

SITE OBSERVATIONAL WORK PLAN FOR THE UMTRA PROJECT SITE AT FALLS CITY, TEXAS

June 1995

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**SITE OBSERVATIONAL WORK PLAN
FOR THE UMTRA PROJECT SITE
AT FALLS CITY, TEXAS**

June 1995

**Prepared for
U.S. Department of Energy
UMTRA Project
Albuquerque, New Mexico**

**Prepared by
Jacobs Engineering Group Inc.
Albuquerque, New Mexico**

EXECUTIVE SUMMARY

The requirements for ground water compliance for Uranium Mill Tailing Remedial Action (UMTRA) Project sites, including the Falls City site, are found in the Uranium Mill Tailings Radiation Control Act (42 USC §7901 *et seq.*) and the U.S. Environmental Protection Agency's Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR Part 192; 60 FR 2854).

Ground water beneath the Falls City site was contaminated by uranium ore processing activities, open pit mining, and *in situ* solution leaching of tailings. Open pit mining occurred at the Falls City site before the milling activities. The mines were on parcels A and B of the site. Also, the shallow ground water in the mined areas is often of naturally poor quality because of ore bodies in the aquifer matrix.

A total of 2.5 million tons (2.3 million tonnes) of uranium ore were extracted and processed on the site. An acid-leach, countercurrent-decantation solvent extraction system was used to extract and concentrate uranium. The Deweesville sandstone containing the uranium was mined, ground, and then agitated in a sulfuric acid solution. An organic solution (tertiary amine and kerosene) was added during the extraction circuit. The uranium was stripped from the organic solution with either a sodium carbonate or an acidified sodium chloride solution. The residue sands, sandy-slimes, and slimes from processing uranium ore (tailings) were left on the mill site.

During surface remedial action, an estimated 7.0 million tons (6.4 million tonnes) of uranium mill tailings and other contaminated materials were consolidated and stabilized on the site. The ground water protection strategy at the Falls City disposal site for the UMTRA Surface Project was an application for supplemental standards, based on limited use ground water in the uppermost aquifer. This water is not a current or potential source of drinking water. Ground water from the uppermost aquifer (ground water from the Deweesville/Conquista Members and the Dilworth Member) contains widespread ambient contamination resulting from naturally occurring conditions and from the effects of human activity not related to uranium milling operations (uranium exploration and mining activities). The ground water cannot be effectively cleaned up for drinking purposes with treatment methods reasonably employed by public water supply systems. The U.S. Nuclear Regulatory Commission (NRC) and the state of Texas concurred with the ground water protection strategy for the disposal site in September 1992. Surface remedial action in accord with 40 CFR Part 192 Subpart A was completed in April 1994.

The proposed ground water compliance strategy at the Falls City site is to perform no remedial action based on application for supplemental standards because the ground water in the uppermost aquifer is classified as limited-use ground water. Limited-use ground water includes ground water that is not a current or potential source of drinking water because of widespread, ambient contamination that cannot be cleaned up using treatment methods reasonably employed by public water supply systems (40 CFR §192.11(e)).

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LIST OF ACRONYMS AND ABBREVIATIONS

<u>Acronym</u>	<u>Definition</u>
ACL	alternate concentration limit
ASTM	American Society for Testing Materials
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FM	Farm-to-Market
GPS	global positioning system
MCL	maximum concentration limit
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission
PEIS	programmatic environmental impact statement
PVC	polyvinyl chloride
QA	quality assurance
RAP	remedial action plan
RRM	residual radioactive materials
SOP	standard operating procedure
SOWP	site observational work plan
SWI	Susquehanna-Western, Inc.
TAC	Technical Assistance Contractor
TDS	total dissolved solids
TKA	Turk, Kehle & Associates
U ₃ O ₈	uranium oxide
UMTRA	Uranium Mill Tailings Remedial Action
UMTRCA	Uranium Mill Tailings Radiation Control Act
USGS	U.S. Geological Survey

1.0 INTRODUCTION

Produced by the U.S. Department of Energy (DOE), this site observational work plan (SOWP) will be used to determine site-specific activities to comply with the U.S. Environmental Protection Agency (EPA) ground water standards at this Uranium Mill Tailings Remedial Action (UMTRA) Project site. The purpose of the SOWP is to recommend a site-specific ground water compliance strategy at the Falls City UMTRA Project site. The Falls City SOWP presents a comprehensive summary of site hydrogeological data, delineates a conceptual model of the aquifer system, and discusses the origins of milling-related ground water contamination. It also defines the magnitude of ground water contamination, potential environmental and health risks associated with ground water contamination and data gaps, and targets a proposed compliance strategy.

1.1 GROUND WATER COMPLIANCE STRATEGY

The proposed ground water compliance strategy for the Falls City site is no remediation, with an application for supplemental standards based on the following criteria:

- The ground water is considered limited-use ground water. Limited-use ground water is ground water that is not a current or potential source of drinking water because widespread ambient contamination cannot be cleaned up with treatment methods reasonably employed by public water supply systems (60 FR 2854). However, U.S. Environmental Protection Agency (EPA) standards require the DOE to consider the impact of milling contamination on current or future beneficial uses of ground water. In Falls City, potential beneficial uses would be limited to watering livestock and gardens because the quality of naturally occurring ground water is poor and the yield is low.

Section 2.0 describes the requirements for meeting standards at UMTRA Project sites. Section 3.0 provides site-specific data that support the proposed ground water compliance strategy. Section 4.0 justifies the proposed ground water compliance strategy.

1.2 UMTRA PROJECT PROGRAMMATIC DOCUMENTS

The programmatic documents that guide the SOWP include the *UMTRA Groundwater Program Plan* (DOE, 1992a) the *Programmatic Environmental Impact Statement* (PEIS) (DOE, 1995), and *Technical Approach to Groundwater Restoration* (DOE, 1993a). The *Groundwater Program Plan* states the mission and objectives of the UMTRA Project Ground Water Program and provides a technical and management approach for conducting the program. The PEIS is the proposed programmatic decision-making framework for conducting the UMTRA Ground Water Project. DOE will follow PEIS guidelines to assess the potential programmatic impacts of the Ground Water Project, to determine site-specific ground water compliance strategies, and to prepare site-specific environmental impacts analyses more efficiently. Technical guidelines for

conducting the ground water program are found in the *Technical Approach to Ground Water Restoration*.

1.3 RELATIONSHIP TO SITE-SPECIFIC DOCUMENTS

The surface remedial action plan (RAP) provides site characterization information (DOE, 1992b). This information was updated in developing the SOWP to formulate the site conceptual model. If a ground water compliance strategy requiring remedial action activities is selected for this site, a ground water RAP or surface RAP modification will be prepared.

In 1994, a baseline risk assessment was prepared (DOE, 1994) identifying potential public health and environmental risks at the site. Potential risks identified in the risk assessment are considered in this SOWP to ensure that the proposed compliance strategy is protective of human health and the environment.

After identification of a proposed compliance strategy in the SOWP, a site-specific National Environmental Policy Act (NEPA) document (e.g., environmental assessment) will be prepared to determine the potential impacts, if any, of implementing the proposed compliance strategy.

1.4 SOWP REVISIONS

This SOWP presents a summary of existing data, a conceptual model, a recommended compliance strategy based on this conceptual model, and data needed to further support the selected strategy. This document will be revised as more information is collected. The final document will describe the additional data and correlate it to previous information, update the site conceptual model, and, if necessary, will revise the proposed ground water compliance strategy.

2.0 REGULATORY FRAMEWORK

This section identifies the requirements for selecting a ground water compliance strategy for the Falls City, Texas, processing site to achieve compliance with Subpart B of the EPA health and environmental protection standards for uranium and thorium mill tailings (40 CFR Part 192), and the final rule to the standards published in 60 FR 2854.

2.1 URANIUM MILL TAILINGS RADIATION CONTROL ACT

The United States Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*) in 1978 in response to public concerns about potential health hazards from long-term exposure to uranium mill tailings. The UMTRCA authorized DOE to stabilize, dispose of, and control uranium mill tailings and other contaminated materials at inactive uranium mill processing sites.

Title I of the UMTRCA designates 22 inactive processing sites for remediation. It directs the EPA to promulgate standards; mandates remedial action in accordance with these standards; stipulates that remedial action be selected and performed with the concurrence of the U.S. Nuclear Regulatory Commission (NRC), and in consultation with the states and Indian tribes; directs the NRC to license the disposal sites; and directs the DOE to enter into cooperative agreements with the affected states and Indian tribes. Title II applies to active uranium mills. Title III applies only to certain uranium mills in New Mexico. The UMTRA Project is responsible for administering only Title I of the UMTRCA.

In 1988, Congress passed the Uranium Mill Tailings Remedial Action Amendments Act (Amendments Act) (42 USC §7922 *et seq.*), authorizing the DOE to extend without limitation the time needed to complete ground water remediation activities at the processing sites.

2.1.1 EPA ground water protection standards

The UMTRCA requires EPA to promulgate standards for protecting public health, safety, and the environment from radiological and nonradiological hazards associated with uranium processing and the resulting residual radioactive materials (RRM). On 5 January 1983, the EPA published standards (40 CFR Part 192) for RRM disposal and cleanup. The standards were revised and a final rule was published 11 January 1995 (60 FR 2854).

The standards address two ground water contamination scenarios: future ground water contamination that might occur from tailings piles after disposal, and the cleanup of contamination resulting from the milling process at the processing sites (60 FR 2854). The UMTRA Surface Project is designed to control and stabilize tailings and contaminated soil. The Ground Water Project addresses residual contamination at the processing sites and is regulated by Subparts B and C of the EPA standards.

Subpart B, "Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials From Inactive Uranium Processing Sites," requires remedial action at the former processing sites to ensure the RRM in ground water meets any of the following three criteria:

- **Background levels.** Concentrations of constituents in nearby ground water not contaminated by processing activities.
- **Maximum concentration limits (MCL).** Maximum concentrations set by the EPA for certain hazardous constituents in ground water, proposed for the UMTRA Project (Table 2.1).
- **Alternate concentration limits (ACL).** An alternate concentration limit for a hazardous constituent that does not pose a substantial hazard (present or potential) to human health or the environment as long as the limit is not exceeded. An ACL maybe applied after considering options to achieve background levels or MCLs (60 FR 2867).

Subpart B also allows natural flushing to meet the standards. Natural flushing allows natural ground water processes to reduce the contamination in ground water to acceptable standards (background levels, MCLs, or ACLs). Natural flushing must allow the standards to be met within 100 years. In addition, institutional controls to protect human health and an adequate monitoring program must be established and maintained during the period of natural flushing; institutional controls restrict access to contamination. The ground water also must not be a current or projected source of drinking water during the period of natural flushing, and beneficial uses of ground water must be protected (60 FR 2867).

Subpart C, "Implementation," provides guidance for implementing methods and procedures to reasonably ensure the provisions of Subpart B are satisfied. Subpart C requires the following:

- The conditions of Subpart B must be met on a site-specific basis, using information gathered during site characterization and monitoring. The plan to meet the conditions of Subpart B must be stated in a site-specific compliance strategy plan or RAP; either plan must contain a compliance strategy and a monitoring program and must demonstrate effectiveness (60 FR 2868).

Subpart C also describes the conditions under which DOE may apply supplemental standards to contaminated ground water, rather than meeting background levels, MCLs, or ACLs. The standards define limited use ground water as ground water that is not a current or potential source of drinking water because total dissolved solids (TDS) exceed 10,000 milligrams per liter (mg/L); widespread ambient contamination cannot be cleaned up using treatment methods reasonably employed by public water supply systems; the quantity of water available is less than 150 gallons (570 liters) per day; or because cleanup

Table 2.1 Maximum concentration of inorganic constituents for ground water protection for UMTRA project sites

Constituent	Maximum concentration ^a
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Molybdenum	0.1
Nitrate (as N)	10.0 ^b
Selenium	0.01
Silver	0.05
Combined radium-226 and radium-228	5 pCi/liter
Combined uranium-234 and uranium-238	30 pCi/liter ^c
Gross alpha-particle activity (excluding radon and uranium)	15 pCi/liter

^aConcentrations reported in milligrams per liter (mg/L) unless otherwise noted.

^bEquivalent to 44 mg/L nitrate as nitrate.

^cEquivalent to 0.044 mg/L, assuming secular equilibrium of uranium-234 and uranium-238.

pCi - picocuries.

Ref: 60 FR 2854.

of ground water would cause excessive environmental harm, or because cleanup is technically impractical (60 FR 2867). Subpart C requires the DOE to inform private owners and occupants of the area affected by hazardous constituents and to solicit their comments before applying supplemental standards. The DOE has implemented a public participation program in Falls City to meet the requirements of Subpart C.

The DOE proposes a no remediation/supplemental standards compliance strategy for the Falls City, Texas, site. This strategy will achieve compliance with the EPA ground water standards applicable to Title I UMTRA Project sites. To protect ground water and to achieve compliance with the proposed EPA ground water standards under Subpart A (UMTRA Surface Project), a narrative supplemental standard for the Falls City site was proposed and approved. The supplemental standard application for the surface remedial action was based on widespread ambient contamination that could not be cleaned up with methods reasonably employed by public water supply systems. Therefore, the DOE concluded that ground water in the uppermost aquifer meets the widespread ambient contamination criteria of limited use ground water. The NRC and the state of Texas concurred with the DOE ground water protection strategy for the UMTRA Surface Project in 1992. The Falls City ground water compliance strategy (to meet Subpart B requirements) is identical to the Surface Project ground water protection strategy. The regulatory drivers that guide the selection of the proposed ground water compliance strategy for the Falls City, Texas, site and all other UMTRA sites are identified below.

2.1.2 Cooperative agreements

The UMTRCA requires remedial action to include full participation of the states and Indian tribes that own land containing uranium mill tailings. The UMTRCA also directs DOE to enter into cooperative agreements with the states and Indian tribes.

2.2 NATIONAL ENVIRONMENTAL POLICY ACT

The UMTRCA is a major NEPA activity (42 USC §4321 *et seq.*). Regulations of the Council on Environmental Quality (to implement the NEPA) are codified in 40 CFR Part 1500; these regulations require each federal agency to develop its own implementing procedures (40 CFR §1507.3). The DOE-related NEPA regulations are contained in 10 CFR Part 1021, *National Environmental Policy Act; Implementing Procedures*. Guidance is provided in *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE, 1993b).

Pursuant to the NEPA, in 1994 the DOE drafted a PEIS for the UMTRA Ground Water Project to analyze the potential impacts of implementing four programmatic alternatives for ground water compliance at the designated processing sites. Once the preferred alternative for the UMTRA Ground Water Project is selected, that alternative will be published in a record of decision. All

subsequent action on the UMTRA Ground Water Project must comply with that record of decision.

3.0 SITE CONDITIONS

This section discusses past uranium mining and milling activities at and in the vicinity of the site, the surface remedial action, and the status of surface cleanup efforts. Site characterization data are summarized and the site conceptual model is presented. The site conceptual model is based on the ground water characterization data and is intended to enhance understanding of contaminant fate and transport, exposure pathways, risk to public health and the environment, and the remediation strategy. The model also provides the rationale for the proposed ground water compliance strategy.

Hydrogeologic and geochemical characterization efforts at the Falls City site began before surface cleanup and continued throughout surface remedial action. Thus, sufficient data are available to develop conceptual model for the former processing site. Section 3.3 presents a conceptual model and discusses contaminant fate and transport.

3.1 SITE HISTORY

3.1.1 Physical setting

The Falls City site is in Karnes County, Texas, approximately 8 miles (mi) [13 kilometers (km)] southwest of the town of Falls City and 46 mi (74 km) southeast of San Antonio, Texas (Figure 3.1). Before surface remedial action, the tailings site consisted of two parcels. Parcel A consisted of the mill site, one mill building, five tailings piles, and one tailings pond south of Farm-to-Market (FM) Road 1344 and west of FM 791. A sixth tailings pile designated Parcel B was north of FM 791 and east of FM 1344 (Figure 3.2).

3.1.2 Land and water use

Most of the land surrounding the former processing site is used for cattle grazing and dry farming. Local residents primarily grow hay and other livestock feed crops. Most livestock in the site area are beef cattle; some residents keep small poultry flocks.

The Deweesville/Conquista and the Dilworth aquifers are not used as domestic or potable water supplies in the immediate site vicinity, although the Dilworth aquifer is occasionally used within a 2-mi (3-km) radius of the site to water stock (DOE, 1992b). The Three Oaks Water Company supplies residences within the site area with water from a Carrizo Sandstone well. This well is 2000 feet (ft) (600 meters [m]) deep and is approximately 10 mi (16 km) northwest of the site. Livestock are watered primarily from surface collection tanks or stock ponds.

3.1.3 History of operations

In late 1955, the Climax Molybdenum Company identified uranium ore deposits averaging 0.20 percent uranium oxide (U_3O_8) in an area 8 mi (13 km) west of

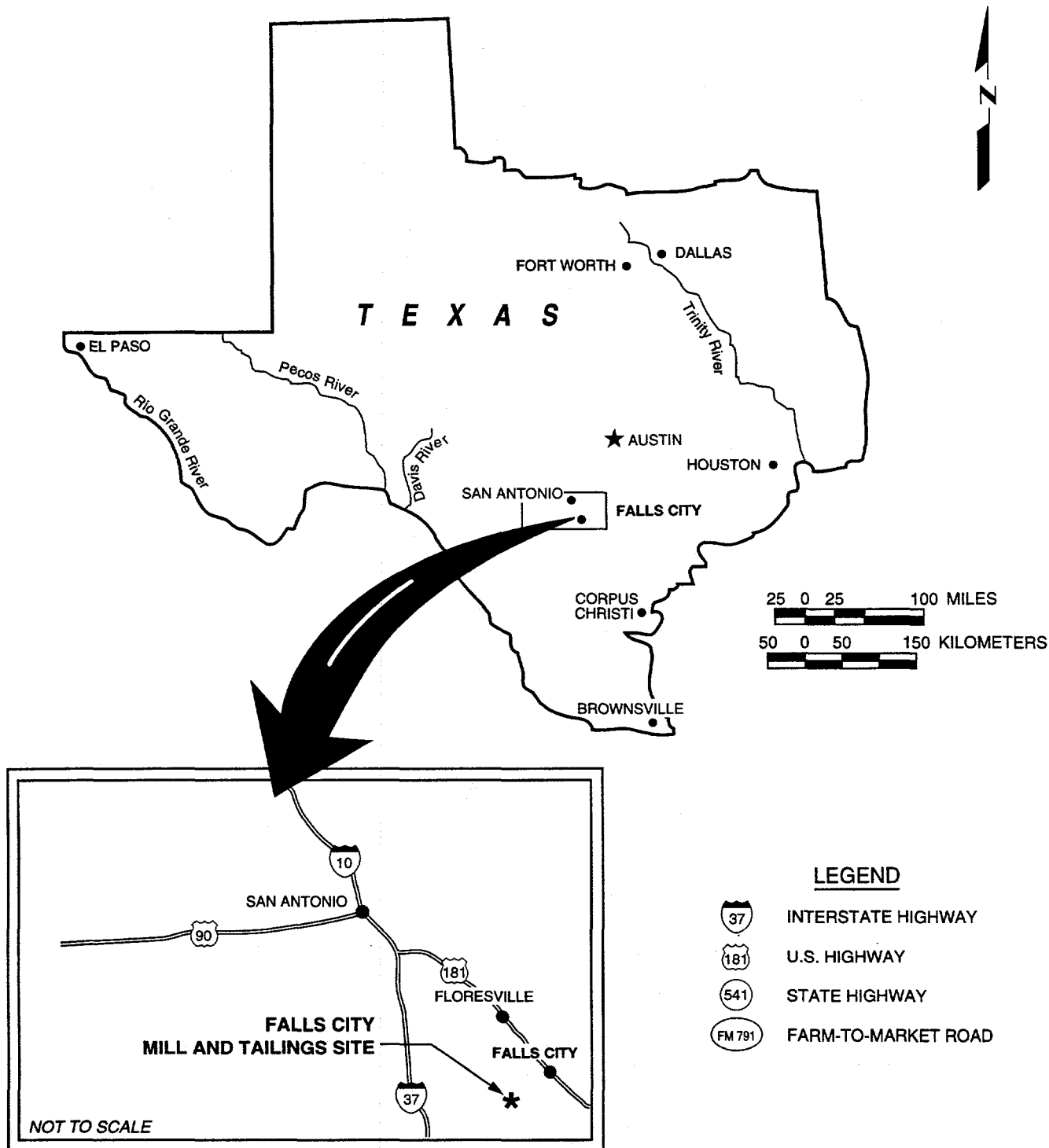
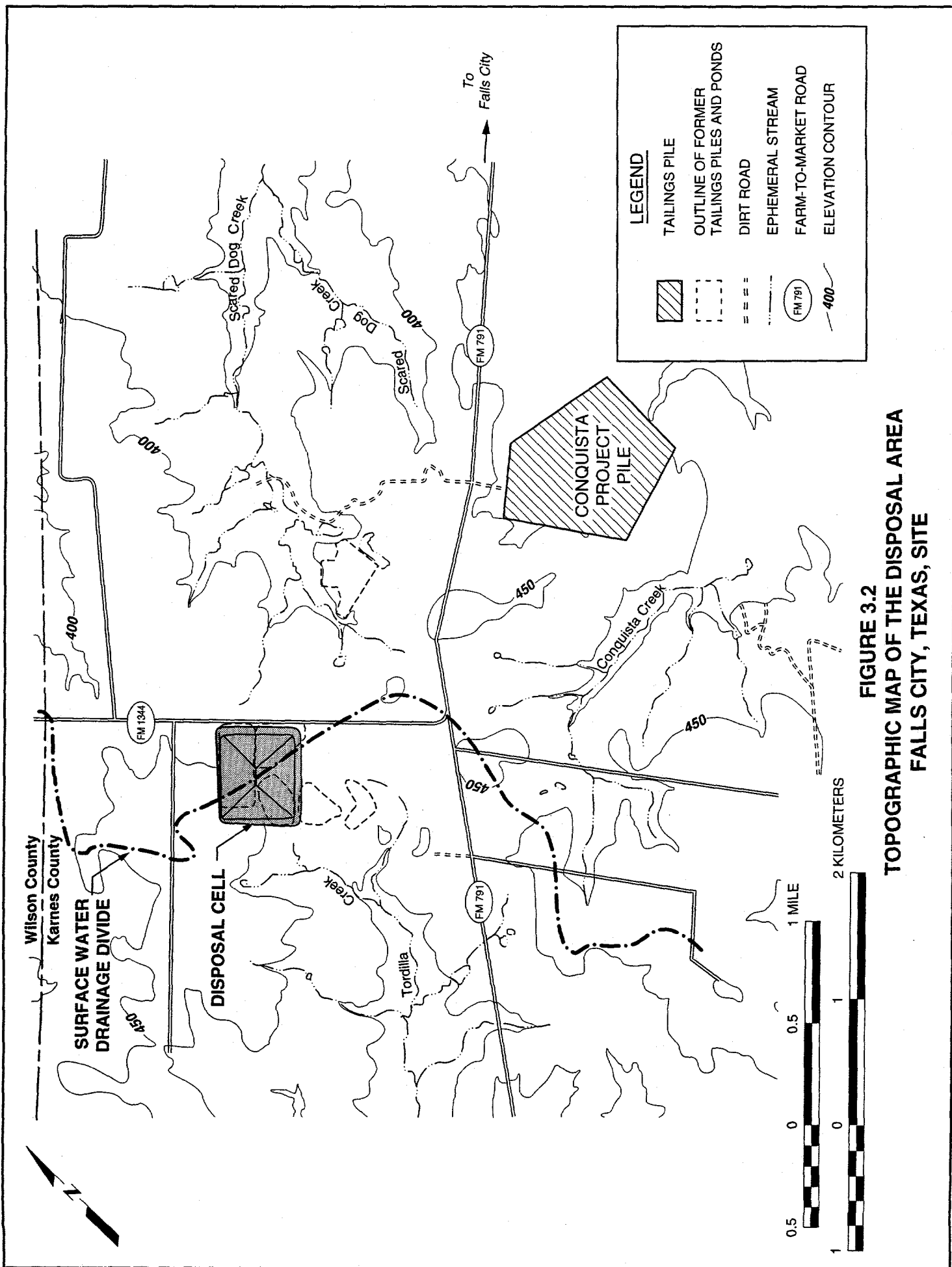


FIGURE 3.1
LOCATION OF THE FALLS CITY, TEXAS, SITE



Falls City. Open pit mining occurred from 1959 to 1960 and was completed when Susquehanna-Western, Inc. (SWI), acquired the property as a mill site in 1961. Open pit mining occurred at the former locations of piles 3, 4, 5, and 6. The mill was constructed as a nominal 300-ton-per-day (tpd) operation, but operated at 220 tpd from April 1961 until early 1968 (Merritt, 1971). In 1968, the mill expanded to operate at 900 tpd and, for short periods, up to 1000 tpd (Merritt, 1971). In August 1973, the mill ceased operations, having treated 2.5 million tons (2.3 million tonnes) of ore (FBDU, 1981).

During mill operations, ground water from a well adjacent to the mill building was the only source of processing water. The well was 3650 ft (1110 m) deep in the Carrizo Sandstone; the state decommissioned the well in 1991.

An SWI solid waste registration application submitted in 1973 stated that fresh water consumption ranged from 50 to 150 gallons (190 to 570 liters) per minute. Consumption depended on the ore, amount of rainfall and/or tailings pond solution available for recycle (in 1973 ponded water from tailings pile 7 was the only solution in active use), and reagent consumption required by the process. SWI also stated in the application that "75 gpm [gallons per minute] fresh water consumption may be considered a fair average." That measurement represents a net discharge to tailings pile 7 of approximately 121 acre (ac)-ft per year. The ponds on the tailings piles were not lined, but sumps along the pile perimeters pumped runoff and seepage back to the tailings piles. During mill operation (1961 to 1973), approximately 865 ac-ft of ore-processing water and precipitation that fell on the ponds might have infiltrated the Deweesville/Conquista aquifer. This calculation is included as an appendix to this document.

At the completion of SWI operations in 1973, a 40-ac (16-hectare [ha]) pond had been created at the top of pile 7. The liquids in this pond were acidic raffinates. In August 1978, Solution Engineering, Inc., of Alice, Texas, initiated *in situ* extraction mining on the tailings piles, installing an injection/withdrawal system in pile 7. Fluids from the raffinate pond were injected to a depth of 30 to 45 ft (9 to 14 m) at a rate of about 500 gallons (1900 liters) per minute. Between 300 and 550 gallons (1140 to 2100 liters) per minute of fluids were extracted from the pile; those uranium-bearing solutions were processed at the mill. Eventually, the operation expanded to piles 1, 2, 4, and 5. *In situ* solution mining ended in February 1982. In 1983, after 3.5 years of leaching operations, the state of Texas annulled Solution Engineering's operating license and directed the company to conduct interim restoration activities. Interim restoration consisted of spray-evaporating the large ponds on top of piles 7 and 2, capping piles 7 and 2 with a 1- to 2-ft (0.3- to 0.6-m)-thick clay cover, and dismantling the mill. The interim restoration was completed in 1986 and probably reduced the rate of pore fluid seepage into the aquifer (DOE, 1992b).

3.1.4 Milling process

An acid-leach countercurrent-decantation solvent-extraction system extracted and concentrated the uranium (as U_3O_8). This process is described below (Merritt, 1971).

Sulfuric acid was added as a leaching agent to the ore slurry, producing a slurry with a pH near 1.0. A five-stage, countercurrent washing circuit included a polyacrylamide-type flocculent to assist in separating the slimes from the process stream. The solvent extraction circuit included an organic solution containing 7.5 percent tertiary amine and 2.5 percent isodecanol in kerosene. Uranium was stripped from the loaded organic with either a sodium carbonate or acidified sodium chloride solution. The final uranium product ("yellow cake") was precipitated by adding caustic soda.

3.1.5 Surface remedial action

Remedial action consolidated and stabilized 7.0 million tons (6.4 million tonnes) of tailings and contaminated materials into a disposal cell covering 132 ac (53.4 ha) in the vicinity of piles 7 and 2. The approximate footprint of these piles is 2600 x 2200 ft (790 x 670 m). At least 30 monitor wells within or around the construction area were decommissioned (cutoff and grouted) during surface remedial action.

The DOE is required to demonstrate that RRM surface cleanup and disposal will not impact (or further impact) ground water in the vicinity of the former processing site. Thus, the NRC required the site-specific RAP to include a ground water protection strategy.

To protect the ground water and achieve compliance with the EPA ground water standards, a narrative supplemental standard for the Falls City site was proposed. The supplemental standard for the surface remedial action was based on widespread ambient contamination that could not be cleaned up using methods reasonably employed by public water supply systems. Also, there were few potential beneficial uses of the ground water due to poor quality and low yield. Historically, the uppermost aquifer has not been used as a drinking water source for those two reasons. Because the ground water quality is so poor (TDS 7500 mg/L) in the upper aquifers, they are rarely used except as a water source for limited stock watering and occasional home garden irrigation. Therefore, ground water in the uppermost aquifers meets the widespread ambient contamination criterion of limited use ground water (DOE, 1992b).

The NRC and the state of Texas concurred with the surface RAP and ground water protection strategy in September 1992. Surface remedial action was completed in May 1994.

3.2 SOURCES OF EXISTING DATA

The UMTRA Project and other investigators conducted several hydrologic, geologic, and geochemical studies at and in the vicinity of the Falls City processing site.

In a U.S. Geological Survey (USGS) report based largely on data from the exploratory drilling programs conducted in the late 1950s, Bunker and MacKallor (1973), describe the geology of uranium ore deposits in the Falls City area. The USGS report includes detailed discussions of the stratigraphy and mineralogy of several ore deposits in the Tordilla Hill-Deweeseville area, including the two deposits (Nuhn and Luckett) mined at the Falls City site (open pit mines).

Kallus (1975) prepared a report for EPA Region VI on the general environmental impacts of uranium mining and milling in the South Texas uranium district. That report summarizes surface and ground water monitoring data compiled from USGS and Texas Water Quality Board records. Ground water data were derived from approximately 100 samples, with complete chemical analyses performed on one-third of the samples. Kallus found highly variable natural levels of radioactivity, arsenic, molybdenum, and selenium in South Texas ground water. The only reported health impact from uranium mining was molybdenosis in cattle that grazed in runoff-contaminated areas near overburden piles.

Turk, Kehle & Associates (TKA) conducted the first site-specific hydrogeologic study at the Falls City mill site in 1976 (TKA, 1976). This study was a reconnaissance-level investigation that relied on existing water level and water quality data from 26 monitor wells around the site and included a general characterization of the local climate, geology, surface water quality, and ground water conditions. The TKA study concluded radioactive contamination (gross alpha and beta activity) was not evident in the aquifer system beneath the site.

Ford, Bacon & Davis Utah Inc. (FBDU, 1981) prepared an engineering assessment of the Falls City site that included field sampling of the 14 monitor wells installed by Solution Engineering Inc. around the tailings piles. Analyses of samples from these wells indicated contamination of the shallow aquifer in the vicinity of the tailings piles.

In 1983, Geochemistry and Environmental Chemistry Research, Inc. (GECR, 1983), initiated a geochemical investigation of the Falls City site. Approximately 50 surface water and soil core samples were analyzed to define the extent of surficial contamination on and around the tailings piles. However, only two wells in the vicinity of the site were sampled.

The recent site characterization program conducted by the UMTRA Project included a three-phase hydrogeologic field investigation. In the first phase (December 1985 through May 1986), 39 new 4-inch (100 millimeter [mm]) polyvinyl chloride (PVC) cased monitor wells were installed and sampled; 25 existing wells were sampled as well.

The second phase of the investigation (December 1988 through March 1990) was designed to gather supplemental data from the site to fill data gaps and achieve full compliance with the EPA ground water protection standards. In addition, 12 more monitor wells were installed at depths ranging from 40 to 230 ft (2 to 70 m), completed primarily in the Dilworth Sandstone Member and the upper Manning Clay Formation; ground water from 50 to 55 monitor wells was sampled, including the 12 new wells and selected Conoco background wells in the site vicinity; and 16 lysimeters were installed to characterize the water quality of tailings fluids in piles 1, 2, 4, 5, 7, and pond 6.

Between 1990 and 1992, with the assistance of the Texas Bureau of Economic Geology, the UMTRA Project conducted a third phase of the field program to further characterize site geochemistry. The program included drilling 13 coreholes, analyzing the geochemistry of the cores, and installing 17 new monitor wells.

In 1991 and in early spring of 1994, domestic well surveys were conducted of a 2-mi (3-km) radial area centered upon the site. The survey determined the historical and current use of ground water in the Deweesville/Conquista and Dilworth aquifers. Figure 3.3 shows locations of all wells drilled or sampled by the DOE at the Falls City site.

3.3 CONCEPTUAL SITE MODEL

A conceptual model of the site was developed to understand the site and to support the proposed ground water compliance strategy and remediation objectives. The conceptual model is summarized below; Sections 3.3.1 through 3.3.5 provide details of the model.

Two low-yield (generally less than 1 gallon [4 liters] per minute) aquifers underlying the site have been identified: the Deweesville/Conquista and the Dilworth. The Deweesville and Conquista Members are grouped together as one aquifer because no impermeable strata separates them and there are no apparent restrictions in ground water movement between the two members.

Several investigators, including the Technical Assistance Contractor (TAC) and the Texas Bureau of Economic Geology, concluded the upper portions of the Deweesville/Conquista Formations (the subsurface at the processing site) historically were unsaturated, and milling and *in situ* mining activities caused the current saturated conditions beneath the site. The TAC and the Texas Bureau of Economic Geology determined that processing and mining water created a ground water mound under the site and that ground water from the mound moves radially outward and downdip. The TAC used MODFLOW (USGS, 1988) to simulate ground water flow at the site; preliminary modeling results support the hydrologic representation of site conditions suggested by the TAC and Texas Bureau of Economic Geology.

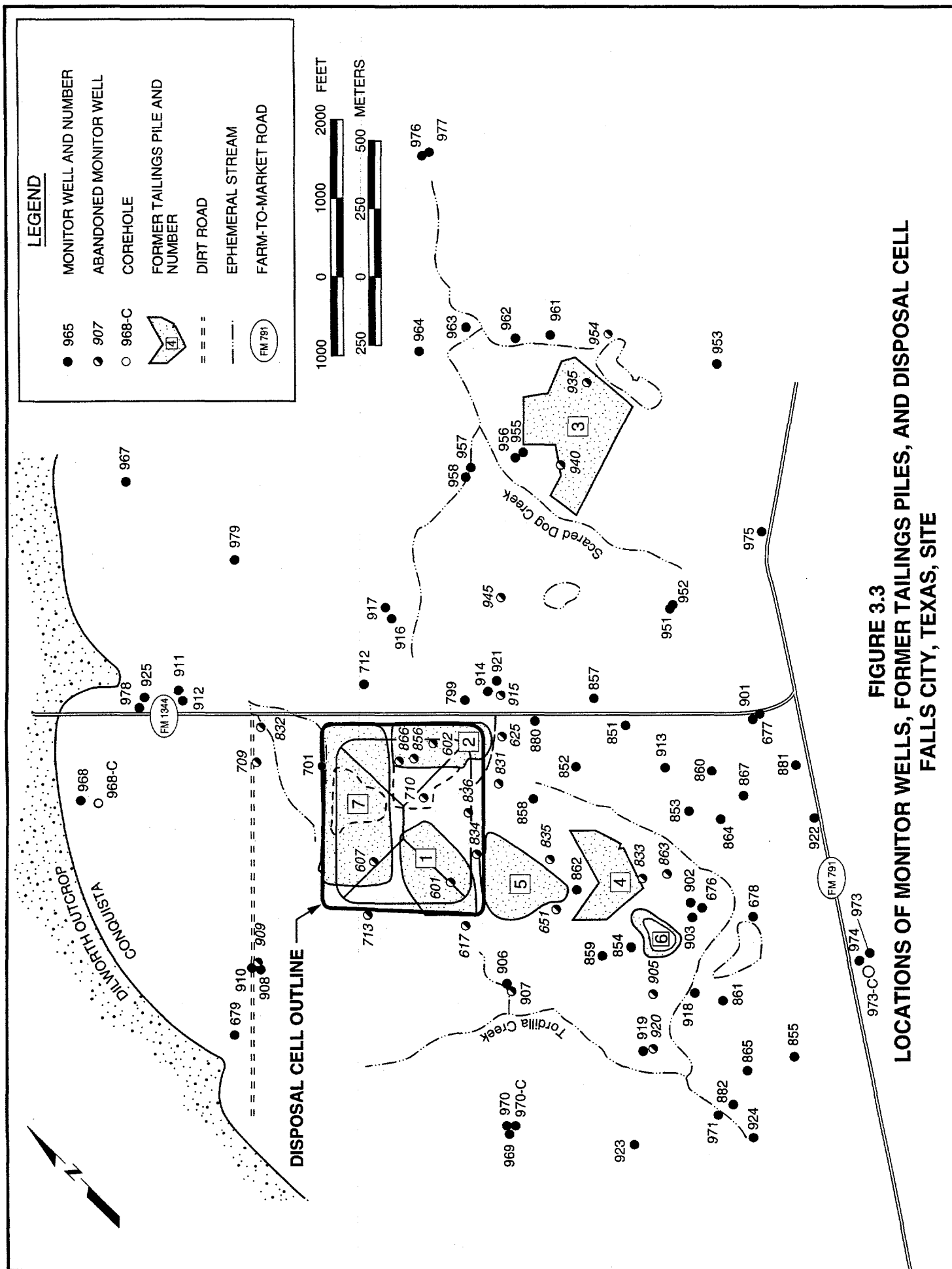


FIGURE 3.3
LOCATIONS OF MONITOR WELLS, FORMER TAILINGS PILES, AND DISPOSAL CELL
FALLS CITY, TEXAS, SITE

The principal ore-bearing unit at the site is the Deweesville Sandstone. Because the uranium mineralization associated with the ore bodies causes background ground water quality in both the Deweesville/Conquista and Dilworth aquifers to vary with depth and location, the ground water quality is difficult to define deterministically. Thus, a complete understanding of geochemical conditions at the site has not been established. However, the contaminants of concern in the aquifer that are related to the mill processing have been identified.

3.3.1 Hydrogeologic setting

The Falls City site is on the coastal plain of the Gulf of Mexico. The main topographic element in the Karnes County area is a series of ridges trending predominantly northeast to southwest. These ridges are mainly cuestas (sloping plains) formed by resistant gulfward-dipping strata, although some river terrace gravels also form local topographic highs. Small intermittent streams follow the easily eroded strata between cuestas, producing a pronounced northeast trend in the drainage pattern in the site area. Relief from ridges to intervening drainage pathways is generally less than 100 ft (30 m) (TKA, 1976). Figure 3.2 presents a topographic map of the site area.

Mean annual precipitation in the site area is 30 inches (760 mm) (NOAA, 1979). Virtually all measurable precipitation is in the form of rain, which reaches monthly maxima in both May and September (NOAA, 1979). Most precipitation occurs as heavy rainfall during brief thunderstorms, which causes great spatial and temporal variability in rainfall distribution.

The Falls City site is underlain by clastic sedimentary strata that dip gently southeast (approximately 20 ft per 1000 ft) as part of the thick homoclinal sequence of the Gulf Coastal Plain. The local sedimentary strata are comprised of generally unlithified sand, silt, and clay deposits of the Whitsett and Manning Clay Formations. The site rests on outcrops of the Dubose Clay, Deweesville Sandstone, and Conquista Clay Members of the Whitsett Formation (Figure 3.4). Tailings were placed in several old open pits excavated through the ore-bearing Deweesville and upper Conquista Members. Underlying the Conquista Clay is the Dilworth Sandstone Member, which, in turn, overlies the Manning Clay Formation. The Manning Clay is the oldest geologic unit encountered during the site drilling program. The site is located on a ground water divide. This divide coincides with a surface drainage divide oriented west-northwest through the disposal cell area.

