Technical Report Documentation Page

1. Report No. FHWA/TX-01/1858-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle THE VALUE OF PIPELINES TO THE TRANSPORTATION SYSTEM OF TEXAS: YEAR ONE REPORT		5. Report Date October 2000 6. Performing Organization Code
7. Author(s) Stephen S. Roop, Leslie E. Olson, David Bierling, Angela Sandoval and Theodore Weisner		8. Performing Organization Report No. Report 1858-1
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135		10. Work Unit No. (TRAIS) 11. Contract or Grant No. Research Project No. 0-1858
12. Sponsoring Agency Name and Address Texas Department of Transportation Construction Division Research and Technology Transfer Section P. O. Box 5080 Austin Texas 78763-5080		13. Type of Report and Period Covered Research: September 1999 – August 2000 14. Sponsoring Agency Code

15. Supplementary Notes
Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.
Research Project Title: The Value of Pipelines to the Transportation System of Texas

16. Abstract

Pipelines represent a major transporter of petrochemical commodities in Texas. The Texas pipeline system represents as much as 17 percent of the total pipeline mileage in the U.S. and links many segments of the country with energy sources located on the Gulf Coast. This research is expected to provide TxDOT a broad understanding of pipeline operations and their relationship to other modes of transportation. Knowledge of the location and interaction dynamics of pipelines with other forms of transportation (trucks, railroads and ocean) is essential for TxDOT to be able to plan and execute transportation improvements in the 21st century. This research is designed to provide TxDOT with an understanding of the location, function, interconnectivity of the state's pipeline system, and insight into how it or other state agencies may best work with pipelines to optimize the transportation system.

The first year task work is described in this report. Each task is described in a chapter devoted to that research work. Chapter 1 describes many of the operating characteristics for pipelines affecting their general business outlook. This chapter also includes information on preliminary work performed on the regulatory overview task and on the potential for pipeline integration task. Chapter 2 reveals the extent of the literature review and provides the basic or fundamental design considerations for a pipeline. Chapter 3 provides example maps and information regarding the GIS mapping data included in the report. Chapter 4 provides the basis background on the various modes of surface transportation interconnecting with the pipeline system in the state and how the interconnections function in relation to each other. Included in this chapter are various examples of the actual means and methods of the interconnections. Chapter 5 summarizes the research results of year one and outlines the research program for year two of this two year effort.

17. Key Words Commodities, Interconnections, Pipelines	18. Distribution Statement No Restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161		
19. Security Classif.(of this report) Unclassified	20. Security Classif.(of this page) Unclassified	21. No. of Pages 146	22. Price

Form DOT F 1700.7 **(8-72)** **Reproduction of completed page authorized**

THE VALUE OF PIPELINES TO THE TRANSPORTATION SYSTEM OF TEXAS: YEAR ONE REPORT

by

Stephen S. Roop, Ph.D.,
Research Scientist
Texas Transportation Institute

Leslie E. Olson
Associate Research Scientist
Texas Transportation Institute

David Bierling
Graduate Research Assistant
Texas Transportation Institute

Angela Sandoval
Graduate Research Assistant
Texas Tech University

and

Theodore Weisner
Assistant Professor
Texas Tech University

Report 1858-1
Project Number 0-1858
Research Project Title: The Value of Pipelines to the Transportation System of Texas

Sponsored by the
Texas Department of Transportation
In Cooperation with the
U.S. Department of Transportation
Federal Highway Administration

October 2000

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

DISCLAIMER

The contents of this report reflect the views of the authors, who is are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

ACKNOWLEDGMENTS

The authors wish to thank Mr. Raul Cantu, the Project Directorr and Mr. Jim Randall of the TP&P for their support in this research effort. In addition, the authors would like to recognize the contribution of the project monitoring committee in setting a clear direction for this important project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 – TEXAS PIPELINES AS AN ELEMENT OF THE TRANSPORTATION SYSTEM

INTRODUCTION AND OVERVIEW

Pipelines represent a major transporter of hydrocarbon commodities in Texas. The Texas hydrocarbon pipeline system represents as much as 17 percent of the total hydrocarbon pipeline mileage in the United States and links many segments of the country with energy sources located on the Gulf Coast. The critical role of this pipeline transportation and the largely unseen nature of the system makes it increasingly important for the Texas Department of Transportation (TxDOT) to understand the scope of pipeline operations and its relationship to other modes of transportation. Knowledge of the location and interaction dynamics of pipelines with other forms of transportation is essential for TxDOT to be able to plan and execute transportation improvements in the 21st century. This research is expected to provide TxDOT with an improved understanding of the location, function, and interconnectivity of the state's pipeline system, and insight into how it or other state agencies may best work with pipelines to optimize the transportation system.

The pipeline system in Texas, as a major transporter of gas, petroleum, and chemical commodities, serves in a very literal sense as the unseen transportation mode. Without this low-cost, efficient system in place, the economy of Texas and the nation could not function as it currently does. If the tonnages moved annually in pipelines (nearly 82 million tons of Texas crude oil and natural gas alone in 1999) (*1*) were to be transported by truck, rail, or barge, the volume would quickly overwhelm the surface transportation system. Furthermore, due to its scope and strategic location adjacent to the Gulf of Mexico, the Texas pipeline system is a necessary element in the national transportation of both refined petroleum products and natural gas. Without the Texas pipeline system in place, little of the nation's energy needs for transportation fuel and boiler fuel would be met.

A principal element of pipeline operating economics is the basic understanding that essentially everything moved in pipelines is a commodity. All but a few special cases interstate pipelines are required to file general transportation rates with the Federal Energy Regulatory Commission (FERC) for moving natural gas. In practice, all interstate oil pipelines are also required to act as public access carriers for commodities by filing transportation rates with the FERC. This requirement of having publicly filed transportation rates makes the pipeline business as much a commodity business as the actual sale of the commodity itself. There is no room for marginal error by the pipeline operator when providing transportation. Competition within the industry for business is so intense that even marginal knowledge of a competitor's business is tantamount to ruin for the exposed business.

Study Objectives

This research will assist TxDOT in understanding the full scope of the state pipeline system. How pipelines connect and interface with the other transportation modes under TxDOT's

purview, and how they can be integrated to the fullest extent to meet the needs of Texas and the nation.

Research Approach

The Texas Transportation Institute (TTI) and Texas Tech University (TTU) are collaborating in this effort to meet the needs of the research. The two research organizations have combined to provide geographically broad coverage for the work. With the separation distance between TTI and TTU, the ability to contact more sources to collect data is enhanced, thereby increasing the team's efficiency at carrying the research forward.

In addition to our ongoing university collaboration, TTU has applied funds obtained in a settlement from Koch Industries as "matching funds" to reduce the cost of the research to TxDOT. The $50,000 settlement in 1998 between the state of Texas and Koch Industries contained a provision that provided TTU with funds to apply to pipeline research. TTU, in general discussions with TTI, has decided that the best use of these funds is within the context of this more comprehensive research effort. By using the Koch Industries settlement funds as a match against TxDOT research funding, both potential efforts are expanded to the mutual benefit of each.

Review Pipeline Characteristics

This research is restricted in scope to the petroleum/hydrocarbon business sector of pipelines. Up until the late 1980s the pipeline business operated in two distinct sectors: the open access liquid pipeline business and the protected but highly regulated natural gas pipeline business. The liquid transportation business operated with a public rate structure and open access to all shippers regardless of where the product to be shipped was purchased. One customer's product was typically comingled with another customer's identical product and transported in batch fashion from a receiver to a destination. The natural gas transportation business operated more as a wholesale supplier business. The natural gas producer or well gas owner was not allowed to directly sell or ship his product to end customers. This situation applied even if the producer owned and operated a natural gas transmission system.

The liquid transmission business has essentially been open access since the breakup of Rockefeller's Standard Oil by use of the 1911 Sherman Anti-Trust Act (*2*), when the U.S. Supreme Court asserted the government's authority to control big business by breaking up Standard Oil. One of the recognized premises of Standard Oil's controls was the total monopoly of the transportation of oil and oil products. After the breakup of Standard Oil, the Interstate Commerce Commission (ICC) was required to regulate oil transportation rates by shippers. The results of this regulation ultimately led to open access as we know it today. Any shipper of product can contract with any transporter of product to ship his product at guaranteed rate with equal shipping treatment, regardless of quantity or business position.

The natural gas business was barely conceived of at the time of the Standard Oil break-up. Because of the regulatory climate that had already been established in the 1920s, when natural gas transmission began to develop as an industry in itself, the lesson had been learned.

However, substantial incentive was required to boost the fledgling natural gas industry. At the onset of expansion of natural gas industries from local use to interstate transmission, natural gas was considered useful only for heating fuel. Although this included industrial boiler fuel, there were virtually no other markets for natural gas in the industry's early days. The promoters of natural gas transmission pipelines required and received the granting of government protection for operating franchises with no other intervention in their business. This condition continued from the 1920s until the "Phillips Decision" of 1954 (*3*). The state of Wisconsin sued Phillips Petroleum over the right to regulate Phillips' natural gas price for gas shipped to Wisconsin in interstate pipelines.

This was a new challenge to the Federal Power Commission's (FPC) review of the jurisdictional authority of companies such as Phillips for the sale of natural gas. Essentially, Wisconsin's right to have the natural gas price for Phillips gas delivered into Wisconsin be held regulated as interstate natural gas was upheld by the Court. The Court held the FPC was required to hold companies like Phillips as natural gas companies in interstate commerce and set and adjust natural gas prices in interstate commerce. For all practical purposes, this decision set the stage for the gas shortages of the early 1970s and the ultimate deregulation of the gas industry as it exists today.

In 1985, the FERC announced its intent to force deregulation in the natural gas industry as a result of the obvious inequity in the industry. The state of Texas had a glut of natural gas availability, but high prices. The rest of the nation had low prices, but regular winter shortages of gas availability. These shortages were at best the artificial results of federal involvement through regulatory controls on the end use of gas. These controls came about in the Public Utility Regulatory Policies Act of 1978 (*4*) (PURPA) through the failed attempt by Congress to develop a comprehensive National Energy Policy. Congress's attempt to dictate gas usage was the result of a misguided understanding of the perceived shortage of natural gas being part of the oil embargo crisis in the energy shortages of 1973 and 1976.

There were real shortages at end user points (Ohio, etc.) of natural gas beginning in 1971. However, the shortages were well understood by energy insiders and based on several operating characteristics of the industry at that time. Most importantly, the price of natural gas in interstate commerce was set artificially low. The low prices were a result of the FPC's inability to act on gas producers' rate request hearings in a timely manner and the method used by the FPC to allocate gas producers' costs to the price of the gas well. The producers' rate request hearings were very complex and difficult cases due to the complexity of the overall U.S. tax code, accounting methods, and petroleum industry drilling practices. The issue of rate equity in the gas industry during this period is beyond the scope of this investigation; however, some background is helpful to grasp the concept of false shortage and market restricted access to the pipeline system.

The past nature of the pipeline business was strictly confidential for each pipeline customer from each source. Pipeline customers invariably have multiple sources for their product delivery needs and hold their material requirements proprietary to protect their competitive position for price and availability in the marketplace. Up until 1996, the pipeline industry maintained the same position with respect to their market deliveries. With the new

structure in the natural gas industry directed by the FERC, pipelines now are required to provide actual energy deliveries to customers under Firm Transportation (FT) rate schedules. (See Appendix A for examples.) Review of the FERC database of reports from pipelines leads to speculation that we can determine the pipeline customer base, the delivery quantities, connections, etc. However, reviewing the basic operating characteristics of the new, open industry immediately shows that the transportation of non-firm gas quantities is not as easily extracted from FERC reports by pipelines. Another problem becomes apparent when trying to learn who owns the physical pipeline system in some of the FT rate deliveries. Many of the pipeline reports are by limited liability corporations (LLCs.) The owners of LLCs are so difficult to determine from the paper trails as to be impossible. For all intents, the database appears to be viable and useful only from a national perspective for industry trend purposes.

The utilization of the pipeline capacity is a very closely held value by each pipeline. If the amount of product moved through any pipeline were made available, the market viability for that pipeline would be compromised and its competitors would undersell services in all the available base load markets, leaving only risky or unprofitable product transportation moves available for the exposed carrier.

Example

The characteristics of the pipeline industry vary from product to product. An accurate inventory for many product sectors interconnections is difficult to obtain because of the differing operating and regulatory characteristics in the industry. An example will illustrate the wide variety of pipeline interconnections with other transportation modes, and the resulting difficulties in ascertaining interconnection means and methods.

Ethane is an example of a commodity principally delivered through pipelines whose pipeline interconnections with other transportation modes exist due to the changing regulatory environment and operating methods. Ethane extracted from its principal source, wellhead natural gas, is a a simple asphyxiant and is used to manufacture ethylene oxide (EtO), a hazardous material and fumigant poison. Ethane and EtO are commonly used in the manufacture of ethylene and propylene products, such as polyethylene and polypropylene plastics, and ethylene and propylene glycol (antifreeze.) It is also used in the manufacture of surfactants (industrial wetting agents) and sterilization of medical devices (syringes and needles).

Ethane and EtO are commodities available for transport by pipeline, railroad tank car and highway transport. In the recent past, both commodities required exemptions from the U.S. Department of Transportation (USDOT) to be transported on the roadway except in specifically designed containers of limited size. Manufacturers using ethane and EtO as production feedstocks typically built their facility near a natural gas processing plant to take feedstock by a product pipeline to their manufacturing plant. Some ethane was delivered at remote long distance sites by specialty railroad tank cars, which keep the ethane extremely cold at –190 degrees Celcius. Several long distance gaseous ethane pipelines existed in the 1960 to 1990 time period, however, it is not clear if any of these long-distance pipelines are currently in continuing operation for delivery of gaseous ethane.

One pipeline operated from Bushton, Kansas, to a chemical plant near Morris, Illinois. Hydocarbon Transport, Inc., (HTI) was a pipeline built specifically to transport ethane removed from the natural gas stream at Internorth's (ENRON) Bushton, Kansas, helium extraction plant. The plant in Morris, Illinois, produced polypropylene plastic pellets for the medical packaging industry and both ethylene and propylene glycol for the automotive industry. During peak production and pipeline service periods the Morris plant brought a portion of its production feedstock (ethane) into the facility by tank car directly from petrochemical plants located on the Texas Gulf Coast. This material was purchased on the spot market during favorable price periods. If the material was not needed for immediate production it was vaporized and injected into underground storage caverns for later use. This operational freedom allowed this manufacturer to maintain secrecy regarding its feedstock requirements for production. However, because the facility had a complex production output, each product having different production stream efficiencies, even the pipeline supplier could not effectively predict the facilities feedstock needs.

The above discussion illustrates that pipeline users tend to maintain multiple modes of supply for their production facility. Additionally, little outside capability exists to determine how much raw material is received by the facility. Furthermore, there was no public source for how much material was received for actual production from any of the various supply sources.

REGULATORY OVERVIEW

Regulatory authority over pipelines is found at both federal and state levels. At the federal level, at least four regulatory bodies are empowered to promulgate pipeline regulations. The Federal Energy Regulatory Commission (FERC) within the Department of Energy (DOE) regulates the permitting of natural gas pipelines in interstate commerce. In this capacity, the FERC has certain Environmental Protection Agency (EPA) powers to include pipeline construction without additional environmental impact statements or studies required. A recent NPRM issued by FERC clarifies and limits this EPA permitting authority to specific classifications of expansion. The FERC regulates many other pipeline activities in interstate commerce; however, these activities have no appreciable impact to the transportation infrastructure regarding product mix.

Federal Regulatory Authority

FERC

The FERC has regulatory authority over rates charged by petroleum pipelines for interstate transportation of product. This regulatory authority is the result of federal legislation enacted in the early 1900s. The legislation required both rate and service regulation to insure the pipelines earned an adequate, i.e., "just and reasonable," rate of return on their capital investment and recovery of operating costs while providing nondiscriminatory access to shippers. FERC regulatory statutes are found in the Code of Federal Regulations (CFR) Title 18.

EPA

EPA has regulatory authority over all aspects of all pipelines, interstate and intrastate, with regard to environmental permitting for both installation of the physical asset and for the actual operation of the asset. This is in contrast to any other regulatory body we have discovered to date. Most regulatory authorities are strictly limited in their authority; however, EPA appears to be relatively broad scoped in its powers. EPA regulatory statutes are found in CFR Title 40.

OPS

The USDOT has regulatory authority over the safety characteristics of the physical asset of the pipeline. This authority is embodied in the Office of Pipeline Safety (OPS) and has variously been promoted within the OPS and has been relegated to the various state authorities to enforce at other times. OPS has not generally been responsible for promulgating regulation, rather it enforces regulation upon the pipeline industry. USDOT is generally viewed as the promulgator of these regulations, which are found in CFR Title 49, Part 195 inclusive.

OSHA

The Department of Labor (DL) empowers the Occupational Safety and Health Administration (OSHA) to promulgate regulation concerning safe design and design implementation of the physical asset regarding pipelines. Promulgation is generally carried out by OSHA through the adoption of recognized standards set forth by professional societies, such as ASME, ASTM, etc. This function has little to do with the transportation mix of pipelines or their location and operation. OSHA regulatory statutes are found in CFR Title 29, Subsection 1910 inclusive.

State Regulatory Authority

At the state level, Texas regulatory authority for pipelines rests primarily within the Railroad Commission of Texas. However, other authorities within Texas government are specifically empowered to carryout limited regulation of pipelines within their area of expertise, and there may be a general enabling of regulatory authority at TxDOT in their mandate to coordinate the overall transportation system within the state.

Railroad Commission

The Railroad Commission of Texas has primary regulatory authority over petroleum pipelines in Texas. The official rules of the Railroad Commission of Texas are found in the Texas Administrative Code (TAC), Title 16, Part 1. Specifically, Chapter 3 of the code covers the Oil and Gas Division and includes regulations on pipeline permitting, tariffs, connections, and compliance. Chapter 7 covers the Gas Utilities Division and includes regulations for gas distribution including such items as safety, transportation, rates charged for gas in Texas, accounting and recordkeeping, and leaks.

Title 3 of the Texas Utilities Code regulates gas utilities in Subtitle A and gas transportation and use in Subtitle B. Chapter 121 of Subtitle B specifically covers pipelines and designates pipeline authority to the Railroad Commission.

TNRCC and Other Agencies

The Texas Natural Resource Conservation Commission (TNRCC) regulates emissions to the air, water, and ground. TNRCC regulations are contained in Title 30 of the TAC. Other Texas agencies may be designated pipeline authority by various statutes and regulations. For example, the Texas Health and Safety Code Chapter 753 – Flammable Liquids requires that pipelines connecting service stations with bulk plants have safety valves. TNRCC is responsible for inspection and the State Fire Marshal is responsible for enforcement.

PRELIMINARY EXAMINATION OF POTENTIAL FOR INTEGRATION

This section reviews the impact of alternative commodity transportation to the regulatory agencies and its affect on issues it would create for the operator. The very nature of the pipeline business dictates special applicability and consideration of construction and operational safety. The operating business characteristics for different pipeline segments are examined for the potential to transport commodities other than those for which the pipeline was developed.

Crude Lines

Crude oil varies widely in its general constituents and makeup, having either a napthalenic (solvent) base or a paraffinic (wax) base. Many crude constituents are serious contaminants for fuels. For example, vanadium is a heavy metal found in many crude oils that is highly reactive with carbide, stainless, and other exotic steels when subjected to combustion temperatures in jet and diesel engines. This reactivity causes premature material corrosion. Yet, vanadium is easily leached by refined products from crude remaining in the pipeline. Sulfur is another element contained in crude oil that is easily leached by refined products from crude residues in pipelines. Crude oil gathering and transportation lines contain a large amount of product in inventory.

Crude oil lines, including gathering and transmission lines, are restricted to the transportation of crude oil, crude oil mixes, and unrefined products (5). Crude transportation pipelines are served by gathering systems and port and harbor systems for loading and unloading marine vessels.

Natural Gas Lines

Natural gas pipelines are the most abundant pipelines in Texas, even excluding the distribution lines delivering natural gas to the various end users in towns and cities. There are twice as many miles of natural gas pipelines (including gathering lines) than all the crude oil and refined products pipelines combined.

Gathering Lines

Gathering lines are usually small lines compared to gas transmission lines. They are usually of a lesser quality construction than transmission lines. The gathering lines in Texas are approximately on a one-to-one ratio with the transmission lines, including the interstate transmission lines carrying gas outside the state. By comparison, the typical expectation for the crude gathering line to transmission ratio is slightly more than two-to-one transmission miles to gathering mile. The natural gas gathering system grows because the current gas wells become depleted and new wells are drilled farther away in the field. The gathering lines must be extended to continue the supply network to the gas conditioning plant.

The gathering lines and the gas conditioning plant are generally owned and operated by the area gas well producers. The current situation appears to be in a state of flux with the pipeline companies entering into process plant ownership. The price of wellhead gas is no longer (at least from an effective standpoint) regulated. An illustration of a natural gas gathering and transmission system is shown in Figure 1.

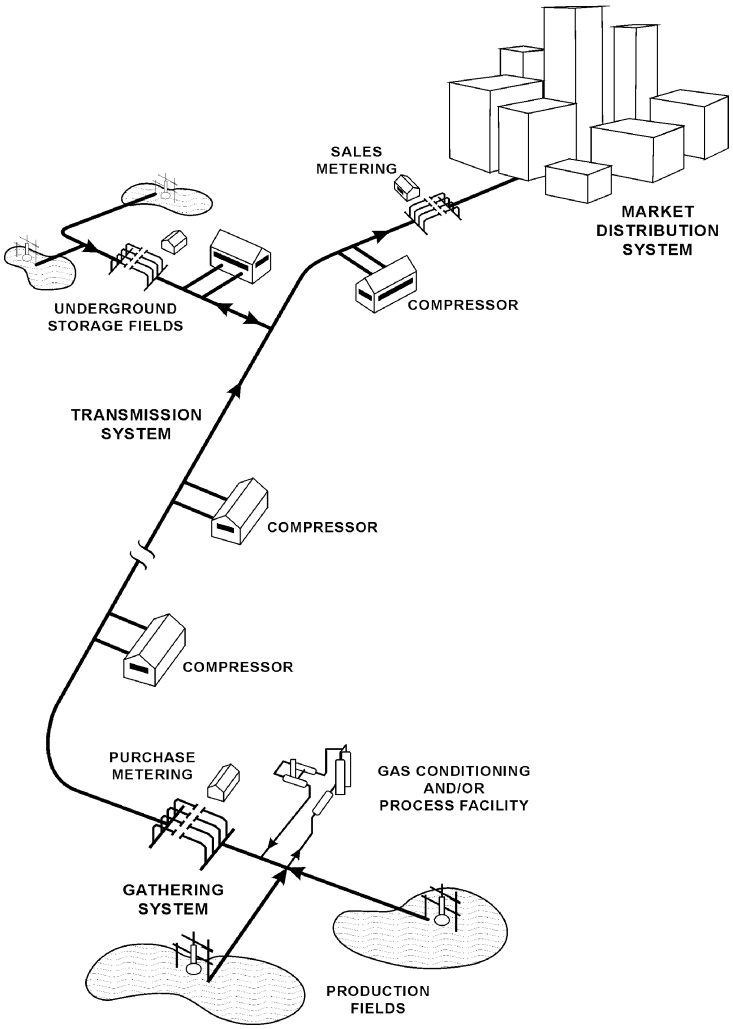

Figure 1: Natural Gas Gathering and Transmission System (*5*).

Transmission Lines

Natural gas transmission pipelines are now required to provide open access transportation for the public. The product mix is governed by FERC regulation requiring a certain quality for minimum heating value, allowable water content, and restriction of the allowable oxide of sulphur in the natural gas in the pipeline. There does not appear to be any upper limit restricting the heating value. Likewise, there is no lower limit on water or sulphur. The operational requirement that the gas continue to flow at nearly constant pressure along the entire pipeline in order to maintain customers' burner tip pressure implies there is no alternative product in these pipelines.

With the change in regulatory status from pipeline ownership of gas and service under a highly scrutinized rate structure to the pipeline companies providing only open-access rate-regulated transportation, the pipelines appear to be set to enter into all areas of the energy business to recoup their previous energy business profits. Pipeline companies are no longer obligated to provide gas to public sector entities, i.e., gas utility companies, along their pipeline system. This leads to the conclusion that a pipeline company can not be held liable for the incremental cost of gas service for gas in transmission from the wellhead to the user's burner tip. This further leads to the conclusion that the pipeline company can compete for profits in the gathering and gas processing sectors of the industry as they did prior to the mid 1960s.

Product Lines

Product lines are currently configured to handle a wide variety of petroleum products in slugs or batch transmission. There are no allowances for product lines to readily flow in the opposite direction from which they are designed to flow. The problem of changing direction is an engineering problem for reversing the compressor systems inlets and outlets in pipes of incompatible size, etc. This does not present an economic opportunity for pipeline operation.

CHAPTER 2 – LITERATURE REVIEW AND RESOURCE IDENTIFICATION

INTRODUCTION

In this chapter research team examines all pertinent material available on the pipeline system in Texas and identifies those agencies, organizations, or firms having a role in the pipeline transportation or in the collection and cataloging of system data. The researchers also investigate the use of pipelines for movement of other compatible commodities and document the physical, business, or policy issues involved. The researchers will make contact with resource experts and provisions will be put in place to gather appropriate data.

This report addresses the progress and the continuing work on the following deliverables:

- the basic design of a typical pipeline;
- a list of commodities that may be transferred from the surface transportation network to pipelines;
- a summary of the physical, business and policy issues involved in transferring commodities from surface modes to the pipeline mode;
- a list of all agencies, organizations, and commercial firms having a role in pipeline transportation in Texas; and
- a list of all entities having a role in the collection and cataloging of data on pipelines in Texas.

THE BASIC DESIGN OF A TYPICAL PIPELINE

Pipeline design is a complex topic that requires the extensive background and knowledge of a pipeline design engineer. The following discussion is not a comprehensive description of pipeline design. Rather, it is a description of the fundamental concepts in the design of a typical pipeline, which will help the non-pipeline design engineer become familiar with the basic design of a typical pipeline.

The design of a pipeline depends on many different variables, such as the commodity to be transported, the volume to be transported, the origin point (inlet), the destination point (outlet), the acceleration forces necessary, the availability of materials, external loads, environmental factors, pipe safety factors, system safety factors, the designer, and cost *(6, 7, 8, 9)*. According to Kennedy (1993), the volume of the fluid to be transported is one of the most important design criteria. It is a difficult task to estimate the volume of liquid to pass through a pipeline, and it is even more difficult to predict the increase or decrease in the future capacity requirements for a pipeline. Most pipelines are, therefore, designed to exceed the capacity originally required or are designed with the ability to increase capacity using additional compression or pumping horsepower *(6)*.

Most pipelines are complicated systems. A pipelines is normally made up of a network of branch lines feeding into a main line, with alternative routes, and their volumes usually

changing throughout its lifetime (*6*). The complexity of pipeline systems requires a series of calculations for their design. Computer programs based on flow equations are used in designing most pipeline systems (*10*).

Many standards and regulations guide pipeline design. The American National Standards Institute (ANSI) and the American Society of Mechanical Engineers (ASME) provide standards for pipeline design (*11*). Liquid petroleum pipelines are covered by ANSI/ASME B31.4 "Liquid Petroleum Transportation Pipeline Systems," and gas pipelines are covered by ANSI/ASME B31.8 "Gas Transmission and Distribution System" (*10*).

General Steps for Typical Pipeline Design

Figure 2 is an example of an offshore gas pipeline system. General steps that are followed in pipeline design once the origin, destination, and projected volume of the pipeline are known are presented below. These steps are given by Kennedy's *Oil and Gas Pipeline Fundamentals* (*6*). The steps are intended for the most basic pipeline, that is, assuming that there are no branch connections, no alternative routes, and no major changes throughout the life of the pipeline.

