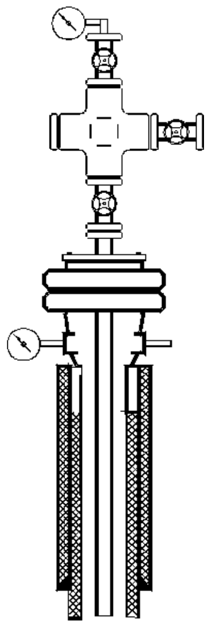
PERMIT APPLICATION TO DISPOSE OF WASTE IN A CLASS I INJECTION WELL

-PERMIT RENEWAL APPLICATIONS -

- WDW-120 AND WDW-312 -



TYSON FRESH MEATS, INC.
AMARILLO HIDES DEPARTMENT
AMARILLO, TEXAS

November 2024

PERMIT APPLICATION TO DISPOSE OF WASTE IN A CLASS I INJECTION WELL

- PERMIT RENEWAL APPLICATIONS -
- WDW-120 AND WDW-312 -

Prepared for

TYSON FRESH MEATS, INC.
AMARILLO HIDES DEPARTMENT
AMARILLO, TEXAS

Prepared by

TERRA DYNAMICS INC

Round Rock, Texas

Project No. 24-112
November 2024

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WDW-120

Texas Commission on Environmental Quality
Permit Application to Dispose of Waste
In A Class I Injection Well

I. General Information

A. Type of Application (check all that apply):

☐ Initial
☑ Renewal
☐ Major Amendment
☐ Minor Amendment
☐ Minor Modification
☐ Transfer
☐ Endorsement

Type of Waste (check all that apply):

☐ Hazardous Waste
☑ Nonhazardous Waste

Type of Facility (check all that apply):

☐ Commercial
☑ Noncommercial

Source of waste for noncommercial (check all that apply):

☑ Onsite
☐ Captured facility
☐ Offsite from facilities owned or effectively controlled by owner/operator

B. Facility Name: Tyson Fresh Meats, Inc.

Street Address: 5000 N. FM 1912

City, State, Zip: Amarillo, TX 79187

Mailing Address: PO Box 30500

Mailing City, State, Zip: Amarillo, TX 79187

County: Potter

TCEQ Solid Waste Registration (SWR) Number: 31455

EPA ID Number: TXD065022121

Give a description of the location of the facility site with respect to known or easily identifiable landmarks. Detail the access routes from the nearest U.S. or State Highway to the facility: The Tyson Fresh Meats facility is located on a 450-acre site approximately 11 miles northeast of the Amarillo city limits. The facility is located on US Highway 60, immediately north of the junction of US Highway 60 and US Highway 66.

Is the facility located within the Coastal Management Program boundary? Refer to Texas Coastal Management Boundary Map [1] for boundary. For questions regarding the Coastal Management Program, please call (800) 998-4456 (within Texas) or (512) 475-0773. [30 TAC §281.41]

☐ Yes ☑ No

Provide the location of the injection well relative to established surveys: 2,862.3 feet from the north line and 1,680 feet from the west line of Section 19, Block 2 of the Adams, Beaty, and Moulton Survey.

Enter the geographical coordinates of the injection well in decimal degrees to 6 decimal places:

Latitude: 35.257300

Longitude: -101.648030

Provide the depths of the injection zone and injection interval:

Injection Zone: Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formation(s) at depths of 3,713 to 8,993 feet below ground level.

Injection Interval: Wichita and Brown Dolomite Formation(s) at depths of 3,993 to 4,993 feet below ground level

C. Operator/Applicant (Individual, Corporation, or other Legal Entity Name)

Name: Tyson Fresh Meats, Inc. (subsidiary of Tyson Foods, Inc.)

Address: PO Box 2020

City, State and Zip: Springdale, AR 72765-2020

Telephone Number: 479-290-4000

If the application is submitted on behalf of a corporation or other business organization with filing requirements, please identify the Charter Filing Number as recorded with the Office of the Secretary of State for Texas.

Charter Filing Number: 800013025

Is the applicant required to designate a registered agent with the Secretary of State of Texas?

☑ Yes ☐ No

[1] https://www.glo.texas.gov/coast/coastal-management/forms/files/CoastalBoundaryMap.pdf

If the application is submitted by a business organization that is required to designate and maintain a registered agent, the applicant must provide the name and address of the registered agent.

Agent: United Agent Group Inc.

Address: 5444 Westheimer #1000

City, State, and Zip: Houston, TX 77056

Telephone Number: 561-694-8107

D. Facility Owner(s) (Individual, Corporation, or other Legal Entity Name)

The facility includes all contiguous land, and structures, other appurtenances, and improvements on the land, used for storing, processing, or disposing of waste. The facility owner must be consistent with the owner on the deed filing bearing the stamp of the county property records or other generally accepted identifying reference of the current ownership record provided in Section I.P.5, Attachment C of the application. If the facility owner is the same as the operator, state "same as operator". If the facility land, structures, appurtenances, and improvements on the land are owned by more than one individual, corporation or other legal entity, provide the following information for all owners. Clearly identify the relationship(s) between the operator and all facility owner(s). [THSC §361.087(1)] **same as operator**

Name: _____

Address: _____

City, State, Zip: _____

Telephone Number: _____

Charter Filing Number: _____

E. Indicate the ownership status of the facility.

Private:

☑ Corporation
☐ Partnership
☐ Proprietorship
☐ Nonprofit organization

Public:

☐ Military
☐ State
☐ Regional
☐ County
☐ Municipal
☐ Federal

Other (specify): _____

F. List those persons or firms authorized to act for the applicant during the processing of the permit application. Indicate the capacity in which each person may represent the applicant (engineering, geology, legal, etc.). The person listed first will be the primary recipient of correspondence regarding this application. Include complete mailing addresses, phone numbers and e-mail addresses.

Administrative issues	Technical issues
Mr. Eric Rodriquez, Area Environmental Manager Tyson Fresh Meats, Inc. P. O. Box 30500 Amarillo, TX 79187 (806) 335-7418 eric.rodriquez@tyson.com	Mr. Brian Shin, PG Terra Dynamics Incorporated 2300 Greenhill Dr. Ste 700 Round Rock, TX 78664 (512) 795-8183 bshin@terradyn.com

G. For new, renewal, and major amendment applications specify the individual who will be responsible for causing notice to be published in the newspaper. Include the complete mailing address, telephone number, fax number and e-mail address.

Mr. Eric Rodriquez, Area Environmental Manager
Tyson Fresh Meats, Inc.
P. O. Box 30500
Amarillo, TX 79187
(806) 335-7418 eric.rodriquez@tyson.com

H. Describe the activities conducted by the applicant which require a permit.

Injection of nonhazardous wastewater from hides processing facility

I. For amendment, modification, transfer or endorsement applications, briefly describe all requested changes to the permit and to the application contents and the reasons for the changes.

None.

J. Business Information

1. Give a brief description of the nature of your business.

   Beef production complex (slaughtering, rendering and tannery).

2. List the principal products and/or services which are provided by your plant. Please itemize by Standard Industrial Classification (SIC) codes. Also label the products with their common names, if applicable.

SIC Code 2011:	Wet salted cattle hides West blue cattle hides Edible beef products Tallow – edible
SIC Code 2077:	Bone meal Tallow – inedible
SIC Code 3111:	Leather Tanning and Finishing

K. Applicant Compliance History

The TCEQ will utilize compliance history when making decisions regarding the issuance, renewal, amendment, modification, denial, suspension, or revocation of a permit. Violations included in a criminal conviction are considered when evaluating and classifying the site's compliance history.

For the five years preceding the filing date of this application, please submit a complete listing of all criminal convictions (i.e., State or Federal) of the operator and facility owner in which a violation of environmental law was an element of the crime. [30 TAC §60.2(d)(1)(E) and §60.2(d)(2)(F)] If there have been no such convictions then the application should state the following. If the operator is not the facility owner, a separate statement should be provided for each facility owner.

> "In the five years preceding the filing of this application (the operator/applicant, owner), Tyson Fresh Meats, Inc., has not been convicted of a State or Federal crime in which a violation of environmental law was an element of the crime."

L. TCEQ Core Data Form

The TCEQ requires that a Core Data Form[2] (TCEQ-10400) be submitted with all new and renewal applications. Submit the form as "Attachment A". For all other applications, if a Regulated Entity Number (RN) and Customer Reference Number (CN) have been issued by the TCEQ and core data information has not changed, a Core Data Form is not required. For more information regarding the Core Data Form, call (512) 239-5175 or go to the Core Data Form Instructions[3] on the TCEQ website.

RN **100212943**

CN **600767016**

M. Public Interest Demonstration

Section 27.051 of the Texas Water Code (TWC) stipulates certain conditions that must exist for the Commission to grant an application and issue a permit. For all new applications, permit renewals, and major and minor amendments, submit as "Attachment B" information addressing the following considerations: Attachment A is provided.

1. That the use or installation of the injection well is in the public interest. [TWC§27.051(a)(1)]

2. That no existing rights, including, but not limited to, mineral rights, will be impaired. [TWC §27.051(a)(2)]

3. That, with proper safeguards, both ground and surface fresh water can be adequately protected from pollution. [TWC §27.051(a)(3)]

4. That the applicant has made a satisfactory showing of financial responsibility if required by Section 27.073 of this code. [TWC §27.051(a)(4)]

[2] https://www.tceq.texas.gov/downloads/permitting/central-registry-docs/10400-core-data-form.docx
[3] https://www.tceq.texas.gov/downloads/permitting/central-registry-docs/10400-core-data-form-instructions.pdf

5. That the compliance history of the applicant and related entities is acceptable. [TWC §27.051(d)(1), 30 TAC § 331.121(b)(1)]

6. That there is no practical, economic, and feasible alternative to an injection well reasonably available. Provide justification for subsurface disposal. Include results of treatability studies of alternate, practical, economic and feasible methods of waste disposal. Explain in detail why each method is considered to be less satisfactory in terms of environmental protection than the proposed subsurface disposal method. Indicate whether this waste is presently being produced and, if so, what method is used for disposal. Describe the manufacturing process(es) and product(s) which produce the waste(s). [TWC §27.051(d)(2), 30 TAC § 331.121(b)(2)]

7. (for hazardous waste injection wells only) That the applicant has provided for the proper operation of the proposed hazardous waste injection well. [TWC §27.051(a)(5)]

8. (for hazardous waste injection wells only) That the applicant for a hazardous waste injection well not located in an area of industrial land use has made a reasonable effort to ensure that the burden, if any, imposed by the proposed hazardous waste injection well on local law enforcement, emergency medical or fire-fighting personnel, or public roadways, will be reasonably minimized or mitigated. [TWC §27.051(a)(6)]

9. (for hazardous waste injection wells only) That the applicant owns or has made a good faith claim to own, or has the consent of the owner to utilize, or has an option to acquire, or has the authority to acquire through eminent domain, the property or portions of the property where the hazardous waste injection well will be constructed. [TWC §27.051(a)(7)]

10. (for hazardous waste injection wells only) That the applicant will maintain sufficient public liability insurance for bodily injury and property damage to third parties that is caused by sudden and non-sudden accidents or will otherwise demonstrate financial responsibility in a manner adopted by the Commission in lieu of public liability insurance. [TWC §27.051(d)(3), 30 TAC § 331.121(b)(3)]

11. (for hazardous waste injection wells only) For on-site generated waste, provide certification by the owner/operator that (1) the generator of the hazardous waste has a program to reduce the volume or quantity and toxicity of the waste to the degree determined by the generator to be economically practicable, and (2) injection of the waste is that practicable method of disposal currently available to the generator which minimizes the present and future threat to human health and the environment. [30 TAC §331.121(b)(4)]

N. For applications for new permits, renewals, and major amendments, a copy of the administratively complete application and subsequent revisions must be made available at a public place in the county where the facility is located or proposed to be located for review and copying by the public. Identify the public place in the county (e.g., public library, county courthouse, city hall), including the address, where the application will be located. [30 TAC §39.405(g)]

Amarillo Public Library – Downtown
413 SE 4th
Amarillo, TX 79101

O. Facility Background Information [30 TAC §305.45(a)(7)]

Indicate (by listing the permit number(s) and governing agency(ies) in the columns below) all existing, pending, interim status, or permit-by-rule State and/or Federal permits, licenses or construction approvals which pertain to pollution control or industrial solid waste management activities conducted by your plant or at your location, or existing at a proposed plant or location. Complete each blank by entering either the **permit number** or **the date of application**, and the **governing agency** or **none**.

Existing Permits

Relevant Program and/or Law	Permit Number or License	Government Agency *
Hazardous Waste Management Program under the Texas Solid Waste Disposal Act	none	
UIC Program under the Texas Injection Well Act (Class I, II, III, IV, V and VI Wells)	WDW-120, WDW-312	TCEQ
Texas Pollutant Discharge Elimination System Program under the Clean Water Act and Waste Discharge Program under the Texas Water Code, Chapter 26	TXR05M948	TCEQ
Prevention of Significant Deterioration Program under the Federal Clean Air Act (FCAA)	none	
Nonattainment Program under the FCAA	none	
National Emission Standards for Hazardous Air Pollutants preconstruction approval under the FCAA	none	
Ocean dumping permits under the Marine Protection Research and Sanctuaries Act	none	
Dredge or fill permits under the Federal Clean Water Act	none	
Licenses under the Texas Radiation Control Act	none	
Subsurface Area Drip Dispersal System permits under Texas Water Code, Chapter 32	none	
Texas Solid Waste Disposal Act	31455	TCEQ
Texas Uranium Surface Mining and Reclamation Act	none	
Texas Surface Coal Mining and Reclamation Act	none	
Other relevant environmental permits/licenses	**	
** Texas Clean Air Act	PG-0024-R 1072, 1073, 1074, 6721, 21000, 44100	TCEQ

* Use the following acronyms for each agency:

TCEQ = Texas Commission on Environmental Quality
RRC = Railroad Commission of Texas
DSHS = Department of State Health Services
TDA = Texas Department of Agriculture
EPA = U.S. Environmental Protection Agency
CORPS = U.S. Army Corps of Engineers

P. Location

1. Is the facility located on Indian lands?

☐ Yes ☑ No

If yes, do not complete this application. Contact EPA Region 6 for application and permitting requirements for injection wells located on Indian lands. [40 CFR §147.2205(a)]

2. Is the facility located in an area in which the governing body of the county or municipality has prohibited the processing or disposal of municipal hazardous waste or industrial solid waste?

   ☐ Yes ☑ No

   If yes, do not complete this application. TCEQ may not grant an application for an injection well permit in this area. [THSC §363.112(d)]

3. If the facility is a new commercial hazardous waste management facility, or the subsequent areal expansion of such a facility, is the boundary of the well or pre-injection units to be located within ½ of a mile of an established residence, church, school, day care center, surface water body used for public drinking water supply, or dedicated park?

   ☐ Yes ☑ No

   If yes, do not complete this application. TCEQ may not issue a permit for a facility in this location. [30 TAC §335.205(a)(3)]

4. Is the location or proposed location of the injection well in the territory of a groundwater conservation district? To determine if the injection well is or will be located in the territory of a groundwater conservation district refer to the Texas Groundwater Conservation District map[4] on the TWDB website.

   ☑ Yes ☐ No

   If yes, provide the contact name and mailing address for the groundwater conservation district. To obtain a point of contact and mailing address refer to the Groundwater Conservation Districts Contact List[5] on the TCEQ website. [TWC §27.017(b)]

   Ms. Britney Britten, Manager
   Panhandle Groundwater Conservation District
   P.O. Box 637
   White Deer, TX 79097

5. Legal Description of Facility Land

   Submit, as "Attachment C", a legal description of the tract or tracts of land upon which the facility is or will be located and the deed filing bearing the stamp of the county property records or other generally accepted identifying reference of the current ownership record. If ownership of the property is transferring and new ownership documents are not final, provide the date upon which the documents will be submitted. The facility includes all contiguous land, and structures, other appurtenances, and improvements on the land, used for storing, processing, or disposing of waste including pre-injection units used for storage and processing waste to be injected into the injection well. The legal description should include the metes and bounds description or for platted urban sites the final plat with appropriate "lot" description(s). [THSC §361.087(2)]

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[4] https://www.twdb.texas.gov/mapping/doc/maps/GCDs_8x11.pdf

[5] https://www.tceq.texas.gov/downloads/groundwater/gcd/gcd-contact-list.pdf

A legal description of the facility is provided in Attachment C. Waste management operations for this permit application occur in Section 19 of TRACT ONE (1).

6. Submit, as "Attachment D", a drawn-to-scale topographic map of the facility and the tract or tracts of land upon which the facility is or will be located as described in Attachment C and area extending at least one mile beyond the tract boundaries. The map must be prepared by a licensed professional engineer or a registered surveyor. The scale should be adequate to depict the following features: [30 TAC §305.45(a)(6)(A), (C) & (E)]

   a. the boundary of the tract or tracts of land upon which the facility is or will be located as described in Attachment C; areal size of the tract or tracts of land in acres should be given;

   b. if different, the boundary of the facility, and the location of all injection wells; each depicted area should be labeled to identify the well(s) and the well status (active, inactive, or proposed); areal size of the facility in acres should be given;

   c. if applicable, the boundaries of captured facilities that generate waste to be disposed in the injection wells, each depicted area should be labeled to identify the names of the captured facilities;

   d. the overall facility, each of its surface intake and discharge structures, each of its waste treatment, storage or disposal facilities, including proposed or existing pre-injection units for processing or storage of waste to be disposed in the injection wells; and

   e. all wells (water, oil and gas, disposal, etc.), springs, other surface water bodies, and drinking water wells listed in public records or otherwise known to the applicant within one mile of the facility property boundary, and the purpose for which each water well is used (e.g., domestic, livestock, agricultural, industrial, etc.).

A topographic map showing the approximate boundaries of the Tyson Fresh Meats, Inc. facility, the location of the active and proposed injection wells, and the locations of all wells within one mile of the property boundary is provided in Attachment D. A facility layout plan is also provided in Attachment D which shows the waste treatment, storage and disposal facilities, including existing and proposed the pre-injection units.

Q. Plain-Language Summary

The TCEQ implemented new rule requirements in 30 TAC Chapter 39 that impact all permit applications subject to the Chapter 39 public notice requirements that are declared administratively complete after May 1, 2022. One of the new rules, 30 TAC §39.405(k), requires the applicant to provide a plain-language summary in English, and in an alternative language if required in accordance with 30 TAC §39.426. The plain-language summaries for all applications will be posted on the TCEQ website.

For new, renewal and major amendment permit applications submit, as “Attachment E”, a Plain-Language Summary of the application that is no more than two pages long. The summary should be entitled “Plain-Language Summary” and should be prepared in simple, concise, easy-to-understand terminology. The summary must include the following information. [30 TAC §39.405(k)] **See Attachment E**

1. the applicant/operator name;
2. the type of application;
3. the type of waste;

4. the type of facility;

5. the facility name and location;

6. the function of the proposed plant or facility;

7. the expected output of the proposed plant or facility;

8. the expected pollutants that may be emitted or discharged by the proposed plant or facility which require an injection well permit; and

9. how the applicant will control those pollutants, so that the proposed plant will not have an adverse impact on human health or the environment.

If the applicant is required to provide notice in an alternative language in accordance with 30 TAC §39.426, provide a copy of the plain-language summary in English and in the alternative language.

In addition, provide a copy of the plain-language summaries in pdf clearly labeled on a flash drive.

R. Public Involvement Plan

TCEQ's Public Participation Plan provides guidance for using preliminary screening and public involvement plans to ensure meaningful public outreach. Applicants who are applying for a new injection well permit are required to complete a Public Involvement Plan. A Public Involvement Plan is intended to provide an applicant and the agency with information to determine if additional public outreach is necessary or beneficial. Applicants may complete a Public Involvement Plan, even if not required, to learn about the communities in which their facilities are located or where their activities may have an impact.

Submit a Public Involvement Plan, as "Attachment F", using the Public Involvement Plan Form[6] (TCEQ-20960) and Instructions for Completing a Public Involvement Plan Form for Permit and Registration Applications[7] (TCEQ-20960). **See Attachment F**

For more information regarding Title VI compliance at TCEQ[8] or the Public Participation Plan[9] go on the TCEQ website.

[6] https://www.tceq.texas.gov/downloads/agency/decisions/hearings/environmental-equity/pip-form-tceq-20960.pdf
[7] https://www.tceq.texas.gov/downloads/agency/decisions/hearings/environmental-equity/instructions-for-pip-form-tceq-20960.pdf
[8] https://www.tceq.texas.gov/agency/decisions/participation/title-vi-compliance
[9] https://www.tceq.texas.gov/downloads/agency/decisions/participation/public-participation-plan-gi-607.pdf

Signature Page

I (Signatory Name) Brian Bernaud (Title) Plant Manager
(Company) Tyson Foods certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ______________ Date: 2/5/25

See 30 TAC §305.44 for signatory authority.

Applications must be signed by the operator of the facility and the facility owner(s). The facility includes all contiguous land, and structures, other appurtenances, and improvements on the land, used for storing, processing, or disposing of waste. Duplicate this page for additional signatories.

To Be Completed by the Applicant if the Applicant Is a Corporation and the Responsible Corporate Officer Is Assigning or Delegating Signature Authority to a Manager in Accordance with 30 TAC §305.44(a)(1)

I (Signatory Name) ______________ (Title) ______________
(Company) ______________ hereby designate (Agent Name and/or Title) ______________ as my agent and hereby authorize said agent to sign any application, submit additional information as may be requested by the Commission, and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a Texas Water Code or Texas Solid Waste Disposal Act permit. I further understand that I am responsible for the contents of this application, for oral statements given by my agent in support of the application, and for compliance with the terms and conditions of any permit which might be issued based upon this application.

Signature: ______________ Date: ______________

(Note: Application Must Bear Signature and Seal of Notary Public)

SUBSCRIBED AND SWORN to before me by the said Brian Bernaud

on this 5th day, 2nd month of February, year of 2025

My commission expires on the 15th day, month of July, year of 2028

____
Notary Public

JASIEL ANDRADE MARQUEZ
NOTARY PUBLIC
STATE OF TEXAS
MY COMM. EXP. 07/15/28
NOTARY ID 13499282-8

NOTARY PUBLIC STATE OF TEXAS

II. Information Required to Provide Notice

Submit, as "Attachment G", a mailing list of landowners identified under Section II.A. and a mailing list of mineral rights owners identified under Section II.B. In accordance with 30 TAC §39.405(b), please also submit this mailing list electronically, in Microsoft Word. The electronic list must contain only the name, mailing address, city, state, and zip code with no reference to the lot number or lot location. The list should contain up to 30 names and addresses (10 per column) per page. Each name and address must be typed in the format that meets the United States Postal Service (USPS) requirements for machine readability. The letters in the name and address must be capitalized, contain no punctuation, and the two-character abbreviation must be used for the state. Contact the USPS for further instructions on formatting addresses for machine readability. The applicant may elect to submit pre-printed mailing labels of this mailing list with the application instead of submitting the mailing list electronically. If you wish to provide the list on printed labels, please use sheets of labels that have 30 labels to a page (10 labels per column). Please provide **four complete sets of labels** of the landowners and mineral rights owners list. **See Attachment G**

A. Provide a complete mailing address for persons who own the property on which the existing or proposed injection well facility is or will be located and all persons who own tracts of land adjacent to the property on which the existing or proposed injection well facility is or will be located and within a reasonable distance from the proposed point or points of discharge, deposit, injection, or other place of disposal or activity. Identify the tracts of land and landowners on a map and provide the general character of the areas adjacent to the facility, including public roads, towns and the nature of development of adjacent lands (e.g., residential, commercial, agricultural, recreational, industrial or undeveloped) on the map. The property boundary of the tract or tracts of land on which the existing or proposed injection facility is or will be located must be consistent with the legal description of the tract or tracts of land provided in Section I.P.5, Attachment C, of the application. (Refer to Example Application Map) [30 TAC §281.5(6), §305.45(a)(6)(B) & (D) and §39.651(c)(4)(A) & (B)]

B. Provide a complete mailing address for all persons who own the mineral rights underlying the existing or proposed injection well facility and underlying the tracts of land adjacent to the property on which the existing or proposed injection well facility is or will be located as required by 30 TAC §39.651(c)(4)(C) & (D). Identify the mineral rights owners on the map provided above in Section II.A.

C. If the facility is located adjacent to navigable territorial waters of the state, or the State of Texas is an adjacent landowner and/or owner of mineral rights underlying the facility or underlying adjacent tracts, your application may affect lands dedicated to the permanent school fund. A determination whether lands dedicated to the permanent school fund will be affected by TCEQ formal action on the application will be made by the Texas General Land Office (TXGLO).

In order for the TXGLO to make a determination, the TCEQ will provide notice to the TXGLO regarding the application. Provide the following information for inclusion in the notice to the TXGLO:

1. state the location of the permanent school fund land, mineral rights, or waters of the state that may be affected; and

The Tyson Fresh Meats facility lies north of the junction of Highways 60 and 66 in Section 19, Block 2, A. B. & M. Survey. The facility covers approximately 450 acres of the northern part of that section. Land and mineral ownership records show that a portion of land along and south of Highways 60 and 66 in the south part of Section 19 is owned by the Texas Department of Transportation and General Land Office. #9 on the surface land ownership records in Attachment G is listed as property of Texas Department of Transportation. The mineral ownership records in Attachment G show that Texas General Land Office owns the mineral rights of #2 and #9.

2. describe any foreseeable impact or effect of the proposed permitted action may have on permanent school fund land.

   No impact or effect is foreseen from the proposed permitted action.

A formal action or ruling by the Commission on an application affecting permanent school fund land that is made without the notice required by 30 TAC §39.651(c)(3) is voidable by the School Land Board as to any permanent school fund lands affected by the action or ruling. [TWC §5.115(c) and (g)]

The General Land Office has determined that lands shown as owned by the State of Texas are not dedicated to the permanent school fund. The determination was made on October 16 – 17, 2013 and attached in Attachment G.

D. Provide the name and mailing address of the mayor and health authority of the municipality in whose territorial limits or extraterritorial jurisdiction the well is or will be located, and the name and mailing address of the county judge and the health authority of the county in which the facility is located. [30 TAC §39.651(c)(5)]

<u>The Tyson Fresh Meats facility is located outside the city boundaries of Amarillo and is not located within any city/town boundaries.</u>

<u>Amarillo Mayor</u>
Mayor Cole Stanley
601 South Buchanan Street
Amarillo TX 79101

<u>Nearest Health Authority</u>
Casie Stoughton
Public Health Authority / Medical Director
City of Amarillo
Department of Public Health
1000 Martin Road
Amarillo, TX 79107

<u>County Judge</u>
Judge Nancy Tanner
500 S. Fillmore, Suite 103
Amarillo, TX 79101

<u>County Health Authority</u>
none

E. Bilingual Notice Instructions. For new, renewal and major amendment permit applications, public notice in an alternate language may be required. If an elementary school or middle school nearest to the facility offers a bilingual program, notice may be required to be published in an alternative language. The Texas Education Code, upon which the TCEQ alternative language notice requirements are based, requires a bilingual education program for an entire school district should the requisite alternative language speaking student population exist. However, there may not be any bilingual-speaking students at a particular school within a district which is required to offer the bilingual education program. For this reason, the requirement to publish notice in an alternative language is triggered if the nearest elementary or middle school, as part of a larger school district, is required to make a bilingual education program available to qualifying students and either the school has students enrolled at such a program on-site or has students who attend such a program at another location to satisfy the school's obligation to provide such a program. [30 TAC §39.426]

Bilingual notice confirmation for this application

1. Is the school district of the elementary or middle school nearest to the facility required by the Texas Education Code to have a bilingual program?

   ☐ Yes ☑ No

   If **no**, alternative language notice publication not required.

2. If **yes** to question 1, are students enrolled in a bilingual education program at either the elementary school or the middle school nearest to the facility?

   ☐ Yes ☐ No

   If yes to questions 1 and 2, alternative language publication is required.
   If no to question 2, then consider the next question.

3. If **yes** to question 1, are there students enrolled at either the elementary school or the middle school nearest to the facility who attend a bilingual education program at another location?

   ☐ Yes ☐ No

   If **yes** to questions 1 and 3, alternative language publication is required.
   If **no** to question 3, then consider the next question.

4. If **yes** to question 1, has the elementary school or the middle school nearest to the facility been granted an exception from the requirement to provide a bilingual education program, as available under 19 TAC §89.1207(a)?

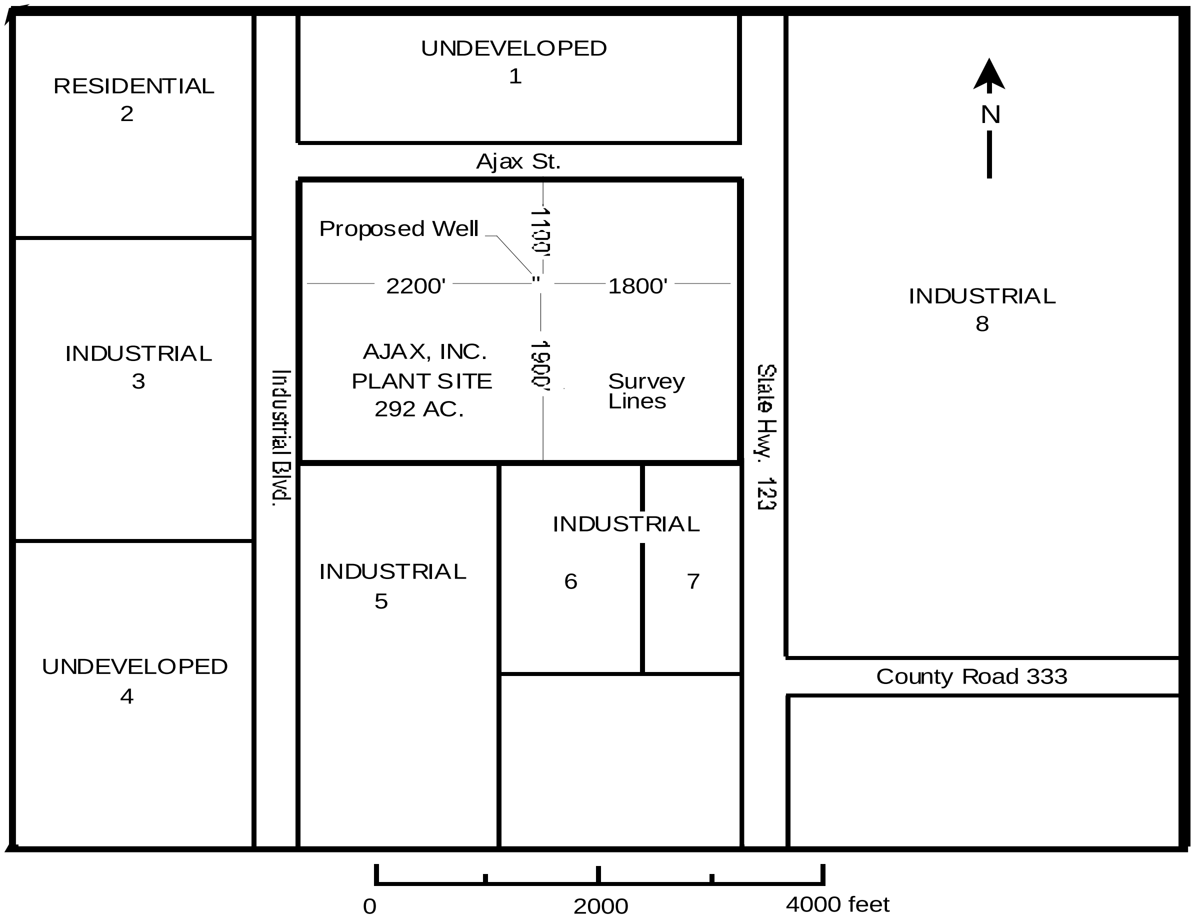
   ☐ Yes ☐ No

   If **yes** to questions 1 and 4, alternative language publication is required.
   If **no** to question 4, alternative language notice publication not required.

5. Provide the alternative language for which the bilingual education program(s) is provided or for which an exception has been approved. _____

Example Application Map

Landowners and Mineral Rights Owners



Landowners

1. Mr. & Mrs. Samuel Davis
2. Mr. & Mrs. Edward Sanchez
3. Texlink Corporation
4. Mr. & Mrs. Ted Goldsby
5. Jaxson Brewing Company
6. Plainview Company
7. ABC Chemicals Inc.
8. Big C Bottle Company

Mineral Rights Owners

1. Mr. & Mrs. Samuel Davis
   Mr. Fred Davis
   Mrs. R.C. Davis
2. The Edward Sanchez Trust
3. Cibolo Energy LP
4. Mr. Don Williams
   Mr. & Mrs. Richard Coons
   Mrs. Dorothy Moore
5. The Larson Family Trust
6. SBN Minerals, LLC
   Sorona Oil & Gas Company
   Klein Operations, LLC.
7. Jack Walsh Family Trust
8. Terrace Flats Exploration Corp.

III. Railroad Commission Letter

Submit, as "Attachment H," a letter from the Railroad Commission stating that "drilling the disposal well and injecting industrial or municipal waste into the subsurface stratum will not endanger or injure any known oil or gas resources." This letter is required with initial and renewal applications, and with permit amendment applications for injection into subsurface formations not addressed by the current Railroad Commission letter for the injection well. [30 TAC §305.49(a)(7)] **See Attachment H**

IV. Financial Assurance, Liability, and Financial Capability

Submit as, "Attachment I," a description of the manner in which compliance with the financial assurance and liability requirements in 30 TAC Chapter 37, Subchapter Q will be attained, and demonstration of financial capability as outlined below. For converted wells and constructed wells provide documentation that financial assurance in the amount provided in Section VI of the application will be in effect upon permit issuance. [30 TAC §305.49(a)(3)] **See Attachment I**

A. Financial Assurance Requirements [30 TAC §§331.142-144 and §331.68(a)(3)]

The financial assurance requirements of 30 TAC Chapter 37, Subchapter Q, require an owner or operator to submit an originally signed financial assurance mechanism to the TCEQ Financial Assurance Unit at least 60 days prior to commencement of drilling operations for new wells. All financial assurance mechanisms shall be in effect before commencement of drilling operations. For converted wells and other previously constructed wells, financial assurance shall be provided at least 30 days prior to permit issuance and be in effect upon permit issuance. [§37.7021 (c) & §37.7031(c)]

1. Financial Assurance for Closure

Secure and maintain financial assurance for plugging and abandonment of each existing and new well in the amount of the closure cost estimate in current dollars developed in accordance with 30 TAC §331.143 and included in Section VI.D. of the application using the mechanisms listed in 30 TAC §37.7021(b).

2. Financial Assurance for Post Closure Care (hazardous waste wells only)

If applicable, demonstrate and maintain financial assurance for post-closure of each existing and new hazardous waste well in the amount of the post-closure care cost estimate in current dollars developed in accordance with 30 TAC §331.68(a)(4)(F) and included in Section VI.D. of the application using the mechanisms provided in 30 TAC §37.7031(b).

B. Liability Requirements (hazardous waste wells only) [30 TAC §331.142(b)]

For hazardous waste injection wells establish and maintain liability coverage for sudden and non-sudden bodily injury and property damage to third parties caused by accidental occurrences arising from operations of the facility in accordance with the requirements of 30 TAC §37.7041. Evidence must be provided to show that the insurance policy covers the injection well(s).

C. Financial Capability Requirements (hazardous waste wells only) [30 TAC §305.49(c)]

For hazardous waste injection wells demonstrate to the satisfaction of the executive director that the applicant has sufficient financial resources to operate the facility in a safe manner and in compliance with the permit and all applicable rules, including, but not limited to, how an applicant intends to obtain financing for construction of the facility, and to close the facility properly as required by 30 TAC §305.50(a)(4)(B).

Information requirements for making this demonstration vary depending on the type of financial information available to applicants, primarily whether audited financial statements are available as well as the type of application submitted. For each type of application described below, financial information must be provided for the specific type of applicant entities.

WDW-312

Texas Commission on Environmental Quality
Permit Application to Dispose of Waste
In A Class I Injection Well

I. General Information

A. Type of Application (check all that apply):

☐ Initial
☑ Renewal
☐ Major Amendment
☐ Minor Amendment
☐ Minor Modification
☐ Transfer
☐ Endorsement

Type of Waste (check all that apply):

☐ Hazardous Waste
☑ Nonhazardous Waste

Type of Facility (check all that apply):

☐ Commercial
☑ Noncommercial

Source of waste for noncommercial (check all that apply):

☑ Onsite
☐ Captured facility
☐ Offsite from facilities owned or effectively controlled by owner/operator

B. Facility Name: Tyson Fresh Meats, Inc.

Street Address: 5000 N. FM 1912

City, State, Zip: Amarillo, TX 79187

Mailing Address: PO Box 30500

Mailing City, State, Zip: Amarillo, TX 79187

County: Potter

TCEQ Solid Waste Registration (SWR) Number: 31455

EPA ID Number: TXD065022121

Give a description of the location of the facility site with respect to known or easily identifiable landmarks. Detail the access routes from the nearest U.S. or State Highway to the facility: The Tyson Fresh Meats facility is located on a 450-acre site approximately 11 miles northeast of the Amarillo city limits. The facility is located on US Highway 60, immediately north of the junction of US Highway 60 and US Highway 66.

Is the facility located within the Coastal Management Program boundary? Refer to Texas Coastal Management Boundary Map[1] for boundary. For questions regarding the Coastal Management Program, please call (800) 998-4456 (within Texas) or (512) 475-0773. [30 TAC §281.41]

☐ Yes ☑ No

Provide the location of the injection well relative to established surveys: 2,612.3 feet from the north line and 2,240 feet from the west line of Section 19, Block 2 of the Adams, Beaty, and Moulton Survey.

Enter the geographical coordinates of the injection well in decimal degrees to 6 decimal places:

Latitude: 35.257890

Longitude: -101.646570

Provide the depths of the injection zone and injection interval:

Injection Zone: Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formation(s) at depths of 3,720 to 9,000 feet below ground level.

Injection Interval: Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formation(s) at depths of 4,000 to 9,000 feet below ground level.

C. Operator/Applicant (Individual, Corporation, or other Legal Entity Name)

Name: Tyson Fresh Meats, Inc. (subsidiary of Tyson Foods, Inc.)

Address: PO Box 2020

City, State and Zip: Springdale, AR 72765-2020

Telephone Number: 479-290-4000

If the application is submitted on behalf of a corporation or other business organization with filing requirements, please identify the Charter Filing Number as recorded with the Office of the Secretary of State for Texas.

Charter Filing Number: 800013025

Is the applicant required to designate a registered agent with the Secretary of State of Texas?

☑ Yes ☐ No

[1] https://www.glo.texas.gov/coast/coastal-management/forms/files/CoastalBoundaryMap.pdf

If the application is submitted by a business organization that is required to designate and maintain a registered agent, the applicant must provide the name and address of the registered agent.

Agent: United Agent Group Inc.

Address: 5444 Westheimer #1000

City, State, and Zip: Houston, TX 77056

Telephone Number: 561-694-8107

D. Facility Owner(s) (Individual, Corporation, or other Legal Entity Name)

The facility includes all contiguous land, and structures, other appurtenances, and improvements on the land, used for storing, processing, or disposing of waste. The facility owner must be consistent with the owner on the deed filing bearing the stamp of the county property records or other generally accepted identifying reference of the current ownership record provided in Section I.P.5, Attachment C of the application. If the facility owner is the same as the operator, state “same as operator”. If the facility land, structures, appurtenances, and improvements on the land are owned by more than one individual, corporation or other legal entity, provide the following information for all owners. Clearly identify the relationship(s) between the operator and all facility owner(s). [THSC §361.087(1)] **same as operator**

Name: _____

Address: _____

City, State, Zip: _____

Telephone Number: _____

Charter Filing Number: _____

E. Indicate the ownership status of the facility.

Private:

☑ Corporation
☐ Partnership
☐ Proprietorship
☐ Nonprofit organization

Public:

☐ Military
☐ State
☐ Regional
☐ County
☐ Municipal
☐ Federal

Other (specify): _____

F. List those persons or firms authorized to act for the applicant during the processing of the permit application. Indicate the capacity in which each person may represent the applicant (engineering, geology, legal, etc.). The person listed first will be the primary recipient of correspondence regarding this application. Include complete mailing addresses, phone numbers and e-mail addresses.

Administrative issues

Mr. Eric Rodriquez, Area Environmental Manager
Tyson Fresh Meats, Inc.
P. O. Box 30500
Amarillo, TX 79187
(806) 335-7418 eric.rodriquez@tyson.com

Technical issues

Mr. Brian Shin, PG
Terra Dynamics Incorporated
2300 Greenhill Dr. Ste 700
Round Rock, TX 78664
(512) 795-8183 bshin@terradyn.com

G. For new, renewal, and major amendment applications specify the individual who will be responsible for causing notice to be published in the newspaper. Include the complete mailing address, telephone number, fax number and e-mail address.

Mr. Eric Rodriquez, Area Environmental Manager
Tyson Fresh Meats, Inc.
P. O. Box 30500
Amarillo, TX 79187
(806) 335-7418 eric.rodriquez@tyson.com

H. Describe the activities conducted by the applicant which require a permit.

Injection of non-hazardous wastewater from hides processing facility

I. For amendment, modification, transfer or endorsement applications, briefly describe all requested changes to the permit and to the application contents and the reasons for the changes.

None.

J. Business Information

1. Give a brief description of the nature of your business.

   Beef production complex (slaughtering, rendering and tannery).

2. List the principal products and/or services which are provided by your plant. Please itemize by Standard Industrial Classification (SIC) codes. Also label the products with their common names, if applicable.

SIC Code 2011:	Wet salted cattle hides
	West blue cattle hides
	Edible beef products
	Tallow – edible
SIC Code 2077:	Bone meal
	Tallow – inedible
SIC Code 3111:	Leather Tanning and Finishing

K. Applicant Compliance History

The TCEQ will utilize compliance history when making decisions regarding the issuance, renewal, amendment, modification, denial, suspension, or revocation of a permit. Violations included in a criminal conviction are considered when evaluating and classifying the site's compliance history.

For the five years preceding the filing date of this application, please submit a complete listing of all criminal convictions (i.e., State or Federal) of the operator and facility owner in which a violation of environmental law was an element of the crime. [30 TAC §60.2(d)(1)(E) and §60.2(d)(2)(F)] If there have been no such convictions then the application should state the following. If the operator is not the facility owner, a separate statement should be provided for each facility owner.

> "In the five years preceding the filing of this application (the operator/applicant, owner), Tyson Fresh Meats, Inc., has not been convicted of a State or Federal crime in which a violation of environmental law was an element of the crime."

L. TCEQ Core Data Form

The TCEQ requires that a Core Data Form[2] (TCEQ-10400) be submitted with all new and renewal applications. Submit the form as "Attachment A". For all other applications, if a Regulated Entity Number (RN) and Customer Reference Number (CN) have been issued by the TCEQ and core data information has not changed, a Core Data Form is not required. For more information regarding the Core Data Form, call (512) 239-5175 or go to the Core Data Form Instructions[3] on the TCEQ website.

RN **100212943**

CN **600767016**

M. Public Interest Demonstration

Section 27.051 of the Texas Water Code (TWC) stipulates certain conditions that must exist for the Commission to grant an application and issue a permit. For all new applications, permit renewals, and major and minor amendments, submit as "Attachment B" information addressing the following considerations: Attachment A is provided.

1. That the use or installation of the injection well is in the public interest. [TWC§27.051(a)(1)]

2. That no existing rights, including, but not limited to, mineral rights, will be impaired. [TWC §27.051(a)(2)]

3. That, with proper safeguards, both ground and surface fresh water can be adequately protected from pollution. [TWC §27.051(a)(3)]

4. That the applicant has made a satisfactory showing of financial responsibility if required by Section 27.073 of this code. [TWC §27.051(a)(4)]

[2] https://www.tceq.texas.gov/downloads/permitting/central-registry-docs/10400-core-data-form.docx
[3] https://www.tceq.texas.gov/downloads/permitting/central-registry-docs/10400-core-data-form-instructions.pdf

5. That the compliance history of the applicant and related entities is acceptable. [TWC §27.051(d)(1), 30 TAC § 331.121(b)(1)]

6. That there is no practical, economic, and feasible alternative to an injection well reasonably available. Provide justification for subsurface disposal. Include results of treatability studies of alternate, practical, economic and feasible methods of waste disposal. Explain in detail why each method is considered to be less satisfactory in terms of environmental protection than the proposed subsurface disposal method. Indicate whether this waste is presently being produced and, if so, what method is used for disposal. Describe the manufacturing process(es) and product(s) which produce the waste(s). [TWC §27.051(d)(2), 30 TAC § 331.121(b)(2)]

7. (for hazardous waste injection wells only) That the applicant has provided for the proper operation of the proposed hazardous waste injection well. [TWC §27.051(a)(5)]

8. (for hazardous waste injection wells only) That the applicant for a hazardous waste injection well not located in an area of industrial land use has made a reasonable effort to ensure that the burden, if any, imposed by the proposed hazardous waste injection well on local law enforcement, emergency medical or fire-fighting personnel, or public roadways, will be reasonably minimized or mitigated. [TWC §27.051(a)(6)]

9. (for hazardous waste injection wells only) That the applicant owns or has made a good faith claim to own, or has the consent of the owner to utilize, or has an option to acquire, or has the authority to acquire through eminent domain, the property or portions of the property where the hazardous waste injection well will be constructed. [TWC §27.051(a)(7)]

10. (for hazardous waste injection wells only) That the applicant will maintain sufficient public liability insurance for bodily injury and property damage to third parties that is caused by sudden and non-sudden accidents or will otherwise demonstrate financial responsibility in a manner adopted by the Commission in lieu of public liability insurance. [TWC §27.051(d)(3), 30 TAC § 331.121(b)(3)]

11. (for hazardous waste injection wells only) For on-site generated waste, provide certification by the owner/operator that (1) the generator of the hazardous waste has a program to reduce the volume or quantity and toxicity of the waste to the degree determined by the generator to be economically practicable, and (2) injection of the waste is that practicable method of disposal currently available to the generator which minimizes the present and future threat to human health and the environment. [30 TAC §331.121(b)(4)]

N. For applications for new permits, renewals, and major amendments, a copy of the administratively complete application and subsequent revisions must be made available at a public place in the county where the facility is located or proposed to be located for review and copying by the public. Identify the public place in the county (e.g., public library, county courthouse, city hall), including the address, where the application will be located. [30 TAC §39.405(g)]

   Amarillo Public Library – Downtown
   413 SE 4th
   Amarillo, TX 79101

O. Facility Background Information [30 TAC §305.45(a)(7)]

   Indicate (by listing the permit number(s) and governing agency(ies) in the columns below) all existing, pending, interim status, or permit-by-rule State and/or Federal permits, licenses or construction approvals which pertain to pollution control or industrial solid waste management activities conducted by your plant or at your location, or existing at a proposed plant or location. Complete each blank by entering either the **permit number** or **the date of application**, and the **governing agency** or **none**.

Existing Permits

Relevant Program and/or Law	Permit Number or License	Government Agency *
Hazardous Waste Management Program under the Texas Solid Waste Disposal Act	none	
UIC Program under the Texas Injection Well Act (Class I, II, III, IV, V and VI Wells)	WDW-120, WDW-312	TCEQ
Texas Pollutant Discharge Elimination System Program under the Clean Water Act and Waste Discharge Program under the Texas Water Code, Chapter 26	TXR05M948	TCEQ
Prevention of Significant Deterioration Program under the Federal Clean Air Act (FCAA)	none	
Nonattainment Program under the FCAA	none	
National Emission Standards for Hazardous Air Pollutants preconstruction approval under the FCAA	none	
Ocean dumping permits under the Marine Protection Research and Sanctuaries Act	none	
Dredge or fill permits under the Federal Clean Water Act	none	
Licenses under the Texas Radiation Control Act	none	
Subsurface Area Drip Dispersal System permits under Texas Water Code, Chapter 32	none	
Texas Solid Waste Disposal Act	31455	TCEQ
Texas Uranium Surface Mining and Reclamation Act	none	
Texas Surface Coal Mining and Reclamation Act	none	
Other relevant environmental permits/licenses	**	
** Texas Clean Air Act	PG-0024-R 1072, 1073, 1074, 6721, 21000, 44100	TCEQ

* Use the following acronyms for each agency:

TCEQ = Texas Commission on Environmental Quality
RRC = Railroad Commission of Texas
DSHS = Department of State Health Services
TDA = Texas Department of Agriculture
EPA = U.S. Environmental Protection Agency
CORPS = U.S. Army Corps of Engineers

P. Location

1. Is the facility located on Indian lands?

☐ Yes ☑ No

If yes, do not complete this application. Contact EPA Region 6 for application and permitting requirements for injection wells located on Indian lands. [40 CFR §147.2205(a)]

2. Is the facility located in an area in which the governing body of the county or municipality has prohibited the processing or disposal of municipal hazardous waste or industrial solid waste?

   ☐ Yes ☑ No

   If yes, do not complete this application. TCEQ may not grant an application for an injection well permit in this area. [THSC §363.112(d)]

3. If the facility is a new commercial hazardous waste management facility, or the subsequent areal expansion of such a facility, is the boundary of the well or pre-injection units to be located within ½ of a mile of an established residence, church, school, day care center, surface water body used for public drinking water supply, or dedicated park?

   ☐ Yes ☑ No

   If yes, do not complete this application. TCEQ may not issue a permit for a facility in this location. [30 TAC §335.205(a)(3)]

4. Is the location or proposed location of the injection well in the territory of a groundwater conservation district? To determine if the injection well is or will be located in the territory of a groundwater conservation district refer to the Texas Groundwater Conservation District map[4] on the TWDB website.

   ☑ Yes ☐ No

   If yes, provide the contact name and mailing address for the groundwater conservation district. To obtain a point of contact and mailing address refer to the Groundwater Conservation Districts Contact List[5] on the TCEQ website. [TWC §27.017(b)]

   Ms. Britney Britten, Manager
   Panhandle Groundwater Conservation District
   P.O. Box 637
   White Deer, TX 79097

5. Legal Description of Facility Land

   Submit, as "Attachment C", a legal description of the tract or tracts of land upon which the facility is or will be located and the deed filing bearing the stamp of the county property records or other generally accepted identifying reference of the current ownership record. If ownership of the property is transferring and new ownership documents are not final, provide the date upon which the documents will be submitted. The facility includes all contiguous land, and structures, other appurtenances, and improvements on the land, used for storing, processing, or disposing of waste including pre-injection units used for storage and processing waste to be injected into the injection well. The legal description should include the metes and bounds description or for platted urban sites the final plat with appropriate "lot" description(s). [THSC §361.087(2)]

[4] https://www.twdb.texas.gov/mapping/doc/maps/GCDs_8x11.pdf
[5] https://www.tceq.texas.gov/downloads/groundwater/gcd/gcd-contact-list.pdf

A legal description of the facility is provided in Attachment C. Waste management operations for this permit application occur in Section 19 of TRACT ONE (1).

6. Submit, as "Attachment D", a drawn-to-scale topographic map of the facility and the tract or tracts of land upon which the facility is or will be located as described in Attachment C and area extending at least one mile beyond the tract boundaries. The map must be prepared by a licensed professional engineer or a registered surveyor. The scale should be adequate to depict the following features: [30 TAC §305.45(a)(6)(A), (C) & (E)]

    a. the boundary of the tract or tracts of land upon which the facility is or will be located as described in Attachment C; areal size of the tract or tracts of land in acres should be given;

    b. if different, the boundary of the facility, and the location of all injection wells; each depicted area should be labeled to identify the well(s) and the well status (active, inactive, or proposed); areal size of the facility in acres should be given;

    c. if applicable, the boundaries of captured facilities that generate waste to be disposed in the injection wells, each depicted area should be labeled to identify the names of the captured facilities;

    d. the overall facility, each of its surface intake and discharge structures, each of its waste treatment, storage or disposal facilities, including proposed or existing pre-injection units for processing or storage of waste to be disposed in the injection wells; and

    e. all wells (water, oil and gas, disposal, etc.), springs, other surface water bodies, and drinking water wells listed in public records or otherwise known to the applicant within one mile of the facility property boundary, and the purpose for which each water well is used (e.g., domestic, livestock, agricultural, industrial, etc.).

    A topographic map showing the approximate boundaries of the Tyson Fresh Meats, Inc. facility, the location of the active and proposed injection wells, and the locations of all wells within one mile of the property boundary is provided in Attachment D. A facility layout plan is also provided in Attachment D which shows the waste treatment, storage and disposal facilities, including existing and proposed the pre-injection units.

Q. Plain-Language Summary

The TCEQ implemented new rule requirements in 30 TAC Chapter 39 that impact all permit applications subject to the Chapter 39 public notice requirements that are declared administratively complete after May 1, 2022. One of the new rules, 30 TAC §39.405(k), requires the applicant to provide a plain-language summary in English, and in an alternative language if required in accordance with 30 TAC §39.426. The plain-language summaries for all applications will be posted on the TCEQ website.

For new, renewal and major amendment permit applications submit, as “Attachment E”, a Plain-Language Summary of the application that is no more than two pages long. The summary should be entitled “Plain-Language Summary” and should be prepared in simple, concise, easy-to-understand terminology. The summary must include the following information. [30 TAC §39.405(k)] **See Attachment E**

1. the applicant/operator name;

2. the type of application;

3. the type of waste;

4. the type of facility;

5. the facility name and location;

6. the function of the proposed plant or facility;

7. the expected output of the proposed plant or facility;

8. the expected pollutants that may be emitted or discharged by the proposed plant or facility which require an injection well permit; and

9. how the applicant will control those pollutants, so that the proposed plant will not have an adverse impact on human health or the environment.

If the applicant is required to provide notice in an alternative language in accordance with 30 TAC §39.426, provide a copy of the plain-language summary in English and in the alternative language.

In addition, provide a copy of the plain-language summaries in pdf clearly labeled on a flash drive.

R. Public Involvement Plan

TCEQ's Public Participation Plan provides guidance for using preliminary screening and public involvement plans to ensure meaningful public outreach. Applicants who are applying for a new injection well permit are required to complete a Public Involvement Plan. A Public Involvement Plan is intended to provide an applicant and the agency with information to determine if additional public outreach is necessary or beneficial. Applicants may complete a Public Involvement Plan, even if not required, to learn about the communities in which their facilities are located or where their activities may have an impact.

Submit a Public Involvement Plan, as "Attachment F", using the Public Involvement Plan Form[6] (TCEQ-20960) and Instructions for Completing a Public Involvement Plan Form for Permit and Registration Applications[7] (TCEQ-20960). **See Attachment F**

For more information regarding Title VI compliance at TCEQ[8] or the Public Participation Plan[9] go on the TCEQ website.

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[6] https://www.tceq.texas.gov/downloads/agency/decisions/hearings/environmental-equity/pip-form-tceq-20960.pdf

[7] https://www.tceq.texas.gov/downloads/agency/decisions/hearings/environmental-equity/instructions-for-pip-form-tceq-20960.pdf

[8] https://www.tceq.texas.gov/agency/decisions/participation/title-vi-compliance

[9] https://www.tceq.texas.gov/downloads/agency/decisions/participation/public-participation-plan-gi-607.pdf

Signature Page

I (Signatory Name) Brian Bernand (Title) Plant Manager
(Company) Tyson Foods certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: [signature] Date: 2/5/25

See 30 TAC §305.44 for signatory authority.

Applications must be signed by the operator of the facility and the facility owner(s). The facility includes all contiguous land, and structures, other appurtenances, and improvements on the land, used for storing, processing, or disposing of waste. Duplicate this page for additional signatories.

To Be Completed by the Applicant if the Applicant Is a Corporation and the Responsible Corporate Officer Is Assigning or Delegating Signature Authority to a Manager in Accordance with 30 TAC §305.44(a)(1)

I (Signatory Name) ____________ (Title) ____________
(Company) ____________ hereby designate (Agent Name and/or Title) ____________ as my agent and hereby authorize said agent to sign any application, submit additional information as may be requested by the Commission, and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a Texas Water Code or Texas Solid Waste Disposal Act permit. I further understand that I am responsible for the contents of this application, for oral statements given by my agent in support of the application, and for compliance with the terms and conditions of any permit which might be issued based upon this application.

Signature: ____________ Date: ____________

(Note: Application Must Bear Signature and Seal of Notary Public)

SUBSCRIBED AND SWORN to before me by the said Brian Bernand

on this 5th day, 2nd month of February, year of 2025

My commission expires on the 15th day, month of July, year of 2028

JASIEL ANDRADE MARQUEZ
NOTARY PUBLIC
STATE OF TEXAS
MY COMM. EXP. 07/15/28
NOTARY ID 13499282-8

NOTARY PUBLIC STATE OF TEXAS

[signature]
Notary Public

II. Information Required to Provide Notice

Submit, as "Attachment G", a mailing list of landowners identified under Section II.A. and a mailing list of mineral rights owners identified under Section II.B. In accordance with 30 TAC §39.405(b), please also submit this mailing list electronically, in Microsoft Word. The electronic list must contain only the name, mailing address, city, state, and zip code with no reference to the lot number or lot location. The list should contain up to 30 names and addresses (10 per column) per page. Each name and address must be typed in the format that meets the United States Postal Service (USPS) requirements for machine readability. The letters in the name and address must be capitalized, contain no punctuation, and the two-character abbreviation must be used for the state. Contact the USPS for further instructions on formatting addresses for machine readability. The applicant may elect to submit pre-printed mailing labels of this mailing list with the application instead of submitting the mailing list electronically. If you wish to provide the list on printed labels, please use sheets of labels that have 30 labels to a page (10 labels per column). Please provide **four complete sets of labels** of the landowners and mineral rights owners list. **See Attachment G**

A. Provide a complete mailing address for persons who own the property on which the existing or proposed injection well facility is or will be located and all persons who own tracts of land adjacent to the property on which the existing or proposed injection well facility is or will be located and within a reasonable distance from the proposed point or points of discharge, deposit, injection, or other place of disposal or activity. Identify the tracts of land and landowners on a map and provide the general character of the areas adjacent to the facility, including public roads, towns and the nature of development of adjacent lands (e.g., residential, commercial, agricultural, recreational, industrial or undeveloped) on the map. The property boundary of the tract or tracts of land on which the existing or proposed injection facility is or will be located must be consistent with the legal description of the tract or tracts of land provided in Section I.P.5, Attachment C, of the application. (Refer to Example Application Map) [30 TAC §281.5(6), §305.45(a)(6)(B) & (D) and §39.651(c)(4)(A) & (B)]

B. Provide a complete mailing address for all persons who own the mineral rights underlying the existing or proposed injection well facility and underlying the tracts of land adjacent to the property on which the existing or proposed injection well facility is or will be located as required by 30 TAC §39.651(c)(4)(C) & (D). Identify the mineral rights owners on the map provided above in Section II.A.

C. If the facility is located adjacent to navigable territorial waters of the state, or the State of Texas is an adjacent landowner and/or owner of mineral rights underlying the facility or underlying adjacent tracts, your application may affect lands dedicated to the permanent school fund. A determination whether lands dedicated to the permanent school fund will be affected by TCEQ formal action on the application will be made by the Texas General Land Office (TXGLO).

In order for the TXGLO to make a determination, the TCEQ will provide notice to the TXGLO regarding the application. Provide the following information for inclusion in the notice to the TXGLO:

1. state the location of the permanent school fund land, mineral rights, or waters of the state that may be affected; and

The Tyson Fresh Meats facility lies north of the junction of Highways 60 and 66 in Section 19, Block 2, A. B. & M. Survey. The facility covers approximately 450 acres of the northern part of that section. Land and mineral ownership records show that a portion of land along and south of Highways 60 and 66 in the south part of Section 19 is owned by the Texas Department of Transportation and General Land Office. #9 on the surface land ownership records in Attachment G is listed as property of Texas Department of Transportation. The mineral ownership records in Attachment G show that Texas General Land Office owns the mineral rights of #2 and #9.

2. describe any foreseeable impact or effect of the proposed permitted action may have on permanent school fund land.

   No impact or effect is foreseen from the proposed permitted action.

A formal action or ruling by the Commission on an application affecting permanent school fund land that is made without the notice required by 30 TAC §39.651(c)(3) is voidable by the School Land Board as to any permanent school fund lands affected by the action or ruling. [TWC §5.115(c) and (g)]

The General Land Office has determined that lands shown as owned by the State of Texas are not dedicated to the permanent school fund. The determination was made on October 16 – 17, 2013 and attached in Attachment G.

D. Provide the name and mailing address of the mayor and health authority of the municipality in whose territorial limits or extraterritorial jurisdiction the well is or will be located, and the name and mailing address of the county judge and the health authority of the county in which the facility is located. [30 TAC §39.651(c)(5)]

<u>The Tyson Fresh Meats facility is located outside the city boundaries of Amarillo and is not located within any city/town boundaries.</u>

<u>Amarillo Mayor</u>
Mayor Cole Stanley
601 South Buchanan Street
Amarillo TX 79101

<u>Nearest Health Authority</u>
Casie Stoughton
Public Health Authority / Medical Director
City of Amarillo
Department of Public Health
1000 Martin Road
Amarillo, TX 79107

<u>County Judge</u>
Judge Nancy Tanner
500 S. Fillmore, Suite 103
Amarillo, TX 79101

<u>County Health Authority</u>
none

E. Bilingual Notice Instructions. For new, renewal and major amendment permit applications, public notice in an alternate language may be required. If an elementary school or middle school nearest to the facility offers a bilingual program, notice may be required to be published in an alternative language. The Texas Education Code, upon which the TCEQ alternative language notice requirements are based, requires a bilingual education program for an entire school district should the requisite alternative language speaking student population exist. However, there may not be any bilingual-speaking students at a particular school within a district which is required to offer the bilingual education program. For this reason, the requirement to publish notice in an alternative language is triggered if the nearest elementary or middle school, as part of a larger school district, is required to make a bilingual education program available to qualifying students and either the school has students enrolled at such a program on-site or has students who attend such a program at another location to satisfy the school's obligation to provide such a program. [30 TAC §39.426]

Bilingual notice confirmation for this application

1. Is the school district of the elementary or middle school nearest to the facility required by the Texas Education Code to have a bilingual program?

   ☐ Yes ☑ No

   If **no**, alternative language notice publication not required.

2. If **yes** to question 1, are students enrolled in a bilingual education program at either the elementary school or the middle school nearest to the facility?

   ☐ Yes ☐ No

   If yes to questions 1 and 2, alternative language publication is required.
   If no to question 2, then consider the next question.

3. If **yes** to question 1, are there students enrolled at either the elementary school or the middle school nearest to the facility who attend a bilingual education program at another location?

   ☐ Yes ☐ No

   If **yes** to questions 1 and 3, alternative language publication is required.
   If **no** to question 3, then consider the next question.

4. If **yes** to question 1, has the elementary school or the middle school nearest to the facility been granted an exception from the requirement to provide a bilingual education program, as available under 19 TAC §89.1207(a)?

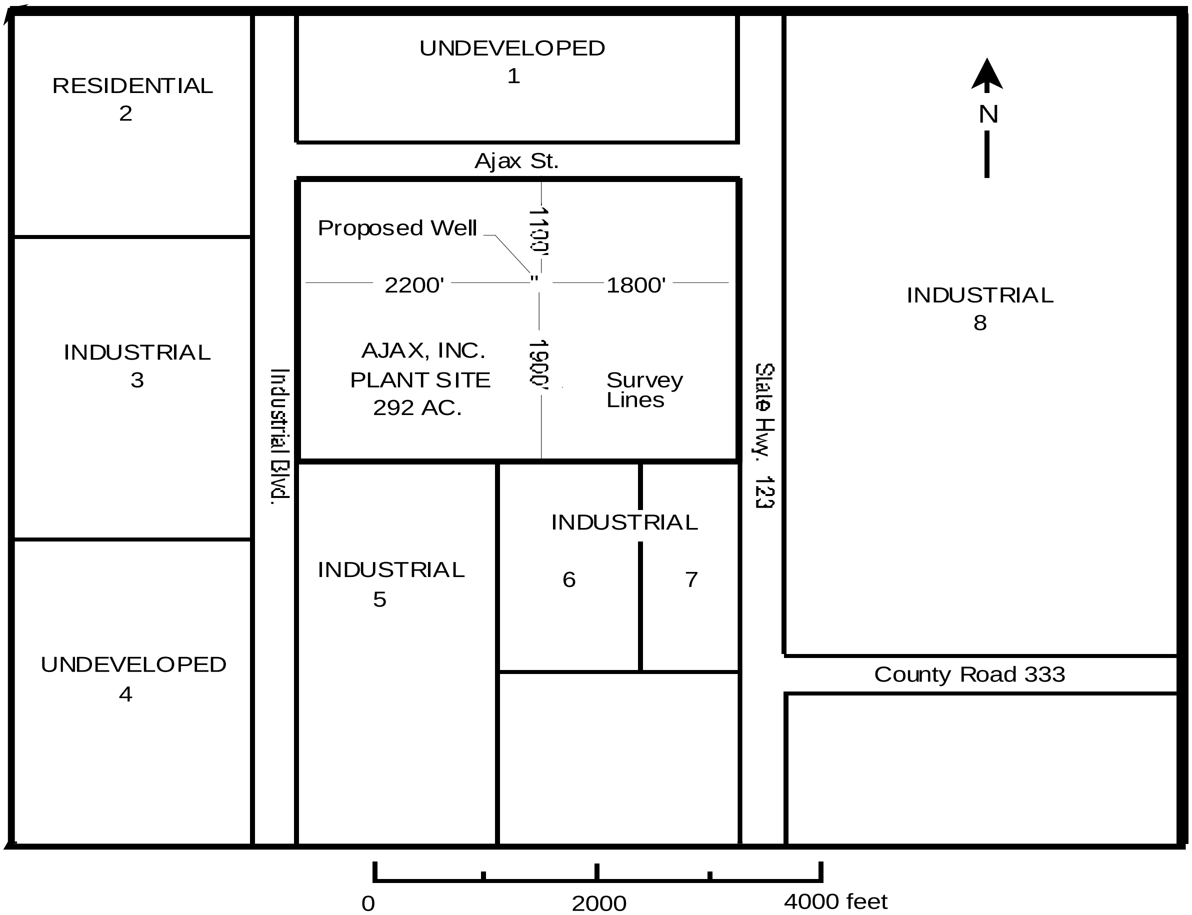
   ☐ Yes ☐ No

   If **yes** to questions 1 and 4, alternative language publication is required.
   If **no** to question 4, alternative language notice publication not required.

5. Provide the alternative language for which the bilingual education program(s) is provided or for which an exception has been approved. _____

Example Application Map

Landowners and Mineral Rights Owners



Landowners

1. Mr. & Mrs. Samuel Davis
2. Mr. & Mrs. Edward Sanchez
3. Texlink Corporation
4. Mr. & Mrs. Ted Goldsby
5. Jaxson Brewing Company
6. Plainview Company
7. ABC Chemicals Inc.
8. Big C Bottle Company

Mineral Rights Owners

1. Mr. & Mrs. Samuel Davis
   Mr. Fred Davis
   Mrs. R.C. Davis
2. The Edward Sanchez Trust
3. Cibolo Energy LP
4. Mr. Don Williams
   Mr. & Mrs. Richard Coons
   Mrs. Dorothy Moore
5. The Larson Family Trust
6. SBN Minerals, LLC
   Sorona Oil & Gas Company
   Klein Operations, LLC.
7. Jack Walsh Family Trust
8. Terrace Flats Exploration Corp.

III. Railroad Commission Letter

Submit, as "Attachment H," a letter from the Railroad Commission stating that "drilling the disposal well and injecting industrial or municipal waste into the subsurface stratum will not endanger or injure any known oil or gas resources." This letter is required with initial and renewal applications, and with permit amendment applications for injection into subsurface formations not addressed by the current Railroad Commission letter for the injection well. [30 TAC §305.49(a)(7)] **See Attachment H**

IV. Financial Assurance, Liability, and Financial Capability

Submit as, "Attachment I," a description of the manner in which compliance with the financial assurance and liability requirements in 30 TAC Chapter 37, Subchapter Q will be attained, and demonstration of financial capability as outlined below. For converted wells and constructed wells provide documentation that financial assurance in the amount provided in Section VI of the application will be in effect upon permit issuance. [30 TAC §305.49(a)(3)] **See Attachment I**

A. Financial Assurance Requirements [30 TAC §§331.142-144 and §331.68(a)(3)]

The financial assurance requirements of 30 TAC Chapter 37, Subchapter Q, require an owner or operator to submit an originally signed financial assurance mechanism to the TCEQ Financial Assurance Unit at least 60 days prior to commencement of drilling operations for new wells. All financial assurance mechanisms shall be in effect before commencement of drilling operations. For converted wells and other previously constructed wells, financial assurance shall be provided at least 30 days prior to permit issuance and be in effect upon permit issuance. [§37.7021 (c) & §37.7031(c)]

1. Financial Assurance for Closure

Secure and maintain financial assurance for plugging and abandonment of each existing and new well in the amount of the closure cost estimate in current dollars developed in accordance with 30 TAC §331.143 and included in Section VI.D. of the application using the mechanisms listed in 30 TAC §37.7021(b).

2. Financial Assurance for Post Closure Care (hazardous waste wells only)

If applicable, demonstrate and maintain financial assurance for post-closure of each existing and new hazardous waste well in the amount of the post-closure care cost estimate in current dollars developed in accordance with 30 TAC §331.68(a)(4)(F) and included in Section VI.D. of the application using the mechanisms provided in 30 TAC §37.7031(b).

B. Liability Requirements (hazardous waste wells only) [30 TAC §331.142(b)]

For hazardous waste injection wells establish and maintain liability coverage for sudden and non-sudden bodily injury and property damage to third parties caused by accidental occurrences arising from operations of the facility in accordance with the requirements of 30 TAC §37.7041. Evidence must be provided to show that the insurance policy covers the injection well(s).

C. Financial Capability Requirements (hazardous waste wells only) [30 TAC §305.49(c)]

For hazardous waste injection wells demonstrate to the satisfaction of the executive director that the applicant has sufficient financial resources to operate the facility in a safe manner and in compliance with the permit and all applicable rules, including, but not limited to, how an applicant intends to obtain financing for construction of the facility, and to close the facility properly as required by 30 TAC §305.50(a)(4)(B).

Information requirements for making this demonstration vary depending on the type of financial information available to applicants, primarily whether audited financial statements are available as well as the type of application submitted. For each type of application described below, financial information must be provided for the specific type of applicant entities.

V. GEOLOGY REPORT

Geoscientist Seal

Signature by Texas Professional Geoscientist

I, Moonsoo (Brian) Shin, the undersigned state: As an employee of Terra Dynamics Incorporated that I am authorized to prepare this document (***V. Geology Report***) and that this document (***V. Geology Report***) was prepared under my supervision and direction. All facts stated herein are true, correct and complete to the best of my knowledge. The geosciences information, calculations and analyses attested to in this document (***V. Geology Report***) were prepared in accordance with generally and currently accepted geosciences principles and practices. The information specifically covered by this seal includes Page V-1 to V-41, Table V-4, and Plate V-5 through V-14.

Signature

11/13/24
Date

Licensed Professional Geoscientist
#15260, State of Texas
Terra Dynamics Incorporated
Texas Registered Engineering Firm
F-3501

V. GEOLOGY REPORT

The following section discusses the regional and local stratigraphic and structural geology, lithology, hydrostratigraphy, and hydrogeology within the Tyson Fresh Meats, Inc. (Tyson) geologic study area. Information obtained from publications, available regional log coverage, and the drilling and completion of Tyson's WDW-120 injection well and other area injection wells was used for the study of the geologic conditions surrounding the Tyson facility.

V.A. Regional Geology and Hydrogeology

The Tyson regional geologic study area covers portions of Potter, Carson, Randall, and Armstrong Counties in the panhandle of Texas. The regional study area is circular within an approximate radius of 20 miles (Figure V-1). The center of the study area is approximately 11 miles east-northeast of Amarillo, Texas.

The Tyson facility is located in southeastern Potter County, which lies on the Southern High Plains (Llano Estacado) (Figure V-2) and along the northern edge of the Palo Duro Basin. The Palo Duro, Dalhart and Anadarko Basins, along with several other structural basins, occur as local members of the larger Permian Basin (Figure V-3). A stratigraphic column of the geologic and hydrologic units present in the regional study area is included as Figure V-4.

V.A.1 Regional Stratigraphy

The regional study area is underlain by basement rocks consisting of granitic to mafic intrusive igneous rocks, extrusive igneous (i.e., volcanic) rocks and metasedimentary rocks (Stone and Webster, 1983). The total thickness of sediment under the regional study area is approximately 9,000 feet as shown by the Precambrian structure map (Figure V-5). This basement material was continuously warped and faulted during the Mississippian, Pennsylvanian and Permian Periods (Budnik, 1989) and served as a major factor in the overall structure (Figure V-6) and deposition (Figure V-7) in the region.

The oldest sedimentary rocks in the 20-mile regional study area are carbonates of the Ordovician Ellenburger Group. The Ellenburger Group is found in the south and east portions of the Palo Duro Basin. This stratigraphic unit is an accumulation of shallow marine shelf carbonates of Early Ordovician time, with a total thickness of less than 1,000 feet (Dutton and others, 1979). Differential erosion related to the Devonian development of the Texas Arch, an eroded Paleozoic structure, modified the thickness of the Ellenburger Group, and explains its absence throughout much of the Palo Duro Basin (Dutton and others, 1979). The Ellenburger Group is absent throughout most of the four-county regional study area (Plates V-1 and V-2), except for the eastern side of Armstrong County, where less than 100 feet of Ellenburger Group is present (Plate V-1).

Overlying the Ellenburger Group are the Mississippian rocks of the Osage and Meramac Series (limestone and dolomite) and the Chester Series (limestone, dolomite and shale). Continued evolution of the Texas Arch modified the thickness of these units within the regional study area, resulting in a total thickness of less than 800 feet (Dutton and others, 1979). The Mississippian sequence has been eroded from much of the Palo Duro Basin, including Potter and Carson Counties (Figure V-4). Since uplift of the Amarillo Mountains eroded all of these pre-Pennsylvanian stratigraphic units within the 20-mile regional study area, none of the sediments are of concern to Tyson injection operations.

More than 2,500 feet of sediments accumulated during the Pennsylvanian time, within the regional study area (Nicholson, 1956). This stratigraphic interval consists of the clastic Morrow and Atoka/Bend Series, the clastic and limestone-rich Strawn Series, the marine shelf carbonate deposits of the Canyon Series, and the basinal marine shale of the Cisco Series (Stone and Webster, 1983). Figure V-8 presents the regional structure of the top of the Pennsylvanian System.

Regional tectonic activity was relatively high during the Pennsylvanian, and produced numerous surface exposures of Precambrian basement rocks. Through middle and late Pennsylvanian and early Permian time, Granite Wash Formation sands and gravels were shed from Precambrian crystalline rocks during uplift and erosion of the Amarillo Mountains north of the Tyson Area of Review (AOR). Across the study area, Granite Wash clastics (arkosic sediments) were deposited in fan deltas near shallow marine environments of relatively low energy, contemporaneous with limestone deposition (Figure V-7). Relatively high porosity (>20 percent) and permeability (>300 millidarcies [mD]) are preserved in the Granite Wash Formation of the regional study area. A regional isopach map of the Granite Wash Formation is shown on Figure V-9. The

Granite Wash Formation is considered the lower portion of the Tyson Injection Zone and a possible Injection Interval for the WDW-312 well.

The contact between the Cisco shales (i.e., the uppermost portion of the Pennsylvanian section) and the overlying Wolfcamp Series (Permian) is distinguished by a relatively sharp transition from interbedded marine and marginal-marine deposits to shelf carbonate deposits. The Permian sediments consist of the Wolfcamp, Leonard, Guadalupe, and Ochoa Series, and comprise the portion of the regional and local stratigraphic sequence that contains the Tyson Injection (upper portion) and Confining Zones.

The Wolfcamp Series consists of a limestone, shale and dolomite sequence, which records a period of gradual basin evolution within the regional study area (Figure V-7). Arkosic sand (i.e., Granite Wash stringers) deposits are found within the basal portion of the Wolfcamp Series, and reflect the deposition of erosional debris derived from the Amarillo Uplift area. The thickness of the Wolfcamp Series ranges up to approximately 3,000 feet, within the northern portion of the Palo Duro Basin.

The Brown Dolomite Formation, when differentiated, informally defines the uppermost portion of the Wolfcamp Series. This dolomitic formation is found to possess relatively high levels of porosity and permeability in the Potter County area and accounts for the majority of the available porous zone within the Wolfcamp Series. The regional structure of the top of the Wolfcamp Series (i.e., Brown Dolomite Formation) is shown on Figure V-10. The Brown Dolomite Formation, along with the overlying lower Wichita Group, serves as the permitted Injection Interval for the WDW-120 injection well and one of two proposed Injection Intervals for the WDW-312 injection well.

The Leonard Series conformably overlies the Wolfcamp Series, and is comprised of over 2,000 feet of Permian anhydrite, gypsum, anhydritic dolomite, dolomite, sandstone, and halite (i.e., salt). The Leonard Series consists of the Wichita Group and the Clear Fork Group (i.e., Red Cave Formation, Lower Clear Fork Formation, Tubb Formation, Upper Clear Fork Formation, and Glorieta Formation) (Hartman and Woodward, 1969).

A member of the Leonard Series, the Wichita Group conformably overlies the Wolfcamp Series, and records a period of restricted-marine and marginal-marine deposition (Dutton, 1980). As a result, it consists primarily of interbedded anhydritic dolomite, dolomite and shale. The Wichita Group is generally less than 1,200 feet thick within the regional study area, and serves as the top of the Injection Zone for Tyson wells WDW-120 and WDW-312. The lower portion of the Wichita Group also serves as the upper portion of the Injection Interval for the injection wells (Figure V-4).

The Red Cave Formation is the oldest formation of the Clear Fork Group. This formation is composed of red and green shale, and fine-grained sandstone with some carbonate and evaporite deposits, and records a period of relative shoreline instability (Hanford and Fredericks, 1980). Within the Palo Duro Basin, the Red Cave Formation is generally less than 200 feet thick (Birsa, 1977). The regional structure of the top of the Red Cave Formation is shown on Figure V-11. Natural gas is produced from the Red Cave Formation within the Panhandle Field in northern Potter County (Pippin, 1970).

The Lower Clear Fork Formation consists of anhydrite and dolomite with very little salt and some sandstone and shale deposits. Within the Palo Duro Basin, the Lower Clear Fork Formation ranges up to approximately 300 feet in thickness (Gustavson and others, 1980).

The Tubb Formation consists of terrigenous clastic red beds separated by some carbonate and evaporite beds in the Palo Duro Basin. The carbonates and evaporites of the lower Clear Fork Formation grade into the predominately red-bed shale deposits of the Tubb Formation (Gustavson and others, 1980). The Tubb Formation serves as the top of the Confining Zone for Tyson wells WDW-120 and WDW-312. Figure V-12 is a regional structure map of the top of the Tubb Formation.

The Upper Clear Fork Formation overlies the Tubb Formation, and contains carbonate and evaporite deposits. These sediments grade into the shale, sandstone and evaporite sediments of the Glorieta Formation. The combined thickness of the upper Clear Fork Formation and Glorieta Formation range from 900 to 1,300 feet in the Palo Duro Basin (Hanford and Fredericks, 1980).

The San Andres Formation overlies the Glorietta Formation and can be up to 1,300 feet thick. The formation consists of salt layers with dolomite, anhydrite and mudstone interbeds and is equivalent to the Blaine Formation in the Anadarko and Dalhart Basins (Stone and Webster, 1983).

The post-San Andres Formation sediments within the Palo Duro Basin account for more than 1,500 feet of sedimentary sequence (Stone and Webster, 1983), and consist of the Queen/Grayburg, Seven Rivers, Yates, Salado, Alibates and Dewey Lake (also known as Quartermaster) Formations. These formations consist predominantly of sandstone, mudstone, anhydrite, dolomite and shale deposits with some salt found in the Queen/Grayburg, and Seven Rivers Formations. The Yates Formation contains relatively more fine grained sandstone and shale beds. The Salado Formation is composed of anhydrite, dolomitic shale with some salt in the southern part of the Palo Duro Basin. The Alibates Formation is generally less than 100 feet thick and consists of a chert-bearing dolomite with some anhydrite. The Dewey Lake Formation, which overlies the Alibates Formation, consists of red sandstone and siltstone deposits, and ranges in thickness from 40 to 200 feet.

The Triassic-aged Dockum Group disconformably overlies the Permian stratigraphic sequence within the regional study area. The Dockum Group is comprised of a series of fluvial and lacustrine mudstone, siltstone, sandstone, and silty dolomite deposits (McGowen and others, 1979), which range up to approximately 1,200 feet thick in the Palo Duro Basin (Baldwin and Muehlberger, 1959). These sediments were deposited within a relatively large, land-locked basin (McGowen and others, 1979).

The Jurassic and Cretaceous stratigraphic sequence is not found in the Palo Duro Basin (Figure V-4). Therefore, the Ogallala Formation (Pliocene) and Quaternary (Pleistocene and Holocene) alluvial deposits rest unconformably upon either the Triassic Dockum Group (where present) or the Permian Alibates or Dewey Lake (Quartermaster) Formations within the area. The Ogallala Formation contains the principal source of potable water across the regional study area. The body of continental sand, silt, clay, and conglomerate was distributed across the regional study area by southeast-flowing fluvial systems in Tertiary Pliocene time (Seni, 1980). The Ogallala typically ranges from 200 to 400 feet thick in the Palo Duro Basin (Seni, 1980), however, Figure V-13 shows that the Ogallala and overlying Quaternary deposits range up to 800 feet in thickness in Carson County, east of the Asarco facility. Figure V-14 shows general easterly structural dip at the base of the Ogallala, with closed, low depressions in and near the study area that may be the result of collapse after solution of underlying Permian evaporites.

V.A.2 Regional Hydrostratigraphy

Figure V-15 shows a regional hydrostratigraphic cross section through the Palo Duro Basin. The regional study area has been projected into the plane of the cross section. The geologic section is divided into aquifers and aquitards; groundwater flow lines are shown recharging at western exposures and discharging at the base of eastern caprock escarpments and through Permian and Pennsylvanian-age sediments to the east. Refer to Plates V-3 and V-4 to compare the cross-section diagram with formations in the regional study area. Plates V-3 and V-4 west to east and north to south regional cross sections of the mid-Permian to Quaternary strata across the study area.

Shallow hydrostratigraphic units within the regional study area are the Quaternary-age alluvium, Pliocene Ogallala Formation, Triassic Dockum Group, and Permian (Ochoan) Dewey Lake and Alibates Formations, which are known to produce fresh to moderately saline water (less than 1,000 parts per million [ppm] of dissolved solids to less than 10,000 ppm dissolved solids) and are considered underground sources of drinking water (USDWs). Deeper units including the Permian Wolfcamp carbonates, Pennsylvanian carbonates, and Pennsylvanian Granite Wash sands and gravels produce very saline (10,000 to 35,000 ppm dissolved solids) to brine water (greater than 35,000 ppm dissolved solids) and are better suited for waste disposal activities.

<u>Shallow Aquifers</u>

Aquifers of three (3) geologic ages in the region have been used as water supplies: the Tertiary Pliocene Ogallala Formation, Triassic Norian Dockum Group and Permian Ochoan Dewey Lake.

The Ogallala Formation is the primary aquifer in the region, though the Triassic Dockum Group, present in the southwestern two-thirds of the study area, may also contain water of potable quality. The Dockum groundwater flow is southwesterly (Figure V-16), in contrast to shallow and deep regional groundwater flows. Figure V-13 shows the Tertiary Ogallala Formation and overlying Quaternary deposits to range from 0 to 500 feet in thickness through the regional study area, thickening to the southeast. Figure V-14 shows general easterly structural dip at the base of the Ogallala, with closed-low depressions in and near the study area that may be the result of collapse after solution of underlying Permian evaporites. Groundwater within the Ogallala Aquifer is typically under water table conditions, with a regional flow gradient of approximately 10 feet/mile toward the east/southeast (Figure V-17) and an average hydraulic conductivity of 200 gpd/ft^2 (Stone and Webster, 1983).

The Dockum Group (Dockum) is recharged principally from the overlying Ogallala. Net flow of water in the Dockum is to the south and southwest (Dutton and Simpkins, 1986). According to pump tests by Myers (1969) analogous mean hydraulic conductivities of the Ogallala and Dockum Aquifers of the Southern High Plains are 8.0 m/day and 0.8 m/day, respectively. Vertical conductivities could be an order of magnitude less due to stratification.

The Permian Ochoan Dewey Lake and Alibates Formations are recharged by water from the overlying Dockum Group, or from the Ogallala Formation and alluvium deposits where the Dockum is absent. Dewey Lake and Alibates rocks outcrop in the northwestern portion of the study area in the Canadian River Drainage, where discharge springs have been identified (Baker, 1915). Discharge of water from the Dewey Lake and Alibates Formations is associated with solution of sodium and calcium salts in underlying Permian strata.

Regionally, the Permian strata produce varying quantities of fresh to moderately saline water (Stone and Webster, 1983). Some stock and domestic wells withdraw fresh to slightly saline water from Ochoan Series sandstone, siltstone, and cherty dolomite. Moderate amounts of generally more saline water are produced from the older Guadalupe Series shale, sandstone, and gypsum. Although much of the Permian strata consist of salt and gypsum which render any groundwater found there unsuitable for drinking water supply purposes, the deepest of the local USDWs is considered to be the water-bearing intervals within the Alibates Formation. The base of the local USDW is discussed in further detail in Section V.B.3.a.

Deep Aquifers

The deep basin aquifer system includes formations that are of lower Permian age or older. These include the Permian Wolfcamp carbonates, Pennsylvanian carbonates, Pennsylvanian Granite Wash sands and gravels, and, where present, the Lower Paleozoic carbonates and sandstones (Figure V-4). Previous work within the regional study area indicates that the regional flow direction in the deep basin aquifer system is toward the east and northeast, away from outcrop areas to the west (Figures V-15 and V-18). In addition, regional topography and stratigraphic porosity trends are thought to be the driving forces governing regional flow patterns (Conti and others, 1988). The deep basin system is subnormally pressured and discharge points for the deep basin system have not been determined (Bassett and Bentley, 1983).

Hydrologic Properties

Tables V-1 and V-2 show reservoir properties of major divisions of the stratigraphic section of the Palo Duro Basin. Based on deep-reservoir volume and recharge and discharge rates, Fisher and Kreitler (1987) report that 6.7 storage times may have elapsed for the Palo Duro Basin. Groundwater flow velocities could be approximately 25-30 kilometers/million years for Wolfcampian aquifers, and 30 to 100 kilometers /million years for older, deeper aquifers including Granite Wash.

Permeability of hydrogeologic units is shown in Table V-1 in absolute and relative terms. For example, the difference in permeability between "Upper Paleozoic granite-wash aquifer" and "Permian Evaporite Aquitard" is a factor of 10^{-4}, according to Table V-1.

In Table V-2, a wide range of data is shown for six hydrologic units. Through comparison of data, it is clear that "Evaporite strata" display considerably less vertical permeability than units of the "Deep Basin Brine Aquifer." Evaporite strata of the table exhibit vertical permeability 36 times to more than 1,357,000 times smaller than permeability in Granite Wash of the Palo Duro Basin.

V.A.3 Confining and Injection Zone Definition and Description

The Confining Zone for the Tyson injection wells consists of the Tubb, Lower Clear Fork, and Red Cave Formations and the Injection Zone is within the Wichita, Brown Dolomite, Wolfcamp and Granite Wash Formations below the facility location.

*V.A.3.*a Confining Zone

The Confining Zone for the WDW-120 and WDW-312 injection wells contains sediments of the Clear Fork Group, which is composed of anhydrite, Sabkha salt, red beds, and peritidal dolomite (Collins and Luneau, 1986) of the Tubb, Lower Clear Fork, and Red Cave Formations. The Confining Zone depths are from 2,780 feet to 3,720 feet below kelly bushing (KB) in WDW-120 and are expected to be of similar depth in the proposed WDW-312 injection well. A structure map of the top of the Confining Zone is included as Plate V-5. A gross thickness isopach map of the Confining Zone is included as Plate V-6.

V.A.3.b Injection Zone

The Injection Zone for the two Tyson injection wells includes the following formations: (1) Wichita and Wolfcampian Brown Dolomite Formations for WDW-120 and (2) Wichita Formation, Wolfcampian Brown Dolomite Formation, Cisco-Canyon-Strawn Group carbonates, and Granite Wash Formation for proposed WDW-312. These formations consist of fine to coarse-grained sandstones, siltstones, and conglomerates; marine shale, shaley limestone, dolomitic limestone, and dolomite (Johnson, 1989). The Injection Zone depths are from 3,720 feet to 9,000 feet KB in WDW-120 (7 feet above ground level [GL]) and from 3,720 feet to 9,000 feet GL in the proposed WDW-312 well. A structure map of the top of the Injection Zone is included as Plate V-7. An isopach map of the Injection Zone is included as Plate V-8.

V.A.4 Regional Cross Sections

A west-east Texas Panhandle Regional Cross Section (Plate V-1) and a north-south Texas Panhandle Regional Cross Section (Plate V-2) are included in this application. On these two published cross sections the strata from the Precambrian to mid-Permian are illustrated. Plates V-3 and V-4 are regional cross sections of the mid-Permian to Quaternary strata. These cross sections show the regional stratigraphic and structural character of the Tyson Injection and Confining Zones.

V.A.5 Regional Structural Geology

Structurally, the regional study area is located on the southern margin of the buried Amarillo Uplift just north of the Palo Duro Basin (Figure V-3). The Amarillo Uplift is the most prominent structural feature in the study area. The uplift divides the Palo Duro Basin from the Anadarko Basin and extends into Oklahoma where it is known as the Wichita Uplift. The Amarillo Uplift has a Precambrian core and is fault-bounded on the north and south by a system of high-angle reverse faults (Johnson, 1989). The faults generally trend northwest - southeast and are thought to have originated during Precambrian time (Brewer and others, 1981). Fault movement, as indicated by depositional rates for Granite Wash sediments, was relatively minor during the early Pennsylvanian (Morrow and Atoka), but was much greater during the late Pennsylvanian due to the uplift of the Ancestral Rocky Mountains (Stone and Webster, 1983). By Wolfcamp time regional subsidence had begun to cause burial of the Amarillo Uplift.

The majority of the Paleozoic structural elements within the regional study area were induced by the warping and faulting of the underlying, older, Precambrian basement rocks (Figure V-5). A comparison of the structural fabric of the basement rocks to the younger Permian section (Figures V-11 and V-12) indicates that the younger structure is intimately related to the Precambrian basement. However, this comparison also shows that only a minor portion of the faulting that cuts the Precambrian basement actually extends up into the overlying Permian interval.

Within the regional study area, only the Potter County Fault appears to displace portions of the Permian section (Figure V-12). However, detailed structural mapping of the Lower Clear Fork Formation, covering much of Potter County and portions of adjacent counties, did not indicate the presence of Permian through Triassic faulting. The results of this mapping process, combined with local cross section results are fully discussed in Section V.B.1.

From the end of Permian deposition until Late Cretaceous time, there was relatively little tectonic activity except for periods of slight regional uplifting and downwarping. Late Cretaceous and early Tertiary time marked the beginning of the Laramide orogeny, which formed the Cordilleran Range to the west of the Permian Basin. This event uplifted the region to essentially its present position, supplied sediments for the Pliocene Ogallala Group and initiated the present hydrologic regime. There have been no major tectonic events within the Permian Basin since that time, except for a period of minor volcanism during the late Tertiary, in northeastern New Mexico (Stone and Webster, 1983). The regional structural framework may be locally modified by differential subsidence related to the dissolution of salt within the Permian deposits (Gustavson and others, 1980).

Basement-involved fault trends that pass near or through the region have also been drawn by Stone and Webster (1983) and Dutton and others (1982) and are shown in Figures V-5 and V-9 (maps of Precambrian Granite and Granite Wash). Normal fault structural relationships are common in the region, and normal faults are usually downthrown to the northeast; wrench fault style has been interpreted by Ruppel (1985). See structural cross sections, Plates V-1 and V-2.

Regional south-north and west-east structural cross sections showing total thickness of the sedimentary column suggest that most fault displacement, if present under the regional study area, occurred prior to deposition of Granite Wash facies. Some northwesterly trending faults of the region have probably been active to modern time. Evidence includes interpretations of linear trends visible on the surface (Figure V-19), and earthquake data (Section V.A.6).

There is evidence that fault trends through the region do not allow significant vertical migration of fluids above the Upper Clear Fork Formation; the Upper Clear Fork (Cimarron anhydrite) is approximately 800 feet below the USDW across the region. Evidence for vertical closure includes the presence of trapped natural gas and oil in the Red Cave and Brown Dolomite Formations, approximately 2,500 feet below the USDW across the regional study area. The Red Cave Formation is a productive gas reservoir through the northern portion of Potter County and the Brown Dolomite Formation is a productive hydrocarbon reservoir through much of the giant-class Panhandle-Hugoton Field (Figure V-20). Hydrocarbons are not detected in USDWs. If fault trends are active conduits for vertical fluid migration to aquifers and sources of drinking water, buoyant hydrocarbons would be detected in USDW aquifers. Thus, there is no evidence for fluid communication by any natural path between the Injection Zone and USDWs.

Collins and Luneau (1986) studied fractures and faults along the margins of Palo Duro Basin, comparing Ogallala, Triassic, and Permian styles of deformation. Along the Canadian River, the authors found that joint orientations in Eocene-age Ogallala rocks differ from those in underlying Triassic and Permian rocks, suggesting different stress fields active in Tertiary time, in contrast to late Paleozoic time. In Permian and Triassic rocks that outcrop in Palo Duro Basin, Collins and Luneau (1986) found dominant fracture trends oriented (degrees azimuth): 275° - 295°; and, 305° - 320°. The authors also reviewed insitu stress measurements after hydraulic fracturing of Permian strata in the SWEC Holtzclaw No. 1 well. The Holtzclaw No. 1 well is located in southern Randall County, approximately 60 miles southwest of the regional study area. The authors concluded that modern principal compressive stress is northeast-southwest through the region.