Three low-yield water-bearing strata are within the upper 200 ft (60 m) of the Whitsett Formation sediments underlying the site. These water-bearing strata in descending order are the Deweesville Sandstone Member, the Conquista Clay Member, and the Dilworth Sandstone Member. The Conquista Clay Member is composed of three subunits: an oxidized upper Conquista Clay/silt, the Conquista Sandstone, and a lower Conquista Clay (Figure 3.5). The Conquista Sandstone extends downdip into the subsurface but thins significantly and becomes considerably finer-grained. The Deweesville Sandstone Member, upper

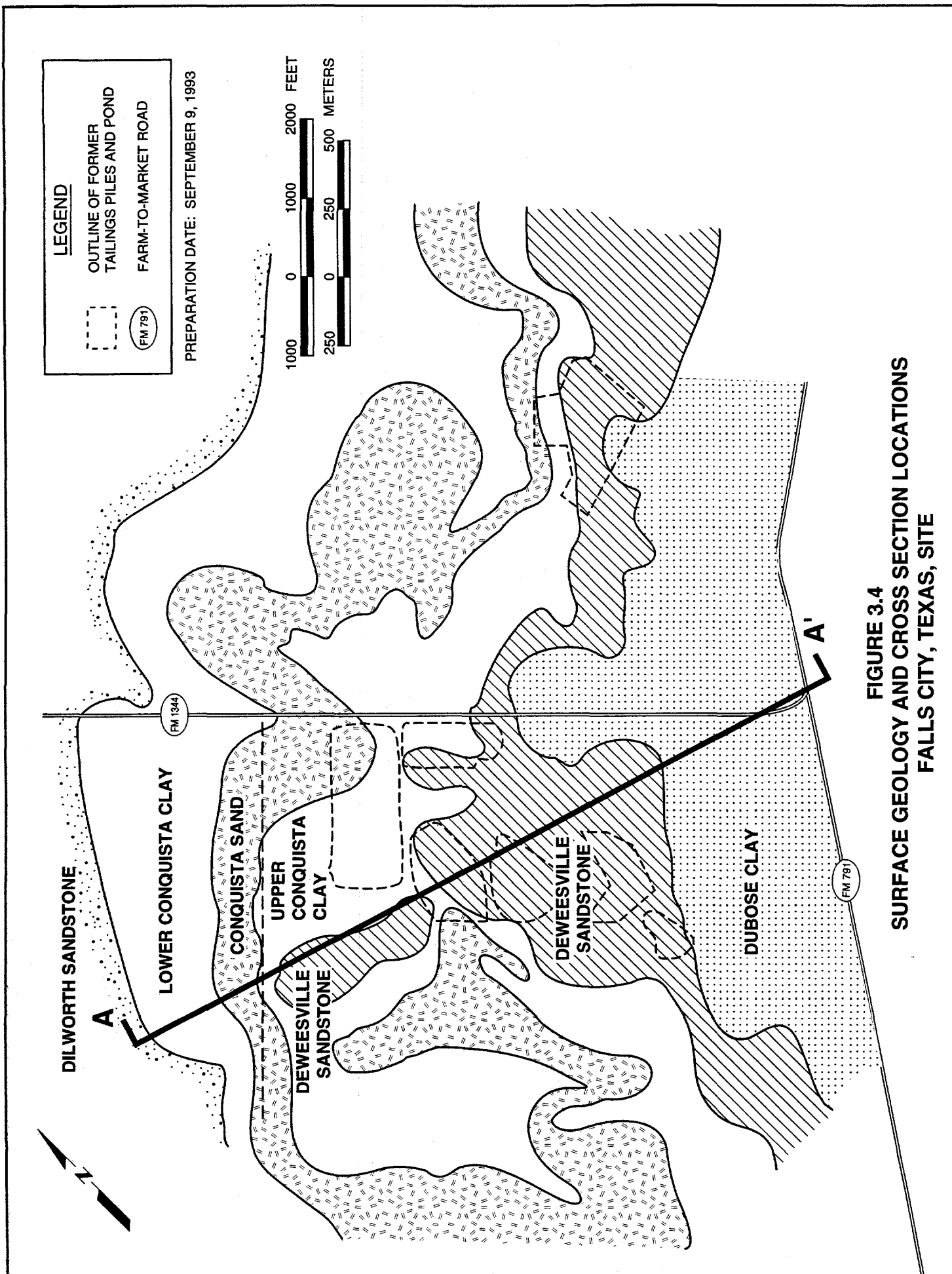
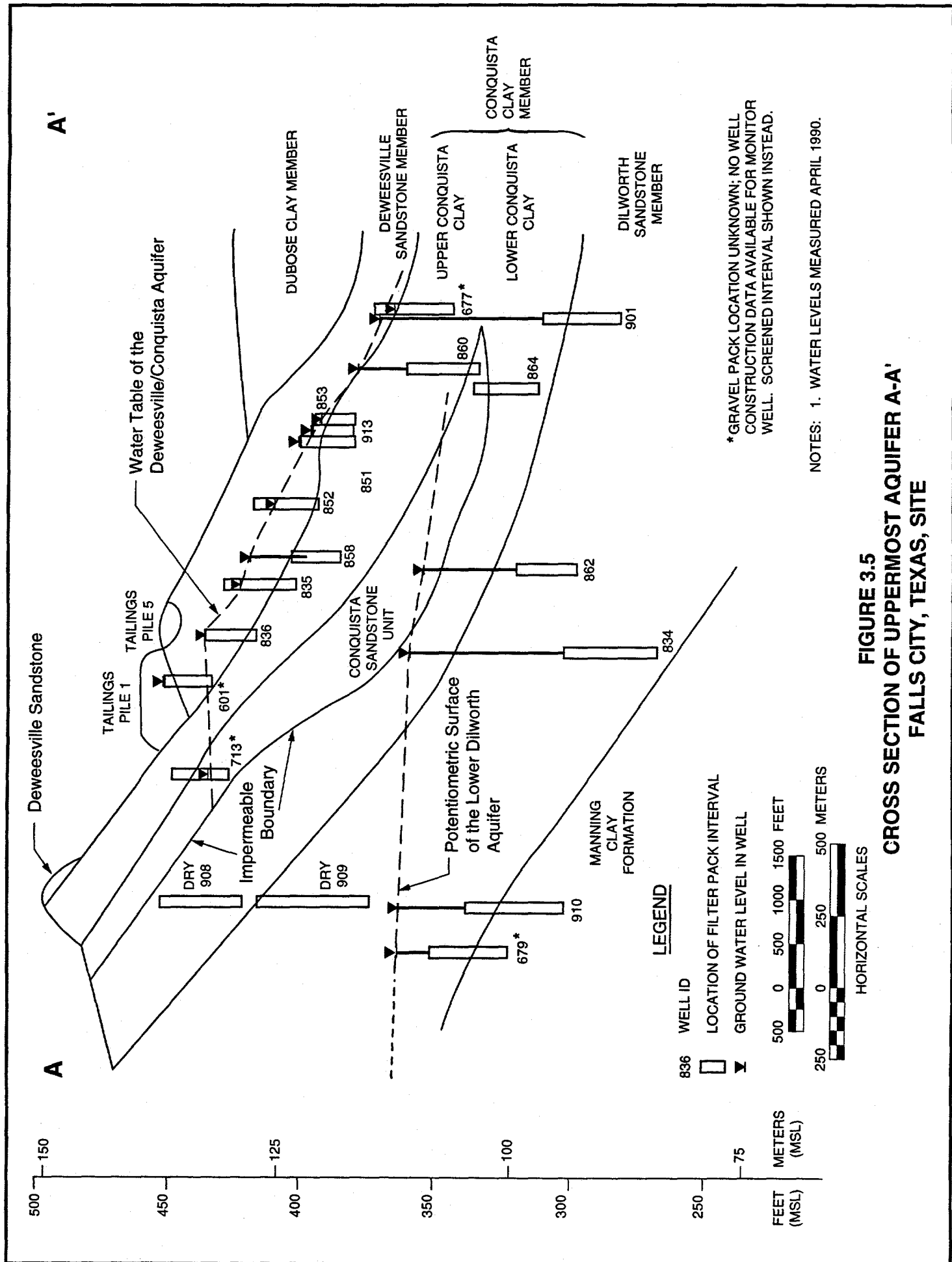


FIGURE 3.4
SURFACE GEOLOGY AND CROSS SECTION LOCATIONS
FALLS CITY, TEXAS, SITE



Conquista Clay, and Conquista Sandstone subunits are grouped together as one aquifer because impermeable strata do not separate the members, with no apparent restrictions in ground water movement between the two members. Although the Deweesville/Conquista and Dilworth are referred to as aquifers in this document, these members have never been developed as a source for drinking water supply because of their low yield (generally less than 1 gallon [4 liters] per minute) and poor water quality.

Deweesville/Conquista aquifer

Shallow ground water in the site vicinity is found in the Deweesville/Conquista aquifer at depths of 5 to 30 ft (2 to 9 m) below land surface. Ground water within the aquifer occurs under unconfined conditions in the northern and western portions of the site vicinity and along creek beds. In areas where the Deweesville/Conquista aquifer is unconfined, the potentiometric surface generally is a subdued replica of the surface topography. The saturated condition of the Deweesville/Conquista in the immediate vicinity of the disposal cell is due, in part, to the discharge of milling-process water

The top of the lower Conquista Clay defines the lower boundary of the Deweesville/Conquista aquifer. The intersection of the Deweesville/Conquista water table and the top of the lower Conquista Clay marks the updip limit of saturation in the Deweesville/Conquista aquifer (Figure 3.5). Monitor wells 908 and 923 are completed updip of this intersection and consequently are dry. Because the tailings piles overlie outcrops of the Deweesville Sandstone and the upper Conquista Clay at the surface, it is impossible to install upgradient, background monitor wells screened in the Deweesville/Conquista aquifer.

Ground water within the Deweesville/Conquista aquifer is recharged by infiltrating precipitation in the Deweesville/Conquista outcrop areas, seepage of tailings fluids, and interformation leakage in downdip areas. Ground water within the Deweesville/Conquista aquifer immediately downgradient of the disposal cell discharges to the eastern tributary of Tordilla Creek. Ground water discharge might continue downdip into the subsurface, where some ground water might discharge into Conquista Creek, southeast of FM 791. North of former tailings pile 3, ground water flows locally to the north toward Scared Dog Creek.

Seepage from tailings disposed of in old pits and on the outcrop of the Deweesville Sandstone and upper and middle Conquista subunits has resulted in a ground water mound in the Deweesville/Conquista aquifer. The Deweesville/Conquista potentiometric surface beneath tailings piles 1, 2, 4, and 5 is higher than background ground water levels. Ground water levels near the tailings have risen since initial mining. Before milling and tailings disposal activities, there was little water in the Deweesville/Conquista from the tailings area down to the tributary of Tordilla Creek (BEG, 1992). A review of the scientific literature on this site suggests this zone of the Deweesville/Conquista might have contained very little water prior to milling activity. The floor of open

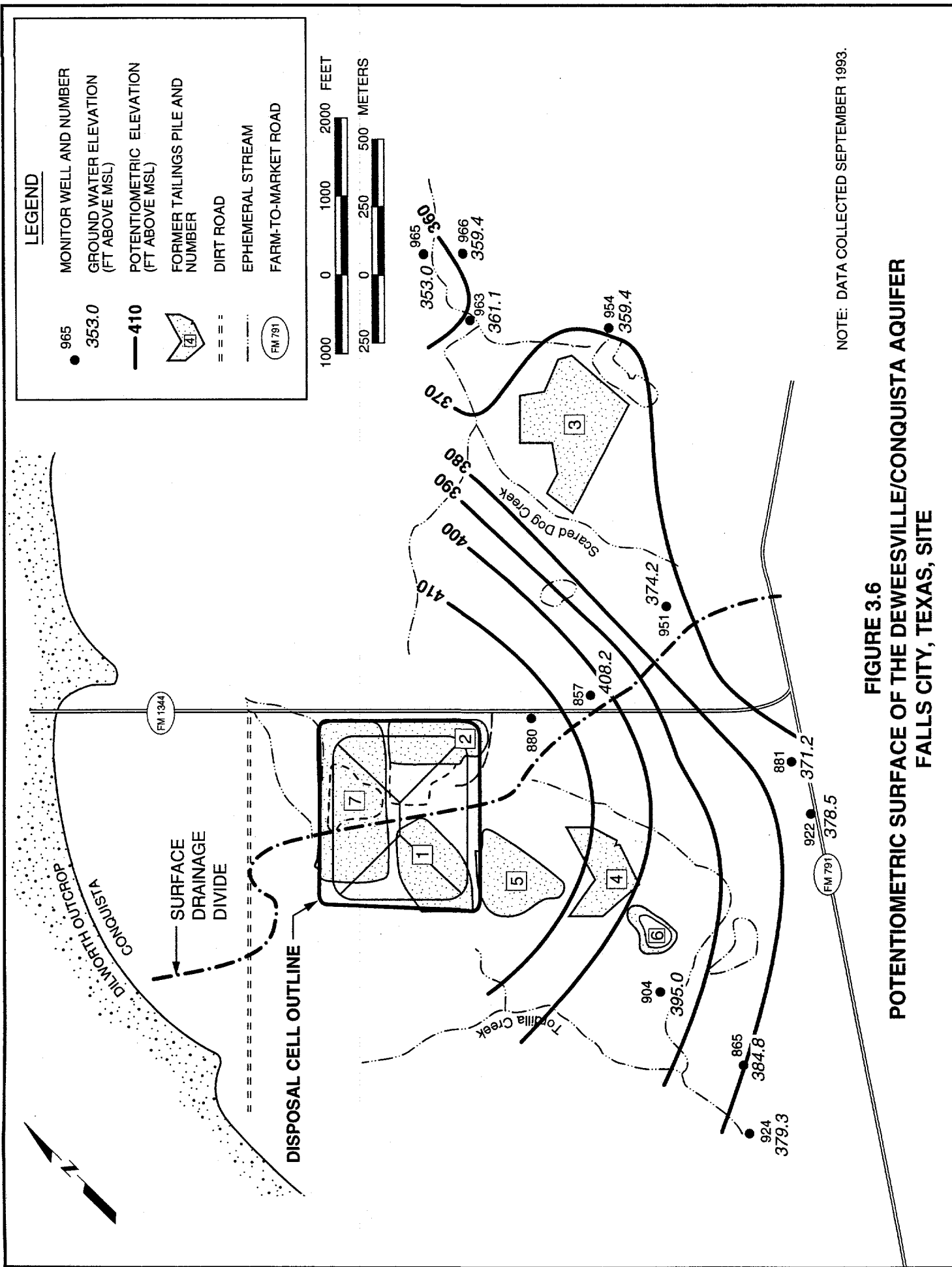
pit mine 5 (former tailings pile 5) extended several feet below the Deweesville/Conquista interface; a 1960 photograph of this pit (Bunker and MacKallor, 1973) shows the contact between the Deweesville and the Conquista was dry. After these pits were filled with saturated tailings and the later leachate injection/*in situ* leaching began, large volumes of tailings pore water were introduced to the Deweesville/Conquista. Consequently, a ground water mound developed on the processing site in and around the tailings piles. Currently, the water table in the outcrop area of the Deweesville is 8 to 17 ft (2 to 5 m) above the base of the Deweesville. The Conquista Clay also was affected by these milling-related processes and water levels beneath pile 7 (on the Conquista outcrop) may have been as much as 40 ft (10 m) higher than the background water table elevation (BEG, 1992). Background ground water conditions do not exist in the outcrop area of the Deweesville Sandstone immediately east of the site. Naturally occurring ground water might only exist where the Deweesville/Conquista aquifer dips below the Dubose (BEG, 1992). As shown on the map of the potentiometric surface contours developed from water levels measured in 1993 (Figure 3.6), ground water from the tailings flows in three directions: east, away from former tailings pile 2; south, toward the eastern tributary of Tordilla Creek; and southeast, down the structural dip of the Deweesville beneath FM 791 and into the deeper subsurface.

Dilworth aquifer

The Dilworth aquifer is a sandstone member of the Whitsett Formation. It is separated from the Deweesville/Conquista aquifer by 30 to 50 ft (9 to 15 m) of carbonaceous clay of the lower Conquista Clay subunit, which acts as an aquitard to downward seepage. The Dilworth aquifer extends approximately 100 ft (30 m) below the disposal cell.

Near the outcrop of the Dilworth sandstone (Figure 3.4), ground water is unconfined. Depths to ground water in the Dilworth aquifer range from approximately 30 to 100 ft (9 to 30 m) below land surface. Downdip to the southeast, ground water in the Dilworth aquifer becomes confined by the lower Conquista clay. A cross-sectional view of the potentiometric surface of the Dilworth aquifer is shown on Figure 3.5.

A downward hydraulic gradient occurs between the Dilworth aquifer and the overlying Deweesville/Conquista aquifer. The potentiometric surface in the lower Dilworth aquifer shows ground water flows generally southeast beneath the site from the Dilworth outcrop (recharge area) northwest of the site. Thus, ground water from the Deweesville/Conquista aquifer could recharge the Dilworth aquifer. The Texas Bureau of Economic Geology identified three discrete potentiometric highs as an indication of leakage from the Deweesville/Conquista aquifer into the Dilworth aquifer. These leakages were caused by extensive deep drilling by mining companies exploring for ore. The potentiometric highs are near monitor wells 901, 915 and 917, and 905 and 907. The mining exploration programs drilled approximately 370 boreholes that typically penetrated through the Dilworth and were not abandoned properly



NOTE: DATA COLLECTED SEPTEMBER 1993.

FIGURE 3.6
POTENTIOMETRIC SURFACE OF THE DEWEESVILLE/CONQUISTA AQUIFER
FALLS CITY, TEXAS, SITE

(BEG, 1992). The monitor wells were constructed with the filter pack interval placed across the Conquista/Dilworth contact. The elevated water levels might be influenced by drainage from the Deweesville/Conquista aquifer through the well bore annulus rather than drainage through the formations. The Dilworth is underlain by the carbonaceous clays and lignite seams of the Manning Clay Formation, effectively forming a 300-ft (90-m)-thick aquitard.

Because improperly abandoned exploratory boreholes form a potential hydraulic interconnection between the Deweesville/Conquista aquifer and the Dilworth unit, the Dilworth unit is included as part of the uppermost aquifer.

Hydraulic and transport properties

The saturated hydraulic conductivities of the most permeable beds of the Whitsett Formation aquifer system, as determined by aquifer tests and single-packer pressure testing, range from approximately 0.5 to 2.6 ft per day (1.8×10^{-4} to 9.0×10^{-4} centimeters per second [cm/s]). The TAC conducted this aquifer test (and all other aquifer tests discussed here) in the spring of 1991. The hydraulic conductivities are consistent with the ranges generally reported in the hydrologic literature for sandy clays, silty to clayey sands, and fine sandstones. The sandy members contain a high percentage of silts and clays, and yield small amounts of water (1 to 2 gallons [4 to 8 liters] per minute) to extraction wells. The lowest hydraulic conductivities are found in the carbonaceous clays of the lower Conquista Clay unit and the silty to clayey sands of the upper Dilworth Sandstone unit. The most permeable intervals tested are the fossiliferous sands of the middle Conquista Clay Member and the unconsolidated, fine-to-medium sands of the lower Dilworth Sandstone.

The horizontal hydraulic conductivities in the Deweesville and Conquista units are highly variable, with a value range of 2 orders of magnitude. The maximum horizontal hydraulic conductivity for the Deweesville/Conquista aquifer was 2.6 ft per day (9.0×10^{-4} cm/s), calculated from aquifer test data from a well screened in the Conquista Sandstone (DOE, 1992b). Using Darcy's Law, an assumed effective porosity of 0.1, and an average hydraulic gradient of 0.013 to the east-southeast, the maximum average linear ground water velocity is 130 ft (40 m) per year.

Average linear ground water velocities in the Dilworth aquifer were calculated using a hydraulic conductivity of 0.68 ft per day (2.4×10^{-4} cm/s) (approximate maximum value from aquifer test), a hydraulic gradient of 0.009 to the east-southeast, and an assumed effective porosity of 0.1 for the fine sands of this zone (DOE, 1992b). The average linear velocity for ground water flow in the lower Dilworth aquifer is approximately 22 ft (6.7 m) per year.

A downward hydraulic potential flow exists between the Deweesville/Conquista and Dilworth aquifers. During a 10-hour aquifer test of monitor well 902 completed in the Dilworth, drawdown was observed in an adjacent monitor well (676) screened in the Deweesville. Vertical leakage was calculated to be

$7.4 \times 10^{-5} \text{ day}^{-1}$ from the analysis of time-drawdown data. Considering an aquitard thickness of 60 ft (20 m), the vertical hydraulic conductivity is $4.4 \times 10^{-3} \text{ ft per day}$ ($1.6 \times 10^{-6} \text{ cm/s}$).

3.3.2 Background ground water quality

Background ground water quality for the Deweesville/Conquista and Dilworth aquifers is defined as the quality of ground water at the Falls City site that would be present if uranium processing activities had not occurred.

There is no single background ground water quality for each of these aquifers. The natural ground water quality varies within these aquifers as a function of residence time and aquifer matrix composition. The Deweesville/Conquista and Dilworth aquifers can each be separated into three general regions or zones with different mineralogical and compositional characteristics. These zones are defined as the oxidized, transitional, and reduced zones. Although these zones overlap, the ground water in each zone typically is distinct in composition from the ground water in the other zones. Table 3.1 summarizes the range of background ground water quality at the site. The constituents and concentrations presented in Table 3.1 are based on the latest available data. Other background water quality data are presented in the Falls City RAP (DOE, 1992b). The numerous unmined and mined ore bodies in the oxidizing, transitional, and reducing zones of the regional sediments cause considerable variation in the concentrations of hazardous constituents from zone to zone.

Deweesville/Conquista

The oxidized zone of the Deweesville/Conquista is defined as the outcrop area and shallow subsurface. At the Falls City UMTRA site, this zone was largely unsaturated before mining and milling. The oxidized zone later became saturated by the influx of large volumes of tailings leachate and mill processing water. Thus, ground water in this zone at the mill site is not the result of natural processes, and a background ground water quality for the oxidized, outcrop zone of the Deweesville/Conquista aquifer does not exist in the mill site area.

The transitional zone begins at the downdip edge of the Deweesville/Conquista outcrop (where the sediments are dominantly oxidized) and ends before the downgradient limit of the DOE monitor well array (e.g., 922 and 881, where the sediments are dominantly reduced). Ground water quality before mining and milling activities in the uranium mineralized zone might have varied from conditions found in monitor well 951 to the much poorer quality ground water found in monitor well 922. The interaction of oxidizing water from the recharge area with the pyrite- and ore-bearing sediments causes high variability in the background ground water in the transitional zone.

The upgradient limit of the reduced zone for the Deweesville/Conquista is defined by the DOE and Texas Bureau of Economic Geology as the

Table 3.1 Typical water quality data for Dilworth and Deweesville/Conquista background wells

Constituents	Tailings fluid ^a		Reduced zone		Transitional zone		Oxidized zone (outcrop area)		
	607		667	668	951	969	967	968	979
Alkalinity ^b			252	250	307	291	116	226	193
Calcium	494		335	405	364	495	278	90	258
Chloride	1210		785	944	708	779	793	338	672
Iron	430		0.45	0.19	0.03	0.87	<0.03	<0.03	<0.03
Magnesium	185		31.8	45.1	29	61	30.5	8.1	28.3
Manganese	21.8		0.21	0.78	0.21	2.94	0.02	<0.01	0.07
Nitrate	0.5		4.9	3.5	4	1.3	10.2	12.4	4.4
pH	2.95		6.65	6.63	6.75	6.70	5.98	6.58	6.08
Potassium	1.77		43	29	45	43	30	18	36
Sodium	739		678	583	652	550	675	121	531
Sulfate	7700		1043	930	856	1290	817	156	569
Total dissolved solids	12900		3120	3310	2291	3650	2750	624	2210
Uranium	1.19		0.015	0.017	0.008	0.010	0.003	0.068	0.25

^aWater quality data from January 1991.

^bmg/L CaCO₃.

Note: 1. Water quality data from June 1991 and July 1991 from Dilworth background wells 967, 968, 969, and 979; and Deweesville/Conquista background wells 951, 667, and 668, except where noted.

2. Concentrations are reported in milligrams per liter except for pH.

downgradient edge of the DOE monitor well array (beginning at FM 791). Ground water quality data from Conoco monitor wells 667 and 668 suggest the ground water quality of the Deweesville/Conquista in parts of this zone is lower in sulfate, chloride, and many other constituents than water from the transitional zone. Figure 3.7 shows the locations of the Conoco monitor wells (657 and 668) and Dilworth background monitor wells.

To expand the background water quality data base for the Deweesville/Conquista aquifer, ground water quality data from other areas in the Deweesville/Conquista were evaluated. Thirty-nine monitor wells were completed in the Deweesville Sandstone before mining activities began at the Hobson *in situ* uranium mine site, 8 or 9 mi (about 13 km) east of the UMTRA site. Of those 39 wells, 28 were completed in the ore body and the remaining 11 were completed nearby. Table 3.2 presents a statistical summary of water quality data obtained from the Deweesville monitor wells.

The Deweesville wells at the Hobson site are generally screened between 300 and 450 ft (90 to 140 m) below land surface. Therefore, ground water from the Hobson site has probably migrated farther into the reduced zone of this aquifer than ground water from monitor wells 667 and 668. The greater residence time of contaminants in deeper ground water is reflected in the lower concentrations of sulfate, chloride, and other major and minor constituents in the Hobson ground water relative to the 600 series wells (Table 3.2). Nonetheless, the ground water from the 600 series wells and the Hobson wells might have followed a similar ground water quality evolutionary trend. Figure 3.8 shows a trilinear plot of wells 667 and 668 and the 11 Hobson wells drilled around the ore body.

Unlike the major and minor element data, the trace element data from the Hobson area ground water differ from those of monitor wells 667 and 668. The Hobson data show significantly elevated levels of lead, radium-226, and uranium (Table 3.2) because most of the Hobson samples were Deweesville ground water equilibrating with uranium ore.

Dilworth

Four upgradient Dilworth monitor wells (967, 968, 969, and 979) are used to delineate the background water quality of this aquifer at the Falls City site. As shown on a trilinear plot (Figure 3.9), the upgradient Dilworth ground waters are dominated by no single anionic species, and they contain subequal milliequivalents of sulfate and chloride with lesser bicarbonate. Sodium and calcium are the dominant cations. Table 3.3 presents a statistical summary of the water quality of Dilworth background ground water.

Of the four DOE Dilworth background wells at the UMTRA site, three (967, 968, and 979) are completed in the oxidized zone, and one (969) is screened in the transitional zone of the aquifer. The ground water quality of monitor well 969 is more representative of the remaining Dilworth wells at the site.

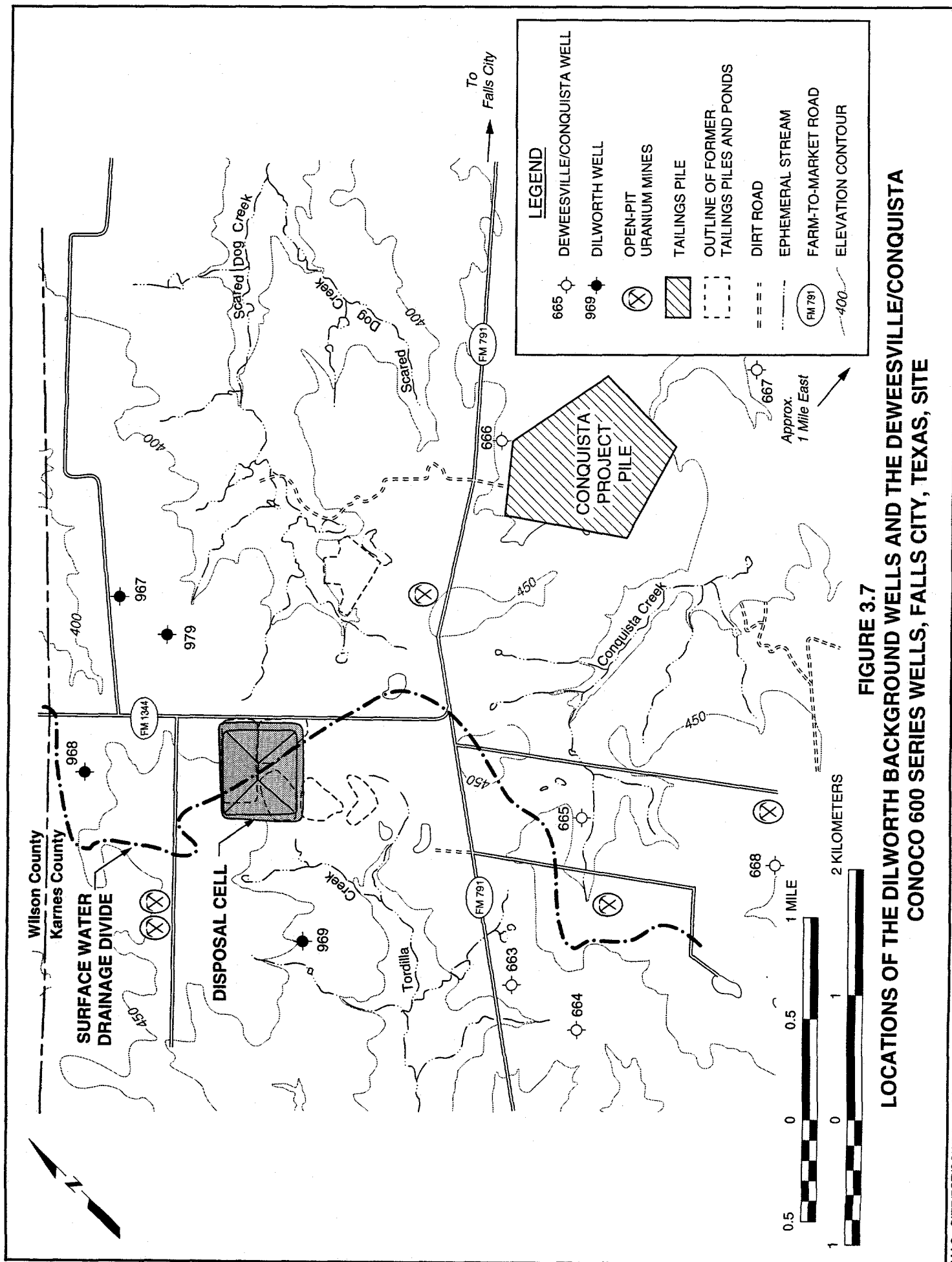


Table 3.2 Water quality in the Deweesville/Conquista aquifer at the Falls City, Texas, site

Constituent	Background ground water				Ground water at mill site by region			
	On-site cross gradient well ^b	Area southeast of FM 791 ^c	Hobson area ^a		East ^d	North ^e	South ^f	West ^g
			Mine zone	Production zone				
Inorganic								
Aluminum								
FOD	2/6	0/6	NA	NA	27/29	9/17	17/35	22/31
Range	<0.05-0.05	<0.05-<0.1			<0.05-98	<0.05-796	<0.05-109	<0.05-57
Ammonium								
FOD	5/6	2/6	NA	NA	25/28	13/16	31/31	23/30
Range	<0.1-0.8	<0.1-0.3			<0.01-3.9	0.05-288	0.1-2.1	<0.01-1.2
Antimony								
FOD	1/7	0/6	NA	NA	7/33	4/18	5/33	4/30
Range	<0.003-0.014	<0.003			<0.003-0.031	<0.003-0.007	<0.003-0.029	<0.003-0.013
Arsenic								
FOD	4/7	6/6	?	?	9/33	9/19	18/37	8/34
Range	0.008-0.01	0.01-0.02	0.003-0.035	0.003-0.09	0.001-0.09	0.005-0.16	0.001-0.30	0.001-0.02
Barium								
FOD	6/7	2/6	?	?	22/33	15/19	32/37	23/34
Range	0.02-0.04	0.03-0.06	<0.4	<0.4	<0.01-0.06	<0.01-0.04	0.01-0.08	<0.01-0.11
Beryllium								
FOD	0/7	0/6	NA	NA	24/33	6/18	13/33	16/30
Range	<0.005-<0.01	<0.005-<0.01			<0.005-0.62	<0.005-0.38	<0.005-0.20	<0.005-0.09
Boron								
FOD	6/6	6/6			29/29	16/16	31/31	27/27
Range	0.7-1.0	0.5-1.0	0.06-2.3	0.8-3.0	0.5-2.4	0.5-1.8	0.9-2.4	0.7-2.2
Bromide								
FOD	6/6	6/6	NA	NA	27/27	14/16	27/30	25/27
Range	1.0-4	2.5-4.8			0.6-12	0.7-19	0.8-28	0.3-25
Cadmium								
FOD	3/7	0/6	?	?	27/33	14/19	20/37	22/34
Range	<0.001-0.009	<0.001-<0.01	0.01-0.01	0.005-0.01	<0.00-0.99	<0.001-0.55	<0.001-0.18	<0.001-0.05
Calcium								
FOD	7/7	6/6	?	?	33/33	9/19	37/37	34/34
Range	297-364	321-422	75-180	69-120	323-975	38-1760	396-3710	509-1720

Table 3.2 Water quality in the Deweesville/Conquista aquifer at the Falls City, Texas, site (Continued)

Constituent	Background ground water				Ground water at mill site by region			
	On-site cross gradient well ^b	Area southeast of FM 791 ^c	Hobson area ^a		East ^d	North ^e	South ^f	West ^g
			Mine zone	Production zone				
Chloride								
FOD	7/7	6/6	?	?	31/31	19/19	36/36	34/34
Range	708-780	785-1090	379-600	264-542	621-2480	558-3800	680-7480	173-6820
Chromium								
FOD	1/7	0/6	?	?	3/33	5/19	3/37	4/34
Range	<0.01-0.01	<0.01	<0.01-0.1	<0.01-0.1	<0.01-0.01	<0.01-0.03	<0.01-0.02	<0.01-0.03
Cobalt								
FOD	1/7	0/6	NA	NA	31/33	6/18	15/18	19/30
Range	0.01	<0.03-<0.05			<0.03-1.2	0.01-0.7	0.01-0.6	0.01-0.3
Copper								
FOD	1/7	0/6	?	?	13/33	9/18	14/33	14/30
Range	<0.01-0.03	<0.01-<0.02	0.01-0.2	<0.01-0.5	<0.01-0.25	<0.01-0.12	<0.01-0.07	<0.01-0.11
Cyanide								
FOD	0/5	0/6	NA	NA	1/24	1/12	0/18	2/19
Range	<0.01-<0.02	<0.01			<0.01-0.01	<0.01-0.02	<0.01-<0.02	<0.01-0.02
Fluoride								
FOD	6/6	6/6	?	?	26/28	15/16	26/30	24/27
Range	0.2-0.8	0.6-0.7	0.1-2	0.04-0.4	<0.1-4.3	<0.1-4.3	<0.1-1.2	<0.1-4
Iron								
FOD	4/7	5/6	?	?	29/33	11/19	33/37	19/34
Range	0.02-0.06	<0.03-0.45	0.06-2.3	0.07-5.8	<0.03-126	0.02-458	0.02-49	0.02-77
Lead								
FOD	1/7	0/6	?	?	9/33	4/19	8/37	7/34
Range	0.001	<0.005-<0.01	0.03-0.10	0.02-0.15	0.001-0.04	0.001-0.02	<0.001-0.03	0.001-0.02
Magnesium								
FOD	7/7	6/6	?	?	33/33	19/19	37/87	34/34
Range	26-33	32-51	0.3-9.4	1.8-4.2	36-574	5-1050	44-752	81-381
Manganese								
FOD	7/7	6/6	?	?	32/33	19/19	37/37	34/34
Range	0.04-0.6	0.2-0.8	0.1-0.4	0.03-0.3	<0.01-51	0.04-74	1.59-49	0.04-16

Table 3.2 Water quality in the Deweesville/Conquista aquifer at the Falls City, Texas, site (Continued)

Constituent	Background ground water				Ground water at mill site by region			
	On-site cross gradient well ^b	Area southeast of FM 791 ^c	Hobson area ^a		East ^d	North ^e	South ^f	West ^g
			Mine zone	Production zone				
Mercury								
FOD	0/6	0/6	?	?	3/29	1/15	1/30	4/28
Range	<0.0002	<0.0002	<0.001-0.001	<0.001	<0.0002-0.002	<0.0002-0.001	<0.0002-0.0002	<0.0002-0.009
Molybdenum								
FOD	3/7	4/6	?	?	3/33	10/19	15/37	11/34
Range	<0.01-0.02	<0.01-0.02	<0.1-0.1	<0.1-0.2	<0.01-0.02	<0.01-0.09	<0.01-0.68	<0.01-0.18
Nickel								
FOD	2/7	0/6	?	?	29/33	8/19	18/37	22/34
Range	0.01-0.1	<0.04	<0.02-0.2	<0.01-0.08	0.03-1.3	0.01-0.9	0.01-1.0	0.01-0.3
Nitrate								
FOD	4/7	2/6	?	?	27/32	15/18	28/33	25/32
Range	<0.1-4	<1.0-4.9	1-4	2-9	0.3-15	<1.0-53	<1.0-62	0.7-18
Phosphate								
FOD	5/6	2/6	NA	NA	22/28	13/15	19/26	20/25
Range	0.1-0.3	<0.1-0.1			<0.1-1.1	0.1-14	<0.1-2.0	<0.1-1.6
Potassium								
FOD	7/7	6/6	?	?	33/33	19/19	37/37	34/34
Range	38-46	29-44	31-51	30-45	21-94	6-287	47-505	45-114
Selenium								
FOD	2/7	0/6	?	?	19/33	11/19	17/37	20/34
Range	0.002-0.012	<0.005	0.004-0.05	0.003-0.06	0.002-0.60	<0.005-0.22	0.002-1.2	0.002-1.2
Silica								
FOD	6/6	6/6	?	?	29/29	17/17	34/34	31/31
Range	43-49	34-49	53-76	55-103	11-165	43-171	22-141	42-198
Silver								
FOD	0/7	0/6	?	?	2/33	1/18	1/33	1/30
Range	<0.01	<0.01	<0.01-0.02	<0.01-0.09	<0.01-0.08	<0.01-0.07	<0.01-0.01	<0.01-0.01
Sodium								
FOD	7/7	6/6	?	?	33/33	19/19	37/37	34/34
Range	530-652	560-678	313-564	248-399	383-1560	90-2870	606-3540	742-2310

Table 3.2 Water quality in the Deweesville/Conquista aquifer at the Falls City, Texas, site (Continued)

Constituent	Background ground water				Ground water at mill site by region			
	On-site cross gradient well ^b	Area southeast of FM 791 ^c	Hobson area ^a		East ^d	North ^e	South ^f	West ^g
			Mine zone	Production zone				
Strontium								
FOD	6/6	6/6	NA	NA	29/29	17/17	35/35	31/31
Range	2.2-2.9	2.4-3.0			2.5-11.9	0.3-19.6	3.0-51.5	5.4-27.4
Sulfate								
FOD	7/7	6/6	?	?	32/32	19/19	36/36	34/34
Range	833-910	898-1043	133-354	78-334	1420-5780	74-11,100	1450-2500	1570-2970
Sulfide								
FOD	3/5	3/6	NA	NA	3/23	5/13	4/18	4/19
Range	<0.1-9.2	<0.05-1.4			<0.1-5.4	<0.1-4.6	<0.1-19.2	<0.1-3.1
Thallium								
FOD	0/7	0/6	NA	NA	2/33	2/18	2/33	5/30
Range	<0.01-<0.10	<0.01-<0.10			<0.01-0.10	<0.01-0.40	<0.01-0.08	<0.01-0.10
Tin								
FOD	1/7	0/6	NA	NA	8/33	5/18	4/33	4/30
Range	<0.005-0.06	<0.005-<0.05			<0.005-0.13	<0.005-0.18	<0.005-0.11	<0.005-0.10
Uranium								
FOD	7/7	6/6	?	?	81/33	19/19	29/36	33/34
Range	0.008-0.078	0.015-0.022	0.01-0.06	0.01-11	<0.001-70	0.043-33	<0.001-8.0	<0.001-18
Vanadium								
FOD	1/7	0/6	?	?	10/33	12/19	4/87	4/34
Range	<0.01-0.04	<0.01	<0.2	<0.2	<0.01-0.55	<0.01-3.0	<0.01-0.07	<0.01-0.09
Zinc								
FOD	6/7	5/6	?	?	31/33	16/19	35-37	30/34
Range	<0.005-0.02	<0.005-0.30	0.12-2.4	0.02-1.2	<0.005-2.6	<0.005-3.1	<0.005-2.8	<0.005-1.6
Radionuclide								
Lead-210								
FOD	2/2	NA	NA	NA	9/9	4/4	6/6	6/6
Range	0.0-1.7				0.0-500	5.7-75	0.3-58	0.6-118
Polonium-210								
FOD	2/2	NA	NA	NA	9/9	8/8	6/6	6/6
Range	0.0-0.1				0.0-1.4	0.2-2.6	0.0-5.4	0.1-7.6

Table 3.2 Water quality in the Deweesville/Conquista aquifer at the Falls City, Texas, site (Concluded)

Constituent	Background ground water				Ground water at mill site by region			
	On-site cross gradient well ^b	Area southeast of FM 791 ^c	Hobson area ^a		East ^d	North ^e	South ^f	West ^g
			Mine zone	Production zone				
Radium-226								
FOD	7/7	6/6	?	?	33/33	18/18	36/36	34/34
Range	1.3-2.7	1.9-2.8	0.4-15.5	3.7-1023	0.0-14	0.9-34	0.4-140	0.2-654
Thorium-230								
FOD	2/2	NA	NA	NA	9/9	6/6	11/11	10/10
Range	0.1-0.4				0.0-8.1	0.0-46	0.2-3.6	0.0-54

^aNear mine zone - H102, H48, B110, B46, B98, B99, B100, B108, B109, B40, B42, with 11 ground water samples collected from these wells from 1979 to 1981. Production zone wells - T6-A, M95, M94, M93, T92, M10, M9, M7, M5, M3, T95A, M96, M97, M98, P100, P101, I102, I103, I104, I105, I106, I107, M16, M96, M97, M98, H96, H97; 28 ground water samples were collected from these wells from 1978 to 1979.

^bMonitor well 951.

^cMonitor wells 667 and 668. Filtered-sample data are from 1991.

^dWells 940, 953, 955, 963, 965, 966.

^eWells 625, 713, 799, 880, 914, 921.

^fWells 677, 853, 860, 864, 867, 881, 913.

^gWells 854, 859, 882, 904, 918, 919.

NA - data not available (sample was not analyzed for this constituent).

? - detection limit not reported.

FOD - frequency of detection; the number of measurements at or above detection limits divided by total number of measurements.

Notes: 1. Filtered samples 1989 to April 1993, except as noted.