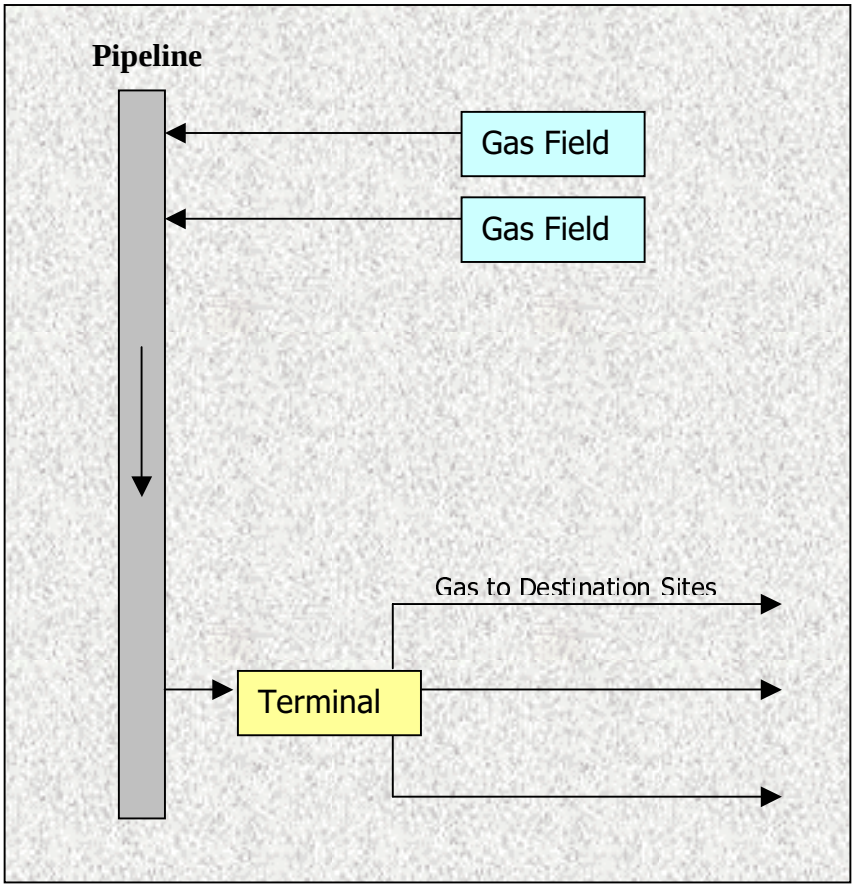

Figure 2: Example of a Gas Pipeline System.

1. A required delivery pressure is determined at the pipeline's destination. This pressure may be set by the customer's facilities or, if the line is a branch line, by the pressure required at the junction with the main line to permit fluid to flow into the main line.
2. Pressure losses due to friction and the pressure required to overcome changes in elevation are added to the delivery pressure to determine the inlet pressure. In single-phase flow, the pressure drop in the line that must be overcome by pumps or compressors is essentially the friction loss plus the pressure exerted by a liquid or gas column whose height equals the difference in elevation between the ends of the line. The pressure drop in any segment of the line is calculated in a similar manner. A trial-and-error procedure may be involved because it is necessary to choose a tentative pipe size in order to calculate pressure losses. If pressure loss is too high, the resulting inlet pressure may exceed the pressure rating of the pipe, or an excessive amount of pumping or compression horsepower may be required. If this is the case, a larger pipe is selected and the calculations are repeated. The goal is to select a pipe size that can be operated efficiently at a pressure permitted by applicable regulations.
3. With the line size and operating pressure determined, the pumping or compression horsepower needed to deliver the desired volume of fluid at the specified delivery pressure can be accurately calculated. If more than one pump or compressor station is required, the location and size of additional stations is set by calculating pressure loss along the line and determining how much pump or compressor horsepower is needed to maintain operating pressure.
4. In most cases, it is necessary to perform economic calculations to compare the design with other combinations of line size, operating pressure, and horsepower in order to choose the best system.

The basic design of any pipeline must integrate all the factors and properties pertinent to its anticipated use. Though the basic pipeline design is governed predominantly by the physical parameters and volume of fluids moved, the distance to be moved, forces necessary for movement, and integrity during transportation, the interdependence of all the basic factors mentioned enables the optimal determination of pipeline design. Integrating these factors results in the most appropriate selection of steel grades and dimensions for line-pipe, pumps and pumping pressures, numbers of boosting stations and pressure reducing stations, flange and valve ratings, locations for valves, launching and retrieval hatches, filters, meters, flow controllers and other associated facilities (9).

Basic Terms To Calculate Pressure Drop and Flow Capacity

There are many other variables along with key properties of fluids (liquids and gases), to consider when designing pipelines. Most of these variables and properties with most of their effects or use in pipeline design are given in Table 1.

Table 1: Variables and Other Definitions Used in Pipeline Design.

VARIABLES/PROPERTIES	EFFECT OR USE IN PIPELINE DESIGN
Pipeline Diameter	Given that all other variables are fixed, a larger diameter allows a higher volume of fluid to flow through it and a lower operating pressure (*9*).
Pipeline Length	The longer the length of pipeline the more the total pressure will drop (*6*).
Density and Specific Gravity	Density is weight per unit volume. Specific gravity for a gas is its density divided by the density of air. Specific gravity for a liquid is its density divided by the density of water. Both density and specific gravity are used in various calculations for pipeline design (*7*). The higher the density, the more power required for pumping.
Compressibility	In designing gas pipelines, a supercompressibility factor must be included in calculations when conditions are not standard, usually at high pressures and temperatures (*6*).
Temperature	Given that all other variables are fixed, a lower temperature in gas pipelines allows for a greater capacity (*6*). Temperature also affects variables used to calculate capacity for both liquid and gas pipelines. Temperature also induces longitudinal stresses in the wall of the pipeline (*7*).
Viscosity	Viscosity is the property in a fluid that resists flow between adjacent parts (*6*). It is used to calculate the size of the pipeline and the pump horsepower requirements.
Vapor Pressure	Vapor pressure is the pressure at which vapor and liquid are at equilibrium, at a given temperature (*12*). When moving volatile petroleum through a pipeline the minimum vapor pressure must maintain the gas in its liquid state. Vapor pressure is called Reid vapor pressure (RVP) for petroleum products under certain test conditions and procedures (*6*).
Barometric Pressure	Barometric pressure is the atmospheric pressure above a perfect vacuum. It is a point of reference for measuring pressure.
Absolute Pressure	Absolute pressure is the pressure of a pipeline or a vessel above a perfect vacuum.
Gauge Pressure	Gauge pressure is the measured pressure above atmospheric pressure in a pipeline or a vessel (*6*).
Standard Atmospheric Pressure	Standard atmospheric pressure is 760 mm of mercury. Atmospheric pressure varies with elevation.
Pour Point	The pour point is the lowest temperature at which oil or other liquid will flow under given conditions (*12*). Problems occur in pipeline at temperatures below the pour point.
Reynolds Number	Reynolds number describes the flow of a fluid. Most agree that a Reynolds number less than 1,000 identifies a streamlined flow; 1,000 – 2,000 identifies unstable flow; and greater than 2,000 identifies turbulent flow (*6*). The type of fluid flow in a pipeline is important because it affects the pressure drop.
Friction Factors	Friction factors relate to the roughness of the inside wall of the pipeline. These factors are used in pipeline design equations (*7*).

Flow of Fluids

An accurate description of the flow of fluid is necessary in pipeline design because the pumps and compressors must be able to overcome the losses from friction (*6*). Fluid flow is described by formulas derived from Bernoulli's theorem. Bernoulli's theorem is based on the

law of conservation of energy. This law states that the work done on a fluid (liquid or gas), the pressure times the volume, is equal to the change in kinetic energy of the fluid (*13*). In order to accurately describe the flow of fluids through a pipeline, coefficients are used to modify the equation to include losses from friction (*6*).

COMMODITIES THAT MAY BE TRANSFERRED FROM SURFACE TRANSPORTATION TO PIPELINES

Texas pipelines are currently utilized for transporting various commodities such as oil, petroleum, gas and slurry. In order to optimize the use of this transportation system it is necessary to further research the movement of commodities through pipeline in comparison to other modes of transportation. The goal is to identify possible pipeline commodities that are currently moved by surface transportation modes.

Current investigation has led to the 1997 Commodity Flow Survey (CFS) for the state of Texas. This document was produced through a collaboration of the U.S. Bureau of Census, U.S. Department of Commerce, Bureau of Transportation Statistics, and U.S. Department of Transportation. The CFS provides the following data on the movement of goods from the mining, manufacturing, wholesale trade, and selected retail industries in the United States:

- commodities shipped,
- value of commodities shipped,
- weight shipped,
- mode of transportation,
- origin of shipment, and
- destination of shipment.

Terms and Definitions

Before discussing the findings in the 1997 CFS, the terms used in this document are explained or defined in Table 2.

Table 2: Definitions of Terms Used in Figures 3 through 8.

TERM	EXPLANATION OR DEFINITION
Commodity	A product that is produced, sold, or distributed. These products were classified using the Standard Classification of Transported Goods (SCTG) coding system.
Railroad	Any common carrier or private railroad.
Pipeline	Movements of commodities through pipelines, not including the movement of water.
Truck	Usage of for-hire truck, private truck, or a combination of for-hire truck and private truck.
Air	Usage of commercial or private aircraft, including air freight and air express, with shipments weighing over 100 pounds. Includes shipments that use air or a combination of truck and air.
Water	The independent usage of draft vessels, deep draft vessels, or Great Lakes vessel, not any combination of these modes.
Other and Unknown Modes	Modes reported as "Other" or "Unknown," or were not reported.
Tons	The total weight in the entire shipment.

TOTAL COMMODITY TONNAGE BY MODE OF TRANSPORTATION IN TEXAS

The tonnage in the following graphs (Figures 3 through 8) will be used to describe the distribution of commodities by mode of transportation. It is important to note that the 1997 CFS does not include data from the oil and gas extraction industry because of unresolved industry-wide reporting issues. Figures 3 and 4 compare the use of pipeline with other modes of transportation. These figures clearly suggest that pipelines play a significant role in the transportation of commodities in the state of Texas. With its movement of 22.6 thousand tons, making up 23 percent of total tonnage, pipeline is the second to truck in tons of commodities moved. Truck moved 465,355 thousand tons, making up 50 percent of total tonnage moved, suggesting the possibility for pipelines to relieve trucks, which may be overloaded causing congestion and safety hazards on highways.

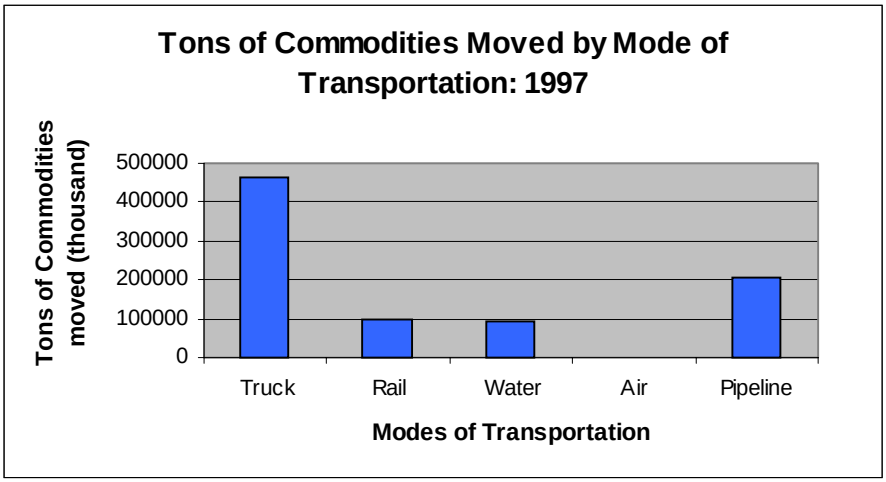

Figure 3: Total Commodity Tonnage by Mode of Transportation for the State of Texas.
Data extracted from the Commodity Flow Survey, U.S. Department of Transportation and U.S. Department of Commerce, 1997.

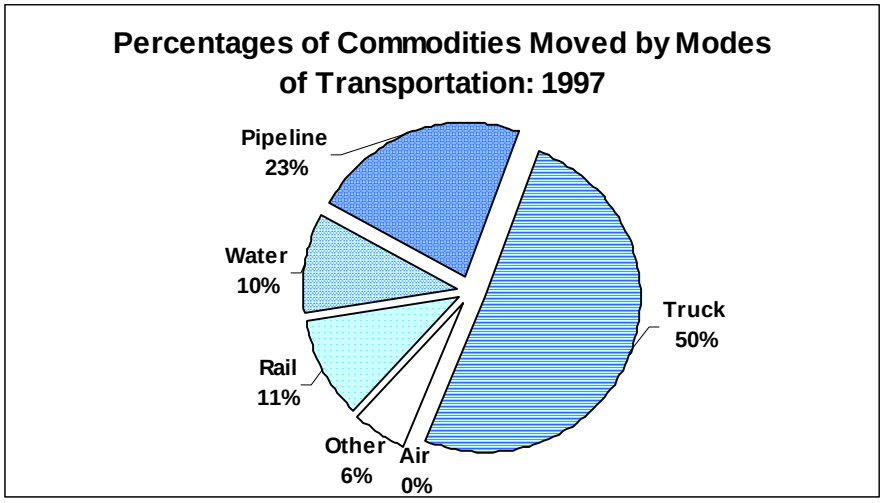

Figure 4: Distribution of Total Commodity by Mode of Transportation in Texas.
Data extracted from the Commodity Flow Survey, U.S. Department of Transportation and U.S. Department of Commerce, 1997.

Commodity Tonnage and Mode Of Transportation

The commodities of focus are the classifications of liquid products that are compatible with the pipeline system. These classifications include:

- gasoline and aviation turbine fuel,
- fuel oils,
- coal and petroleum products, NEC,
- basic chemicals, and
- fertilizers.

Comparisons are made between the tonnage of these commodities moved by pipeline and other modes. Figures 5 and 6 show that pipeline, by far, is the main mode for transporting gasoline and aviation turbine fuel, where pipeline make of approximately 70 percent of the tonnage, as well as for Fuel Oils, where it makes up 65 percent of the tonnage. Thus, pipeline usage for these two commodities is somewhat sufficiently utilized. The need to investigate the increase of pipeline transportation for these products is not a priority at this time.

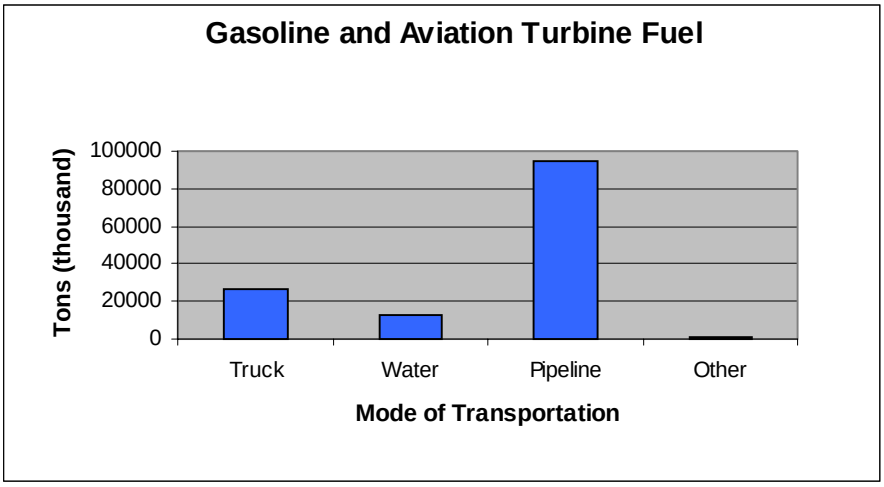

Figure 5: Tonnage of Gasoline and Aviation Turbine Fuel by Mode of Transportation.
Data extracted from the Commodity Flow Survey, U.S. Department of Transportation and U.S. Department of Commerce, 1997.

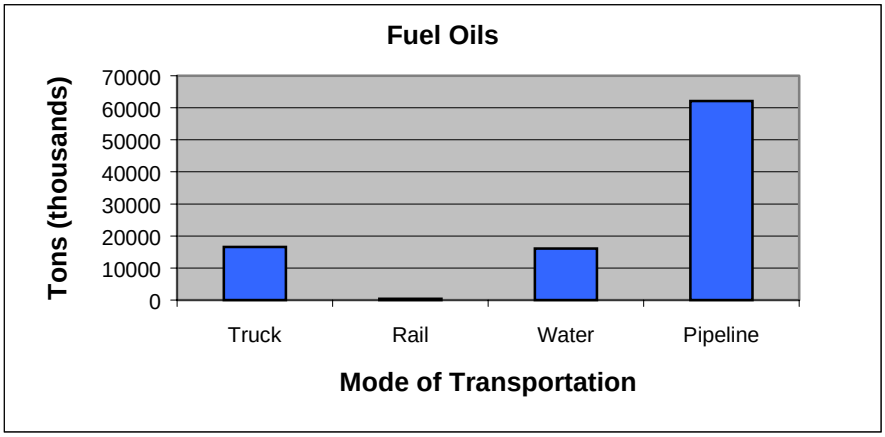

Figure 6: Tonnage of Fuel Oil Broken by Mode of Transportation.
Data extracted from the Commodity Flow Survey, U.S. Department of Transportation and U.S. Department of Commerce, 1997.

However, the tonnage distribution by mode for coal and petroleum product, and basic chemicals seems to invite more of an interest to investigate the possibility to increase their transportation by pipeline. A wider distribution in transportation modes for these two commodities can be seen in Figures 7 and 8. Pipeline only makes up for 20 percent of the tonnage for coal and petroleum produces and less than 20 percent for the tonnage of basic chemicals. The small usage of pipeline for these commodities could be due to the incompatibility of their physical properties with the pipeline. If the physical properties are compatible, Figures 7 and 8 suggest that commodities classified under coal and petroleum product, and basic chemicals currently transported by other modes could be transferred to pipeline. Further detailed investigations on these commodities, as well as on the current capacity utilization of pipeline, is necessary to determine whether more of these commodities can be transferred to a pipeline mode.

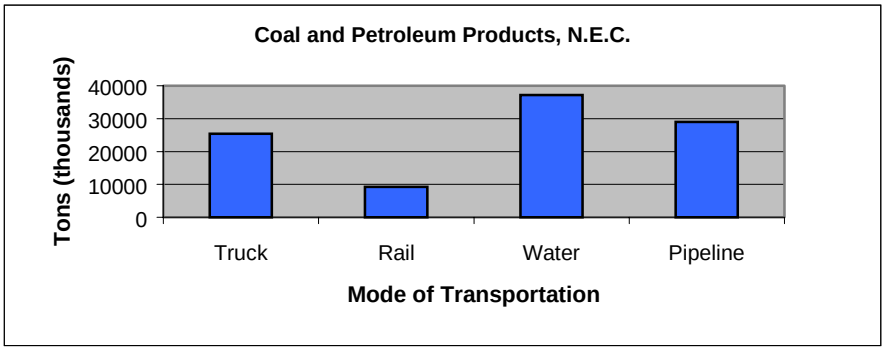

Figure 7: Tonnage of Coal and Petroleum Products Not Elsewhere Classified (NEC) by Mode of Transportation.
Data extracted from the Commodity Flow Survey, U.S. Department of Transportation and U.S. Department of Commerce, 1997.

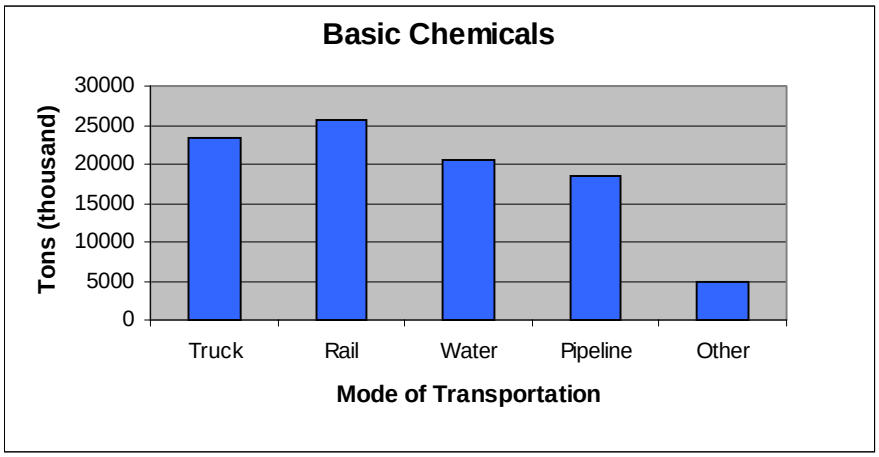

Figure 8: Tonnage of Basic Chemicals by Mode of Transportation.
Data extracted from Commodity Flow Survey, U.S. Department of Transportation and U.S. Department of Commerce, 1997.

SUMMARY OF THE PHYSICAL, BUSINESS AND POLICY ISSUES INVOLVED IN TRANSFERRING COMMODITIES FROM SURFACE MODES OF TRANSPORTATION TO PIPELINE

Investigation for information regarding the physical, business and policy issues involved in transferring commodities from surface modes to pipeline has led to the Federal Highway Administration's report titled *U.S. Intermodal Freight Transportation; Opportunities and Obstacles* (*14*). The report addresses many issues and challenges that are involved in transferring commodities from one form of transportation to another. The following summarizes the key issues from this report that apply to the transfer of commodities to a pipeline mode of transportation.

Competition and Impediments of Using Pipeline to Domestic Intermodal Freight Transportation

When considering the use of pipeline to domestic intermodal freight transportation, pipelines:

- require multiple handling of commodities before reaching the customer, which can lead to less monitoring of goods and damage;
- requires longer time for short-hands;
- have less flexible scheduling of shipments;
- have higher costs of use;
- lack an adequate infrastructure, such as well-located intermodal terminals;
- have congestion of desire routes;
- have operational inefficiencies caused by need for better located routes and better management of intermodal operations;
- have regulation delays and/or the higher costs of developing new facilities; and

- lack institutional relationships between the private and public sectors.

Objectives of Commodity Transportation

The objectives of commodity transportation are:

- reliable service;
- accurate and paperless, worldwide, and immediate documentation;
- maximum flexibility/recovery to delays, load variations, etc.;
- minimum overall costs to users and carriers;
- continuous and seamless intermodal transportation; and
- security (protection from electronic or physical disruption).

Proposed Research Framework

The proposed research framework includes:

- applied information technology;
- systems engineering/systems assessments;
- policy analysis;
- infrastructure enhancements; and
- technology transfer (information dissemination).

Proposed Governmental Role in Research

The proposed governmental role in research would:

- bring the stakeholders together,
- identify and eliminate institutional barriers to innovation,
- exert leverage over technological issues (such as systems architectures and interoperability standards,
- assure the developments of tools (such as simulations databases and special-purpose communication link),
- allow optimization among various modes of commodity transportation,
- efficiently affect the commodity transportation modes interfaces,
- foster consensus among many stakeholders as priority objectives,
- develop decision aids and evaluation tools to assist the intermodal freight transportation process, and
- insure that measurable progress is achieved.

AGENCIES, ORGANIZATIONS, AND COMMERCIAL FIRMS HAVING A ROLE IN PIPELINE TRANSPORTATION IN TEXAS

Pipeline systems require and involve the support of many different agencies, organizations, and commercial firms in their existence and for their optimal performance. Many entities play a role in the function and support of Texas pipeline transportation. Some of these roles include lawmaker, regulator, researcher, educator, and advisor.

The research team herein endeavors to provide a comprehensive list of federal, state, and private agencies, organizations, and commercial firms along with their responsibilities and function in the Texas pipeline transportation system. Tables 3 and 4 categorize these entities by national (Table 3) and state (Table 4) affiliation. A total of 37 entities are listed along with their general function in Texas pipeline transportation, contact information (address, phone number, and fax), and website address. The information (name, function, contact information, and website address) contained in Tables 3 and 4 was extracted from the websites of the respective organizations.

ENTITIES HAVING A ROLE IN THE COLLECTION AND CATALOGING OF TEXAS PIPELINE DATA

Many federal, state, and private organizations, agencies, and commercial firms are involved in the collection and cataloging of data from Texas pipelines. Seventeen entities are listed in Table 5, along with the Texas pipeline data that they collect and catalog. The Railroad Commission of Texas is the only one of the 17 entities discovered that is a Texas institution. The information contained in Table 5 was obtained from the respective website of the organization, which is also listed in the table. This research is not comprehensive and requires additional effort to complete.

Table 3: National Pipeline Organizations and Agencies.

