ENFORCEMENT OF REGULATIONS GOVERNING GROUND WATER CONTAMINATION FROM UNDERGROUND INJECTION OR DISPOSAL OF SALT WATER IN KANSAS AND TEXAS

by

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Although the research described in this report has been funded wholly or in part by the United States Environmental Protection Agency through Cooperative Agreement CR-809353 to East Central University Environmental Research Institute, it has not been subjected to the agency's peer and policy review and therefore does not necessarily reflect the views of the agency and no official endorsement should be inferred.

FOREWORD

The Environmental Protection Agency was established to coordinate administration of the major Federal programs designed to protect the quality of our environment.

An important part of the Agency's effort involves the search for information about environmental problems, management techniques and new technologies through which optimum use of the Nation's land and water resources can be assured and the threat pollution poses to the welfare of the American people can be minimized.

EPA's Office of Research and Development conducts this search through a nationwide network of research facilities.

As one of these facilities, the Robert S. Kerr Environmental Research Laboratory is the Agency's center of expertise for investigation of the soil and subsurface environment. Personnel at the laboratory are responsible for management of research programs to: (a) determine the fate, transport and transformation rates of pollutants in the soil, the unsaturated zone and the saturated zones of the subsurface environment; (b) define the processes to be used in characterizing the soil and subsurface environment as a receptor of pollutants; (c) develop techniques for predicting the effect of pollutants on ground water, soil and indigenous organisms; and (d) define and demonstrate the applicability and limitations of using natural processes, indigenous to the soil and subsurface environment, for the protection of this resource.

This report contributes to that knowledge which is essential in order for EPA to establish and enforce pollution control standards which are reasonable, cost effective and provide adequate environmental protection for the American public.

Clinton W. Hall
Director
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Research Laboratory

PREFACE

Enforcement of Regulations Governing Ground Water Contamination from Underground Injection or Disposal of Salt Water in Kansas and Texas has been developed under the guidance of East Central University Environmental Research Institute in conjunction with the U.S. Environmental Protection Agency, for use by all of those involved in efforts to implement state Underground Injection Control (UIC) Programs. The report provides a concise description of regulations, administrative procedures and reported ground water contamination incidents in two states with a large number of Class II wells.

For those concerned with implementation of a UIC program and with protecting ground water, this document may be helpful as a ready summary of different ways to administrate a UIC program and methods for investigating ground water contamination by injection operations. Finally, this manual partially fulfills a mandate contained in the Safe Drinking Water Act (P.L. 93-523) requiring the Administrator of the Environmental Protection Agency to "...carry out a study of methods of underground injection which do not result in the degradation of underground drinking water sources."

ABSTRACT

The Underground injection or disposal of salt water produced with oil and gas is regulated as a result of the enactment of the Underground Injection Control (UIC) Program under the authority of the Safe Drinking Water Act. The Act requires the EPA to develop minimum standards to assist the states in establishing effective programs to protect underground sources of drinking water from contamination resulting from the subsurface emplacement of fluids through well injection.

Nearly half of the salt water produced with oil and gas operations in the United States is generated in the states of Texas and Kansas; much of this is either reinjected into the subsurface in enhanced recovery operations or disposed of through subsurface injection in wells designated as Class II wells by UIC program criteria. In the state of Texas, primary enforcement responsibility for UIC program regulations, specifically those pertaining to Class II wells, has been assumed by the Texas Railroad Commission. In the state of Kansas, the Kansas Department of Health and Environment (KDHE) and the Kansas Corporation Commission (KCC) have jointly assumed primary enforcement responsibility. Each of these two states has developed an effective program to deal with salt water injection and disposal wells; each of the agencies in these two states administers and enforces UIC program regulations differently.

This document describes in detail the UIC programs relating to Class II wells that have been developed in the states of Texas and Kansas. The UIC program regulations, the individual agency administrative procedures and the methods of handling ground-water contamination incidents resulting from the injection or disposal of salt water are discussed. In addition, several case studies of contamination caused by Class II wells are detailed.

This report was submitted in partial fulfillment of Cooperative Agreement No. CR-809353 by the National Water Well Association under the sponsorship of the Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma and in cooperation with East Central University Environmental Research Institute, Ada, Oklahoma. This report covers a period from December, 1981, to December, 1983, and work was completed as of December, 1983.

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ACKNOWLEDGEMENTS

The authors wish to acknowledge the staffs of the Kansas Corporation Commission, Wichita, Kansas, the Kansas Department of Health and Environment, Topeka, Kansas and the Texas Railroad Commission, Austin, Texas for their patience and assistance in the preparation of this document. Without their helpful support, the writing of this document would not have been possible.

SECTION 1

INTRODUCTION

OBJECTIVES AND SCOPE

This report has been prepared to provide a concise description of regulations, administrative procedures and methods for dealing with ground water contamination incidents in two states with a large number of Class II injection wells. The report may also provide information to industry representatives, government officials and others to help them understand the potential problems associated with underground injection through Class II wells, and provide examples of how two state programs have been designed to deal with such problems. Although this report details the administration of regulations in the States of Texas and Kansas, different regulatory and administrative systems developed in other states may prove equally as effective in dealing with similar problems.

This report is intended to be informative rather than prescriptive in nature. Impetus for the report was provided by passage of Public Law 93-523 (The Safe Drinking Water Act), which requires the U.S. Environmental Protection Agency (EPA) to develop minimum requirements for the establishment of effective state programs to protect underground sources of drinking water from the subsurface emplacement of fluids through well injection. Additionally, the Act states that these requirements not impede the re-injection of brine or other fluids used in secondary or tertiary recovery unless drinking water sources would be endangered (Federal Register, June 24, 1980).

For purposes of the Underground Injection Control (UIC) Program, injection wells were classified into five categories as follows: (a) Class I wells are (1) those used by generators of hazardous waste or owners or operators of hazardous waste management facilities to inject hazardous waste beneath the lowermost formation containing, within one quarter (1/4) mile of the well bore, an underground source of drinking water; (2) other industrial and municipal disposal wells which inject fluids beneath the lowermost formation containing, within one quarter (1/4) mile of the well bore, an underground source of drinking water; (b) Class II wells are wells which inject fluids (1) which are brought to the surface in connection with conventional oil or natural gas production and may be commingled with waste waters from gas plants which are an integral part of production operations, unless these waters are classified as a hazardous waste at the time of injection, (2) for enhanced recovery of oil and natural gas, and (3) for storage of hydrocarbons which are liquid at standard temperature and pressure; (c) Class III wells inject for the purpose of extraction of minerals including: (1) mining of sulfur by the Frasch Process, (2) in situ production of uranium or other metals, and (3) solution mining of salts or potash; (d) Class IV wells include disposal wells used by hazardous and radioactive waste generators and disposal site operators to dispose of hazardous waste or radioactive waste (1) into a formation which within one-quarter mile contains an underground source of drinking water, (2) above a formation which

within one-quarter mile contains an underground source of drinking water, and (3) which cannot be classified under (1) or (2); Class V wells includes injection wells not covered by the four other classes.

Recognizing that there are many different ways that similar UIC regulations can be administered in each state, this document attempts to detail the efforts of both Kansas and Texas. This document neither endorses nor criticizes the adminstrative procedures, but simply details them for possible use by other states with similar implementation responsiblities. In addition, reported incidents of ground-water contamination by salt water injection wells and the method of handling complaints are described.

HISTORICAL PERSPECTIVE OF PROBLEM

Since 1859, when the first oil well was drilled at Titusville, Pennsylvania, the disposal of salt water has been an environmental problem. In the early days of oil production, brine disposal was often an uncontrolled discharge to a stream or ditch (EPA, 1977). Practices such as this led to environmental contamination which went unchecked until the late 1920's when industry began to internally develop production practices and techniques which recognized the impact on water resources (IOOC, 1966). In the succeeding years, studies of the proper disposal of oil field brines were made by regulators charged with protecting surface and ground-water supplies and by companies faced with the problem of disposing of salt water, and the basis for today's regulatory framework was established.

Ground and surface-water contamination from oil field salt water disposal practices, primarily from surface discharges and unlined pits, are well-documented in the literature (Fryberger, 1972; Oklahoma Water Resources Board, 1975; Pettyjohn, 1971; Payne, 1966). As a result, the present disposition of salt water produced with oil or gas is principally by underground injection. It is estimated that there are approximately 140,000 Class II wells in use across the United States.

Class II wells are generally associated with four activities: (1) to maintain underground pressures which would otherwise be reduced by virtue of the production of oil and/or gas; (2) cycling or recycling, to introduce residue gas into a formation after liquifiable hydrocarbons have been extracted from gas produced from the formation; (3) secondary recovery operations, to introduce a fluid to decrease the viscosity of oil, reduce its surface tension, lower its specific gravity, and/or to drive oil into producing wells, resulting in greater production of oil, and (4) tertiary recovery operations to introduce chemicals or energy as required for displacement and for the control of flow rate and flow pattern in the reservoir (TRRC, 1983).

In developing background data for this report, representatives of state agencies involved with the administration of regulations pertaining to salt water injection and disposal were contacted. Copies of regulations, forms and published information on ground-water contamination relating to salt water injection wells were obtained. Visits were made to the appropriate state

agencies to interview agency personnel about administration and enforcement of the regulations and the handling of complaints. Files pertaining to possible ground-water contamination by injection wells were either manually searched by the authors (Kansas) or compiled by the state personnel (Texas). Kansas records were searched for the period January, 1979 to December, 1982. Information from the state of Texas was obtained for: (1) January 1967 to December 1975, (2) January 1979 to June 1980, and (3) January 1982 to December 1982.

ORGANIZATION

This document contains four sections, five subsections and four supporting appendices. Section 3 contains information on the state of Kansas; Section 4 on the state of Texas. The sections have been divided to provide an easy reference of state responsiblities and regulations and to detail the information on contamination by salt water injection wells during the study period for each state.

TABLE 1. DISPOSAL OF PRODUCED SALT WATER, 1963 (IOCC, 1966)
(BARRELS PER DAY)

	Volumes Produced	INJECTION		Impervious Pits	Unlined Pits	Streams and Rivers	Other Methods
		For Water Flood	For Disposal Only				
KANSAS	5,011,400	800,000	4,200,000	1,800	9,600	--	--
TEXAS	6,127,671	2,736,755	1,472,954	--	1,262,719	615,566	39,677*

*unaccounted

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SECTION 2

CONCLUSIONS/RECOMMENDATIONS

As part of the regulatory process, both states promulgated statewide rules to ensure that Class II (salt water injection and disposal) wells would be operated without endangering the ground-water resources of the state. Although the mandate of ground-water protection is the same for both states, the provisions contained within the rules and the administrative procedures are different. The rules have been tailored to address differing geologic conditions in each state. Administratively, the enforcement of the UIC program for Class II wells has been jointly assumed by two state agencies in Kansas and one agency in Texas. Both states have attempted to integrate new provisions into existing rules and administrative authorities.

A variety of enforcement options for rule violations are available in both states. Similar enforcement actions such as the ability to immediately shut in a well for serious violations, to revoke an operating permit or producer's license or to seek remedies through the courts are used in both Kansas and Texas. In the state of Kansas, a maximum fine of $10,000 a day for every offense can be levied. In Texas, additional penalties such as pipeline severance can be imposed. This penalty in Texas has historically proven effective in enforcement of the rules of the Texas Railroad Commission. In Kansas, the $10,000 fine is a relatively new enforcement tool, and its effectiveness as a deterrent against violations has yet to be tested.

Ground-water contamination incidents due to injection operations are not well documented in the literature. This is often the case because alleged contamination incidents are most commonly investigated by state personnel who do not routinely publish information in the literature, although some reports are available in an open file. In other instances, the source of the contamination may only be inferred and not officially documented. Problems with injection wells are more easily documented in cases where injection operations cause direct evidence of contamination through surface expression such as flow through improperly plugged or abandoned wells. One of the most illustrative examples of problems associated with injection in an area containing abandoned wells that were improperly plugged is cited by Hopkins (1963). In east-central Kentucky, a pressurized injection well was located about 200 feet away from a gas well used for domestic fuel. Upon initiation of injection operations, the gas furnace in the living room of the farmhouse spouted brine. After injection was stopped, the flow ceased.

A search of state records for selected periods indicated that ground water contamination problems were most frequently identified through complaints of salt water in a water well or identification of flowing abandoned wells.

Regulatory agencies in the states of Kansas and Texas maintain field staff who perform routine inspections of injection operations and respond to complaints about alleged violations or actual contamination resulting from injection or disposal of salt water. Lab analysis for chloride content in water wells and pressure testing of nearby injection wells are the most common methods used to investigate the causes or sources of ground-water contamination.

Although extensive field work may be conducted, few investigations lead to positive identification of a source of contamination. This is due to the nature of the problem, the cost of many of the investigative methods necessary for determining mechanical integrity, flow in the subsurface etc., and the logistics of working with industry to determine what is happening in an area without endangering the protection of oil or gas.

The two states both have a well plugging fund which was established to help remediate problems with improperly plugged or unplugged abandoned wells where a legally responsible party cannot be identified or where a legally responsible party does not have the assets to correct the problem. The state funds are used only as a final option where no other sources or funds are available and where there is a recognized problem with the well.

SECTION 3

UNDERGROUND INJECTION IN KANSAS

AGENCY RESPONSIBILITIES

The Underground Injection Control (UIC) Program in the state of Kansas is jointly administered by the Kansas Corporation Commission (KCC) and the Kansas Department of Health and Environment (KDHE). KDHE has been given statutory (legislative) authority to regulate all wastes in the state. Therefore, KDHE must enforce Section 1422 of the Safe Drinking Water Act, which gives the state primary enforcement responsibility over the UIC Program. However, it is the responsibility of KCC to enforce Section 1425 of the Act which pertains strictly to Class II wells. This gives KCC the power to permit and, when necessary, to plug salt water injection wells. In fact, KCC has primary control over Class II wells, while KDHE's concerns are with environmental pollution related to salt water disposal. In addition to sharing regulatory responsibilities for Class II wells, KCC and KDHE also maintain six joint district offices. The offices are located in Dodge City, Wichita, Chanute, Topeka, Salina, and Hays (Figure I).

All rules and regulations in the state pertaining to fluid injection must be reviewed by a ten member board. The board consists of one member each from KCC, KDHE, Division Water Resources, Kansas Geological Survey, Kansas Water Office, three organizations representing the oil and gas industry, a representative of water management districts, and one public representative. In addition to considering regulations, the board reviews minimum standards for water protection, and disposal/injection practices. A previously established board developed minimum depths necessary to protect ground water in the State. A part of that table is shown in Table 2. These depths are determined by county and in some counties by township. The board has also developed a list of the minimum depth allowed for brine injection in each county and in some cases for particular townships (Table 3).

HISTORY OF SALT WATER DISPOSAL REGULATIONS

Oil was first discovered in Kansas in 1860 when two or three wells were drilled near Paola. The Civil War stopped development, however, and it was some 30 years before new wells were drilled (Latta 1963). The first big oil play was 1914 when the El Dorado Field was discovered in Butler County. However, it was not until 1920 that production of oil and gas exceeded 50 million barrels per year (Jewett 1979). The production of oil and gas also led to the production of salt water. During the early years of production, neither the operators nor the landowners gave any thought to the brine produced with oil.

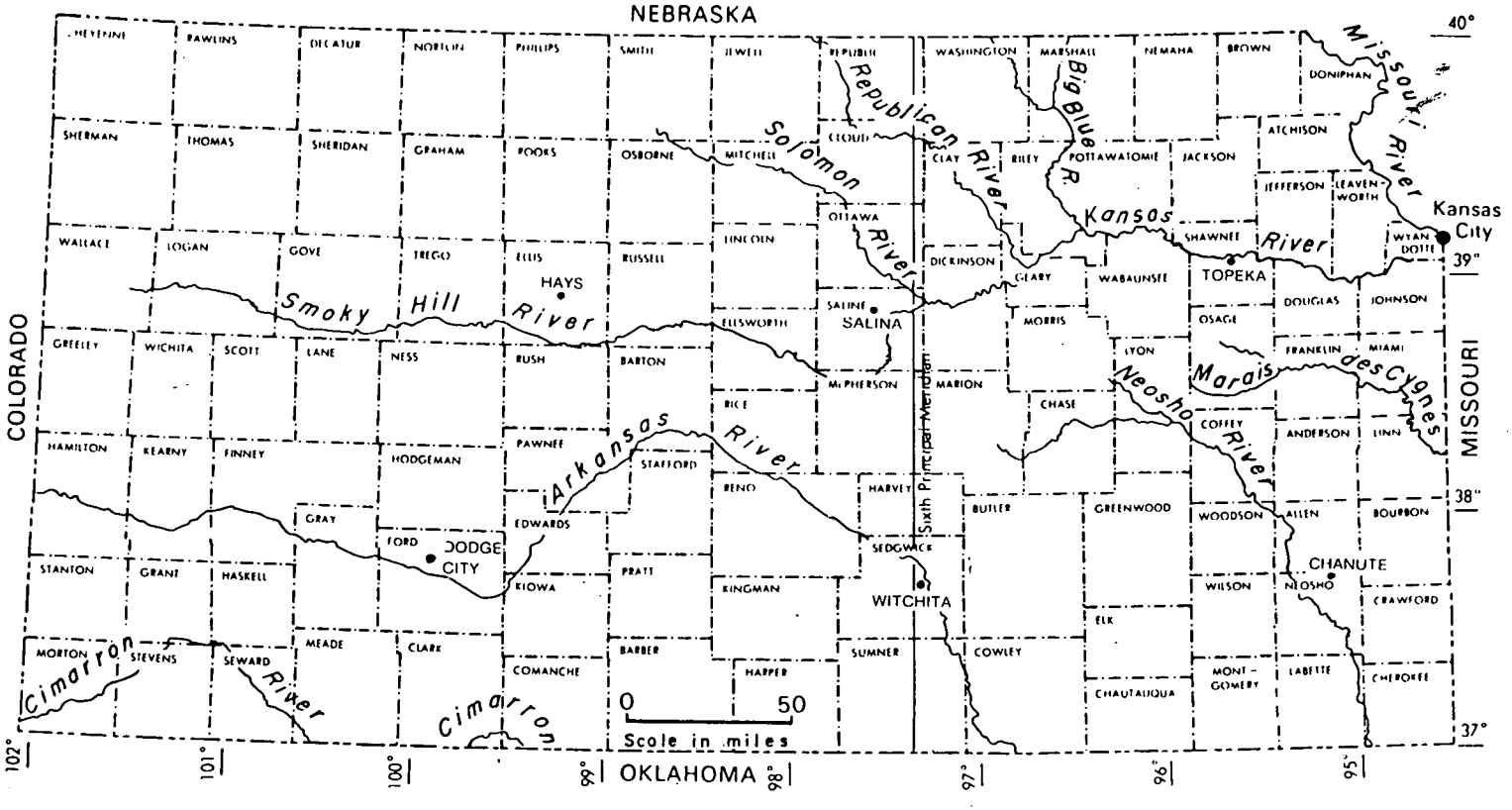

Figure 1. Map of Kansas showing location of district offices.