V.A.6 Regional Seismic Activity

The Panhandle area of Texas is historically an area of low seismicity with naturally occurring earthquakes being rare and of low magnitude. Tyson is located in one of the areas recognized as having the moderate to low level of seismic risk in the continental United States (Figure V-21). Rare instances of fluid injection-induced and fluid withdrawal-induced earthquakes from oil field operations have been documented over the regional scheme. However, fluid injection-induced earthquakes are associated with much higher injection pressures and volumes than what is encountered during Class I waste injection operations; fluid withdrawal-induced earthquakes are most associated with large scale oil and gas production of greater magnitude than any past/present production in the Panhandle area.

V.A.7 Regional Groundwater Flow in the Injection Zone

Regional groundwater flow velocities within the deep saline aquifers of the Texas Panhandle are relatively low. This is attributed to the lack of discharge pathways related to the burial and enclosure of permeable bodies by dense, relatively low permeability evaporites and shales referred to as the Permian evaporite aquitard (Wirojanagud and others, 1986). Flow lines shown in Figure V-15 depict paths of greatest groundwater velocity; note significant barriers to flow above the Permian Wichita Group, and note the recharge for Pennsylvanian and Permian systems in New Mexico located tens of miles to the West of Palo Duro Basin and Potter and Carson Counties; discharge is tens of miles easterly to Pennsylvanian and Permian facies below deep basin brine aquifers or aquitards of lowest Permian-age limestones and shales.

Figure V-18 presents the interpreted regional flow lines with the potentiometric surface map for the High Plains area, showing east and northeast potential flow through the regional study area. It is important to note this interpretation is subject to significant uncertainty due to available data constraints. In addition, the potentiometric map was prepared for the Wolfcampian Aquifer, which is present over a much broader area of the region than is the Granite Wash and deeper formations. A thorough review of the available literature did not reveal any additional information which conflicts with the work of Fisher and Kreitler (1987). Fisher and Kreitler (1987) include a table adapted from Bassett and Bentley (1983) comparing gross hydrologic divisions of the Palo Duro Basin and relative permeability (see Table V-1). A similar table is shown in Wirojanagud and others (1986), where absolute permeability and mean permeabilities for Palo Duro Basin and Potter County analogous units can be compared (Table V-2).

In addition to relatively slow lateral groundwater velocity (25-30 km/million years average [1.0 to 1.2 inches/year] in Wolfcampian aquifers, according to Fisher and Kreitler, 1987), the county-wide extent of relatively low porosity across an interval hundreds of feet thick will act to limit vertical migration of fluids, with little driving force over the post-operational period.

V.B. Local Geology and Hydrogeology

This discussion addresses the local stratigraphic and structural geology, lithology, hydrostratigraphy, and hydrology pertinent to the present Tyson injection operations at WDW-120 and to the proposed well site (WDW-312). For the purposes of this application, the local geologic area of study is defined as the area within the 2.5-mile radius composite AOR. However, due to the relatively sparse nature of available log coverage within the local area, additional data within approximately 10 miles of WDW-120 has been incorporated into the Tyson geologic study to more accurately depict the local subsurface conditions. Table V-4 presents the well control used for detailed mapping of the AOR.

V.B.1 Stratigraphy

Most of the strata in the approximately 9,000-foot thick sedimentary column within the local AOR (Figure V-4) are Paleozoic in age (from 250 to 570 million years old), and the sediments were deposited near sea level through a relatively long time interval when the climate was warm and dry. Plates V-1, V-2, V-3 and V-4 (Regional Structural Cross Sections) depict the lithologies of the stratigraphic section. Through Pennsylvanian and Permian time, the climate and shallow marine setting contributed to deposition of limestones and salts upward from the Granite Wash Formation to the base of the present-day USDW. The carbonates and evaporites constitute a rock thickness of approximately 3,050 feet (Plates V-12 and V-13 [Dip Oriented and Strike Oriented Structural Cross Sections]). To modern time the layers of salts and shales have been relatively unaltered and act as barriers to vertical fluid movement, though some of the limestone in the section has been converted to dolomite by circulating groundwater adding magnesium to the carbonate.

The Ogallala, Tubb, Red Cave, Wolfcamp Series, and Precambrian Granite Formations have been mapped in the region, and the regional interpretations of other workers are shown across the AOR. Figure V-23 shows a plan-view and a block-diagram of mechanisms by which sediments might have been eroded and distributed through Potter County and the AOR. The source direction of sediment was primarily from the north, and granitic material was washed to the sea during Pennsylvanian time and deposited near carbonate platforms. The regional interpretation is supported by lithologic data from wells drilled through the

Brown Dolomite Formation and into deeper formations within 10 miles of the Tyson facility.

A group of 43 wells (including the existing Tyson injection well) in southern Potter County, western Carson County, and northern Randall and Armstrong Counties, was used to estimate both gross thickness and depth to top of the Confining Zone, the Injection Zone, and the Injection Intervals through the AOR (see Table V-4). The most complete stratigraphic section can be observed from geophysical logs at location #8 (Plate V-12) and location #31 (Plate V-13). A general description and approximate interval thickness of the various geologic units of interest to this application follows.

Precambrian Units

The Precambrian section beneath the Tyson local geologic study area is comprised of granitic rocks of the Panhandle Volcanics (Stone and Webster, 1983). These rocks are very hard, crystalline and are approximately 1.14 billion years old.

The uppermost portion of the Precambrian section can be seen at location #8 on cross section A-A' (Plate V-12). For the purpose of cross section presentation, the well log at location #8 was cut off at a depth of 9,000 feet KB. However, the original log extends to a depth of 12,581 feet KB and shows a similar log response to that portion of the log depicted on Plate V-12.

The geophysical log response within the Precambrian section is rather abrupt and anomalous when compared to the overlying sedimentary section. The resistivity response is comparatively high, rounded-off and appears to meander. The natural gamma-radiation log response is relatively low and also appears to be rounded-off.

Although the Precambrian log response is unique, only six wells (#5, #6, #8, #29, #31, and #39) within the expanded geologic study penetrate the top of the Precambrian section, limiting a detailed mapping of basement structure. However, deep penetrations at well locations #1, #28, #30, #33, and #34 do indicate the minimum depth to which the younger sedimentary sequence must extend. This information is used in the development of the local structural framework, which is discussed in detail later in this section.

Pre-Pennsylvanian Units

Uplift of the Amarillo Mountains locally eroded the pre-Pennsylvanian stratigraphic section and these units are absent from the local study area.

Pennsylvanian Units

The boundaries of the Palo Duro Basin were actively forming during Pennsylvanian time (Budnik, 1989). Structural warping, faulting and the related changes induced on the Pennsylvanian depositional environments resulted in rapid facies changes (Dutton, 1980). The Pennsylvanian section (undifferentiated) beneath the geologic study area records this period of structural evolution with a diverse sequence of interbedded marine shale, shaley limestone, limestone, dolomite, and fluvial-deltaic Granite Wash layers (possible Injection Interval for undrilled Tyson well WDW-312).

The level of Pennsylvanian stratigraphic diversity is confirmed by a driller's log at location #8. The subsurface interval from approximately 7,500 to 8,700 feet KB (-3,900 to -5,100 feet mean sea level [MSL]) is comprised of a highly interbedded sequence of shale, shaley limestone, limestone, and granite wash. Due to this lithologic diversity, and due to the similarity between the upper Pennsylvanian sediments compared to those of the basal Wolfcamp Series, the contact between the Pennsylvanian and Permian section can be difficult to delineate (Conti and others, 1988).

The thickness of the Pennsylvanian section ranges from approximately 900 feet at location #29 to approximately 3,100 feet at location #6 (Plate V-11). This dramatic increase in Pennsylvanian thickness is due to the differential erosion and deposition caused by the evolving Pennsylvanian structural framework (Budnik, 1989) and suggests the presence of a deeper fault between these two locations. The local structural relationships are discussed further in Section V.B.5.

Pennsylvanian - Granite Wash (lower Injection Interval)

The proposed lower Injection Interval for the WDW-312 injection well is contained within the Granite Wash beds of the Pennsylvanian System. The top of the interbedded sand, shale, and lime section occurs at a depth of 5,595 feet KB or at an elevation of -2,067 feet MSL at location #28. Based on available log data, the Injection Interval may extend to a depth of approximately 9,000 feet. Below this depth is the Precambrian basement. The Granite Wash Injection Interval is projected to contain a minimum of approximately 150 feet of net sand thickness below the Tyson facility and is laterally extensive throughout the local study area (Figure V-9).

The Granite Wash Formation is derived from granitic Precambrian-age rocks of the Amarillo Uplift which were exposed to erosion through upper Pennsylvanian Virgilian and Missourian time. Coarse feldspathic clastics moved northward by fluvial processes. The term "fan delta" has been used to describe the wash of granitic particles distributed throughout the panhandle of Texas and across the AOR by McGowen (1970) and Dutton (1980); Erxleben (1975) and Handford (1980). Figure V-23 illustrates spatial relationships of environments and sediments in the Texas Panhandle.

Permian - Wolfcamp Series (lower part of Wichita-Brown Dolomite Injection Interval)

Locally, the Wolfcamp Series rests conformably upon the Pennsylvanian section, and records a period of marine deposition within the Palo Duro Basin. As a result, it is comprised of a relatively thick sequence of marine shale, shaley limestone, limestone, dolomitic limestone, dolomite, and some fluvial-deltaic granite wash layers.

Within the geologic study area, the basal portion of the Wolfcamp Series is comprised primarily of a 700 to 1,000 feet thick sequence of marine shale with isolated layers of shaley limestone, limestone, and sandstone. This is confirmed by a driller’s log at location #8 (Plate V-12).

The upper portion of the Wolfcamp Series consists of a rather thick sequence dolomite, know locally as the Brown Dolomite Formation. The Brown Dolomite Formation is an informal stratigraphic term used in the Panhandle Field and defines the uppermost portion of the Wolfcamp Series (Conti and others, 1988). Within the northern Palo Duro Basin, the Brown Dolomite Formation is characterized by a well defined upward decrease in apparent matrix porosity, and by a gradational transition from porous, coarsely crystalline dolomite within the Brown Dolomite Formation, to non-porous, anhydritic dolomite within the overlying Wichita Group (Conti and others, 1988; Havorka, 1990). This portion of the Wolfcamp Series can be distinguished from the lower Wolfcamp Series based on its moderately resistive, low radioactivity geophysical log response (Plates V-12 and V-13).

The characteristic log response of the Brown Dolomite Formation is common throughout the geologic study area, and can be observed particularly well on cross section A-A′ (Plate V-12). Based on this log signature, the thickness of the Brown Dolomite Formation is estimated from approximately 400 feet at location #8 to approximately 500 feet at location #28. This thickness relationship tends to follow the general thickness trend shown for the Wichita Group and Tubb Formation (Plates V-12 and V-13, respectively). The method used in this report to delineate the upper and lower contacts of the Brown Dolomite Formation is based on a convention used by the Bureau of Economic Geology (Conti and others, 1988; Havorka, 1990), and is confirmed by lithologic logs at location #1, location #11, and location #15.

The Brown Dolomite Formation consists of buff-colored sucrosic dolomite with gray shale and chert inclusions (Rogatz, 1961). Original carbonate of the Brown Dolomite Formation was deposited in a stable shelf margin marine environment; the upper part of the interval records shallowing marine conditions to restricted shallow shelf and supratidal environments above the Brown Dolomite Formation. The Brown Dolomite Formation is a diagenetic unit (Conti and others, 1988); thus the lower boundary crosses limestone and shale stratal boundaries.

Permian - Wichita Group (Top of Injection Zone and Injection Interval)

The Wichita Group conformably overlies the Wolfcamp Series, within the geologic study area, and records a period of restricted-marine and marginal-marine deposition (Dutton, 1980). Locally, the basal portion of the Wichita Group is informally referred to as the Hollinberg Dolomite (Cunningham, 1990). This interval consists of a non-porous, relatively non-anhydritic dolomite, and is discernable on geophysical logs as a blocky interval which exhibits a minimum self potential, minimum natural gamma-radiation and maximum resistivity response. Within the geologic study area, the Hollinberg Dolomite has a maximum thickness of approximately 200 feet, and may contribute to the ambiguous nature of the Wichita Group/Wolfcamp Series contact.

The upper portion of the Wichita Group is informally referred to as the Panhandle Lime, due to the white and limy appearance of the cuttings derived from its sediments (Cunningham, 1990). This portion of the Wichita Group consists of a relatively interbedded sequence of non-porous, anhydritic dolomite, anhydrite, and gray shale. This upper portion of the Wichita Group serves as the upper containment interval for the

WDW-120 and WDW-312 injection wells, and provides an excellent low permeability, areally extensive barrier to upward waste migration.

Within the geologic study area, the thickness trend of the Wichita Group (Plate V-12) appears to be dependent upon the local structural framework (Plate V-13). Relative structural highs tend to possess a thinner sequence of Wichita Group sediments. This suggests that the development of these structural features actively impacted the rate of sedimentation and/or erosion within the geologic study area.

The Wichita Group thins onto the flanks of two structural highs within the geologic study area (Plate V-13). A minimum thickness value of 620 feet occurs at location #31 on top of a structural high to the east of the Tyson facility, while a minimum thickness value of 750 feet occurs at location #11, on the flank of Bush Dome, to the west of the Tyson facility (Plate V-13). A maximum Wichita Group thickness value of 910 feet occurs between these two structural highs, at location #8 (Plate V-12). The structural framework of the geologic study area is further described later in this section. Top of the Wichita (top of Injection Zone) is at a depth of 3,720 feet KB and an elevation of -178 feet MSL in WDW-120. The Wichita has a thickness of 867 feet in WDW-120.

Permian - Red Cave Formation

The Red Cave Formation rests conformably upon the Wichita Group, and records a period of cyclic deposition in extensive coastal sabkhas. As a result, the Red Cave Formation is composed of a sequence consisting primarily of red and green shales and siltstones deposited in a mud-rich sabkha environment, with thin evaporite and carbonate layers deposited in a carbonate-evaporite sabkha environment (Hanford and Fredericks, 1980; Texas Panhandle Sample Log Service, 1976). The thickness of the Red Cave Formation remains relatively constant throughout the geologic study area (Plates V-12 and V-13), ranging from approximately 250 feet to approximately 330 feet.

Within the geologic study area, the thickness of the Red Cave Formation appears to be somewhat dependent upon the local structural framework (Plate V-12). Structural highs found at the west and northeast edges of the mapped area tend to be reflected by a thinner sequence of Red Cave Formation strata. The Red Cave strata immediately underlying Tyson are stratigraphically thicker, lying within a local structural low. This suggests that these structural features affected the deposition of the Red Cave Formation strata within the geologic study area.

The Red Cave Formation thins to a minimum of 248 feet at location #1, near the top of a structural high ten miles to the north of the Tyson facility (Plate V-12). A maximum Red Cave Formation thickness of 334 feet occurs at location #8, located within a structural low mapped on top of the Wichita Group (Plate V-7). At the Tyson facility, the Red Cave Formation is 303 feet thick.

There is no evidence of fractures or faults within the Red Cave within the geologic study area, based on evaluation of geophysical logs, sample descriptions, and published literature of the area. Based on regionally available information regarding Permian shales and anhydrites within the Palo Duro Basin, the Red Cave Formation contains very low permeability, areally extensive strata which provide an excellent barrier to upward waste migration.

Permian - Lower Clear Fork Formation

The Lower Clear Fork Formation rests conformably on top of the Red Cave Formation and consists primarily of restricted-marine and marginal-marine evaporite deposits. These deposits include: anhydrite, gypsum, salt, and shale (Texas Panhandle Sample Log Service, 1976). Within the geologic study area, the thickness of the Lower Clear Fork Formation varies from approximately 400 feet at location #1, to approximately 470 feet at the WDW-120 (Plate V-12).

Permian - Tubb Formation (Top of Confining Zone)

The Tubb Formation rests conformably on top of the Lower Clear Fork Formation, and records a period of marine regression and restricted-marine, evaporitic deposition (Gustavson and others, 1980). The sedimentary section consists of a sequence of interbedded shale, fine-grained sand, and salt deposits (Texas Panhandle Sample Log Service, 1976).

The Tubb Formation serves as the top of the Confining Zone for the WDW-120 and proposed WDW-312 injection wells, and its structure was mapped throughout the geologic study area (Plate V-5). The result of this mapping indicates that the Tubb Formation was actively impacted by local tectonic activity. Structural highs to the north, east and west of the present-day location of the Tyson facility determined the relative rate of sedimentation and/or erosion, as illustrated by thickness values of 145 feet at location #1 to the north and 190 feet at location #28 to the south (Plate V-12). The Tubb Formation has a thickness of 165 feet in WDW-120. The Tubb Formation is laterally continuous throughout the geologic study area, and does not show signs of faulting.

Remaining Permian Sequence

The remaining Permian stratigraphic sequence within the geologic study area consists of seven general units, including: 1) Upper Clear Fork Formation; 2) Glorieta Formation; 3) San Andres Formation (Blaine Formation); 4) Yates, Seven Rivers, Queen, and Grayburg Formations (undiff.); 5) Salado and Tansill Formations (undiff.); 6) Alibates Formation; and 7) Dewey Lake Formation (Quartermaster Formation) (Plates V-12 and V-13). These stratigraphic units record a wide variety of marine, restricted-marine, and marginal-marine depositional environments, and contain sediment types ranging from sandstone, siltstone, shale, to carbonate and evaporite deposits. Within the geologic study area, this portion of the Permian stratigraphic sequence contributes over 2,100 feet of total thickness (Plates V-12 and V-13), which is sufficient to provide protection against potential movement of waste constituents from the Injection Zone. Specifically, this site contains a formation of sufficient thickness and with lithologic and stress characteristics capable of preventing initiation and/or propagation of fractures. Further, the Confining Zone is separated from the base of the lowermost USDW or freshwater aquifer by strata that will provide protection for the USDW and freshwater aquifer in the event of movement of fluids in an unlocated borehole or transmissive fault.

Triassic Units

Within the geologic study area, the Triassic sequence rests disconformably on top of the Permian strata. The Triassic is locally represented by the red clay, shale, siltstone, sand, sandstone, and conglomerate deposits of the fluvial, fluvial-deltaic, deltaic, and shallow lacustrine Dockum Group. This unit outcrops in the northwestern portion of the geologic study area (Figure V-24), and accounts for less than 120 feet of total thickness (Plates V-12 and V-13).

Tertiary Units

The Tertiary section consists of a relatively thin sequence of fluvial sediments which comprise the Ogallala Formation (Pliocene). This unit outcrops throughout much of the geologic study area, and ranges up to approximately 600 feet thick to the northeast of the Tyson facility (Figure V-13). The Ogallala Formation (i.e., Ogallala Aquifer), serves as the primary source of fresh groundwater within the geologic study area.

Quaternary Units

The Quaternary stratigraphic sequence consists of a variety of thin, sandy and silty deposits (Figure V-24), and accounts for less than 75 feet of total thickness within the geologic study area (Plates V-12 and V-13).

V.B.2 Hydrostratigraphy

An inventory of water wells within a 1-mile radius of the Tyson property boundary was performed based on existing state agency records. Thirty wells were found within the specified area; 26 were drilled for domestic purposes and 4 were drilled as monitor wells. All of these wells are completed in the Ogallala Aquifer and/or the Dockum Aquifer at depths ranging from 190 feet to 400 feet GL. The locations of the wells are shown on Attachment C-1 and a table containing information about the wells is included in Appendix D, as are the available well records.

All of the shallow hydrostratigraphic units discussed in Section V.A.2 are present within the 2.5-mile local study area. The Ogallala Aquifer is the only significant source of potable water within the local area. The Ogallala groundwater flow pattern in southeastern Potter County in 1984 was generally toward the northeast (Figure V-17), at an estimated rate of approximately 10 feet/year (Knowles and others, 1984). The map in Figure V-17 indicates that the potentiometric surface in the Ogallala Aquifer is approximately 200 feet GL in the vicinity of Tyson. The base of the Ogallala Formation is found at a depth of approximately 280 feet GL based on drilling records from the local water wells (Appendix D).

A potentiometric surface map of the underlying Dockum Aquifer, which locally contains poor quality fresh water, is included as Figure V-16. This map shows that the potentiometric surface in the Dockum Aquifer is at a depth of approximately 250 feet GL in the Tyson area and direction of flow is toward the northeast. The base of the Dockum Group is found at a depth of approximately 400 feet.

The base of the Dewey Lake Formation is found at a depth of approximately 500 feet in the Tyson area and the underlying Alibates Formation (deepest USDW) is found at a depth of approximately 675 feet. Direction of flow of these aquifers is assumed to also be toward the northeast, as the limited amount of fluid level data from wells in the Dewey Lake or Alibates Formation precludes the construction of potentiometric surface maps of these horizons.

The deep basin hydrostratigraphic units discussed in Section V.A.2 are also present within the local study area. The local flow direction within the deep brine aquifer system is toward the east-northeast below the Tyson facility (Figure V-18). A brine sample collected from the Brown Dolomite Formation during the drilling of WDW-120 in 1974, had a total dissolved solids (TDS) of approximately 172,000 milligrams per liter (see Table VII-2 and Appendix B).

V.B.3 USDW, Confining and Injection Zone Definition and Description

From the WDW-120 injection well, the approximate depths to the various zones of interest for these permit renewal applications include the following:

Depth to:	WDW-120*	Proposed WDW-312**
Base of USDW	675′	665′
Top of Upper Confining Zone	2,780′	2,780′
Top of Injection Zone	3,720′	3,720’
Top of Wichita-Brown Dolomite Injection Interval	4,000′	4,000′
Base of Wichita-Brown Dolomite Injection Interval	5,000′	5,000′
Top of Granite Wash Injection Interval		5,850′
Base of Granite Wash Injection Interval		9,000′
Base of Injection Zone	9,000′	9,000′

* Note: depths are relative to kelly bushing.
** Note : estimated depths are relative to ground level.

V.B.3.a Base of USDW

For the purposes of these permit applications, a USDW was defined as an aquifer in the Tyson area which: 1) contained sufficient quantities of groundwater to supply a public water system; and, 2) contained fewer than 10,000 milligrams per liter (mg/L) TDS. It is difficult to map the base of the USDW because: 1) surface casings for oil and gas wells are typically set to a sufficient depth to protect groundwater supplies containing groundwater having less than 10,000 mg/L TDS; 2) all local groundwater supply wells are completed into much shallower and much fresher horizons; and, 3) it is typical that wells drilled in the Panhandle are not logged across shallow horizons (within the Tyson area, most wells are logged from total depth to about 1,500 feet to 1,600 feet KB). However, it was possible to develop a cross section which portrays the base of the USDW using electric logs from wells which were logged above the zone where water salinity approached 10,000 mg/L.

The primary source of groundwater within the regional area, including the Tyson AOR is the Ogallala Aquifer. However, as discussed in Section V.A.2, the base of the lowermost USDW is considered to occur at the base of the Alibates Formation (Permian). Therefore, the vertical interval that contains a potentially usable quality of groundwater incorporates five stratigraphic units: undifferentiated surficial deposits (Quaternary), Ogallala Formation (Tertiary), Dockum Group (Triassic), Dewey Lake Formation (Permian), and Alibates Formation (Permian) (Figure V-4). The local groundwater system will be isolated from deep injection activities at the Tyson facility by the Confining Zone and the injection well completion methods (Section VI).

Based on geophysical log response and limited chemical analyses from water wells, the Ogallala, Dockum Group, Dewey Lake, and Alibates Formations contain relatively fresh (less than 3,000 ppm TDS) to moderately saline (3,000-10,000 ppm TDS) water. No area water wells are known to produce water of usable quality from formations below the Alibates Formation. Therefore, the base of the USDW is determined to be at the base of the Alibates Formation, which is found at a depth of 675 feet KB in the WDW-120 injection well, and is expected to occur at approximately 665 feet GL in WDW-312. As such, the injection wells will inject into a formation that is beneath the lowermost formation containing, within at least 1/4-mile of the wellbore, a USDW or freshwater aquifer.

The Dip Oriented Structural Cross Section A-A′, and Strike Oriented Structural Cross Section B-B′ (Plates V-12 and V-13) show the configuration of the lowermost USDW across the 10-mile Tyson local study area. Based on the available logs, the lowermost USDW horizon is shallowest at location #31 (600 feet KB) in the southeast and deepens to 760 feet KB at location #8 north of the Tyson facility.

V.B.3.b Confining Zone

The Confining Zone for the WDW-120 and WDW-312 injection wells consists of Clear Fork sediments of the Tubb, Lower Clear Fork, and Red Cave Formations. The Confining Zone depths range from 2,780 to 3,720 feet KB at the WDW-120 well location, approximately 940 feet thick. The Confining Zone rock types include: anhydrite, red beds, peritidal dolomite, and Sabkha salt deposits. A structure map of the top of the Confining Zone is included as Plate V-5. A gross thickness isopach map of the Confining Zone is included as Plate V-6.

The Confining Zone provides an additional layer of confinement strata between the Injection Zone and the base of the USDW. The stratigraphic sequence in the Confining Zone provides an adequate barrier to the upward migration of waste fluids. The Confining Zone is laterally continuous and free of transecting faults or fractures over an area sufficient to prevent movement of constituents into USDWs and contains a formation with sufficient thickness and with lithologic and stress characteristics capable of preventing vertical propagation of fractures. In addition, the Confining Zone is separated from the base of the lowermost USDW by at least one sequence of permeable (Glorieta Formation) and less permeable strata (Upper Clear Fork) that will provide an added layer of protection for the USDWs.

V.B.3.c Injection Zone

The Injection Zone for the WDW-120 and WDW-312 injection wells includes the following formations: Wichita Group, Brown Dolomite, Wolfcamp Series, and Granite Wash. The permitted Injection Zone depths are from 3,720 to 9,000 feet KB in WDW-120 (KB is 7 feet above ground level in WDW-120) and 3,720 to 9,000 feet GL in proposed WDW-312. A structure map of the top of the Injection Zone is included as Plate V-7. A gross thickness isopach map of the Injection Zone is included as Plate V-8.

The Wichita Group, which serves as the upper portion of the Injection Zone, is approximately 870 feet thick across the 2.5-mile radius composite AOR. The Wichita Group consists of anhydritic and non-anhydritic dolomite interbedded with shale and extends over hundreds of square miles in Potter and Carson Counties. The anhydritic dolomite and interbedded shales of the upper portion of the Wichita Group inhibit vertical fluid movement.

V.B.3.d Injection Intervals

WDW-120 is currently completed in porous intervals of the Wichita Group and Brown Dolomite Formation, which serve as the Injection Interval for this well. The designated Injection Interval depths for WDW-120 are from 4,000 to 5,000 feet KB. A structure map of the top of the Wichita-Brown Dolomite Injection Interval is included as Plate V-9. A gross thickness isopach map of this Injection Interval is included as Plate V-10. The proposed WDW-312 injection well may be drilled and completed in the Granite Wash Injection Interval at a depth of up to 9,000 feet GL, or if this is not feasible, then completed in the Wichita-Brown Dolomite Injection Interval. No structure of the Granite Wash Injection Interval is provided because of the limited log data available. However, a gross thickness isopach map of the Granite Wash Injection Interval is included as Plate V-11.

Wichita-Brown Dolomite Injection Interval

The Wichita-Brown Dolomite Injection Interval consists of an interbedded sequence of anhydritic dolomite, anhydrite, and crystalline dolomite. The Injection Interval becomes increasingly anhydritic above 4,590 feet KB. The structure on top of the Wichita-Brown Dolomite Injection Interval dips from northeast to southwest (Plate V-9). As indicated on the structure map, the Injection Interval is laterally continuous and free of transecting faults or fractures within the Tyson composite AOR, and contains a formation with sufficient thickness and with lithologic and stress characteristics capable of preventing vertical propagation of fractures.

A variety of data was reviewed to determine the Injection Interval rock property values. The investigation included consideration of literature data, core data, and analysis of available transient pressure well tests conducted on the WDW-120 injection well, and other injection wells in the Amarillo area.

Although no core was taken during the drilling of WDW-120, extensive information was gathered during the drilling of Asarco well WDW-324 in 1996. This data can be extrapolated to the Injection Interval strata in the vicinity of the Tyson injection wells. A total of 30 feet of whole core samples were obtained from the Brown Dolomite Injection Interval from 4,720 to 4,750 feet KB using diamond coring equipment. The core data reports are included in Appendix B. Properties of rock types identified from the Asarco WDW-324 core and from log responses across those intervals are summarized in the following table:

WDW-324 Rock Properties

	Brown Dolomite
Core Depth For Lithology Specified	4,720' – 4,750'
Log Gamma API	20 - 30
Core Air Permeability (horizontal) mD	0.4 – 23.6
Core Porosity %	8.3 – 18.5
Core Water Saturation %	82
Log Sonic Porosity %	not logged
Log Borehole Caliper Permeability	Yes
Log Induction Resistivity Ohms	20 - 24

Based on the core analysis, research of available literature, and a review of porosity logs from WDW-120 and nearby artificial penetrations, an average porosity value of 10 percent has been selected as a representative value for the porosity of the Wichita-Brown Dolomite Injection Interval for the Tyson wells. Similarly, a permeability value of 20 mD has been selected based on reservoir tests conducted in WDW-120 since 2003 (see Section VII.A.2).

The Granite Wash Injection Interval sediments are described as clear to white to pink, coarse-grained, rounded to angular, friable detrital sediments. The Granite Wash interval consists of the following minerals: feldspar, quartz and chert, micas and clays, pyrite, magnetite, calcite, and dolomite.

No direct reservoir data is available pertaining to the Granite Wash interval near the Tyson facility. A significant amount of study has been conducted on the properties of the Granite Wash Formation in the Palo Duro Basin. Wirojanagud and others (1986) presented data listing a range of Granite Wash permeability as 0.01 to 380 mD with average values of less than 10 mD (Table V-2). Typical values for Granite Wash porosity were listed between 11 and 27 percent. However, since direct data are available, porosity and permeability values of 10 percent and 40 mD have been chosen as representative of the Granite Wash Injection Interval for the proposed WDW-312 well.

V.B.3.e Confining Strata Beneath Injection Zone

The confining strata beneath the Injection Zone are comprised of Precambrian granite. It is anticipated that the porosity and permeability of the Precambrian sediments are sufficient to contain any injected fluids which may migrate below the Injection Interval. Depth to top of the Precambrian below WDW-120 and the proposed WDW-312 injection well may be up to 9,000 feet, based on area well logs.

V.B.3.f Uninterpreted Copy of Base Map Used in (b), (c) and (d)

An uninterpreted copy of the base map used for mapping is included as Plate V-14.

V.B.4 Local Structural Cross Sections

Plates V-5, V-7 and V-9 show the local structural cross section locations and well control used for mapping and cross section construction through the Tyson study area. Plates V-12 (Dip Oriented Structural Cross Section A-A′) and V-13 (Strike Oriented Structural Cross Section B-B′) illustrate the continuity of the Confining Zone, Injection Zone, and Injection Intervals within the area. The local cross section locations are also shown on these plates. The WDW-120 and WDW-312 injection well locations are identified on all structure and isopach maps and on the strike oriented cross section.

V.B.5 Structural Geology

The Tyson facility is located near the axis of a relatively narrow structural syncline that opens to the south toward the Palo Duro Basin (Plates V-5, V-7 and V-9). This synclinal structure is bordered to the east by an anticlinal structure in southwestern Carson County, and is bordered to the west by Bush Dome (Figure V-11).

A comparison of the structural relationship of the Precambrian basement (Figure V-5) to that of the top of the Tubb Formation (Figure V-12) indicates that only the Potter County Fault, located outside of the 10-mile geologic study area, extends up from the Precambrian into the Permian stratigraphic section and is of potential regional significance to this report. However, detailed structural mapping of the top of the Wichita Group (Plate V-7), and cross section preparation using well log control did not provide any evidence of Permian faulting within the geologic study area (Plates V-12 and V-13).

The Precambrian basement is penetrated at six locations within the local study area (#5, #6, #8, #29, #31, and #39). Data derived from these six locations and five other locations that penetrate only the top of the Pennsylvanian Series (#1, #28, #30, #33, and #34) indicate that the structure of the Precambrian basement changes abruptly from sea-level relative depths of approximately -2,600 to -4,500 feet in the vicinity of wells #28, #29, #31, and #39, to approximately -5,170 to -5660 feet near wells #5, #6, and #8. This indicates the presence of a deep fault that offsets the surface of the Precambrian basement, and roughly agrees with the Precambrian structural framework shown in

Figure V-7. However, the structure of the top of the Wichita Group does not indicate the continuation of this deep fault into the Permian section (Plate V-7).

The structural framework within the geologic study area is consistent with the regional framework discussed in Section V.A.5. Sediments within the geologic study area appear to have been warped into relatively gentle, domal, and synclinal structures (Plate V-5).

Plate V-5 is a structure contour map of the top of the Confining Zone (Tubb Formation). This map shows the top of the Confining Zone to lie between sea-level relative depths of approximately +900 feet and +600 feet across the 2.5-mile composite AOR. The top of this formation is at a depth of 2,780 feet KB, and an elevation of +762 feet in the WDW-120 injection well. A structure contour map of the top of the Injection Zone (Wichita Group) is depicted in Plate V-7. This map shows the top of the Injection Zone to be between datums of approximately 0 feet and -240 feet across the 2.5-mile composite AOR. The top of the Injection Zone is at a depth of 3,720 feet KB, and an elevation of -178 feet in the WDW-120 injection well.

Gross interval thickness isopach maps of the Confining Zone and Injection Zone are shown in Plates V-6 and V-8, respectively. The gross thickness of the Confining Zone ranges from 900 to more than 950 feet across the 2.5-mile composite AOR (Plate V-6), while the Injection Zone is from approximately 4,100 feet to more than 4,500 feet thick across the composite AOR (Plate V-8). The Confining Zone is 940 feet thick in the WDW-120 injection well. The thickness of the Injection Zone beneath the Tyson facility is estimated to be approximately 4,400 feet based on the geological mapping, as the WDW-120 well does not penetrate the full stratigraphic section.

A gross interval thickness isopach map of the Wichita-Brown Dolomite Injection Interval is shown on Plate V-10. The gross thickness of the Wichita-Brown Dolomite Injection Interval ranges from less than 950 feet to approximately 1,050 feet thick across the 2.5-mile composite AOR. The Wichita-Brown Dolomite Injection Interval is 1,000 feet thick in the WDW-120 injection well. Plate V-11 is a gross interval thickness isopach map of the Granite Wash Injection Interval. The gross thickness of the Granite Wash Injection Interval ranges from more than 900 feet to approximately 1,400 feet thick across the composite AOR. The gross thickness of the Granite Wash Injection Interval is estimated to be approximately 1,200 feet beneath the Tyson facility.

V.B.6 Delineation of Faults and Fault Transmissivity

No direct evidence of faults or transmissivity of faults and fractures within the 2.5-mile composite AOR was found. A possible deep-seated fault is located approximately five miles to the northeast of the AOR. The AOR is located on the southern flank of the Amarillo Uplift - a structural setting in a region where many examples of faults are available for study. Through the Paleozoic Era, movement on faults included wrench and normal fault styles. Uplift, erosion, and deposition of sediment was contemporaneous with movement on deep-seated faults; the presence of Pennsylvanian age Granite Wash sediment within the AOR is evidence of uplifted granitic terrain a few tens of miles from the site. Precambrian crystalline rocks and sediments probably include faults that extend upward to the Pennsylvanian age Granite Wash sediments; fault surfaces cutting older rocks may or may not continue upward through post-Pennsylvanian rocks across surfaces of erosion -- an interpretation shown in Plate V-12.

The presence of deep-seated faults does not imply fault displacement to the surface, nor does the presence of a fault in itself indicate a relatively more permeable fluid flow path along the fault surface.

V.B.7 Confining Zone Lateral Continuity

As discussed in the previous section, no evidence of faults or transmissivity of faults within the 2.5-mile radius composite AOR has been found. The Confining Zone within the AOR, based on all mapping performed and literature researched, is laterally continuous and free of transecting, transmissive faults or fractures which could cause movement of fluids into a USDW or freshwater aquifer.

V.B.8 Confining Zone Lithologic and Stress Characteristics

The Confining Zone consists of the Tubb, Lower Clear Fork, and Red Cave Formations. The Confining Zone depths range from approximately 2,780 to 3,720 feet below ground level at the WDW-120 and WDW-312 well locations; approximately 940 feet thick. The Confining Zone rock types include: anhydrite, Sabkha salt, red beds, and peritidal dolomite. As discussed in Section V.B.1, because of the interbedded nature the Tubb, Lower Clear Fork, and Red Cave Formations, the Confining Zone is of sufficient thickness and possesses lithologic and stress characteristics capable of preventing vertical propagation of fractures.

V.B.9 Confining Zone-USDW Demonstration

The lowermost USDW is separated from the Confining Zone by strata that will provide an added layer of protection for the USDW.

V.B.9.a Confining Zone – USDW Separation

The top of the Confining Zone (top of Tubb Formation) is present at a subsurface depth of approximately 2,780 feet at WDW-120 and WDW-312. The base of the lowermost USDW (base of the Alibates Formation) at this location is at a depth of approximately 675 feet. A total of over 2,100 feet of alternating sandstone, siltstone, shale, carbonate, and evaporite sequences separate these two horizons. Thus, the Confining Zone is separated from the base of the lowermost USDW by at least one sequence of permeable (Glorieta Formation) and less permeable strata (Upper Clear Fork Formation) that will provide an added layer of protection for the USDW in the event of fluid movement in an unlocated borehole or transmissive fault.

V.B.9.b Injection Zone-USDW Potentiometric Surface

As shown in V.B.9.a, the Confining Zone is separated from the base of the lowermost USDW by at least one sequence of permeable and less permeable strata that will provide an added layer of protection for the USDW in the event of fluid movement in an unlocated borehole or transmissive fault.

V.B.9.c Presence of USDWs

As shown in V.B.9.a, the Confining Zone is separated from the base of the lowermost USDW by at least one sequence of permeable and less permeable strata that will provide an added layer of protection for the USDW in the event of fluid movement in an unlocated borehole or transmissive fault.

V.B.10 Seismic History

Regional seismic history is discussed in Section V.A.6. Local potential for a seismic event due to injection is discussed in the following section.

Additional analysis on induced seismicity in the Texas panhandle was performed by Acevedo and others (2022). In their comparison of oil and gas production and Class II injection well injection volumes in proximity to known faults, Acevedo and others identified geographic regions and geologic structures with higher Class II injection volume related to induced seismicity. Their study identified that most of the tectonically derived earthquakes occurred to the west of the Tyson study area or in the Palo Duro Basin to the south; earthquakes with stronger evidence of induced seismicity occurred in the basement uplift regions, such as the Amarillo-Wichita uplift to the east toward Gray County, or near high volume oil and gas production or Class II activities, such as the Whittenburg trough to the west or the Anadarko Basin to the east.

V.B.10a. Recorded Seismic Activity

The Tyson study area is an area of moderate to low intensity seismic activity, based on observational data obtained from the TexNet Earthquake Catalog of the Bureau of Economic Geology, the National Earthquake Information Center (NEIC) of the United States Geological Survey (USGS, 2024) and seismic hazards mapping of the USGS (2018). Figure V-21 (National Seismic Hazard Map) projects peak ground acceleration in the United States for 50 years in the future with a 2 percent probability that the mapped values will be exceeded. As shown in Figure V-21, peak ground acceleration at the Tyson facility location is moderate to low. This is due, in part, to the relatively low level of tectonic activity occurring within the regional study area.

A search for recorded seismic events within a 50-kilometer (31-mile) radius of the Tyson facility provided a list of 33 individual events during the period from 1907 to 2024 (Table V-3, Figure V-22). Based on the collected data, the nearest seismic activity was one low intensity earthquake event that occurred in 2023 within a range of 6 kilometers [km] of the Tyson injection wells. No other reported earthquake events of any intensity or magnitude have occurred within a 2.5-mile radius around the injection well locations. The seismic activity that has occurred within 31 miles of the injection site is probably associated with salt dissolution or movement along faults near the Amarillo Uplift (Stone and Webster, 1983). A review of the collected data for the subject area indicates a depth range of approximately 4.14 – 13.7 km to the earthquake epicenters.

The maximum intensity of any of the 33 events on the Modified Mercalli Scale (MM) was MM VI (shown as 6 on Table V-3), while the maximum recorded magnitude was 4.9. The nearest seismic disturbance of this intensity occurred approximately 21.1 miles (34 km) northeast of the Tyson facility on July 30, 1925. The disturbance that occurred in 2003 at a distance of 6.2 miles to the northwest was MM IV (shown as 4 on Table V-3).

Earthquake Risk Assessment

Risk assessment of earthquakes requires description of the kinds of events that would disrupt injection operations. In this report, four aspects of earthquake risk assessment are addressed:

* Earthquake Intensity
* Time interval between Earthquakes
* Distance from an Earthquake to an Injection Site
* Earthquake Data Quality.

Earthquake Intensity

The most severe earthquakes within the 50-kilometer radius of search occurred in 1925 and 2020 at distances of approximately 21 and 8 miles, respectively, from the Tyson facility. The earthquakes had magnitudes of 4.9 and 4.7, respectively, and two (1917 and 1925) had intensities of MM VI (6). Intensity MM VI on the Modified Mercalli Scale is:

> "Felt by all, indoors and outdoors. Frightened many, excitement general, some bushes shaken slightly to moderately. Liquid set in strong motion. Small church bells rang. Damage slight in poorly built buildings. Fall of plaster in small amounts. Cracked plaster somewhat, especially fine cracks in chimneys in some instances. Broken dishes, glassware in considerable quantity, also some windows. Fall of knickknacks, books, pictures. Overturned furniture in many instances. Moved furnishings of moderately heavy kind."

Compared to the description above, it is unlikely that the occurrence of an intensity of MM VI earthquake at a distance of 21 miles from the Tyson site would shear cemented casing and steel tubing downhole, cause interruption in injection operations, or impair the mechanical integrity of the Tyson injection wells. This is supported by the fact that there are no recorded incidents of impairment of oil and/or gas wells within the Tyson study area due to the occurrence of seismic activity of an intensity of MM VI in 1917 and 1925, or from the less intense earthquakes recorded as shown in Table V-3. Given the distance to epicenter for these events, and the fact that the earthquake intensity decreases radially from the epicenter, it is estimated that an earthquake of an intensity of MM VI at a distance of 21 miles from the Tyson facility, would be felt or reported as a MM IV within the Tyson study area (see discussion below of Distance From An Earthquake To The Injection Site).

If a relatively strong earthquake happens within 50 kilometers of the Tyson site, the distance between the injection site and a hypocenter (focus of earthquake energy) would determine potential damage because the energy of earthquakes generally decreases in relation to radial distance from the hypocenter. The rate of decreasing energy can be expressed as an exponential function of the radius. Of earthquakes for which depth to a hypocenter is recorded in this study, the median depth is approximately 3 miles (5 kilometers) and nearest distance to the site is 4.79 km.

Time Interval Between Earthquakes

An earthquake of a size sufficient to disrupt industrial operations or threaten life has not occurred in recorded history within 50 kilometers of the Tyson site. There is no evidence based on frequency of earthquakes for forecasting a significant shock within the radius of investigation.

Data recorded through the last 117 years suggest that at least one measurable earthquake will occur every 1 to 10 years within 50 kilometers of the study area. Earthquakes will be between intensities of IV and VI (Modified Mercalli Scale), which means the greatest disturbance will be breakage of dishes and slight shaking of trees and bushes. There is no basis from the available data to allow accurate prediction of time to possible occurrence of an earthquake stronger than MM IV to VI within 50 kilometers of the study area. Assuming that the nearest of these events will be no closer than six km from the Tyson facility, earthquakes of these intensities will probably not be felt or reported at the facility.

Earthquake Data Quality

All earthquakes recorded in the study area are below magnitude 5.0 on either a Local Magnitude Richter scale, Nuttli Magnitude, Coda Length Magnitude, or Felt Area Magnitude. There are no fault-plane solutions on record. There are no ground acceleration or ground displacement data in the National Earthquake Information Center report; no quantitative assessment of facility design is done for this report. Maximum and minimum horizontal stress data have not been obtained that would allow resolution of the present state of stress in the Wolfcamp Dolomites or in the Pennsylvanian Granite Wash Formations.

The state of stress is not presently known in the Texas Panhandle (Stone and Webster, 1983). However, Zoback and Zoback (1980) have prepared a map of the modern stress field in the coterminous United States utilizing principal stress directions determined from geological observations, earthquake focal mechanism, and in situ stress measurements. Zoback and Zoback (1980) place most of the Texas Panhandle area in the southern Great Plains province and note that this province is characterized by a very uniform state of stress in which the least principle horizontal stress direction is NNE-SSW. This direction is consistent with the strike of the faults present on the perimeter of the Amarillo Uplift, and suggests that movement along these faults may be due to NNE-SSW extension of the Anadarko Basin.

Based on: (1) a 117-year history of seismic activity (intensity and magnitude) within the area, (2) information regarding geologic structures (faulting) within the subject area, (3) reports regarding damage associated with seismic activity in the area, and (4) the location of seismic activity in the study area, seismic activity within the regional study area should have no impact on injection well activity at the Tyson facility. In addition, given the distances to faults which may be associated with some of the recorded seismic activity, Injection Interval permeability and lateral continuity, injection at the Tyson facility should not generate any noticeable seismic events. This is supported by a 48.5-year injection well history at the WDW-120 injection well, with no record of any impact on injection related to recordable seismic events during that time frame within the 50-kilometer radius of this well.

V.B.10b. Injection Wells Authorized to Inject into the Injection Zone

Tyson operates one active injection well (WDW-120) and maintains an active permit for one proposed injection well (WDW-312) at the facility as described within this permit renewal application. And, there is no Class I injection well within the Area of Review as described in Section VIII.

V.B.10c. Pattern of Injection for Permitted Injection Wells

Tyson operates one active injection well (WDW-120) on a continuous basis at the Amarillo facility. WDW-120 is permitted to inject at a maximum cumulative injection rate of 200 gallons per minute.

In 2023, Tyson injected a total of 20,174,957 gallons of wastewater into WDW-120. The average injection rate for WDW-120 between 1975 and 2023 has been approximately 32.35 gallons per minute.

V.B.10d. Thickness of Sediment Between the Base of Injection Zone and Basement Rocks

Through middle and late Pennsylvanian and early Permian time, Granite Wash Formation sands and gravels were shed from Precambrian crystalline rocks during uplift and erosion of the Amarillo Mountains north of the Tyson Area of Review (AOR). Across the study area, Granite Wash clastics (arkosic sediments) were deposited in fan deltas near shallow marine environments of relatively low energy, overlying the basement rocks consisting of granitic to mafic intrusive igneous rocks, extrusive igneous (i.e., volcanic) rocks and metasedimentary rocks (Stone and Webster, 1983).

The base of the Injection Zone is located at 8,993 feet below ground level, which is estimated very close to the top of the basement rocks at the injection well location as shown in the Precambrian structure map and regional cross sections (Figure V-5; Plates V-1 and V-2). However, since no logs fully penetrate the base of Injection Zone in the study area, the full thickness between the base of Injection Zone and basement rocks is unknown.

V.B.10.e Character of Sediment Between the Base of Injection Zone and Basement Rocks

Since no logs fully penetrate the base of Injection Zone in the study area, the character of sediment between the base of Injection Zone (8,993 feet below ground level) and basement rocks is unknown. Sediment between the base of the Injection Zone and top of the basement rocks is estimated absent or very little, if any, due to the Amarillo uplift and erosion of the Amarillo Mountains north of the Tyson Area of Review (AOR).

V.B.10.f Faults within the AOR

Fault transmissivity is discussed in Section V.B.6. The transmissivity of fluids across a fault must be considered with respect to both lateral (horizontal) and vertical components, requiring an assessment of the likelihood of a sealing surface (top seal and/or lateral seal) being present.

Beneath the Amarillo facility, the Amarillo Uplift has a Precambrian core and is fault-bounded on the north and south by a system of high-angle reverse faults while the Precambrian faults generally trend northwest – southeast. Vertically, only a minor portion of the faulting that cuts the Precambrian basement actually extends up into the overlying Pennsylvanian age Granite Wash sediments or Permian interval. Within the geologic study area, the upper Permian stratigraphic sequence contributes over 2,100 feet of total thickness (Plates V-12 and V-13), which is sufficient to provide protection against potential movement of waste constituents from the Injection Zone.

Also, being unable to detect hydrocarbons near USDWs is the evidence that fault trends through the region do not allow vertical migration of fluids above the Confining Zone with the presence of trapped natural gas and oil in the Red Cave and Brown Dolomite Formations, approximately 2,500 feet below the USDW across the regional study area. If fault trends are active conduits for vertical fluid migration to aquifers and sources of drinking water, buoyant hydrocarbons would be detected in USDW aquifers. Thus, fluid communication by any natural path between the Injection Zone and USDWs is protected by the multiple formations with sufficient thickness and lithologic characteristics capable of preventing vertical propagation of fractures. Also, as described in V.B.1, the Permian aged Confining Zone strata such as the Red Cave and Tubb Formation are laterally continuous and free of transecting faults or fractures over an area sufficient to prevent movement of constituents into USDWs.

V.B.11 Surface Geology

The shallow deposits that outcrop within 2.5 miles of the Tyson facility consist of Loess and Playa Lake (Pleistocene time) sediments (Figure V-24). Elevation in the vicinity of the Tyson site ranges from approximately 3,480 feet to 3,590 feet above sea level (see Attachment C-1).

The Loess deposits that occur at the surface within the local study area consist of silt-sized sediments that were transported and deposited by wind currents during the last glacial period. These deposits occur throughout the study area, including the immediate plant area (Figure V-24).

Isolated Playa Lake deposits occur throughout the local study area (Figure V-24). These deposits consist of clay, silt and sand-sized sediments which tend to weather to light gray. These deposits are Pleistocene in age, and were formed by the transportation and deposition of surface sediments during periods of relatively heavy rainfall.

V.C. Well Logs

Separate copies of one inch well logs from artificial penetrations within the regional study area, evaluated during the preparation of these permit applications, are included in Appendix A.

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Engineering Seal

Signature by Texas Professional Engineer

I, Bryan K. Bell, the undersigned state: As an employee of Terra Dynamics Incorporated that I am authorized to prepare this document (***VI. Injection Well Engineering Report***) and that this document (***VI. Injection Well Engineering Report***) was prepared under my supervision and direction. All facts stated herein are true, correct and complete to the best of my knowledge. The specifications and recommendations attested to in this document (***VI. Injection Well Engineering Report***) were prepared in accordance with generally and currently accepted engineering principles and practices. The engineering drawings, specifications, and other related documents referenced herein are subject to revision based on workovers of the WDW-120 injection well, and drilling and completion of the WDW-312 injection well.

STATE OF TEXAS
BRYAN K. BELL
120310
LICENSED
PROFESSIONAL ENGINEER

11/15/2024

Signature | Date

Registered Professional Engineer
#120310, State of Texas
Terra Dynamics Incorporated
Texas Registered Engineering Firm
F-3501

Document pages VI-1 to VI-64 and Table VI-1 are covered by the seal.

VI. INJECTION WELL ENGINEERING REPORT

VI. INJECTION WELL ENGINEERING REPORT

Tyson Fresh Meats, Inc. (Tyson) is requesting a permit renewal for one existing non-hazardous Class I injection well (WDW-120) and one proposed non-hazardous Class I injection well (WDW-312) to be located and operated at its Amarillo Plant. Tyson holds an approved permit for the proposed WDW-312 injection well to be located approximately 615 feet northeast of WDW-120. The WDW-312 injection well will be constructed in accordance with provisions and specifications set forth in 30 TAC §331.62. Tyson's compliance with existing regulatory requirements - specifically through logging, sampling, and annual testing of WDW-120 - ensures the well's construction continues to prevent the migration of injected fluids into or between underground sources of drinking water (USDW).

Section VI.A discusses the procedures that will be followed to drill, construct, test, and plug and abandon (when operations cease) the proposed WDW-312 injection well. Information regarding the permit renewal application for the existing WDW-120 injection well is included in Section VI.B.

VI.A. Proposed New Well Design and Construction (WDW-312)

All depths in Section VI.A of this permit application, unless otherwise noted, are referenced to ground level (GL). The proposed Injection Interval for the WDW-312 well consists of the Wichita-Brown Dolomite Formation, found between the approximate subsurface depths of 4,000 to 5,000 feet below ground level (BGL), which is utilized for injection in WDW-120. However, prior to this completion, consideration may be given to the possible deeper Granite Wash sand units, found between the approximate subsurface depths of 5,850 to 9,000 feet BGL, contained within the Pennsylvanian System sediments to determine if these units exist and are suitable for injection. The Injection Zone is in the Wichita, Brown Dolomite, Wolfcamp and Granite Wash Formations between the approximate subsurface depths of 3,720 to 9,000 feet BGL.

VI.A.1 Proposed Well Schematics

Three construction schematics of the proposed WDW-312 injection well are shown in Figures VI-1A, VI-1B and VI-1C. The drawings provide casing and cementing information, as well as details regarding the injection tubing, packer, and annulus fluid for the Wichita-Brown Dolomite and Granite Wash completion scenarios, respectively. All depths shown on the schematic are referenced to GL.

VI.A.2 Total Depth

The total depth (TD) of the proposed WDW-312 injection well is approximately 5,000 feet BGL for a Wichita-Brown Dolomite completion or 9,000 feet BGL for a Granite Wash completion. Should the Granite Wash completion be deemed not suitable for injection, the well would be plugged back to a depth of approximately 5,200 feet BGL and completed in the Wichita-Brown Dolomite Formation.

VI.A.3 Casing and Tubing Strings

The WDW-312 well, if drilled to evaluate the Granite Wash Formation (Figures VI-1B and VI-1C), is designed to be completed with either three or four strings of casing in addition to the conductor pipe; 1) 13 3/8-inch surface casing to isolate the USDW from the lower zones; 2) 9 5/8-inch longstring (protection) casing to isolate the Injection Zone from the overlying formations and to provide for a portion of the monitored annular space after the well has been completed; 3) 7 5/8-inch flush joint drilling liner to isolate the subnormally-pressured, low frac gradient Wichita-Brown Dolomite Formation prior to drilling the exploratory tail into the Granite Wash Formation (also expected to be subnormally-pressured); and, 4) 5 ½-inch flush joint production liner extending from the lower portion of the drilling liner through the Granite Wash Formation (if successfully encountered). The 5 ½-inch flush joint production liner would not be installed if Granite Wash Formation was not encountered and the well was plugged back. If the WDW-312 well is drilled only as a Wichita-Brown Dolomite completion (Figure VI-1A), then only the first two strings of casing (surface and longstring) would be installed in addition to the conductor pipe.

VI.A.3.a Casing and Tubing Specifications

The surface casing of the proposed Tyson injection well will consist of 13 3/8-inch, 54.5 lb/ft, J-55, STC pipe, and will be set and cemented at approximately 1,500 feet. The base of the surface casing at 1,500 feet will extend into confining beds below the base of the lowermost USDW and will be cemented from the base of the casing to the surface in a single cementing stage using a minimum of 120 percent of the calculated annular volume, or as appropriate based on borehole conditions (open hole caliper measurements). This depth allows for protection of the lowermost USDW (base at approximately 665 feet, see Section V.B.3) from injected fluids.

13 3/8-Inch, 54.5 lb/ft, J-55, STC Casing Specifications are as Follows:

Wall	0.380 inches
id	12.615 inches
Drift	12.459 inches
Coupling od	14.375 inches
Capacity	0.1546 bbl/ft
Length	±1,500 feet

Setting Depth	±1,500 feet
Life Expectancy	50+ years

The longstring or protection casing will consist of 9 5/8-inch, 40 lb/ft, J-55, LTC pipe. The protection casing will be set to an approximate depth of 4,000 feet BGL and cemented to surface in a single cement stage using a minimum of 120 percent of the calculated annular volume, or as appropriate based on borehole conditions (open hole caliper measurements). Setting the casing at the proposed depth will isolate the Injection Interval from the overlying formations and provide the monitored annular space after the well has been completed as an open hole completion in the Wichita-Brown Dolomite Formation.

9 5/8-Inch, 40 lb/ft, J-55, LTC Casing Specifications are as Follows:

Wall	0.395 inches
id	8.835 inches
Drift	8.679 inches
Coupling od	10.625 inches
Capacity	0.0758 bbl/ft
Length	±4,000 feet
Setting Depth	±4,000 feet
Life Expectancy	40 years

The drilling liner casing will consist of 7 5/8-inch, 25.59 lb/ft (plain end weight), L-80, Seal-Lock Flush (or equivalent) flush joint connection pipe. The drilling liner will be set from approximate depths of 3,750 feet to 6,200 feet below ground level and cemented to the top of the liner in one cementing stage using a minimum of 120 percent of the calculated annular volume, or as appropriate based on borehole conditions (open hole caliper measurements). Setting the liner at the proposed depth will isolate the Granite Wash Injection Interval from the overlying formations. Should the Granite Wash Formation be determined to be non-existent or unsuitable for injection, the 7 5/8-inch liner would then be used for accessing the Wichita-Brown Dolomite Formation via perforated completion techniques.

7 5/8-Inch, 25.59 lb/ft, L-80, Seal-Lock Flush Liner Specifications are as Follows:

Wall	0.328 inches
id	6.969 inches
Drift	6.844 inches
Coupling od	7.625 inches (flush)
Capacity	0.0472 bbl/ft
Length	±2,450 feet
Setting Depth	±3,750-6,200 feet
Life Expectancy	40 years

The production liner casing will consist of 5 ½-inch, 16.89 lb/ft (plain end weight), K-55, Seal-Lock Flush (or equivalent) flush joint connection pipe. The production liner casing will be set from approximate depths of 5,900 feet to 9,000 feet BGL and cemented to the top of the liner in one cementing stage using a minimum of 120 percent of the calculated annular volume, or as appropriate based on borehole conditions (open hole caliper measurements). Setting the liner at the proposed depth will provide access to the Granite Wash Injection Interval if it is found to be present at the site.

5 1/2-Inch, 16.89 lb/ft, K-55, Seal-Lock Flush Liner Specifications are as Follows:

Wall	0.304 inches
id	4.892 inches
Drift	4.767 inches
Coupling od	5.50 inches (flush)
Capacity	0.0232 bbl/ft
Length	±3,100 feet
Setting Depth	±5,900-9,000 feet
Life Expectancy	40 years

The injection tubing will consist of 4 ½-inch, 11.6 lb/ft, K-55, LTC API Standard grade carbon steel, internally plastic-coated with Tube-Kote TK-99 coating or lined with PVC. The injection tubing will be set from surface to an approximate depth of 3,960 feet (Figure VI-1A), 3,750 feet (Figure VI-1B) or 5,900 feet (Figure VI-1C). The injection tubing will be exposed to the injected waste stream. Corrosion induced by contact with the waste stream is expected to be very low.

4 1/2-Inch, 11.6 lb/ft, K-55, LTC Tubing Specifications are as Follows:

Wall	0.250 inches
id	4.000 inches
Drift	3.875 inches (pipe only, does not consider PVC lining or IPC)
Coupling od	5.00 inches
Capacity	0.0155 bbl/ft
Length	±3,960 feet or ±3,750 feet or ±5,900 feet
Setting Depth	±3,960 feet or ±3,750 feet or ±5,900 feet
Life Expectancy	20 years

VI.A.3.b Casing and Tubing Strength Specifications

The casings proposed for the WDW-312 well (including casing connections) are rated to have sufficient structural strength to withstand, for the design life of the well, the maximum burst and collapse pressures and the maximum tensile stress which may be experienced at any point along the length of casing or tubing. The collapse resistance, internal yield pressure, joint strength and yield strength for the casings and tubing proposed for use in the construction of the Tyson injection well are listed below. The sources of these ratings are the U.S. Steel Oil Country Tubular Goods Tubing & Casing Tables (U.S. Steel, 2014) and Baker Hughes Tech Facts Engineering Handbook

(2011) for the 13 3/8-inch surface casing, 9 5/8-inch longstring casing, 7 5/8-inch drilling liner casing, 5 ½-inch production liner casing and 4 ½-inch injection tubing.

13 3/8-inch, 54.5 lb/ft, J-55, STC Surface Casing

Internal Yield (Burst) Pressure: 2,740 psi
Collapse Resistance: 1,130 psi
Pipe Body Yield Strength: 853,000 lb
Joint Yield Strength: 514,000 lb

9 5/8-inch, 40 lb/ft, J-55, LTC Longstring Casing

Internal Yield (Burst) Pressure: 3,950 psi
Collapse Resistance: 2,570 psi
Pipe Body Yield Strength: 630,000 lb
Joint Yield Strength: 520,000 lb

7 5/8-inch, 25.59 lb/ft, L-80, Seal-Lock Flush Drilling Liner Casing

Internal Yield (Burst) Pressure: 6,020 psi
Collapse Resistance: 3,400 psi
Pipe Body Yield Strength: 602,000 lb
Joint Yield Strength: 294,000 lb

5 ½-inch, 16.89 lb/ft, K-55, Seal-Lock Flush Production Liner Casing

Internal Yield (Burst) Pressure: 5,320 psi
Collapse Resistance: 4,910 psi
Pipe Body Yield Strength: 273,000 lb
Joint Yield Strength: 177,000 lb

4 ½-inch, 11.6 lb/ft, K-55, LTC Injection Tubing (with TK-99 coating or PVC lining)

Internal Yield (Burst) Pressure: 5,350 psi
Collapse Resistance: 4,960 psi
Pipe Body Yield Strength: 184,000 lb
Joint Yield Strength: 180,000 lb

VI.A.3.c Pressures and Structural Loads During Construction, Operation and Closure

During the construction, operation and closure of the proposed WDW-312 injection well, the casing and tubulars will be subjected to varying external pressures, internal pressures and axial loading. The strings specified in the permit application are designed for the worst case or maximum possible load which could reasonably occur during the drilling, cementing, operation or testing of the well. The design process evaluated the Collapse, Internal Yield (Burst) and Yield Strength (Tension) for each string of casing or tubing.

Surface Casing

The following calculations use worst-case assumptions to determine the maximum pressures and loads for the surface casing string. Of note, the value 0.052 (psi/ft)/(lb/gal) included in the calculations on the following pages is the conversion factor from pounds per gallon (lb/gal) to pounds per square inch per foot (psi/ft).

The collapse pressure used in casing design is the differential of pressure exerted on the outside of the casing to the internal pressure. The maximum pressure differential occurs after the casing has been set and cemented and the shoe has been drilled out to drill the longstring borehole. It is assumed the surface casing was cemented to surface, but that the cement sheath contains a continuous 9.2 pounds per gallon (ppg) mud channel from the casing setting depth (approximately 1,500 feet) to the top of the casing. It is also assumed that circulation is lost while drilling the longstring borehole resulting in a full evacuation of the surface casing.

Surface Casing Collapse Calculations

Depth (ft)	External Pressure (psi)	Internal Pressure (psi)	Differential Pressure (psi)	Calculation
0	0	0	0	9.2 ppg * 0 ft * 0.052 (psi/ft)/(ppg)
1,500	**718**	**0**	**718**	**9.2 ppg * 1,500 ft * 0.052 (psi/ft)/(ppg)**

The maximum collapse pressure differential of 718 psi occurs at 1,500 feet (ft).

The burst pressure used in casing design is the differential pressure of the internal fluid forces acting on the pipe less the external fluid forces. The maximum pressure differential occurs after the casing has been set and cemented and the casing is being tested with an applied surface pressure of 1,000 psi per Texas Commission on Environmental Quality (TCEQ) guidelines. It is assumed the casing will be full of 9.2 ppg mud. It is assumed the surface casing was cemented to surface, but that the cement sheath contains a continuous 9.2 ppg mud channel from the casing setting depth (approximately 1,500 feet) to the top of the casing.

Surface Casing Burst Calculations

Depth (ft)	Internal Pressure (psi)	External Pressure (psi)	Differential Pressure (psi)	Calculation
0	1,000	0	1,000	(9.2 ppg – 9.2 ppg) * 0 ft * 0.052 (psi/ft)/(ppg) + 1,000 psi
1,500	1,718	718	1,000	(9.2 ppg – 9.2 ppg) * 1,500 ft * 0.052 (psi/ft)/(ppg) + 1,000 psi

The maximum burst pressure differential of 1,000 psi occurs across the entire length of surface casing.

For pipe body and joint strength yield, the maximum tensile load is taken to be the weight of the pipe hanging in air for a worst-case basis and neglects the effects of buoyancy. An additional load due to the plug bump pressure (assumed 1,000 psi) against the cross-sectional area of the float collar is also added to the weight of the pipe hanging in air.

Surface Casing Tensile Calculations

Depth (ft)	Load (lbf)	Calculation
0	**206,737**	**54.5 lb/ft * 1,500 ft + 1,000 psi * π * (12.615 in / 2)^2**
1,500	124,987	54.5 lb/ft * 0 ft + 1,000 psi * π * (12.615 in / 2)^2

The maximum tensile load of 206,737 pound force (lbf) occurs at the surface.

Longstring Casing

The following calculations use worst-case assumptions to determine the maximum pressures and loads for the longstring casing.

The collapse pressure used in casing design is the differential of pressure exerted on the outside of the casing to the internal pressure. The maximum pressure differential occurs after the casing has been set and cemented, but the cement sheath contains a continuous 9.2 ppg mud channel from total depth (approximately 4,000 feet) to the top of the casing. It is also assumed cleanout operations result in a full evacuation of the longstring casing.

Longstring Casing Collapse Calculations

Depth (ft)	External Pressure (psi)	Internal Pressure (psi)	Differential Pressure (psi)	Calculation
0	0	0	0	9.2 ppg * 0 ft * 0.052 (psi/ft)/(ppg)
4,000	**1,914**	**0**	**1,914**	**9.2 ppg * 4,000 ft * 0.052 (psi/ft)/(ppg)**

The maximum collapse pressure differential is 1,914 psi at 4,000 feet.

The burst pressure used in casing design is the differential pressure of the internal fluid forces acting on the pipe less the external fluid forces. The maximum pressure differential occurs during construction activities. It is assumed that the casing is fully cemented to surface with the inclusion of a continuous 9.2 ppg mud channel from surface to 4,000 feet. The casing is full of 9.2 ppg mud and a longstring casing pressure test is being conducted to 1,500 psi per TCEQ guidelines.

Longstring Casing Burst Calculations

Depth (ft)	Internal Pressure (psi)	External Pressure (psi)	Differential Pressure (psi)	Calculation
0	**1,500**	**0**	**1,500**	**1,500 psi + (9.2 ppg - 9.2 ppg) * 0 ft * 0.052 (psi/ft)/(ppg)**
4,000	**3,414**	**1,914**	**1,500**	**1,500 psi + (9.2 ppg - 9.2 ppg) * 4,000 ft * 0.052 (psi/ft)/(ppg)**

The maximum burst pressure differential is 1,500 psi along the entire length.

For pipe body and joint strength yield, the maximum tensile load is taken to be the weight of the pipe hanging in air for a worst-case basis and neglects the effects of buoyancy. An additional load due to the plug bump pressure (assumed 1,000 psi) against the cross-sectional area of the float collar is also added to the weight of the pipe hanging in air.

Longstring Casing Tensile Calculations

Depth (ft)	Load (lbf)	Calculation
0	**221,306**	**40.0 lb/ft * 4,000 ft + 1,000 psi * π * (8.835 in / 2)^2**
4,000	61,306	40.0 lb/ft * 0 ft + 1,000 psi * π * (8.835 in / 2)^2

The maximum tensile load is 221,306 lbf at the surface.

Drilling Liner Casing

The following calculations use worst-case assumptions to determine the maximum pressures and loads for the drilling liner casing from 3,750 to 6,200 feet. They are applicable to Construction Schematic Figures VI-1B and VI-1C.

The collapse pressure used in liner casing design is the differential of pressure exerted on the outside of the liner to the internal pressure. The maximum pressure differential occurs after the liner has been set and cemented, but the cement sheath contains a continuous 9.2 ppg mud channel from total depth (approximately 6,200 feet) to the top of the liner (approximately 3,750 feet). It is also assumed cleanout operations result in a full evacuation of the liner casing.

Drilling Liner Collapse Calculations

Depth (ft)	External Pressure (psi)	Internal Pressure (psi)	Differential Pressure (psi)	Calculation
3,750	1,794	0	1,794	9.2 ppg * 3,750 ft * 0.052 (psi/ft)/(ppg)
6,200	**2,966**	**0**	**2,966**	**9.2 ppg * 6,200 ft * 0.052 (psi/ft)/(ppg)**

The maximum collapse pressure differential is 2,966 psi at 6,200 feet.

The burst pressure used in casing design is the differential pressure of the internal fluid forces acting on the pipe less the external fluid forces. The maximum pressure differential occurs during construction activities. It is assumed that the liner is fully cemented to 3,750 feet with the inclusion of a continuous 9.2 ppg mud channel from 3,750 to 6,200 feet. The liner is full of 9.2 ppg mud and a liner pressure test is being conducted to 1,500 psi per TCEQ guidelines.

Drilling Liner Burst Calculations

Depth (ft)	Internal Pressure (psi)	External Pressure (psi)	Differential Pressure (psi)	Calculation
3,750	3,294	1,794	1,500	1,500 psi + (9.2 ppg - 9.2 ppg) * 3,750 ft * 0.052 (psi/ft)/(ppg)
6,200	4,466	2,966	1,500	1,500 psi + (9.2 ppg - 9.2 ppg) * 6,200 ft * 0.052 (psi/ft)/(ppg)

The maximum burst pressure differential is 1,500 psi along the entire length.

For pipe body and joint strength yield, the maximum tensile load is taken to be the weight of the pipe hanging in air for a worst-case basis and neglects the effects of buoyancy (total liner length is 2,450 feet). An additional load due to the plug bump pressure (assumed 1,000 psi) against the cross-sectional area of the float collar is also added to the weight of the pipe hanging in air.

Drilling Liner Tensile Calculations

Depth (ft)	Load (lbf)	Calculation
3,750	**100,840**	**25.59 lb/ft * 2,450 ft + 1,000 psi * π * $(6.969 \text{ in} / 2)^2$**
6,200	38,144	25.59 lb/ft * 0 ft + 1,000 psi * π * $(6.969 \text{ in} / 2)^2$

The maximum tensile load is 100,840 lbf at 3,750 feet.

Production Liner Casing

The following calculations use worst-case assumptions to determine the maximum pressures and loads for the production liner casing from 5,900 to 9,000 feet. These calculations are applicable to Construction Schematic Figure VI-1C.

The collapse pressure used in casing design is the differential of pressure exerted on the outside of the liner to the internal pressure. The maximum pressure differential occurs after the liner has been set and cemented, but the cement sheath contains a continuous 9.2 ppg mud channel from total depth (approximately 9,000 feet) to the top of the liner (approximately 5,900 feet). It is also assumed cleanout operations result in a full evacuation of the liner casing.

Production Liner Collapse Calculations

Depth (ft)	External Pressure (psi)	Internal Pressure (psi)	Differential Pressure (psi)	Calculation
5,900	2,823	0	2,823	9.2 ppg * 5,900 ft * 0.052 (psi/ft)/(ppg)
9,000	**4,306**	**0**	**4,306**	**9.2 ppg * 9,000 ft * 0.052 (psi/ft)/(ppg)**

The maximum collapse pressure differential is 4,306 psi at 9,000 feet.

The burst pressure used in casing design is the differential pressure of the internal fluid forces acting on the pipe less the external fluid forces. The maximum pressure differential occurs during construction activities. It is assumed that the liner is fully cemented to 5,900 feet with the inclusion of a continuous 9.2 ppg mud channel from 5,900 to 9,000 feet. The liner is full of 9.2 ppg mud and a liner pressure test is being conducted to 1,500 psi per TCEQ guidelines.

Production Liner Burst Calculations

Depth (ft)	Internal Pressure (psi)	External Pressure (psi)	Differential Pressure (psi)	Calculation
5,900	4,323	2,823	1,500	1,500 psi + (9.2 ppg - 9.2 ppg) * 5,900 ft * 0.052 (psi/ft)/(ppg)
9,000	5,806	4,306	1,500	1,500 psi + (9.2 ppg - 9.2 ppg) * 9,000 ft * 0.052 (psi/ft)/(ppg)

The maximum burst pressure differential is 1,500 psi along the entire length.

For pipe body and joint strength yield, the maximum tensile load is taken to be the weight of the pipe hanging in air for a worst-case basis and neglects the effects of buoyancy (total liner length is 3,100 feet). An additional load due to the plug bump pressure (assumed 1,000 psi) against the cross-sectional area of the float collar is also added to the weight of the pipe hanging in air.

Production Liner Tensile Calculations

Depth (ft)	Load (lbf)	Calculation
5,900	**71,155**	**16.89 lb/ft * 3,100 ft + 1,000 psi * π * (4.892 in / 2)^2**
9,000	18,796	16.89 lb/ft * 0 ft + 1,000 psi * π * (4.892 in / 2)^2

The maximum tensile load is 71,155 lbf at 5,900 feet.

Injection Tubing

The following calculations use worst-case assumptions to determine the maximum pressures and loads for the injection tubing string. The packer depth will be approximately 3,960 feet (Figure VI-1A), 3,750 feet (Figure VI-1B) or 5,900 feet (Figure VI-1C).

The collapse pressure used in tubing design is the differential of pressure exerted on the outside of the tubing to the internal pressure. The maximum pressure differential occurs while conducting an annulus test to 370 psi with the annulus full to surface with 9.6 ppg inhibited brine and the injection tubing is evacuated to approximately 2,500 feet BGL (expected head level of the reservoir) with freshwater in the well. The injection tubing is set into the packer at approximately 3,960 feet.

Injection Tubing Collapse Calculations

Depth (ft)	External Pressure (psi)	Internal Pressure (psi)	Differential Pressure (psi)	Calculation
0	370	0	370	370 psi + 9.6 ppg * 0 ft * 0.052 (psi/ft)/(ppg)
2,500	1,618	0	1,618	370 psi + 9.6 ppg * 2,500 ft * 0.052 (psi/ft)/(ppg)
5,900	**3,315**	**1,473**	**1,842**	**370 psi + 9.6 ppg * 5,900 ft * 0.052 (psi/ft)/(ppg) – 8.33 ppg * (3,960 ft – 2,500 ft) * 0.052 (psi/ft)/(ppg)**

The maximum collapse pressure differential of 1,842 psi occurs at 5,900 feet.

The burst pressure used in tubing design is the differential pressure of the internal fluid forces acting on the pipe less the external fluid forces. The maximum pressure differential occurs while injecting the heaviest permitted waste stream (9.58 ppg, 1.15 sp.gr.) at the maximum surface pressure (270 psi) with the annulus full to surface with 9.6 ppg inhibited brine with an annulus surface pressure of zero psi. Note that the annulus must be maintained at 100 psi above injection pressure, thus this calculation is overly conservative. The injection tubing is set into the packer at approximately 3,960 feet (Figure VI-1A), 3,750 feet (Figure VI-1B) or 5,900 feet (Figure VI-1C).

Injection Tubing Burst Calculations

Depth (ft)	Internal Pressure (psi)	External Pressure (psi)	Differential Pressure (psi)	Calculation
0	270	0	270	270 psi + (9.58 ppg – 9.6 ppg) * 0 ft * 0.052 (psi/ft)/(ppg)
3,960	**2,243**	**1,977**	**266**	**270 psi + (9.58 ppg – 9.6 ppg) * 3,960 ft * 0.052 (psi/ft)/(ppg)**

The maximum burst pressure differential of 270 psi occurs at surface.

For pipe body and joint strength yield, the maximum tensile load is taken to be the weight of the 3,960 feet (Figure VI-1A), 3,750 feet (Figure VI-1B) or 5,900 feet (Figure VI-1C) of pipe hanging in air (neglecting buoyancy) prior to engaging the packer for a worst-case basis.

Injection Tubing Tensile Calculations

Depth (ft)	Load (lbf)	Calculation
0	**68,440**	**11.6 lb/ft * 5,900 ft**
5,900	0	11.6 lb/ft * 0 ft

The maximum tensile load of 68,440 lbf occurs at the surface.

VI.A.3.d Casing and Tubing Safety Factor Calculations

Industry standards for design safety factors for this application are as follows:

Collapse: 1.0 to 1.125 based on minimum collapse pressures.
Internal Yield (Burst): 1.0 to 1.1 based on minimum yield values.
Tension: 1.8 based on minimum joint strength. 1.5 based on minimum pipe body strength.

The following minimum safety factors are required for each string in the proposed injection well.

Collapse:	1.125
Internal Yield (Burst):	1.1
Tension (Joint):	1.8 (API 8rd) to 1.6 (Buttress)
Tension (Pipe Body):	1.5

The safety factors are calculated by dividing the rated strength of the tubular by the maximum pressure differential (for collapse and burst) or tensile loading.

Calculated Safety Factors

Tubular	Collapse Loading	Burst Loading	Tensile Loading (Joint)	Tensile Loading (Pipe Body)
Surface Casing	1.574	2.740	2.486	4.126
Longstring Casing	1.343	2.633	2.350	2.847
Drilling Liner	1.146	4.013	2.916	5.970
Production Liner	1.140	3.547	2.488	3.837

Injection Tubing	2.693	19.815	2.630	2.688

VI.A.3.e Packer Specifications and Proposed Setting Depths

The injection packer for WDW-312 well will be a Baker Lok-Set (or equivalent), Seal Tite PVC lined (or internally plastic-coated) and externally plastic coated, 7 5/8-inch x 4 ½-inch (if Granite Wash completion) or Baker Lok-Set (or equivalent), Seal Tite PVC lined (or internally plastic-coated) and externally plastic coated 9 5/8-inch x 4 ½-inch (if Wichita-Brown Dolomite completion), retrievable packers which have been widely used in injection well applications. Packer life expectancy is approximately 20+ years. The packer will be set at an approximate depth of 3,960 feet (Figure VI-1A), 3,750 feet (Figure VI-1B) or 5,900 feet (Figure VI-1C) depending upon the Injection Interval chosen for the well.

VI.A.3.f Discussion of Tubular Selection and Design Process

The casing and injection tubing strings proposed for utilization in the construction of the injection well were selected based on the anticipated downhole conditions present at the project location. The tubulars selected for the proposed new well are consistent with the tubulars that have been successfully used in WDW-120. The chemical composition, corrosive effects, temperature and density of injected fluids and reservoir brine were considered to ensure proper selection of all strings. Also, the life expectancy of the injection well (a minimum of 30 years) was also an important consideration in the design of the longstring casing. Surface casing will be composed of carbon steel with more than adequate strength properties to be set and cemented below the base of the lowest USDW (surface casing set to approximately 1,500 feet). The longstring casing will be composed of carbon steel to approximately 4,000 feet. Drilling and production liners will also be composed of carbon steel from approximately 3,750 to 9,000 feet (depending on final well configuration).

Casing depths take into account potential lost circulation zones, the USDW and other conditions, known to possibly exist at the Tyson site. Injection tubing selection was based on injection rates, volumes and pressure to ensure laminar flow and to minimize friction loss.

The life expectancy of the tubing and packer is 20 years. Should the tubing or packer become compromised, those items can be removed from the well and replaced. The 4 ½-inch outer diameter of the tubing was chosen to allow washover clearance should future workover operations warrant.

VI.A.3.g Casing and Tubing Inspection and Preparation

The carbon steel casings and tubing will be inspected and tested prior to installation via the following methods and procedures: Hydrotest to 80 percent of the rated burst characteristics of the tube, electronic inspection - white band 0 to 12.5 percent, API thread inspection and full-length drift.

VI.A.4 Type of Completion Intervals and Completion Type

The proposed WDW-312 well will be completed either through perforations within a liner casing beneath the longstring and drilling liner casings, injection tubing and packer, and adjacent to the proposed Granite Wash Injection Interval sands, or as a perforated or open hole completion in the Wichita-Brown Dolomite Injection Interval. The proposed Injection Zone is in the Wichita Group, Brown Dolomite, Wolfcamp Series, and Granite Wash Formations in the subsurface interval between 3,720 and 9,000 feet BGL. The proposed Injection Interval within the Granite Wash Formation will be within the approximate subsurface depths from 5,850 to 9,000 feet BGL. The proposed Injection Interval within the Wichita-Brown Dolomite Formation will be within the approximate subsurface depths from 4,000 to 5,000 feet BGL.

VI.A.5 Centralizers

The 13 3/8-inch, 54.5 lb/ft, J-55 (or equivalent), STC carbon steel casing will be run from surface to approximately 1,500 feet. Centralizers will be run as follows:

1 - center of shoe joint on stop ring
1 - center of joint above float collar on stop ring
1 - across collar on joint above float collar
17 - across every other collar to surface

The 9 5/8-inch, 40 lb/ft, J-55 (or equivalent), LTC carbon steel longstring casing will be run from surface to approximately 4,000 feet. Centralizers will be run as follows:

1 - center of shoe joint on stop ring
1 - center of joint above float collar on stop ring
1 - across collar on joint above float collar
30 - spaced every other collar to 1,500 feet
12 - spaced every third joint from 1,500 feet to surface

The 7 5/8-inch, 25.59 lb/ft, L-80 (or equivalent), seal-lock flush carbon steel liner casing will be run from 3,750 feet to approximately 6,200 feet (depending on final well configuration). Centralizers will be run as follows:

1 - center of shoe joint on stop ring
1 - center of joint above float collar on stop ring
1 - across collar on joint above float collar
1 - center of joint above the landing collar on stop ring
30 - spaced every other collar to 3,800 feet

The 5 1/2-inch, 16.89 lb/ft, K-55 (or equivalent), seal-lock flush carbon steel liner casing will be run from 5,900 feet to approximately 9,000 feet (depending on final well configuration). Centralizers will be run as follows:

1 - center of shoe joint on stop ring
1 - center of joint above float collar on stop ring
1 - across collar on joint above float collar
1 - center of joint above the landing collar on stop ring
38 - spaced every other collar to approximately 5,950 feet

VI.A.6 Annulus Fluid

The fluid that will be circulated into the annulus between the injection tubing and the well casing will be 9.6 ppg brine containing corrosion inhibitor. A diesel fuel cap will be used to protect against freezing problems with the annular fluids at the surface. The annulus pressure will be maintained at a level at least 100 psi greater than the pressure on the injection tubing.

VI.A.7 Drilling and Completion Program

A preliminary injection well drilling and completion program consistent with applicable federal and state regulations is outlined below. The downhole well design provides for drilling, completion, and workovers to a maximum depth of approximately 5,000 feet. Tyson will assure all phases of well construction and all phases of any well workover shall be supervised by a qualified individual knowledgeable and experienced in practical drilling engineering and familiar with the special conditions and requirements of injection well construction in accordance with 30 TAC §331.62(9). The qualified individual will act under the responsible charge of a licensed, Professional Engineer with current registration pursuant to the Texas Engineering Practice Act.

Any material of equipment used in the actual construction of the proposed well that differs from the original permit technical application construction specifications shall equal or exceed the performance criteria specified in the original permit technical application.

After finalizing the perforated or open hole completion, hydraulic communication will be established with the reservoir. Before stimulating the formation (if found to be necessary), the bottomhole pressure and bottomhole temperature will be measured as close to the completion depth as practical to obtain these initial reservoir conditions. In addition, the static fluid level in the well will be determined.

After determination of the initial static bottomhole pressure, the completion interval will then be thoroughly cleared of drilling fluid and a reservoir fluid sample will be collected. The completion interval can then be stimulated, as needed, to break any residual mud blockage that might have resulted from the drilling operations, thus improving the hydraulic connection with the reservoir.

The final phase of the completion will involve installation of a retrievable injection packer and the running of the 4 ½-inch injection tubing. In addition, post-assembly mechanical integrity testing consisting of an annulus pressure test (APT), a baseline temperature log, a radioactive tracer survey (RTS) and a spinner survey (or other flow distribution survey) will be performed.

Injectivity tests will be conducted following well stimulation (if required) and completion to establish the initial reservoir parameters before injection operations commence. Injection tests will provide estimates of the permeability and thickness of the Injection Zone. Following the injectivity test, the well will then be closed in for a pressure decay (falloff) test. Bottomhole pressure and surface pressure will be recorded during the flow and shut in periods. The results of these tests will be utilized to calculate average reservoir pressure, permeability and reservoir volume.

Preliminary Injection Well Drilling and Completion Program

1. Location Preparation and Conductor Installation:
    - Survey and stake location as required.
    - Prepare location access, grade, freshwater supply, spill containment (ditches, dikes, etcetera) and other preparations as required.
    - Set 20-inch outside diameter (od), carbon steel conductor pipe to approximately 60 feet below ground level and cement to surface with pre-mixed concrete.
    - Prepare well cellar as required.

2. Move in and rig up drilling rig and equipment.
    - Install 20-inch riser and diverter stack.
    - Rig up a two-man mudlogging unit. Cuttings samples will be taken every ten feet from base of conductor to TD.

3. Surface Borehole and 13 3/8-Inch Casing Installation:
   - Notify TCEQ 24 hours before commencement of drilling operations.
   - Drill a 17 ½-inch hole to approximately 1,500 feet using freshwater base mud. The hole should be drilled with drilling fluid under laminar flow conditions and with proper fluid loss control. This will put the surface casing into the San Andres (Blaine) Formation. Take deviation surveys at 120-foot intervals to 600 feet, then every 300 feet to TD.

     Drilling records for WDW-120, WDW-129, WDW-273, WDW-324, WDW-342 and WDW-432 were reviewed to identify lost circulation zones and other drilling problems. The wells are the following approximate distances from the proposed WDW-312 locations: (1) WDW-120 – 615 feet, (2) WDW-129 – 4.9 miles, (3) WDW-273 – 5.2 miles, (4) WDW-324 – 4.8 miles, (5) WDW-342 – 6.0 miles and (6) WDW-432 – 4.9 miles.

     Circulation was partially lost while drilling WDW-273 at approximately 950 feet. Circulation was regained by introducing lost circulation material (LCM) into the mud. LCM was added to the mud while drilling WDW-120 starting at approximately 1,450 feet.

17 ½-INCH BOREHOLE DRILLING LOST CIRCULATION CONTINGENCY PLAN

If circulation is lost while drilling the 17 ½-inch borehole, lost circulation material pills will be pumped to reestablish circulation. Depending upon the severity of lost circulation encountered, lost circulation material may need to be blended with the drilling fluid in concentrations dictated by hole conditions to maintain circulation to the 13 3/8-inch casing point. Should lost circulation occur while drilling from the base of conductor to the 13 3/8-inch surface casing point, paper, cottonseed hulls or other forms of standard lost circulation material may be used to remedy the loss condition.

17 ½-INCH BOREHOLE DRILLING OVER PRESSURED ZONE CONTINGENCY PLAN

If an overpressure zone is encountered while drilling the 17 ½-inch borehole, pump mud down the drill pipe at an increased rate and higher density. Keep pumping mud down the drill pipe at an increased rate until the well stops flowing.

17 ½-INCH BOREHOLE DEVIATION AND CONTINGENCY PLAN

The maximum desirable borehole deviation will be approximately 1° per 1,000 feet of depth with a maximum recommended deviation of no more than 2° per 100 feet (to minimize dogleg severity) at any point in the borehole. If the maximum recommended deviation is exceeded, an evaluation will be made to determine whether remedial action is necessary. Remedial action may include changing the bottomhole assembly, underreaming the borehole, running a hole wiper assembly, or under a worst-case scenario, plugging back the well or appropriate borehole section and re-drilling with appropriate bottomhole assembly to put the borehole back within acceptable deviation limits.

   - Circulate and condition hole and mud to optimum properties for logging. Pull out of hole and stand back drilling assembly.
   - Rig up and run logs. Open hole logs of 17 ½-inch open hole to include Spontaneous Potential, Dual Induction, Natural Gamma Ray, Compensated Neutron, Litho-Density, Multi-Arm Integrated Borehole Caliper logs from TD to surface.
   - Trip back in hole with drilling assembly. Circulate and condition hole and mud to optimum properties for running casing. Pull out of hole and stand back drilling assembly while laying down any components that will not be used to drill the 12 ¼-inch hole section.
   - Run 13 3/8-inch, 54.5 lb/ft, J-55, STC, carbon steel surface casing to approximately 1,500 feet. Use float shoe and stab-in float collar. Cement the casing string using the inner-string cementing method. Threadlock float shoe and float collar. Run centralizers as follows:

1 - center of shoe joint on stop ring
1 - center of joint above float collar on stop ring
1 - across collar on joint above float collar
17 - across every other collar to surface

13 3/8-Inch, 54.5 lb/ft, J-55, STC Casing Specifications are as Follows:

Wall	0.380 inches
id	12.615 inches
Drift	12.459 inches
Coupling od	14.375 inches
Capacity	0.1546 bbl/ft
Burst	2,740 psi
Collapse	1,130 psi
Pipe Body Strength	853,000 lb
Joint Strength	514,000 lb

- Circulate and condition hole and mud to establish optimum properties commensurate with good cementing practices.
- Notify TCEQ 24 hours before commencement of cementing operations.
- Trip in hole with drill pipe and sting into adapter. Pump spacers as required. Mix and pump lead slurry down drill pipe until cement returns are obtained at surface. Lead slurry will consist of SBM CEM VARICEM™ LEAD with 0.25 lbm/sk Poly-E-Flake and one percent Calcium Chloride ($CaCl_2$), mixed at 12.8 lb/gal, 2.012 cuft/sk, 11.25 gal/sk water, for fill interval from 1,000 feet to ground surface. Once lead slurry is at surface, pump SBM CEM HALCEM™ SYSTEM tail cement, mixed at 14.8 lb/gal, 1.342 cuft/sk, 6.43 gal/sk water, for fill interval from 1,500 feet to 1,000 feet. The actual volume of cement pumped will be based upon the Integrated Borehole Caliper volume plus a minimum of 20 percent excess. If specified cement blends are not available at the time of construction, equivalent cement blends will be substituted. Bump plug with no more than 1,500 psi.

Slurry Properties:	Lead Cement	Tail Cement
Slurry Weight:	12.8 ppg	14.8 ppg
Slurry Yield:	2.012 cu. ft./sk	1.342 cu. ft./sk
Water Required:	11.25 gal/sk	6.43 gal/sk

13 3/8-INCH CASING CEMENTING LOST CIRCULATION CONTINGENCY PLAN

If circulation is lost while performing the lead cementing operation for the 13 3/8-inch casing, reduce cementing pump rate to between 1/3 and ½ of the mixing and pumping rate to reduce equivalent circulating density (ECD) and continue mixing and pumping lead slurry to attempt to reestablish returns. Should lost circulation occur while mixing, pumping and/or displacing the tail slurry, continue mixing, pumping and/or displacing the tail slurry as required.

After completion of the cement job, the operator will drill out the float equipment and conduct cement bond and/or temperature logging to determine the top of cement. The operator will then evaluate options to obtain sufficient cementing. If necessary, the operator will perforate and squeeze to complete cementing. Once sufficient isolation has been demonstrated, no further action should be required since the 13 3/8-inch surface casing will be behind cemented 9 5/8-inch longstring casing following 9 5/8-inch longstring casing installation.

Should cement fallback occur after completion of cementing operations, the top of cement will be identified from a temperature log or the post drill out bond log. If necessary, the casing would then be cemented externally (top job) using thin tubing to ensure sufficient cementing is accomplished.

- Upon completion of cementing operations, pull the inner string out of the hole and lay down the stab-in adapter.
- Center the casing, wash out the 20-inch riser and flowline to rig shaker tank. Do not move the casing for a minimum of 24 hours.
- Run a temperature log from surface to float collar within 12 hours after cementing.
- Cut off 13 3/8-inch surface casing (rough cut).
- Install 13 3/8-inch slip-on-weld (SOW) by 13 5/8-inch, 3,000 psi casing head.
- Nipple up 13 5/8-inch blowout preventer (BOP) stack.
- Run Cement Bond with Variable Density Log from float collar to surface after required wait-on-cement (WOC) period.
- Pressure test 13 3/8-inch od surface casing and BOP stack to 1,000 psi for a minimum of 30 minutes.

4. Longstring Borehole and 9 5/8-Inch Casing Installation:
   - Drill out cement and shoe. Drill 12 ¼-inch borehole with water based mud (aerated as required) to core point at approximately 2,780 feet. Cut a 30-foot core. After obtaining core, ream core hole and continue drilling to casing point at 4,000 feet. Approximate depths to core points are specified in Section VI.A.9.c.i. Exact core depths will be determined by Wellsite Geologist. Hole should be drilled with drilling fluid under laminar flow conditions and with proper fluid loss control.
   - Note: Obtain inclination surveys every 300 feet from base of surface casing to 4,000 feet, unless hole conditions indicate concerns for stuck pipe. Hole angle will be recorded during open hole logging operations.
   - LCM was used while drilling the longstring borehole for WDW-120 with no lost circulation events. Lost circulation occurred at approximately 3,600 feet while drilling WDW-129, WDW-324 and WDW-342. Circulation was regained by introducing LCM into the mud. LCM was introduced into the mud starting at approximately 2,600 feet while drilling WDW-432 with no lost circulation events noted while drilling the longstring borehole. Halliburton records indicate a 0.45 psi/ft fracture gradient for the Red Cave formation.

12 ¼-INCH BOREHOLE DRILLING LOST CIRCULATION CONTINGENCY PLAN

If circulation is lost while drilling the 12 1/4-inch borehole, lost circulation material pills will be pumped to reestablish circulation. Depending upon the severity of lost circulation encountered, lost circulation material may need to be blended with the drilling fluid in concentrations dictated by hole conditions to maintain circulation to the casing point.

12 ¼-INCH BOREHOLE DRILLING OVER PRESSURED ZONE CONTINGENCY PLAN

If an overpressured zone is encountered while drilling the 12 ¼-inch borehole, pick up kelly such that any tool joints that could be opposite the BOP sealing elements are above the elements. Stop pumps and check for flow. Close BOP pipe rams and measure shut-in drill pipe and casing pressures. Calculate control mud weight and weight up mud system accordingly. Pump control weight mud down the drill pipe at slow pump rate and higher density while maintaining casing pressure with choke to minimize further influx and maintaining casing pressure below burst rating of casing. Keep pumping mud down the drill pipe at the slow pump rate until the well stops flowing.