ORGANIZATION NAME	FUNCTION	CONTACT INFORMATION
U.S. DEPT. OF TRANSPORTATION (US DOT)	• Ensures a fast, safe, and efficient pipeline transportation system, and • houses the Research and Special Programs Administration, which contains the Office of Pipeline Safety.	400 7th Street, SW Washington, DC 20590 www.dot.gov
SECRETARY OF TRANSPORTATION	• Advises the U.S. President in all matters relating to federal transportation programs, and • oversees the formulation of national transportation policy and promotes intermodal transportation.	400 7th Street, SW Washington, DC 20590 Tel: 202-366-4000 http://www.dot.gov/ost
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION (RSPA)	• Oversees rules governing the safer transportation and packaging of hazardous materials by all modes of transportation; • provides services to the transportation system in the U.S. concerning safety, intermodalism, cost-effective regulation, compliance, training and research; • assists local and state authorities with training for hazardous materials emergencies; • establishes and maintains pipeline safety standards; • directs the Office of Pipeline Safety; and • requires the filing tariffs of rates and charges.	400 7th Street, NW Washington, D.C. 20001-4580 Tel: 202-366-4580 www.rspa.dot.gov/
U.S. DEPT. OF TRANSPORTATION, OFFICE OF PIPELINE SAFETY (OPS)	• Administrates national pipeline safety regulatory program; • regulates interstate hazardous liquid and carbon dioxide pipeline systems; • evaluates performance of state agencies; • develops regulations; • develops approaches to risk management to assure safety in design, construction, testing, operation, maintenance, and emergency response of pipeline facilities; • sets parameters for administering pipeline safety program; and • sets requirements for onshore oil pipeline response plans.	Tel: 713-718-3746 http://ops.dot.gov/
U.S. GENERAL ACCOUNTING OFFICE (GAO)	• Improves the performance and accountability of the federal government; • examines use of public funds, evaluates federal programs and activities, and provides analyses, options, and recommendations, and other assistance to help Congress make effective oversight, policy, and funding decisions; and • oversees the FERC performance in pipeline regulations.	1441 G Street, NW Washington, DC 20548 http://www.gao.gov/
BUREAU OF TRANSPORTATION STATISTICS (BTS)	• Compiles, analyzes and publishes statistics relevant the U.S. transportation system, and • collects information on transportation.	400 7th Street, SW RM 3430 Washington, DC 20590 Tel: 202-366-3640 http://www.bts.gov

ORGANIZATION NAME	FUNCTION	CONTACT INFORMATION
SURFACE TRANSPORTAION BOARD (STB)	• Regulates the economics of interstate surface transportation; • ensures competitive, efficient, and safe transportation services to meet needs of shippers, receivers, and consumers; • promotes regulatory reform in economic regulation of surface transportation; and • provides a forum for resolution of disputes.	1925 K Street, NW Washington, DC 20423-001 Tel: 202-565-1674 http://www.stb.dot.gov
NATIONAL TRANSPORTATION SAFETY BOARD (NTSB)	• Investigates significant accidents in modes of transportation, including aviation, railroad, highway, marine, and pipeline.	490 L'Enfant Plaza, SW Washington, DC 20594 Tel: 202-314-6000 www.ntsb.gov
OFFICE OF HAZARDOUS MATERIAL SAFETY (HAZMAT SAFETY)	• Sets standards regarding the safe transportation of hazardous materials; • recommends regulatory changes governing the multimodal transportation of hazardous materials; • coordinates proposed regulations to appropriate DOT Operating Administration before issuance; • conducts public hearings in conjunction with regulatory changes; • issues exemptions; • makes final determinations regarding registration approvals and reconsideration petitions; • develops regulatory policy options and initiatives based on social, economic, technological, environmental, and safety impacts of regulatory, legislative, or program activities involving hazardous materials transportation; and • participates in policy determinations and approvals.	400 7th Street, SW Washington, DC 20590 http://hazmat.dot.gov/
AMERICAN PETROLEUM INSTITUTE (API)	• Develops industry policies that encourage the safe, economic, and environmentally sound transportation of liquid petroleum and its products by pipeline; • advances those policies with governmental bodies and private organizations; • provides a forum for and encourages the development of standards and practices that are necessary to ensure sound pipeline transportation systems; and • maintains liaison with such other industry associations and committees as may be required to carry out its tasks.	1220 L Street N.W. Washington, DC 2005-4070 Tel: 202-682-8000 www.api.org/
INTERNATIONAL TRANSPORTATION SAFETY ASSOCIATION	• Unites independent transportation accident investigation boards.	www.itsasafety.org/ITSA/

ORGANIZATION NAME	FUNCTION	CONTACT INFORMATION
INTERSTATE NATURAL GAS ASSOCIATION OF AMERICA (INGAA)	• Represents interstate and interprovincial natural gas pipeline companies; • stands as a regulatory, legislative and business advocate on issues concerning the natural gas pipeline companies; and • provides information on the natural gas industry.	555 13th Street, N.W. Washington, D.C. 20004 Tel: 202-626-3200 http://www.ingaa.org/main.html
GAS TECHNOLOGY INSTITUTE (Formerly, Gas Research Institute)	• Manages research, development, and commercialization for the natural gas industry, and • operates the GTI Website Help Desk Phone: 773-399-8309	1700 South Mount Prospect Road DesPlaines, IL 60018-1804 Ph: 773-399-8100 Fax: 773-399-8170 http://www.gri.org/
NATIONAL RESEARCH COUNCIL (NRC)	• Provides knowledge and advising to the government, the public, and the scientific and engineering communities.	The National Academies 2101 Constitution Ave., NW Washington, DC 20418 Tel: 202-334-2000 http://www.nas.edu/nrc/
U.S. DEPT. OF ENERGY (DOE)	• Works to assure clean, affordable, and dependable supplies of energy for our nation; • supports strengthening domestic production of oil and gas and increasing energy efficiency; and • conducts research in energy sciences and technology.	Tel: 202-586-5575 http://www.doe.gov/
DEPT. OF ENERGY, FEDERAL ENERGY REGULATORY COMMISSION (FERC)	• Regulates the transmission and sale for resale of natural gas in interstate commerce; • regulates the transmission of oil by pipeline interstate commerce; • oversees related environmental matters; and • administers accounting and financial reporting regulations and conducts of jurisdictional companies.	888 First Street, N.E. Washington, D.C. 20426 Tel: 202-208-0200 http://www.ferc.fed.us/
MARITIME ADMINISTRATION (MARAD)	• Ensures efficient ports and effective intermodal water and land transportation systems.	http://www.marad.dot.gov
AMERICAN GAS ASSOCIATION (AGA)	• Focuses on the advocacy of issues that are priorities for the natural gas utility membership (including natural gas pipeline companies); • encourages members to share information for improvement in efficiency, reliability, safety, and environmental performance; • assists members in managing industry needs; and • collects and analyzes data and disseminates information to policy makers and to the public about natural gas industry.	400 N. Capitol Street, NW Washington, DC 20001 Tel: 202-824-7000 Fax: 202-824-7115 http://www.aga.org/

ORGANIZATION NAME	FUNCTION	CONTACT INFORMATION
AMERICAN PUBLIC GAS ASSOCIATION (APGA)	• Encourages the exchange of information about the natural gas market among pipelines, public gas systems, suppliers, joint purchasing groups, and other local distribution systems; • reviews gas pipeline issues as well as all other public gas issues; • recommends pipeline policy positions; • suggests way to ensure adequate and secure natural gas supplies at reasonable prices; • cooperates research with GRI; • monitors all government and industry developments; and • speaks for interest of public gas systems to Congress, FERC, and other federal state regulatory and legislative bodies.	11049-D Lee Highway, Suite 102 Fairfax, Virginia 22030-5014 Tel: 703-352-3890 http://www.apga.org/index.mv
SOUTHERN GAS ASSOCIATION (SGA)	• Collects, analyzes and distributes information that is essential to making informed business decisions in gas pipeline industry, as well as the gas industry as a whole; • provides training that is essential for all levels in the gas industry; • helps companies address legislative and regulatory issues concerning gas pipeline; • promotes the increased use of natural gas; and • cooperates and affiliates with other similar organizations, such as, the American Gas Association, New England Gas Association, and the American Public Gas Association.	3030 LBJ Freeway, Suite 1300 Dallas, TX 75234 Tel: 972-620-8505 Fax: 972-620-8518 http://www.southerngas.org/
TRANSPORTATION SAFETY INSTIUTE (TSI), PIPELINE SAFETY DIVISION	• Provides a pipeline safety training program supported by OPS, that gives pipeline safety personnel a broad understanding of the federal minimum safety requirements, and • provides information on pipeline safety regulations	Tel: 405-954-1138 http://www.tsi.dot.gov/dti60/
U.S. COAST GUARD (USCG)	• Ensures safe transportation on America's waterways and protection of the marine environment; • promotes marine safety in through regulation, inspection, and education; • prevents spills and clears waterways; • promotes marine safety through regulation, inspection, and education; • responds to environmental pollution reports in U.S. and surrounding waters; and • patrols shores, saves lives, protects property, and enhances flow of commerce.	2100 Second Street, SW Washington, DC 20593 Tel: 202-267-2229 http://www.uscg.mil/
ENERGY INFORMATION ADMINISTRATION, U.S. NATURAL GAS PIPELINES	• Provides information on natural gas pipelines, such as deliverability, pipeline change and growth, changes in pipeline transportation market, and natural gas flow and rates.	http://www.eia.doe.gov/oil_gas/natural_gas/info_glance/pipelines.html

ORGANIZATION NAME	FUNCTION	CONTACT INFORMATION
NATIONAL RESPONSE TEAM (NRT)	• Promotes enhanced preparedness capabilities at the national, regional, state, and local levels for oil and hazardous material spills; • provides a forum for to assess the effectiveness of oil spills and hazardous substance incident reporting and response mechanisms; and • provides a forum to delegate responsibilities in research and development.	401 M Street, SW Washington, DC 20460 Fax: 202-260-0154 http://www.nrt.org/
GAS TECHNOLOGY INSTITUTE (GRI)	• Provides information on current technology used in pipeline systems.	4800 Research Forest Drive Woodlands, TX 77381-4142 Tel: 281-363-7991 Fax: 281-363-7990 http://www.gri.org/
NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)	• Protects environment, promotes public safety, and reduces economic impact of corrosion through corrosion engineering and science, and • develops pipeline standards on corrosion and cathodic protection.	1440 South Creek Drive Houston, TX 77084 Tel: 281-228-6200 http://www.nace.org/nacehome.html
AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)	• Provide standards and recommended operations guidelines based on research for pipeline design, construction, operation, maintenance, and management.	Three Park Avenue New York, NY 10016-5990 Tel: 800-the-asme http://www.asme.org/
BAKER HUGHES, BAKER PETROLITE	• Provide the latest chemical technologies for increasing pipeline throughput eliminating internal deposits that restrict flow and mitigate internal corrosion.	12645 West Airport Blvd. Sugar Land, TX 77478 Tel: 281-276-5400 Fax: 281-275-7395 http://www.bakerhughes.com/bakerpetrolite/gassfluids/index.htm

Table 4: State Pipeline Organizations and Agencies in Texas.

ORGANIZATION NAME	FUNCTION	CONTACT INFORATION
TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT)	• Provides a safe, effective and efficient movement of goods; • supports research necessary to provide safe, cost-effective, and environmentally sensitive transportation systems; and • has authority to grant easements along state roads and highways.	Mapping and Right of Ways: Randy Anderson Tel: 512-416-2953 www.dot.state.tx.us
TEXAS RAILROAD COMMISSION (RRC)	• Regulates Texas oil and gas industry, which includes gas utilities, pipeline and rail safety, safety in the liquefied petroleum gas industry, and the surface mining of coal and uranium; • provides information about Texas alternative fuels, LP gas, natural gas, crude oil, surface mining and reclamation; and • responsible for pipeline operations and economic issues for over 150,000 miles of intrastate pipelines that transport natural gas, crude oil, and refined products across the state.	P.O. Box 12967 Austin, TX 78711-2967 Tel: 512-463-7288 http://www.rrc.state.tx.us/
TEXAS GENERAL LAND OFFICE (GLO)	• Has Jurisdiction with natural gas pipeline easements on State lands and in oil spills of 220 barrels or more in counties bordering the Gulf of Mexico, and • requires an oil response plan must be filed with GLO before operating pipeline systems in the Gulf Coast counties.	Director of Surveying: Ben Thomson Tel: 512-463-5212 Oil Spill Prevention: Greg Pollock Tel: 512-463-5329 www.glo.state.tx.us
TEXAS PUBLIC UTILITY COMMISSION (PUC)	• Fosters utility market competition.	1701 N. congress Ave Austin, TX 78711 Tel: 512-936-7000 http://www.puc.state.tx.us/index.cfm
NORTH TEXAS OIL & GAS ASSOCIATION AND WEST CENTRAL TEXAS OIL & GAS ASSOCIATION	• Unite oil and gas industry organizations, and • work together on issues affecting the industry.	719 Scott Avenue, Suite 500 Wichita Falls, TX 76301 Tel: 800-299-2998 940-723-4131 Fax: 940-723-4132 http://www.ntoga.org/
TEXAS TRANSPORTATION INSTITUTE (TTI)	• Improves the safety and efficiency of the Texas transportation system, and • conducts transportation research by working with state and federal agencies.	Texas A&M University System 3135 TAMU College Station, TX 77843-3135 Tel: 979-845-1713 Fax: 979-845-9356 http://tti.tamu.edu/
TEXAS GAS ASSOCIATION (TGA)	• Provides services that enhance performance, promote safety and broaden public awareness of the natural gas industry's contribution to society and the environment.	3321 South Broadway Blvd #202 Garland, TX 75043 Tel: 972-926-8318 Fax: 972-926-8851 http://www.texasgas.com/

ORGANIZATION NAME	FUNCTION	CONTACT INFORATION
BUREAU OF ECONOMIC GEOLOGY (BEG)	• Conducts research in advanced oil and gas discovery and recovery optimization, environmental waste and coastal processes.	The University of Texas at Austin Tel: 512-471-1534 http://www.beg.utexas.edu/
TEXAS NATURAL RESOURCE CONSERVATION COMMISSION (TNRCC)	• Has jurisdiction over the natural gas pipeline operations' impact on air quality, and • is concerned with natural gas pipeline emissions.	Air Policy & Regulations: Herb Williams, Jr. Tel: 512-239-4884 www.tnrcc.state.tx.us/

Table 5. Entities that Collect and Catalog Data on Pipelines in Texas.

ORGANIZATION	DATA COLLECTED OR CATALOGED	WEBSITE ADDRESS
RAIL ROAD COMMISSION OF TEXAS (RRC)	• Crude oil and natural gas drilling and production statistics. ***Natural Gas Reports*** • Accident reports, leak reports, and incident reports; • pipeline safety annual reports; • safety reports related to any condition outlined in the 49 Code of Federal Regulations (CFR), Part 191; • new construction report (for over five miles of pipe) within 30 days before construction, containing originating and terminating points, counties to be traversed, size and type of pipe, type of service, design pressure, and length; and • offshore pipeline condition report within 60 days of inspection completion containing conditions under 49 CFR 192.612. ***Hazardous Liquids Reports*** • Accident reports involving any hazardous liquid release and intrastate pipeline facility; • annual report from each operator listing sizes and lengths, hazardous liquids being transported and accident/failure data; • new construction report from each operator within 30 days of construction must state the location, path, size and type of pipe, intended use, design pressure, and length; • operations and maintenance procedure manual within 20 days of effective date of use; • facility response plan required by the 49 CFR; and • records required by 49 CFR.	http://www.rrc.state.tx.us/
OFFICE OF PIPELINE SAFETY (OPS)	• Distributions system incident report, • distribution system annual report, • gas transmission or gathering system reports, • transmission and gathering systems incident report, • safety-related condition reports, • offshore pipeline condition reports, • telephonic notice of certain accidents, • liquid accident yearly summaries, • natural gas incident yearly summaries for transmission operators, • natural gas incident yearly summaries for distribution operators, • liquid pipeline accident summary by cause and commodity, • natural gas transmission and distribution incident summary by cause, • distribution and transmission annuals of data, and • distribution and transmission accident and incident data.	http://ops.dot.gov/

ORGANIZATION	DATA COLLECTED OR CATALOGED	WEBSITE ADDRESS
U.S. FEDERAL ENERGY REGULATORY COMMISSION (FERC)	• Annual report of oil pipelines.	www.ferc.fed.us
RESEARCH & SPECIAL PROGRAMS ADMINISTRATION (RSPA)	• Tariff rates and charges.	www.rspa.dot.gov/
BUREAU OF TRANSPORTATION STATISTICS (BTS)		http://www.bts.gov
PENNWELL PUBLISHING COMPANY	• Pipeline maps, • detailed economic pipeline information, and • product, volume, and mileage per pipeline company.	www.pennwell.com
OIL AND GAS JOURNAL	• Various time series oil, gas, and energy industry statistics including the areas of production, imports/exports, demand/consumption, and natural gas.	www.ogjonline.com
INTERSTATE NATURAL GAS ASSOCIATION OF AMERICA (INGAA)	• Information on natural gas.	http://www.ingaa.org/main.html
ASSOCIATION OF OIL PIPE LINES (AOPL)	• Information on economic regulation of the pipeline industry.	
U.S. COAST GUARD (USCG)	• Incident command system reports, • statistics on pollution from pipeline and other modes of transportation, • pollution Incident Compendium (comprehensive report of spills in and around U.S.), • spills of non-floating oils: risk and response reports, • oil pollution research and technology plans, • incident specific preparedness review team reports, and • area contingency plans natural resource damage assessments.	http://www.uscg.mil/
NATIONAL RESPONSE CENTER (NRC)	• Incident reports (marine pollution reports), and • notification statistics.	
NATIONAL TRANSPORTATION SAFETY BOARD (NTSB)	• Pipeline accident descriptions, • pipeline accident reports and studies, • most wanted pipeline improvements, • schedule and exhibits items from public hearings held on major investigations and special investigations, and • schedule for discussion of major reports and safety studies, with links to report abstract.	http://www.ntsb.gov/
COMPRESSED GAS ASSOCIATION (CGA)	• Gas incident reports.	http://www.cganet.com/

ORGANIZATION	DATA COLLECTED OR CATALOGED	WEBSITE ADDRESS
AMERICAN GAS ASSOCIATION (AGA)		www.aga.org
BUREAU OF LAND MANAGEMENT (BLM)	• Site cleanup evaluations.	http://www.blm.gov/nhp/index.htm
SOUTHERN GAS ASSOCIATION (SGA)		http://www.southerngas.org/
ENERGY INFORMATION ADMINISTRATION, U.S. NATURAL GAS PIPELINES	• Deliverability of natural gas pipelines, • natural gas pipeline change and growth, • changes in natural gas pipeline transportation market, and • natural gas flow and rates.	http://www.eia.doe.gov/oil_gas/natural_gas/info_glance/pipelines.html

SUMMARY

The following were discussed in this chapter:

- the basic design of a typical pipeline,
- a list of commodities that may be transferred from the surface transportation network to pipelines,
- a summary of the physical, business and policy issues involved in transferring commodities from surface modes to the pipeline mode,
- a list of all agencies, organizations, and commercial firms having a role in pipeline transportation in Texas, and
- a list of all entities having a role in the collection and cataloging of data on pipeline in Texas.

Continued Investigations

The investigation of commodities that may be transferred from the surface transportation network to pipeline continues, including the following:

- the exact commodities classified under the SCTG coding system,
- physical properties of commodities for compatibility with pipelines, and
- additional commodities to be transferred to pipelines.

Continuing work on this section of the report includes:

- searching for other entities involved in Texas pipeline,
- gathering more detailed information regarding their function in Texas pipeline, and
- searching for missing contact information.

Continued work to provide a comprehensive list of entities that collect and catalog Texas pipeline data include:

- searching for other entities using necessary resources,
- investigating the data collected and cataloged, and
- listing entities along with the data they collect and catalog.

CHAPTER 3 – COMPREHENSIVE INVENTORY OF THE STATE'S PIPELINE INFRASTRUCTURE

INTRODUCTION

The research effort to develop a comprehensive inventory of the state's pipeline infrastructure utilizes the Railroad Commission of Texas, Gas Services Division's (GSD) geographical information system (GIS) map. The research efforts to produce a compilation of the Texas hydrocarbon pipeline system are centered on two functional sources. The first functional source is the Railroad Commission of Texas for intrastate pipelines as the Texas Legislature's designated regulatory body for petroleum and petroleum-related pipelines. As such, PSD has jurisdictional authority over nearly 164,387 miles of liquids and gas transmission, gathering, production and flow pipelines. GSD holds the second functional topic as the repository for and maintainer of a GIS for the U.S. DOT's Office of Pipeline Safety (OPS) interstate pipelines in Texas, or nearly 31,780 miles of pipelines and interconnections. The overall total mileage of all pipelines represented in the database is 196,167 miles.

TTI has acquired the developing Texas pipeline GIS database from the GSD of the Railroad Commission of Texas as our principal source document. The comprehensive inventory effort is approximately 80 percent complete. The inventory will be completed in year two of this research project. This work is provided in GIS using the software product ArcView to provide the locations for the pipelines cataloged.

Table 6 provides a breakdown of the various business segments and their pipeline miles are provided, i.e., crude lines, natural gas transmission lines, etc., in the GIS database.

Table 6: Pipeline Miles by Inter/Intrastate Use and Business Category.

	Miles of Pipeline	% of Total Length
Statewide Total	**196,170**	
Intra/Interstate		
Intrastate	159,640	81
Interstate	31,860	16
Unknown	4,660	2
System Types		
Carbon Dioxide	680	<1
Crude	33,910	17
Natural Gas	127,230	65
Refined Products	30,250	15
Unknown	4,100	2

Table 7 further delineates the pipeline miles in the business category by use for transmission, gathering, offshore, and in the products category as either highly volatile or nonvolatile pipelines.

Table 7: Pipeline Miles by Business Category and Use Type.

System Types	Miles of Pipeline	% of Total Length
Carbon Dioxide	680	<1
Crude		
Gathering	9,660	5
Transmission	21,050	11
Offshore	3,200	2
Natural Gas		
Gathering	61,650	31
Transmission	59,230	30
Offshore	6,340	3
Refined Products		
Non-HVL Products	11,320	6
HVL Products	18,920	10
Unknown	4,100	2

STATE OF THE RRC DATABASE

The Railroad Commission of Texas, Gas Services Division undertook the process of gathering the necessary pipeline information to create a GIS database approximately four years ago. Only a small portion of this data was already available in a format for easy inclusion into the database. The remaining data evolved from tedious research, data collection, and data transformation for inclusion into the GIS database. The included database is accurate within plus or minus 500 feet.

Upon reception of the database by TTI, PSD stated the pipeline database was approximately 95 percent complete. In order to complete the database, PSD is in the process of updating and modifying the database attributes to conform to the National Pipeline Mapping System (NPMS). GSD continues to re-evaluate the existing data for completeness and correctness.

As the official repository of the Texas state pipeline GIS, PSD will update and modify the database continually. This process will lead to a more accurate and comprehensive database of the state pipeline system.

Attributes of RRC Database

There are 13 attribute items within the pipeline database. Several important attributes for this project are listed below. The full listing of the GSD database is provided for TxDOT's use in Appendix B.

- Fluids – Primary commodity categories carried by the pipeline system
- System – Operator-assigned name for a functional grouping of pipelines
- System Type – Abbreviation for the system type description
- County – County FIPS code

- Intra – Designates a pipeline as either inter- or intrastate
- Miles – Pipeline segment length

Changes to the Database for TxDOT

The GIS database received by TTI from the Railroad Commission is basically the same database supplied on compact disc for TxDOT's use with a few minor modifications and additions. TTI spent a considerable amount of time correcting minor "data entry" errors, such as spelling of words, etc., to make the database more user friendly. The RRC supplies the pipeline system as two separate files that TTI subsequently combined into one file.

Percentage of Pipeline System Included

The GIS database included in this report contains 100 percent of the pipeline GIS data available in the RRC pipeline database. This database and the resulting mapping and locating capability presented is continually being enhanced and updated by the Gas Services Division of the RRC. TTI expects to renew the database in year two and provide the updated GIS database to TxDOT with the Final Report at the conclusion of this work.

Example Maps

Crude Oil Pipelines – Statewide

The crude oil pipeline system is presented in Figure 9. This map shows the entire state of Texas crude oil pipeline system. The gathering system is presented in blue color. The crude oil transmission or trunk lines are presented in red. All the offshore crude lines are in green. Figure 10 is an enlarged section of the overall state map depicting the North Texas Crude System crude oil pipelines. This map is illustrative of the easy access to detail mapping available with ArcView and the supplied GIS database.

Natural Gas Pipelines – Statewide

The natural gas pipeline system is presented in Figure 11. The natural gas gathering pipeline systems are depicted in a dark blue color. The transmission pipelines are presented in a lighter blue and all offshore gas pipelines are shown in green. The quantity of gas gathering lines is so dense where the principal gas fields are as to become indistinguishable. However, the GIS user has complete access to locate and depict these lines in any degree of detail supported by the accuracy of the database.

Refined Products Pipelines – Statewide

Figure 12 presents the refined products pipelines operating in the state. The refined products lines are presented in two colors to distinguish the highly volatile lines (HVL) from the nonvolatile (non-HVL) ones. HVL lines carry products such as butane, propane, butane/propane mixes, acetylene, pentanes, etc. The non-HVL lines transport such products as gasoline, nitrogen, benzenes, etc.

From a purely chemical or physical consideration, the descriptive use of volatile does not comply with the dictionary definition of evaporating readily at normal temperatures and pressures. TTI cautions there should be no rational attachment with common engineering or chemical usage associated with the terms HVL and non-HVL. Many of the products transported in the non-HVL refined products lines are dangerously volatile from the physical characteristics of the products.

Carbon-dioxide Pipelines – Statewide

Figure 13 depicts the pipelines throughout the state that carry carbon dioxide for well treatment uses. The vast majority of these lines are in extreme west Texas. The carbon dioxide is normally used in enhanced oil extraction techniques for reduced production wells.

Figure 14 is an ArcView overlay capability for the display of the GIS's two database segments of the crude oil map Figure 3.1 and Figure 3.5 illustrating the carbon-dioxide pipelines coincidence with the crude oil gathering system in the lower Anadarko region of West Texas. Almost all U.S. carbon dioxide floods (enhanced oil recovery) are in West Texas, because there's a source of carbon dioxide nearby (New Mexico) to flood the deep, "light" oil reservoirs.

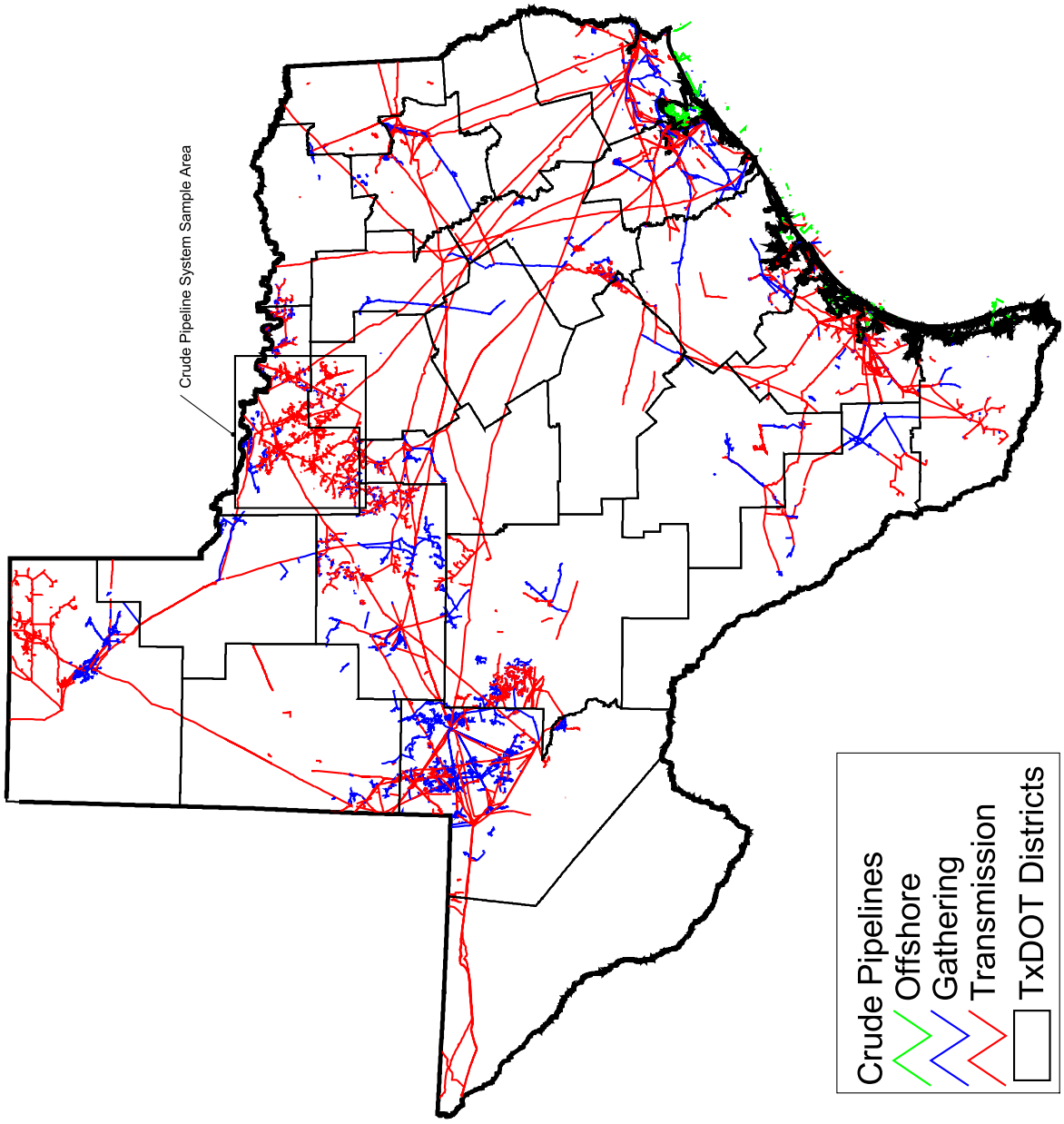

Figure 9: The Statewide Texas Crude Oil Pipeline System.

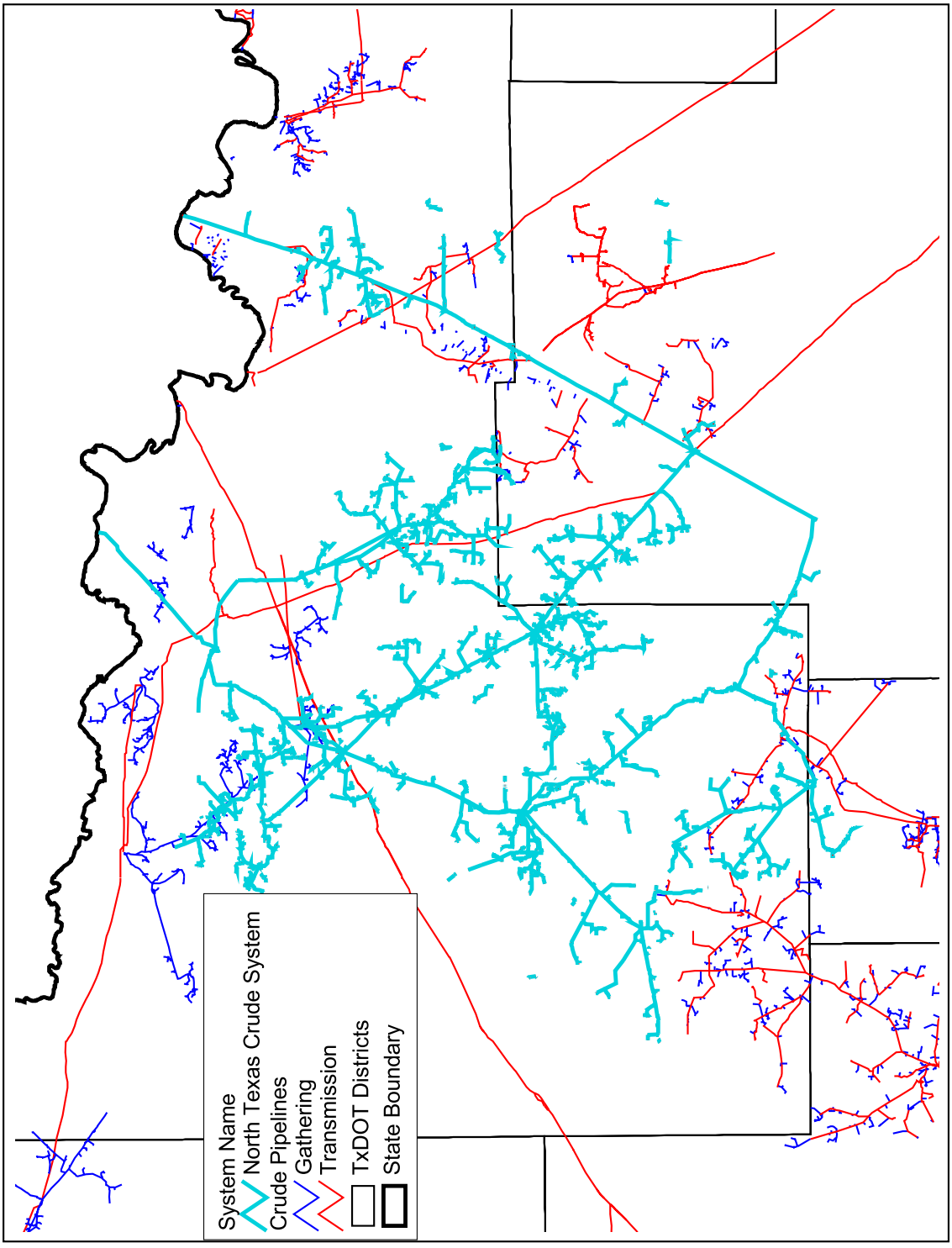

Figure 10: Enlarged View of the North Texas Crude System.