TABLE 2. PART OF TABLE I SETTING MINIMUM DEPTHS FOR THE PROTECTION OF USABLE AND FRESH WATER

Rule 82-2-123 TABLE I

(Revised March 1, 1967)*

Established depths above which usable and fresh water should be protected by recommended methods

County	Minimum Requirements
Allen	R. 17E and 18E set a minimum of 150 feet, T. 25S R. 21E, set a minimum of 175 feet, T. 26S, R. 20E and 21E set a minimum of 175 feet. In all other areas set a minimum of 100 feet. In all cases, set through all unconsolidated material plus 20 feet into the underlying formation.
Anderson	T. 23S, R. 20E and 21E set a minimum of 100 feet. T. 21S and 22S, R. 21E set a minimum of 100 feet. In all other areas set a minimum of 125 feet. In all cases, set through all unconsolidated material plus 20 feet into the underlying formation.

S = Section
T = Township
R = Range

*This is only part of Table I, showing minimum depth requirements for two counties.

TABLE 3. PART OF TABLE II SETTING MINIMUM DEPTHS FOR SALT WATER DISPOSAL

(Revised April 26, 1971)*

Rule 82-2-400 TABLE II

Established minimum depths for disposal wells*

The following depths are the absolute minimum depths which will be permitted. Depths greater than those given may be required for some areas.

County	Minimum Depths
Allen	350 feet
Anderson	350 feet
Atchison	500 feet
Barber	Township 34S Range 15W and Township 35S Rang 15W - - 200 feet. All other areas - - 500 feet.
Barton	Top of "Red Beds"

The problem of brine disposal reached a climax sometime prior to 1935. In 1934, the state legislature enacted a law permitting the return of produced brine to any subsurface formation that already carried highly mineralized water. Another act allowed the use of produced brine for repressuring oil zones (Latta 1963).

In 1952, a three-member board was established to set minimum depth standards similar to those used in the state today. At that time the board consisted of the KDHE, the Kansas Geological Survey and the Department of Agriculture's Division of Water. Beginning in 1956, operators were required to file "intention to drill" applications which gave an API number to each well. In 1967, a regulation was adopted requiring that disposal wells be drilled to a depth of at least 500 feet below the surface and at least 50 feet below any producing oil or gas formation.

Following the passage of the federal Safe Drinking Water Act (SDWA), Kansas adopted its underground injection regulations to comply with national requirements and to retain primary enforcement responsiblity for the Underground Injection Control Program.

Because the KCC had regulated salt water disposal and enhanced recovery wells for over 25 years, it retained primary control over Class II wells. However, because the main emphasis of the federal UIC program was the protection of water, the KDHE continues to be involved in environmental concerns regarding salt water injection wells.

In January 1981, Kansas submitted its two-part UIC program to the U.S. EPA. Part 1 (KDHE responsibility) addressed Class I, III, and V wells. Part 2 (KCC responsibility) addressed Class II wells. The EPA decided that it was necessary for Kansas to rewrite portions of its Part I UIC program. Consequently, the rules were rewritten and resubmitted to the EPA in February, 1983. Kansas received primacy under Section 1422 of the SDWA in December, 1983, and under Section 1425 in February, 1984.

KDHE has estimated that there are approximately 13,000 Class II wells in Kansas. Of these, there are 6,000 permitted salt water disposal wells. It is difficult to determine the exact number of enhanced recovery wells because as many as 100 (or more) repressuring wells can be included on the same permit.

SUMMARY OF REGULATIONS

Rules and regulations governing salt water injection and enhanced recovery wells in the state of Kansas are documented by the Kansas Corporation Commission in the "General Rules and Regulations for the Conservation of Crude Oil and Natural Gas" (effective May 1, 1984). The latest rules combine the enhanced recovery and disposal injection wells into one group. Rules for injection wells are found in Sections 82-3-400 through 82-3-411. Persons requesting copies of the rules and regulations may also receive a copy of "Fundamental Guide for Salt Water Disposal Wells" by Rice Engineering and Operating, Inc.. This is a practical, readable guide which briefly describes the major considerations of completing and operating a disposal well. The guide includes diagrams of various methods of completing a well and an example of a completed permit application.

RULES AND REGULATIONS

Section 400 of the rules and regulations states that it is necessary to obtain a permit to operate an injection or disposal well in the state of Kansas and that the proposed injection zone must be separated from fresh or usable water by impervious beds to give protection to the fresh and usable water formations. It further states that wells requiring well head pressure to dispose of salt water must be completed with a packer, with certain exceptions. Additionally, records concerning the amount and kind of fluid being injected must be kept current for a period of five years and a report of such must be submitted to the KCC at the end of each year.

Section 401 defines the information required in an UIC application. The applicant must show certain specific information on the injection or disposal well (see Appendix A). This section also outlines the data that must be considered prior to issuing an order approving injection or disposal wells. An example of an application form for a salt water disposal well is shown in Appendix A, Figure A-1.

Disposal wells require separate orders for each-well but enhanced recovery well orders cover multi-well projects. A copy of the application must be mailed or delivered (by the applicant) to each operator producing or drilling wells (offset operators) within a 1/2 mile radius of the proposed disposal well and to the landowners. Notice of the application must be published in at least one issue of a local paper having general circulation throughout the county or counties in which the lease is located. Objections or complaints concerning the proposed well must then be filed within 15 days after the application is filed. Should an objection or complaint be filed, or should the KCC require it, a hearing will be held. At the hearing anyone who has filed a complaint must state any reasons why the proposed well may cause damage to fresh water resource (or to a hydrocarbon resource). The KCC will then make a decision to either grant or deny the permit based on the evidence provided.

Section 402 pertains to casing and cement. Injection and disposal wells must be cased and the casing cemented in such a manner that damage will not be caused to hydrocarbon sources or fresh and usable water sources. Specific instructions are given for certain types of wells.

Cement bond logs or temperature surveys demonstrating adequate cement protection may be submitted to the commission.

Section 403 outlines requirements pertaining to commencement and discontinuance of injection or disposal operations. Immediately after injection or disposal has begun the operator must inform the KCC of the date of commencement. Within 90 days after permanent discontinuance, the KCC must be notified of the date of the discontinuance and the reason for it. Though it is not stated in the regulation, a commission representative must always be present during the abandonment procedure to ensure that plugging is carried out in a satisfactory manner.

Tubing and packer requirements are listed in Section 404. Wells must be equipped to inject through tubing, below a packer set in the casing opposite a cemented interval, immediately above the uppermost disposal perforation or open hole interval. The use of a packer and tubing, including diagrams, is explained in the "Fundamental Guide for Salt Water Disposal Wells". A corrosion-inhibiting fluid or hydrocarbon liquid must fill the annulus between the tubing and the casing. This liquid further protects the well casing from corrosion by foreign fluids. The KCC may authorize packerless completions if specific stipulations are met.

A tubingless completion may also be authorized if the certain criteria are met throughout the life of the well.

The requirements concerning proper operation of a salt water injection or disposal well are described in Section 405. Before operation begins, the casing outside the tubing and above the packer must be tested. The test must be witnessed by a representative of the KCC or KDHE. A pressure of 100 psi or the maximum allowable disposal pressure, whichever is greater, must be used in the test. The well must be shut-in for a period of 30 minutes. The allowable pressure dropoff during this time will be set by the representative of the regulatory agency on a site by site basis, but typically 10 percent dropoff is acceptable. Mechanical integrity must be established periodically during operation of the well using either pressure tests or monitoring. Pressure tests are required once every five years as outlined above. A minimum of 25% of the tests must be witnessed by a representative of KCC or KDHE. Instead of pressure testing, the operator may monitor and record the pressure in the annulus of the well during actual disposal. Continual monitoring or periodic testing of an injection well should indicate when leakage is occurring or when the formation or well are becoming plugged.

Section 406 states that the authorization to inject fluids into a well remains valid throughout the life of the well, unless revoked by KCC for just cause. This section gives KCC the authority to shut-in a well if just cause is indicated. Just cause includes mechanical failures or other conditions which indicate a well is not directing fluid into the permitted injection zone. Furthermore, if an operator detects such a problem, the operator must notify KCC of the situation within 24 hours (verbally) or within five days (in writing). In addition to this notification, the operator must inform KCC and KDHE of the plan intended to test and repair the well. Results of the testing and repair will be given to KCC and KDHE and will be included in the annual report. Any downhole well repair should be included in the annual report.

Section 407 restates the requirement of keeping accurate records for five years. Section 408 details the information which must be sent to KCC when a transfer of ownership occurs. Section 409 defines an "existing" injection or disposal well and the inventory forms necessary to obtain that status. Finally, Section 410 states that the commission will establish a fee for each lease involved in the application. This fee must be paid within 30 days after the commission makes notice of the charge. The application fee is put into a general operating fund which makes it possible for KCC to administer Class II well regulations.

Fundamental Guide for Salt Water Disposal Wells

The guide for salt water disposal wells includes sections covering topics such as application procedures for obtaining a disposal well permit and plugging procedures for a disposal well.

One of the most useful aspects of the guide is that it defines practices required by KCC and KDHE when enforcing general statements found in the rules and regulations that are considered necessary to prevent ground-water contamination resulting from salt water disposal practices. For instance, Section 82-3-402 states "injection and disposal wells shall be cased and the casing cemented in such a manner that damage will not be caused to hydrocarbon sources or fresh and usable water sources". Section I (E) of the guide, explains that KCC and KDHE require that surface pipe be set on a hard formation and cement circulated to the surface. Casing must also be set and cemented through any disposal formation that is loose and subject to caving. Many disposal wells can be completed by setting the long casing string on a formation where open hole completion is possible with injection through tubing and packer set near the top of the disposal zone.

Other sections of the guide suggest the best or recommended methods of completion or operation of a disposal well to prevent salt water contamination. Section III discusses tubing and lining. It suggests using the largest size of tubing able to be run inside the size of casing that is used in a well. Internally lined steel tubing is recommended.

Section 82-3-404 requires that the annulus between the tubing and casing be filled with a corrosion-inhibiting fluid or hydrocarbon. The salt water disposal guide describes a simple method of filling the annulus by using oil, and explains how to calculate the proper oil gravity which will protect the annulus.

The same section (IV) of the guide recommends the use of packer when: (a) the well fluid level is extremely low, and (b) the condition of the long casing string is questionable. The guide also states that packers often leak resulting in false indications of tubing or casing problems. Packers often become stuck and have to be drilled out.

Section V of the guide defines normal injection rate, normal injection pressure, maximum injection rate, maximum injection pressure, and tubing vacuum and explains how to determine each. Section VI briefly explains remedial treatment and clean-out methods used to stimulate wells. It also suggest the best methods in use for stimulating the two main disposal zones in Kansas.

The two formations commonly used for salt water disposal are discussed in Section II. The Arbuckle dolomite (lower Ordovician) is the recommended disposal zone. The guide lists reasons for the frequent use of the Arbuckle formation and states that for high volume disposal, a total of 300 feet or more of open hole in the Arbuckle is necessary. The Cedar Hills formation (Permian) is also commonly used for salt water disposal in Kansas, but it can not be completed open hole because it is a poorly cemented sand. The Cedar Hills sand will collapse into the borehole if not cased and cemented (and then the casing perforated for injection).

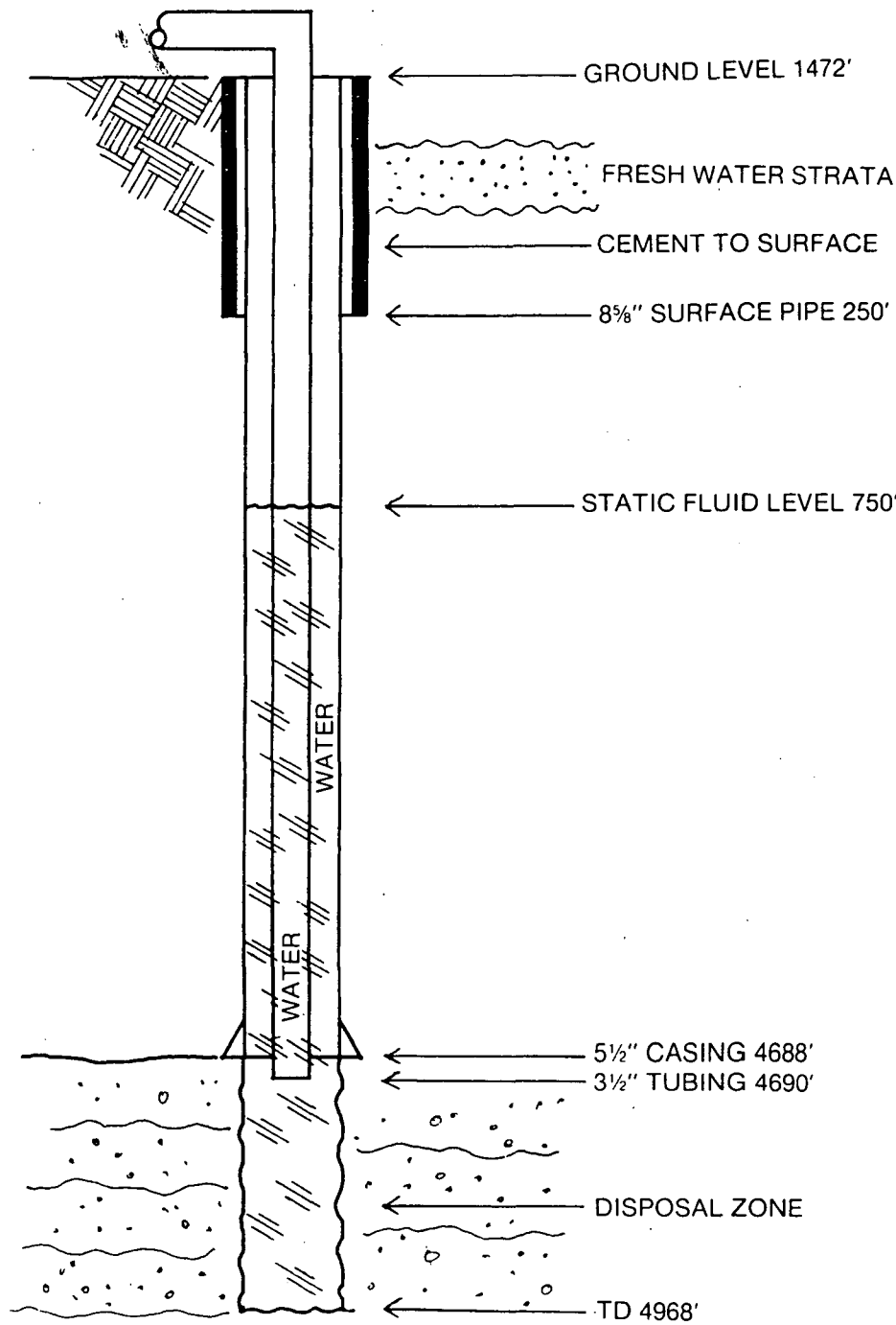

Figure 2. Proper salt water disposal well completion.

ADMINISTRATIVE PROCEDURES

Both KCC and KDHE have developed standard procedures to handle complaints about, or discoveries by their own personnel of incorrect operation of salt water disposal wells. Most often, the problem is discovered because some type of contamination has occurred. Consequently, the person affected by the contamination (usually the landowner) reports the problem to one of the two agencies. The KCC and KDHE follow slightly different procedures to investigate the problem. This section will detail the standard procedures followed by each of the agencies to enforce the salt water disposal well regulations.

KCC Procedure

When a case of improper salt water disposal well operation is discovered, the main KCC office is contacted about the problem. The director of the UIC program determines the initial course of action to be taken by the Commission. If a field inspection has not been made, the Wichita office notifies the appropriate district office of the problem and instructs a field inspector to inspect the site. A description of the site, which may include a discussion of the problem with the landowner or a neighboring landowner, is filed on a standard field report form (Appendix B, Figure B-1). The problem may be further documented with: 1) polaroid pictures of the site; 2) the registry of deeds indicating the legal lease holder, or 3) in the case of a flowing (abandoned) well, a dye test to determine whether the flow is caused by the use of an injection well.

The Commission then sends a letter to the operator of the well detailing the problem and instructing the operator that the problem must be corrected. Letters sent by the KCC to operators are of fairly standard form, indicating the name of the lease and its location, a statement to the effect that "a report has been made to the KCC indicating....," and either a statement that action must be taken within 30 days or legal action will be taken.

At the end of the 30-day period, the site is reinspected by the district field inspector. If the problem has not been corrected, it is referred to the Commission's legal counsel for action (Schoof, personal communication, 1983). KCC's attorney then sends another letter to the operator threatening an administrative hearing if the problem is not resolved by a given date. KCC attempts to do as much as possible to correct the problem by working with the operator. However, if this fails, the Commission can take several steps to rectify the situation. First, an administrative hearing is conducted. At this hearing, the KCC presents all of the information it has gathered pertaining to the problem site and operations at the site which violate UIC regulations. The operator may present a defense of his operations at the hearing. Following the hearing, the hearing examiner makes a recommendation to KCC. The Commission relays this recommendation to the operator who has 10 days to comply with the recommendations. The recommendations may be to plug the well or make a specific correction. A fine as high as $10,000 per day may be imposed (1) every day after the 10 day period in which the correction was to have been made, or (2) every day after the hearing until a correction is made, in the event that the operator does not appear at the hearing.

Following the first hearing, the operator has the option of requesting a second hearing. If the operator again refuses to comply with the Commission's demands, the KCC can take the offender to the State District Court (Ellis, personal communication, 1983). At any time during this process, if deemed necessary, KCC can have one of its field inspectors shut in the salt water injection well, or KCC can revoke the operator's production license. Finally, following the District Court hearing, it may be necessary for the Commission to plug a well that is in violation with the State's UIC regulations if the operator still refuses to comply with the court's demands.

KDHE Procedure

Every complaint received by KDHE about a salt water disposal well, is referred to and investigated by the appropriate district office (if received by the main office in Topeka). Either a field investigation is carried out within 72 hours, or the operator of the questionable operation is contacted by phone. Frequently KDHE investigates the site with the person who made the complaint or with the operator involved. Following his investigation, the field inspector then writes to the offender, detailing the problem and requesting that the problem be corrected within two weeks. If the problem concerns an unpermitted salt water disposal well, KDHE refers the operation to KCC, which is then responsible for bringing the operation into compliance.

The field inspector checks the site again after the two week period. If the contamination problem has not been resolved, KDHE can issue an administrative order or take the offender to court. The administrative order is sent by certified mail to the operator of the injection well. It demands that the operation be closed within 30 days within which time the operator may protest the closure. If the operator takes no action in that 30 day period, another certified letter is sent to the operator. This time the letter states the sum of the fine imposed on the operator for violation UIC regulations. In the event that KDHE decides to take the offender to court, it must decide whether to take the case to the County Court or to the State District Court, depending on the local situation. Either KDHE or the complainant may also sue an operator in civil court. When a private citizen sues an oil and gas producer for salt water contamination, KDHE is responsible for providing the appropriate information concerning the case.