2. Concentrations are reported in milligrams per liter, except radionuclides which are reported in picocuries per liter.

LEGEND

- 1 H-102
- 2 H-4B
- 3 B-110
- 4 B-46
- 5 B-98
- 6 B-99
- 7 B-100
- 8 B-108
- 9 B-109
- A B-40
- B B-42
- C 667
- D 668

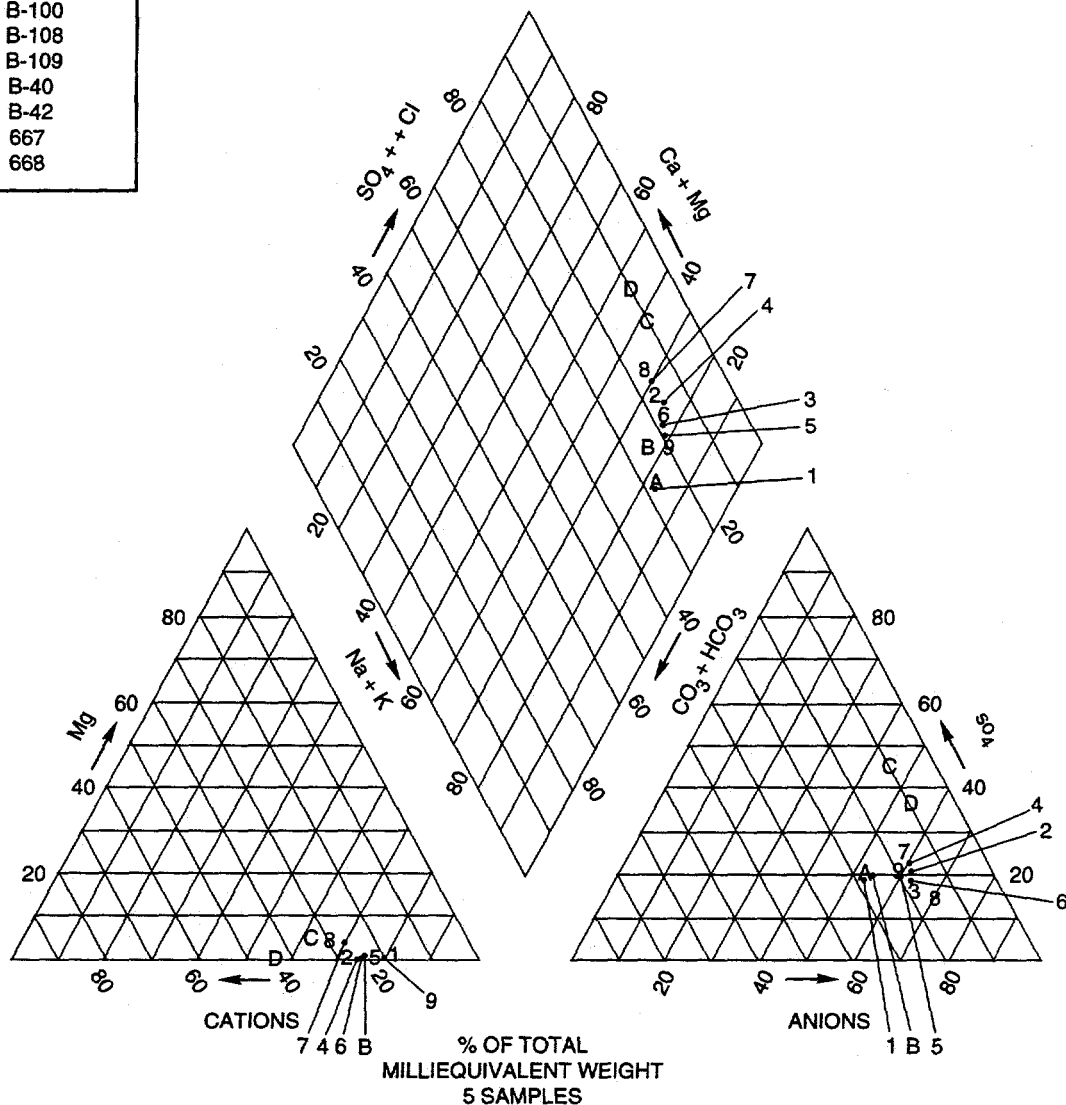
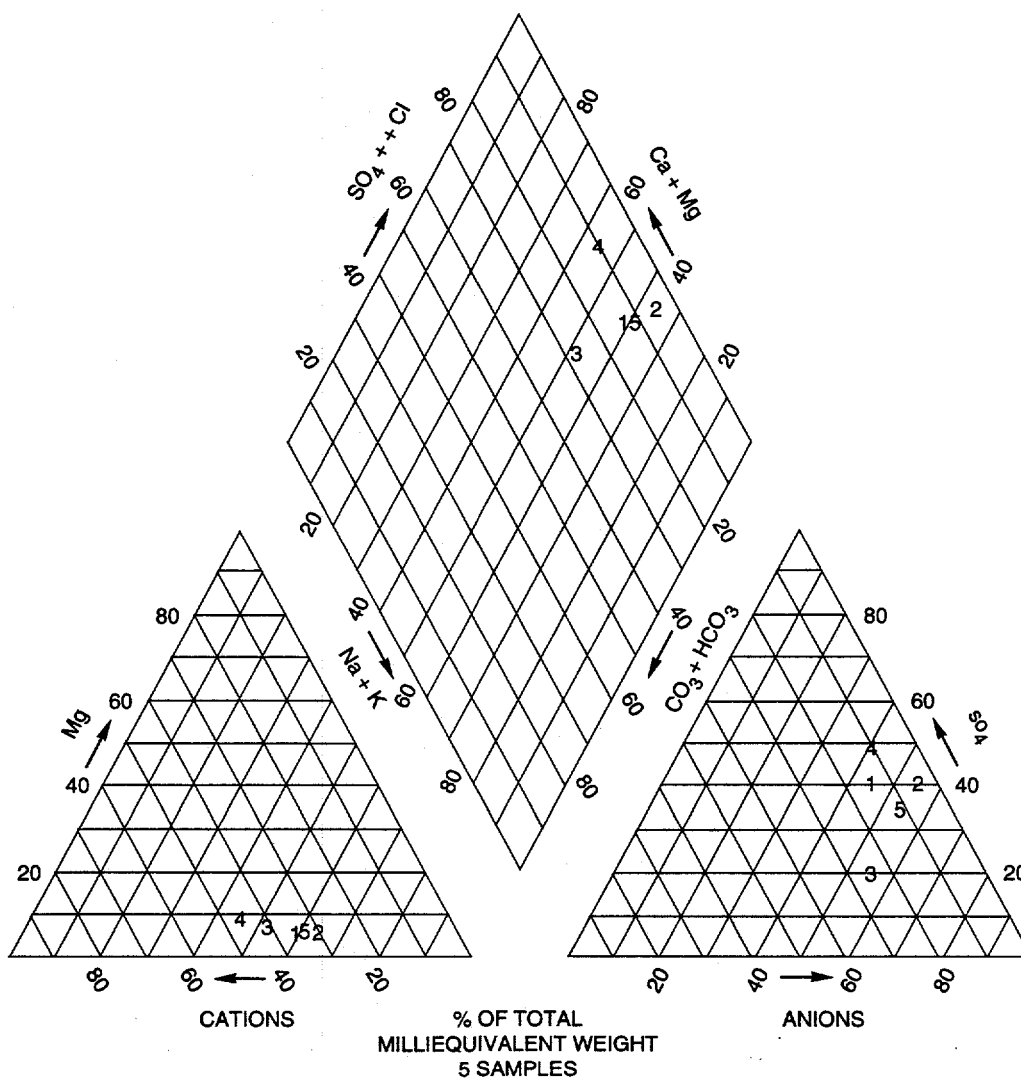


FIGURE 3.8
TRILINEAR PLOT OF DATA FROM DEWEESVILLE/CONQUISTA MONITOR WELLS
667, 668, AND SELECTED HOBSON MONITOR WELLS
FALLS CITY, TEXAS, SITE



LEGEND

- 1 MW 951 - DEWEESVILLE/CONQUISTA REFERENCE WELL
- 2 MW 967 - DILWORTH BACKGROUND WELL
- 3 MW 968 - DILWORTH BACKGROUND WELL
- 4 MW 969 - DILWORTH BACKGROUND WELL
- 5 MW 979 - DILWORTH BACKGROUND WELL

FIGURE 3.9
TRILINEAR PLOT OF DILWORTH BACKGROUND GROUND WATER
AND DEWEESVILLE/CONQUISTA REFERENCE WATER
FALLS CITY, TEXAS, SITE

Table 3.3 Statistical summary of the Dilworth ground water quality at the Falls City, Texas, site

Constituent	Frequency of detection	Observed concentration		
		Minimum	Median ^a	Maximum
		(mg/L)	(mg/L)	(mg/L)
Chemical				
Aluminum				
Background ^b	2/18	<0.05	c	0.05
833 ^c	1/1	d	0.71	d
977 ^e	4/4	0.45	0.71	1.02
Ammonium				
Background ^b	12/18	<0.1	0.1	2.0
833 ^b	1/1	d	5.7	d
977 ^c	3/4	<0.1	0.2	0.9
Antimony				
Background	2/22	<0.003	d	0.008
833	0/1	d	d	d
977	1/5	<0.003	d	0.004
Arsenic				
Background (969)	6/6	0.10	0.28	0.39
833	1/1	d	0.05	d
977	0/5	d	d	d
Barium				
Background (969)	6/6	0.04	0.05	0.10
833	1/1	d	0.03	d
977	4/5	0.01	0.01-0.02	0.02
Beryllium				
Background ^b	0/22	d	d	d
833 ^c	0/1	d	d	d
977 ^e	1/5	<0.005	d	0.005

Table 3.3 Statistical summary of the Dilworth ground water quality at the Falls City, Texas, site (Continued)

Constituent	Frequency of detection	Observed concentration		
		Minimum	Median ^a	Maximum
		(mg/L)	(mg/L)	(mg/L)
Boron				
Background (967)	4/4	0.88	1.03	1.10
833	1/1	d	0.85	d
977	4/4	0.72	0.83	0.98
Bromide				
Background (969)	5/5	2.6	3.2	5.8
833	1/1	d	1.0	d
977	4/4	1.7	1.8	2.1
Cadmium				
Background	6/22	<0.001	d	0.005
833	0/1	d	d	d
977	5/5	0.013	0.020	0.022
Calcium				
Background (969)	6/6	481	502	560
833	1/1	d	367	d
977	5/5	188	242	282
Chloride				
Background ^b (967, 969)	11/11	680	793	1020
833 ^c	1/1	d	472	d
977 ^e	5/5	280	374	553
Chromium				
Background	4/22	<0.01	d	0.02
833	0/1	d	d	d
977	1/5	<0.01	d	0.01
Cobalt				
Background	3/22	0.01	d	0.05
833	1/1	d	0.08	d
977	5/5	0.06	0.08	0.09

Table 3.3 Statistical summary of the Dilworth ground water quality at the Falls City, Texas, site (Continued)

Constituent	Frequency of detection	Observed concentration		
		Minimum	Median ^a	Maximum
		(mg/L)	(mg/L)	(mg/L)
Copper				
Background	4/22	<0.01	d	0.06
833	0/1	d	d	d
977	2/5	<0.01	d	0.03
Cyanide				
Background	2/20	<0.01	d	0.02
833	d	d	d	d
977	1/5	<0.01	d	0.01
Fluoride				
Background ^b (979)	5/5	0.4	0.4	0.5
833 ^c	1/1	d	1.0	d
977 ^e	1/4	<0.1	d	0.2
Iron				
Background (969)	6/6	0.24	0.78	2.70
833	1/1	d	127	d
977	5/5	0.14	0.53	1.43
Lead				
Background	2/22	0.001	d	0.002
833	0/1	d	d	d
977	0/5	d	d	d
Magnesium				
Background (969)	6/6	54	57	65
833	1/1	d	67	d
977	5/5	20	27	33
Manganese				
Background (969)	6/6	2.8	3.2	3.7
833	1/1	d	3.3	d
977	5/5	1.4	1.7	2.4

Table 3.3 Statistical summary of the Dilworth ground water quality at the Falls City, Texas, site (Continued)

Constituent	Frequency of detection	Observed concentration		
		Minimum	Median ^a	Maximum
		(mg/L)	(mg/L)	(mg/L)
Mercury				
Background ^b	0/22	d	d	d
833 ^c	0/1	d	d	d
977 ^e	0/5	d	d	d
Molybdenum				
Background	11/11	0.02	0.04	0.07
(968, 969)				
833	1/1	d	0.02	d
977	1/5	<0.01	d	0.01
Nickel				
Background	2/22	0.01	d	0.01
833	1/1	d	0.09	d
977	5/5	0.07	0.10	0.11
Nitrate				
Background	16/22	<1.0	3.3	13.0
833	1/1	d	1.8	d
977	4/5	<1.0	3.1	6.4
Phosphate				
Background	16/18	0.3	0.5	1.1
833	1/1	d	0.5	d
977	3/4	<0.1	0.2	0.2
Potassium				
Background ^b	6/6	37	42	44
(969)				
833 ^c	1/1	d	44	d
977 ^e	5/5	24	30	37
Selenium				
Background	8/22	0.002	d	0.024
833	0/1	d	d	d
977	1/5	<0.005	d	0.007

Table 3.3 Statistical summary of the Dilworth ground water quality at the Falls City, Texas, site (Continued)

Constituent	Frequency of detection	Observed concentration		
		Minimum	Median ^a	Maximum
		(mg/L)	(mg/L)	(mg/L)
Silica				
Background (968)	4/4	88	91	100
833	1/1	d	45	d
977	4/4	88	102	121
Silver				
Background	1/22	<0.01	d	0.02
833	0/1	d	d	d
977	0/5	d	d	d
Sodium				
Background (967, 969)	11/11	482	550	675
833	1/1	d	604	d
977	5/5	412	484	520
Strontium				
Background ^b (979)	5/5	1.5	1.8	77
833 ^c	1/1	d	3.3	d
977 ^e	100	1.7	2.3	2.6
Sulfate				
Background (969)	6/6	1220	1300	1440
833	1/1	d	1930	d
977	5/5	1160	1320	1580
Sulfide				
Background	6/20	<0.1	d	55
833	d	d	d	d
977	0/5	d	d	d
Thallium				
Background	1/22	<0.01	d	0.1
833	0/1	d	d	d
977	0/5	d	d	d

Table 3.3 Statistical summary of the Dilworth ground water quality at the Falls City, Texas, site (Continued)

Constituent	Frequency of detection	Observed concentration		
		Minimum	Median ^a	Maximum
		(mg/L)	(mg/L)	(mg/L)
Tin				
Background	5/22	<0.005	d	0.019
833	0/1	d	d	d
977	2/5	0.01	d	0.02
Uranium				
Background ^b (968)	5/5	0.026	0.056	0.068
833 ^c	1/1	d	3.04	d
977 ^e	5/5	0.016	0.023	0.054
Vanadium				
Background	10/22	<0.01	d	0.05
833	0/1	d	d	d
977	1/5	<0.01	d	0.03
Zinc				
Background	15/22	<0.005	0.012	0.544
833	1/1	d	0.213	d
977	5/5	0.120	0.182	0.206

Table 3.3 Statistical summary of the Dilworth ground water quality at the Falls City, Texas, site (Concluded)

Constituent	Number of samples	Observed concentration		
		Minimum (pCi/L)	Median ^a (pCi/L)	Maximum (pCi/L)
Radionuclide				
Lead-210				
Background ^b	8	0.0	1.5	6.8
833 ^c	0	d	d	d
977 ^e	2	0.0	0.4	0.8
Polonium-210				
Background	8	0.0	0.2	0.7
833	0	d	d	d
977	2	0.0	0.05	0.1
Radium-226				
Background (969)	6	2.0	3.3	4.6
833	1	d	2.4	d
977	5	0.7	1.2	1.9
Thorium-230				
Background	8	0.1	0.3	0.9
833	0	d	d	d
977	2	0.1	0.3	0.5

^aThe median, or 50th percentile of the sample data, cannot be determined if 50 percent or less of the data are above detection.

^bData are pooled from monitor wells 967, 968, 969, and 979 unless one or more of these wells has significantly higher levels than the others. In such cases, background represents the higher levels.

^cRepresents the western contaminated zone. Water quality data from one sampling round in December 1991 were used to determine constituents of concern for this contaminated zone.

^dData not available.

^eRepresents the eastern contaminated zone. Water quality data from 1989 through 1991 were used to determine constituents of concern for the eastern contaminated zone.

Note: Filtered samples, 1989-1992.

Although more data are needed to verify ambient ground water quality, the three upgradient wells in the oxidized zone of the Dilworth produce ground water of better quality than is probably typical of Dilworth ground water.

3.3.3 Magnitude of site-related ground water contamination

A statistical, geochemical, and hydrological analysis of the Falls City water quality data for 1989 through 1993 indicates tailings-related contamination in the Deweesville/Conquista aquifer, with less contamination in the Dilworth aquifer.

Deweesville/Conquista

Elevated levels of contaminants in the Deweesville/Conquista aquifer generally occur in four distinct contaminant zones (Figure 3.10). Ground water from some wells in these zones shows elevated levels of aluminum, arsenic, cadmium, manganese, molybdenum, selenium, sulfate, and uranium.

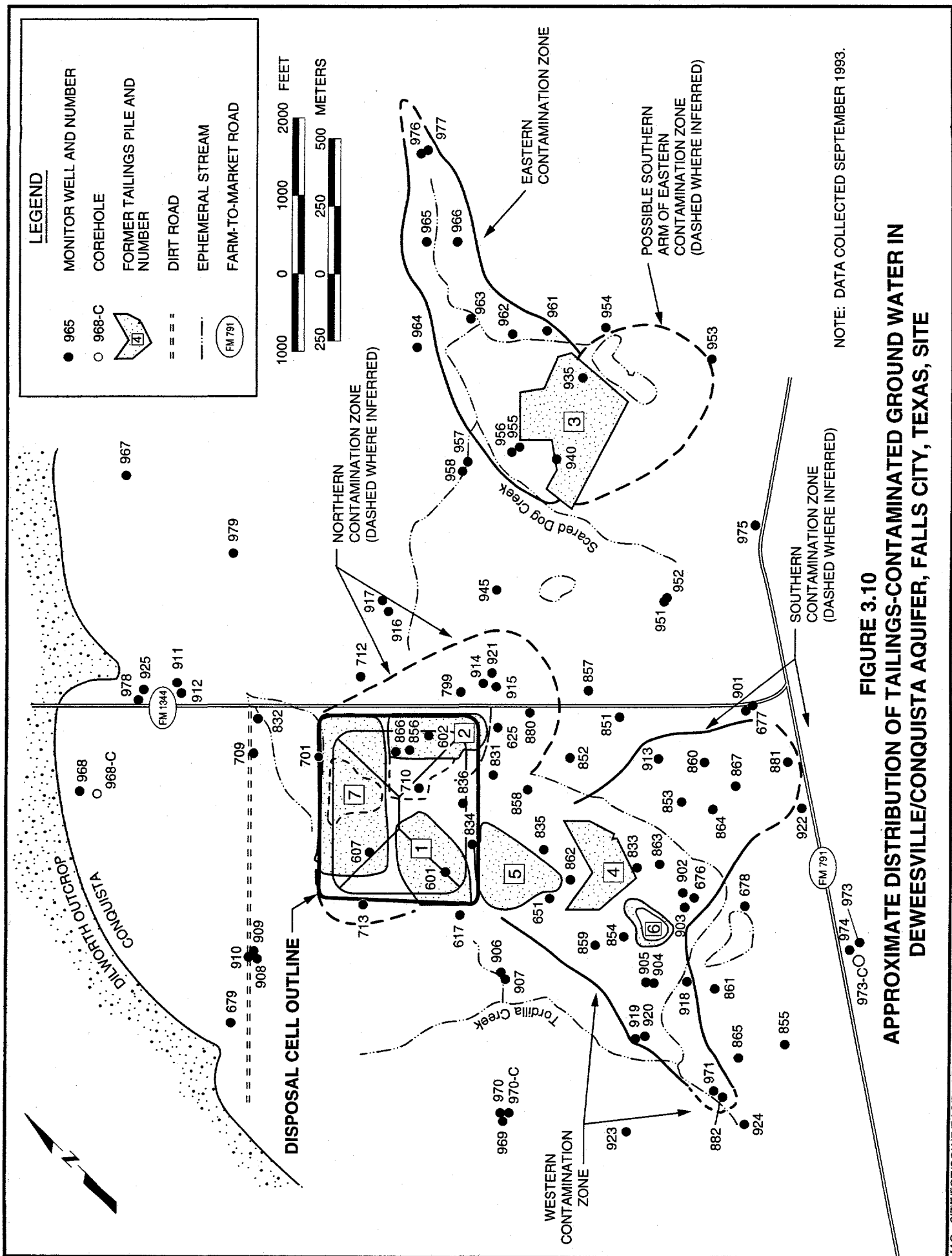
Although the four contaminated zones, including a possible southern arm of the eastern zone, show many chemical similarities, each contaminated zone has important chemical differences that give it a distinct geochemical signature. The locations of Deweesville/Conquista monitor wells are shown on Figure 3.10.

Eastern contaminated zone

The eastern contaminated zone originates from tailings pile 3. A major lobe of contamination extends approximately 3000 ft (900 m) north-northeast in ground water beneath Scared Dog Creek. The pH of contaminated ground water in several monitor wells along Scared Dog Creek (e.g., 962, 963, 965, and 966) commonly ranges between 3 and 5; however, in some areas the contaminated zone is not acidic (e.g., monitor wells 955 and 961) (DOE, 1992b). Monitor well 953, approximately 1200 ft (3600 m) east-southeast of pile 3, also shows evidence of tailings-related contamination such as elevated uranium levels and low pH (DOE, 1992b). The lack of monitor wells in this zone south of tailings pile 3 precludes a more precise delineation of a possible southeastern lobe of the eastern contaminated zone.

Northern contaminated zone

The northern contaminated zone is associated primarily with former tailings piles 2 and 7. The pH of the ground water in this zone varies from about 3 in monitor well 625 to almost 7 in well 921. Locally in this zone, sulfate levels are high (approximately 11,000 milligrams per liter [mg/L] in monitor well 625). The extremely high sulfate concentrations in this part of the Deweesville/Conquista aquifer were probably generated by a tailings pond that existed in the southern end of pile 2.



Southern contaminated zone

The primary source areas of the southern contaminated zone appear to be tailings piles 4 and 5. The southern contaminated zone appears to extend as far as FM 791, approximately 2500 ft (760 m) southeast of the former processing site. The contaminated zone is generally acidic, with pH ranging from 3 to 4 and significantly higher chloride concentrations than other contaminated zones.

Western contaminated zone

Most of the western contaminated zone is acidic (e.g., monitor wells 854, 882, and 904). Ground water from monitor well 918 is only slightly acidic (pH of about 5) (DOE, 1992b). The southwest contaminated zone appears to originate from piles 4 and 5. This contaminated zone extends more than 3000 ft (900 m) southwest of pile 4 and pond 6 in ground water beneath Tordilla Creek.

The area between former piles 4 and 5 contains a 1- to 3-ft (0.3- to 1-m)-thick zone of acid-, sulfate-, and possibly metals-rich ground water perched on top of a thin but laterally extensive silicified layer in the Deweesville/Conquista. The shallow perched saturated zone was probably generated by horizontal flow along this silicified layer when tailings leachate was injected into piles 4 and 5 during *in situ* mining operations (DOE, 1992b).

Dilworth

Contamination in the Dilworth aquifer was identified in monitor well 977 north of pile 3 and in former monitor well 833 at the southern edge of pile 4. Ground water sampled from monitor well 977 (sampled June 1991) is acidic (pH 4.23) and contains moderately elevated levels of aluminum (1.02 mg/L), iron (1.4 mg/L), sulfate (1580 mg/L), and uranium (0.054 mg/L) (DOE, 1992b).

Only two sampling rounds (February 1986 and December 1991) were conducted on monitor well 833 before it was abandoned during construction of the disposal cell. The decrease in alkalinity and pH and the significant increase in concentrations of ammonium, iron, manganese, sulfate, and uranium in the ground water from this well over time (DOE, 1992b) suggest the Dilworth is being contaminated in this area. New monitor wells at locations beneath the former tailings piles are needed to verify if the Dilworth is contaminated by processing site activities.

3.3.4 Contaminant fate and transport

The chemical species present in aqueous systems are a function of pH, Eh, and the concentrations of different anions and cations. Speciation determines the mobility of the chemicals and might also influence their toxicity. The predominant species of the contaminants of concern for human health were predicted through the geochemical model MINTEQA2 (Allison et al., 1991). The contaminants of concern are identified in the site-specific baseline risk

assessment (in preparation): cadmium, cobalt, fluoride, nickel, iron, sulfate, and uranium.

Constituents in the contaminated zone waters are subject to dilution and to different chemical reactions, including oxidation/reduction, precipitation and coprecipitation, possible reactions with biologic organisms, and adsorption onto aquifer mineral surfaces. Concentrations of the dominantly cationic metals and the major cations calcium, magnesium, potassium, and sodium are controlled by dilution and precipitation and sorption reactions. Cadmium, iron, cobalt, nickel, and fluoride concentrations will also be controlled by these processes. Chloride concentrations are affected only by dilution or evaporation. Attenuation mechanisms that should control the concentrations of the contaminants of concern for the Falls City site are discussed below.

Cadmium

Cadmium will be removed rapidly by the precipitation of otavite (CdCO_3) and by hydrolysis reactions as the low pH of the tailings leachate is neutralized by alkaline ground water and the calcite in the aquifer matrix. Dilution with background water produces cadmium concentrations below detection limits in downgradient ground water. Elevated cadmium levels are restricted to the areas underneath or immediately adjacent to the tailings pile.

Iron, cobalt, and nickel

Aqueous species of iron are typically not stable in ground water that is oxidizing and that has a pH near or above 6. Dissolved iron in oxidizing water with a pH of 7 should oxidize rapidly and remove as iron oxyhydroxides. Although ground water from many downgradient monitor wells in the Deweesville/Conquista yields pH measurements below 4 and has iron levels significantly higher than reference well 951, ground water from only one Dilworth well (977) has an acidic pH. The pH in ground water from Dilworth background well 969 is historically between 6.5 and 7 (DOE, 1992b). Nonetheless, iron concentrations in these waters are well above the values present in the other Dilworth background wells at the site.

Elevated cobalt levels might have been introduced to the aquifer by acidic tailings leachate. Because of its chemical similarity to iron, however, cobalt typically coprecipitates during the precipitation of manganese and iron hydroxides. At the typical pH range (6 to 8) observed for ground water in the Dilworth aquifer at the Falls City site, cobalt should be present at levels below or near the detection limit. Slightly elevated cobalt levels (e.g., up to 0.05 mg/L in monitor well 969) and iron levels could be expected in naturally reducing, alkaline, background Dilworth ground waters. More elevated cobalt concentrations can occur in low-pH contaminated ground water (up to 0.09 mg/L in acidic Dilworth monitor well 977). When the pH of this oxidizing water rises above 5.5, cobalt concentrations should be much lower.

Sulfate

Sulfate concentrations in the contaminated zones of the aquifer immediately adjacent to the processing site are controlled primarily by gypsum solubility. Farther downgradient, sulfate concentrations are controlled largely by physical processes such as dispersion and dilution. Reduction of sulfate to sulfide is also possible if the contaminated zone interacts with reducing sediment or ground water.

Presently, gypsum precipitation predominantly controls sulfate concentrations because the shallow ground water in and around the tailings piles was saturated with gypsum. As the tailings piles are consolidated and covered, the sulfate level in ground water around the former piles will decrease. Eventually, as sulfate levels drop below gypsum saturation, the gypsum that precipitated previously will begin to redissolve. The dissolution of gypsum will buffer the sulfate concentrations at fairly high levels until the gypsum supply is exhausted. At this point, natural flushing with background water will substantially lower the sulfate concentrations in the former tailings pile area.

Because the sulfate concentrations are high, adsorption reactions probably will not significantly affect sulfate concentrations in the shallow ground water. Given the high redox potential of the shallow ground water in the Deweesville/Conquista and Dilworth aquifers, sulfate removal by reduction to sulfide is not likely until the contamination migrates well off the site.

Uranium

Uranium is mobile in acidic ground water (e.g., pH is 3 to 4) where it typically exists as positively charged uranyl, uranium hydroxyl, and (in high sulfate systems) uranium sulfate complexes. In oxidizing, alkaline ground water over a range of elevated pH values (e.g., between 6.5 and 8.5), uranium can form stable anionic carbonate complexes that facilitate uranium transport in ground water.

Uranium levels are elevated in both acidic and alkaline ground water at the Falls City site. In both these environments, uranium concentrations will be reduced mainly by adsorption onto aquifer materials and by dilution with uncontaminated ground water.

3.3.5 Risk evaluation

The uranium milling activities at the Falls City site led to ground water contamination in the Deweesville/Conquista and Dilworth aquifers. The near-surface geologic members include the Deweesville, the Conquista, and the Dilworth. For assessing risk to potential ground water users, the Deweesville and Conquista water-bearing members are evaluated as a single aquifer.

Residents near the site use ground water from the deeper Carrizo aquifer (2000 to 3000 ft [600 to 900 m] below the surface). Because of its depth below the land surface and the confining layer overlying the aquifer, the Carrizo aquifer is not affected by mining and milling activities at the Falls City site.

Dilworth aquifer

Ground water from the Dilworth aquifer was historically considered to be poor quality. No drinking-water wells are screened in the Dilworth aquifer within a 2-mi (3-km) radius of the site (DOE, 1994). This is because historically the Dilworth ground water was considered to be of poor quality. Although the DOE does not have evidence of its use, ground water from the Dilworth aquifer might have been used for watering livestock in the vicinity of the site. Using these livestock for food could create an exposure pathway to humans. Therefore, the potential current and future use of the Dilworth aquifer at the site was evaluated.

Levels of aluminum, ammonium, cadmium, cobalt, fluoride, iron, nickel, sulfate, uranium, and zinc in ground water from two monitor wells completed in the Dilworth aquifer were significantly higher (at the 0.10 level of significance) than the concentrations reported in ground water from background wells (DOE, 1994). As discussed in Section 3.3.1, ground water contamination in monitor well 833 (Figure 3.3) may be due to vertical leakage through exploratory borings and/or the monitor well's annulus. Ground water contamination in monitor well 977 (Figure 3.3) is derived from the zone of contamination along Scared Dog Creek that intercepts the Dilworth outcrop. Therefore, the contamination in the Dilworth appears to be confined to a few isolated areas. The constituents elevated above background are presented in Table 3.4. High levels of arsenic and manganese occur naturally in some areas of the Dilworth aquifer. Both arsenic and manganese typically are associated with the uranium ore deposits found in the Falls City site area. Also, high levels of sulfate occur naturally in the Dilworth ground water and are associated with gypsum deposits.

Although zinc was observed above background, it was eliminated as a contaminant of potential concern because it is an essential nutrient and because the levels at which it is observed are within nutritional ranges, even when added to expected dietary intake. Ammonium and aluminum were eliminated as contaminants of potential concern based on low toxicity, and because the levels at which they are observed in the most contaminated downgradient monitor wells will not produce adverse health effects. Cadmium, cobalt, fluoride, iron, nickel, sulfate, and uranium remain as the contaminants of potential concern for the Dilworth.

Potential adverse health effects are a function of the contaminant amount an individual takes into his or her body. The risk of exposure to humans was estimated by examining the three ways in which contaminants can enter the body: drinking the water, eating meat from livestock which drank the water, or drinking milk from livestock which drank the water.

Table 3.4 Contaminants of potential concern for the Dilworth aquifer

Contaminant levels exceed background	Contaminant levels in nutritional range	Contaminants of low toxic potency and/or high dietary range	Contaminants of potential concern ^a
Aluminum Ammonium Cadmium Cobalt Fluoride Iron Nickel Sulfate Uranium Zinc	Zinc	Aluminum Ammonium	Cadmium Cobalt Fluoride Iron Nickel Sulfate Uranium

^aScreening process has started with the first column; constituents listed in the second and third columns were subtracted from the list of constituents in the first column; the remaining constituents form the list shown in the last column.

It should be kept in mind that the highest contaminant concentrations from the most contaminated wells were used to estimate the amount of exposure. Therefore, this evaluation provides the upper limit of possible risks resulting from Dilworth ground water contamination; real risks are not likely to reach that limit. Only people who drilled a drinking water well in the most contaminated area (a small portion of the site) could experience the health problems discussed below.

Considering these relevant human exposure pathways, small amounts of the contaminants could be passed from the livestock to humans or from garden produce to humans. The estimated amounts of contaminants that could be ingested could cause adverse health effects if the Dilworth aquifer background ground water were used to water domestic stock and irrigate gardens.

Iron and sulfate concentrations in the ground water make the human health risks associated with the potential future use of this ground water as a drinking water source unacceptable. However, such consumption is unlikely because of the water's unpleasant taste and odor, historical knowledge of poor water quality, and the presence of better quality water from other sources. Nevertheless, the estimated iron exposure level could be associated with elevated levels of iron (above normal values) in internal organs such as the liver and pancreas. Elevated levels of iron in the body would lead to increased skin pigmentation and possibly cirrhosis of the liver. Although no drinking water wells are within a 2-mi (3-km) radius of the site, if the Dilworth ground water were used as untreated drinking water for infants, sulfate levels could result in severe persistent diarrhea, potentially leading to dehydration, because infants are sensitive to sulfate toxicity. Laxative effects could be produced in adults who drink the water. Moreover, natural levels of sulfate present in the Dilworth ground water near the site, and typically found in this area of Texas, are known to produce diarrhea in some individuals.

Human health would not be at risk from exposure to cadmium, cobalt, fluoride, or nickel through these pathways. Exposure to uranium may be of health concern due to its chemical toxicity and potential radiological damage. Chemical toxicity from exposure to uranium is not anticipated if humans drink the Dilworth ground water. The additional cancer risk from radioactive uranium and longer-lived progeny of the uranium decay series, however, is at an unacceptable level of 1 in 1000 over a lifetime. Any excess lifetime cancer risks associated with radionuclides due to human consumption of meat or milk from cattle that drank this water as their sole drinking water source are within an acceptable range as defined by the National Contingency Plan range, which is between 1 in 10,000 and 1 in 1,000,000.

The levels of manganese and arsenic observed in the natural Dilworth ground water that is unaffected by the former mill tailings could lead to an increased risk of developing nervous system disorders resembling Parkinson's disease and/or skin cancer if the water were used as the sole source for a prolonged

period. Naturally occurring manganese and arsenic, therefore, limit the potential use of ground water in some areas as a source for drinking water.

An evaluation of the potential effects on livestock, if the Dilworth ground water were used to water cattle, showed livestock would suffer no adverse health effects from drinking Dilworth ground water. The Dilworth ground water is also suitable for crop irrigation.

Deweesville/Conquista aquifer

Although no livestock, domestic, or drinking water wells are screened in the Deweesville/Conquista aquifer within a 2-mi (3-km) radius of the site, the use of Deweesville/Conquista ground water downgradient and farther than 2 mi (3 km) from the site has not been evaluated. The shallow ground water at the Falls City site appears to have originated largely from past *in situ* mining and milling operations, and its use as a water supply is unlikely. Although the DOE has not determined whether the ground water in the Deweesville/Conquista farther downgradient from the site is a usable water resource, it has not historically been used as a drinking-water source.

The background water quality in the Deweesville/Conquista aquifer was partially assessed before surface remedial action began. Sulfate, manganese, and uranium concentrations in the Deweesville/Conquista ground water are high enough to cause serious adverse health effects. The health effects associated with exposure to sulfate, manganese, and uranium make the ground water unsuitable for drinking, irrigating crops, or watering livestock (DOE, 1994).

3.4 EVALUATION OF INTERIM ACTION OPPORTUNITIES

The DOE has determined there is no immediate danger to public health and the environment from contaminated ground water because no wells are completed in the systems, thereby eliminating an exposure pathway to a receptor. Furthermore, a rural water supply system provides good quality water to residents in the site vicinity. Interim action opportunities at the Falls City site will be evaluated as a research-and-development application supporting innovative technological approaches.

4.0 GROUND WATER COMPLIANCE STRATEGY SELECTION

The ground water compliance strategies for the Falls City site and an explanation of the application of site-specific data to the ground water compliance selection framework are presented below (Figure 4.1).

4.1 COMPLIANCE STRATEGY SELECTION PROCESS

A health- and environmental risk-based framework for selecting site-specific compliance strategies is being applied to each UMTRA Project processing site. This compliance selection framework was developed in the UMTRA Ground Water PEIS. The framework enables the DOE to apply the same criteria to determine the ground water compliance strategy at each site and to determine the appropriate compliance strategy.

A step-by-step approach is followed until one or a combination of three compliance strategies below is selected for a specific site.

- No remediation. Compliance with the EPA ground water protection standards would be met without altering the ground water or cleaning it up in any way. This strategy could be applied at sites with contamination at or below MCLs or background levels or at sites that have contamination above MCLs or background levels but qualify for supplemental standards or ACLs.
- Natural flushing. Allows natural ground water movement and geochemical processes to decrease contaminant concentrations to levels within regulatory limits within a given time period. This strategy could be applied at sites where ground water compliance would be achieved with natural flushing within 100 years, where effective monitoring and institutional controls could be maintained, and where the ground water is not and is not projected to be a drinking water source.
- Active ground water remediation. Requires application of engineered ground water remediation methods such as gradient manipulation, ground water extraction and treatment, and *in situ* ground water treatment to achieve compliance with the standards.

4.2 FALLS CITY, TEXAS, COMPLIANCE STRATEGY SELECTION

The ground water compliance selection framework was applied to the uppermost aquifer known to be affected by activities at the processing site. Site conditions were used to determine that the no-remediation (with additional characterization) application of supplemental standards strategy could be appropriate for the uppermost aquifer based on widespread ambient contamination and acceptable risks to human health and the environment. Figure 4.1 shows how this target was selected.

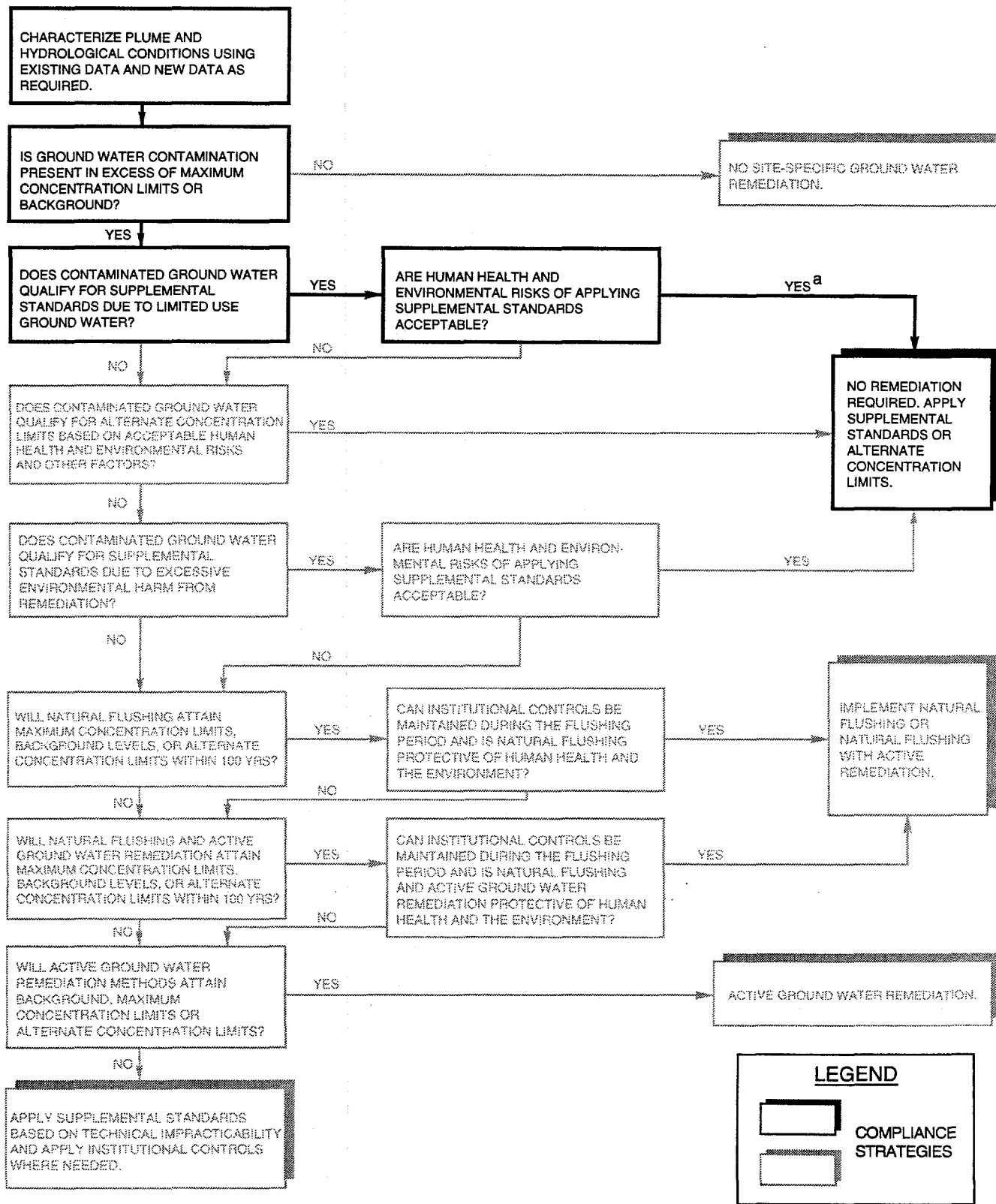


FIGURE 4.1
FRAMEWORK APPLICATION OF CONTAMINANTS OF POTENTIAL CONCERN
IN THE UPPERMOST AQUIFERS
FALLS CITY, TEXAS, SITE

Uppermost aquifer compliance strategy

Figure 4.1 shows how the framework was used to prepare the uppermost aquifer strategy of no remediation and the application of supplemental standards. Table 4.1 shows how each of the contaminants of concern move through the framework.

To protect ground water and to achieve compliance with EPA ground water standards under the UMTRA Surface Project (Subpart A of 40 CFR Part 192), the DOE proposed a narrative supplemental standard for Parcel A of the Falls City site and the disposal site. The supplemental standard for surface remedial action classified ground water from the uppermost aquifer as limited use, based on widespread ambient contamination that could not be cleaned up with methods reasonably employed by public water systems. To demonstrate existing widespread contamination in the uppermost aquifer, the DOE established background ground water quality in the site vicinity (DOE, 1992b). Supplemental standards did not apply to Parcel B. However, there is no evidence that conditions are different in the uppermost aquifer in the vicinity of Parcel B. Background monitor wells were installed and monitored to demonstrate widespread ambient contamination of the uppermost aquifer in the vicinity of the disposal site. The DOE, NRC, and the state concurred with the supplemental standard application and agreed that the uppermost aquifer was limited use in 1992. Thus, the first step toward achieving compliance with the ground water standards was to determine whether widespread, ambient contamination persists in the uppermost aquifer in the site vicinity.

The second step was to determine whether compliance with the standards could still be achieved by applying supplemental standards based on limited use ground water. Regulations define limited use ground water as ground water that is not a current or potential source of drinking water for the following three reasons: the concentration of total dissolved solids exceeds 10,000 mg/L; the ground water contains widespread, ambient contamination, not caused by activities involving RRM from a designated processing site, that cannot be cleaned up with treatment methods reasonably employed by public water-supply systems; or the quantity of water available from a well is less than 150 gallons (570 liters) per day.

Hydrogeologic conditions and ground water contamination conditions at the Falls City site have been characterized and are presented in Section 3.0. The background water in the uppermost aquifer still meets the criteria for limited use ground water based on widespread, ambient contamination not caused by activities involving RRM from a designated processing site. The background water cannot be cleaned up with treatment methods reasonably employed by public water-supply systems. Making water from the uppermost aquifer potable would require multiple treatment technologies not typically used in Texas or in the region. Removing radionuclides from the ground water will produce treatment plant wastes containing both hazardous and radioactive constituents. Also, treated ground water from the uppermost aquifer would cost local

Table 4.1 Framework application of contaminants of potential concern for the Dilworth aquifer

Contaminant	Criteria			
	Are new data required?	Does contamination exceed background or MCLs?	Is contaminant found in limited use ground water?	Are human health and environmental risks of applying supplemental standards acceptable?
Aluminum	No	Yes	Yes	Yes
Ammonium	No	Yes	Yes	Yes
Cadmium	No	Yes	Yes	Yes
Cobalt	No	Yes	Yes	Yes
Fluoride	Yes	Yes	Yes	Yes
Iron	Yes	Yes	Yes	Unknown ^a
Nickel	No	Yes	Yes	Yes
Sulfate	Yes	Yes	Yes	Unknown ^a
Uranium	Yes	Yes	Yes	Unknown ^a
Zinc	No	Yes	Yes	Yes

^aFurther characterization of contaminated zone is needed.

residents considerably more than what they now pay for drinking water (DOE, 1992b).

The DOE has determined from the data that supplemental standards are protective of human health and the environment, and that site-specific remediation is not required. Section 3.3.5 describes the limited uses of ground water from the uppermost aquifer and the risk associated with exposure to iron and sulfate in the ground water. Because the DOE is proposing no remediation as a compliance strategy, however, it will analyze exposure pathways and collect additional data to demonstrate that existing or potentially beneficial uses of ground water are protected; the pathway analysis and data collection activities are discussed further in Section 5.0.

4.3 DEVIATIONS, CONTINGENCIES, AND DECISION RULES

The DOE's environmental restoration process generally, and the UMTRA Ground Water Project specifically, must make restoration decisions under conditions of inherent uncertainty. Uncertainties associated with limited site condition information and with uncertain remedial strategy performance are reduced to the extent practicable, in an effort to minimize time and resources spent on studying the problems and to expedite restoration activities. In developing this SOWP, the DOE maximized the use of existing information to select a realistic remedial strategy. This SOWP developed and used a conceptual model to provide a foundation for remediation planning and action. If the proposed remedial strategy is not supported by additional data, the DOE will reevaluate the strategy selection and assess the feasibility of implementing an alternative remedial strategy.

5.0 DATA COLLECTION AND ASSESSMENT

5.1 STATEMENT OF DATA NEEDS

The DOE has evaluated existing site information and identified data gaps (uncertainties) that must be addressed to confirm the appropriateness of the proposed ground water compliance strategy and the feasibility of alternative strategies if required. An alternate strategy might be required if the proposed primary compliance strategy is unacceptable from a stakeholder's perspective, or if additional characterization leads to a different approach.

The DOE's methods for reducing system uncertainties are described below. These methods are designed to enhance understanding of site conditions and to ensure the appropriate ground water compliance strategy is implemented.

5.1.1 Qualitative analysis of background ground water quality

Background ground water quality in the Deweesville/Conquista aquifer has been sufficiently characterized to demonstrate that it qualifies for a supplemental standard application (DOE, 1992b). However, a literature search and a review of ground water quality data from monitor wells and other wells near the site will be conducted to demonstrate qualitatively that the supplemental standards are protective of potential beneficial uses of ground water in the site vicinity.

5.1.2 Land and water use survey

The DOE must demonstrate that the ground water compliance strategy will protect human health and the environment and protect potential beneficial uses of the ground water. To evaluate the health risks and environmental impacts associated with ground water contamination, investigators will continue the process of identifying potential exposure pathways within and downgradient from the contaminated zones and further assess the likelihood of direct or indirect human contact with contaminated ground water through the exposure pathways (DOE, 1994).

5.1.3 Hydrogeologic investigations

Installing monitor wells and ground water sampling

The DOE must further define the extent and magnitude of contamination in the uppermost aquifer, refine its understanding of ground water flow direction(s), further assess the potential affects of the contamination on other aquifers, and further assess potential beneficial uses of those aquifers.

Water level monitoring

Water levels will be monitored during routine ground water sampling and during aquifer tests in the uppermost aquifer to observe short- and long-term fluctuations in ground water levels. Long-term fluctuation of ground water levels will be monitored with dedicated ground water level recording data loggers. Water levels will also be monitored during aquifer tests in the Dilworth aquifer to observe the degree of interconnection between the Deweesville/Conquista and Dilworth aquifer.

Aquifer testing

Aquifer tests are proposed to quantify aquifer properties more accurately to determine ground water velocities and to obtain the data needed to perform computer simulations of the ground water flow system.

Core analysis

Core analyses will be conducted on newly collected core samples to estimate bulk density and effective porosity.

5.2 DATA COLLECTION OBJECTIVES

This investigation has established the following data collection objectives:

- Further define background ground water quality data of the uppermost aquifer. Background ground water quality will be defined qualitatively through a literature search and by reviewing ground water quality data from existing wells.
- Continue the process of identifying potential exposure pathways downgradient of the site (DOE, 1994). This includes collecting data to help identify potential routes of contaminant migration from the site to an existing or potential point of contact.
- Determine the nature and occurrence of ground water recharge for the uppermost aquifer.
- Define the extent of downgradient contamination in the uppermost aquifer in each of the contaminated zones described in Section 3.3.2.
- Estimate the volume of contaminated ground water and the mass of constituents of concern.
- Define the area of variability in aquifer hydraulic conductivity to estimate advective velocities.