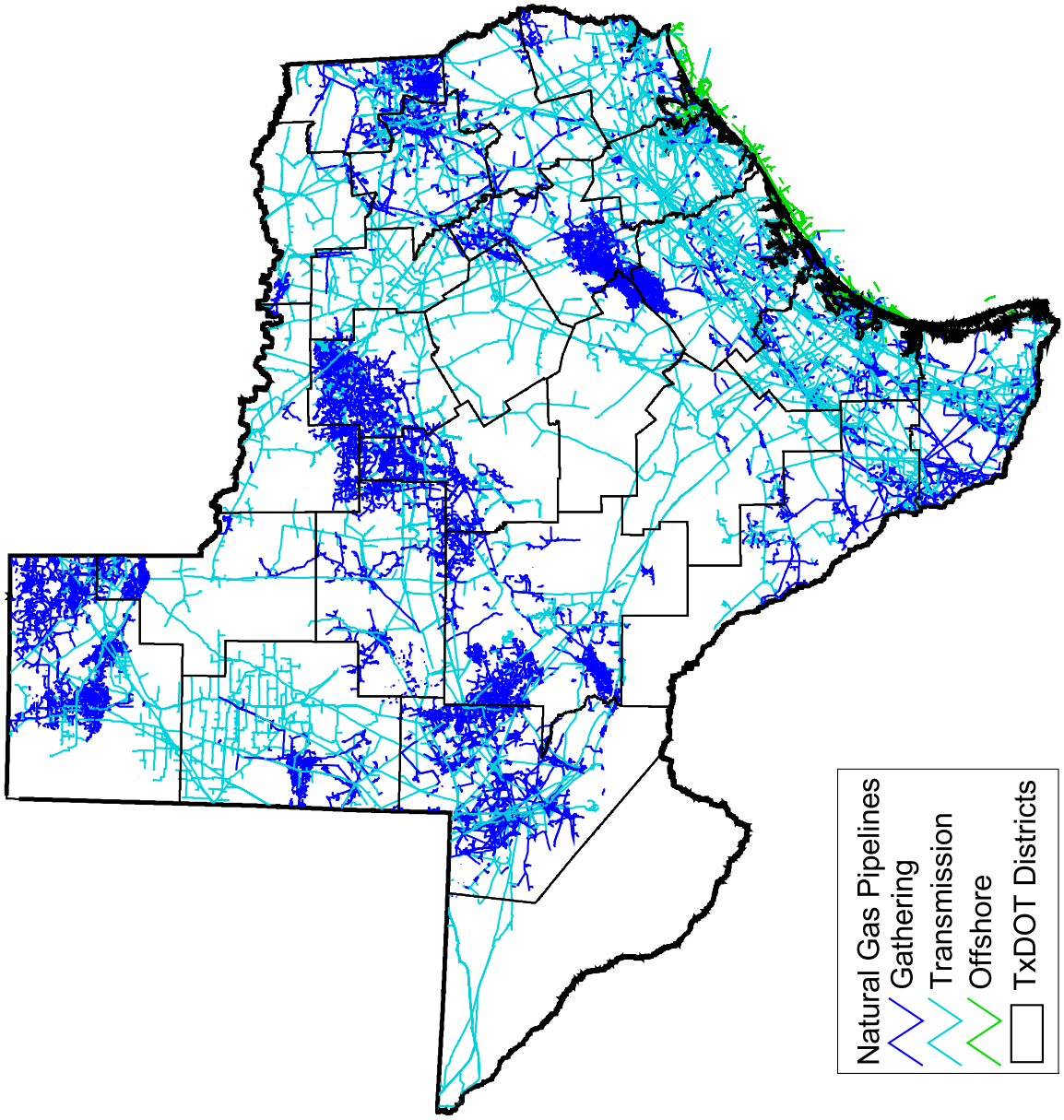

Figure 11: The Statewide Texas Natural Gas Pipeline System.

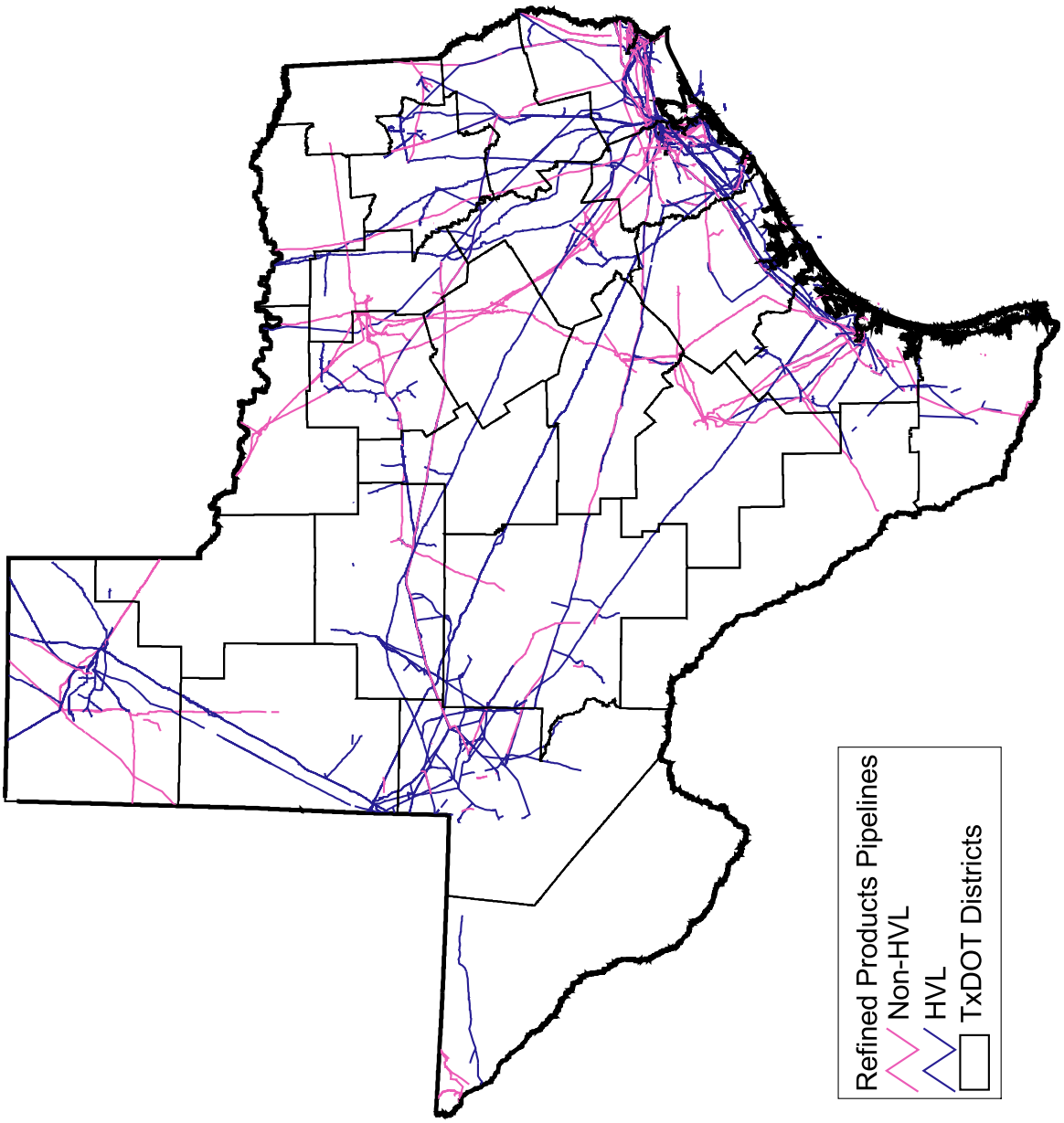

Figure 12: The Statewide Texas Refined Products Pipeline System.

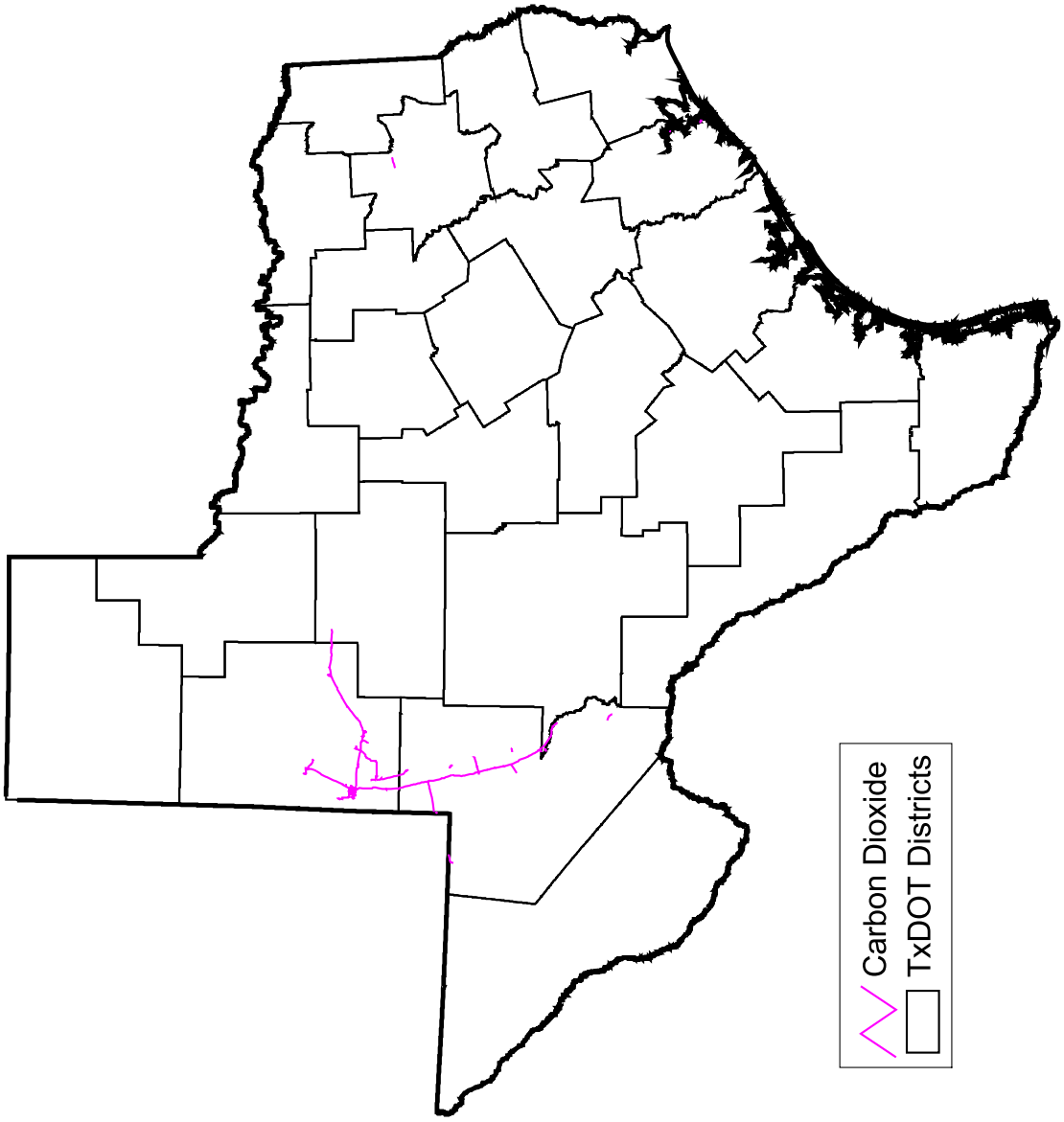

Figure 13: The Statewide Texas Carbon Dioxide Pipeline System.

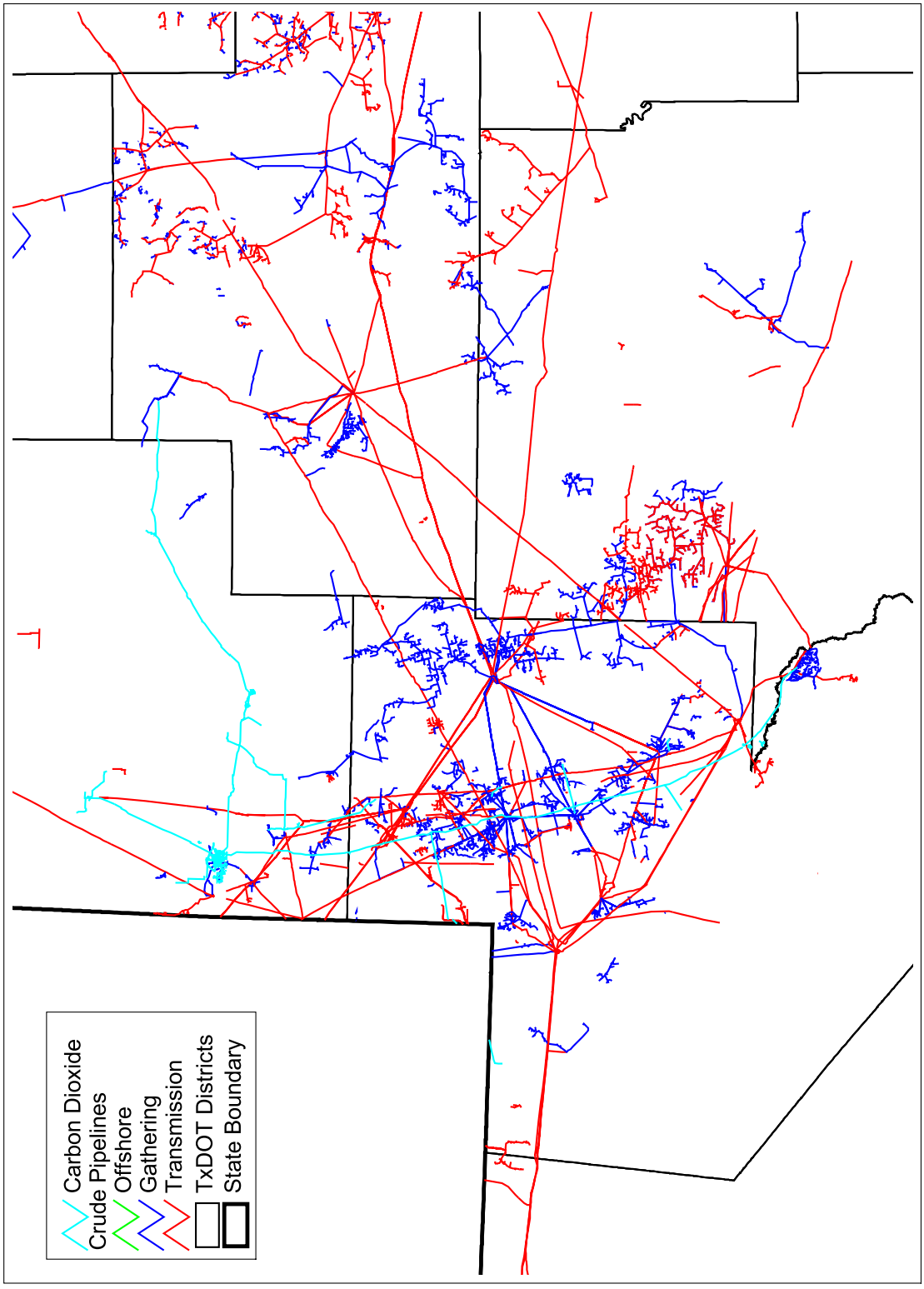

Figure 14: The Texas Carbon Dioxide and Crude Oil Pipeline System in West Texas Anadarko Region.

Facilities Included in the Database

The database represents to include all the pipelines under the jurisdiction of the Railroad Commission of Texas. These include all intrastate natural gas gathering and transmission lines and all crude gathering and transmission lines. All product lines used for transmission and those used in manufacturing or process facilities where permits are required are also included in the database.

Abandoned Pipeline Information in the Database

The database includes abandoned pipeline information. The research team elected to disregard the abandoned pipeline attribute with respect to the pipeline mileage in the database. It was determined that the pipeline exists and should be included as present, regardless of operational status.

Information Not Included in the Database

The database does not include all field lines. Only field lines that require permits or are otherwise under the jurisdiction of the RRC are accounted for in the database. Further clarification of field lines and product/process lines will be undertaken by the research team. Many field and process lines are not buried, but merely lie on top of the soil surface. The database does not include an attribute for where the pipeline is located with respect to the surface. Field lines not required to be permitted are not in the database.

CONCLUSION

The GIS database is materially complete with respect to the extent of the pipelines in the state, whether they are intrastate or interstate pipelines. The accuracy of the exact placement of the pipelines is not of survey quality and, hence, has limited value with respect to uses of the database information for digging and other like purposes. The database is ideally suitable for determining where and to what extent materials are moved in pipelines in metropolitan and rural areas. Additionally, the database will eventually allow TxDOT to incorporate the location of other pipeline-related facilities in a single database to develop highly integrated and accurate roadway traffic patterns attributable to pipeline shipment patterns.

CHAPTER 4 – INVENTORY OF PIPELINE CONNECTIONS WITH OTHER MODES

INTRODUCTION

In this chapter, the researchers review and inventory the pipeline interconnections with other modes of transportation in as follow-on steps to developing a pipeline inventory for the state. Several areas of interest for this effort are included for review. The connection of pipelines to tank storage facilities impacts local road usage. Pipeline interconnections within the ports and harbors used to load or off-load ships and barges are another connection. The railroad tank car interconnection is made at product storage tank distribution terminals by providing railroad spur tracks into these facilities.

REVIEW OF PIPELINE CHARACTERISTICS

Texas' statewide pipeline system, as included in the RRC database, is discussed in Chapter 3 of this report. In summary, Texas' total pipeline system includes over 196,000 miles of pipeline, used for transport of natural gas, crude oil, refined products, and carbon dioxide. Of the total, there are over 127,000 miles of natural gas pipline, approximately half of which are inland gathering and transmission, and approximately 5 percent are offshore natural gas gathering lines. There are approximately 34,000 and 30,000 miles of crude and refined products lines, respectively.

OTHER TRANSPORTATION MODES IN TEXAS

Truck

The Texas highway system is the largest and considered among the best in the nation. "The 77,000 mile system under the Texas Department of Transportation's jurisdiction includes interstate highways and frontage roads, United States highways, state highways, and farm-to-market and ranch-to-market roads. In addition, local governments maintain 213,317 miles of county roads and city streets, bringing the total number of public road miles in Texas to almost 300,000 *(15)*."

The public road and highway network is essential in providing access to pipelines and their commodities. Tanker trucks are used for transporting these commodities from refineries located on pipelines, or for transfer from pipeline storage and distribution terminals to industrial and commercial sites. During their operations, tanker trucks use Texas' public road network, resulting in accelerated wear and decay of the roads. These results are exaggerated when trucks are overloaded beyond a road's weight capacities. Figure 15 shows a tanker truck at a pipeline terminal.

Figure 15: Tanker Truck at Sun Pipeline Co. in Sour Lake, Texas.

Rail

According to the Association of American Railroads (AAR), there were 10,713 miles of track operated in Texas in 1998, carrying 6,569,518 railcars and 295,773,105 tons of freight. Approximately 97 million tons of freight originated in Texas and about 172 million tons of freight "terminated", or reached its destination, in Texas.

The AAR reports that in 1998, 36 percent and 7 percent (35 million tons and 7 million tons) of freight originating in Texas were chemicals and petroleum-related products, respectively. For the same year, about 12 percent and 4 percent (20 million tons and 7 million tons) of freight terminating in Texas were chemicals and petroleum-related products, respectively (*16*). Figure 16 shows rail cars at a petroleum product terminal.

Figure 16: Rail Cars at TransMontaigne Terminal in Brownsville, Texas.

Marine

Texas is home to a variety of marine transportation facilities. There are 12 major deep-draft (greater than 15 foot depth) ports located on the Gulf of Mexico, Gulf Intracoastal Waterway (GIWW), and major bays. In addition, there are 15 public shallow-draft ports located along the GIWW and inland rivers. Private (chemical and refinery) facilities are also located along the Gulf Coast, GIWW, and inland waterways. Figure 17 shows a barge and tug in the Houston Ship Channel.

Figure 17: Barge and Tug in Houston Ship Channel.

Petroleum and chemical commodities are among the most important facets of the Texas economy, and the ports and waterways provide an access for commodity import and export. For example, the Port of Houston, which ranks second in the nation in total tonnage, handled over 76.6 million tons of total foreign trade in petroleum, petroleum products and organic chemicals, worth over $11.7 billion in 1999 (*17*). The Port of Corpus Christi, which ranks fifth in the nation in total tonnage, handled over 75.5 million tons of petroleum and chemical commodities in 1999 (*18*).

In addition, USACE data indicate that over 32.7 million tons of petroleum and petroleum products and over 20.7 million tons of chemicals and related products were transported on the Texas portion of the Gulf Intracoastal Waterway in 1998 (*19*). According to the National Waterways Alliance, the value of chemicals, petroleum products, crude oil, and chemical fertilizers handled on Texas waterways totaled over $28.4 billion in 1995 (*20*).

PETROLEUM TRANSPROTATION FROM CRUDE TO PRODUCT TERMINAL

A principal pipeline interconnection or mechanism of interest to TxDOT for integration is the intermodal connection of the crude and refined product pipelines to trucks using Texas roadways. This interconnection uses tank storage facilities as an intermediary system for transfer of products between pipelines and refineries, into trucks for roadway transport and railroad tank cars (see Figure 18). The storage tank interconnection with crude pipelines and refinery product

pipelines is extensively used as an intermediary holding and agglomerating site for the convenience of processing and shipping product. These storage tanks are not generally used as locations of interconnection with railroad or highway trucks for product distribution to market. The principal interconnection for refined products to railroad tank cars and tank trucks for highway transportation are the terminal and distribution storage tanks.

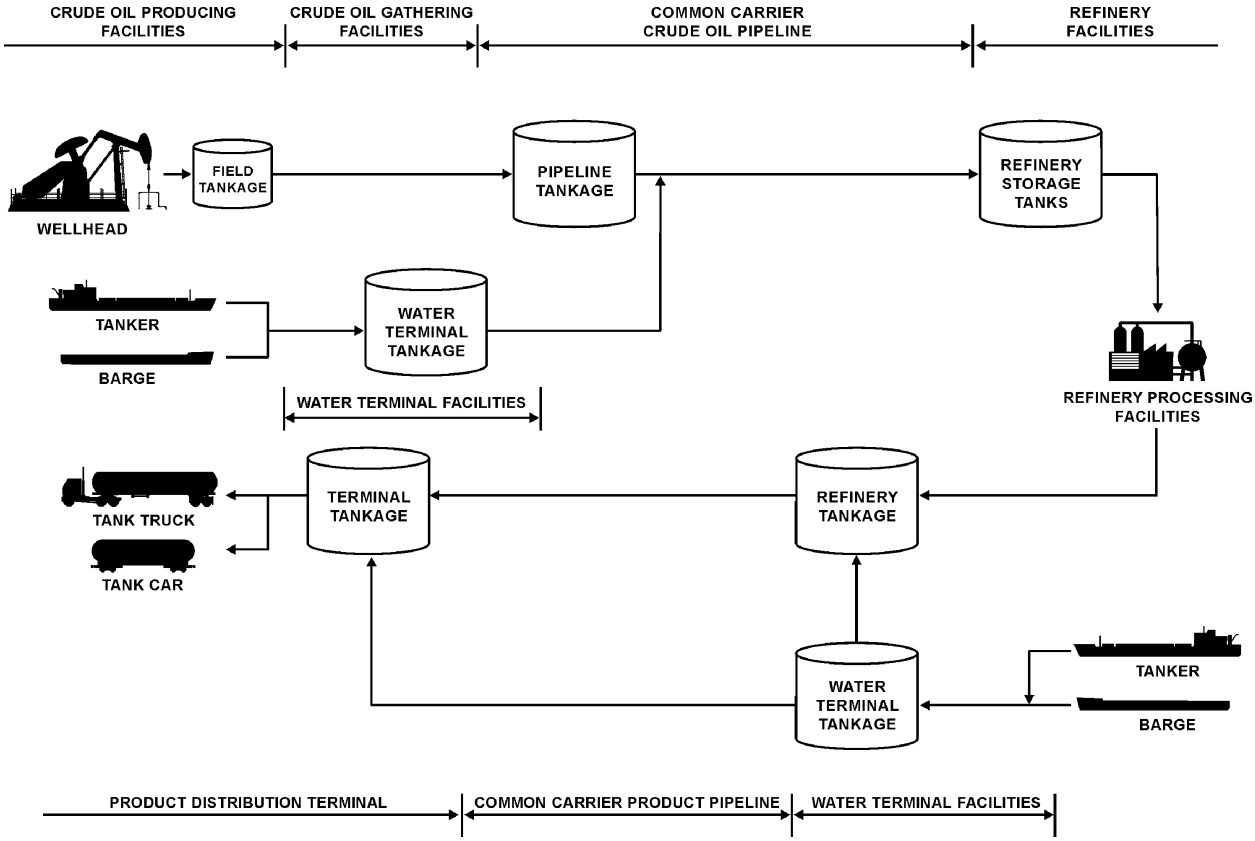

Figure 18: Transportation Mode Mix Relationship with the Pipeline, Refinery Processing and Storage Tank System (5).

In order to understand and manage the impact of this system on Texas roads, an understanding of how the pipeline, storage tank, and truck mechanism works is required.

Well Gathering System to Storage Tank

The pipeline network involves storage tanks at focal points or hubs for several different pipelines. Texas has several major points where this activity occurs: Midland/Odessa in West Texas and Longview in East Texas are notable examples. These hubs generally occur on gathering pipeline systems or main trunk lines carrying crude oil long distances to refineries and processors. The storage tanks are used to provide a holding site for segregation or batch gathering for feed stocks to maintain continuous pipeline operation. When a large enough batch of particular product for economic production is gathered in the storage tank(s) and the destination processing facility is prepared to accept shipment of the product, the storage tank is valved onto the pipeline to deliver the material to its destination.

Crude Storage Facility to Refinery Processing Facility

The product held in the crude storage tank is ultimately shipped by pipeline to the refinery processor where it is again placed in storage tanks to await processing. The processor will have large storage tanks for receiving pipeline-shipped product. These tanks may also be used as preliminary processing units where particular blending may be conducted by the refiner processor for his process.