Like KCC, KDHE has the authority to shut in wells at the discretion of its field inspectors. There is no pipeline severence in Kansas (the authority to shut off oil and gas production from the operator's producing wells) however, KDHE can revoke an operator's license for his oil and gas production wells due to a violation of UIC regulations (Glotzbach, personal communication, 1983).

Part of the process of terminating a salt water contamination problem involves defining the source and direction of movement of the contamination. For this reason, KDHE owns a drilling rig to drill ground-water monitoring wells. One method of defining the source of salt water contamination, which KDHE utilizes, is salt water "fingerprinting". This technique assumes that waters originating from the same place retain essentially the same chemistry (except that they are diluted). Therefore, on a water chemistry diagram such as a Stiff diagram, which shows a chemical analysis of water in distinctive graphical shapes, water having the same origin should have similar chemistries and thus similarly shaped Stiff diagrams (Figure 3) (Denig-Chakroff, unpublished).

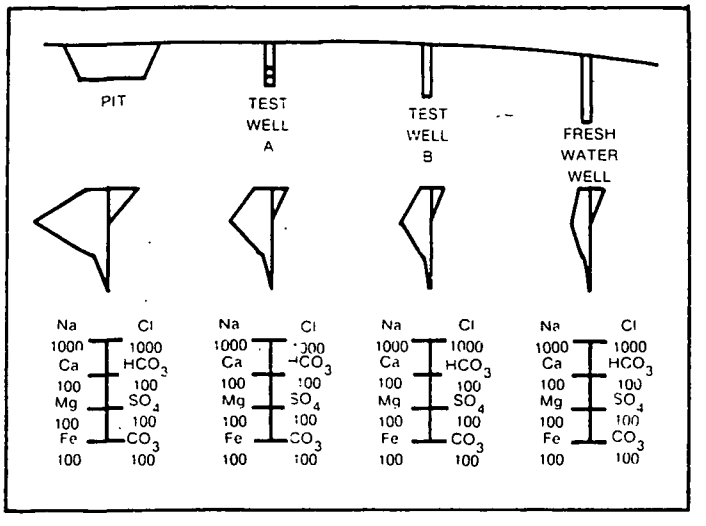

Figure 3. Stiff diagram used for brine fingerprinting (Denig-Chakroff, unpublished).

TABLE 4. GROUND AND SURFACE WATER CONTAMINATION INCIDENTS RELATED TO CLASS II WELLS INVESTIGATED BY KDHE AND/OR KCC BETWEEN 1979 - 1982

Water Contamination Incidents Reported in Kansas, 1979 - 1982

Source of Problem	Eastern*	Western	Total
Storage Tank/Ponds**	2	5	7
Emergency Pit Full/Overflowing	21	3	24
Overflowing Dike	1	-	1
Tank Overflow/Leak	11	8	19
Unpermitted Pond/Pit	2	-	2
Line Leaks**	23	3	26
Disconnected Line	2	-	2
Line Leading Directly to Open Pit	6	4	10
Line Directly to Stream	1	-	1
Injection Wells**	28	12	40
Pump Failure	26	1	27
Not Accepting Sufficient Brine	5	-	5
Packer or Tubing Leak	2	3	5
Must Have Automatic Controls	2	-	2
Casing Leak	-	1	1
Must be Modified to Comply	1	-	1
Unpermitted Well	12	2	14
Flowing Abandoned Well	24	19	43
Undetermined Source***	7	5	12

*The 6th Principal Meridian is considered the boundary between Eastern and Western Kansas (Figure 1).

**General problem - more specific source unidentified.

***Saline water detected, after monitoring and/or tests; source not pinpointed. Many still under investigation.

CONTAMINATION INCIDENTS BY SALT WATER DISPOSAL WELLS

It is very difficult to separate incidents of ground-water contamination from those of surface-water contamination. The problem of documenting cases of ground-water contamination due to salt water disposal is further complicated because it is difficult to determine the cause of most ground-water contamination. The twelve unresolved contamination incidents listed in Table 4 (listed under "undetermined source"), all involved ground-water contamination. All twelve cases are incidents of saline water detected in domestic or irrigation wells, or flowing out of springs, stream banks, or abandoned wells (both plugged and unplugged) or in natural drainages. Unlike contamination problems detected on the surface, these problems can not be "visibly" traced back to their sources. Each of these cases is documented by several pages of water quality analyses, flag tests, and drilling or plugging records. In one case, numerous auger holes were drilled by KDHE to sample water quality in an area surrounding a household well contaminated by saline water. However even with thorough documentation of the existence of a problem, the source of contamination in each of the cases remains undetermined.

The slow flow of ground water makes it difficult to always reach a conclusion as to the source of a ground water pollution problem. In the past, evaporation pits and ponds were used to "store" salt water from oil and gas production. Salt water seeped from these pits into the ground water and slowly moved away from its point of origin. Because ground-water movement is slow, salt water from those pits remains in the ground and will be drawn into water wells and will discharge naturally into surface drainage for many years.

Proving a salt water disposal contamination incident in Kansas is further complicated because many of the water bearing zones in the state have high background mineralization. Because saline water is present does not mean it was produced by a salt water disposal operation; it may have been caused by natural mineralization.

Case #1

One of the well-documented but yet unresolved ground-water problems in Kansas was reported by a landowner in September, 1979. The landowner discovered a 10 foot diameter area of subsidence surrounding an abandoned, plugged well. He reported that two years earlier his 30 foot deep house well went dry and he was forced to have a deeper (60 foot) well drilled. The first test well drilled in an attempt to establish a new house well had a chloride content of 4041 milligrams per liter (mg/l). Another 60-foot well was drilled which produced water with a chloride content of 542 mg/l. Three neighboring wells tested by KDHE produced saline water. KDHE then drilled several auger holes in the area to determine the source of the salt water. Water quality analysis from these holes and the plugging records of a nearby abandoned well did not help in defining the source. Six additional holes were drilled in the area highest mineralization and near an abandoned unplugged well. The water quality analyses from these wells were helpful but inconclusive. Unfortunately, with the augering equipment that KDHE owned, the agency was unable to do any further analysis. KDHE suggested that the landowner hire a driller to drill several holes in two particular locations to help in defining the problem. KDHE also

suggested that if the landowner chose not to have further test drilling done, another house well should be drilled in a third suggested location. A final report on this situation was sent from KDHE to the landowner in February, 1980.

Case # 2

Though it is difficult, it is not always impossible to determine the source of saline ground water; the cooperation of local oil and gas producers help to make this problem solvable. For example, another complaint concerning a contaminated house well was made to KDHE by a landowner who had a 35 foot deep house well drilled. After three months of use, the well water developed a bad taste and odor. A second well was drilled to a depth of 55-65 feet and water from the well was tested by a private laboratory. When it was found that the chloride content of water from the well was 1130 mg/l, KDHE requested all of the producers in the area to check for leaks in their salt water disposal well surface pipes. Several producers contacted KDHE to inform the agency that they had run pressure tests on their wells and found no evidence of salt water leakage. One of the nearby producers ran a pressure test and found no evidence of leakage, but told KDHE that he had unsuccessfully attempted to pull the tubing on his salt water disposal well to check for leaks. He decided, on his own accord, to abandon the disposal well and complete another deeper well for salt water disposal. Six months after the complaint to KDHE (March, 1981), it appeared that the source of ground-water contamination had been eliminated.

Case #3

Pits and ponds are considered a major source of saline ground-water contamination; however, it is difficult to draw a direct connection between ground-water contamination and a salt water pond without extensive ground-water monitoring data. There is at least one case in Kansas in which a ground-water contamination problem was inferred to have been caused by a salt water storage pond. In this instance, a saline seepage zone developed adjacent to a salt water pond. During a KDHE inspection, the district geologist discovered the seepage zone; a sample of the seepage water had a chloride content of 50,000 ppm; and the operator was ordered to stop the seepage from the pond or his pond permit would be revoked. The letter also stated that Kansas was attempting to eliminate the use of salt water ponds at salt water disposal operations. Therefore, the operator was to take this into consideration when deciding how to solve the seepage problem.

It should be understood that salt water ponds in Kansas are allowed only for emergency or temporary storage purposes. The regulatory agencies prefer the use of salt water storage tanks. In view of the number of contamination incidents related to emergency pits (Table 4) this is an understandable position.

In examining Table 4, it is immediately realized that the number of contamination problems caused by injection wells is high. This table only lists detected problems and there may be as many or more undetected problems of a different nature. Again, though most of the contamination sources listed in Table 4 indirectly affect the ground surface, ground water may be indirectly affected by many of these contamination sources.

REFERENCES

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Latta, Bruce F., 1963, Fresh water pollution hazards related to the petroleum industry in Kansas; Transactions of the Kansas Academy of Science, vol. 66, no. 1, pp. 25-33.

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SECTION 4

UNDERGROUND INJECTION IN TEXAS

AGENCY RESPONSIBILITIES

The Underground Injection Control (UIC) Program in the state of Texas is jointly enforced by the Texas Department of Water Resources (TDWR) and the Railroad Commission of Texas (RRC). The Texas Department of TDWR has jurisdiction over Class I, II, IV and V wells and the RRC has authority over Class II wells. The Commission also has authority over Class II wells used for the enhanced recovery of oil and gas and underground hydrocarbon storage.

The Underground Injection Control Section of the Oil and Gas Division of the Commission is charged with administering a program which (1) processes and issues new permit applications for injection/disposal wells, (2) oversees the operation of injection/disposal wells for which permits have already been issued, and (3) coordinates the protection of fresh water is Texas with other state and federal agencies. The Oil and Gas Division has a central office and ten district offices to oversee the program. Each of the ten district offices is staffed with engineers, geologists and engineering technicians who are involved as needed for monitoring, inspection and reporting. Figure 4 is a map showing the delineation of the districts and the city in which each district office is located.

HISTORY OF SALT WATER DISPOSAL REGULATIONS

The RRC was created in 1890 for the primary purpose of regulating the railroad industry. It was the first regulatory agency authorized for the State of Texas.

The Commission's oil and gas regulatory role began in 1917, when pipelines were placed under its jurisdiction. Two years later, the Legislature enacted a statute requiring oil and gas conservation, forbidding waste, and giving the jurisdiction for regulating this industry to the Commission.

The Commission has been active in the control of underground injection activities for more than forty years. The first permit to inject gas into a reservoir producing oil or gas was in 1928; the first permit to inject water into a producing reservoir was issued in 1938. The permits specified that injected fluids must enter no formation other than those authorized. By 1955 the Railroad Commission adopted a policy requiring all operators of wells drilled in new areas to obtain a letter from the Board of Water Engineers stating the depth to which ground water should be protected. In 1961, the Commission required that a letter from the Texas Water Commission stating that the drilling of such injection well and the injection of such salt water or other such waste into such subsurface stratum will not endanger the fresh water strata in that area and that the formation or strata to be used for such salt water or other such waste disposal are not fresh water sands.

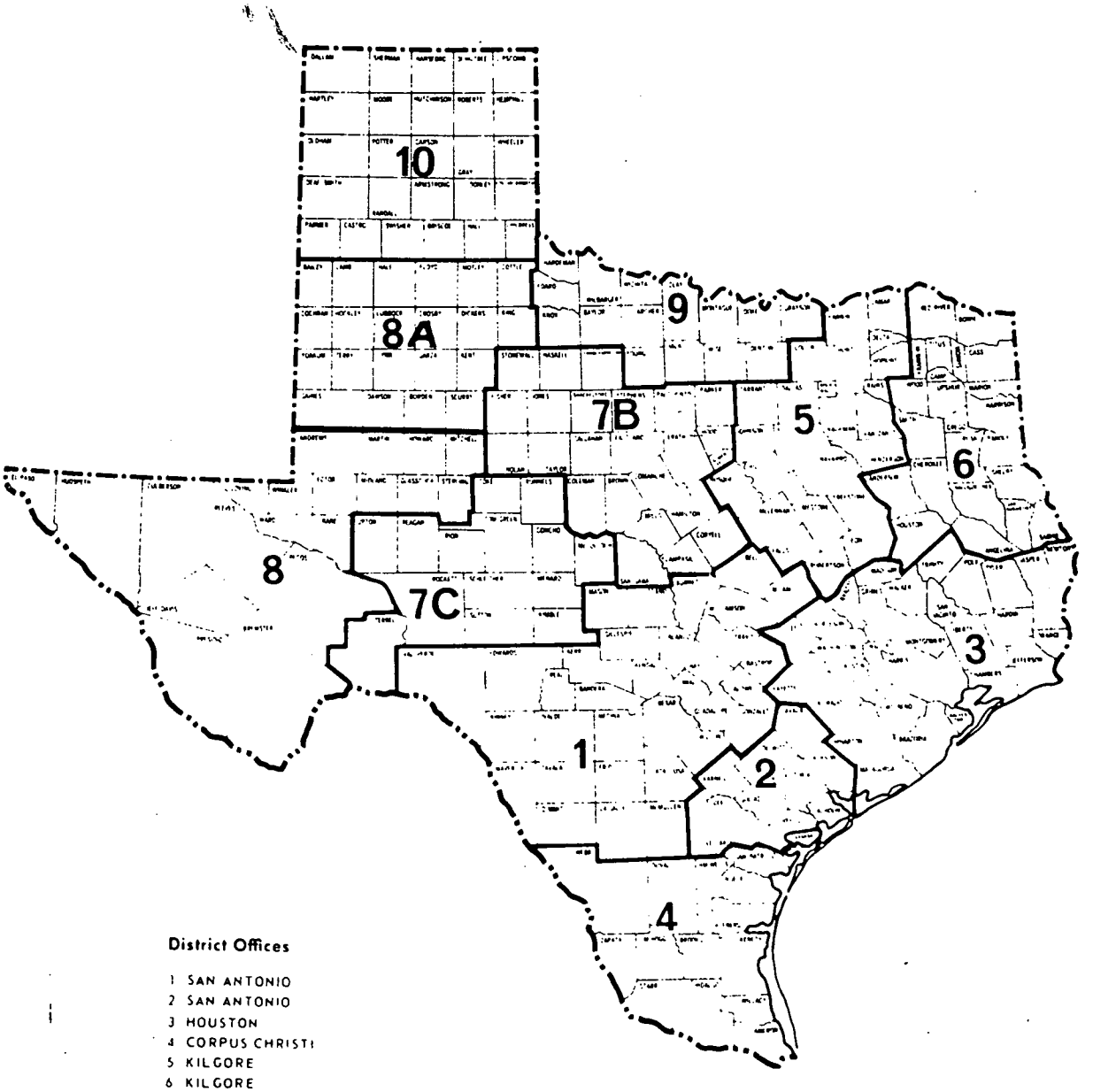


Figure 4. District map of Oil and Gas Division, Texas Railroad Commission.

In the ensuing years, revision of the laws and regulations pertaining to salt water disposal and injection required a strengthening of the regulations in this area. In January, 1969, a Commission order outlawed the use of salt water disposal pits for both the storage and evaporation of salt water. On January 2, 1980, the Underground Injection Control (UIC) Section of the Oil and Gas Division was created to administer a program consistent with state and federal law, including oversight of the injection, disposal, and hydrocarbon storage well permits already issued, processing and issuing new permit applications, and coordinating with EPA and other federal and state agencies in a concerted program to protect fresh water in Texas. And, on April 23, 1982, Texas became one of the first two states to receive primacy in enforcement of the UIC program.

A better concept of the magnitude of the program for Class II wells in Texas can be provided by reviewing some statistics. According to a report prepared by the Water Task Group of the Midcontinent Oil and Gas Association (1975), in 1973, there were over 51,500 salt water injection or disposal wells in the state. Approximately seventy percent of these wells were used for secondary recovery or pressure maintenance operations. Approximately 16,000 wells were used for salt water disposal. This number was evenly divided between disposal into non-productive and productive formations. Over five billion barrels of salt water were injected for disposal and recovery operations in 1973. By 1983, the estimated number of injection/disposal wells had been reduced to 44,500. However, the responsibilities of enforcement of the UIC regulations did not decline proportionately.

SUMMARY OF REGULATIONS

Underground injection procedures and provisions to protect the groundwater resources of Texas from such operations are prescribed by statewide rules in these areas; Water Protection, Disposal Wells, Fluid Injection into Productive Reservoirs, and Underground Hydrocarbon Storage. Certain provisions included in rules regarding casing and plugging of wells are also applicable. Appendices E, F, G and H contain the complete text of these rules and a summary of the applicable provisions of the rules are described below.

Water Protection

This rule requires that fresh water whether above or below the surface, shall be protected from pollution whether drilling, plugging, producing or disposing of salt water already produced. This rule applies to all operators conducting oil, gas or geothermal resources development and production operations.

The rule prohibits the use of salt water disposal pits for storage and evaporation of oil field brines and geothermal resource waters or other mineralized waters, without specific approval from the Commission. The rule outlines instructions pertaining to the use of basic sediment pits, impervious collecting pits, disposition of oil field brines, geothermal resource waters, or other mineralized waters, and exceptions to the rule, as well as penalties to be imposed if the rule is violated.

The rule provides instructions regarding the disposition of all wastes so as to ensure adequate pollution prevention. All data applicable to salt water haulers, including permitting, identification, and salt water hauling operations, are also outlined.

Disposal Wells

Information regarding the disposal of salt water, or other oil and gas waste, by injection into a porous formation not productive of oil, gas or geothermal resources is outlined. Other matters contained in the Rule consist of filing of application (Form W-14); notice and opportunity for hearing; protested applications; geological requirements; and special equipment requirements.

The Rule also outlines instructions regarding records maintenance; monitoring and reporting; testing; plugging; and penalties to be imposed for non-compliance with the rule. Besides permit revocation, penalties may also be imposed for non-compliance with the rules.

Fluid Injection into Productive Reservoirs

This statewide rule governs applications for the permitting of fluid injection into reservoirs productive of oil, gas or geothermal resources. Application for a permit is on Forms H-1 and H-1A. The rule also contains matters regarding the application review; notice and opportunity for hearing; protested applications; and modification, suspension or termination of permits.

Also included are requirements regarding casing and cementing (in accordance with another statewide rule); special equipment (tubing and packer, pressure observation valves); records maintenance; monitoring and reporting; testing; plugging; and penalties for violation of the Rule.

Underground Hydrocarbon Storage

This rule prescribes the methodology for permitting an underground hydrocarbon storage facility. It outlines the procedures for filing an application; technical requirements pertinent to the storage facility; notice of and opportunity for hearing; transfer or permits; and subsequent Commission action.

The rule also prescribes the system for monitoring and reporting, testing, plugging, and penalties to be assessed for violation of the rule.

REGULATORY AND PERMITTING PROCEDURES FOR CLASS II WELLS

Casing and Cementing

Class II wells must be cased and cemented to confine the injection fluids to the injection interval. Cement around surface casing must be circulated to the surface by the pump and plug method and the casing cement must meet certain specified quality. If a well is converted from a production well to a disposal

well and injection is into a formation above the producing formation, one of the following criteria must be met to determine the height of cement above the disposal zone:

a) presence of 100 feet of bonded cement as determined by a cement bond log,
b) 250 feet of cement as evidenced by a temperature log, or
c) 400 to 600 feet of cement as determined by a slurry yield calculation.