- Determine the degree of interconnection between the Deweesville/Conquista and Dilworth aquifers.
- Understand the major solute transport phenomenon.

5.3 DATA QUALITY OBJECTIVES

The purpose of data quality objectives (DQO) is to ensure that data of known and appropriate quality are obtained during an investigation and to ensure the data are adequate to support DOE, state, and public decisions for remedial action. The DQOs for each task proposed in Section 5.1 are presented below.

5.3.1 Qualitative analysis of background ground water quality

Literature and records will be searched for data. The quality of the data sources will be based on its merits and its applicability to Falls City site conditions. For example, reports issued by state or federal agencies are assumed to be accurate and reliable sources of information.

5.3.2 Land and water use survey

For the water use survey, investigators will attempt to obtain well construction and water use information from at least 90 percent of the former and existing domestic wells in the uppermost aquifer. The horizontal positions of domestic wells and stock ponds will be determined with a global positioning system (GPS) instrument. The horizontal accuracy of most GPS terminals is 1 radial meter or less.

5.3.3 Hydrogeologic investigations

Installing monitor wells, and ground water sampling and analysis

A hydrogeologist will be present during all phases of borehole drilling and well installation. Boreholes will be logged and monitor wells will be installed following procedures described in standard operating procedures (SOP) 14.1.3, 14.4.1, 16.1.5.4.3.2, and 16.1.2 (JEG, n.d.). The TAC has specified or established procedures for installing and developing monitor wells, sampling water and soil, preserving and transporting samples, filing procedures, chain-of-custody, analyzing sample, quality assurance (QA), and managing and validating analytical data. Fieldwork is conducted in accordance with these SOPs, which are reviewed annually and updated (as appropriate) to reflect changes in industry standards, best management practices, and DOE or EPA guidelines.

Each well site will be properly permitted, and as much as possible, restored to preinstallation conditions. Wastes generated by the drilling operations (drilling fluid and well water) will be disposed of according to approved procedures.

The well casing will consist of 4-inch-(100-mm) diameter, schedule 40 PVC pipe with flush-threaded joints. Solvent glues will not be used and couplings will not obstruct the well annulus, with no potential for screws to enter the inside of the casing and obstruct placement of the pump. Schedule 40 PVC pipe is large enough to allow the placement of a standard electric submersible pump designed for 4-inch (100 mm) diameter wells.

New monitor wells were sampled twice in 1994 and will be sampled twice in 1995 to determine different water quality parameters. Samples will be collected, preserved, and shipped according to the UMTRA Project SOPs (JEG, n.d.).

Water level monitoring

The purpose of water level monitoring is to observe short- and long-term fluctuations in ground water levels and determine the rate of ground water mound dissipation immediately downgradient of the disposal cell. Sufficient sensitivity, accuracy, and temporal recording resolution are needed to ensure the collected data can be used for their intended purpose. Standard pressure transducers (e.g., In Situ®) have a resolution of 0.004 ft (0.001 m) with an accuracy of 0.035 ft (0.01 m). Using standard equipment and procedures should provide sufficient accuracy to compute declining or rising ground water elevations. Water level data will be measured daily with data loggers for a minimum of 2 years. The data loggers will be routinely calibrated with measurements made with a steel tape.

Aquifer testing

Slug tests and short- and long-term aquifer testing and analyses will determine the spatial distribution of hydraulic conductivity and the degree of interconnection between the Dilworth and Deweesville aquifers; quantify how the aquifer would respond to stressed conditions, and (combined with core and slug test data) provide a data base sufficient for stochastic modeling analysis. Standard data loggers and pressure transducers, used in accordance with the manufacturer's instructions, will produce reliable data for the analyses. Tests will be designed and analyzed according to standards, such as American Society for Testing Materials (ASTM) standard D4050-1991 (ASTM, 1994a). The pH, oxidation/reduction potential, specific conductivity, and temperature of the water will be checked every 15 minutes using standard field instrumentation and operating procedures.

A potential problem with analyzing aquifer pumping tests is the possibility that pumping rate variations can create multiple solutions (Horne, 1994). To alleviate the problem of nonunique solutions, each test will be analyzed during both the drawdown and recovery phases. The recovery phase has a constant rate of zero and will provide a more accurate result. Slug tests are useful for estimating near-well bore parameters.

Core/analysis

Core analysis for porosity, bulk density, and grain size analysis will provide more detailed, small-scale information on aquifer characteristics. Core tests will relate the parameters determined on a small portion of the aquifer (cubic centimeters) to the macroscopic behavior of the aquifer (cubic kilometers). Laboratories qualified by the DOE will conduct the tests.

5.4 DATA COLLECTION ACTIVITIES

To achieve the data collection objectives of this investigation, the DOE will collect ground water quality data for the uppermost aquifer to reconfirm that ground water still meets limited use ground water criteria. In addition, land and water use in the site vicinity will be defined to demonstrate that the proposed ground water compliance strategy will be protective of human health and environment, and protect beneficial uses of the ground water.

5.4.1 Qualitative analysis of background ground water quality

A literature search and a review of ground water quality data for former and current wells will be used to qualitatively assess background ground water quality in the site area. The literature search will locate relevant reports or documents from state and federal agencies, professional journals, and information collected by mining companies that worked in the area. The water use survey discussed below will obtain relevant data from local property owners.

5.4.2 Land and water use survey

The survey will extend up to 3 mi (5 km) radially from the site (Figure 5.1). This survey will expand the area of the previous survey, which was conducted within a 2-mi (3-km) radius of the site. The survey will cover an area that extends well beyond the current, known lateral extent of ground water contamination.

During the land and water use survey, the following activities will be conducted:

- A literature search and review of ground water quality data from existing wells to further define background ground water quality.
- A well record search by reviewing appropriate files from the state of Texas. The well records will help to determine well construction information, depth to water, well productivity information, and water quality.
- Aerial photography of the region to quickly locate and identify stockponds that could be used to water livestock.
- A door-to-door survey to interview local landowners regarding past and present land and water use. Domestic wells and stock ponds will be

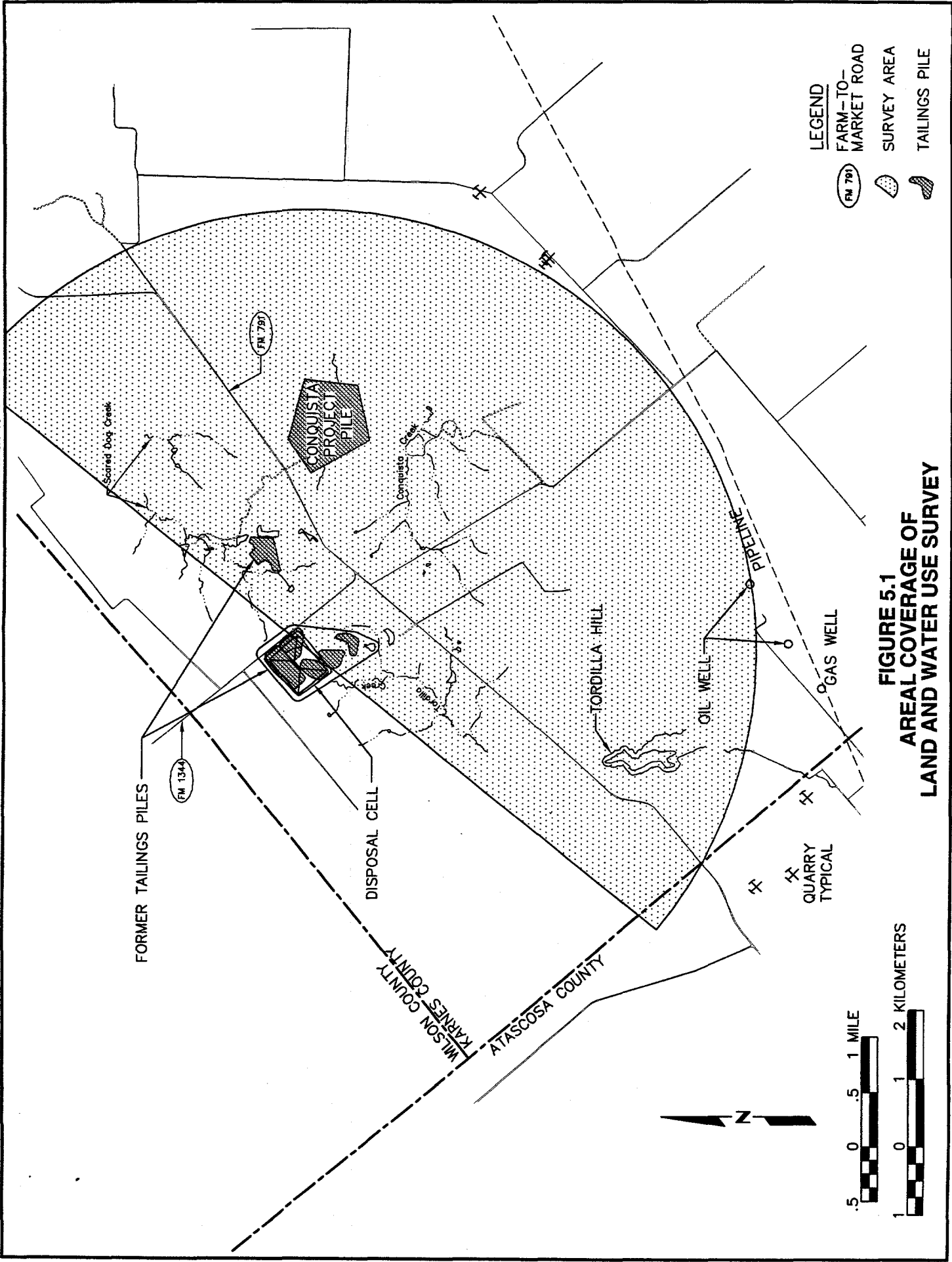


FIGURE 5.1
AREAL COVERAGE OF
LAND AND WATER USE SURVEY

located and sampled, if possible. Depth-to-water will be measured in domestic wells.

- Determine the horizontal and vertical position of domestic wells and surface water bodies, including those that have been identified but not located. Because of the size of the survey area (approximately 25 square miles [65 square kilometers]), the DOE proposes using a GPS to locate the position of domestic wells and stock ponds with respect to the site.

5.4.3 Hydrogeologic investigations

Twelve additional monitor wells will be installed on the site. Table 5.1 summarizes the proposed depth, screened interval, and the purpose of each new well. Figure 5.2 shows the proposed locations of these new wells. The exact locations are dependent on obtaining access agreements from landowners. After the monitor wells are installed, they will be surveyed by a registered land surveyor or with a GPS.

- One well (883) will be installed in the Deweesville/Conquista aquifer immediately downgradient of the site southeast of FM 791 (Figure 5.2) to determine the extent of contamination in the southern contaminated zone.
- Four monitor wells will determine the extent of ground water contamination in the Deweesville/Conquista aquifer caused by former tailings pile 3. These monitor wells (884, 885, 886, and 887) will be south and east of former tailings pile 3 and north of FM 791 (Figure 5.2) to determine the extent and magnitude of contamination in the southern arm of the eastern contaminated zone. These monitor wells may help determine the impact of the Conquista tailings pile on ground water flow and quality in the Deweesville/Conquista aquifer.
- One well (888) will be installed in the Dilworth aquifer east of former tailings pile 3 to verify that contamination has not reached the Dilworth aquifer in this area.
- Three monitor wells (889, 890, and 891) will determine the extent of ground water contamination in the Dilworth aquifer in the northern arm of the eastern contaminated zone along Scared Dog Creek.
- Two monitor wells (892 and 893) will be installed downgradient of the disposal cell near the former location of monitor well 833. Abandoned during surface remediation activities, well 833 is believed to be completed in the Dilworth aquifer. Water samples collected from well 833 have shown evidence of mill-related contamination. This contamination is believed to be caused by improper well construction.
- Monitor well 892 will be installed in the Dilworth aquifer near the former location of monitor well 833 to determine if mill-related contamination is

Table 5.1 Construction summary of proposed monitor wells

Well ID	Estimated well depth (ft)	Estimated depth to water (ft)	Screened interval (ft)	Purpose
883	90	70	70-90	Define extent of contamination in southern contaminated zone in Deweesville/Conquista aquifer
884	110	50	100-110	Define extent of contamination in contaminated zone south of former tailings pile 3 in Deweesville/Conquista aquifer
885	110	50	100-110	Define extent of contamination in contaminated zone south of former tailings pile 3 in Deweesville/Conquista aquifer
886	110	50	100-110	Define extent of contamination in contaminated zone south of former tailings pile 3 in Deweesville/Conquista aquifer
887	110	50	100-110	Define extent of contamination in contaminated zone south of former tailings pile 3 in Deweesville/Conquista aquifer
888	180	100	170-180	Determine water quality of Dilworth aquifer east of former tailings pile 3
889	30	20	20-30	Define extent of contamination in eastern contaminated zone along Scared Dog Creek in Dilworth aquifer
890	30	20	20-30	Define extent of contamination in eastern contaminated zone along Scared Dog Creek in Dilworth aquifer
891	30	20	20-30	Define extent of contamination in eastern contaminated zone along Scared Dog Creek in Dilworth aquifer
892	160	80	140-160	Define extent of contamination in Dilworth aquifer immediately downgradient of disposal cell
893	30	10	20-30	Serve as an observation well during aquifer test of well 892
894	30	10	20-30	Serve as an observation well during aquifer test of existing well 880

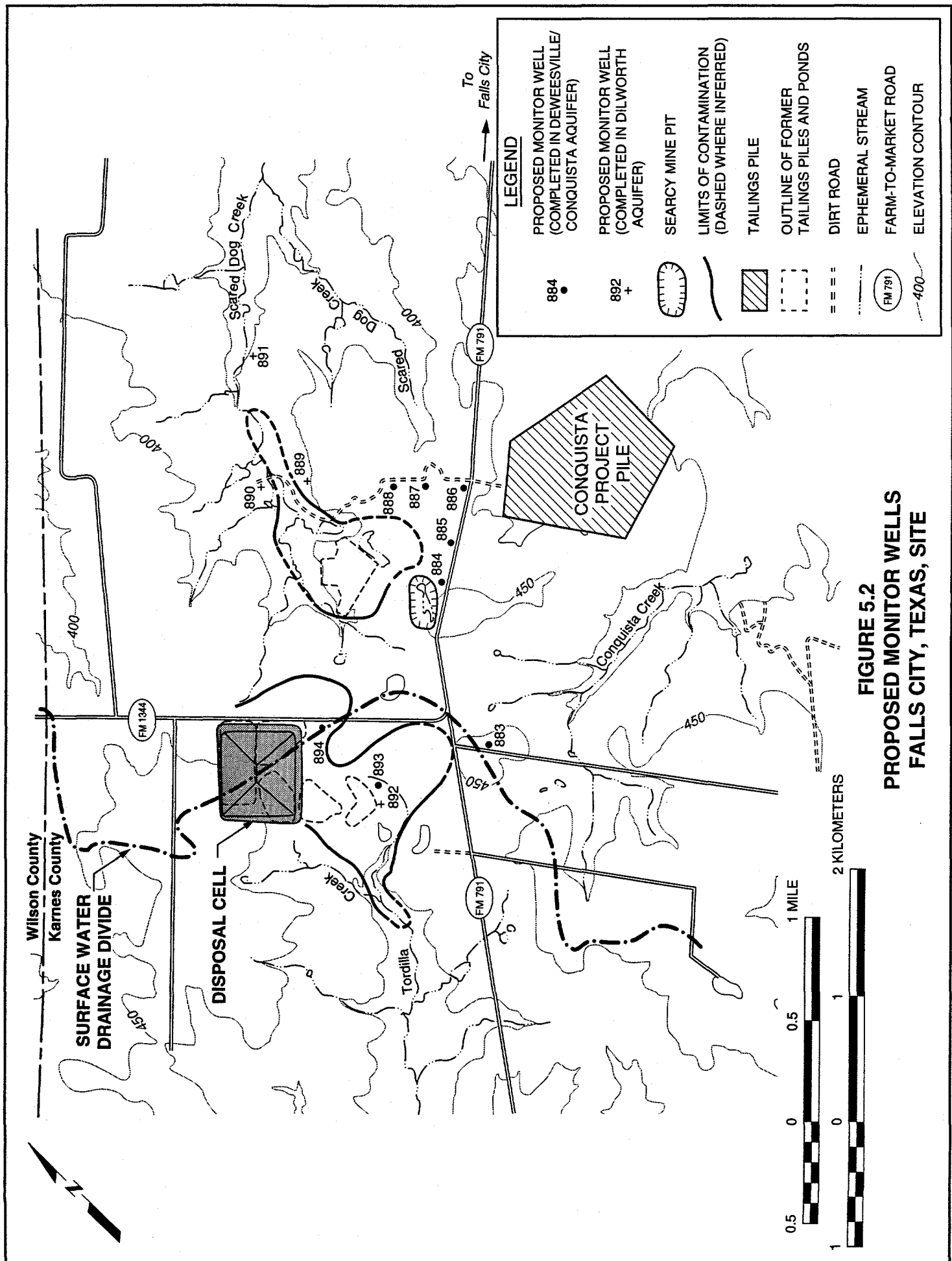


FIGURE 5.2
PROPOSED MONITOR WELLS
FALLS CITY, TEXAS, SITE

present in the Dilworth aquifer in this area. An aquifer test will also be conducted on this well to determine aquifer properties.

Monitor well 893 will be installed in the Deweesville aquifer adjacent to well 892. Well 893 will function as an observation well during the aquifer test and will be used to determine the interconnection between the two aquifers.

Wells installed in the Dilworth aquifer will be constructed using drilling methods that minimize potential cross contamination from the overlying Deweesville/Conquista aquifer.

- Monitor well 894 will be installed in the Deweesville/Conquista aquifer next to existing well 880. Existing well 880 is completed in the Deweesville/Conquista aquifer. An aquifer test will be performed in well 880 to determine the aquifer characteristics of the Deweesville/Conquista aquifer; well 894 will serve as an observation well during the test.

Additional observation wells may be needed in this area as part of the aquifer test. These additional locations will be determined during the planning stages of the aquifer test.

Each well, including the new monitor wells, will be sampled for the contaminants of concern identified in the baseline risk assessment. The new monitor wells will be sampled for a complete set of parameters during the first two sampling rounds in fiscal year 1995 to identify new potential contaminants of concern. Field analyses will be conducted for pH, oxidation-reduction potential, dissolved oxygen, specific conductance, and temperature.

Water level monitoring

Water table hydrographs constructed during infiltration events will be used to analyze the nature and occurrence of ground water recharge in the uppermost aquifer. Daily rainfall data will be obtained from an on-site recording rain gauge. The monitoring period will be a minimum of 2 years.

Monitor wells near the disposal cell will be monitored for a minimum of 2 years to determine the rate of ground water mound dissipation immediately downgradient of disposal cell.

Aquifer testing

Slugs tests will be conducted in a selected group of monitor wells screened in one of the four contaminated zones of the uppermost aquifer (Section 3.3.2). At least three and perhaps four slug tests will be conducted in each contaminated zone to provide adequate information on the spatial distribution of hydraulic conductivity. If possible, at least one monitor well in each contaminated zone will be tested in each aquifer.

Aquifer tests will be conducted on wells screened within the Deweesville and Dilworth aquifers. During each aquifer test, water levels will be measured in nearby monitor wells to determine the extent of influence of the pumped well and the aquifer hydraulic parameters between the pumped well and each monitor well.

During each aquifer test, pH, oxidation-reduction, and specific conductivity will be measured periodically. Also, time-sequenced ground water sampling will be conducted for selected constituents during each aquifer test.

An aquifer pumping test will be conducted in the newly installed well screened in the Dilworth aquifer downgradient from the disposal cell. An aquifer pumping test will also be conducted in a monitor well completed in the Deweesville/Conquista aquifer. These tests will help determine hydraulic conductivity within the Dilworth and Deweesville aquifers and the degree of interconnection between the Dilworth and the overlying Deweesville/Conquista systems.

The DOE is evaluating the potential use of *in situ* ground water velocity probes to augment or replace the aquifer pumping tests.

5.5 RESULTS AND EVALUATION OF DATA COLLECTION ACTIVITIES

When each data collection activity is complete, results will be compiled and made available to the DOE. The compilation will describe field activities, instrumentation used, and survey locations. It will contain copies of field measurement data, copies of field logs and notebooks, and methods of interpretation; and it will summarize the results relative to the data collection objective. A proposed ground water flow model will integrate detailed, site-specific information. The model also will allow quantitative evaluation of the flow rates required to meet the selected remedial strategy and the possible effects of the uncertainties in the conceptual model. The modeling, data results, and reports will be incorporated in the final SOWP.

6.0 LIST OF CONTRIBUTORS

The following individuals contributed to the preparation of this report.

Name	Contribution
E. Storms	Principal author
J. Crain	Document coordinator
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J. Blount, T. Jackson	Geochemistry
J. Crain	Engineering
B. Malczewska-Toth	Risk assessment
M. Gawthrop-Cooper	Regulatory compliance
L. Sanchez	Word processing
S. Suniga, B. Harvey	Graphic design
J. Torline, J. Bartel	Technical editing, document production coordination

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40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency (1994).

40 CFR Part 1500, *Purpose, Policy, and Mandate*, Council on Environmental Quality (1994).

UNITED STATES CODES

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42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act*, November 8, 1978.

42 USC §7922 *et seq.*, *Uranium Mill Tailings Remedial Action Amendments Act*, November 5, 1988.

FEDERAL REGISTER

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APPENDIX A

CALCULATION FCT-06-91-12-01-00

CALCULATION COVER SHEET

CALC NO. ECT-06-91-12-01-00 DISCIPLINE Engineering/Hydrology NO. OF SHEETS 10

PROJECT: UMTRA

SITE: FALLS CITY

FEATURE: SURFACE WATER MASS BALANCE

SOURCES OF DATA:
See page 1 of text

SOURCES OF FORMULAE & REFERENCES:
see text

PRELIMINARY CALC. ☒ FINAL CALC. ☐ SUPERSEDES CALC. NO. _____

00		J. Crain	6/21/91	T. J. J. J.	6/24/91	R. J. J.	6/26/91
REV. NO.	REVISION	CALCULATION BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE

DATE 6/21/91

SUBJECT

SHEET NO. 1/10BY JDC CHKD. _____

JOB NO. _____

1. Problem statement

Estimate the volume of water that may have accumulated on Parcel "A" of the Falls City site during the times the mill was in operation

2. Data

1. precipitation data — National Climatic Data Center, Asheville, North Carolina
 - a. weather station — located inside city limits Falls City, Texas
 - b. period of record: August 1946 through November 1990
2. information on discharge rates to ponds and depth of ponds from former mill supervisor (Susquehanna-Western) Filvin E. Wiatrek, phone: 512-780-3911

3. Assumptions

- a. maximum pond area is equal to area of tailings pile minus 6 acres to allow for area of starter dikes
- b. rainfall-volume (column 3 of tables) is inches of precipitation times the maximum pond area.



DATE 6/21/91

SUBJECT

SHEET NO. 2/10

BY JDC CHKD.

JOB NO.

c. For computing evaporative surface area (column 6 of tables)
Where diked drainage areas are used, the water surface area may be expressed as a variable function dependent on pond volume. Diked retention areas may be modeled as conical volumes. The surface area when the pond is less than full is approximated by:

$$A = K A_F (V_p / V_F)^{2/3}$$

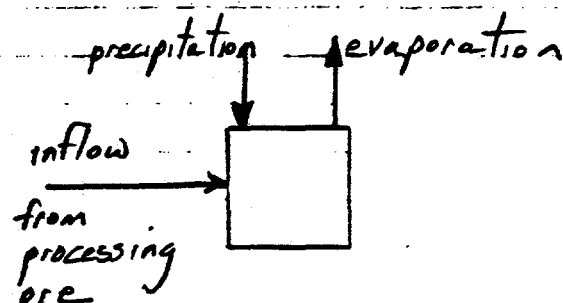
where: A_F = maximum water surface area

V_F = maximum volume

V_p = monthly volume (processing water + precipitation)

$K = 1.0$ for accumulating conditions

d. infiltration is not considered in the mass balance. A diagram of the mass balance is presented below



DATE 6/21/91

SUBJECT

SHEET NO. 3/10BY JPL CHKD. _____

JOB NO. _____

4. calculation

tables on pages

PILE	MAXIMUM POND AREA. acres	MAXIMUM POND DEPTH. feet
1	18	6
2	20	6
4	7	6
5	15	6
7	40	6

5. Summary

rainfall data (table), page: 10

mass balance (tables), pages: 4-8

mass balance summary, page: 9

6/21/91
90C

4/10

FALLS CITY, TEXAS PILE No. 1
APRIL 1961 THROUGH DECEMBER 1963

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MONTH	MEAN PRECIPITATION, inches	TOTAL RAINFALL VOLUME, acre-feet	ASSUMED INFLOW FROM PROCESSING, acre-feet	TOTAL WATER VOLUME, acre-feet	AVERAGE POND AREA, acres	EVAPORATION DISTRIBUTION FACTOR	ESTIMATED EVAPORATED VOLUME, acre-feet	ACCUMULATED WATER VOLUME, acre-feet	WATER HEIGHT IN POND, feet
1961 APR	2.45	3.68	3	6.68	5.85	0.082	2.16	4.52	3.42
MAY	3.73	5.59	3	8.60	6.93	0.102	3.18	5.42	3.72
JUN	2.89	4.33	3	7.33	6.23	0.127	3.56	3.77	3.53
JUL	1.83	2.75	3	5.75	5.30	0.143	3.41	2.34	3.25
AUG	2.51	3.77	3	6.76	5.91	0.133	3.53	3.23	3.44
SEP	3.86	5.79	3	8.79	7.03	0.096	3.04	5.75	3.75
OCT	2.95	4.43	3	7.43	6.28	0.071	2.01	5.42	3.54
NOV	2.02	3.03	3	6.03	5.47	0.049	1.21	4.82	3.31
DEC	1.48	2.22	3	5.22	4.97	0.039	0.87	4.35	3.15
1962 JAN	1.58	2.37	3	5.37	5.06	0.039	0.89	4.48	3.18
FEB	1.70	2.55	3	5.55	5.18	0.046	1.07	4.48	3.22
MAR	1.08	1.62	3	4.62	4.58	0.073	1.50	3.12	3.03
APR	2.45	3.68	3	6.68	5.85	0.082	2.16	4.52	3.42
MAY	3.73	5.59	3	8.60	6.93	0.102	3.18	5.42	3.72
JUN	2.89	4.33	3	7.33	6.23	0.127	3.56	3.77	3.53
JUL	1.83	2.75	3	5.75	5.30	0.143	3.41	2.34	3.25
AUG	2.51	3.77	3	6.76	5.91	0.133	3.53	3.23	3.44
SEP	3.86	5.79	3	8.79	7.03	0.096	3.04	5.75	3.75
OCT	2.95	4.43	3	7.43	6.28	0.071	2.01	5.42	3.54
NOV	2.02	3.03	3	6.03	5.47	0.049	1.21	4.82	3.31
DEC	1.48	2.22	3	5.22	4.97	0.039	0.87	4.35	3.15
1963 JAN	1.58	2.37	3	5.37	5.06	0.039	0.89	4.48	3.18
FEB	1.70	2.55	3	5.55	5.18	0.046	1.07	4.48	3.22
MAR	1.08	1.62	3	4.62	4.58	0.073	1.50	3.12	3.03
APR	2.45	3.68	3	6.68	5.85	0.082	2.16	4.52	3.42
MAY	3.73	5.59	3	8.60	6.93	0.102	3.18	5.42	3.72
JUN	2.89	4.33	3	7.33	6.23	0.127	3.56	3.77	3.53
JUL	1.83	2.75	3	5.75	5.30	0.143	3.41	2.34	3.25
AUG	2.51	3.77	3	6.76	5.91	0.133	3.53	3.23	3.44
SEP	3.86	5.79	3	8.79	7.03	0.096	3.04	5.75	3.75
OCT	2.95	4.43	3	7.43	6.28	0.071	2.01	5.42	3.54
NOV	2.02	3.03	3	6.03	5.47	0.049	1.21	4.82	3.31
DEC	1.48	2.22	3	5.22	4.97	0.039	0.87	4.35	3.15
1964 JAN	1.58	2.37	3	5.37	5.06	0.039	0.89	4.48	3.18
		122.19	102						
								147.47 ac-ft	
								4.81E+07 gallons	

5/10

FALLS CITY, TEXAS FILE No. 2

FEB. 1964 THROUGH JAN. 1965 AND AUG. 1965 THROUGH JAN. 1966

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

AVERAGE MONTHLY LAKE EVAPORATION - 34 INCHES										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MONTH	MEAN PRECIPITATION, inches	TOTAL RAINFALL VOLUME, acre-feet	ASSUMED INFLOW FROM PROCESSING, acre-feet	TOTAL WATER VOLUME, acre-feet	POND AREA, acres	EVAPORATION DISTRIBUTION FACTOR	ESTIMATED EVAPORATED VOLUME, acre-feet	ACCUMULATED WATER VOLUME, acre-feet	WATER HEIGHT IN POND, feet	
1964 FEB	1.70	2.83	3	5.83	5.54	0.046	1.15	4.69	3.16	
MAR	1.08	1.80	3	4.80	4.87	0.073	1.60	3.20	2.96	
APR	2.45	4.08	3	7.08	6.31	0.082	2.33	4.76	3.37	
MAY	3.73	6.22	3	9.22	7.52	0.102	3.45	5.77	3.68	
JUN	2.89	4.82	3	7.82	6.73	0.127	3.85	3.97	3.48	
JUL	1.83	3.05	3	6.05	5.68	0.143	3.65	2.40	3.20	
AUG	2.51	4.18	3	7.18	6.37	0.133	3.81	3.37	3.39	
SEP	3.86	6.43	3	9.43	7.63	0.096	3.30	6.14	3.71	
OCT	2.95	4.92	3	7.92	6.79	0.071	2.17	5.75	3.50	
NOV	2.02	3.37	3	6.37	5.87	0.049	1.30	5.07	3.25	
DEC	1.48	2.47	3	5.47	5.31	0.039	0.93	4.54	3.09	
1965 JAN	1.58	2.63	3	5.63	5.41	0.039	0.95	4.68	3.12	
FEB	1.70	2.83	0	2.83	3.42	0.046	0.71	2.12	2.48	
MAR	1.08	1.80	0	1.80	2.53	0.073	0.83	0.97	2.13	
APR	2.45	4.08	0	4.08	4.37	0.082	1.61	2.47	2.80	
MAY	3.73	6.22	0	6.22	5.78	0.102	2.65	3.56	3.23	
JUN	2.89	4.82	0	4.82	4.88	0.127	2.79	2.03	2.96	
JUL	1.83	3.05	0	3.05	3.60	0.143	2.31	0.74	2.54	
AUG	2.51	4.18	3	7.18	6.37	0.133	3.81	3.37	3.39	
SEP	3.86	6.43	3	9.43	7.63	0.096	3.30	6.14	3.71	
OCT	2.95	4.92	3	7.92	6.79	0.071	2.17	5.75	3.50	
NOV	2.02	3.37	3	6.37	5.87	0.049	1.30	5.07	3.25	
DEC	1.48	2.47	3	5.47	5.31	0.039	0.93	4.54	3.09	
JAN	1.58	2.63	3	5.63	5.41	0.039	0.95	4.68	3.12	
FEB	1.70	2.83	3	5.83	5.54	0.046	1.15	4.69	3.16	
		96.43	57							
									100.44 ac-ft	
									3.27E+07 gallons	

6/21/91
902

6/10

FALLS CITY, TEXAS PILE No. 4
JULY 1968 THROUGH FEBRUARY 1969

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MONTH	MEAN PRECIPITATION, inches	TOTAL RAINFALL VOLUME, acre-feet	ASSUMED INFLOW FROM PROCESSING, acre-feet	TOTAL WATER VOLUME, acre-feet	AVERAGE POND AREA, acres	EVAPORATION DISTRIBUTION FACTOR	ESTIMATED EVAPORATED VOLUME, acre-feet	ACCUMULATED WATER VOLUME, acre-feet	WATER HEIGHT IN POND, feet
1968 JUL	1.83	1.07	3	4.07	3.07	0.143	1.98	2.09	3.97
AUG	2.51	1.46	3	4.46	3.27	0.133	1.96	2.51	4.10
SEP	3.86	2.25	3	5.25	3.64	0.096	1.57	3.68	4.33
OCT	2.95	1.72	3	4.72	3.39	0.071	1.02	3.64	4.12
NOV	2.02	1.18	3	4.18	3.13	0.049	0.69	3.49	4.01
DEC	1.48	0.86	3	3.86	2.97	0.039	0.52	3.34	3.91
1969 JAN	1.58	0.92	3	3.92	3.00	0.039	0.53	3.40	3.93
FEB	1.70	0.99	3	3.99	3.03	0.046	0.63	3.36	3.95
		10.46	24						
								25.51 ac-ft	
								8.31E+06 gallons	

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7/10

FALLS CITY, TEXAS PILE NO. 5
MARCH 1969 THROUGH FEBRUARY 1970

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MONTH	MEAN PRECIPITATION, inches	TOTAL RAINFALL VOLUME, acre-feet	ASSUMED INFLOW FROM PROCESSING, acre-feet	TOTAL WATER VOLUME, acre-feet	AVERAGE POND AREA, acres	EVAPORATION DISTRIBUTION FACTOR	ESTIMATED EVAPORATED VOLUME, acre-feet	ACCUMULATED WATER VOLUME, acre-feet	WATER HEIGHT IN POND, feet
1969 MAR	1.08	1.35	10	11.35	7.85	0.073	2.58	8.77	4.34
APR	2.45	3.06	10	13.06	8.62	0.082	3.18	9.88	4.55
MAY	3.73	4.66	10	14.66	9.31	0.102	4.27	10.39	4.73
JUN	2.69	3.61	10	13.61	8.86	0.127	5.06	8.55	4.61
JUL	1.83	2.29	10	12.29	8.27	0.143	5.32	6.96	4.46
AUG	2.51	3.14	10	13.14	8.65	0.133	5.18	7.96	4.56
SEP	3.86	4.83	10	14.82	9.38	0.096	4.05	10.77	4.74
OCT	2.95	3.69	10	13.69	8.89	0.071	2.84	10.85	4.62
NOV	2.02	2.53	10	12.53	8.38	0.049	1.85	10.68	4.48
DEC	1.48	1.85	10	11.85	8.08	0.039	1.42	10.43	4.40
1970 JAN	1.58	1.98	10	11.97	8.13	0.039	1.43	10.58	4.42
FEB	1.70	2.12	10	12.12	8.20	0.046	1.70	10.43	4.44

35.10 120

116.23 ac-ft
3.79E+07 gallons

6/21/91

8/10

FALLS CITY, TEXAS FILE No. 7
MARCH 1970 THROUGH MAY 1973

AVERAGE ANNUAL LAKE EVAPORATION = 54 inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MONTH	MEAN PRECIPITATION, inches	TOTAL RAINFALL VOLUME, acre-feet	ASSURED INFLOW FROM PROCESSING, acre-feet	TOTAL WATER VOLUME, acre-feet	AVERAGE POND AREA, acres	EVAPORATION DISTRIBUTION FACTOR	ESTIMATED EVAPORATED VOLUME, acre-feet	ACCUMULATED WATER VOLUME, acre-feet	WATER HEIGHT IN POND, feet
1970	MAR	1.08	3.60	10	13.60	12.28	0.073	4.03	3.32
	APR	2.45	8.17	10	18.17	14.89	0.082	5.49	3.66
	MAY	3.73	12.43	10	22.43	17.14	0.102	7.87	3.93
	JUN	2.89	9.63	10	19.63	15.68	0.127	8.96	3.76
	JUL	1.83	6.10	10	16.10	13.74	0.143	8.84	3.52
	AUG	2.51	8.37	10	18.37	15.00	0.133	8.98	3.67
	SEP	3.86	12.87	10	22.87	17.36	0.096	7.50	3.95
	OCT	2.95	9.83	10	19.83	15.79	0.071	5.04	3.77
	NOV	2.02	6.73	10	16.73	14.09	0.049	3.11	3.56
	DEC	1.48	4.93	10	14.93	13.06	0.039	2.29	3.43
1971	JAN	1.58	5.27	10	15.27	13.26	0.039	2.33	3.45
	FEB	1.70	5.67	10	15.67	13.49	0.046	2.79	3.48
	MAR	1.08	3.60	10	13.60	12.28	0.073	4.03	3.32
	APR	2.45	8.17	10	18.17	14.89	0.082	5.49	3.66
	MAY	3.73	12.43	10	22.43	17.14	0.102	7.87	3.93
	JUN	2.89	9.63	10	19.63	15.68	0.127	8.96	3.76
	JUL	1.83	6.10	10	16.10	13.74	0.143	8.84	3.52
	AUG	2.51	8.37	10	18.37	15.00	0.133	8.98	3.67
	SEP	3.86	12.87	10	22.87	17.36	0.096	7.50	3.95
	OCT	2.95	9.83	10	19.83	15.79	0.071	5.04	3.77
	NOV	2.02	6.73	10	16.73	14.09	0.049	3.11	3.56
	DEC	1.48	4.93	10	14.93	13.06	0.039	2.29	3.43
1972	JAN	1.58	5.27	10	15.27	13.26	0.039	2.33	3.45
	FEB	1.70	5.67	10	15.67	13.49	0.046	2.79	3.48
	MAR	1.08	3.60	10	13.60	12.28	0.073	4.03	3.32
	APR	2.45	8.17	10	18.17	14.89	0.082	5.49	3.66
	MAY	3.73	12.43	10	22.43	17.14	0.102	7.87	3.93
	JUN	2.89	9.63	10	19.63	15.68	0.127	8.96	3.76
	JUL	1.83	6.10	10	16.10	13.74	0.143	8.84	3.52
	AUG	2.51	8.37	10	18.37	15.00	0.133	8.98	3.67
	SEP	3.86	12.87	10	22.87	17.36	0.096	7.50	3.95
	OCT	2.95	9.83	10	19.83	15.79	0.071	5.04	3.77
	NOV	2.02	6.73	10	16.73	14.09	0.049	3.11	3.56
	DEC	1.48	4.93	10	14.93	13.06	0.039	2.29	3.43
1973	JAN	1.58	5.27	10	15.27	13.26	0.039	2.33	3.45
	FEB	1.70	5.67	10	15.67	13.49	0.046	2.79	3.48
	MAR	1.08	3.60	10	13.60	12.28	0.073	4.03	3.32
	APR	2.45	8.17	10	18.17	14.89	0.082	5.49	3.66
	MAY	3.73	12.43	10	22.43	17.14	0.102	7.87	3.93

305.00

340

475.92 ac-ft

1.55E+06 gallons

6/21/91
JOL

9/10

SUMMARY OF INFILTRATION VOLUMES

PILE	TOTAL SOURCE VOLUME, gallons	FRACTION FROM RAINFALL	FRACTION FROM PROCESSING	***TOTAL VOLUMES THAT*** ***MAY HAVE INFILTRATED***	
				RAINFALL, gallons	ORE PROCESSING, gallons
1	4.81E+07	0.55	0.45	2.65E+07	2.16E+07
2	3.27E+07	0.63	0.37	2.06E+07	1.21E+07
4	8.31E+06	0.30	0.70	2.49E+06	5.82E+06
5	3.79E+07	0.23	0.77	8.72E+06	2.92E+07
7	1.55E+08	0.47	0.53	7.28E+07	8.22E+07
				2.82E+08	1.31E+08
				1.31E+08	1.51E+08

6/21/91
JOL

p/10

FALLS CITY, TEXAS WEATHER STATION
PERIOD OF RECORD AUG 1946 THROUGH NOV 1990

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RAINFALL
1946								10.25	7.05	8.15	2.80	2.10	
1947	2.52	0.00	1.77	2.93	6.98			3.71	0.00				
1948								3.50	2.55	1.37			
1949	2.85	3.46	1.04	9.89	1.48	2.51	3.28	1.66	0.72	6.54	0.00	5.63	39.06
1950	0.30	1.00	2.15	1.59	3.14	3.94	1.63	2.81	1.85	0.42	0.11	0.00	18.94
1951	0.34	1.16	2.27	0.44	6.19	3.44	0.32	0.17	3.59	1.29	1.48	0.13	20.82
1952	0.20	2.11	0.92	1.61	3.07	0.68	2.09	0.00	6.92	0.00	3.05	1.54	22.19
1953	0.34	1.80	0.25	1.67	7.71	2.70	0.68	1.93	3.72	5.29	0.29	1.98	28.36
1954	0.28	0.06	0.06	4.27	5.32	1.10	1.57	1.26	0.90	1.45	0.94	0.08	17.29
1955	0.95	2.40	0.63	0.13	2.71	2.39	1.12	5.36	1.18	0.21	0.76	0.75	18.59
1956	0.55	0.42	0.30	0.85	0.93	1.60	0.33	0.63	1.70	1.26	1.37	1.40	11.34
1957	0.22	1.89	2.72	9.17	4.85	2.71	0.00	0.28	10.74	1.42	6.70	0.45	41.15
1958	6.21	1.78	0.22	1.15	3.22	2.77	0.48	2.04	3.90	7.48	0.98	1.56	31.79
1959	0.27	3.05	0.11	2.25	3.91	2.40	0.63	1.01	1.05	3.35	3.59	0.19	21.81
1960	0.81	2.11	1.02	1.41	0.66	4.43	6.74	11.21	1.00	8.79	4.14	3.73	46.05
1961	1.23	2.48	0.48	3.57	0.34	5.01	1.78	0.00	2.27	5.73	5.57	0.50	28.96
1962	0.51	0.65	0.94	4.27	1.46	6.01	0.00	0.00	4.13	0.82	1.98	3.41	24.16
1963	0.28	3.00	0.09	0.75	2.86	2.72	2.05	0.00	2.20	2.16	3.73	2.53	22.37
1964	2.01	2.05	1.72	0.99	1.86	1.44	0.00	5.77	1.96	1.44	0.73	1.10	21.07
1965	1.97	5.88	0.95	1.18	7.80	1.04	0.18	0.87	2.26	2.85	1.00	3.36	29.34
1966	2.02	1.93	0.85	4.09	3.50	2.30	2.16	1.68	2.51	0.53	0.00	0.45	22.02
1967	0.63	0.88	1.52	1.50	1.24	0.00	3.00	6.05	15.23	3.67	3.25	0.96	37.93
1968	6.47	2.02	0.91	1.38	4.66	2.39	2.69	2.46	12.56	1.51	2.92	1.96	41.93
1969	1.52	1.03	1.85	—	7.15	1.91	0.00	2.95	0.81	4.92	2.66	3.45	28.25
1970	2.31	2.52	3.09	1.64	6.24	1.27	1.27	2.80	2.15	0.36	0.00	0.31	23.96
1971	0.00	1.10	0.00	1.50	0.06	4.74	0.00	3.85	7.46	3.05	1.16	2.01	24.93
1972	1.48	0.39	1.06	0.57	5.84	2.89	6.25	4.11	4.45	0.57	1.94	0.34	29.89
1973	2.71	4.07	1.13	3.66	1.09	12.85	0.37	2.11	10.03	4.95	0.36	0.45	43.78
1974	2.40	0.36	0.88	0.88	7.23	0.77	1.22	6.26	3.63	0.93	2.39	1.05	28.00
1975	—	1.32	0.00	1.40	8.67	6.21	1.06	1.75	1.27	2.29	0.20	0.52	24.69
1976	0.42	0.00	0.72	5.24	4.17	0.12	4.19	0.00	6.12	8.27	3.56	2.49	35.30
1977	2.36	1.18	0.60	8.11	3.67	1.37	0.00	0.00	0.98	0.87	2.75	0.21	22.10
1978	1.02	1.61	0.78	1.73	1.40	3.12	3.37	1.82	8.78	0.98	2.78	2.03	29.42
1979	3.45	1.30	0.77	4.86	3.95	4.03	4.52	2.98	1.67	0.00	0.77	1.35	29.65
1980	0.69	0.63	0.37	0.33	8.20	0.00	1.56	7.11	8.32	1.06	3.32	0.97	32.56
1981	1.67	1.19	1.14	2.35	7.31	4.94	0.12	2.85	1.85	4.00	0.60	0.44	~~22.11~~ 28.46
1982	0.12	6.12	0.29	1.05	4.64	3.04	0.21	1.92	2.48	6.65	2.24	0.85	29.61
1983	1.43	1.80	2.77	0.00	2.68	2.53	4.22	2.71	5.47	1.12	1.74	0.23	26.70
1984	3.35	0.66	0.44	0.50	0.68	0.22	0.00	0.00	1.85	7.13	0.77	1.25	16.85
1985	2.68	1.44	2.01	5.79	1.41	1.04	1.73	0.00	5.54	4.18	6.21	0.36	32.39
1986	1.51	0.54	0.28	0.46	4.33	3.43	0.00	0.20	—	3.77	2.55	5.53	22.60
1987	1.27	4.30	0.88	0.00	3.23	11.72	1.53	4.00	0.76	0.30	3.15	3.01	34.15
1988	0.45	0.07	0.42	1.84	2.93	2.49	2.38	0.00	3.80	0.85	0.00	0.91	16.14
1989	3.51	0.39	1.76	3.32	0.81	1.31	1.05	1.84	0.35	4.42	2.19	0.48	21.43
1990	1.06	0.91	4.30	2.76	0.92	0.00	10.92	2.12	1.12	2.05	0.97	—	27.13
AVE MONTHLY RAINFALL	1.58	1.70	1.08	2.45	3.73	2.89	1.83	2.51	3.86	2.95	2.02	1.48	