Once the refiner is ready to process the crude in his storage tanks, he must isolate his storage tanks for the product. The production run on the crude will continue until the crude in storage is reduced to the minimum operating tank level. The refiner maintains a minimum operating level in crude storage tanks to prevent problems or run-outs from occurring. (Dry storage tanks encounter various problems that can be very costly for the refiner. For example, anaerobic bacterial growth can take place in residual amounts of crude oil in dry storage tanks, which can in turn cause contamination of the overall refinery system. Clean-up of the tank may be nearly as costly as the cost of tank replacement.)

Processor Refined Product Storage to Distribution Terminal Storage

Once the refinery has completed processing the crude oil into refined product, the product must be stored in segregated storage tanks to await pipeline shipment to a terminal for distribution. The refined product storage tanks are generally segregation holding tanks, because refined products must meet industry and government product specifications and standards to be offered for sale as specific products. For example, only kerosene meeting American Society for Testing and Materials (ASTM) specification D3699-88 is allowed in the U.S. military supply system (*21*). Refined products complying with standard specifications are not typically comingled in storage tanks due to the amount of refined product retained in the bottom of storage tanks that will contaminate the newly introduced product (see Figure 19).

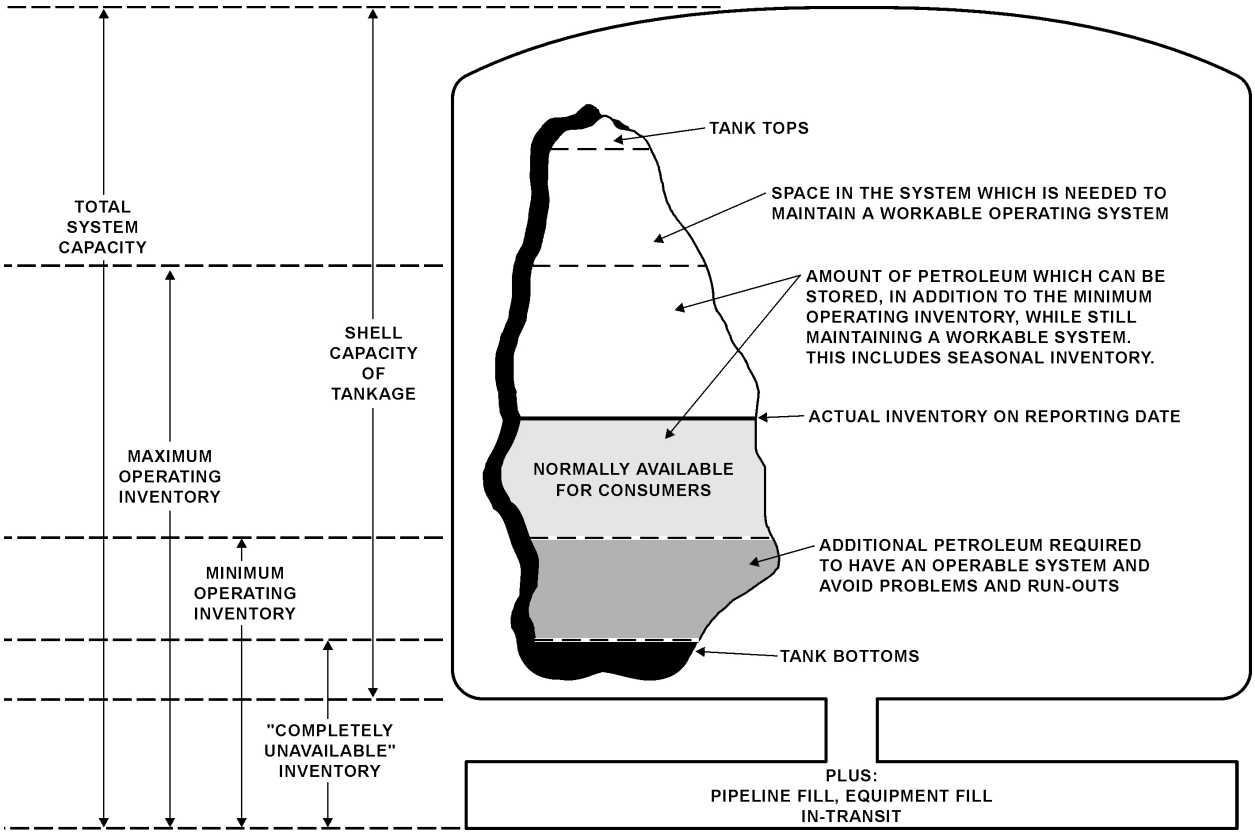

Figure 19: Petroleum Storage and Operating Volumes (*5*).

The refined product being moved in a product pipeline can be traded, swapped, diverted from its current destination, or almost any transaction accomplished as long as it is in the pipeline. Once the product is diverted to terminal or customer storage, the product is essentially committed to the particular market and customer base it was last transacted for delivery to. This situation often sets the market value for refined product and demand for storage terminal tank truck transportation requirements (*5*).

PETROLEUM PRODUCT TERMINALS

General Terminal Description

A "terminal" is defined by Webster as a "terminus (end of route, station, town or building)" or "a device … for facilitating connections" (*22*). A "petroleum terminal" may then be considered to be a location at the end of a pipeline, or a location that is used to facilitate connections between the pipeline mode of transportation and other modes of transportation: truck, marine, and rail. A petroleum product terminal is one of the most important parts of pipeline interconnection with other modes, allowing for the mass storage and distribution of refined petroleum commodities.

Terminals may differ on equipment specifics, but they all have some basic components used to facilitate the transfer of commodities from one mode to another. Petroleum terminals are complex and require specialized types of pipes, pumps, valves, meters, gauges, controls, safety and emission apparatus, and other equipment. While a detailed treatment of terminal operations and equipment is beyond the scope of this document, a basic description of the functions of major components is included.

Commodity Movement

Pipeline products are either transported via "installation" pipelines, which are dedicated to a particular terminal, or "inter-terminal" pipelines, which connect two or more facilities. When a transfer of a commodity is needed from pipeline to terminal, a system of valves are opened and allow the commodity to flow from the pipeline to the appropriate storage location (tank) in the terminal. Commodities may also be transported from the terminal back into the pipeline system.

Commodities are transferred in slugs, or bulk quantities. The beginning and end of a particular slug may be determined by sampling for the change in commodity characteristics, or the slugs may be separated by "pigs", which are devices placed in a pipeline between slugs. The pigs are pushed through the pipeline with the commodity, and are separated at their destination using pig launching and receiving equipment. Slugs of commodities may also be separated using a separate slug of immiscible fluid, such as water, placed between the commodities.

Storage Tanks

The terminal storage tanks are generally aboveground and vertically oriented. Some underground storage tanks (USTs) are also used in terminal operations, but to a much lesser degree and for low-volume commodities, or for oil/water separation from runoff systems. The aboveground storage tanks (ASTs) are very large, capable of holding millions of gallons each. Depending on required storage capacities, a terminal may have from only a few up to dozens of large ASTs. Figure 20 shows a petroleum product terminal.

Figure 20: Nighttime View of Terminal Storage Tanks in Chocolate Bayou, Texas *(23)*.

Loading Rack

Because a terminal is the interconnection between the pipeline and other modes, the terminal must have facilities for loading and unloading commodities to and from trucks, railcars, or marine vessels. This transfer takes place at a loading rack, which has a location for the vehicle or vessel to park or dock. Petroleum products are transferred from the storage tanks to the vehicle and vice versa through dedicated hoses, meaning that each hose is used for loading only one type of commodity. A series of piping connects the loading rack to the terminal storage tanks and, thus, to the petroleum pipeline system.

Loading racks may vary depending on the type of vehicles and commodities that are handled at the terminal. Equipment used at most loading racks can be placed in the following general categories:

- flexible hose assemblies and/or loading arms;
- closure devices (for sealing off open connections);
- emission, spill and flow monitoring equipment;
- vapor recovery systems;
- drainage and spill containment piping and tanks (often a UST);
- electrical control and emergency shutdown equipment; and
- communications and lighting.

Tank Truck and Tank Car Loading/Unloading Facilities

Petroleum commodities are hauled by tank truck and tank car in horizontal, cylindrical tanks mounted on the trailer or railcar chassis. When a refined product is sold to a customer for delivery by truck, preparations are made for delivery of the product to the buyer's facility. The seller releases title to the product quantity at the terminal to the buyer. The buyer's designated representative takes delivery of the product in a tank truck at the storage terminal's loading station and departs the facility. Figure 21 shows a tank truck loading facility.

Figure 21: Tank Truck Loading Rack (*24*).

Railroad tank car operations are essentially the same for taking delivery of product at the product storage terminal. The principal difference between truck and rail operation is the railroad operator never participates in the product loading operation. The terminal operator will even move and position the delivered tank cars into the loading rack. Figure 22 shows a tank car loading facility.

Figure 22: Rail Tank Car Loading Facility *(24)*.

Marine Vessels and Loading/Unloading Facilities

Vessels

Chemicals and petroleum products are carried predominantly in tankers and barges, and to a lesser degree in bulk cargo ships. Lloyds of London describes tankers as ships "…designed for the carriage of liquid in bulk, her cargo space consisting of several, or indeed many, tanks. Tankers carry a wide variety of products including crude oil, refined products, liquid gas and wine. Size and capacity range from ultra-large crude carrier of over half a million tons to the small coastal tanker of a few hundred tons. Tankers load their cargo by gravity from the shore or by shore pumps and discharge using their own pumps" *(25)*. A chemical tanker ship is shown in Figure 23.

Figure 23: Chemical Tanker Ship.

A barge is a "flat-bottomed vessel mainly used on rivers and canals. Some types are self-propelled while those which are not are towed or pushed. Barges are often linked together and towed in a line known as a string or train" (*25*). A barge's shallow draft allows the vessel to transport cargo far inland or to shallow draft locations that are inaccessible to tankers. The barge may load commodity from the tanker at an offshore location in a process known as lightering, or may load the commodity at one landside location and discharge it at another. Barges can carry large amounts of commodities: "One 3,300 ton tank-barge carries the same tonnage as a string of 33 rail cars. The same tonnage would require 110 tank trucks spanning three miles" (*19*).

Facilities

Loading/unloading activities for marine vessels, which include tankers, barges and other marine vessels, are done at piers, wharfs, or offshore-mooring facilities. "Typically, a structure is referred to as a pier if it is perpendicular or at an angle to the shore. If it runs parallel to the shore, the structure is called a wharf" (*21*). The loading/unloading facilities on piers and wharfs that are used for marine vessels are similar to those used for tank trucks and railcars: a system of hoses and piping connect the vessel to the terminal storage tanks. Figures 24 and 25 show marine loading/unloading facilities located on the Houston Ship Channel.

Figure 24: GATX Ship Dock No. 3 at Galena Park Terminal in Houston, Texas.

Figure 25: GATX Ship Dock No. 1 at Galena Park Terminal in Houston, Texas. Note Rail Spur and Piping to Storage Tanks.

"Where it is not feasible to use piers to moor ships …offshore moorings are used. These systems facilitate the receipt and discharge of fuel in cases where an activity is not geographically suitable for typical fueling operations or a tanker is too large for the body of water, as in the case of a super tanker, or the draft restrictions do not permit pier side loading/discharge of fuel" (*21*). From the mooring buoys, underwater pipelines carry the product along the seabed to an onshore terminal, which may be many miles distant. The need for offshore mooring buoys in Texas is limited due to access to deepwater petroleum facilities on the Texas coast. An offshore mooring buoy is shown in Figure 26.

Figure 26: Offshore Mooring Buoy (26).

PROJECT INTERCONNECTIONS FOCUS

Information Resources for Developing Interconnection Database

Table 5 in Chapter 2 contains information regarding entities that collect and catalog data about pipelines in Texas. While pipeline-specific information is available from many of these sources, this information is extremely limited in its applicability to an assessment of pipeline interconnectivity with other modes. In addition, no single data source for pipeline interconnectivity has been found that meets the budgetary limits of this funding effort. Pennwell has developed a GIS pipeline mapping database that contains terminal information and can be purchased for $43,000 or accessed annually for a fee of $15,000 per year.

Relevant but limited information about modal-interconnectivity is obtainable from both pipeline-specific sources and modal-specific sources. Synthesis and assimilation of this information requires extensive cross-referencing and assimilation. These sources are discussed in the following subsection.

Data Collection Plan

Many sources have been reviewed for pertinent information about pipeline interconnectivity with other modes, with several sources being evaluated in year one of this research effort as providing potentially relevant information. These sources include the following:

Pennwell Publishing Company

In addition to the GIS database, pipeline wall maps are also available from Pennwell and may be purchased for a minimum of $750 per map. According to Pennwell, these maps include location of major terminals, pipelines on which terminals are located and their respective

commodities, and facility infrastructure. The researchers are evaluating the value of obtaining Pennwell pipeline maps for natural gas systems, crude oil systems, and refined product systems in year two of this funding effort. A Pennwell *Pipelines of the United States Gulf Coast* Atlas has been obtained that provides limited information on major pipelines, refineries, and terminals along the Texas Gulf Coast.

USACE

The U.S. Army Corps of Engineers Navigation Data Center collects and maintains information about harbor and waterway infrastructure. This information is published in the Corps' *Port Series*, and includes site location, ownership, berthing, handling equipment (e.g., hoses, cranes, etc.), railway connections, highway connections, and contact information. It should be noted that this source does not provide a listing of pipeline connections, however, many of the marine terminals that have facilities included in the reports do have pipeline connections. Further, the accuracy of the information contained in the reports is limited, particularly for multimodal information included prior to the late 1990s. Reports are available for all of Texas' Gulf Coastline and its larger waterways.

Texas Natural Resource Conservation Commission (TNRCC)

The TNRCC maintains an information database of petroleum storage tanks as part of its emissions inventory program. A copy of the database is available and has been requested by the researchers. While the database is not anticipated to include pipeline interconnectivity information for storage tanks, it is hoped that locations of larger terminal and processing facilities may be determined using the information. It is expected that such facilities are the most likely to be located along pipelines and have significant multimodal activities. Analysis of another TNRCC database for petroleum storage tank capacity and emission controls information has provided little relevant information.

Local Economic Development Councils (EDCs) and Metropolitan Planning Organizations (MPOs)

An *Intermodal Facility Inventory* prepared for the Houston-Galveston Area Council includes "regionally significant" facilities as defined by the Federal Highway Administration (FHWA), and describes their locations, modes of connection, and facility characteristics such as freight types and volumes, and percentage of mode used for shipping. This inventory provides valuable information for some of the largest of the intermodal pipeline facilities in the Houston-Galveston region. Similar information will be requested from other Texas EDC/MPOs and evaluated as available.

Additional Sources

Additional sources will be evaluated as they are found and obtained by the researchers. These sources may include other federal, state, and local government entities, and petroleum marketing and handling companies.

Facility Significance

In addition to obtaining information and data sources, the researchers continue to investigate the criteria for defining facility significance to impacting pipeline and multimodal transportation relationships. The FHWA has established criteria for defining "regionally significant" intermodal facilities, such as truck-pipeline facilities with traffic greater than 100 trucks per day. Complicating this definition are the varying degrees to which other transportation modes interface with and have access to pipeline systems. Another factor is that information regarding pipeline and terminal total throughputs is generally closely held, and provided to governmental and regulatory agencies under conditions of confidentiality. The "accuracy" and relevance of much of the information that is publicly available is called into question because of such issues as double-counting throughputs for pipeline sections that are controlled or held by multiple entities.

Data Collection Implementation and Integration With Existing Knowledge Systems

As the project effort proceeds into year two, the data collection and analysis and work toward obtaining valid new information sources will continue. The data collection implementation plan includes:

- analysis of those information sources already located and obtained;
- continued effort in uncovering new information sources, within project budget feasibility, that are pertinent to the interconnection of pipelines with other transportation modes;
- continued efforts toward obtaining throughput information that may help define facility significance;
- integration of intermodal data with pipeline information, particularly in area of port, harbor and waterway infrastructure, and the distribution, location, size and commodities of major inland terminals located on pipelines; and
- investigation toward defining an effective economic radius of operation for petroleum terminals located on pipelines in an effort determine the maximum distance between storage tank systems and road systems that are impacted (e.g. interstate systems, federal highways, state highways, etc.).

The results of the continued work toward analysis of pipeline-multimodal connections will be documented in the results for year two. While this funding effort limits the completeness of this evaluation, we hope to have a more complete understanding and inventory of pipeline interconnections for the largest of those in the port and waterway environment, along with pertinent information on the most significant of the inland terminals.

Pipeline-multimodal connections are illustrated in the following example. The GATX Galena Park Terminal is located on the Houston Ship Channel in Harris County. An overhead image taken from the U.S. Army Corps of Engineers Port Series map for Houston, Texas, is shown is Figure 27. The GATX terminal dock facilities are numbered 147 through 151. The map symbols indicate that among the materials handled at the marine docks are wastewater and ballast water, bulk liquid commodities, vegetable and animal oils, chemicals and petrochemicals,

and petroleum products. The facility is also located on Union Pacific Railroad trackage and may be accessed from East Loop 610, IH10, and Highway 288.

Information from the HGAC *Intermodal Facility Inventory* (*27*) and the USACE *Port Series 24* (*28*) for the Port of Houston is shown in Table 8. The GATX facility is located on pipelines as indicated by the reports; however, the information is believed to be incomplete regarding total number of pipelines, ownership, locations, and construction.

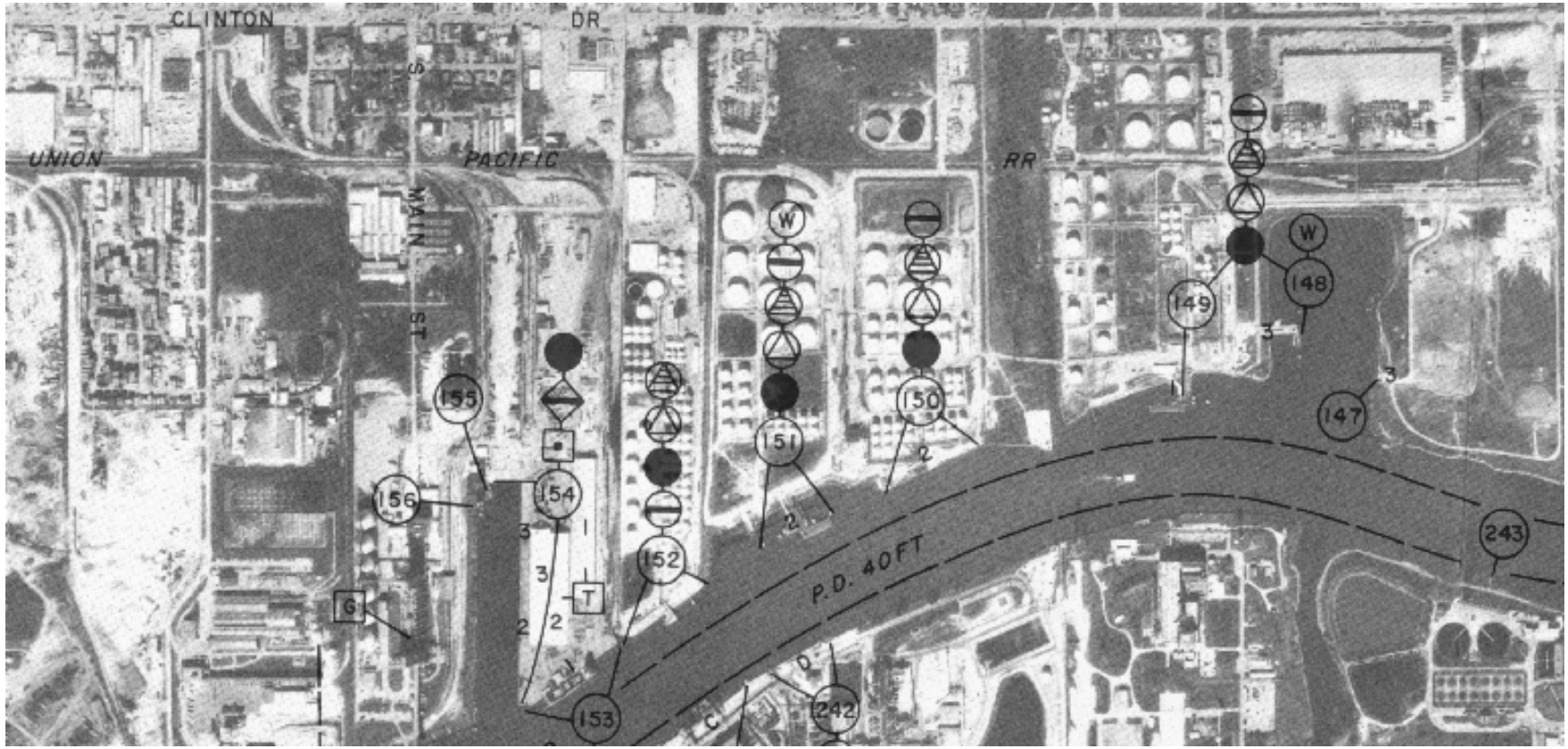

Figure 27: Aerial Photograph of GATX Park Terminal in Houston, Texas (*28*).

Table 8: Terminal Description and Modal Characteristics.

FACILITY:	GATX Terminals Corp. Galena Park Terminal, 906 Clinton Drive, Galena Park, TX 77547 TxDOT District
COMMODITIES:	Petroleum and Chemical Liquid Products
THROUGHPUT:	27,000,000 bbls/yr (3.86 million tons/year)
MARINE COMMODITY MOVEMENT AND INFRASTRUCTURE:	30 percent inbound by ship; 50 percent outbound by ship. • Ship Dock No. 3 (Map No. 148) has two 20-inch and ten 8-inch commodity pipelines that extend to terminal storage tanks. • Ship Dock No.1 (Map No. 149) has five 12-inch, one 10-inch, six 8-inch, and twelve 6-inch commodity pipelines that extend to 16 terminal storage tanks (capacity 635,000 barrels). Also eight 8-inch lube oil pipelines extend to eight terminal storage tanks (capacity 170,000 barrels). • Barge Dock No. 2 (Map No. 150) has eight 12-inch, two 10-inch, forty-five 8-inch, and four 6-inch commodity pipelines that extend to 45 terminal storage tanks (capacity 1,174,000 barrels). Also has one 3-inch pipeline that extends to truck loading rack. • Ship Dock No. 2 (Map No. 151) has eight 12-inch, one 10-inch, nineteen 8-inch and five 6-inch commodity pipelines that extend to 24 terminal storage tanks (capacity 1,026,000 barrels).
RAIL COMMODITY MOVEMENT AND INFRASTRUCTURE:	10 percent inbound by rail; 10 percent outbound by rail. • Tank car loading racks are accessed by two Union Pacific Railroad tracks (see map).
TRUCK COMMODITY MOVEMENT AND INFRASTRUCTURE:	10 percent inbound by truck; 10 percent outbound by truck (less than 100 trucks per day). • Road Access: East Loop 610 via Clinton Dr.; IH10 via Federal-Clinton Dr.; Highway 288 via Red Bluff-Federal-Clinton Dr. (see map for Clinton Drive location).
PIPELINE COMMODITY MOVEMENT AND INFRASTRUCTURE:	50 percent inbound by pipeline; 20 percent outbound by pipeline. • One 20-inch commodity pipeline extends from Ship Dock No. 3 to GATX's Pasadena terminal. • One 8-inch aviation fuel pipeline extends from Ship Dock No. 3 to one 10,0000-barrel Texaco storage tank located at 780 Clinton Dr. • Terminal lube-oil storage tanks connected to Texaco facility at 780 Clinton Dr. via pipeline. • One 12-inch pipeline extends from terminal storage tanks to Valero Energy Corp. Basis Petroleum refinery near Sims Bayou, Houston. • Facility may be located on additional pipelines.

Source: HGAC *Intermodal Facility Inventory* (*27*) and USACE *Port Series No. 24* (*28*).

CHAPTER 5 – REVIEW OF WORK COMPLETED AND FOLLOW-ON FOR YEAR TWO PROJECT COMPLETION

INTRODUCTION

The first year's work for this two-year effort focused on three major points by developing the literature review, the GIS and the inventory of pipeline interconnections. Continuing work on these tasks will complete each with current and comprehensive data.

Literature Review

The research team examined available pertinent material on the pipeline system in Texas and identified those agencies, organizations, or firms having a role in the pipeline transportation or in the collection and cataloging of system data. The team investigated the potential use of pipelines for movement of other compatible commodities and documented the physical, business, or policy issues involved.

The literature review provides a simple design outline for a pipeline. Pertinent design criteria and characteristics are outlined and discussed. A review of potential commodities that may be transferable from the surface transportation mode to pipelines is provided in Chapter 2. The research team has gathered a base of commodity flow information along with certain physical, business and policy issues to begin an analysis for moving potential commodities from surface transportation mode to pipeline mode where applicable.

Chapter 2 provides a comprehensive listing of national and Texas state agencies, organizations and commercial entities involved in collecting and cataloging data regarding Texas pipelines. The listing also includes both national and state entities having a role in pipeline transportation policy making and rules in Texas.

GIS Mapping

The GIS effort is 80 percent complete. We expect to provide an updated GIS database to TxDOT with all the current modifications of the GSD. GSD continues to add new pipeline information on lines in the various channels and waterways in the state. The database will be provided in a single comprehensive unit for TxDOT's use in the Austin offices. The database will be further personalized for individual use by the 26 TxDOT districts.

Inventory of Interconnections

The work to inventory the intermodal interconnections of the pipeline system in Texas continues to evolve. No regular or straightforward inventories of intermodal connections with the pipeline system have been discovered. Sources of limited inventories of interconnections have been discovered in both the public and private sector, as discussed in Chapter 4.

Potential For Increased Pipeline Integration into the State's Transportation System

Initial research into the potential for increased integration of the petroleum, refined, and chemical product pipeline systems into the overall state transportation system assumes the private pipeline companies management maximizes their assets income. Using this premise, the research team has conducted research into the regulatory issues of what restrictions exist on the pipeline's ability to alter its business focus. Preliminary results are presented in Chapter 1 in "Regulatory Overview" and "Preliminary Examination of Potential for Integration."

PROPOSED YEAR TWO TASKS

Complete the Literature Review

Task 2, the literature review, for the final report is estimated to be 75 percent complete. Work is therefore on schedule within time and budget. Further work on Task 2 will include any suggested or required work on the sections presented in this report upon review, further investigation for a list of commodities to be transferred to a pipeline mode of transportation and a more detailed investigation of specific physical, business and policy issues involved, and completion of lists of agencies, organizations, and commercial firms having a role in Texas pipeline transportation and those specifically having a role in the collection and cataloging of Texas pipeline data.

The research team will contact resource experts and make provisions to gather appropriate data.

Complete Comprehensive Inventory of the State's Pipeline Infrastructure

The GIS effort to provide a comprehensive database will be completed to provide a single unit for TxDOT's use in the Austin offices. The database will be further personalized for individual use by each of the 26 TxDOT districts.

Examine Current State and Federal Pipeline Regulatory Responsibilities

Continued examination of state and federal regulatory agencies' responsibilities regarding pipelines and pipeline interaction with other transportation modes will focus on the agencies' published interpretations of their understanding and enforcement intent of the pertinent regulations. Many regulations appear to be somewhat ambiguous. The researchers will attempt to provide TxDOT with an understanding of the various agencies' perceived ownership authority with respect to pipeline operations. The duties and responsibilities of the agencies involved will be detailed in this work for review by TxDOT.

The location of new pipeline alignments is a local permitting process subject to state and local regulation. The specific regulations governing these processes will be reviewed and documented for future use by TxDOT. In addition, the research team will evaluate the extent to which existing safety regulations govern the upgrading of in-place pipelines. This will become

increasingly important as metropolitan growth extends over land occupied by existing pipelines, regardless of whether the lines are subject to federal or state regulation.

Potential for Increased Pipeline Integration into the State's Transportation System

Completion of the research effort described in Chapter 1, "Regulatory Overview" and "Preliminary Examination of Potential for Integration," into the potential for increased integration of the petroleum, refined, and chemical product pipeline systems into the overall State transportation system assumes the private pipeline companies management maximizes their assets income. Using this premise, the research team has conducted research into the regulatory issues of what restrictions exist on the pipeline's ability to alter its business focus. Preliminary results are presented in Chapter One in sections, Regulatory Overview and Preliminary Examination of Potential for Integration.