Tubing and Packer

All new wells must be completed with tubing set on a mechanical packer which shall be set no higher than 100 feet above the top of the permitted interval. Existing wells must have been so equipped at the time of the first workover or no later than January 1, 1984.

Completion Reports

A completion report (Form W-2 or G-1) must be filed with the appropriate district office within 30 days of completion or conversion to disposal, injection, or underground hydrocarbon storage operations to reflect the new or current completion.

Operating Requirements

Pressure limitations are established to provide adequate assurance that injection will not initiate fractures in the confining zone.

Mechanical Integrity

All Class II wells must be pressure-tested at least once every five years to determine if leaks exist in the casing, tubing, or packer. The appropriate district office must be given 48-hour notice prior to the test. The long string casing must be pressure tested at the maximum authorized injection pressure or 500 psig whichever is less, but must be at least 200 psig. This test must be conducted prior to the beginning disposal operations and at least once every five years thereafter. As an alternative to the pressure-testing, the operator may monitor the tubing-casing annulus pressure and report the results annually to demonstrate that no additional pressure-testing is needed.

Monitoring and Reporting

The pressure and injection volume of each well shall be monitored on at least a monthly basis and reported to the Commission annually on Form H-10. For Class II wells, except hydrocarbon storage facilities, any downhole problem must be reported to the appropriate district office within twenty-four hours and confirmed in writing within five working days. Operators of hydrocarbon storage facilities must report problems to the appropriate district office immediately and must confirm this report in writing within five days.

Area of Review

Class II disposal and injection well operators must examine the data of record for wells that penetrate the proposed injection zone within a quarter mile radius of the proposed well to determine if all abandoned wells have been

plugged in a manner that will prevent the movement of fluids into strata other than the authorized zone. Applicants for new permits must submit a map showing the location of all wells of public record within a 1/4 mile radius as part of their permit application.

For those wells that penetrate the top of the injection zone, the applicant must attach a tabulation of the wells showing the dates the wells were drilled and the present status of the wells.

If the applicant can show, by computation, that a lesser area will be affected by pressure increases, then the lesser area may be used in lieu of the fixed radius.

No permit will be issued where the information submitted indicates that fresh water sources will be endangered unless permit conditions require appropriate corrective action in the area.

Plugging and Abandonment

All Class II wells must be plugged upon abandonment in accordance with commission regulation. Plugging must begin within ninety days after injection operations have ended. The purpose of plugging is to assure the protection of all formations bearing usable-quality water, oil, gas, or geothermal resources.

ADMINISTRATIVE PROCEDURES

Complaints and Enforcement

Suspected cases of ground water contamination or situations which may lead to contamination of ground water may be discovered in a variety of ways. First, field inspectors may notice a problem or violation during routine on-site inspections of Class II wells. Second, the operator may notice changes in annular pressure or other signs that a leak in the casing, tubing or packer may be present and notify the district office. Third, a landowner or other party may file a complaint with the Commissioner about operator activity or problems with a water well. In all instances, it is the field inspector who must investigate and initiate any enforcement actions.

In suspected ground water contamination incidents, the complaint is often the most common route of recognition. A citizen will complain about the quality of water in a water well or discharge seepage of salt water at the land surface. A citizen may either call the district office or the central office in Austin. When a complaint is received, a complaint form (Appendix D) is filled out. If the complaint is received in the district office, a copy is sent to the central office for coordination to assure that all complaints are followed through. If a complaint is received in the central office, a copy of the complaint is forwarded to the district for investigation. Regardless of the office in which the complaint was received, the complaint is logged on a 3 x 5 card which contains the following information:

- complainant name,
- company (operator),
- lease,

- county,
- type of problem,
- action taken, and
- date resolved.

The complaint is assigned a follow-up date and filed by the name of the complainant. The 1st and 15th of every month, the card file is checked for status of the complaint. If the central office has not been advised of district action or resolution, a follow-up letter about the complaint is sent to the district requesting an update. When the complaint is resolved, it is filed by county. An automated tracking system is proposed for a a more efficient way of handling complaints. Through this procedure and tracking system, it is assured that each complaint received is investigated and followed up until eventually resolved.

It is the responsibility of personnel in the district offices to investigate complaints and respond to other field problems. To assist inspectors in investigations, Statewide Rule 2 grants representatives of the Commission the permission to enter upon any lease and make any tests necessary to determine compliance with the rules. If a problem is brought to the attention of the district personnel by a complaint, the inspector interviews the complainant and files a written report, sending a copy to the complainant. The inspector then contacts the operator and makes an inspection. If the inspection finds a situation where pollution is occurring or is imminent, the commission may order the well shut in under the applicable rule provisions. If the violation is minor and not directly causing pollution, the operator will be given a specified time to correct the problem. In either situation, the inspector will file a report detailing the investigation and any recommendations for resolution. If penalty actions are anticipated or requested, a draft list of information which will assist in efficient processing of the action has been formulated by the division. The following information also serves to document the details of the investigation:

1) date,
2) operator,
3) lease and number,
4) field,
5) county,
6) operator address,
7) type of discharge or violation (leak, pit, leaking well, etc.),
8) type of fluid,
9) source of fluid,
10) estimated amount of fluid,
11) size of area affected,
12) chloride concentration (field test),
13) date sample(s) submitted to lab,
14) custody tag number,
15) date violation first noted,
16) is violation still continuing?
17) if not, give date corrected,
18) depth of fresh water in area and chlorides,
19) any water courses affected?

20) identification of water course,
21) list actions in this case (attach correspondence),
22) list any previous violation by operator and give dates,
23) describe violations (exact details and dates),
24) name of inspector(s),
25) attach pictures of site,
26) attach plat of lease showing area affected, where samples collected and location of wells, tanks, pits, etc.,
27) attach any appropriate inspection tickets or worksheets, and
28) additional information.

If the violation is not corrected, the district directors may request a show-cause hearing by the Commission. The hearing is placed on the commission docket and notification is sent to all parties and published in the Texas Register. At the hearing, all testimony and evidence is heard and an examiner recommends a course of action to the Commission which specifies a time period within which the violation must end. The order issued by the Commission may 1) maintain the shut-in order, 2) order pipeline severance, 3) modify revoke or suspend the operator's permit, 4) require the well to be plugged, or 5) impose other necessary corrective measures.

If the violation is still not resolved as the Commission has ordered, a second hearing may be held and the operator may be fined $500 per day for contempt and may be subject to up to six months imprisonment for each contempt citation.

The Commission may further request that the Attorney General seek civil penalties or other injunction to remedy the violation. A maximum of $10,000 per violation or per day of violation may be collected where an oil or gas disposal well is involved. A maximum of $5,000 in criminal violations may also be collected. Finally, the commission may invoke other less-used powers to remediate the violation.

CONTAMINATION INCIDENTS BY SALT WATER DISPOSAL WELLS

In an effort to document ground water contamination incidents related to underground injection or disposal of salt water, files of plugging reports and complaints were compiled by state personnel and made available for this study. Information on wells plugged by the Railroad Commission was available for the years 1967 through 1975. Information for more recent years was based on complaints received by the Commission which alleged contamination due either to salt water injection or disposal wells. Data were available for the periods January 1979 through June 1980 and January 1982 through December 1982.

The information available from plugging records of the Commission where the problem was attributed to either a disposal or secondary recovery well is included in Table 5. Information on the cost of plugging, a brief description on the situation, the area contaminated and completion or operation dates have been included. The cost figures are for the year during which the investigation was conducted and are not referenced to a base year. The costs also reflect

TABLE 5. SUMMARY OF WELLS PLUGGED BY THE COMMISSION WHERE THE PROGRAM WAS ATTRIBUTED TO A DISPOSAL OR INJECTION WELL, 1967 THROUGH 1975

SUMMARY	COUNTY	DATE OF INVESTIGATION	AREA CONTAMINATED	DISPOSAL WELL	SECONDARY RECOVERY WELL	COMPLETION OR OPERATION DATES
Cost: $1868.00 - TD 2010 - leaking oil and salt water. The leakage is apparently being caused by water injection on offsetting leases, of which there are three.	Wichita	1968	Land damage	-	x	1921
Cost: $648.70 TD 420 - originally plugged 1957. Started leaking to surface 1968. Well offset by shallow waterflood. Injection well shut down - leak stopped.	Shackelford	1968	Hubbard Creek Watershed	-	x	1954
Cost: $976.50 - The most apparent source or cause of this problem is shallow disposal wells.	Young	1968	Land damage	x	-	1938
Originally plugged 1950 (Well 1) - Well 1-B TD 3194 - wells adjacent to waterflood	Runnels	1968	Land damage & creek	-	x	1950
Leaking salt water through hole in surface casing	Runnels	1968	Land damage	-	x	1951
Cost: $972.25 - TD 1310 - leaking salt water and gas 58,000 ppm. Salt water is apparently the result of waterflood operations to the east, north and northeast.	Baylor	1969	Land damage	-	x	1961
TD 1767 - 48,000 ppm salt water. Leakage probably caused by waterflood operations to the east.	Archer	1969	Land damage	-	x	1925

TABLE 5. (continued)

Plugging report indicated 108' of 8 5/8" set and cemented w/90 sacks cement. RRC determined there was no surface pipe in well. SWD from 203'-600'. SWD well deepened in 1964 to 2000+ feet. Contamination in 1968 caused by hole in casing which allowed salt water to be pumped into the zone from 200' to 300'.	Knox	1969	Irrigation Well	x	-	1959
Cost: $2206.40 TD 3509' 15 BPD salt water - 53,150 ppm cl. Well is offset of Unit Waterflood. Nearest injection well about 1800' South.	Stephens	1969	?	-	x	1921
Cost: $1,147.45. TD 3182. Originally plugged 1923. Hole full of mud and left 106' of 8 1/4" and 230' of 12 1/2" pipe in well. Adjacent well used as a disposal well but quit when leaking well was discovered.	Stephens	1969	?	x	-	1922
Cost: $953.45 TD 827' - leaking 10 BPD salt water. 350' injection well 600' NE of leaking well.	Throckmorton	1969	Land damage	x	-	1926
Cost: $817.60. Well offsetting a waterflood of a 400' sand	Coleman	1969	Ground water	-	x	1925
Cost: $2,518.63 - leaking salt water 32,000 ppm cl TD 4991 - originally plugged 1954. Offset lease SWD well has casing leak @ 200' which is contributing to problem.	Wood	1969	Land damage	x	-	1951

TABLE 5. (continued)

Originally plugged 1957 - TD 2400' - Form 4 indicates that 100' of surface pipe had been set and cemented with 40 sacks of cement. They also reported that a cement plug was placed at the surface; however, we were able to run a string line to a depth of about 110', so evidently this plug was not set. Two water injection systems in the area could be causing the well to leak. Disposal well seems to be the most likely source for the problem. A tracer survey revealed a hole in the pipe at a depth of 1800'. The two wells are 3000' apart.	Knox	1970	Land damage	x	x	1957
Cost: $1676.50 - TD 1795 - leaking 20-30 BPD salt water. Waterflood on adjoining lease 800' south of leaking well shut down in September. Presently injecting 100 BPD into well #10 about 1600' SE of leaking well.	Knox	1970	Land damage	-	x	1962
Well apparently started flowing salt water in 1961. There have been a number of breakouts in the past (1965-67) as a result of overcharged conditions in this area. Pressure on this well was measured @ 115 psi after it had been shut in 11 days. Injection from about 700-800 psi.	Cooke	1970	Land damage	-	x	?
Cost: $847.74 TD 4156 SWD well about 3/4 mile south of leaking well.	Throckmorton	1970	Land damage	x	-	1961

TABLE 5. (continued)

Cost: $1,216.23 - Injection project 1/2 mile away	Haskell	1970	Land damage	-	x	?
TD 2350 - Cost: $1325.50 - reportedly plugged with mud in 1960. Salt water leaking from hole in pipe just below steel cap. 75,700 ppm cl. SWD may have been the source of the leakage. Had hole in pipe at 1800' in 1969.	Knox	1970	Ground water	x	-	1960
Cost: $1185.48 TD 3100' - well plugged by RRC in 1968. Began leaking again 5 BPD salt water, shallow zone charged by a bradenhead injection several years ago.	Stephens	1970	Gonzales Creek	x	-	1921
Cost: $169.50 - TD 418. Several shallow disposal wells ranged in depth from 100-490' leaking well flowing salt water 88,000 ppm cl.	Stephens	1970	Pecan Creek	x	-	1948
Cost: $2434.04. TD 2478. Water flow from the well is quite variable, ranging from no flow to an estimated 300 BPD. 142,000 ppm cl.	Crane	1971	Land damage	-	x	1934
Cost: $9560.04 - TD 2960' - originally plugged 1947. Leaking 75-100 BPD salt water 113,000 ppm cl.	Howard	1971	Land damage Large fresh water tank	-	x	1937
Cost: $3046.87 - wells standing open. A waterflood 4500' SE of leak may be contributing.	Mitchell	1971	Land damage	-	x	1965

TABLE 5. (continued)

TD 1250 - leaking salt water 11,500 ppm. The leakage is apparently being caused by waterflood operations. Plugging report indicates that it was plugged with mud.	Cooke	1972	Land damage	-	x	1935
TD 4050 - Cost $1338.21 - flowing salt water 5-10 BPD. Originally plugged with mud. Annulus salt water disposal from 354'-2302' from April 1961 - Feb. 1971.	Young	1972	?	x	-	1950
Cost: $660.83 - seeping mud and salt water. Well is located about 3500' south of a SWD well.	Young	1972	Land damage	x	-	1941
Cost: $871.25 - TD 2801' - Injection of water at about 600 lbs. pressure may be contributing to the leak.	Howard	1972	Land damage	-	x	1958
Cost: $942.00 TD 1025 - leaking	Navarro	1973	Land damage	-	x	?
Cost: $2952 - plugged 9/73 Flowing 500-800 bbls/day. Injection well 5500' from plugged well - not believed a problem 9/73 broke out (at injection well) on 11/30/73 flowing salt water and oil. 12/7/73 one of City wells went salty (150 ppm to 500 ppm)	Jack	1973	Surface and probably aquifer. City water wells 190-345' - not contaminated (9/73)	1 or more	-	1936 (drilled) 1941 (plugged)

TABLE 5. (continued)

Cost: $857.80 - TD 1020 - leaking 1/2 BPD apparently due to water injection on offset lease.	Shackelford	1973	Land damage	-	x	1949
Cost: $96,041.46 - TD 5796 - originally plugged 1954, replugged 1973 - salt water 10-15 BPD 24,900 ppm cl.	Haskell	1974	Land damage	-	x	1954
Cost: ? - plugged 3/74 - Salt water broke out in and around 60' water well - also mud and salt water appeared in vicinity of a dry hole 200' NW of water well. Base of fresh water 1300' (Trinity Sand). Found tubing leak in 2 of injection wells. Nearby 500' water well not now contaminated.	Cooke	1974	Water well and trinity aquifer and surface	3	-	1956
Cost: $1891 - plugged 1/75	Wichita	1974	Surface	1 or more	-	1953
1/29/75 mud and water forced way into house through cement slab of house. Flow decreased when injection stopped.	Shackelford	1975	Surface	-	x	1941 (Drilled) 1948 (Plugged w/mud only)
Cost: $7,694 Plugged: 8/75 Flows salt water - Another old well leaked SW & abandoned 8/74 (near disposal well) 1 disposal well is WDS-38, permitted 4/68 3 disposal wells 3100'; 2700'; & 2150' - Report connects flow from well w/injection rate of all three injection wells	Harris	1975	Surface and probably ground water	3	-	1920

TABLE 6. SYNOPSIS OF COMPLAINTS OF ALLEGED CONTAMINATION BY UNDERGROUND INJECTION, JANUARY, 1979 THROUGH JUNE, 1980

DATE RECEIVED	COUNTY	COMPLAINT
1/79	Archer	Breakout of abandoned well. Well replugged with State funds. Contributed to salt water injection programs on surrounding leases.
2/79	Young	Complaint of two SWD* wells equipped with 4 1/2" casing only. No apparent relative pollution problem.
3/79	Montague	Water well contamination which complaining party believed contributable to nearby SWD well. Conclusion: No apparent violation re: SWD well. Contamination of well apparently due to coliform bacteria infiltration and high concentration of manganese in aquifer.
3/79	Cooke	Breakout of abandoned well. Well replugged by operator of adjacent lease. Breakout contributed to increased salt water injection on this lease.
3/79	Archer	Complaint of stock pond contamination due to tubing or packer failure in SWI** well. Tubing replaced, problem resolved.
4/79	Wise	Concern that newly completed SWD well would cause problems with nearby city water wells. Inspection revealed well properly equipped. Lab analyses of water samples revealed no contamination of city wells. No further complaints to date.
4/79	Wichita	Breakout of 3 abandoned wells. Wells reentered and replugged by operator of waterflood on adjacent lease. Breakout occurred as injection program expanded.
4/79	Young	Casing leak in SWD well resulting in salt water flowing to the ground surface. Well repaired, problem resolved.
5/79	Jack	Complaint that newly drilled shallow well was salty. Inspection revealed water well had been drilled adjacent to abandoned well replugged with State funds September 4, 1973. Abandoned well was flowing + 1000 bbl/day salt water prior to replugging. Breakout contributed to SWI programs on surrounding leases.

TABLE 6.(continued)

6/79	Wichita	Brackish water flowing into newly constructed stock pond. Complaintant believed nearby SWI well causing problem. Inspection revealed no apparent malfunction in SWI wells. Pond dug adjacent to irrigation ditch containing brackish water. This was concluded to be most probable cause of contamination.
9/79	Knox	Complaint of salt water being injected down annulus of producing well. Situation rectified through pipeline severance. No apparent pollution problem.
10/79	Archer	Tubing failure on SWI well on lease resulted in salt water flowing to the ground surface. Tubing replaced, area cleaned.
11/79	Archer	Breakout of abandoned well. Replugged with State funds. Breakout contributed to increased secondary recovery operations in area. No particular SWI well found to be defective.
11/79	Archer	Breakout of abandoned well. When nearby SWI well was shut in, flow from breakout ceased. SWI well recompleted, no further problems.
12/79	Clay	Vegetative kill areas which ranch foreman felt was caused by nearby SWI wells. Inspection of wells revealed no apparent malfunction. Kill areas concluded to be due to abandoned pit localities upslope.
12/79	Wichita	Breakout of unidentified abandoned well in the community cemetery. Re-entered and replugged with State funds. Contributable to large waterflood operations to the north and west. Viewing the number of abandoned poorly plugged or unplugged wells in the cemetery and in the area, and the scope of secondary recovery operations in the area, this type problem can be expected to occur again at any time.
1/80	Knox	Breakout of abandoned well. Well replugged with State funds. Contributable to workover of SWI wells on adjacent lease.
2/80	Clay	Water well contamination which complainant felt was due to SWI wells on nearby lease. Tests showed no apparent malfunction of SWI wells. Area residents stated that this particular aquifer had been high in salt for $\pm$ 30 years.
2/80	Archer	Breakout of abandoned well on adjacent lease. Operator of adjacent lease reentered and replugged leaking well. Contributed to SWI well recently completed nearby in same zone.