APPENDIX B

WELL LOGS

PROJECT Falls City Site
Texas

Page 1 of 1

LOG OF TEST BORING NO. 851

JOB NO. FCT01 DATE 91/3/29

SURFACE ELEVATION 431.86

TOTAL DEPTH 50.0 feet

TOP OF FILTER PACK 18.00

RIG TYPE Rotary and core rig

WELL CASING TYPE 4.0-in sched. 40 PVC

BORING TYPE Rotary air

FORMATION OF COMPLETION Deweeseville/Conquista contact

LOCATION N 59877.71 E 67424.58

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CH	SOIL. Silty Clay, little sand, high plasticity, black.
5		4-in well installed		CH	DUBOSE MEM. Claystone, poorly indurated, soft, dark gray.
10		Grout installed from 0 to 10 feet		CL	DUBOSE MEM.- DEWEESEVILLE MEM. GRAD. ZONE Claystone, sandy, occ. sandstone lenses, limonite staining, soft, light tan.
15		Bentonite chips placed from 10 to 13 feet		SP	DEWEESEVILLE MEM. Sandstone, poorly indurated, fine grained, soft, light greyish tan.
20		Bentonite pellets placed from 13 to 18 feet		SC CL	Mudstone, very soft, lt. tan.
25		Sand pack installed from 18 to 44 feet		CL	Claystone, silty, with organics, soft, light to dark brown.
30		Screen installed from 27 to 37 feet		SM	Silty Sandstone, fine grained, uncemented, soft, lt. tan.
35					
40		Blank sump placed from 44 to 37 feet		CL	CONQUISTA MEM. Claystone, poorly indurated, soft, lt. greyish tan to lt. grey
45		Borehole sealed at 44 to 48.8 feet with bentonite pellets.			
50					TD AT 50 FEET

GROUNDWATER

DEPTH	HOUR	DATE
31.0	09:30	3-29-91

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 852

JOB NO. FCT01 DATE 91/2/17SURFACE ELEVATION 437.85TOTAL DEPTH 47.0 feetRIG TYPE ROTARY AND CORE RIGTOP OF FILTER PACK 17.00BORING TYPE ROTARY AIRWELL CASING TYPE 4.0-IN.SCHED.40 PVCLOCATION N 59902.03 E 66684.55FORMATION OF COMPLETION Deweeseville /Conquista contactDATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				ML	SOIL Clayey Silt, mod. plast., dk. grey, moist.
5		Installed 4-in. well Installed grout seal to 4.6 feet.		SC	DEWEESVILLE MEM. Clayey Sand, fine grained, loose, lt. yellow, to tan, moist
10					
15		Placed bentonite pellets at 4.6 to 17 feet		SP	Sandstone, fine, mod. hard, lt. tan to buff.
20		Installed No. 8-12 sandpack at 17 to 39 feet.		SM	Silty Sand, fine, uncemented, yellow green, slightly moist.
25					
30		installed 10 -ft. screen at 30 to 40 feet.			
35		Cuttings v. moist at 32 to 35 feet.			
40		Sealed hole bottom with bent. pellets at 39 to 47 feet.		CL	CONQUISTA CLAY MEM. Silty Clay, soft, dk. grey, limonite stained zone 37 to 39 feet.
45		Water in boring upon completion of hole			
50					TD AT 47 FEET

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 853

JOB NO. FCT01 DATE 9/12/26SURFACE ELEVATION 415.38TOP OF FILTER PACK 15.00WELL CASING TYPE 4.0-IN.SCHED.40 PVCFORMATION OF COMPLETION Deweesville Member.TOTAL DEPTH 41.5 feetRIG TYPE ROTARY AND CORE RIGBORING TYPE ROTARY AIRLOCATION N 58402.85 E 67051.20DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CL	SOIL Silty Clay, brn., moist.
				ML	Clayey Silt, some fine sand, sl. plast., dk. brn., moist.
5		installed 4-in. well.			
		Installed grouted steel casing to 5.0 feet		SC	DEWEESVILLE MEM. Clayey Sand, fine, uncemented, lt. tan, moist.
10				SP	Sand, fine, uncemented, lt. reddish tan, moist.
15		Placed bentonite pellets from 5 to 15 feet.		SP	Sandstone, fine, med. soft, friable, lt. reddish tan.
20					
25		Cuttings very moist at 24 to 25 feet.		SC	Clayey Sand, fine, low plast., reddish brn., v. moist.
30		Placed sandpack from 15 to 34 feet			
		installed screen from 24.5 to 34.5 feet.		CH	CONQUITA CLAY MEM. Silty Clay, high plast., dk. grey, moist to wet.
35		placed bent. seal from 34 to 40 feet.			
40		Placed sump from 34.5 to 41.5 feet			
		cave material below 40.			
45					TD AT 41.5
50					

GROUNDWATER

DEPTH	HOUR	DATE

NAN

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 854

JOB NO. FCT01 DATE 9/2/26SURFACE ELEVATION 412.29 409.88TOP OF FILTER PACK 9.00WELL CASING TYPE 4.0-in. Sched. 40 PVCFORMATION OF COMPLETION Deweeseville Mem.TOTAL DEPTH 34.5 feetRIG TYPE ROTARY AND CORE RIGBORING TYPE Rotary airLOCATION N 57716.31 E 65230.62DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in well		CL	SOIL Silty clay, grey, moist
		Grout placed to 3 ft.		ML	Sandy Silt, v. fine, low plast. brown, moist.
5		Installed steel casing to 5 feet		SM	DEWEESVILLE MEM. Silty Sand, fine, low plast., lt. tan, sl. moist.
10		Placed bent. pellets from 3 to 9 feet.		SC	Clayey Sand, fine, med. plast. lt. reddish tan, moist.
15		$\frac{7}{3}$		SC	Clayey Sand interbedded with sandy clay, med. plast., lt red v. moist.
20		Screen placed at 16.9 to 26.9 feet.		CL	Sandy Clay, med. plast., lt. red. v. moist.
25		Placed sand pack from 9 to 24 feet. Water encountered at 21 feet.		CH	CONQUISTA CLAY MEM. Silty Clay, high plasticity, dk. grey, very moist.
30		Placed bent. pellet seal from 24 to 34.5.			
35		Sump placed from 26.9 to 33.9 feet.			TD AT 34.5 FEET.
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT **Falls City Site**
Texas

LOG OF TEST BORING NO. 855

Page 1 of 1

JOB NO. **FCT01** DATE **9/14/1**
SURFACE ELEVATION **412.29**
TOP OF FILTER PACK **12.00**
WELL CASING TYPE **4.0-IN.SCHED 40 PVC**
FORMATION OF COMPLETION **CONQUISTA CLAY MEM.**

TOTAL DEPTH **35.0 feet**
RIG TYPE **ROTARY AND CORE RIG**
BORING TYPE **ROTARY AIR**
LOCATION **N 55580.23 E 65392.07**
DATUM **MSL, GROUND SURFACE**

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		4-in well installed		CH	SOIL Silty Clay, high plast. dk. brn.
5		Steel casing grouted in place to 5 feet Bent. pellets placed from 3.5 to 12 feet		CH	CONQUISTA CLAY MEM. Claystone, poorly indurated, soft, very light greyish tan. Occasional thin seam of gypsum
10					
15		Sandpack installed from 12 to 26 feet. Screen installed from 11 to 21 feet.			
20					
25					
30		Bent. pellets installed from 26 to 35 feet.			Thin seam of sandstone at 25.5 feet. Strong odor of H ₂ S gas at 27 feet.
35					TD AT 35 FEET
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE



PROJECT <u>Falls City Site</u>		LOG OF TEST BORING NO. 856	
JOB NO. <u>FCT01</u>		DATE <u>91/3/1</u>	TOTAL DEPTH <u>80.0 feet</u>
SURFACE ELEVATION <u>458.17</u>		RIG TYPE <u>ROTARY AND CORE RIG</u>	
TOP OF FILTER PACK <u>32.20</u>		BORING TYPE <u>ROTARY AIR</u>	
WELL CASING TYPE <u>4.0-IN.SCHED.40 PVC</u>		LOCATION <u>N 61631.13 E 65281.81</u>	
FORMATION OF COMPLETION <u>CONQUISTA,MIDDLE SAND</u>		DATUM <u>MSL, GROUND SURFACE</u>	

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				SP	SOIL Sand, fine, loose, tan, sl. moist
2.5		Grout to 2.5 feet			
5				SP	DEWEESVILLE MEM Sandstone, fine, soft, friable, tan.
5		Steel casing installed to 5 feet			
10				CL SC	Clayey Sand, fine, sl. plast., buff, moist; interbedded with lenses of Sandy Clay, mod. plast., lt. brn. moist.
15		Changed to rotary mud at 15 feet			
20		Bentonite chips installed to 18.5 feet. Bentonite pellets placed from 18.5 to 32.2 feet		CH	CONQUISTA CLAY MEM, UPPER Clay to Claystone, massive, limonite stain in fractures, high plasticity, mod. soft, tan, moist.
32.2		Sandpack at 32.2 to 52.6 feet.		SP SC	CONQUISTA, MIDDLE SAND Sand, fine, low plast., soft, lt. brn., sl. moist.
40		Screen placed from 40 to 50 feet.			
50					

GROUNDWATER

DEPTH	HOUR	DATE
31.9	08:58	3-3-91

PROJECT Falls City SiteTexas

LOG OF TEST BORING NO. 856

JOB NO. FCT01DATE 91/3/1TOTAL DEPTH 80.0 feetSURFACE ELEVATION 458.17RIG TYPE ROTARY AND CORE RIGTOP OF FILTER PACK 32.20BORING TYPE ROTARY AIRWELL CASING TYPE 4.0-IN.SCHED.40 PVCLOCATION N 61631.13 E 65281.81FORMATION of COMPLETION CONQUISTA,MIDDLE SANDDATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Fill of caved formation from 52.6 to 80 feet.			
60				SP CL	Sandstone, fine, mod. hard, reddish brown, interbedded with; Silty Clay, mod. soft, lt. tan,
65				CH	CONQUISTA, LOWER Clay/ Claystone, mod. hard to hard, high plast. dark grey.
70					
75					
80					TD AT 80 FEET
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
31.9	08:58	3-3-91

1444

PROJECT Falls City Site

LOG OF TEST BORING NO. 857

JOB NO. FCT01

DATE 91/3/14

TOTAL DEPTH 73.0 feet

SURFACE ELEVATION 442.18

RIG TYPE ROTARY AND CORE RIG

TOP OF FILTER PACK 36.00

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 60451.37 E 67319.24

FORMATION OF COMPLETION CONQUISTA CLAY MEM.

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CH	SOIL Silty Clay, high plast.
		Installed 4-in. well.		CH	DUBOSE MEM Silty Clay, high plasticity, brownish grey
5		Installed steel casing to 5 feet.		SP	DEWEESVILLE MEM Sandstone, poorly indurated, gravelly at upper contact, fine, soft, lt. tan.
		Grouted to 9 feet.			Occ. thin lenses of claystone
10		Placed bentonite chips from 9 to 30 feet.		CH	Claystone, very soft, lt. tan.
15					
20				SP	Sandstone, fine, hard, lt. tan
25				SM	Sandstone, silty, fine, soft, lt. tan
30		Placed bentonite pellets from 30 to 36 feet.		CH	Sandy claystone to mudstone, soft, lt. greenish grey, gradational contact zone between Deweesville and Conquista mem.
35		Sandpack installed from 36 to 59 feet.		CH	CONQUISTA CLAY MEM Claystone, tr. sand, poorly indurated, v. soft, lt. greenish grey
40					(harder claystone from 38 to 46)
45		Installed .050 slot screen from 44 to 54 feet.		CH	Claystone, mod. soft, some iron oxide staining, dark grey.
50					

GROUNDWATER

DEPTH	TIME	DATE
31.0	11:30	3-14-91

JOB NO. **FCT01** DATE **91/3/14** TOTAL DEPTH **73.0 feet**
 SURFACE ELEVATION **442.18** RIG TYPE **ROTARY AND CORE RIG**
 TOP OF FILTER PACK **36.00** BORING TYPE **ROTARY AIR**
 WELL CASING TYPE **4.0-IN.SCHED.40 PVC** LOCATION **N 60451.37 E 67319.24**
 FORMATION OF COMPLETION **CONQUISTA CLAY MEM.** DATUM **MSL, GROUND SURFACE**

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		PVC well casing installed to 61 feet			
60		Placed bentonite chips below casing to TD.			
65				CH	Claystone, with shell fragments, soft, greenish grey.
70					
75					TD AT 73 FEET
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
31.0	11:30	3-14-91

JOB NO. FCT01 DATE 9/13/2

TOTAL DEPTH 80.0 feet

SURFACE ELEVATION 441.84

RIG TYPE ROTARY AND CORE RIG

TOP OF FILTER PACK 35.00

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN SCHED 40 PVC

LOCATION N 60184.41 E 65945.20

FORMATION OF COMPLETION DEWEESVILLE AND CONQUISTA DATUM

MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Grouted to 2 feet		CL	SOIL Silty Clay, grey
		Installed steel casing to 5 feet		SP	DEWEESVILLE SANDSTONE Sandstone, fine, soft friable, tan
5				SC	Sandstone, clayey, fine mod.
				CH	soft, tan; interbedded with Sandy Clay, fine, highly plastic clay seams, sl. moist.
10					
15		Placed bentonite chips from 2 to 14.1 feet			
20					
25					
30		Installed bentonite pellets from 14.1 to 35 feet		SP	CONQUISTA CLAY MEM.
				ML	Sandstone fine, mod. soft, lt. tan ; interbedded with Siltstone, mod. hard.
35					
40				CH	Clay to claystone, mod. soft, dk grey.
				CL	Claystone, mod. soft, lt. grey; interbedded with thin sandstone lenses, fine, mod. soft, lt. tan, and with Siltstone, lt. red.
				SP	
45		Placed .050 screen from 41.3 to 51.3 feet			
50		Installed sandpack from 35.2 to 50 feet.			

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Texas LOG OF TEST BORING NO. 858
 JOB NO. FCT01 DATE 9/13/2 TOTAL DEPTH 80.0 feet
 SURFACE ELEVATION 441.84 RIG TYPE ROTARY AND CORE RIG
 TOP OF FILTER PACK 35.00 BORING TYPE ROTARY AIR
 WELL CASING TYPE 4.0-IN SCHED 40 PVC LOCATION N 60184.41 E 65945.20
 FORMATION OF COMPLETION DEWEESVILLE AND CONQUISTA DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Blank sump placed from 51.3 to 58.3 feet		CL	Silty Clay, soft, lt. grey, low plasticity.
60		Installed pellets from 50 to 57 feet.		CH	Claystone, mod. soft, lt. grey; interbedded with Siltstone, mod. hard, red.
65				ML	Siltstone, mod. hard, red; interbedded with Sandstone, mod. soft, friable, lt. tan; also thin lenses of Claystone
70					
75		Placed bentonite chips in open hole from 57 to 80 feet.			
80					TD AT 80 FEET
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 859

JOB NO. FCT01 DATE 91/3/4SURFACE ELEVATION 426.26TOP OF FILTER PACK 27.30WELL CASING TYPE 4.0-IN.SCHED.40 PVCFORMATION OF COMPLETION CONQUISTA CLAY MEM.TOTAL DEPTH 79.0 feetRIG TYPE ROTARY AND CORE RIGBORING TYPE ROTARY AIRLOCATION N 38209.29 E 64798.23DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CL	SOIL Silty Clay, brn.
		Placed grout seal to 2 ft.		SP	DEWEESVILLE MEM. Sandstone, v. fine, tuffaceous, friable, soft, iron stain, lt. tan to white, al. moist.
5		Steel surf. casing installed to 5 feet			
				SM	Silty Sand, little clay, lt. tan, al. moist.
10				CL	CONQUISTA CLAY MEM Clay to Shale, fissle, with silt lenses
		Bentonite chips installed from 2 to 12 feet			
15				CL	Silty Clay, low to mod plast., soft, with limonite stain, yellow brn., moist.
20					
25		bentonite pellets placed from 12 to 27.3 feet.			
				CL	(oxidation/ reduction boundary) Clay to Shale, fissle, with gypsum, soft, med. plasticity, dk. grey.
30					
35		Installed .050 screen at 33.5 to 43.5 ft.		CL	Silty Clay to Clayey silt, some fine sand, low to mod. plast., very moist.
40		Sandpack placed from 27.3 to 45 feet			
45				CL	Shale, dk. grey.
50		Bentonite chips and pellets installed to fill			

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 859

JOB NO. FCT01 DATE 9/13/4

TOTAL DEPTH 79.0 feet

SURFACE ELEVATION 426.26

RIG TYPE ROTARY AND CORE RIG

TOP OF FILTER PACK 27.30

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 58209.29 E 64798.23

FORMATION OF COMPLETION CONQUISTA CLAY MEM.

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		open hole. below the casing, at 45.5 to 79 feet.		ML	Clayey Silt to Silty Clay, low plasticity, dark grey, sl. moist.
				CL	
60				CL	Shale, fissile, mod. soft, dk. grey.
65				CL	Silty Clay, mod. soft, mod. plast., dk. grey, moist.
70					
75					Lignite, mod. soft, dk brn.
				SP	Sandstone, fine, mod. hard, grey to brown.
80					
					TD AT 79 FEET
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 860

JOB NO. FCT01 DATE 91/3/13
SURFACE ELEVATION 419.99
TOP OF FILTER PACK 44.00
WELL CASING TYPE 4.0-IN. SCHED. 40 PVC
FORMATION OF COMPLETION CONQUISTA CLAY MEM.TOTAL DEPTH 83.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 58361.82 E 67690.24
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CL	SOIL Silty Clay, brn.
5		Placed steel casing to 5 feet		CH	DUBOSE MEM (?) Silty Clay, high plast. brn.
10		Placed grout seal from 0 to 8.5 feet		CH	DUBOSE MEM., WHITSETT FM. Silty Clay, highly weathered shale, high plasticity, tan.
15					Occasional gypsum frag. and limonite staining.
20				SP	DEWEESVILLE MEM. Sandstone, fine, soft, lt. tan. Limonite staining from 20.5 to 21.5. Occasional clay seams.
25				SP	Sandstone, very fine grained, cemented, mod. hard to hard, lt. tan
30				SP	Sandstone, fine, poorly indurated, soft, tan. Becoming very moist at 32 feet.
35					
40		Installed bentonite chips from 8.5 to 44 feet.		SC	TRANSITION ZONE: DEWEESVILLE TO CONQUISTA MEM's Clayey Sandstone, poorly indurated, soft, tan.
45					
50		Installed bentonite pellets from 44 to 55.8		CH	CONQUISTA CLAY MEM. Claystone, poorly indurated, soft, lt. grey.

GROUNDWATER

DEPTH	HOUR	DATE
32.0	17:30	3-12-91

JOB NO. FCT01 DATE 9/3/13
 SURFACE ELEVATION 419.99
 TOP OF FILTER PACK 44.00
 WELL CASING TYPE 4.0-IN.SCHED.40 PVC
 FORMATION OF COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 83.0 feet
 RIG TYPE ROTARY AND CORE RIG
 BORING TYPE ROTARY AIR
 LOCATION N 58361.82 E 67690.24
 DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		feet			
60					Small gypsum fragments at 60 feet. Oxidized tan zone at 60 feet.
65					
70		Installed .050 screen from 65 to 75 feet			Becoming harder at 70 feet. Trace shell fragments.
75					
80		Installed sandpack from 55.8 to 82.5 feet Sump placed @75 to 82 ft.			
85					TD AT 83 FEET
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
32.0	17:30	3-12-91

WATER

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 861

JOB NO. FCT01 DATE 9/12/3

TOTAL DEPTH 70.0 feet

SURFACE ELEVATION 414.61

RIG TYPE ROTARY AND CORE RIG

TOP OF FILTER PACK 40.50

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

LOCATION N 56466.90 E 65333.28

FORMATION OF COMPLETION CONQUISTA CLAY MEM., UPPER

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CL	SOIL Silty Clay, brn.
				SM	DEWEESVILLE SS. MEM. (?) Silty Sand, fine to med., lt. cemented, tan, moist.
5		Installed grouted steel casing to 4 feet			
10		Bentonite chips placed at 4 to 19 feet.			
15				CL	Sandy Clay, v. fine sand, mod. to high plasticity, lt. tan, moist.
20		Bentonite pellets placed at 19 to 40.5 feet.			
25				SC	DEWEESVILLE SS. MEM. (?) Sandstone, clayey, fine, soft, friable, lt. tan
30				CL	Some gypsum at 25 feet. CONQUISTA CLAY MEM. UPPER ZONE Silty Clay, high plasticity, dk, grey. Reduction zones indicated by red color.
35		Began drilling with water injection at 35 feet.			
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas
JOB NO. FCT01 DATE 9/2/3
SURFACE ELEVATION 414.61
TOP OF FILTER PACK 40.50
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION OF COMPLETION CONQUISTA CLAY MEM.,UPPER

LOG OF TEST BORING NO. 861
TOTAL DEPTH 70.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 56466.90 E 65333.28
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Installed sandpack from 40.5 to 59 feet			At 52 feet observed shell fragments. Possible marker of third Conquista fossiliferous sand member.
60		Installed .050 screen from 50 to 60 feet			
65		Placed bentonite chips from 59 to 65 feet Placed blank sump from 60 to 67 feet			
70		Placed bentonite pellets from 65 to 70 feet.			
75					TD AT 70 FEET. Possibly into Lower Conquista Zone.
80					
85					
90					
95					
100					

GROUNDWATER		
DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 862

JOB NO. FCT01 DATE 9/14/1TOTAL DEPTH 150.0 feetSURFACE ELEVATION 437.17RIG TYPE ROTARY AND CORE RIGTOP OF FILTER PACK 111.30BORING TYPE ROTARY AIRWELL CASING TYPE 4.0-IN.SCHED.40 PVCLOCATION N 58816.97 E 65415.51FORMATION OF COMPLETION DILLWORTH SANDSTONE MEM.DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CL	FILL Sandy Clay, w/ gravel.
5		Grouted steel casing installed to 5 feet		CH CH	SOIL Silty Clay, hi. plast. DEWEESVILLE MEM. Sandstone, poorly indurated, fine, soft, lt. tan.
10		Difficult drilling resulted in loss of first three holes attempted. Holes within 15 ft rad.			
15					Claystone seam at 14 to 16. Very hard sandstone lense at 16 to 18 feet. Occasional claystone lenses below 18 feet. Very moist from 22 feet. Below 20 feet the grain size is increasingly finer, with more silt.
20		Placed bentonite chips from 5 to 87 feet.			
25					
30					CONQUISTA CLAY MEM., UPPER Claystone, poorly indurated, some limonite staining,, very soft, lt. tan to brown.
35					Small amount of gypsum fragments.
40					
45				CL	Claystone, mod. indurated, soft, med. grey.
50					

GROUNDWATER

DEPTH	HOUR	DATE
22.0	14:40	4-1-91

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 862

JOB NO. FCT01 DATE 91/4/1
SURFACE ELEVATION 437.17
TOP OF FILTER PACK 111.30
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION OF COMPLETION DILLWORTH SANDSTONE MEM.

TOTAL DEPTH 150.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 58816.97 E 65415.51
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					Becoming sandier at 55 feet.
60					Below 60 feet fossiliferous to 65 feet.
65					Becoming harder with color changing to dark olive grey below 65 feet.
70					
75					
80					
85					
90		Bentonite pellets installed from 87 to 111.3 feet.			
95					
100					Lignite, some Claystone seams, soft, dark brown, mod. weathered.
				SP	DILLWORTH MEMBER Sandstone, very fine grained, mod. hard to soft, light greenish grey.

GROUNDWATER

DEPTH	HOUR	DATE
22.0	14:40	4-1-91

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 862

JOB NO. FCT01 DATE 9/14/1
SURFACE ELEVATION 437.17
TOP OF FILTER PACK 111.30
WELL CASING TYPE 4.0-IN.SCHED.40 PVC
FORMATION OF COMPLETION DILLWORTH SANDSTONE MEM.TOTAL DEPTH 150.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 58816.97 E 65415.51
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Water added at 105 feet to aid in drilling			
110					
115		Sandpack installed from 111.3 to 135			
120		Blank PVC casing installed to 120 feet			From 120 feet, with occasional thin hard sandstone seams.
125		Installed .050 screen at 120 to 130 feet			
130					
135		Blank sump installed from 130 to 137			
140		Bentonite chips installed from 135 to 141 feet. Caved material filled from 141 to 150 feet.			
145					
150					TD AT 150 FEET.
155					

GROUNDWATER

DEPTH	HOUR	DATE
22.0	14:40	4-1-91

PROJECT Falls City Site

Texas

LOG OF TEST BORING NO. 863

JOB NO. FCT01 DATE 9/13/3

TOTAL DEPTH 47.0 feet

SURFACE ELEVATION 416.05

RIG TYPE ROTARY AND CORE RIG

TOP OF FILTER PACK 31.70

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 37986.41 E 66138.58

FORMATION OF COMPLETION CONQUISTA CLAY MEM., LOWER

MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				SM	SOIL Silty Sand, brn.
				SM	DEWEESVILLE MEM.
					Silty Sand to Clayey Sand, very fine, yellow brown to dark red, moist, little gypsum frag.
					Cemented at 3.5 to 4.0 feet.
5		Grout to 3 feet			
		Placed steel case @ 5 ft.			
10					
15					
					Color change to dk. red at 11.5 feet
20					
		bentonite chips placed from 3 to 16.3 feet		CH	Sand, fine, soft, red. brown, moist.
25					
		water encountered at 21 feet			
30					
		bentonite pellets placed from 16.3 to 31.7			
35				SM	CONQUISTA SAND MEMBER
					Silty Sand, fine, soft, dk. red; increased water flow at 32 feet.
40				CL	CONQUISTA CLAY MEM., LOWER.
		Installed .050 screen from 35 to 45 feet.			Silty Clay, mod. to low plasticity, with fine sand, dark grey.
45					
		Sandpack installed from 31.7 to 42			
		Pellets placed from 42 to 47 feet			
		Blank sump placed at 45 to 47 feet			
50					TD AT 47 FEET

GROUNDWATER

DEPTH	MOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 864

JOB NO. FCT01 DATE 91/3/4

SURFACE ELEVATION 416.07

TOP OF FILTER PACK 75.00

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

FORMATION OF COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 107.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 58028.61 E 67276.16

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CL	SOIL: Silty Clay, black.
5		grouted top 2 feet		CL	DUBOSE MEMBER (?): Sandy Clay, fine, oxidized to reddish tan.
10					
15		Installed 8-in. steel surface casing to 15 feet.			
20		Installed bentonite chips from 2 to 25 feet			
25		Installed bentonite pellets from 25 to 75 feet in annulus		SP	DEWEESVILLE MEM.: Sandstone, med. to fine, very soft, tan to lt. tan.
30					
35					
40					
45				CL	CONQUISTA CLAY MEM.: Siltstone to claystone, mod. to weakly indurated, thin bedded, soft, greenish grey. Some gypsum fragments present.
50					

GROUNDWATER

DEPTH	HOUR	DATE
32.0	15:45	3-4-91

PROJECT Falls City Site

Texas

LOG OF TEST BORING NO. 864

JOB NO. FCT01

DATE 91/3/4

TOTAL DEPTH 107.0 feet

SURFACE ELEVATION 416.07

RIG TYPE ROTARY AND CORE RIG

TOP OF FILTER PACK 75.00

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 58028.61 E 67276.16

FORMATION OF COMPLETION CONQUISTA CLAY MEM.

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					
75					
80					
85					
90		Installed blank PVC casing to 90 feet			
95		Installed sandpack from 75 to 98 feet			
100		Installed .05. screen from 100 to 90 feet			
		Placed pellets, 98 to 103.			
					Middle sand facies not encountered.
					Lignite, soft, dark brown.

GROUNDWATER

DEPTH	HOUR	DATE
32.0	15:45	3-4-91

PROJECT Falls City Site
Texas

Page 3 of 3

LOG OF TEST BORING NO. 864

JOB NO. FCT01 DATE 91/3/4

SURFACE ELEVATION 416.07

TOP OF FILTER PACK 75.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

FORMATION OF COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 107.0 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 38028.61 E 67276.16

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Installed blank sump from 107 to 100 feet		SP	DILWORTH MEM.: Sandstone, fine, mod. hard, light greenish grey. TD AT 107 FEET.
110					
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
32.0	15:45	3-4-91

JOB NO. FCT01 DATE 9/13/31
SURFACE ELEVATION 414.96
TOP OF FILTER PACK 26.00
WELL CASING TYPE 4.0-IN. SCHED. 40 PVC
FORMATION OF COMPLETION CONQUISTA CLAY MEM.

TOTAL DEPTH 60.0 feet
RIG TYPE ROTARY AND CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 55659.62 E 64803.20
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CH	SOIL: Silty Clay, brn.
				SP	DEWEESVILLE MEM.: Sandstone, mod. to poorly indurated, soft, occ. thin hard layers, tan. Occ. oxidized staining
5		Installed steel casing to 5 feet Grout placed to 6 feet			
10					
15				CL	TRANSITION ZONE: DEWEESVILLE TO CONQUISTA: Silty Claystone, soft, lt. tan.
				CL	CONQUISTA CLAY MEM., UPPER: Silty Claystone, with oxidized staining, soft, tan, some gypsum fragments.
20					
25		Bentonite chips placed from 6 to 21 feet			
		Bentonite pellets placed from 21 to 26 feet.			
30				CL	Claystone, very soft to soft, med. grey.
35		Blank PVC casing installed to 35 feet			H2S odor at 34 feet. Considerable fossils from 35 to 40 feet.
40		Installed .050 screen from 35 to 45 feet			Hard thin, sandstone lense at 40 feet.
45		Installed sandpack from 26 to 46 feet			
50		Installed blank sump from 45 to 52 feet			No fossils below 50 feet.

GROUNDWATER

DEPTH	MOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 865

JOB NO. FCT01 DATE 91/3/31

TOTAL DEPTH **60.0 feet**

SURFACE ELEVATION 414.96

RIG TYPE ROTARY AND CORE RIG

TOP OF FILTER PACK	26.00

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

LOCATION N 55659.62 E 64803.20

FORMATION of COMPLETION CONQUISTA CLAY MEM.

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Installed bentonite pellets from 46 to 60 feet			Very thin sandstone lens at 54 feet.
60					TD AT 60 FEET
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 866

JOB NO. FCT01 DATE 91/5/23SURFACE ELEVATION 406.96TOTAL DEPTH 124.2 feetRIG TYPE ROTARY AND CORE RIGTOP OF FILTER PACK 108.00BORING TYPE ROTARY AIRWELL CASING TYPE 4-IN SCHED 40 PVCLOCATION N 57630.75 E 65174.90FORMATION OF COMPLETION DILWORTH MEM.DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				SC	SOIL: Clayey Sand, fine, tan. Possibly tailings or fill.
5		Installed 4-in. well			
		installed grouted steel casing to 5 feet.		CH	TRANSITION ZONE: DEWEESVILLE TO CONQUISTA MEM.:
10		Installed bentonite chips from 5 to 21 feet		CL	Silty clay, high plasticity, lt. tan.
15					CONQUISTA CLAY MEM.: Claystone, poorly indurated, some oxidized staining, very soft, tan.
20		Switched from air circulation to bentonite mud rotary at 20 feet			
25		Placed heavy bentonite slurry seal from 21 to 106 feet			
30					
35					Becoming more sandy at 33 feet.
40				SC	MIDDLE ZONE ?, CONQUISTA CLAY: Clayey sandstone, very fine grained, very soft, some oxidized staining, tan.
45		Added polymer, "Fluid Drill", to mud at 42 feet.			Occasional hard sandstone seam.
50					

GROUNDWATER

DEPTH	HOUR	DATE

11/1/23

LOG OF TEST BORING NO. 866

JOB NO. FCT01 DATE 91/5/23

SURFACE ELEVATION 406.96

TOP OF FILTER PACK 108.00

WELL CASING TYPE 4-IN SCHED 40 PVC

FORMATION OF COMPLETION DILWORTH MEM.

TOTAL DEPTH 124.2 feet

RIG TYPE ROTARY AND CORE RIG

BORING TYPE ROTARY AIR

LOCATION N 57630.75 E 65174.90

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Allowed slurry to settle overnite before topping off at 21 feet			Occasional lignite seam from 51 feet.
60				SP CL	Sandstone intercalated with Claystone, poorly indurated, soft to very soft, trace lignite seams, tan. Possible transition from lower to upper Conquista Mem.
65				CH	LOWER CONQUISTA CLAY MEM.: Claystone, massive, soft, med. grey.
70					
75					
80					
85					
90					
95				SP	DILWORTH MEMBER: Sandstone, fine, soft to mod. hard, lt. greenish grey.
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 866

JOB NO. FCT01 DATE 91/5/23SURFACE ELEVATION 406.96TOTAL DEPTH 124.2 feetRIG TYPE ROTARY AND CORE RIGTOP OF FILTER PACK 108.00BORING TYPE ROTARY AIRWELL CASING TYPE 4-IN SCHED 40 PVCLOCATION N 57630.75 E 65174.90FORMATION OF COMPLETION DILWORTH MEM.DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					(continued)
110		Placed bentonite pellet seal from 108 to 106 feet.			
115		Installed sandpack from 122 to 108 feet			
120		Installed blank PVC casing from 0 to 117 feet			
		Installed .050 screen from 117.2 to 122.2 feet.			
125		Installed blank sump from 122.2 to 124.2s			TD AT 124.2 FEET
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 867

JOB NO. FCT01 DATE 9/5/25TOTAL DEPTH 168.0 feetSURFACE ELEVATION 427.19RIG TYPE ROTARY /CORE RIGTOP OF FILTER PACK 45.50BORING TYPE ROTARY AIRWELL CASING TYPE 4.0-IN SCHED 40 PVCLOCATION N 56471.97 E 67450.59FORMATION OF COMPLETION DEWEESVILLE MEM.DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CH	SOIL: Silty Clay, black.
5		Installed grouted steel surface casing to 5.0 feet.		CL	DUBOSE MEM. Silty Claystone, poorly indurated, very soft, lt. tan to lt. grey, occasional limonite staining on partings. Occasional thin gypsum seam.
10		Placed bentonite chips from 5 to 36 feet.			
15					
20					
25					
30				CL	Claystone, soft, lt. greenish grey, occasional very fine gypsum seam.
35					
40		Placed bentonite pellets from 36 to 45.5 feet.			
45		Installed No.8-12 sandpack from 45.5 to 64.5 feet		SP	Lignite, soft, dark brown to black. DEWEESVILLE MEM.: Sandstone, poorly indurated, fine, soft, lt. greenish grey.
50					

GROUNDWATER

DEPTH	HOUR	DATE
168		

PROJECT Falls City Site
Texas

LOG OF TEST BORING NO. 867

JOB NO. FCT01 DATE 9/15/25
SURFACE ELEVATION 427.19
TOP OF FILTER PACK 45.50
WELL CASING TYPE 4.0-IN SCHED 40 PVC
FORMATION OF COMPLETION DEWEESVILLE MEM.

TOTAL DEPTH 168.0 feet
RIG TYPE ROTARY /CORE RIG
BORING TYPE ROTARY AIR
LOCATION N 56471.97 E 67450.59
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Installed .050 slot screen from 53 to 63.			From 52 feet encountered moderately hard to hard zones.
60					
65		Placed 2-ft. sump from 63 to 65.			TD AT 65 FEET.
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.

DATE COMPL. 91/2/12

RIG TYPE ROTARY AND CORE RIG

METHOD PUNCH CORE & SPOON

CORE SIZE, IN. 4.0

GRID COORD. N / E N60839.5 E66253.0

SURFACE ELEV. FT. 444.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	NONE	FRACTURES ANGLE, DEG. HIDE, 28 IN. MOD. 5-28 IN. CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	METHOD	PUNCH CORE & SPOON	
									CORE SIZE, IN.	4.0	
									GRID COORD. N / E	N60839.5 E66253.0	
									SURFACE ELEV. FT.	444.8	
									REMARKS	STRATIGRAPHIC DESCRIPTION	
0								SC	Continuous samples taken by grab samples (GB) from rotary, split spoon (SP), Punch Core (PC), or HX core bit (HX).	SOIL: Clayey Sand, med. to fine, mod. plast. brn, moist.	
5											
10	PC 35	0						SC			DEWEESVILLE MEM. Clayey Sand; interbedded with Sandstone, fine, mod. soft, lt. grey to lt. green.
15	SP 58	0									Clayey Sand, fine, soft, slightly plastic, lt. greyish green.
20	PC 100	48						SC	Water injection used from 14 to TD.		
25											
30	PC 96	40									
35											
40	PC 40	0									
45											
50	PC 63	48						CH	The hole was plugged using bentonite chips from 117 to 3 feet. Placed grout from 0 to 3 feet.	CONQUISTA CLAY MEM., UPPER: Sandy Clay, laminated, thin seams oxidized stain, soft, mod. to high plasticity, lt. brn.	
55											
60	PC 85	50						CH			Clay, massive, occasional Shale laminations, iron oxide stains on partings, soft, grey.
65	PC 100	84									Gypsum deposits in bedding planes from 34 to 39.
70											
75	PC 100	60									
80											
85	PC 100	94									Organic material on plane at 42 feet.
90											
95	PC 100	86									
100											

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.
DATE COMPL. 91/2/12
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE, IN. 4.0
GRID COORD. N / E N60839.5 E66253.0
SURFACE ELEV. FT. 444.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG.	SLIDE, IN.	HOLES, IN.	CLOSE, IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	PC 188	88										(continued)
60	PC 44	0								CL		Clay/ Clay Shale, shell frag. mod. soft, grey.
65	PC 100	100								CL		CONQUISTA MEM; LOWER: Clay/ Clay Shale, massive, to laminated, slightly carboniferous at occ. intervals, mod. soft, grey.
70	PC 100	52										
75	PC 100	98								CL		Claystone, silty, massive to laminated, mod. indurated, mod. hard, grey.
80	PC 100	90										
85	PC 90	84										
90	PC 100	100										
95	PC 92	92										Fossiliferous from 90.3 to 91.
100	PC 100	87										Lignite, highly carbonaceous, mod. soft, dk. brn. to black.
100	PC 77	70								SC		DILWORTH SANDSTONE MEM. Clayey Sandstone, fine, medium bedded, mod. soft, friable, greyish green.

GROUNDWATER

DEPTH	HOUR	DATE

WATER

PROJECT Falls City Site Texas ;UMTRA
 JOB NO. FCT01

LOG OF CORE HOLE NO. 91/2/12
 DATE COMPL. 91/2/12
 RIG TYPE ROTARY AND CORE RIG
 METHOD PUNCH CORE & SPOON
 CORE SIZE, IN. 4.0
 GRID COORD. N / E N60839.5 E66253.0
 SURFACE ELEV. FT. 444.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES	GRAPHICAL LOG	LITHOLOGY	SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	PC 95	92								(continued)
110	PC 98	93								
115	PC 100	88								
120										TD AT 117 FEET.
125										
130										
135										
140										
145										
150										
155										

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT

Falls City Site Texas

;UMTRA

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869

JOB NO.

FCT01

LOG OF CORE HOLE NO.

DATE COMPL.

91/12/15

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH-CORE & SPOON

CORE SIZE, IN.

4.0

GRID COORD. N / E

N61668.9 E64537.9

SURFACE ELEV. FT.

468.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP	100					CL		FILL: Silty Clay, dk. brn.
5							SC	Continuous sampling with split spoon, Punch Core, and HX core bit.	TAILINGS: Sandy Clay to Clayey Sand, fine sand, mod. to high plast. grey to green, v. moist to wet.
10	PC	0							
	PC	0							
	PC	75					SC		Clayey Sand (slimes?), very loose , slightly plastic, grey, very moist to wet.
	PC	50							
	PC	100							
15	PC	48						Began using water injection at 47 feet.	
	PC	100							
20	PC	100						The hole was plugged using bentonite pellets and chips.	
	PC	100							
	PC	100							
25	PC	100							
30	PC	0							
	PC	75							
	PC	75							
35	PC	100							
	PC	100					CH		SOIL: Sandy Clay to Clayey Sand, fine, high plasticity, yellow brown, moist to wet.
40	PC	100							
	PC	100							
	PC	100							
45	PC	100							
	PC	70							
	HX	60							
50	HX	100					SP		DEWEESVILLE MEM.: Sandstone, fine, mod. to thin bedded, mod. soft, oxidized, lt. red/ tan.
	HX	74							

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
 JOB NO. FCT01

LOG OF CORE HOLE NO.
 DATE COMPL. 91/12/15
 RIG TYPE ROTARY AND CORE RIG
 METHOD PUNCH-CORE & SPOON
 CORE SIZE, IN. 4.0
 GRID COORD. N / E N61668.9 E64537.9
 SURFACE ELEV. FT. 468.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	NO. OF FRACTURES	ANGLE, DEG.	TYPE, IN.	MOD. IN.	CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	EX	100	60								CL		Claystone, massive, mod. soft, greyish green.
	EX	100	88										
110													
	EX	100	90										
115													
	EX	50	36								SP ML		LOWER DILWORTH MEM. Sandstone, fine carbonaceous, friable, greyish green; interbedded with Siltstone, grey to green; and minor Claystone, grey green. Vugs and burrows present throughout.
120													
	EX	80	0										
125													
	EX	100	0										TD AT 127 FEET.
130													
135													
140													
145													
150													
155													

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

Page 1 of 3 870

LOG OF CORE HOLE NO.
DATE COMPL. 91/2/20
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE, IN. 4
GRID COORD. N / E N60494.5 E63340.0
SURFACE ELEV. FT. 473.2

DEPTH IN FEET	PC SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. HIDE > 28 IN HIDE 5-28 IN HIDE < 5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
5	PC 80						ML	Corehole decommissioned as follows:	SOIL Clayey Silt, dk. brn.
	PC 70								
	PC 72								
	PC 80						SC	Placed bentonite pellets from 110 to 71 feet	DEWEESVILLE MEM. Clayey Sand, very fine, ltgrn.
	PC 80						CL	The formation caved from 71 to 59 feet.	Clay, little sand, med. plasticity, iron staining on partings, lt. tan to yellow, moist.
10	PC 100							Bentonite pellets installed from 59 to 40 feet.	Occ. zones of Sandy Clay.
	PC 100							the formation caved at 40 to 29 feet.	
15	PC 97	83					CH	Bentonite chips installed from 29 TO 4 feet.	Clay/Claystone, high plasticity, massive, mod. soft., lt. yellow to grey, iron staining on partings surfaces.
	PC 98	58						grout placed from 0 to 4 feet	
20									
	PC 30	0							
25									
	PC 75	0							
30	HX 100	25					SP CL	Continuous samples taken with split spoon, Punch	MIDDLE CONQUISTA CLAY MEM.: Sandstone, fine, interbedded with Sandy Claystone.
	HX 80							Core, and HX core.	Sand, fine grained, soft, tan.
	PC 80						SP		
35									
40	HX 70								
	HX 70						SP CL		Sandstone, fine, medium bedded, mod. soft, to mod. hard, tan, iron stains on partings, filled burrows/vugs present:
45	PC 73	40							interbedded with Claystone, thin bedded, mod. soft., lt. tan, with iron stain partings.
	PC 73	40							
50	PC 43	43					CH		LOWER CONQUISTA CLAY MEM Clay/Claystone, high plasticity,

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

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LOG OF CORE HOLE NO.
DATE COMPL. 91/2/20
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE, IN. 4
GRID COORD. N / E N60494.5 E63340.0
SURFACE ELEV. FT. 473.2

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE	ANGLE, DEG.	LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	PC 100	100								massive, indurated, mod. hard, iron stains on partings, lt. grey.
	PC 100	50								Clayey Sand lens encountered at 56 to 57 feet.
60	PC 100	86								
65	PC 100	76								Encountered gypsum filled fracture (50 deg.) at 66 feet. No iron staining observed below 67 feet.
70	PC 70	59								Lignite lens at 67.5 to 68.5 feet.
75	MX 100	95								
80	MX 96	92								
85	MX 100	80								Increasing carbonaceous and shaley from 85 feet.
90	MX 100	92								Lignite (marker bed), shaley to thin bedded, mod. hard, dk. brn.
95	MX 70	30						SC		DILWORTH MEM. Clayey Sandstone, fine, carbonaceous, thin bedded, thin clayey lamina present, mod. soft, with fossil burrows, greyish green.
								SP CL		Claystone, thin bedded, med. plast., greyish green.
100	MX 84	52						CL		interbedded with Sandstone, fine thin bedded, mod. hard, green.
										Claystone, massive, mod. hard, greyish green.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.
DATE COMPL. 91/2/20
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH CORE & SPOON
CORE SIZE, IN. 4
GRID COORD. N / E N60494.5 E63340.0
SURFACE ELEV. FT. 473.2

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	NONE	ANGLE, DEG.	TIME, >20 IN	TIME, 5-20 IN	CLOSE <5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	100	76											
110													(Continued)
115													TD AT 110 FEET.
120													
125													
130													
135													
140													
145													
150													
155													

GROUNDWATER

DEPTH	HOUR	DATE

JOB NO.