Data Collection Implementation and Integration With Existing Knowledge Systems

The data collection and analysis and work toward obtaining valid new information sources will continue. The data collection implementation plan for year two includes:

- analysis of those information sources already located and obtained;
- obtaining additional information sources that appear to be relevant to pipeline-intermodal connections, within project budget feasibility;
- continued efforts toward obtaining throughput information that may help define facility significance;
- integration of intermodal data with pipeline information, particularly in area of port, harbor and waterway infrastructure, and the distribution, location, size and commodities of major inland terminals located on pipelines;
- investigation toward defining an effective economic radius of operation for petroleum terminals located on pipelines in an effort determine the maximum distance between storage tank systems and road systems that are impacted (e.g. interstate systems, federal highways, state highways, etc.); and
- continued effort in uncovering new information sources pertinent to the interconnection of pipelines with other transportation modes, which was the most significant challenge of the work for Task 4 in year one.

The results of the continued work toward analysis of pipeline-multimodal connections will be documented in the results for year two. While this funding effort limits the completeness of this evaluation, we hope to have a more complete understanding and inventory of pipeline interconnections for the largest of those in the port and waterway environment, along with pertinent information on the most significant of the inland terminals.

Propose New Roles and Responsibilities for TxDOT and/or Other State Agencies

The research team will examine existing state responsibilities relative to pipeline transportation and assess whether new roles or functions add value to the current transportation

activities of Texas or not. This assessment will include examining safety and productivity issues and considering the current role of pipelines as well as potential future roles.

The research team will review pipeline-operating characteristics, potential new commodities for transport, new or developing pipeline traffic flow routes, and the potential for including new pipelines to provide transportation in these sectors. The research team will evaluate which areas of the pipeline transportation industry in the state TxDOT will be able to most favorably impact by active participation. For example, one avenue for TxDOT influence may be to develop specific information systems for tracking pipeline and traditional surface transportation commodity flows where competition between modes is evident from the research developed.

Final Report

A research report and a project summary report will document the results of the research and serve as a resource document for future reference. The report will contain a detailed inventory of the state's pipeline system and be cross-referenced to GIS mapping of the current network, interconnections with other modes and available information on any new pipeline systems permitted, under construction, or planned for the future.

REFERENCES

1. "A Monthly Data Review from the Railroad Commission of Texas," Vol. 14, No. 8, Texas PetroFacts, August 2000.
2. Supreme Court Anti-trust Decisions, Standard Oil vs. U.S.
3. Phillips Petroleum Co. vs Wisconsin 347 U.S. 672 No. 280. Argued April 6-7, 1954 - Decided June 7, 1954 - 92 U.S. App. D.C. 284, 205 F.2d 706, Affirmed.
4. 16 U.S.C. § 2601 et seq.
5. *Petroleum Storage & Transportation Capacities*, Vol. 1, National Petoleum Counsel, December 1979
6. Kennedy, John L. *Oil and Gas Pipeline Fundamentals*. 2nd Edition. PennWell Publishing Company. Tulsa, Oklahoma. Kennedy, 1993.
7. Moser, A. P. *Buried Pipe Design*. McGraw-Hill. New York, 1990
8. Muhlbauer, W. Kent. *Pipeline Risk Management Manual*. Gulf Publishing Company. Houston, Texas, 1992.
9. The Pipeline Industries Guild. *Pipelines: Design, construction and operation.* Construction Press. New York, 1984.
10. McAllister, E. W. *Pipe Line Rules of Thumb Handbook: A manual of quick, accurate solutions to everyday pipe line engineering problems.* Gulf Publishing Company. Houston, Texas, 1998.
11. Frankel, Michael. *Facility Piping Systems Handbook.* McGraw Hill, New York, 1996.
12. *The American Heritage Dictionary of the English Language*, 3rd Edition. Houghton Mifflin Company, 1996.
13. *LEGO Design and Programming System*. "Physics Concepts." NASA Communicating Science. (http://ldaps.ivv.nasa.gov/Physics/bernoulli.html)
14. U.S. Department of Transportation, Federal Highway Administration, *U.S. Intermodal Freight Transportation; Opportunities and Obstacles,* August 1996
15. Texas Department of Transportation, *Texas Transportation Plan*, 1994 Edition.
16. Association of American Railroads, *1998 Railroad Service in Texas*, http://www.aar.org.
17. Port of Houston Authority, *1999 Foreign Trade Statistics*, www.portofhouston.com.
18. Port of Corpus Christi, *Yearly Statistics*, www.portofcorpuschristi.com.
19. United States Army Corps of Engineers Navigation Data Center, *Waterborne Commerce of the United States*, http://www.wrsc.usace.army.mil/ndc/.
20. National Waterways Association, *Navigation and Water Resources Programs: Importance to America's Chemical Industry*. http://www.waterways.org/.
21. *Maintenance and Operation of Petroleum Fuel Facilities*, Naval Facilities Engineering Command, NAVFAC MO-230, August 1990.
22. *New Webster's Dictionary and Thesaurus for the English Language*, Lexicon Publications, Inc., Danbury, CT, 1993.
23. Photo by Kyle Rhorer.
24. Photo by Advanced Computer Concepts, http://www.ac2.net, Houston, TX.
25. Brodie, Peter R. *Illustrated Dictionary of Cargo Handling*, Lloyds of London Press Ltd., London, U.K., 1991.
26. Photo by Han-Padron Associates, LLP.
27. Houston-Galveston Area Council, *Intermodal Facility Inventory*, January 2000.
28. U.S. Army Corps Of Engineers, Port Series No. 24: Port of Houston, Texas, 1999.

BIBLIOGRAPHY

American Heritage Dictionary of the English Language, 3rd Edition, Houghton Mifflin, Company, (1996).

Association of American Railroads, *1998 Railroad Service in Texas*, http://www.aar.org

Brodie, Peter R. *Illustrated Dictionary of Cargo Handling*, Lloyds of London Press Ltd., London, U.K., 1991.

Case Name: PHILLIPS PETROLEUM CO. V. WISCONSIN 347 U.S. 672 NO. 280. ARGUED APRIL 6-7, 1954 - DECIDED JUNE 7, 1954 - 92 U.S. APP. D.C. 284, 205 F.2D 706, AFFIRMED, http://www.fedworld.gov/supcourt/index.htm

Frankel, Michael, *Facility Piping Systems Handbook,* McGraw-Hill, New York, (1996).

Houston-Galveston Area Council, *Intermodal Facility Inventory*, January 2000.

Kennedy, John L., *Oil and Gas Pipeline Fundamentals*, 2nd Edition, PennWell Publishing Company, Tulsa, Oklahoma, (1993).

LEGO Design and Programming System, "Physics Concepts," NASA Communicating Science, (http://ldaps.ivv.nasa.gov/Physics/bernoulli.html)

Maintenance and Operation of Petroleum Fuel Facilities, Naval Facilities Engineering Command, NAVFAC MO-230, August 1990.

McAllister, E. W., *Pipe Line Rules of Thumb Handbook: A manual of quick, accurate solutions to everyday pipe line engineering problems*, Gulf Publishing Company, Houston, Texas, (1998).

Moser, A. P., *Buried Pipe Design,* McGraw-Hill, New York, (1990).

Muhlbauer, W. Kent, *Pipeline Risk Management Manual,* Gulf Publishing Company, Houston, Texas, (1992).

National Waterways Association, *Navigation and Water Resources Programs: Importance to America's Chemical Industry*. http://www.waterways.org/

New Webster's Dictionary and Thesaurus for the English Language, Lexicon Publications, Inc, Danbury, CT, 1993.

Petroleum Storage & Transportation Capacities, Vol. 1, National Petoleum Counsel, December 1979.

Pipeline Industries Guild, The, *Pipelines: Design, Construction and Operation*, Construction Press, New York, New York, (1984).

Port of Corpus Christi, *Yearly Statistics*, www.portofcorpuschristi.com.

Railroad Commission of Texas, *A Monthly Data Review*, Vol. 14, No. 8, Texas PetroFacts, August 2000

Supreme Court Anti-trust Decisions, Standard Oil vs. U.S., http://www.fedworld.gov/supcourt/index.htm

Texas Department of Transportation, *Texas Transportation Plan*, 1994 Edition.

United States Army Corps Of Engineers, *Port Series No. 24: Port of Houston, Texas*, 1999.

United States Army Corps of Engineers Navigation Data Center, *Waterborne Commerce of the United States*, http://www.wrsc.usace.army.mil/ndc/.

16 USC Sec. 792, Sec. 792. Federal Power Commission.

APPENDIX
A

EXAMPLES FROM FERC

INDEX OF CUSTOMERS

Pipeline Company Reports for Firm Transport Rate customers.

H	**HIGH ISLAND OFFSHORE SYSTEM**	**77**	**8/2/00**	**O**	**7/1/00**	**B**	**B**	**VERONICA HILL 713-420-3555**
D	TEXAS GAS TRANSMISSION CORPORATION	FTS-1	9/25/85	12/7/00		21280		
H	**TEXAS GAS TRANSMISSION CORPORATION**	**18**	6/30/00	O	7/1/00	B	B	**KATHY FORT (270) 688-6825**
D	**PROLIANCE ENERGY, LLC**	**FSS**	4/1/98	3/31/00	365	63968	4920606	
D	AIR PRODUCTS AND CHEMICALS, INC.	FT	1/1/00	12/31/15		12500		
D	BALTIMORE GAS & ELECTRIC COMPANY	FT	12/1/95	10/31/07		22672		
D	BAY STATE GAS COMPANY	FT	11/1/93	10/31/05		4336		
D	BENTON, CITY OF	FT	1/1/95	12/31/05		100		
D	BOONVILLE NATURAL GAS CORPORATION	FT	11/1/93	10/31/98	1825	700		
D	BOSTON GAS COMPANY	FT	11/1/93	10/31/05		13280		
D	BROOKLYN UNION GAS COMPANY, THE	FT	10/1/93	10/31/05		3737		
D	BROWNSVILLE UTILITY BOARD, CITY OF	FT	5/1/94	3/31/04		700		
D	CENTRAL ILLINOIS PUBLIC SERVICE COMPANY	FT	11/1/91	10/31/96	1460	1000		
D	CHANDLER NATURAL GAS CORPORATION	FT	11/1/93	10/31/98	1825	100		
D	CINCINNATI GAS & ELECTRIC COMPANY, THE	FT	11/1/90	10/31/00		30500		
D	CINCINNATI GAS & ELECTRIC COMPANY, THE	FT	6/1/94	10/31/04		12810		
D	CMS MARKETING, SERVICES AND TRADING COMPANY	FT	11/1/96	10/31/00		1000		
D	CMS MARKETING, SERVICES AND TRADING COMPANY	FT	11/1/98	3/31/00	365	0		
D	COMMONWEALTH GAS COMPANY	FT	10/1/93	10/31/05		1802		
D	COMMUNITY NATURAL GAS COMPANY, INC.	FT	11/1/93	10/31/98	1825	400		
D	CONOCO INC.	FT	5/1/96	4/30/98	1095	7200		
D	CORNING NATURAL GAS CORPORATION	FT	10/1/93	10/31/05		2882		
D	DAYTON POWER AND LIGHT COMPANY, THE	FT	11/1/94	10/31/04		4190		
D	DOW CORNING CORPORATION	FT	6/1/93	10/31/00		1200		
D	DOW CORNING CORPORATION	FT	11/1/93	10/31/00		2000		
D	DUKE ENERGY FUELS, L.P.	FT	11/1/97	10/31/08		90000		
D	DUKE ENERGY FUELS, L.P.	FT	11/1/98	10/31/08		90000		
D	DYERSBURG, CITY OF	FT	11/1/96	10/31/03		0		

Additional records not included by research team

H	Total Peaking Services, L.L.C.	170	7/1/00	O	7/1/00	T	T	Larry McGaughy 203-382-8645
D	CNE Peaking	LSV	10/1/98	9/30/03		42000	600000	
D	CNE Peaking	LSV	4/1/99	3/31/01		18000	300000	
D	CNE Peaking	LSV	4/1/00	3/31/01		8842	190000	
D	CNE Peaking	LSV	4/15/00	3/31/01		3158	50000	

H	KANSAS PIPELIE COMPANY	166	6/30/00	O	7/1/00	B	B
	Contact "CLAUDIA	SCHRULL"		(713) 821	-2045		
D	GREELEY GAS COMPANY	SCT-NN	11/1/99	10/31/00		1000	0
D	GREELEY GAS COMPANY	IT	6/1/98	5/31/00		10000	0
D	MARGASCO PARTNERSHIP	IT	6/1/98	5/31/00		70000	0
D	MISSOURI GAS ENERGY	FT	2/24/95	10/31/09		46332	0
D	ONECK GAS MARKETING COMPANY	IT	9/1/98	8/31/00		10000	0
D	UNITED CITIES GAS COMPANY	IT	6/1/98	5/31/00		10000	0
D	UNITED CITIES GAS COMPANY	SCT-NN	6/1/98	10/31/03		500	0
D	UNITED CITIES GAS COMPANY	SCT-NN	6/1/98	3/31/03		4000	0
D	KANSAS GAS SERVICE	FT	10/3/91	10/31/09		21100	0
D	KANSAS GAS SERVICE	FT	10/3/91	10/31/09		27568	0
D	KANSAS GAS SERVICE	FT-NN	10/3/91	10/31/09		35000	0
D	WESTERN RESUORCES INC.	FT-NN	2/28/95	3/31/17		6857	0
D	WESTERN RESUORCES INC.	FT-NN	2/28/95	9/30/17		6900	0
D	WESTERN RESUORCES INC.	FT	2/28/95	10/31/07		5700	0
D	WESTERN RESUORCES INC.	FT	11/1/09	10/31/14		27568	0
D	WESTERN RESUORCES INC.	FT-NN	11/1/09	10/31/14		35000	0
F		1 Affiliate of Kansas Pipeline Company					

H	Discovery Gas Transmission LLC		160	6/15/00	O	7/1/00	T
	Contact Mr. Landy Roberson	(713) 752-7	712				
D	American Resources Offshore Inc.	FT-2		9/1/98		2283	m1

D	British-Borneo Exploration Inc.	FT-2		12/1/96			54795			m1
D	British-Borneo Petroleum Inc.	FT-2		5/1/99			16781			m1
D	EEX Corporation	FT-2		10/1/99			6935			m1
D	Enserch Exploration Inc.	FT-2		1/1/97			27397			m1
D	Petrobas America Inc.	FT-2		11/1/99			2312			m1
D	Santa Fe Energy Resources Inc.	FT-2		1/1/97			30822			m1
D	Texaco Exploration and Production Inc.	FT-2		12/22/97			66438			m1
D	Vastar Gas Resources	FT-2		9/1/99			6849			m1
D	Walter Oil & Gas	FT-2		9/1/99			6849			m1
F		1	Term is for							
	life of lease, therefore there is no primary		contract							
	ending date or evergreen provision.									

H	**Sabine Pipe Line LLC**		79	6/15/00	O		7/1/00	T		
	Contact L. Wade Hopper (713) 752-7188									
D	Texaco Natural Gas Inc.	FT-1		11/1/97		12/31/11			30000	
D	Dynegy Gas Transportation, Inc.	FT-1		7/1/96		6/30/04			60000	
D	Coral Energy Resources, L.P.	FT-1		11/1/96		10/31/11			20000	
D	Texaco Natural Gas Inc.	FT-1		4/1/97		3/31/02			60000	
D	Reliant Energy Services, Inc.	FT-1		7/1/98		6/30/00		31	20000	
D	Dynegy Midstream Services,Limited Partnership	FT-1		10/1/98		7/31/04			4000	
D	Duke Energy Trading and Marketing, L.L.C.	FT-1		11/1/98		10/31/03			5000	
D	Reliant Energy Services, Inc.	FT-1		4/1/00		4/30/02			20000	

APPENDIX A
This Appendix is the FERC Instruction Manual for Electronic Filing of the Index of Customers

GENERAL INFORMATION

PURPOSE:

Under the authority of the Natural Gas Act (15 USC 717), the Commission promulgated 18 CFR §284.106(c) and §284.223(b), which state that each calendar quarter an interstate pipeline must file with the Commission an index of all of its firm transportation and storage customers under contract as of the first day of the calendar quarter. The pipeline must also post an electronic format of this information on its electronic bulletin board (EBB). The instructions herein will provide the format for the electronic dissemination of the data on the respondent's EBB in a downloadable file, as well as for the electronic file submitted to the Commission.

WHO MUST SUBMIT:

Each interstate pipeline regulated by the Commission that provides firm transportation or storage service under Subparts B or G of Part 284 of the Commission's regulations must file this information and also post it on its EBB.

WHAT TO SUBMIT:

Submit the data file on a MS-DOS formatted (or compatible) computer diskette or compact disc (CD) according to the electronic filing record formats prescribed herein. The diskette must have a label affixed to it stating the respondent's name, as well as the name of the electronic file. The CD must be enclosed in an appropriate disc protector with a label affixed to the protector stating the respondent's name and the name of the file. Filings submitted on CD must also conform to the specifications provided in Appendix B. The diskette or CD filings must be accompanied by a cover letter stating the content of the electronic filing. The cover letter must also include the subscription provided in Part 385.2005(a). All data submitted will be considered non-confidential and will be made available to the public upon request. There is no paper format required for this data. If the respondent submits a revised filing, the respondent must restate the original file with all additions, deletions, revisions, and corrections incorporated. The Header record, specifically data items, Report Date and Original/Revised Filing Indicator, and the filename must accurately reflect that the file is a revision.

WHEN TO SUBMIT:

The EBB posting date and Commission filing date for this information will be the first business day after the start of each calendar quarter. The first day of the calendar quarters are January 1, April 1, July 1, and October 1 of each year.

WHERE TO SUBMIT:
(1) Submit the electronic filing to:

Office of the Secretary
Federal Energy Regulatory Commission
Washington, DC 20426
(2) Hand deliveries can be made to:

Office of the Secretary
Federal Energy Regulatory Commission
Room 1-A
888 First Street, NE
Washington, DC 20426

You shall not be penalized for failure to respond to this collection of information unless the collection of information displays a valid OMB control number.

GENERAL INSTRUCTIONS

1. The information required for this filing must be recorded in a "TAB" delimited format with the data ordered as specified in the Electronic Filing Format section of these instructions. An example "TAB" delimited file adhering to the prescribed electronic filing formats is also provided. The "TAB" delimiter is an ASCII 9 - decimal or 09 – hexadecimal character. **There are two important instructions regarding "TAB" delimited files:**

   A. It is imperative the respondent realizes that the "TAB" characters are as important as the actual data coded onto the record. Without the correct "TAB" characters on the record to locate and distinguish data fields, the file cannot be data processed. The respondent must be careful not to use a software program to create the "TAB" delimited records which converts the "TAB" characters into equivalent space characters (ASCII 0 – decimal or 00 - hexadecimal). Refer to Appendix C for further information on how to create a "TAB" delimited file using various common software packages.

   B. If a data item is not applicable, the data item must be omitted, but the associated "TAB" character for that item still must be recorded on the record. For example, assume a record consists of four data items:

      company name, report year, beginning balance, and ending balance. Further, assume that the beginning balance field is to be left blank. Then, the structure of the reported record would be as follows:

      XYZ Natural Gas Company<TAB>1996<TAB><TAB>123456
      The double "TAB" characters denote a null (or blank) entry for the beginning balance data item on this record.

2. Each logical record should be terminated by a carriage return (CR) character (ASCII character - 13 decimal, 0D -hexadecimal) and line feed (LF) character (ASCII character 10 - decimal, 0A - hexadecimal).

3. All information required to be filed should be recorded in one file. The naming convention for this file is:

   "INNNYYMM.TAB", where "I" is the file name indicator used for the Index of Customers filing, "NNN" is the three-digit FERC pipeline code for the respondent from Appendix A, and "YYMM" is the two digit year and the two digit beginning month for each quarterly submittal. If it is necessary to submit revised reports, the file names should be
   "INNNYYMM.TA1", "INNNYYMM.TA2", etc., where ".TA1" indicates the first revision, ".TA2" the second revision, etc. For any revised reports, "YYMM" must refer to the year and beginning month of the quarter to which the revisions apply. The file name should be included in the transmittal letter accompanying the respondent's filing.

4. The definitions, instructions, and record type formats for this electronic filing specify explicitly the data items to be reported and the sequence for recording the information on the diskette.

5. All fields must adhere to the following conventions for coding data on the electronic filing:
   A. Numeric items do not require leading zeros, unless otherwise noted.
   B. If a data item is not applicable, its value must be omitted by using a second "TAB" delimiter immediately after the "TAB" delimiter of the previous data item.
   C. In accordance with 18 CFR §284.4, all quantities must be reported in MMBtu. If the Commission has granted the respondent a waiver of this regulation, and the respondent reports data in Mcf, report these volumes measured at 14.73 psia and 60 degrees Fahrenheit rounded to the nearest Mcf.
   D. Do not include commas in reporting any numeric value.

6. **Footnotes.** Footnotes may be used to submit additional information about any data items included in this report. A "Footnote" record is provided for this purpose.

7. **Source of Codes.**
   A. Pipeline ID - Use the FERC three-digit code for the respondent's pipeline. Appendix A is a list of valid pipeline codes. If your pipeline is not listed, call Judy Gantt or Curtis Chappell at 202-208-2020.
   B. Rate Schedule - Report the respondent's own designation for the rate schedule being reported. This rate schedule name must be entered exactly as it is reported in the FERC Forms Nos. 2 (or 2-A) and 11, as approved in Order No. 581.

Index of Customers

Electronic Filing Formats

Data Type	Item Id	Item	Format or value	Max Length	Instructions
Header	Header Record Identifier		H	1	Enter H to identify the header information
Enter one header record per filing	*a*	Pipeline Name	Char	55	Enter the full legal name
	b	Pipeline Id.	Num	3	Enter the 3 digit FERD pipeline code
	c	Report date	mm/dd/yy	10	Enter using the format provided making sure to include a 4 digit year. Enter the date the pipeline expects to file this report with the Commission.
	d	Original/Revised Filing Indicator	Char	1	Enter 0 if original filing, or R if revised filing.
	e	First day of Calendar Quarter	mm/dd/yy	10	Enter using the format provided making sure to include a 4 digit year.
	f	Unit of Measurement for Transportation Max Daily Quantity	Char	1	Enter B if MMBtu; F if MCF; T if Dth.
	g	Unit of Measurement for Storage Max Quanity	Char	1	Enter B if MMBtu; F if MCF; T if Dth.
	h	Contact Person and Phone Number	Char	50	Include full name of contact person and telephone number, including area code.
	i	Footnote Id	Char	50	Enter up to 10 Footnote Id's separated by /. Refer to the item footnoted in the first position of the Footnote Id (e.g., b10 indicated footnote 10 applies to item b. Use x of footnote applies to entire record, e.g., x10).

Electronic Filing Formats

Data Type	Item Id	Item	Format or value	Max Length	Instructions
DETAILS		Detail Block Identifier	D	1	Enter H to identify the header information
Enter one Detail record for each combination of customer/rate schedule/contract	*j*	Customer Name	Char	75	Enter the full legal name
	k	Rate Schedule	Char	30	Enter precisely as reported in FERC Forms 2 (or 2A) and 11, as approved in Order No. 581.
	l	Contract Effective Date	Mm/dd/yy	10	Enter using the format provided making sure to include a 4 digit year.
	m	Contract Primary Term Expiration Date	Mm/dd/yy	10	Enter the expiration date of the primary term of the contract using the format provided, making sure to include a 4 digit year.
	n	Days until Next Possible Contract Expiration	Num	5	If Contract Primary Term Expiration Date has passed and contract continues under an "evergreen" or "roll-over" provision, as defined in Order No. 636 (III FERC Statutes and Regulations ¶ 30,939 at 30,455), enter number of days in the roll-over or evergreen period. (E.g., if contract continues on monthly basis, enter 31; if annual, enter 365; if unknown or non-specific, leave blank, but include pertinent contract expiration information in a footnote).
	o	For Transportation, Max Daily Quantity	Num	15	Enter quantity in units specified in item f.
	p	For Storage, Max Quantity	Num	15	Enter quantity in units specified in item g. Enter the largest quantity of natural gas the pipeline is obligated to store for the shipper under the contract.
	q	Footnote Id	Char	50	Enter up to 10 Footnote Id's separated by /. Refer to the item footnoted in the first position of the Footnote Id (e.g., j5 indicates footnote 5 applies to item j. Use x of footnote applies to entire record, e.g., x5).

Index of Customers

Electronic Filing Formats

Data Type	Item Id	Item	Format or value	Max Length	Instructions
FOOTNOTES		Footnote Block Identifier	F	1	Enter F to identify the header information
Enter one Footnote record for each 255 character segment of a footnote.	*r*	Footnote Number	num	3	Enter the footnote number corresponding to any Footnote Id's referenced in the other records. The Footnote Number is that part of the Footnote Id without the Item Id character. E.g., if a Footnote Id entered on the HEADER record is "e1", then the Footnote Number to report in this field is "1".
	s	Footnote Text	Char	255	Separate the text of a single footnote into segments of up to 255 characters each. Enter the same Footnote Number for each segment of a single footnote. It is not necessary to use all 255 characters. E.g., You may have several lines of 80 characters for a single footnote. Neither is it necessary to pad a line to the 255th character.