TABLE 6.(continued)

3/80	Young	Salt water flowing to ground surface due to tubing failure in SWI well. Tubing repaired, problem resolved.
3/80	Young	Seepage of brackish water near city. City feared contamination of nearby fresh water wells. Tests of nearby SWI wells revealed no apparent problems. Recent inspection revealed seep area has dried up. Appears to be contributable to abandoned pit locality nearby.
4/80	Clay	Salt water flowing to the ground surface as the result of tubing failure. Tubing replaced, problem resolved.
4/80	Archer	Salt water breakout. Well No. 5 on adjacent lease was found to be equipped for SWI through 5 1/2" casing only. No. 5 shut in, breakout ceased.
4/80	Archer	Dug cellar in yard, pit filled with salt water. Found that cellar pit had been dug ± 50 yards from prior breakout locality.
4/80	Knox	Breakout of abandoned well resulted in salt water filling fresh water pond. SWD well shut in and breakout ceased. Tubing leak and casing leak repaired, contaminated pond currently being pumped out.
5/80	Wichita	Complaint of salty water seep near property. Complainant felt nearby SWD well was causing problem. Test of SWD well revealed no apparent problem. Seep area surrounded by old salt scald areas. Apparently contributable to leaching of ground salts.
5/80	Jack	Packer failure in No. 4 SWI well on adjacent lease resulted in salt water flowing to the ground surface. Packer replaced, problem resolved.
5/80	Wichita	Breakout of abandoned well. Tubing leak in nearby SWD well repaired, breakout ceased.
5/80	Archer	Pit dug while constructing grain elevator filled with brackish water, owner blamed nearby SWD well. Test of well revealed no apparent malfunction. Low chloride content of seep water led to conclusion of high ground water table. Substantiated by later reports and inquiries.

TABLE 6.(continued)

6/80	Clay	Leakage from nearby SWD well resulted in salt water flowing to the ground surface and contaminated stock pond. SWD well to be plugged, contaminants currently being removed from affected pond.
7/80	Cooke	Complaint of salt water surfacing around SWD wells. Found to be result of tubing failure. Tubing replaced, problem rectified.

*salt water disposal
**salt water injection

plugging procedures in accordance with the rules at the time the well was plugged. A review of Table 5 indicates that land damage accounts for over 60 percent of the areas which were contaminated, while ground-water contamination was confirmed in only four of the cases and suspected in another two cases. Flowing abandoned wells provided the best documentation of ground-water contamination which could be linked to injection operations.

Information for more recent years was obtained based on complaints and showed similar results. Table 6 contains a description of the complaint and findings for the period January 1979 through June 1980. Of the 31 complaints in which contamination problems were attributed to underground injection, eleven were found linked to abandoned wells which flowed at the surface and which could be associated with nearby injection operations. According to available information, no reports of ground-water contamination resulting from complaints about saline water in a water well were directly attributed to injection operations. Table 7 contains a summary of the information available for 1982. Of the 220 complaints received which alleged problems due to injection or disposal wells, there were 12 incidents of breakouts through abandoned or improperly plugged wells, 59 confirmed cases of surface problems and 149 cases where no pollution or damage occurred. The Commission further concluded that during 1982 no contamination of ground water was confirmed or documented.

To better understand the difficulty in positively documenting ground-water contamination from injection operations, the following two case histories serve to illustrate the procedures and perseverence necessary to attempt to document a problem.

Case #1

Complaints from occupants of two farmhouses approximately one mile apart relating to increased chlorides and iron in well water were received by the Commission at approximately the same time. The houses were located in Sutton County in a sparsely populated area near a fairly new oil field which had been developed around 1959. The complainants indicated that they had never experienced any problems before. A quick reconnaissance of the area revealed that one field to the north of the houses was under waterflood and was producing at approximately 2700 feet. Another operator west of the houses had 4 producing wells and one disposal well. The water wells were developed in approximately 35 feet of alluvium at a depth of approximately 85 feet.

The investigation began with a trial and error process to check the condition of wells in the area. Testing began with a bradenhead pressure test using fresh water. By testing the wells, one injection well was found to have holes in the tubing and the tubing was replaced; another well had a leak in the long string at 1400 feet which was subsequently repaired. Neither of these wells could be directly implicated as the source of the problem. An additional gas well located to the southwest of the houses was also checked for leaks. A leak in the casing two feet below the ground was found and subsequently repaired, but again, could not be confirmed as the source of the problem. Fluorescein dye was also used to try to confirm a source, but to date, no source of ground-water contamination has been documented despite an intensive field effort.

TABLE 7. SUMMARY OF COMPLAINTS INVOLVING INJECTION/DISPOSAL WELLS, JANUARY, 1982 THROUGH DECEMBER, 1982*

PROBLEM OR FINDING	NUMBER OF WELLS
**Salt water surface breakouts through unplugged or improperly plugged abandoned wells	12
Salt water spills	4
Injection/disposal wellhead leaks	1
Flowline leaks	30
Salt water in pits or firewall	11
Salt water in waterway, drainageway, or ditches	3
Bleed-off water to land surface	1
Injection/disposal well pump leaks	2
Salt water seeps immediately adjacent to injection/disposal well	2
Salt water tank leak or overflow	5
No damage or no pollution	149
TOTAL	220

*No contamination of ground water was confirmed or documented.

**These abandoned wells were plugged or re-plugged with state funds when a responsible operator could not be located.

Case #2

When a salt water breakout occurred in Limestone County, the breakout appeared to be definitely caused by injection well operations. The breakout occurred approximately 1800 feet away from a production and injection well which were located only 200 feet from each other. The field had been developed in the 1920's and production was from a depth of approximately 2900 feet. Well records showed two unidentifiable map symbols in the vicinity of the breakout. Testing of the quality of the breakout fluid and fluid being injected through the injection well indicated that the two were of approximately the same quality. The breakout was a source of particular problem because it was flowing into a lake which served as the source for a public water supply. The problem with documenting the source of the breakout was complicated when it was discovered that the breakout was on the opposite side of a fault from the production/injection wells. The injection well was shut in to determine if the breakout would stop. The flow was somewhat reduced, but did not stop. It was then thought that a nearby quarry may be contributing to the problem. In the interim, the operator of the disposal well volunteered to have 390 barrels of salt water a day hauled away from the breakout to help ease the urgency of the problem. The breakout site was found to be an abandoned unplugged borehole which was subsequently plugged with State funds.

Additional cases of suspected problems, but unconfirmed documentation may thus make compilations of figures such as those found in Tables 5, 6, and 7 misleading because they do not convey the magnitude of the problem, only the documentation that a problem exists.

APPENDIX A

APPLICATION FORMS USED BY KCC IN THE ADMINISTRATION OF THE KANSAS UIC PROGRAM.

To:
STATE CORPORATION COMMISSION
CONSERVATION DIVISION - UIC SECTION
200 COLORADO DERBY BUILDING
WICHITA, KANSAS 67202

Docket No._____

_____,Sec.____,T____S,R____W/E

_____ feet from N/S section line

_____ feet from W/E section line

Lease Description
_____

APPLICATION FOR INJECTION WELL

DISPOSAL ☐ ENHANCED RECOVERY ☐

DATE_____

WELL NO. _____
Lease Name_____

Operator License #_____

Field Name_____

Operator:
Name &
Address

County_____

Contact Person Name_____
Phone_____

Deepest usable water formation_____. Depth_____feet to zone bottom

Old Well Being Converted ☐ Newly Drilled Well ☐ Well to be drilled ☐

Mechanical Integrity Test Completed YES___NO___ DATE_____tested/scheduled
Fieldman observing or scheduled_____

Test results enclosed ☐ Not applicable ☐

Surface elev.____feet, Well Total Depth____feet, Plug back depth____feet

INJECTION FORMATION DESCRIPTION

name	top/bottom	perf/open hole	depth
_____	____/____	_____	at_____to_____feet
_____	____/____	_____	at_____to_____feet

LIST OF WELLS SUPPLYING SALT WATER (use extra sheet if needed)

	LEASE OPERATOR	LEASE NAME	LEASE DESCRIPTION	WELL IDENT #
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

	PRODUCING FORMATION	STRATA DEPTH	TOTAL DISSOLVED SOLIDS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

_____to_____feet _____mg/l

Liquid Injection Rate: Max_____ bbl/day, Min_____ bbl/day
or Gas Injection Rate: Max_____ scf/day, Min_____ scf/day, Type of gas_____

Injection Pressure: Min_____psig, Max_____ psig

LITHOLOGY from Injection zone up to deepest Usable Water:

Estimated Maximum safe injection pressure_____ psig.

FORM U-1

Figure A-1. Application form for salt water disposal wells in the state of Kansas.

Name and Addresses of those receiving copies of this application and attachments:

OFFSET OPERATOR'S AND LANDOWNERS CORRECT NAME	MAILING ADDRESS

A notice of this application was placed in the following general circulation newspaper:

Paper Name_____ Date of issue_____
Address_____ Page of notice_____

I hereby certify that the statements herein are true and correct to the best of my knowledge and belief:

_____
Applicant or Duly Authorized Agent

Subscribed and sworn to before me this_____day of_____19____.

_____
Notary Public

_____
My Commission Expires

INSTRUCTIONS

1. Attach plat map showing subject well and all known oil and gas wells abandoned,being drilled, and dry holes within 1/2 mile, giving name of operator, landowner, and all leases and wells to be connected to the system.
2. Attach Drillers Log (Form ACO-1). Appropriate Surety must be on file with Conservation Division.
3. Fill in schematic drawing of subsurface facilities including: Size, setting depth, amount of cement used, measured or calculated tops of cement of surface, intermediate (if any) and production casing; size and setting depth of tubing; type and setting depth of packer; geological zone of injection showing top and bottom of injection interval.
4. The original and 1 copy of application and attachments shall be mailed to the State Corporation Commission.
5. Deliver 1 copy of application to landowner on whose land injection well is located and to each operator of the producing leasehold within 1/2 mile of the well.
6. Approval of this application, if granted, is valid only as long as there is no substantial change in the operation set forth in the application. A substantial operation change requires the approval of a new application.

FORM U-1

Figure A-1. (continued)

ENHANCED RECOVERY APPLICATION
(Complete the following)

1. Present daily oil production of lease or unit from formation to be repressured. _____ barrels.

2. Number of presently producible wells on lease or unit producing from formation to be repressured._____wells. (Include the well to be used as input, if producing or dry and abandoned.)

3. Number of injection wells ultimately to be used in repressuring the lease or unit. _____wells.

4. Number of wells, completed in formation to be repressured, to be converted to input wells. _____ wells.

5. Number of wells to be drilled for input wells. _____wells.

6. Number of oil wells to be drilled to formation to be repressured on lease or unit. _____wells.

7. Estimate of maximum daily oil production on lease or unit from formation to be repressured. _____barrels.

8. Project will ultimately be: a five spot_____, a seven spot___ _____, a nine spot_____, a peripheral_____, or an irregular_____ __ flood.

9. Supplemental information for additional producing formations other than formation to be repressured.

FORMATION NAME	NUMBER OF PRODUCIBLE WELLS	DAILY OIL PRODUCTION

NOTE: If estimated maximum daily average oil produced per well is more than 50 barrels, this application will be set for Hearing.

ENHANCED RECOVERY INJECTION FLUIDS:

Original fluid quality/analysis:

Additives:(chemical name, formula, phase, concentration)

Toxicity: high___, medium____, low____, none____.

Carcinogensis: high___, medium____, low___, none___.

Density of fluid: _____lbs/gal or_____gm/ml or gas gravity_____.

Viscosity of fluid: _____cp

Estimated injection zone permeability: _____ md

Well Treatment Plan:

Figure A-2. Application form for enhanced recovery wells in the state of Kansas.

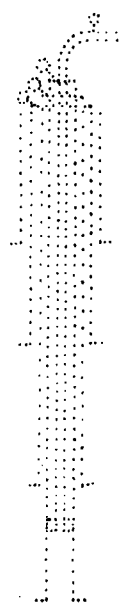
WELL COMPLETION:

STRING	CONDUCTOR	SURFACE	INTERMEDIATE	PRODUCTION	TUBING
SIZE					
SETTING DEPTH					
CEMENT SACKS					
CEMENT TOPS BOTTOMS					

TUBING TYPE & GRADE:

PACKER TYPE & DEPTH:

LIST LOGS ENCLOSED:



(To sketch installation, darken appropriate lines, indicate cement, and show depths.)

Figure A-2. (continued)

FORM U-1

APPENDIX B

FORMS USED BY KCC AND KDHE TO INVESTIGATE SALT WATER CONTAMINATION.

FIELD REPORT

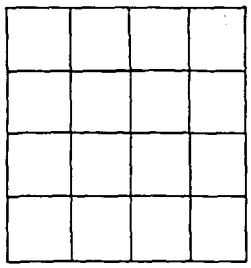
DATE: _____

OPERATOR: _____

LEASE: _____

LOCATION: Sec. _____ Twp. _____ Rge. _____ (E) (W)

COUNTY: _____



REMARKS: (What was said or seen)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

FOR THE STATE (signed) _____

MAKE TWO (2) COPIES. KEEP ONE AND SEND THE ORIGINAL TO: KCC, 200 Colorado-Derby Building, Michigan, Kansas 67202.

Figure B-1. Form used by KCC field investigator to detail salt water disposal well problem.

State of Kansas
Department of Health & Environment
Division of Environment
Bureau of Oil Field and Environmental Geology
Topeka, Kansas 66620

REPORT OF INVESTIGATION

Initial Report: _____ Recheck: _____

Date of Investigation: _____ Location: _____

Company, City, etc: _____ County: _____

Problem: _____

_____

Reason for Investigation: _____

_____

Persons Interviewed: _____

_____

Findings: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Action and/or Recommendation: _____

_____

_____

_____

_____

_____

Date _____ Investigator _____

Figure B-2. Form used by KDHE field investigator to detail salt water contamination.

APPENDIX C

FORMS USED BY THE TEXAS RAILROAD COMMISSION IN THE ADMINISTRATION OF THE TEXAS UIC PROGRAM.

Return To
DIRECTOR Underground Injection Control
Oil and Gas Division
Railroad Commission of Texas
Capitol Station-P.O. Drawer 12967
Austin, Texas 78711

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

Form W-14
1-82

APPLICATION TO DISPOSE OF OIL AND GAS WASTE BY INJECTION INTO A POROUS FORMATION NOT PRODUCTIVE OF OIL OR GAS

1 Operator Name — 2 Operator No.

3 Address (Street, City, State and Zip Code) — 4 RRC Dist.

5 Lease Name — 6 RRC Lease/ID No. — Oil ☐ Gas ☐ — 7 Well No.

8 Field Name — 9 RRC Field No. — 10 County

11 (a) Location (Sec., Blk., Survey. Give perpendicular location from two designated survey lines.) — 11 (b) This well is to be located ____ miles ____ ____ direction from ____ (nearest town)

CASING AND TUBING DATA

NAME OF STRING	SIZE	SETTING DEPTH	SACKS CEMENT	TOP OF CEMENT	TOP DETERMINED BY	HOLE SIZE	CASING WEIGHT
12 Surface Casing							
13 Intermediate							
14 Long String							

15 Tubing (Size and Depth) — 16 Name, Mode and Depth of Tubing Packer — 17 Total Depth of Well

18 Injection Interval: Top / Bottom — 19 Name of Formation — 20 Is Injection through ☐ Tubing or ☐ Casing — 21 Fracture Gradient

22 Is Injection through ☐ Perforations or ☐ Open Hole — 23 Date Well Drilled — 24 API No. — 25 Ground Surface Elevation

26 List All Cement Squeeze Operations Giving Interval and Number of Sacks of Cement

27 Depth to Base of Deepest Fresh Water Zone — 28 Depth of Shallowest Zone Productive of Oil or Gas in this Field — 29 Anticipated Daily Injection Volume(Bbls): Average / Maximum

30 Is Injection System ☐ Open or ☐ Closed — 31 Is Injection by: Gravity ___ Pressure — 32 Injection Pressure (Psi): Average / Maximum

33 Will it be necessary for water to be filtered or chemically treated ☐ Yes ☐ No — 34 Is this well so cased and completed that water can enter no other formation than the above set out injection zone? ☐ Yes ☐ No

35 Name and Address of Surface Owner

36 (a) Source of Fluids (Geological Name of Formation and Depth) — (b) Are Fluids produced from sources other than Applicant's? ☐ Yes ☐ No

(c) If answer is Yes to Question 36(b) attach a list of other sources identifying operators, sources and types of waste

37 Have notices of this application been mailed or given to all Offset Operators? ☐ Yes ☐ No — 38 Are there any other Salt Water Disposal Wells using this same Zone in this Field? ☐ Yes ☐ No

39 If answer is Yes to Question 38, name one such well:
Name of Operator — Lease Name — Lease or I.D. No. — Well No.

CERTIFICATE

I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code that I am authorized to make this report; that this report was prepared by me or under my supervision and direction and that data and facts stated therein are true, correct and complete to the best of my knowledge

Signature

Name of Person (type or print) — Title

Telephone: Area Code / Number — Date

FOR RRC USE ONLY

APPLICANT MUST COMPLY WITH THE INSTRUCTIONS ON REVERSE SIDE

Figure C-1. Application to dispose of oil and gas waste by injection into a porous formation not productive of oil or gas.

INSTRUCTIONS (W-14)

1. File the original application, including all attachments, with the Director of Underground Injection Control, Railroad Commission of Texas, P. O. Drawer 12967, Capitol Station, Austin, Texas 78711. File one copy of the application and its attachments with the appropriate District Office.

2. Attach complete electrical log of this well or log of a nearby well. Attach any other logging and testing data available for the well such as cement bond logs.

3. Attach a letter from the Texas Department of Water Resources stating that the well will not endanger the usable quality water strata in the area and that the formation or stratum used for disposal does not contain usable quality water. To obtain this letter, submit two copies of Form W-14, a plat with surveys marked, and a representative electrical log to the Texas Department of Water Resources, P. O. Box 13087, Capitol Station, Austin, Texas 78711.

4. Attach a map showing the location and depth of all wells of public record within one quarter (¼) mile radius of the wellbore with surveys marked. For those wells which penetrate the top of the injection interval, attach a tabulation of the wells showing the dates the wells were drilled and the present status of the wells. Identify any abandoned well that is indicated to be unplugged or improperly plugged. The Director of Underground Injection Control may adjust or waive this data requirement in accordance with provisions of the "Area of Review" section of Statewide Rule 9.

5. (a) Attach a plat of leases showing the location of the disposal well lease and ownership of offsetting leases.

   (b) (1) Send a copy of the application, including both sides of the form, to the surface owner, the offset operators, and to the county and city clerk of the county and city in which the well is located. Attach a signed statement indicating the date the copies of the application were mailed or delivered and the names and addresses of the persons to whom copies were sent.

   (2) Attach an affidavit of publication signed by the publisher that notice of the application has been published in a newspaper of general circulation in the county where the wells will be located. Notice instructions and forms may be obtained from the Commission's Austin Office or the District Offices.