FCT01

DATE COMPL.

91/3/18

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, CORE & SPOON

CORE SIZE, IN.

4.0

GRID COORD. N / E

N58672.1 E68073.8

SURFACE ELEV. FT.

421.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. LINE, >20 IN MOD. 5-20 IN CLOSE <5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP 55						CH		SOIL Silty Clay, hi. plast., black.
5	SP 61						CH	All samples retained by State of Texas.	DUBOSE MEM. OF WHITSETT FM. Silty Clay, high plasticity, very soft, light tan, with small gypsum fragments and some iron staining along partings. Small sandstone concretions from 6 to 8 feet
	SP 78							used Punch Core, split spoon and hx core to sample.	
	SP 91								
10	PC 100	20						Plugged hole with bentonite chips and pellets.	V. thin gypsum seam at 14 feet. Occasional silty and fine sandy seams with considerable iron oxide staining
	PC 100	55							
15	PC 100	89							
20	PC 100	75					SC		DUBOSE / DEWEESVILLE TRANSITION ZONE Clayey Sand, fine, limonite stains, lt. tan.
	PC 99	0					SP		DEWEESVILLE MEM. Sandstone, fine, soft, lt. tan; with occ. thin seams of Sandy Clay, med plast. lt. brn.
25	PC 100	0						Began water injection w/air at 24.5 feet	Clayey Silt, with fine sand, some lignite, dk brn.
	PC 40	0					ML		
	PC 50	50							
	PC 100	100							
30	PC 27	0					SP		Sandstone, fine, mod. indurated, soft, brown to lt. grey. Occasional thin lenses of claystone, some zones with iron staining. Becoming moderately hard at 32.5 feet.
	PC 35	0							
	PC 30	0							
35	HX 100	90							
	HX 96	92							
	HX 5	0					SP		Sandstone, fine, thinly bedded, soft, lt. grey.
40									
	HX 17	0					SP		DEWEESVILLE / CONQUISTA TRANSITION ZONE Intercalated Sandstone, and Claystone, some lignite, very soft, to lt. tan
45	HX 10	0					CL		
	PC 85	25							
50	PC 72	0					ML		CONQUISTA CLAY MEM. Siltstone, some fine sand, very soft, lt. tan

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT

Falls City Site Texas

;UMTRA

LOG OF CORE HOLE NO.

JOB NO.

FCT01

DATE COMPL.

91/3/18

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, CORE & SPOON

CORE SIZE, IN.

4.0

GRID COORD. N / E

N58672.1 E68073.8

SURFACE ELEV. FT.

421.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. HIDE > 20 IN HIDE 15-20 IN HIDE 10-15 IN CLOSE < 5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	PC 87	83					CL		Silty Claystone, w/ gypsum and iron stain.
	EX 93	50					CL		Claystone, massive, fresh, thin bedded, soft, grey; Some carbonaceous fragments on bedding planes.
60	EX 44	11							
	EX 67	40							
65	EX 100	100							
	EX 100	100							
70									
	EX 96	96							
75									
	EX 100	52					CL		Claystone, thin bedded, with fossil shell frag.
80							CL		Claystone, fresh, thin bedded, occ. fine sandy lenses, soft, lt. grey. Thin fossil zone at 82.5 With black carbonaceous partings from 83 feet.
	EX 95	86							
85									
	EX 100	94							
90									Encountered thin silty stratum from 90 to 91.5 feet
	EX 100	90							
95									
	EX 100	100							
100									From 100 feet observed occasional thin lignite parting.
	EX 97	97							

GROUNDWATER

DEPTH HOUR DATE

10/1/18

PROJECT

Falls City Site Texas

;UMTRA

LOG OF CORE HOLE NO.

JOB NO.

FCT01

DATE COMPL.

91/3/18

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, CORE & SPOON

CORE SIZE, IN.

4.0

GRID COORD. N / E

N58672.1 E68073.8

SURFACE ELEV. FT.

421.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. HIDE > 20 IN HIDE 5-20 IN CLOSE < 5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105									Scattered occurrences of shell fossil frag. from 105 to 111 feet.
	EX 100	76							Observed compaction slickenside at 108 feet.
110									Lignite, very soft, brown to dk. brown with thin claystone seams.
	EX 96	88							DILWORTH MEM.
115							SP		Sandstone, fine, fresh, massive, mod. hard, lt. greenish grey. Thin bedded from 118 feet.
	EX 75	52							
120									
	EX 33	16							
125							ML CL		Intercalated Siltstone and Sandy claystone, soft to moderately hard, lt. grey.
	EX 68	30							
	EX 100	60							
130									TD AT 130 FEET
135									
140									
145									
150									
155									

GROUNDWATER

DEPTH	HOUR	DATE

4442

PROJECT Falls City Site Texas ;UMTRA

JOB NO. FCT01

LOG OF CORE HOLE NO.

DATE COMPL. 91/3/30

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, CORE, & SPOON

CORE SIZE, IN.

4.0

GRID COORD. N / E

N55630.2 E64917.2

SURFACE ELEV. FT.

419.9

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. JUNE 28 IN MOD. 5-28 IN CLOSE 5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP 87						CH SP		SOIL Silty clay, fine, brn.
5	SP 100							Sampled using Punch Core, Spoon, core barrel, and grab samples.	DEWEESVILLE MEM. Sandstone, fine, mod. hard, lt. tan. Becoming soft at 5.0 feet.
10	PC 100								
10	PC 100								
10	PC 88								
15	PC 75							Plugged hole with bentonite pellets and chips.	From 10 feet observed some iron staining and small amount of gypsum frag.
15	PC 90								
20	PC 85								
20	PC 100								
20	PC 100						SP CL	Began using air/mist at 20.75 feet	DEWEESVILLE / CONQUISTA TRANSITION ZONE Interbed. Sandstone/ Claystone.
25	PC 83 53						CL		CONQUISTA CLAY MEM. Claystone, very thinly bedded, some iron staining, soft, v. lt. tan to grey Occasional thin gypsum seam and carbonaceous partings.
25	PC 80 50								
30	EX 100 0								
30	EX 80 0								
35	EX 100 60								
35	EX 95 0								
40	EX 67 33								
40	EX 100 40								
45	EX 100 100						CL		Claystone, some silt, soft, grey.
45	EX 98 87								
50	EX 100 93								Encountered hard sandstone seam at 42.7 to 43.0 feet.
50	EX 96 66								Considerable fossil shells from 47 feet.
50	EX 100 75								V. thin hard sandstone lens at 51.7 feet. End of fossils.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
 JOB NO. FCT01

LOG OF CORE HOLE NO.
 DATE COMPL. 91/3/30
 RIG TYPE ROTARY AND CORE RIG
 METHOD PUNCH, CORE, & SPOON
 CORE SIZE, IN. 4.0
 GRID COORD. N / E N55630.2 E64917.2
 SURFACE ELEV. FT. 419.9

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE	ANGLE, DEG.	SIZE, IN.	MOD.	CLOSE	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	HX 91	64									CL		Sandy Claystone, laminated, soft, lt. grey. Becoming less sandy from 55 feet.
60	HX 98	98											
65	HX 100	100											Becoming harder below 65 feet.
70	HX 100	100											
75	HX 97	97									CL		Claystone, greenish grey, with scattered fossil frag.
80	HX 97	67											
	HX 94	69											Lignite, laminated, very soft, dk. brn. to black. Odor of H2S.
85	HX 90	50									ML SP		DILWORTH MEM. Siltstone. Sandstone, very fine, mod. bedded, fresh, mod. hard, lt. grey Becoming finer grained at 86 ft.
90	HX 62	8											
	PC 100	35											
95	PC 65	0											
	HX 90	0									SP		Sandstone, laminated, mod. hard, grey.
	HX 100	35											
100													TD AT 100 FEET.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.
DATE COMPL. 91/4/26
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE, IN. 4.0
GRID COORD. N / E N60405.2 E65278.0
SURFACE ELEV. FT. 456.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY	DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. WIDE > 20 IN MOD. 5-20 IN CLOSE < 5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
5	SP 68							CH		SOIL Silty Clay, high plast. black.
	SP 78							CL	Continuous samples taken by grab samples, Punch Core, Spoon or, HX core barrel.	DEWEESVILLE MEM Sandy Claystone, some iron staining on partings, very, soft, lt. tan.
	PC 100									
	PC 100									
10	PC 92								Hole plugged with bentonite pellets and chips.	Occasional thin seam of gypsum.
	PC 90									
	PC 100									
15	PC 100									
20	PC 100									
	HX 96							CL ML		UPPER CONQUISTA CLAY MEM. Intercalated Claystone and Siltstone, laminated, soft, occ. thin gypsum seam, tan to lt. brown.
25	HX 78									
30	HX 62									
35	HX 82							CL		Claystone, massive, soft, medium grey.
40	HX 77	75								
45	HX 100	94								
50	HX 100	100								

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT

Falls City Site Texas

;UMTRA

LOG OF CORE HOLE NO.

JOB NO.

FCT01

DATE COMPL.

91/4/26

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, SPOON & CORE

CORE SIZE, IN.

4.0

GRID COORD. N / E

N60405.2 E65278.0

SURFACE ELEV. FT.

456.5

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES ANGLE, DEG.	HIDE, IN.	MOD. 5-20 IN.	CLOSE < 5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	EX 91	26								CL		Sandy Claystone, massive, considerable fossil shell frag., very soft, med. grey.
												Fossils becoming less frequent at 56.5 feet
60	EX 20	0								SP		CONQUISTA CLAY MEM. SAND UNIT:
	PC 80	0										Sandstone, very fine, very soft, greenish grey.
	PC 100	0										
65	PC 27											
	PC 85	23								CL		LOWER CONQUISTA CLAY MEM.:
70	EX 100	50										Claystone, soft, greenish grey.
	EX 92	83										Small amount of fossils at 67 and 69 feet. Hard Sandstone layer at 69.5 to 70 feet.
75												TD AT 75 FEET
80												
85												
90												
95												
100												

GROUNDWATER

DEPTH HOUR DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.
DATE COMPL. 91/5/9
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE, IN. 4.0
GRID COORD. N / E N58062.5 E68789.1
SURFACE ELEV. FT. 441.1

DEPTH IN FEET	SAMPLE NO.	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. HIDE, >20 IN MOD. 5-20 IN CLOSE <5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP 60						CH		SOIL: Silty Clay, high plast. dk. grey. (cultivated area)
5	SP 51						CH	Sampled continuously with Punch core, Spoon,	
	SP 80						CH	HX core, or grab sample.	DURABLE MERM.: Silty Clay, some iron staining on partings, high plast., lt. tan
	PC 100						ML		Clayey Silt, with organic matter, occ. oxidized zone, med. plast., dk. brn.
10	PC 100						ML	Hole plugged using bentonite pellets and chips.	Clayey Silt, laminated, with iron staining, med. to high plasticity, lt. tan.
	PC 100								
15	PC 100								
	PC 100								
20	PC 100								
	PC 30						CH		Silty clay, iron stain on partings, lt. tan.
	PC 10								
25	PC 90								
	PC 100								
	PC 100								
30	PC 100								
	PC 100								
	PC 100								
35	PC 100								
	PC 100								
40	PC 67								
	PC 100	90					CL		Claystone, thinly bedded, some iron staining, soft, lt. greyish tan to dark yellowish brown.
45	PC 100	98							
	PC 100								
50	PC 100	80							Occasional thin gypsum seam from 50 feet.

GROUNDWATER

DEPTH	HOUR	DATE

91/5/9

DATE COMPL.

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, SPOON & CORE

CORE SIZE,IN.

4.0

GRID COORD. N / E

N58062.5 E68789.1

SURFACE ELEV. FT.

441.1

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.

DATE COMPL.

91/5/9

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, SPOON & CORE

CORE SIZE, IN.

4.0

GRID COORD. N / E

N58062.5 E68789.1

SURFACE ELEV. FT.

441.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. JULIE, 28 IN MOD. 5-28 IN CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	EX 100	70							fresh, soft, variable color lt. olive to dk. olive grey.
110	EX 98	98					CL		Sandy Claystone,, slightly fractured, fresh, soft, lt. olive grey.
115	EX 83	38					CL		Claystone, massive, slightly fractured, mod. hard, lt greyish green to dk. olive grey.
	EX 77	74							
120	EX 93	82							
	EX 85	80					CL		Sandy Claystone, some shell fossils, mod fractured, very soft, lt. olive grey.
125									.M = CL
	EX 92	86							Claystone, fresh, slightly fractured, massive, mod. hard, dk. olive grey.
130									
	EX 100	100							
135									
	EX 100	100							
140	EX 88	88							
									Thin lignite seam at 143 feet
145	EX 100	95							
	EX 100	100							Slightly fossiliferous from 148 feet.
150									
	EX 100	100					CL		
155									Claystone, considerable lignite, slightly fract.

GROUNDWATER

DEPTH	HOUR	DATE

444

PROJECT Falls City Site Texas ;UMTRA
 JOB NO. FCT01

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LOG OF CORE HOLE NO.

DATE COMPL.

91/5/9

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, SPOON & CORE

CORE SIZE, IN.

4.0

GRID COORD. N / E

N58062.5 E68789.1

SURFACE ELEV. FT.

441.1

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG.	HIDE, IN. >28 IN. 300.3-28 IN. CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
155	EX 100	100						SP		DILWORTH MEM.: Sandstone, fine, massive, soft, lt. greenish grey. With coaly frag. and partings to 158.5 feet.
160	EX 32	32								
165	EX 0	0								
170										
175										TD AT 167 FEET
180										
185										
190										
195										
200										
205										

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.
DATE COMPL. 91/5/12
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE, IN. 4.0
GRID COORD. N / E N62305.0 E64184.3
SURFACE ELEV. FT. 445.6

DEPTH IN FEET	SAMPLE NO.	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE	ANGLE, DEG.	TYPE, IN.	MOD. 5-20 IN.	CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	49										CH		SOIL: Silty Clay, high plasticity, black.
5	87										CL	Continuous sampling using Punch Core, spoon, HX core barrel, or rotary cuttings.	Sandy Clay, oxid. staining.
	75										SC		MIDDLE, CONQUISTA CLAY
	100	30											MEM: Clayey Sandstone, soft, with thin clay lenses, lt. tan.
	40	0									LS		Limestone, mod. close
10	100										SC		fract. manganese coating on fract
												The hole was plugged using bentonite pellets or chips.	Clayey Sandstone, very soft, with limonite staining, lt. greyish tan to tan.
15	100												Becoming moist at 16 feet.
	74	0									CL	Changed from air to air/mist circulation at 16 ft.	Sandstone, soft to mod. hard, mod. to thin bedded, mod. to closely fractured, lt. greyish tan.
20	58	0											LOWER, CONQUISTA CLAY MEM.:
													Silty Claystone, highly oxidized, very soft, lt. tan.
25	100												Occasional zone of gypsum fragments.
													Mineralization becoming more reduced from 25 feet.
30	100												Claystone, thinly bedded, mod. closely fractured, soft, dk. tan.
	100	65									CL		Occasional thin gypsum seams, and limonite staining on partings.
35	100	70											End of oxidation zone at 36 feet.
													Becoming olive grey. Thin gypsum and lignite seams at 35 feet.
	80	72											Occasional carbonaceous partings.
40													
	45	30									CL		
45													Claystone, massive, fresh, mod. hard to soft, olive grey.
	100	100											
	64	56											
50	100	100											

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 91/5/12
DATE COMPL. 91/5/12
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE, IN. 4.0
GRID COORD. N / E N62305.0 E64184.3
SURFACE ELEV. FT. 445.6

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. HIDE, 20 IN HIDE, 5-20 IN HIDE, <5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	EX 100	100							
60	EX 92	88							
65	EX 97	75							
70	EX 72	48					SP		
75	EX 21	10							
80	EX 85	22							
85	EX 90	69					CL		
90	EX 100	100							
95	EX 48	32							
100	EX 8	0					SP		
	EX 42	0							
	EX 0	0							
	EX 0	0							
	EX 0	0							
	EX 18	0					SP CL		

Lignite, soft, dark brown to black. Occasional seam of bentonitic clay.

DILWORTH MEM.:
Sandstone, fine, wide spaced fractures, fresh, soft to mod. hard, lt. greenish grey.

Claystone, v. thinly bedded, mod. spaced fractures parallel to bedding, soft, lt. olive grey. Occasional thin sandstone lenses.

Sandstone, fine, soft to mod. hard, lt. greenish grey. Occasional coaly frag. Occasional thin claystone seams.

Intercalated Sandstone and Claystone: moderately spaced

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.

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DATE COMPL. 91/5/12

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, SPOON & CORE

CORE SIZE, IN.

4.0

GRID COORD. N / E

N62305.0 E64184.3

SURFACE ELEV. FT.

445.6

DEPTH IN FEET	SAMPLE % CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES ANGLE, DEG. HIDE, >28 IN HIDE, 2-28 IN HIDE, <2 IN CLOSE <5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105	45	25				CL		fractures, soft, lt. greenish grey to dark olive grey.
110	95	40				CL		Claystone, thickly bedded to laminated, soft to v. soft, dark olive grey. Occasional thin seam of Clayey Sandstone.
115	55	0				SC		Clayey Sandstone, very fine, soft, lt. greenish grey.
120	0	0						
125	67	33						
130	47	12						Less clay content from 117 feet.
135	47	0						
140	17	0						
145	77	0				CL		
150	69	58				SP		Sandy Claystone, thinly bedded to massive, widely spaced fractures, soft, olive grey. Occasional coaly fragment.
155	100	100				CL		Sandstone, fine, soft, widely spaced fractures, some carbonaceous partings olive grey.
160	91	91				CL		Claystone, massive, soft, dark olive grey. Occasional sandy seam.
165	100	85						
170	98	98						
175	100	100						
180	73	50						
185						CL		Very thin Lignite seams at 154 to 155 feet.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
 JOB NO. FCT01

LOG OF CORE HOLE NO.
 DATE COMPL. 91/5/12
 RIG TYPE ROTARY AND CORE RIG
 METHOD PUNCH, SPOON & CORE
 CORE SIZE, IN. 4.0
 GRID COORD. N / E N62305.0 E64184.3
 SURFACE ELEV. FT. 445.6

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE	ANGLE, DEG.	LOG	LITHOLOGY	SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
160	98	98									MANNING MEM. OF McELROY FM.: Claystone, massive, soft, lt. greenish grey. Occasional thin carbonaceous partings.
165											TD AT 160 FEET
170											
175											
180											
185											
190											
195											
200											
205											

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.
DATE COMPL. 91/5/15
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE, IN. 4
GRID COORD. N / E N59175.1 E64429.0
SURFACE ELEV. FT. 439.3

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. HIDE > 28 IN HIDE 2-28 IN HIDE < 2 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	SP 37						CH		DEWEESVILLE MEM: Sandy Clay, med. plasticity, tan. (possibly disturbed material)
5	SP 71						CL	Continuous sampling using Punch Core, spoon, grab sample or HX core bit.	CONQUISTA CLAY MEM., UPPER: Silty Claystone, high plast., soft, tan, some limonite stain on partings. Possible traces of uranium mineralization at 5.5 to 10 feet.
10	PC 100							Hole was plugged using bentonite pellets or chips.	
15	PC 100	77							Color becoming variable tan to lt. greenish tan to orange at 15 feet.
20	PC 83	34							
25	PC 100	91							Occasional thin gypsum seam from 17 feet.
30	PC 100	60							
35	PC 90	30							
40	HX 100	50					SP		MIDDLE, CONQUISTA CLAY MEM.: Sandstone fine, soft, lt. greenish tan. Occasional thin gypsum seam. Occasional carbonaceous seam. Becoming more clayey from 37 feet.
45	HX 40	8							
50	PC 30	0							
55	PC 0	0					SP		Sandstone, very fine, very soft, lt. greenish grey. Occasional thin Claystone seam. Occ. thin gypsum seam.
60	PC 65	0							
65	HX 75	0							
70	HX 100	83					CL		LOWER, CONQUISTA CLAY MEM.: Claystone, laminated, widely spaced fractures, soft, lt. greenish grey to olive grey. Occasional coaly frag.
75	HX 95	95							

GROUNDWATER		
DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 91/5/15
DATE COMPL. 91/5/15
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE, IN. 4
GRID COORD. N / E N59175.1 E64429.0
SURFACE ELEV. FT. 439.3

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	WIRE ANGLE, DEG.	FRACTURES HIDE, >20 IN. 100.5-20 IN. CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	EX 100	100								
60	EX 100	100								
65	EX 82	58								Sandy at 62 to 64 feet; varved from 64 to 67 feet.
70	EX 100	100								
75	EX 98	98								Scattered fossil shell frag. at 74 feet.
80	EX 100	100								
85	EX 100	88						SP		Lignite, soft, widely spaced fractures. dk. brn. to black. Occ. Claystone seam.
90	EX 82	52								DILWORTH MEM.: Sandstone, fine, widely spaced fractures, soft to mod. hard, lt. greenish grey. Becoming Clayey at 87 ft. Some coaly frag. and partings; some Claystone seams from 91 feet.
95	EX 100	93								
100	EX 96	82						SP CL		Intercalated Sandstone and Claystone: widely spaced fractures, soft, lt. greenish grey to olive grey.
	EX 100	95								Claystone predominates from 100 feet.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT

Falls City Site Texas

;UMTRA

LOG OF CORE HOLE NO.

JOB NO.

FCT01

DATE COMPL.

91/5/15

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, SPOON & CORE

CORE SIZE, IN.

4

GRID COORD. N / E

N59175.1 E64429.0

SURFACE ELEV. FT.

439.3

DEPTH IN FEET	LOG SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG.	WIDE, IN.	MOD. IN.	CLOSE <5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
160	EX 100	100	74							SP		Sandstone, fine, mod. spaced fractures, soft, lt. greenish grey. Occasional Claystone seam and lignite parting.
165	EX 85	62										
170	EX 8	0										Frequent Claystone seams from 170 feet.
175	EX 66	49										
180	EX 73	64								CL		Claystone, fractured, soft, olive grey. Occasional thin Sandstone lenses and lignite partings.
185	EX 100	100										
190	EX 100	100										Claystone, lignite rich, olive grey to greenish grey.
195	EX 82	65								CL		Claystone, soft, olive grey.
200	EX 100	100										Lignite layer at 186 to 186.5 feet.
205	EX 100	100								CL		Lignite, soft, dark brn.
												MANNING MEM. OF McELROY FM.: Claystone, massive, some coaly seams, soft, lt. bluish green.
												TD AT 193 FEET

GROUNDWATER

DEPTH HOUR DATE

444

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.

DATE COMPL.

91/5/21

RIG TYPE

ROTARY AND CORE RIG

METHOD

PUNCH, SPOON & CORE

CORE SIZE, IN.

4

GRID COORD. N / E

N58781.7 E65317.1

SURFACE ELEV. FT.

433.4

DEPTH IN FEET	TEST SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES ANGLE, DEG. HOLE > 28 IN HOLE 5-28 IN CLOSE < 5 IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
5	PC	82					SP		DEWEESVILLE MEM.: Intercalated Sandstone and Sandy Claystone; very soft, tan to lt. tan. With some limonite staining and minor amounts of carbonaceous material in partings.
	PC	55					SP	Continuous sampling using spoon, Punch Core or HX core bit..	
	PC	71					SP		
	PC	100	73						Increasing clay content with depth.
	PC	100	80						
10	PC	65	0				SP	Hole was plugged with bentonite pellets and ships.	Sandstone, fine, thinly bedded, mod. hard, lt. brn.
	DX	90	25						Softer with little orange limonite stain from 13 feet.
15	DX	78	50				SP		Sandstone, with clay, fine mod. spaced fractures, soft, lt. brn. to greenish grey.
	DX	25	0						Some cross bedding.
	DX	60	30						
25	DX	92	38						
	DX	92	30				CL		CONQUISTA CLAY MEM., UPPER: Claystone, soft, lt. greenish grey. Occasional Siltstone lenses, and some limonite staining on partings.
35	DX	92	28						Occasional thin green banding from 31 to 33 feet.
	DX	100	88				CL		Occ. thin gypsum seam and varigated zone from 35 to 38 feet.
45	DX	100	82						Claystone, massive, soft, dark olive grey.
	DX	86	81						
50									

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
 JOB NO. FCT01

LOG OF CORE HOLE NO. 91/5/21
 DATE COMPL. 91/5/21
 RIG TYPE ROTARY AND CORE RIG
 METHOD PUNCH, SPOON & CORE
 CORE SIZE, IN. 4
 GRID COORD. N / E N58781.7 E65317.1
 SURFACE ELEV. FT. 433.4

DEPTH IN FEET	LOG SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. HIDE > 20 IN HIDE < 20 IN HIDE < 5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55	100	100							
55	98	80					ML		MIDDLE, CONQUISTA CLAY MEM.: Sandy siltstone, with fossils, very soft, olive grey. Occ. Claystone seams. Limestone lens at 59.9 ft. TD AT 60 FEET.
60									
65									
70									
75									
80									
85									
90									
95									
100									

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 91/1/22
DATE COMPL. 91/1/22
RIG TYPE ROTARY AND CORE RIG
METHOD PUNCH, SPOON & CORE
CORE SIZE, IN. 4.0.
GRID COORD. N / E N60374.5 E67198.7
SURFACE ELEV. FT. 442.9

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. SLIDE, IN. HOLE, IN. HOLE, IN. CLOSE, IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
0	GB 100						SM		SOIL: Silty Sand, fine to med., dk. brn. moist.
5							SP	Attempted continuous sampling using grab samples and HX core.	DEWEESVILLE MEM. OF WHITSETT FM.: Sandstone, med. to fine, thin to mod. bedded, mod. soft, lt. tan. Some cross bedding and some thin bentonite seams present.
10	HX 90	76							
15	HX 100	95					CH		Claystone to clay, little sand, laminated, soft, bentonitic, lt. yellowish green to lt. tan.
20	HX 82	75					SP	Strata and sample description taken from average of two holes	Silty Sandstone, very fine to med., thin bedded, mod. soft, with clay seams present, lt. brown to grey.
25	HX 24	0						Lost first hole due to caving at 29 feet.	Brecciated zone at 22 to 22.5 feet. One inch lignite seam at 24 feet.
30	HX 38	0						Second hole nearby lost samples from 32 to 42.5 feet	Mod. hard from 27 to 27.5.
35	HX 0	0							Unknown Strata due to lack of sample recovery from 32.3 to 42.5 feet.
40									
45	HX 60	0					SC	Hole plugged with bentonite pellets and chips.	Clayey Sandstone, very fine, thin bed., soft, lt. yellow. TD AT 44.5 FEET
50									

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas

;UMTRA LOG OF CORE HOLE NO.

JOB NO. FCT01

DATE COMPL. 91/2/1

RIG TYPE

ROTARY AND CORE RIG

METHOD

CORE BIT

CORE SIZE, IN.

4.0

GRID COORD. N / E

N56764.4 E65276.2

SURFACE ELEV. FT.

407.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE	ANGLE, DEG.	SIZE, IN.	LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
	SP 73								CH		SOIL: Silty Clay, brown.
5									SM	Upon completion the hole caved from 168 to 90 feet.	DEWEESVILLE MEM.: Silty sand, fine to med., slightly plast., mod. hard, brown to tan, moist. Occ. thin cemented seams from 3 to 10 feet.
	SP 86									Plugged hole with bentonite chips from 90 to 2 feet installed grout plug at surface.	
10	SP 82	77									
	SP 82	30							CL		Sandy Clay, fine sand, soft, med. plast., tan, moist. Some iron stain on partings.
15	PC 44	18									
	PC 46	21								Continuous samples taken with spoon, Punch Core, and HX core bit.	Thin gypsum seam on bedding plane at 19 feet.
20											
	PC 70	22							CL		CONQUISTA CLAY MEM., UPPER: Claystone, thin bedded to massive, soft to very soft, grey. Occasional minor siltstone seams.
25	PC 100	80									
30	PC 90	0									
	PC 100	20									
35	PC 98	63									
40	PC 100	80									
45	PC 87	60									
	HX 100	75							CL		MIDDLE, CONQUISTA CLAY MEM.: Sandstone, fine, fossiliferous, thin bedded, mod. hard, lt. grey to green.
50	PC 83	42									

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 91/2/1
DATE COMPL. 91/2/1
RIG TYPE ROTARY AND CORE RIG
METHOD CORE BIT
CORE SIZE, IN. 4.0
GRID COORD. N / E N56764.4 E65276.2
SURFACE ELEV. FT. 407.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE ANGLE, DEG. HOLE > 20 IN HOLE 5-20 IN CLOSE < 5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
55									Some interbedded Shale and Siltstone, thin bedded. LOWER, CONQUISTA CLAY MEM.: Claystone to clay, massive to thin bedded, soft, dk. grey moist.
	PC 20	0							
	MX 100	43							
60									Clayey Siltstone layer at 59 to 60.7 feet
	MX 100	52							
65									
	MX 70	65					CL		Claystone, laminated to massive, mod. soft, dk. grey. Some Siltstone seams and fossil burrows present. Odor of petroleum on fresh fracture.
	MX 84	83							
70									
	MX 92	90							
75									
	MX 100	84							
80									Lignite, sandy, soft, black. Odor of methane present.
	MX 96	92							
85							ML SP CL		DILWORTH MEM.: Clayey Sandstone to Siltstone. Silty sandstone, fine, carbonaceous, thin bedded, mod. soft, lt. green to lt. grey; interbedded with Claystone, massive to thin bedded, mod. soft, dk. grey.
	MX 72	36							
90									
	MX 84	56							
95									
	MX 90	75							
	MX 93	82							
100									
	MX 96	96					CL		Claystone, massive to thin bedded, mod. hard, interbedded with minor siltstone, thin bedded, mod.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO. 91/2/1
DATE COMPL. 91/2/1
RIG TYPE ROTARY AND CORE RIG
METHOD CORE BIT
CORE SIZE, IN. 4.0
GRID COORD. N / E N56764.4 E65276.2
SURFACE ELEV. FT. 407.8

DEPTH IN FEET	SAMPLE	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	FRACTURES NONE	ANGLE, DEG.	TIME, >20 IN	TIME, 5-20 IN	TIME, <5 IN	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
105													hard, grey.
	EX 58	30											
110											LS		Limestone, w/ calcite, mod. thick bedded, mod. hard, grey.
	EX 74	44									SC		Sandstone, clayey, mod. thick bedded, mod. soft, friable grey to lt. grey.
115													Cross bedded with 0.3 ft fossiliferous zone at upper contact. Some carbonaceous material present.
	EX 60	17											
120													
	EX 73	60											
125													
	EX 100	90											
130													
	EX 20	18									SP CL		Sandstone, fine, thin bedded, mod. soft, lt. grey.; interbedded with Claystone/Shale, laminated, soft, grey. The stratum is bioturbated with fossil burrows throughout.
135													
	EX 60	60											
	EX 100	98											
140													
	EX 98	90											
145													
	EX 52	40											
150													
	EX 0	0											
155													
	EX 100	95											

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site Texas ;UMTRA
JOB NO. FCT01

LOG OF CORE HOLE NO.
DATE COMPL. 91/2/1
RIG TYPE ROTARY AND CORE RIG
METHOD CORE BIT
CORE SIZE, IN. 4.0
GRID COORD. N / E N56764.4 E65276.2
SURFACE ELEV. FT. 407.8

DEPTH IN FEET	SAMPLE NO.	% CORE RECOVERY	ROCK QUALITY DESIGNATION	% MEDIA RECOVERY	NONE	ANGLE, DEG.	LINE, IN.	MOD. IN.	CLOSE, IN.	GRAPHICAL LOG	LITHOLOGY SYMBOL	REMARKS	STRATIGRAPHIC DESCRIPTION
157	0												
160	100	100											
165	100	100											
165	100	50											
170											CL		
175													
180													
185													
190													
195													
200													
205													

From 157 feet the Claystone is the major lithology.

MANNING FORMATION:
Claystone, massive, soft, grey.
TD AT 168 FEET.

GROUNDWATER

DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

Lower ~~Section~~ 20.19. 2
Upper ~~Section~~ Page 1 of 1
LOG OF WELL BORING NO. 868

JOB NO. FCT01 DATE 04/14/93 TOTAL DEPTH 37.0 feet
SURFACE ELEVATION 444.14 RIG TYPE JED1
TOP OF FILTER PACK 18.00 BORING TYPE HOLLOW STEM AUGER
WELL CASING TYPE 2.0-IN. SCHED. 40 PVC LOCATION N 60857.90 E 66634.30
COMPLETION DEWEESVILLE DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2.0-inch PVC well to 37 feet.		CL	DEWEESVILLE MEM.: SANDY CLAY, the sand, weakly cemented, olive-tan.
5		Installed steel casing with grout to 3 feet.		CL	SILTY CLAY, very moist, high plasticity, brown.
10		Bentonite chips seal placed from 3 to 13.5 feet.		SC	SANDSTONE, with clay, very moist, high plasticity, brown.
15		Bentonite pellet seal placed from 13.5 to 18 feet.		CL	CLAY, very moist, high plasticity.
20		Installed sandpack from 18 to 37 feet			Note: Color change to greyish green from 20 ft., very moist, no odor.
25		Blank PVC casing installed to 24.1 feet		SP	SILTY SANDSTONE, very moist to wet, partially lithified, with traces of limonite, grey. Note: Water encountered at 27 feet.
30		Installed .050 screen from 24.1 to 34.1 feet		CH	SILTY CLAY, high plasticity, partially lithified, very moist, grey.
35		Installed blank sump from 34.1 to 37 feet			TD AT 37 FEET.

GROUNDWATER		
DEPTH	HOUR	DATE
12.2	07:40	4-14-93

Note:
Logs for Wells
868 - 870
have been temporarily
called 968-970
because of existing
boreholes with same
Number

Note:
• Nothing for Well
869(969) needs to
be confirmed
• No lithology log
for Well 870(970)
• How about sample
method? spoons or
5 feet continuous

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 57687.81

JOB NO. FCT01 DATE 04/08/93
SURFACE ELEVATION 445.68
TOP OF FILTER PACK 71.00
WELL CASING TYPE 2.0-IN. SCHED. 40 PVC
COMPLETION CONQUISTA CLAY, nothing?

TOTAL DEPTH 93.0 feet
RIG TYPE JEDI
BORING TYPE HOLLOW STEM AUGER
LOCATION N 57687.81 E 68468.88
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2.0-inch PVC well to 93 feet.		SM	SOIL: SILTY SAND, partially cemented, light olive tan.
5		Installed steel casing with grout to 3 feet.			
		Bentonite slurry seal placed from 3 to 71 feet.		CH	CONQUISTA CLAY MEM.: CLAY, trace of sand, stiff to very stiff, high plasticity, light olive tan.
10		Blank PVC casing installed to 80.1 feet			
15				CH	CLAY, with lignite seams, high plasticity, brown.
20				CH	CLAY, high plasticity, light olive tan.
25					
30					
35					
40					
45					
50					

Note: Color change to light tan to grey.

GROUNDWATER

DEPTH	HOUR	DATE
76.8	15:53	4-15-93

JEG TAC TEAM

PROJECT Falls City Site
Texas

Page 2 of 2 821
LOG OF WELL BORING NO. 969

JOB NO. FCT01 DATE 04/08/93
SURFACE ELEVATION 445.68
TOP OF FILTER PACK 71.00
WELL CASING TYPE 2.0-IN. SCHED. 40 PVC
COMPLETION CONQUISTA CLAY, nothing?

TOTAL DEPTH 93.0 feet
RIG TYPE JEDI
BORING TYPE HOLLOW STEM AUGER
LOCATION N 57678.81 E 68468.88
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					Note: color change to dark blueish grey.
56					
57					
58					
59					
60					LIGNITE, black.
61					
62					
63					
64					
65					
66					
67					
68					
69					
70		Installed sandpack from 71 to 93 feet			
71					
72					
73					
74					
75					
76					
77					
78					
79					
80		Installed .050 screen from 80.1 to 90.1 feet			
81					
82					
83					
84					
85					
86					
87					
88					
89					
90		Installed blank sump from 90.1 to 93 feet			
91					
92					
93					TD AT 93 FEET.
94					
95					
96					
97					
98					
99					
100					

GROUNDWATER

DEPTH	HOUR	DATE
76.8	15:53	4-15-93

JEG TAC TEAM

PROJECT Falls City Sit. Texas

LOG OF WELL BORING NO. 970

JOB NO. FCT01 DATE 04/06/93 TOTAL DEPTH 34.0 feet
 SURFACE ELEVATION 387.55 RIG TYPE
 TOP OF FILTER PACK BORING TYPE HOLLOW STEM AUGER
 WELL CASING TYPE 2.0-IN. SCHED. 40 PVC LOCATION N 58793.18 E 69389.33
 COMPLETION CONQUISTA MEM. (SAND) DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2.0-inch PVC well to 34 feet.		SP	Lithology log not available
5		Installed steel casing with grout to 3 feet.			
		Bentonite chips seal placed from 3 to 16 feet.			
10		Blank PVC casing installed to 21 feet			
15		Installed sandpack from 16 to 34 feet			
20		Installed .050 screen from 21 to 31 feet			
25					
30		Installed blank sump from 31 to 34 feet			
35					TD AT 34 FEET
40					
45					
50					

GROUNDWATER		
DEPTH	HOUR	DATE
▽		
▽		
▽		

PROJECT UMTRA
Falls City, Texas

Page 1 of 3

LOG OF TEST BORING NO. 901

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 427.60

TOP OF CASING ELEVATION 428.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Conquista/Dilworth

TOTAL DEPTH 145.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 58597.70 E 68461.80

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, intercalated clay, poorly indurated sandstone and siltstones, and carbonaceous tuff.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25		Cement grout			DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone and some sandstone and clay.
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					

GROUNDWATER

DEPTH	HOUR	DATE
57.2	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 901JOB NO. FCT03 DATE 1/16/86SURFACE ELEVATION 427.60TOTAL DEPTH 145.0 feetTOP OF CASING ELEVATION 428.81RIG TYPE Mayhew 1500WELL CASING TYPE 4" schedule 40 PVCBORING TYPE 8" triconeFORMATION OF COMPLETION Conquista/DilworthLOCATION N 58597.70 E 68461.80DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					
75					
80		Formation cave-in material			
85					
90					
95					
100					

CONQUISTA CLAY MEMBER:Whitsett Formation, claystone locally
tuffaceous and fossiliferous,
carbonaceous, few thin beds of fine
grained sandstone.

GROUNDWATER

DEPTH	HOUR	DATE
57.2	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 901JOB NO. FCT03 DATE 1/16/86SURFACE ELEVATION 427.60TOTAL DEPTH 145.0 feetRIG TYPE Mayhew 1500TOP OF CASING ELEVATION 428.81BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 58597.70 E 68461.80FORMATION OF COMPLETION Conquista/DilworthDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Formation cave-in material			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous and fossiliferous, carbonaceous, few thin beds of fine grained sandstone.
110		Bentonite pellet seal - Note: two 5 gallon buckets placed; no measurable thickness recorded			
115		Silica sand filter pack			
120					
125					DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
130		Screen slot opening = 0.051 inches			
135					
140					
145					Stopped drilling at 145 feet.
150					
155					

GROUNDWATER

DEPTH	INCH	DATE
57.2	N.K.	01/31/86

PROJECT UMTRA LOG OF TEST BORING NO. 902
Falls City, Texas
 JOB NO. FCT03 DATE 12/20/85 TOTAL DEPTH 152.0 feet
 SURFACE ELEVATION 407.15 RIG TYPE Mayhew 1500
 TOP OF CASING ELEVATION 408.69 BORING TYPE 8" tricone
 WELL CASING TYPE 4" schedule 40 PVC LOCATION N 57503.80 E 65983.90
 FORMATION OF COMPLETION Dillworth Sandstone DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, intercalated sand and silt.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, a few thin beds of fine grained sandstone locally.
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, a few thin beds of fine grained sandstone locally.
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, a few thin beds of fine grained sandstone locally.
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, a few thin beds of fine grained sandstone locally.
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, a few thin beds of fine grained sandstone locally.
51					
52					
53					
54					
55					
56					
57					
58					
59					

Cement bentonite grout

GROUNDWATER

DEPTH	HOUR	DATE
54.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 902

JOB NO. FCT03 DATE 12/20/85
 SURFACE ELEVATION 407.15
 TOP OF CASING ELEVATION 408.69
 WELL CASING TYPE 4" schedule 40 PVC
 FORMATION OF COMPLETION Dilworth Sandstone

TOTAL DEPTH 152.0 feet
 RIG TYPE Mayhew 1500
 BORING TYPE 8" tricone
 LOCATION N 57503.80 E 65983.90
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Cement bentonite grout			
110		Bentonite pellet seal			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
115					
120		Silica sand filter pack			
125					
130		Screen slot size opening = 0.051 inches			
135					
140		Bentonite pellet seal			Note: lithologic log taken from geophysical log of # 903.
145		Sand backfill			
150					
155					Stopped drilling at 152 feet.