Index of Customers
Sample Tab Delimited File

```
H  ABC Pipeline Company   123            01/10/1996  O          01/01/1996  B     B   John Doe 202-208-1111  e2
D  Customer #1            Rate Sched #1  01/01/1994  1/01/2000              1000      l1/o3
D  Customer #2            Rate Sched #2  06/01/1994  12/31/1994  31         1000      x2
D  Customer #2            Rate Sched #1  03/01/1993  12/31/1995             1500      m3/k4/p5
D  Customer #3            Rate Sched #3  01/01/1992  12/31/1993  365        1200       x4
F  1   This is the first line of footnote 1 which can continue for 255 characters
F  1   This is the 2nd line of footnote 1 .....
F  2   First line of footnote 2
F  3   First line of footnote 3 ..... .....
F  3   2nd line of footnote 3 .....
F  4   First line of footnote 4
F  5   First line of footnote 5.....
F  5   2nd line of footnote 5

H  ABC Pipeline Company   123            01/10/1996  O          01/01/1996  B     B   John Doe 202-208-1111 e2
D  Customer #1            Rate Sched #1  01/01/1994  01/01/2000             1000      l1/o3
D  Customer #2            Rate Sched #2  06/01/1994  12/31/1994  31         1000      x2
D  Customer #2            Rate Sched #1  03/01/1993  12/31/1995             1500      m3/k4/p5
D  Customer #3            Rate Sched #3  01/01/1992  12/31/1993  365        1200      x4
F  1   This is the first line of footnote 1 which can continue for 255 characters
F  1   This is the 2nd line of footnote 1
F  2   First line of footnote 2
F  3   First line of footnote 3
F  3   2nd line of footnote 3
F  4   First line of footnote 4
F  5   First line of footnote 5
F  5   2nd line of footnote 5
```

APPENDIX C
Pipeline ID Codes
This Appendix is the FERC Instruction Manual for Electronic Filing of the Index of Customers

Code	Pipeline Name
001	Alabama-Tennessee Natural Gas Company
020	Algonquin Gas Transmission Company
048	ANR Pipeline Company
091	ANR Storage Company
118	Arkansas Western Pipeline Company
061	Bayou Interstate Pipeline Systems
088	Black Marlin Pipeline Company
083	Blue Dolphin Pipeline Company
112	Blue Lake Gas Storage Company
109	Boundary Gas, Inc.
067	Canyon Creek Compression Company
084	Caprock Pipeline Company
120	Carnegie Interstate Pipeline Company
063	Carnegie Natural Gas Company
097	Chandeleur Pipe Line Company
003	Chattanooga Gas Company
022	CNG Transmission Corporation
032	Colorado Interstate Gas Company
021	Columbia Gas Transmission Corporation
070	Columbia Gulf Transmission Company
044	Commercial Pipeline Company, Inc.
125	Consumers Power Company
127	Cove Point LNG Limited Partnership
123	Crossroads Pipeline Company
012	Distrigas of Massachusetts Corporation
002	East Tennessee Natural Gas Company
023	Eastern Shore Natural Gas Company
033	El Paso Natural Gas Company
024	Equitable Gas Co./Equitrans Inc.
034	Florida Gas Transmission Company
105	Frontier Gas Storage Company
013	Gas Gathering Corporation
113	Gasdel Pipeline System Inc.
004	Granite State Gas Transmission, Inc.
051	Great Lakes Gas Transmission, Limited Partnership
095	Green Canyon Pipe Line Company
101	Gulf States Transmission Corporation
077	High Island Offshore System
094	Inland Gas Company, Inc., The
045	Inter-City Minnesota Pipelines Ltd., Inc.
081	Interstate Power Company

110	Iroquois Gas Transmission System, Limited Partnership
065	Jupiter Energy Corporation
117	K N Wattenberg Transmission L.L. Co.
053	K N Interstate Gas Transmission Company
046	Kentucky West Virginia Gas Company
099	Kern River Gas Transmission Company
011	Koch Gateway Pipeline Company
014	Lawrenceburg Gas Transmission Corporation
060	Locust Ridge Gas Company
098	Lone Star Gas Company
054	Louisiana-Nevada Transit Company
071	Michigan Consolidated Gas Company
124	Michigan Gas Storage Company
015	Mid Louisiana Gas Company
005	Midwestern Gas Transmission Company
047	MIGC, Inc.
025	Mississippi River Transmission Corporation
114	Mobile Bay Pipeline Company
092	Mojave Pipeline Company
103	Moraine Pipeline Company
036	Mountain Fuel Supply Company
096	NatGas U.S. Inc.
016	National Fuel Gas Supply Corporation
026	Natural Gas Pipeline Company of America
100	Nora Transmission Company
031	NorAm Gas Transmission Company
027	North Penn Gas Company
089	Northern Border Pipeline Company
059	Northern Natural Gas Company
093	Northwest Alaska Pipeline Company
037	Northwest Pipeline Corporation
116	Oktex Pipeline Company
078	Overthrust Pipeline Company
073	Ozark Gas Transmission System
086	Pacific Gas Transmission Company
064	Pacific Interstate Offshore Company
039	Pacific Interstate Transmission Company
062	Pacific Offshore Pipeline Company
041	Paiute Pipeline Company
028	Panhandle Eastern Pipe Line Company
072	Pelican Interstate Gas System
108	Penn York Energy Corporation
055	Questar Pipeline Company
040	Raton Gas Transmission Company
038	Ringwood Gathering Company
079	Sabine Pipe Line Company

006	Sea Robin Pipe Line Company
102	Seagull Interstate Corporation
008	South Georgia Natural Gas Company
007	Southern Natural Gas Company
106	Southwest Gas Storage Company
111	Steuben Gas Storage Company
069	Stingray Pipeline Company
115	Sumas International Pipeline Inc.
066	Superior Offshore Pipeline Company
080	Tarpon Transmission Company
122	TCP Gathering Company
009	Tennessee Gas Pipeline Company
010	Tennessee Natural Gas Lines, Inc.
017	Texas Eastern Transmission Corporation
018	Texas Gas Transmission Corporation
058	Texas Gas Pipe Line Corporation
090	Texas Sea Rim Pipe Line Company
068	Trailblazer Pipeline Company
075	Transco Gas Supply Company
029	Transcontinental Gas Pipe Line Corporation
042	Transwestern Pipeline Company
030	Trunkline Gas Company
087	Trunkline LNG Company
126	Tuscarora Gas Transmission Company
074	U-T Offshore System
019	Utah Gas Service Company
056	Valero Interstate Transmission Company
050	Valley Gas Transmission Company
082	Viking Gas Transmission Company
107	Washington Natural Gas Company
104	Washington Water Power Company
035	West Texas Gas Inc.
085	West Texas Gathering Company
052	Western Gas Interstate Company
057	Western Transmission Corporation
121	Westgas Interstate, Inc.
043	Williams Natural Gas Company
049	Williston Basin Interstate Pipeline Company
076	Wyoming Interstate Company, Ltd.
119	Young Gas Storage Company, Ltd.

CD SPECIFICATIONS

Filing on CD is an option for those respondents who wish to do so. However, all data filed on CD must adhere to the following two constraints:

1. All data submitted must be on CD-Recordable (CD-R) media or traditional CD-ROM media.

2. The file directory structure of the CD must adhere to the ISO 9660 Level One standard.

What is CD-R and how does it differ from traditional CD-ROM media?

CD-R is a technology that allows for creating CD-ROMs on the desktop more cheaply than traditional CD-ROM media. Traditional CD-ROMs are made by using a laser to "burn" pits in a thin metallic layer, thus recording the binary data. By comparison, CD-R uses special discs impregnated with an organic dye, which serves the same function as the pits, but at a much lower cost. Both kinds of discs are readable with a traditional CD-ROM drive. Other kinds of discs, magneto optical, or floptical discs, are not readable by the common CD-ROM drive, and require a different system altogether.

What is Level One ISO 9660?

The ISO 9660 standard is for file directory systems on CD-ROMs. It is a non-proprietary standard and can be used on different platforms. It defines naming conventions and directory depth. There are two main levels of ISO 9660: level one and level two. The major difference lies within the naming conventions. Level one ISO 9660 allows for MS-DOS style filenames (eight-character and three-character extensions). Level two ISO 9660 allows for 32-character filenames. Because the commission relies upon MS-DOS compatible personal computers, data submitted on CD-ROMs must be in compliance with Level One ISO 9660.

APPENDIX E
FILE CREATION HINTS

1. If you are using word processing software to create the electronic filing, make sure the package you select has the capability to convert a "TAB" character to an ASCII 9 – decimal or 09 - hexadecimal character, and does not just convert the "TAB" into a certain number of blank spaces. Remember that each record must occupy only one line within the word processing document. Therefore, before you start entering data, determine the maximum length of the longest record in your filing, and establish any combination of fonts and paper size/orientation settings that will allow for that longest record to be entered on a single line. If the data for any record "wraps" to another line, then you must change the document settings to allow for more characters to be entered per line. Allowing the text to wrap to another line within the word processor document will create two separate records when the file is converted to a "TAB" delimited file. Another suggestion you may find helpful is to set your tabs according to the length of the data fields for each record. This not only gives the appearance of order for each record type, but also permits you to visually edit the data for obvious errors, such as mixing character data in a numeric field.

   A. WordPerfect:
      1. DOS versions thru 5.1 - Create the individual records using the "TAB" key to separate the data items and the "Enter" key to end each record with a carriage return/line feed. Save the file using the "Text In/Text Out" / "Save As" / "Generic" commands.
      2. DOS version 6.0 - Create the individual records using the "TAB" key to separate the data items and the "Enter" key to end each record with a carriage return/line feed. Save the file using the "File" / "Save As" / "ASCII Text (Stripped)" commands.
      3. Windows versions 5.2 and 6.1 - Create the individual records using the "TAB" key to separate the data items and the "Enter" key to end each record with a carriage return/line feed. Save the file using the "File" / "Save As" / "ASCII Generic Word processor (DOS)" commands.

   B. Microsoft Word: Create the individual records using the "TAB" key to separate the data items and the "Enter" key to end each record with a carriage return/line feed. Save the file using the "File" / "Save As" / "Save File As Type" / "Text Only (*.txt)" commands.

   C. Windows Write: Create the individual records using the "TAB" key to separate the data items and the "Enter" key to end each record with a carriage return/line feed. Save the file using the "File" / "Save As" / "Save File As Type" / "Text Files (*.TXT)" commands.

2. If using a spreadsheet program to create the electronic filing, make sure that it can save the spreadsheet as a "TAB" delimited file. The only spreadsheet that staff has

accessibility to, and has found capable of saving "TAB" delimited files, is Microsoft Excel for Windows.

A. Excel 4.0: Create the individual records using the spreadsheet column cells to separate the data items and rows for each record. Save the file using the "File" / "Save As" / "Save File As Type" / "Text (OS/2 or MS_DOS)" commands.

B. Excel 5.0: Create the individual records using the spreadsheet column cells to separate the data items and rows for each record. Save the file using the "File" / "Save As" / "Save File As Type" / "Text (Tab delimited)" commands.

3. To test whether or not you have truly created a "TAB" delimited file, read the file into a word processor program and change the "TAB" settings of the document. If the text from the delimited file changes with the new "TAB" settings, then the original file you created was in a "TAB" delimited format.

APPENDIX
B

RAILROAD COMMISSION OF TEXAS

INFORMATION TECHNOLOGY SERVICES DIVISION

USER'S GUIDE

DIGITAL MAP INFORMATION

PUBLICATION NUMBER: OGA094

PUBLISHED BY THE
RAILROAD COMMISSION OF TEXAS
P.O. BOX 12966
AUSTIN, TEXAS 78711

The Information Technology Services Division (ITS) developed this publication for the general public in response to inquiries concerning the availability of digital map data. Any request for assistance with using the manual will be given every consideration.

First Edition: January 2000

Publication Number: OGA094

TABLE OF CONTENTS

I. GENERAL INFORMATION

IDENTIFICATION

Developed For:	Users of RRC Mapping Information
By:	RRC of Texas, Information Technology Services Division, Hope Morgan, Dir.
Computer:	Digital Alpha Workstation, UNIX 4.OD Operating System

OUTPUT MEDIUMS

The Digital Well Location Mapping information is available for output onto the following mediums:

CD-ROM (Compact Disk)
FTP (File Transfer Protocol)

TAR and GZIP
The Railroad Commission uses the UNIX commands TAR and GZIP on all GIS export files. TAR, an acronym for "tape archiving", is commonly used to combine – or “archive” -- two or more files for storage or distribution. The RRC uses GZIP to compress TARed files.

RRC GIS data files can be uncompressed and unarchived on UNIX operating systems with the following commands:

```
gunzip <file_name>.tar.gz
tar xf <file_name>.tar
```

The Railroad Commission has successfully uncompressed and unarchived GIS export files using WinZip 6.3 and PKZip 2.6 on an IBM-compatible PC. It is assumed more recent versions of both WinZip and PKZip retain their previous extract capabilities.

Once the original RRC GIS digital data file is uncompressed and unarchived, the user will have all requested data layers in the appropriate format for a particular county or USGS quadrangle.

Disk Size Requirements
Documentation for the UNIX command GZIP states, in part, “The GZIP command uses the Lempel-Ziv algorithm used in the ZIP and PKZIP commands. The amount of compression obtained depends on the size of the input and the distribution of common substrings.” GZIP compresses the typical RRC shapefile data set 55 percent - 65 percent and .E00 files 80 percent - 90 percent. Therefore, users should expect and plan for uncompressed RRC GIS export files to

occupy, depending on the export format, anywhere from 1.5 to almost twice the disk space of the compressed files.

Also, ESRI software users should be aware that ArcInfo and ArcView may require considerable amounts of free disk space to successfully execute commands. For example, ArcInfo documentation states that the CLEAN command "requires free disk space around 13 times the size of (the) <in_cover> to create temporary scratch files."

SYSTEM DESCRIPTION

The Railroad Commission of Texas exports double-precision map data from ARC/INFO version 7.2.1 mounted on a Digital Alpha workstation operated by UNIX ver. 4.0D. Exports are to Environmental Systems Research Institute's (ESRI) ARC/INFO interchange file (.E00) and shapefile (.SHP) formats.

Interchange files, used to transfer ARC/INFO coverage information amongst machines, is a fixed-length ASCII file. Each interchange file has an .E00 file extension and contains all coverage information and appropriate INFO file information.

Shapefiles, developed by ESRI for use with its ARCVIEW software, store a feature's geographic location and attribute information. The shapefile format is a collection of three different files:

<shape_file>.SHP – contains a feature's geometry.
<shape_file>.SHX – contains a feature's geometry index.
<shape_file>.DBF – contains a feature's dBase attribute information.

ESRI considers their interchange file format to be proprietary and the shapefile format cannot be adequately explained here. If necessary, users can access detailed information about both file formats at:

http://www.geocities.com/~vmushinskiy/fformats/fformats.htm

ARCVIEW shapefiles are created from the RRC's ARC/INFO map data. Features are translated from ARC/INFO to ARCVIEW in the following manner:

A/I Feature Class	A/V Shapefile Type
Points	Type 1 – Point
Tic	Type 1 – Point
Node	Type 1 – Point
Arcs	Type 3 – Line
Polygons	Type 5 – Polygon
Region	Type 5 – Polygon
Annotation	**NOT SUPPORTED**

COORDINATE SYSTEM

MIMS: The Railroad Commission exports all map data to the Geographic projection (Latitude/longitude). The following parameters define the Geographic projection:

Projection:	Geographic
Units:	Decimal Degrees
Datum:	NAD27

Region subclasses (.PAT<subclass_name>) were not supported by ESRI prior to Rev. 7.0 and will not import into ARC/INFO versions prior to Rev. 7.0.

Annotation subclasses will import into versions prior to Rev. 6.0 but will not function the same way they do at Rev. 6.0.

PC ARC/INFO, Rev. 3.4.2D or higher, will import RRC double-precision .E00 interchange files but will create single-precision coverages.

ArcCAD 11.2 and 11.3 and versions of PC ARC/INFO prior to Rev. 3.4.2D require single-precision interchange files. Please contact the Railroad Commission for assistance.

DISCLAIMER

The digital data described in this manual was generated by the Geographic Information System of the Railroad Commission of Texas. Base map information was obtained directly from U.S. Geological Survey 7.5 minute quadrangle maps. Patent Survey lines from Texas General Land Office maps were interpreted as accurately as possible over the U.S. Geological Survey base. Oil and gas well data or pipeline data (if included) was obtained from public records of the Railroad Commission. The mapping system from which this data was extracted is currently under development. The data is intended solely for the internal use of the Railroad Commission, which makes no claim as to its accuracy or completeness.

II. DISCUSSION OF FILES

AVAILABLE MAP DATA

****

Please note that GIS feature layers may not necessarily exist in all counties or in all USGS quadrangles. If a GIS feature layer - such as railroads or government lands - does not exist in a particular county or USGS quadrangle, you will not receive a file for that feature layer. The absence of feature layers in particular counties and USGS quadrangles is already accounted for in the data pricing.

****

The digital data used to create the files was taken from the forms system within the RRC, from the General Land Office (GLO) county survey maps, and, United States Geological Survey (USGS) quadrangle maps.

ESRI's export formats are recognized and accepted industry-wide and are easily imported to and used in many GIS and CAD software packages. However, the user is responsible for confirming that their specific GIS or CAD software fully supports the importation and use of either interchange files or shapefiles.

Available digital map data layers includes:

1. Basemap:
    a. Airports
    b. Cemeteries
    c. Cities
    d. Government Lands
    e. Political Boundaries (includes, where applicable, county, state, offshore and gulf area boundaries.)
    f. Railroads
    g. Roads
    h. Ship Channels
    i. Subdivisions
    j. Surveys (Includes, where applicable, abstracts and bay tracts.)
    k. Water Features
2. Wells:
    a. Utility Well Locations
    b. Surface Well Locations
    c. Bottom Well Locations
    d. For horizontal and directional wells, arcs connecting surface and bottom locations.
3. Pipelines:
    a. Pipelines – Abandoned
    b. Pipelines – Liquid
    c. Pipelines – Gas

FILE NAMING CONVENTIONS

The archived and compressed files you receive from the Railroad Commission are named as follows:

If you ordered data by county:

1. The 1st letter is a "C"
2. The county FIPS code follows the initial letter.
3. If you ordered .E00 interchange files, "_e00" follows the FIPS or quad number
4. If you ordered .SHP shapefiles, "_shp" follows the FIPS or quad number
5. All files have the suffix ".tar.gz"

   Examples:

   a. Harris County exported to .E00 files: c201_e00.tar.gz
   b. County FIPS code 307 exported to .SHP files: c307_shp.tar.gz

If you ordered data by USGS quadrangle:

1. The 1st letter is a "Q"
2. The USGS quad number follows the initial letter
3. If you ordered .E00 interchange files, "_e00" follows the FIPS or quad number
4. If you ordered .SHP shapefiles, "_shp" follows the FIPS or quad number
5. All files have the suffix ".tar.gz"

   Examples:

   a. USGS quad SOUTHMOST exported to .E00 files:597432_e00.tar.gz
   b. USGS quad number 3099142 exported to .SHP files:
   q3099142_shp.tar.gz

A. Exports by *County FIPS Code* to ArcInfo .E00 interchange files and *County Name* to ArcInfo .E00 interchange files:

1. Airport arcs:	air<fips_number>.e00
2. Cemetery arcs/points:	cem<fips_number>.e00
3. City arcs:	cit<fips_number>.e00
4. County Boundary arcs/polys/regions:	cty<fips_number>.e00
5. Government Land arcs:	gov<fips_number>.e00
6. Railroad arcs:	rail<fips_number>.e00
7. Road arcs:	road<fips_number>.e00
8. Ship Channel arcs:	ship<fips_number>.e00
9. Subdivision arcs/points:	subd<fips_number>.e00
10. Survey arcs/polygons/regions:	surv<fips_number>.e00
11. Water arcs/polygons:	watr<fips_number>.e00
12. Wells:	
Utility Well points:	well<fips_number>u.e00
Surface Well points:	well<fips_number>s.e00
Bottom Well points:	well<fips_number>b.e00
Surface/Bottom arcs:	well<fips_number>l.e00

13. Pipelines:

B. Exports by *County FIPS Code* to ArcView Shape files and *County Name* to ArcView Shape files:

1. Airport arcs: air<fips_number>.shp; .shx; .dbf
2. Cemetery arcs: cem<fips_number>l.shp; .shx; .dbf
   - points: cem<fips_number>p.shp; .shx; .dbf
3. City arcs: cit<fips_number>.shp; .shx; .dbf
4. County Boundary arcs: cty<fips_number>l.shp; .shx; .dbf
   - polygons: cty<fips_number>a.shp; .shx; .dbf
   - coastal regions: cty<fips_number>g.shp; .shx; .dbf
   - counties regions: cty<fips_number>h.shp; .shx; .dbf
   - gulfareas regions: cty<fips_number>i.shp; .shx; .dbf
   - offshore regions: cty<fips_number>j.shp; .shx; .dbf
   - state regions: cty<fips_number>k.shp; .shx; .dbf
5. Government Land arcs: gov<fips_number>.shp; .shx; .dbf
6. Railroad arcs: rail<fips_number>.shp; .shx; .dbf
7. Road arcs: road<fips_number>.shp; .shx; .dbf
8. Ship Channel arcs: ship<fips_number>.shp; .shx; .dbf
9. Subdivision arcs: subd<fips_number>l.shp; .shx; .dbf
   - points: subd<fips_number>p.shp; .shx; .dbf
10. Survey arcs: surv<fips_number>l.shp; shx; dbf
    - polygons: surv<fips_number>a.shp; shx; dbf
    - abstract region: surv<fips_number>s.shp; shx; dbf
    - baytract region: surv<fips_number>b.shp; shx; dbf
11. Water arcs: watr<fips_number>l.shp; .shx; .dbf
    - polygons: watr<fips_number>a.shp; .shx; .db

12. Wells:
    - Utility Well points: well<fips_number>u.shp; .shx; .dbf
    - Surface Well points: well<fips_number>s.shp; .shx; .dbf
    - Bottom Well points: well<fips_number>b.shp; .shx; .dbf
    - Surface/Bottom arcs: well<fips_number>l.shp; .shx; .dbf

File Naming Convention For Exports By USGS Quadrangle To .E00 Interchange Files:
Exported by USGS quadrangle to .E00 interchange files comply with 8.3 naming conventions. Information about the 8.3 naming convention can be found in Appendix E.

<feature_layer_letter>{well_feature_type_number}<latitude_identifier>
<five_digit_quadrangle_number>

<feature_layer_letter>: A single letter identifying one of the 13 possible GIS data layers. This letter always occupies the first position in the shapefile name. Feature layer letters are:

a = airports	b = cemeteries	c = cities
d = boundaries	e = government lands	f = railroads

g = roads	h = ship channels	i = subdivisions
j = surveys	k = water	l = wells
m = pipelines		

{well_feature_type_number}: Only horizontal/directional arcs and utility, surface and bottom well point locations require feature type numbers. No other feature type other than wells will have a feature type number. Well feature type numbers always occupy the second position in the filename.

Well feature type numbers are:

utility well points	1
surface well points	2
bottom well points	3
surface/bottom arcs	4

<latitude_identifier>: A single letter identifying one of 12 possible latitudes in Texas. This letter always occupies the second position in the shapefile name except for well .E00 interchange files, where the latitude identifier occupies the third position . Latitude identifiers are:

a = 25th latitude	b = 26th latitude	c = 27th latitude
d = 28th latitude	e = 29th latitude	f = 30th latitude
g = 31st latitude	h = 32nd latitude	i = 33rd latitude
j = 34th latitude	k = 35th latitude	l = 36th latitude

<five_digit_quadrangle_number>: The last five digits of a USGS quadrangle number.

EXAMPLES

1. Airport .E00 files are created for USGS quadrangle number 3501231. The airport file is named:

ak01231.e00
a: Is the feature layer letter for Airports
k: Is the latitude identifier for the 35th latitude – the USGS quadrangle number's first two digits.
01231: The USGS quadrangle's last five digits.

2. Cemetery .E00 files are created for USGS quadrangle number 2798112. The cemetery file is named:

bc98112.e00

b: Is the feature layer letter for Cemeteries
c: Is the latitude identifier for the 27th latitude – the USGS quadrangle number's first two digits.
98112: The USGS quadrangle's last five digits.

3. Bottom well location .E00 files are created for USGS quadrangle number 3294321. The bottom well location file is named:

l3h94321.e00

l: Is the feature layer letter for Wells
3: Is the feature type number for Bottom Wells
h: Is the latitude identifier for the 32nd latitude – the USGS quadrangle number's first two digits.
94321: The USGS quadrangle's last five digits.

Naming Convention for Quadrangle Exports to Shapefiles: Exports by USGS quadrangle to .SHP shapefiles comply with 8.3 naming conventions. Information about the 8.3 naming convention can be found in Appendix E.

<feature_layer_letter><feature_type_number><latitude_indentifier>
<five_digit_quadrangle_number>

<feature_layer_letter>: A single letter identifying one of the 13 possible GIS data layers. This letter always occupies the first position in the shapefile name. Feature layer letters are:

a = airports	b = cemeteries	c = cities
d = boundaries	e = government lands	f = railroads
g = roads	h = ship channels	i = subdivisions
j = surveys	k = water	l = wells
m = pipelines		

<feature_type_number>: A single number identifying the feature type. Feature types are always point, line or polygon. (Shapefiles do not support annotation features.) Since feature layers may contain multiple point or polygon shapefiles, refer to the table below for specific feature type numbers for particular feature layers. The feature number always occupies the second position.

FEATURES	FEATURE LAYER LETTERS	TYPES	FEATURE TYPE NUMBERS
airport	a	arcs	1
cemeteries	b	arcs	1
		points	2
cities	c	arcs	1
boundaries	d	arcs	1
		polygons	2
		coastal polygons	3
		county polygons	4
		gulfareas polygons	5
		offshore polygons	6
		state polygons	7

government land	e	arcs	1
railroads	f	arcs	1
roads	g	arcs	1
ship channels	h	arcs	1
subdivisions	i	arcs	1
		points	2
surveys	j	arcs	1
		polygons	2
		abstract polygons	3
		baytracts polygons	4
water	k	arcs	1
		polygons	2
Wells	l	utility well points	1
		surface well points	2
		bottom well points	3
		surface/bottom arcs	4
pipelines	m	arcs	1

<latitude_identifier>: A single letter identifying one of 12 possible latitudes in Texas. This letter always occupies the third position in the shapefile name. Latitude identifiers are:

a = 25th latitude	b = 26th latitude	c = 27th latitude
d = 28th latitude	e = 29th latitude	f = 30th latitude
g = 31st latitude	h = 32nd latitude	i = 33rd latitude
j = 34th latitude	k = 35th latitude	l = 36th latitude

<five_digit_quadrangle_number>: The last five digits of a USGS quadrangle number.

EXAMPLES

1. Airport shapefiles are created for USGS quadrangle number 3501231. The airport arc shapefiles are named:

a1k01231.shp, .shx, .dbf

a: Is the feature layer letter for Airports
1: Is the feature type number for Airport arcs
k: Is the latitude identifier for the 35th latitude – the USGS quadrangle number's first two digits.
01231: The USGS quadrangle's last five digits.

2. Cemetery shapefiles are created for USGS quadrangle number 2798112. The cemetery point shapefiles are named:

b2c98112.shp, .shx, .dbf

b: Is the feature layer letter for Cemeteries
2: Is the feature type number for Cemetery points
c: Is the latitude identifier for the 27th latitude – the USGS quadrangle number's first two digits.
98112: The USGS quadrangle's last five digits.

3. Boundary shapefiles are created for USGS quadrangle number 3294321. The offshore polygon shapefiles are named:
d6h94321.shp, .shx, .dbf

d: Is the feature layer letter for Boundaries
6: Is the feature type number for Offshore polygons
h: Is the latitude identifier for the 32nd latitude – the USGS quadrangle number's first two digits.
94321: The USGS quadrangle's last five digits.

III. RAILROAD COMMISSION MAPPING TERMS

MAPPING TERMS USED AT THE RRC

Survey
A survey is a certified measured description of a piece of land. The term sometimes refers to the land itself. In Texas, original surveys were performed as part of the patenting process whereby land was transferred from the public domain. These "*patent surveys*," recorded at the Texas General Land Office, constitute an official land grid for the State and are the basis for subsequent land surveys.

Block
A block is a defined set of original land surveys. A block has an identifying name and/or number, and surveys within it are usually consecutively numbered, mile-square sections. Land grants from the State of Texas to railroad companies were often patented in blocks and sections. The term block is also used as a unit of a subdivision, i.e., subdivision/block/lot.

Section
A section refers to a square land survey measuring exactly one mile on each side. Some of the land transferred from the public domain by the state of Texas was surveyed and patented in units of square miles. The Texas General Land Office officially considers these units sections. Also, it was common that larger land grants, such as school lands and capitol lands, were subsequently surveyed into square mile units for the convenience of sale; these surveys are also called sections. In addition, the term "*section*" is commonly used to describe surveys in a group that have been assigned consecutive survey numbers, even though some of them do not have the proper shape or size to truly be sections.

Abstract
In Texas, the term abstract refers to an original land survey describing an area transferred from the public domain by either the Republic of Texas or the State of Texas. These surveys are recorded in the "*State Abstract of Land Titles*," which is maintained by the Texas General Land Office. Each survey so recorded is assigned an abstract number, which is unique within the county in which the survey falls. Because Texas has never performed a uniform statewide land survey, these original surveys called "*Patent Surveys*" constitute the State's Official Land Survey System.

IV. FILE LAYOUT AND DATA DICTIONARY

DATA DICTIONARY

This data dictionary defines unique RRC map attribute items and is structured as follows:

<ITEM NAME> <INPUT WIDTH, OUTPUT WIDTH, TYPE {NUMBER_OF_DECIMALS}>

Item Name:
The name of an attribute item in a data file

Input Width:
Number of spaces (or bytes) used to store item values.

Output Width:
Number of spaces used to display the item values.

Type:
One of the following data types:

B – Whole numbers stored as binary integers.
C – Character
D – Dates
F – Decimal numbers stored in internal floating-point.
I – Integers
N – Decimals

Number_of_Decimals:
Number of digits to the right of the decimal place for data types holding decimals.

GENERAL ARC ATTRIBUTE INFORMATION

All coverage arc attribute tables (<COVERAGE_NAME.AAT>) have the following two items:

DTYPE: (2,3,B)
Data type. All data types are given in Appendix A. (Arcs where DTYPE and LTYPE both = 0, are USGS quad boundary arcs.)

LTYPE: (2,3,B)

Line type. All line types are given in Appendix A. (Arcs where DTYPE and LTYPE both = 0, are USGS quad boundary arcs.)

COUNTY BOUNDARY ATTRIBUTE INFORMATION

Data Items in the <COVERAGE_NAME>.PATCOASTAL AND
<COVERAGE_NAME>.PATGULFAREAS AND
<COVERAGE_NAME>.PATOFFSHORE:

FIPS: (3,3,C)
Federal Information Processing Standard code (FIPS) is a three character county code. FIPS codes are listed in Appendix B.

COUNTYNAME1: (14,14,C)
(named C_NAME1 in shape files) The county name is in upper case letters.

DISTRICT: (2,2,C)
RRC field office territories or designated areas.