   (c) No public hearing will be held on this application unless an affected person or local government requests a public hearing. Any such request for a public hearing shall be in writing and contain: (1) the name, mailing address, and phone number of the person making the request; and (2) a brief description of how the protestant would be adversely affected by the granting of the application. If the Commission determines that a valid protest has been received, or that a public hearing would be in the public interest, a hearing will be held after the issuance of proper and timely notice of the hearing by the Commission. If no protest is received within fifteen (15) days of publication or receipt in Austin of the application, the application may be processed administratively.

Figure C-1. (continued)

Form H-10
4/83
483-031

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION
Annual Disposal/Injection Well Monitoring Report

Return To
DIRECTOR Underground Injection Control
Oil and Gas Division
Railroad Commission of Texas
Capitol Station - P.O. Drawer 12967
Austin, Texas 78711

UIC CONTROL NO
Type
FOR RRC USE ONLY

PLEASE TYPE OR PRINT — READ INSTRUCTIONS ON REVERSE SIDE

1. OPERATOR'S NAME			2 RRC OPERATOR NO
3 ADDRESS			4 RRC DISTRICT NO
			5 COUNTY
6 FIELD NAME (Exactly as shown on proration schedule)		7 FIELD NO	8 API NO
9 LEASE NAME		10a OIL LEASE NO / 10b GAS ID NO	11 WELL NO

12 MONTH YR	13 INJECTION PRESSURE AVG PSIG	13 INJECTION PRESSURE MAX PSIG	14 TOTAL VOLUME INJECTED BBL	14 TOTAL VOLUME INJECTED MCF	15 TUBING - CASING ANNULUS PRESSURE (Optional Monitoring) READINGS	MIN PSIG	MAX PSIG

16 ☐ Check here if an alternative mechanical integrity monitoring procedure other than annulus monitoring is used. ATTACH DETAILS

17 Depth to Top of Injection Zone Ft | 18 Depth to Bottom of Injection Zone Ft | 19 Is injection through Tubing or Casing? ☐ 1 Tubing ☐ 2 Casing | 20 Depth of Tubing Packer Ft

21 Type of Injection Fluid
☐ 1 Salt Water ☐ 2 Fresh Water ☐ 3 Brackish Water ☐ 4 Air ☐ 5 Gas ☐ 6 LPG ☐ 7 Other

22. Are the injected fluids produced from sources other than your own? ☐ 1 Yes ☐ 2 No
If answer is yes, identify other sources by operator, source, and type of fluid. ATTACH A LIST.

23 Well Status (insert code no.) ☐ SEE INSTRUCTIONS

CERTIFICATE
I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Signature
Name of Person (type or print) Title
Telephone Area Code Number Date

RRC COPY

Figure C-2. Annular disposal/injection well monitoring report.

INSTRUCTIONS (H-10)

WHEN TO FILE - The Annual Monitoring Report Form (Form H-10) is computer-generated on the first day of the last month of the reporting cycle for each disposal, injection, or hydrocarbon storage well and mailed to the operator. Form H-10 must be completed and returned to the Austin Office within 30 days after the last month of the reporting cycle (item 12). Reporting has been scheduled on a staggered cycle, by RRC District, according to the following timetable.

DISTRICT	REPORTING CYCLE
01,02	January through December
03	February through January
04	March through February
05, 06, 6E	April through March
7B	May through April
7C	June through May
08	July through June
8A	September through August
09	November through October
10	December through November

WHERE TO FILE - File the original form, including any attachments with the Director of Underground Injection Control, Railroad Commission of Texas, P. O. Drawer 12967, Capitol Station, Austin, Texas 78711.

WHAT TO REPORT -

A. Correct any erroneous computer-printed information (items 1 through 12) and supply any missing information, including the API No. (item 8), if an API number has been assigned.

B. Report data on the injection pressure (item 13) and the injection volume (item 14) for the specified reporting cycle. In addition, all monitoring records must be retained by the operator for at least five years.

C. Report the minimum and maximum tubing-casing annulus pressure (item 15), if this monitoring option is selected, and include the number of readings made each month.

D. If a monitoring or testing procedure other than monitoring the pressure of the tubing-casing annulus is used or is required, check item 16 and attach an explanation.

E. Report the current status of the well (item 23) using one of the following codes:

1 - Authorized to inject, but not yet drilled
2 - Drilled but not yet completed
3 - Active
4 - Temporarily abandoned
5 - Other (specify on front side, item no. 23)

F. Return all Forms H-10 which are received on any well(s) which is no longer being operated for disposal, injection, or underground hydrocarbon storage. Provide an attached explanation such as a copy of Form W-2, G-1, W-3, P-4, etc.

G. Form H-10 must be completed and returned to the Austin Office within 30 days after the last day of the reporting cycle on all wells operated for disposal, injection, or underground hydrocarbon storage purposes. If you do not receive Form H-10 on a well of this type that you operate, obtain blank Form H-10 from the Railroad Commission District Office or the Austin Office (Supply Section).

Figure C-2. (continued)

RAILROAD COMMISSION OF TEXAS
Oil and Gas Division

Type or print only

Form W-2
Rev. 4-1-83
483-046

API No. 42-

Oil Well Potential Test, Completion or Recompletion Report, and Log

1 FIELD NAME (as per RRC Records or Wildcat)

2 LEASE NAME

3 OPERATOR'S NAME (Exactly as shown on Form P-5, Organization Report)

RRC Operator No.

4 ADDRESS

5 If Operator has changed within last 60 days, name former operator

6a Location (Section, Block, and Survey)

6b Distance and direction to nearest town in this county

12 If workover or reclass, give former field (with reservoir) & gas ID or oil lease no.
FIELD & RESERVOIR

GAS ID or OIL LEASE #

Oil O Gas G

WELL NO.

13 Type of electric or other log run

14 Completion or recompletion date

7 RRC District No.

8 RRC Lease No.

9 Well No.

10 County of well S/T

11 Purpose of filing
Initial Potential ☐
Retest ☐
Reclass ☐
Well record only (explain in Remarks) ☐

SECTION I: POTENTIAL TEST DATA IMPORTANT: Test should be for 24 hours unless otherwise specified in field rules.

15 Date of test	16 No. of hours tested	17 Production method (Flowing, Gas Lift, Jetting, Pumping-Size & Type of pump)			18 Choke size
19 Production during Test Period ▶	Oil - BBLS	Gas - MCF	Water - BBLS	Gas - Oil Ratio	Flowing Tubing Pressure PSI
20 Calculated 24 Hour Rate ▶	Oil - BBLS	Gas - MCF	Water - BBLS	Oil Gravity-API-60°	Casing Pressure PSI
21 Was swab used during this test? Yes ☐ No ☐		22 Oil produced prior to test (New & Reworked wells)			23 Injection Gas - Oil Ratio

REMARKS

INSTRUCTIONS File an original and one copy of the completed Form W-2 in the appropriate RRC District Office within 30 days after completing a well and within 10 days after a potential test. If an operator does not properly report the results of a potential test within the 10 day period, the effective date of the allowable assigned to the well will not extend back more than 10 days before the W-2 was received in the District Office. (Statewide Rules 16 and 511) To report a completion or recompletion, fill in both sides of this form. To report a retest, fill in only the front side.

WELL TESTER'S CERTIFICATION
I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I conducted or supervised this test by observation of (a) meter readings or (b) the top and bottom gauges of each tank into which production was run during the test. I further certify that the potential test data shown above is true, correct, and complete to the best of my knowledge.

Signature, Well Tester | Name of Company | RRC Representative

OPERATOR'S CERTIFICATION
I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete to the best of my knowledge.

Typed or printed name of operator's representative | Title of Person

Telephone: Area Code Number | Date: mo / day / year | Signature

Figure C-3. Oil well potential test, completion or recompletion report and log.

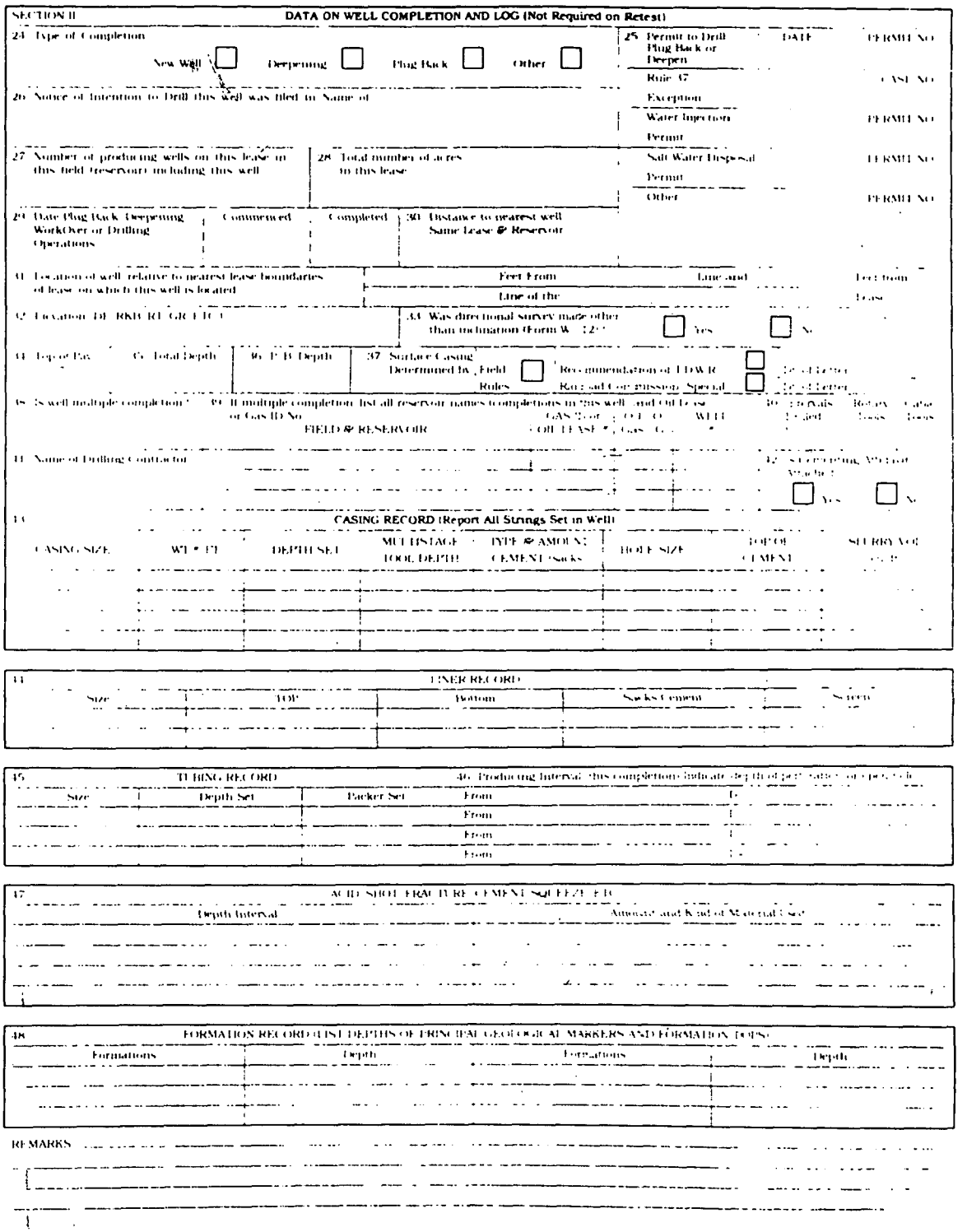


Figure C-3. (continued)

RAILROAD COMMISSION OF TEXAS
Oil and Gas Division

Form G-1
Rev. 4-1-83

Type or print only

483-047

API No. 42-

Gas Well Back Pressure Test, Completion or Recompletion Report, and Log

1 FIELD NAME (as per RRC Records or Wildcat)
2 LEASE NAME
3 OPERATOR'S NAME (Exactly as shown on Form P-5, Organization Report)
RRC Operator No.
4 ADDRESS
5 Location (Section, Block, and Survey)
5b Distance and direction to nearest town in this county
6 If operator has changed within last 60 days, name former operator
12 If workover or reclass, give former field (with reservoir) & Gas ID or oil lease no.
FIELD & RESERVOIR
GAS ID or OIL LEASE #
OIL - O Gas - G
WELL #
13 Pipe Line Connection
14 Completion or recompletion date
15 Any condensate on hand at time of workover or recompletion? ☐ Yes ☐ No
16 Type of Electric or other Log Run
7 RRC District No.
8 RRC Gas ID No.
9 Well No.
10 County of well site
11 Purpose of filing
Initial Potential ☐
Retest ☐
Reclass ☐
Well record only (Explain in remarks) ☐

Section I — GAS MEASUREMENT DATA

Date of Test
Gas Measurement Method (Check One)
Orifice Meter ☐ ▶ Flange Taps ☐ Pipe Taps ☐
Positive Choke ☐
Orifice Vent Meter ☐
Pitot Tube ☐
Critical flow Prover ☐
Gas produced during test MCF

Run No.	Line Size	Orif. or Choke Size	24 Hr. Coeff. Orif. or Choke	Static P_m or Choke Press.	Diff. h_w	Flow Temp. °F	Temp. Factor F_{tf}	Gravity Factor F_g	Compress. Factor F_{pv}	Volume MCF/DAY
1										
2										
3										
4										

Section II — FIELD DATA AND PRESSURE CALCULATIONS

Gravity (Dry Gas)
Gravity Liquid Hydrocarbon Deg. API
Gas Liquid Hydro. Ratio CF/Bbl
Gravity of Mixture G_{mix} =
Avg. Shut-in Temp °F
Bottom Hole Temp °F @ (Depth)

$D_{eff}^{8/3}$ = $\sqrt{T_f}$ = $\sqrt{\quad}$

$C = \frac{1118 \times D_{eff}^{8/3}}{\sqrt{T}}$ = = =

$\frac{\sqrt{G_f}}{C}$ = = =

Run No.	Time of Run Min.	Choke Size	Wellhead Press. PSIA P_w	Wellhead Flow Temp. °F	P_w^2 (Thousands)	R	R^2 (Thousands)	P_f	$P_w - P_f$
Shut-In									
1									
2									
3									
4									

Run No.	F	R	$S = \frac{1}{Z}$	F^{ks}	P_f and P_s	P_f^2 and P_s^2 (Thousands)	$P_f^2 - P_s^2$ (Thousands)	Angle of Slope
Shut-In								
1								θ
2								n
3								Absolute Open Flow
4								MCF/DAY

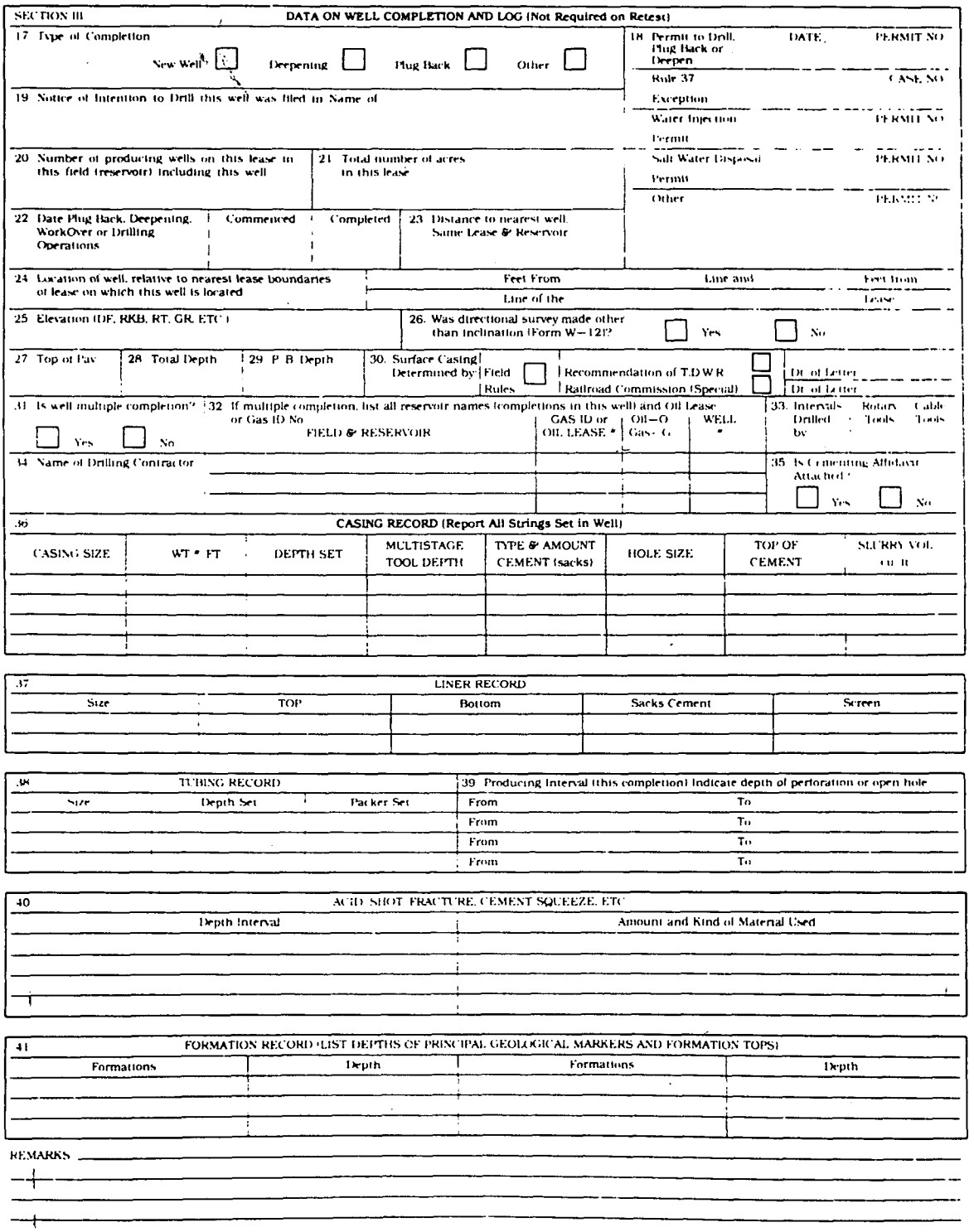
WELL TESTER'S CERTIFICATION I declare under penalties prescribed in Sec. 91.143 Texas Natural Resources Code that I conducted or supervised this test and that data and facts shown in Sections I and II above are true, correct and complete to the best of my knowledge. Bottomhole temperature and the diameter and length of flow string were furnished by the operator of the well.

Signature Well Tester — Name of Company — RRC Representative

OPERATOR'S CERTIFICATION I declare under penalties prescribed in Sec. 91.143 Texas Natural Resources Code that I am authorized to make this report, that I prepared or supervised and directed this report, and that data and facts stated therein are true, correct and complete, to the best of my knowledge.

Signature: Operator's representative — Title — Date — Tel. A/C Number

Figure C-4. Gas well back pressure test, completion or recompletion report and log.