GROUNDWATER

DEPTH	HOUR	DATE
54.0	N.K.	01/31/86

JOB NO. FCT03 DATE 12/5/85

SURFACE ELEVATION 407.23

TOP OF CASING ELEVATION 408.43

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Manning Clay Formation

TOTAL DEPTH 218.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57493.30 E 65971.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0				CH	DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sandy clay, high plastic, very fine to fine sand, organics, very dark greyish brown.
5					Sandy clay, medium plastic, very fine to fine sand, yellowish brown mottled with greyish brown and dark yellowish brown.
10					Clayey sand, very fine to fine sand, medium plastic, greyish brown mottled with yellowish brown, 3 inch lignite seam at 10 feet.
15					CONQUISTA CLAY MEMBER: Whitsett Formation, Claystone, sandy clay, high plastic, very fine to fine sand, yellowish to greyish brown mottled with dark yellowish brown and dark brown, 4 inch lignite seam at 18.5 feet.
20					Clay, some very fine sand to 21 feet, laminated, very dark greyish brown.
25					Clay, laminated, very dark greyish brown.
30		Cement grout			
35					
40					
45					
50					Clay, trace very fine sand,

GROUNDWATER

DEPTH	HOUR	DATE
64.1	N.K.	01/31/86

JOB NO. FCT03 DATE 12/5/85SURFACE ELEVATION 407.23TOP OF CASING ELEVATION 408.43WELL CASING TYPE 4" schedule 40 PVCFORMATION OF COMPLETION Manning Clay FormationTOTAL DEPTH 218.0 feetRIG TYPE Mayhew 1500BORING TYPE 8" triconeLOCATION N 57493.30 E 65971.60DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					laminated (very fine sand and carbonaceous flecks), small shell fragments, very dark greyish brown.
60					Clay, laminated, (very fine sand and carbonaceous flecks), very dark greyish brown to bluish black.
65					
70					
75					
80					
85					
90					Lignite, laminated, faint petroliferous smell, very dark brown to dark brown.
95					DIL WORTH SANDSTONE MEMBER: Whitsett Formation, clayey sand, very fine sand, silty, occasionally laminated with carbonaceous materials (dark brown), moderately to well cemented in lenses, dark greyish brown.
100					Siltstone, hard, very dark greyish brown.
					Siltstone, trace clay, laminated,

GROUNDWATER

DEPTH	NOUR	DATE
64.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 903

Page 3 of 5

JOB NO. FCT03 DATE 12/5/85

SURFACE ELEVATION 407.23

TOP OF CASING ELEVATION 408.43

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Manning Clay Formation

TOTAL DEPTH 218.0 feet

RIG TYPE Mayhew 1500

BORING TYPE 8" tricone

LOCATION N 57493.30 E 65971.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					carbonaceous flecks, moderatley hard, very dark greyish brown.
110					Clay, silty, laminated (very fine sand), flecks of carbonaceous materials in upper part, moderately hard with soft to well indurated siltstone beds, dark greyish brown to dark olive brown.
115					Note: occasional 1 to 4 inch thick siltstone lense.
120					Sand, very fine sand, laminated, soft, some shell fragments, dark greyish brown.
125					Clay, silty, laminated, sparsely fossiliferous, soft to well indurated between 117.5 to 118 feet, dark greyish brown.
130		Cement grout			DILWORTH SANDSTONE MEMBER Sand, very fine sand, clayey to silty, occasional lamination and fleck of carbonaceous material, soft to well indurated below 125 feet, dark greyish brown.
135					Sandstone, well indurated 130 to 133.5 feet, petroliferous smell on dark brown laminations.
140					Clay, silty, laminated, soft, dark olive brown lower part.
145					Sand, clayey and silty, laminated carbonaceous laminations and flecks, petroliferius smell, sparsely fossiliferous, soft, dark olive brown to dark greyish brown.
150					Sand, laminations and flecks of carbonaceous material, petroliferous smell, soft, dark greyish brown.
155					

GROUNDWATER

DEPTH	WELL	DATE
64.1	N.K.	01/31/86

JOB NO. FCT03 DATE 12/5/85
SURFACE ELEVATION 407.23
TOP OF CASING ELEVATION 408.43
WELL CASING TYPE 4" schedule 40 PVC
FORMATION OF COMPLETION Manning Clay FormationTOTAL DEPTH 218.0 feet
RIG TYPE Mayhew 1500
BORING TYPE 8" tricone
LOCATION N 57493.30 E 65971.60
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165		Cement grout			
170					
175					MANNING CLAY MEMBER: Whitsett Formation, claystone, laminated with very fine sand, dark olive brown.
180		Bentonite pellet seal			Clay, laminated (with very fine sand), petroliferous smelling, soft to well indurated at 187 to 187.5 feet, very dark brown.
185		Silica sand filter pack			
190					Lignite, laminated, very dark brown, hard.
195		Screen slot size opening = 0.051 inches			Clay, laminated (with very fine sand), moderately indurated, dark greyish brown.
200					Lignite, laminated, moderately to well indurated, very dark brown.
205					Clay, laminated (with very fine sand), moderately indurated, dark greyish brown.

GROUNDWATER

DEPTH	HOUR	DATE
64.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 903

JOB NO. FCT03 DATE 12/5/85

TOTAL DEPTH 218.0 feet

SURFACE ELEVATION 407.23

RIG TYPE Mayhew 1500

TOP OF CASING ELEVATION 408.43

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 57493.30 E 65971.60

FORMATION OF COMPLETION Manning Clay Formation

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210		Bentonite pellet seal			Lignite, laminated, moderately to well indurated, very dark brown.
		Cement backfill grout			Clay, laminated, dark greyish brown.
215					
220					Stopped jamming at 218 feet.
225					
230					
235					
240					
245					
250					
255					
260					

GROUNDWATER

DEPTH	HOUR	DATE
64.1	N.K.	01/31/86

JOB NO. FCT03 DATE 12/19/85

SURFACE ELEVATION 398.76

TOTAL DEPTH 28.0 feet

RIG TYPE Mayhew 1500

TOP OF CASING ELEVATION 400.03

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 57170.90 E 64874.50

FORMATION OF COMPLETION Conquista Clay Member

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5		Cement bentonite grout			
10		Bentonite pellets seal			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
15		Silica sand filter			
20		Screen slot opening = 0.051 inches			Stopped drilling at 28 feet.
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
2.5	N.K.	01/31/86



PROJECT UMTRA

Page 1 of 2

Falls City, TexasLOG OF TEST BORING NO. 905JOB NO. FCT03 DATE 12/19/85SURFACE ELEVATION 398.82TOTAL DEPTH 90.0 feetRIG TYPE Mayhew 1500TOP OF CASING ELEVATION 399.63BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 57169.70 E 64865.30FORMATION OF COMPLETION Conquista Clay Member/Dilworth DATUMMSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, fossiliferous sandstone.
5					
10					
15					
20					
25		Cement grout			<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, claystone.
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	WELL	DATE
14.1	N.K.	01/31/86

PROJECT UMTRA		LOG OF TEST BORING NO. 905	
Falls City, Texas			
JOB NO. FCT03	DATE 12/19/85	TOTAL DEPTH	90.0 feet
SURFACE ELEVATION 398.82		RIG TYPE	Mayhew 1500
TOP OF CASING ELEVATION 399.63		BORING TYPE	8" tricone
WELL CASING TYPE 4" schedule 40 PVC		LOCATION	N 57169.70 E 64865.30
FORMATION OF COMPLETION Conquista Clay Member/Dilworth	DATUM	MSL	

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite pellets seal			
60		Silica sand filter pack			
65		Screen slot size opening = 0.051 inches			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
70					
75		Bentonite seal			
80		Sand backfill			
85					
90					Stopped drilling at 90 feet.
95					
100					

GROUNDWATER		
DEPTH	MOOR	DATE
14.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 906

JOB NO. FCT03 DATE 12/18/85
 SURFACE ELEVATION 418.66
 TOP OF CASING ELEVATION 420.17
 WELL CASING TYPE 4" schedule 40 PVC
 FORMATION OF COMPLETION Conquista Sandstone/Claystone

TOTAL DEPTH 30.0 feet
 RIG TYPE Mayhew 1500
 BORING TYPE 8" tricone
 LOCATION N 58670.90 E 63758.40
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5		Cement grout			
10		Bentonite pellets seal			
15		Silica sand filter pack			
20		Screen slot size opening = 0.051 inches			
25					
30					
35					
40					
45					
50					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone. Note: Lithologic log taken from geophysical log of # 907.
					Stopped drilling at 30 feet.

GROUNDWATER

DEPTH	HOUR	DATE
12.0	N.K.	1/31/87

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 907JOB NO. FCT03 DATE 12/17/85SURFACE ELEVATION 418.24TOTAL DEPTH 150.0 feetRIG TYPE Mayhew 1500TOP OF CASING ELEVATION 419.77BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 58658.60 E 63744.50FORMATION OF COMPLETION Dilworth SandstoneDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
10					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
15					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
20		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
25					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
30					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
35					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
40					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
45		Bentonite pellets seal			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
50					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.

GROUNDWATER

DEPTH	HOUR	DATE
42.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 907

JOB NO. FCT03 DATE 12/17/85
 SURFACE ELEVATION 418.24
 TOP OF CASING ELEVATION 419.77
 CASING TYPE 4" schedule 40 PVC
 PLUG ON of COMPLETION Dilworth Sandstone

TOTAL DEPTH 150.0 feet
 RIG TYPE Mayhew 1500
 BORING TYPE 8" tricone
 LOCATION N 58658.60 E 63744.50
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Silica sand filter pack			<u>DILWORTH SANDSTONE</u> <u>MEMBER:</u> Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
56					
57					
58					
59					
60					
61					
62					
63					
64					
65		Screen slot size opening = 0.051 inches			
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					
76					
77					
78					
79					
80		Benonite seal			
81					
82					
83					
84					
85					
86					
87					
88					
89					
90		Sand backfill			
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					
101					
102					
103					
104					

GROUNDWATER

DEPTH	WELL	DATE
42.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 908

Page 1 of 2

JOB NO. FCT03 DATE 12/18/85

TOTAL DEPTH 75.0 feet

SURFACE ELEVATION 494.34

RIG TYPE Badger 1400

TOP OF CASING ELEVATION 495.67

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 61478.20 E 61847.50

FORMATION OF COMPLETION Conquista Sandstone/Claystone

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, claystone.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10		Cement bentonite grout			
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, fossiliferous sandstone.
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35		Bentonite pellets seal			
36					
37					
38					
39					
40		Silica sand filter pack			
41					
42					
43					
44					
45		Screen slot size opening = 0.051 inches			
46					
47					
48					
49					
50					

GROUNDWATER

DEPTH	HOUR	DATE
57.5	N.K.	01/31/86

PROJECT **UMTRA**
Falls City, Texas**LOG OF TEST BORING NO. 908**JOB NO. **FCT03** DATE **12/18/85**SURFACE ELEVATION **494.34**TOTAL DEPTH **75.0 feet**RIG TYPE **Badger 1400**TOP OF CASING ELEVATION **495.67**BORING TYPE **8" tricone**WELL CASING TYPE **4" schedule 40 PVC**LOCATION **N 61478.20 E 61847.50**FORMATION OF COMPLETION **Conquista Sandstone/Claystone**DATUM **MSL**

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
60		Benonite seal			
65					
70		Sand backfill			
75					
80					Stopped drilling at 75 feet.
85					
90					
95					
100					

GROUNDWATER

DEPTH	WQUR	DATE
57.5	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 909JOB NO. FCT03 DATE 1/4/86SURFACE ELEVATION 494.11TOP OF CASING ELEVATION 495.45WELL CASING TYPE 4" schedule 40 PCVFORMATION OF COMPLETION Dilworth Upper SandTOTAL DEPTH 120.0 feetRIG TYPE Badger 1400BORING TYPE 8" triconeLOCATION N 61497.20 E 61852.30DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
5					
10					
15					
20					
25		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	MOUR	DATE
105.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas
 JOB NO. FCT03 DATE 1/4/86
 SURFACE ELEVATION 494.11
 TOP OF CASING ELEVATION 495.45
 WELL CASING TYPE 4" schedule 40 PCV
 FORMATION OF COMPLETION Dilworth Upper Sand

LOG OF TEST BORING NO. 909
 TOTAL DEPTH 120.0 feet
 RIG TYPE Badger 1400
 BORING TYPE 8" tricone
 LOCATION N 61497.20 E 61852.30
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
60					
65		Cement grout			
70					
75					
80		Bentonite pellets seal			Note: lignite, very carbonaceous, moderately hard, dark brown.
85		Silica sand filter pack			
90					DILWORTH SANDSTONE MEMBER: "Upper sand" Whitsett Formation, sand, very fine, hard 85.5 to 86 feet soft thereafter, laminations of carbonaceous material and sand, moist, greyish brown.
95					
100		Screen slot size opening = 0.051 inches			

GROUNDWATER		
DEPTH	HOUR	DATE
105.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 909JOB NO. FCT03 DATE 1/4/86SURFACE ELEVATION 494.11TOP OF CASING ELEVATION 495.45WELL CASING TYPE 4" schedule 40 PCVFORMATION OF COMPLETION Dilworth Upper SandTOTAL DEPTH 120.0 feetRIG TYPE Badger 1400BORING TYPE 8" triconeLOCATION N 61497.20 E 61852.30DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					DILWORTH SANDSTONE MEMBER: "Upper sand" Whitsett Formation, clayey sand, laminations of carbonaceous material, soft, greyish brown.
110					
115		Benonite seal			
		Sand backfill			DILWORTH SANDSTONE MEMBER: "Intermediate Silt" Whitsett Formation, sandy clay, very fine sand stringers or laminations, soft to moderately firm, dark brown.
120					
					Stopped Jamming at 120 feet.
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
105.1	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 910

JOB NO. FCT03 DATE 12/16/85
SURFACE ELEVATION 494.37
TOP OF CASING ELEVATION 494.88
WELL CASING TYPE 4" schedule 40 PVC
FORMATION of COMPLETION Lower Dilworth/Manning Clay

TOTAL DEPTH 197.0 feet
RIG TYPE Mayhew 1500
BORING TYPE 8" tricone
LOCATION N 61483.70 E 61836.10
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, clayey silt, considerable fine sand.
5					
10					
15					
20					
25		Cement grout			
30					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone, sand, occasional silt and clay lense.
35					
40					
45					
50					
GROUNDWATER					

GROUNDWATER

DEPTH	HOUR	DATE
141.5	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 910

JOB NO. FCT03 DATE 12/16/85

SURFACE ELEVATION 494.37

TOTAL DEPTH 197.0 feet

RIG TYPE Mayhew 1500

TOP OF CASING ELEVATION 494.88

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 61483.70 E 61836.10

FORMATION OF COMPLETION Lower Dilworth/Manning Clay

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, clay.
60					
65					
70					
75					
80					
85					
90					
95					
100					

Cement grout

DILWORTH UPPER SANDSTONE
MEMBER: Whitsett Formation, very
fine to fine sand.

GROUNDWATER

DEPTH	NO. OF	DATE
141.5	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 910JOB NO. FCT03 DATE 12/16/85SURFACE ELEVATION 494.37TOTAL DEPTH 197.0 feetTOP OF CASING ELEVATION 494.88RIG TYPE Mayhew 1500WELL CASING TYPE 4" schedule 40 PVCBORING TYPE 8" triconeFORMATION OF COMPLETION Lower Dilworth/Manning ClayLOCATION N 61483.70 E 61836.10DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120		Cement grout			DILWORTH (INTERMEDIATE) SANDSTONE MEMBER: Whitsett Formation, silt.
125					
130					
135					DILWORTH (LOWER) SANDSTONE MEMBER: Whitsett Formation, sand.
140					
145		Bentonite pellets and bentonite slurry mix			
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
141.5	N.K.	01/31/86

4417

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 911

JOB NO. FCT03 DATE 1/13/86

TOTAL DEPTH 20.0 feet

SURFACE ELEVATION 417.94

RIG TYPE Badger 1400

TOP OF CASING ELEVATION 419.46

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 64517.70 E 64050.10

FORMATION OF COMPLETION Upper Dilworth

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
5		Bentonite pellet seal			
10		Silica sand filter pack			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand. Note: lithologic log taken from geophysical log of # 912.
15		Screen slot size opening = 0.051 inches			
20					Stopped drilling at 20 feet.
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	MOUR	DATE
	NONE	N.K.

JOB NO. FCT03 DATE 1/7/86

SURFACE ELEVATION 417.86

TOP OF CASING ELEVATION 418.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Dilworth Upper Sand

TOTAL DEPTH 125.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 64508.10 E 64035.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
1					
2					
3					
4					
5					DILLWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand.
6					
7					
8					
9					
10					
11					
12					
13					
14					
15		Cement grout			
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30		Bentonite pellet seal			
31					
32					
33					
34					
35		Silica sand filter pack			
36					
37					
38					
39					
40					
41					
42					
43					
44					
45		Screen slot size opening = 0.051 inches			
46					
47					
48					
49					
50					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	N.K.

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 912

JOB NO. FCT03 DATE 1/7/86

SURFACE ELEVATION 417.86

TOTAL DEPTH 125.0 feet

RIG TYPE Badger 1400

TOP OF CASING ELEVATION 418.81

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 64508.10 E 64035.90

FORMATION OF COMPLETION Dilworth Upper Sand

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110		Cave-in material			
115					Note: lithologic log obtained from geophysical investigation at this location.
120					
125					
130					Stopped drilling at 125 feet.
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	N.K.

JOB NO. FCT03 DATE 12/21/85 TOTAL DEPTH 50.0 feet
 SURFACE ELEVATION 422.62 RIG TYPE Badger 1400
 TOP OF CASING ELEVATION 424.11 BORING TYPE 8" tricone
 WELL CASING TYPE 4" schedule 40 PVC LOCATION N 59086.40 E 67228.00
 FORMATION OF COMPLETION Conquista Clay Member - Claystone MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10		Cement bentonite grout			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, few thin beds of fine grained sandstone.
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					Note: lithologic log taken from geophysical logging of this boring.
21					
22					
23					
24					
25		Bentonite pellet seal			
26					
27					
28					
29					
30		Silica sand filter pack			Stopped drilling at 50 feet.
31					
32					
33					
34					
35		Screen slot size opening = 0.051 inches			
36					
37					
38					
39					
40		Benonite pellet seal			Stopped drilling at 50 feet.
41					
42					
43					
44					
45		Sand backfill			
46					
47					
48					
49					
50					

GROUNDWATER

DEPTH	HOUR	DATE
21.5	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 914JOB NO. FCT03 DATE 1/14/86TOTAL DEPTH 20.0 feetSURFACE ELEVATION 433.94RIG TYPE Badger 1400TOP OF CASING ELEVATION 435.79BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 64381.50 E 66677.10FORMATION OF COMPLETION Deweesville/Conquista MemberDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Bentonite pellet seal			DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.
5		Silica sand filter pack			
10					
15		Screen slot size opening = 0.051 inches			
20					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, few thin beds of fine grained sandstone.
25					Stopped drilling at 20 feet.
30					Note: lithologic log taken from geophysical log of # 915.
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
12.0	N.K.	01/31/86

JOB NO. FCT03 DATE 1/14/86

SURFACE ELEVATION 434.20

TOP OF CASING ELEVATION 435.55

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Upper Dilworth Sand

TOTAL DEPTH 110.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 61371.90 E 66687.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.
1					
2					
3					
4					
5					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
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48					
49					
50					
51					
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88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					
101					
102					
103					
104					
105					
106					
107					
108					
109					
110					

Cement grout

CONQUISTA CLAY MEMBER:
Whitsett Formation, fossiliferous sandstone.

GROUNDWATER

DEPTH	NOUR	DATE
57.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 915JOB NO. FCT03 DATE 1/14/86SURFACE ELEVATION 434.20TOP OF CASING ELEVATION 435.55WELL CASING TYPE 4" schedule 40 PVCFORMATION OF COMPLETION Upper Dilworth SandTOTAL DEPTH 110.0 feetRIG TYPE Badger 1400BORING TYPE 8" triconeLOCATION N 61371.90 E 66687.60DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60		Cement grout			
65					
70					
75					
80		Bentonite pellet seal			
85					
90		Silica sand filter pack			
95					
100					

CONQUISTA CLAY MEMBER:
Whitsett Formation, claystone.**DILWORTH SANDSTONE**
MEMBER: Whitsett Formation, very
fine to fine grained, locally
fossiliferous and carbonaceous.

GROUNDWATER

DEPTH	HOUR	DATE
57.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas
 JOB NO. FCT03 DATE 1/14/86
 SURFACE ELEVATION 434.20
 TOP OF CASING ELEVATION 435.55
 WELL CASING TYPE 4" schedule 40 PVC
 FORMATION OF COMPLETION Upper Dilworth Sand

LOG OF TEST BORING NO. 915
 TOTAL DEPTH 110.0 feet
 RIG TYPE Badger 1400
 BORING TYPE 8" tricone
 LOCATION N 61371.90 E 66687.60
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Screen slot size opening = 0.051 inches			Note: lithologic log taken from geophysical logging of this boring.
110					Stopped drilling at 110 feet.
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
57.0	N.K.	01/31/86

4444

PROJECT UMTRA
Falls City, Texas

Page 1 of 1
LOG OF TEST BORING NO. 916

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 418.54

TOP OF CASING ELEVATION 420.39

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Conquista Sand/Claystone

TOTAL DEPTH 90.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 62972.90 E 66711.40

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Bentonite pellet seal			<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, claystone.
5		Silica sand filter pack			
10					<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, fossiliferous sandstone.
15					
20					<u>CONQUISTA CLAY MEMBER:</u> Whitsett formation, claystone.
25					
30		Screen slot size opening = 0.051 inches			Stopped drilling at 35 feet. Note: lithologic log taken of geophysical log of # 917.
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
19.6	N.K.	01/31/86

PROJECT UMIRA
Falls City, Texas

LOG OF TEST BORING NO. 917

JOB NO. FCT03 DATE 1/16/86

TOTAL DEPTH 90.0 feet

SURFACE ELEVATION 418.14

RIG TYPE Badger 1400

TOP OF CASING ELEVATION 419.56

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 62979.90 E 66715.10

FORMATION OF COMPLETION Dilworth Sand/Conquista Claystone

MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					
5					
10					
15					
20					
25		Cement grout			
30					
35					
40					
45					
50					

CONQUISTA CLAY MEMBER:
 Whitsett Formation, claystone.

CONQUISTA CLAY MEMBER:
 Whitsett Formation, fossiliferous sandstone.

CONQUISTA CLAY MEMBER:
 Whitsett Formation, claystone.

GROUNDWATER

DEPTH	HOUR	DATE
55.5	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

Page 2 of 2

LOG OF TEST BORING NO. 917

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 418.14

TOTAL DEPTH 90.0 feet

TOP OF CASING ELEVATION 419.56

RIG TYPE Badger 1400

WELL CASING TYPE 4" schedule 40 PVC

BORING TYPE 8" tricone

FORMATION OF COMPLETION Dilworth Sand/Conquista Claystone

LOCATION N 62979.90 E 66715.10

MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite pellet seal			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
60		Silica sand filter pack			
65					
70					DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand. Note: lithologic log taken from geophysical logging of this boring.
75		Screen slot size opening = 0.051 inches			
80					
85					Stopped drilling at 90 feet.
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
55.5	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas
 JOB NO. FCT03 DATE 1/7/86
 SURFACE ELEVATION 402.77
 TOP OF CASING ELEVATION 404.03
 WELL CASING TYPE 4" schedule 40 PVC
 FORMATION OF COMPLETION Lower Deweesville Sand Member

LOG OF TEST BORING NO. 918

TOTAL DEPTH 40.0 feet
 RIG TYPE Badger 1400
 BORING TYPE 8" tricone
 LOCATION N 56863.70 E 65174.60
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Bentonite pellet seal			DEWEESVILLE FORMATION: sand.
5		Silica sand filter pack			
10		Screen slot opening = 0.051 inches			
15		Bentonite pellet seal			CONQUISTA CLAY MEMBER: claystone. Note: lithologic log taken from geophysical logging of this boring.
20					
25					
30					
35					
40					
45					
50					
					Stopped drilling at 40 feet.

GROUNDWATER

DEPTH	MOUR	DATE
4.0	N.K.	1/31/86

PROJECT UMTRA
Falls City, Texas

Page 1 of 1

LOG OF TEST BORING NO. 919

JOB NO. FCT03 DATE 1/4/85
 SURFACE ELEVATION 399.83
 TOP OF CASING ELEVATION 401.05
 WELL CASING TYPE 4" schedule 40 PVC
 FORMATION OF COMPLETION Conquista Sandstone/Claystone

TOTAL DEPTH 40.0 feet
 RIG TYPE Badger 1400
 BORING TYPE 8" tricone
 LOCATION N 56737.40 E 64209.90
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Bentonite gel			CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5		Bentonite pellet seal			
10		Silica sand filter pack			
15		Screen slot size opening = 0.051 inches			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
20		Well installed to 20 feet			
25		Note: original hole abandoned, new hole drilled adjacent to original for well installation			
30					Note: lithologic log taken from geophysical logging of boring # 920.
35					
40					
45					Stopped drilling at 40 feet.
50					

GROUNDWATER

DEPTH	WELL	DATE
6.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas
 JOB NO. FCT03 DATE 1/5/86
 SURFACE ELEVATION 395.18
 TOP OF CASING ELEVATION 396.67
 WELL CASING TYPE 4" schedule 40 PVC
 FORMATION OF COMPLETION Conquista Claystone/Upper Dillworth

LOG OF TEST BORING NO. 920
 TOTAL DEPTH 80.0 feet
 RIG TYPE Badger 1400
 BORING TYPE 8" tricone
 LOCATION N 56731.40 E 64229.00
MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35		Bentonite pellet seal			
36					
37					
38					
39					
40		Silica sand filter pack			
41					
42					
43					
44					
45		Screen slot size opening = 0.051 inches			
46					
47					
48					
49					
50					DILLWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand.
51					
52					
53					
54					

GROUNDWATER		
DEPTH	WELL	DATE
35.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 920

JOB NO. FCT03 DATE 1/5/86

SURFACE ELEVATION 395.18

TOP OF CASING ELEVATION 396.67

WELL CASING TYPE 4" schedule 40 PVC

FORMATION of COMPLETION Conquista Claystone/Upper Dilworth

TOTAL DEPTH 80.0 feet

RIG TYPE Badger 1400

BORING TYPE 8" tricone

LOCATION N 56731.40 E 64229.00

MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite pellet seal			DILLWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine sand.
60					
65					
70					
75					
80					
85					Stopped drilling at 80 feet.
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
35.0	N.K.	01/31/86

WATER

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 921

JOB NO. FCT03 DATE 1/14/86

TOTAL DEPTH 57.0 feet

SURFACE ELEVATION 434.30

RIG TYPE Badger 1400

TOP OF CASING ELEVATION 435.75

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 61389.40 E 66693.50

FORMATION OF COMPLETION Conquista Fossiliferous Sand

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
31					
32					
33					
34					
35		Bentonite pellet seal			
36					
37					
38					
39					
40		Silica sand filter pack			
41					
42					
43					
44					
45		Screen slot size opening = 0.051 inches			
46					
47					
48					
49					
50					

GROUNDWATER

DEPTH	HOUR	DATE
19.0	N.K.	01/31/86

1441

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 921JOB NO. FCT03 DATE 1/14/86TOTAL DEPTH 57.0 feetSURFACE ELEVATION 434.30RIG TYPE Badger 1400TOP OF CASING ELEVATION 435.75BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 61389.40 E 66693.50FORMATION OF COMPLETION Conquista Fossiliferous SandDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					Stopped drilling at 57 feet.
65					Note: lithologic log taken from geophysical logging of # 915.
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
19.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 922JOB NO. FCT03 DATE 1/20/86SURFACE ELEVATION 440.98TOP OF CASING ELEVATION 441.96WELL CASING TYPE 4" schedule 40 PVCFORMATION OF COMPLETION Deweeseville SandTOTAL DEPTH 80.0 feetRIG TYPE Mayhew 1000BORING TYPE 8" triconeLOCATION N 57056.50 E 67960.90DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, intercalated clay, poorly indurated sandstones and siltstones, and carbonaceous tuff.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10		Cement grout			
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30		Formation cave-in			
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53					
54					

GROUNDWATER

DEPTH	HOUR	DATE
64.5	N.K.	01/31/86

JOB NO. FCT03 DATE 1/20/86

SURFACE ELEVATION 440.98

TOP OF CASING ELEVATION 441.96

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Deweeseville Sand

TOTAL DEPTH 80.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 57056.50 E 67960.90

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite pellet seal			<u>DEWEESVILLE SANDSTONE MEMBER:</u> Whitsett Formation, sand and silt with some siltstone, sandstone and clay. Note: lithologic log taken from geophysical logging of this boring.
56					
57					
58					
59					
60					
61					
62					
63					
64					
65		Silica sand filter pack			Stopped drilling at 80 feet.
66					
67					
68					
69					
70		Screen slot size opening = 0.051 inches			
71					
72					
73					
74					
75					
76					
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					

GROUNDWATER

DEPTH	HOUR	DATE
64.5	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 923JOB NO. FCT03 DATE 4/16/86SURFACE ELEVATION 405.26TOTAL DEPTH 20.0 feetRIG TYPE Mayhew 1000TOP OF CASING ELEVATION 407.15BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 56118.30 E 63170.50FORMATION OF COMPLETION Conquista Sandstone/ClaystoneDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement grout			CONQUISTA CLAY MEMBER: fossiliferous sandstone, sand, very fine to fine grained, dense, moist, light yellowish to light greyish brown mottled with yellowish brown.
		Bentonite pellet seal			
5		Silica sand filter pack			
10					
15		Screen slot size opening = 0.051 inches			CONQUISTA CLAY MEMBER: claystone, very stiff, brown.
20					
25					Stopped drilling at 20 feet.
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	04/18/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 924JOB NO. FCT03 DATE 4/16/86
SURFACE ELEVATION 395.14
TOP OF CASING ELEVATION 396.44
WELL CASING TYPE 4" schedule 40 PVC
FORMATION OF COMPLETION Conquista Claystone/SandstoneTOTAL DEPTH 31.0 feet
RIG TYPE Mayhew 1000
BORING TYPE 8" tricone
LOCATION N 55041.90 E 64049.80
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					
5		Cement grout			CONQUISTA CLAY MEMBER: claystone, sandy, very stiff, light brown.
10					
15		Bentonite pellet seal			
20		Silica sand filter pack			
25		Screen slot size opening = 0.051 inches			CONQUISTA CLAY MEMBER: sandstone, fossiliferous, sand, very fine to fine grained, dense, light yellowish to dark brown mottled with yellowish brown.
30					
35					CONQUISTA CLAY MEMBER: claystone, very dark greyish brown.
40					Stopped drilling at 31 feet.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	

4/16/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 925

JOB NO. FCT03 DATE 4/16/86

SURFACE ELEVATION 415.81

TOTAL DEPTH 90.0 feet

RIG TYPE Mayhew 1000

TOP OF CASING ELEVATION 416.08

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 64843.20 E 63664.00

FORMATION OF COMPLETION Lower Dilworth Sandstone / Manning

MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONOIUSTA CLAY MEMBER: claystone, silty, dark brown.
5					
10		Cement grout			DILWORTH SANDSTONE MEMBER: sand, very fine to fine grained, well cemented to 20 feet, moderately cemented to 45 feet, soft thereafter, light brown to greyish brown.
15					
20					
25					
30					
35					
40					
45		Bentonite pellet seal			
50		Silica sand filter pack			

GROUNDWATER

DEPTH	HOUR	DATE
	N.K.	

JOB NO. FCT03 DATE 4/16/86 TOTAL DEPTH 90.0 feet
 SURFACE ELEVATION 415.81 RIG TYPE Mayhew 1000
 TOP OF CASING ELEVATION 416.08 BORING TYPE 8" tricone
 WELL CASING TYPE 4" schedule 40 PVC LOCATION N 64843.20 E 63664.00
 FORMATION OF COMPLETION Lower Dilworth Sandstone / Manning MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					DILWORTH SANDSTONE MEMBER: sand, very fine to fine grained, well cemented to 20 feet, moderately cemented to 45 feet, soft thereafter, light brown to greyish brown.
56					
57					
58					
59					
60					
61					
62					
63					
64					
65		Screen slot size opening = 0.051 inches			
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					
76					
77					
78					
79					
80					MANNING CLAY MEMBER: clay, silty, dark greyish brown.
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					Stopped drilling at 90 feet.
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					

GROUNDWATER

DEPTH	WOUR	DATE
	N.K.	

Nov. 9/94

NOTE:

Logs for Test Boring No's 935, 940 + 945
could not be located in Document Control.

J. Miller

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 951

JOB NO. FCT03 DATE 1/16/86

SURFACE ELEVATION 436.36

TOP OF CASING ELEVATION 437.97

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Conquista Claystone

TOTAL DEPTH 90.0 feet

RIG TYPE Badger 1000

BORING TYPE 8" tricone

LOCATION N 60334.90 E 68978.50

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Formation Cave-in material			
60					
65		Bentonite pellets seal			
70		Silica sand filter			
75					
80		Screen slot opening = 0.051 inches			
85					
90					
95					
100					

CONQUISTA CLAY MEMBER:
 Whitsett Formation, claystone.

Note: lithologic description taken from geophysical log taken from this hole.

Stopped drilling at 90 feet.

GROUNDWATER

DEPTH	HOUR	DATE
68.7	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 952JOB NO. FCT03 DATE 1/19/86TOTAL DEPTH 50.0 feetSURFACE ELEVATION 436.44RIG TYPE Badger 1000TOP OF CASING ELEVATION 437.77BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 60334.50 E 68984.60FORMATION OF COMPLETION Dubose/DeweesevilleDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification	
0					DUBOSE MEMBER: Whitsett Formation, intercalated clay, poorly indurated sandstones, siltstones, and carbonaceous tuffs.	
5		Cement grout				
10						
15		Bentonite pellets seal				
20		Silica sand filter				
25						
30						
35		Screen slot opening = 0.051 inches				
40						
45						
50						
						DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay. Note: lithologic description taken from geophysical log of # 951
Stopped drilling at 50 feet.						

GROUNDWATER

DEPTH	HOUR	DATE
N.K.		01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 953JOB NO. FCT03 DATE 1/19/86TOTAL DEPTH 100.0 feetSURFACE ELEVATION 414.60RIG TYPE Badger 1400TOP OF CASING ELEVATION 415.81BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 62028.60 E 71914.10FORMATION OF COMPLETION Dubose/DeweesevilleDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, intercalated clay, poorly indurated sandstones and siltstones and carbonaceous tuff.
5		Cement grout			
10		Bentonite pellet seal			
15		Silica sand filter pack			
20					
25		Screen slot size opening = 0.051 inches			
30					
35					
40					
45		Bentonite pellet seal			
50		Formation cave-in material			DEWEESVILLE SANDSTONE MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.

GROUNDWATER

DEPTH	HOUR	DATE
24.4	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 953

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 414.60

TOTAL DEPTH 100.0 feet

TOP OF CASING ELEVATION 415.81

RIG TYPE Badger 1400

WELL CASING TYPE 4" schedule 40 PVC

BORING TYPE 8" tricone

FORMATION OF COMPLETION Dubose/Deweeseville

LOCATION N 62028.60 E 71914.10

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous fossiliferous and carbonaceous, few thin beds of very fine sandstone.
56					
57					
58					
59					
60					
61					
62					
63					
64					
65		Formation cave-in material			Note: lithologic log taken from geophysical logging at this location.
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					
76					
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					Stopped drilling at 100 feet.

GROUNDWATER

DEPTH	HOUR	DATE
▽	N.K.	01/31/86
▽		
▽		

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 954JOB NO. FCT03 DATE 1/19/86SURFACE ELEVATION 410.18TOTAL DEPTH 60.0 feetRIG TYPE Mayhew 1000TOP OF CASING ELEVATION 411.39BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 63162.90 E 71323.40FORMATION OF COMPLETION Conquista Claystone/SandstoneDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DEWEESVILLE SAND MEMBER: Whitsett Formation, sand and silt with some siltstone, sandstone and clay.
5		Cement grout			
10					
15					
20					
25		Bentonite pellet seal			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, locally tuffaceous, fossiliferous and carbonaceous, few thin beds of fine grained sandstone.
30		Silica sand filter pack			
35					
40		Screen slot size opening = 0.051 inches			
45					
50					

GROUNDWATER

DEPTH	MOUR	DATE
37.3	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 955JOB NO. FCT03 DATE 1/29/86SURFACE ELEVATION 392.67TOTAL DEPTH 30.0 feetRIG TYPE Badger 1000TOP OF CASING ELEVATION 393.67BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 63099.60 E 69449.20FORMATION of COMPLETION Conquista ClayDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement grout			CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5		Bentonite pellet seal			
10		Silica sand filter pack			
15					
20		Screen slot size opening = 0.051 inches			CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
25					
30					
35					
40					Stopped drilling at 30 feet.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
18.9	N.K.	01/31/86

JOB NO. FCT03 DATE 1/14/86SURFACE ELEVATION 391.80TOP OF CASING ELEVATION 393.25WELL CASING TYPE 4" schedule 40 PVCFORMATION OF COMPLETION Conquista/DilworthTOTAL DEPTH 70.0 feetRIG TYPE Badger 1400BORING TYPE 8" triconeLOCATION N 63104.30 E 69434.60DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5					
10		Cement grout			
15					
20		Formation cave-in material			
25					
30					
35					
40		Bentonite pellet seal			
45					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
50		Silica sand filter pack			

GROUNDWATER

DEPTH	WELL	DATE
18.5	N.K.	01/31/86

4404

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 956JOB NO. FCT03 DATE 1/14/86SURFACE ELEVATION 391.80TOTAL DEPTH 70.0 feetRIG TYPE Badger 1400TOP OF CASING ELEVATION 393.25BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 63104.30 E 69434.60FORMATION OF COMPLETION Conquista/DilworthDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Screen slot size opening = 0.051 inches			
60					
65					
70					
75					
80					
85					
90					
95					
100					

DILWORTH SANDSTONE**MEMBER:** Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.

Note: lithologic log taken from geophysical logging at this location.

Stopped drilling at 70 feet.

GROUNDWATER

DEPTH	INCH	DATE
18.5	N.K.	01/31/86

JOB NO. FCT03 DATE 1/16/86
 SURFACE ELEVATION 386.97
 TOP OF CASING ELEVATION 388.19
 WELL CASING TYPE 4" schedule 40 PVC
 FORMATION OF COMPLETION Conquista Sandstone/Claystone

TOTAL DEPTH 15.0 feet
 RIG TYPE Mayhew 1500
 BORING TYPE 8" tricone
 LOCATION N 63435.20 E 68807.70
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Bentonite pellet seal			<u>CONQUISTA CLAY MEMBER:</u> <u>Whitsett Formation, fossiliferous</u> <u>sandstone.</u>
5		Silica sand filter pack			
10		Screen slot size opening = 0.051 inches			<u>CONQUISTA CLAY MEMBER:</u> <u>Whitsett Formation, claystone.</u>
15					Stopped drilling at 15 feet.
20					Note: lithologic log taken from geophysical logging from boring # 958.
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	MOUR	DATE
10.4	N.R.	01/31/86

JOB NO. **FCT03** DATE **1/15/86**

SURFACE ELEVATION **385.91**

TOP OF CASING ELEVATION **388.23**

WELL CASING TYPE **4" schedule 40 PVC**

FORMATION OF COMPLETION **Upper Dilworth Sandstone**

TOTAL DEPTH **150.0 feet**

RIG TYPE **Badger 1400**

BORING TYPE **8" tricone**

LOCATION **N 63430.10 E 68799.70**

DATUM **MSL**

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone.
5					
10					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone.
15		Cement grout			
20					
25					
30					
35					
40					
45					
50		Bentonite pellet seal			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.

GROUNDWATER

DEPTH	HOUR	DATE
46.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 958JOB NO. FCT03 DATE 1/15/86SURFACE ELEVATION 385.91TOTAL DEPTH 150.0 feetTOP OF CASING ELEVATION 388.23RIG TYPE Badger 1400WELL CASING TYPE 4" schedule 40 PVCBORING TYPE 8" triconeFORMATION OF COMPLETION Upper Dilworth SandstoneLOCATION N 63430.10 E 68799.70DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Silica sand filter pack			
60					
65		Screen slot size opening = 0.051 inches			
70					
75					
80					
85		Bentonite pellet seal			
90					
95		Sand backfill			
100					

GROUNDWATER

DEPTH	HOUR	DATE
46.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 958

JOB NO. FCT03 DATE 1/15/86

SURFACE ELEVATION 385.91

TOTAL DEPTH 150.0 feet

TOP OF CASING ELEVATION 388.23

RIG TYPE Badger 1400

WELL CASING TYPE 4" schedule 40 PVC

BORING TYPE 8" tricone

FORMATION OF COMPLETION Upper Dilworth Sandstone

LOCATION N 63430.10 E 68799.70

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120		Sand backfill			
125					
130					
135					
140					
145					
150					
155					

MANNING CLAY MEMBER:
Whitsett Formation, claystone.

Note: lithologic log taken from
geophysical logging of this boring.

Stopped drilling at 150 feet.

GROUNDWATER

DEPTH	HOUR	DATE
46.0	N.K.	01/31/86

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 961

Page 1 of 2

JOB NO. FCT03 DATE 1/19/86

SURFACE ELEVATION 382.03

TOP OF CASING ELEVATION 382.98

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Conquista Clay

TOTAL DEPTH 60.0 feet

RIG TYPE Mayhew 1000

BORING TYPE 8" tricone

LOCATION N 63815.10 E 70828.50

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, fossiliferous sandstone.
5		Cement grout			
10		Bentonite pellets seal			
15		Silica sand filter			
20					
25		Screen slot opening = 0.051 inches			<u>CONQUISTA CLAY MEMBER:</u> Whitsett Formation, claystone.
30					
35					
40					
45		Bentonite pellets seal			
50		Sand backfill			

GROUNDWATER

DEPTH	HOUR	DATE
14.4	N.K.	01/31/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. **961**

JOB NO. FCT03 DATE 1/19/86

TOTAL DEPTH 60.0 feet

SURFACE ELEVATION 382.03

RIG TYPE Mayhew 1000

TOP OF CASING ELEVATION 382.98

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 63815.10 E 70828.50

FORMATION of COMPLETION Conquista Clay

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Sand backfill			DILWORTH SANDSTONE MEMBER: Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.
60					Stopped drilling at 60 feet.
65					Note: lithologic log taken from geophysical logging in this boring.
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
14.4	N.K.	01/31/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 962JOB NO. FCT03 DATE 1/19/86SURFACE ELEVATION 372.72TOTAL DEPTH 40.0 feetTOP OF CASING ELEVATION 374.20RIG TYPE Mayhew 1000WELL CASING TYPE 4" schedule 40 PVCBORING TYPE 8" triconeFORMATION OF COMPLETION Conquista ClaystoneLOCATION N 64140.10 E 70535.80DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					
5		Bentonite pellets seal			
10		Silica sand filter			
15		Screen slot opening = 0.051 inches			
20					
25		Bentonite pellets seal			
30		Sand backfill			
35					
40					
45					
50					

CONQUISTA CLAY MEMBER:
Whitsett Formation, claystone.**DILWORTH SANDSTONE MEMBER:** Whitsett Formation, very fine to fine grained, locally fossiliferous and carbonaceous.

Stopped drilling at 40 feet.

Note: lithologic log taken from geophysical logging of this boring.