SPZONE: (1,1,C)
The State Plane Coordinate System is based on the Lambert Conformal Conic projection. This coordinate system includes five horizontal state plane coordinate zones following the county boundaries throughout Texas. Measurements are in feet. The zones are named and numbered as follows:

STATE PLANE ZONE	ZONE NAME	ZONE NUMBER	FIPS ZONE
1	North	5326	4201
2	North Central	5351	4202
3	Central	5376	4203
4	South Central	5401	4204
5	South	5426	4205

COUNTYNAME2: (14,14,C)
(Named C_NAME2 in shape files). The county name where only the first letter of the name is capitalized.

DATA ITEMS IN THE <COVERAGE_NAME>.PATGULFAREAS:

AREANAME: (50,50,C)
The FIPS code and county name for a gulf area. FIPS codes and names are listed in Appendix B.

RAILROAD ATTRIBUTE INFORMATION

DATA ITEMS IN THE <COVERAGE_NAME>.AAT:

RAIL_COID: (4,5,B)
Railroad company identification number

SUBDIVISION ATTRIBUTE INFORMATION

DATA ITEMS IN THE <COVERAGE_NAME>.PAT:

FIPS: (3,3,C)
Three character county code. FIPS codes are listed in Appendix B.

NAME: (55,55,C)
The subdivision name.

SURVEY ATTRIBUTE INFORMATION
DATA ITEMS IN THE <COVERAGE_NAME>.PATABSTRACT:

ANUM: (12,12,C)
Abstract Number, e.g., A-0000. Assigned to the surveyed parcel by the General Land Office at the time of patenting. If the abstract number field contains a "?" or is blank, then no abstract number was found.

L1SURNAM: (32,32,C)

Survey name. The name of the original grantee or the name of the company, individual or eleemosynary institution that is common among a formed group of surveys as shown on the General Land Office (GLO) county patent survey map or the GLO State Abstract of Land Titles.

L2BLOCK: (10,10,C)
Block Number. The number or letter used in description of a group of surveys identified as a Block on the GLO map. Example: 101

L3SURNUM: (8,8,C)
Section number. Further describes an abstracted surveyed parcel. Or, when preceded by “SUR”, a surveyed parcel further divided into numbered abstracted areas. Example: SUR 101

L4SURNAM: (32,32,C)
Sub-Survey name of the grantee when the survey is a part of a larger refined area surveyed by a common party, and is only added if it is shown on the GLO map. A scrap file number corresponding to GLO records may also appear in the field.

L5SFOMF: (9,9,C)
Scrap or mineral file number from the GLO Abstract of Land Titles

FIPS: (3,3,C)
Three character county code. FIPS codes are listed in Appendix B.

DATA ITEMS IN THE <COVERAGE_NAME>.PATBAYTRACT:

BAYNUM: (9,9,C)
Provided by the General Land Office

BAYID: (3,3,C)

Bay area name abbreviations.

TRACTNUM: (6,6,C)
Provided by the General Land Office

WATER ATTRIBUTE INFORMATION

DATA ITEM IN THE <COVERAGE_NAME>.PAT:

TYPE: (1,1,C)
Identifies a polygon as either land (L) or water (W).

WELL ATTRIBUTE INFORMATION

****
For some historical wells, fields such as APINUM and CWELLNUM may be blank due to the limited amount of research time to capture this information.
****

UTILITY WELLS:

API: (8,8,C)
(Utility, Bottom and Surface Wells .PAT) Eight character field equivalent to APINUM minus the 2 digit STATE Code and minus the 2 digit STCODE.

COUNTY: (3,3,C)
(Utility, Bottom and Surface Wells) Three character FIPS county code. FIPS codes are listed in Appendix B.

RELIAB: (2,2,C)
(Utility, Bottom and Surface Wells .PAT) Indicates the reliability of the well spot (the accuracy of the location of the well). Valid reliability codes are listed in Appendix C.

SURFACE-ID: (4,7,B)
(Utility, Bottom and Surface Wells .PAT) Surface well identification number.

SYMNUM: (2,3,B)
(Utility, Bottom and Surface Wells .PAT) Indicates the type of well under Datatype 50 in Appendix A.

WELLID: (5,5,C)
(Utility, Bottom and Surface Wells .PAT) Character field equal to APINUM's last five digits.

BOTTOM WELLS:

API: (8,8,C)
(Utility, Bottom and Surface Wells .PAT) Eight character field equivalent to APINUM minus the 2 digit STATE and minus 2 digit STCODE.

API10: (10,10,C)
(Bottom Wells .PAT) Ten character field equivalent to APINUM minus the 2 digit STATE Code.

APINUM: (12,12,C)
(Bottom Wells .PAT) The American Petroleum Institute (API) number of the wellbore in which the well is located. This 12-digit number includes a two-digit state code (Texas=42), an eight-digit API code, and a two-digit sidetrack code. (A sidetrack code identifies wells drilled from within a wellbore.)

BOTTOM-ID: (4,7,B)
(Bottom Wells .PAT) Bottom well identification number.

COUNTY: (3,3,C)
(Utility, Bottom and Surface Wells) Three character FIPS county code. FIPS codes are listed in Appendix B.

CWELLNUM: (6,6,C)
(Bottom Wells .PAT) Current well number as assigned by the operator.

FRESHWTR: (1,1,C)
(Bottom Wells .PAT) If given the value "Y", indicates a well converted to a fresh water well.
LAT: (8,12,F,7)
(Bottom and Surface Wells .PAT) Latitudinal position of the well. Datum is 1927.

LONG: (8,12,F,7)
(Bottom and Surface Wells .PAT) Longitudinal position of the well. Datum is 1927.

RADIOACT: (1,1,C)
(Bottom Wells .PAT) Whether the well is radioactive (if the bore contains any known radioactive material).

Y - well is radioactive.

N - well is not radioactive.

RELIAB: (2,2,C)
(Utility, Bottom and Surface Wells .PAT) Indicates the reliability of the well spot (the accuracy of the location of the well). Valid reliability codes are listed in Appendix C.

STATE: (2,2,C)
(Bottom Wells .PAT) Two character API-assigned identifier. Texas = 42

STCODE: (2,2,C)
(Bottom Wells .PAT) Side Track Code. Side tracks are numbered incrementally from 1 to 9, then from A through Z.

POSITION 1:1	POSITION 2:2
D = Directional	1 to 9 or,
H = Horizontal	A to Z
W = Well	

SURFACE-ID: (4,7,B)
(Utility, Bottom and Surface Wells .PAT) Surface well identification number.

SYMNUM: (2,3,B)
(Utility, Bottom and Surface Wells .PAT) Indicates the type of well under Datatype 50 in Appendix A.

WELLID: (5,5,C)
(Utility, Bottom and Surface Wells .PAT) Character field equal to APINUM's last five digits.

WELLID7: (7,7,C)
(Bottom Wells .PAT) Character field equal to APINUM's last five digits plus STCODE.

SURFACE WELLS:

API: (8,8,C)
(Utility, Bottom and Surface Wells .PAT) Eight character field equivalent to APINUM minus the 2 digit STATE Code and minus the 2 digit STCODE.

COUNTY: (3,3,C)
(Utility, Bottom and Surface Wells) Three character FIPS county code. FIPS codes are listed in Appendix B.

LAT: (8,12,F,7)
(Bottom and Surface Wells .PAT) Latitudinal position of the well. Datum is 1927.

LONG: (8,12,F,7)
(Bottom and Surface Wells .PAT) Longitudinal position of the well. Datum is 1927.

RELIAB: (2,2,C)
(Utility, Bottom and Surface Wells .PAT) Indicates the reliability of the well spot (the accuracy of the location of the well). Valid reliability codes are listed in Appendix C.

SURFACE-ID: (4,7,B)
(Utility, Bottom and Surface Wells .PAT) Surface well identification number.

SYMNUM: (2,3,B)
(Utility, Bottom and Surface Wells .PAT) Indicates the type of well under Data type 50 in Appendix A.

WELLID: (5,5,C)
(Utility, Bottom and Surface Wells .PAT) Character field equal to APINUM's last five digits.

WELL ARCS:

API_NUM: (12,12,C)
(Well Arcs .AAT) The American Petroleum Institute (API) number of the wellbore in which the well is located. This 12-digit number includes a two-digit state code (Texas=42), an eight-digit API code, and a two-digit sidetrack code. (A sidetrack code identifies wells drilled from within a wellbore.)

BOTT-ID: (4,7,B)
(Well Arcs .AAT) Bottom well identification number.

LTYPE: (2,3,B)
(Well Arcs .AAT) Line type of the directional well line

SURF-ID: (4,7,B)
(Well Arcs .AAT) Surface well identification number.

PIPELINE ATTRIBUTE INFORMATION

****
The Texas Railroad Commission is currently in the process of modifying and updating pipeline attributes to conform with the National Pipeline Mapping System (NPMS). Users of RRC pipeline data can expect specific items within the pipeline attribute table to be updated at any time.
****

DATA ITEMS IN THE <PIPELINE>.AAT

LINE_TYPE: (2,3,B)
Line type. All line types are given in Appendix A.

T4PERMIT: (5,5,C)
RRC-assigned five-digit pipeline permit number.

DIAMETER: (5,5,C)

Nominal diameter, in inches, of the pipeline segment.

FLUIDS: (20,20,C)

Abbreviation for the primary commodity carried by the pipeline system. The following is a listing of fluid categories and their systypes. Appendix D has a complete listing of specific products within the fluid categories.

Fluid Category	Land Systypes	Offshore Systypes
Acetylene	Q	
Alcohols	P	
Ammonia	P	
Benzenes	P	
Butanes	Q	
Carbon Dioxide	K	
Condensate	K	
Crude	L (Gathering)	A
Crude	O (Transmission)	A
Diesels	P	
Ethanes	Q	
Ethlyene	Q	
Ethylene (Gas)	T	
E/P Mix	Q	
Feedstock	P	
Fuel Oil	P	
Gasoline	P	
Hydrogen Gas	T	
Jet Fuel	P	
Kerosene	P	
LPG	Q	
Natural Gas	T (Transmission)	Z
Natural Gas	G (Gathering)	Z
Natural Gas Liquids	Q	
Nitrogen	P	
Oxygen	T	
Pentanes	Q	
Propanes	Q	
Refined Products	P	

SYSTEM: (35,35,C)

Operator-assigned name for a functional grouping of pipelines.

SUBSYSTEM: (35,35,C)

Operator-assigned name for a smaller subsection of a pipeline system. A subset of the SYSTEM attribute.

SYSTYPE: (2,2,C)
Abbreviation for the system type description. The character "A" is added to the abbreviation if the segment is abandoned.

G = Gas Gathering
K = Carbon Dioxide
L = Crude Gathering
O = Crude Transmission
P = Non_HVL Liquid Products
Q = HVL Products
T = Gas Transmission

See Appendix D for full listing of systypes.

COUNTY: (3,3,C)
The County FIPS code. FIPS codes are listed in Appendix B.

INTRA: (1,1,C)
Designates a pipeline as either inter or intrastate. "Y" indicates an intrastate pipeline, "N" indicates an interstate pipeline.

IDLE: (1,1,C)
Designates a pipeline as either idle or active. "Y" indicates an idle pipeline, "N" indicates a pipeline that is active but not currently in use. "Idle" does not mean the pipeline is abandoned. Idle pipelines are included in total pipeline miles permitted, abandoned pipelines are not.

MODDATE: (10,10,C)
Date pipeline segment was digitized or last modified (YYYY-MM-DD)

MILES: (4,8,F)
Pipeline length, in miles. Generated by the Arc/Info software.

SYS-ID: (16,16,I)
A six-digit RRC-generated system identifier. This item may not be present in all pipeline attribute files. The first number is the region number. Second is the system-type number. A four digit RRC assigned sequence number completes the item.

Region Numbers	Region Name
1	Amarillo
2	Midland
3	Kilgore
4	Austin
5	Houston
6	Dallas
7	Corpus Christi
8&9	Multi-Regional

System Type Number	System Type Name
3	Gas
4	Liquid
5	

V. APPENDIX A

DATA AND LINE TYPE ASSIGNMENTS

This appendix lists all data and line types. Data and line types are RRC defined data categories relevant to RRC mapping. Line types are listed beneath data types. For example, data type 10 represents the general data type, political boundaries. Line type 37 of data type 10 represents national political boundaries; line type 2 of data type 10 represents state political boundaries, etc.

Data Type	**Data Type Name**:
10	**POLITICAL BOUNDARIES**
	2 - State
	3 - County
	21 - City
	37 - National
	58 - Offshore - Three League Line
11	**POLITICAL BOUNDARY ANNOTATION**
	29 - County, State
	81 - Town
	84 - City
	113 - Major Cities
12	**ORIGINAL LAND SURVEYS**
	5 - Block Line
	6 - Overlap Block Lines
	7 - Survey, Section Lines
	8 - Abstract Division Lines
	28 - Offshore Abstract Division
	29 - Offshore Tract, Survey Line
	30 - Offshore Block Line
	32 - Offshore Overlap Tract, Survey Line
	77 - Annotation Outline Arrow
	113 - Overlap Survey, Section Lines
	126 - Survey Annotation Outline
13	**SURVEY ANNOTATION**
	2 - Ex. Small Survey
	5 - Small Survey

6 - Small Offshore Tract/Survey
55 - Medium Survey, Section
56 - Medium Offshore Tract/Survey
62 - Medium Survey, Section
64 - Small Overlap Survey
96 - Abstract Annotation for Multi-Parcel Abstracts
102 - Large Block, Grant, League
111 - Large Offshore Block
112 - Large Block, Grant, League

17 WATER FEATURES
10 - Creeks
11 - Coastline
12 - Canals
27 - Rivers
31 - Lakes
35 - Original River Course Under Lake
55 - Dam Structures

18 WATER ANNOTATION
42 - Creeks and Small Lakes
44 - Rivers and Lakes

19 TRANSPORTATION LINES
14 - Heavy/Medium Duty
15 - Unimproved Roads
16 - Light Duty Roads and Streets
17 - Railroads
24 - Ship Channel

20 TRANSPORTATION ANNOTATION
2 - Highways
14 - Railroads
103 - Highways
107 - Ship Channel

21 TRANSPORTATION SYMBOLS
30 - State Highway/3 digit
31 - State Highway/4 digit
32 - Interstate Highway
33 - Farm or Ranch Road
34 - Park or Recreational Road
35 - U.S. Highway

24 GOVERNMENT LAND
116 - Parks and Military Reservations

25 **GOVERNMENT LAND ANNOTATION**
26 - Small
30 - Medium
32 - Large

26 **CEMETERIES**
36 - Cemetery Boundary

27 **CEMETERY ANNOTATION**
69 - Cemetery Name

28 **CEMETERY SYMBOLS**
48 - Cemetery Symbol

29 **AIRPORTS**
36 - Runways and Boundaries

30 **AIRPORT ANNOTATION**
69 - Airport Name

31 **SUBDIVISION LINES**
9 - Subdivision Lot Line
124 - Subdivision Outline
125 - Subdivision Labor Line

32 **SUBDIVISION ANNOTATION**
117 - Ex. Small Subdivision
118 - Small Subdivision
119 - Medium Subdivision
120 - Large Subdivision

50 **OIL & GAS WELLS**
2 Permitted Location
3 Dry Hole
4 Oil Well
5 Gas Well
6 Oil/Gas Well
7 Plugged Oil Well
8 Plugged Gas Well
9 Canceled/Abandoned Location
10 Plugged Oil/Gas Well
11 Injection/Disposal
17 Storage from Oil
18 Storage from Gas
19 Shut-In (Oil)
20 Shut-In (Gas)

21 Inj/Disposal From Oil
22 Inj/Disposal From Gas
23 Inj/Disposal From Oil/Gas
36 Geothermal Well
73 Brine Mining
74 Water Supply
75 Water Supply from Oil
76 Water Supply from Gas
77 Water Supply from Oil/Gas
78 Observation
79 Observation from Oil
80 Observation from Gas
81 Observation from Oil/Gas
1. Storage
2. Service
90 Service from Oil
91 Service from Gas
92 Service from Oil/Gas
103 Storage from Oil/Gas
104 Inj/Disposal from Storage
105 Inj/Disposal from Storage/Oil
106 Inj/Disposal from Storage/Gas
107 Inj/Disposal from Storage/Oil/Gas
108 Observation from Storage
109 Observation from Storage/Oil
110 Observation from Storage/Gas
111 Observation from Storage/Oil/Gas
112 Service from Storage
113 Service from Storage/Oil
114 Service from Storage/Gas
115 Service from Storage/Oil/Gas
116 Plugged Storage
117 Plugged Storage/Oil
118 Plugged Storage/Gas
119 Plugged Storage/Oil/Gas
120 Brine Mining
121 Brine Mining/Oil
122 Brine Mining/Gas
123 Brine Mining/Oil/Gas
124 Inj/Disposal from Brine Mining
125 Inj/Disposal from Brine Mining/Oil
126 Inj/Disposal from Brine Mining/Gas
127 Inj/Disposal from Brine Mining/Oil/Gas
128 Observation from Brine Mining
129 Observation from Brine Mining/Oil
130 Observation from Brine Mining/Gas

131 Observation from Brine Mining/Oil/Gas
132 Service from Brine Mining
133 Service from Brine Mining/Oil
134 Service from Brine Mining/Gas
135 Service from Brine Mining/Oil/Gas
136 Plugged Brine Mining
137 Plugged Brine Mining/Oil
139 Plugged Brine Mining/Gas
139 Plugged Brine Mining/Oil/Gas
140 Storage Brine Mining
141 Storage Brine Mining/Oil
142 Storage Brine Mining/Gas
143 Storage Brine Mining/Oil/Gas
144 Inj/Disposal from Storage/Brine Mining
145 Inj/Disposal from Storage/Brine Mining/Oil
146 Inj/Disposal from Storage/Brine Mining/Gas
147 Inj/Disposal from Storage/Brine Mining/Oil/Gas
148 Observation from Storage/Brine Mining
149 Observation from Storage/Brine Mining/Oil
150 Observation from Storage/Brine Mining/Gas
151 Observation from Storage/Brine Mining/Oil/Gas
152 Plugged Storage/Brine Mining
153 Plugged Storage/Brine Mining/Oil
154 Plugged Storage/Brine Mining/Gas
155 Plugged Storage/Brine Mining/Oil/Gas

56 DIRECTIONAL DRILL LINES

25 - Horizontal Drainhole Line
42 - Directional Well Line
43 - Directional Well Line

57 GRAPHIC WELL SYMBOLS

12 - Core Test
13 - Directional Surface Location
15 - Radioactive Symbol
16 - Sulphur Test
86 - Horizontal Drainhole
87 - Sidetrack Well Surface Location

VI. APPENDIX B County FIPS Codes

COUNTY	FIPS Code
Anderson	001
Andrews	003
Angelina	005

Aransas	007
Archer	009
Armstrong	011
Atascosa	013
Austin	015
Bailey	017
Bandera	019
Bastrop	021
Baylor	023
Bee	025
Bell	027
Bexar	029
Blanco	031
Borden	033
Bosque	035
Bowie	037
Brazoria	039
Brazos	041
Brewster	043
Briscoe	045
Brooks	047
Brown	049
Burleson	051
Burnet	053
Caldwell	055
Calhoun	057
Callahan	059
Cameron	061
Camp	063
Carson	065
Cass	067
Castro	069
Chambers	071
Cherokee	073
Childress	075
Clay	077
Cochran	079
Coke	081
Coleman	083
Collin	085
Collingsworth	087
Colorado	089
Comal	091
Comanche	093
Concho	095
Cooke	097

Coryell	099
Cottle	101
Crane	103
Crockett	105
Crosby	107
Culberson	109
Dallam	111
Dallas	113
Dawson	115
Deaf Smith	117
Delta	119
Denton	121
Dewitt	123
Dickens	125
Dimmitt	127
Donley	129
Duval	131
Eastland	133
Ector	135
Edwards	137
Ellis	139
El Paso	141
Erath	143
Falls	145
Fannin	147
Fayette	149
Fisher	151
Floyd	153
Foard	155
Fort Bend	157
Franklin	159
Freestone	161
Frio	163
Gaines	165
Galveston	167
Garza	169
Gillespie	171
Glasscock	173
Goliad	175
Gonzales	177
Gray	179
Grayson	181
Gregg	183
Grimes	185
Guadalupe	187
Hale	189

Hall	191
Hamilton	193
Hansford	195
Hardeman	197
Hardin	199
Harris	201
Harrison	203
Hartley	205
Haskell	207
Hays	209
Hemphill	211
Henderson	213
Hidalgo	215
Hill	217
Hockley	219
Hood	221
Hopkins	223
Houston	225
Howard	227
Hudspeth	229
Hunt	231
Hutchinson	233
Irion	235
Jack	237
Jackson	239
Jasper	241
Jeff Davis	243
Jefferson	245
Jim Hogg	247
Jim Wells	249
Johnson	251
Jones	253
Karnes	255
Kaufman	257
Kendall	259
Kenedy	261
Kent	263
Kerr	265
Kimble	267
King	269
Kinney	271
Kleberg	273
Knox	275
Lamar	277
Lamb	279
Lampasas	281

La Salle	283
Lavaca	285
Lee	287
Leon	289
Liberty	291
Limestone	293
Lipscomb	295
Live Oak	297
Llano	299
Loving	301
Lubbock	303
Lynn	305
McCulloch	307
McLennan	309
McMullen	311
Madison	313
Marion	315
Martin	317
Mason	319
Matagorda	321
Maverick	323
Medina	325
Menard	327
Midland	329
Milam	331
Mills	333
Mitchell	335
Montague	337
Montgomery	339
Moore	341
Morris	343
Motley	345
Nacogdoches	347
Navarro	349
Newton	351
Nolan	353
Nueces	355
Ochiltree	357
Oldham	359
Orange	361
Palo Pinto	363
Panola	365
Parker	367
Parmer	369
Pecos	371
Polk	373

Potter	375
Presidio	377
Rains	379
Randall	381
Reagan	383
Real	385
Red River	387
Reeves	389
Refugio	391
Roberts	393
Robertson	395
Rockwall	397
Runnels	399
Rusk	401
Sabine	403
San Augustine	405
San Jacinto	407
San Pactricio	409
San Saba	411
Schleicher	413
Scurry	415
Shakelford	417
Shelby	419
Sherman	421
Smith	423
Somervell	425
Starr	427
Stephens	429
Sterling	431
Stonewall	433
Sutton	435
Swisher	437
Tarrant	439
Taylor	441
Terrell	443
Terry	445
Throckmorton	447
Titus	449
Tom Green	451
Travis	453
Trinity	455
Tyler	457
Upshur	459
Upton	461
Uvalde	463
Val Verde	465

Van Zandt	467
Victoria	469
Walker	471
Waller	473
Ward	475
Washington	477
Webb	479
Wharton	481
Wheeler	483
Wichita	485
Wilbarger	487
Willacy	489
Williamson	491
Wilson	493
Winkler	495
Wise	497
Wood	499
Yoakum	501
Young	503
Zapata	505
Zavala	507

OFFSHORE COUNTY AREAS	**FIPS CODE**
South Padre Island-SB	600
North Padre Island-SB	601
Mustang Island-SB	602
Matagorda Island-SB	603
Brazos-SB	604
Galveston-SB	605
High Island-SB	606
Sabine Pass-SB	607
South Padre Island-LB	700
North Padre Island-LB	701
Mustang Island-LB	702
Matagorda Island-LB	703
Brazos-LB	704
Brazos-S	705
Galveston-LB	706
Galveston-S	707
High Island-LB	708
High Island-S	709
High Island-E	710
High Island-E-S	711
Mustang Island-E	712

North Padre Island-E	713
South Padre Island-E	714
Sabine Pass-LB	715

VII. APPENDIX C Well Reliability Codes

WELL RELIABILITY CODES

The reliability of a well's location is determined by the source used to spot the well into the Well Location Database. Valid codes are:

CODES

10	Historic Map (non-RRC)
15	RRC Hardcopy Map
16	Spotted from Reliability Code 15 wells
17	Location adjusted during survey maintenance
20	WELLBORE Distances
25	Unit or hearing plat, plat with form for another well, or form for this well without a plat.
30	Operator reported location (distances without plat or plat without distances).
40	Operator reported location (distances and plat).
45	Field Inspection by RRC personnel.
48	Spotted from Reliability Code 50 wells
50	U.S.G.S. 7.5 minute quad or aerial photograph.
55	Coordinates from operator.
59	Coordinates – RRC personnel reported 2D GPS (Accuracy of 200-300 feet.)
60	Coordinates – RRC personnel reported 3D GPS (Accuracy of about 15 feet.)

VIII. APPENDIX D: FLUID TYPES AND SYSTYPES

FLUID TYPES	LAND SYSTYPES	OFFSHORE SYSTYPES
Acetylene	Q	
Alcohols	P	
Ammonia	P	
Benzenes	P	
Butanes	Q	
Butadiene		
Butane/Butylene		
Butane/Distillates		
Butane/Pentane		
Butylene		
Iso-Butane		
Isobutane		

Carbon Dioxide CO2	K	
Condensate Slop Oil Water	K	
Crude	L (Gathering)	A
Crude O/G Oil Petroleum	O (Transmission)	A
Diesels	P	
Ethanes	Q	
Ethlyene	Q	
Ethylene (Gas)	T	
E/P Mix E/P Propane Ethane/Propane Ethane/Propane Mix P/P Mix EPBC	Q	
Feedstock	P	
Fuel Oil Bistone Fuel Gas Fuel Oil/Natural Gas Fuel Oils/Gas Fuel Residum	P	
Gasoline Gasoline/Diesel/Jet Gasoline/Fuel Oils	P	
Hydrogen Gas Liquid Hydrogen Pure H2 Raw H2	T	
Jet Fuel	P	
Kerosene	P	

LPG	Q	
Raw LPG		
Natural Gas	T (Transmission)	Z
Natural Gas	G (Gathering)	Z
Dry Gas		
Natural		
Natural Gas/Cond		
Sweet Gas		
Synthesis		
Natural Gas Liquids	Q	
NGL		
Refinery Off Gas		
Nitrogen	P	
Oxygen	T	
Oxygen/Nit.		
Pentanes	Q	
Propanes	Q	
Methyl Propane		
Propadiene		
Propane/Butane		
Propane/LPG		
Propane/Propylene		
Propylene		
Propylene Oxide		
Propyne		
Refined Products	P	
Acnylonitrile		
Cutter Stock		
Cyclohexane		
Deisohex Stock		
Distillates		
Dripoline		
Feed Gas		
HCL Acid Anhydrous		
Hexene		
HPG		
Isoprene		
Methanol		
MTBE		

Naptha
Products
Raffinate
RPG
Tertiary Butyl Alcohol
Toluene

SYSTYPES

A = Offshore (Liquids)
B = Apartment Complexes
C = Compressor Station
D = Distribution
E = Interstate Transmission Gas
F = Non-Jurisdictional Gathering
G = Gas Gathering
H = Government (Housing Authority)
I = LP Gas Distribution
J = Direct Sales Customer
K = Carbon Dioxide Pipelines
O = Crude Transmission
M = Municipal Distribution
N = City Not Served
L = Crude Gathering
P = Product Lines (NOT Highly Volatile)
Q = Other Liquid Lines (Highly Volatile)
S = Municipal Supply Line
T = Transmission
U = Underground Liquid Storage
V = Underground Gas Storage
W = Mobile Home Parks
X = Liquified Natural Gas
Z = Offshore (Gas) Gathering

IX. APPENDIX E NAMING CONVENTIONS

8.3 NAMING CONVENTION

The 8.3 naming convention stipulates that, exclusive of the filename suffix, a digital filename cannot be more than 8 characters long.

Although some computer operating systems and software programs accept file names longer than 8 characters, the Railroad Commission adheres to the 8.3 naming convention for a number of reasons.

1. ESRI, the manufacturer of ArcInfo and ArcView, suggests that their users adhere to the 8.3 naming convention. ESRI, in various ways to various extents, codes its software to enforce compliance with the 8.3 naming convention.
2. All RRC GIS data is compressed. Unfortunately, some decompression software packages truncate long filenames such as, “water3402112.shp” to meaningless names like, “water34~1.shp”
3. The Railroad Commission is committed to making its digital data accessible and usable to as wide an audience as possible. Adherence to the 8.3 naming convention ensures that at least one major hurdle of data portability is cleared.