SECTION III — DATA ON WELL COMPLETION AND LOG (Not Required on Retest)

17 Type of Completion — New Well ☐ Deepening ☐ Plug Back ☐ Other ☐

18 Permit to Drill, Plug Back or Deepen — DATE — PERMIT NO

Rule 37 Exception — CASE NO

Water Injection Permit — PERMIT NO

Salt Water Disposal Permit — PERMIT NO

Other — PERMIT NO

19 Notice of Intention to Drill this well was filed in Name of

20 Number of producing wells on this lease in this field (reservoir) including this well

21 Total number of acres in this lease

22 Date Plug Back, Deepening, WorkOver or Drilling Operations — Commenced — Completed

23 Distance to nearest well, Same Lease & Reservoir

24 Location of well, relative to nearest lease boundaries of lease on which this well is located — Feet From — Line and — Feet from — Line of the — Lease

25 Elevation (DF, RKB, RT, GR, ETC.)

26. Was directional survey made other than inclination (Form W–12)? ☐ Yes ☐ No

27 Top of Pay | 28 Total Depth | 29 P B Depth

30. Surface Casing Determined by — Field Rules ☐ — Recommendation of T.D.W.R. ☐ — Railroad Commission (Special) ☐ — Dt. of Letter — Dt. of Letter

31 Is well multiple completion? ☐ Yes ☐ No

32 If multiple completion, list all reservoir names (completions in this well) and Oil Lease or Gas ID No. — FIELD & RESERVOIR — GAS ID or OIL LEASE # — Oil—O Gas—G — WELL #

33. Intervals Drilled by — Rotary Tools — Cable Tools

34 Name of Drilling Contractor

35 Is Cementing Affidavit Attached? ☐ Yes ☐ No

36 CASING RECORD (Report All Strings Set in Well)

CASING SIZE	WT # FT	DEPTH SET	MULTISTAGE TOOL DEPTH	TYPE & AMOUNT CEMENT (sacks)	HOLE SIZE	TOP OF CEMENT	SLURRY VOL CU FT

37 LINER RECORD

Size	TOP	Bottom	Sacks Cement	Screen

38 TUBING RECORD

Size	Depth Set	Packer Set

39 Producing Interval (this completion) Indicate depth of perforation or open hole

From	To
From	To
From	To
From	To

40 ACID, SHOT, FRACTURE, CEMENT SQUEEZE, ETC.

Depth Interval	Amount and Kind of Material Used

41 FORMATION RECORD (LIST DEPTHS OF PRINCIPAL GEOLOGICAL MARKERS AND FORMATION TOPS)

Formations	Depth	Formations	Depth

REMARKS

Figure C-4. (continued)

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

Form H - 1
(Rev. 4-82)

APPLICATION TO INJECT FLUID INTO A RESERVOIR PRODUCTIVE OF OIL OR GAS

1. Field Name (as per current proration schedule - including reservoir, if applicable.)	2. RRC District
3. Operator & Address	4. County
5. Lease Name(s) and RRC Lease Number(s)	6. Reservoir Discovery Date

7. Have any injection permits been granted previously to any operator in this reservoir? ☐ Yes ☐ No
If answer to this question is "NO", ALL OPERATORS IN THE RESERVOIR MUST BE NOTIFIED of this application, and copies of notification attached hereto.

8. Check the Appropriate Block(s):
☐ New Project or ☐ Expansion of Previous Authority to Add Either: ☐ New Lease(s) or ☐ Additional Well(s) on Same Lease(s)
Initial Authority Dated _____ by ☐ Administrative Action or ☐ Hearing, Special Order No. _____

RESERVOIR AND FLUID DATA ON ENTIRE RESERVOIR

9. Name of Reservoir	10. Estimated Productive Area of Entire Reservoir (acres)
11. Composition (sand, limestone, dolomite, etc.)	12. Type of Structure (Include cross-section and structural maps.)
13. Subsea Depth of Oil-Water Contact (ft.)	14. Subsea Depth of Gas-Oil Contact (ft.)
15. Original Bottom Hole Pressure (psig)	16. Current Bottom Hole Pressure (psig)
17. Was a Gas Cap Present Originally?	18. Is a Gas Cap Present Now?
19. Ratio of Gas Cap Volume to Oil Zone Volume	20. Saturation Pressure (psig)
21. Formation Volume Factor Original: _____ Current: _____	22. Type Drive During Primary Production

RESERVOIR AND FLUID DATA

23. Number of Productive Acres in Lease(s) within Project Area	24. Average Depth to Top of Pay (ft.)	25. Average Effective Pay Thickness (ft.)
26. Average Horizontal Permeability (mds.)	27. Range of Horizontal Permeability (mds.)	28. Connate Water Saturation (% of pore space)
29. Average Porosity (%)	30. Gravity of Oil (deg. API.)	31. Viscosity (cps @ ° F.)

PRODUCTION HISTORY OF RESERVOIR

32. Date First Well Completed on Lease(s)	33. Stage of Primary Depletion of Project Area
34. Current Average Gas-Oil Ratio (SCF/bbl.)	35. Current Water Production (% of total fluid production or bbls./day)
36. Current Number of Producing Wells on Each Lease in Project Area	37. Current Average Daily Oil Production per Well (bbls./day/well)
38. Cumulative Oil Production to Date from Lease(s) (bbls.)	39. SUBMIT ATTACHED SHEET(S) GIVING THE OIL, GAS, & WATER PRODUCTION BY YEARS SINCE DISCOVERY & TOTALS FOR THE LAST 3 YEARS. GIVE THESE FIGURES BY MONTHS

TYPE OF INJECTION PROJECT AND RESULTS EXPECTED

40. Type of Injection Project (Check the appropriate block(s):)
☐ Waterflood, ☐ Miscible Displacement, ☐ Thermal Recovery, ☐ Pressure Maintenance, ☐ Other _____ (specify)

41. Current Estimated Oil Saturation (% of pore space)	42. Estimated Residual Oil Saturation at Abandonment (% of pore space)
43. Estimated Original Oil-In-Place (bbls.)	44. Estimated Ultimate Additional Oil that will be Recovered as a Direct Result of Injection (bbls.)

INJECTION DATA

45. Type of Injection Fluid (Check the appropriate block(s):)
☐ Salt Water, ☐ Brackish Water, ☐ Fresh Water, ☐ Gas, ☐ Air, ☐ LPG, ☐ Other _____ (specify)

46. Source of Injected Fluid(s) (formation(s) and depth(s) in ft.)	47. Injection Pattern and Spacing
48. Total Number of Injection Wells to be Approved in this Application	49. Estimated Maximum Daily Rate of Injection per Well (bbls./day/well)
50. Total Estimated Maximum Daily Rate of Injection for All Wells in this Application. (bbls./day)	51. Maximum Injection Pressure to be Used (psig)

52. LIST COMPLETE INJECTION WELL DATA ON FORM H-1A AND ATTACH.

DATA ON PROPOSED PROJECT AREA

APPLICANT MUST COMPLY WITH THE INSTRUCTIONS AND SIGN CERTIFICATION ON REVERSE SIDE

Figure C-5. Application to inject fluid into a reservoir productive of oil or gas.

INSTRUCTIONS (H-1)

1. File the original application, including all attachments, with the Director of Underground Injection Control, Railroad Commission of Texas, P. O. Drawer 12967, Capitol Station, Austin, Texas 78711. File one copy of the application and its attachments with the appropriate District Office.

2. Attach complete electrical log or similar well log of one of the proposed injection wells. Attach any other logging and testing data available for the well such as cement bond logs.

3. (a) For a new project, attach a map with surveys marked showing the location and depth of all wells of public record within a one-quarter (¼) mile radius of the project area.

   (b) For an expansion of a previous authority, attach a map with surveys marked showing the location and depth of all wells of public record within one-quarter (¼) mile radius of the additional wells, unless such data previously has been submitted for the project.

   (c) For those wells in 3(a) or 3(b) that penetrate the top of the injection interval, attach a table of wells showing the dates drilled and their present status. Identify any abandoned well which available data indicate is unplugged or improperly plugged. The Director of Underground Injection Control may adjust or waive this data requirement in accordance with provision of the "Area of Review" section of Statewide Rule 46.

4. Attach a letter from the Texas Department of Water Resources for a well within the project area stating the depth to which usable quality ground water occurs.

5. Attach Form H-1A showing each injection well to be used in the project. Up to three wells can be listed on each H-1A Form.

6. Attach Form H-7, Fresh Water Data Form, for a new injection project that includes the use of fresh water. An updated H-7 must be attached to Form H-1 for an expansion of a previously authorized fresh water injection project unless the fresh water is purchased from a commercial supplier, public entity, or from another operator.

7. (a) Attach a plat of lease(s) showing producing wells, injection wells, offset wells, and identifying ownership of all surrounding leases.

   (b)(1)Send a copy of the application to the surface owner, the offset operators, and to the county and city clerk of the county and city in which the well is located. If this is the initial application for fluid injection authority for this reservoir, send copies of the application to all operators in the reservoir. Attach a signed statement indicating the date the copies of the application were mailed or delivered and the names and addresses of the persons to whom copies were sent.

   (2) Attach an affidavit of publication signed by the publisher that notice of the application has been published in a newspaper of general circulation in the county where the wells will be located. Notice instructions and forms may be obtained from the Commission's Austin Office or the District Offices.

   (c) No public hearing will be held on this application unless an affected person or local government requests a public hearing. Any such request for a public hearing shall be in writing and contain: (1) the name, mailing address, and phone number of the person making the request; and (2) a brief description of how the protestant would be adversely affected by the granting of the application. If the Commission determines that a valid protest has been received, or that a public hearing would be in the public interest, a hearing will be held after the issuance of proper and timely notice of the hearing by the Commission. If no protest is received within fifteen (15) days of publication or receipt in Austin of the application, the application may be processed administratively.

CERTIFICATE

I declare under penalties prescribed in Sec. 91.143, Texas Natural Resources Code, that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge

_____
Signature

_____
Name of Person (type or print) Title

Telephone _____ Date _____
Area Code Number

Figure C-5. (continued)

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

FORM H-1A
INJECTION WELL DATA
Attach to Form H-1

1. Operator Name	2. Lease Name	3. RRC Lease ID No.
4. Field Name	5. RRC Field No.	6. Depth to Base of Deepest Fresh Water Zone
7. Location	10. County	8. This lease is located ____ miles ____ direction from ____ nearest town

9. WELL NO.	WELL CASING AND TUBING						
	SIZE	SETTING DEPTH	SACKS CEMENT	TOP OF CEMENT	TOP DETERMINED BY	HOLE SIZE	CASING WEIGHT
10. Surface Casing							
11. Intermediate							
12. Long String							

13. Tubing (Size and Depth) 14. Name, Model and Depth of Tubing Packer

15. Total Depth of Well 16. Date Well Drilled 17. API No. 18. Ground Surface Elevation 19. Perforation or Open Hole ☐ ☐

20. List All Cement Squeeze Operations Giving Interval and Sacks of Cement

21. Injection Interval Top Bottom 22. Name of Reservoir 23. Injection System Open or Closed ☐ ☐

24. Anticipated Daily Injection Volume (Bbls) Average Maximum 25. Injection Pressure (Psi) Average Maximum 26. Is this well so cased and completed that water can enter no other formation than the above set out injection zone? ☐ Yes ☐ No

9. WELL NO.	WELL CASING AND TUBING						
	SIZE	SETTING DEPTH	SACKS CEMENT	TOP OF CEMENT	TOP DETERMINED BY	HOLE SIZE	CASING WEIGHT
10. Surface Casing							
11. Intermediate							
12. Long String							

13. Tubing (Size and Depth) 14. Name, Model and Depth of Tubing Packer

15. Total Depth of Well 16. Date Well Drilled 17. API No. 18. Ground Surface Elevation 19. Perforation or Open Hole

20. List All Cement Squeeze Operations Giving Interval and Sacks of Cement

21. Injection Interval Top Bottom 22. Name of Reservoir 23. Injection System Open or Closed ☐ ☐

24. Anticipated Daily Injection Volume (Bbls) Average Maximum 25. Injection Pressure (Psi) Average Maximum 26. Is this well so cased and completed that water can enter no other formation than the above set out injection zone? ☐ Yes ☐ No

9. WELL NO.	WELL CASING AND TUBING						
	SIZE	SETTING DEPTH	SACKS CEMENT	TOP OF CEMENT	TOP DETERMINED BY	HOLE SIZE	CASING WEIGHT
10. Surface Casing							
11. Intermediate							
12. Long String							

13. Tubing (Size and Depth) 14. Name, Model and Depth of Tubing Packer

15. Total Depth of Well 16. Date Well Drilled 17. API No. 18. Ground Surface Elevation 19. Perforation or Open Hole

20. List All Cement Squeeze Operations Giving Interval and Sacks of Cement

21. Injection Interval Top Bottom 22. Name of Reservoir 23. Injection System Open or Closed

24. Anticipated Daily Injection Volume (Bbls) Average Maximum 25. Injection Pressure (Psi) Average Maximum 26. Is this well so cased and completed that water can enter no other formation than the above set out injection zone? ☐ Yes ☐ No

Figure C-6. Injection well data form.

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

Form H-7
(Eff. 3/1/68)

FRESH WATER DATA FORM

Date:

1. RRC District	2. Field Name (as per current proration schedule)
3. County	4. Reservoir (into which fresh water is to be injected)
5. Operator	
6. Lease Name(s) and RRC No(s). (on which fresh water is to be injected)	
7. Name of Fresh Water Formation or Source	8. Depth to Top of Fresh Water Formation (Feet)
9. Gross Thickness of Fresh Water Formation (Feet)	10. Net Thickness of Fresh Water Formation (Feet)
11. Total Number of Acres in Project Area where Applicant has Exclusive Use of Fresh Water Rights for Subject Project. Include Land Description. (Also furnish plat. See "Required Attachments" on back.)	
12. Volume of Recoverable Fresh Water-in-Place beneath Applicant's Water Rights Acreage (Barrels)	13. Rate of Recharge of Fresh Water Formation beneath Subject Water Rights Acreage (Barrels/Day)
14. Total Volume of Fresh Water to be Used in Injection Project (Barrels)	15. Fresh Water Withdrawal Rates for Project (Barrels/Day)

16. Other Uses and Withdrawal Rates in Project Area for the same Fresh Water Formation or Source

USES (Specify each.)	RATES (Barrels/Day)

17. Names of and Distances to Municipal Water Supplies Utilizing Same Fresh Water Formation or Source (within 20 mile radius)

CITY/TOWN	DISTANCE AND DIRECTION

18. Name of Shallowest Salt Water or Brackish Water Supply Zone	19. Depth of Shallowest Salt Water or Brackish Water Supply Zone (Feet)	20. Rate of Salt Water or Brackish Water Available from All Sources for Project (Barrels/Day)

(OVER)

Figure C-7. Fresh water data form.

21. Reason for Use of Fresh Water
(Explain necessity of using fresh water rather than salt water.)

REQUIRED ATTACHMENTS:

1. WATER QUALITY ANALYSIS REPORT ON FRESH WATER FORMATION.
2. PLAT(S) SHOWING FRESH WATER RIGHTS ACREAGE (AS PER ITEM II) AND LOCATION AND DENSITY OF FRESH WATER SUPPLY WELLS.

I declare under penalties prescribed in Article 6036c, R.C.S., that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

DATE _____ SIGNATURE _____

OPERATOR _____ NAME OF PERSON (TYPE OR PRINT) _____

ADDRESS _____ TITLE _____

_____ ZIP CODE: _____ TELEPHONE: AREA CODE _____ _____

Figure C-7. (continued)

APPENDIX D

FORM USED BY THE UIC STAFF TO RECORD COMPLAINTS ABOUT SALT WATER INJECTION OR DISPOSAL WELLS.

COMPLAINT

COMPLAINTANT: _____

ADDRESS: _____ TELEPHONE: _____

DATE RECEIVED: _____ HOW RECEIVED: _____

COMPLAINT AGAINST:

OPERATOR: _____

LEASE: _____

FIELD: _____

COUNTY: _____

NATURE OF COMPLAINT: _____

_____

_____

_____

_____

_____

_____

DATE OF INSPECTION: _____ INSPECTOR: _____

COMMISSION ACTION: _____

_____

_____

_____

_____

_____

_____

DATE COMPLAINTANT APPRISED OF COMMISSION ACTION: _____

DATE COMPLAINT RESOLVED: _____

DATE AUSTIN NOTIFIED: _____

Figure D-1. Administrative form used by the UIC program to record complaints.

APPENDIX E

TEXAS STATEWIDE RULE 8 - WATER PROTECTION

(a) Fresh Water to be Protected

Fresh water, whether above or below the surface, shall be protected from pollution whether in drilling, plugging, producing, or disposing of salt water already produced.

(b) Exploratory Wells

Any oil, gas or geothermal resource well or well drilled for exploratory purposes shall be governed by the provisions of statewide or field rules which are applicable and pertain to the drilling, safety, casing, production, abandoning and plugging wells, and all operations in connection therewith shall be carried on so that no pollution of any stream or water course of this State, or any subsurface waters, will occur as the result of the escape or release or injection of oil, gas, salt water, geothermal resource or other mineralized waters for any well.

(Reference Order No. 20-56, 841, effection 1-1-69).

(c) (1) All operators conducting oil, gas, or geothermal resources development and production operations are prohibited from using salt water disposal pits for storage and evaporation of oil field brines, geothermal resource waters or other mineralized waters.

(A) The provisions of this rule do not affect the use of burning pits which are used exclusively for the burning of tank bottom waste accumulation.

(B) Impervious collecting pits may be approved for use in conjunction with approved salt water disposal operations, provided that authority must be received for use of such pits from the director of the oil and gas division or his delegate. If the director of the oil and gas division declines administratively to grant, to continue, or to extend the authority to use a pit, the operator shall make a recommendation for final action by the Commission.

(C) Discharge of oil field brines, geothermal resource waters or other mineralized waters into a surface drainage water course, whether it be a dry creek, a flowing creek or a river, except where permitted by the Commission, is not an acceptable disposal operation and is prohibited.

(D) Disposition of oil field brines, geothermal resource waters or other mineralized waters through off-lease facilities where transportation is by tank trucks, pipelines or other means, is the initial responsibility of the lease operator and shall not be initiated until such method of disposition is permitted by the Railroad Commission. Such permit shall be subject to review and cancellation should investigation show that the permit method of disposition is abused.

(2) Exceptions to the provisions of this rule may be granted by the Railroad Commission on special request where good and sufficient cause is shown.

(3) Penalty for non-compliance with any part of this rule shall be pipeline severance for each lease operated in violation of this rule.

(4) In any instance where a salt water disposal pit is presently in use and is abandoned, due to cessation of flow of salt water thereto, whether voluntary or mandatory, such pit shall be backfilled and compacted.

(d) Pollution Prevention

(Reference Order No. 20-59, 200, effective 5-1-69)

(1) The operator shall not pollute the waters of the Texas offshore and adjacent estuarine zones (salt water bearing bays, inlets, and estuaries) or damage the aquatic life therein.

(2) All oil, gas, and geothermal resource well drilling and producing operations shall be conducted in such a manner as to preclude the pollution of the waters of the Texas offshore and adjacent estuarine zones. Particularly, the following procedures shall be utilized to prevent pollution.