GROUNDWATER

DEPTH	HOUR	DATE
10.0	N.K.	01/31/86

PROJECT UNITRA
 Falls City, Texas
 LOG OF TEST BORING NO. 963
 JOB NO. FCT03 DATE 1/29/86 TOTAL DEPTH 20.0 feet
 SURFACE ELEVATION 368.61 RIG TYPE Badger 1400
 TOP OF CASING ELEVATION 370.44 BORING TYPE 8" tricone
 WELL CASING TYPE 4" schedule 40 PVC LOCATION N 64640.20 E 70391.60
 FORMATION OF COMPLETION Conquista Fossiliferous Sandstone DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: Whitsett Formation, fossiliferous sandstone. Note: lithology log identified from cuttings.
		Bentonite pellets seal			
5		Silica sand filter			
10					
15		Screen slot opening = 0.051 inches			
20					
25					
30					
35					
40					Stopped drilling at 20 feet.
45					
50					

GROUNDWATER		
DEPTH	HOUR	DATE
10.4	N.K.	02/22/86

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 964JOB NO. FCT03 DATE 4/17/86SURFACE ELEVATION 378.09TOTAL DEPTH 90.0 feetRIG TYPE Mayhew 1000TOP OF CASING ELEVATION 379.39BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 64926.20 E 69745.40FORMATION OF COMPLETION Dilworth SandDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: claystone, silty, brown to 15 feet very dark greyish brown to 21 feet.
5					
10					
15					
20					Note: lignite, dark brown to black at 20 to 21 feet.
25		Cement grout			DILWORTH SANDSTONE MEMBER: sand, very fine to fine grained, greyish brown.
30					
35					
40					
45					
50		Bentonite pellets seal			

GROUNDWATER

DEPTH	HOUR	DATE
5	NONE	
10		
15		

JOB NO. FCT03 DATE 4/17/86SURFACE ELEVATION 378.09TOTAL DEPTH 90.0 feetTOP OF CASING ELEVATION 379.39RIG TYPE Mayhew 1000WELL CASING TYPE 4" schedule 40 PVCBORING TYPE 8" triconeFORMATION OF COMPLETION Dilworth SandLOCATION N 64926.20 E 69745.40DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Silica sand filter			DILWORTH SANDSTONE MEMBER: siltstone, very dark olive brown.
60					
65					DILWORTH SANDSTONE MEMBER: sand, very fine to fine grained, greyish brown.
70					
75		Screen slot opening = 0.051 inches			
80					
85					
90					MANNING CLAY MEMBER: clay, silty dark greyish brown.
95					Stopped drilling at 90 feet.
100					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 965JOB NO. FCT03 DATE 4/17/86TOTAL DEPTH 20.0 feetSURFACE ELEVATION 367.11RIG TYPE Mayhew 1000TOP OF CASING ELEVATION 368.31BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 65774.50 E 70672.00FORMATION OF COMPLETION Conquista Fossiliferous SandstoneDATUM
MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					
		Cement grout Bentonite pellets seal			<u>CONQUISTA CLAY MEMBER:</u> claystone, silty, very dark greyish brown.
5					
		Silica sand filter			<u>CONQUISTA CLAY MEMBER:</u> sandstone, fossiliferous, sand, very fine to fine grained, clayey, dark brown to yellowish to greyish brown mottled with yellowish brown.
10					
		Screen slot opening = 0.051 inches			<u>CONQUISTA CLAY MEMBER:</u> claystone, sandy to silty, greyish brown.
15					
20					Stopped drilling at 20 feet.
25					
30					
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
<u>NONE</u>		

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 966JOB NO. FCT03 DATE 4/17/86SURFACE ELEVATION 368.86TOTAL DEPTH 25.0 feetRIG TYPE Mayhew 1000TOP OF CASING ELEVATION 371.56BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 65378.40 E 70988.10FORMATION OF COMPLETION Conquista Sandstone/ClaystoneDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement grout			CONQUISTA CLAY MEMBER: fossiliferous, sandstone, sand, very fine to fine grained, carbonaceous peat zone" from 5 to 7 feet, dark brown to yellowish brown.
5		Bentonite pellets seal			
		Silica sand filter			
10					
15		Screen slot opening = 0.051 inches			
20					CONQUISTA CLAY MEMBER: claystone, greyish brown.
25					
30					
35					
40					
45					Stopped drilling at 25 feet.
50					

GROUNDWATER

DEPTH	HOUR	DATE
13.6	N.K.	05/11/89

JOB NO. FCT03 DATE 4/18/89
SURFACE ELEVATION 430.02
TOP OF CASING ELEVATION 432.11
WELL CASING TYPE 4" schedule 40 PVC
FORMATION OF COMPLETION Lower Dilworth SandstoneTOTAL DEPTH 110.0 feet
RIG TYPE Gardner-Denver 1500
BORING TYPE 8" tricone
LOCATION N 66836.50 E 65846.00
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DEWEESVILLE SANDSTONE MEMBER: silty sand, trace clay, fine, predominately hard, light grey to tan.
5		Cement / bentonite slurry grout			Note: more clay from 5 to 10 feet.
10					CONQUISTA CLAY MEMBER: clayey sand, considerable silt, light grey to brown.
15					
20					Sandy clay, soft, light grey to light brown.
25		Bentonite chip seal			Clayey sand, fine sand, light grey interbedded with lense of light brown clay.
30					
35					Clay, fossiliferous, carbonaceous, dark grey to black.
40					
45					Note: lignite seam at 48.5 to 50 feet.
50					Clay, fossiliferous, carbonaceous.

GROUNDWATER

DEPTH	HOUR	DATE
85.9	N.K.	06/01/89

WATER

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 967JOB NO. FCT03 DATE 4/18/89SURFACE ELEVATION 430.02TOTAL DEPTH 110.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 432.11BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 66836.50 E 65846.00FORMATION OF COMPLETION Lower Dilworth SandstoneDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					black. Note: lignite seam at 52 to 53 feet.
60		Bentonite chip seal			DILWORTH MEMBER: sandstone, clay, fossiliferous, carbonaceous, grey to black.
65					Sand, silty, fine, soft, grey.
70					Clayey sand, fine, soft, grey.
75		10-20 Silica sand filter pack			Sand, medium fine, soft, trace to some grey clay.
80					Clayey sand, fine with interbedded siltstone and clays, grey.
85					
90		Screen slot size opening = 0.051 inches			Siltstone, with very fine sand, trace clays, grey.
95					Sand, trace to some clays, fine, relatively soft.
100					

GROUNDWATER

DEPTH	HOUR	DATE
85.9	N.K.	06/01/89

PROJECT UMTRAFalls City, TexasLOG OF TEST BORING NO. 967JOB NO. FCT03DATE 4/18/89TOTAL DEPTH 110.0 feetSURFACE ELEVATION 430.02RIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 432.11BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 66836.50 E 65846.00FORMATION OF COMPLETION Lower Dilworth SandstoneDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Formation cave-in material			Sandstone, fine, very hard, light grey.
					Sand, trace clays, fine, soft.
110					Stopped drilling at 110 feet.
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE
85.9	N.K.	06/01/89

PROJECT UMTRA
Falls City, Texas

Page 1 of 2
LOG OF TEST BORING NO. 968

JOB NO. FCT03 DATE 5/3/89

SURFACE ELEVATION 433.57

TOP OF CASING ELEVATION 435.36

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Lower Dilworth Sandstone

TOTAL DEPTH 80.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 64511.40 E 62105.50

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: black clay, alluvium.
5		Cement / bentonite slurry grout			Clay, white mottling, reddish brown.
10					
15					
20					DILWORTH SANDSTONE MEMBER: very fine, very hard, grey.
25		Bentonite chip seal			Silty sand, fine, grey.
30					
35					Silty sand, trace clay, soft, grey. Clayey sand, fine, soft, light green to tan.
40					Sand, relatively clean, fine, light grey to tan.
45					
50		10-20 Silica sand filter pack			

GROUNDWATER

DEPTH	MOOR	DATE
62.6	N.K.	05/31/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 968JOB NO. FCT03 DATE 5/3/89SURFACE ELEVATION 433.57TOTAL DEPTH 80.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 435.36BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 64511.40 E 62105.50FORMATION OF COMPLETION Lower Dilworth SandstoneDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					Sand, fine, occasional siltstone lenses.
60					
65		Screen slot size opening = 0.051 inches			Clayey sand, fine, light brown to grey.
70					
75					Siltstone, hard, light brown. Clayey sand, medium to fine grained, soft, light brown to grey.
80					Stopped drilling at 80 feet.
85					
90					
95					
100					

GROUNDWATER

DEPTH	WELL	DATE
62.6	N.K.	05/31/89

JOB NO. **FCT03** DATE **4/30/89**

SURFACE ELEVATION **440.38**

TOP OF CASING ELEVATION **442.72**

WELL CASING TYPE **4" schedule 40 PVC**

FORMATION OF COMPLETION **Dilworth Sandstone**

TOTAL DEPTH **110.0 feet**

RIG TYPE **Gardner-Denver 1500**

BORING TYPE **8" tricone**

LOCATION **N 57396.10 E 62190.40**

DATUM **MSL**

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					
5		Cement / bentonite slurry grout			CONQUISTA CLAY MEMBER: claystone, soft, greyish brown to light brown.
10					Sandy clay, soft, light brown to grey.
15					Silty sand, fine, tan to light brown.
20					
25					
30		Bentonite chip seal			Sandy clay, soft, light brown.
35					Clay, carbonaceous, fossiliferous, dark grey to black.
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
77.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 969JOB NO. FCT03 DATE 4/30/89TOTAL DEPTH 110.0 feetSURFACE ELEVATION 440.38RIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 442.72BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 57396.10 E 62190.40FORMATION OF COMPLETION Dilworth SandstoneDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60		Bentonite chip seal			
65					Note: lignite seam at 66 to 67 feet.
70					<u>DILWORTH SANDSTONE</u> <u>MEMBER:</u> sandy clays and clayey sand, interbedded carbonaceous, fossiliferous, dark grey.
75					
80		10-20 Silica sand filter pack			
85					
90					
95		Screen slot size opening = 0.051 inches			Clayey sand, fine, fossiliferous, medium to dark grey.
100					

GROUNDWATER

DEPTH	HOUR	DATE
77.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 969

JOB NO. FCT03 DATE 4/30/89

TOTAL DEPTH 110.0 feet

SURFACE ELEVATION 440.38

RIG TYPE Gardner-Denver 1500

TOP OF CASING ELEVATION 442.72

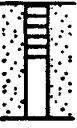
BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 57396.10 E 62190.40

FORMATION OF COMPLETION Dilworth Sandstone

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Formation cave-in material			
110					Stopped drilling at 110 feet.
115					
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	WELL	DATE
77.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 970JOB NO. FCT03 DATE 5/2/89TOTAL DEPTH 158.5 feetSURFACE ELEVATION 439.68RIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 441.46BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 57410.00 E 62203.80FORMATION OF COMPLETION Manning Clay FormationDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Cement / bentonite slurry grout			CONQUISTA CLAY MEMBER: claystone, silty clay, medium plastic to high plastic, soft, reddish brown to brown.
5					
10					
15					
20					Sandy clay, soft with considerable yellow to brown staining, grey.
25					
30		Bentonite chip seal			
35					Clayey sand, fine, brown with white mineral section. Clay, fossiliferous, carbonaceous, grey to black.
40					Note: same as above - 1 foot sand, fine, grey at 43 feet with trace of lignite at 43 feet.
45					
50					Sandy clay, fossiliferous, carbonaceous, grading to very sandy at 48.5 feet, dark grey.

GROUNDWATER

DEPTH	HOUR	DATE
116.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 970JOB NO. FCT03 DATE 5/2/89SURFACE ELEVATION 439.68TOTAL DEPTH 158.5 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 441.46BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 57410.00 E 62203.80FORMATION OF COMPLETION Manning Clay FormationDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					Clayey sand, fine, dark grey.
					Silty clay, occasional vertical fractures to 10 inches long, grey black
60					Sandy clay, soft, grey.
65					Clay, fossiliferous, carbonaceous, dark grey to black, lignite.
					Note: lignite seam from 66 to 68 feet.
70					
					DILWORTH SANDSTONE MEMBER Clay, fossiliferous, carbonaceous, dark grey to black.
75		Bentonite chip seal			Clayey sand, becoming more sandy with depth, grey.
					Sandstone, very fine, considerable silt and trace dark clay, moderately cemented, frequent dark banding.
80					
					Sandy clay, considerable silt, moderately well consolidated, occasional 2 inch interbedded sands.
85					Clay, trace to some fine sand, consolidated, grey.
90					Siltstone, alternating very hard sandstone and soft sands, fine, grey.
95					Sand, medium to fine grained, soft, grey.
100					

GROUNDWATER

DEPTH	HOUR	DATE
116.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 970JOB NO. FCT03 DATE 5/2/89SURFACE ELEVATION 439.68TOTAL DEPTH 158.5 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 441.46BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 57410.00 E 62203.80FORMATION OF COMPLETION Manning Clay FormationDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115		Bentonite chip seal			
120					Sandy clay, with sandstone nodules, dark grey.
125					Clayey sand, fine, relatively hard.
130		10-20 Silica sand filter pack			MANNING CLAY FORMATION Sandy clay, fossiliferous, occasional carbonaceous flecks, dark grey.
135					
140		Screen slot opening = 0.02 inches			Clay, trace fine sand, relatively hard, dark grey.
145					Siltstone with claystone, strongly cemented, grey to white.
150					Clay, relatively soft, dark grey.
155		Formation cave-in material			Clay, black carbonaceous mottling, light bluish grey.

GROUNDWATER

DEPTH	HOUR	DATE
116.5	N.K.	06/03/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 971

JOB NO. FCT03 DATE 4/28/89

SURFACE ELEVATION 389.97

TOTAL DEPTH 158.5 feet

RIG TYPE Gardner-Denver 1500

TOP OF CASING ELEVATION 392.14

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 55530.00 E 64106.40

FORMATION of COMPLETION Dilworth Sandstone

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: clay, soft, grey to black.
5		Cement / bentonite slurry grout			Sandy silty clay, greyish brown to brown.
10					
15					Clay, trace to some fine clay, reddish brown to brown,
20		Bentonite chip seal			
25					
30					Sandy clay, soft, grey.
35					Clay, fossiliferous and carbonaceous, strong sulfur odor, dark grey.
40					Note: lignite seam at 39 to 41 feet.
45					Sandy clay, carbonaceous, strong sulfur odor, grey.
50					

GROUNDWATER

DEPTH	HOUR	DATE
30.7	N.K.	05/31/89

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 971

JOB NO. FCT03 DATE 4/28/89

SURFACE ELEVATION 389.97

TOTAL DEPTH 158.5 feet

TOP OF CASING ELEVATION 392.14

RIG TYPE Gardner-Denver 1500

WELL CASING TYPE 4" schedule 40 PVC

BORING TYPE 8" tricone

FORMATION OF COMPLETION Dilworth Sandstone

LOCATION N 55530.00 E 64106.40

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55		Bentonite chip seal			
60					
65		10-20 Silica sand filter pack			
70					DILWORTH SANDSTONE MEMBER: siltstone and sand, alternating very hard, trace lignite.
75					
80		Screen slot opening = 0.02 inches			Clayey sand, fine, dark grey.
85					Sands, trace to some fine clay, predominately fine, dark grey.
90					
95					Stopped drilling at 95 feet.
100					

GROUNDWATER

DEPTH	HOUR	DATE
30.7	N.K.	05/31/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 973JOB NO. FCT03 DATE 4/12/89SURFACE ELEVATION 435.94TOTAL DEPTH 230.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 437.99BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 55362.30 E 66834.00FORMATION OF COMPLETION Manning ClayDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, clay, medium plastic to high plastic, light grey.
5		Cement / bentonite slurry grout			
10					
15					Sandy clay, considerable silt, light grey.
20					DEWEESVILLE SAND MEMBER: Whitsett Formation, very thin sandstone linses, reddish brown to light grey.
25		Bentonite chip seal			
30					Clayey sand, fine, light grey.
35					
40					Silty sand, soft, fine to medium grained, grey to brown.
45					Siltstone, hard, reddish brown.
					Silty sandstone, fine grained, trace clays, grey to light brown.
50					Sand, medium to fine with

GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 973JOB NO. FCT03 DATE 4/12/89SURFACE ELEVATION 435.94TOP OF CASING ELEVATION 437.99WELL CASING TYPE 4" schedule 40 PVCFORMATION OF COMPLETION Manning ClayTOTAL DEPTH 230.0 feetRIG TYPE Gardner-Denver 1500BORING TYPE 8" triconeLOCATION N 55362.30 E 66834.00DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					considerable silts, soft, moist.
60					
65					
70					CONQUISTA CLAY MEMBER: Whitsett Formation, claystone, considerable silt and fine sand, carbonaceous, fossiliferous, sulfur odor, grey to black.
75		Bentonite chip seal			
80					
85					
90					
95					Note: very strong sulfur odor at 95 to 100 feet.
100					

GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

PROJECT UMTRA Falls City, Texas LOG OF TEST BORING NO. 973
 JOB NO. FCT03 DATE 4/12/89 TOTAL DEPTH 230.0 feet
 SURFACE ELEVATION 435.94 RIG TYPE Gardner-Denver 1500
 TOP OF CASING ELEVATION 437.99 BORING TYPE 8" tricone
 WELL CASING TYPE 4" schedule 40 PVC LOCATION N 55362.30 E 66834.00
 FORMATION OF COMPLETION Manning Clay DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120					
125		Bentonite chip seal			
130					
135					
140					
145					Note: possibly lignite 140 to 145 with strong sulfur odor.
150					DILWORTH LOWER MEMBER: sand, fine sand, clayey with carbonaceous lenses, grey to brown.
155					

GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

1411

JOB NO. **FCT03** DATE **4/12/89**

SURFACE ELEVATION **435.94**

TOTAL DEPTH **230.0 feet**

RIG TYPE **Gardner-Denver 1500**

TOP OF CASING ELEVATION **437.99**

BORING TYPE **8" tricone**

WELL CASING TYPE **4" schedule 40 PVC**

LOCATION **N 55362.30 E 66834.00**

FORMATION OF COMPLETION **Manning Clay**

DATUM **MSL**

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					Sand, medium to fine grained considerable silt, very soft, grey.
170		Bentonite chip seal			
175					
180					Sand, medium to fine grained considerable silt, poor cuttings, recovery, very soft, increasing clays 180 to 185 feet, grey.
185					Sand, medium, some fine, some silt, grey.
190					
195					
200		10-20 Silica sand filter pack			MANNING CLAY MEMBER: Whitsett Formation, clay, fossiliferous, carbonaceous, soft, strong sulfur odor, grey to black.
205					

GROUNDWATER

DEPTH	HOUR	DATE
101.0	N.K.	05/11/89

PROJECT UMIRA **LOG OF TEST BORING NO. 973**
Falls City, Texas
 JOB NO. FCT03 DATE 4/12/89 TOTAL DEPTH 230.0 feet
 SURFACE ELEVATION 435.94 RIG TYPE Gardner-Denver 1500
 TOP OF CASING ELEVATION 437.99 BORING TYPE 8" tricone
 WELL CASING TYPE 4" schedule 40 PVC LOCATION N 55362.30 E 66834.00
 FORMATION OF COMPLETION Manning Clay DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210					MANNING CLAY FORMATION: Clay, fossiliferous, carbonaceous, soft, strong sulfur odor, grey to black.
215					
220		Screen slot opening = 0.02 inches			
225					
230					Stopped boring at 230 feet.
235					
240					
245					
250					
255					
260					

GROUNDWATER

DEPTH	INCH	DATE
101.0	N.K.	05/11/89

PROJECT UMTRA **LOG OF TEST BORING NO. 974**
Falls City, Texas
 JOB NO. FCT03 DATE 4/14/89 TOTAL DEPTH 170.0 feet
 SURFACE ELEVATION 434.84 RIG TYPE Gardner-Denver 1500
 TOP OF CASING ELEVATION 436.64 BORING TYPE 8" tricone
 WELL CASING TYPE 4" schedule 40 PVC LOCATION N 55370.60 E 66813.30
 FORMATION OF COMPLETION Dilworth Sand DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, clay, medium plastic to high plastic, soft, grey to light brown.
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					Clay, soft, reddish brown to purple.
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					Sand, silty and clayey, fine, soft.
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					Clay, reddish brown.
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					DEWEESVILLE FORMATION: sandstone, sand, hard.
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					Sandstone, sand, medium to fine
52					
53					
54					
55					
56					
57					
58					
59					
60					

GROUNDWATER

DEPTH	HOUR	DATE
▽	NONE	
▽		
▽		

PROJECT UMTRA
Falls City, Texas

LOG OF TEST BORING NO. 974

JOB NO. FCT03 DATE 4/14/89

TOTAL DEPTH 170.0 feet

SURFACE ELEVATION 434.84

RIG TYPE Gardner-Denver 1500

TOP OF CASING ELEVATION 436.64

BORING TYPE 8" tricone

WELL CASING TYPE 4" schedule 40 PVC

LOCATION N 55370.60 E 66813.30

FORMATION of COMPLETION Dilworth Sand

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					grained, considerable silt with clay.
60					Sandstone, sand, medium to fine grained, considerable silt with clay.
65					Sandstone, clay, carbonaceous, fossiliferous, with thin siltstone with sandstone lenses.
70					
75					
80					
85					
90					Sandstone, clay, carbonaceous, fossiliferous, with thin siltstone with sandstone lenses.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
7	NONE	

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 974JOB NO. FCT03 DATE 4/14/89SURFACE ELEVATION 434.84TOTAL DEPTH 170.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 436.64BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 55370.60 E 66813.30FORMATION OF COMPLETION Dilworth SandDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120					
125					
130					
135					
140					
145					
150					
155					

Sandstone, clay, carbonaceous, fossiliferous, with thin siltstone with sandstone lenses.

Note: lignite, lignitous clay, strong sulfur odor.

DILWORTH LOWER MEMBER:
sandstone, sandy clay, fine, relatively hard.

Sand, predominatly fine, relatively soft, grey.

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 974JOB NO. FCT03 DATE 4/14/89SURFACE ELEVATION 434.84TOTAL DEPTH 170.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 436.64BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 55370.60 E 66813.30FORMATION of COMPLETION Dilworth SandDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					
170					
175					Stopped boring at 170 feet, set well screen at 148 to 168.
180					
185					
190					
195					
200					
205					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 975JOB NO. FCT03 DATE 4/15/89SURFACE ELEVATION 449.62TOTAL DEPTH 210.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 451.89BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 60037.00 E 70540.80FORMATION OF COMPLETION Dilworth SandDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					DUBOSE MEMBER: Whitsett Formation, sand, considerable silt, fine, grey to white.
5					
10					
15					Clayey sand, fine, grey to white.
20					
25					
30					Clay, medium plasticity, reddish brown with white mottling.
35					
40					Clay, carbonaceous, soft, dark reddish brown.
45					
50					Sandy clay, considerable silt, carbonaceous, grey.

GROUNDWATER

DEPTH	HOUR	DATE
<u>NONE</u>		

PROJECT **UMTRA**
Falls City, Texas

LOG OF TEST BORING NO. 975

JOB NO. **FCT03** DATE **4/15/89** TOTAL DEPTH **210.0 feet**
 SURFACE ELEVATION **449.62** RIG TYPE **Gardner-Denver 1500**
 TOP OF CASING ELEVATION **451.89** BORING TYPE **8" tricone**
 WELL CASING TYPE **4" schedule 40 PVC** LOCATION **N 60037.00 E 70540.80**
 FORMATION OF COMPLETION **Dilworth Sand** DATUM **MSL**

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					
75					
80					
85					
90					
95					
100					

Sandy clay, considerable silt,
carbonaceous, grey.

Note: lignite seam

DEWEESVILLE FORMATION:
sandstone, medium to fine grained,
alternation hard to soft layers, light
grey,

Sandstone, medium to fine grained,
alternation hard to soft layers, light
grey,

Clayey sand, fine, soft, grey,

GROUNDWATER

DEPTH	HOUR	DATE
114	NONE	

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 975JOB NO. FCT03 DATE 4/15/89SURFACE ELEVATION 449.62TOTAL DEPTH 210.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 451.89BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 60037.00 E 70540.80FORMATION OF COMPLETION Dilworth SandDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					CONQUISTA CLAY FORMATION: sandy clay, relatively hard, grey,
120					Sandy clay, relatively hard, grey,
125					
130					
135					
140					
145					Sandy clay, soft, grey,
150					Sandy clay, soft, grey,
155					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 975JOB NO. FCT03 DATE 4/15/89SURFACE ELEVATION 449.62TOTAL DEPTH 210.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 451.89BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 60037.00 E 70540.80FORMATION OF COMPLETION Dilworth SandDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					Note: carbonaceous at 155 feet.
165					
170					
175					
180					Note: lignite, with black clay interbedded.
185					DILWORTH LOWER MEMBER: sand, clayey, medium to fine grained, alternating hard to soft layers, grey.
190					
195					
200					Sand, fine, carbonaceous, soft, grey.
205					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT

UMTRA

Falls City, Texas

LOG OF TEST BORING NO.

975

JOB NO.

FCT03

DATE

4/15/89

TOTAL DEPTH

210.0 feet

SURFACE ELEVATION

449.62

RIG TYPE

Gardner-Denver 1500

TOP OF CASING ELEVATION

451.89

BORING TYPE

8" tricone

WELL CASING TYPE

4" schedule 40 PVC

LOCATION

N 60037.00 E 70540.80

FORMATION of COMPLETION

Dilworth Sand

DATUM

MSL

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	210					
						Stopped boring at 210 feet.
	215					
	220					
	225					
	230					
	235					
	240					
	245					
	250					
	255					
	260					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRA
Falls City, Texas

Page 1 of 2

LOG OF TEST BORING NO. 976

JOB NO. FCT03 DATE 4/26/89

SURFACE ELEVATION 359.42

TOP OF CASING ELEVATION 361.27

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Upper Dilworth

TOTAL DEPTH 110.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 66683.63 E 71636.97

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					ALLUVIUM: sandy clay, soft, grey to black.
5					
10					Sand, fine, dark grey to black.
15					CONQUISTA CLAY MEMBER: clay, trace to some fine sand, grey to black.
20					Silty sand, predominately fine, light brown to brown.
25					
30					Note: fossiliferous sandstone unit.
35					
40					Clay, relatively hard, fossiliferous, dark grey to black.
45					Clay, relatively hard, fossiliferous, dark grey to black.
50					

GROUNDWATER

DEPTH	HOUR	DATE
19.5	N.K.	

PROJECT UMTRA
Falls City, Texas

Page 2 of 2

LOG OF TEST BORING NO. 976

JOB NO. FCT03 DATE 4/26/89

SURFACE ELEVATION 359.42

TOP OF CASING ELEVATION 361.27

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Upper Dilworth

TOTAL DEPTH 110.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 66683.63 E 71636.97

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					Clayey sand, fossiliferous, dark grey to black.
60					<u>CONQUISTA CLAY MEMBER:</u> clay, carbonaceous, dark grey to black.
65					
70					<u>CONQUISTA CLAY MEMBER:</u> sandy clay, fossiliferous, carbonaceous, dark grey to black.
75					<u>CONQUISTA CLAY MEMBER:</u> sandy clay, alternating hard to soft.
80					<u>DILWORTH LOWER MEMBER:</u> lignite, lenses at 77 to 78 feet.
85					Note: trace yellow mineralization, 85 to 86 feet.
90					Sandy clay, occasional siltstone, relatively hard,
95					Clay, relatively soft, grey to black.
100					Stopped drilling at 100 feet.

GROUNDWATER

DEPTH	HOUR	DATE
19.5	N.K.	

PROJECT UMTRA
Falls City, Texas

Page 1 of 1

LOG OF TEST BORING NO. 977

JOB NO. FCT03 DATE 4/25/89
 SURFACE ELEVATION 359.42
 TOP OF CASING ELEVATION 361.17
 WELL CASING TYPE 4" schedule 40 PVC
 FORMATION OF COMPLETION Conquista Clay Member

TOTAL DEPTH 40.0 feet
 RIG TYPE Gardner-Denver 1500
 BORING TYPE 8" tricone
 LOCATION N 66667.66 E 71651.71
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					ALLUVIUM: sandy clay, soft, grey to black.
5					
10					Sand, fine, dark grey.
15					CONQUISTA CLAY MEMBER: clay, trace to some fine sand, grey to black.
20					Silty sand, predominately fine, light brown to brown.
25					
30					Note: fossiliferous sandstone unit.
35					
40					CONQUISTA CLAY MEMBER: clay, relatively hard, fossiliferous, dark grey to black.
45					Stopped drilling at 40 feet.
50					

GROUNDWATER

DEPTH	HOUR	DATE
20.5	N.K.	04/25/89

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 978JOB NO. FCT03 DATE 4/28/89SURFACE ELEVATION 414.63TOTAL DEPTH 140.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 417.12BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 64822.20 E 63668.70FORMATION OF COMPLETION Manning Clay FormationDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: clay, soft, yellowish brown.
5					DILWORTH LOWER MEMBER: sand, fine, brown to grey.
10					
15					Clayey sand, soft, grey to brown.
20					
25					Sand, predominately fine, soft.
30					
35					
40					Sand, predominately fine, soft, light brown to grey brown.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRAFalls City, TexasLOG OF TEST BORING NO. 978JOB NO. FCT03 DATE 4/28/89SURFACE ELEVATION 414.63TOTAL DEPTH 140.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 417.12BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 64822.20 E 63668.70FORMATION OF COMPLETION Manning Clay FormationDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					Note: some interbedded black clays 70 to 80 feet.
75					Note: relatively hard, cemented lenses 70 to 80 feet.
80					
85					
90					
95					
100					MANNING CLAY FORMATION: sandy clay, relatively slow drilling, grey to black.

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRA
Falls City, TexasLOG OF TEST BORING NO. 978JOB NO. FCT03 DATE 4/28/89SURFACE ELEVATION 414.63TOTAL DEPTH 140.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 417.12BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 64822.20 E 63668.70FORMATION OF COMPLETION Manning Clay FormationDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120					
125					
130					
135					
140					
145					
150					
155					

Sandy clay, relatively slow drilling,
grey to black.

Stopped drilling at 140 feet.

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

4/28/89

PROJECT UMTRA
Falls City, Texas

Page 1 of 2

LOG OF TEST BORING NO. 979

JOB NO. FCT03 DATE 4/18/89

SURFACE ELEVATION 418.40

TOP OF CASING ELEVATION 420.81

WELL CASING TYPE 4" schedule 40 PVC

FORMATION OF COMPLETION Dilworth Sand Whitsett Formation

TOTAL DEPTH 102.0 feet

RIG TYPE Gardner-Denver 1500

BORING TYPE 8" tricone

LOCATION N 65119.20 E 65944.60

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0					CONQUISTA CLAY MEMBER: clay, soft, medium to hard plastic, black.
5		Bentonite cement slurry grout			Sandy clay, relatively hard, grey.
10					
15					Clayey sand, very fine, considerable silt, light grey.
20					Sandy clay, relatively soft, grey to grey brown.
25					
30					Clay, carbonaceous, medium to high plastic, dark grey.
35					Note: lignite layers from 36 to 37 feet and 38 to 39 feet.
40		Bentonite pellet seal			DILWORTH LOWER MEMBER: silty sand, fine, grey.
45					
50					Sandy clay, dark grey.

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT UMTRA

Page 2 of 2

LOG OF TEST BORING NO. 979Falls City, TexasJOB NO. FCT03 DATE 4/18/89SURFACE ELEVATION 418.40TOTAL DEPTH 102.0 feetRIG TYPE Gardner-Denver 1500TOP OF CASING ELEVATION 420.81BORING TYPE 8" triconeWELL CASING TYPE 4" schedule 40 PVCLOCATION N 65119.20 E 65944.60FORMATION OF COMPLETION Dilworth Sand Whitsett FormationDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60		10-20 Silica sand filter pack			Sand, very fine, hard, grey. Sand, very fine, considerable silt, light grey.
65					
70					
75					
80		Screen slot size opening = 0.051 inches			Sand, medium to fine, silty, light grey.
85					
90					
95		Bentonite pellet backfill			
100					
					Stopped drilling at 100 feet.

GROUNDWATER

DEPTH	HOUR	DATE
	NONE	

PROJECT Falls City Site
Texas

Page 1 of 6
 LOG OF WELL BORING NO. 1012

JOB NO. FCT01 DATE _____ TOTAL DEPTH 284.0 feet
 SURFACE ELEVATION _____ WELL OWNER _____
 DEPTH OF SEAL _____ BORING TYPE _____
 WELL CASING TYPE 4-in ID, Sched. 40 PVC LOCATION N E
 COMPLETION _____ DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		SLOTTED FROM 226 TO 276 FT.		SM	SAND, WITH OCC THIN LENSES OF CLAY/SHALE
5					
10		POSSIBLE SAND PACK FROM 167 TO TD.			
15					
20					
25					
30					
35					
40					
45					
50					

GROUNDWATER		
DEPTH	HOUR	DATE
▽		
▽		
▽		

JEG TAC TEAM

PROJECT Falls City Site
Texas

Page 2 of 6
 LOG OF WELL BORING NO. 1012

JOB NO. FCT01 DATE _____
 SURFACE ELEVATION _____
 DEPTH OF SEAL _____
 WELL CASING TYPE 4-in ID, Sched. 40 PVC
 COMPLETION _____

TOTAL DEPTH 284.0 feet
 WELL OWNER _____
 BORING TYPE _____
 LOCATION N E
 DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70				CL	SHALE
75				SM	SAND
80					
85					
90				CL	CLAY/SHALE
95					
100				SM	SAND

GROUNDWATER		
DEPTH	HOUR	DATE
▽		
▽		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1012

JOB NO. FCT01 DATE _____ TOTAL DEPTH 284.0 feet
SURFACE ELEVATION _____ WELL OWNER _____
DEPTH OF SEAL _____ BORING TYPE _____
WELL CASING TYPE 4-in ID, Sched. 40 PVC LOCATION N E
COMPLETION _____ DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120					
125					
130					
135					
140					
145				CL	CLAY/SHALE
150					
155					

GROUNDWATER		
DEPTH	HOUR	DATE
Δ		
▽		

JEG TAC TEAM

PROJECT Falls City Site
Texas

Page 4 of 6
 LOG OF WELL BORING NO. 1012

JOB NO. FCT01 DATE _____
 SURFACE ELEVATION _____
 DEPTH OF SEAL _____
 WELL CASING TYPE 4-in ID, Sched. 40 PVC
 COMPLETION _____

TOTAL DEPTH 284.0 feet
 WELL OWNER _____
 BORING TYPE _____
 LOCATION N E
 DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					
170					
175				SM	(USING DENSITY LOG BELOW FILTER PACK) SAND
180					
185				CL	CLAY/SHALE
190					
195				SM	
200					
205				CL	CLAY/SHALE

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

JOB NO. <u>FACT01</u>	DATE _____	TOTAL DEPTH <u>284.0 feet</u>
SURFACE ELEVATION _____	WELL OWNER _____	
DEPTH OF SEAL _____	BORING TYPE _____	
WELL CASING TYPE <u>4-in ID, Sched. 40 PVC</u>	LOCATION <u>N E</u>	
COMPLETION _____	DATUM <u>MSL, GROUND SURFACE</u>	

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	210					
	215				SM	SAND
	220				CL	CLAY/SHALE
	225					
	230					
	235					
	240					
	245					
	250				CL SC	SAND SHALE
	255					
	260					

GROUNDWATER		
DEPTH	HOUR	DATE

PROJECT Falls City Site
Texas

Page 6 of 6
 LOG OF WELL BORING NO. 1012

JOB NO. FCT01 DATE _____
 SURFACE ELEVATION _____
 DEPTH OF SEAL _____
 WELL CASING TYPE 4-in ID, Sched. 40 PVC
 COMPLETION _____

TOTAL DEPTH 284.0 feet
 WELL OWNER _____
 BORING TYPE _____
 LOCATION N E
 DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
260					
265					
270				SM	SAND
275					Note: Coal seam at 272 to 273 ?
280					
285					TD AT 284
290					
295					
300					
305					
310					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1000

JOB NO. FCT01 DATE _____ TOTAL DEPTH 207.0 feet
SURFACE ELEVATION _____ WELL OWNER _____
DEPTH OF SEAL _____ BORING TYPE unknown
WELL CASING TYPE 3.8 ID steel LOCATION N E
COMPLETION windmill DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					
75					
80					
85					
90				SM	SAND
95					
100				CL	SHALE

GROUNDWATER		
DEPTH	HOUR	DATE
116.0		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1000

JOB NO. FCT01 DATE _____ TOTAL DEPTH 207.0 feet
SURFACE ELEVATION _____ WELL OWNER _____
DEPTH OF SEAL _____ BORING TYPE unknown
WELL CASING TYPE 3.8 ID steel LOCATION N E
COMPLETION windmill DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115				SM	SAND
120					
125					
130					
135					
140					
145					
150					
155					

GROUNDWATER		
DEPTH	HOUR	DATE
116.0		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1000

JOB NO. FCT01 DATE _____

TOTAL DEPTH 207.0 feet

SURFACE ELEVATION _____

WELL OWNER _____

DEPTH OF SEAL _____

BORING TYPE unknown

WELL CASING TYPE 3.8 ID steel

LOCATION N E

COMPLETION windmill

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					
170					
175					
180				CL	SHALE
185					
190					
195					
200					
205					
					TD AT 207

GROUNDWATER

DEPTH	HOUR	DATE
116.0		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE _____

TOTAL DEPTH 435.0 feet

SURFACE ELEVATION _____

WELL OWNER _____

DEPTH OF SEAL _____

BORING TYPE _____

WELL CASING TYPE 3.85 ID steel

LOCATION N E

COMPLETION windmill

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		SURFACE CASING TO 45 FEET.	?		SURFACE CASING TO 45 MASKS LITHOLOGY
5		SLOTTED SECTION FROM 141 TO 201 AND 401 TO 431	?		
10		BROKEN JOINT AT 321?	?		
15			?		
20			?		
25			?		
30			?		
35			?		
40			?		
45			?	SM	SAND
50					

GROUNDWATER		
DEPTH	HOUR	DATE
Δ		
▽		

JEG TAC TEAM

PROJECT Falls City Site
Texas

Page 3 of 9
LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE _____

TOTAL DEPTH 435.0 feet

SURFACE ELEVATION _____

WELL OWNER _____

DEPTH OF SEAL _____

BORING TYPE _____

WELL CASING TYPE 3.85 ID steel

LOCATION N E

COMPLETION windmill

DATUM MSL, GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105						
110						
115						
120						
125						
130						
135						
140						
145						
150						
155						

GROUNDWATER

DEPTH	HOUR	DATE
▽		
▽		
▽		

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE _____ TOTAL DEPTH 435.0 feet
SURFACE ELEVATION _____ WELL OWNER _____
DEPTH OF SEAL _____ BORING TYPE _____
WELL CASING TYPE 3.85 ID steel LOCATION N E
COMPLETION windmill DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165					
170					
175					
180					
185					
190					
195					
200					
205					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 **DATE** _____ **TOT** _____

TOTAL DEPTH 435.0 feet

SURFACE ELEVATION

WELL OWNER _____

DEPTH OF SEAL _____

BORING TYPE _____

WELL CASING TYPE 3.85 ID steel

LOCATION	N	E

COMPLETION windmill

DATUM MSL, GROUND SURFACE

	Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
	210					
	215					
	220					
	225					
	230					
	235				CL	SHALE
	240				SM	SAND
	245					
	250					
	255					
	260					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE _____ TOTAL DEPTH 435.0 feet
SURFACE ELEVATION _____ WELL OWNER _____
DEPTH OF SEAL _____ BORING TYPE _____
WELL CASING TYPE 3.85 ID steel LOCATION N E
COMPLETION windmill DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
260					
265					
270					
275					
280				CL	SHALE
285				SM	SAND
290					
295					
300					
305					
310					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE _____

TOTAL DEPTH 435.0 feet

SURFACE ELEVATION _____

WELL OWNER _____

DEPTH OF SEAL _____

BORING TYPE _____

WELL CASING TYPE 3.85 ID steel

LOCATION N E

COMPLETION windmill

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
315					
320					
325					
330					
335					
340					
345					
350					
355					
360					

GROUNDWATER		
DEPTH	HOUR	DATE
▽		
▽		

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1003

JOB NO. FCT01 DATE _____

TOTAL DEPTH 435.0 feet

SURFACE ELEVATION _____

WELL OWNER _____

DEPTH OF SEAL _____

BORING TYPE _____

WELL CASING TYPE 3.85 ID steel

LOCATION N E

COMPLETION windmill

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
365					
370					
375					
380					
385					
390					
395					
400					
405					
410					
415					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

Page 1 of 3
LOG OF WELL BORING NO. 1010

JOB NO. FCT01 DATE _____ TOTAL DEPTH 135.0 feet
SURFACE ELEVATION _____ WELL OWNER _____
DEPTH OF SEAL _____ BORING TYPE _____
WELL CASING TYPE 3.85 in. ID LOCATION N E
COMPLETION _____ DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		SLOTTED SECTION FROM 89 TO 109	?		POSSIBLE STEEL SURFACE CASING TO 14 FEET
			?		
			?		
			?		
			?		
			?		
			?		
			?		
			?		
			?		
5		SLOTTED SECTION SEVERELY CORRODED. POSSIBLE BREAK AT 98 FT	?		
			?		
			?		
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			?		
			?		
			?		
			?		
15			CL		CLAY OR GROUT SEAL?
20					
25					
30			CL		SANDY CLAY ?
35					
40					
45					
50					
				SM	SAND

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1010

JOB NO. FCT01 **DATE** _____ **TOT**

TOTAL DEPTH 135.0 feet

SURFACE ELEVATION

WELL OWNER _____

DEPTH OF SEAL _____

BORING TYPE

WELL CASING TYPE 3.85 in. ID

LOCATION	N	E

COMPLETION _____

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65					
70					
75					
80					
85					
					COAL OR BENTONITE SEAL
90				SM	SAND
95					
100					

GROUNDWATER

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 **DATE** _____

TOTAL DEPTH 281.0 feet

SURFACE ELEVATION

WELL OWNER

DEPTH OF SEAL _____

BORING TYPE

WELL CASING TYPE 4.9 in ID

LOCATION **N** **E**

COMPLETION _____

DATUM	MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		SLOTTED SECTION AT 112 TO 152 AND FROM 251 TO 276.			(No log from surface to 50 because of steel casing masking lithology)
5					
10		BROKEN JOINT AT 251			
15					
20					
25					
30					
35					
40					
45					
50					
				SM	SAND

GROUNDWATER

	DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. <u> FCT01 </u>	DATE <u> </u>	TOTAL DEPTH <u>281.0 feet</u>
SURFACE ELEVATION <u> </u>		WELL OWNER <u> </u>
DEPTH OF SEAL <u> </u>		BORING TYPE <u> </u>
WELL CASING TYPE <u> 4.9 in ID </u>		LOCATION <u> N E </u>
COMPLETION <u> </u>		DATUM <u> MSL, GROUND SURFACE </u>

<i>Depth</i>	<i>Well Con.</i>	<i>Remarks</i>	<i>Lithology</i>	<i>USCS</i>	<i>Visual Classification</i>
55					
				CL	CLAY/SHALE
60				SM	SAND
65					
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. <u> FCT01 </u>	DATE <u> </u>	TOTAL DEPTH <u>281.0 feet</u>
SURFACE ELEVATION <u> </u>		WELL OWNER <u> </u>
DEPTH OF SEAL <u> </u>		BORING TYPE <u> </u>
WELL CASING TYPE <u> 4.9 in ID </u>		LOCATION <u> N E </u>
COMPLETION <u> </u>		DATUM <u> MSL, GROUND SURFACE </u>

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105				CL	CLAY/SHALE
110					
115					
120					
125					
130					
135				SM	SAND
140					
145					
150					
155					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 DATE _____
SURFACE ELEVATION _____
DEPTH OF SEAL _____
WELL CASING TYPE 4.9 in ID
COMPLETION _____

TOTAL DEPTH 281.0 feet
WELL OWNER _____
BORING TYPE _____
LOCATION N E
DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
160					
165				CL	CLAY/SHALE
170					
175				SM	SAND
180					
185				CL	CLAY/SHALE
190					
195					
200					
205					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

Page 5 of 6
 LOG OF WELL BORING NO. 1011

JOB NO. FCT01 DATE _____
 SURFACE ELEVATION _____
 DEPTH OF SEAL _____
 WELL CASING TYPE 4.9 in ID
 COMPLETION _____

TOTAL DEPTH 281.0 feet
 WELL OWNER _____
 BORING TYPE _____
 LOCATION N E
 DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210					
215				SM	SAND
220				CL SC	SANDY CLAY
225					
230					
235					
240					
245				CL	SHALE
250				SM	SAND
255					
260				CL	CLAY

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT Falls City Site
Texas

LOG OF WELL BORING NO. 1011

JOB NO. FCT01 **DATE** _____

TOTAL DEPTH 281.0 feet

SURFACE ELEVATION

WELL OWNER

DEPTH OF SEAL _____

BORING TYPE

WELL CASING TYRE 4.9 in ID

LOCATION **N** **E**

COMPLETION

DATUM MSL, GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
260					
265					
270					
275					
280					
285					
290					
295					
300					
305					
310					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM