**Gallery system** is a series of two or more salt solution mining wells that are artificially connected within the salt horizon and are produced as one or more wells designed for withdrawal of solutioned salt.

As mentioned previously, the UIC program categorizes injection wells into six classes of wells. These are:

**Class I:** Wells used to inject hazardous wastes or dispose of industrial and municipal fluids beneath the lower formation containing, within one quarter (1/4) mile of the wellbore, a source of fresh or usable water.

**Class II:** Wells used to inject fluids associated with the production of oil and natural gas or fluids/compounds used for enhanced hydrocarbon recovery. These wells normally inject below the lower-most fresh or usable water bearing zone except in cases where this zone is hydrocarbon producing. These wells are regulated by the Kansas Corporation Commission (KCC).

**Class III:** Wells which inject fluids for the extraction of minerals.

**Class IV:** Wells which dispose of hazardous or radioactive wastes into or above a fresh or usable water bearing zone. **Class IV wells are prohibited.**

**Class V:** Wells not included in other classes. Typically Class V injection wells are shallow wells used to place a variety of fluids below the land surface.

**Class VI:** These wells inject carbon dioxide (CO$_2$) for long term storage, also known as Geologic Sequestration ort Co$_2$. These wells are regulated by EPA.

Injection into a Class I, III and certain types of Class V wells requires obtaining a permit from KDHE prior to construction. Injection into a Class II well requires obtaining a permit from the KCC and injection into a Class VI well requires a permit from EPA.

The subject of this document is that part of KDHE’s UIC Program addressing Class III salt solution mining wells.
LOCATION OF CLASS III INJECTION WELL FACILITIES

As of January 1, 2013, there are currently four active salt production facilities located in Kansas which utilize a total of 141 active Class III wells for the solution mining of salt. The location of these facilities is indicated in Figure 1.

Figure 1 – CLASS III FACILITIES

(*- Denotes Facility)

DESCRIPTION OF HUTCHINSON SALT DEPOSIT IN KANSAS

The salt which is solution mined in Kansas is the Hutchinson Salt member of the Wellington formation and is of Permian age. The Hutchinson Salt is a layered salt formation consisting of halite and “dirty” halite beds separated by shale beds, shale partings, thin anhydrite layers and thin limestone layers. On average, the Hutchinson Salt consists of 80% halite, 5% calcium sulfate, 5% carbonate and 10% shale. The Hutchinson Salt varies in thickness from a few feet to 400 feet. Where solution mining is conducted in Kansas, the average thickness is approximately 375 feet. The depth to the top of the Hutchinson Salt, in areas where solution mining takes place, varies from approximately 225 feet below ground surface in Sedgwick County to 725 feet below ground surface in Rice County. The depositional environment of the Hutchinson Salt is described as a broad, shallow embayment with extensive tidal flats. The salt beds are nearly horizontal with a westerly regional dip of approximately 30 feet/mile.

The Hutchinson Salt is overlain by shale beds of the Wellington formation. These Wellington shale deposits are nearly impermeable and serve to separate the salt beds from the unconsolidated sand and gravel aquifers which overlie the shale.

Figures 2 through 9 provide information about the hydrogeology relevant to the salt formation and the solution mining of the salt.
DESCRIPTION OF SALT SOLUTION MINING ACTIVITY

Salt solution mining is accomplished using the gallery system. For each solution mining well, surface casing is set through all fresh and usable water formations (water <10,000 mg/L Total Dissolve Solids) and encased to the surface. The production casing is then set at least 55 feet in the top of the salt formation and cemented from the bottom of the casing to surface. The requirement to set the casing 55 feet into the salt formation is to ensure the existence of a 50 foot salt roof in the wells. Figure 10 depicts a typical Class III well.

Solution mining occurs by injection of fresh water or unsaturated brine down the production casing. When this water contacts the salt, solutioning occurs and a cavern begins to form. The saturated brine that results from this process is then withdrawn from another well. Figure 11 depicts side view of a typical salt solution cavern. This view of the cavern is obtained by the use of a sonar survey tool. The solid line represents the cavern wall.

A design for gallery systems that is commonly used and which was introduced by industry approximately 25 years ago is the “horizontal well gallery” and is developed by drilling a horizontal borehole along the base of the salt formation and the construction of vertical wells which intersect the horizontal borehole. The vertical wells and horizontal well are washed until connection occurs. Mining can then begin. With this type of gallery, connection of the gallery wells is more probable and much more controlled. Also, the development of the caverns can be controlled by alternating the injection and withdrawal modes of wells in the gallery. Figure 12 depicts the profile of a typical horizontal well gallery.

BRINE PRODUCTION

A total of 1,372,000,000 gallons of brine were safely produced in Kansas calendar year 2012 by the salt solution mining industry.

Three facilities use the brine from these wells for production of such items as: food grade salt; salt for pharmaceutical products; salt blocks for livestock; and water softener pellets. One chemical manufacturing facility uses the brine as a chlorine feed stock for use in production of various chemicals, including chlorinated hydrocarbon chemicals.

Almost all production now occurs using the horizontal gallery system.

The industry and KDHE work together to successfully ensure the public health, safety and the environment are protected.

PLUGGING

Upon the end of the useful life of a Class III salt solution mining well, the KDHE regulations require the well to be properly plugged to protect the public health, safety and the environment. Figure 13 depicts a typical well plugging.

REQUIREMENTS

The Article 46 regulations governing the permitting, construction, operation, monitoring, testing, financial assurance and plugging can be found at http://kdheks.gov/uic.
Figure 2 is composite stratigraphic section of rocks present in Kansas. Beds older than Mississipian are known only in the subsurface (modified from Moore and others, 1952).
Figure 3 is a stratigraphic section showing the Hutchinson Salt member of the Permian series (source: "The Kansas Rock Column 1951").
Figure 4 Source: Kansas Geologic Survey Postcard
Figure 5 is an east-west geologic cross-section.
Figure 6 depicts the major structural features in Kansas from KGS Open File Report 2003-59.
Figure 7 depicts the principal aquifers of Kansas.
Figure 8 depicts the thickness and extent of the Hutchinson Salt member of the Wellington formation.

HUTCHINSON SALT MEMBER
WELLINGTON FORMATION
PERMIAN SYSTEM
Extent and Thickness
Figure 9 is a geologic cross-section depicting the relationship of the Hutchinson salt to formations above and below.
Figure 10 is a typical Class III well design.

TYPICAL CLASS III WELL CONFIGURATION
Figure 11 is the Side View of a Typical Cavern in the Salt Formation.
Figure 12 depicts a typical horizontal well gallery.
Figure 13 depicts a typical Class III well after being plugged and abandoned when the well is no longer needed.