(A) The disposal of liquid waste material into the Texas offshore and adjacent estuarine zones shall be limited to salt water and other materials which have been treated, when necessary, for the removal of constituents which may be harmful to aquatic life or injurious to life of property.

(B) No oil or other hydrocarbons in any form or combination with other materials or constituent shall be disposed of into the Texas offshore and adjacent estuarine zones.

(C) All deck areas on drilling platforms, barges, workover unit and associated equipment both floating and stationary subject to contamination shall be either curbed and connected by drain to a collection tank, sump or enclosed drilling slot in which might reasonably be considered a source from which pollutants may escape into surrounding water. These drip pans must be piped to collecting tanks, sumps or enclosed drilling slots designed to accommodate all reasonably expected drainage. Satisfactory means must be provided to empty the sumps or enclosed drilling slots to prevent overflow or prevent pollution of the surrounding water.

(D) Solid combustible waste may be burned and the ashes may be disposed of into Texas offshore and adjacent estuarine zones.

Solid wastes such as cans, bottles, or any form of trash must be transported to shore in appropriate containers. Edible garbage, which may be consumed by aquatic life without harm, may be disposed of into Texas offshore and adjacent estuarine zones.

(E) Drilling muds which contain oil shall be transported to shore or a designated area for disposal. Only oil-free cuttings and fluids from mud systems may be disposed of into Texas offshore and adjacent estuarine zones at or near the surface.

(F) Fluids produced from offshore wells shall be mechanically contained in adequately pressure-controlled piping or vessels from producing to disposition point. Oil and water separation facilities at offshore and onshore locations shall contain safeguards to prevent emission of pollutants to the Texas offshore and adjacent estuarine zones prior to proper treatment.

(G) All deck areas on producing platforms subject to contamination shall be either curbed and connected by drain to a collecting tank or sump in which the contamiment will be treated and disposed of without causing hazard or pollution, or else drip pans, or their equivalent, shall be placed under any equipment which might reasonably be considered a source from which pollutants may escape into surrounding water. These drip pans must be piped to collecting tanks or sumps designed to accommodate all reasonably expected drainage. Statisfactory means must be provided to empty the sumps to prevent overflow.

(H) Any person observing water pollution shall report such sighting, noting size, material, location and current conditions to the ranking operation personnel. Immediate action or notification shall be made to eliminate further pollution. The operator shall then transmit the report to the appropriate commission district office.

(I) Immediate corrective action shall be taken in cases where pollution has occurred. An operator responsible for the pollution, shall remove immediately such oil, oil field waste, or other pollution materials from the waters and the shore line where it is found. Such removal operations will be at the expense of the responsible operator.

(3) The Commission may suspend producing and/or drilling operations from any facility when it appears that the provisions of this rule are being violated.

(4) (Reference Order No. 20-61, 214, effective 10-1-70)

The foregoing provisions of Rule 8(d) shall also be required and enforced as to all oil, gas or geothermal resource operations conducted on the inland and fresh waters of the State of Texas, such as lakes, rivers, and streams.

(e) Salt Water Haulers

(1) A person who transports salt water for hire by any method other than by pipeline shall not haul and dispose of water containing salt or other mineralized substances produced by oil and gas operations, off a lease, unit, or other oil or gas property where it is produced unless such transporter has qualified for and been issued a Salt Water Hauler Permit by the commission.

(A) Application for a Salt Water Hauler's Permit will be made on the commission prescribed form, and in accordance with the instructions thereon, and must be accompanied by:

(1) Salt Water Haulers Permit bond on the commission prescribed form

(2) Vehicle Identification information to support commission issuance of a Vehicle Identification card

(3) A statement of Haulers Authority to use a commission approved disposal system

(4) Submit each truck for inspection by commission district personnel

(B) A Salt Water Hauler's Permit when issued will expire August 31 of each year, but it is subject to renewal by the filing of a Renewal Certificate, and a copy of a Salt Water Hauler's Permit Bond for the next permit period.

(C) Each Salt Water Hauler shall conduct operations in strict compliance with the Instructions and Conditions stated on the permit issued which provide:

(i) This permit, unless suspended or revoked for cause shown, shall remain valid until August 31 of the permit year (Permit period September 1 to August 31 set by Law).

(ii) Each vehicle used by a permittee shall be marked on both sides and the rear with the permittee's name and permit number in characters not less than three inches high. (For the purposes of this permit "vehicle" means any truck tank, trailer tank, tank car, or other container in which salt water will be hauled by the permittee.)

(iii) A Vehicle Identification Card must be obtained from the district office and carried at all times with the vehicle described thereon. This card will contain the permittee's name, permit number, vehicle description, vehicle number, permit authority, and a list of all approved disposal systems that the permittee is authorized to use.

(iv) This permit is issued pursuant to the information furnished on the application form, and any change in conditions must be reported to the commission on an amended application form. The permit authority will be revised by the amended application.

(v) This permit authority is limited to the hauling, handling, and disposal of salt water that is produced in connection with the drilling or producing operations of an oil or gas well.

(vi) This permit authorizes the permittee to use only those approved disposal systems for which he has submitted affidavits from the operators stating he has permission to use the systems. A list of the systems that the permittee is to use will be placed on the back of the Vehicle Identification Card.

(vii) The permittee must file an application for a renewal permit, using his assigned permit number, on or before August 31 of each year.

(viii) The permittee must compile and keep current a list of all persons by whom he is hired to haul produced salt water, and furnish such list to the commission upon request.

(2) A record shall be kept by each Salt Water Hauler showing daily salt water hauling operations under the permitted authority.

(A) Such daily records shall be dated and signed by the vehicle driver and it shall show the following information:

(i) Identity of the property from which the the produced water is hauled.

(ii) Identity of the commission approved disposal system to which the water is delivered.

(iii) The volume of water received at the property where produced.

(iv) The volume of water transported and delivered to the approved disposal system.

(B) Such record shall be kept open for the inspection of the commission or its representatives.

(C) Such records shall be kept on file for a period of two (2) years from the date of operations and recordation.

APPENDIX F

TEXAS STATEWIDE RULE 9 - DISPOSAL WELLS

Any person who disposes of salt water or other oil and gas waste by injection into a porous formation not productive of oil, gas, or geothermal resources shall be responsible for complying with this rule, Chapter 27 of the Texas Water Code, and Title 3 of the Natural Resources Code.

(a) General. Salt water or other oil and gas waste, as that term is defined in Chapter 27 of the Texas Water Code, may be disposed of, upon application to and approval by the commission, by injection into nonproducing zones of oil, gas, or geothermal resources bearing formations that contain water mineralized by processes of nature to such a degree that the water is unfit for domestic, stock, irrigation, or other general uses. Every applicant who proposes to dispose of salt water or other oil and gas waste into a formation not productive of oil, gas, or geothermal resources, must obtain a permit from a commission authorizing the disposal in accordance with this rule. Permits from the commission issued before the effective date of this rule shall continue in affect until revoked, modified, or suspended by the commission.

(b) Geological requirements. Before such formations are approved for disposal use the applicant shall show that the formations are separated from fresh water formations by impervious beds which give adequate protection to such fresh water formations. The applicant must submit a letter from the Texas Department of Water Resources, Austin, Texas, stating that the use of such formation will not endanger the fresh water strata in that area and that the formations to be used for disposal are not fresh water bearing.

(c) Application. The application to dispose of salt water or other oil and gas waste by injection into a porous formation not productive of oil, gas, or geothermal sources shall be filed with the commission in Austin. On the same date, one copy shall be filed with the appropriate district office.

(d) Notice and opportunity for hearing.

(1) The applicant shall give notice by mailing or delivering a copy of the application to the surface owner of the tract on which the well is located, to each adjoining offset operator, to the county clerk of the county in which the well is located, and to the city clerk or other appropriate city official of any city where the well is located within the municipal boundaries of the city, on or before the date the application is mailed to or filed with the commission.

(2) In order to give notice to other local governments, interested, or affected persons, notice of the application shall be published once by the applicant in a newspaper of general circulation for the county where the well will be located in a form approved by the director of underground injection control (hereinafter "director"). The applicant shall file with the commission in Austin proof of publication prior to the hearing or administrative approval.

(3) Protested applications.

(A) If a protest from an affected person or local government is made to the commission within 15 days of receipt of the application or of publication, or if the director determines that a hearing is in the public interest, then a hearing will be held on the application after the commission provides notice of hearing to all affected persons, local governments, or other persons, who express an interest in writing in the application.

(B) For purposes of this rule, "affected person" means a person who has suffered or will suffer actual injury or economic damage other than as a member of the general public and includes surface owners of property on which the well is located and adjoining offset operators.

(4) If no protest from an affected person is received by the commission, the director may administratively approve the application. If the director denies administrative approval, the applicant shall have a right to a hearing upon request. After hearing, the examiner shall recommend a final action by the commission.

(e) Subsequent commission action.

(1) A permit for salt water or other oil and gas waste disposal may be modified, suspended, or terminated by the commission for just cause after notice and opportunity for hearing if:

(A) a material change of conditions occurs in the operation or completion of the disposal well, or there are material changes in the information originally furnished;

(B) fresh water is likely to be polluted as a result of continued operation of the well;

(C) there are substantial violations of the terms and provisions of the permit or of commission rules;

(D) the applicant has misrepresented any material facts during the permit issuance process; or

(E) injected fluids are escaping from the permitted disposal zone?

(2) A disposal well permit may be transferred from one operator to another operator provided that:

(A) Written notice of the intended permit ransfer is submitted to the director at least 15 days prior to the date the transfer is to take place; and

(B) the director does not notify the present permit holder of an objection to the transfer prior to the transfer date stated in the above notification.

(f) Area of review. The applicant shall review the data of public record for wells that penetrate the proposed disposal zone within a one-quarter (1/4) mile radius of the proposed disposal well to determine if all abandoned wells have been plugged in a manner that will prevent the movement of fluids from the disposal zone into fresh water strata. Alternatively, if the applicant can show by computation that a lesser area will be affected by pressure increases, then the lesser area may be used in lieu of the one-quarter (1/4) mile radius area of review. The applicant shall identify in the application any wells which appear from such review of public records to be unplugged or improperly plugged and any other unplugged or improperly plugged wells of which the applicant has actual knowledge.

(g) Casing. Disposal wells shall be cased and the casing cemented in compliance with §3.13 (051.02.02.013) in such a manner that the injected fluids will not endanger oil, gas, geothermal resources or fresh water resources.

(h) Special equipment.

(1) Tubing and Packer. New wells drilled or converted for disposal after the effective date of this rule shall be equipped with tubing set on a mechanical packer. Packers shall be set no higher than 100 feet above the top of the permitted interval. Existing disposal wells shall be so equipped at the time of the first workover but no later than January 1, 1984.

(2) Pressure valve. The well head shall be equipped with a pressure observation valve on the tubing and for each annulus of the well. Operators of existing disposal wells shall comply with this requirement by no later than January 1, 1983.

(3) Exceptions. The director may grant an exception to any provision of this paragraph upon proof of good cause. If the director denies an exception, the operator shall have a right to a hearing upon request. After hearing, the examiner shall recommend a final action by the commission.

(4) The operator shall report the appropriate district office within 24 hours any significant pressure changes or other monitoring data indicating the presence of leaks in the well. The operator shall confirm this report in writing within five working days.

(k) Testing.

(1) Before beginning disposal operations, the operator shall pressure test the long string casing. The test pressure must equal the maximum authorized injection pressure or 500 psig, whichever is less, but must be at least 200 psig.

(2) Each disposal well shall be pressure-tested in the manner provided in paragraph (k) (1) at least once every five years to determine if there are leaks in the casing, tubing, or packer. The director may prescribe a schedule and mail notification to operators to allow for orderly and timely compliance with this requirement.

(3) As an alternative to the testing required in paragraph (k) (2), the tubing-casing annulus pressure may be monitored and included on the annual monitoring report required by paragraph (j) provided that there is no indication of problems with the well. The director may grant exception for viable alternative tests or surveys such as monitoring of injecton rate/injection pressure relationships.

(4) The operator shall notify the appropriate district office at least 48 hours prior to the testing. Testing shall not commence before the end of the 48-hour period unless authorized by the district office.

(5) A complete record of all tests shall be filed in duplicate in the district office on the appropriate form within 30 days after the testing.

(l) Plugging. Disposal wells shall be plugged upon abandonment in accordance with Statewide Rule 14.

(m) Penalties.

(1) Violations of this rule may subject the operator to penalties and remedies specified in Chapter 27 of the Texas Water Code and Title 3 of Natural Resources Code.

(2) The certificate of compliance for any oil, gas, or geothermal resource well may be revoked in the manner provided in §3.68 (051.02.02.073) for violation of this rule.

APPENDIX G

TEXAS STATEWIDE RULE 46 - FLUID INJECTION INTO PRODUCTIVE RESERVOIRS

(a) Permit Required. Any person who engages in fluid injection operations in reservoirs productive of oil, gas, or geothermal resources must obtain a permit from the commission. Permits may be issued when the injection will not endanger oil, gas, or geothermal resources or cause the pollution of fresh water strata unproductive of oil, gas, or geothermal resources. Permits from the commission issued before the effective date of this rule shall continue in effect until revoked, modified, or suspended by the commission.

(b) Filing of application. An application to conduct fluid injection operations in a reservoir productive of oil, gas, or geothermal resources shall be filed in Austin on the form prescribed by the commission. On the same date, one copy shall be filed with the appropriate district office. The form shall be executed by a party having knowledge of the facts entered on the form. The applicant shall file the fresh water injection data form if fresh water is to be injected.

(c) Notice and opportunity for hearing.

(1) The applicant shall give notice by mailing or delivering a copy of the application to the surface owner of the tract on which the well is located, to each adjoining offset operator, to the county clerk of the county in which the well is located, and to the city clerk or other appropriate city official of any city where the well is located within the corporate limits of the city on or before the date the application is mailed to or filed with the commission.

(2) In order to give notice to other local governments, interested, or affected persons, notice of the application shall be published once by the applicant in a newspaper of general circulation for the county where the well will be located in a form approved by the director of Underground Injection Control (hereinafter "director"). The applicant shall file with the commission in Austin proof of publication prior to the hearing or administrative approval.

(3) Protested applications.

(A) If a protest from an affected person or local government is made to the commission within 15 days of receipt of the application or of publication, or if the director determines that a hearing is in the public interest, then a hearing will be held on the application after the commission provides notice of hearing to all affected persons, local governments, or other persons, who express an interest in writing in the application.

(B) For purposes of this rule, "affected person" means a person who has suffered or will suffer actual injury or economic damage other than as a member of the general public and includes surface owners of property on which the well is located and adjoining offset operators.

(4) If no protest from an affected person is received by the commission, the director may administratively approve the application. If the director denies administrative approval, the applicant shall have a right to a hearing upon request. After hearing, the examiner shall recommend a final action by the commission.

(d) Subsequent commission action.

(1) An injection well permit may be modified, suspended, or terminated by the commission for just cause after notice and opportunity for hearing, if:

(A) A material change of conditions occurs in the operation or completion of the injection well, or there are material changes in the information originally furnished;

(B) Fresh water is likely to be polluted as a result of continued operation of the well;

(C) There are substantial violations of the terms and provisions of the permit or of commission rules;

(D) The applicant has misrepresented any material facts during the permit issuance process; or

(E) Injected fluids are escaping from the permitted injection zone.

(2) An injection well permit may be transferred from one operator to another operator provided that:

(A) Written notice of the intended permit transfer is submitted to the director at least 15 days prior to the date the transfer is to take place; and

(B) The director does not notify the present permit holder of an objection to the transfer prior to the transfer date stated in the above notification.

(e) Area of review. The applicant shall review the data of public record for wells that penetrate the proposed injection zone within a one-quarter (1/4) mile radius of the proposed injection well to determine if all abandoned wells have been plugged in a manner that will prevent the movement of fluids from the injection zone into fresh water strata. Alternatively, if the applicant can show by computation that a lesser area will be affected by pressure increases, then the lesser area may be used in lieu of the one-quarter (1/4) mile radius area of review. The applicant shall identify in the application wells which appear from such review of public records to be unplugged or improperly plugged and any other unplugged or improperly plugged wells of which the applicant has actual knowledge.

(f) Casing. Injection wells shall be cased and the casing cemented in compliance with Statewide Rule 13 in such a manner that the injected fluids will not endanger oil, gas, or geothermal resources and will not endanger fresh water formations not productive of oil, gas, or geothermal resources.

(g) Special equipment.

(1) Tubing and packer. New wells drilled or converted for injection after the effective date of this rule shall be equipped with tubing set on a mechanical packer. Packers shall be set no higher than 200 feet below the known top of cement behind the long string casing but in no case higher than 150 feet below the base of usable quality water.

(2) Pressure valve. The wellhead shall be equipped with a pressure observation valve on the tubing and for each annulus of the well. Operators of existing injection wells shall comply with this requirement by no later than January 1, 1983.

(3) Exceptions. The director may grant an exception to any provision of this paragraph upon proof of good cause. If the director denies an exception, the operator shall have a right to a hearing upon request. After hearing, the examiner shall recommend a final action by the commission.

(h) Well record. Within 30 days after the completion or conversion of an injection well, the operator shall file in duplicate in the district office a complete record of the well on the appropriate form which shows the current completion.

(i) Monitoring and reporting.

(1) The operator shall monitor the injection pressure and injection rate of each injection well on at least a monthly basis.

(2) The results of the monitoring shall be reported annually to the commission on the prescribed form.

(3) All monitoring records shall be retained by the operator for at least five years.

(4) The operator shall report to the appropriate district office within 24 hours any significant pressure changes or other monitoring data indicating the presence of leaks in the well. The operator shall confirm this report in writing within five working days.

(j) Testing.

(1) Before beginning injection operations, the operator shall pressure test the long string casing. The test pressure must equal the maximum authorized injection pressure or 500 psig, whichever is less, but must be at least 200 psig.

(2) Each injection well shall be pressure-tested in the manner provided in paragraph (j) (1) at least once every five years to determine if there are leaks in the casing, tubing, or packer. The director may prescribe a schedule and mail notification to operators to allow for orderly and timely compliance with this requirement.

(3) As an alternative to the testing required in paragrph (j) (2), the tubing-casing annulus pressure may be monitored and included on the annual monitoring report required by subsection (i) provided that there is no indication of problems with the well. The director may grant an exception for viable alternative tests or surveys such as monitoring of injection rate/injection pressure relationships.

(4) The operator shall notify the appropriate district office at least 48 hours prior to the testing. Testing shall not commence before the end of the 48-hour period unless authorized by the district office.

(5) A complete record of all tests shall be filed in duplicate in the district office within 30 days after the testing.

(k) Plugging. Injection wells shall be plugged upon abandonment in accordance with Statewide Rule 14.

(l) Penalties.

(A) Violations of this rule may subject the operator to penalties and remedies specified in Title 3 of the Natural Resources Code and any other statutes administered by the commission.

(B) The certificate of compliance for any oil, gas, or geothermal resource well may be revoked in the manner provided in §3.68 (051.02.02.073) for violation of this rule.