12 ¼-INCH BOREHOLE DEVIATION AND CONTINGENCY PLAN

The maximum desirable borehole deviation will be approximately 1° per 1,000 feet of depth with a maximum recommended deviation of no more than 2° per 100 feet (to minimize dogleg severity) at any point in the borehole. If the maximum recommended deviation is exceeded, an evaluation will be made to determine whether remedial action is necessary. Remedial action may include changing the bottomhole assembly, underreaming the borehole, running a hole wiper assembly, or under a worst-case scenario, plugging back the well or appropriate borehole section and re-drilling with the appropriate bottomhole assembly to put the borehole back within acceptable deviation limits.

- Notify TCEQ of logging and cementing schedule. Give at least 24 hours advance notice.
- Circulate and condition hole and mud to optimum properties for logging.
- Pull the drilling assembly out of the hole and run the following logs: Spontaneous Potential, Dual Induction, Natural Gamma Ray, Litho-Density, Compensated Neutron, Microlog, Formation Microscanner (high-resolution dipmeter) as required, and Multi-Arm Integrated Borehole Caliper (with Directional Telemetry) logs from TD to base of surface casing.
- Circulate and condition hole and mud in preparation for running casing.
- Rig up and run 4,000 feet of 9 5/8-inch, 40 lb/ft, K-55, LTC casing to total depth. Install a double-valved float shoe, shoe joint and float collar one joint up from the shoe. Threadlock float shoe, float collar and next joint up. Use SealLube on non-threadlocked connections. Continue running 9 5/8-inch casing until all casing has been run. Run centralizers as follows:

1 - center of shoe joint on stop ring
1 - center of joint above float collar on stop ring
1 - across collar on joint above float collar
30 - spaced every other collar to 1,500 feet
12 - spaced every third joint from 1,500 feet to surface

9 5/8-Inch, 40 lb/ft, J-55, LTC Casing Specifications are as Follows:

Wall	0.395 inches
id	8.835 inches
Drift	8.679 inches
Coupling od	10.625 inches
Capacity	0.0758 bbl/ft
Burst	3,950 psi
Collapse	2,570 psi
Pipe Body Strength	630,000 lb
Joint Strength	520,000 lb

- Circulate and condition hole and mud to establish optimum properties commensurate with good cementing practices.
- Cement 9 5/8-inch intermediate casing from TD back to ground surface as follows: Lead slurry will consist of SBM CEM VARICEM™ LEAD cement with 0.25 lbm/sk Poly-E-Flake, mixed at 11.5 lb/gal, 2.805 cuft/sk, 17.21 gal/sk water, for fill interval from 3,500 feet to surface, followed by tail slurry of SBM CEM HALCEM™ SYSTEM tail cement, mixed at 14.8 lb/gal, 1.326 cuft/sk, 6.34 gal/sk water, for fill interval from 4,000 feet to 3,500 feet. The actual volume of cement pumped will be based upon the Integrated Borehole Caliper volume plus a minimum of 20 percent excess. If specified cement blends

are not available at the time of construction, equivalent cement blends will be substituted. Bump plug with no more than 1,500 psi.

Slurry Properties:	Lead Cement	Tail Cement
Slurry Weight:	11.5 ppg	14.8 ppg
Slurry Yield:	2.805 cu. ft./sk	1.326 cu. ft./sk
Water Required:	17.21 gal/sk	6.34 gal/sk

- Run a Temperature log from surface to the float collar within 12 hours after cementing.
- Nipple down and release the 13 5/8-inch BOP. Cut off the 13 3/8-inch casing head and the 9 5/8-inch casing. Install a 9 5/8-inch slip-on-weld (SOW) by 11-inch 3,000 psi casing head.
- Install and test 11-inch, 3,000 psi BOP stack.
- Run in the hole with an 8 ¾-inch bit to the top of the float collar. Circulate the hole clean. Pull the bit out of the hole and go back in the hole to the float collar with a scraper for the 9 5/8-inch casing. Circulate the hole clean and pull the scraper out of the hole.
- Run a Cement Bond Log with Variable Density and Gamma Ray with Collar Locator from the float collar to surface after the required wait-on-cement (WOC) period.
- Pressure test the 9 5/8-inch longstring casing to 1,500 psi for a minimum of 30 minutes.

5. Drilling Liner Borehole and 7 5/8-inch Liner Installation.
   - Drill out cement and shoe.
   - Drill 8 ¾-inch hole with water-based mud (aerated as required) to the next core point at approximately 4,580 feet. Use graded calcium carbonate or other acid-soluble materials for seepage and control of loss of circulation in this interval. Hole should be drilled with drilling fluid under laminar flow conditions and with proper fluid loss control. Approximate depths to core points are specified in Section VI.A.9.c.i. Exact core depths will be determined by the wellsite geologist. After coring, ream and drill to approximately 5,000 feet with 8 ¾-inch bit. Hole angle will be recorded during open hole logging operations due to risk of stuck pipe in this interval.
   - The proposed WDW-312 location is within close proximity to WDW-120. WDW-120 is permitted for non-hazardous wastewater injection through perforations into the Panhandle Lime formation below 4,135 feet BGL. While drilling the completion borehole, all fluids and cuttings for disposal will be segregated. Fluids, cuttings and equipment will be tested and appropriate steps will be taken for disposal and decontamination (if necessary). It is possible that wastewater injection by WDW-120 could cause an overpressure zone. See contingency plan below if an overpressure zone is encountered.
   - Multiple lost circulation events occurred while drilling WDW-342 between approximately 4,250 and 4,600 feet while drilling with fresh water. Circulation was lost while drilling WDW-273 at approximately 4,270 feet. LCM was added to regain circulation. The bottomhole assembly became stuck at 4,331 feet, was backed off and fished before drilling resumed. Circulation was lost while coring at 4,421 feet. LCM was pumped to regain circulation. WDW-324 was drilled with fresh water comingled with air with no lost circulation issues. Circulation was lost while drilling at 4,100 feet and at 4,250 feet. The borehole was drilled with no returns from 4,385 to 5,100 feet.

- Halliburton records indicate a 0.45 psi/ft fracture gradient for the Wichita Group/Brown Dolomite formation.

8 ¾-INCH BOREHOLE DRILLING LOST CIRCULATION CONTINGENCY PLAN
If circulation is lost while drilling the 8 3/4-inch borehole, lost circulation material pills will be pumped to reestablish circulation. Depending upon the severity of lost circulation encountered, lost circulation material may need to be blended with the drilling fluid in concentrations dictated by hole conditions to maintain circulation to the casing point.
8 ¾-INCH BOREHOLE DRILLING OVER PRESSURED ZONE CONTINGENCY PLAN
If an overpressured zone is encountered while drilling the 8 ¾-inch borehole, pick up kelly such that any tool joints that could be opposite the BOP sealing elements are above the elements. Stop pumps and check for flow. Close BOP pipe rams and measure shut-in drill pipe and casing pressures. Calculate control mud weight and weight up mud system accordingly. Pump control weight mud down the drill pipe at slow pump rate and higher density while maintaining casing pressure with choke to minimize further influx and maintaining casing pressure below burst rating of casing. Keep pumping mud down the drill pipe at the slow pump rate until the well stops flowing.
8 ¾-INCH BOREHOLE DEVIATION AND CONTINGENCY PLAN
The maximum desirable borehole deviation will be approximately 1° per 1,000 feet of depth with a maximum recommended deviation of no more than 2° per 100 feet (to minimize dogleg severity) at any point in the borehole. If the maximum recommended deviation is exceeded, an evaluation will be made to determine whether remedial action is necessary. Remedial action may include changing the bottomhole assembly, underreaming the borehole, running a hole wiper assembly, or under a worst-case scenario, plugging back the well or appropriate borehole section and re-drilling with the appropriate bottomhole assembly to put the borehole back within acceptable deviation limits.

- Notify TCEQ of logging and cementing schedule with at least 24 hours advance notice**.**
- Circulate and condition hole and mud to optimum properties for logging.
- Pull drill pipe and drilling assembly out of the hole.
- Run open hole logs of the 8 ¾-inch borehole to include Dual Induction, Spontaneous Potential, Natural Gamma Ray, Litho-Density, Compensated Neutron, Fracture Identification Log and Borehole Caliper Log using borehole telemetry sub to obtain wellbore directional information from total depth to base of 9 5/8-inch casing at approximately 4,000 feet.
- **Note:** If an election is made to complete the well as an open hole completion in the Wichita-Brown Dolomite Formation, drilling operations will end and the drilling rig will be released. Well operations will continue with the completion of the well for injection into the Wichita-Brown Dolomite interval. See the completion scenario (Completion Program A). If the Granite Wash completion approach is selected, drilling operations will continue as follows.
- Go back in the hole with an underreamer assembly and open the 8 ¾-inch hole interval from 4,000 feet to 6,200 feet to 9 ½ inches.
- Pull out of hole with underreamer and run a Borehole Caliper Log from TD (approximately 6,200 feet) to the base of the 9 5/8-inch casing at approximately 4,000 feet.
- Circulate and condition hole and mud in preparation for running a drilling liner.
- Pull drill pipe and drilling assembly out of the hole, laying down components of bottomhole assembly that will not be used in drilling the next hole section.
- Rig up and run 2,450 feet of 7 5/8-inch, 25.59 lb/ft, L-80, Seal-Lock Flush, flush joint casing from approximately 3,750 feet to TD. Install a double-valved float shoe, shoe joint and float collar (with landing collar) one joint up from the shoe. Threadlock float shoe,

float collar and next joint up. Continue running 7 5/8-inch casing until all liner casing has been run, then install mechanical liner hanger. Run centralizers as follows:

1 - center of shoe joint on stop ring
1 - center of joint above float collar on stop ring
1 - across collar on joint above float collar
1 - center of joint above the landing collar on stop ring
30 - spaced every other collar to 3,800 feet

7 5/8-Inch, 25.59 lb/ft, L-80, Seal-Lock Flush Liner Specifications are as follows:

Wall	0.328 inches
id	6.969 inches
Drift	6.844 inches
Coupling od	7.625 inches (flush)
Internal Yield (Burst) Pressure	6,020 psi
Collapse Resistance	3,400 psi
Pipe Body Yield Strength	602,000 lb
Joint Yield Strength	294,000 lb
Capacity	0.0472 bbl/ft

- Run liner in hole on drill pipe and tag bottom. Pick up five feet and set liner hanger.
- Cement as follows: Pump spacers as required. Pump cement slurry consisting of SBM CEM ISOBOND SYSTEM cement with 12 percent salt and 0.8 percent CHEM ISOGUARD, mixed at 13.6 lb/gal, 1.626 cuft/sk, 8.03 gal/sk water, for a fill interval from 6,200 feet up to 3,750 feet. The actual volume of cement pumped will be based upon the Integrated Borehole Caliper volume plus a minimum of 20 percent excess.

Slurry Properties:	Cement
Slurry Weight:	13.6 ppg
Slurry Yield:	1.626 cu. ft./sk
Water Required:	8.03 gal/sk

7 5/8-INCH DRILLING LINER CEMENTING CONTINGENCY PLAN

If circulation is lost while performing the cementing operation for the 7 5/8-inch drilling liner prior to releasing the drill pipe wiper plug, reduce the pump rate to between 1/3 and ½ of the mixing and pumping rate to reduce ECD and continue mixing and pumping the lead slurry until returns are re-established. Should lost circulation occur after releasing the drill pipe wiper plug and displacing the cement, reduce the displacement pump rate to between 1/3 and ½ of the mixing and pumping rate to reduce ECD and continue displacing the slurry until returns are re-established or the plug lands in the landing collar. Provisions for remedial cementing will be developed as necessary based upon results of cement evaluation logging.

- Check to make sure floats are holding, then pull out of hole with drill pipe and hanger setting tool.
- Wait on cement for 24 hours, then run in hole with a 12 ¼-inch bit and clean out cement to the top of the liner at approximately 3,750 feet.
- Run a 9 5/8-inch packer into the 9 5/8-inch casing to just above the liner top. Set packer and test the liner top and liner to 1,500 psi for 30 minutes. If the liner top is found to be leaking, remedial procedures will be evaluated and implemented as required. Pull out of hole with test packer.

- Pick up a 6 ¾-inch bit and go in hole to the top of cement in liner. Drill out cement in the liner down to the float collar and circulate the hole clean. Pull out of the hole with the bit and make a scraper run back to the top of the float collar. Pull the drill pipe and scraper out of the hole.
- Run a Cement Bond Log with Variable Density and Gamma Ray with Collar Locator from the float collar back to the top of the liner after the required wait-on-cement (WOC) period.
- Test 9 5/8-inch protection casing and the 7 5/8-inch drilling liner simultaneously to 1,500 psi for 30 minutes.

6. Production Liner Borehole and 5 ½-inch Liner Installation
   - Drill out cement and shoe. Drill 6 ¾-inch hole with freshwater based, low solids mud (aerated as required) to a selected core point in the Granite Wash formation below 6,200 feet. Hole should be drilled with drilling fluid under laminar flow conditions and with proper fluid loss control. Approximate depths to core points are specified in Section VI.A.9.c.i. Exact core depths will be determined by the Wellsite Geologist. After coring, continue drilling with the 6 ¾-inch bit to 9,000 feet (or as required for lithologic data).

6 3/4-inch BOREHOLE DEVIATION CONTINGENCY PLAN
The maximum desirable borehole deviation will be approximately 1° per 1,000′ of depth with a maximum recommended deviation of no more than 2° per 100′ (to minimize dogleg severity) at any point in the borehole. If the maximum recommended deviation is exceeded, an evaluation will be made to determine whether remedial action is necessary. Remedial action may include changing the bottomhole assembly, underreaming the borehole, running a hole wiper assembly, or under a worst case scenario, plugging back the well or appropriate borehole section and re-drilling with appropriate bottomhole assembly to put the borehole back within acceptable deviation limits.

   - Notify TCEQ of logging and cementing schedule with at least 24 hours advance notice**.**
   - Circulate and condition hole and mud to optimum properties for logging.
   - Pull drill pipe and drilling assembly out of the hole.
   - Run open hole logs of the 6 ¾-inch borehole to include Dual Induction, Spontaneous Potential, Natural Gamma Ray, Litho-Density, Compensated Neutron, Fracture Identification Log and Borehole Caliper Log using borehole telemetry sub to obtain wellbore directional information from total depth to the base of the 7 5/8-inch drilling liner at approximately 6,200 feet.
   - If the Granite Wash Formation is considered viable for injection, proceed with the following steps. If the Granite Wash Formation is not deemed viable for injection, plug the 6 ¾-inch borehole and up into the 7 5/8-inch liner with an approved cement slurry to a depth of approximately 5,200 feet (inside the 7 5/8-inch liner) or as instructed by the Wellsite Geologist to assure that all of the Brown Dolomite Formation and approximately 200 feet of rathole inside the 7 5/8-inch liner will be usable, then proceed with the Wichita / Brown Dolomite interval cased hole completion scenario (Completion Program B).
   - Go back in the hole to circulate and condition the hole and mud to optimum properties for running the 5 ½-inch production liner. Pull the drill pipe out of the hole.
   - Rig up and run 3,100 feet of 5 ½-inch, 16.89 lb/ft, K-55, Seal-Lock Flush liner from 5,900 feet to total depth. Install a double-valved float shoe, shoe joint and float collar (with landing collar) one joint up from the shoe. Threadlock float shoe, float collar and next joint

up. Continue running 5 ½-inch liner and install mechanical liner hanger and setting tool. Run centralizers as follows:

1 - center of shoe joint on stop ring
1 - center of joint above float collar on stop ring
1 - center of joint above the landing collar on stop ring
39 - spaced every second collar to 5,950 feet

5 ½-Inch, 16.89 lb/ft, K-55, Seal-Lock Flush Production Liner Specifications are as follows:

Wall	0.304 inches
id	4.892 inches
Drift	4.767 inches
Coupling od	5.50 inches (flush)
Internal Yield (Burst) Pressure	5,320 psi
Collapse Resistance	4,910 psi
Pipe Body Yield Strength	273,000 lb
Joint Yield Strength	177,000 lb
Capacity	0.0232 bbl/ft

- Run liner in hole on drill pipe and tag bottom. Pick up five feet and set liner hanger.
- Pump spacers as required. Pump cement slurry consisting of SBM CEM ISOBOND SYSTEM with 5 percent Potassium KCl and 0.25 percent Suspension Agent, mixed at 14.5 ppg, 1.30 cuft/sk, 5.62 gal/sk water, for a fill interval from 9000 feet up to approximately 5,600 feet (300 feet above the top of the liner). The actual volume of cement pumped will be based upon the Integrated Borehole Caliper volume plus a minimum of 20 percent excess.

5 1/2-INCH DRILLING LINER CEMENTING CONTINGENCY PLAN

If circulation is lost while performing the cementing operation for the 5 1/2-inch drilling liner prior to releasing the drill pipe wiper plug, reduce the pump rate to between 1/3 and ½ of the mixing and pumping rate to reduce ECD and continue mixing and pumping the lead slurry until returns are re-established. Should lost circulation occur after releasing the drill pipe wiper plug and displacing the cement, reduce the displacement pump rate to between 1/3 and ½ of the mixing and pumping rate to reduce ECD and continue displacing the slurry until returns are re-established or the plug lands in the landing collar. Provisions for remedial cementing will be developed as necessary based upon results of cement evaluation logging.

- Check to make sure floats are holding, then pull out of hole with drill pipe and liner hanger setting tool.
- Rig down and release drilling rig. Prepare for Completion Program C.

7. Completion Program A – Wichita-Brown Dolomite Open Hole Completion (Figure VI-1A)
   - Move in and rig up well service unit and accessory equipment.
   - Install 11-inch, 3,000 psi BOP and a rotating head.
   - Go in hole with casing scraper for 9 5/8-inch casing to the shoe.
   - Pull the scraper and run an 8 ¾-inch bit to clean out the open hole interval to TD at approximately 5,000 feet.
   - Circulate hole clean with 2 percent KCl water and pull the bit out of the hole.

- Mobilize a wireline unit and run a baseline Casing Inspection Log over the full length of the 9 5/8-inch casing.
- Obtain initial static bottomhole pressure measurement, fluid level and gradient survey using surface recording downhole pressure gauge.
- Rig up an air compressor to the standpipe. Go in hole with open-ended workstring to TD. Circulate well with aerated 2 percent KCl water until fluid returns are clean.
- Cease pumping of KCl water while continuing air injection into standpipe and attempt to obtain sample of formation fluid. Cease air injection and pull the workstring out of the hole.
- Displace well with 2 percent KCl water and test injectivity.
- Run Baker Lok-Set (or equivalent) 9 5/8-inch by 4 ½-inch externally plastic-coated packer (either PVC-lined or internally plastic-coated) with 4 ½-inch 11.6 lb/ft, K-55, LTC injection tubing (Seal-Tite PVC lined or TK-99 internally plastic-coated tubing) to approximately 3,960 feet and space out as required to account for thermal fluctuations in the injected waste stream.

4 ½-Inch, 11.6 lb/ft, K-55, LTC, Seal Tite PVC-Lined or Internally Plastic-Coated Tubing Specifications are as follows:

Wall	0.250 inches
id	4.000 inches
Drift	3.875 inches (pipe only, does not consider PVC lining or IPC)
Coupling od	5.00 inches
Capacity	0.0155 bbl/ft
Burst	5,350 psi
Collapse	4,960 psi
Pipe Body Strength	184,000 lb
Joint Strength	180,000 lb

- Displace annulus with inhibited 9.6 ppg brine and provide for a diesel fuel cap in the annulus for freeze protection at the surface.
- Set packer and remove BOP. Install slips, pack off flange and tree valves.
- Run preliminary annulus pressure test, release well service unit and allow 72 hours for wellbore thermal stabilization prior to conducting mechanical integrity and reservoir pressure testing operations.

8. Completion Program B – Wichita-Brown Dolomite Perforated Completion (Figure VI-1B)
   - Move in and rig up well service unit and accessory equipment.
   - Install 11-inch, 3,000 psi blowout preventer and rotating head.
   - Go in hole with 6 ¾-inch bit to clean out the 7 5/8-inch liner to the PBTD of approximately 5,200 feet.
   - Circulate hole with clean 2 percent KCl water. Pull out of hole with bit and go back in hole with scraper for 9 5/8-inch casing.
   - Scrape the 9 5/8-inch casing to the top of the liner at approximately 3,750 feet.
   - Pull out of the hole and go back in with a scraper for the 7 5/8-inch liner.
   - Scrape the 7 5/8-inch liner casing to approximately 5,200 feet.
   - Circulate hole with clean 2 percent KCl water.
   - Mobilize a wireline unit and run baseline Casing Inspection Logs in the 7 5/8-inch liner and 9 5/8-inch casing from TD to surface.

- Perforate Wichita-Brown Dolomite Formation as instructed by Wellsite Geologist.
- Obtain initial static bottomhole pressure measurement, fluid level and gradient survey using surface recording downhole pressure gauge and associated equipment.
- Rig up an air compressor to the standpipe. Go in hole with open-ended workstring to total depth. Circulate well with aerated 2 percent KCl water until fluid returns are clean.
- Cease pumping KCl water while continuing air injection into standpipe and attempt to obtain sample of formation fluid. Cease air injection and pull out of hole with workstring. Displace well with 2 percent KCl water and test injectivity.
- Run Baker Lok-Set (or equivalent) 9 5/8-inch x 4 ½-inch externally plastic-coated packer (either internally PVC-lined or internally plastic-coated depending upon tubing selected for use) with 7 5/8-inch liner tie-back seal unit on bottom of packer with 4 ½-inch, 11.6 lb/ft, K-55, LTC (Seal Tite PVC lined or TK-99 internally plastic-coated tubing) to approximately 3,750 feet (until tie-back seals engage into 7 5/8-inch liner tie-back receptacle) and space out as required to account for thermal fluctuations in the injected waste stream.

4 ½-Inch, 11.6 lb/ft, K-55, LTC, Seal Tite PVC-Lined or Internally Plastic-Coated Tubing Specifications are as follows:

Wall	0.250 inches
id	4.000 inches
Drift	3.875 inches (pipe only, does not consider PVC lining or IPC)
Coupling od	5.00 inches
Capacity	0.0155 bbl/ft
Burst	5,350 psi
Collapse	4,960 psi
Pipe Body Strength	184,000 lb
Joint Strength	180,000 lb

- Pick back up out of tie-back receptacle and displace annulus with inhibited 9.6 ppg brine and provide for a diesel fuel cap in the annulus for freeze protection at the surface.
- Set back down into liner tie-back receptacle, set packer and remove BOP. Install slips, pack off flange and tree valves.
- Run preliminary annulus pressure test, release well service unit and allow 72 hours for wellbore thermal stabilization prior to conducting mechanical integrity and reservoir pressure testing operations.

9. Completion Program C – Granite Wash Perforated Completion (Figure VI-1C)
   - Move in and rig up well service unit and accessory equipment.
   - Install 11-inch, 3,000 psi blowout preventer and rotating head.
   - Go in hole with 6 ¾-inch bit to clean out the 7 5/8-inch liner to the top of the 5 ½-inch liner at 5,900 feet using freshwater – do not rotate on liner top.
   - Run a test packer into the top of the 7 5/8-inch liner to just above the 5 ½-inch liner top. Set the packer and test the liner top and liner to 1,500 psi for 30 minutes. (This test is required by TCEQ regulation.) If the liner top is found to be leaking, remedial squeeze procedures or installation of a liner hanger packer will be evaluated and implemented as required. Pull the test packer out of the hole.

- Go in the hole with a 4 ¾-inch bit to the top of cement in the 5 ½-inch production liner. Clean out cement in the liner to the float collar. Circulate the hole clean and displace the hole with 2 percent KCl water.
- Pull out of hole with bit and go back in hole with scraper for 9 5/8-inch casing.
- Scrape the 9 5/8-inch casing to the top of the 7 5/8-inch liner at approximately 3,750 feet.
- Pull out of the hole and go back in with a scraper for the 7 5/8-inch liner.
- Scrape the 7 5/8-inch liner to the top of the 5 ½-inch liner at approximately 5,900 feet.
- Pull out of the hole and go back in hole with a scraper for the 5 ½-inch liner.
- Scrape the 5 ½-inch liner to the float collar. Circulate hole clean with 2 percent KCl water. Test the longstring casing an both liners simultaneously to 1,500 psi for 30 minutes.
- Mobilize a wireline unit and run a Temperature Log followed by a Cement Bond Log with Variable Density Log, Gamma Ray and Casing Collar Locator from the float collar to the top of the 5 ½-inch liner. Run a baseline Casing Inspection Log in the 5 ½-inch liner, 7 5/8-inch liner and 9 5/8-inch casing from TD to surface.
- Perforate the Granite Wash Formation as instructed by Wellsite Geologist.
- Obtain initial static bottomhole pressure measurement, fluid level and gradient survey using surface recording downhole pressure gauge and associated equipment.
- Rig up an air compressor to the standpipe. Go in hole with open-ended work string to total depth. Circulate well with aerated 2 percent KCl water until fluid returns are clean.
- Cease pumping KCl water while continuing air injection into standpipe and attempt to obtain sample of formation fluid. Cease air injection and pull out of hole with work string. Displace well with 2 percent KCl water and test injectivity.
- Run Baker Lok-Set (or equivalent) 7 5/8-inch x 4 ½-inch externally plastic-coated packer (either internally PVC-lined or internally plastic-coated depending upon tubing selected for use) with 5 1/2-inch liner tie-back seal unit on bottom of packer with 4 ½-inch, 11.6 lb/ft, K-55, LTC (Seal Tite PVC lined or TK-99 internally plastic-coated tubing) to approximately 5,900 feet (until tie-back seals engage into 5 1/2-inch liner tie-back receptacle) and space out as required to account for thermal fluctuations in the injected waste stream.

4 ½-Inch, 11.6 lb/ft, K-55, LTC, Seal Tite PVC-Lined or Internally Plastic-Coated Tubing Specifications are as follows:

Wall	0.250 inches
id	4.000 inches
Drift	3.875 inches (pipe only, does not consider PVC lining or IPC)
Coupling od	5.00 inches
Capacity	0.0155 bbl/ft
Burst	5,350 psi
Collapse	4,960 psi
Pipe Body Strength	184,000 lb
Joint Strength	180,000 lb

- Pick back up out of tie-back receptacle and displace annulus with inhibited 9.6 ppg brine and provide for a diesel fuel cap in the annulus for freeze protection at the surface.
- Set back down into liner tie-back receptacle, set packer and remove BOP. Install slips, pack off flange and tree valves.

- Run preliminary annulus pressure test, release well service unit and allow 72 hours for wellbore thermal stabilization prior to conducting mechanical integrity and reservoir pressure testing operations.

10. Mechanical Integrity Testing and Ambient Pressure Monitoring
    Note: Formal procedures will be developed based upon actual depths and data obtained during the completion operations.
    - Pressure annulus to 370 psi for 30 minutes. Maximum allowable pressure loss will be 5 percent of applied pressure or 19 psi.
    - Move in and rig up wireline unit.
    - Go in hole with differential temperature tool and obtain baseline differential temperature log to total depth.
    - Run surface recording pressure gauge to the top of open hole interval (or at a selected datum point for the open hole completion) while making 5-minute gradient stops to determine static fluid level and wellbore fluid gradient profile. Leave gauge on depth at top of open hole interval (or at selected datum point) for four hours to collect static bottomhole pressure data.
    - Perform step rate, injection and falloff tests to evaluate reservoir performance characteristics.
    - Following reservoir testing, run spinner and radioactive tracer survey to determine injection profile and to verify integrity of formation isolation.
    - Prepare and submit well completion report.
    - Place well in service following receipt of written certification of construction and completion from the TCEQ. Prior to initiation of waste injection, pump appropriate volume of buffer fluid, if required or appropriate.

VI.A.8 Cement and Cementing Procedures

Historical materials performance, discussions with vendors, past performance records and materials brochures were also considered when selecting the cementing materials to be used in constructing the proposed injection well. Cementing will be by the inner-string method for the surface casing, by the pump and plug method in combination with staging for the longstring casing and by the pump and plug method in combination with liner hanger for the drilling and production liners. Cementing recommendations prepared by Halliburton Energy Services for the cementing of the surface and longstring casings are included in Appendix F. Cement information, additives, quantities (fill intervals), etc., follow:

<u>20-inch Conductor Casing</u>: Cemented to surface with Redi-mix.

<u>13 3/8-inch Surface Casing Cement</u>:

The surface casing will be cemented in a single stage using lead and tail cement slurries of slightly different compositions as follows:

Lead Slurry: SBM CEM VARICEM™ lead cement with 0.25 lbm/sk Poly-E-Flake and one percent Calcium Chloride, mixed at 12.8 lb/gal; 2.012 cuft/sk, and11.25 gal/sk water **(1,000 feet to surface fill interval)**.

Tail Slurry: SBM CEM HALCEM™ SYSTEM tail cement, mixed at 14.8 lb/gal; 1.342 cuft/sk, and 6.43 gal/sk water **(1,500 to 1,000 feet fill interval).**

Appropriate borehole conditioning fluids will be pumped and circulated prior to pumping the cement. Cementing will be performed using the inner-string method. The calculated system excess cement volume will equal a minimum of 20 percent and will be applied to the lead slurry only. Actual cement volume pumped to be based upon actual hole volume calculated from the caliper log plus 20 percent excess. If the caliper log cannot measure the diameter of the hole over any interval, then the minimum amount of cement for that interval shall be a volume calculated to be equivalent to 150 percent of the space between the casing and the maximum measurable diameter of the caliper.

9 5/8-inch Longstring Casing Cement:

The longstring casing will be cemented in a single stage using lead and tail cement slurries of slightly different compositions as follows:

Lead Slurry: SBM CEM VARICEM™ lead cement with 0.25 lbm/sk Poly-E-Flake, mixed at 11.5 lb/gal; 2.805 cuft/sk, and17.21 gal/sk water **(3,500 feet to surface fill interval).**

Tail Slurry: SBM CEM HALCEM™ SYSTEM tail cement, mixed at 14.8 lb/gal; 1.326 cuft/sk, and 6.34 gal/sk water **(4,000 to 3,500 feet fill interval)**

Appropriate borehole conditioning fluids will be pumped and circulated prior to pumping the cement. The calculated system excess cement volume will equal a minimum of 20 percent. Actual cement volume pumped to be based upon actual annular volume calculated from the caliper log plus 20 percent excess. If the caliper log cannot measure the diameter of the hole over an interval, then the minimum amount of cement for that interval shall be a volume calculated to be equivalent to 150 percent of the space between the casing and the maximum measurable diameter of the caliper.

7 5/8-Inch Drilling Liner Casing:

Slurry: SBM CEM ISOBOND SYSTEM lead slurry with 12 percent salt and 0.8 percent ISOGUARD, mixed at 13.6 lb/gal; 1.626 cuft/sk, and 8.03 gal/sk water **(6,200 to 3,750 feet fill interval).**

Actual cement volume pumped will be based upon actual hole volume calculated from open hole caliper, plus 20 percent excess, plus the volume of the float joint plus the volume of the 9 5/8-inch protection casing for a distance of approximately 200 feet above the 7 5/8-inch liner top.

5 ½-Inch Production Liner Casing:

Slurry: SBM CEM ISOBOND SYSTEM lead slurry with 5 percent calcium chloride and 0.8 percent ISOGUARD, mixed at 13.8 lb/gal; 1.456 cuft/sk, and 6.89 gal/sk water **(9,000 to 5,900 feet fill interval).**

Actual cement volume pumped will be based upon actual hole volume calculated from open hole caliper, plus 20 percent excess, plus the volume of the float joint plus the volume of the 7 5/8-inch drilling liner for a distance of approximately 200 feet above the 5 ½-inch liner top.

Auxiliary Cementing Equipment:

13 3/8-Inch Surface Casing Equipment:

13 3/8-inch Double-Valve Float Shoe
13 3/8-inch Float Collar
13 3/8-inch Stab-in Adapter

9 5/8-Inch Longstring Casing Equipment:

9 5/8-inch Double-Valve Float Shoe
9 5/8-inch Float Collar

7 5/8-Inch Drilling Liner Casing Equipment:

7 5/8-inch Double-Valve Float Shoe
7 5/8-inch Float Collar
7 5/8-inch Landing Collar
9 5/8-inch x 7 5/8-inch Liner Hanger

5 ½-Inch Production Liner Casing Equipment:

5 ½-inch Double-Valve Float Shoe
5 ½-inch Float Collar
5 ½-inch Landing Collar
7 5/8-inch x 5 ½-inch Liner Hanger

VI.A.9 Logging, Coring and Testing

During the drilling and construction of the injection well, appropriate logs and tests will be run to determine or verify the depth, thickness, porosity, permeability, rock type, and the salinity of any entrained fluids, in all relevant geologic units to assure conformance with applicable regulations, and to establish accurate baseline data against which future measurements may be compared.

Following is a list of the various logging which will be performed on the open and cased holes of the injection well. Information on coring and testing plans is also included. Logs and tests will be interpreted by the service company processing the logs or performing tests or by other qualified persons.

VI.A.9.a Logging in Surface Casing Hole

The following logs will be run in the 17 ½-inch surface casing borehole and in the 13 3/8-inch surface casing:

17 ½-inch Open Hole: Dual Induction, Spontaneous Potential, Natural Gamma Ray, Compensated Neutron, Litho-Density and Integrated Borehole Caliper Logs using borehole telemetry sub to obtain wellbore directional information.

13 3/8-inch Cased Hole: Cement Bond with Variable Density Log/, Casing Collar Locator and a Temperature Log.

VI.A.9.b Logging in Longstring Casing Hole

The following logs will be run in the 12 ¼-inch longstring casing borehole and in the 9 5/8-inch longstring casing:

12 ¼-inch Open Hole: Dual Induction, Spontaneous Potential, Natural Gamma Ray, Litho-density, Compensated Neutron, Fracture Identification Log and Borehole Caliper Log using borehole telemetry sub to obtain wellbore directional information.

9 5/8-inch Cased Hole: Cement Bond Log/Variable Density Log/Gamma Ray/Casing Collar Locator, a Temperature Log and a Baseline Casing Inspection Log from TD to surface.

The following logs will be run in the 8 3/4-inch drilling liner borehole and in the 7 5/8-inch drilling liner:

8 ¾-inch Open Hole: Dual Induction, Spontaneous Potential, Natural Gamma Ray, Litho-density, Compensated Neutron, Fracture Identification Log and Borehole Caliper Log using borehole telemetry sub to obtain wellbore directional information.

7 5/8-inch Cased Hole: Cement Bond Log/Variable Density Log/Gamma Ray/Casing Collar Locator, a Temperature Log and a Baseline Casing Inspection Log from TD to surface.

The following logs will be run in the 6 3/4-inch drilling liner borehole and in the 5 1/2-inch production liner:

6 ¾-inch Open Hole: Dual Induction, Spontaneous Potential, Natural Gamma Ray, Litho-density, Compensated Neutron, Fracture Identification Log and Borehole Caliper Log using borehole telemetry sub to obtain wellbore directional information.

5 1/2-inch Cased Hole: Cement Bond Log/Variable Density Log/Gamma Ray/Casing Collar Locator, a Temperature Log and a Baseline Casing Inspection Log from TD to surface.

VI.A.9.c Injection Zone and Confining Zone

The injection well will have an Injection Zone from approximately 3,720 to 9.000 feet BGL. The Confining Zone will be from approximately 2,780 to 3,720 feet BGL.

The proposed injection well will be located within close proximity of the Tyson WDW-120 injection well.

VI.A.9.c.i Injection Zone and Confining Zone Cores

A full-hole core (30-foot total core length) will be collected from the Tubb Formation (in the lowermost part of the overlying Confining Zone) beginning at an approximate depth of 2,780 feet. Full-hole cores (30-foot core lengths) will also be collected from selected intervals in the Injection Zone (in the Wichita, Brown Dolomite and Granite Wash Formations). If full-hole coring is not feasible or adequate core recovery is not achieved, sidewall cores will be recovered in the impermeable strata of the lowermost overlying Confining Zone and in the permeable strata of the Injection Zone for analysis. During the drilling of the well coring depths may be adjusted to ensure the depths targeted for coring are representative of the impermeable strata of the Confining Zone and the permeable strata of the Injection Zone. Core analysis shall include a determination of permeability, porosity, bulk density, Poisson's ratio, formation compressibility and other necessary tests.

VI.A.9.c.ii Formation Fluid Samples

Formation fluid samples were obtained from the WDW-120 injection well when it was drilled. Prior to injectivity tests, formation fluid samples may be obtained from the new well at the discretion of the operator. The fluid samples will be analyzed for physical, chemical and radiological characteristics in accordance with 30 TAC §331.62(a)(8) and 30 TAC §331.121(a)(2)(H).

VI.A.9.c.iii Compatibility Analysis

Tyson has operated the nearby WDW-120 since it was placed into operation in 1975. During that period, no evidence of incompatibility between waste stream to fluids in the Injection Zone or incompatibility between the waste stream to minerals of both the Injection Zone and the Confining Zone has ever been observed. There has been no evidence that incompatibility has altered the permeability, thickness or other relevant characteristics of the Confining or Injection Zones such that they would no longer meet the requirements of 30 TAC §331.121(c) nor react to generate gases.

VI.A.9.d Well Mechanical Integrity

To demonstrate mechanical integrity of the wellbore, formal procedures will be developed based upon actual depths and data obtained during drilling and completion operations.

VI.A.9.d.i Pressure Test with Liquid or Gas

The monitored annulus will be pressure tested to 370 psi for 30 minutes (100 psi above the maximum requested surface injection pressure of 270 psi). Maximum allowable pressure loss will be five percent of the applied pressure or 19 psi.

VI.A.9.d.ii Radioactive Tracer Survey

An RTS will be run to ensure that all injected fluids are entering the Injection Interval through the open hole or perforated completion and that no fluids are moving upward behind the casing such that they would be a hazard to USDW.

VI.A.9.d.iii Temperature or Noise Log

A Temperature or Noise Log will be run from total depth (±5,000 feet or ±9,000 feet) to surface during well completion to establish a baseline for the initial condition of the well.

VI.A.10 Well Stimulation Program

No stimulation program is anticipated.

VI.A.11 Injectivity/Falloff Test

After the well has been completed and fluid level in the well has stabilized, the static bottomhole pressure and temperature will be collected using a downhole pressure gauge set immediately above the open hole or perforated interval. The preferred injection intervals and open hole or perforated interval will be determined from the open hole logs run on the 12 ¼-inch, 8 ¾-inch and 6 ¾-inch boreholes. Gradient stop checks will be performed to identify fluid level and wellbore fluid gradient profile in the well at the time of static bottomhole pressure and temperature measurement.

Following is a description of proposed injectivity test procedures which will be followed to determine the well capacity and reservoir characteristics. Analysis of the data will follow the current falloff test analysis guidelines established by the USEPA and the TCEQ. Reservoir characteristics determined by the injectivity test will include reservoir fluid pressure, transmissibility, permeability, faulting or other boundaries, evidence of dual porosity, skin factor, completion anomalies and other physical characteristics of the reservoir. A conservative estimate of the fracture pressure has been included in Section VII.A.5.

1. Rig up lubricator containing calibrated downhole surface readout (SRO) pressure gauge to the completed injection well. Obtain atmospheric pressure readings with SRO gauge in the lubricator and verify tool calibrations.
2. Open the well's crown valve and record surface shut in pressure (if any) with SRO gauge for five minutes. Run in hole with SRO gauge in the well to a depth immediately to the selected datum point for the open hole or perforated completion.
3. Obtain static bottomhole pressure and temperature data in the well for no less than one hour.
4. Initiate injection of non-hazardous fluid (2 percent KCl or equivalent KCl substitute) at 300 gpm. Monitor pressure buildup response for approximately 12 hours or until reaching steady state. Injection testing may be concluded earlier if steady state is achieved.
5. Cease injection and shut in the well. Close flowline valves at the pumps and at the wellhead. Run falloff test for 24 hours or until bottomhole pressures have stabilized and data are in the infinite-acting, radial flow period.
6. Upon completion of the injection/falloff test in the proposed well, retrieve SRO gauge while making gradient stops for 5 minutes every 1,000 feet from the test depth to surface.
7. With the SRO tool in the lubricator, close the crown valve.

VI.A.12 Engineering Drawings of Wellhead Configuration and Annulus Monitoring Systems

Figure VI-2 is a diagram of the proposed injection wellhead and injection tree for the well. The injection wellhead area will have secondary containment to collect and contain spills, leaks, or on-site stormwater. Any liquids collected in the secondary containment surrounding the wellhead will be returned to the surface pre-treatment facilities for subsequent injection. Figure VI-3 is a diagram of the proposed annulus monitoring system.

VI.A.13 Materials of Construction Compatibility Testing

Tyson (previously IBP) has operated WDW-120 for approximately 49 years. During that period, no evidence of waste stream to cement incompatibility has been observed. In addition, Tyson conducts quarterly corrosion monitoring using a section of PVC-lined pipe similar to the material from which WDW-120 and the proposed WDW-312 well will be constructed. No corrosion has been observed since the installation of the monitoring loop indicating the lined tubing to be used in the construction of WDW-312 should be appropriate and compatible with the injected waste stream. Corrosion monitoring results are included in Appendix C.

WDW-312 will be constructed using similar cements and PVC-lined (or internally plastic-coated) carbon steel components (tubulars, wellhead components, packers) and casings as those used in the construction of WDW-120. Given the acceptable waste-to-well construction component compatibility history of the WDW-120 injection well and the cements selected for utilization, no compatibility problems are anticipated in association with the proposed WDW-312 injection well, and no additional well construction compatibility testing is planned for the proposed well.

VI.A.14 Plans for Notification of Well Construction and Submittal of Pre-Operation Reports

Prior to commencement of construction of the proposed injection well, and in accordance with 30 TAC §331.62(a)(10), Tyson will notify the TCEQ (Austin headquarters and Region 1) at least 30 days in advance of commencing drilling operations of the well. Tyson will also notify the TCEQ (Austin headquarters and Region 1) at least 24 hours prior to beginning drilling operations. TCEQ representatives will be made aware of scheduling and will be provided an opportunity to witness all cementing of casing strings, logging and testing. TCEQ representatives will be given at least 24-hour notice before each activity in order that a representative of the TCEQ may be present to witness these activities.

In accordance with 30 TAC §331.65(b)(1), within 90 days after completion of the proposed injection well, Tyson will submit a Completion Report to TCEQ which documents the construction and testing activities associated with the proposed injection well. For purposes of this discussion, completion is defined as that point when both 1) final mechanical integrity has been successfully demonstrated and 2) all required ambient pressure monitoring activities have been completed. The Completion Report will include a surveyor's plat providing the exact location and the latitude and longitude of the completed injection well. The Completion Report will also include a certification that a notation has been made on the deed to the Tyson property (or on some other instrument which is normally examined during title search) stating (1) the surveyed location of the well, (2) the well permit number and (3) the permitted waste streams.

The Completion Report will be prepared and sealed by a licensed Professional Engineer and/or licensed Professional Geoscientist with current registration under the Texas Engineering Practice Act or Texas Geoscience Practice Act. Tyson will include the following information in the Completion Report for each of the proposed injection wells:

1. Actual as-built drilling and completion data on the well;
2. All logging and testing data on the well;
3. A demonstration of mechanical integrity;
4. Anticipated maximum pressure and flow rate at which the permittee will operate;
5. Results of the Injection Zone and Confining Zone testing program (as required in 30 TAC §331.62 relating to Construction Standards);
6. Adjusted formation pressure increase calculations, fluid front calculations and updated cross sections of the Confining and Injection Zones, based on the data obtained during construction and testing;
7. The actual injection procedure;
8. The compatibility of injected wastes with fluids in the Injection Zone and minerals in both the Injection Zone and the Confining Zone and materials used to construct the well;
9. The calculated Area of Review and Cone of Influence based on data obtained during logging and testing of the well and the formation, and where necessary, revisions to the information submitted under 30 TAC §331.121;
10. The status of corrective action required for defective wells in the Area of Review;
11. A Well Data Report on forms provided by the executive director;
12. Compliance with the casing and cementing performance standard in 30 TAC §331.62(a)(5);
13. Compliance with the cementing requirements in 30 TAC §331.62(a)(6).

Tyson will also provide written notice to the TCEQ (Austin headquarters and Region 1) that a copy of the permit has been filed with the health and pollution control authorities of the county, city and town where the well is located.

Prior to startup of the proposed injection well, Tyson will notify the TCEQ (Austin headquarters and Region 1) in writing of the anticipated well startup date. Tyson will demonstrate compliance with all pre-operation terms of the permit prior to beginning injection operations. Tyson will not commence operations until they have received written approval to do so from the TCEQ.

VI.B. Existing Well Design and Condition (WDW-120)

The following sections provide construction data related to this permit renewal application for WDW-120, which was constructed in 1974 and has been in operation since 1975.

VI.B.1 Injection Well Schematic

Figure VI-4 is a schematic drawing illustrating the current construction details of WDW-120. The diagram includes information on type, size, weight, grade and setting depths for casings, tubulars and packers. All depths shown on the schematic are referenced to kelly bushing (KB) elevation which is 7 feet above GL.

VI.B.2 Well History

Plant Disposal Well No. 1 (WDW-120) was permitted and drilled in 1974 and completed as a perforated completion in the Permian Wolfcamp Formation (Godsey-Earlougher, 1975). The well was drilled to a depth of 5,015 feet KB and completed with 5 ½-inch, 14 and 15.5 lb/ft, J-55, STC 8rd longstring casing set to 4,881 feet KB. The 5 ½-inch casing was perforated at 2 to 4 jet shots per foot (jspf) at various intervals from 4,658 to 4,860 feet KB. The injection tubing consisted of 2 7/8-inch, 6.5 lb/ft, EUE 8rd, PVC-lined Seal Tite tubing connected to an Otis Type WB Permadrill packer located at 4,595 feet KB. WDW-120 was initially put into service in 1975.

Over the operational time period from 1975 to 1992, WDW-120 experienced a significant decrease in injection capacity. This was evidenced by the marked increase in bottomhole pressure buildup through time with a corresponding decrease in injection rate. Caustic and acid stimulations had been routinely performed to recover acceptable levels of injection (30 to 50 gpm for eight hours per day). However, decreasing periods of injection recovery between treatments resulted. Also, plans were initiated to expand operations at the Amarillo facility and additional injection capacity (up to 150 gpm) would be needed to accommodate the resulting increase in generated waste volume.

In September 1992, in order to increase injectivity performance, the 5 ½-inch casing shoe was drilled out and underreamed to an open hole total depth of 5,017 feet KB to access the prolific portion of the Brown Dolomite Formation via open hole completion. Expansion into the overlying Panhandle Lime (Wichita) Formation included selectively perforating the 5 ½-inch longstring casing from a depth of 4,142 to 4,570 feet KB. In addition, the original Wolfcamp completion interval from 4,658 to 4,860 feet KB was selectively re-perforated with a high shot density to maximize the injectivity potential in this interval. New perforations at a shot density of 4 jspf were added between depths from 4,600 to 4,860 feet KB. The original injection tubing and packer were replaced with 124 joints and one pup joint of 3 ½-inch, 9.3 lb/ft (10 lb/ft actual lined weight), J-55, EUE 8rd, PVC-lined, Seal Tite tubing and a 5 ½-inch by 2 7/8-inch PVC-lined Baker Model TSN-2 retrievable injection packer set from 4,031 to 4,038 feet KB. Annular fluid consists of freshwater with corrosion inhibitor, topped off with diesel fuel for freeze protection (TDI, 1992).

In February 1999, a workover was performed to remediate an annulus leak detected in December 1998. The workover consisted of the following tasks: removal of injection tubing and packer, performing a casing inspection log, pressure testing the 5 ½-inch longstring casing to identify the source of the annulus leak, cleanout of the open hole interval by underreaming to 8 ½-inch diameter (original underreamed diameter), and stimulation treatment with an organic oxidizer (Oxol II) and iron sequestering Hydrochloric Acid (FeHCl). The primary objective of the workover was to remediate the annulus leak by squeezing cement into a suspected casing leak. A casing leak was detected at the depth of the stage tool during the workover, but stopped leaking during pressure testing. Since the leak sealed before it could be identified, a Cal Carb polymer annulus fluid was installed which is designed to seal any small leaks which may develop in the casing. The 3 ½-inch PVC-lined injection tubing and the PVC-lined Baker Model TSN-2 packer were replaced in the well with the packer set from 4,026 to 4,033 feet KB. The cleanout and stimulation activities performed on the well resulted in improved injectivity. The well was injecting at less than 100 gpm with limited vacuum prior to the cleanout and stimulation. Following the cleanout and stimulation the well was injecting at 150 gpm with 24 in-Hg vacuum on the wellhead (TDI, 1999).

An annulus leak was detected in WDW-120 in April 2001. A workover was performed to investigate the leak, determine the source and remediate the leak, thereby restoring the well to an operable condition. This was accomplished by disassembling the removable components of the well, visually inspecting the 3 ½-inch injection tubing and packer as these components were removed from the well, and performing an evaluation of the 5 ½-inch longstring casing. In so doing, the source of the leak was determined and remediated. It was determined the source of the leak was in the 5 ½-inch casing in the original packer seat, between 4,022 and 4,026 feet KB. The specific cause of the leak, could have been due either to a penetration in the casing at that point, or from the packer "losing its grip" on the inside surface of the casing at that point. The casing did demonstrate pressure integrity below that point at 4,036 feet KB, indicating that a penetration in the casing was probably not the cause of the leak. Results of the leak investigation, indicated that no unauthorized injection had occurred, since the leak was located within the permitted Injection Interval (top at 4,000 feet) in WDW-120. Leak remediation was accomplished by reassembling the well with the packer positioned from 3,750 to 3,756 feet KB (above the stage tool) within the successfully pressure-tested interval of the 5 ½-inch longstring casing, and below the top of the permit Injection Zone (3,720 feet). Following acid stimulation and well reassembly, the well was observed to be accepting 192 gpm with 20 inches of vacuum at the surface (TDI, 2001).

In March 2005, a workover was again performed to improve the injectivity in the well. The workover consisted of the following tasks: removal of injection tubing and packer, minimum inner diameter (id) logging of the casing to detect scale buildup, scraping of the casing, performing a casing inspection log, cleanout of the open hole interval by underreaming, acid/caustic stimulation treatment, pressure testing the 5 1/2-inch longstring casing, and installation of the tail pipe, packer and injection tubing. The minimum id log indicated buildup on the casing wall resulting in an id reduction of 0.10 to 0.70 inch and a missing section of casing from 4,664 to 4,665 feet KB. The missing casing was consistent with a caliper log performed in 1992 which indicated significant casing damage in the interval. A decision was made to run a pre-perforated tail pipe through the interval with the casing anomaly (4,664 feet to 4,666 feet KB). This decision was made to provide a guide for future wireline tools. Since the 4 3/4-inch bit would not pass through the casing anomaly there was a possibility of wireline tools hanging up in this interval. The tail pipe acquired for the well was 2 7/8-inch 7.9 lb/ft, PH6 made of 13 Chrome for corrosion resistance. The tail pipe was required to extend from the bottom of packer at 3,758 feet KB to below the casing anomaly at 4,666 feet KB. As the tail pipe was to be placed across perforated intervals below 4,140 feet KB, sections were pre-perforated to allow direct injection into the perforated completion intervals behind the tail pipe. A total of 1,005 feet of tail pipe was run with the lower 660 feet being pre-perforated with ½-inch holes (24 holes per foot). It was connected to the packer with a 3 ½-inch EUE 8rd box by 2 7/8-inch PH6 pin crossover sub. The redressed Seal Tite lined Baker TSN-2 injection packer and the 3 ½-inch Seal Tite lined injection tubing were then reinstalled in the well. The packer was positioned from 3,751 to 3,758 feet KB (3,741 to 3,748 feet wireline depth). Following the cleanout and stimulation, the well was injecting at 85 gpm with vacuum on the wellhead (TDI, 2005).

WDW-120 has experienced a gradual decrease in injectivity since 2001. Attempts to regain well performance have included cleanouts, acid/caustic stimulations and underreaming (discussed above). The coiled tubing cleanouts and/or stimulations were performed in 2003, 2004, 2007, 2008, 2009, 2011, 2013, 2016, 2017, 2018, 2019 and 2024. Although some improvement has been noted following each of the stimulations, the recovery has yielded progressively lower injection rates with a shorter duration of improvement. The degradation in injectivity appears to be related to precipitation of solids and biochemical reactions downhole.

An inspection of the corrosion monitoring loop in 2014 revealed a calcium carbonate scale buildup in the piping and well system that is affecting injectivity. Since the precipitate is acid soluble, scale control chemicals are now added to the waste stream just prior to filtration for cleaning the well system and associated piping. The anti-scalant is added at the approximate rate of 25 to 50 ppm (equivalent to about 0.0025 percent of the average daily flow). A minor modification to the permit was approved by the TCEQ on March, 2014, to include the scale control; pumps and filters to the pre-injection units. A second minor modification was approved on February, 2017, to modify the description of the pre-injection units and clarify the chemical composition of the anti-scalant.

An additional hypothesis of the cause of the injectivity decrease observed in WDW-120 is proliferation of biology in the aerated ponds. Since 2024, a biocide treatment program has been implemented in WDW-120. The program uses a proprietary formula of scale inhibitor (Momar 15625) and biocide feed (Momar B-1203). Detailed description of the program is presented in Section IX.A. Results of the plan will be estimated after the reservoir pressure falloff test is performed at the end of October 2024.

VI.B.3 Corrosion Monitoring, Annual Testing, and Condition of Tubulars

Tyson has a corrosion monitoring plan in place and conducts annual mechanical integrity testing of the WDW-120 injection well. Based on corrosion monitoring data (see Appendix C), an assessment of the present condition of the tubing, casing and packer was performed. Tyson currently conducts corrosion monitoring to determine the corrosion rate for the PVC-lined carbon steel from which the injection well tubulars and the packer and landing joint are constructed. A corrosion monitoring loop (consisting of one length of PVC-lined carbon steel injection tubing [test spool]) was installed in the flowline between the brine storage tank and the wellhead and is continuously exposed to the Tyson well injectate (with the exception of when the well is taken out of service). The test spool is evaluated on a quarterly basis according to Underground Injection Control (UIC) guidelines. The corrosion monitoring of the PVC-lined test spool exposed to the wastewater shows no level of attack to the PVC lining material. Inhibited freshwater is used as the packer fluid and is designed to minimize internal corrosion of the longstring casing and external corrosion of the injection tubing. Mineral deposits that appear on the length of PVC-lined tubing are cleaned off periodically following quarterly evaluations. Tyson has concluded the recorded corrosion rates are excellent and well within industry standards.

Given the results of the annual annulus pressure testing and the results of the recent corrosion monitoring data, it can be concluded that WDW-120 is mechanically sound and has not recently been affected by any unusual or excessive corrosion. It is anticipated the current injection tubulars should be able to withstand corrosive effects of the currently-injected waste stream and subsurface environment for the remaining life expectancy of the injection well (assumed to be 10 years) assuming the future corrosion rates remain relatively similar to the historical corrosion rates observed from 2002 to 2023.

Based on corrosion monitoring data, an assessment of the present condition, and an assessment of the future condition of the waste flow-wetted materials that provide protection to the USDW (i.e., casing, tubing, and packer) was performed. Given the completion geometry of WDW-120, the following assessment was made only for the 5 ½-inch, 14 and 15.5 lb/ft (mixed) carbon steel casing material which constitutes a portion of the monitored annulus (above the packer) for WDW-120 and the 3 ½-inch tubing string (the external surface which also constitutes a portion of the monitored annulus for WDW-120 and internal surface which is flow-wetted).

The following calculations are made using API Bulletin 5C3 (American Petroleum Institute, 1994) to determine the casing burst, collapse, joint and pipe body strengths using the estimated wall thickness in 2034 (ten years of future operation).

$$Burst\ Strength = 0.875\left[\frac{2Y_p t}{D}\right]$$

Collapse Modes Based on D/t Ratio				
Casing Grade	**"Yield"**	**"Plastic"**	**"Transition"**	**"Elastic"**
J-55	0 – 14.81	14.81 – 25.01	25.01 – 37.21	> 37.21

$$Collapse\ Strength\ (\text{"Yield"}) = 2Y_p\left[\frac{(D/t)-1}{(D/t)^2}\right]$$

$$Collapse\ Strength\ (\text{"Plastic"}) = Y_p\left[\frac{A}{D/t} - B\right] - C$$

$$Collapse\ Strength\ (\text{"Transition"}) = Y_p\left[\frac{F}{D/t} - G\right]$$

$$Collapse\ Strength\ (\text{"Elastic"}) = \frac{46.95\ x\ 10^6}{\left(\frac{D}{t}\right)\left(\left(^{D}/_{t}\right) - 1\right)^2}$$

$$Pipe\ Body\ Yield = \frac{\pi}{4}(D^2 - d^2)Y_p$$

where

$$A = 2.8762 + 0.10679x10^{-5}Y_p + 0.21301x10^{-10}{Y_p}^2 - 0.53132x10^{-16}{Y_p}^3$$

$$B = 0.026233 + 0.50609x10^{-6}Y_p$$

$$C = -465.93 + 0.030867Y_p - 0.10483x10^{-7}{Y_p}^2 + 0.36989x10^{-13}{Y_p}^3$$

$$F = \frac{46.95x10^6\left[\frac{3B/A}{2 + B/A}\right]^3}{Y_p\left[\frac{3B/A}{2 + B/A} - B/A\right]\left[1 - \frac{3B/A}{2 + B/A}\right]^2}$$

$$G = FB/A$$

$$D = outer\ diameter\ of\ casing\ (inches)$$

$$d = inner\ diameter\ of\ casing\ (inches)$$

$$t = wall\ thickness\ (inches)$$

$$Y_p = minimum\ yield\ strength\ of\ casing$$

The following assessment is made for the tubing and the longstring casing in WDW-120. This assessment uses the observed general (average) corrosion values, and does not take into account the effects of localized (crevice or pitting) corrosion that can cause higher levels of corrosion in a smaller area, potentially resulting in accelerated loss of integrity. No corrosive attack is expected to occur in the tubulars, packer or landing joint given the results of the historical corrosion rates observed from 2002 through 2023.

WDW-120 Casing and Tubing Burst, Collapse and Tensile Considerations

The longstring casing for WDW-120 consists of 5 ½-inch, 14 and 15.5 lb/ft, J-55, STC carbon steel from surface to 4,881 feet. As stated previously, the well was initially constructed in 1974 and put into service in 1975. This assessment of the 5 ½-inch casing will focus on the effects of uniform corrosion on the 14 lb/ft, J-55 casing material above the internally lined packer. (Assuming a uniform corrosion rate applied equally to the 14 lb/ft and 15.5 lb/ft casing, the lighter weight, 14 lb/ft casing, would experience greater structural fatigue from loss of wall thickness.)

Longstring Casing

The 5 1/2-inch, 14 lb/ft, J-55 carbon steel casing (from surface to top of packer at 3,751 feet) has a 0.244-inch wall thickness, a collapse pressure rating of 3,120 psi and an internal yield (burst) pressure rating of 4,280 psi (U.S. Steel, 2014). Corrosion monitoring has been conducted since 1993 with PVC coupons (representing the internal PVC lining of the injection tubing) exposed to the waste stream. Analysis of the PVC coupons exposed to the waste stream showed no level of attack to the PVC lining material. Inhibited freshwater is used as the packer fluid and is designed to minimize internal corrosion of the longstring casing and external corrosion of the injection tubing. During the 2005 workover, a multi-caliper log was run on the longstring casing and no significant corrosion was observed. The log showed a maximum id of approximately 5.15 inches with average id throughout the casing of approximately 5.1 inches.

For carbon steel, a corrosion rate of less than 2 mils per year (0.0020 ipy) is considered ideal, but 2 to 10 mpy is considered to be very good. For purposes of this assessment, a corrosion rate of 2 mils per year (0.0020 ipy) is assumed, since no data is available to substantiate a corrosion rate for mild carbon steel in an inhibited freshwater packer fluid environment. It is reasonable to assume the inhibited freshwater environment should result in a minimal to non-existent corrosion rate of the carbon steel above the packer. Assuming 10 more years of operation for the permit renewal period (total of 60 years of exposure), by 2034, the total loss in wall thickness (assuming a 0.0020 ipy corrosion rate) of the 5 1/2-inch, 14 lb/ft, J-55 casing section above the packer will be 0.120 inches (60 years x 0.0020 inches/year) for a remaining wall thickness of 0.124 inches.

As stated above, the estimated wall thickness (t) in 2034 is 0.124 inches. The outer diameter (D) is 5.5 inches and the inner diameter (d) is 5.252 inches. The minimum yield strength (Y_p) for J-55 casing is 55,000 psi. The D/t ratio is 44.35, therefore the casing would fail under the "elastic" collapse mode.

$$Burst\ Strength = 0.875\left[\frac{2\ (55{,}000\ psi)\ (0.124\ in)}{5.5\ in}\right] = 2{,}170\ psi$$

$$Collapse\ Strength\ (\text{"Elastic"}) = \frac{46.95\ x\ 10^6}{\left(\frac{5.5\ in}{0.124\ in}\right)\left(\left({}^{5.5\ in}/_{0.124\ in}\right) - 1\right)^2} = 563\ psi$$

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Pipe body yield and joint strength calculations are unnecessary as the casing is cemented in place, therefore the axial loads are supported by the cement and formation closure.

<u>Injection Tubing</u>

The 3 ½-inch, 9.3 lb/ft, J-55, EUE 8rd, internally PVC-lined carbon steel tubing has a 0.254-inch wall thickness, a collapse pressure rating of 7,400 psi and an internal yield (burst) pressure rating of 6,990 psi (U.S. Steel, 2014). As stated previously, the well was constructed in 1974 but the current injection tubing string was originally installed during a workover performed in 1999. In 2005, another workover was performed, and the injection tubing was pulled, visually inspected, then rerun in the well. Corrosion monitoring has been conducted since 1993 with PVC coupons (representing the internal PVC lining of the injection tubing) exposed to the waste stream, which showed no level of attack to the PVC lining material. Since the waste stream can only contact the PVC lining, no wall thickness reduction due to corrosion is expected to occur in the injection tubing. The annulus is filled with inhibited freshwater to minimize the corrosive effects on the exterior of the injection tubing. As such, no structural loss of integrity (either burst or collapse ratings) would be expected for the 3 ½-inch injection tubing unless long-term failure of the PVC lining or coupling sleeves should occur.

As stated above, the estimated wall thickness (t) in 2034 is 0.254 inches. The outer diameter (D) is 3.5 inches and the inner diameter (d) is 2.992 inches. The minimum yield strength (Y_p) for J-55 tubing is 55,000 psi. The D/t ratio is 13.78, therefore the casing would fail under the "yield" collapse mode.

$$Burst\ Strength = 0.875\left[\frac{2\ (55{,}000\ psi)\ (0.254\ in)}{3.5\ in}\right] = 6{,}985\ psi$$

$$Collapse\ Strength\ (\text{"Yield"}) = 2\ (55{,}000\ psi)\left[\frac{\left(3.5\,\frac{in}{0.254}\,in\right) - 1}{\left(3.5\,\frac{in}{0.254}\,in\right)^2}\right] = 7{,}404\ psi$$

$$Pipe\ Body\ Yield = \frac{\pi}{4}(3.5\ in^2 - 2.992\ in^{\,2})\ (55{,}000\ psi) = 142{,}461\ psi$$

Joint strength for the 3 ½-inch, 9.3 lb/ft, J-55, EUE 8rd, internally PVC-lined carbon steel tubing estimated in 2034 is 142,500 lb (U.S. Oil, 2014).

Operational Pressures and Loads

The burst pressure used in casing design is the differential pressure of the internal fluid forces acting on the casing less the external fluid forces. For worst-case casing differentials under operation, it is assumed that the internal pressure acting on the casing is the sum of the hydrostatic pressure due to the casing being full of inhibited freshwater annulus fluid from the depth of the packer to surface, plus an applied 370 psig surface pressure required by permit operating parameters for the annulus pressure test. For the external pressure, it is assumed that the casing is cemented, but that the cement sheath contains a continuous mud channel from the depth of the injection packer to the top of the casing. For casing burst calculations, it is assumed that the mud used during drilling prior to cementing the longstring casing was 9.2 lb/gal. This is a conservative assumption because it disregards external pressure on the casing due to lithostatic stress and assumes the presence of an assumed 9.2 lb/gal mud-filled channel behind the pipe rather than continuous cement from surface to the packer. Both factors would increase the presence of external back-up pressure on the casing, thus decreasing the maximum potential differential burst pressure across the 5 1/2-inch longstring casing above the packer.

For tubing, it is assumed that the internal pressure acting on the tubing is the hydrostatic pressure resulting from the tubing being full to surface with the heaviest permitted wastewater (1.15 sp.gr. = 9.58 lb/gal) and the well is operated at the maximum permitted surface injection pressure (270 psig). For the external pressure, it is assumed that the annulus is full from the depth of the packer to surface with inhibited freshwater, with no annulus pressure (assuming the annulus monitoring system experiences a temporary loss of pressure). This is a conservative assumption because it disregards any additional pressure due to positive pressure on the annulus at the surface. This factor would increase the presence of external burst-backup pressure on the tubing, thus decreasing the maximum potential differential pressure across the 3 1/2-inch injection string. The annulus is currently filled with inhibited freshwater (8.33 lb/gal fluid containing corrosion inhibitor) to minimize corrosive effects on the exterior of the injection tubing and the interior of the longstring casing.

The collapse pressure used in casing design is the differential of pressure exerted on the outside of the casing to the internal pressure. It is assumed that the external pressure results from the casing being cemented but that the cement sheath contains a continuous mud channel from the depth of the packer to the top of the casing. For the casing collapse calculations, it is assumed that the mud used during drilling before cementing the longstring casing was 9.2 lb/gal. It is also assumed the annulus is filled with inhibited freshwater with no applied pressure, and the casing is fully cemented to surface with inclusion of a continuous 9.2 lb/gal mud channel from surface to the top of the packer at approximately 3,751 feet. The maximum differential pressure acting to collapse the casing is the difference between the hydrostatic pressure of the mud column on the external side of the casing at a depth of 3,751 feet and the internal casing pressure due to the hydrostatic column of the freshwater annulus fluid. The worst-case casing collapse condition is examined at the packer depth as this depth experiences the largest pressure differential.

For tubing collapse calculations, it is assumed that the internal pressure acting on the tubing is the hydrostatic pressure resulting from the tubing being evacuated to 2,071 feet, a case in which 50-percent of the well is evacuated from the top of the perforations to surface during nitrogen jetting operations. For the external pressure, it is the hydrostatic pressure resulting from the annulus being full from the depth of the packer to surface with inhibited freshwater and also the regulatory-driven pressure which is imposed for conducting an annulus pressure test (370 psig).

Pipe body and joint strength tests only apply to the tubing under operating conditions since the casings have already been cemented which supports the load along their lengths. For tubing pipe body and joint strength yield, the maximum tensile load is normally taken to be the weight of the pipe hanging in air for a worst-case basis and neglects the effect of buoyancy.

The following calculations use worst-case assumptions to determine the maximum pressures and loads for the various casing strings. Of note, the value 0.052 (psi/ft)/(lb/gal) include in the calculations on the following pages is the conversion factor from lb/gal to psi/ft. Also, these calculations assume a maximum requested injection pressure in this permit renewal application to be 270 psig.

WDW-120 Longstring Casing

Collapse Worst Case Assumptions: Casing cemented with inclusion of a continuous 9.2 lb/gal mud channel from surface to 3,751 feet (depth to injection packer) and no pressure in the annular space.

Longstring Casing Collapse Calculations

Depth (ft)	External Pressure (psi)	Internal Pressure (psi)	Differential Pressure (psi)	Calculation
0	0	0	0	(9.2 ppg – 8.33 ppg) * 0 ft * 0.052 (psi/ft)/(ppg)
3,751	**1,794**	**1,625**	**169**	**(9.2 ppg – 8.33 ppg) * 3,751 ft * 0.052 (psi/ft)/(ppg)**

The maximum collapse pressure differential of <u>169 psi</u> occurs at 3,751 feet in the longstring casing.

Burst Worst Case Assumptions: Casing cemented with inclusion of a continuous 9.2 lb/gal mud channel from surface to 3,751 feet (depth to injection packer). 5 1/2-inch by 3 1/2-inch annulus full of inhibited freshwater and maintaining 370 psig on annulus (100 psi in excess of the maximum surface injection pressure of 270 psig) in accordance with TCEQ permit requirements.

Longstring Casing Burst Calculations

Depth (ft)	Internal Pressure (psi)	External Pressure (psi)	Differential Pressure (psi)	Calculation
0	**370**	**0**	**370**	**370 psi + (8.33 ppg - 9.2 ppg) * 0 ft * 0.052 (psi/ft)/(ppg)**
3,751	1,995	1,794	201	370 psi + (8.33 ppg - 9.2 ppg) * 3,751 ft * 0.052 (psi/ft)/(ppg)

The maximum burst pressure differential of <u>370 psi</u> occurs at surface in the longstring casing.

Joint and Pipe Body Strength: No additional test required as casing presumed to be cemented and supported by cement and formation closure forces.

WDW-120 Injection Tubing

Collapse Worst Case Assumptions: Annulus full to surface with inhibited freshwater with 370 psig surface pressure (100 psi over maximum surface injection pressure of 270 psi). During nitrogen jetting activities, the tubing is evacuated to 2,071 feet with 8.33 lb/gal freshwater.

Injection Tubing Collapse Calculations

Depth (ft)	External Pressure (psi)	Internal Pressure (psi)	Differential Pressure (psi)	Calculation
0	370	0	370	370 psi + 8.33 ppg * 0 ft * 0.052 (psi/ft)/(ppg)
2,071	**1,267**	**0**	**1,267**	**370 psi + 8.33 ppg * 2,071 ft * 0.052 (psi/ft)/(ppg)**
3,751	1,267	728	538	370 psi + (8.33 ppg * 2,071 ft – 8.33 ppg * [3,751 ft – 2,071 ft]) * 0.052 (psi/ft)/(ppg)

The maximum collapse pressure differential of <u>1,267 psi</u> occurs at 2,071 feet.

Burst Worst Case Assumptions: Annulus full to surface with inhibited freshwater and maintaining zero psi on annulus with heaviest permitted waste stream (9.58 lb/gal, 1.15 sp.gr.) while injecting at the maximum surface injection pressure of 270 psi. Note that annulus pressure must be maintained at 100 psi above injection pressure, thus this calculation is overly conservative.

Injection Tubing Burst Calculations

Depth (ft)	Internal Pressure (psi)	External Pressure (psi)	Differential Pressure (psi)	Calculation
0	270	0	270	270 psi + (9.58 ppg * 0 ft – 8.33 ppg * 0 ft) * 0.052 (psi/ft)/(ppg)
3,751	**2,139**	**1,625**	**514**	**270 psi + (9.58 ppg * 3,751 ft – 8.33 ppg * 3,751 ft) * 0.052 (psi/ft)/(ppg)**

The maximum burst pressure differential of <u>514 psi</u> occurs at 3,751 feet.

For pipe body and joint strength yield, the maximum tensile load is taken to be the weight of the 3,751 feet of pipe hanging in air prior to engaging the packer for a worst-case basis and neglects the effects of buoyancy.

Injection Tubing Tensile Calculations

Depth (ft)	Load (lbf)	Calculation
0	**34,884**	**9.3 lb/ft * 3,751 ft**
3,751	0	9.3 lb/ft * 0 ft

The maximum tensile load of <u>34,884 lbf</u> occurs at the surface.

WDW-120 Casing and Tubing Safety Factor Calculations

Industry standards for design safety factors for this application are as follows:

<u>Collapse</u>: 1.0 to 1.125 based on minimum collapse pressures.
<u>Internal Yield (Burst)</u>: 1.0 to 1.1 based on minimum yield values.
<u>Tension</u>: 1.8 based on minimum joint strength. 1.5 based on minimum pipe body strength.

The following minimum safety factors are required for each casing string.

Collapse:	1.125
Internal Yield (Burst):	1.1
Tension:	1.8

The safety factors are calculated by dividing the rated strength of the tubular by the maximum pressure differential (for collapse and burst) or tensile loading.

Calculated Safety Factors

Tubular	Collapse Loading	Burst Loading	Tensile Loading (Joint)	Tensile Loading (Pipe Body)
Longstring Casing	3.331	5.865	N/A	N/A
Injection Tubing	5.844	13.589	4.085	4.084

This analysis suggests the portion of the longstring casing (above the packer assembly) should be able to withstand the maximum probable burst and collapse pressures to which it may be exposed through the end of the permit renewal period (2034) short of a premature failure resulting from a connection leak or leak resulting from an external corrosion mechanism.

VI.B.4 Future Design Changes

No changes are currently planned to the construction or operation of WDW-120.

VI.B.5 Surface Equipment Engineering Drawings

Figure VI-5 is a schematic illustrating the existing wellhead configuration of WDW-120. The drawing illustrates the type and size of valves, flanges, fittings, etc. which currently exist on the WDW-120 injection wellhead. The wellbore annulus monitoring system of the WDW-120 injection well is identical to the system for the proposed injection well WDW-312 (Figure VI-3).

VI.C. Well Operation, Monitoring and Maintenance

During normal operation, the existing and proposed injection wells will operate continually except when mechanical integrity tests, workovers, maintenance or possible emergency shutdowns occur. All operating parameters will be closely monitored to prevent exceeding TCEQ permit limits. A tabulation of monitored operating parameters is included as Table VI-1.

VI.C.1 Maximum Instantaneous Injection Rate

The cumulative and individual maximum instantaneous rate of injection requested in this permit renewal application for Tyson WDW-120 and WDW-312 is 300 gpm.

VI.C.2 Average Injection Rates and Total Volumes

During normal operation, WDW-120 and WDW-312 will operate continually except when mechanical integrity tests, maintenance work, or possible emergency shutdowns occur. Requested cumulative average injection rates, as calculated on a monthly basis, and total volumes are summarized below:

Rate/Volume Category	Rate/Volume
Average Injection Rate for Each Well	200 gpm
Average Injection Rate (Cumulative)	200 gpm
Average Monthly Injection Volume for Each Well	8,760,000 gallons(1)
Annual Injection Volume for Each Well	105,120,000 gallons(2)
Average Monthly Injection Volume (Cumulative)	8,760,000 gallons(1)
Annual Injection Volume (Cumulative)	105,120,000 gallons(2)

(1) equivalent to 200 gpm for 365 days divided by 12
(2) equivalent to 200 gpm for 365 days

VI.C.3 Projected Average and Maximum Daily Rates and Volumes

The rate of injection for WDW-120 is expected to vary from 100 to 300 gpm during normal operations. Average rate of injection for the injection well is expected to be about 200 gpm. The maximum injection rate is expected to be no more than 300 gpm. The total cumulative volume of waste disposed of into WDW-120 through December 31, 2023 is 825,153,077 gallons. The anticipated typical annual volume of waste to be disposed of into the injection well is 105,120,000 gallons (based on an average rate of 200 gpm). The projected remaining operational life of WDW-120 is ten years (permit renewal period). Therefore, the anticipated volume to be injected over the life of the well is 1,876,353,077 gallons (based on the cumulative volume injected through December 31, 2023 and an average projected [and monthly maximum] injection rate of 200 gpm for a remaining life of ten years [825,153,077 gal + 1,051,200,000 gal]).

Average monthly rate of injection for the proposed WDW-312 injection well is anticipated to range from 100 to 300 gpm. The anticipated annual volume of waste to be disposed of into the proposed injection well is 105,120,000 gallons (based on an average [and monthly maximum] rate of 200 gpm). The anticipated operational life of the proposed WDW-312 injection well is 30 years. The estimated volume of waste to be disposed of in the proposed injection well over the anticipated life of the well is 3,153,600,000 gallons (based on the maximum injection rate of 200 gpm for 30 years).

VI.C.4 Average and Maximum Surface Injection Pressures

The average surface injection pressure for WDW-120 is approximately 151 psi. The requested maximum surface injection pressure is 270 psig for injection of all permitted waste streams into WDW-120 and WDW-312. This is consistent with the existing permits for the injection wells and with fracture pressure calculations made using the MASIP computer program (see Section VII.A.5). Anticipated surface injection pressures for the injection wells should range from 0 psig (vacuum) to 270 psig.

VI.C.5 Well Operation and Injection Procedures

Tyson operates the WDW-120 injection well and the injection pump system to ensure the permitted operating parameters, as reviewed, approved, and permitted by the TCEQ, are not exceeded. These operation and injection procedures demonstrate compliance with the operating requirements of 30 TAC §331.63 and §331.66(c). The operation and injection procedures will prevent the movement of fluids that could result in pollution of the USDW. There will be no injection between the outermost casing and the wellbore.

The instrumentation and pressure gauges for the injection well are located in a weatherproof building which encloses the wellhead. Recording devices are located in the well building which record well operating parameters. These instruments measure and continuously monitor and record the injection pressure, flow rate and temperature of the injected fluids, along with the tubing-to-longstring casing annulus pressure and the volume of wastewater injected into the injection well.

The instrumentation and pressure gauges for the proposed WDW-312 injection well will be in weatherproof enclosures at the wellheads. Recording devices will be in the control room which record well operating parameters. These instruments will measure and continuously monitor and record the injection pressure, flow rate and temperature of the injected fluids; tubing-to-longstring casing annulus pressure; and volume injected into the injection well.

Annulus pressure and injection pressure gauges are installed at the WDW-120 wellhead and will be installed on the WDW-312 wellhead to allow visual monitoring of operating conditions. Additionally, alarms are provided to alert operators to high flow rates, low annulus pressure, and low level in the annulus fluid tank. All gauges, pressure sensing and recording devices are, and will continue to be, tested and calibrated quarterly. In the event that an alarm sounds, facility personnel notify a trained operator who investigates and corrects the problem.

Appropriate action will be taken if pressure or flow rates exceed the limits set forth in the injection well permits. Tyson will notify the TCEQ within 24 hours of any significant change in monitoring parameters or any other observations which could reasonably be attributed to a leak or other failure of the well equipment or Injection Zone integrity. Table VI-1 (Injection Well Monitoring and

Reporting Requirements) summarizes the functions of the injection wells which are monitored, and the measurement frequencies and reporting schedules, as required by UIC rules of the TCEQ.

Tyson operates WDW-120 and the injection pump system to ensure the maximum allowable surface injection pressure, as reviewed and permitted by the TCEQ, is not exceeded. This operational practice prevents any potential pressure increases in the Injection Zone which could potentially fracture the Injection Zone and the thick Confining Zones present below the Tyson facility. The fluid in the annulus of WDW-120 consists of freshwater with corrosion inhibitor, topped off with diesel fuel or equivalent fluid for freeze protection, and is essentially non-corrosive to carbon steel. Tyson will maintain an annulus pressure that is at least 100 psi greater than the injection tubing pressure measured at the surface to prevent leaks from the well into unauthorized zones and to detect well malfunctions. This operating procedure demonstrates that mechanical integrity of the well is maintained at all times per 30 TAC §331.63(1).

There does not appear to be any potential for reactivity between the injected fluid and the formation to generate gas. The lack of a carbonate injection interval in the Wichita-Brown Dolomite and Granite Wash Injection Interval, which consists of sands, negates the potential for subsurface gas generation due to injection of the Tyson waste stream.

Waste Analysis Plan

Tyson annually samples and tests its injectate to obtain a detailed chemical and physical analysis of the fluid to be disposed of in its injection well. Analysis of the injection fluid is currently performed following the guidelines set forth in the waste analysis plan (Table IX.C) and is done with a frequency to yield representative samples regarding the characteristics of the fluid. This monitoring assures that permit limits are not exceeded. The plan describes the procedures for chemical and physical analysis of a representative sample of the waste. Tyson will continue to analyze the injected waste following the applicable guidelines as long as Class I injection wells are operated at the Amarillo Plant. In addition, Tyson will conduct continuous or periodic monitoring of parameters specified or required by the permit, and the chemical and physical characteristics of the injected fluids will be maintained within specified permit limits. Tyson will, at all times, properly operate and maintain all facilities and systems of treatment and control which are installed and/or used to achieve compliance with the conditions of the permit. Monitoring activity records will include the following information:

1) date and time of sample measurement;
2) identity of individual who collected the sample or made the measurement;

3) date of analysis;
4) identity of individual in laboratory who performed the analysis;
5) technique and method of analysis; and,
6) the results of the analysis or measurement.

Workover Operations

Tyson will notify the TCEQ before commencing any workover operation. The notification will be in writing and include plans for the proposed work. The workover will not begin until TCEQ approval has been obtained. An exception to the prior written notification and permission requirements may be granted by TCEQ when immediate action is required to prevent movement of fluids into the USDW and to prevent leaks from the well into unauthorized zones. In addition, pressure control equipment will be installed and maintained during workovers which involve the removal of tubing.

Notification of Resuming Injection

If injection operations have ceased in a Tyson well for more than two years and the well is subject to closure as described in 30 TAC §305.154(a)(7), Tyson will notify the TCEQ in writing 30 days prior to resuming operation of the well.

Operations Record Maintenance

Tyson maintains complete and accurate records of all monitoring required by the permit, all periodic well tests, all shut in periods and times that emergency measures were used for handling injection fluid, and all additional information on conditions that might reasonably affect the operation of WDW-120. Tyson retains all monitoring and reporting records at the facility site for a period of at least three years from the date of the record or sample. Tyson will also retain, for a period of five years following abandonment of WDW-120, records of all information resulting from any monitoring activities or other records required by the permit. Tyson will make available to the TCEQ all records, upon request, that are required to be kept by the permit.

VI.C.6 Well Monitoring Plans

Tyson will operate the injection well and the injection pump system to ensure the permitted operating parameters, as permitted by the TCEQ, are not exceeded.

VI.C.6.a Wellhead Pressure Gauges (30 TAC §331.64(c))

Pressure gauges are installed on the WDW-120 wellhead and will be installed on the WDW-312 wellhead and are maintained in proper operating conditions at all times. The gauges monitor the injection tubing pressure and the annulus pressure between the injection tubing and longstring casing. A schematic of the wellhead annulus monitoring system is included as Figure VI-3. A sight gauge is installed on the annulus fluid tank for visual inspection. Additionally, visual and audible alarms are provided to alert operators to high flow rates, low annulus pressure, and low level in the annulus fluid tank. All gauges, pressure sensing and recording devices are tested and calibrated quarterly.

VI.C.6.b Continuous Recording Devices (30 TAC §331.64(d))

Primary and backup recording instrumentation for WDW-120 is housed in the well house, next to the wellhead. These instruments measure and continuously monitor the injection pressure, flow rate and temperature of the injected fluids, and tubing/longstring casing annulus pressure, and volume injected into the injection well. In addition to recording these parameters for permanent records, each measured parameter is displayed on a recording unit and the information is transmitted to the Tyson website. This provides the operator with the opportunity to visually monitor the required operating and monitoring parameters.

Alarms and Shutdown Response (30 TAC §331.64(d)(3))

Visual and audible alarms occur at the well house and control room to alert operators when established operating parameters are exceeded. Alarms are set to sound at the following parameters, as approved in the UIC permit for the existing WDW-120 injection well:

1) Longstring casing/tubing annulus pressure is at 203 psig, at 185 psig and at 183 psig.
2) Injection pressure is at 85 psig. Tyson has set the injection pressure alarm at 85 psig, rather than near 270 psig, to maintain optimal operating conditions for the entire aboveground and belowground well system.
3) Flow rate exceeds 200 gpm and 300 gpm.
4) Tank level at 15 feet and at 5 feet.

In the event that an alarm on WDW-120 sounds, facility personnel will be instructed to contact a trained operator to investigate and correct the problem. If upon investigation, it is determined the well is lacking mechanical integrity, or if continued monitoring otherwise indicates the well may be lacking mechanical integrity, Tyson will: (1) cease injection of waste fluids (unless authorized by the TCEQ executive director to continue or resume injection); (2) take the steps necessary to determine the presence or absence of a leak; and, (3) notify the TCEQ within 24 hours after the alarm or shutdown occurs.

The injection pressure alarm is set at 85 psig. When the injection pressure alarm sounds at 85 psig or the annulus pressure alarm sounds at 185 or 183 psig, operators check the system and take action if necessary to maintain the required minimum differential pressure of 100 psi over the tubing injection pressure. Those actions may include reducing the flow to the well. For low annulus pressure, operators inspect the annulus fluid system (annulus fluid tank and lines) for leaks. Any leaks detected are repaired. Pressure may be added to the annulus fluid tank to maintain or restore normal annulus pressure. If a minimum 100 psi pressure differential cannot be achieved within 15 minutes, then operators begin well shutdown procedures.

Loss of Mechanical Integrity (30 TAC §331.64(d)(4))

If it is determined the injection well(s) has suffered a loss of mechanical integrity either by monitoring or during periodic mechanical integrity testing, Tyson will: (1) immediately cease injection of waste; (2) take the steps reasonably necessary to determine whether there may have been a release of injected fluids into any unauthorized zone; and, (3) notify the TCEQ within 24 hours after the loss of mechanical integrity is discovered. Once a solution, remedy or course of action has been determined, Tyson will (1) notify the TCEQ regarding when injection can be expected to resume and will (2) restore and demonstrate mechanical integrity to the satisfaction of the TCEQ prior to resuming injection of waste fluids.

Release of Wastes into Unauthorized Zone (30 TAC §331.64(d)(5))

If Tyson discovers there may have been a release of injected wastes into an unauthorized zone, Tyson will immediately cease injection of wastes. Tyson will then: (1) notify the TCEQ within 24 hours of obtaining evidence of the unauthorized release; (2) take all necessary steps to identify and characterize the extent of any release; (3) propose a remediation plan for TCEQ review and approval; (4) comply with any remediation plan specified by the TCEQ; and, (5) implement the remediation plan approved by the TCEQ. If the release is into a USDW or freshwater aquifer currently serving as a water supply, Tyson will, within 24 hours, notify the local health authority, place a notice in a newspaper of general circulation, and send notification by mail to the adjacent landowners. Tyson understands the TCEQ may allow Tyson to resume injection prior to completing cleanup action if Tyson demonstrates the injection operation will not endanger USDWs or freshwater aquifers.

VI.C.6.c Continuous or Periodic Monitoring Devices (30 TAC §331.64(b)(3))

Tyson will analyze the injected waste following the applicable guidelines. Tyson will conduct continuous or periodic monitoring of parameters specified or required by the permit and the chemical and physical characteristics of the injected fluids will be maintained within specified permit limits. In addition, Tyson will, at all times, properly operate and maintain all facilities and systems of treatment and control which are installed and/or used to achieve compliance with the conditions of the permit. Table VI-1 (Injection Well Monitoring and Reporting Requirements) summarizes the functions of the injection wells which will be monitored, and the measurement frequencies and reporting schedules, as required by UIC rules of the TCEQ.

VI.C.6.d Annual Mechanical Integrity Testing (30 TAC §331.64(e))

Tyson will conduct annual MIT of the WDW-120 and the proposed WDW-312 wells in accordance with the requirements of 30 TAC §331.64(e). The MIT procedures will include an APT and an RTS. Results of the APT demonstrate the injection well has maintained pressure integrity in the longstring casing, tubing, packer and wellhead seal. The RTS is used to confirm there has been no upward movement of wastewater above the completion interval or permitted Injection Zone. A temperature log, noise log, oxygen activation log or other approved log will be run once every five years to test for fluid movement along the borehole. Additionally, a casing inspection, casing evaluation, or other approved log will be run whenever a workover is conducted during which the injection tubing is pulled. This requirement may be waived by the TCEQ due to well construction or other factors which limit the test's reliability, or based upon the satisfactory results of a casing inspection log run within the previous five years.

VI.C.6.e Quarterly Corrosion Monitoring (30 TAC §331.64(g))

Tyson has installed a corrosion monitoring loop in the flowline at the WDW-120 injection wellhead. Test materials consist of one length of PVC-lined tubing located between the brine storage tank and the injection tree. With the exception of when the well is taken out of service, the spool is continuously exposed to the injectate and can be isolated for easy removal. The injection tubing in the corrosion loop is inspected for the degree of corrosion on a quarterly basis. WDW-312 will be completed with the same tubing material as WDW-120, therefore, no additional corrosion loop will be installed at well WDW-312 as long as WDW-120 is still in use.

Corrosion monitoring data has been collected for the tubulars in WDW-120 (see Appendix C). The tubulars currently utilized in WDW-120 are the same as those proposed for use in WDW-312. The corrosion monitoring of the coated tubulars in WDW-120 indicates no corrosion of the coating on the tubulars.

The following criteria are used by Tyson for the evaluation of corrosion date and determination of acceptable corrosion rates:

- No aggressive preferential corrosion of the weld metal or heat-affected zones;
- If pitting is observed, the calculated rate of corrosion pitting will not exceed 10 mpy based on maximum pit depth;
- No evidence of stress corrosion cracking; and,
- No excessive softening, hardening or loss of the PVC coating.

VI.C.6.f Annual Pressure Buildup Monitoring (30 TAC §331.64(h)(2))

The pressure buildup in the Injection Zone will be monitored annually by means of a static gradient survey, static bottomhole pressure measurements, and pressure buildup and falloff testing, consistent with the requirements of 30 TAC §331.64(h)(2). During pressure buildup and falloff testing, the well will be shut in for a sufficient time to reach radial flow. Reservoir analysis will include a determination of formation transmissibility and permeability.

VI.C.7 Wellhead and Associated Facilities Painting and Maintenance

The wellhead and associated facilities have been (or will be for WDW-312) painted and are maintained in good working order without leaks, consistent with the requirements of 30 TAC §331.66(b)(3).

VI.C.8 Secondary Containment Demonstration

The WDW-120 injection well is located within an 11-foot by 30-foot well house that has a diked, concrete floor to protect the ground surface from spills and releases from the wellhead and ancillary equipment. In addition, any liquid collected from spills or releases will be disposed of in an appropriate manner. The proposed WDW-312 injection well will be located in a similar well house with secondary containment.

VI.C.9 All-Weather Road Demonstration

Both the WDW-120 and proposed WDW-312 injection well locations are within close proximity to an all-weather road. Easy access to the injection well(s) and related facilities is currently present at the well installation site, consistent with the requirements of 30 TAC §331.66(b)(2).

VI.C.10 Signage at Well Location

A sign is posted outside the control house next to the WDW-120 well site which shows the name of the company, company well number, and TCEQ permit number. The sign identification is in the English language, clearly legible and composed of numbers and letters at least 1-inch high.

Once completed, a similar sign will be posted at the WDW-312 well site.

VI.C.11 Contingency Plans

If an injection well suffers a mechanical failure and can no longer be used for injection, an alarm and automatic shutdown will be triggered, and a trained operator will immediately investigate and identify as expeditiously as possible the cause of the alarm and shutdown to prevent migration of wastes into USDW or freshwater aquifers. If, upon investigation, Tyson believes WDW-120 has lost mechanical integrity, Tyson will comply with applicable requirements of 30 TAC §331.44 and 30 TAC §305.152.

If mechanical failure of the well is to such a degree that injection operations are suspended for an extensive length of time, Tyson will manage the fluids to be injected by utilizing the permitted on-site brine evaporation pond and storage tank pre-injection facilities. Once WDW-312 is operational, Tyson will divert the fluids to the other permitted injection well (either WDW-120 or WDW-312, depending upon which well experienced failure).

VI.D. Well Closure, Post-Closure Care and Cost Estimates

The following sections discuss the plugging and abandonment procedures to be implemented once the existing (WDW-120) and proposed (WDW-312) injection wells reach the end of their useful life.

VI.D.1 Closure Plans

At the end of service, the Tyson WDW-120 and proposed WDW-312 injection wells will be plugged and abandoned following the requirements of applicable regulations. In developing the closure plan, geological and economic conditions were considered. The geology of the proposed Wichita-Brown Dolomite and Granite Wash Formation Injection Interval is well understood and has been used for wastewater disposal for decades by numerous Class I injection operators. Many of these operators are located within ten miles of the Tyson facility. No adverse reactions in the Wichita-Brown Dolomite and Granite Wash Formations are expected from operation of the Tyson existing and proposed injection wells. The well closure cost estimate will be adjusted as needed to account for inflation in the cost of oilfield materials and services.

Prior to closing the well, Tyson will observe and record the pressure decay for a time specified by the TCEQ. A determination will be made whether the injection activity has conformed with predicted values regarding the observed and recorded pressure decay testing at closure. In addition, appropriate mechanical integrity testing will be conducted to ensure the integrity of that portion of the longstring casing and cement that will be left in the ground after closure to ensure that no fluids move into or between USDW.

Prior to plugging, each well to be closed will be in a state of static equilibrium with the mud or fluid weight equalized top to bottom, either by circulating the mud or fluid in the well at least once or by a comparable method prescribed by the Executive Director.

Notice of intent to plug and abandon the disposal well will be given at least 60 working days prior to closure of each disposal well. A closure report certifying the well was closed in accordance with applicable requirements will be submitted to the proper agencies within 30 calendar days of plugging each well. The report will include any newly constructed or discovered wells within the Area of Review. The closure report will also include information on any materials (packer, injection tubing, tailpipe, etc.) left in the well after closure. When plugging and abandonment is complete, Tyson will submit certification to the TCEQ (by Tyson and by a licensed Professional Engineer with current registration pursuant to the Texas Engineering Practice Act, who is knowledgeable and experienced in practical drilling engineering and who is familiar with the special conditions and requirements of injection well construction) the injection well has been closed in accordance with 30 TAC §331.46.

Tyson will accomplish plugging of the wells by cementing the well from total depth to surface. The surface and longstring casings will be left in the wells and not be parted. The procedures utilized for the closure of the injection well are described on the following pages:

WDW-120 Well Closure Plan

1. Notify the TCEQ at least 60 days prior to commencement of closure according to the following closure plan (once approved) as required by 30 TAC §331.46(f). Provide TCEQ with any revised, updated or additional closure plans for approval.

2. Prepare location for closure operations.

3. Move in and rig up well service unit and support equipment.

4. Pressure test 5 ½-inch x 3 ½-inch annulus to 370 psi for 30 minutes with TCEQ inspector present. Record test results.

5. Perform and record a pressure decay test for a length of time specified by the Executive Director.

6. Run logging program to include radioactive tracer survey to verify the mechanical integrity of the well.

7. Pump two tubing volumes of brine water of sufficient density to kill well. Steps 5 and 7 serve to flush the well with non-hazardous buffer fluid as required by 30 TAC §331.46(d).

8. Break down the injection tree valving and bonnet. Nipple up BOP stack to tubing head.

9. Nipple up to tubing, pull slips, release packer and pull injection tubing, laying down joints and packer. If packer does not release, arrange to sever tubing above packer, recover tubing and abandon with packer and tailpipe in place.

10. Rig up and run casing inspection log.

11. Run and set squeeze retainer at approximately 3,750 feet.

12. Rig up and pump approximately 200 sacks of Premium Plus (API Class C) cement below the squeeze retainer and squeeze cement through the perforations in the perforated interval and into the open hole interval below 4,883 feet into the geologic formation. Unsting from retainer and dump approximately 20 sacks of cement on top of retainer. Wait 12 hours for cement to cure.

13. Tag and pressure test first plug for seal and stability.

14. Rig up and circulate approximately 400 sacks of Premium Plus cement from top of lower cement plug to surface in 1,000-foot stages. Wait 12 hours for cement to cure. Top off with additional Premium Plus cement as required to assure cement to surface.

15. Rig down BOP stack and cut off tubing head and 5 ½-inch casing below grade.

16. Weld ¼-inch steel plate to 5 ½-inch and 8 5/8-inch casings.

17. Set marker with Facility Well No., TCEQ Permit No., date of abandonment, and company name.

18. Release workover rig and support equipment. Restore location.

WDW-312 Well Closure Plan

1. Notify the TCEQ at least 60 days prior to commencement of closure according to the following closure plan (once approved) as required by 30 TAC §331.46(f). Provide TCEQ with any revised, updated or additional closure plans for approval.

2. Prepare location for closure operations.

3. Move in and rig up well service unit and support equipment.

4. Pressure test 9 5/8-inch x 4 ½-inch annulus to 370 psi for 30 minutes with TCEQ inspector present. Record test results.

5. Perform and record a pressure decay test for a length of time specified by the Executive Director.

6. Run logging program to include radioactive tracer survey to verify the mechanical integrity of the well.

7. Pump two tubing volumes of brine water of sufficient density to kill well. Steps 5 and 7 serve to flush the well with non-hazardous buffer fluid as required by 30 TAC §331.46(d).

8. Break down the injection tree valving and bonnet. Nipple up BOP stack to tubing head.

9. Nipple up to tubing, pull slips, release packer and pull injection tubing, laying down joints and packer.

10. Rig up and run casing inspection log.

11. Run and set squeeze retainer at approximately 3,750 feet.

12. Rig up and pump approximately 500 sacks of Premium Plus (API Class C) cement below the squeeze retainer and squeeze cement into the open hole interval below 4,000 feet into the geologic formation. Unsting from retainer and dump approximately 20 sacks of cement on top of retainer. Wait 12 hours for cement to cure.

13. Tag and pressure test first plug for seal and stability.

14. Rig up and circulate approximately 1,200 sacks of Premium Plus cement from top of lower cement plug to surface in 1,000 foot stage. Wait 12 hours for cement to cure. Top off with additional Premium Plus cement as required to assure cement to surface.

15. Rig down BOP stack and cut off tubing head and 9 5/8-inch and 13 3/8-inch casings below grade.

16. Weld ¼-inch steel plate over 13 3/8-inch and 9 5/8-inch casing strings.

17. Set marker with Facility Well No., TCEQ Permit No., date of abandonment, and company name.

18. Release workover rig and support equipment. Restore location.

VI.D.2. Well Closure Cost Estimates

In 2024 dollars, the closure plan and plugging procedure is expected to cost approximately $269,191 for WDW-120, and approximately $335,319 for WDW-312 (see below).

WDW-120 Closure Cost Estimate

	Estimated Cost
Upfront Engineering Cost	7,200
Well Service Unit	73,000
Wireline – Casing Inspection Log/Cement Retainer	13,188
Wireline Mechanical Integrity Testing	25,000
Rental Equipment	24,017
Casing Services	6,625
Fluids, Pumping, Vacuum Trucks and Hauling	10,710
Cementing and Abandonment	22,717
Supervision	23,500
TCEQ Closure Report	9,600
Estimated Taxes	8,770
Subtotal	224,326
Contingency (20%)	44,865
Total	**$ 269,191**

WDW-312 Closure Cost Estimate

	Estimated Cost
Upfront Engineering Cost	7,200
Well Service Unit	73,000
Wireline – Casing Inspection Log/Cement Retainer	13,450
Wireline Mechanical Integrity Testing	25,000
Rental Equipment	24,000
Casing Services	6,940
Fluids, Pumping, Vacuum Trucks and Hauling	11,786
Cementing and Abandonment	73,567
Supervision	23,500
TCEQ Closure Report	9,600
Estimated Taxes	11,390
Subtotal	279,432
Contingency (20%)	55,886
Total	**$ 335,319**

The closure costs assume that all closure activities will be conducted by a third party with no operable on-site equipment. See Attachment I for financial assurance carried by Tyson for plugging and abandonment of WDW-120 and WDW-312.

VI.D.3. Post-Closure Plan for Hazardous Waste Wells

The Tyson WDW-120 and WDW-312 wells are classified as non-hazardous and, therefore, post-closure plans are not required for these wells.

VI.D.4. Post-Closure Care Cost Estimate for Hazardous Waste Wells

The Tyson WDW-120 and WDW-312 wells are classified as non-hazardous and, therefore, post-closure care cost estimates are not required for these wells.

References

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Table VI-1
Injection Well Monitoring and Reporting Requirements

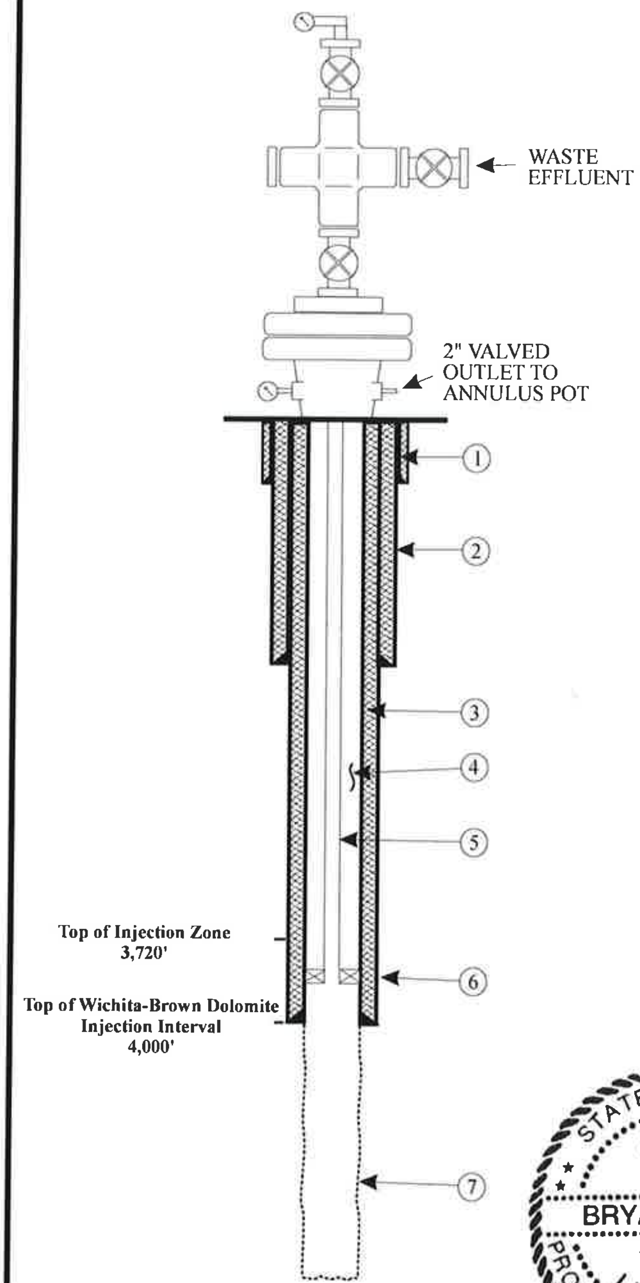
Tyson Fresh Meats, Inc.
Amarillo, Texas

Condition	Measurement Frequency	Specific Measurements to be Reported	When Reported to TCEQ
Annulus Pressure	Continuously Recorded	Instantaneous Minimum, Minimum Differential	Quarterly
Analysis of Fluid Injected	Annually Sampled	pH, Conductivity, SG, TDS, TSS, Alkalinities, Mineral Constituents, TCLP Organics and Metals	Annually
Injection Tubing Pressure	Continuously Recorded	Instantaneous Maximum, Monthly Average	Quarterly
Injection Flow Rate	Continuously Recorded	Instantaneous Maximum, Monthly Average	Quarterly
Cumulative Volume of Fluid Injected	Calculated and Recorded Daily	Monthly Total	Quarterly
Temperature of Fluid Injected	Continuously Recorded	Upon Request	Upon Request
pH and Specific Gravity of Fluid Injected	Continuously Recorded or Grab Daily	Minimum and Maximum pH and Specific Gravity	Quarterly
Total Chromium of Fluid Injected	Weekly	Upon Request	Upon Request
Exceedance of Annulus Pressure or Injection Pressure Limits	Every Incident	Description of Event	Quarterly or Within 24 Hours of Incident if Well Integrity is Suspect
Any Alarm or Shutdowns	Every Incident	Any Event Which Results in Significant Failure	Within 24 Hours of Incident if Well Integrity is Suspect
Changes in Volume of Annular Fluid	Continuously Recorded	Upon Request	Upon Request
Bottomhole Pressure	Annually	Direct Measurement	Annually
Corrosion	Test Spool Monitored Quarterly	Weight Loss	Upon Request

Table VI-1
Injection Well Monitoring and Reporting Requirements (Continued)

Tyson Fresh Meats, Inc.
Amarillo, Texas

Condition	Measurement Frequency	Specific Measurements to be Reported	When Reported to TCEQ
Pressure Fall-Off	Annually as Part of MIT	Pressure Fall-Off Over Sufficient Time Span to Generate Curve	Annually
Newly Constructed/Newly Discovered Wells in AOR	Annually	Location and Tabulation of Data as Required in 30 TAC §331.121(a)(2)(B)	Annually
Mechanical Integrity of:			
a) Longstring Casing, Injection Tube, and Annular Seal	Annually	Results of Pressure Test	Within 30 Working Days of Test Completion
b) Bottomhole Cement by RAT Survey	Annually	RAT Survey Log Evaluation	Within 30 Working Days of Test Completion
c) Fluid Movement Along Borehole	Every 5 years	Temperature, Noise or Other Approved Logging Methods	Within 30 Working Days of Test Completion
Any Well Workover	Time of Work	Workover Report of Field Activities and Reason for Workover	Within 30 Working Days of Test Completion
Any other Required Test of the Injection Well	Time of Work	Test Results	Within 30 Working Days of Test Completion



BELOW GROUND DETAIL

1. **CONDUCTOR**:
20" carbon steel set to approximately 60' in 26" hole and cemented to surface with Redi-Mix cement.

2. **SURFACE CASING**:
13 3/8", 54.5 lb/ft, J-55, STC set in 17 ½" hole to approximately 1,500'. Cemented to surface with lead slurry of SBM CEM VARICEM™ lead cement with 1% $CaCl_2$ and ¼ lbm/sk Poly-E-Flake with design coverage from approximately 1,000' to surface and tail slurry of SBM CEM HALCEM™ SYSTEM tail cement with design coverage from approximately 1,500' to 1,000'.

3. **LONGSTRING CASING**:
9 5/8", 40 lb/ft, J-55, LTC set in 12 ¼" hole from surface to approximately 4,000'. Cemented to surface with lead slurry of SBM CEM VARICEM™ lead cement with ¼ lbm/sk Poly-E-Flake with design coverage from approximately 3,500' to surface and tail slurry of SBM CEM HALCEM™ SYSTEM tail cement with design coverage from approximately 4,000' to 3,500'.

4. **ANNULUS FLUID**: 9.6 lb/gal brine containing corrosion inhibitor. Annulus topped off with diesel fuel for freeze protection.

5. **INJECTION TUBING**: 4 ½", 11.6 lb/ft, K-55, LTC, Seal Tite PVC-lined or TK-99 internally plastic-coated tubing, set into packer at approximately 3,960'.

6. **PACKER**: Baker, 9 5/8" x 4 ½", Lok-Set (or equivalent) externally plastic-coated packer set from 3,960'± to 3,970'±. Internally PVC-lined or internally plastic-coated depending upon tubing selected for use.

7. **OPEN HOLE INTERVAL**: Wichita-Brown Dolomite Formation, 4,000' to 5,000'± in 8 3/4" hole.

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TOTAL DEPTH = 5,000' (approximate)

ALL DEPTHS ARE RELATIVE TO GROUND LEVEL

FIGURE VI-1A

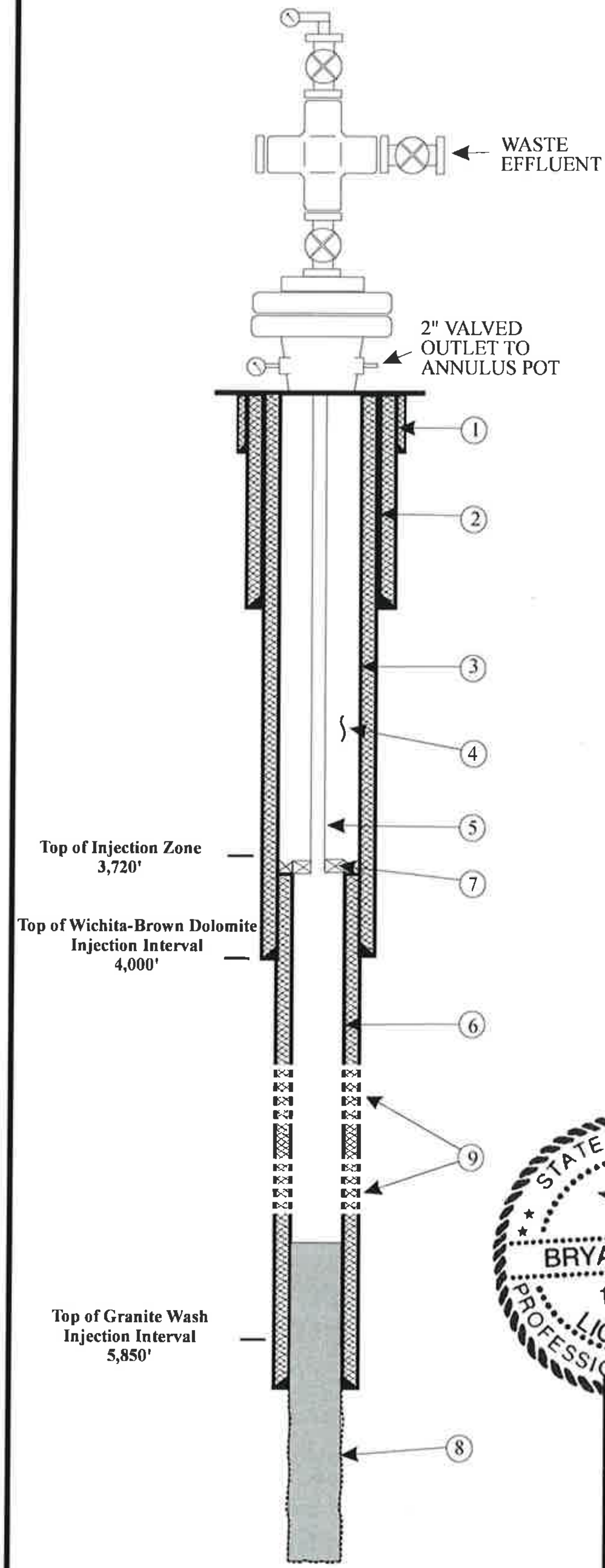
TERRA DYNAMICS INC

PROPOSED CONSTRUCTION SCHEMATIC
OF PLANT DISPOSAL WELL NO. 2 (WDW-312)
WICHITA-BROWN DOLOMITE - OPEN HOLE

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: VASB	SCALE:	DATE: 11/15/24	
DESIGNED BY: TG	N.T.S.	JOB NO. 24-112	
CHECKED BY: BKB			



TOTAL DEPTH = 9,000' (approximate)
PLUGBACK DEPTH = 5,200' (approximate)

ALL DEPTHS ARE RELATIVE TO GROUND LEVEL

BELOW GROUND DETAIL

1. **CONDUCTOR**: 20" carbon steel set to approximately 60' in 26" hole and cemented to surface with Redi-Mix cement.

2. **SURFACE CASING**: 13 3/8", 54.5 lb/ft, J-55, STC set in 17 ½" hole to approximately 1,500'. Cemented to surface with lead slurry of SBM CEM VARICEM™ lead cement with 1% $CaCl_2$ and ¼ lbm/sk Poly-E-Flake with design coverage from approximately 1,000' to surface and tail slurry of SBM CEM HALCEM™ SYSTEM tail cement with design coverage from approximately 1,500' to 1,000'.

3. **LONGSTRING CASING**: 9 5/8", 40 lb/ft, J-55, LTC set in 12 ¼" hole from surface to approximately 4,000'. Cemented to surface with lead slurry of SBM CEM VARICEM™ lead cement with ¼ lbm/sk Poly-E-Flake with design coverage from approximately 3,500' to surface and tail slurry of SBM CEM HALCEM™ SYSTEM tail cement with design coverage from approximately 4,000' to 3,500'.

4. **ANNULUS FLUID**: 9.6 lb/gal brine containing corrosion inhibitor. Annulus topped off with diesel fuel for freeze protection.

5. **INJECTION TUBING**: 4 ½", 11.6 lb/ft, K-55, LTC, Seal Tite PVC-lined or TK-99 internally plastic-coated tubing, set into packer at approximately 3,750'.

6. **DRILLING LINER CASING**: 7 5/8", 25.56 lb/ft, L-80, Seal-Lock flush joint connection pipe set in 8 3/4" hole underreamed to 9 ½" from 3,750'± to 6,200'±. Cemented from 6,200' to the top of the liner at 3,750' with SBM CEM ISOBOND cement with 0.8% ISOGUARD and 12% salt.

7. **PACKER**: Baker, 9 5/8" x 4 ½", Lok-Set (or equivalent) externally plastic-coated packer with 7 5/8" locating tie-back seal assembly on bottom set to approximately 3,750'±. Internally PVC-lined or internally plastic-coated depending upon tubing selected for use.

8. **PLUG**: Cement slurry plug from 5,200'± to total depth of 9,000'± in 6 3/4" borehole and 7 5/8" liner.

9. **PERFORATIONS**: Wichita-Brown Dolomite Formation, as determined from logs.

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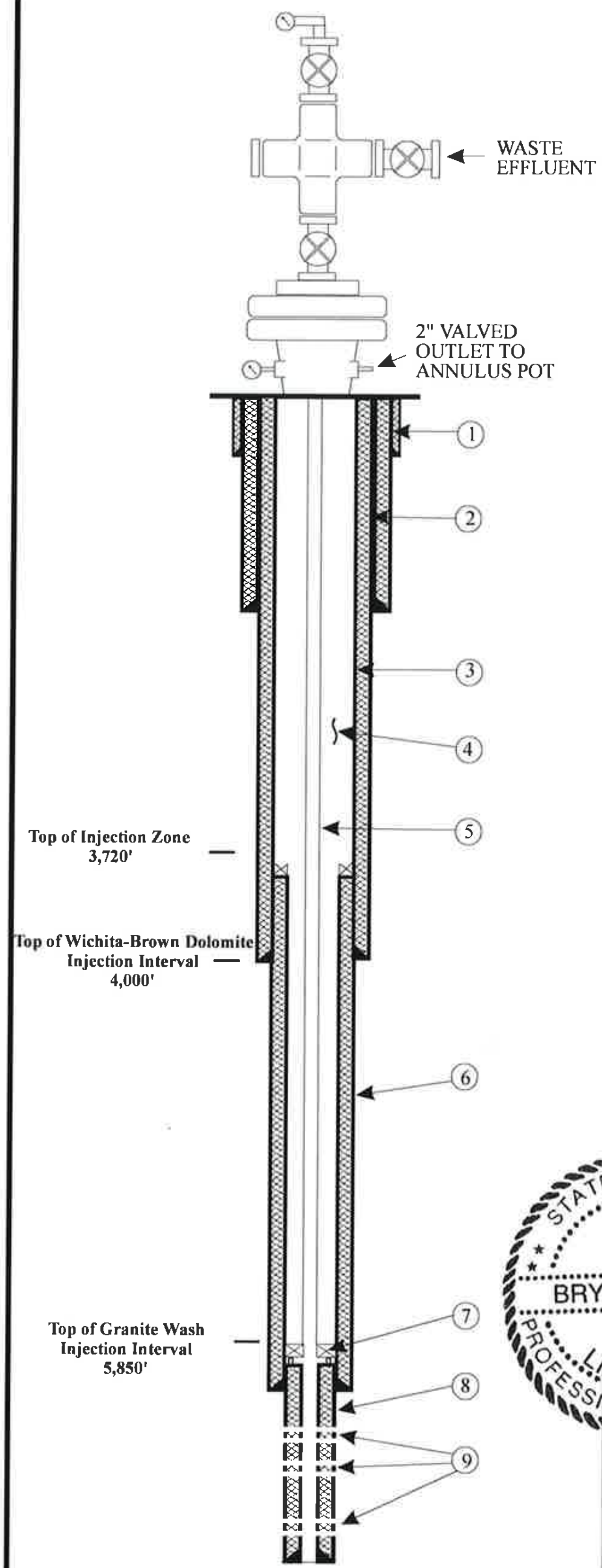
FIGURE VI-1B

TERRA DYNAMICS INC

PROPOSED CONSTRUCTION SCHEMATIC
OF PLANT DISPOSAL WELL NO. 2 (WDW-312)
WICHITA-BROWN DOLOMITE - CASED HOLE

PREPARED FOR
TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: VASB	SCALE:	DATE:	11/15/2024
DESIGNED BY: TG	N.T.S.	JOB NO.	24-112
CHECKED BY: BKB			



TOTAL DEPTH = 9,000' (approximate)

ALL DEPTHS ARE RELATIVE TO GROUND LEVEL

BELOW GROUND DETAIL

1. **CONDUCTOR**:
   20" carbon steel set to approximately 60' in 26" hole and cemented to surface with Redi-Mix cement.

2. **SURFACE CASING**:
   13 3/8", 54.5 lb/ft, J-55, STC set in 17 ½" hole to approximately 1,500'. Cemented to surface with lead slurry of SBM CEM VARICEM™ lead cement with 1% $CaCl_2$ and ¼ lbm/sk Poly-E-Flake with design coverage from approximately 1,000' to surface and tail slurry of SBM CEM HALCEM™ SYSTEM tail cement with design coverage from approximately 1,500' to 1,000'.

3. **LONGSTRING CASING**:
   9 5/8", 40 lb/ft, J-55, LTC set in 12 ¼" hole from surface to approximately 4,000'. Cemented to surface with lead slurry of SBM CEM VARICEM™ lead cement with ¼ lbm/sk Poly-E-Flake with design coverage from approximately 3,500' to surface and tail slurry of SBM CEM HALCEM™ SYSTEM tail cement with design coverage from approximately 4,000' to 3,500'.

4. **ANNULUS FLUID**: 9.6 lb/gal brine containing corrosion inhibitor. Annulus topped off with diesel fuel for freeze protection.

5. **INJECTION TUBING**: 4 ½", 11.6 lb/ft, K-55, LTC, Seal Tite PVC-lined or TK-99 internally plastic-coated tubing, set into packer at approximately 5,900'.

6. **DRILLING LINER CASING**: 7 5/8", 25.56 lb/ft, L-80, Seal-Lock flush joint connection pipe set in 8 3/4" hole underreamed to 9 ½" from 3,750'± to 6,200'±. Cemented from 6,200' to the top of the liner at 3,750' with SBM CEM ISOBOND cement with 0.8% ISOGUARD and 12% salt.

7. **PACKER**: Baker, 7 5/8" x 4 ½", Lok-Set (or equivalent) externally plastic-coated packer with 5 ½" locating tie back seal assembly on bottom set to approximately 5,900'±. Internally PVC-lined or internally plastic-coated depending upon tubing selected for use.

8. **PRODUCTION LINER CASING**: 5 ½", 16.87 lb/ft, K-55, Seal-Lock (or equivalent) flush joint connection pipe set in 6 3/4" hole from 5,900'± to 9,000'±. Cemented from approximately 9,000' to the top of the liner at approximately 5,900' with SBM CEM ISOBOND with 0.8% ISOGUARD and 5% KCl.

9. **PERFORATIONS**: Granite Wash Formation, as determined from logs.

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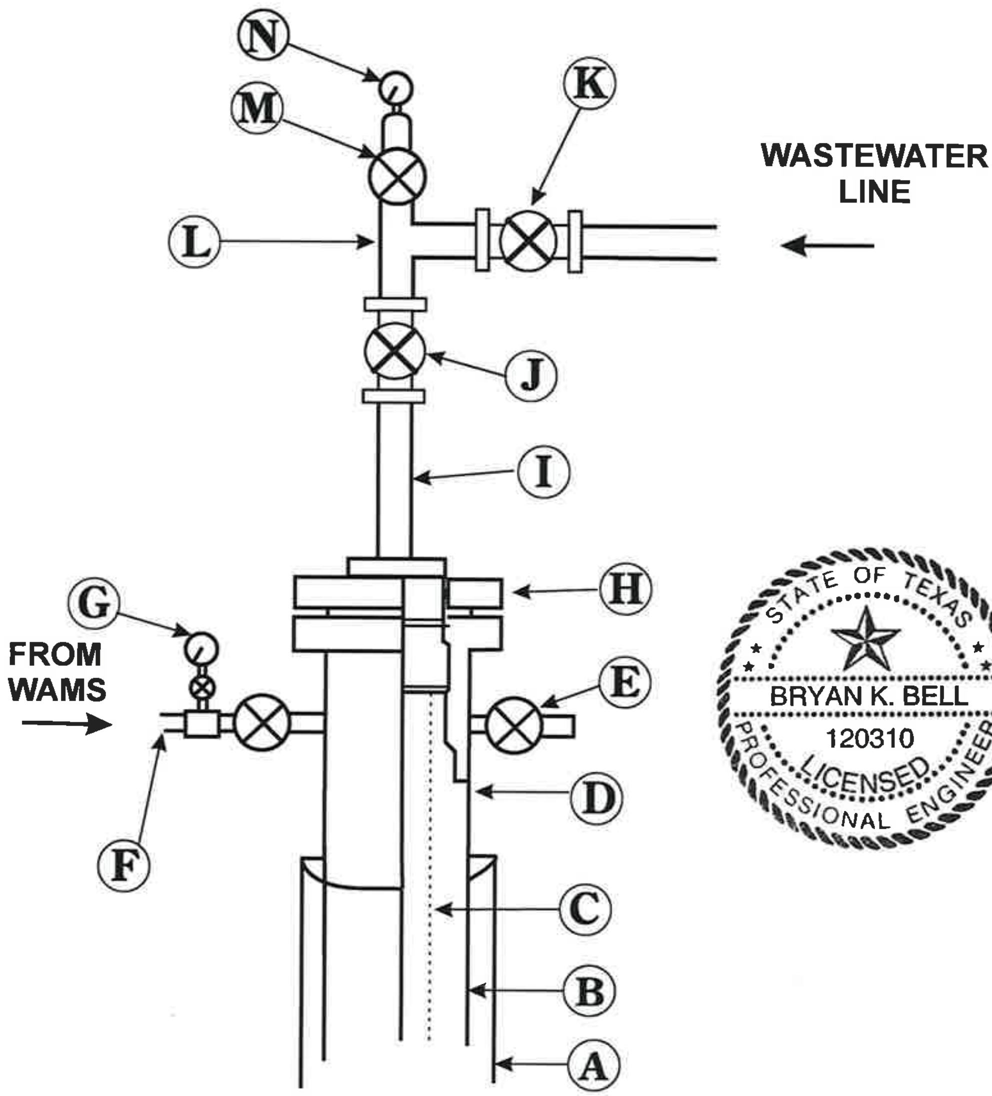
FIGURE VI-1C

TERRA DYNAMICS INC

PROPOSED CONSTRUCTION SCHEMATIC
OF PLANT DISPOSAL WELL NO. 2 (WDW-312)
GRANITE WASH

PREPARED FOR
TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: VASB	SCALE: N.T.S.	DATE: 11/15/2024	
DESIGNED BY: TG		JOB NO. 24-112	
CHECKED BY: BKB			



A. 13 3/8", 54.5 lb/ft, J-55, STC surface casing.
B. 9 5/8", 40 lb/ft, J-55, LTC carbon steel to surface.
C. 4 ½", 11.6 lb/ft, K-55, LTC, IPC or PVC-lined injection tubing.
D. 13 3/8" x 13 5/8" 3,000 psi WP casing head.
E. 2" ball valve.
F. 2" x 1" NPT bushing and 1" line to annulus tank.
G. 0 to 1,000 psi pressure gauge, 1/2" NPT.
H. 13 5/8" x 11" 3,000 psi WP tubing head.
I. 4 ½" carbon steel pipe (PVC-lined).
J. 4 ½" stainless steel ball valve.
K. 4 ½", stainless steel ball valve.
L. 4 ½", stainless steel tee.
M. 2" stainless steel ball valve.
N. 2" stainless steel bull plug tapped ½" NPT with vacuum gauge.

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FIGURE VI-2

TERRA DYNAMICS INC

PROPOSED WELLHEAD AND TREE VALVE ARRANGEMENT - WDW-312

PREPARED FOR
TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

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DESIGNED BY: IBP, Inc.		JOB NO. 24-112
CHECKED BY: BKB		

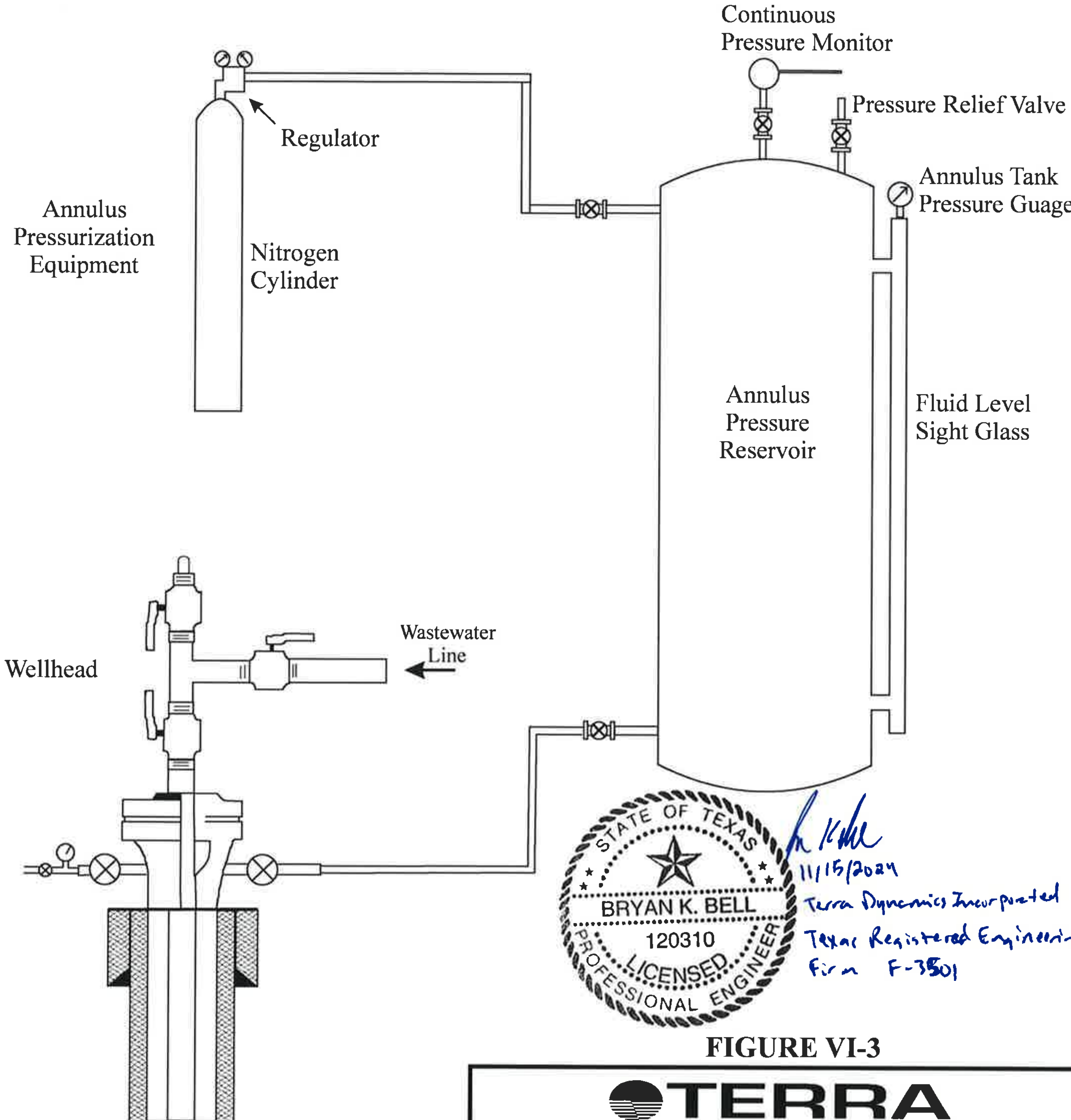

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FIGURE VI-3

TERRA DYNAMICS INC

WELLHEAD ANNULUS MONITORING
SYSTEM - WDW-120 AND WDW-312 (PROPOSED)

PREPARED FOR
TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: VASB	SCALE: Not to Scale	DATE: 11/15/2024
DESIGNED BY: TG		JOB NO.: 24-112
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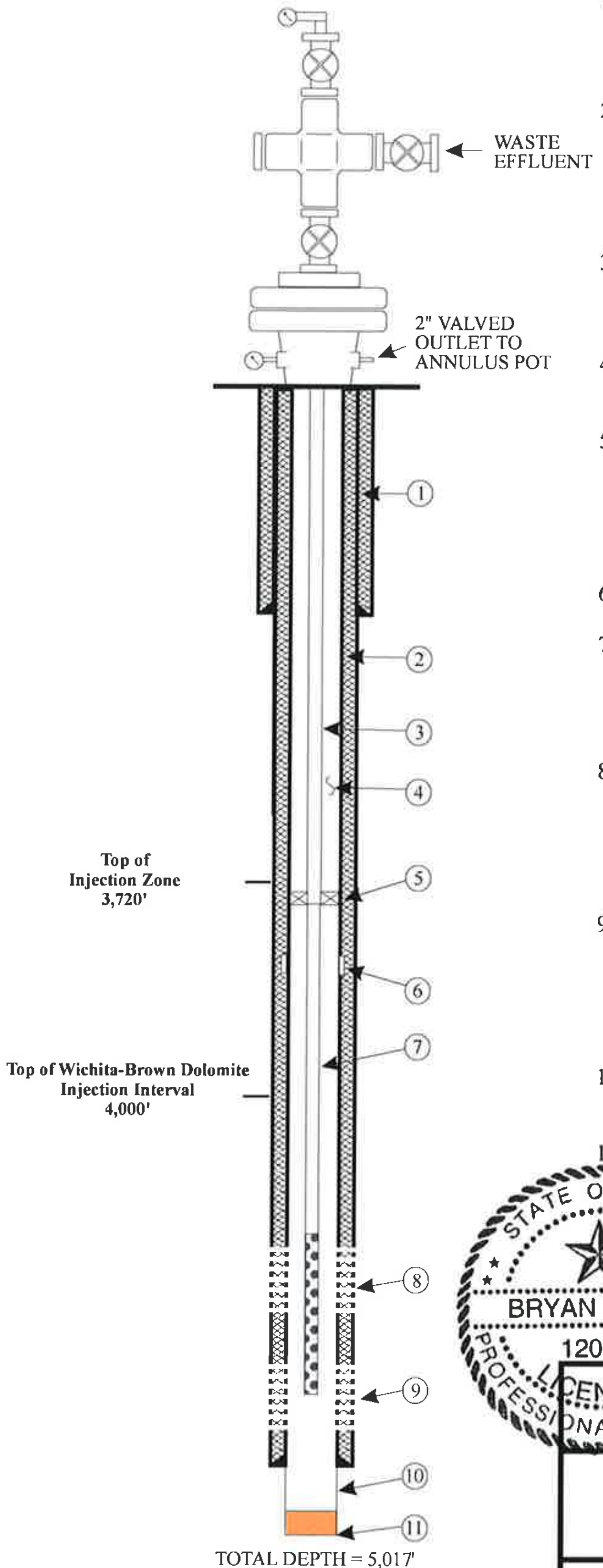

BELOW GROUND DETAIL

1. SURFACE CASING: 8 5/8", 32 lb/ft, C-75, STC casing set to 1,843' in 12 1/4" hole. Cemented to surface with 1,360 sx of Howco Lite containing 5% salt followed by 250 sx of Class H containing 3% $CaCl_2$.

2. LONGSTRING CASING: 5 1/2", 14 & 15.5 lb/ft, J-55 casing set to 4,881' in 7 7/8" hole, cemented in two stages:
   1st Stage - 25 sx Howco Lite followed by 165 sx 50/50 Pozmix with 12 1/2 lb/sk Gilsonite and 12% salt.
   2nd Stage - 1,200 sx of Howco Lite.

3. INJECTION TUBING: 3 1/2", 9.3 lb/ft, J-55, EUE 8rd, Seal Tite PVC lined tubing (actual weight = 10 lb/ft) with 4.18" od special clearance couplings (121 joints) set on packer to 3,751'.

4. ANNULUS FLUID: Inhibited fresh water topped off with diesel fuel cap for freeze protection.

5. PACKER: Weatherford, 5 1/2" x 2 7/8", AS I-X set from 3,751' to 3,758' by tubing measure (3,741' to 3,748' by log measure) with 14,000 lb stackout weight, Internally Nickel Coated. Packer crossed over to 3 ½" injection tubing string via 3 ½" EUE 8rd box x 2 7/8" EUE 8rd pin crossover sub, internally lined with Seal Tite PVC.

6. STAGE TOOL: 5 1/2" from 3,799' to 3,802'.

7. TAIL PIPE: 2 7/8", 7.9 lb/ft, 13 Chrome, PH6. Tail pipe hung from bottom of packer at 3,758' via internally lined crossovers from 2 7/8" EUE 8rd box to 2 7/8" PH6 pin. The tail pipe is perforated 24 holes per foot (½" diameter) from 4,103' to 4,753'.

8. PERFORATIONS: Panhandle Lime, 4 jspf, 0.49" dia. holes

4,142'-4,161'	4,165'-4,174'	4,179'-4,188'	4,196'-4,204'
4,210'-4,250'	4,257'-4,283'	4,287'-4,298'	4,311'-4,322'
4,329'-4,358'	4,384'-4,419'	4,419'-4,458'	4,461'-4,475'
4,491'-4,511'	4,522'-4,542'	4,547'-4,570'	

9. PERFORATIONS: New, Wolfcamp, 4 jspf, 0.49" dia. holes

4,600'-4,620'	4,630'-4,658'	4,658'-4,676'	4,690'-4,704'
4,704'-4,743'	4,743'-4,782'	4,782'-4,821'	4,821'-4,860'

   Original Wolfcamp Perforations, 2 jspf, (* 4 jspf)

4,658'-4,661'	4,661'-4,669'*	4,669'-4,676'	4,711'-4,860'

10. OPEN HOLE INTERVAL: Wolfcamp, 4,881' to 5,017', Underreamed from 7 7/8" to 8 3/4" average hole diameter.

11. DEPTH TO FILL: 4,925' (tagged during 10/24/2023 Radioactive Tracer Survey)

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FIGURE VI-4

TERRA DYNAMICS INC

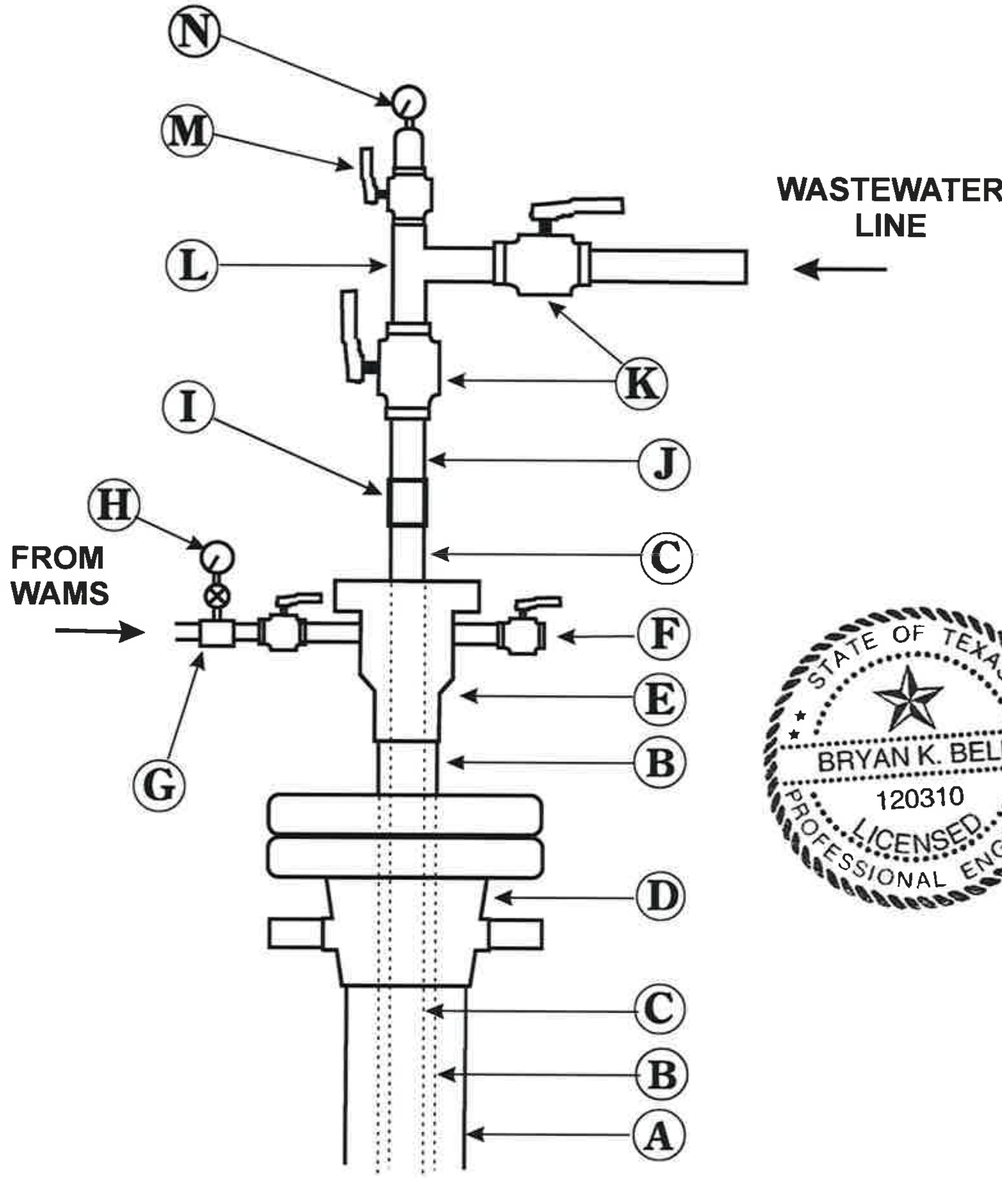
CONSTRUCTION SCHEMATIC
OF PLANT DISPOSAL WELL NO. 1
PERMIT NO. WDW-120

PREPARED FOR

TYSON FRESH MEATS
AMARILLO, TEXAS

ALL DEPTHS ARE RELATIVE TO KELLY BUSHING WHICH IS 7 FEET ABOVE GROUND LEVEL

DRAWN BY: VASB	SCALE: N.T.S.	DATE: 11/15/2024
DESIGNED BY: RFB		JOB NO. 24-112
CHECKED BY: BKB		



A. 8 5/8", 32 lb/ft, C-75, STC surface casing.
B. 5 ½", 14 & 15.5 lb/ft, J-55, STC carbon steel to surface.
C. 3 ½", 9.3 lb/ft, J-55, EUE, PVC-lined injection tubing.
D. 8 5/8" x 5 ½" 3,000 psi WP casing head.
E. 5 ½" x 3 ½" 3,000 psi WP tubing head.
F. 2" nipple and ball valve.
G. 2" nipple and ball valve with 2" x 1" NPT bushing and 1" line to annulus tank.
H. 0 to 1,000 psi pressure gauge, 1/2" NPT.
I. Crossover - 3 ½" EUE to 3 ½" line pipe connection
J. 3 ½" carbon steel pipe (PVC-lined).
K. 3 ½" stainless steel ball valve.
L. 3 ½" stainless steel tee, flanged.
M. 2" stainless steel ball valve.
N. 2" stainless steel bull plug tapped ½" NPT with vacuum gauge.

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FIGURE VI-5

TERRA DYNAMICS INC

WELLHEAD AND TREE VALVE
ARRANGEMENT - WDW-120

PREPARED FOR
TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: VASB	SCALE: DRAWING NOT TO SCALE	DATE: 11/15/2024
DESIGNED BY: IBP, Inc.		JOB NO. 24-112
CHECKED BY: BKB		

TABLE V-1

DEPOSITIONAL ENVIRONMENT - HYDROLOGIC PROPERTIES CHART

Palo Duro Basin Strata
Analogy for Potter County Formations

TYSON FRESH MEATS, INC.
Amarillo, Texas

System	Series	Group	General lithology and depositional setting	Hydrogeologic element	Hydrogeologic unit	Approximate permeability (gpd/ft^2)
Quaternary			Fluvial and lacustrine clastics	Ogallala aquifer	Upper aquifer system	200 ⓐ
Tertiary						
Cretaceous			Nearshore marine clastics			
Triassic		Dockum	Fluvial-deltaic and lacustrine clastics and limestones	Dockum aquifer		2 - 20(?) ⓑ
Permian	Ochoan		Salt, anhydrite, red beds, and peritidal dolomite	Evaporite aquifer	Evaporite confining system	2 x 10^{-6} ⓒ
	Guadalupian	Artesia				
		Pease River				
	Leonardian	Clear Fork				
		Wichita				
	Wolfcampian		Shelf and platform carbonates, basin shale, and deltaic sandstones	Wolfcamp carbonate aquifer	Deep-Basin Brine aquifer system	2 x 10^{-2} ⓓ
Pennsylvanian				Pennsylvanian carbonate aquifer; Upper Paleozoic granite-wash aquifer	Basin shale aquitard	
Mississippian			Shelf limestone and chert	Lower Paleozoic carbonate aquifer		
Ordovician		Ellenburger	Shelf dolomite			
Cambrian			Shallow marine (?) sandstone	Lower Paleozoic sandstone aquifer		
Precambrian			Igneous and metamorphic	Basement aquiclude	Basement aquiclude	0

ⓐ Cronin and Wells (1960), Cronin (1961), Myers (1969)
ⓑ Stevens (1980, written communication)
ⓒ Geotechnical Engineers, Inc. (1978)
ⓓ Bassett and Bentley (1983)

Adapted from Fisher and Kreitler (1987), Bassett and Bentley (1983)

TABLE V-2

POROSITY AND PERMEABILITY OF HYDROLOGIC UNITS

Palo Duro Basin
Analogy for Potter County Formations

TYSON FRESH MEATS, INC.
Amarillo, Texas

Table 3. Porosity of hydrogeologic units, Palo Duro Basin.

Hydrogeologic unit		Porosity from neutron-density log analysis: Mean	Standard deviation	Number of data	Typical value*
Evaporite strata		-	-	-	Less than .01
Deep-Basin Brine aquifer	Wolfcamp carbonate	.08 (.064)**	.055	53 data points from a 50-ft interval at Sawyer No. 1 and Mansfield No. 1 wells	.063 - .12
	Pennsylvanian carbonate	.08	.055		
	Shale	-	-	-	.05 - .25
	Granite wash	.23	.12	18 data points from a 50-ft interval	.11 - .27
	Pre-Pennsylvanian rock	-	-	-	-

* *From Davis and DeWiest (1966) and Davis (1980).*
***Average value for Wolfcampian strata (Conti and others, 1985).*

Table 2. Permeability of hydrogeologic units, Palo Duro Basin.

Hydrogeologic unit		Y = ln(k): Average md value, $\bar{y}$	Variance, s^2	Geometric mean of k ($e^{\bar{y}}$), md	Number and source of data	Typical value, md
Evaporite strata		-	-	-	-	.00028 (vertical permeability)
Deep-Basin Brine aquifer	Wolfcamp carbonate	2.19	2.89	8.90	25 - DST data 70 - TWDB core data 6 - Sawyer No. 1 pumping-test data	.07 - 300*
	Pennsylvanian carbonate	2.88	3.73	17.90	25 - DST data 118 - TWDB core data	
	Shale	-	-	-	-	.00001 - .08*
	Granite wash	1.27 (2.15 without Mobeetie data)	6.17 (4.15 without Mobeetie data)	3.55 (8.60 without Mobeetie data)	10 - DST data 10 - Sawyer No. 1 pumping-test data 415 - Mobeetie field core data 11 - TWDB core data	.01 - 380*
	Pre-Pennsylvanian rock	1.56	2.87	4.76	11 - DST data 14 - Sawyer No. 1 pumping-test data	-

* *From Davis and DeWiest (1966), Freeze and Cherry (1979), and Davis (1980).*
Note: (1) 1 md = 0.00115 m/day for saline water having salt concentration of 127,000 mg/L at 115°F.
(2) DST = drill-stem test; TWDB = Texas Water Development Board (Core Laboratories, 1972).

From Wirojanagud, Kreitler, and Smith (1986)

TABLE V-3

SEISMIC ACTIVITY RECORDED WITHIN A 50-KM RADIUS OF THE INJECTION WELLS

Tyson Fresh Meats, Inc.
Amarillo, Texas

U N I T E D S T A T E S G E O L O G I C A L S U R V E Y
E A R T H Q U A K E D A T A B A S E

FILE CREATED: Thu May 2 11:59:59 2024
Circle Search Earthquakes= 33
Circle Center Point Latitude: 35.255N Longitude: 101.640W
Radius: 50.000 km
Catalog Used: SRA, USHIS, PDE, TEXNET
Data Selection: Eastern, Central and Mountain States of U.S. (SRA), Significant U.S. Earthquakes (USHIS),
and Historical & Preliminary Data (PDE and PDE-W)

CATALOG SOURCE	D A T E YEAR	MO	DA	ORIGIN TIME	***COORDINATES** LAT	LONG	DEPTH km	pP	STD DEV	*****M A G N I T U D E S**** mb	OBS	Ms	OBS	CONTRIBUTED VALUES	F-E REG	STA	****INFORMATION**** IEMFMDIPF NFAPOEDFL TFPS PEDG	PHENOMENA DTSVNWG	RADIAL DIST km
SRA	1907	04		Z	35.200	-101.800									497	F	5........	....	15
USHIS	1917	03	28	1956 Z	35.400	-101.300								3.80FASC	497	F	6F.......	....	34
SRA	1917	03	28	2338 Z	35.400	-101.300									497	F	.F.......	....	34
USHIS	1925	07	30	1217 Z	35.400	-101.300								4.90FASC	497	F	6F.......	....	34
PDE	1986	12	11	012300.60D&	35.090	-101.605	5 G							2.50MnTUL	497	006	....	....	18
PDE	1990	07	01	130634.79*	35.413	-102.106	5 G		0.68					2.70MnTUL	497	005	....	....	45
PDE	2000	08	02	122130.06M	35.200	-101.900	5 G							2.70MnGS	497	003	.F.......	....	24
PDE	2000	08	07	171908 S	35.392	-101.812	5 G							3.30MnGS	497	011	.F.......	....	21
PDE	2000	08	07	183409 S	35.392	-101.812	5 G							3.00MnGS	497	007	.F.......	....	21
PDE	2000	08	07	213621 S	35.392	-101.812	5 G							3.00MnGS	497	005	.F.......	....	21
PDE	2000	08	10	133950 S	35.392	-101.812	5 G							3.00MnGS	497	004	.F.......	....	21
PDE	2000	08	17	010805.45*	35.390	-101.814	5 G		1.54					3.90MnGS	497	005	.F.......	....	21
PDE	2000	12	16	220854 M	35.400	-101.800	5 G							3.90MnGS	497	008	.F.......	....	21
PDE	2002	01	16	152532.45*	35.341	-101.818	5 G		0.93					2.50MnGS	497	006	.F.......	....	18
PDE	2002	03	31	025408.13*	35.359	-101.824	5 G		1.40					2.80MnGS	497	006	.F.......	....	20
PDE	2003	09	24	150209.09	35.28	-101.74	5							3.3 LgGS			4F.......	....	10
PDE	2003	10	28	232013	35.28	-101.74	5							2.4 LgGS			.F.......	....	10
PDE	2005	03	17	191950.94	35.35	-101.80	5							2.4 LgGS			.F.......	....	18
PDE	2006	02	18	054941.45	35.67	-101.79	5							3.5 MLGS			.F.......	....	48
PDE	2006	03	28	235511.49	35.36	-101.87	5							3.0 MLGS			.F.......	....	24
PDE	2007	02	07	070217.99	35.35	-101.76	5							2.5 MLGS			....	....	15
PDE-W	2012	01	03	170427.98	35.38	-101.77	5							2.8 LgGS			....	....	18
PDE-W	2012	08	12	003605.15	35.37	-101.90	5							3.3 LgGS			....	....	27
PDE	2014	09	15	232041.51	35.38	-102.17	5							2.8 MBLG			....	....	50
PDE	2015	02	02	003927.42	35.30	-101.69	4.14							3.1 MBLG			....	....	7
PDE	2015	07	09	110109.18	35.58	-101.63	6.76							2.8 MBLG			....	....	36
PDE	2015	12	26	182521.12	35.38	-101.20	4.99							2.7 MBLG			....	....	42
TEXNET	2018	10	20	130431	35.36	-101.72	13.7							4.7 ML			....	....	13
TEXNET	2020	11	07	100455	35.59	-101.98	8							2.7 ML			....	....	48
PDE	2021	01	14	233011.14	35.24	-101.57	5							2.9 MBLG			....	....	7

TERRA DYNAMICS INC

PDE	2022 10 28 133321.00	35.17	-101.77	6.11	2.5 ML	....	....	15
PDE	2023 08 14 164505.02	35.31	-101.70	6.77	3.4 ML	....	....	8
PDE	2023 11 17 070849.94	35.24	-101.58	4.79	2.7 ML	....	....	6

Note: DEPTH: G = restrained by geophysicist
CONTRIBUTED VALUES: FA = Felt area magnitude (approximately equal to an mb value); Mn = Nuttli magnitude (Nuttli, 1973); Lg = Short-period surface waves; ML = Local magnitude; SC = Seismological Centre; TUL = Oklahoma Geophysical Observatory; GS = US Geological Survey, Denver
F-E: Flinn-Engdahl geographic region number (497 = Texas Panhandle)
STA: number of stations used; F = Noninstrumental epicenter accuracy is estimated to be within 0.0 - 0.5 degrees
INFORMATION: 5 or 6 = Modified Mercalli Intensity Scale; F = felt

Source: USGS, 2024 and Texnet, 2024.

TABLE V-4

TYSON FRESH MEATS, INC.
UIC Permit Renewal
Regional Well Control for Detailed Mapping
Structure and Gross Thickness

TDI Ref.	Operator	Lease and Well	Kelly Bushing Elevation	Top of Confining Zone (KB)-Tubb Fm.	Top of Injection Zone (KB)-Wichita Fm.	Top of Injection Interval (KB) - Wichita-Brown Dolo. Fm.	Base of Injection Interval (KB) WDW-120	Top of Injection Interval (KB) - Granite Wash Fm.	Base of Injection Interval (KB) WDW-312	Top Confining Zone (CZ) Datum	Confining Zone (CZ) Thickness in feet	Top Injection Zone (IZ) Datum	Injection Zone (IZ) Thickness in feet	Top Injection Interval (II) Wichita Datum	Injection Interval (WDW-120) Thickness in feet	Containmen t Interval (UCI) Thickness in feet	Granite Wash Interval (UCI) Thickness in feet
	Tyson	WDW-120	3,542	2,780	3,720	4,000	5,000	NDE	NDE	**762**	**940**	**-178**	**NDE**	**-458**	**1,000**	**280**	**NDE**
1	Continental Oil Co.	Bitting #1	3,583	2,343	3,137	3,290	4,250	5,703	NDE	**1,240**	**794**	**446**	**NDE**	**293**	**960**	**153**	**NDE**
2	Paradox Pet.	Webster #1	3,574	2,320	3,120	3,330	NDE	NDE	NDE	**1,254**	**800**	**454**	**NDE**	**244**	**NDE**	**210**	**NDE**
3	Phillips	Smith #1U	3,579	2,512	3,396	3,670	NDE	NDE	NDE	**1,067**	**884**	**183**	**NDE**	**-91**	**NDE**	**274**	**NDE**
4	Attebury	Locke #1	3,552	2,674	3,585	3,867	NDE	NDE	NDE	**878**	**911**	**-33**	**NDE**	**-315**	**NDE**	**282**	**NDE**
5	Paradox Pet.	Gray #1	3,502	NLI	NLI	NLI	NLI	5,540	7,240	**NLI**	**NLI**	**NLI**	**NLI**	**NLI**	**NLI**	**NLI**	**1700**
6	Catherine Whittenburg	Morris #1	3,500	2,630	3,507	3,777	4,430	6,016	9,163	**870**	**877**	**-7**	**5,656**	**-277**	**653**	**270**	**3147**
7	Paradox Pet.	Sparks #1	3,570	2,335	3,172	3,368	NDE	NDE	NDE	**1,235**	**837**	**398**	**NDE**	**202**	**NDE**	**196**	**NDE**
8	Catherine Whittenburg	Masterson #1	3,567	2,740	3,665	3,945	4,990	7,520	8,735	**827**	**925**	**-98**	**5,070**	**-378**	**1,045**	**280**	**1215**
9	Farmers Oil	Jones #1	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
10	SPS	WDW-342	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
11	Asarco	WDW-273	3,583	2,755	3,611	3,848	4,974	NDE	NDE	**828**	**856**	**-28**	**NDE**	**-265**	**1,126**	**237**	**NDE**
12	Asarco	WDW-129	3,547	2,725	3,605	3,845	4,975	NDE	NDE	**822**	**880**	**-58**	**NDE**	**-298**	**1,130**	**240**	**NDE**
13	Asarco	WDW-324	3,592	2,735	3,635	3,870	4,964	NDE	NDE	**857**	**900**	**-43**	**NDE**	**-278**	**1,094**	**235**	**NDE**
14	Bright & Schiff	Murray #1	3,498	2,648	3,520	3,677	NDE	NDE	NDE	**850**	**872**	**-22**	**NDE**	**-179**	**NDE**	**157**	**NDE**
15	Sohio Pet.	Berg #1	3,515	2,668	3,550	3,790	NDE	NDE	NDE	**847**	**882**	**-35**	**NDE**	**-275**	**NDE**	**240**	**NDE**
16	Whitaker	Pavillard #1	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
17	R & J Drlg.	Pavillard #1	NL	NDE	NDE	NDE	NDE	NDE	NDE	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**
18	Seven States	Ball #1	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
19	Texaco	WDW-135	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
20	Texaco	WDW-136	3,648	2,856	3,810	4,084	5,120	NDE	NDE	**792**	**954**	**-162**	**NDE**	**-436**	**1,036**	**274**	**NDE**
21	Texas Co.	LPG #2	NL	NDE	NDE	NDE	NDE	NDE	NDE	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**
22	Texas Co.	LPG #1	NL	NDE	NDE	NDE	NDE	NDE	NDE	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**
23	Texas Co.	SWD #1	NL	NDE	NDE	NDE	NDE	NDE	NDE	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**
24	Colorado Interstate Gas	Bivins Est #98A	3,391	NDE	NDE	NDE	NDE	NDE	NDE	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**
25	Miller O & G	Tanner #1	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
26	Colorado Interstate Gas	Bivins #91A	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
27	Colorado Interstate Gas	Bivins #53R	NL	NDE	NDE	NDE	NDE	NDE	NDE	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**

Notes: NDE - log not deep enough, NLI - not logged over interval, NL - no log available.

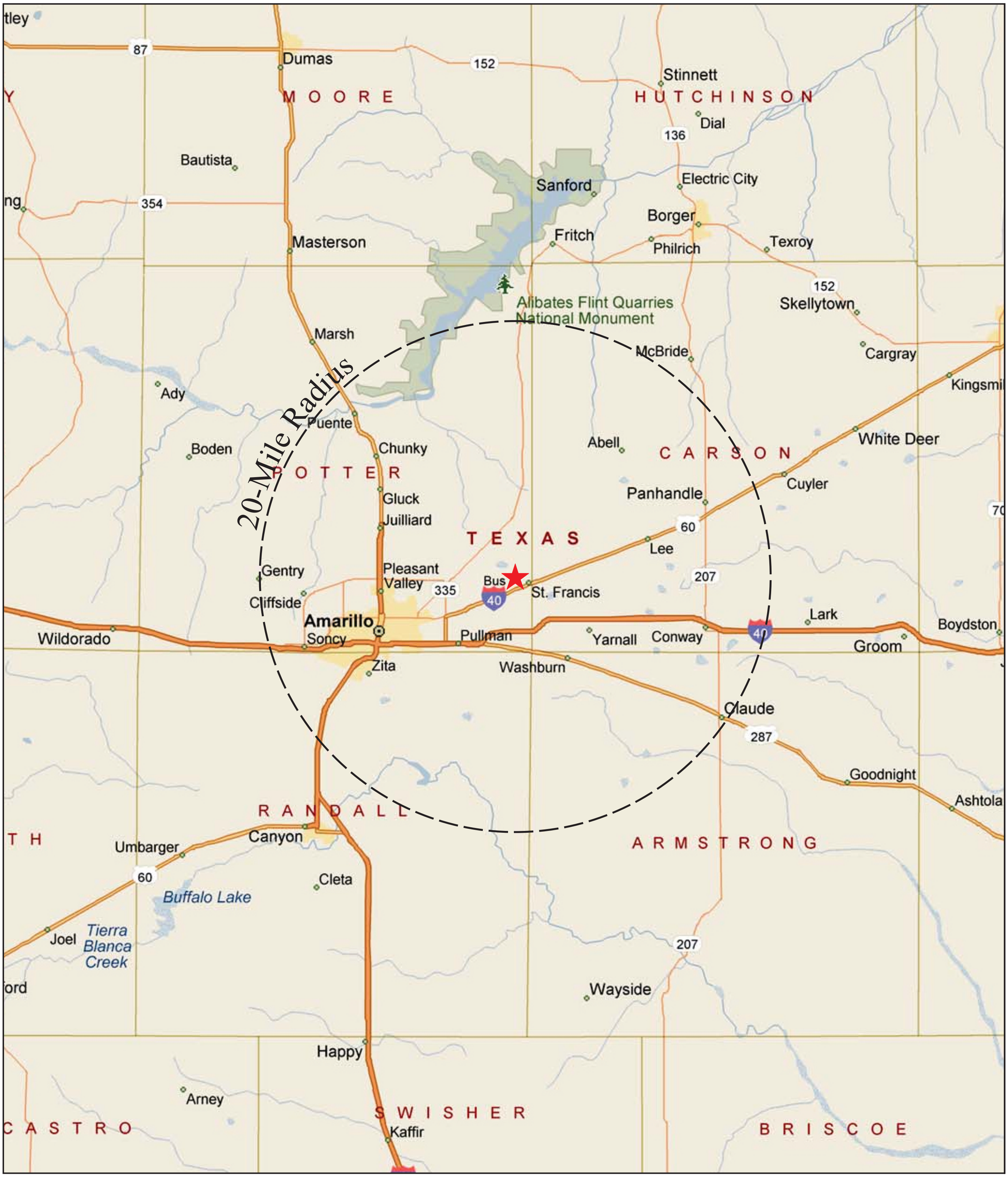
TERRA DYNAMICS INC

TABLE V-4

TYSON FRESH MEATS, INC.
UIC Permit Renewal
Regional Well Control for Detailed Mapping
Structure and Gross Thickness

TDI Ref.	Operator	Lease and Well	Kelly Bushing Elevation	Top of Confining Zone (KB)- Tubb Fm.	Top of Injection Zone (KB)- Wichita Fm.	Top of Injection Interval (KB) - Wichita-Brown Dolo. Fm.	Base of Injection Interval (KB) WDW-120	Top of Injection Interval (KB) - Granite Wash Fm.	Base of Injection Interval (KB) WDW-312	Top Confining Zone (CZ) Datum	Confining Zone (CZ) Thickness in feet	Top Injection Zone (IZ) Datum	Injection Zone (IZ) Thickness in feet	Top Injection Interval (II) Wichita Datum	Injection Interval (WDW-120) Thickness in feet	Containment Interval (UCI) Thickness in feet	Granite Wash Interval (UCI) Thickness in feet
28	Stanolind O & G	Griffin #1	3,528	2,540	3,500	3,890	5,080	5,595	NDE	**988**	**960**	**28**	**NDE**	**-362**	**1,190**	**390**	**NDE**
29	Cities Service	Mays #1A	3,524	NLI	3,715	4,000	4,995	7,080	7,997	**NLI**	**NLI**	**-191**	**4,282**	**-476**	**995**	**285**	**917**
30	Carr Exploration	Adams #1B	3,540	2,622	3,500	3,655	4,520	6,405	NDE	**918**	**878**	**40**	**NDE**	**-115**	**865**	**155**	**NDE**
31	Pure Oil	Read #1	3,520	2,580	3,457	3,670	4,596	5,606	6,910	**940**	**877**	**63**	**NDE**	**-150**	**926**	**213**	**1304**
32	Texas Crude Oil	Riley #1	3,510	2,755	3,615	3,896	4,813	NDE	NDE	**755**	**860**	**-105**	**NDE**	**-386**	**917**	**281**	**NDE**
33	Standard Oil of Texas	Palm #1A	3,511	2,715	3,565	3,845	4,890	6,105	NDE	**796**	**850**	**-54**	**NDE**	**-334**	**1,045**	**280**	**NDE**
34	Frankfort Oil	White #1	3,551	2,967	3,860	4,125	4,994	6,818	NDE	**584**	**893**	**-309**	**NDE**	**-574**	**869**	**265**	**NDE**
35	Gruy Federal Inc.	White #1	3,573	3,020	3,940	NDE	NDE	NDE	NDE	**553**	**920**	**-367**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**
36	Meridian Oil	Winters #1	3,572	3,050	3,955	4,230	NDE	NDE	NDE	**522**	**905**	**-383**	**NDE**	**-658**	**NDE**	**275**	**NDE**
37	Burdell Oil	Winters #1A	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
38	Oxnard	Oxnard #1	NL	NL	NL	NL	NL	NL	NL	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**	**NL**
39	Frankfort Oil	Erwin #1	3,581	3,138	4,072	4,350	5,325	6,872	7,750	**443**	**934**	**-491**	**3,678**	**-769**	**975**	**278**	**878**
40	Eason Oil	Bivins Ranch #1	3,353	2,428	3,350	NDE	NDE	NDE	NDE	**925**	**922**	**3**	**NDE**	**NDE**	**NDE**	**NDE**	**NDE**
41	Bivins Interest	Lx Shell #1	3,309	2,370	3,293	3,567	NDE	NDE	NDE	**939**	**923**	**16**	**NDE**	**-258**	**NDE**	**274**	**NDE**
42*	Asarco	WDW-432	3,601	2,745	3,645	3,880	4,970	NDE	NDE	**856**	**900**	**-44**	**NDE**	**-279**	**1,100**	**240**	**NDE**

Notes: NDE - log not deep enough, NLI - not logged over interval, NL - no log available.
*Picks estimated from neighboring Asarco wells



Drawing No.: 13-120.F1
Date: 5/1/24
Job No.: 24-112

Drawn By: MBS
Designed By: SKW
Checked By: SKW

★ Tyson Facility Location

0 mi 10 20 30 40

Base Map: Streets and Trips, 2008.

FIGURE V-1

REGIONAL STUDY AREA LOCATION MAP

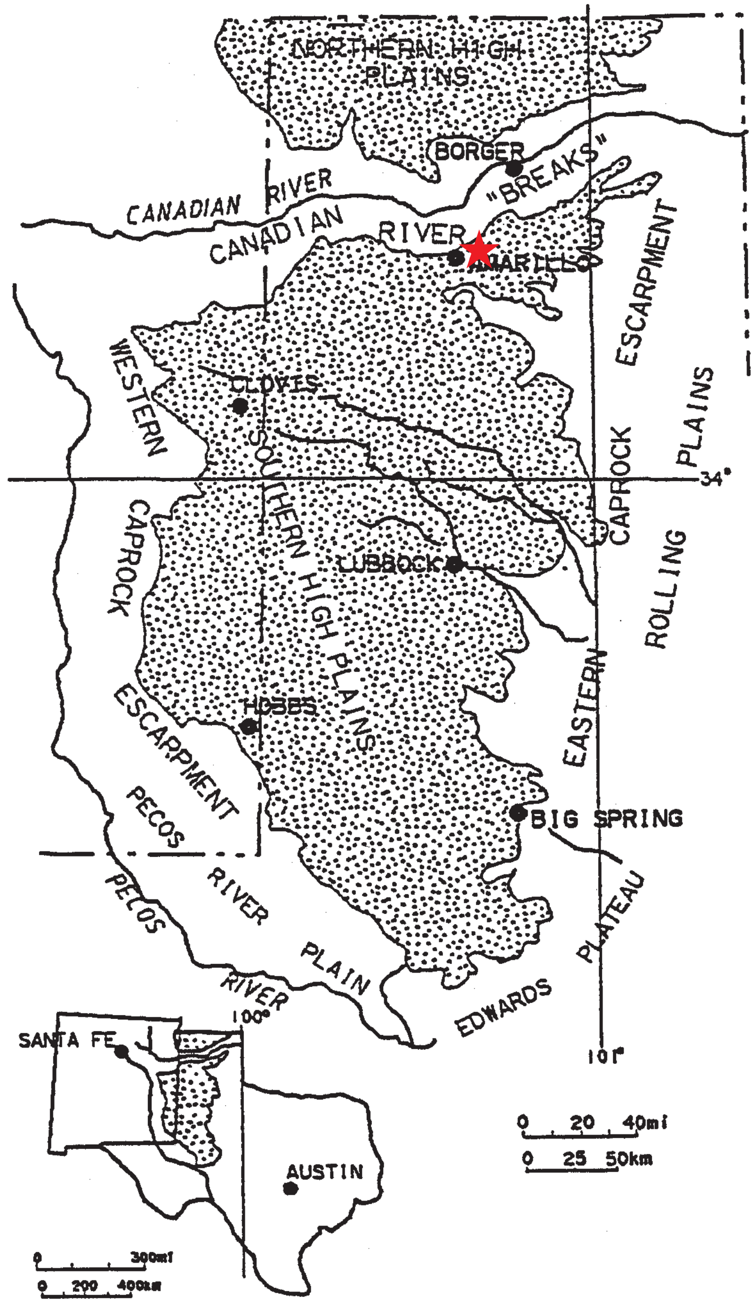
PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

Drawing No.: 13-120.F2
Date: 5-1-24
Job No.: 24-112

Drawn By: Finley and Gustavson
Designed By: A. Bell, PG
Checked By: B. Shin, PG



★ Location of Tyson Facility

Source: Finley and Gustavson, 1981.

FIGURE V-2

PHYSIOGRAPHIC UNITS OF THE TEXAS PANHANDLE AND EASTERN NEW MEXICO

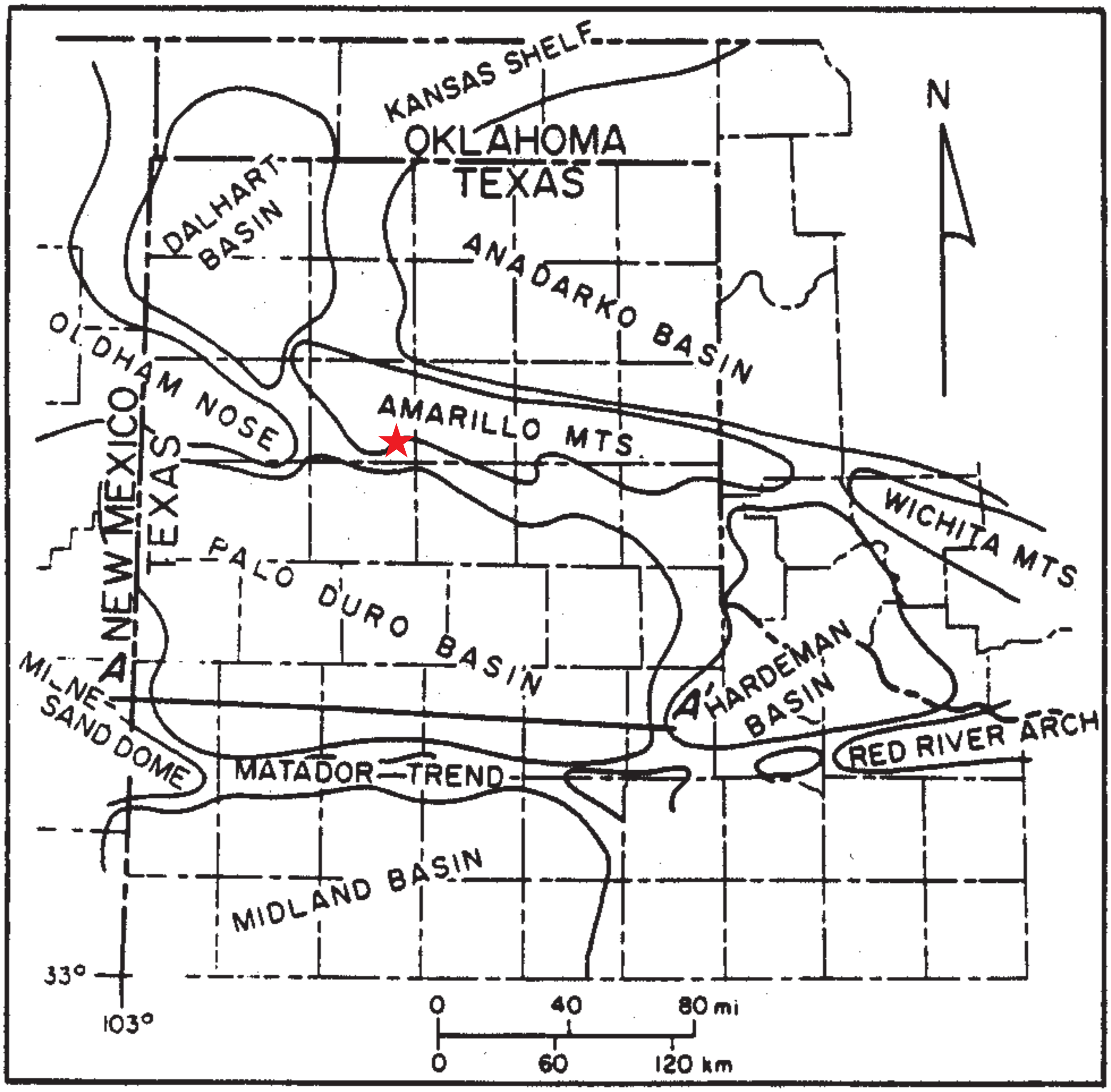
PREPARED FOR

**TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS**

TERRA DYNAMICS INC

Drawn By: Wirojanagud and others
Designed By: A. Bell, PG
Checked By: B. Shin, PG

Drawing No.: 13-120.F3
Date: 5-1-24
Job No.: 24-112



★ Location of Tyson Facility

Source: Wirojanagud and others, 1986.

FIGURE V-3

MAJOR STRUCTURAL ELEMENTS TEXAS PANHANDLE

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

SYSTEM/SERIES		GROUP	FORMATION	HYDROLOGIC UNIT
QUATERNARY			Allluvium and Terrace Deposits	Alluvium
TERTIARY			Ogallala	Ogallala Aquifer
CRETACEOUS				
JURASSIC				
TRIASSIC		DOCKUM		Dockum Aquifer
PERMIAN	OCHOA		Dewey Lake Alibates	Base of USDW
	GUADALUPE	ARTESIA/ WHITEHORSE	Salado / Tansill Yates Seven Rivers Queen / Grayburg San Andres / Blaine	Evaporite Aquitard
	LEONARD	CLEAR FORK	Glorieta U. Clear Fork / U. Cimarron Tubb L. Clear Fork / L. Cimarron Red Cave	Confining Zone
		WICHITA		Top of Injection Zone
	WOLFCAMP		"Brown Dolomite"	**WDW-120 & WDW-312 Injection Interval**
			"GRANITE WASH"	
PENNSYLVANIAN	VIRGIL	CISCO		**WDW-312 Injection Interval**
	MISSOURI	CANYON		
	DESMOINES	STRAWN		
	ATOKA	ATOKA / BEND		Base of Injection Interval & Injection Zone
	MORROW	MORROW		
MISSISSIPPIAN	CHESTER			
	MERAMEC			
	OSAGE			
SILURIAN-DEVONIAN		HUNTON		
ORDOVICIAN	UPPER		Sylvan Shale	
		VIOLA		
	MIDDLE	SIMPSON		
	LOWER	ELLENBURGER		
CAMBRIAN	UPPER		Reagan Sandstone	
	MIDDLE		Granite, rhyolite, gabbro, and metasediments	
	LOWER			
PRECAMBRIAN			Granite and related igneous and metaigneous rocks	Basement Aquiclude

Depth to:	WDW-120*	Proposed WDW-312**
Base of USDW	675′	665′
Top of Upper Confining Zone	2,780′	2,780′
Top of Injection Zone	3,720′	3,720'
Top of Wichita-Brown Dolomite Injection Interval	4,000′	4,000′
Base of Wichita-Brown Dolomite Injection Interval	5,000′	5,000′
Top of Granite Wash Injection Interval		5,850′
Base of Granite Wash Injection Interval		9,000′
Base of Injection Zone	9,000′	9,000′

* Note: depths are relative to kelly bushing.
** Note : estimated depths are relative to ground level.

Injection Zone

Injection Interval

Sources: Stone & Webster, 1983; Bassett & Bentley, 1983; Budnik, 1989.

FIGURE V-4

STRATIGRAPHIC COLUMN AND HYDROLOGIC UNITS PALO DURO BASIN

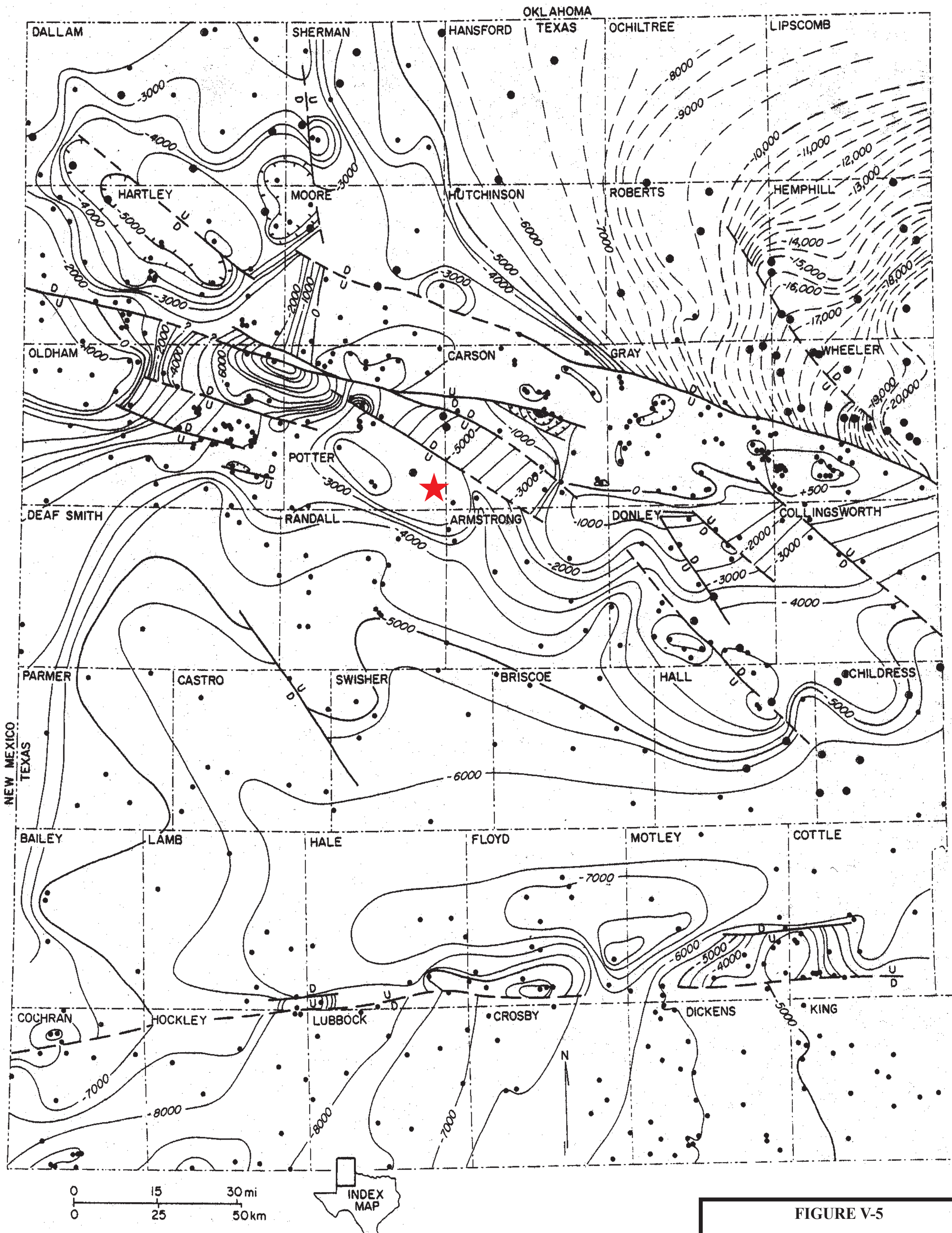
PREPARED FOR

**TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS**

TERRA DYNAMICS INC

Drawing No.: 24-112.F4
Date: 5-1-24
Job No.: 24-112

Drawn By: B. Shin, PG
Designed By: A. Bell, PG
Checked By: S. Williams, PG



Location of Tyson Facility

N

Datum = sea level
Contour interval = 500 ft
● Well used to constrain probable basement elevation
• Well penetrating basement

Source: Stone & Webster, 1983.

FIGURE V-5

REGIONAL STRUCTURE CONTOUR MAP TOP OF PRECAMBRIAN GRANITE

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

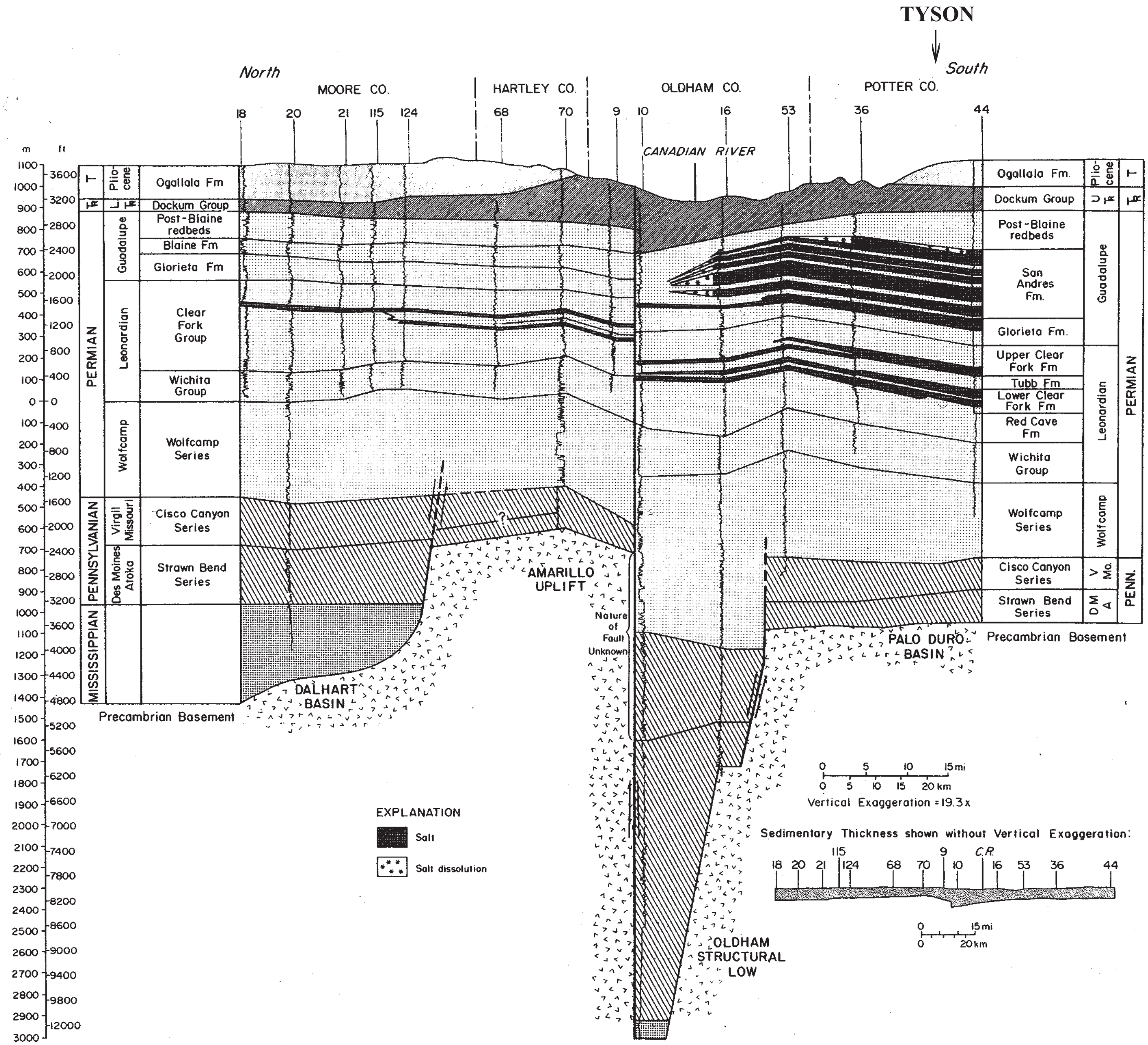
TERRA DYNAMICS INC

Drawing No.: 13-120.F5
Date: 5-1-24
Job No.: 24-112

Drawn By: Stone and Webster
Designed By: A. Bell, PG
Checked By: B. Shin, PG

Drawn By:	Gustavson and others
Designed By:	Ann Bell, PG
Checked By:	B. Shin, PG

Drawing No.:	13-120.F6
Date:	5-1-24
Job No.:	24-112



Source: Gustavson and others, 1982.

FIGURE V-6

REGIONAL GEOLOGIC CROSS SECTION

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

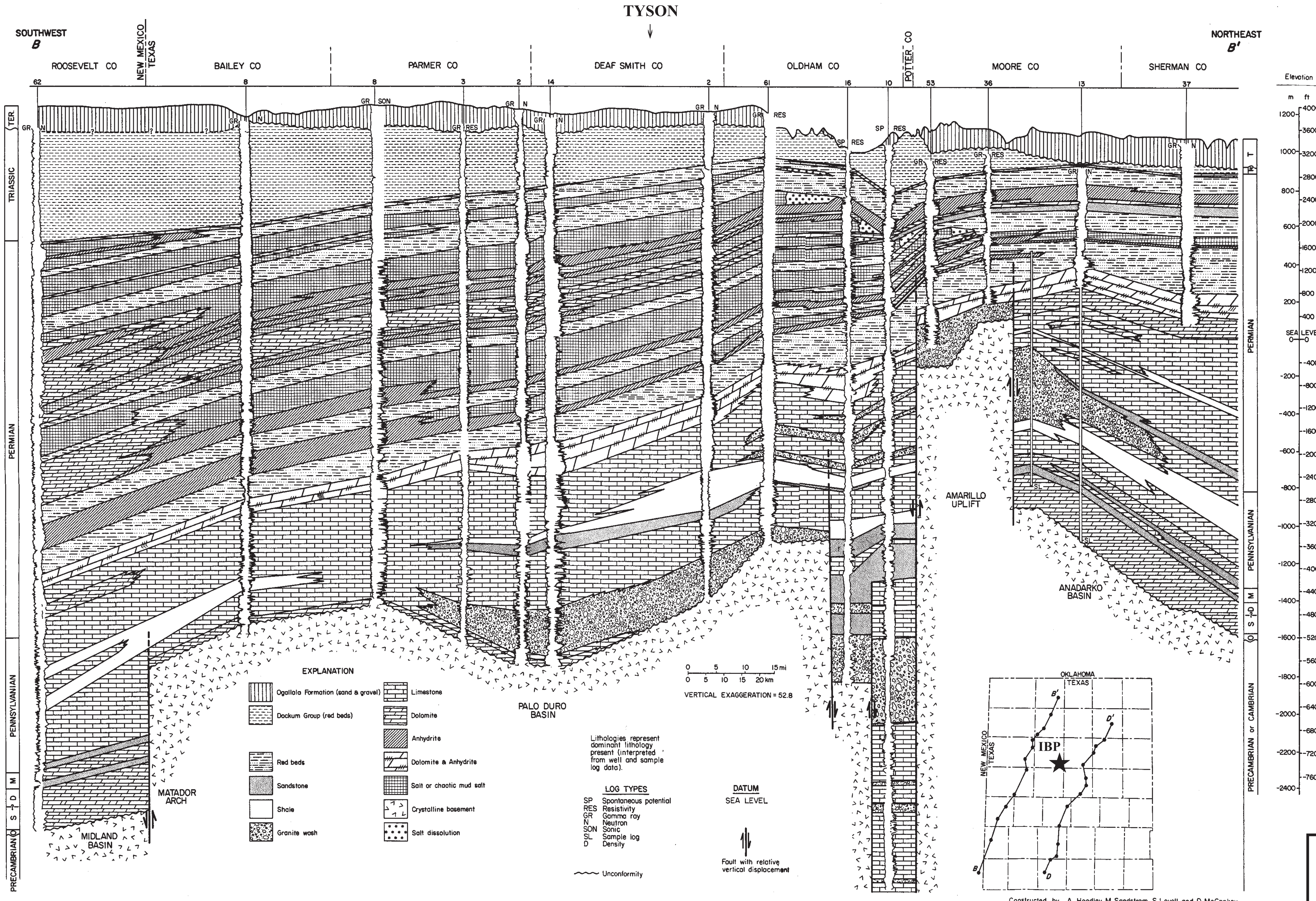


FIGURE V-7

REGIONAL DEPOSITIONAL CROSS SECTION

PREPARED FOR

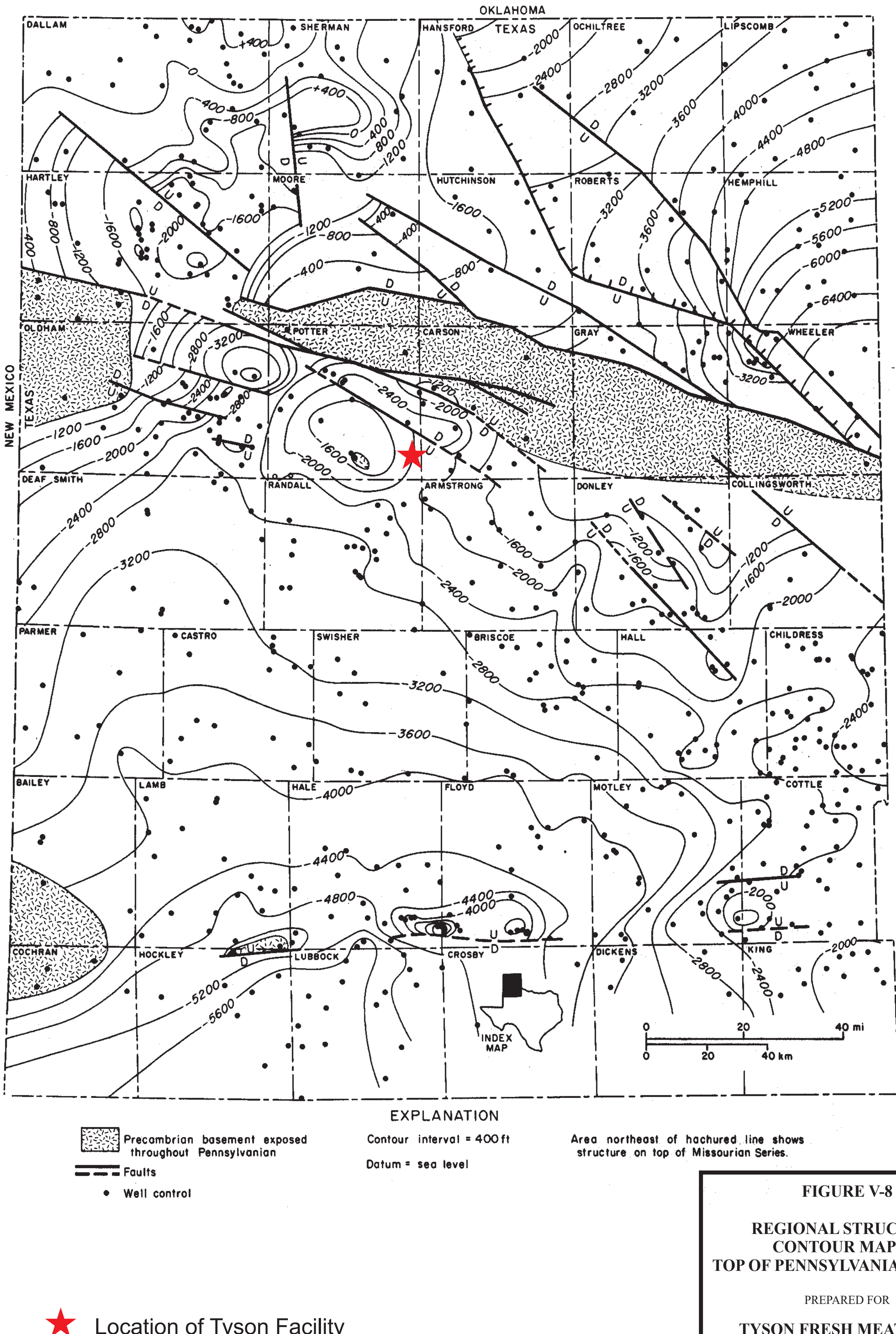
**TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS**

TERRA DYNAMICS INC

Source: S.P. Dutton and others, 1982.

Drawing No.: 13-120.F8
Date: 5-1-24
Job No.: 24-112

Drawn By: S.P. Dutton and others
Designed By: A. Bell, PG
Checked By: B. Shin, PG



Source: S.P. Dutton and others, 1982.

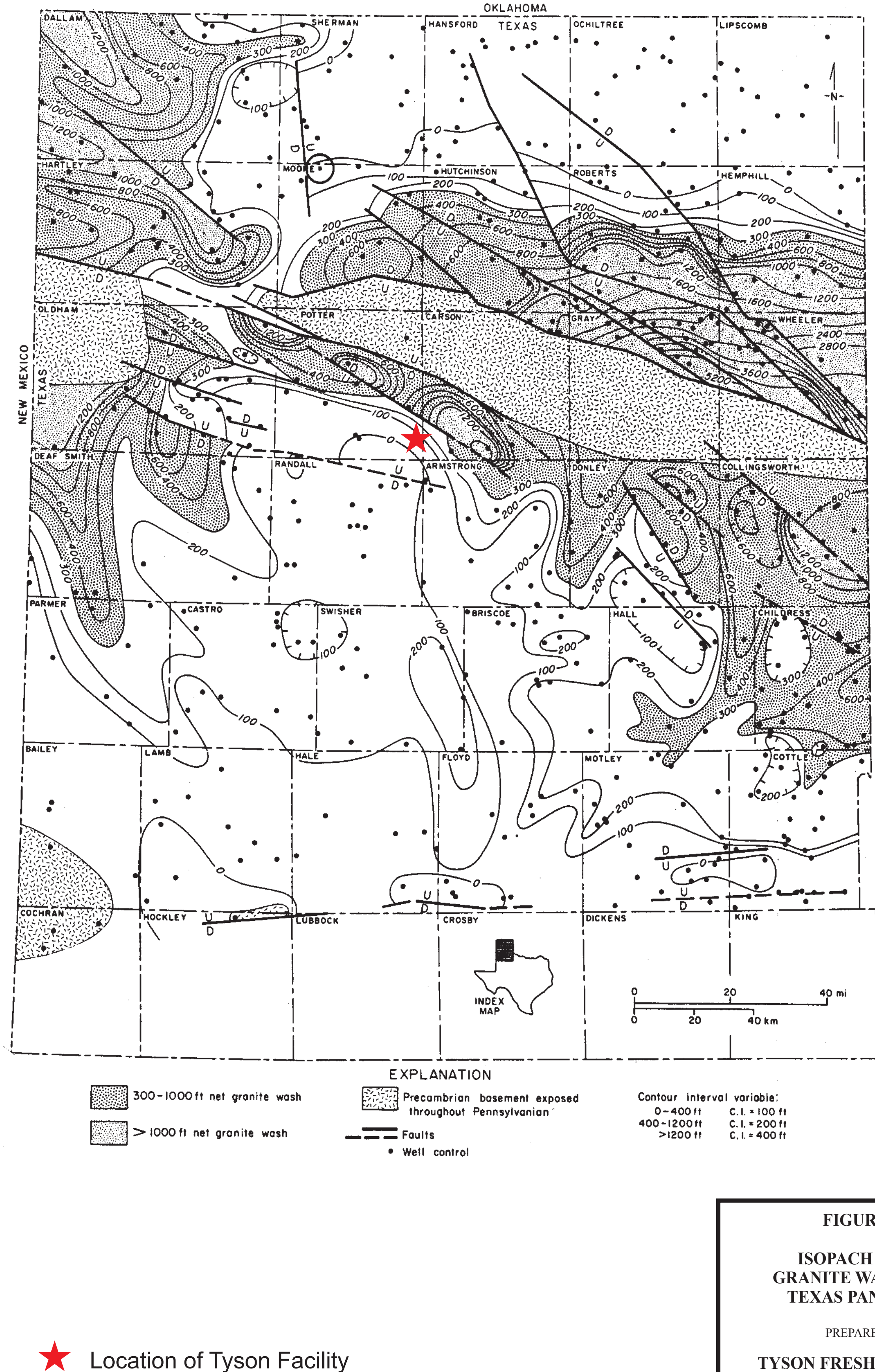
FIGURE V-8

REGIONAL STRUCTURE CONTOUR MAP OF TOP OF PENNSYLVANIAN SYSTEM

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC



Source: S.P. Dutton and others, 1982.

Drawing No.: 13-120.F9
Date: 5-1-24
Job No.: 24-112

Drawn By: S.P. Dutton and others
Designed By: A. Bell, PG
Checked By: B. Shin, PG

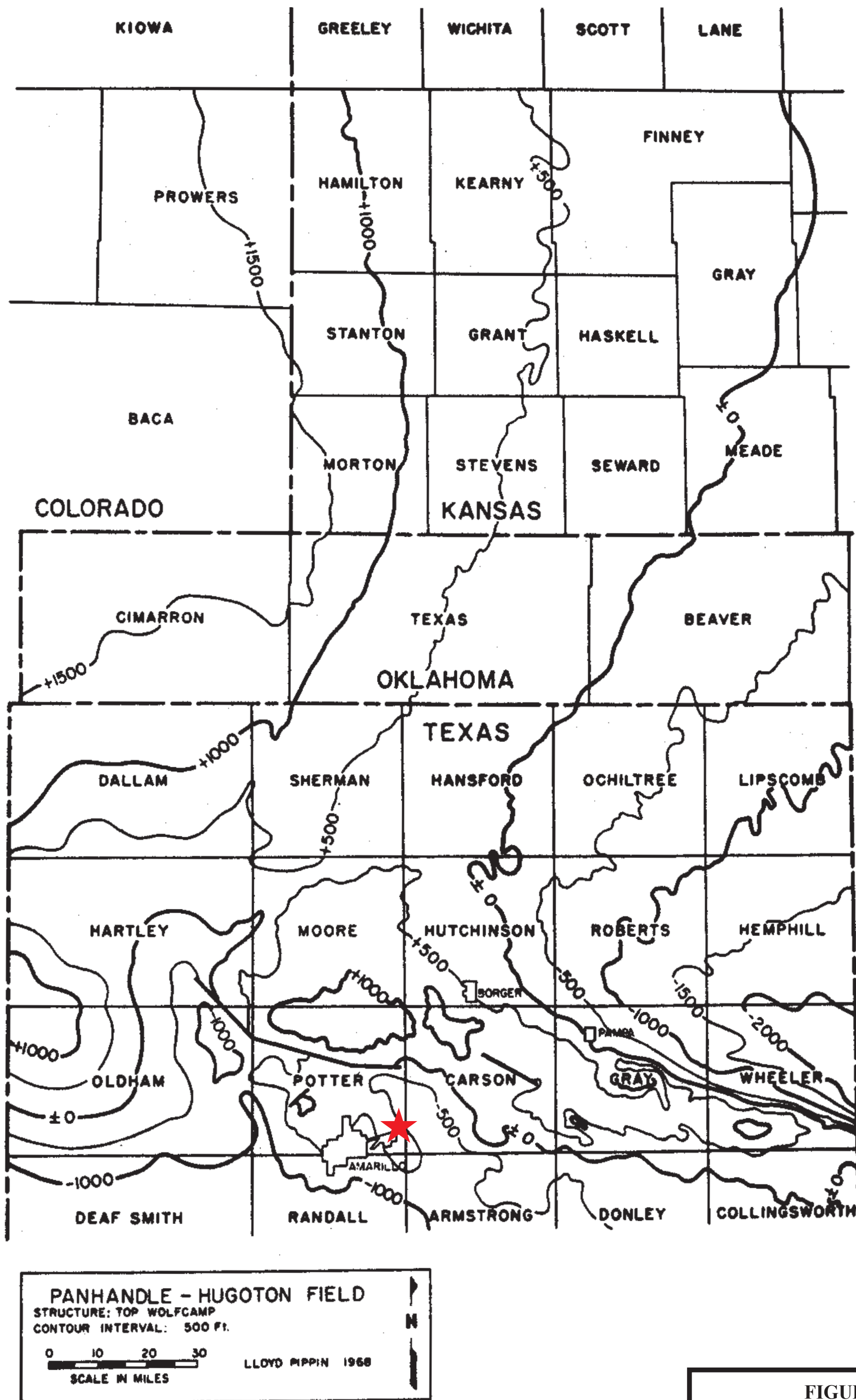
FIGURE V-9

ISOPACH MAP OF GRANITE WASH IN THE TEXAS PANHANDLE

PREPARED FOR

**TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS**

TERRA DYNAMICS INC



★ Location of Tyson Facility

Source: Pippin, 1970.

FIGURE V-10

REGIONAL STRUCTURE CONTOUR MAP TOP OF WOLFCAMP SERIES

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

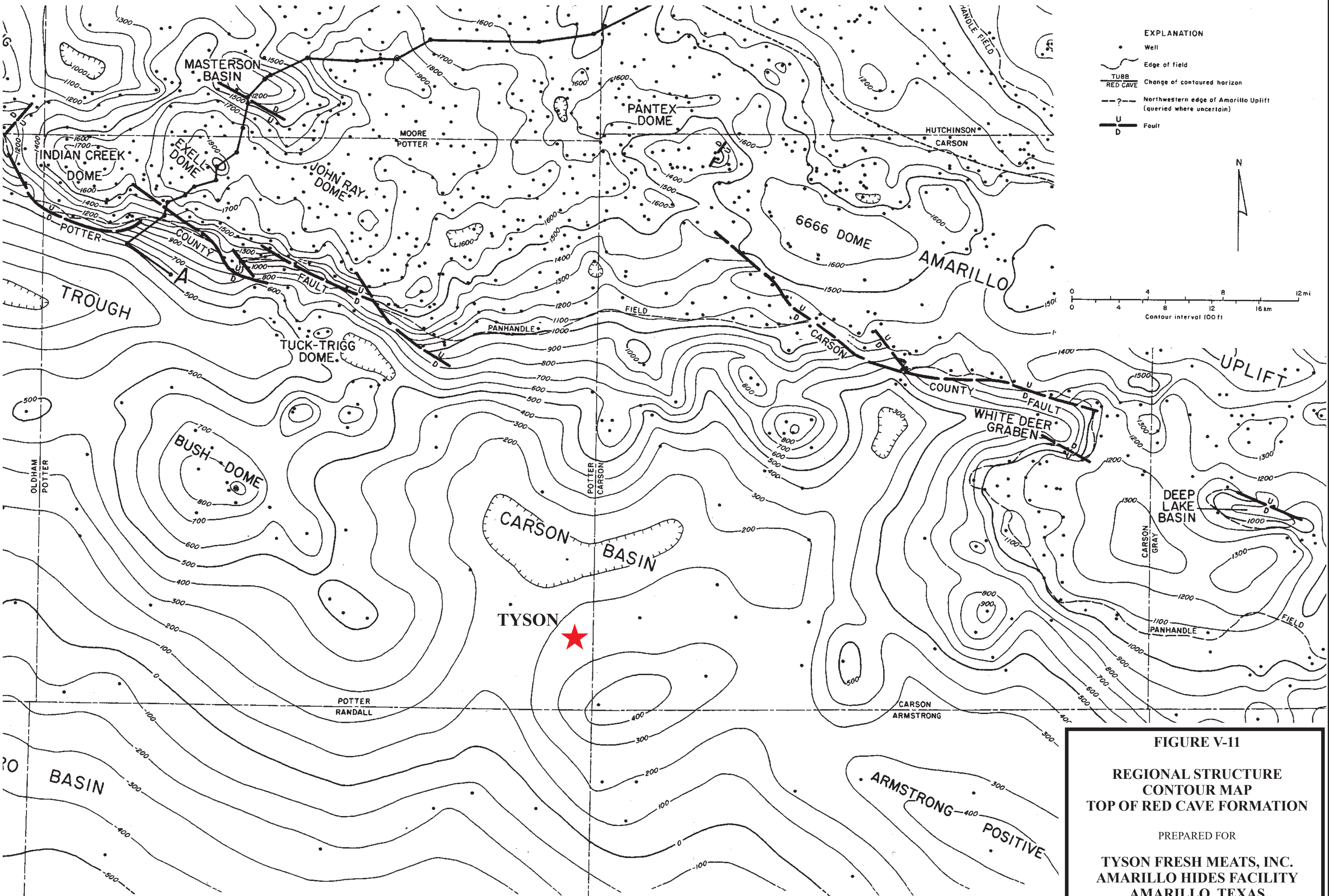
TERRA DYNAMICS INC

Drawing No.: 13-120.F10
Date: 5-1-24
Job No.: 24-112

Drawn By: Pippin
Designed By: A. Bell, PG
Checked By: B. Shin, PG

Drawn By:	Budnik
Designed By:	Ann Bell, PG
Checked By:	B. Shin, PG

Drawing No.: 13-120.F11
Date: 5-1-24
Job No.: 24-112



Source: Budnik, 1987.

FIGURE V-11

REGIONAL STRUCTURE CONTOUR MAP
TOP OF RED CAVE FORMATION

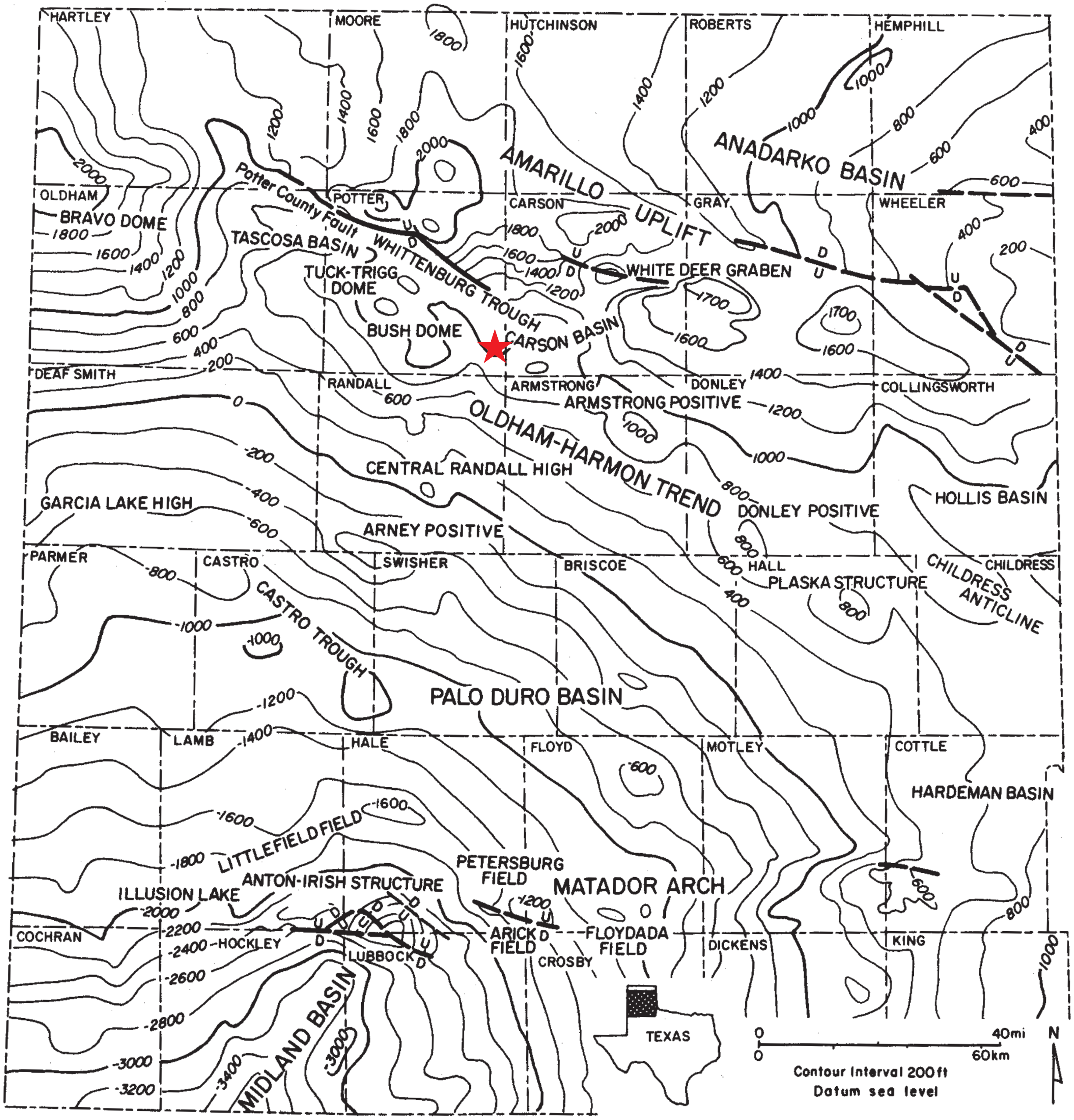
PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

Drawing No.: 13-120.F12
Date: 5-1-24
Job No.: 24-112

Drawn By: Budnik
Designed By: A. Bell, PG
Checked By: B. Shin, PG



★ Location of Tyson Facility

Source: Budnik, 1989.

FIGURE V-12

REGIONAL STRUCTURE CONTOUR MAP TOP OF THE TUBB FORMATION

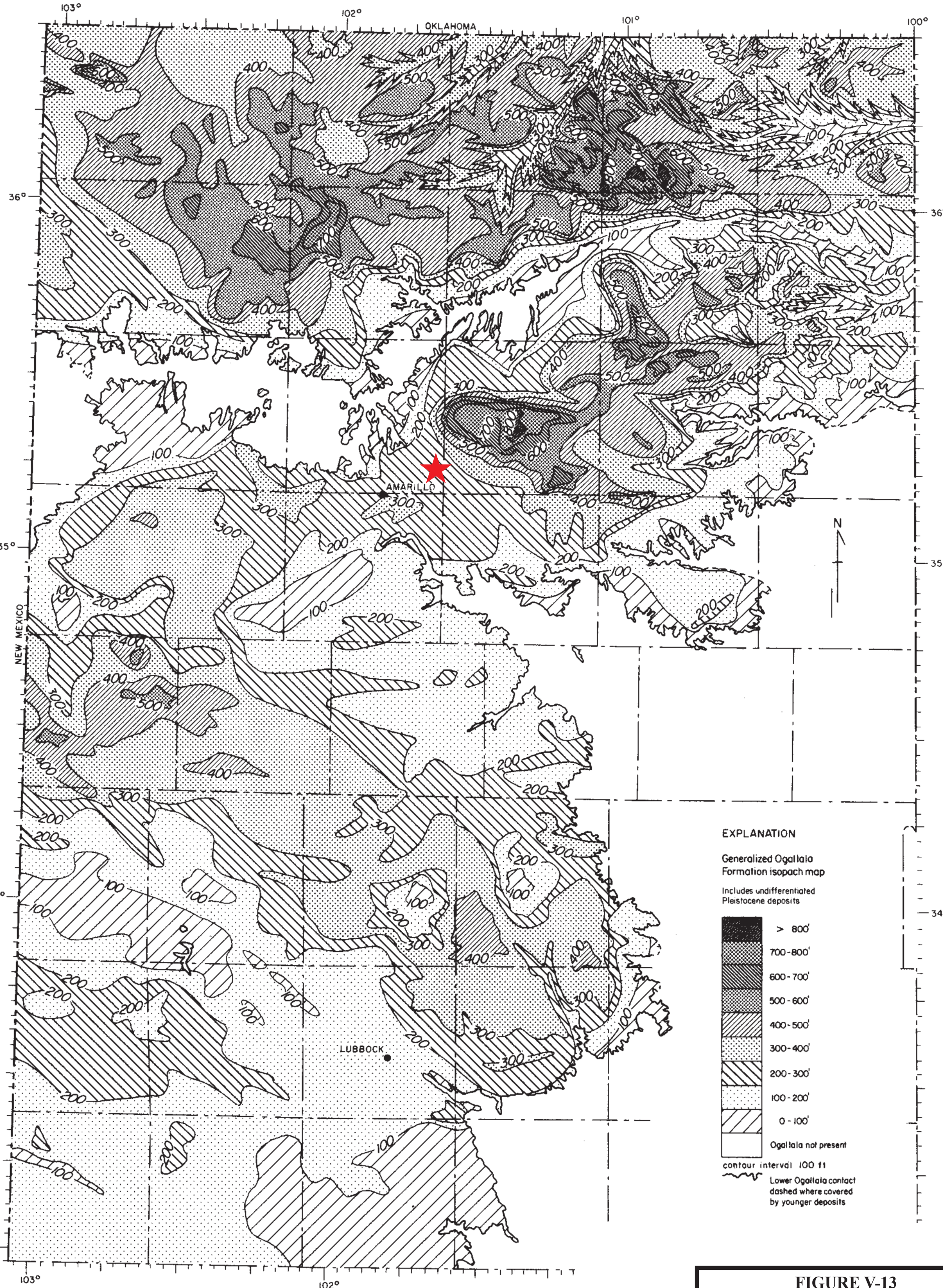
PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

Drawing No.: 13-120.F13
Date: 5-1-24
Job No.: 24-112

Drawn By: Seni
Designed By: A. Bell, PG
Checked By: B. Shin, PG



0 50 mi
0 80 km

★ Location of Tyson Facility

Source: Seni, 1980.

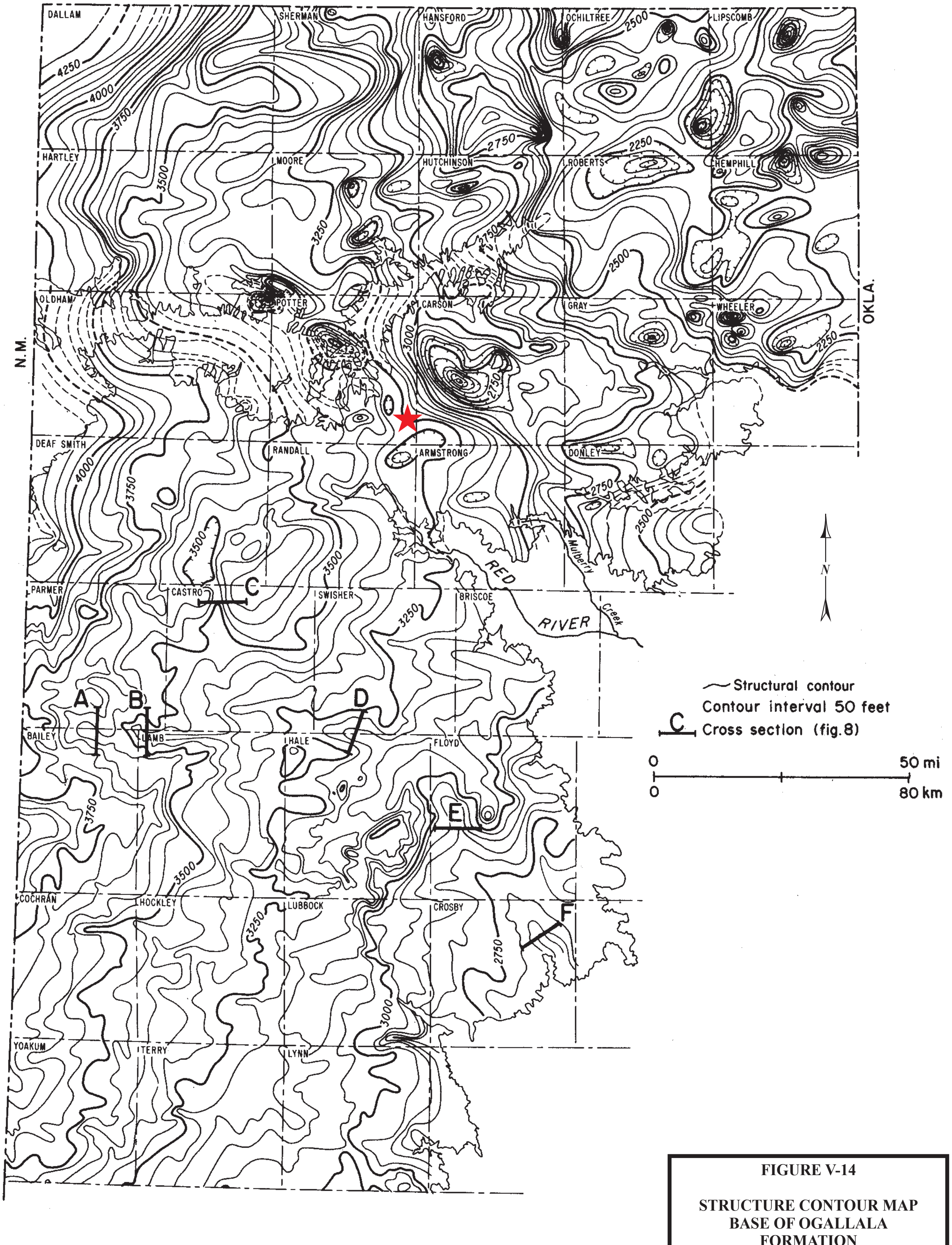
FIGURE V-13

ISOPACH MAP OF OGALLALA AND QUATERNARY DEPOSITS

PREPARED FOR

**TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS**

TERRA DYNAMICS INC



Source: Seni, 1980.

FIGURE V-14

STRUCTURE CONTOUR MAP BASE OF OGALLALA FORMATION

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

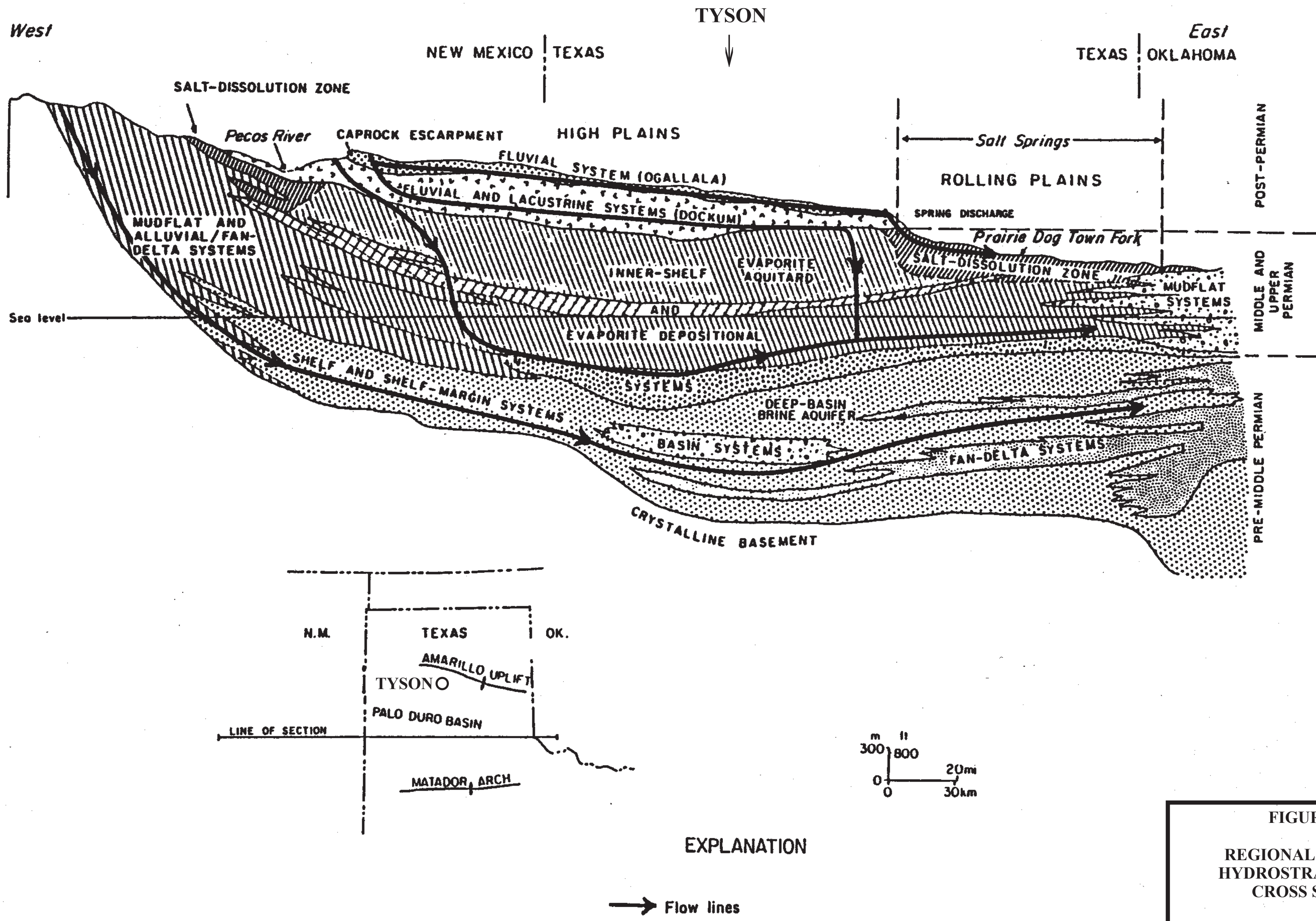
TERRA DYNAMICS INC

Drawing No.: 13-120.F14
Date: 5-1-24
Job No.: 24-112

Drawn By: Seni
Designed By: A. Bell, PG
Checked By: B. Shin, PG

Drawn By:	Bassett and Bentley, Fisher and Kreitler
Designed By:	Ann Bell, PG
Checked By:	B. Shin, PG

Drawing No.: 13-120.F15
Date: 5-1-24
Job No.: 24-112



Source: Bassett and Bentley, 1983; Fisher and Kreitler, 1987.

FIGURE V-15

REGIONAL WEST-EAST HYDROSTRATIGRAPHIC CROSS SECTION

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

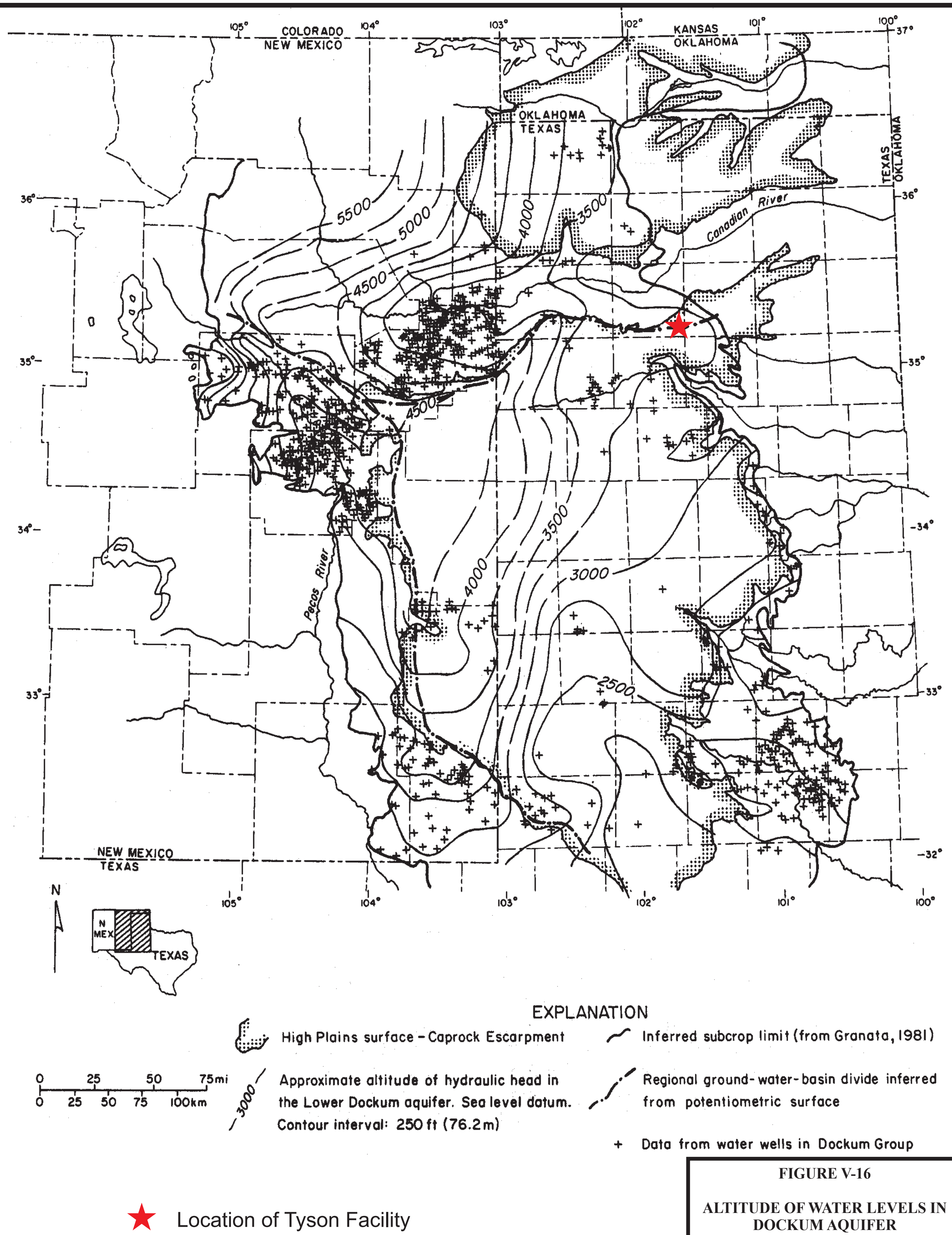


FIGURE V-16

ALTITUDE OF WATER LEVELS IN DOCKUM AQUIFER

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

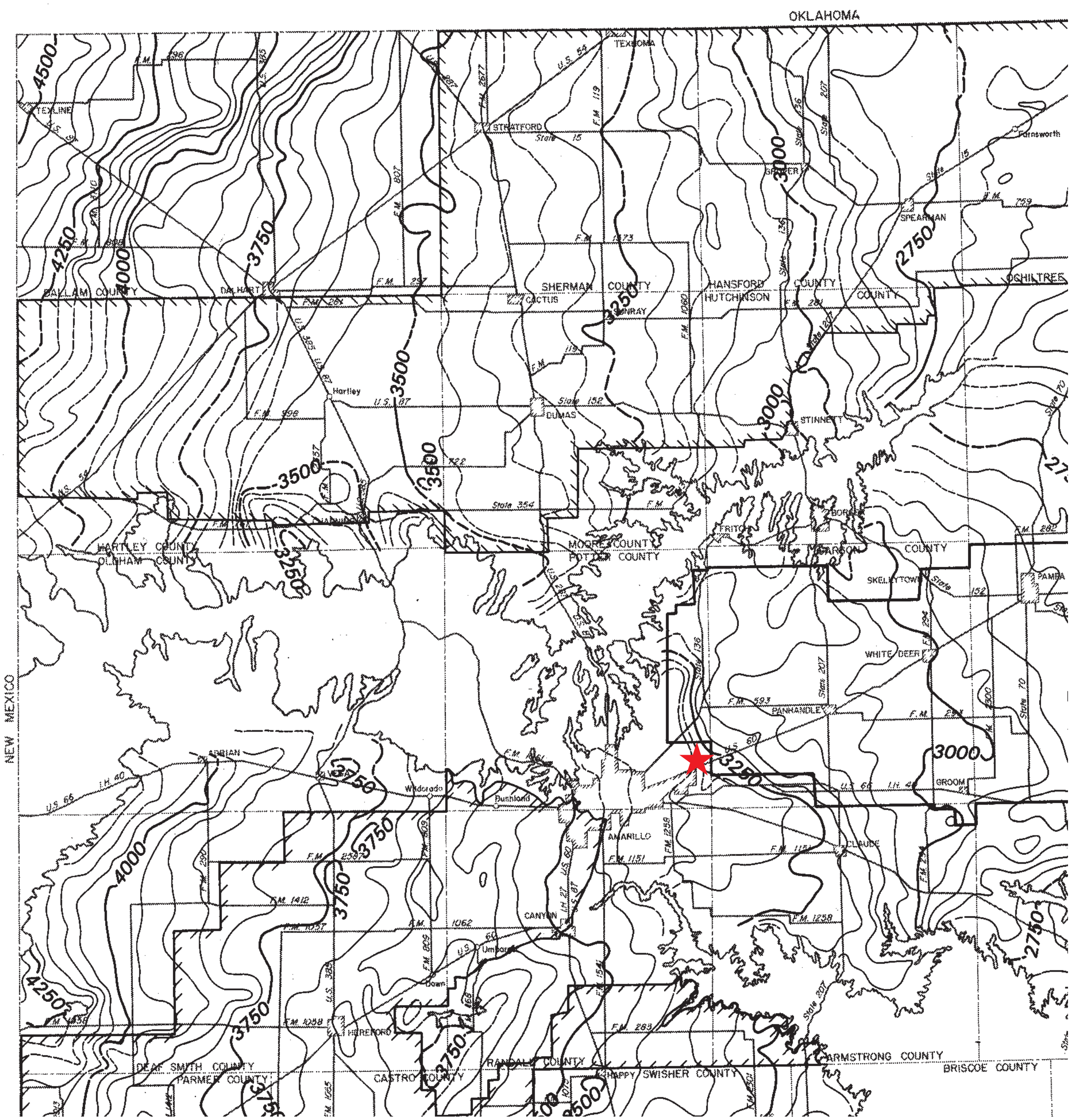
Source: Dutton and Simpkins, 1986.

Drawing No.: 13-120.F16
Date: 5-1-24
Job No.: 24-112

Drawn By: Dutton and Simpkins
Designed By: A. Bell, PG
Checked By: B. Shin, PG

Drawing No.: 13-120.F17
Date: 5-1-24
Job No.: 24-112

Drawn By: Knowles and others
Designed By: A. Bell, PG
Checked By: B. Shin, PG



EXPLANATION

3000

Line showing approximate altitude of water level in the High Plains aquifer
Dashed where control is absent or limited
Interval is 50 feet
Datum is mean sea level

★ Location of Tyson Facility

0 4 8 12 16 20 Miles
0 4 8 12 16 20 Kilometers

Base map from general highway maps of the Texas Department of Highways and Public Transportation.

FIGURE V-17

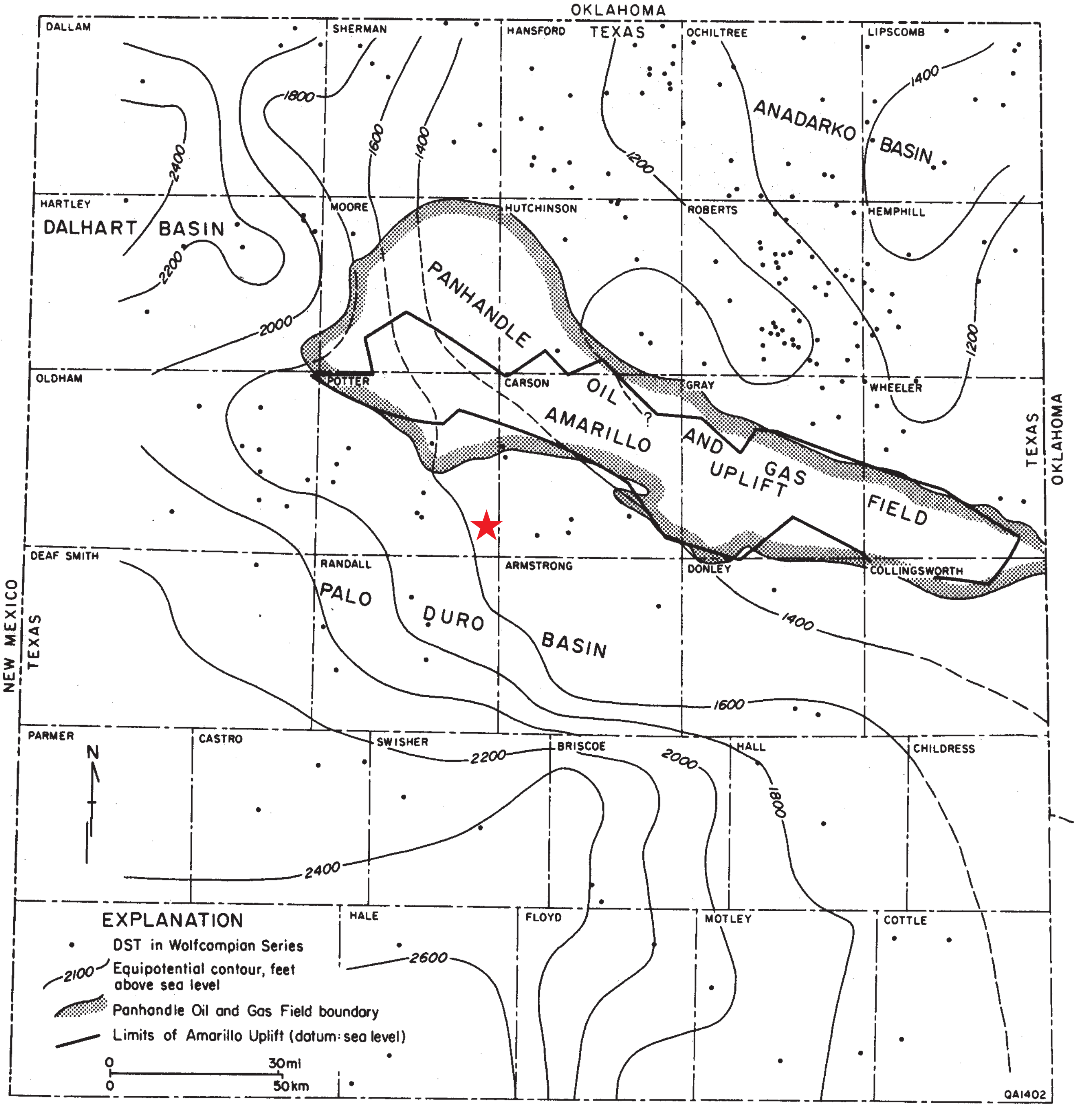
ALTITUDE OF WATER LEVELS IN HIGH PLAINS (OGALLALA) AQUIFER

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

Source: Knowles and others, 1984.



★ Location of Tyson Facility

Source: Gustavson and others, 1983.

FIGURE V-18

POTENTIOMETRIC SURFACE OF THE WOLFCAMP AQUIFER

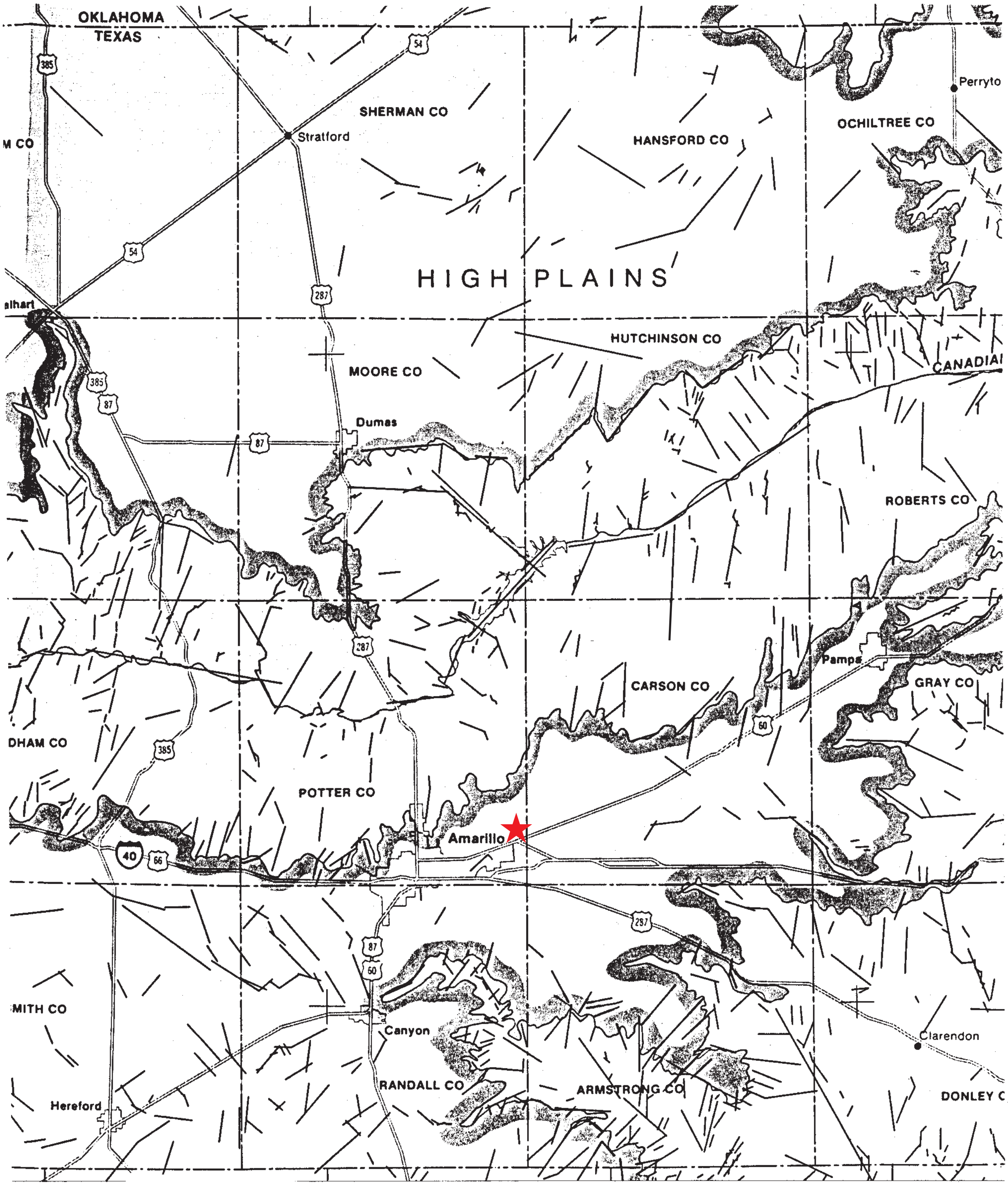
PREPARED FOR

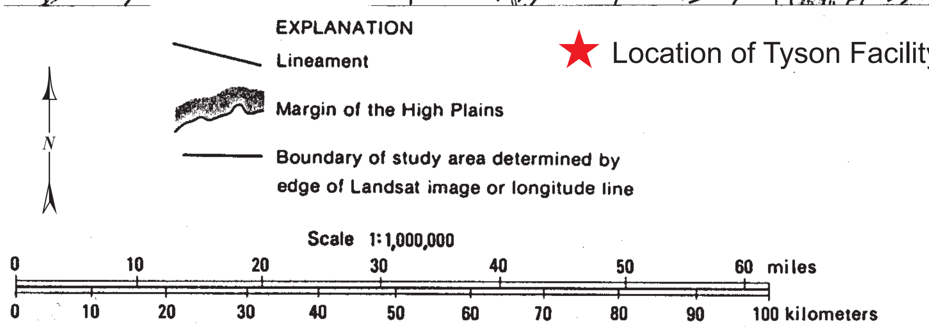
TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

Drawing No.: 13-120.F18
Date: 5-1-24
Job No.: 24-112

Drawn By: Gustavson and others
Designed By: A. Bell, PG
Checked By: B. Shin, PG





★ Location of Tyson Facility

Source: Finley and Gustavson, 1981.

FIGURE V-19

REGIONAL SURFACE LINEATION MAP

PREPARED FOR

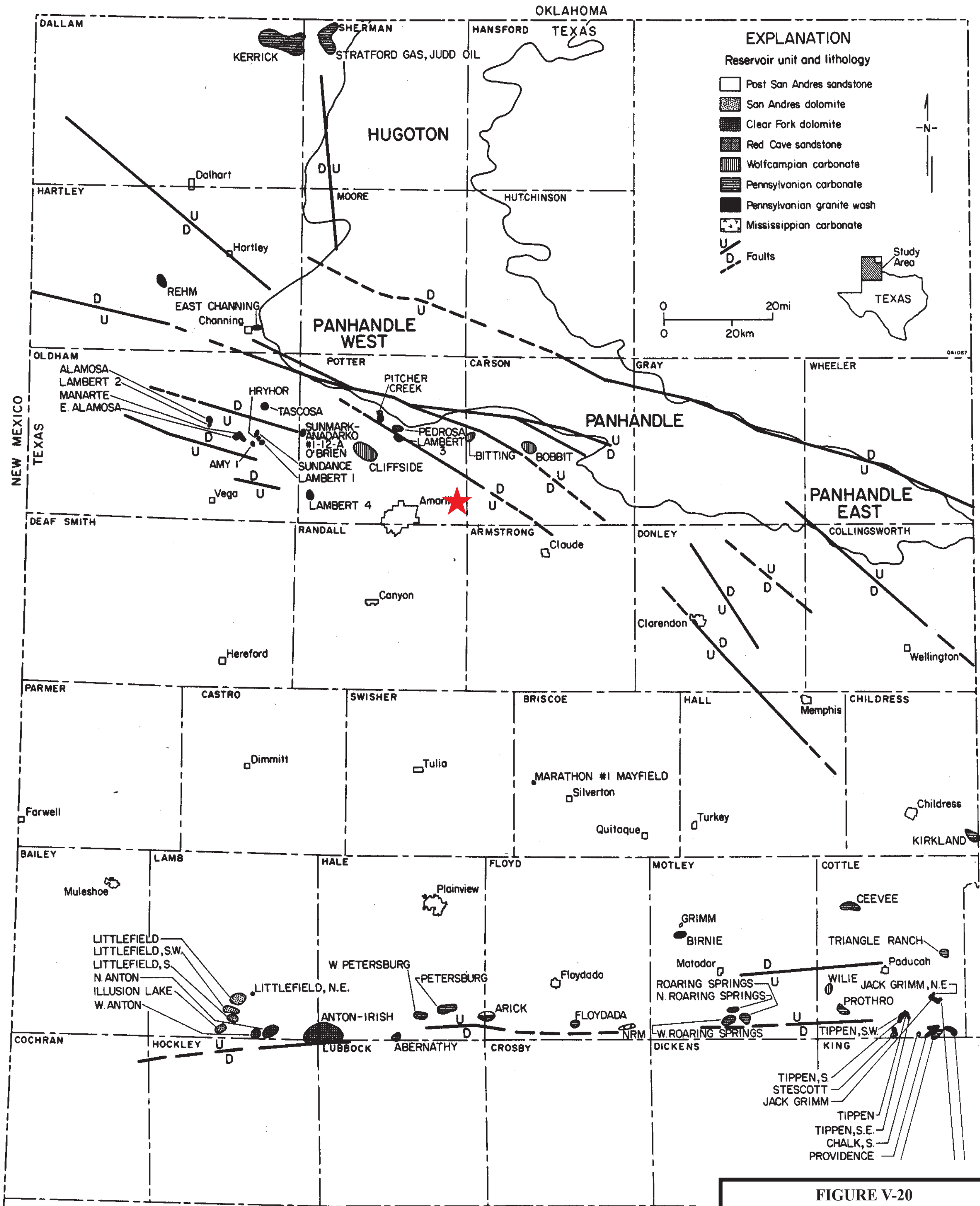
**TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS**

TERRA DYNAMICS INC

Drawing No.: 13-120.F19
Date: 5-1-24
Job No.: 24-112

Drawn By: Finley and Gustavson
Designed By: A. Bell, PG
Checked By: B. Shin, PG

Drawing No.: 13-120.F20
Date: 5-1-24
Job No.: 24-112



★ Location of Tyson Facility

Source: Gustavson and others, 1983.

Drawn By: Gustavson and others
Designed By: A. Bell, PG
Checked By: B. Shin, PG

FIGURE V-20

LOCATION OF OIL AND GAS FIELDS IN THE PALO DURO BASIN

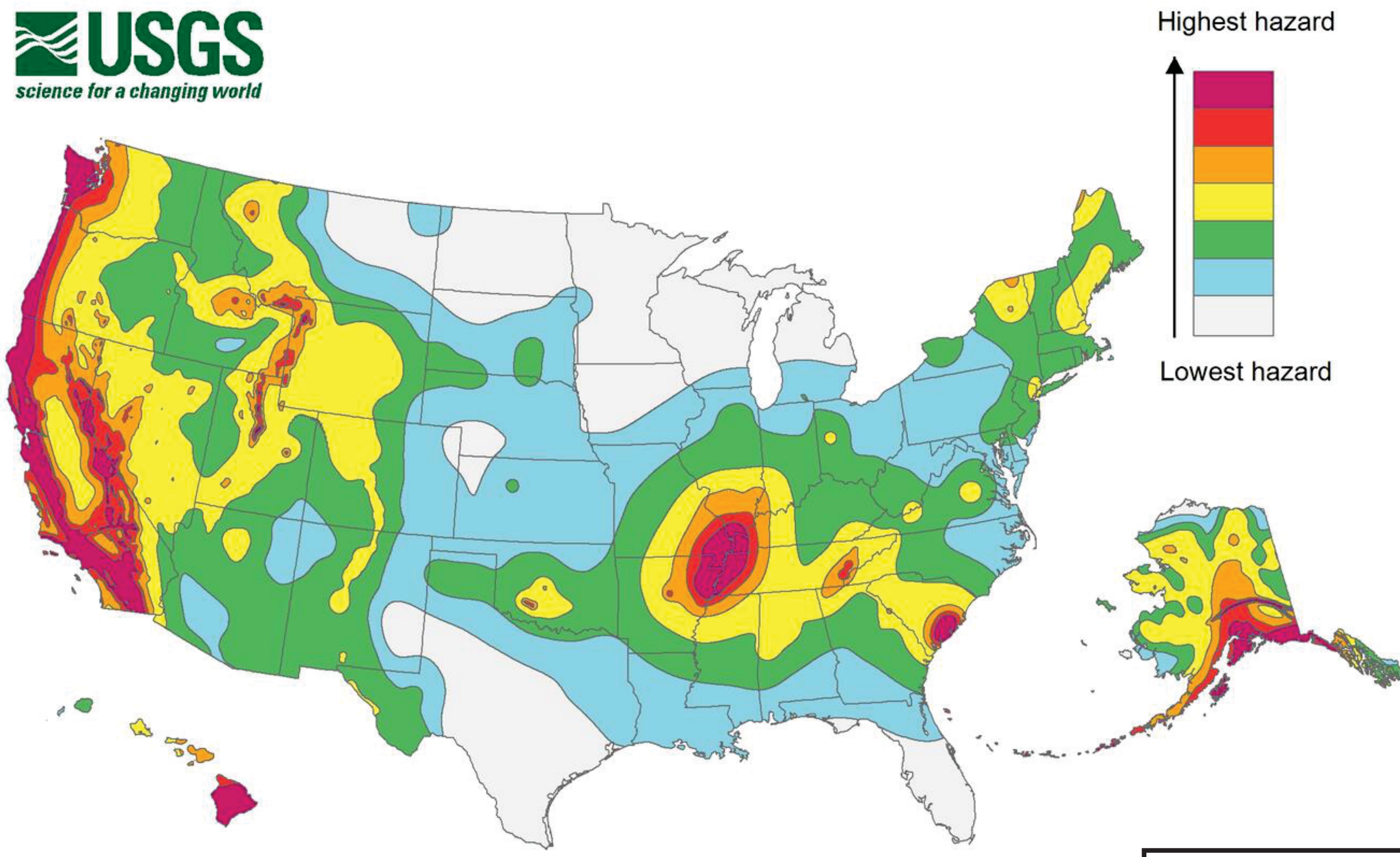
PREPARED FOR

**TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS**

TERRA DYNAMICS INC

Drawn By: USGS	Drawing No.: 13-120.F21
Designed By: MBS	Date: 5/2/2024
Checked By: MBS	Job No.: 24-112

Peak Ground Acceleration with 2% in 50 Year Probability of Exceedance



★ Tyson Location

Source: USGS, 2018

FIGURE V-21

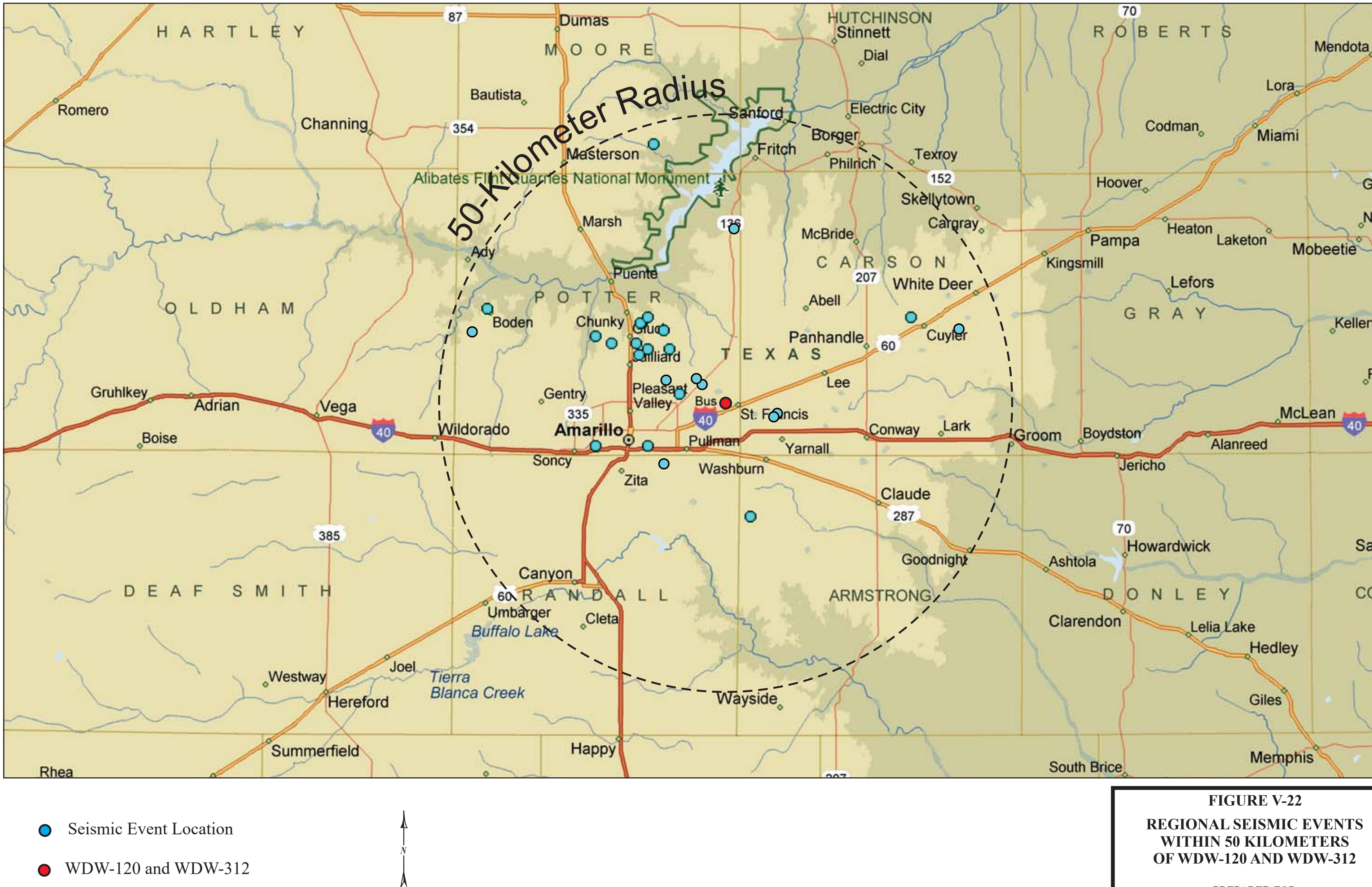
NATIONAL SEISMIC HAZARD MAP

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

Drawn By: MBS	Drawing No.: 13-120.F22
Designed By: SKW	Date: 5-2-2024
Checked By: SKW	Job No.: 24-112



Base Map: Streets and Trips, 2008

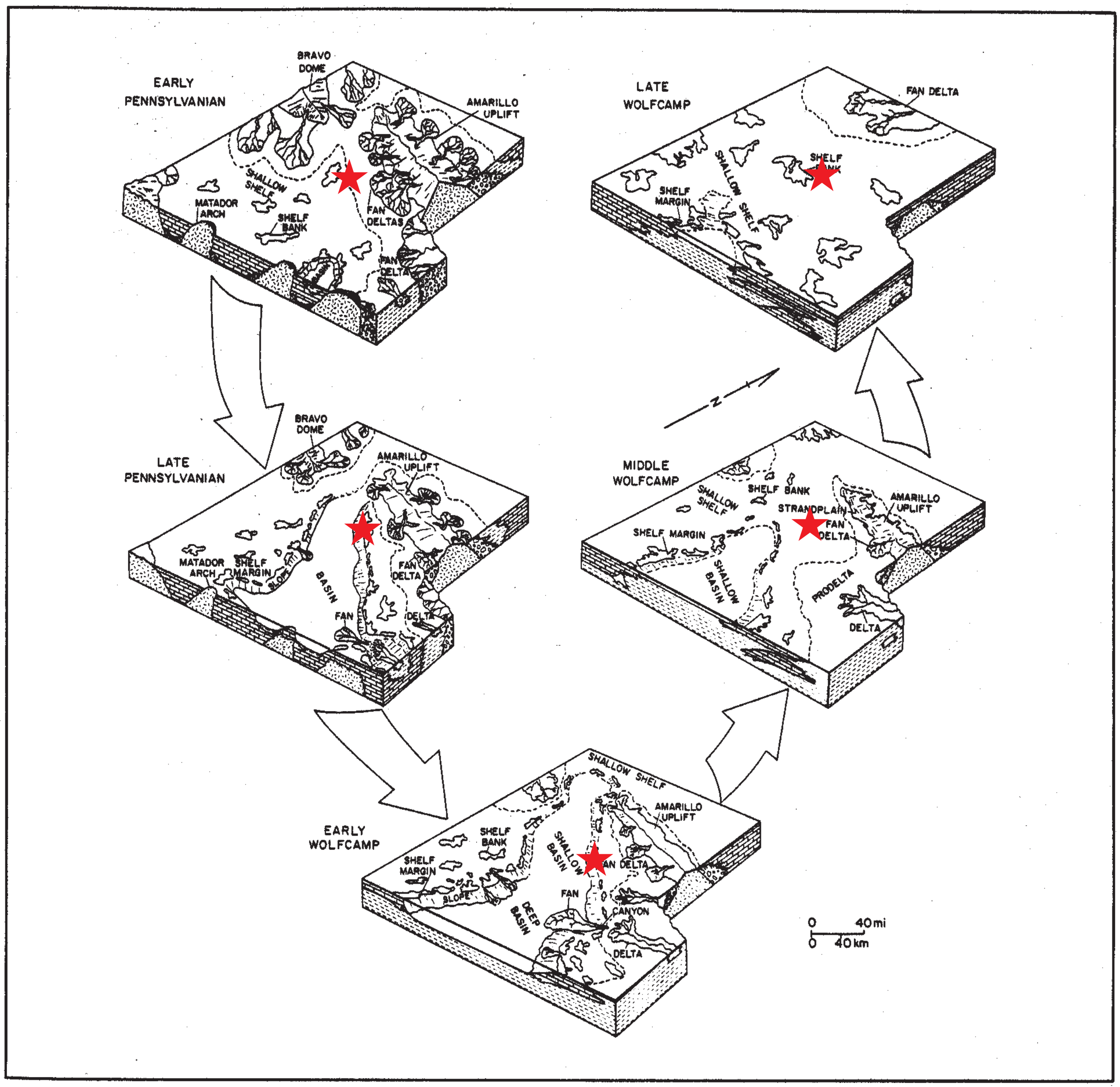
FIGURE V-22

REGIONAL SEISMIC EVENTS WITHIN 50 KILOMETERS OF WDW-120 AND WDW-312

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC



★ Inferred Location of Tyson Facility

Source: S.P. Dutton and others, 1982.

FIGURE V-23

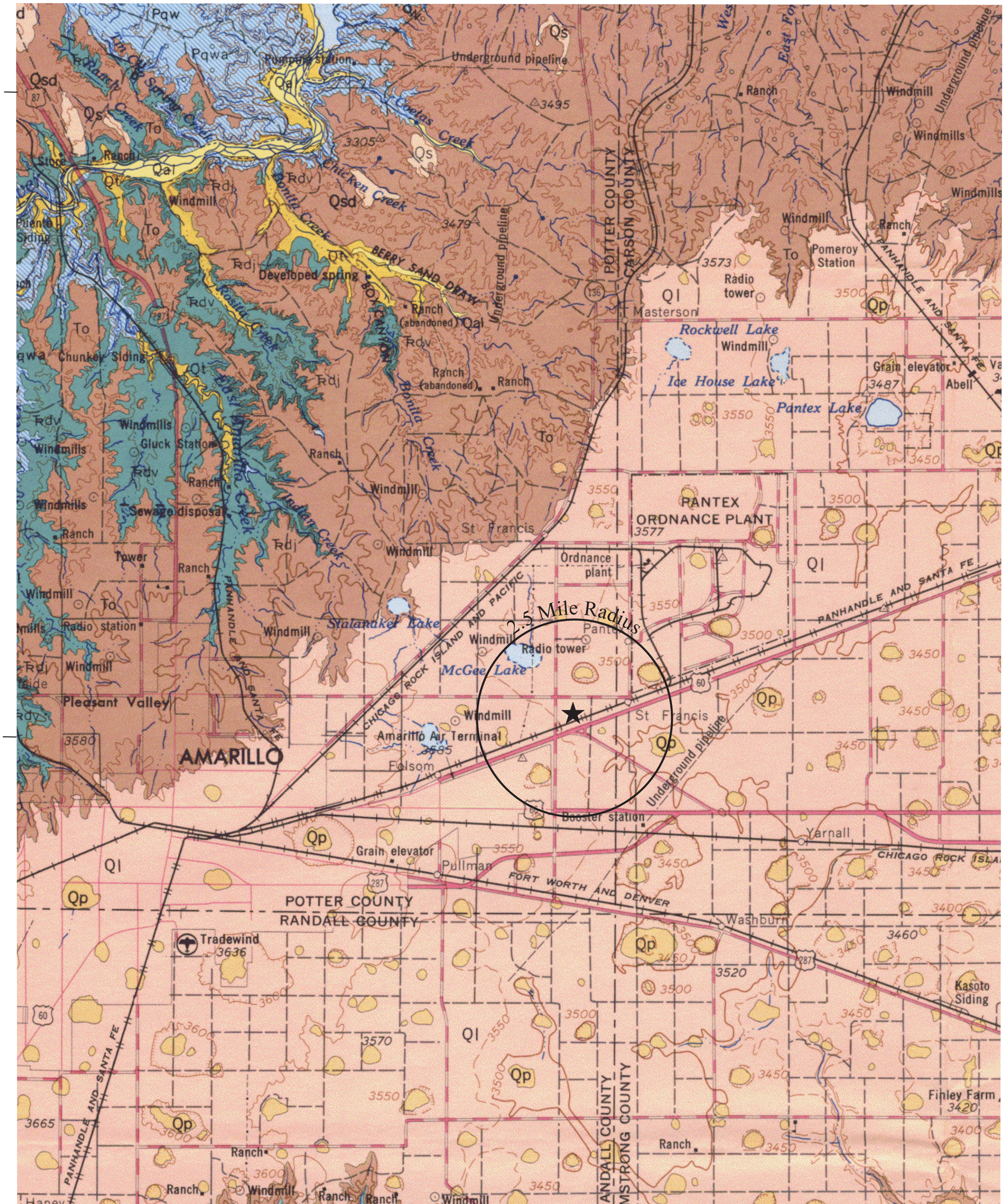
PENNSYLVANIAN AND EARLY PERMIAN PALEOGEOGRAPHIC FEATURES

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

TERRA DYNAMICS INC

Drawing No.: 13-120.F23
Date: 5-1-24
Job No.: 24-112
Drawn By: S.P. Dutton and others
Designed By: A. Bell, PG
Checked By: B. Shin, PG



EXPLANATION

★ Location of Tyson facility

N

MILES

0 4

SCALE

Qal	Alluvium
Qs, Qsd	Windblown sand
Qt	Fluviatile terrace deposits
Qp	Playa deposits
Ql	Loess
To	Ogallala Formation
Trd	Dockum Group
Trdj	Trujillo Formation
Trdv	Tecovas Formation
Pqwa	Alibates Dolomite
Pqw	Quartermaster, Cloud Chief, Whitehorse, undivided

Source: Barnes, 1981.

FIGURE V-24

SURFACE GEOLOGY OF THE AMARILLO AREA

PREPARED FOR

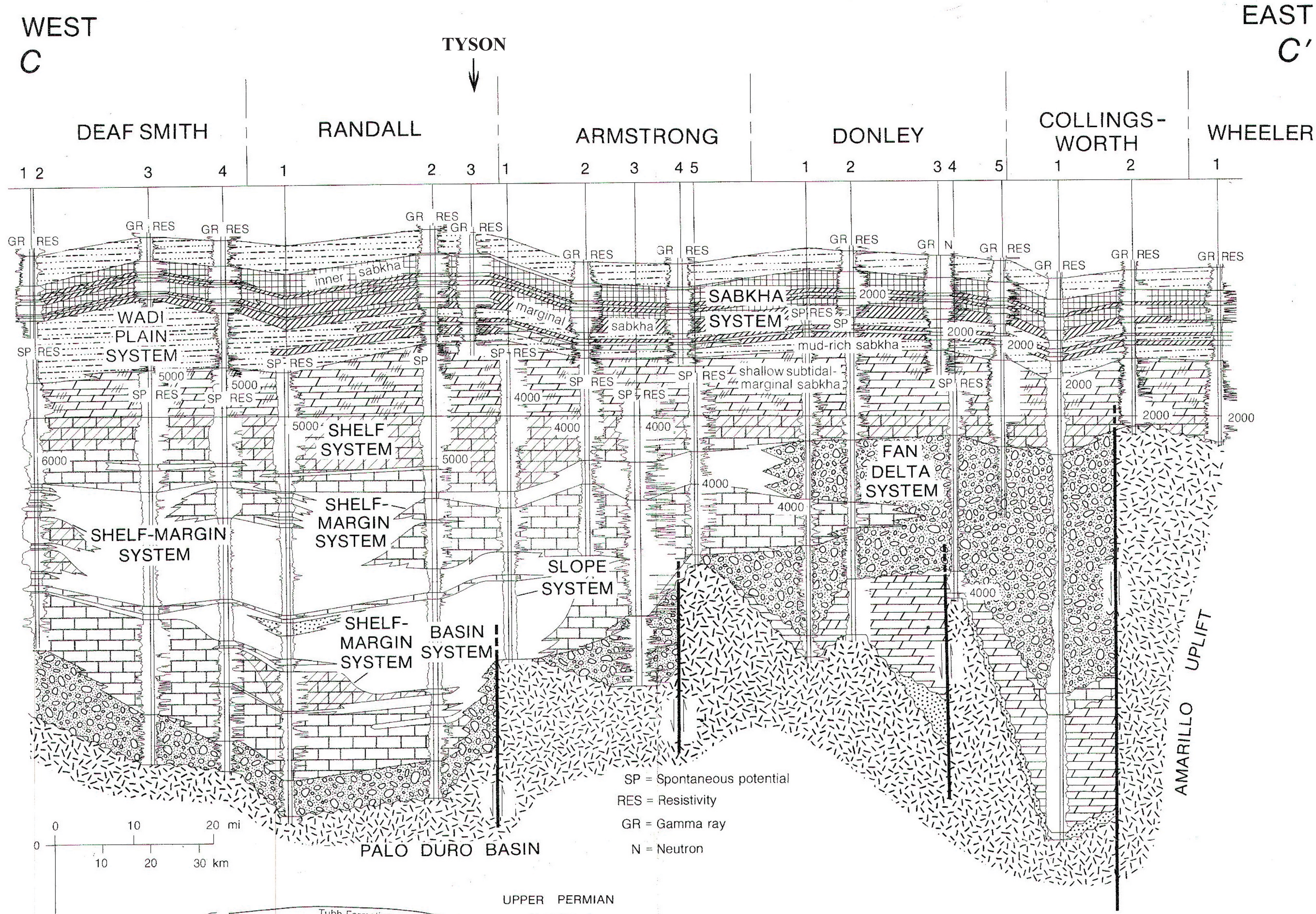
TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
AMARILLO, TEXAS

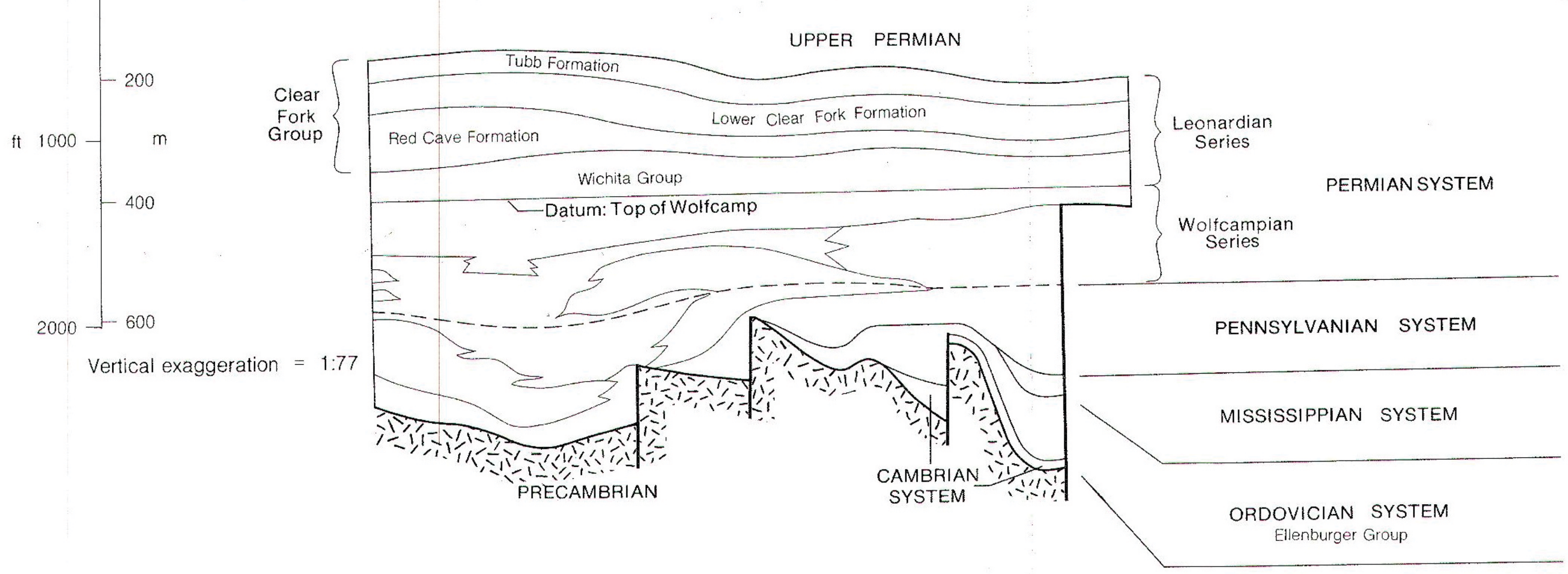
TERRA DYNAMICS INC

Drawing No.: 13-120.F24
Date: 5/1/2024
Job No.: 24-112

Drawn By: Barnes
Designed By: AEB
Checked By: MBS

THE UNIVERSITY OF TEXAS AT AUSTIN
BUREAU OF ECONOMIC GEOLOGY
W. L. FISHER, DIRECTOR





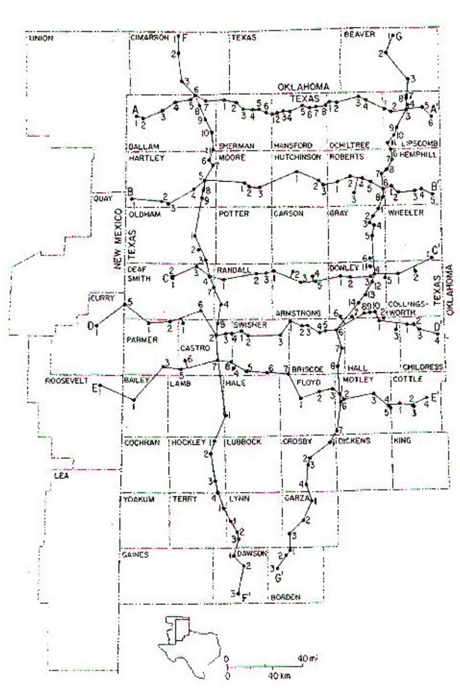
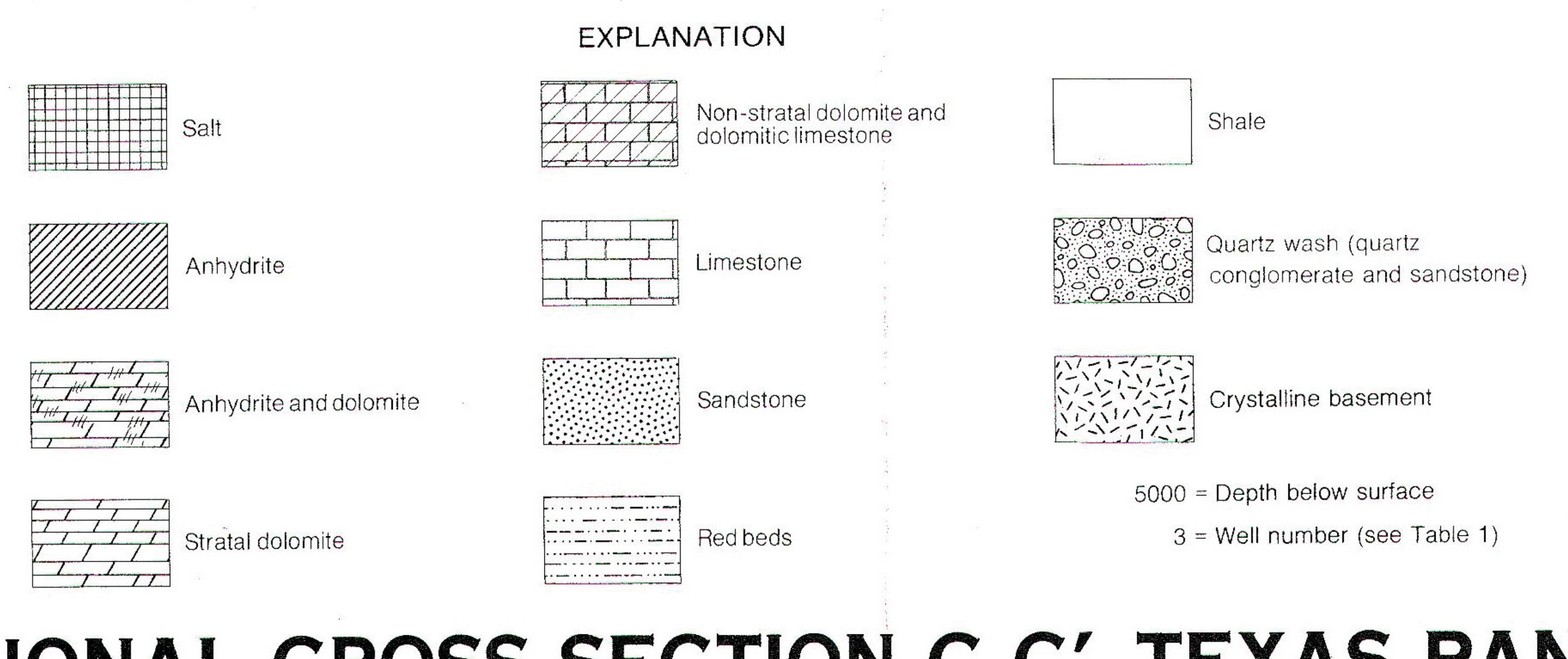


Figure 2. Index map showing locations of cross sections.



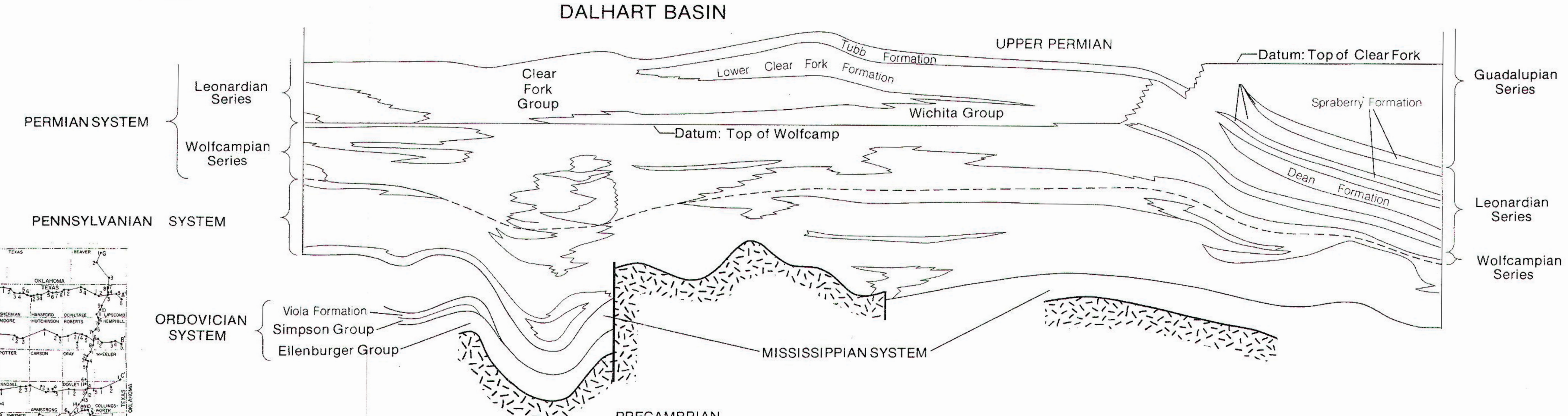
By
C. Robertson Handford,
Shirley P. Dutton,
and Paul E. Fredericks

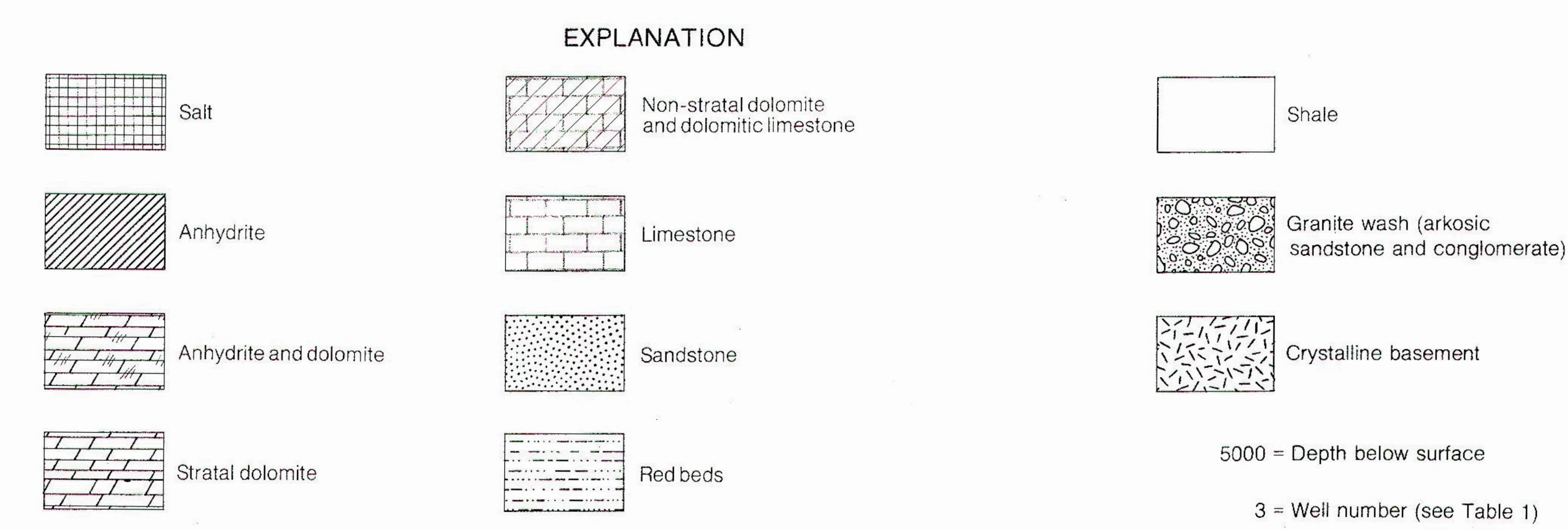
REGIONAL CROSS SECTION C-C′, TEXAS PANHANDLE
1981

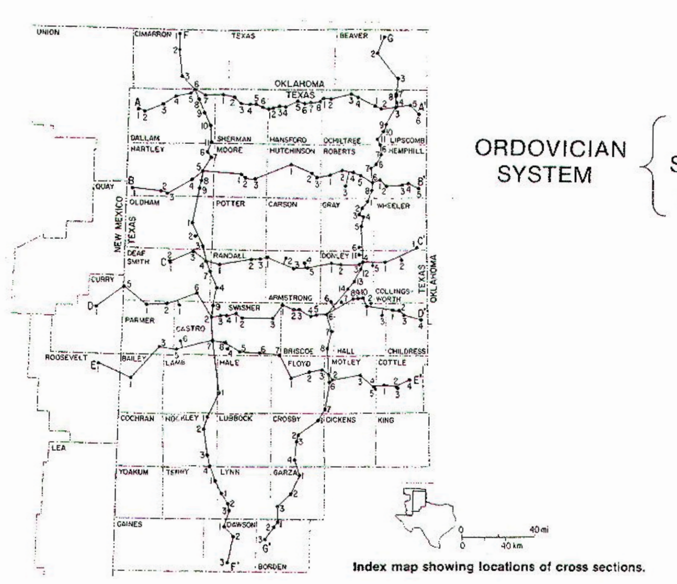
PLATE V-1

THE UNIVERSITY OF TEXAS AT AUSTIN
BUREAU OF ECONOMIC GEOLOGY
W. L. FISHER, DIRECTOR

REGIONAL CROSS SECTIONS
OF THE TEXAS PANHANDLE:
PRECAMBRIAN TO MID-PERMIAN







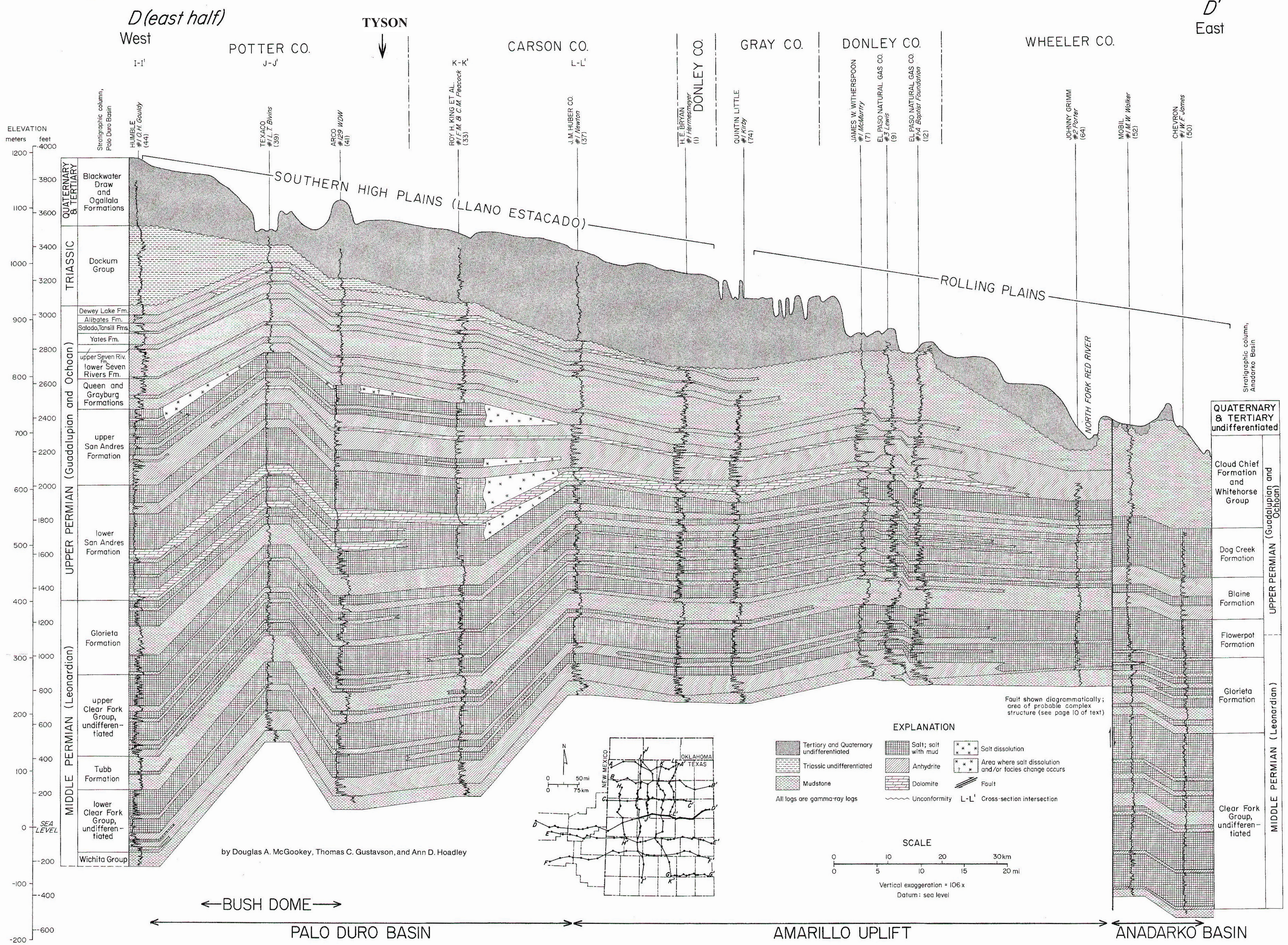
By C. Robertson Handford, Shirley P. Dutton, and Paul E. Fredericks

REGIONAL CROSS SECTION F-F′, TEXAS PANHANDLE
1981

PLATE V-2

THE UNIVERSITY OF TEXAS AT AUSTIN
BUREAU OF ECONOMIC GEOLOGY
W. L. FISHER, DIRECTOR

REGIONAL STRUCTURAL CROSS SECTIONS,
MID-PERMIAN TO QUATERNARY STRATA,
TEXAS PANHANDLE AND EASTERN NEW MEXICO



CROSS SECTION D-D' (east half)

1988

PLATE V-3

THE UNIVERSITY OF TEXAS AT AUSTIN
BUREAU OF ECONOMIC GEOLOGY
W. L. FISHER, DIRECTOR

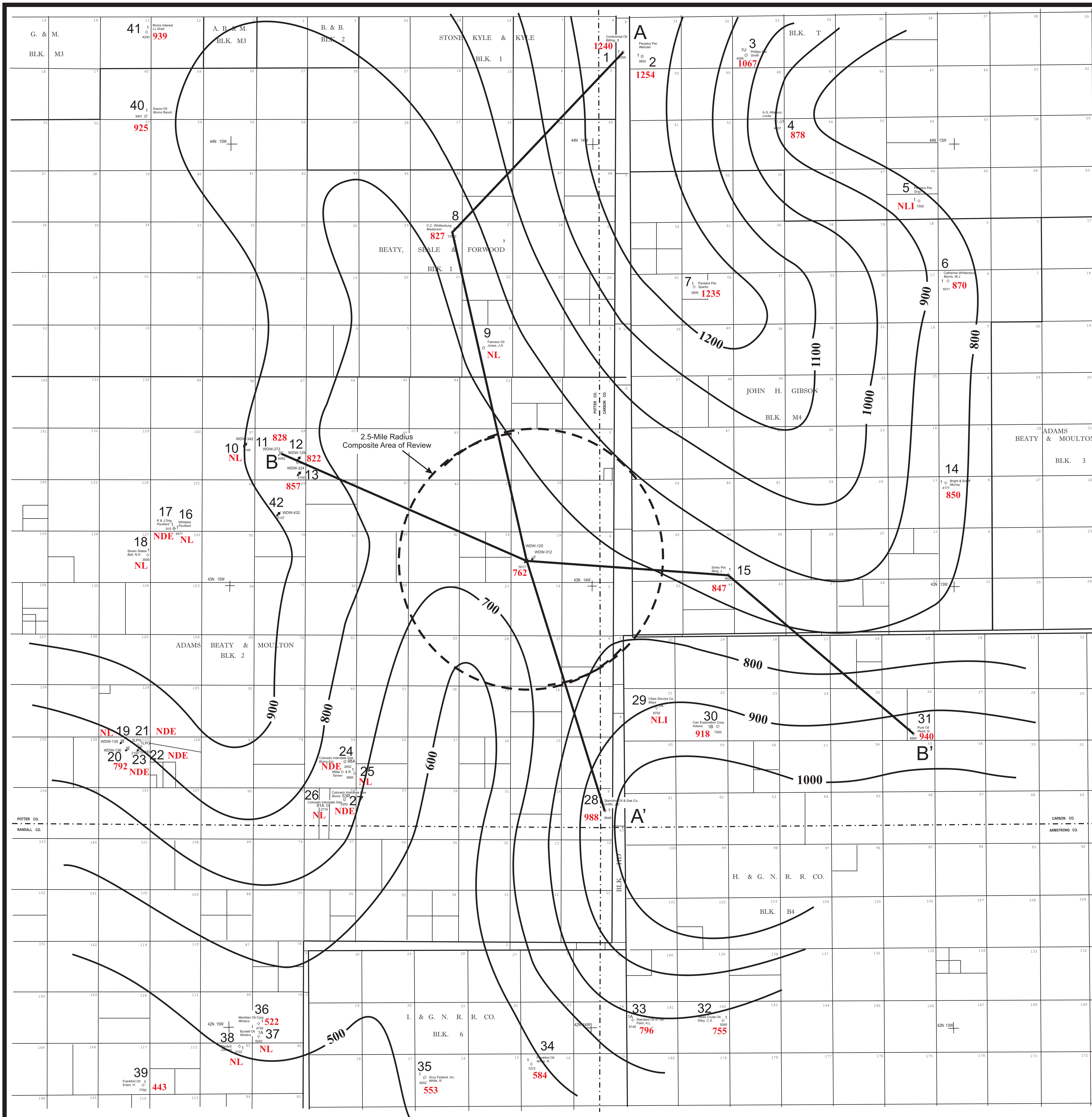
REGIONAL STRUCTURAL CROSS SECTIONS,
MID-PERMIAN TO QUATERNARY STRATA,
TEXAS PANHANDLE AND EASTERN NEW MEXICO

by Douglas A. McGookey, Thomas C. Gustavson, and Ann D. Hoadley

CROSS SECTION J-J'

1988

PLATE V-4



LEGEND

- Class 1 Disposal Well
- Proposed Class 1 Disposal Well
- Gas Well
- Gas Well, Plugged
- Dry Hole
- New Suspended or Temp. Abd.
- Class I or Salt Water Disposal, Plugged

A - A' Line of Cross Section

500 — Line of Equal Elevation (relative to mean sea level)

39 — Well Number

443 — Elevation Top of Confining Zone (NDE - well not deep enough, NL - no log available, NLI - not logged over interval)

Contour Interval = 100 feet

N

0' 4000' 8000'
SCALE

TERRA DYNAMICS INC

PLATE V-5

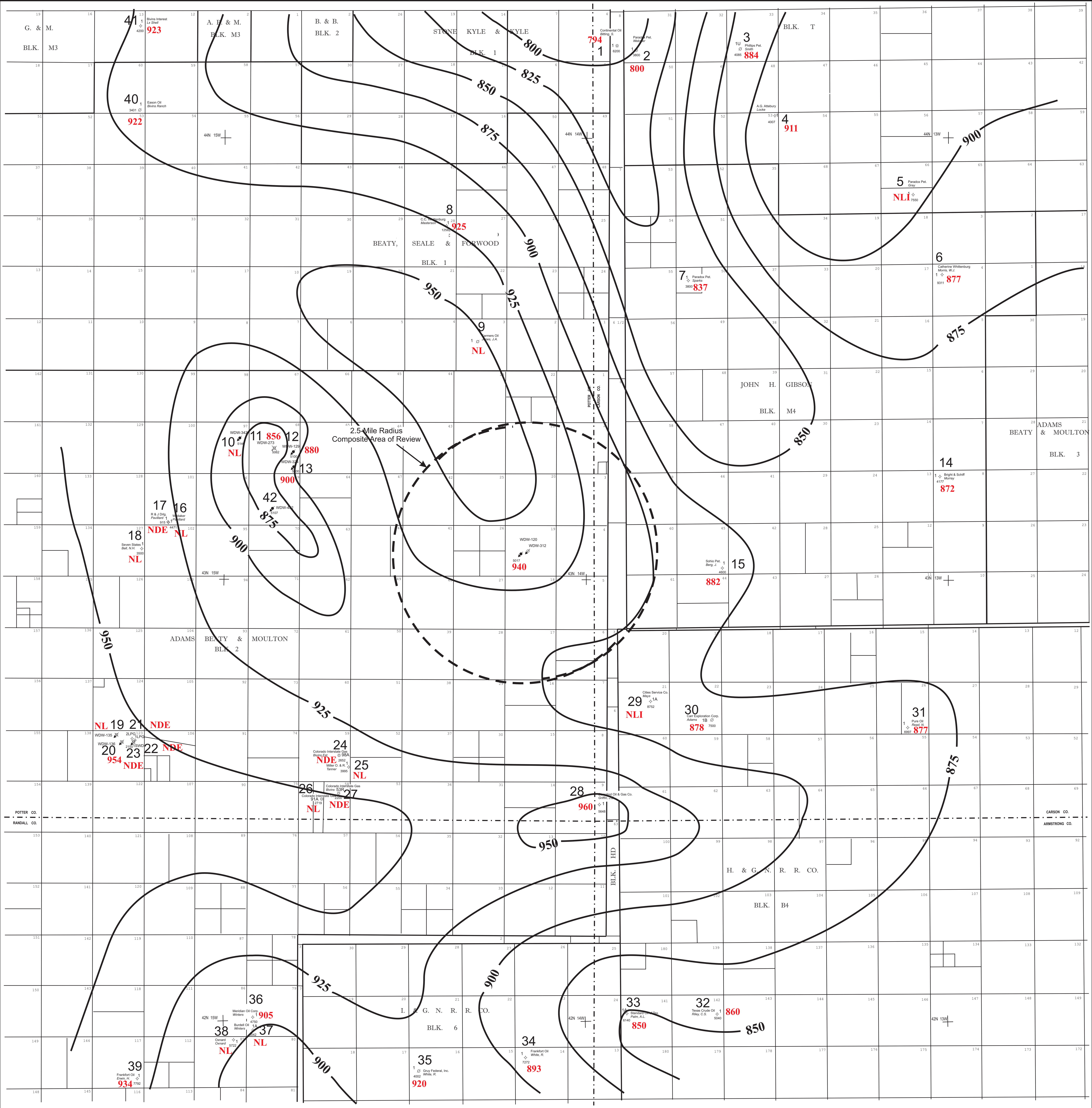
Structure Map on Top of the Confining Zone

PREPARED FOR:

TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: B. SHIN	SCALES:	DATE: 6/3/2024
DESIGNED BY: A. BELL	As Indicated	JOB NO.: 24-112
CHECKED BY: S. WILLIAMS		© 2024

STATE OF TEXAS
MOONSOO SHIN
GEOLOGY
15280
LICENSED
PROFESSIONAL GEOSCIENTIST



LEGEND

- Class 1 Disposal Well
- Proposed Class 1 Disposal Well
- Gas Well
- Gas Well, Plugged
- Dry Hole
- New Suspended or Temp. Abd.
- Class I or Salt Water Disposal, Plugged

900 Line of Equal Thickness

39 Well Number

934 Thickness of Confining Zone (NDE - well not deep enough, NL - no log available, NLI - not logged over interval)

Contour Interval = 25 feet

N

0' 4000' 8000'
SCALE

TERRA DYNAMICS INC

PLATE V-6

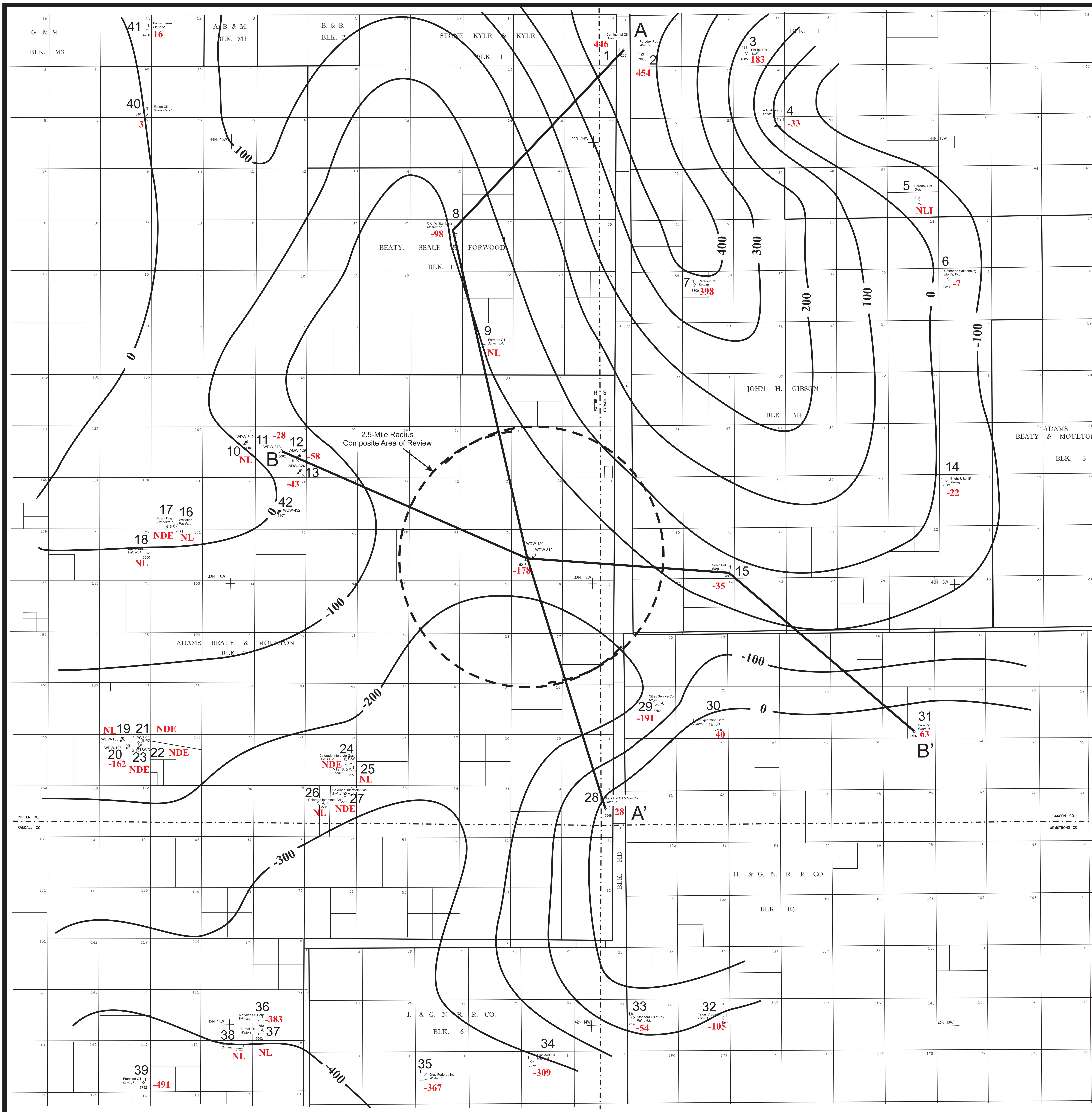
Gross Thickness Isopach Map of the Confining Zone

PREPARED FOR:

**TYSON FRESH MEATS, INC.
AMARILLO, TEXAS**

DRAWN BY: B. SHIN	SCALES:	DATE: 6/3/2024	
DESIGNED BY: A. BELL	As Indicated	JOB NO.: 24-112	
CHECKED BY: S. WILLIAMS			

STATE OF TEXAS MOONSOO SHIN GEOLOGY 15280 LICENSED PROFESSIONAL GEOSCIENTIST



LEGEND

- Class 1 Disposal Well
- Proposed Class 1 Disposal Well
- Gas Well
- Gas Well, Plugged
- Dry Hole
- New Suspended or Temp. Abd.
- Class I or Salt Water Disposal, Plugged

A - A' Line of Cross Section

-400 Line of Equal Elevation (relative to mean sea level)

39 Well Number

-491 Elevation Top of Injection Zone (NDE - well not deep enough, NL - no log available, NLI - not logged over interval)

Contour Interval = 100 feet

N

0' 4000' 8000'
SCALE

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BRIAN MOONSOO SHIN 5-24-2024
TEXAS REGISTERED FIRM F-3501

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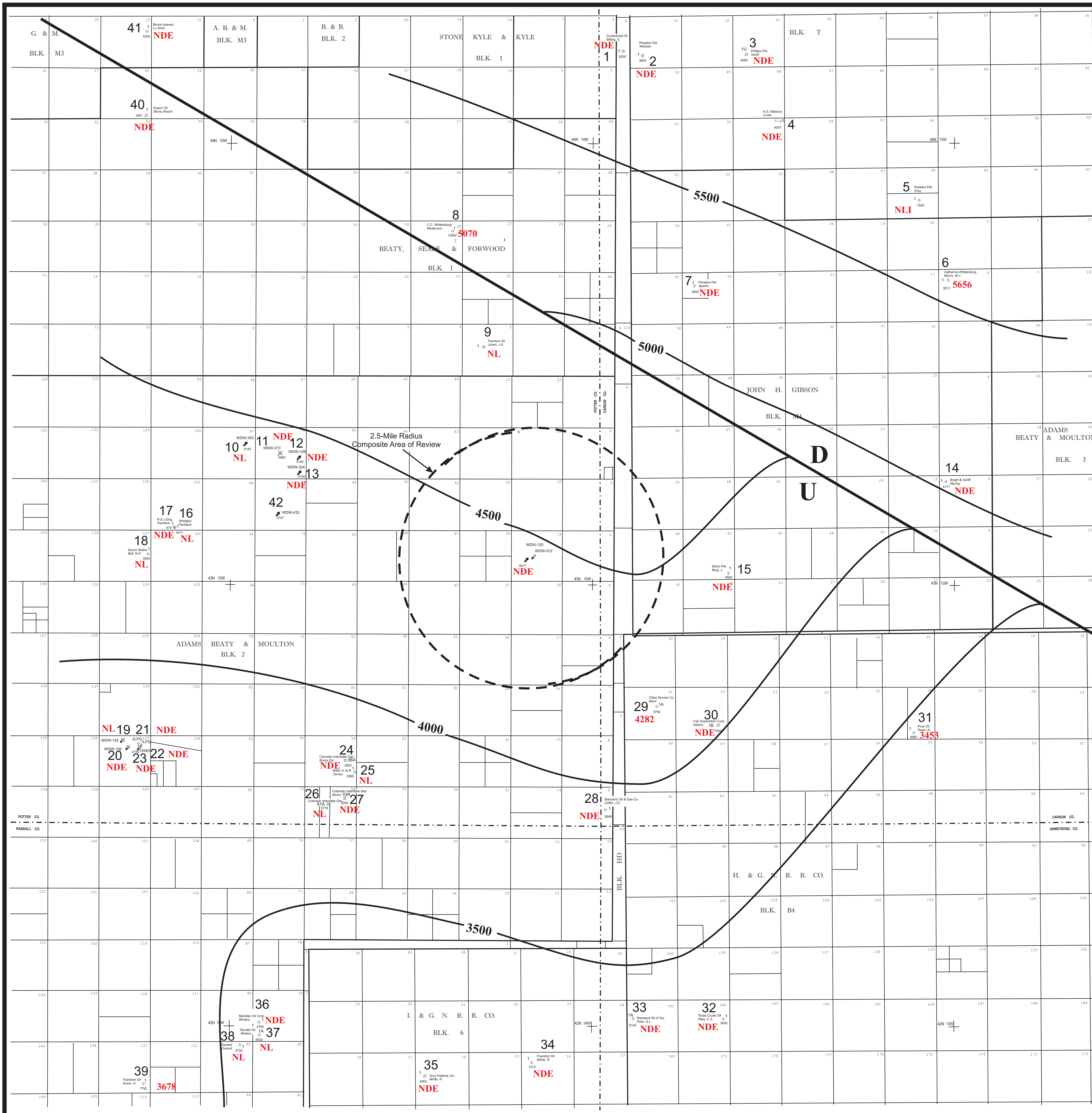
PLATE V-7

Structure Map on Top of the Injection Zone

PREPARED FOR:

**TYSON FRESH MEATS, INC.
AMARILLO, TEXAS**

DRAWN BY:	B. SHIN	SCALES:	DATE: 6/3/2024
DESIGNED BY:	A. BELL	As Indicated	JOB NO.: 24-112
CHECKED BY:	S. WILLIAMS		© 2024



LEGEND

- Class 1 Disposal Well
- Proposed Class 1 Disposal Well
- Gas Well
- Gas Well, Plugged
- Dry Hole
- New Suspended or Temp. Abd.
- Class I or Salt Water Disposal, Plugged

4000 — Line of Equal Thickness

39 — Well Number

3678 — Thickness of Injection Zone (NDE - well not deep enough, NL - no log available, NLI - not logged over interval)

Contour Interval = 500 feet

N

0′ 4000′ 8000′
SCALE

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PLATE V-8

Gross Thickness Isopach Map of the Injection Zone

PREPARED FOR:

TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: B. SHIN	SCALES:	DATE: 6/3/2024	
DESIGNED BY: A. BELL	As Indicated	JOB NO.: 24-112	© 2024
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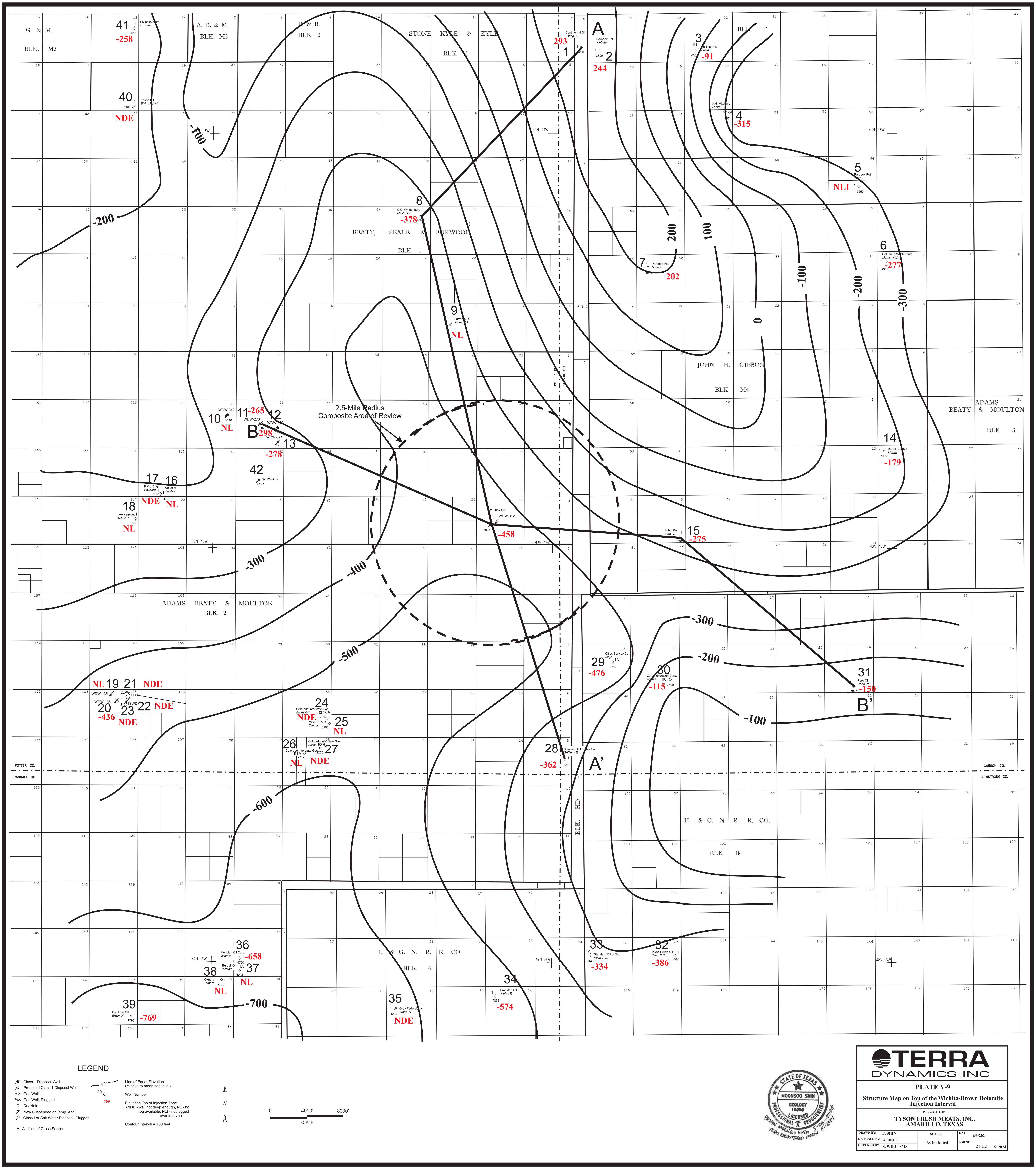

2.5-Mile Radius
Composite Area of Review
A
A'
B
B'
POTTER CO.
RANDALL CO.
CARSON CO.
ARMSTRONG CO.
G. & M. BLK. M3
A. B. & M. BLK. M3
STONE KYLE & KYLE BLK. 1
BEATY, SEALE & FORWOOD BLK. 1
JOHN H. GIBSON BLK. M4
ADAMS BEATY & MOULTON BLK. 3
ADAMS BEATY & MOULTON BLK. 2
H. & G. N. R. R. CO. BLK. B4
I. & G. N. R. R. CO. BLK. 6
BLK. HD
BLK. T
LEGEND
Class 1 Disposal Well
Proposed Class 1 Disposal Well
Gas Well
Gas Well, Plugged
Dry Hole
New Suspended or Temp. Abd.
Class I or Salt Water Disposal, Plugged
A - A' Line of Cross Section
Line of Equal Elevation (relative to mean sea level)
Well Number
Elevation Top of Injection Zone (NDE - well not deep enough, NL - no log available, NLI - not logged over interval)
Contour Interval = 100 feet
0' 4000' 8000'
SCALE
TERRA DYNAMICS INC
PLATE V-9
Structure Map on Top of the Wichita-Brown Dolomite Injection Interval
PREPARED FOR:
TYSON FRESH MEATS, INC.
AMARILLO, TEXAS
DRAWN BY: B. SHIN
DESIGNED BY: A. BELL
CHECKED BY: S. WILLIAMS
SCALES: As Indicated
DATE: 6/3/2024
JOB NO.: 24-112
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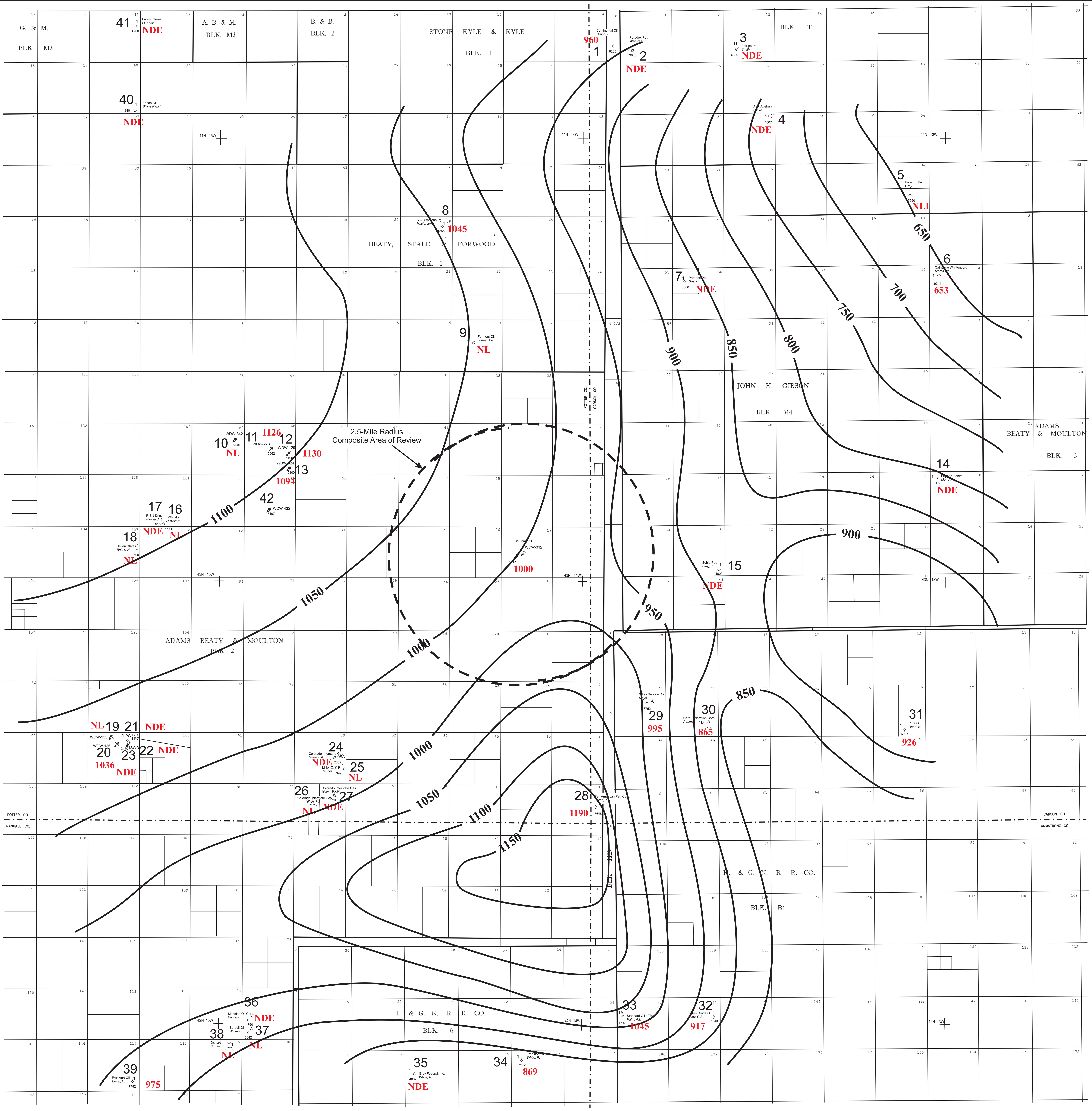

LEGEND

- Class 1 Disposal Well
- Proposed Class 1 Disposal Well
- Gas Well
- Gas Well, Plugged
- Dry Hole
- New Suspended or Temp. Abd.
- Class I or Salt Water Disposal, Plugged

900 — Line of Equal Thickness

39 — Well Number

975 — Thickness of Wichita-Brown Dolomite Injection Interval (NDE - well not deep enough, NL - no log available, NLI - not logged over interval)

Contour Interval = 50 feet

N

0′ 4000′ 8000′
SCALE

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PLATE V-10

Gross Thickness Isopach Map of the Wichita-Brown Dolomite Injection Interval

PREPARED FOR:

TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: B. SHIN	SCALES:	DATE:	6/3/2024
DESIGNED BY: A. BELL	As Indicated	JOB NO.:	24-112
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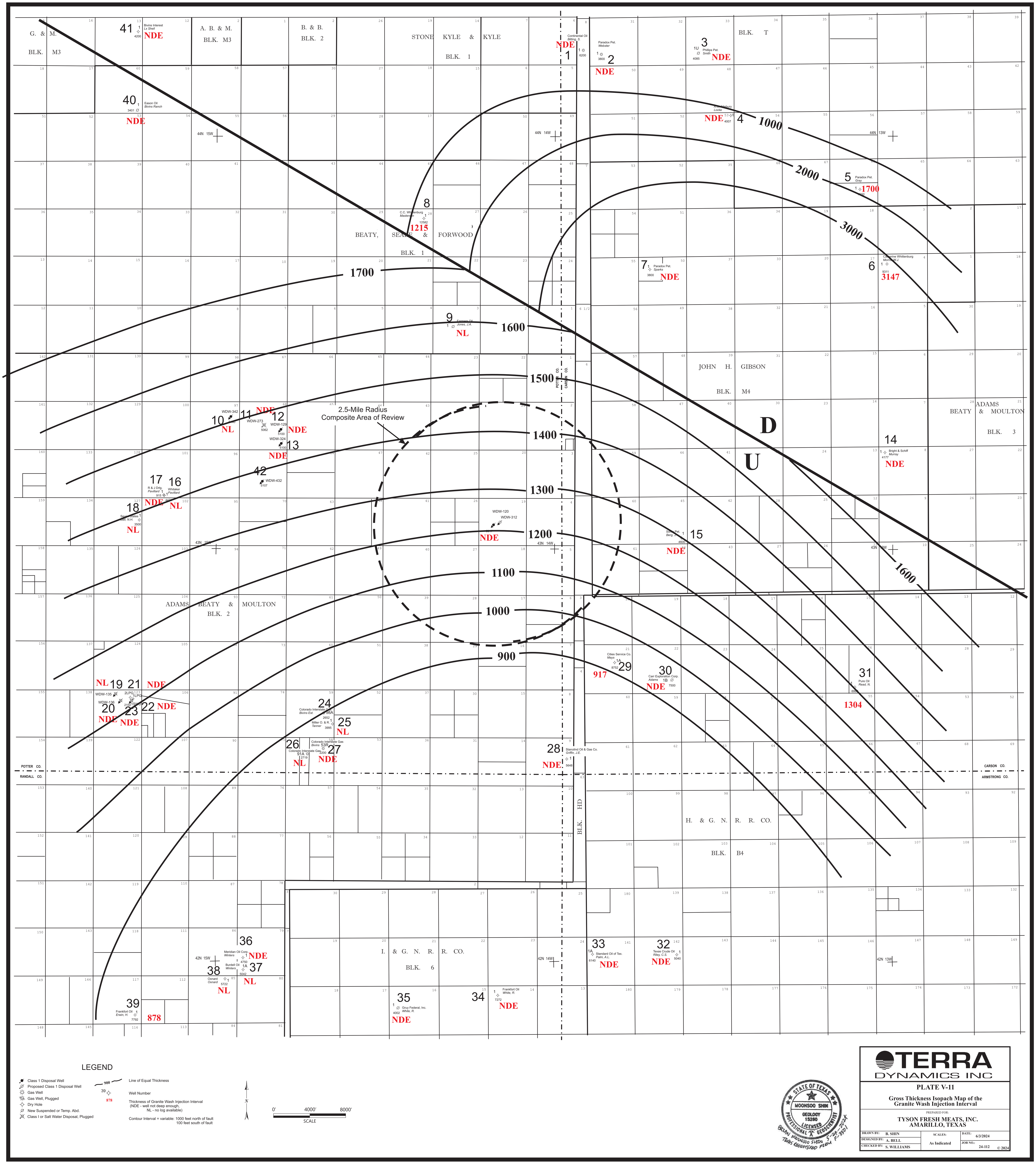

2.5-Mile Radius
Composite Area of Review
1000
2000
3000
1700
1600
1500
1400
1300
1200
1100
1000
900
D
U
BEATY, SEALE & FORWOOD
BLK. 1
ADAMS BEATY & MOULTON
BLK. 2
JOHN H. GIBSON
BLK. M4
H. & G. N. R. R. CO.
BLK. B4
I. & G. N. R. R. CO.
BLK. 6
STONE KYLE & KYLE
BLK. 1
POTTER CO.
RANDALL CO.
CARSON CO.
ARMSTRONG CO.
LEGEND
Class 1 Disposal Well
Proposed Class 1 Disposal Well
Gas Well
Gas Well, Plugged
Dry Hole
New Suspended or Temp. Abd.
Class I or Salt Water Disposal, Plugged
Line of Equal Thickness
Well Number
Thickness of Granite Wash Injection Interval
(NDE - well not deep enough,
NL - no log available)
Contour Interval = variable: 1000 feet north of fault
100 feet south of fault
0' 4000' 8000'
SCALE
TERRA
DYNAMICS INC
PLATE V-11
Gross Thickness Isopach Map of the
Granite Wash Injection Interval
PREPARED FOR:
TYSON FRESH MEATS, INC.
AMARILLO, TEXAS
DRAWN BY: B. SHIN
DESIGNED BY: A. BELL
CHECKED BY: S. WILLIAMS
SCALES: As Indicated
DATE: 6/3/2024
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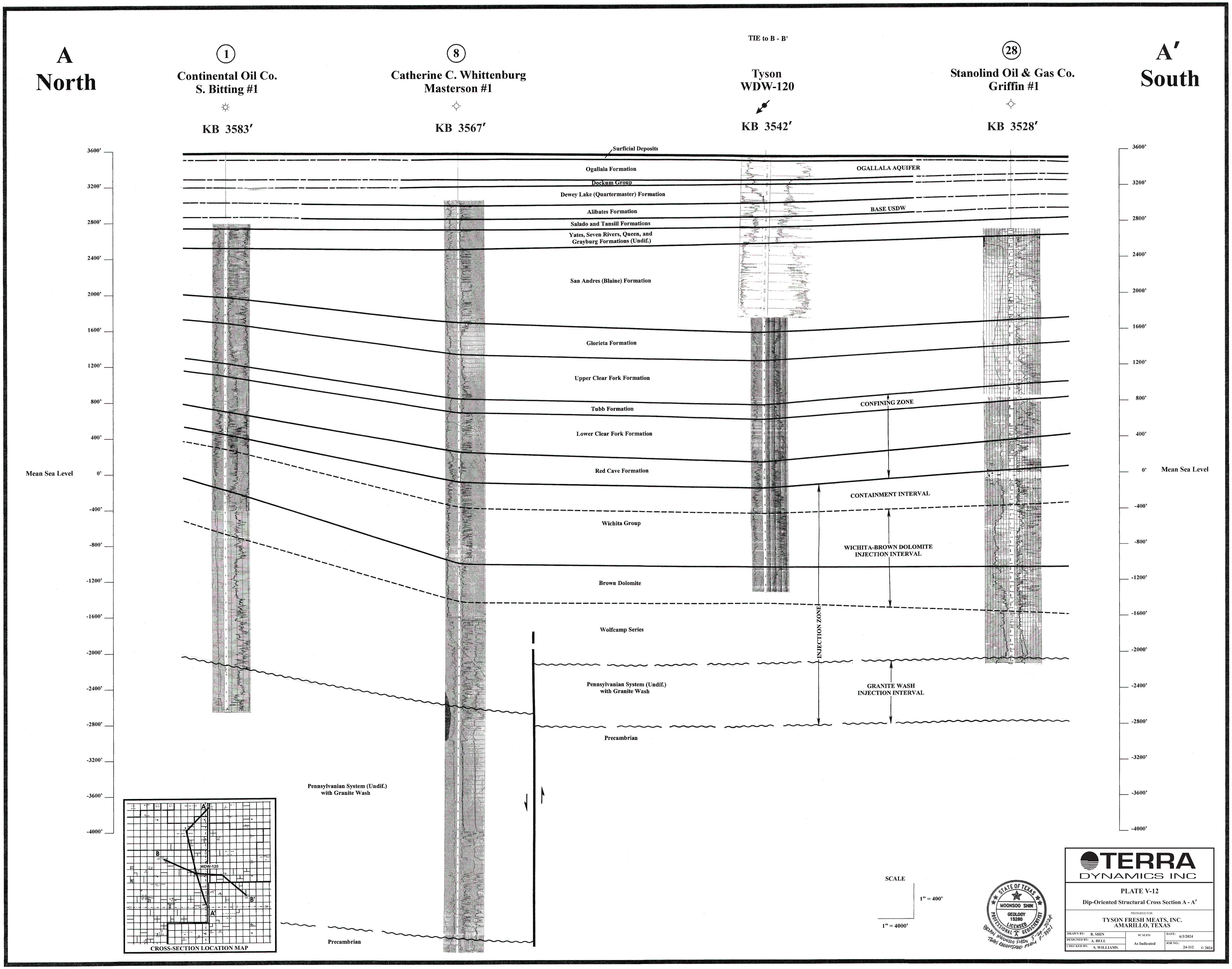

A
North
1
Continental Oil Co.
S. Bitting #1
KB 3583′
8
Catherine C. Whittenburg
Masterson #1
KB 3567′
TIE to B - B'
Tyson
WDW-120
KB 3542′
28
Stanolind Oil & Gas Co.
Griffin #1
KB 3528′
A′
South
3600'
3200'
2800'
2400'
2000'
1600'
1200'
800'
400'
Mean Sea Level
0'
-400'
-800'
-1200'
-1600'
-2000'
-2400'
-2800'
-3200'
-3600'
-4000'
Surficial Deposits
Ogallala Formation
OGALLALA AQUIFER
Dockum Group
Dewey Lake (Quartermaster) Formation
Alibates Formation
BASE USDW
Salado and Tansill Formations
Yates, Seven Rivers, Queen, and
Grayburg Formations (Undif.)
San Andres (Blaine) Formation
Glorieta Formation
Upper Clear Fork Formation
Tubb Formation
CONFINING ZONE
Lower Clear Fork Formation
Red Cave Formation
CONTAINMENT INTERVAL
Wichita Group
WICHITA-BROWN DOLOMITE
INJECTION INTERVAL
Brown Dolomite
INJECTION ZONE
Wolfcamp Series
Pennsylvanian System (Undif.)
with Granite Wash
GRANITE WASH
INJECTION INTERVAL
Precambrian
Pennsylvanian System (Undif.)
with Granite Wash
Precambrian
CROSS-SECTION LOCATION MAP
WDW-120
SCALE
1" = 400'
1" = 4000'
STATE OF TEXAS
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PLATE V-12
Dip-Oriented Structural Cross Section A - A′
PREPARED FOR:
TYSON FRESH MEATS, INC.
AMARILLO, TEXAS
DRAWN BY: B. SHIN
DESIGNED BY: A. BELL
CHECKED BY: S. WILLIAMS
SCALES: As Indicated
DATE: 6/3/2024
JOB NO.: 24-112
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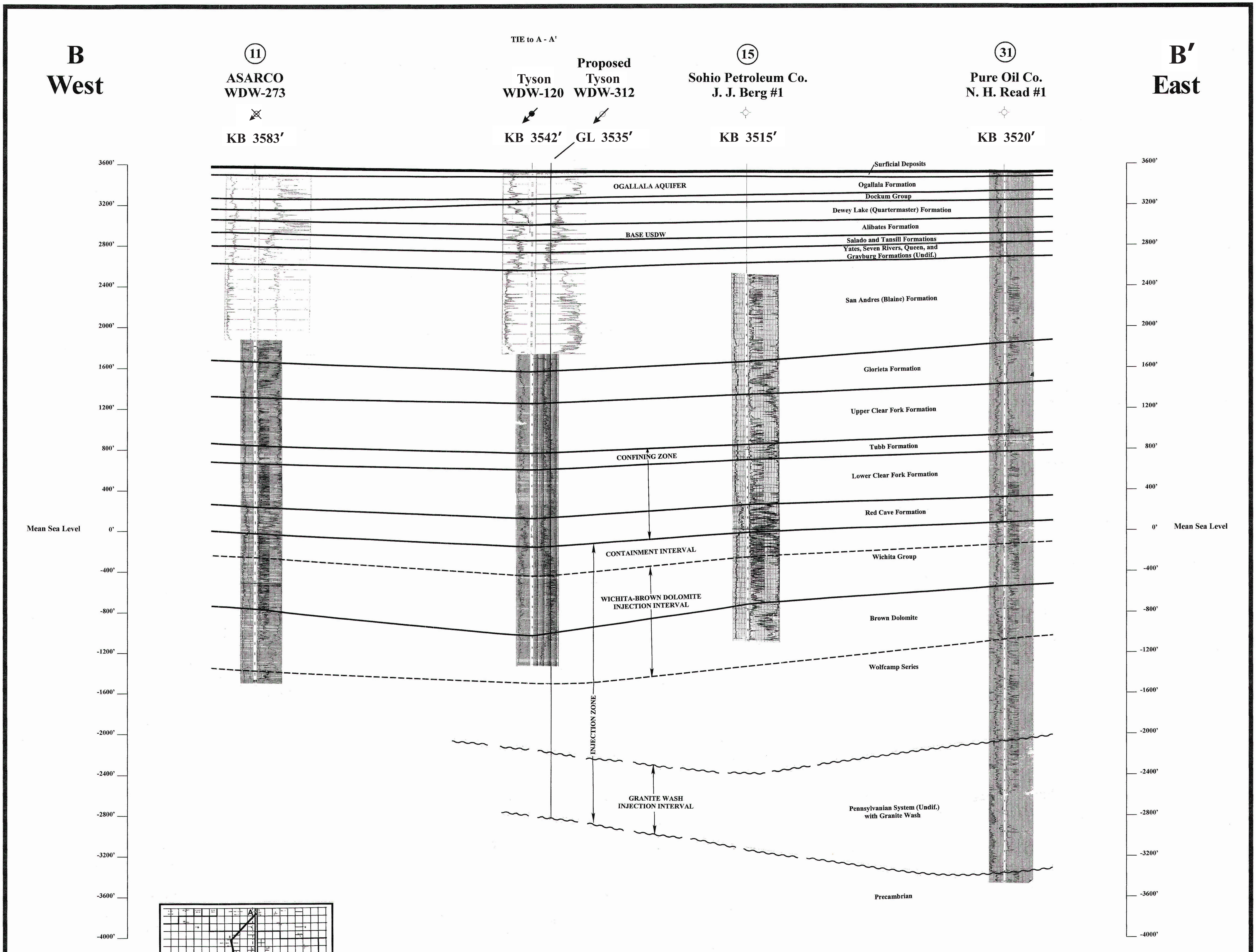

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PLATE V-13

Strike-Oriented Structural Cross Section B - B′

PREPARED FOR:

TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

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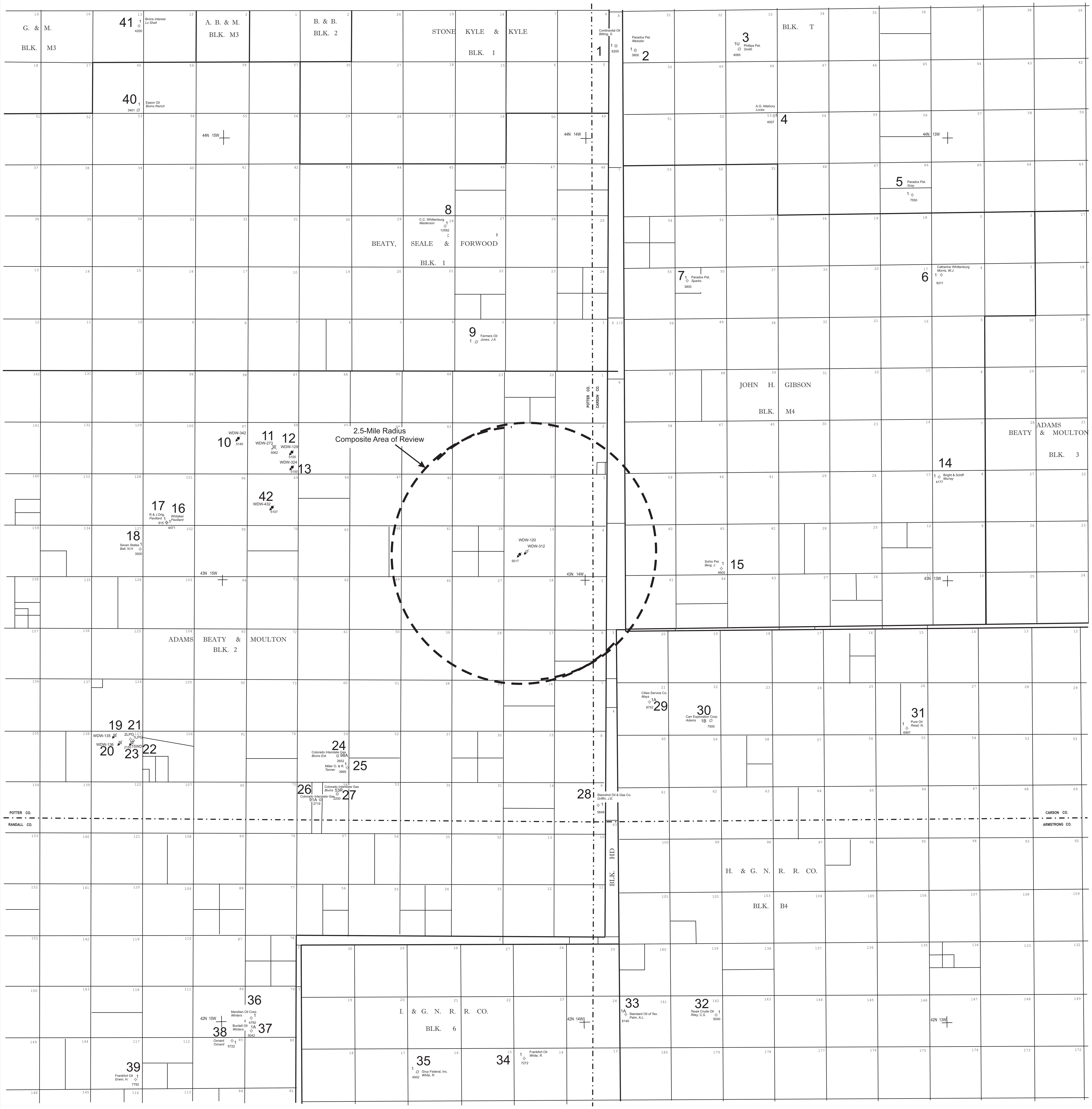
CHECKED BY: S. WILLIAMS			



LEGEND

- Class 1 Disposal Well
- Proposed Class 1 Disposal Well
- Gas Well
- Gas Well, Plugged
- Dry Hole
- New Suspended or Temp. Abd.
- Class I or Salt Water Disposal, Plugged

39 Well Number

N

0' 4000' 8000'
SCALE

STATE OF TEXAS
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PLATE V-14

Blank Base Map

PREPARED FOR:

TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY: B. SHIN	SCALES:	DATE: 6/3/2024	
DESIGNED BY: A. BELL	As Indicated	JOB NO.: 24-112	
CHECKED BY: S. WILLIAMS			

VII. RESERVOIR MECHANICS REPORT

Geoscientist Seal

Signature by Texas Professional Geoscientist

I, Moonsoo (Brian) Shin, the undersigned state: As an employee of Terra Dynamics Incorporated that I am authorized to prepare this document (***VII. Reservoir Mechanics***) and that this document (***VII. Reservoir Mechanics***) was prepared under my supervision and direction. All facts stated herein are true, correct and complete to the best of my knowledge. The geosciences information, calculations and analyses attested to in this document (***VII. Reservoir Mechanics***) were prepared in accordance with generally and currently accepted geosciences principles and practices. The information specifically covered by this seal includes Page VII-1 to VII-20, Table VII-1, Table VII-3 through VII-7, and Figure VII-1 through VII-5.

STATE OF TEXAS
MOONSOO SHIN
GEOLOGY
15260
LICENSED
PROFESSIONAL GEOSCIENTIST

11/13/24

Signature

Date

Licensed Professional Geoscientist
#15260, State of Texas
Terra Dynamics Incorporated
Texas Registered Engineering Firm
F-3501

VII. RESERVOIR MECHANICS REPORT

The WDW-120 Injection Interval has sufficient permeability, porosity, thickness and areal extent to prevent migration of constituents from the Injection Zone into a USDW or freshwater aquifer. The Wichita Group Injection Interval for the proposed WDW-312 is assumed to be equivalent in stratigraphy, lithology, and mechanical properties to that of WDW-120. A summary of the reservoir parameters, bottomhole pressure (BHP) and bottomhole temperature (BHT), fracture gradient, Cone of Influence, and pressure buildup calculations is provided in the following sections.

VII.A. Injection Interval Reservoir Mechanics and Hydrology

For purposes of this permit renewal, the informal unit "injection reservoir" is considered to be the formally defined and permitted Injection Interval, from a depth of 4,000 to 5,000 feet (Wichita Group and Brown Dolomite Formation). This is the part of the Injection Zone through which it is predicted that injected wastewater and displaced reservoir fluids will flow and pressure will increase. This permitted Injection Interval lies within the permitted WDW-120 Injection Zone (Permian and Pennsylvanian strata), present from a depth of 3,720 feet to 9,000 feet. The depths for WDW-120 are relative to kelly bushing and the estimated depths for WDW-312 are relative to ground level.

VII.A.1 Injection Zone Stratigraphy and Lithology

Based on information from WDW-120 (Tyson), WDW-273 (Asarco), and WDW-324 (Asarco) the proposed Injection Zone has sufficient permeability, porosity, thickness, and areal extent for continued, successful injection activity. A summary of lithologic, mineralogic, permeability, porosity, bottomhole pressure (BHP) and bottomhole temperature (BHT) information is provided in Table VII-1. A summary of Injection Interval fluid characteristics is provided in Table VII-2.

The Injection Zone for WDW-120 lies within the Permian/Leonardian Wichita Group and Brown Dolomite Formation. The upper part of the Injection Zone (the Containment Interval, above the Injection Interval) is at a depth of 3,720 to 4,000 feet; the central part of the Injection Zone (the Injection Interval) is at a depth of 4,000 to 5,000 feet; the lower part of the Injection Zone (the lower Containment Interval, below the Injection Interval) is below a depth of 5,000 feet. A structure map of the top of the Injection Zone is included as Plate V-7. An isopach map of the Injection Zone is included as Plate V-8. An isopach map of the Confining Zone is included as Plate V-6. A local strike cross section is included as Plate V-13. A local dip cross section is included as Plate V-12.

Upper Containment Interval

The Upper Containment Interval for both WDW-120 and the proposed WDW-312 is defined as occurring between the approximate depths of 3,720 feet to 4,000 feet. There were no cores taken during the drilling of WDW-120 and therefore are no site specific core data for the Tyson facility. There were also no density logs performed between the depths of 1,846 feet and 4,000 feet. However, the closest off-set well (WDW-324 - located at the Asarco Copper Refinery) had a sonic log performed across the interval of interest and had the drill cuttings logged. Sample descriptions and geophysical log information indicate that the upper Containment Interval consists of approximately 280 feet of interbedded limestone, dolomite and shale. The lower porosity dolomite and shale identified from 3,820 to 4,000 feet will provide a barrier to vertical fluid movement in the upper Containment Interval due to their continuity and hydrologic character. The average acoustic porosity across the interval from 3,720 feet to 4,000 feet (based on readings at 2 foot increments) was 6 percent with a minimum of 0 percent and a maximum of 34 percent and a median value of 4 percent. The cuttings collected and logged from 3,720 feet to 4,000 feet in WDW-324 were described as limestone, dolomite and shale. The Long Spaced Sonic log and cuttings descriptions are included in the 1997 drilling and completion report for Asarco WDW-324 (Appendix J and Appendix G, respectively of that document). As no cores were taken in the interval there are no permeability data.

Injection Interval

The WDW-120 Injection Interval consists of the Wichita Group and the Brown Dolomite Formation (Figure V-8). The proposed WDW-312 Injection Interval will coincide with the WDW-120 interval with the addition of the Granite Wash Formation. The WDW-120 interval (Wichita Group and the Brown Dolomite Formation) occurs at depths of 4,000 feet to 5,000 feet at the WDW-120 location. Within the geologic study area, the total thickness of the combined Wichita Group and Brown Dolomite ranges from approximately 600 to 1200 feet (Plate V-8). The Granite Wash Formation has not been penetrated within the AOR.

The lithologic description developed from the drill cuttings of WDW-120 describes the Wichita Group as brown, gray, and buff anhydritic dolomites. The dolomite is described as very slightly to slightly porous with the fabric types described as dense, sucrosic, fine crystalline, oolitic, and vuggy. The higher porosity was described as occurring in the interval between 4,300 feet and 4,590 feet.

The description of the drill cuttings recovered during the drilling of WDW-120 describes the Brown Dolomite Formation as buff to gray dolomite containing chalk and chert. The fabric is described as slightly porous to porous, fine crystalline to medium crystalline, and containing traces of oolites in a crinoidial dolomite.

Core samples of the Brown Dolomite Formation were collected during the drilling of WDW-324 at the nearby Asarco Facility. A whole core of the Brown Dolomite Formation was cut and retrieved from 4,720 feet to 4,750 feet. Complete petrographic analyses were performed on six core samples. The samples were described as dolomitic packstones and dolomitic grainstones. The predominant pore system observed in the samples was vugs with the secondary pore system being intercrystalline pores. Extensive anhydrite and gypsum cementation was observed in the six core samples. The Core Labs report is included in Appendix B.

No data has been discovered pertaining to the Granite Wash interval near the Tyson facility. For the purposes of this permit renewal application, it has been assumed that the Granite Wash Formation will be present in a minimum thickness of 100 feet. It is also assumed that the Granite Wash Formation will consist of sands and/or conglomerates. Reservoir parameters are assumed to be equal or more conservative than those employed in the permitting of the closest Granite Wash Formation injection well located in Borger, Texas. The Phillips 66 well (WDW-325), located some 50 miles to the northeast, has whole core information available from the Granite Wash Formation. That Granite Wash core consists of fine to coarse-grained sandstones, siltstone, and conglomerate. The porosity average from that core is 18 percent, whereas the Tyson model uses a much more conservative value of 10 percent. The permeability average from the WDW-325 core is 528 mD, whereas the Tyson model uses a much more conservative value of 40 mD. A copy of the WDW-325 open hole core from the Granite Wash Formation is attached for inclusion into Appendix B.

A summary of the lithologic properties of the Injection Intervals is provided in Table VII-1.

VII.A.2 Reservoir Rock Parameters

Porosity

Again, as no core samples were collected during the installation of WDW-120 there is no site specific core data on porosity for the Injection Interval. However, a density log was performed across the upper portion of the Injection Interval from 4,000 feet to 4,875 feet. The density log indicates that the porosity from approximately 4,000 feet to 4,580 feet averages approximately 2 percent. A porosity increase was indicated on the density log below 4,580 feet (see Appendix B). The average porosities indicated on the WDW-120 density log are as follows:

Depth Range	Average Porosity
4,580 feet to 4,638 feet	4%
4,638 feet to 4,686 feet	9%
4,686 feet to 4,770 feet	13%
4,770 feet to 4,875 feet	16%

The Brown Dolomite core from WDW-324 (Asarco) was analyzed for porosity at 1-foot intervals. The average porosity derived from the WDW-324 core was 13 percent. Based upon the porosity derived from the density log and the data from the WDW-324 core a porosity of 10 percent has been selected for the Injection Interval modeling.

The Granite Wash Formation is typically a very porous formation. However, since there is no site specific data on the Granite Wash Formation the average porosity derived for the Wichita Group/Brown Dolomite Formation (10%) will be employed for modeling purposes.

Permeability

Permeability values for the Wichita Group Injection Interval have not been obtained for the site specific rock as no cores were collected during the installation of WDW-120. However, the Injection Interval of WDW-120 has been subjected to annual reservoir tests since the last permit renewal. The permeability values derived from the reservoir tests since 2003 are as follows.

Year	Derived Permeability (mD)
2003	17
2004	2
2005	20
2006	2
2007	17
2008	25
2009	23
2010	28
2011	45
2012	82
2013	15
2014	20
2015	46
2016	39
2017	38
2018	14
2019	10
2020	12
2021	14
2022	13
2023	15
2024	12

The average permeability derived from the last 21 years of reservoir testing for WDW-120 is 23.1 millidarcies (mD). For modeling purposes, a permeability value of 20 mD is selected for the Wichita Group/Brown Dolomite interval.

The Granite Wash Formation is typically a very permeable formation. However, since there is no site specific data on the Granite Wash Formation, a conservative permeability of 40 mD will be assumed for modeling purposes.

A summary of the porosity and permeability properties of the Injection Interval is provided in Table VII-1.

Reservoir Thickness

The WDW-120 Injection Interval consists of perforated casing and open hole intervals. A total of 549 feet of perforations are present in the well. The open hole interval is 136 feet.

The total interval available for injection is 685 feet. To maintain a conservative approach to the model only half of the available interval (342 feet) is employed in the modeling.

The interval thickness for the Granite Wash Formation in the proposed WDW-312 is conservatively assumed to be 100 feet for modeling purposes.

Bottomhole Temperature

The bottomhole temperature recorded during the open hole logging of WDW-120 was 113 ^{o}F. The log was run to a depth of 4,875 feet. The gradient extrapolated from this reading is 2.32 ^{o}F per 100 feet of depth.

VII.A.3 Reservoir Fluid Parameters

A chemical analysis of the Brown Dolomite brine was performed on a sample of native formation brine collected during the drilling of WDW-120. The brine sample was collected during a drill stem test performed October 10, 1974. The test interval was from 4,828 feet to 4,875 feet. This data indicates that the Injection Interval formation fluid consists of brine with a total dissolved solids (TDS) value of 172,000 mg/L, a specific gravity of 1.118 at 60 ^{o}F, and a pH of 6.8 @ 60 ^{o}F, which is converted to 0.484 psi/ft as the formation brine gradient (1.118 sp. gr. x 0.433). The extrapolated viscosity (extrapolated using Matthews and Russell type curves) of the recovered brine is 0.85 cP at 113 ^{o}F. A complete summary of Injection Interval fluid characteristics is provided in Table VII-2.

VII.A.4 Reservoir Pressures

The initial reservoir was measured in WDW-120 as 1,299 psi at 4,814 feet during the performance of the drill stem test. The observation depth is estimated as ten feet above the upper packer on the drill stem test tool. A summary of the Injection Interval BHP properties is provided in Table VII-1.

VII.A.5 Fracture Pressure

The core samples recovered from Asarco WDW-273 were analyzed by Core Labs to determine fracture pressure. The test derived two gradients (fracture gradient and closure gradient) relevant to fracturing the formation rock. The fracture gradient represents the pressure gradient at which fracturing will be initiated. The closure gradient represents the pressure gradient at which induced fractures would close under ambient reservoir conditions. The fracture gradient range derived from the testing was 0.999 psi/ft to 1.236 psi/ft. The closure gradient range derived from the testing was 0.592 psi/ft to 0.676 psi/ft.

A conservative fracture pressure may be calculated using the lowest closure gradient. The fracture pressure for WDW-120 with the top of the Injection Interval at 4,000 feet would be 4,000 x 0.592 = 2,368 psi. The fracture pressure for WDW-312 with the top of the Injection Interval at 5,850 feet would be 5,850 x 0.592 = 3,463 psi. A copy of the Core Labs report is included in Appendix B.

The maximum allowable surface injection pressure (MASIP) can be calculated using the above core data. Using the heaviest currently permitted injectate specific gravity of 1.15 and the depth to the top of the Wichita Group/Brown Dolomite Injection Interval (4,000 feet) and the Granite Wash Injection Interval (5,850 feet), the hydrostatic head of an injectate column is 1,992 psi (4,000 feet x 1.15 x 0.4333 psi/ft) or 2,915 psi (5,850 feet x 1.15 x 0.4333 psi/ft). Subtracting the hydrostatic head pressure from the fracture pressure (2,368 psi – 1,992 psi, or 3,463 psi – 2,915 psi) results in a maximum surface injection pressure that can be employed without fracturing the top of the Wichita Group/Brown Dolomite Injection Interval, of 376 psi, or the top of the Granite Wash Injection Interval, of 548 psi. Subtracting the 100 psi safety factor yields a MASIP of 276 psi for the Wichita Group/Brown Dolomite Injection Interval and 448 psi for the Granite Wash Injection Interval. These MASIP pressures are extremely conservative, as the values ignore the pressure drop that will occur in the wellbore during injection due to tubing friction loss. Additionally, the maximum density fluid used in this calculation is rarely if ever reached; the densities observed the last several years during the pressure falloff test have been near 1.05. Also, the fracture gradient used (0.592 psi/ft) is substantially lower than the average for the Injection Interval cores analyzed. Tyson thus requests that the maximum allowable surface injection pressure is permitted at 270 psi (as presently permitted) for WDW-120 and 470 psi for WDW-312.

The MASIP program was run to confirm the values derived. The results of this spreadsheet (included as Table VII-4 and VII-5) indicate a MASIP value of 287 psi and 509 psi depending on the Injection Interval, similar to what are provided through the above calculation. This confirms the validity of the results, and the continued use of a MASIP of 270 psi and request of a MASIP of 470 PSI for WDW-312.

VII.A.6 Reservoir Pressure Increase Predictions

The PRESS2 analytical pressure model was used to calculate the maximum pressure increases which could occur in the Injection Interval one year (12/31/24) from the present (most recently available volume data is 12/31/23) and after ten years (12/31/33) for WDW-120, and one year, ten years, and thirty years after injection is initiated into the proposed

WDW-312 Granite Wash Injection Interval. From the pressure model outputs, the projected pressure increase within the Injection Interval reservoir was contoured and plotted, and the size of the calculated Cone of Influence (see Section VII.A.7 following) was determined.

The PRESS2 model was used to simulate the pressure buildup in the AOR due to injection at WDW-120 and the proposed WDW-312 well locations. The full 48.5-year injection history of WDW-120 was used through December 31, 2023 (total injected volume of 825,153,077 gallons) to determine an average injection rate. The rate was determined to be 32.35 gallons per minute (gpm). This rate was used in the model from May 30, 1975 through December 31, 2023. After December 31, 2023, the maximum permitted average rate of 200 gpm was used in the model. The injection rate modeled for the proposed WDW-312 is also the maximum permitted average rate of 200 gpm. The WDW-120 pressure model was run for one year from the present (December 31, 2023), and ten years into the future (December 31, 2033). The model for WDW-312 was run for one, ten, and thirty years into the future at a constant injection rate of 200 gpm.

The computed Injection Interval reservoir pressure increases are a conservative approximation for the purposes of predicting pressure increases within the AOR and potential endangerment of USDWs. Upper and lower aquifer limits are modeled as no-flow boundaries and thus do not allow pressure dissipation vertically. The projected annual maximum injection rate in the model for both wells is assumed to be at a continuous rate (200 gpm), whereas the injection rate actually will fluctuate and will be effectively lower during the injection life of the well. These model parameters thus conservatively forecast the conditions in the injection reservoir, and the resultant predictions are more than satisfactory for the purposes of determining pressure increases within the 2.5-mile radius AOR and surrounding area.

The pressure model input parameters and their sources are given in Table VII-3 for the Wichita/Brown Dolomite and the Granite Wash intervals. As there is no site data for the Granite Wash Formation in the nearby area, the permeability was estimated to be 40 mD and porosity of the Brown Dolomite/Wichita Group (10%) is employed in the model for WDW-312. The model parameters input into PRESS2 are primarily derived from WDW-120 well logs, sample descriptions and reservoir tests. Along with the data from WDW-120, the core data from Asarco's WDW-273 and WDW-324 were also used. The model input parameters for WDW-120 include: porosity (10%), permeability (20 mD - average permeability derived from reservoir testing on WDW-120 from 2003 to 2024); net reservoir thickness (342 feet - 1/2 of the perforated and open hole interval); total compressibility (6.6 x $10^{-6)}$; and viscosity (0.85 cP at 113 ºF - viscosity of Wichita Group/Brown Dolomite formation fluid samples). The model input parameters for the proposed WDW-312 well include: porosity (10%), permeability (40 mD); net reservoir thickness (100 feet - assumed thickness based on isopach maps of the Granite Wash Formation); total compressibility (6.6 x $10^{-6)}$; and viscosity (0.85 cP at 113 ºF - viscosity of Wichita Group/Brown Dolomite formation fluid samples). These values are very conservative as the Granite Wash Formation is typically a sandstone/conglomerate with abundant porosity and permeabilities in excess of 100 mD.

The results of the PRESS2 modeling were used in an analytical gridding program called THWELLS to produce pressure contour maps illustrating the projected pressure increases due to injection. The projected pressure increase was modeled for intervals of one year (12/31/24) from the present (Figure VII-1), one year from the initiation of injection into WDW-312 (Figure VII-2), ten years (12/31/33) from the present for WDW-120 (Figure VII-3), and ten years from the initiation of injection into WDW-312 (Figure VII-4), and thirty years from the initiation of injection into WDW-312 (Figure VII-5). The PRESS2 modeling results for WDW-120 and WDW-312 are presented in Table VII-6 and Table VII-7, respectively.

The pressure model results indicate that the Wichita/Brown Dolomite Injection Interval reservoir pressure increase one and ten years from the present at WDW-120 would be 1,183 psi and 1,301 psi respectively. The pressure model results indicate that the Granite Wash Injection Interval reservoir pressure increase one, ten, and thirty years after initiation of injection at WDW-312 would be 2,029 psi, 2,266 psi, and 2,379 psi respectively.

The pressure increase around the wells decreases radially with distance from the well. After an additional one and ten years of injection, the pressure increases at the edge of the 2.5-mile radius AOR for WDW-120 Wichita Group/Brown Dolomite interval are 64 psi and 162 psi, respectively (Table VII-6). After one, ten, and thirty years of injection the projected pressure increases at the edge of the 2.5-mile radius AOR for WDW-312 Granite Wash interval are 102 psi, 317 psi, and 428 psi, respectively (Table VII-7).

VII.A.7 Cones of Influence Determination

The Cone of Influence is considered for the purposes of this application as that area in which increased pressures at the top of the injection reservoir are sufficient to drive reservoir fluids into a wellbore. That wellbore is considered to contain a 9.0 pounds per gallon (ppg) fluid column extending from the top of the injection reservoir to a level 50 feet below the ground surface. A minimum uniform depth for the top of the reservoir is used in order to conservatively delineate the area.

In order to determine whether artificial penetrations within the AOR surrounding WDW-120 and the proposed WDW-312 meet standards so as to prevent endangerment of USDWs due to increased Injection Interval pressures, reservoir pressure increases are calculated using an analytical solution model. The THWELLS model, in conjunction with the PRESS2 model, projects the effects of injection incorporating the historical injection rates, and assuming all future injection into WDW-120 and WDW-312 occurs at projected maximum permitted average rates (200 gpm). The model predicts the maximum Injection Interval reservoir pressure increases that would be expected at artificial penetration locations within the AOR. These expected reservoir pressure increases are then compared to the calculated reservoir pressure increase that would be required to displace a mud or weighted fluid column in a wellbore such that fluids would be driven into USDW.

Drilling mud in an abandoned wellbore is a barrier to vertical migration of native or injected fluids from the Injection Zone because of the hydrostatic pressure differential between the mud column and the Injection Zone reservoir pressure. One purpose of drilling mud is to control or overcome the formation pressures of the geologic stratum penetrated. To accomplish this, the hydrostatic gradient of the mud column must be equal to or greater than the equivalent of the formation pressure encountered. To determine the pressure or gradient exerted by a column of mud, a reported or estimated value of the mud weight in the wellbore is required. A review of available data indicates a range of mud weights used for drilling and plugging wells in the Texas panhandle. As there are no wells in the AOR this data was used for determining mud weights. However, the typical mud weight recorded as used for plugging was 9 lb/gal. The pressure gradient increases in direct proportion with the weight of the fluid. A mud weight of 9 lb/gal would result in a pressure gradient of approximately 0.468 psi/foot of depth. Before vertical migration of fluids from an abandoned wellbore can occur, the Injection Zone reservoir pressure at the abandoned wellbore (plugged only with mud) would have to increase to that pressure necessary to displace a 9 lb/gal mud column. This is considered to be a very conservative figure since the gel strength of the mud, the resistance of the mud to flow, borehole conditions, and other factors have not been considered.

The top of the Wichita/Brown Dolomite Injection Interval reservoir is at 4,000 feet at WDW-120. Using this reference depth of 4,000 feet for the top of the Injection Interval reservoir, the pressure exerted by a mud column of that height, less 50 feet of fallback, at a wellbore filled only with 9.0 ppg mud would be 1,848 psi ([4,000 ft - 50 ft] x 0.468 psi/ft).

The most recent static bottomhole pressure measured at WDW-120 during the 2024 annual mechanical integrity testing (MIT) is calculated as 2,203 psia (2,188 psig) at a depth of 4,800 feet, which is converted to 1,816 psia ([4,800 ft – 4,000 ft] x 0.484 psi/ft) using the formation brine gradient. The pressure increase from the estimated native formation pressure (905 psi) to the most recent static bottomhole pressure (1,816 psi) may have been caused by Tyson's utilization of aerated ponds while processing wastewater in the Amarillo facility. The ponds storing the wastewater before injection provide biological treatment, but also generates a biological slime when not properly managed. The slime could block the perforated zones downhole and result in increasing bottomhole pressure over time. Therefore, the initial rock properties should have remained almost identical, but the well would have been received the skin damage as calculated up to -1,835 psi of ΔP skin (pressure change caused by formation damage) during the pressure falloff test of the 2024 annual MIT (TDI, 2024). Tyson plans to continue remediating the increasing trend in bottomhole pressure by performing treatment tests with a custom blend of inhibitors and biocide at the well (see Section IX.A for more details).

Assuming the increasing trend in the bottomhole pressure buildup is caused from the site specific issues such as the organisms living in the aerated ponds, the intrinsic static bottomhole pressure was evaluated from the neighboring four Class I injection wells currently being operated within an approximate 6-mile radius of the Tyson facility (Plate V-14). All four of the wells are located between 4.5 and 6 miles to the west-northwest of the study area while WDW-342 is the most distant at 5.9 miles from WDW-120 and is operated by Southwest Public Service (SPS). WDW-129, WDW-324, and WDW-432 are located at and operated by Asarco. The closest well, WDW-324, is 4.7 miles from WDW-120. All of these wells are completed into the Brown Dolomite Formation. The SPS well is permitted for injection at 1,500 gpm. The Asarco wells are permitted to inject at 300 gpm cumulative to all three wells. The historical bottomhole pressure data of each well are included below, demonstrating that each well has commonly experienced some degree of bottomhole pressure buildup. However, the bottomhole pressures at each well have only increased within the range of 67 to 328 psi (from initial to the historical maximum measurement performed up to 2023).

Historical Bottomhole Pressure Data of Neighboring SPS WDW-342 and ASARCO WDW-129, WDW-324 and WDW-432

Year	Static Pressure (psia) SPS WDW-342 at 4,000 feet KB	Static Pressure (psia) ASARCO WDW-129 at 4,120 feet KB	Static Pressure (psia) ASARCO WDW-324 at 4,300 feet KB	Static Pressure (psia) ASARCO WDW-432 at 4,120 feet KB
1999	**1,763**	-	-	-
2000	1,643	-	-	-
2001	1,873	-	-	-
2002	1,937	-	-	-
2003	1,956	-	-	-
2004	1,940	-	-	-
2005	1,969	-	-	-
2006	1,947	**1,878***	**1,890***	-
2007	1,950	1,972*	1,844*	-
2008	2,002	1,989	1,870*	-
2009	2,006	2,027	1,858*	-
2010	2,033	1,999	2,084*	-
2011	2,063	2,051	2,066*	-
2012	2,040	1,966	2,127	-
2013	2,024	1,900	2,077	-
2014	2,051	1,989	1,962	**1,493**
2015	2,053	2,016	1,930	1,497
2016	2,074	2,016	2,083	1,495
2017	2,039	2,003	2,006	1,503
2018	2,068	2,020	2,025	1,510
2019	2,039	2,008	2,006	1,601
2020	2,041	1,998	1,979	1,520
2021	2,054	1,947	2,067	1,603
2022	2,091**	2,052	2,001	1,621**
2023	2,020	2,067**	2,142**	1,559
ΔBHP	257/328**	189**	252**	66/128**

*Extrapolated to datum using fluid gradient of 0.45 psi/ft
** ΔBHP calculated from the historical maximum measurement

The above pressure data suggest that the neighboring Class I injection wells completed into the Brown Dolomite Formation have experienced a reservoir pressure increase of about 328 psia over 24 years of injection. Among the four Class I injection wells, during the 24 years of operation, SPS has injected the largest historical volumes of wastewater

(5,517,800,710 gallons into WDW-342) at approximately 6.7 times of what Tyson has injected into WDW-120 over 48.5 years of operation (825,153,077 gallons). Thus, the historical maximum increase of bottomhole pressure measured at WDW-342 is a very conservative, yet representative value suitable to calculating the intrinsic pressure buildup at WDW-120. The historical pressure analysis of WDW-120 from VII.A.8 derives a historical pressure buildup of 732 psia since its recompletion performed in 1992. Subtracting the historical maximum pressure increase of WDW-342 (328 psia) from the historical pressure increase of WDW-120 (732 psia), the estimated intrinsic bottomhole pressure buildup at WDW-120 is calculated as 1,412 psi [(2,203 psi - (4,800 ft – 4,000 ft) x 0.484 psi/ft) – (732 psi – 328 psi)], using the formation brine gradient of 0.484 psi/ft.

Using the current bottomhole pressure measured from the 2024 MIT, the formation pressure increase at 4,000 feet would have to exceed **32 psi [1,848 psi – 1,816 psi]** before any movement of reservoir fluids into a wellbore, or vertically into any USDWs. Below 32 psi, there is no potential for movement of reservoir fluids into a wellbore, or vertically into any USDWs. Assuming the estimated intrinsic static pressure extrapolated from the neighboring Class I injection wells, the formation pressure increase at 4,000 feet would have to exceed **436 psi [1,848 psi – 1,412 psi]** before any fluid movement into wellbore, or vertically into any USDWs could occur. The **436 psi** pressure increase is defined as the Cone of Influence for this demonstration.

Although there is no site specific data on the reservoir pressure in the Granite Wash Formation, it is calculated that the Cone of Influence pressure would be able to meet required criteria because the Granite Wash Formation has higher permeability and never been utilized for injection in the vicinity of the study area. The top of the Granite Wash Injection Interval reservoir is at 5,850 feet at WDW-312. Using this reference depth of 5,850 feet for the top of the Injection Interval reservoir, the pressure exerted by a mud column of that height, less 50 feet of fallback, at a wellbore filled only with 9.0 ppg mud would be 2,714 psi ([5,850 ft - 50 ft] x 0.468 psi/ft).

The native formation pressure at WDW-120, prior to injection into the reservoir, was measured to be 1,299 psig at a depth of 4,814 feet BGL. Converting to 5,850 feet BGL using the measured pressure gradient of 0.484 psi/ft, the native formation pressure at this depth is estimated to be 1,800 psi (1,299 psi + [1,036 ft x 0.484 psi/ft]).

The formation pressure increase at 5,850 feet GL would have to exceed **914 psi [2,714 psi – 1,800 psi]** before any upward movement of fluid from the Granite Wash Injection Reservoir would be possible.

The projected Wichita Group/Brown Dolomite Injection Interval reservoir pressure increase is calculated to be a maximum of 1,301 psi at WDW-120 and 162 psi at a distance of approximately 2.5 miles from WDW-120 after ten additional years of continuous future injection (see Section VII.A.6). The projected Granite Wash Injection Interval reservoir pressure is calculated to be a maximum of 2,379 psi at WDW-312 and 428 psi at a distance of approximately 2.5 miles from WDW-312 after 30 years of continuous future injection (see Section VII.A.6). The projected Cone of Influence after ten years future injection (436 psi) for the WDW-120 Wichita Group/Brown Dolomite interval extends approximately 1,320 feet from the wellbore (Table VII-6). The projected Cone of Influence after 30 years future injection for the WDW-312 Granite Wash interval extends less than 1,240 feet from the wellbore (Table VII-7), also remaining within the property boundaries of the facility. As there are no wells within the AOR that penetrate the Injection Zone there is no conduit for fluid movement. This future pressure projection is conservative since injection wells typically do not operate continuously at maximum injection rates, allowing for reservoir pressure recovery periods that reduce the maximum build up pressures. In addition, it is unlikely that Tyson will operate either well at a continuous, non-ceasing, maximum cumulative injection rate of 200 gpm.

The isobars are illustrated on Figures VII-1, VII-3 and VII-5 as red line with annotations. The Cones of Influence do not extend outside of the plant boundary for WDW-312. This in combination with the absence of artificial penetrations within the 2.5 mile AOR assures that reservoir pressurization due to injection activity does not present a danger for USDWs.

VII.A.8 Historical Pressure Analysis

The bottomhole pressure has been measured on WDW-120 annually since its recompletion in 1992. A summary of those measurements is presented in the following table:

Year	Shut-In Time (hr)	Static Pressure (psia)
1992	36	1,471
1993	36	1,679
1994	36	1,756
1995	36	1,833
1996	36	1,899

1997	36	1,864
1998	36	1,917
1999	36	1,841
2000	36	1,772
2001	36	1,859
2002	36	1,882
2003	36	1,931
2004	36	1,908
2005	36	1,932
2006	36	1,952
2007	36	1,998
2008	36	2,009
2009	36	1,988
2010	36	2,025
2011	36	2,016
2012	36	1,960
2013	36	2,077
2014	37	2,155
2015	37	2,155
2016	38	2,168
2017	38	2,204
2018	37	2,218
2019	38	2,226
2020	37	2,129
2021	41	2,255
2022	45	2,204
2023	46	2,165
2024	45	2,203
ΔBHP	-	732

These measurements are corrected to a common datum of 4,800 feet, if not initially measured at that depth. It is evident from this chart that historical Tyson injection operations into the Wichita Group/Brown Dolomite interval have increased the static bottomhole pressures in the Injection Interval reservoir. A portion if not the majority of the pressure increase is due to near-wellbore formation damage due to solids (exoskeleton) or slimes present in the injectate. However, the pressures have stabilized at approximately 2,150 – 2,200 psia for last ten years. To maintain a conservative approach to the model, the most recent measurement from the 2024 annual MIT is employed in modeling.

VII.A.9 Potentiometric Surface and Regional Gradient

The Tyson WDW-120 Injection Zone includes the upper Wolfcamp Series, whose hydrogeologic system has been mapped on a regional basis. A potentiometric surface map of the Tyson Injection Zone is provided as Figure V-19 (Potentiometric Surface of the Wolfcamp Aquifer). The regional flow direction of this deep saline aquifer system in the Palo Duro Basin is toward the northeast below the Tyson facility (Figure V-19). Regional topography and stratigraphic porosity trends appear to be the driving forces governing regional flow patterns. The deep basin system is subnormally pressured, and discharge points, if any, for the deep basin system have not been determined.

The Tyson WDW-312 proposed Injection Zone includes the Granite Wash formation. As there is little information about the Granite Wash Formation in the immediate area the potentiometric properties of the formation are unknown.

VII.A.10 Waste Plume Geometry Justification

The WDW-120 Injection Interval strata are primarily composed of low porosity fractured dolostone. In the near wellbore region fluids will move away from the well in linear tracks along the fractures. However, in a large scale the interconnectivity of the fractured rock results in the plume moving away from the well as if in a radially homogeneous, isotropic formation. For the waste plume geometry, a radial flow solution to the waste plume geometry is therefore assumed.

The proposed WDW-312 assumes Injection Interval strata composed of porous and Granite Wash sandstone, siltstone, and conglomerate. Historical well tests from Granite Wash wells in the Texas Panhandle indicate radial flow patterns common to porous medium models. For the waste plume geometry, a radial flow solution to the waste plume geometry is therefore assumed.

VII.A.11 Waste Plume Extent

WDW-120

The calculated extent of the WDW-120 waste plume projected ten years from the present can be determined by using the analytical solution presented below. The predicted positions of the WDW-120 waste front over time were calculated, assuming a continuous maximum rate of 200 gpm injected into WDW-120 from January 1, 2024 to December 31, 2033. This provides a worst case plume size determination, as the average historical injection rate over 48.5 years has been 32.35 gpm, and it is very unlikely that WDW-120 will inject into the future at an average rate 200 gpm over the remaining life of that well. The radial distance of displacement was calculated using the following equation:

$$r = \sqrt{\frac{Q}{\pi h \phi}} \quad \text{(TWDB, 1983)}$$

where:

r = radial distance of fluid front from well, feet;
Q = cumulative volume of fluid injected, cubic feet (ft^3)
ϕ = porosity of receiving formation; and
h = thickness of formation, feet.

For the current and ten-year projected time (December 31, 2023 and December 31, 2033), the variables for WDW-120 are:

Q = Historical volume (to December 31, 2023) = 825,153,077 gallons (110,306,922 ft^3)
Q = Projected volume for ten years = 1,052,064,000 gal (3,653 days x 1,440 min/day x 200 gpm) equals 140,650,436 ft^3
ϕ = 8% effective porosity (reduced from 10% by immoveable water as per TCEQ guidelines)
h = 342 feet (modeled reservoir thickness)

Thus, the current (2023) plume front for WDW-120 has a radius of

$$\sqrt{\frac{110{,}306{,}922 \text{ ft}^3}{(\pi)(342 \text{ ft})(0.08)}} = 1{,}133 \text{ ft}$$

and the projected (2033) plume front for WDW-120 has a radius of

$$\sqrt{\frac{250{,}957{,}358 \text{ ft}^3}{(\pi)(342 \text{ ft})(0.08)}} = 1{,}709 \text{ f}t$$

An estimate of the influence of dispersion was made with the following equation:

$$r' = r + 2.3\sqrt{Dr}$$

where

r` = radial distance of travel with dispersion
D = dispersion coefficient; 65 feet (65 feet for limestones and dolomites).

Thus, the current (2023) plume front for WDW-120, including dispersion, has a radius of

r\` = 1,757 ft

And the projected (2033) plume front for WDW-120, including dispersion, has a radius of

r\` = 2,476 ft.

The worst-case radial distances of displacement, including dispersive effects, for the current and projected ten-year waste plumes is determined to be 1,757 feet and 2,476 feet respectively from WDW-120.

<u>WDW-312</u>

The calculated extent of the proposed WDW-312 waste plume projected 30 years into the future can be determined by the same method as that used for WDW-120. The predicted positions of the WDW-312 waste front over time were calculated, assuming a continuous maximum rate of 200 gpm injected into WDW-312. This provides a worst case plume size determination, as it is unlikely that WDW-312 will inject more than an average 200 gpm over the life of that well. The radial distance of displacement was calculated using the same equations as provided previously.

For the ten-year and 30-year projected operational periods of WDW-312 the variables are:

Q = Projected volume for ten years = 1,052,064,000 gal (3,653 days x 1,440 min/day x 200 gpm) equals 140,650,436 ft^3
Q = Projected volume for 30 years = 3,155,904,000 gal (10,958 days x 1,440 min/day x 200 gpm) equals 421,912,806 ft^3
ϕ = 8% effective porosity (reduced from 10% by immoveable water as per TCEQ guidelines)
h = 100 feet (assumed reservoir thickness)

Thus, the ten-year future plume front has a radius of

$$\sqrt{\frac{140{,}650{,}436\ \text{ft}^3}{(\pi)(100\ \text{ft})(0.08)}} = 2{,}366\ \text{feet}$$

and the 30-year future plume front has a radius of

$$\sqrt{\frac{421{,}912{,}806\ \text{ft}^3}{(\pi)(100\ \text{ft})(0.08)}} = 4{,}097\ \text{feet}.$$

An estimate of the influence of dispersion was made with the following equation:

$$r' = r + 2.3\sqrt{Dr}$$

where

r' = radial distance of travel with dispersion
D = dispersion coefficient; 3 feet for sandstone aquifers.

Thus, the ten-year future plume front, including dispersion, has a radius of

$$r' = 2{,}366 + 2.3\sqrt{(3)(2{,}366)}$$

$$r' = 2{,}560 \text{ feet}$$

and the 30-year future plume front, including dispersion, has a radius of

$$r' = 4{,}097 + 2.3\sqrt{(3)(4{,}097)}$$

$$r' = 4{,}352 \text{ feet.}$$

The worst-case radial distances of displacement, including dispersive effects, for the ten- and 30-year waste plumes were determined to be 2,560 feet and 4,352 feet respectively from WDW-312.

VII.B. Other Subsurface Disposal Operations

A total of four additional Class I injection wells are currently being operated within an approximate 6-mile radius of WDW-120 and the proposed WDW-312 location (Plate V-14). All four of the wells are situated between 4.5 and 6 miles to the west-northwest of the Tyson Facility. WDW-342 is the most distant at 5.9 miles from WDW-120 and is operated by Southwest Public Service (SPS). WDW-129, WDW-324, and WDW-432 are located at and operated by Asarco. The closest well, WDW-324, is 4.7 miles from WDW-120.

All of these wells are completed into the Brown Dolomite Formation. The SPS well is permitted to inject at 1,500 gpm. The Asarco wells are permitted to inject at 300 gpm cumulative to all three wells. These wells are distant enough that they should have no impact on the operation of WDW-120. Since these wells are not completed in the Granite Wash Formation, they will have no impact on WDW-312.

References

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TDI, 1997, “Drilling and Completion of WDW-324 Asarco Incorporated Amarillo Copper Refinery Amarillo, Texas”: Terra Dynamics Incorporated, Austin, Texas, Project No. 96-169.

TDI, 1998 “Permit Renewal Application to Dispose of Waste in a Class I Injection Well WDW-273, Asarco Incorporated, Amarillo, Texas”: Terra Dynamics Incorporated, Austin, Texas, Project No. 98-135.

TDI, 1999, “1999 Mechanical Integrity Testing and Ambient Pressure Monitoring of WDW-67, WDW-68, and WDW-219, Phillips Chemical Company, A Division of Phillips Petroleum Company, Borger, Texas”: Terra Dynamics Incorporated, Austin, Texas, Project No. 99-161.

TDI, 2024, “2024 Annual Mechanical Integrity Testing and Ambient Pressure Monitoring of WDW-120”: Terra Dynamics Incorporated, Round Rock, Texas, Project No. 24-141.

Texas Water Development Board (TWDB), 1983, “Underground Injection Control Technical Assistance Manual”: Texas Water Development Board, Report 274, 61 p.

TABLE VII-1

SUMMARY OF INJECTION ZONE CHARACTERISTICS

Tyson Fresh Meats, Inc.
Amarillo, Texas

	INJECTION ZONE		
	Granite Wash Injection Interval	*Wichita-Brown Dolomite Injection Interval*	*Containment Interval*
Stratigraphic Unit	Granite Wash, Pennsylvanian Series	Wichita Group, Wolfcamp Series	Wichita Group
Approx. Subsurface Interval (ft)	5,850 - 9,000 RKB	4,000 - 5,000 RKB	3,720 - 4,000 RKB
Approx. Total Thickness (ft)	3,150	1,000	280
Dominant Lithology	sandstone, conglomerate, siltstone	dolomite, anhydritic dolomite	anhydritic dolomite, shale, anhydrite, salt
Bottomhole Pressure (psi)	1,800 @ 5,850′ (assumed)	1,299 @ 4,814′ RKB	-
Pressure Gradient (psi/ft)[1]	0.270 (assumed)	0.270	-
Min. Est. Frac. Pressure (psi)[2]	3,463 at 5,850′ (assumed)	2,365 @ 4,000′ RKB	-
Fracture Gradient (psi/ft)[2]	0.592 (assumed)	0.592 - 0.676	-
Bottom Hole Temperature (°F)	-	113 @ 4,800′ RKB	-
Temperature Gradient (°F/ft)[1]	-	0.024	-
Permeability (mD)[3]	40 (assumed)	20 (derived)	-
Porosity (%)[4]	10 (assumed)	10	0.0 - 36

Notes: RKB - relative to kelly busing
[1] relative to ground surface
[2] closure pressure, based on core data (Core Labs, 1990; WDW-273 core, Granite Wash Fm assumed same fracture gradient)
[3] based on pressure falloff tests at WDW-120 (TDI, 2003-24) and core data (Core Labs, 1996)
[4] based on core data (Core Labs, 1996) and porosity log data (IBP, 1974, Asarco WDW-324, 1996)

Table VII-2

GODSEY-EARLOUGHER, INC.

TULSA, OKLA.

RESULTS OF WATER ANALYSES

SAMPLE RECEIVED 10-14-74 RESULTS REPORTED 10-21-74 LABORATORY NO. 1721

COMPANY Iowa Beef Processors LEASE Iowa Beef

FIELD OR POOL

SECTION 29 Blk - 2 Sur AB&M COUNTY Potter STATE Texas

SOURCE OF SAMPLE AND DATE TAKEN:

No. 1 1721 - Well No. 1 DST No. 1 1/ 10-11-74

No. 2 1715 - Brine disposal system @ Emporia, Kansas 6-11-74

No. 3

No. 4

No. 5

CHEMICAL AND PHYSICAL PROPERTIES

	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5
SPECIFIC GRAVITY @ 60/60° F	1.118	1.178			
pH	6.8	7.0			
TOTAL ALKALINITY AS $CaCO_3$	142.	680.			
SUPERSATURATION AS $CaCO_3$	--	--			
UNDERSATURATION AS $CaCO_3$	4.	--			
CALCIUM	7,960.	688.			
MAGNESIUM	1,540.	83.			
SODIUM	56,200.	106,000.			
BARIUM	0.	0.			
SULFATE	1,600.	3,300.			
CHLORIDE	104,000.	162,000.			
SILICA	4.	18.			
TOTAL IRON	27.	11.5			
ALUMINUM	.3	.2			
TURBIDITY AS SiO_2	> 150.	> 150.			
Bicarbonate, HCO_3	173.	830.			
Redox potential, Ec, mv	+60.	+42.			
TOTAL DISSOLVED SOLIDS	172,000.	273,000.			
CARBON DIOXIDE	180.	210.			
HYDROGEN SULFIDE	0.	0.			
DISSOLVED OXYGEN	N.D.	N.D.			

REMARKS: 1/ Brown Dolomite formation 4824 - 4875 feet.

INJECTION RATE: B/D | PRODUCED WATER RATE: B/D

TREATMENT:

NOTE: N. D. = NOT DETERMINED. ALL RESULTS REPORTED AS MILLIGRAMS PER LITER UNLESS OTHERWISE MARKED.

By Trueman N Harkins

TABLE VII-3

Pressure Model Input Parameters

Parameter	Wichita-Brown Dolomite Value	Source	Granite Wash Value	Source
Transmissivity (T)	165 gpd/ft	Based on 48.5 years of injection at WDW-120	96 gpd/ft	Calculated by PRESS2
Flow Capacity (FC)	1,432 mD-ft	Based on falloff test analyses from WDW-120	4,000 mD-ft	Calculated
Thickness (b)	342 feet	Net Perforated and Open Hole Interval in WDW-120	100 feet	Estimated from Plate V-9
Storativity (S)	9.8 E-5	Calculated by PRESS2	2.9 E-5	Calculated by PRESS2
Intrinsic Permeability (k)	20 mD	Based on falloff test analyses from WDW-120	40 mD	Assumed
Injectate Fluid Viscosity (μ)	0.85 cP at 113 °F	Wichita Group brine analysis	0.85 cP at 113 °F	Wichita Group brine analysis
Total Compressibility (Ct)	6.6 E-6/psi	Typical value	6.6 E-6/psi	Typical value
Porosity (ϕ)	0.10	Density Log of WDW-120	0.10	Assumed

Table VII-4

Maximum Allowable Surface Injection Pressure (MASIP)
Injection Well WDW-120
Wichita Group Injection Interval

Date:	5/9/2024
Permit Number:	WDW-120
Permittee:	Tyson
Analyst:	Shin

Reservoir Characteristics	
Reservoir Depth (ft)	4814
Reservoir Pressure (psig)	1299
Poisson's Ratio	0.271
Overburden Gradient	1.1

------------*Calculated Results*------------

Fracture Gradient (psi/ft)	0.5784
Hydraulic Pressure Head (psi)	2398
Fracture Pressure (psig)	**2785**

Frictional Pressure Loss in Tubing	
Injected Fluid Density (lb/gal)	9.5795
Specific Gravity	1.15
Fluid Viscosity (cp)	0.68
Tubing ID (inches)	2.992
Tubing Length (ft)	3751
Relative Roughness (inch/inch)	1.50E-04
Injection Rate (gpm)	300

------------*Calculated Results*------------

Reynolds Number	5.35E+05
Friction Factor	1.49E-02
Frictional Pressure Loss (psi)	326

Maximum Allowable Surface Injection Pressure (psi) 287
Includes 100 psi Factor of Safety
Excludes tubing friction loss

Table VII-5

Maximum Allowable Surface Injection Pressure (MASIP)
Injection Well WDW-312
Granite Wash Injection Interval

Date:	6/12/2024
Permit Number:	WDW-312
Permittee:	Tyson
Analyst:	Shin

Reservoir Characteristics	
Reservoir Depth (ft)	5850
Reservoir Pressure (psig)	1800
Poisson's Ratio	0.271
Overburden Gradient	1.1

------------*Calculated Results*------------

Fracture Gradient (psi/ft)	0.60222
Hydraulic Pressure Head (psi)	2914
Fracture Pressure (psig)	**3523**

Frictional Pressure Loss in Tubing	
Injected Fluid Density (lb/gal)	9.5795
Specific Gravity	1.15
Fluid Viscosity (cp)	0.68
Tubing ID (inches)	3.958
Tubing Length (ft)	5900
Relative Roughness (inch/inch)	1.50E-04
Injection Rate (gpm)	300

------------*Calculated Results*------------

Reynolds Number	4.05E+05
Friction Factor	1.54E-02
Frictional Pressure Loss (psi)	130

Maximum Allowable Surface Injection Pressure (psi) 509
Includes 100 psi Factor of Safety
Excludes tubing friction loss

TABLE VII-6

PRESSURE INCREASE DUE TO INJECTION INTO WDW-120

Tyson Fresh Meats, Inc.
Amarillo, Texas

Pressure Increase Due to Injection (PRESS2 Program Results)

Date	5/6/24 15:00	Permeability (md)	20	Specific Gravity	1
Permit Number	WDW-120	Porosity (fraction)	0.1	Viscosity (cp)	0.85
Permittee Name	TYSON	Rock Compressibility (l/psi)	0.0000033	Zone Thickness (ft)	342
Permit Reviewer	MBS	Fluid Compressibility (1/psi)	0.0000033		

Inj Well ID	X Coord (ft)	Y Coord (ft)	Injection Rate (gpm) 48.5 Years	49.5 Years	58.5 Years	0.0 Years	0.0 Years	0.0 Years	0.0 Years	0.0 Years
WDW-120	1	0	32.35	200	200	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0

Observ Well ID	X Coord (ft)	Y Coord (ft)	Pressure Increase (psi) 48.5 Years	49.5 Years	58.5 Years	0.0 Years	0.0 Years	0.0 Years	0.0 Years	0.0 Years
WDW-120	1	1	222	1,183	1,301					
2	0	1.9	208	1,091	1,209					
3	0	500	102	435	553					
4	0	1,320	83	319	436					
5	0	2,640	69	236	353					
6	0	5,280	56	156	270					
7	0	13,200	38	64	162					

Transmissivity (gpd/ft) 164.96   Storage Coefficient 9.7804E-05

TABLE VII-7

PRESSURE INCREASE DUE TO INJECTION INTO WDW-312

Tyson Fresh Meats, Inc.
Amarillo, Texas

Pressure Increase Due to Injection (PRESS2 Program Results)

Date	5/6/24 16:00	Permeability (md)	40	Specific Gravity	1
Permit Number	WDW-312	Porosity (fraction)	0.1	Viscosity (cp)	0.85
Permittee Name	TYSON	Rock Compressibility (1/psi)	0.0000033	Zone Thickness (ft)	100
Permit Reviewer	MBS	Fluid Compressibility (1/psi)	0.0000033		

Inj Well ID	X Coord (ft)	Y Coord (ft)	**Injection Rate (gpm)** 1.0 Years	10.0 Years	30.0 Years	0.0 Years	0.0 Years	0.0 Years	0.0 Years	0.0 Years
WDW-312	1	0	200	200	200	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0

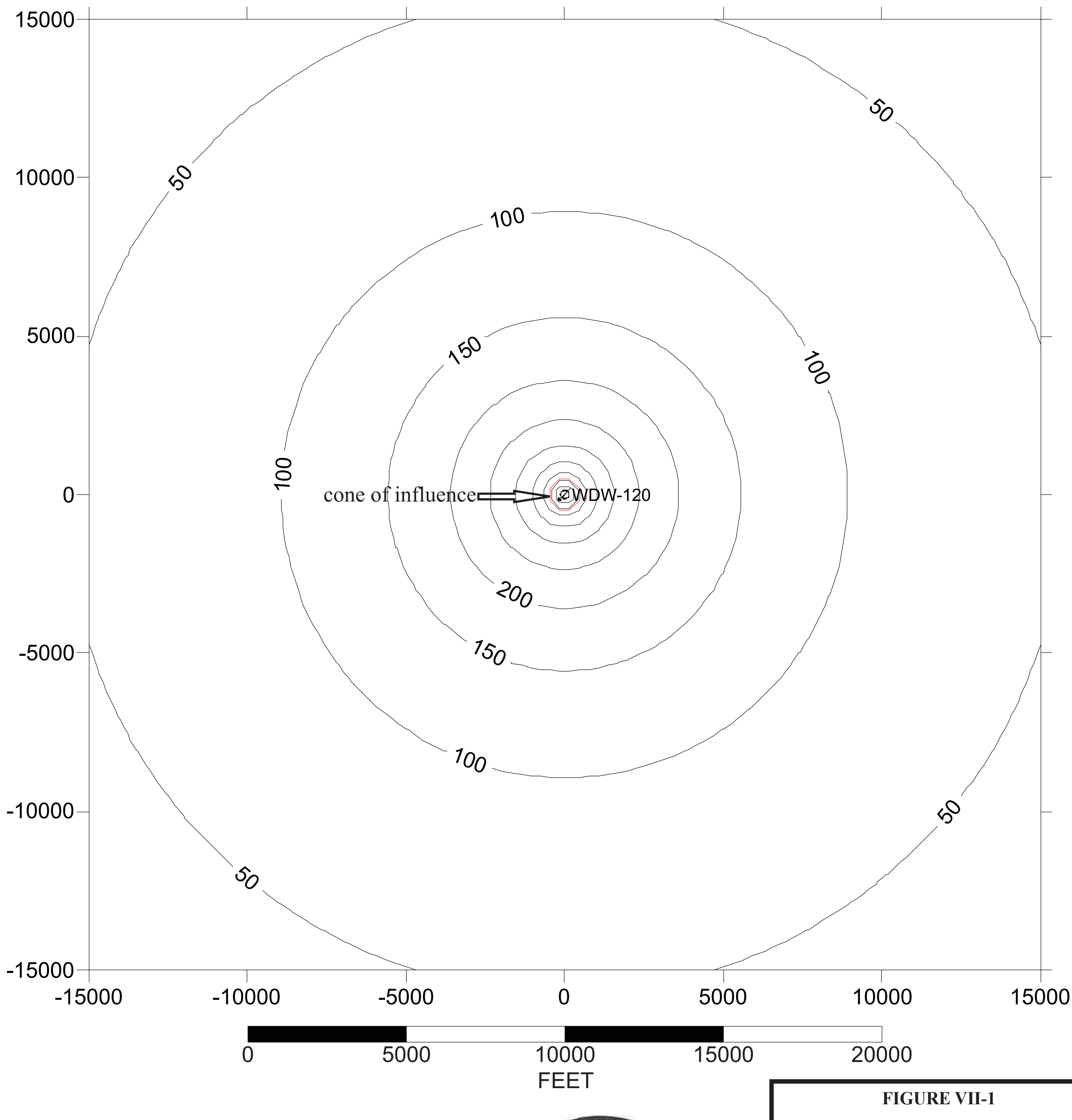
Observ Well ID	X Coord (ft)	Y Coord (ft)	**Pressure Increase (psi)** 1.0 Years	10.0 Years	30.0 Years	0.0 Years	0.0 Years	0.0 Years	0.0 Years	0.0 Years
WDW-312	1	1	2,029	2,266	2,379					
2	0	20	1,412	1,650	1,763					
3	0	298	857	1,094	1,207					
4	0	1,240	564	801	914					
5	0	1,320	551	788	901					
6	0	5,280	270	503	616					
7	0	13,200	102	317	428					

Transmissivity (gpd/ft) 96.47 Storage Coefficient 2.8598E-05

Drawing No.: 13-120.F7-1
Date: 11-8-24
Job No.: 24-112

Drawn By: B. SHIN, PG
Designed By: P GRANT, PG
Checked By: S. WILLIAMS, PG

Wichita-Brown Dolomite Injection Interval
Pressure Increase Due to Injection at WDW-120
on December 31, 2024
(48.5 yrs historical volumes plus one year future injection at 200 gpm)



Cone of Influence (psi) = 436

STATE OF TEXAS
MOONSOO SHIN
GEOLOGY
15260
LICENSED
PROFESSIONAL GEOSCIENTIST
BRIAN MOONSOO SHIN 5-24-2024
TEXAS REGISTERED FIRM F-3501

FIGURE VII-1

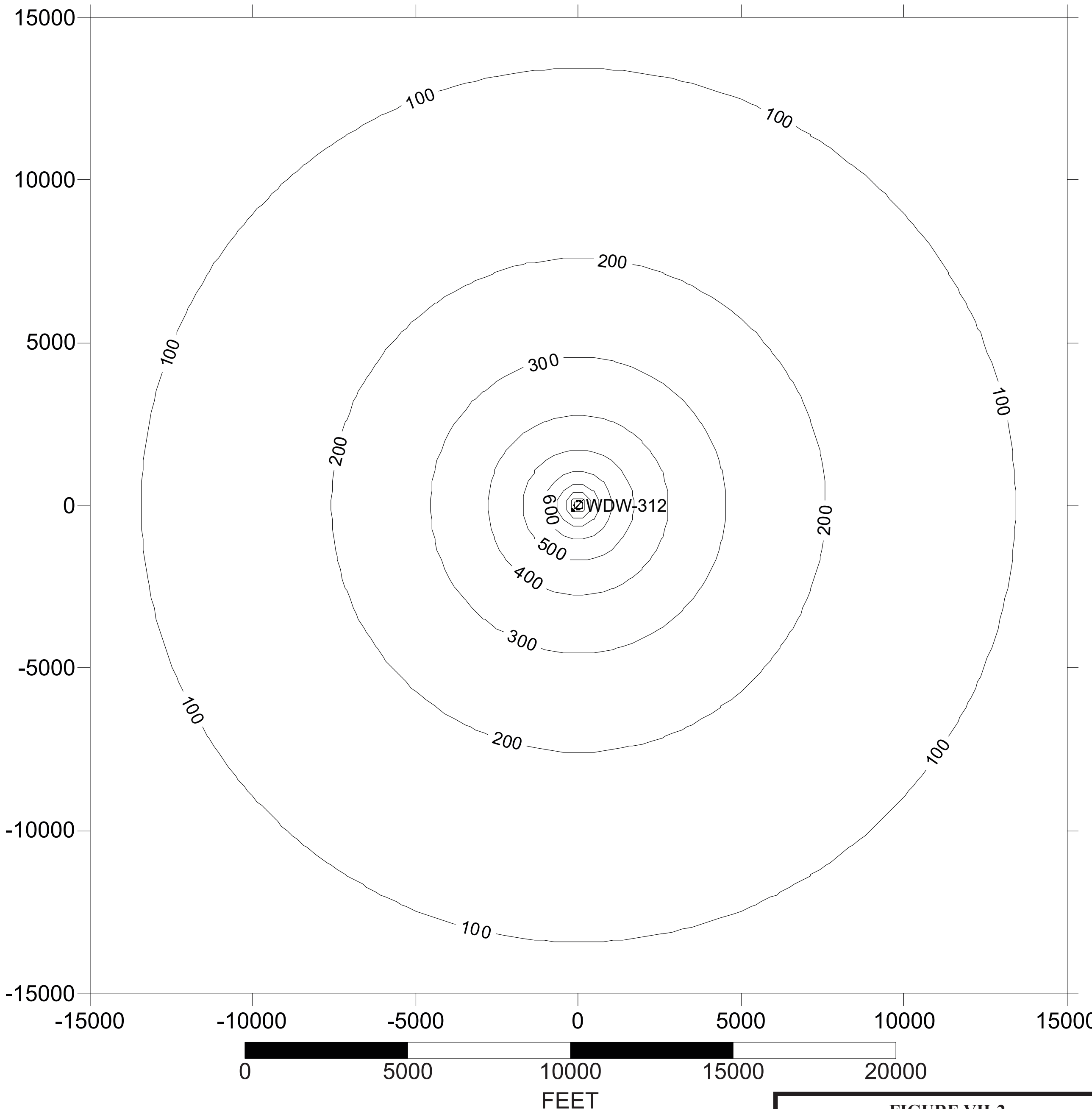
WICHITA-BROWN DOLOMITE PRESSURE INCREASE DUE TO INJECTION ON 12/31/2024

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES DEPARTMENT
AMARILLO, TEXAS

TERRA DYNAMICS INC

Granite Wash Injection Interval
Pressure Increase Due to Injection at WDW-312
After One Year of Injection



Cone of Influence (psi) = 914

FIGURE VII-2

GRANITE WASH
PRESSURE INCREASE
AFTER ONE YEAR OF INJECTION

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES DEPARTMENT
AMARILLO, TEXAS

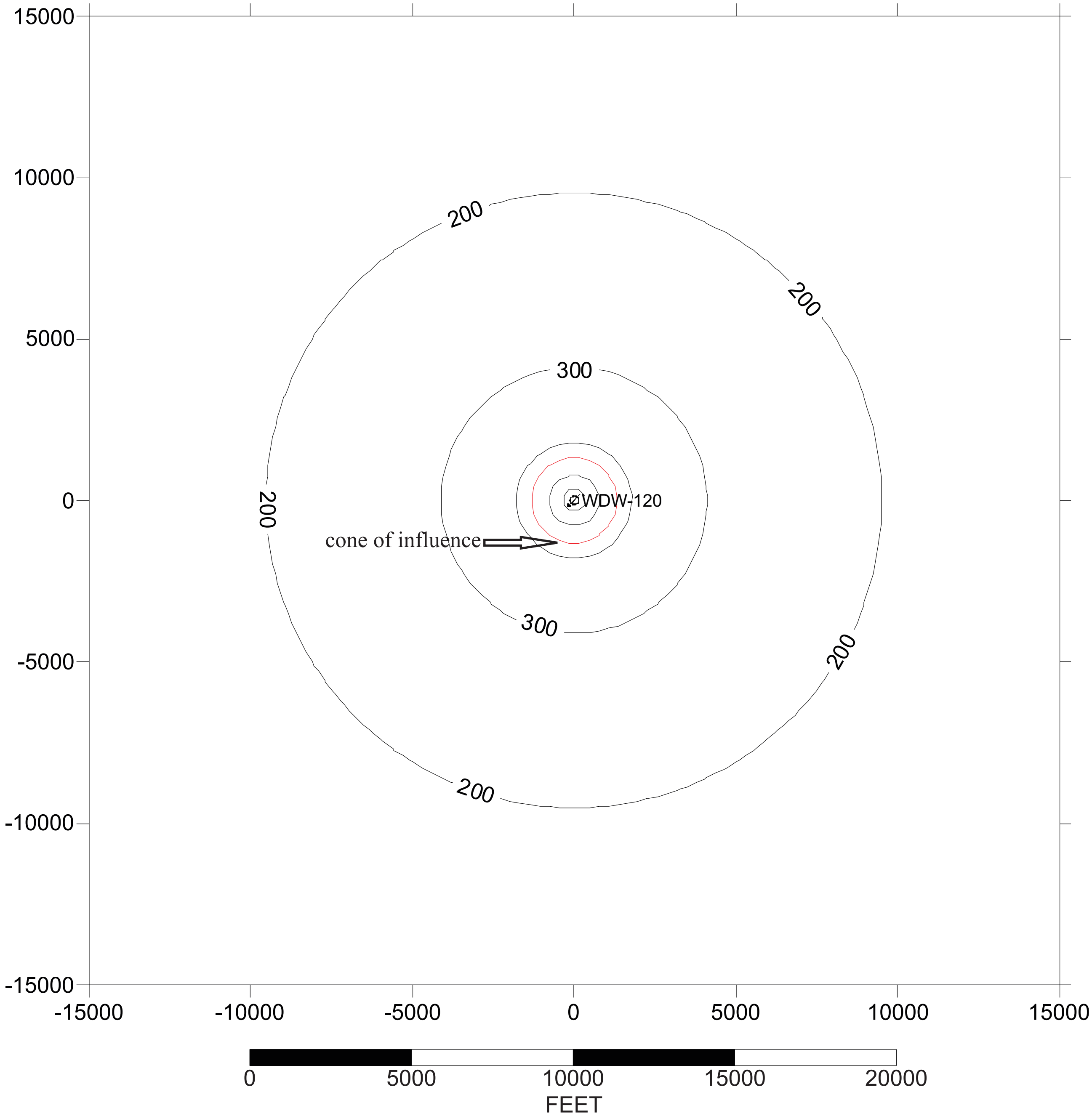
TERRA DYNAMICS INC

Drawing No.: 13-120.F7-2
Date: 5-8-24
Job No.: 24-112

Drawn By: B. SHIN, PG
Designed By: P GRANT, PG
Checked By: S. WILLIAMS, PG

Drawing No.: 13-120.F7-3
Date: 11-8-24
Job No.: 24-112

Wichita-Brown Dolomite Injection Interval
Pressure Increase Due to Injection at WDW-120
on December 31, 2033
(48.5 yrs historical volumes plus ten years future injection at 200 gpm)



Cone of Influence (psi) = 436

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TEXAS REGISTERED FIRM F-3501

FIGURE VII-3

WICHITA-BROWN DOLOMITE PRESSURE INCREASE DUE TO INJECTION ON 12/31/2033

PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES DEPARTMENT
AMARILLO, TEXAS

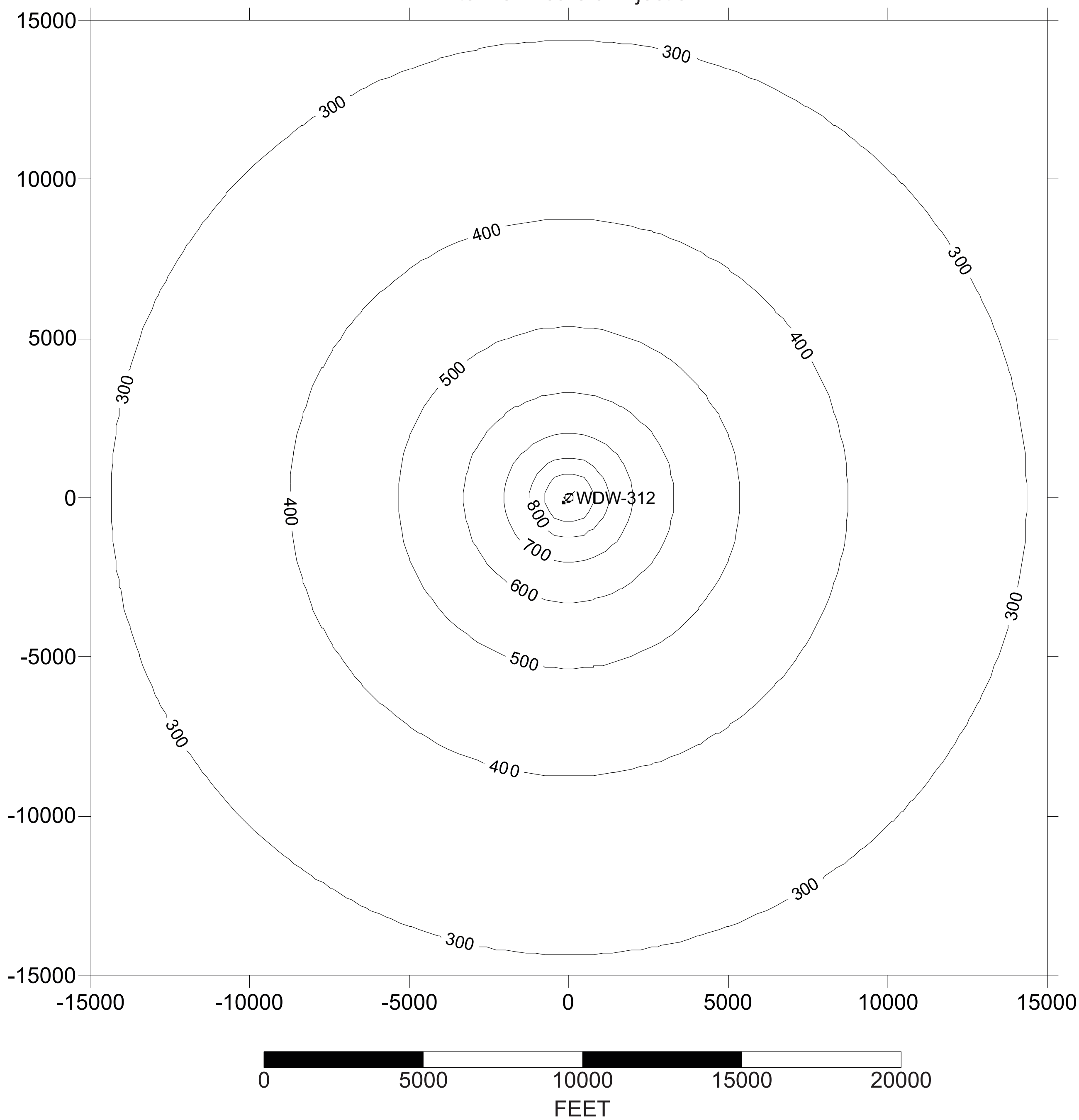
TERRA DYNAMICS INC

Drawn By: B. SHIN, PG
Designed By: P GRANT, PG
Checked By: S. WILLIAMS, PG

Drawing No.: 13-120.F7-4
Date: 5-8-24
Job No.: 24-112

Drawn By: B. SHIN, PG
Designed By: P GRANT, PG
Checked By: S. WILLIAMS, PG

Granite Wash Injection Interval
Pressure Increase Due to Injection at WDW-312
After Ten Years of Injection



Cone of Influence (psi) = 914

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FIGURE VII-4

GRANITE WASH
PRESSURE INCREASE
AFTER TEN YEARS OF INJECTION

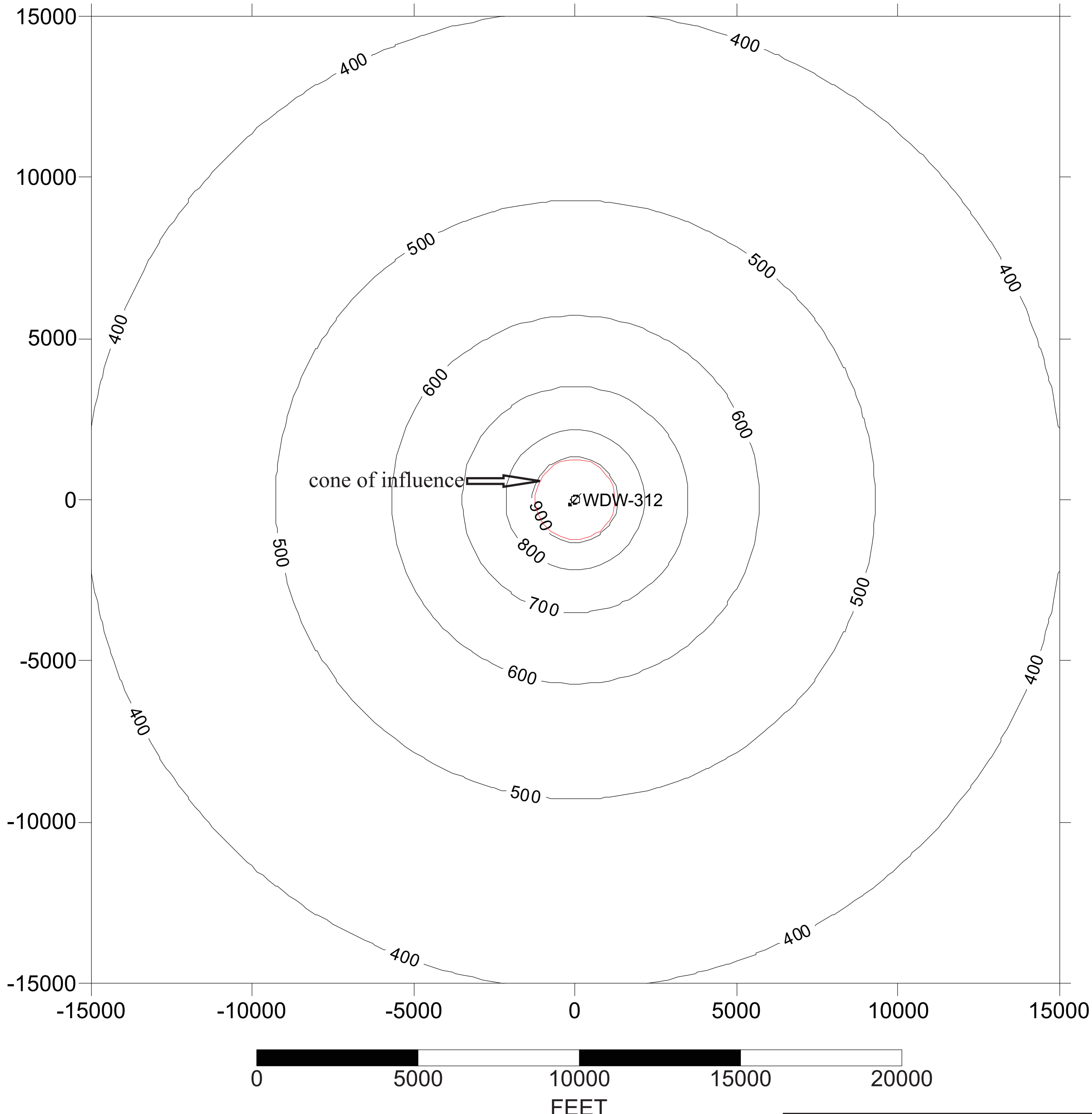
PREPARED FOR

TYSON FRESH MEATS, INC.
AMARILLO HIDES DEPARTMENT
AMARILLO, TEXAS

TERRA DYNAMICS INC

Drawing No.: 13-120.F7-5
Date: 5-8-24
Job No.: 24-112

Granite Wash Injection Interval
Pressure Increase Due to Injection at WDW-312
After Thirty Years of Injection



Cone of Influence (psi) = 914

Drawn By: B. SHIN, PG
Designed By: P GRANT, PG
Checked By: S. WILLIAMS, PG

FIGURE VII-5

**GRANITE WASH
PRESSURE INCREASE
AFTER THIRTY YEARS OF INJECTION**

PREPARED FOR

**TYSON FRESH MEATS, INC.
AMARILLO HIDES DEPARTMENT
AMARILLO, TEXAS**

TERRA DYNAMICS INC

VIII. AREA OF REVIEW REPORT

VIII. AREA OF REVIEW REPORT

Geoscientist Seal

Signature by Texas Professional Geoscientist

I, Moonsoo (Brian) Shin, the undersigned state: As an employee of Terra Dynamics Incorporated that I am authorized to prepare this document (***VIII. Area of Review Report***) and that this document (***VIII. Area of Review Report***) was prepared under my supervision and direction. All facts stated herein are true, correct and complete to the best of my knowledge. The geosciences information, calculations and analyses attested to in this document (***VIII. Area of Review Report***) were prepared in accordance with generally and currently accepted geosciences principles and practices. The information specifically covered by this seal includes Pages VIII-1 to VIII-2, Plate VIII-1 and Appendix D.

STATE OF TEXAS
MOONSOO SHIN
GEOLOGY
15260
LICENSED
PROFESSIONAL GEOSCIENTIST

Signature

11/13/24
Date

Licensed Professional Geoscientist
#15260, State of Texas
Terra Dynamics Incorporated
Texas Registered Engineering Firm
F-3501

VIII. AREA OF REVIEW REPORT

VIII.A. Area of Review Map

An Area of Review (AOR) base map is included as Plate VIII-1, prepared from the Mayer, Pullman, Sevenmile Basin, and Washburn, TX 7.5-minute USGS topographic maps. The Tyson AOR consists of those areas within the composite of each 2.5-mile radius around WDW-120 and the proposed WDW-312 wells. The Plate VIII-1 map shows the location of the existing Tyson WDW-120 injection well, the proposed location of WDW-312, and the known water wells within the composite AOR. There are no known non-freshwater artificial penetrations (oil and gas wells, exploratory tests, injection wells) within the composite AOR. The map also shows all surface bodies of water, springs, mines (surface and subsurface), quarries, and other pertinent surface features, including residences and roads. No surface fault traces are shown on this map, as there are no known subsurface faults in the AOR. A listing of the water wells that are located within 1 mile of the Tyson facility is included in Appendix D. All known water wells within the composite 2.5-mile radius AOR are less than 500 feet deep and, therefore, no artificial penetrations (shallow or deep) penetrate the Injection Zone and/or Confining Zone.

VIII.B. Non-Freshwater Artificial Penetration Identification, Location, Condition, and Search Protocol

There are no known non-freshwater artificial penetrations identified within the AOR other than Tyson injection well WDW-120. This well has been located on Plate VIII-1 as discussed above. The search protocol is discussed in the following paragraph.

Protocol for Non-Freshwater Artificial Penetration Identification and Location

In accordance with 30 TAC §331.121(a)(2)(A), a search of the artificial penetrations within the Tyson composite AOR was conducted, updated through April 2024. A description of the protocol used to conduct the artificial penetrations identification, location, and plugging adequacy review for the Tyson AOR is included in Appendix D.

VIII.C Well Tabulation and Records

There are no known non-freshwater artificial penetrations within the composite AOR, other than the Tyson WDW-120 injection well. Therefore, no tabulation or records for wells that penetrate the Confining and/or Injection Zones is required.

VIII.D. Well Schematics

There are no non-freshwater artificial penetrations within the calculated Cone of Influence (Section VII.A.7). Therefore, no well schematics are required to be included with these applications.

VIII.E. Potential Problem Wells

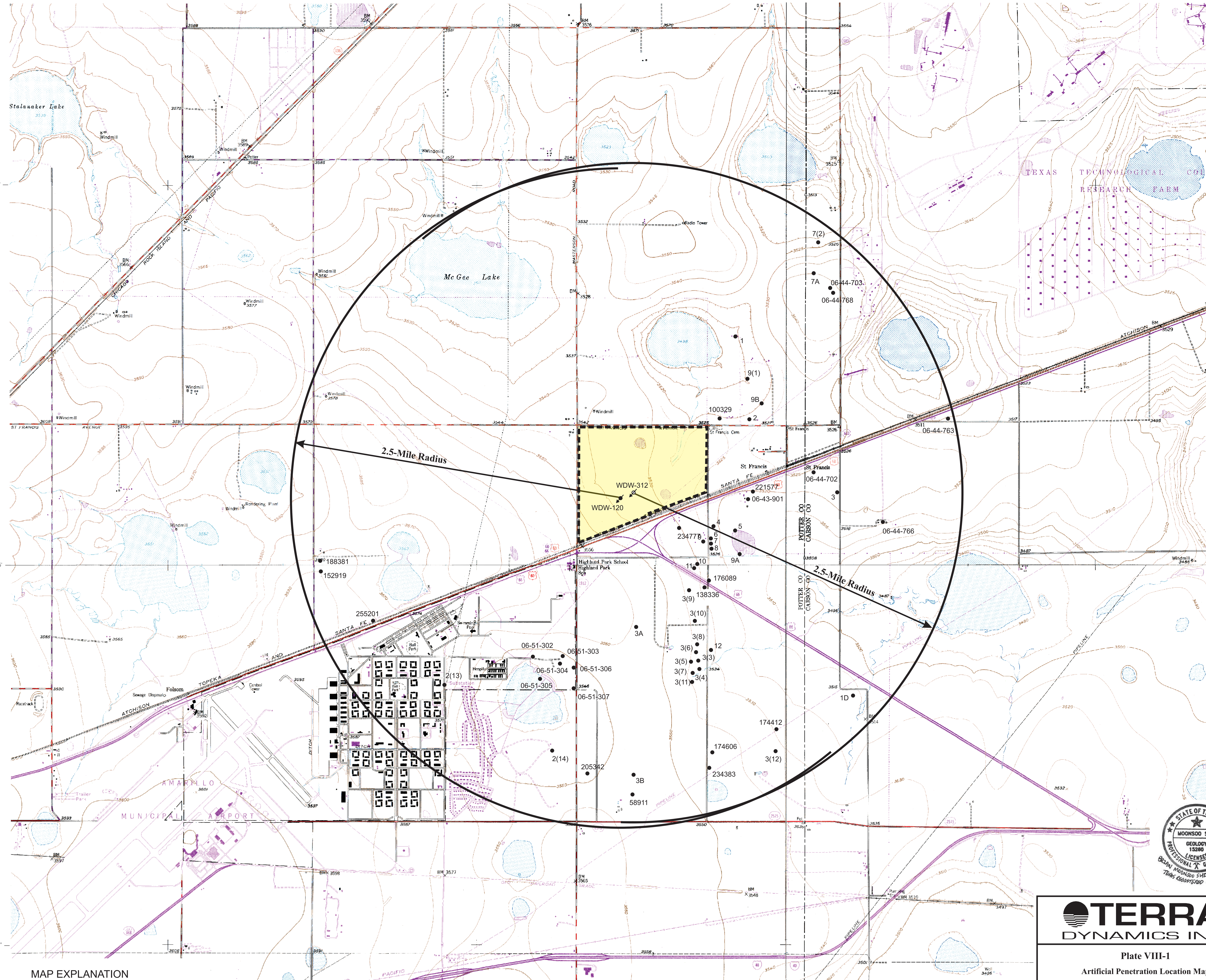
Since there are no non-freshwater artificial penetrations within the composite AOR, there are no wells that are improperly constructed or abandoned (potential problem wells), which would allow the movement of fluids into or between USDWs due to pressure increases in the Injection Zone as a result of operation of the Tyson injection wells.

VIII.F. Corrective Action Plan for Problem Wells

No corrective action plan for any problem wells is presented, as there are no inadequately constructed or abandoned problem wells that penetrate the Tyson Injection Zone within the calculated Cone of Influence. No wells are known to exist within the calculated Cone of Influence that could result in endangerment to USDWs as a result of the projected increased pressures in the Injection Zone due to operation of the Tyson wells.

VIII.G. Proposed Ambient Monitoring Plan

There is no indication that ambient monitoring is needed to assess or monitor the potential for fluid movement from the Tyson wells or the Injection Zone. Therefore, no ambient monitoring plan is proposed for these permit renewals.



MAP EXPLANATION

- Class 1 Disposal Well
- Proposed Class 1 Disposal Well
- Area Water Well
- Tyson Plant Boundary

Base Map Source: Mayer, Pullman, Sevenmile Basin, and Washburn, TX, USGS 7.5-Minute Topographic Maps

SCALE 1:24000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET

N

TERRA DYNAMICS INC

Plate VIII-1

Artificial Penetration Location Map

PREPARED FOR:

TYSON FRESH MEATS, INC.
AMARILLO, TEXAS

DRAWN BY:	B. SHIN	SCALES:	DATE:	5/3/2024
DESIGNED BY:	A. BELL	As Indicated	JOB NO.:	
CHECKED BY:	S. WILLIAMS		24-112	© 2024

IX. WASTES AND WASTE MANAGEMENT

IX. WASTES AND WASTE MANAGEMENT

The Tyson facility is a registered TCEQ and EPA solid waste generator. The TCEQ Solid Waste Registration Number for the Amarillo Hides Facility is 31455. The EPA Facility ID No. is TXD065022121. Tyson is currently authorized to inject nonhazardous wastewater streams generated either by the facility, or from the one-time generation of waste during closure of the wells and associated facilities, or from other associated wastes generated on a non-continuous basis. No hazardous waste (as defined in 40 CFR 261) is disposed of by injection at the Tyson facility.

Tyson has prepared these permit renewal applications for its existing WDW-120 and proposed WDW-312 Class I injection wells to continue authorization from the TCEQ to inject nonhazardous waste streams similar to those included in the existing well permits. These waste streams are shown in Table IX.A and match those permitted for WDW-120 and WDW-312.

IX.A. Waste Generation and Management Activities

The waste stream disposed of by deep well injection at the Tyson facility is primarily surplus brine water. Cattle hides are conveyed from the slaughter floor to the hide processing facility. Hides are treated with brine water to remove the fresh water that impregnated them during the slaughter process. In the curing phase, the hides are immersed in a saltwater bath. The salt concentration is subsequently diluted by the amount of fresh water carried into the system with the hides. In order to maintain the brine concentration, it is necessary to continuously add salt to the system, thereby generating surplus brine. The excess brine can be sent to an evaporation pond, two (2) fluid storage tanks, one (1) settling tank and/or to the injection well.

Wastewaters from the bate, pickle, and tan cycles in the tanning process are also sent to the injection and pre-injection facilities. Wastewaters from these procedures are non-hazardous and will consist primarily of water and salt but may also contain residues from the compounds used in the process. The bate cycle uses compounds such as ammonium sulfate, surfactants, bacterial bate, and sulfuric acid. The pickle cycle uses compounds such as sulfuric or formic acid. The tan cycle uses compounds such as sodium formate, bleaching agents, magnesium oxide, and chromium sulfate if a blue chrome leather is being produced. An aldehyde based tanning agent may also be used in place of the chromium compound to produce a different type leather. A chromium recovery system within the tannery prevents the discharge of large concentrations of chromium. Chromium sulfate is a common tanning compound. All chromium is in the trivalent form. The discharge of chromium is restricted by permit to less than 5.0 mg/L.

Scale control chemicals are added to the waste stream at the brine pond to prevent obstruction and just prior to filtration to combat the calcium carbonate scale buildup in the well system. The anti-scalant is added at rates recommended by the vendor and the rates will be such that the overall pH and specific gravities of the injection fluid are not altered significantly and remain within acceptable ranges allowed by the permit. The anti-scalant will be compatible with the various materials that are common to well construction. No compatibility testing has been performed between the injection fluid containing anti-scalant and the formation. However, since the Wichita-Brown Dolomite Injection Interval is predominantly dolomite and anhydritic dolomite, the anti-scaling chemicals which are designed to inhibit the precipitation of calcium carbonate should pose no compatibility problems with the formation which is composed of calcium and magnesium carbonate.

Due to the increasing trend of bottomhole pressure at WDW-120, Tyson plans to perform trials associated with utilizing a custom blend of inhibitors (Momar 15625, or equivalent) and biocide (B-1203, or equivalent). Not only it will act as a chelating agent to clean up the old scale over time, custom blend of inhibitors such as Momar 15626 has proven records of preventing 95% of the scale that is forming in various applications. Tyson will feed 30 ppm of Momar 15625, or equivalent inhibitors before the pump that transfers wastewater from the ponds to the injection well pump. Additionally, a tote of B-1203, or equivalent biocide will be applied downhole within two hours during the first application. Tyson will perform a weekly slug feed of a lesser prescribed biocide as long as the reduction in pressure occurs.

IX.A.1 Waste Management Information Table

Table IX.A provides a list of each waste stream planned for injection into the injection wells. The source of each waste is on-site. The volumes shown are based on the maximum permitted annual volumes for the two wells combined (105.120 million gallons). The actual 2023 injection volume for WDW-120 was approximately 20.175 million gallons.

IX.A.2 Injected Waste Streams Table

Tables IX.B provides descriptions for each waste to be injected; any appropriate USEPA waste codes, USEPA hazard codes, TCEQ waste classifications, and TCEQ waste codes are shown. No additional waste codes beyond those already permitted for WDW-120 and WDW-312 are requested in these permit renewal applications.

IX.A.3 Description and Analysis of Waste Streams

The wastewaters proposed for injection into the Tyson WDW-120 and WDW-312 injection wells will consist of a composite of a number of individual waste streams, as shown on Table IX.A. The wastewaters will contain low to moderate levels of dissolved and suspended solids. Typical analyses of the waste stream are included in Appendix E. Composite wastewater samples will be collected annually for chemical analysis of those constituents listed in Table IX.C. The composite waste stream will be low to moderate-total dissolved solids (TDS) water with minor amounts of various inorganic and organic constituents. Table IX-1 lists a range of primary constituents which are present in the waste stream analyses included in Appendix E.

IX.A.4 Waste Streams pH and Specific Gravity

The pH of the injected waste streams shall be greater than 2.0 and less than 12.5. The specific gravity shall be greater than 1.01 and less than 1.15. The chromium concentration of the injected waste streams shall be less than 5.0 mg/L.

IX.A.5 Waste Analysis Plan and Table

Table IX.C provides a listing of sampling and analytical methods that will be employed in testing the composite injected waste stream for various chemical constituents. The table includes sampling location, sampling method, sample frequency, parameter, and test method for each waste constituent analyzed. Test methods listed in Table IX.C are methods specified in the current editions of EPA SW-846, ASTM or other methods accepted by the TCEQ. Tyson will use a TCEQ-accredited laboratory for the annual waste stream analysis to assure that matrix, analyte and procedures for analysis are followed correctly. Injected wastewater samples will be collected from a sample tap in the flowline to the injection wellhead. Several constituents listed in Table IX.C are analyzed weekly or daily by the Tyson in-house laboratory.

IX.A.6 Hazardous Wastes Subject to 40 CFR 148 Subpart B

None of the wastes to be injected is classified as hazardous and subject to federal land disposal restrictions, as each of the wastes to be injected is defined as a nonhazardous industrial waste.

IX.A.7 Hazardous Wastes Not Subject to 40 CFR 148 Subpart B

None of the wastes to be injected is classified as hazardous and subject to federal land disposal restrictions, as each of the wastes to be injected is defined as a nonhazardous industrial waste.

IX.A.8 Injection Well Checklist Table

Table IX.D provides the status, design capacity, and number of years utilized for each of the existing and proposed injection wells at the Tyson facility.

IX.B. Waste Management--Hazardous Waste Wells

This section pertains to hazardous waste injection wells only; therefore, this section does not apply to Tyson's permit renewal applications.

TABLE IX.A

WASTE MANAGEMENT INFORMATION FOR WDW-120 AND WDW-312

TYSON FRESH MEATS, INC.
Amarillo, Texas

Waste	*Source*	*Volume (gallons/year)*
1. Wastes generated during closure of the well and associated facilities that are compatible with permitted wastes, reservoir and the well.	on-site	see note below(1)
2. Wastewater having a specific gravity of greater than 1.01 and less than 1.15, from the following waste streams: a. Hide processing wastewater, b. Backflush effluent, c. Tannery chrome recovery system effluent, with chromium concentration less than 5.0 mg/L.	on-site	105,120,000 (2)
3. Other associated wastes such as groundwater and rainfall contaminated by the above authorized wastes, spills of the above authorized wastes, scale inhibitors, biocide, and wash waters and solutions used in cleaning and servicing the waste disposal well system equipment which are compatible with the permitted waste streams, reservoir and well materials.	on-site	see note below(3)

Note: (1) the generation of waste stream No. 1 will occur as a one-time-only waste and the volume of waste generated will be minuscule in comparison to the other wastes injected
(2) Volume stated is based on maximum combined injection rate of 200 gpm.
(3) Wastestream is non-continuous. The volume of waste generated by waste stream No. 3 will be minuscule in comparison to the other wastes injected.

TABLE IX.B

INJECTED WASTE STREAMS FOR WDW-120 AND WDW-312

TYSON FRESH MEATS, INC.
Amarillo, Texas

Waste Number	Waste	EPA Waste Codes	EPA Hazard Codes (I, C, R, E, H, T)	TCEQ Waste Classifications (H, 1, 2, 3)	TCEQ Waste Codes
1.	Wastes generated during closure of the well and associated facilities that are compatible with permitted wastes, reservoir and the well.	nonhazardous	nonhazardous	Class I nonhazardous	
2.	Wastewater having a specific gravity of greater than 1.01 and less than 1.15, from the following waste streams: a. Hide processing wastewater, b. Backflush effluent, c. Tannery chrome recovery system effluent, with chromium concentration less than 5.0 mg/L.	nonhazardous	nonhazardous	Class I nonhazardous	00101991
3.	Other associated wastes such as groundwater and rainfall contaminated by the above authorized wastes, spills of the above authorized wastes, scale inhibitors, biocide, and wash waters and solutions used in cleaning and servicing the waste disposal well system equipment which are compatible with the permitted waste streams, reservoir and well.	nonhazardous	nonhazardous	Class I nonhazardous	00211141

TABLE IX.C

WASTE ANALYSIS PLAN FOR WDW-120 AND WDW-312

TYSON FRESH MEATS, INC.
Amarillo, Texas

Waste Number (From Table IX.B)	Sampling Location	Sampling Method	Frequency	Parameter	Test Method [5]
see note below[1]	injection wellhead[2]	grab	annually[3]	NH3-N	350.2
see note below[1]	injection wellhead[2]	grab	annually[3]	BOD*5	5210 B
see note below[1]	injection wellhead[2]	grab	annually[3]	Carbonaceous BOD	5210 B
see note below[1]	injection wellhead[2]	grab	annually[3]	Chloride	325.2 or 9253
see note below[1]	injection wellhead[2]	grab	annually[3] & weekly[4]	Total Chromium	200.8
see note below[1]	injection wellhead[2]	grab	annually[3]	Oil & Grease	1664
see note below[1]	injection wellhead[2]	grab	annually[3] & weekly[4]	pH	150.1
see note below[1]	injection wellhead[2]	grab	annually[3] & weekly[4]	Specific Gravity	2710 F
see note below[1]	injection wellhead[2]	grab	annually[3]	Sodium	200.8
see note below[1]	injection wellhead[2]	grab	annually[3]	Total Dissolved Solids	1684 or 2540 B
see note below[1]	injection wellhead[2]	grab	annually[3]	Total Alkalinity	310.1 or 2320 B
see note below[1]	injection wellhead[2]	grab	annually[3]	Total Kjeldahl Nitrogen	351.1
see note below[1]	injection wellhead[2]	grab	annually[3]	Total Suspended Solids	1684
see note below[1]	injection wellhead[2]	grab	annually[3]	Total Volatile Solids	1684
see note below[1]	injection wellhead[2]	grab	annually[3]	Volatile Suspended Solids	1684

[1] Injected wastewater samples will be collected from a sample tap in the flowline to the injection wellhead and represent a composite sample of the waste stream typically injected.
[2] Samples are collected after wastewater passes through the pre-injection unit filters.
[3] Samples are collected annually at the minimum unless otherwise stated.
[4] Laboratory is an in-house lab that performs work only for its owner. If laboratory is unable to perform analysis, the sample will be sent to a NELAC-accredited laboratory.
[5] Equivalent or updated methods recognized by EPA or TCEQ may be substituted for any of these methods. Laboratory will be in compliance with requirements of 30 TAC Chapter 25.

TABLE IX.D

INJECTION WELL CHECKLIST

WDW Number	Status[1]	Injected Volume[2]	Maximum Permitted Injection Rate[3]	Number of Years Utilized	Date in Service
120	Active	825,153,077	105,120,000*	48.5	5/30/1975
312	Proposed	0	105,120,000*	0	-

[1] Indicate only one of the following: Active, Inactive, Closed, or Proposed
[2] Total volume (gallons) injected into the well through December 31, 2023
[3] Gallons per year, individually or cumulatively (*)

TABLE IX-1

INJECTION FLUID ANALYSES

Tyson Fresh Meats, Inc.
Amarillo, Texas

Parameters	**November 2018 Analysis**	**December 2019 Analysis**	**November 2020 Analysis**	**November 2021 Analysis**	**November 2022 Analysis**	**November 2023 Analysis**
Carbonaceous BOD	694	1,330	1,240	1,220	1,700	1,060
Total BOD	917	979	1,210	1,270	1,550	1,260
NH_3 (as N)	184	375	250	331	310	280
TKN	216	428	293	371	409	435
Total Solids	43,500	53,400	58,700	50,200	43,300	26,400
Total Volatile Solids	3,160	3,140	2,240	2,700	12,500	6,500
Total Suspended Solids	228	107	94	380	124	244
Total Suspended Volatile Solids	60	32	94	64	64	69
Chloride	14,300	15,600	27,900	15,400	13,600	9,190
Sodium	9,712	14,760	19,750	14,510	14,760	10,990
Oil & Grease	-	-	-	-	-	-
pH	8.37	8.62	8.23	8.34	8.38	8.24
Specific Gravity	1.04*	1.05*	1.06*	1.05*	1.05*	1.05*
Total Alkalinity	1,430	1,690	1,610	2,240	2,460	1,230
Total Cr	0.19	0.79	0.54	1.38	0.29	1.86

NOTE: pH in standard units
Concentration in mg/L
* Specific gravity determined during annual ambient pressure monitoring performed on WDW-120

\- not determined

X. RCRA PERMIT BY RULE REQUIREMENTS

X. RCRA PERMIT BY RULE REQUIREMENTS

This section pertains to facilities where the UIC well is the only unit which requires a RCRA permit and the well is designated for hazardous waste injection. If this is the case, an evaluation for corrective action for releases from any solid waste unit is required. This section does not apply to Tyson's permit renewal applications, since WDW-120 and WDW-312 are not currently being permitted to receive hazardous waste.

XI. DISPOSAL OF WASTES CONTAINING RADIOACTIVE MATERIALS

XI. DISPOSAL OF WASTES CONTAINING RADIOACTIVE MATERIALS

Tyson does not dispose of wastes containing radioactive materials. This section is thus not applicable to Tyson's well permit renewal applications, and no further information is herein provided.

XII. PRE-INJECTION UNITS

XII. PRE-INJECTION UNITS

Tyson does not dispose of hazardous waste or commercial non-hazardous wastes. Instead of including the surface units in the injection well permits, Tyson applied to register the pre-injection units as allowed under 30 TAC §331.17 in 2013 and received approval as PIU31455 on February 19, 2015. The pre-injection unit registration is set to expire on the expiration date of Class I injection well permit of WDW-120 and WDW-312.

Effective January 7, 2021, PIUs associated with nonhazardous, noncommercial injection wells regulated under 30 TAC Ch. 331, Underground Injection Control, are no longer required to be permitted or registered. Any existing PIU registration will expire at the end of its own term. Thus, the registration application and supporting documentation are not provided.

XIII. CONFIDENTIAL MATERIAL

XIII. CONFIDENTIAL MATERIAL

Tyson has not included information in the Technical Report of these permit renewal applications which it deems confidential. Thus, no separate document labeled CONFIDENTIAL is included here.

XIV. INDEX OF ATTACHMENTS

XIV. INDEX OF ATTACHMENTS

Description of Attachment	Part	Attachment	Included	Not Included	Not Applicable
Core Data Form	I.L	A	**X**		
Public Interest Demonstration	I.M	B	**X**		
Site Legal Description	I.P.5	C	**X**		
Facility boundaries and adjacent waters topographic map	I.P.6	D	**X**		
Plain-Language Summary	I.Q	E	**X**		
Public Involvement Plan	I.R	F			**X**
Affected land and mineral owners	II.	G	**X**		
Letter from Railroad Commission	III.	H	**X**		
Financial Assurance	IV.	I	**X**		
Radioactive Waste Statement	XI.	J			**X**

TCEQ Use Only

TCEQ Core Data Form

For detailed instructions on completing this form, please read the Core Data Form Instructions or call 512-239-5175.

SECTION I: General Information

1. Reason for Submission *(If other is checked please describe in space provided.)*

☐ New Permit, Registration or Authorization (*Core Data Form should be submitted with the program application.)*

☒ Renewal *(Core Data Form should be submitted with the renewal form)*

☐ Other

2. Customer Reference Number *(if issued)*	Follow this link to search for CN or RN numbers in Central Registry**	**3. Regulated Entity Reference Number** *(if issued)*
CN 600767016		**RN 100212943**

SECTION II: Customer Information

4. General Customer Information

5. Effective Date for Customer Information Updates (mm/dd/yyyy) 11/5/2024

☐ New Customer ☐ Update to Customer Information ☐ Change in Regulated Entity Ownership
☐ Change in Legal Name (Verifiable with the Texas Secretary of State or Texas Comptroller of Public Accounts)

The Customer Name submitted here may be updated automatically based on what is current and active with the Texas Secretary of State (SOS) or Texas Comptroller of Public Accounts (CPA).

6. Customer Legal Name *(If an individual, print last name first: eg: Doe, John)*

If new Customer, enter previous Customer below:

Tyson Fresh Meats, Inc.

7. TX SOS/CPA Filing Number	**8. TX State Tax ID** (11 digits)	**9. Federal Tax ID** (9 digits)	**10. DUNS Number** *(if applicable)*
800013025	17108575147	710857514	065022121

11. Type of Customer: ☒ Corporation ☐ Individual Partnership: ☐ General ☐ Limited

Government: ☐ City ☐ County ☐ Federal ☐ Local ☐ State ☐ Other ☐ Sole Proprietorship ☐ Other:

12. Number of Employees

☐ 0-20 ☐ 21-100 ☐ 101-250 ☐ 251-500 ☒ 501 and higher

13. Independently Owned and Operated?

☐ **Yes** ☒ **No**

14. Customer Role (Proposed or Actual) – *as it relates to the Regulated Entity listed on this form. Please check one of the following*

☐ Owner ☐ Operator ☒ Owner & Operator
☐ Occupational Licensee ☐ Responsible Party ☐ VCP/BSA Applicant ☐ Other:

15. Mailing Address:

PO BOX 30500

City	Amarillo	**State**	TX	**ZIP**	79120	**ZIP + 4**	0500

16. Country Mailing Information *(if outside USA)*	**17. E-Mail Address** *(if applicable)*
	Eric.Rodriquez@tyson.com

18. Telephone Number	19. Extension or Code	20. Fax Number *(if applicable)*
(806) 335-7418		( ) -

SECTION III: Regulated Entity Information

21. General Regulated Entity Information *(If 'New Regulated Entity" is selected, a new permit application is also required.)*

☐ New Regulated Entity ☐ Update to Regulated Entity Name ☐ Update to Regulated Entity Information

The Regulated Entity Name submitted may be updated, in order to meet TCEQ Core Data Standards (removal of organizational endings such as Inc, LP, or LLC).

22. Regulated Entity Name *(Enter name of the site where the regulated action is taking place.)*

Tyson Fresh Meats

23. Street Address of the Regulated Entity: ***(No PO Boxes)***	5000 N. FM 1912						
	City	Amarillo	**State**	TX	**ZIP**	79108	**ZIP + 4**
24. County	Potter						

If no Street Address is provided, fields 25-28 are required.

25. Description to Physical Location:	North East of Amarillo Airport

26. Nearest City	State	Nearest ZIP Code
Amarillo	TX	79108

Latitude/Longitude are required and may be added/updated to meet TCEQ Core Data Standards. (Geocoding of the Physical Address may be used to supply coordinates where none have been provided or to gain accuracy).

27. Latitude (N) In Decimal:	35.257300		**28. Longitude (W) In Decimal:**	-101.648030	
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
35	15	25	101	38	49

29. Primary SIC Code (4 digits)	**30. Secondary SIC Code** (4 digits)	**31. Primary NAICS Code** (5 or 6 digits)	**32. Secondary NAICS Code** (5 or 6 digits)
2011	3111	311611	311613

33. What is the Primary Business of this entity? *(Do not repeat the SIC or NAICS description.)*

Disposal of hide porcessing wastewater

34. Mailing Address:	**PO BOX 30500**						
	City	**Amarillo**	**State**	**TX**	**ZIP**	**79120**	**ZIP + 4**
35. E-Mail Address:	**Eric.Rodriquez@tyson.com**						

36. Telephone Number	37. Extension or Code	38. Fax Number *(if applicable)*
(806) 335-7418		( ) -

39. TCEQ Programs and ID Numbers Check all Programs and write in the permits/registration numbers that will be affected by the updates submitted on this form. See the Core Data Form instructions for additional guidance.

☐ Dam Safety	☐ Districts	☐ Edwards Aquifer	☐ Emissions Inventory Air	☐ Industrial Hazardous Waste
☐ Municipal Solid Waste	☐ New Source Review Air	☐ OSSF	☐ Petroleum Storage Tank	☐ PWS
☐ Sludge	☐ Storm Water	☐ Title V Air	☐ Tires	☐ Used Oil
☐ Voluntary Cleanup	☐ Wastewater	☐ Wastewater Agriculture	☐ Water Rights	☒ Other: Underground Injection Control
				WDW-120; WDW-312

SECTION IV: Preparer Information

40. Name:	Brian Shin	**41. Title:**	Senior Geologist
42. Telephone Number	**43. Ext./Code**	**44. Fax Number**	**45. E-Mail Address**
(512) 795-8183	4598	( ) -	bshin@terradyn.com

SECTION V: Authorized Signature

46. By my signature below, I certify, to the best of my knowledge, that the information provided in this form is true and complete, and that I have signature authority to submit this form on behalf of the entity specified in Section II, Field 6 and/or as required for the updates to the ID numbers identified in field 39.

Company:	Tyson Fresh Meats, Inc	**Job Title:**	Area Environmental Manager
Name *(In Print)*:	Eric Rodriquez	**Phone:**	(806) 335- **7418**
Signature:	Eric Rodriguez	**Date:**	2/7/25

N. Public Interest Demonstration

Section 27.051 of the Texas Water Code (TWC) stipulates certain conditions that must exist for the Commission to grant an application and issue a permit. For all new applications, permit renewals, and permit amendments, submit as "Attachment B" information addressing the following considerations:

1. That the use or installation of the injection well is in the public interest. [TWC §27.051(a)(1)]

   The approval of this application is in the public interest in that it is the safest method to dispose of the non-hazardous wastewater generated at the Tyson Fresh Meats, Inc. (Tyson) Amarillo Hides Department facility. The disposal well is used to dispose of a waste stream that contains constituents that are classified as non-hazardous by RCRA. By injecting this wastewater into the subsurface, the wastewater is sealed thousands of feet below the earth's surface, far below the human environment and drinking water, resulting in no emissions to the surface.

2. That no existing rights, including, but not limited to, mineral rights, will be impaired. [TWC §27.051(a)(2)]

   There will be no impairment to existing rights, including mineral rights.

3. That, with proper safeguards, both ground and surface fresh water can be adequately protected from pollution. [TWC §27.051(a)(3)]

   The injection well is constructed to 30 TAC Chapter 331 requirements and does adequately protect ground and surface fresh water from pollution.

4. That the applicant has made a satisfactory showing of financial responsibility if required by Section 27.073 of this code. [TWC §27.051(a)(4)]

   Financial responsibility is addressed in Section IV – Financial Assurance of this submittal.

5. That the compliance history of the applicant and related entities is acceptable. [TWC §27.051(d)(1), 30 TAC §331.121(b)(1)]

   Tyson's compliance history is above-satisfactory. The TCEQ Compliance History rating is 0.00, high in classification. The Point Range for an above-satisfactory rating is below 0.10.

6. That there is no practical, economic, and feasible alternative to an injection well reasonably available. Provide justification for subsurface disposal. Include results of treatability studies of alternate, practical, economic and feasible

methods of waste disposal. Explain in detail why each method is considered to be less satisfactory in terms of environmental protection than the proposed subsurface disposal method. Indicate whether this waste is presently being produced and, if so, what method is used for disposal. Describe the manufacturing process(es) and product(s) which produce the waste(s). [TWC §27.051(d)(2), 30 TAC § 331.121(b)(2)].

There is no practical, economic, and feasible alternative to an injection well reasonably available to Tyson Fresh Meats, Inc. This consideration is fully explored in the following paragraphs. Deep well disposal of the Tyson non-hazardous waste stream provides an environmentally safe and low-risk method of waste disposal and significantly reduces the potential for human and environmental exposure that could occur with alternate waste disposal methods.

Alternatives Considered To Injection

<u>NPDES Discharge</u>

An NPDES Discharge Permit would not be a feasible alternative method of disposal of the tannery brine at this time. To meet federal and state discharge limits imposed by the EPA under the 1990 Clean Water Act would be very costly or impossible with today's technology. The costs would be attributed to the equipment and chemicals, if they could be developed, that would be required to remove the dissolved solids in the form of chlorides. Because the chloride levels are high in comparison to the levels generated in the meat processing plant, pre-treatment would be necessary. There are many other costs involved in the installation of any processing equipment including maintenance, reporting and monitoring. In order to stay competitive in this industry, it is not desirable at this time to incur these extraordinarily high costs.

<u>Irrigation of Wastewater</u>

The brine water that is generated in the processing of hides is high in chlorides. Chlorides applied as irrigation water have a negative impact on the soils and plant growth. Current Land Application and Irrigation regulations and state requirements would be difficult at best to meet. Large amounts of land would be needed to dispose of the volumes of water that will be generated and to meet the required chloride application levels. It would not be cost effective to purchase the land required or enter into agreements with local owners to lease and irrigate the volume of wastewater that will be discharged.

Justification for On-Site Underground Injection

The best alternative for disposal of wastewater brine from the Tyson hide tanning operation is by disposal well. As can be seen in the above discussion, disposal by NPDES Discharge Permit is too costly and probably not even a possibility, and disposal by irrigation would require too many acres of land and cause too many potential environmental impacts. Tyson is able to operate the existing WDW-120 injection well with the regulations and monitoring requirements established by the TCEQ. Tyson is also able to dispose of the volumes of wastewater that are generated without difficulty. The equipment is and will be maintained and *monitored in the daily scheduled operations of the facility. All rules and regulations imposed under the permit to operate a disposal well can be adhered to without difficulty. Therefore, it is Tyson's desire and belief that the operation of a disposal well is best suited to this facility at this time.*

7. (for hazardous waste injection wells only) That the applicant has provided for the proper operation of the proposed hazardous waste injection well. [TWC §27.051(a)(5)]

   N/A – The injection wells inject non-hazardous waste.

8. (for hazardous waste injection wells only) That the applicant for a hazardous waste injection well not located in an area of industrial land use has made a reasonable effort to ensure that the burden, if any, imposed by the proposed hazardous waste injection well on local law enforcement, emergency medical or fire-fighting personnel, or public roadways, will be reasonably minimized or mitigated. [TWC §27.051(a)(6)]

   N/A – The injection wells inject non-hazardous waste.

9. (for hazardous waste injection wells only) That the applicant owns or has made a good faith claim to, or has the consent of the owner to utilize, or has an option to acquire, or has the authority to acquire through eminent domain, the property or portions of the property where the hazardous waste injection well will be constructed. [TWC §27.051(a)(7)]

   N/A – The injection wells inject non-hazardous waste.

10. (for hazardous waste injection wells only) That the applicant will maintain sufficient public liability insurance for bodily injury and property damage to third parties that is caused by sudden and non-sudden accidents or will otherwise demonstrate financial responsibility in a manner adopted by the Commission in lieu of public liability insurance. [TWC §27.051(d)(3), 30 TAC § 331.121(b)(3)]

    N/A – The injection wells inject non-hazardous waste.

11. (for hazardous waste injection wells only) For on-site generated waste, provide certification by the owner/operator that (1) the generator of the hazardous waste has a program to reduce the volume or quantity and toxicity of the waste to the degree determined by the generator to be economically practicable, and (2) injection of the waste is that practicable method of disposal currently available to the generator which minimizes the present and future threat to human health and the environment. [30 TAC §331.121(b)(4)]

    N/A – The injection wells inject non-hazardous waste.

from 12/14/73 & 4/30/74 letters

THE STATE OF TEXAS)

KNOW ALL MEN BY THESE PRESENTS:

COUNTY OF POTTER)

That we, OSCAR HUFF, Individually; RUTH B. HUFF, CITIZENS BANK AND TRUST COMPANY, Pampa, Texas, WM. JARREL SMITH and MARVIN C. WEBSTER, as Independent Executors of the Will of BEULA HUFF, Deceased, and as Trustees of the Trust created in the Will of BEULA HUFF, Deceased; and RUTH B. HUFF, a feme sole, all of Gray County, Texas; and HELENE HUFF McCORMICK, of Bernalillo County, New Mexico, for and in consideration of the sum of TEN AND NO/100 DOLLARS ($10.00) and other good and valuable consideration to us in hand paid by IOWA BEEF PROCESSORS, INC., a Corporation, the receipt and sufficiency of which are hereby acknowledged, have granted, sold and conveyed, and by these presents do grant, sell and convey, but subject to the reservations and other matters herein set forth, unto the said IOWA BEEF PROCESSORS, INC., a corporation, the following described land in Potter County, Texas:

All of Section Number Nineteen (19), in Block Number Two (2), AB&M Survey, Potter County, Texas, lying North of the Panhandle and Santa Fe Railroad Right-of-Way.

BEGINNING at an iron pipe in pavement, the N.E. corner of Survey No. 19, in Block 2, AB&M;

THENCE West with the North line of said Survey No. 19, 30 feet;

THENCE South 00° 1' 40" W. parallel with the East line of said Survey No. 19, 30 feet to an iron pipe, the N.E. and beginning corner of this tract;

THENCE West parallel with the North line of said Survey No. 19, 5222 feet to the N.W. Corner of this tract, whence the West line of said Survey No. 19, bears West 35 feet;

THENCE S. parallel with the West line of Survey No. 19, at 10 feet pass a 1-1/4 inch x 42 inch Galvanized iron pipe, at 4707.5 feet set a 1 inch iron pipe in the North line of the Santa Fe Railroad Right-of-way whence the center line of the South Main Track of the Santa Fe Railroad bears S. 20° 40' 40" E. 75 feet;

THENCE N. 69° 19' 20" E. parallel with the Santa Fe Railroad and with the North line of said Railroad right-of-way 2893.55 feet;

THENCE N. 20° 40' 40" West 50 feet;

THENCE N. 69° 19' 20" E. with said Railroad Right-of-Way, 2710.51 feet to an iron pipe 30 feet West of the East line of said Section No. 19;

THENCE N. 00° 1' 40" E. parallel with the East line of Section No. 19, at 1007 feet pass a sewer line, at 2683.54 feet to the beginning corner of this tract.

Containing 443.04 acres more or less.

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There is reserved and excepted from this conveyance a non-participating royalty interest of 1/16th of the proceeds from the sale of gas produced, saved and marketed from the property above described, and 1/16th of the oil and other minerals, similar or disimilar, produced, saved and marketed from the premises, free of cost in the pipeline to which the wells may be connected or at the mine where the other minerals may be produced. Water is not to be considered as a mineral within the meaning of this exception. This reservation creates no obligation upon the Grantee to lease the premises

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or explore the premises or develop the premises for the production or marketing of any of said minerals.

This conveyance is subject to any and all valid and subsisting easements, if any, in the property above described as are properly of record.

Proper adjustment having been made, Grantee herein assumes and agrees to pay the 1973 ad valorem taxes levied and assessed against the above described property.

TO HAVE AND TO HOLD the above described premises, together with all and singular the rights and appurtenances thereto in anywise belonging, but subject to the reservations, exceptions and other matters above set forth, unto the said IOWA BEEF PROCESSORS, INC., a corporation, its successors and assigns forever, and we do hereby bind ourselves, our heirs, executors and administrators, to warrant and forever defend, all and singular the said premises, but subject to the reservations, exceptions and other matters above set forth, unto the said IOWA BEEF PROCESSORS, INC., its successors and assigns, against every person whomsoever lawfully claiming, or to claim the same or any part thereof.

WITNESS our hands, this 13th day of June, A.D. 1973.

Oscar Huff

Oscar Huff, Individually

Ruth B. Huff

Ruth B. Huff

CITIZENS BANK AND TRUST COMPANY, Pampa, Texas

BY: F. E. Imel Pres

Wm Jarrel Smith

Wm. Jarrel Smith

Marvin C. Webster

Marvin C. Webster
AS INDEPENDENT EXECUTORS OF THE WILL OF BEULA HUFF, DECEASED, AND AS TRUSTEES OF THE TRUST CREATED IN THE WILL OF BEULA HUFF, DECEASED

Ruth B. Huff

Ruth B. Huff, Individually

Helene Huff McCormick

Helene Huff McCormick, Individually

THE STATE OF TEXAS)

COUNTY OF GRAY)

BEFORE ME, the undersigned, a Notary Public in and for said County and State, on this day personally appeared OSCAR HUFF, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he executed the same for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this 13th day of June, A.D. 1973.

Betty Merriman
NOTARY PUBLIC IN AND FOR GRAY COUNTY, TEXAS

THE STATE OF TEXAS)

COUNTY OF GRAY)

BEFORE ME, the undersigned, a Notary Public in and for said County and State, on this day personally appeared RUTH B. HUFF, a feme sole, Individually and as Independent Executor of the Will of Beula Huff, Deceased, and as Trustee of the Trust created in the Will of Beula Huff, Deceased, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that she executed the same for the purposes and consideration therein expressed, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this 13th day of June, A.D. 1973.

Betty Merriman
NOTARY PUBLIC IN AND FOR GRAY COUNTY, TEXAS

THE STATE OF TEXAS)

COUNTY OF GRAY)

BEFORE ME, the undersigned, a Notary Public in and for said County and State, on this day personally appeared F. E. IMEL, President, known to me to be the person and officer whose name is subscribed to the foregoing instrument and acknowledged to me that that the same was the act of the said CITIZENS BANK AND TRUST COMPANY, a corporation, and that he executed the same as the act of such corporation, and as Independent Executor of the Will of Beula Huff, Deceased, and as Trustee of the Trust created in the Will of Beula Huff, Deceased, for the purposes and consideration therein expressed, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this the 14th day of June, A.D. 1973.

Pat Young
NOTARY PUBLIC IN AND FOR GRAY COUNTY, TEXAS

THE STATE OF TEXAS)

COUNTY OF GRAY) VOL 1198 PAGE 148

BEFORE ME, the undersigned, a Notary Public in and for said County and State, on this day personally appeared WM. JARREL SMITH as Independent Executor of the Will of Beula Huff, Deceased, and as Trustee of the Trust created in the Will of BEula Huff, Deceased, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he executed the same for the purposes and consideration therein expressed, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this 14th day of June, A.D. 1973.

Betty Merriman
NOTARY PUBLIC IN AND FOR GRAY COUNTY, TEXAS

THE STATE OF TEXAS)

COUNTY OF GRAY)

BEFORE ME, the undersigned, a Notary Public in and for said County and State, on this day personally appeared MARVIN C. WEBSTER, as Independent Executor of the Will of Beula Huff, Deceased, and as Trustee of the Trust created in the Will of Beula Huff, Deceased, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he executed the same for the purposes and consideration therein expressed, and in the capacity therein stated.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this the 14th day of June, A.D. 1973.

Betty Merriman
NOTARY PUBLIC IN AND FOR GRAY COUNTY, TEXAS

THE STATE OF ~~NEW MEXICO~~ Texas)

COUNTY OF ~~BERNALILLO~~ Gray)

BEFORE ME, the undersigned, a Notary Public in and for said County and State, on this day personally appeared HELENE HUFF McCORMICK, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that she executed the same for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this 13th day of June, A.D. 1973.

Betty Merriman
NOTARY PUBLIC IN AND FOR ~~BERNALILLO~~ Gray COUNTY, ~~NEW MEXICO~~ Texas

THE STATE OF TEXAS }
County of Potter }

I, ANN LYLE RIGLER, County Clerk of said County, do hereby certify that the foregoing instrument of writing together with its Certificate of Authentification was filed for record in my office the 3 day of July A. D. 1973 at 1:15 o'clock p M., and duly recorded this 5 day of July A. D. 1973 in the Deed Records of said county, in volume 1198 on page 145.

Witness my hand and Official Seal, at my office in Amarillo, Texas, the day and year last above written.

ANN LYLE RIGLER
County Clerk, Potter County, Texas
By Jo Mulanax Deputy

389837

Warranty Deed

Estate of Beula Goff, Deceased, etal

to

Iowa Beef Processors, Inc.

4.50 6-13-73

FILED FOR RECORD
at 1:15 o'clock P M
JUL 3 1973
ANN LYLE RIGLER
COUNTY CLERK, POTTER COUNTY, TEXAS
BY ________ DEPUTY

Robert S. Templeton
American Nat'l Bank
79101 Bldg.

1198-145

ALT/GF#811347/LKB

Delaware

The First State

01078280
5/30/06, Potter

VOL. 3745 PAGE 689
PAGE 1 5/30/06 Potter

I, HARRIET SMITH WINDSOR, SECRETARY OF STATE OF THE STATE OF DELAWARE, DO HEREBY CERTIFY THE ATTACHED IS A TRUE AND CORRECT COPY OF THE CERTIFICATE OF AMENDMENT OF "IBP, INC.", CHANGING ITS NAME FROM "IBP, INC." TO "TYSON FRESH MEATS, INC.", FILED IN THIS OFFICE ON THE TWENTY-EIGHTH DAY OF APRIL, A.D. 2003, AT 6:49 O'CLOCK P.M.

Harriet Smith Windsor

Harriet Smith Windsor, Secretary of State

3327200 8100

060498511

AUTHENTICATION: 4770478

DATE: 05-24-06

VOL. 3745 PAGE 690
5/30/06, Potter

CERTIFICATE OF AMENDMENT

TO THE

CERTIFICATE OF INCORPORATION

OF

IBP, inc.

The undersigned corporation hereby executes this Certificate of Amendment for the purpose of amending its Certificate of Incorporation:

1. The name of the corporation is IBP, inc.

2. The following amendment to the charter of the corporation was adopted by its sole stockholder on the 18th day of April, 2003, in the manner prescribed by law.

   Paragraph 1 of the Certificate of Incorporation is deleted in its entirety and the following is substituted therefore:

   "The name of the corporation is Tyson Fresh Meats, Inc."

3. The number of shares of the corporation outstanding at the time of such adoption was 100 shares; and the number of shares entitled to vote thereon was 100.

4. The number of shares voted for such amendment was 100; and the number of shares voted against such amendment was 0.

5. The amendment herein effected does not give rise to dissenter's rights to payment for the reason that the only effect of such amendment is to change the name of the corporation.

6. The amendment shall become effective on the 1st day of May, 2003 at 12:01 a.m unless the Secretary of State of the State of Delaware or the applicable provisions of the General Corporation Law of the State of Delaware dictate otherwise.

L:\Md\Board\ibp.name change.wpd

COUNTY CLERK'S MEMO
Portions of this document not legible and/or reproducible when received for recording

State of Delaware
Secretary of State
Division of Corporations
Delivered 07:11 PM 04/28/2003
FILED 06:49 PM 04/28/2003
SRV 030274968 - 3327200 FILE

IN WITNESS WHEREOF, this Certificate of Amendment is signed by the Executive Vice President and Secretary of the corporation this 22nd day of April, 2003.

IBP, inc.

By: [signature]
Steve Hankins, Executive Vice President
and Chief Financial Officer

ATTEST:

By: R. Read Hudson
R. Read Hudson, Secretary

STATE OF ARKANSAS)
COUNTY OF Washington)

I, Janet Kesner, a notary public, hereby certify that on this 22nd day of April, 2003, personally appeared before me Steve Hankins and R. Read Hudson, each of whom being by me first duly sworn, declared that they signed the foregoing document in the capacity indicated, that they were authorized so to sign, and that the statements therein contained are true.

[signature]
Notary Public

My Commission Expires:

5-1-2004

JANET KESNER
COMM. EXP.
NOTARY PUBLIC
05-01-2004
WASHINGTON COUNTY, ARKANSAS

COUNTY CLERK'S MEMO
Portions of this document not legible and/or reproducible when received for recording

Return to:
American Land Title
2501 Lakeview
Amarillo, Texas 79109

TOTAL P.04

FILED AND RECORDED
OFFICIAL PUBLIC RECORDS
On: May 30,2006 at 03:11P

Receipt# - 87227

Document Number: 01078280

Amount 19.00

Mrs Sue Daniel
County Clerk, Potter County., TX

By__________, Deputy

VOL. 3745 PAGE 692

STATE OF TEXAS 1078280 COUNTY OF POTTER
I hereby certify that this instrument was FILED on this date and at the time stamped hereon by me and was duly RECORDED in the OFFICIAL PUBLIC RECORDS OF POTTER COUNTY TEXAS, in the volume and page as shown.

Mrs Sue Daniel, County Clerk
Potter County.,Texas

By__________ Deputy

Any provision herein which restricts the sale, rental or use of the described real property because of color or race is invalid and unenforceable under federal law. 5/30/06

COUNTY CLERK'S MEMO

Portions of this document may not be legible and/or reproducible when received for recording

1239159 OGM
06/28/2013 01:52 PM Total Pages: 3
Julie Smith, County Clerk - Potter County, Texas

MEMORANDUM OF OIL AND GAS LEASE

State:	Texas
County:	Potter
Lessor:	**Tyson Fresh Meats, Inc.**
Lessor's Address:	2200 Don Tyson Parkway, Springdale, Arizona 72762
Lessee:	Bandera Petroleum, Inc.
Lessee's Address:	809 T & P Lane, Abilene, Texas 79602
Effective Date:	June 11, 2013

As of the Effective Date stated above, Lessor, named above, executed and delivered to Lessee, named above, an Oil and Gas Lease (the "Lease") in which Lessor granted, demised, leased and let to Lessee lands (the "Lands") located in Potter County, Texas and described as follows, to-wit:

4,479.162 acres of land, more or less, being more particularly described in the following tracts of land:

TRACT ONE (1)

632.802 acres of land, more or less, situated in SECTION 20, Block 2, AB & M Survey, and being the same land described as Tract 1 containing 314.279 acres and Tract 2 containing 318.523 acres in that certain Warranty Deed dated May 26, 2006 from Amarillo Cotton Warehouse, L.P. to Tyson Fresh Meats, Inc. recorded in Volume 3245, Page 696 of the Deed Records, Potter County, Texas.

635.76 acres of land, more or less, situated in SECTION 21, Block 2, AB & M Survey, and being the same land described in that certain Warranty Deed filed March 30, 1994 from Estate of J. Russell Hogge et al to IBP, Inc. recorded in Volume 2403, Page 765 of the Deed Records, Potter County, Texas.

632.67 acres of land, more or less, situated in SECTION 25, Block 2, AB & M Survey, and being the same land described in that certain Warranty Deed dated January 3, 1978 from W. H. Holden et al to Iowa Beef Processors, Inc. recorded in Volume 1315, Page 621 of the Deed Records, Potter County, Texas.

443.04 acres of land, more or less, situated in SECTION 19, Block 2, AB & M Survey, and being the same land described in that certain Warranty Deed dated June 13, 1973 from Oscar Huff et al to Iowa Beef Processors, Inc. recorded in Volume 1198, Page 145 of the Deed Records, Potter County, Texas.

Tract One (1) containing 2,337.892 acres of land, more or less.

TRACT TWO (2)

All of SECTION 42, Block 2, AB & M Survey, Abstract No. 1140, Certificated 647, and being the same land as described in that certain Warranty Deed dated August 12, 1965 from O. L. Campbell, Sr. to J. L. Whitaker recorded in Volume 1014, Page 34 of the Deed Records, Potter County, Texas, containing 641.43 acres of land, more or less.

498.41 acres of land, more or less, situated in SECTION 43, Block 2, AB & M Survey, and being the same land described as Tract III in that certain Warranty Deed dated December 22, 1977 from J. L. Whitaker and wife, Winifred M. Whitaker to Iowa Beef Processors, Inc. recorded in Volume 1314, Page 194 of the Deed Records, Potter County, Texas.

529.17 acres of land, more or less, situated in SECTION 24, Block 2, AB & M Survey, and being the same land described as Tract I in that certain Warranty Deed dated December 22, 1977 from J. L. Whitaker and wife, Winifred M. Whitaker to Iowa Beef Processors, Inc. recorded in Volume 1314, Page 194 of the Deed Records, Potter County, Texas.

Tract Two (2) containing 1,669.01 acres of land, more or less.

TRACT THREE (3)

472.26 acres of land, more or less, situated in SECTION 41, Block 2, AB & M Survey, and being the same land described as all of SECTION 41, Block 2, AB & M Survey LESS AND EXCEPT the Southwest Quarter (SW/4) of said section.

Tract Three (3) containing 472.26 acres of land, more or less.

The Lease grants Lessee the right to explore for, drill for, produce and market oil, gas and other hydrocarbons from the Lands during the term of the Lease, the right to construct and maintain for its use and operations such facilities as are provided for in the Lease, and the right of ingress and egress on and over the Lands as provided for in the Lease.

This Memorandum of Oil and Gas Lease is executed by Lessor and Lessee and placed of record in the County in which the lands are located for the purpose of placing all persons on notice of the existence of the Lease and which Lease is not, at the request of both parties, being placed of record. A copy of the Lease has been retained by the Lessor and the Lessee.

LESSOR:

TYSON FRESH MEATS, INC.
a Delaware Corporation

By: N Hodne
Printed Name: Nathan Hodne
Title: Vice President & Asst. Secretary

LESSEE:

BANDERA PETROLEUM, INC.
a Texas Corporation

By: Kimberly Fenton
Printed Name: Kimberly Fenton
Title: President

ACKNOWLEDGEMENTS

STATE OF Arkansas §
§
COUNTY OF Washington §

This instrument was acknowledged by me on this 11th day of June, 2013, by Nathan Hodne in his/her capacity as Vice President & Asst. Secretary of **TYSON FRESH MEATS, INC.**, a Delaware corporation, on behalf of said corporation.

Frances Ann Silva
Notary Pubic

FRANCES ANN SILVA
COM. EXPIRES 4/25/2023
NOTARY PUBLIC
BENTON COUNTY, ARKANSAS
COM. #12393395

My Commission Expires: 4/25/2023

STATE OF Texas §
§
COUNTY OF Taylor §

This instrument was acknowledged by me on this 17th day of June, 2013, by Kimberly Fenton in his/her capacity as President, of **BANDERA PETROLEUM, INC.**, a Texas corporation, on behalf of said corporation.

Jamie Rogers
Notary Pubic

JAMIE C. ROGERS
MY COMMISSION EXPIRES
July 29, 2016

My Commission Expires 07-29-16

FILED and RECORDED

Instrument Number: 1239159

Filing and Recording Date: 06/28/2013 01:52:26 PM Pages: 3 Recording Fee: $20.00

I hereby certify that this instrument was FILED on the date and time stamped hereon and RECORDED in the OFFICIAL PUBLIC RECORDS of Potter County, Texas.

COUNTY COURT POTTER COUNTY, TEXAS

Julie Smith

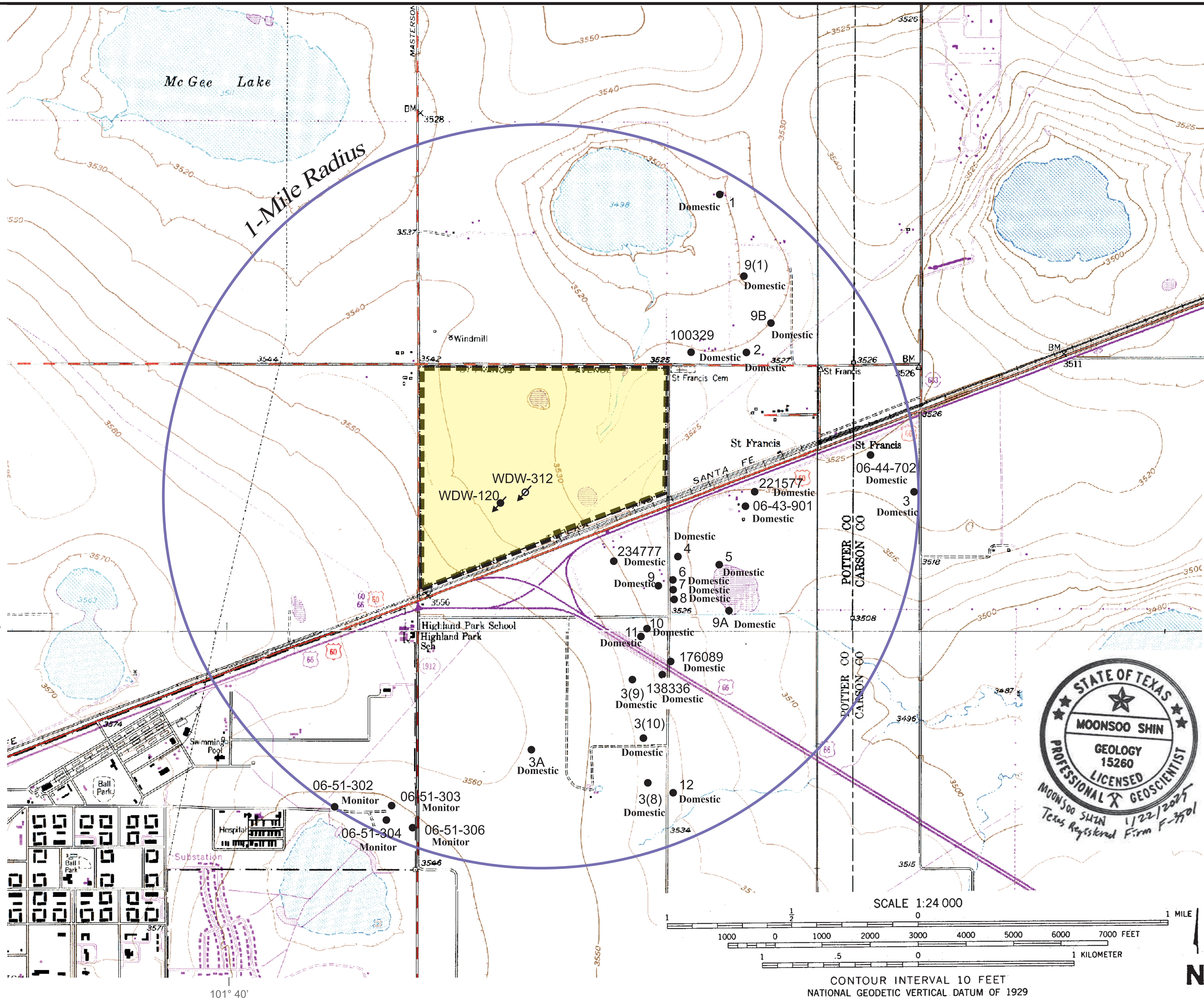
Julie Smith, County Clerk
Potter County, Texas

DO NOT DESTROY - This document is part of the Official Public Record.

msmith

Re 1239159

pu
WALT BEAMS
5249 SHADY GLEN LN
ABILENE, TX 79606



ATTACHMENT D-1

FACILITY BOUNDARIES AND ADJACENT WATERS TOPOGRAPHIC MAP

TYSON FRESH MEATS, INC.
AMARILLO HIDES FACILITY
Amarillo, Texas

WDW-120 Plant Injection Well - Active

WDW-312 Plant Injection Well - Proposed

Area Water Wells

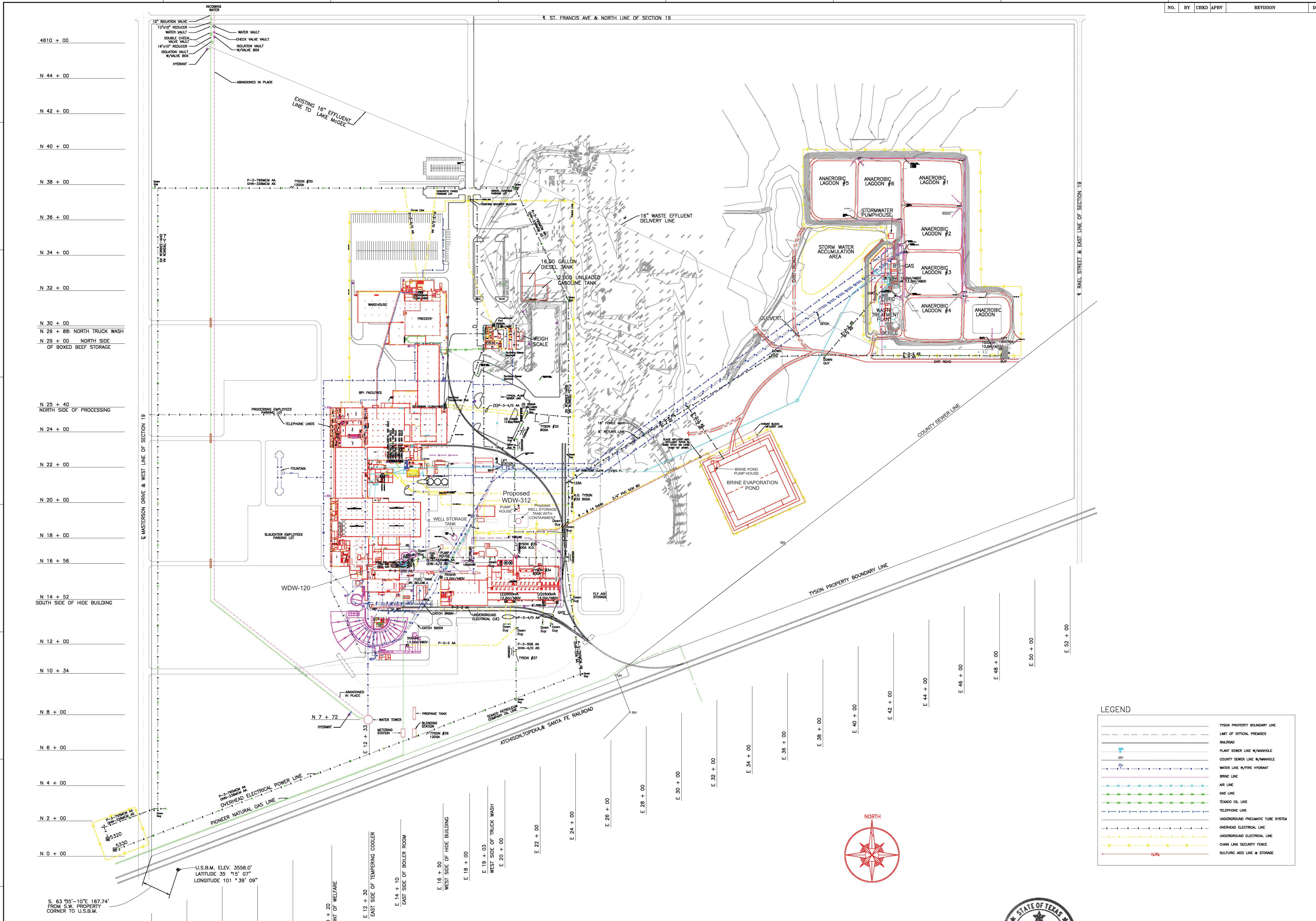
Tyson Plant Boundary (443.04 acres)

Map Source: USGS 7.5-Minute Mayer, 1973, Sevenmile Basin, 1973, Washburn, 1973, and Pullman, Texas, 1973, Quadrangle Maps

Administrative NOD revision in January 2025

TERRA DYNAMICS INC

DRAWN BY: B. SHIN	DATE: 1/9/2025
CHECKED BY: S. WILLIAMS	SCALE: As Indicated
DRAWING NO.: 13120.cdr	JOB NO.: 24-112 © 2025



This drawing is a copy of an original document from Tyson Foods, Inc.'s files. The original drawing was neither sealed nor signed by a licensed professional engineer. Based on my personal observation and inquiry, this drawing substantially describes and represents the overall facility, the location of the active and proposed Injection Wells and the Pre-Injection Units presently constructed and operating at the Tyson Fresh Meats, Inc. Amarillo facility. This drawing is released only for the purpose of Texas Commission on Environmental Quality review of an Underground Injection Control Permit Renewal Application.

ATTACHMENT D-2

Tyson Foods, Inc.
Manufacturing Services/Contact
P.O. Box 2020 2210 W. Oaklawn
Springdale, Arkansas 72762
Tel: 479-290-1741 Fayetteville Office
Tel: 605-235-2002 Dakota Dunes Office

TITLE: GENERAL PLOT PLAN
AMARILLO TEXAS

DRWN BY: CDY	DATE: 10/10/11
CHKD BY:	DWG NO: AM-00-00-002
APVD BY:	REV A
PROJECT:	SCALE: 1″ = 250′
	SHEET:

Attachment E

Plain Language Summary

Tyson Fresh Meats, Inc. WDW-120 and WDW-312
Permit Renewal Application to Dispose of Waste in Class I Injection Wells

Tyson Fresh Meats, Inc. (referred to as Tyson) requests renewal for two Class I injection well permits, which are currently permitted as one active well (WDW-120) and one proposed well (WDW-312). The waste injected in the wells will be primarily surplus brine water associated with hide processing at the beef production complex within the Tyson Amarillo facility, which is located on 5000 N. FM 1912 in Amarillo, Texas. The Amarillo facility generates various beef products.

The wastewater generated for injection into the WDW-120 and WDW-312 injection wells will consist of individual waste streams described in Table IX.A of the permit application. The principal wastes are hide processing wastewater and tannery chrome recovery system effluent. The additional permitted wastes include other associated wastes such as groundwater and rainfall contaminated by the above authorized wastes, spills of the above authorized wastes, wash waters and solutions used in cleaning and servicing the waste disposal well system equipment.

The use of underground injection is a proven and accepted technology for the disposal of nonhazardous industrial waste streams, such as those generated at Tyson. Underground injection is preferred to all other technologies presently available and associated operations are protective of human health and the environment. The liquid wastes disposed of in the injection wells are contained in the defined Injection Intervals on essentially an infinite basis. The reservoirs receiving the injectate are saturated with saline water and are geologically sealed from above with impermeable or nearly impermeable sediments which contain the injected fluids.

Surface waters will be protected through the use of Class I injection operations by continuous monitoring of operations, secondary containment systems and inspection of facility manufacturing operations. Some of the safeguards that will be employed by the Tyson facility are: 1) favorable Injection Interval geology; 2) stringent well design, installation and construction standards; 3) regulatory oversight and reporting; 4) annual mechanical integrity testing of wells per the Texas Commission on Environmental Quality (TCEQ) regulations; 5) operational permit limitations (pressure, volume, fluid density, pH) and 6) monitoring systems for the permitted operational limits.

Groundwater is protected from pollution by adherence to the permitting and operating requirements incorporated into the operating permits for the active and proposed injection wells. The future construction of WDW-312 will incorporate groundwater protection safeguards: completion in appropriate geologic formations, drilling mud, conservative cementing practices, casing strings, pressurized annulus system, annulus fluid monitoring program and injection tubing. The Class I injection program will ensure confinement and isolation of the injected waste from the underground source of drinking water.

ATTACHMENT F PUBLIC INVOLVEMENT PLAN

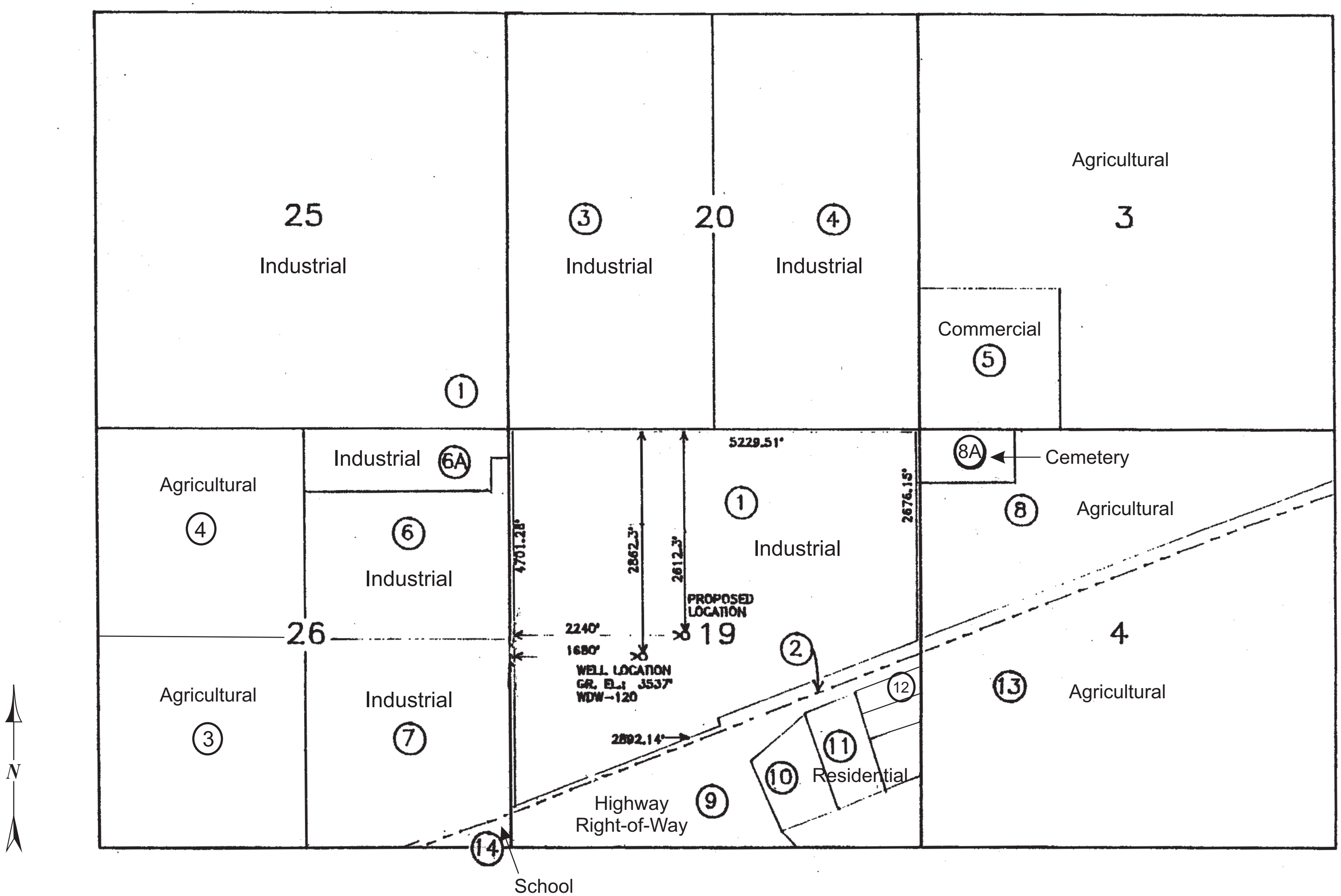
The TCEQ's Public Participation Plan provides guidance for using preliminary screening and public involvement plans to ensure meaningful public outreach. Applicants who are applying for a new injection well permit are required to complete a Public Involvement Plant.

This permit application is for the renewal of permits WDW-120 and WDW-312 and does not request a new injection well permit. Therefore, a Public Involvement Plan is not required and a Public Involvement Plan has not been included in this application.

Administrative NOD revision in January 2025

ATTACHMENT G

ADJACENT LAND AND MINERAL OWNERS MAP
Scale: 1″ = 2,000′



3 Land and Mineral Owners Number

Revision Date: 1/9/2025

ADJACENT SURFACE LANDOWNERS
CROSS-REFERENCED TO ATTACHMENT G MAP

Tyson Fresh Meats, Inc.
Permit for Plant Disposal Wells WDW-120 and WDW-312

1. TYSON FRESH MEATS INC
800 STEVENS PORT DRIVE
SUITE 709
DAKOTA DUNES SD 57049-8709

2. BURLINGTON NORTHERN - SANTA FE RAILROAD
2500 LOU MENK DRIVE
AOB 3
FORT WORTH TX 76131-2830

3. TYSON FRESH MEATS INC
800 STEVENS PORT DRIVE
SUITE 709
DAKOTA DUNES SD 57049-8709

4. TYSON FRESH MEATS INC
800 STEVENS PORT DRIVE
SUITE 709
DAKOTA DUNES SD 57049-8709

5. D T KING JR
310 W 10TH
FRIONA TX 79035

6. AMARILLO COTTON WAREHOUSE
7805 LINDSEY LANE
AMARILLO TX 79121

6A. AMARILLO COTTON WAREHOUSE
7805 LINDSEY LANE
AMARILLO TX 79121

7. AMARILLO COTTON WAREHOUSE
7805 LINDSEY LANE
AMARILLO TX 79121

8. NEBHUT FAMILY LIVING TRUST
207 RATON TRAIL
AMARILLO TX 79108

8A. ROMAN CATHOLIC DIOCESE
PO BOX 5644
AMARILLO TX 79117-5644

9. TEXAS DEPARTMENT OF TRANSPORTATION
125 E 11TH STREET
AUSTIN TX 78701-2483

10. BACA JOANGEL
2108 S ROBERTS ST
AMARILLO TX 79103-2109

11. LAWRENCE ROSE
16800 E HIGHWAY 60
AMARILLO TX 79108-8014

12. DANNY DAVIDSON
2928 BAGARRY ST
AMARILLO TX 79103-7117

13. RAEF PAULINE MARIE ETAL
17000 E HIGHWAY 60
AMARILLO TX 79108

14. HIGHLAND PARK ISD
PO BOX 30430
AMARILLO TX 79120-0430

MINERAL RIGHTS OWNERSHIP
CROSS-REFERENCED TO ATTACHMENT G MAP

Tyson Fresh Meats, Inc.
Permit for Plant Disposal Wells WDW-120 and WDW-312

1. TYSON FRESH MEATS INC
   800 STEVENS PORT DRIVE SUITE 709
   DAKOTA DUNES SD 57049-8709

2. TEXAS GENERAL LAND OFFICE
   1700 N CONGRESS AVE
   SUITE 840
   AUSTIN TX 78701-1495

   BURLINGTON NORTHERN - SANTA FE RAILROAD
   2500 LOU MENK DRIVE
   AOB 3
   FORT WORTH TX 76131-2830

3. CHIEKO H KOESJAN
   2700 S HARRISON ST
   AMARILLO TX 79109-2515

   TYSON FRESH MEATS INC
   800 STEVENS PORT DRIVE SUITE 709
   DAKOTA DUNES SD 57049-8709

4. BARBARA LEE KOESJAN
   458 BLAIRMORE DRIVE
   CHARLOTTE NC 28211-4114

   TYSON FRESH MEATS INC
   800 STEVENS PORT DRIVE SUITE 709
   DAKOTA DUNES SD 57049-8709

5. MAX WINKLER
   8520 RIVER ROAD
   AMARILLO TX 79108-1712

   D T KING JR
   310 W 10TH
   FRIONA TX 79035

6. TYSON FRESH MEATS INC
800 STEVENS PORT DRIVE SUITE 709
DAKOTA DUNES SD 57049-8709

6A. RONALD E MCGEE
5523 N FM 1912
AMARILLO TX 79108-7901

7. TYSON FRESH MEATS INC
800 STEVENS PORT DRIVE SUITE 709
DAKOTA DUNES SD 57049-8709

8. MARY LOUISE KLINKE TRUST
C/O SANDRA CROSS
12251 EXBURY STREET
HERNDON VA 20170

NEBHUT FAMILY LIVING TRUST
207 RATON TRAIL
AMARILLO TX 79108

8A. ROMAN CATHOLIC DIOCESE
PO BOX 5644
AMARILLO TX 79117-5644

9. TEXAS GENERAL LAND OFFICE
1700 N CONGRESS AVE
SUITE 840
AUSTIN TX 78701-1495

10. HISE FAMILY PARTNERSHIP
RR 1
PO BOX 89
GROOM TX 79039

11. LAWRENCE ROSE
16800 E HIGHWAY 60
AMARILLO TX 79108

CITIZENS STATE BANK OF DALHART TX — Vendor's Lien
BANK OF AMERICA
323 DENVER AVE
DALHART TX 79022

12. WESTERN STATES RECYCLING INC
PO BOX 5671
AMARILLO TX 79117

DANNY DAVIDSON
2928 BAGARRY ST
AMARILLO TX 79103-7117

13. GEORGE V RAEF
17000 E HIGHWAY 60
AMARILLO TX 79108-8013

BLAIN EUBANK
5201 ALVARADO ROAD
AMARILLO TX 79106

14. HIGHLAND PARK ISD
PO BOX 30430
AMARILLO TX 79120-0430

TYSON FRESH MEATS INC
800 STEVENS PORT DRIVE
SUITE 709
DAKOTA DUNES SD 57049-8709

BURLINGTON NORTHERN-SANTA FE RR
2500 LOU MENK DRIVE
AOB 3
FORT WORTH TX 76131-2830

D T KING JR
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FRIONA TX 79035

AMARILLO COTTON
WAREHOUSE
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AMARILLO TX 79121

NEBHUT FAMILY LIVING TRUST
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AMARILLO TX 79103-2109

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16800 E HIGHWAY 60
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AMARILLO TX 79103-7117

RAEF PAULINE MARIE ETAL
17000 E HIGHWAY 60
AMARILLO TX 79108

HIGHLAND PARK ISD
PO BOX 30430
AMARILLO TX 79120-0430

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HERNDON VA 20170-2543

NEBHUT FAMILY LIVING TRUST
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AMARILLO TX 79108

ROMAN CATHOLIC DIOCESE
PO BOX 5644
AMARILLO TX 79117-5644

HISE FAMILY PARTNERSHIP
RR 1
BOX 89
GROOM TX 79039-9518

LAWRENCE ROSE
16800 E HIGHWAY 60
AMARILLO TX 79108-8014

CITIZENS STATE BANK OF
DALHART TX Vendor's Lien
323 DENVER AVE
DALHART TX 79022

WESTERN STATES RECYCLING INC
PO BOX 5671
AMARILLO TX 79117-5671

DANNY DAVIDSON
2928 BAGARRY ST
AMARILLO TX 79103-7117

HIGHLAND PARK ISD
PO BOX 30430
AMARILLO TX 79120-0430

GEORGE V RAEF
17000 E HIGHWAY 60
AMARILLO TX 79108-8013

BLAIN EUBANK
5201 ALVARADO ROAD
AMARILLO TX 79106

October 2, 2013 13-120

General Land Office
Deputy Commissioner of Asset Acquisition
Steven F Austin Bldg
1700 N. Congress
Austin, TX 78701

Re: State of Texas Land Ownership – Permanent School Fund Determination
Section 19, Block 2, A. B. & M. Survey, Potter County, Texas
Tyson Fresh Meats, Inc., Amarillo, Texas

Dear Sir:

Terra Dynamics, Inc. (TDI) is currently preparing a Texas Commission on Environmental Quality (TCEQ) permit renewal application for underground injection at the Tyson Fresh Meats, Inc. Amarillo Hides Facility, located northeast of Amarillo, Texas in Potter County. As part of the application, the TCEQ requires that a determination be made to identify any state-owned land that may be dedicated to the permanent school fund.

The Tyson Fresh Meats facility lies north of the junction of Highways 60 and 66 in Section 19, Block 2, A. B. & M. Survey. The facility covers approximately 450 acres of the northern part of that section. Land and mineral ownership records show that a portion of land along and south of Highways 60 and 66 in the south part of Section 19 is owned by the Texas Department of Transportation and General Land Office.

Please review your records regarding this property and let me know whether or not the land is dedicated to the permanent school fund. If you have any questions regarding this request, please contact me at (512) 795-8183.

Sincerely,

Ann E. Bell, PG
Senior Geologist

TEXAS GENERAL LAND OFFICE

JERRY PATTERSON, COMMISSIONER

October 17, 2013

Ann E. Bell
Terra Dynamics, Inc.
4616 West Howard Lane
Suite 9-980
Austin, TX 78728

Re: Permanent School Fund Determination, Section 19, Block 2, A. B. & M. Survey, Potter County

Dear Ms. Bell:

This is in response to your letter dated October 2, 2013, inquiring about Permanent School Fund Land in the vicinity of the above-mentioned property. After doing some research, we do not appear to presently own any land nearby. If you have additional questions, please contact me at (512) 463-4802. Please direct any correspondence to my attention at: Texas General Land Office, Asset Management Division, PO Box 12873, Austin, Texas, 78711-2873.

Sincerely,

Amber Long

Amber Long
Asset Management

From:	Bill O"Hara
To:	Ann Bell
Cc:	Jim Suydam
Subject:	Re: State of Texas Land - Potter Co.-PSF
Date:	Wednesday, October 16, 2013 3:52:19 PM

Ann,

Section 19, Block 2, A B & M Survey, Abst. 8 in Potter County was patented in 1882. According to our records this section of land is not owned by or dedicated to the PSF. I also checked with staff in our Asset Management department who keep records of properties owned by other state agencies and am told the property in question is not owned by another state agency of Texas.

Hope this information is helpful. Please let me know if I can be of further assistance.

Sincerely,

Bill O'Hara
Director, Surveying Division
Professional Services
Texas General Land Office
(512) 463-5223
bill.o'hara@glo.texas.gov
>>> <abell@terradyn.com> 10/16/2013 12:22 PM >>>
NAME: Ann Bell
EMAIL: abell@terradyn.com
PHONE: 512-795-8183
SUBJECT: State of Texas Land - Potter Co.-PSF
SENT_FROM_FORM: www.glo.texas.gov/cf/contact-us-form/index.html
MESSAGE: I am trying to determine if a parcel of land in Potter County that is owned by the State of Texas is dedicated to the Permanent School Fund. The legal description for the land is Section 19, Block 2, A B & M Survey, Abst. 8. The land includes 111.18 acres in the southwestern portion of the section. The location of the property is northeast of Amarillo.
TO: jim.suydam

The Auto Response sent to the customer is:
Thank you for your e-mail. It has been forwarded to the proper agency staff member.

ATTACHMENT H
LETTER FROM THE RAILROAD COMMISSION

Included on the following pages are letters from the Railroad Commission of Texas (RRC) generated during the previous permit applications of the Tyson WDW-120 and WDW-312 injection wells. The RRC letters dated March 28, 2003 and December 10, 2013 assert that the operation of these wells for disposal of non-hazardous wastes into the Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formations at depths between 3,720 and 9,000 feet will not injure or endanger any known oil or gas reservoirs.

Tyson has submitted a copy of this permit renewal application to the RRC. A copy of the cover letter submitted to the RRC is included in this attachment.

TERRA DYNAMICS INC

November 15, 2024 24-112

Mr. Sean Avitt
Technical Programs Manager
Injection-Storage Permits Unit
Technical Permitting
Railroad Commission of Texas
1701 N. Congress, 11th Floor, Room 140
PO Box 12967
Austin, Texas 78711-2967

Re: TCEQ Permit Renewal Application for WDW-120 and WDW-312 Tyson Fresh Meats, Inc.

Dear Mr. Avitt:

Tyson Fresh Meats, Inc. (Tyson) is applying to the Texas Commission on Environmental Quality (TCEQ) for renewal of the permit for two Class I injection wells at its Amarillo Plant in Amarillo, Texas. The permit will allow them to continue to conduct Class I underground injection under provisions of Chapters 26 and 27 of the Texas Water Code. The permit will authorize operation of one existing Class I injection well (WDW-120) and the installation and operation of one proposed Class I injection well (WDW-312) for disposal of nonhazardous wastewaters generated at the site. Tyson is submitting the application and technical report to the Railroad Commission for review as required in the current regulations. Tyson has demonstrated that operating the disposal wells and injecting industrial waste into the subsurface stratum specified in the technical report will not endanger any known oil or gas resources.

The wells will be located approximately 11 miles northeast of Amarillo, Texas on US Highway 60, immediately north of the junction of US Highway 60 and US Highway 66. The WDW-120 (existing) and WDW-312 (proposed) wells are located in Section 19, Block 2, Adams Beaty and Moulton Survey.

Tyson is currently authorized to dispose of nonhazardous wastewater via WDW-120 and the proposed WDW-312 injection wells into the Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formations. The Injection Zone is present from approximately 3,720 feet to 9,000 feet below ground level (BGL) at the well locations. The Injection Interval for WDW-120 is within the Wichita and Brown Dolomite Formations and is present from approximately 4,000 feet to 5,000 feet BGL. The Injection Interval for WDW-312 is within the Wichita, Brown Dolomite, and Granite Formations and is present from approximately 4,000 feet to 9,000 feet BGL. Within the Tyson area of review, the Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formations are <u>not currently</u>, and <u>have never been</u>

historically, productive of hydrocarbons or natural gas. No non-freshwater artificial penetrations are located in the Tyson 2.5-mile area of review.

In order to assist in your review process, I've attached the TCEQ UIC Class I Injection Well Permit Renewal Application for your review. The geology and hydrogeology section is included in Section V. Cross sections, structure and isopach maps, tables, and figures are included with the discussion of local and regional geology. Section VIII discusses the area of review, research protocol and provides information that there are no known non-freshwater artificial penetrations in the area of review. A copy of the previous Railroad Commission letter for the two Tyson (previously IBP, Inc.) wells dated March 28, 2003 is included in Attachment H of the document.

We look forward to working with you toward issuance of a letter confirming that *operating/drilling the WDW-120 and WDW-312 disposal wells and injecting industrial waste into the subsurface stratum specified in the technical report will not endanger any known oil or gas resources.*

Please email via bshin@terradyn.com or call at (512) 795-8183 if you should have any questions about this matter.

Moonsoo (Brian) Shin, PG
Senior Geologist

Attachment

cc: Mr. Eric Rodriquez, Area Environmental Manager
Tyson Fresh Meats, Inc.
P.O. Box 30500
Amarillo, TX 79187

Mr. Bryan Smith
Texas Commission on Environmental Quality
UIC Permits Section, Radioactive Materials Division
Mail Code 233
PO 13087
Austin, Texas 78711-3087

RAILROAD COMMISSION OF TEXAS

OIL AND GAS DIVISION
March 28, 2003

IBP, INC.
P.O. BOX 30500
AMARILLO TEXAS 79187

RE: Class I Non-hazardous Waste Disposal Well Permit Renewal Application
IBP, Inc., Well Nos. WDW-120, WDW-312
Potter County

The Railroad Commission staff has reviewed your renewal application received March 14, 2003, for the referenced Class I injection wells. It is our understanding that no modifications are being requested in this application and all of the permitted conditions and parameters of the previous application are the same in this application as in previous applications.

In previous reviews, the Commission concluded that operation of these wells for disposal of non-hazardous wastes into the Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formations at depths between 3720 and 9000 feet will not injure or endanger any known oil or gas reservoir. A technical review performed for this renewal application reconfirms the Commission's prior conclusion.

Sincerely yours,

Richard F. Ginn,
Deputy Assistant Director
for Underground Injection Control

RG/NDLR

cc: Ben Knape, UIC Unit Head
Hazardous and Solid Waste Enforcement Section
Texas Natural Resource Conservation Commission

cc: Ann E. Bell
Terra Dynamics, Inc.
4900 Spicewood Springs Road
Austin, Texas 78759

RAILROAD COMMISSION OF TEXAS

OIL AND GAS DIVISION

December 10, 2013

JOEL RODRIGUEZ
MAINTENANCE SUPERINTENDENT
TYSON FRESH MEATS, INC.
P.O. BOX 30500
AMARILLO, TX 79187

RE: Class I Injection Well Permit Application
Tyson Fresh Meats, Inc. - Well Nos. WDW-120 and WDW-312
Potter County, Texas

The Railroad Commission staff has received your application dated September 17, 2013, prepared on your behalf by Terra Dynamics Incorporated., for the above-referenced Class I injection wells. It is our understanding that no modifications are being requested in this application and all the permitted conditions and parameters of the previous application are the same in the application as in previous applications.

In previous reviews, the Commission concluded the operation of these wells for disposal of non-hazardous wastes into the Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formations at depths between 3720 and 9000 feet will not injure or endanger any known oil or gas reservoirs. A technical review performed for this renewal application reconfirms the Commission's prior conclusion.

Sincerely yours,

David Hill

David Hill, PE, PG, Manager
Injection-Storage Permits and Support
Technical Permitting

DJ/cb

Cc: LORRIE COUNCIL PG MGR
TCEQ - UIC PERMITS
P.O. BOX 13087
AUSTIN, TX 78711-3087

Cc: ANN E. BELL
TERRA DYNAMICS, INC
4900 SPICEWOOD SPRINGS ROAD
AUSTIN, TX 78759

UIC permitting procedures can also be found at http://www.rrc.state.tx.us/divisions/og/uic/manual/HTML/index.html.

TERRA
DYNAMICS INC
INJECTION WELL SERVICES - OIL & GAS CONSULTING

September 17, 2013

13-120

RECEIVED
RRC OF TEXAS
SEP 18 2013
O&G
AUSTIN TX

Mr. Doug Johnson
Technical Programs Manager
Underground Injection Control
Railroad Commission of Texas
1701 N. Congress, 11th Floor
PO Drawer 12967
Austin, Texas 78711-2967

Re: Class I Injection Well Permit Renewal Applications - WDW-120 and WDW-312
Tyson Fresh Meats, Inc., Amarillo, Texas

Dear Mr. Johnson:

Tyson Fresh Meats, Inc. (Tyson) is applying to the Texas Commission on Environmental Quality (TCEQ) for renewal of permits for two Class I injection wells at their facility northeast of Amarillo, Texas. The permits will allow them to conduct Class I underground injection under provisions of Chapters 26 and 27 of the Texas Water Code. The permits will authorize operation of one existing Class I injection well (WDW-120) and the installation and operation of one new Class I injection well (WDW-312) for disposal of non-hazardous wastewaters generated at the site. Tyson is submitting information from the application and technical report to the Railroad Commission for review as required in the current regulations. Tyson has demonstrated that *operating/drilling the disposal wells and injecting industrial waste into the subsurface stratum specified in the technical report will not endanger any known oil or gas resources.*

The wells will be located approximately 11 miles northeast of Amarillo, Texas on US Highway 60, immediately north of the junction of US Highway 60 and US Highway 66. The WDW-120 (existing) and WDW-312 (proposed) wells are located in Section 19, Block 2, Adams Beaty and Moulton Survey.

Tyson is currently authorized to dispose of nonhazardous wastewater via WDW-120 and the proposed WDW-312 injection wells into the Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formations. The Injection Zone is present from approximately 3,720 feet to 9,000 feet below ground level (BGL) at the well locations. The Injection Interval for WDW-120 is within the Wichita and Brown Dolomite Formations and is present from approximately 4,000 feet to 5,000 feet BGL. The Injection Interval for WDW-312 is within the Wichita, Brown Dolomite, and Granite Formations and is present from approximately 4,000 feet to 9,000 feet BGL. Within the Tyson area of review, the Wichita, Brown Dolomite, Wolfcamp, and Granite Wash Formations are not currently, and have never been historically, productive of hydrocarbons or natural gas. No non-freshwater artificial penetrations are located in the Tyson 2.5-mile area of review.

In order to assist in your review process, I've attached the TCEQ UIC Class I Injection Well Permit Renewal Application for your review. The geology and hydrogeology section is included in Section V. Cross sections, structure and isopach maps, tables, and figures are included with the discussion of local and regional geology. Section VIII discusses the area of review, research protocol and provides information that there are no known non-freshwater artificial penetrations in the area of review. A copy of the previous Railroad Commission letter for the two Tyson (previously IBP, Inc.) wells dated March 28, 2003 is included in Attachment E of the document.

We look forward to working with you toward issuance of a letter confirming that *operating/drilling the WDW-120 and WDW-312 disposal wells and injecting industrial waste into the subsurface stratum specified in the technical report will not endanger any known oil or gas resources.* Please call me at (512) 795-8183 is you should have any questions about this matter.

Sincerely,

Ann E. Bell

Ann E. Bell, PG
Senior Geologist

Attachments

CC: Joel Rodriguez, Tyson Fresh Meats, Inc.,
P.O. Box 30500, Amarillo, TX 79187

ATTACHMENT I
FINANCIAL ASSURANCE

A letter providing demonstration of financial responsibility for plugging and abandonment for UICs lists the 2024 cost estimate for plugging and abandonment of the WDW-120 injection well at $269,191. This cost estimate assumes closure activities will be conducted by a third party with no operable on-site equipment.

Financial assurance documents for closure of the proposed WDW-312 injection well will be provided prior to commencement of drilling activities. Tyson will supply documentation guaranteeing performance of plugging and abandonment consistent with the requirements of 30 TAC §331.142. The documents will demonstrate financial responsibility for closure as specified in 30 TAC §§331.142-144 and 30 TAC §37.7021.

Tyson has prepared two written plugging cost estimates corresponding to well completion, in current dollars, for the cost of plugging the proposed WDW-312 injection well in accordance with the plugging and abandonment planned as specified in the Technical Report of this application. The cost estimate is either $335,319 (Wichita-Brown Dolomite Completion) or $361,185 (Granite Wash Completion) for closure, plugging, and abandonment of the proposed Tyson WDW-312 injection well.

Tyson has sufficient financial resources to operate the facility in a safe manner and in compliance with the permit and all applicable rules, and has sufficient financial resources to obtain financing for closure. Tyson will acquire and maintain financial assurance for the plugging and abandonment of the proposed WDW-312 injection well in accordance with 30 TAC §37.7021(c), *at* least 60 days *prior* to commencement of drilling operations.

INCREASE/DECREASE RIDER

To be attached to and form a part of Bond Number 0190134 in the amount of Three Hundred Fifteen Thousand, Two Hundred Eighty-Four and No/100 ($315,284.00) Dollars issued by Berkley Insurance Company on behalf of Tyson Fresh Meats, Inc. in favor of Texas Commission on Environmental Quality.

It is understood and agreed that the bond described above is hereby modified to **Increase** bond amount:

FROM:	**Three Hundred Fifteen Thousand, Two Hundred Eighty-Four and No/100 ($315,284.00) Dollars**
TO:	**Three Hundred Twenty-Six Thousand, One Hundred Seventy-Seven and No/100 ($326,177.00) Dollars**

It is further expressly understood and agreed that the aggregate liability of the company under said bond to the obligee herein mentioned shall not exceed the amount stated above. Nothing herein contained shall be held to vary, alter, waive, or extend any of the terms, agreements, conditions or limitations of the above mentioned bond, other than as above stated.

To be effective this 7th day of January, 2024.

Signed, Sealed, and dated this 3rd day of January, 2024.

Tyson Fresh Meats, Inc.
Principal

Name: Curt Calaway, SVP and Treasurer
Title:

Berkley Insurance Company
Surety

Hillary D. Shepard, Attorney-in-Fact

No. BI-1345r-el

POWER OF ATTORNEY
BERKLEY INSURANCE COMPANY
WILMINGTON, DELAWARE

KNOW ALL MEN BY THESE PRESENTS, that BERKLEY INSURANCE COMPANY (the "Company"), a corporation duly organized and existing under the laws of the State of Delaware, having its principal office in Greenwich, CT, has made, constituted and appointed, and does by these presents make, constitute and appoint: ***Patrick T. Pribyl; Debra J. Scarborough; Mary T. Flanigan; Jeffrey C. Carey; Christy M. Braile; Charissa D. Lecuyer; Evan D. Sizemore; Charles R. Teter, III; Rebecca S. Leal; C. Stephens Griggs; Tahitia M. Fry; Kellie A. Meyer; Veronica Lawver; Lauren Scott; Hillary D. Shepard; Erin C. Lavin; Kristin D. Thurber; or Danielle R. Capps of Lockton Companies, LLC of Kansas City, MO*** its true and lawful Attorney-in-Fact, to sign its name as surety only as delineated below and to execute, seal, acknowledge and deliver any and all bonds and undertakings, with the exception of Financial Guaranty Insurance, providing that no single obligation shall exceed **Fifty Million and 00/100 U.S. Dollars (U.S.$50,000,000.00),** to the same extent as if such bonds had been duly executed and acknowledged by the regularly elected officers of the Company at its principal office in their own proper persons.

This Power of Attorney shall be construed and enforced in accordance with, and governed by, the laws of the State of Delaware, without giving effect to the principles of conflicts of laws thereof. This Power of Attorney is granted pursuant to the following resolutions which were duly and validly adopted at a meeting of the Board of Directors of the Company held on January 25, 2010:

RESOLVED, that, with respect to the Surety business written by Berkley Surety, the Chairman of the Board, Chief Executive Officer, President or any Vice President of the Company, in conjunction with the Secretary or any Assistant Secretary are hereby authorized to execute powers of attorney authorizing and qualifying the attorney-in-fact named therein to execute bonds, undertakings, recognizances, or other suretyship obligations on behalf of the Company, and to affix the corporate seal of the Company to powers of attorney executed pursuant hereto; and said officers may remove any such attorney-in-fact and revoke any power of attorney previously granted; and further
RESOLVED, that such power of attorney limits the acts of those named therein to the bonds, undertakings, recognizances, or other suretyship obligations specifically named therein, and they have no authority to bind the Company except in the manner and to the extent therein stated; and further
RESOLVED, that such power of attorney revokes all previous powers issued on behalf of the attorney-in-fact named; and further
RESOLVED, that the signature of any authorized officer and the seal of the Company may be affixed by facsimile to any power of attorney or certification thereof authorizing the execution and delivery of any bond, undertaking, recognizance, or other suretyship obligation of the Company; and such signature and seal when so used shall have the same force and effect as though manually affixed. The Company may continue to use for the purposes herein stated the facsimile signature of any person or persons who shall have been such officer or officers of the Company, notwithstanding the fact that they may have ceased to be such at the time when such instruments shall be issued.

IN WITNESS WHEREOF, the Company has caused these presents to be signed and attested by its appropriate officers and its corporate seal hereunto affixed this 20th day of April, 2023.

BERKLEY INSURANCE COMPANY CORPORATE SEAL 1975 DELAWARE

Attest:
By [signature]
Ira S. Lederman
Executive Vice President & Secretary

Berkley Insurance Company
By [signature]
Jeffrey M. Hafter
Senior Vice President

STATE OF CONNECTICUT)
) ss:
COUNTY OF FAIRFIELD)

Sworn to before me, a Notary Public in the State of Connecticut, this 20th day of April, 2023, by Ira S. Lederman and Jeffrey M. Hafter who are sworn to me to be the Executive Vice President and Secretary, and the Senior Vice President, respectively, of Berkley Insurance Company.

MARIA C RUNDBAKEN
NOTARY PUBLIC
CONNECTICUT
MY COMMISSION EXPIRES
APRIL 30, 2024

[signature]
Notary Public, State of Connecticut

CERTIFICATE

I, the undersigned, Assistant Secretary of BERKLEY INSURANCE COMPANY, DO HEREBY CERTIFY that the foregoing is a true, correct and complete copy of the original Power of Attorney; that said Power of Attorney has not been revoked or rescinded and that the authority of the Attorney-in-Fact set forth therein, who executed the bond or undertaking to which this Power of Attorney is attached, is in full force and effect as of this date.

Given under my hand and seal of the Company, this 3rd day of January, 2024.

BERKLEY INSURANCE COMPANY CORPORATE SEAL 1975 DELAWARE

[signature]
Vincent P. Forte

Please **verify the authenticity** of the instrument attached to this power by:

Toll-Free Telephone: (866) 768-3534; or

Electronic Mail: BSGInquiry@berkleysurety.com

Any written notices, inquiries, claims or demands to the Surety on the bond attached to this power should be directed to:

Berkley Surety Group
412 Mount Kemble Ave.
Suite 310N
Morristown, NJ 07960
Attention: Surety Claims Department

Or

Email: BSGClaim@berkleysurety.com

Please include with all communications the bond number and the name of the principal on the bond. Where a claim is being asserted, please set forth generally the basis of the claim. In the case of a payment or performance bond please also identify the project to which the bond pertains.

Berkley Surety Group is an operating unit of W. R. Berkley Corporation that underwrites surety business on behalf of Berkley Insurance Company and Berkley Regional Insurance Company

ATTACHMENT J
RADIOACTIVE WASTE STATEMENT

Tyson does not dispose of wastes containing radioactive materials. This section is thus not applicable to Tyson's well permit renewal applications, and no further information is herein provided.

Tabulation of Well Logs in Appendix A

(Included in Original Set of the
Permit Renewal Applications for WDW-120 and WDW-312)

Log Ref.	Operator	Lease and Well	Deepest Horizon Penetrated
WDW-120	Iowa Beef Processors (Tyson)	WDW-120	Injection Interval
1	Continental Oil Company	S T Bitting #1	Confining Zone
2	Paradox Petroleum Company	Bitting #1	Injection Interval
8	Catharine C. Whittenburg	Masterson #1	Confining Zone
11	PB-KBB Inc.	WDW-273 – Plant Well No. 2	Injection Interval
15	Sohio Petroleum Company	J J Berg #1	Injection Interval
28	Stanolind Oil & Gas Co.	Griffin #1	Injection Interval
31	Pure Oil Company	N H Read #1	Injection Interval

2

SCHLUMBERGER — LATEROLOG

COUNTY: CARSON	COMPANY: CONTINENTAL OIL COMPANY	Other Surveys: SONIC/GR - ML
FIELD or LOCATION: WILDCAT	WELL: S. T. BITTING #1	Location of Well: 3500' FR N/L, 780' FR E/L
WELL: S. T. BITTING #1	FIELD: WILDCAT	
COMPANY: CONTINENTAL OIL CO.	LOCATION: SEC 8, W. P. CANNON SURVEY	
	COUNTY: CARSON	Elevation: K.B.: 3583 D.F.: 3582 or G.L.: 3574
	STATE: TEXAS	

Log Depths Measured From KB 9 Ft. above GL

RUN No.	ONE		
Date	6-18-63		
First Reading	3997		
Last Reading	827		
Feet Measured	3170		
Csg. Schlum.	827		
Csg. Driller	827		
Depth Reached	4000		
Bottom Driller	4181		
Mud Nat.	SALT CLAY		
Dens. / Visc.	8.9 / 38		
Mud Resist.	.204 @ 68 °F	@ °F	@ °F
" Res. BHT	.146 @ 95 °F	@ °F	@ °F
" pH	6.8 @ °F	@ °F	@ °F
" Wtr. Loss	12.8 CC 30 min	CC 30 min	CC 30 min
" Rmf	.104 @ 95 °F	.145 @ 68 °F	@ °F
" Rmc	.187 @ 95 °F	.258 @ 69 °F	@ °F
Bit Size	6 3/4"		
Laterolog 3	a= 6" ; L= 3'	a= ; L=	a= ; L=
Laterolog 7	a= ; n=	a= ; n=	a= ; n=
Opr. Rig Time	2 HRS.		
Truck No.	4538 PAMPA		
Recorded By	GATER		
Witness	ARMSTRONG		

Reproduced By
Panhandle Electrical Log Service
Dallas 2, Texas

ELSI

REFERENCE P7251D

10 COMPLETION RECORD

SPUD DATE

COMP DATE

DST RECORD

CASING RECORD

PERFORATING RECORD

ACID FRAC SHOT

IP

GOR GR

TP CP

REMARKS

FOLD HERE

REMARKS	CALIBRATION:	BACKGND. CPS.	SOURCE CPS.	GALV. INCR. DIVISIONS	SENS. TAP (FOR CAL.)	SENS. TAP (RECORD)	TIME CONST.	RECORD SPEED
	GAMMA RAY:	80	400	82.5	500	300	1	40

MUD SOURCE - CIRCULATED SAMPLE

GAMMA RAY
API UNITS
GAMMA RAY ZERO DIV. TO LEFT OF THIS LINE
0 — 160
160 — 320

SPONTANEOUS-POTENTIAL
MILLIVOLTS

DEPTHS

LATEROLOG
BEAM WIDTH = 1' GUARD LENGTH = 3'
CONDUCTIVITY
MILLIMHOS/M = 1000 OHM-M
1000 500

RESISTIVITY
OHM-M
0 8 16 25 50 ∞
4 12 20 33 100

SPONTANEOUS-POTENTIAL

GAMMA RAY
API UNITS

DEPTHS

CONDUCTIVITY

LATEROLOG
BEAM WIDTH = 1' GUARD LENGTH = 3'

COMPANY CONTINENTAL OIL COMPANY	Rm .146 @ 95 F	SWSC FR 3997
WELL S. T. BITTING #1	Rmf .104 @ 95 F	SWSC TD 4000
FIELD WILDCAT	Rmc .187 @ 95 F	DRLR TD 4181
COUNTY CARSON STATE TEXAS	BHT 95 F	Elev: KB 3583 DF 3582 GL 3574

(1)

Schlumberger

DUAL INDUCTION - LATEROLOG

COUNTY	CARSON
FIELD or LOCATION	WILDCAT
LOCATION	SEC. 8-W.P. CANNON
WELL	BITTING NO. 1
COMPANY	PARADOX PETR. CO.

COMPANY PARADOX PETROLEUM COMPANY

WELL BITTING NO. 1

FIELD WILDCAT

COUNTY CARSON STATE TEXAS

LOCATION 3500'FNL & 780'FEL

Sec. 8 SURVEY W.P. CANNON

Other Services: FDC-GR, SNP-GR

Permanent Datum: GROUND LEVEL, Elev. 3572

Log Measured From K.B., 10 Ft. Above Perm. Datum

Drilling Measured From K.B.

Elev.- K.B. 3582, D.F. 3580, G.L. 3572

Date	5-3-72			
Run No.	TWO			
Depth—Driller	6200			
Depth—Logger	6199			
Btm. Log Interval	6193			
Top Log Interval	3500			
Casing—Driller	8 5/8 @ 812	@	@	@
Casing—Logger	812			
Bit Size	6 3/4			
Type Fluid in Hole	SM			
Dens. / Visc.	9.1 / 41	/	/	/
pH / Fluid Loss	8.5 / 96 ml	ml	ml	ml
Source of Sample	CIRCULATED			
R_m @ Meas. Temp.	0.15 @ 68 °F	@ °F	@ °F	@ °F
R_{mf} @ Meas. Temp.	0.09 @ 74 °F	@ °F	@ °F	@ °F
R_{mc} @ Meas. Temp.	--- @ --- °F	@ °F	@ °F	@ °F
Source: R_{mf} / R_{mc}	M / ---			
R_m @ BHT	0.08 @ 128 °F	@ °F	@ °F	@ °F
Time Since Circ.	3 HOURS			
Max. Rec. Temp.	128 °F	°F	°F	°F
Equip. / Location	5105 / LIBERAL			
Recorded By	STREETER			
Witnessed By	DOBERVICH			

Reproduced By

Electrical Log Services, Inc.

Midland, Texas 79701

REFERENCE P 2432K

ELSI

COMPLETION RECORD

SPUD DATE

COMP DATE

DST RECORD

API NO.

CASING RECORD

PERFORATING RECORD

ACID. FRAC SHOT

I P

GOR GR

T P C P

REMARKS:

REMARKS

Changes in Mud Type or Additional Samples			
Date / Sample No.			
Depth—Driller			
Type Fluid in Hole			
Dens. / Visc.			
ph / Fluid Loss	ml		
Source of Sample			
R_m @ Meas. Temp.	@ °F	@ °F	
R_{mf} @ Meas. Temp.	@ °F	@ °F	
R_{mc} @ Meas. Temp.	@ °F	@ °F	
Source: R_{mf} / R_{mc}	M / ---		
R_m @ BHT	0.08 @ 128 °F	@ °F	
R_{mf} @ BHT	0.05 @ 128 °F	@ °F	
R_{mc} @ BHT	--- @ --- °F	@ °F	

Type Log	Depth	Scale Changes: Scale Up Hole	Scale Down Hole

Run No.	Tool Type	Equipment Data: Tool Position	Other

Run No.	TWO
C.D.	USED
S.O.	1.5"
Equip. Used: PANEL No.	CB-162
CART. No.	B-107
SONDE No.	DB-54
IAP No.	MMP-B-290
S.B.R.	2

NOTE: LOGGED FROM 6090' TO T.D. WITHOUT CENTRALIZERS BECAUSE OF HOLE CONDITION. OLD WELL DRILLED DEEPER. ORIGINAL TOTAL DEPTH 4181'.

Check one, filling in blanks where applicable:

- [x] Surface determined sonde errors used for ILM and ILD.
- [x] ILM and ILD sonde errors corrected for 6 3/4 inch borehole signal at R_m = 0.08
- [ ] ILM and ILD zeros set in hole at depth of feet.

(8)

Reproduced By
Panhandle Electrical Log Service
1304 Commerce Street
Dallas 1, Texas

REFERENCE Nº P 1438 -D

SCHLUMBERGER WELL SURVEYING CORPORATION

LATEROLOG SURVEY
ELECTRICAL SURVEY

COMPANY	CATHARINE C. WHITTENBURG
WELL	MASTERSON NO. 1
FIELD	WILDCAT
LOCATION	SEC. 28, BLK. 1 BS&F SURVEY
COUNTY	POTTER
STATE	TEXAS

Location of Well: 990' FR N/L, 990' FR E/L

ES LL-GR-ML (39) (RUN TWO ML)

Elevation: DF 3567

FILING No.

REMARKS

GAMMA RAY

Radioactivity Increases

LATEROLOG

"MICROLOG"

MICROINVERSE 1½"

MICRONORMAL 2"

11

WDW-273

ATLAS WIRELINE SERVICES

DUAL INDUCTION FOCUSED LOG
GAMMA RAY

FILE NO.

API NO.

COMPANY: PB-KBB INC. / ASARCO

WELL: WDW NO. 273 - PLANT WELL NO. 2

FIELD

COUNTY: POTTER   STATE: TEXAS

FINAL PRINT

LOCATION: 2255' FEL & 2426' FNL SECTION - 68 / BLOCK - 2 SURVEY - A.B. & M.

SEC ___ TWP ___ RGE ___

OTHER SERVICES: CDL-C/CN/GR 4-CAL/GR ACBL/GR/CCL VERTILOG

PERMANENT DATUM: GL   ELEV. 3571.0

LOGGING MEASURED FROM: KB   12.0   FT. ABOVE P.D.

DRILLING MEASURED FROM: KB

ELEVATIONS: KB 3583, DF 3581, GL 3571

DATE	FEBRUARY 13, 1989	FEBRUARY 23, 1989	MARCH 7, 1989
RUN	1	2	3
SERVICE ORDER	002678	002681	002708
DEPTH-DRILLER	1716	4136	5062
DEPTH-LOGGER	1700	4132	5057
BOTTOM LOGGED INTERVAL	1718	4127	5055
TOP LOGGED INTERVAL	88	1760	3818
CASING - DRILLER	20" @ 82	13 3/8" @ 1760	9 5/8" @ 4080
CASING - LOGGER	88	1760	4090 SEE REMARKS
BIT SIZE	17 1/2"	12 1/4"	7 5/8"
TYPE FLUID IN HOLE	SALT-GEL	STARCH	DRISPAC / CHEMICAL MUD
DENSITY / VISCOSITY	10.3 / 36	9.6 / 35	8.6 / 40
PH / FLUID LOSS	6.8 / 32.4	7.0 / 12.8	9.0 / 9.4
SOURCE OF SAMPLE	FLOWLINE	FLOWLINE	FLOWLINE
RM AT MEAS. TEMP.	0.057 @ 89	0.075 @ 89	0.025 @ 79
RMF AT MEAS. TEMP.	0.043 @ 89	0.056 @ 89	0.627 @ 79
RMC AT MEAS. TEMP.	0.072 @ 89	0.094 @ 89	1.020 @ 79
SOURCE OF RMF / RMC	MEASURED / MEASURED	MEASURED / MEASURED	MEASURED / MEASURED
RM AT BHT	0.056 @ 90	0.063 @ 101	0.572 @ 114
TIME SINCE CIRCULATION	2.0 HR	2.5 HR	3.0 HR
MAX. REC. TEMP. DEG. F	90	101	114
EQUIP. NO. / LOC.	HL 6316 / YUKON, OK	HL 6316 / YUKON, OK	HL 6375 / YUKON, OK
RECORDED BY	R. MORIN	HERMANSKI	M. KOMAREK
WITNESSED BY	J. MARR	J. MARR	J. MARR

FOLD HERE

IN MAKING INTERPRETATIONS OF LOGS OUR EMPLOYEES WILL GIVE CUSTOMER THE BENEFIT OF THEIR BEST JUDGEMENT, BUT SINCE ALL INTERPRETATIONS ARE OPINIONS BASED ON INFERENCES FROM ELECTRICAL OR OTHER MEASUREMENTS, WE CANNOT, AND WE DO NOT GUARANTEE THE ACCURACY OR CORRECTNESS OF ANY INTERPRETATION. WE SHALL NOT BE LIABLE OR RESPONSIBLE FOR ANY LOSS, COST, DAMAGES, OR EXPENSES WHATSOEVER INCURRED OR SUSTAINED BY THE CUSTOMER RESULTING FROM ANY INTERPRETATION MADE BY ANY OF OUR EMPLOYEES.

REMARKS RUN (1)

DLL/CDL-C/CN/GR RAN IN COMBINATION AND PRESENTED SEPARATELY.

CREW: G. DEROIN & R. SINDORF

REMARKS RUN (2)

2" = 100' FILM PRESENTED FROM T.D. TO SURFACE CASING.
5" = 100' FILM PRESENTED FROM T.D. TO SURFACE CASING.

DIFL/GR RAN CENTRALIZED TO COMPENSATE FOR THE LARGE BOREHOLE SIZE AND ALSO TO HELP WITH THE BOREHOLE FLUID CONDITIONS.

CREW: G. DEROIN & R. MORIN

REMARKS RUN (3)

BOTTOM OF FIBERGLASS CASING IS 4090'.
BOTTOM OF STEEL CASING IS 3906'.

CREW: R. MORIN, T. BUTRON, R. NEPINAK & J. UHLMAN

EQUIPMENT DATA

RUN	TRIP	TOOL	SERIAL NO.	SERIES NO.	POSITION
1	1	DIFL			
1	1	GR	41750	1309XA	DECENT.
1	1	DLL	74047	1229XA	DECENT.
1	1	CN	56083	2420XA	DECENT.
1	1	CDL	57793	2227XA	DECENT.
1	1	CAL	57993	2227XA	OPEN
2	1	DIFL	78822	1503XA	CENTRALIZED
2	1	GR	52549	1309XA	CENTRALIZED
2	1	TCNT	52913	4304XA	4 - ARM
2	1	BCNT	59603	4304XA	4 - ARM
3	1	DIFL	49388	1503XA	1 1/2" S. O.
3	1	GR	52548	1309XA	FREE

PARAMETERS

NAME	DEPTH INTERVAL	VALUE	UNITS
RW	4140 TO 1637	0.040	OHMM

DISPLAY SCALE CHANGES

*** NONE ***

COMPANY: PB-KBB, INC. / ASARCO   RUN: 2
WELL NAME: WDW NO. 273 - PLANT WELL NO. 2   TRIP: 1
SERVICE: E 21IN   FILE: 4   DATE: 2/23/89   TIME: 13157130
REVISION: FSYSAL REV GS08 VER 2   MODE: PLAYBACK

15

WELEX

GAMMA GUARD LOG

Company SOHIO PETROLEUM CO
Well J J BERG # 1
Field WILDCAT
County CARSON
State TEXAS

COMPANY	SOHIO PETROLEUM CO
WELL	J J BERG # 1
FIELD	WILDCAT
COUNTY	CARSON STATE TEXAS
Location	Sec 45 Blk M-4 J H GIBSON Survey
Other logs	FoRxo

Permanent Datum	GROUND LEVEL	Elev. 3507'
Log Measured From	KELLY BUSHING	KB 3515'
Drilling Measured From	KELLY BUSHING	DF 3513'
		GL 3507'

Run No.	ONE
Date	8-11-81
Total Depth Driller	4600'
Total Depth Welex	4604'
Csg. Shoe Driller	1023'
Csg. Shoe Welex	1016'
Survey Begins	4599'
Survey Ends	1016'
Csg. Size	8-5/8"
Bit Size	7 3/8"
Mud Data Type	WATER BASE SALT GEL, STARCH
Weight	10.6
Viscosity	44
pH	8.0
Wtr. loss cc 30 min	13.0
Res. @ Surface Temp	.08 @ 84
Res. @ Max Hole Temp	.05 @ 106
Rmf CORRECTED	.038 @ 106
Rmc CORRECTED	.067 @ 106
Source Mud Sample	FLOWLINE
Recorded By	MYERS
Witnessed By	MR. ALLEN
Logging Unit No.	10849 10758

GUARD

Dia. 3-5/8"
Type G M
Length 28"
Sensitivity 120 UNITS
Zero 0 Div L
Speed 30'/min

CORRECTED TO Rm .05 @ 106°
Rmf .038 @ 106°
Rmc .067 @ 106°

5682 - PAMPA, TEXAS

POTENTIAL MILLIVOLTS

GAMMA

0 A P I UNITS 120

CONDUCTIVITY MILLIMHOS/M

1000 0

RESISTIVITY OHMS M^2/M

0 50

0 500

28

REFERENCE Nº P 34 -C

SCHLUMBERGER
WELL SURVEYING CORPORATION

Location of Well

COMPANY: STANOLIND OIL & GAS CO.

WELL: GRIFFIN #1

FIELD: W.C.

LOCATION: A.B.& M. BLK. 2, SEC.9

COUNTY: CARSON

STATE: TEXAS

FILING No. P-312 WF-1623

Elevation: D.F. 3528 DF
K.B.
or G.L. 3517 G

COUNTY: CARSON
FIELD OR LOCATION: A.B. & M.
WELL: GRIFFIN #1
COMPANY: STANOLIND OIL & GAS CO.

RUN NO.	1	2			
Date	10-24--42	12-4/5-42			
First Reading	3557	5648			
Last Reading	820	3560			
Footage Measured	2737	2088			
Csg Shoe Schlum.	824	3555			
Csg Shoe Driller	820	3560			
Max. Depth Reached	3558	5648			
Bottom Driller	3557	5648			
Depth Datum	FROM TOP OF ROTARY TABLE				
Mud Nature	NAT., AQUA, FIBROTEX HULLS, BENTONITE				
" Density	9.5	9.5			
" Viscosity	45	35			
" Resistivity	salty mud @ °F	5.6 @ 35 °F	@ °F	@ °F	@ °F
" Resistivity BHT	@ °F	@ °F	@ °F	@ °F	@ °F
" pH	@ °F	@ °F	@ °F	@ °F	@ °F
" Water Loss	CC/30 Min.	CC/30 Min.	CC/30 Min.	CC/30 Min.	CC/30 Min.
Maximum Temp. °F					
Bit Size	12 1/4	9 5/8			
Spacings — AM					
A					
AO					
S.S. Rig Time					
Truck No.					
Recorded By	G.J. DECKER	L. A. PUZIN			
Witnessed By					

REMARKS

SPONTANEOUS-POTENTIAL
millivolts

DEPTHS

RESISTIVITY

Reproduced By
Panhandle Electrical Log Service
1305 Commerce Street
Dallas 1, Texas

31

REFERENCE Nº P 1341 -A

41 (8)

SCHLUMBERGER WELL SURVEYING CORPORATION
HOUSTON, TEXAS

LATEROLOG SURVEY

COUNTY	CARSON	
FIELD or LOCATION	H&GN SURVEY SEC. 26 BLK. B-4	
WELL	N.H. READ NO. 1	
COMPANY	PURE OIL COMPANY	

COMPANY PURE OIL COMPANY
WELL N. H. READ NO. 1
FIELD WILDCAT
LOCATION SEC. 26, BLK. B-4 H&GN SURVEY
COUNTY CARSON
STATE TEXAS

Location of Well
660' fr S/L
2219' fr E/L

LL-GRL-ML.

Elevation: D.F. 3517
K.B. 3520
or G.L. 3507

FILING No.

RUN No.	ONE LL	ONE GR	ONE ML
Date	8-15-54	8-15-54	8-15-54
First Reading	6996	6998	6997
Last Reading	592	0	3300
Feet Measured	6404	6998	
Csg. Schlum.	592		
Csg. Driller	588	588	588
Depth Reached	7000	7000	7000
Bottom Driller	6997	6997	6997
Depth Datum	K B OR 13' ABOVE G L		
Mud Nat.	CONTROLGEL	CONTROLGEL	
" Density	9.4	9.4	9.4
" Viscosity	84	84	84
" Resist.	.15@90 °F	.15@90 °F	.15@90°F
" Res. BHT	.11 @135°F	.11 @135 °F	.11@135°F
" pH	10.5@ °F	10.5@135 °F	10.5
" Wtr. Loss	19cc 30 min.	19cc 30 min.	19
Max. Temp. °F	135	135	135
Bit Size	8 3/4"	8 3/4"	8 3/4"
SPCGS: AO	16"		2"
AM			1.5"
Opr. Rig Time	2 HRS	3 HRS	2 HRS
Truck No.	1779 PAMPA		1779 PAMPA
Recorded By	ECHOLS		ECHOLS
Witness By	PTASYNSKI		PTASYNSKI

REMARKS LATEROLOG — AO 16" = 2.5
GAMMA RAY — SENSITIVITY 6.6 TIME CONSTANT = 2
RECORDING SPEED: 2000'/HR=2"
4000'/HR=5"
CAL: B40-5240-140-100(10)
KL/KS=1.3
REG. H-PAD
INF: 1 13/16" BEFORE & AFTER

GAMMA RAY		LATEROLOG	"MICROLOG"
Radioactivity Increases →		0 — 50	0 MICROINVERSE 1.5" 10
0 Micro-Gms Ra-eq/ton 6.6	Perm.	0 — 500	0 MICRONORMAL 2" 10
6.6 — 13.2	Brkn. Perm.	0 — 5000	

WDW-120

Welex GAMMA-GUARD LOG

COMPANY IOWA BEEF PROCESSORS INC.
WELL IOWA BEEF # 1
FIELD AMARILLO
County POTTER State TEXAS

COMPANY	IOWA BEEF PROCESSORS INC.
WELL	IOWA BEEF # 1
FIELD	AMARILLO
COUNTY	POTTER
STATE	TEXAS
Location	2897.3' fr N/L 1715' fr W/L NW NE SW SEC. 19 BLK. 2 A.B. & M. SURVEY
Other Services:	CDL, FoRxo
Sec. / Twp / Rge	

Permanent Datum GROUND LEVEL Elev. 3535
Log Measured From KELLY BUSHING 7 Ft Above Perm. Datum
Drilling Measured From KELLY BUSHING
Elev.: K.B. 3542' D.F. --- G.L. 3535'

Date	9-25-74	10-7-74		
Run No.	ONE	TWO		
Depth—Driller	1845'	4875'		
Depth—Welex	1846'	4875'		
Btm. Log Inter.	1841'	4871'		
Top Log Inter.	SURFACE	1770'		
Casing—Driller	@	8-5/8" @ 1843'	@	@
Casing—Welex		1845'		
Bit Size	12-1/4"	7-7/8"		
Type Fluid in Hole	SALT GEL W.B. MUD	SALT GEL W.B. MUD		
Dens. | Visc.	10.3 | 34	9.8 | 39	|	|
pH | Fluid Loss	6.4 | 160 ml	5.4 | 10.2 ml	| ml	| ml
Source of Sample	FLOW LINE	FLOW LINE		
R_m @ Meas. Temp.	0.05 @ 80°F	0.12 @ 80°F	@ °F	@ °F
R_{mf} @ Meas. Temp.	0.04 @ 80°F	0.10 @ 80°F	@ °F	@ °F
R_{mc} @ Meas. Temp.	0.05 @ 80°F	0.14 @ 80°F	@ °F	@ °F
Source R_{mf} | R_{mc}	MEAS. | MEAS.	MEAS. | MEAS.	|	|
R_m @ BHT	0.05 @ 80°F	0.095 @ 113°F	@ °F	@ °F
Time Since Circ.		2 HRS.		
Max. Rec. Temp.	80 °F @ 1800'	113°F @ 4800'	°F @	°F @
Equip. | Location	9110 | PAMPA	7579 | PAMPA	|	|
Recorded By	COURTNEY-JOHNSTON-WHITE			
Witnessed By	MR. HATTON-MR. KNOBLOCK			

Fold Here

Service Ticket No. 92393 Remarks:

Change in Mud Type or Additional Samples		
Date | Sample No.	|	|
Depth—Driller		
Type Fluid in Hole		
Dens. | Visc.	|	|
ph | Fluid Loss	| ml	|
Source of Sample		
R_m @ Meas. Temp.	@ °F	@ °F
R_{mf} @ Meas. Temp.	@ °F	@ °F
R_{mc} @ Meas. Temp.	@ °F	@ °F
Source: R_{mf} | R_{mc}	|	|
R_m @ BHT	0.05 @ 80°F	0.085 @ 113°F
R_{mf} BHT	0.04 @ 80°F	0.075 @ 113°F
R_{mc} BHT	0.06 @ 80°F	0.110 @ 113°F

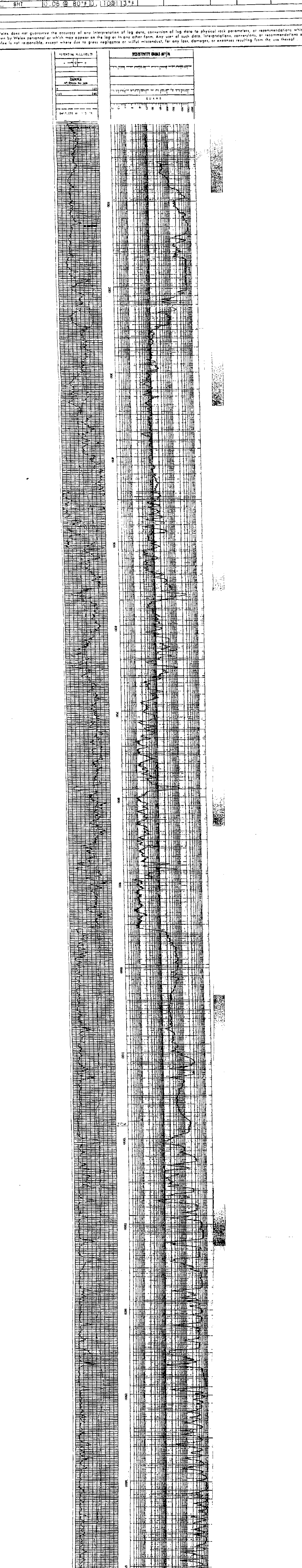
SCALE CHANGES

Type Log	Depth	Scale Up Hole	Scale Down Hole

EQUIPMENT DATA

Run No.	Tool Type and No.	Pad Type	Tool Position	Other
ONE	G/G ---	---	---	
TWO	G/G 18855	---	---	

Welex does not guarantee the accuracy of any interpretation of log data, conversion of log data to physical rock parameters, or recommendations which may be given by Welex personnel or which may appear on the log or in any other form. Any user of such data, interpretations, conversions, or recommendations agrees that Welex is not responsible, except where due to gross negligence or willful misconduct, for any loss, damages, or expenses resulting from the use thereof.



POTENTIAL MILLIVOLTS

RESISTIVITY OHMS M^2/M

GAMMA

WDW-273 (ASARCO)
Core Analysis Report

CORE ANALYSIS REPORT

FOR

PB-KBB INC.

Asarco Copper Refinery No.2

Potter County, Texas

CORE LABORATORIES

Company : PB-KBB INC.
Well : Asarco Copper Refinery No.2
Location :
Co,State : Potter County, Texas

Field :
Formation :
Coring Fluid :
Elevation :

File No.: 57151-16025
Date : 13-Jul-1989
API No. :
Analysts: Devier

C O R E   A N A L Y S I S   R E S U L T S

SAMPLE NUMBER	DEPTH ft	POROSITY (HELIUM) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
	Core No.1 4020 - 4049					
	4020.0- 20.3					Dol gry mocro xln sh lam
	4020.3- 21.3					Anhy blue micro xln sh lam
1	4021.3- 21.9	0.1	0.0	92.0	2.95	Anhy blue micro xln sh lam
	4021.9- 24.4					Anhy blue micro xln sh lam
	4024.4- 25.9					Dol gry micro xln anhy
	4025.9- 26.7					Anhy blue micro xln dol
	4026.7- 35.2					Dol gry micro xln anhy
2	4035.2- 35.8	0.1	0.0	94.0	2.85	Dol gry micro xln anhy
	4035.8- 37.6					Dol gry micro xln slily sh
	4037.6- 38.4					Anhy blue micro xln dol
	4038.4- 40.2					Dol gry micro xln anhy
3	4040.2- 40.9	0.3	0.0	56.2	2.84	Dol gry micro xln anhy
	4040.9- 49.0					Dol gry micro xln anhy

PB-KBB INC.
ASARCO Copper Refinery No.2 2 Well
Potter County, Texas
File No.: 57181-15767

April 11, 1989

Sample No.	Depth	Porosity % 400 PSI	Porosity % 2000 PSI	Air Perm (md) 400 PSI	Air Perm (md) 2000 PSI
1	4021.3-21.9	0.20	0.15	<0.01	<0.01
2	4029.3-29.8	0.24	0.21	0.25	0.019
3	4035.2-35.8	0.13	0.10	<0.01	<0.01
4	4040.2-40.9	0.51	0.40	0.03	<0.01
5	4411.6-12.0	11.3	10.9	4.5	2.9
6	4415.6-16.0	14.9	14.5	30.	23.
7	4418.7-19.1	11.1	10.6	3243.*	653.

* OPEN VERTICAL FRACTURE

WDW-273

Core Photographs


TOP
4020
PB-KBB, INCORPORATED
ASCARO COPPER REFINERY NO. 2
POTTER COUNTY, TEXAS
Western Atlas International
CORE LABORATORIES
4030
BOTTOM

TOP
4030
PB-KBB, INCORPORATED
ASCARO COPPER REFINERY NO. 2
POTTER COUNTY, TEXAS
CORE LABORATORIES
Western Atlas International
4040
BOTTOM


TOP
4040
PB-KBB, INCORPORATED
ASCARO COPPER REFINERY NO. 2
POTTER COUNTY, TEXAS
46
47
Western Atlas International
CORE LABORATORIES
4049
BOTTOM


TOP
4410
PB-KBB, INCORPORATED
ASCARO COPPER REFINERY NO. 2
POTTER COUNTY, TEXAS
CORE LABORATORIES
4420
BOTTOM

WDW-273

Core Mineral Composition and Fracture Properties

TEST RESULTS

TABLES

TABLE 1

BASIC PROPERTIES
Asarco Inc. Well #2, Permit #WDW273
Wolfcamp Formation

DEPTH	POROSITY, PERCENT	GRAIN DENSITY	ROCK TYPE
ft	%	gm/cc	
4021	0.1	2.93	ANHYDRITE
4041	0.3	2.84	DOLOMITE
4412	10.0	2.82	DOLOMITE
4419	2.5	2.80	DOLOMITE

TABLE 2

ULTRASONIC VELOCITY AND DYNAMIC MODULI
Asarco Inc. Well #2, Permit #WDW273
Wolfcamp Formation

DEPTH	Pc NET	BULK DENS	COMP VEL	SHEAR VEL	BULK MODULUS	YOUNG MODULUS	SHEAR MODULUS	POISSON RATIO
ft	psi	gm/cc	ft/sec	ft/sec	mpsi	mpsi	mpsi	
4021	1035	2.93	19725	10855	9.15	11.93	4.65	0.283
4041	1035	2.83	22193	12090	11.35	14.37	5.57	0.289
4412	1134	2.64	17399	9748	6.27	8.61	3.39	0.271
4419	1134	2.76	20566	11605	9.04	12.67	5.00	0.266

Samples were saturated with a simulated formation brine before testing. ther test conditions were:

Temperature: ambient
Confining Pressure: 2035 psi (4021 & 4041)
2134 psi (4412 & 4419)
Pore Pressure: 1000 psi

TABLE 3

SPLITTING TENSILE STRENGTH DATA SUMMARY
Asarco Inc. Well #2, Permit #WDW273
Wolfcamp Formation

DEPTH	LENGTH	DIAMETER	TENSILE STRENGTH	PRESSURE GRADIENT FRACTURE	PRESSURE GRADIENT CLOSURE
ft	inches	inches	psi	psi/ft	psi/ft
4021	0.984	1.464	1541	1.173	0.652
4041	0.975	1.476	1734	1.236	0.676
4412	0.974	1.472	1015	0.999	0.592
4419	0.973	1.475	1568	1.087	0.609

Samples were tested dry.

TABLE 4

MINERALOG™ ANALYSIS (weight %)

DEPTH ft	GRAIN DENSITY INDEX, g/cc	QUARTZ	PLAGIOCLASE	K-FELDSPAR	CALCITE	DOLOMITE	SIDERITE	PYRITE
4021	2.92	4	0	0	1	0	0	0
4041	2.87	0	0	0	3	77	0	0
4412	2.88	0	0	0	3	72	0	0
4419	2.88	0	0	0	0	83	0	0

	ANHYDRITE	GYPSUM	KAOLINITE	CHLORITE	ILL+SMEC
4021	90	1	0	0	4
4041	18	0	0	0	2
4412	25	0	0	0	0
4419	17	0	0	0	0

WDW-324 (ASARCO)
Core Analysis Report

CORE ANALYSIS REPORT

FOR

TERRA DYNAMICS, INC.

ASARCO WDW-324; PLANT WELL NO. 3
DISPOSAL WELL
POTTER COUNTY, TEXAS

CORE LAB

PETROLEUM SERVICES

November 7, 1996

TERRA DYNAMICS, INC.
9011 Mountain Ridge Drive
Travis Bldg., Suite 100
Austin, Texas 78759

File No.: 57181-17521
Subject: Core Analysis
ASARCO WDW-324; Plant Well No. 3
Disposal Well Field
Potter County, Texas

Gentlemen:

The subject well was cored using diamond coring equipment and salt saturated polymer to obtain 4 inch diameter cores from 2775.0 to 2805.0 feet, 3394.0 to 3405.5 feet and 4720.0 to 4750.0 from the Tubb, Red Cave and Brown Dolomite formations.

Core analysis data is presented in tabular and graphical form for your convenience. A porosity vs. permeability plot was prepared for statistical evaluation.

We trust these data will be useful in the evaluation of your property and thank you for the opportunity of serving you.

Very truly yours,

CORE LABORATORIES, INC.

Dean Olson

Dean Olson
Laboratory Supervisor

DO/ym

Core Laboratories, Inc.
2001 Commerce, Midland, Texas 79703, P.O. Box 4337, Midland, Texas 79704-4337, (915) 694-7761, Fax (915) 694-3191

TERRA DYNAMICS, INC.
ASARCO WDW-324; Plant Well No. 3
File No. 57181-17521
Procedural Page

The cores were preserved at the wellsite in PVC tubing and transported to Midland by Core Laboratories personnel.

A Core Gamma Log was recorded for downhole E-log correlation.

Eighteen samples were sent to Core Laboratories in New Orleans, Louisiana for mineralog.

Fresh core was taken from selected intervals and preserved in CoreSeal.

Selected samples were sent to Core Laboratories in Carrollton, Texas for special core analysis.

Core analysis was made from selected intervals requested on full diameter samples.

Fluid removal and saturations were determined using a Dean Stark/ gas solvent extraction method.

Porosity was determined by direct pore volume measurement using Boyle's law helium expansion. Bulk volume was measured by Archimedes Principle. Grain density was calculated from dry weight, bulk volume and pore volume measurements.

$$\text{Grain Density} = \frac{\text{Dry Weight}}{\text{Bulk Vol.} - \text{Pore Vol.}}$$

Steady State Air Permeability was measured in two horizontal directions and vertically on eighteen selected samples while the core was confined in a Hassler rubber sleeve.

The core was slabbed and boxed after analysis.

The slabs were photographed under natural light.

The core will remain at our Midland facility (thirty days free of charge) as we await further disposition instructions.

CORE LABORATORIES

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3
631'FEL & 548'FSL,SEC 68,BLK 2,AB&M SURVEY A-1194
POTTER COUNTY, TEXAS

Field : DISPOSAL WELL
Formation : MISCELLANEOUS
Coring Fluid : SALT SATURATED POLYMER
Elevation : 3592' KB

File No.: 57181-17521
Date : 10-30-96
API No. :
Analysts: SEBIAN

C O R E   A N A L Y S I S   R E S U L T S

SAMPLE NUMBER	DEPTH	PERMEABILITY			POROSITY (HELIUM)	SATURATION (PORE VOLUME)		GRAIN DENSITY	DESCRIPTION
	ft	(MAXIMUM) Kair md	(90 DEG) Kair md	(VERTICAL) Kair md	%	OIL %	WATER %	gm/cc	
				CORE NO. 1 2775.0-2805.0 CUT 30' REC 30'					
					TUBB FORMATION				
1	2775.0- 76.0	28.9	19.3		5.8	0.0	91.5	2.36	Sh, rd-brn, v/salty, vert/frac
2	2776.0- 77.0	0.35	0.15	0.12	4.3	0.0	96.4	2.30	Sh, rd-brn, v/salty
3	2777.0- 78.0	80.8	39.2		8.8	0.0	90.5	2.40	Sh, gry-grn, v/salty, vert/frac
4	2778.0- 79.0	0.88	0.36		3.5	0.0	96.0	2.47	Sh, rd-brn, silty, v/salty, vert/frac
5	2779.0- 80.0	200.	28.6		8.1	0.0	96.9	2.51	Sh, rd-brn, silty, v/salty, vert/frac
6	2780.0- 81.0	242.	60.6	144.	13.1	0.0	90.8	2.62	Sh, brn-gry, dol, silty, salty, vert/frac, lam
7	2781.0- 82.0	0.42	0.37		7.2	0.0	96.9	2.57	Sltstn, rd-brn, anhy, shy, salty
8	2782.0- 83.0	5.49	1.25		7.0	0.0	85.7	2.55	Sltstn, brn-gry, dol, shy, salty, lam
9	2783.0- 84.0	3.87	1.65		9.4	0.0	92.0	2.51	Sh, rd-brn, silty, salty
10	2784.0- 85.0	143.	9.91		9.6	0.0	97.8	2.55	Sh, rd-brn, anhy, silty, salty
11	2785.0- 86.0	1.17	1.13		8.2	0.0	91.4	2.56	Sh, rd-brn, anhy, silty, salty
12	2786.0- 87.0	1.22	0.90	<.01	3.8	0.0	93.3	2.49	Sltstn, gry-rd, shy, sli/salty, xbed
13	2787.0- 88.0	0.86	0.80		1.8	0.0	93.8	2.51	Sltstn, gry-rd, shy, sli/salty, xbed
14	2788.0- 89.0	1.84	1.29		3.1	0.0	89.1	2.47	Sltstn, gry-rd, shy, sli/salty, vert/frac, xbed
15	2789.0- 90.0	4.32	1.68		7.0	0.0	93.4	2.57	Sltstn, rd-brn, v/shy, sli/salty, vert/frac
16	2790.0- 91.0	1.97	0.64		4.1	0.0	95.1	2.40	Sltstn, gry-brn, shy, v/salty, vert/frac, xbed
17	2791.0- 92.0	11.9	1.85		3.6	0.0	93.9	2.41	Sltstn, gry-rd, shy, v/salty, vert/frac, xbed
18	2792.0- 93.0	0.33	0.31	0.09	4.3	0.0	94.6	2.49	Sltstn, gry-rd, shy, salty, vert/frac, xbed
19	2793.0- 94.0	0.41	0.38		4.9	0.0	92.9	2.55	Sltstn, gry-rd, shy, sli/anhy, sli/salty, sli/frac, xbed
20	2794.0- 95.0	0.38	0.37		4.9	0.0	96.9	2.49	Sd, lt gry-rd, vf-sltgr, shy, salty, vert/frac
21	2795.0- 96.0	4.77	1.27	<.01	4.9	0.0	89.1	2.49	Sd, lt gry-rd, shy, salty, vert/frac
22	2796.0- 97.0	0.30	0.25		2.1	0.0	94.5	2.39	Sltstn, gry-rd, shy, v/salty, vert/frac, xbed

CORE LABORATORIES

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3

Field : DISPOSAL WELL
Formation : MISCELLANEOUS

File No.: 57181-17521
Date : 10-30-96

CORE ANALYSIS RESULTS

SAMPLE NUMBER	DEPTH ft	PERMEABILITY (MAXIMUM) Kair md	PERMEABILITY (90 DEG) Kair md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
23	2797.0- 98.0	0.25	0.11		1.0	0.0	95.6	2.45	Sltstn, gry-rd, shy, v/salty, vert/frac, xbed
24	2798.0- 99.0	1.62	0.32		3.7	0.0	89.8	2.43	Sltstn, rd-gry, v/shy, v/salty, vert/frac, xbed
25	2799.0- 00.0	2.60	0.91		3.8	0.0	93.5	2.36	Sltstn, rd-gry, shy, v/salty, vert/frac, xbed
26	2800.0- 01.0	2.93	0.46	<.01	3.8	0.0	94.9	2.30	Sltstn, rd-gry, shy, v/salty, vert/frac, xbed
27	2801.0- 02.0	170.	3.85		2.3	0.0	90.6	2.31	Sltstn, rd-gry, shy, v/salty, sli/anhy, vert/frac, xbed
28	2802.0- 03.0	0.14	0.10		1.1	0.0	93.3	2.35	Sltstn, rd-gry, shy, v/salty, vert/frac, xbed
29	2803.0- 04.0	0.34	0.16		1.7	0.0	96.1	2.42	Sltstn, rd-gry, shy, v/salty, vert/frac, xbed
30	2804.0- 05.0	0.71	0.05		1.9	0.0	99.4	2.32	Sltstn, rd-gry, shy, v/salty, vert/frac, xbed

DRILLED INTERVAL 2805.0-3394.0

CORE NO. 2 3394.0-3405.5 CUT 11.5' REC 11.5'

RED CAVE FORMATION

SAMPLE NUMBER	DEPTH ft	PERMEABILITY (MAXIMUM) Kair md	PERMEABILITY (90 DEG) Kair md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
31	3394.0- 95.0	0.01	0.01		4.9	0.0	92.2	2.50	Sh, brn, sli/frac
32	3395.0- 96.0	0.01	0.01	<.01	4.0	0.0	93.5	2.50	Sh, grn-brn, sli/frac, turb
33	3396.0- 97.0	0.02	0.02		1.4	0.0	88.5	2.82	Sh, grn-brn
34	3397.0- 98.0	0.04	<.01		1.0	0.0	95.2	2.84	Sh, grn-gry, anhy, sli/slty
35	3398.0- 99.0	<.01	<.01	<.01	0.2	0.0	80.0	2.90	Anhy, grn
36	3399.0- 00.0	0.05	<.01		2.2	0.0	94.8	2.70	Sh, grn-gry, anhy, lam
37	3400.0- 01.0	0.04	<.01		2.1	0.0	90.0	2.44	Sh, brn-grn, frac
38	3401.0- 02.0	0.01	0.01	<.01	4.8	0.0	95.8	2.51	Sh, grn-gry, frac
39	3402.0- 03.0	0.01	0.01		4.1	0.0	91.7	2.62	Sh, brn-rd, anhy, frac
40	3403.0- 04.0	0.02	0.02		9.3	0.0	88.7	2.42	Sh, brn-rd, frac
41	3404.0- 05.0	0.02	0.01	<.01	5.0	0.0	95.0	2.49	Sh, brn, frac
42	3405.0- 05.5	0.04	0.04		6.1	0.0	86.1	2.57	Sh, brn-grn, sli/anhy, lam

CORE LABORATORIES

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3

Field : DISPOSAL WELL
Formation : MISCELLANEOUS

File No.: 57181-17521
Date : 10-30-96

C O R E   A N A L Y S I S   R E S U L T S

SAMPLE NUMBER	DEPTH ft	PERMEABILITY (MAXIMUM) Kair md	PERMEABILITY (90 DEG) Kair md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
	DRILLED INTERVAL 3405.5-4720.0								
	CORE NO. 3 4720.0-4750.0 CUT 30' REC 30'								
	BROWN DOLOMITE FORMATION								
43	4720.0- 21.0	10.8	10.6		18.3	0.0	84.9	2.84	Dol, sli/turb
44	4721.0- 22.0	2.97	1.88	1.02	14.8	0.0	89.9	2.84	Dol, sli/anhy, sli/turb
45	4722.0- 23.0	1.68	1.15		13.2	0.0	78.7	2.83	Dol, sli/anhy, sli/frac, pp, sli/turb
46	4723.0- 24.0	0.89	0.59		10.0	0.0	81.6	2.83	Dol, anhy, cht-incl, pp, foss
47	4724.0- 25.0	5.15	4.10	4.09	14.1	0.0	76.3	2.84	Dol, sli/anhy, cht-incl, pp, foss
48	4725.0- 26.0	4.12	4.09		14.2	0.0	75.6	2.83	Dol, sli/anhy, pp, foss
49	4726.0- 27.0	4.55	4.41		11.5	0.0	77.1	2.83	Dol, anhy, cht-incl, pp, foss
50	4727.0- 28.0	2.90	2.57		11.5	0.0	75.1	2.83	Dol, sli/anhy, pp, foss
51	4728.0- 29.0	24.8	2.13	31.2	10.7	0.0	78.6	2.83	Dol, sli/anhy, vert/frac, pp, foss
52	4729.0- 30.0	1.96	1.84		9.8	0.0	78.1	2.82	Dol, sli/anhy, pp, foss
53	4730.0- 31.0	1.91	1.41		8.3	0.0	72.9	2.82	Dol, anhy, cht-incl, pp, foss, shlam
54	4731.0- 32.0	0.50	0.40		10.0	0.0	80.1	2.82	Dol, sli/anhy, sli/turb, shlam
55	4732.0- 33.0	0.58	0.49	0.16	10.5	0.0	88.9	2.81	Dol, sli/anhy, cht-incl, sli/frac, sli/turb
56	4733.0- 34.0	0.58	0.48		11.6	0.0	88.8	2.81	Dol, sli/anhy, cht-incl, sli/turb
57	4734.0- 35.0	0.63	0.50		10.7	0.0	81.2	2.80	Dol, sli/anhy, sli/frac, cht-incl, sli/turb
58	4735.0- 36.0	3.09	2.52		12.5	0.0	78.0	2.81	Dol, sli/anhy, cht-incl, pp, foss
59	4736.0- 37.0	2.62	2.47	1.64	13.3	0.0	87.0	2.83	Dol, sli/anhy, pp, foss
60	4737.0- 38.0	4.65	3.58		13.3	0.0	83.8	2.83	Dol, sli/anhy, cht-incl, pp, foss
61	4738.0- 39.0	5.45	4.97		14.8	0.0	80.2	2.83	Dol, sli/anhy, pp, foss
62	4739.0- 40.0	1.33	1.28		13.2	0.0	79.7	2.83	Dol, sli/anhy, sli/turb, pp, shlam
63	4740.0- 41.0	5.65	2.26	1.11	11.7	0.0	78.2	2.83	Dol, anhy, pp, foss, shlam

CORE LABORATORIES

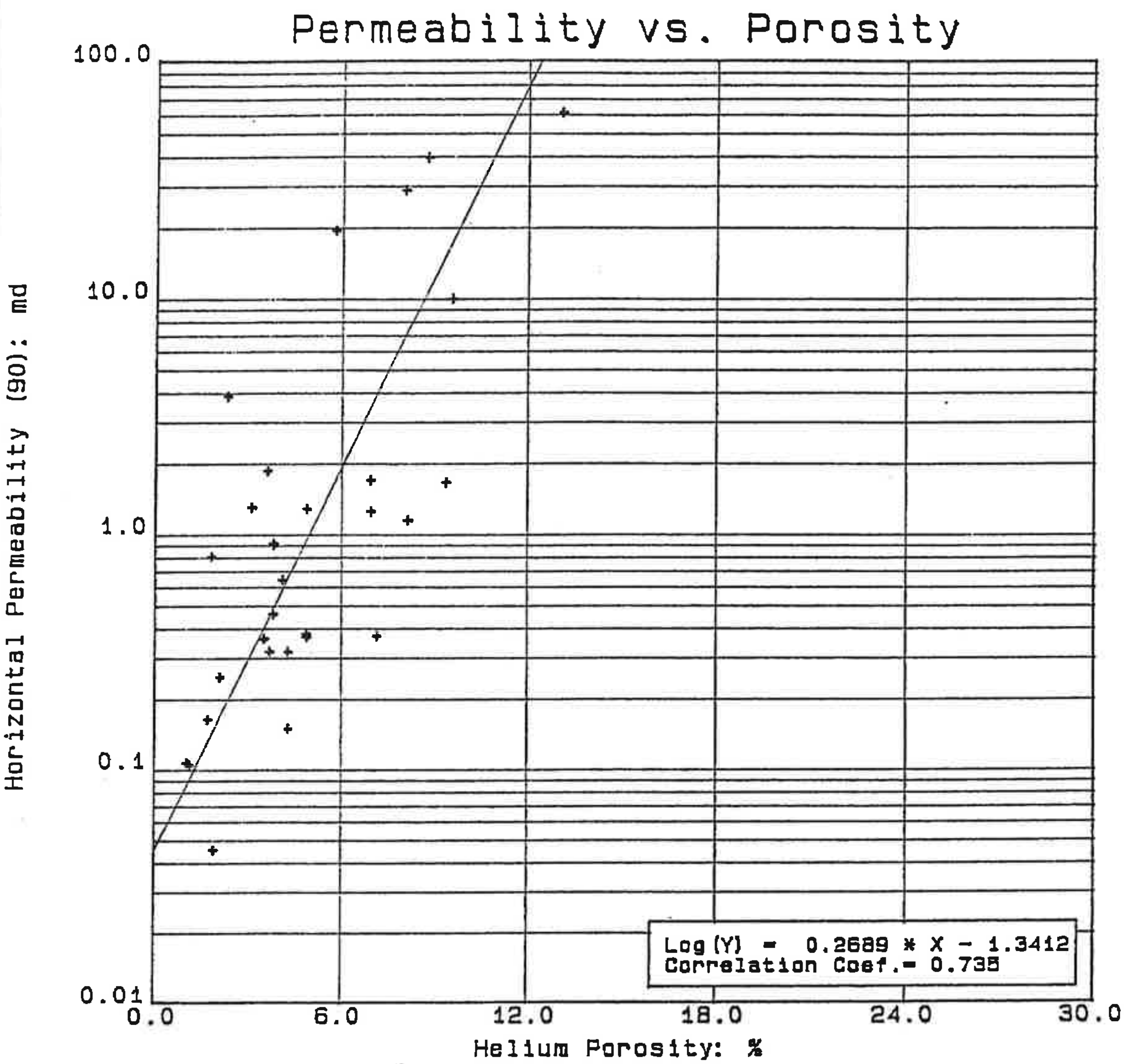
TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3

Field : DISPOSAL WELL
Formation : MISCELLANEOUS

File No.: 57181-17521
Date : 10-30-96

C O R E   A N A L Y S I S   R E S U L T S

SAMPLE NUMBER	DEPTH ft	PERMEABILITY (MAXIMUM) Kair md	PERMEABILITY (90 DEG) Kair md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
64	4741.0- 42.0	25.0	23.6		18.5	0.0	79.8	2.82	Dol, sli/anhy, cht-incl, sli/frac, sli/vug, pp, foss
65	4742.0- 43.0	2.52	1.23		12.3	0.0	78.7	2.83	Dol, sli/anhy, sli/frac, cht-incl, sli/turb, pp
66	4743.0- 44.0	2.70	1.99		12.6	0.0	82.9	2.83	Dol, sli/anhy, pp, foss
67	4744.0- 45.0	6.97	6.63		14.9	0.0	87.6	2.83	Dol, sli/anhy, pp, foss
68	4745.0- 46.0	3.94	3.60	2.04	12.6	0.0	83.0	2.82	Dol, sli/anhy, pp, foss
69	4746.0- 47.0	30.6	12.3		15.9	0.0	83.9	2.86	Dol, anhy, sli/frac, turb, pp
70	4747.0- 48.0	3.91	3.76	2.12	15.1	0.0	80.9	2.82	Dol, sli/anhy, sli/frac, cht-incl, turb, pp
71	4748.0- 49.0	1.56	1.25		14.6	0.0	90.0	2.73	Dol, sli/anhy, cht-incl, turb, pp
72	4749.0- 50.0	3.21	2.82		16.9	0.0	88.4	2.83	Dol, sli/anhy, sli/frac, cht-incl, turb, pp



TERRA DYNAMICS, INC. ASARCO WDW-324; PLANT WELL NO. 3 DISPOSAL WELL TUBB (2775.0-2805.0 feet) ZONE 1 Core Laboratories 10-30-96	- LEGEND - TUBB

CORE LABORATORIES

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3

Field : DISPOSAL WELL
Formation : MISCELLANEOUS

File No.: 57181-17521
Date : 10-30-96

TABLE I

SUMMARY OF CORE DATA

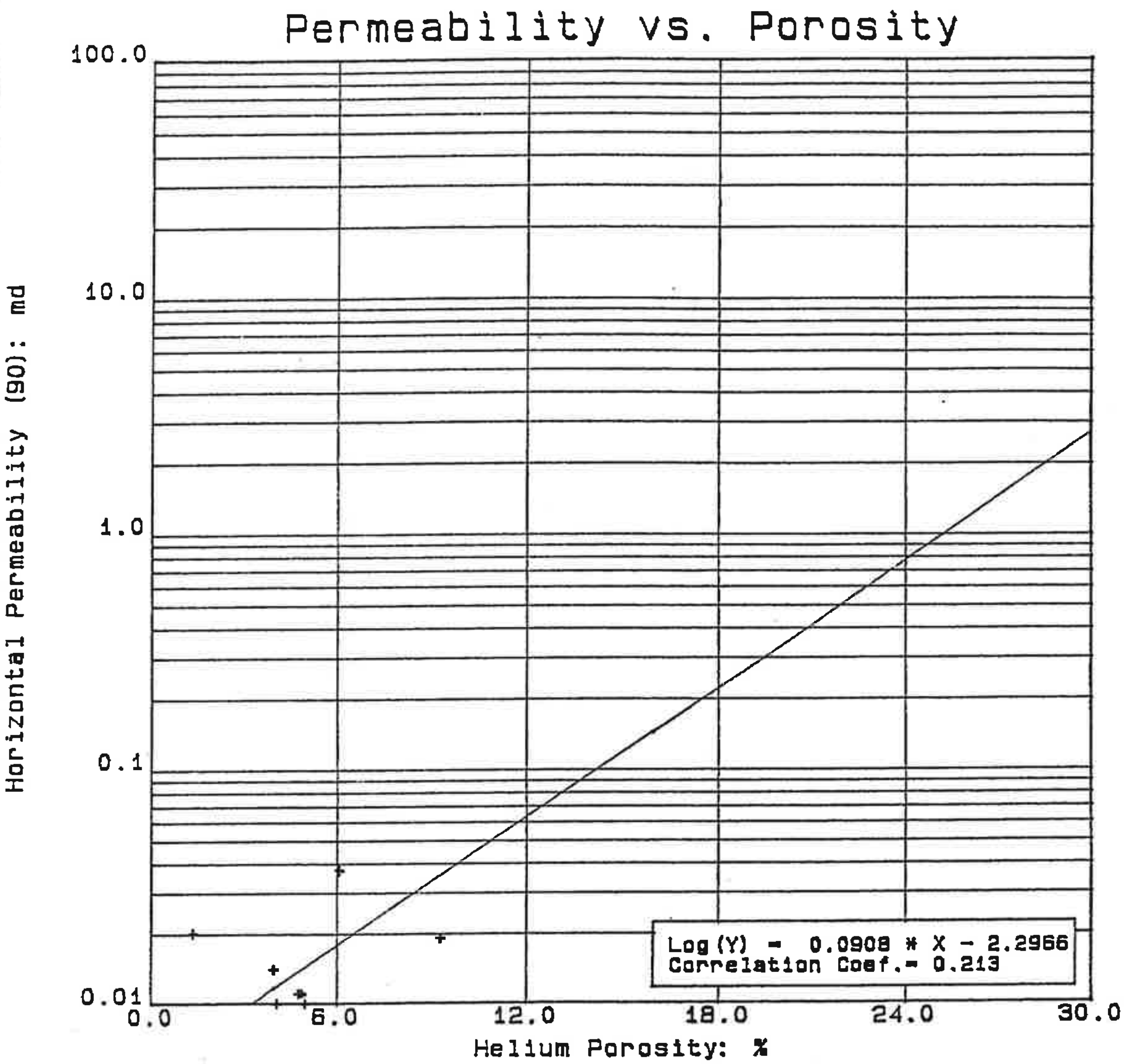
ZONE AND CUTOFF DATA

ZONE:	
Identification --------	TUBB
Top Depth ----------------	2775.0 ft
Bottom Depth -------------	2805.0 ft
Number of Samples --------	30
DATA TYPE:	
Porosity --------------	(HELIUM)
Permeability -----------	(90 DEG) Kair
CUTOFFS:	
Porosity (Minimum) -------	0.0 %
Porosity (Maximum) -------	100.0 %
Permeability (Minimum) ---	0.0100 md
Permeability (Maximum) ---	1000. md
Water Saturation (Maximum)	100.0 %
Oil Saturation (Minimum) -	0.0 %
Grain Density (Minimum) --	2.00 gm/cc
Grain Density (Maximum) --	3.00 gm/cc
Lithology Excluded -------	NONE

CHARACTERISTICS REMAINING AFTER CUTOFFS

ZONE:	
Number of Samples -----	30
Thickness Represented -	30.0 ft
POROSITY:	
Storage Capacity ------	148.8 ϕ-ft
Arithmetic Average ----	5.0 %
Minimum ---------------	1.0 %
Maximum ---------------	13.1 %
Median ----------------	4.2 %
Standard Deviation ----	±2.9 %
GRAIN DENSITY:	
Arithmetic Average ----	2.45 gm/cc
Minimum ---------------	2.30 gm/cc
Maximum ---------------	2.62 gm/cc
Median ----------------	2.47 gm/cc
Standard Deviation ----	±0.09 gm/cc

PERMEABILITY:	
Flow Capacity ---------	178.3 md-ft
Arithmetic Average ----	5.94 md
Geometric Average -----	0.98 md
Harmonic Average ------	0.34 md
Minimum ---------------	0.05 md
Maximum ---------------	60.6 md
Median ----------------	0.85 md
Standard Dev. (Geom) --	$K \cdot 10^{\pm 0.785}$ md
HETEROGENEITY (Permeability):	
Dykstra-Parsons Var. --	0.730
Lorenz Coefficient ----	0.683
AVERAGE SATURATIONS (Pore Volume):	
Oil -------------------	0.0 %
Water -----------------	93.2 %



TERRA DYNAMICS, INC. ASARCO WDW-324; PLANT WELL NO. 3 DISPOSAL WELL RED CAVE (3394.0-3405.5 feet) ZONE 2 Core Laboratories 10-30-96	- LEGEND - RED CAVE

CORE LABORATORIES

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3

Field : DISPOSAL WELL
Formation : MISCELLANEOUS

File No.: 57181-17521
Date : 10-30-96

TABLE II

SUMMARY OF CORE DATA

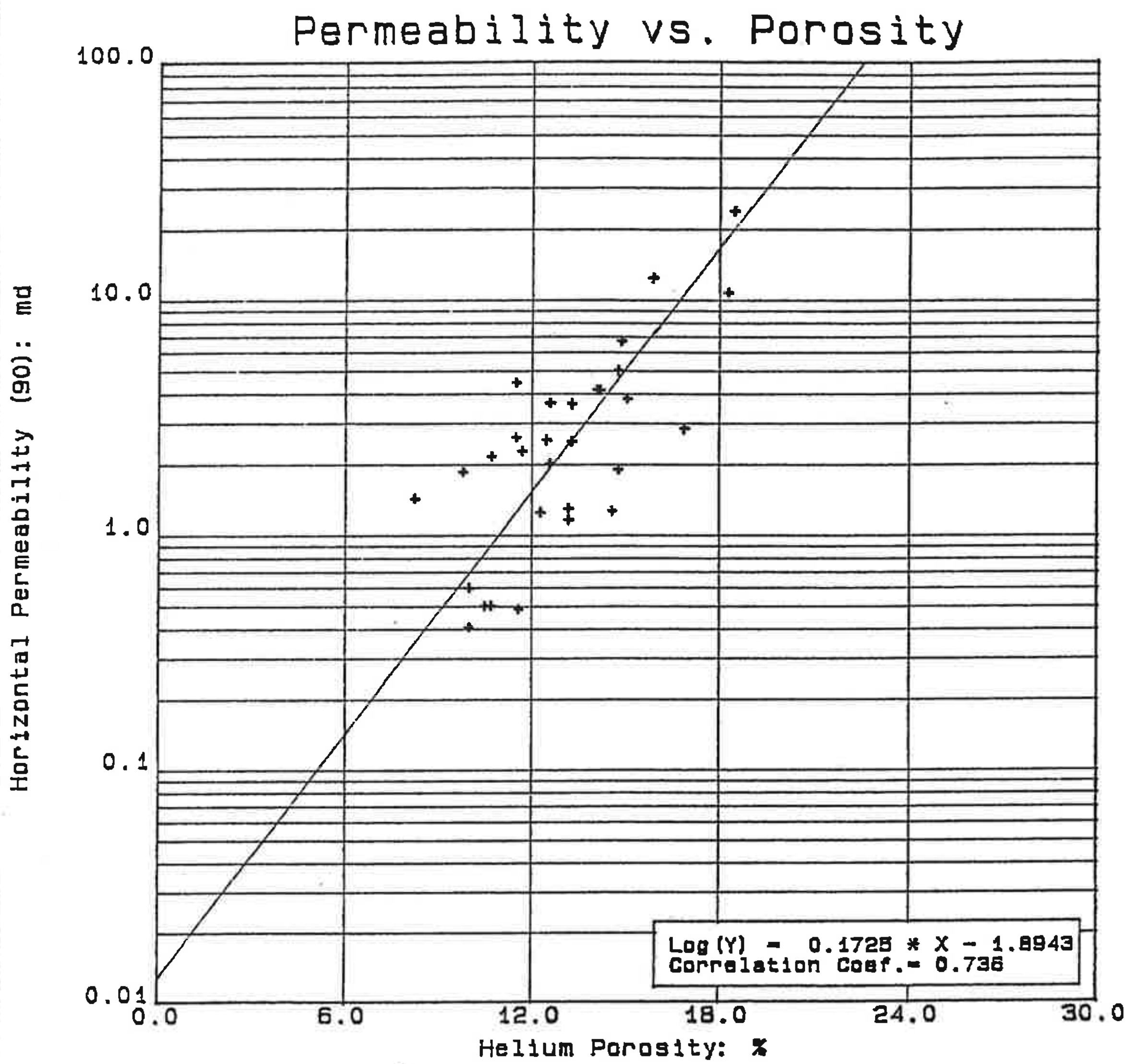
ZONE AND CUTOFF DATA

ZONE:	
Identification	RED CAVE
Top Depth	3394.0 ft
Bottom Depth	3405.5 ft
Number of Samples	12
DATA TYPE:	
Porosity	(HELIUM)
Permeability	(90 DEG) Kair
CUTOFFS:	
Porosity (Minimum)	0.0 %
Porosity (Maximum)	100.0 %
Permeability (Minimum)	0.0100 md
Permeability (Maximum)	1000. md
Water Saturation (Maximum)	100.0 %
Oil Saturation (Minimum)	0.0 %
Grain Density (Minimum)	2.00 gm/cc
Grain Density (Maximum)	3.00 gm/cc
Lithology Excluded	NONE

CHARACTERISTICS REMAINING AFTER CUTOFFS

ZONE:	
Number of Samples	8
Thickness Represented	7.5 ft
POROSITY:	
Storage Capacity	36.5 ϕ-ft
Arithmetic Average	4.9 %
Minimum	1.4 %
Maximum	9.3 %
Median	4.9 %
Standard Deviation	±2.2 %
GRAIN DENSITY:	
Arithmetic Average	2.55 gm/cc
Minimum	2.42 gm/cc
Maximum	2.82 gm/cc
Median	2.51 gm/cc
Standard Deviation	±0.12 gm/cc

PERMEABILITY:	
Flow Capacity	0.1 md-ft
Arithmetic Average	0.02 md
Geometric Average	0.01 md
Harmonic Average	0.01 md
Minimum	0.01 md
Maximum	0.04 md
Median	0.01 md
Standard Dev. (Geom)	$K\cdot10^{\pm0.202}$ md
HETEROGENEITY (Permeability):	
Dykstra-Parsons Var.	0.185
Lorenz Coefficient	0.218
AVERAGE SATURATIONS (Pore Volume):	
Oil	0.0 %
Water	91.6 %



TERRA DYNAMICS, INC. ASARCO WDW-324; PLANT WELL NO. 3 DISPOSAL WELL BROWN DOLOMITE (4720.0-4750.0 feet) ZONE 3 Core Laboratories 10-30-96	- LEGEND - BROWN DOLOMITE

CORE LABORATORIES

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3

Field : DISPOSAL WELL
Formation : MISCELLANEOUS

File No.: 57181-17521
Date : 10-30-96

TABLE III

SUMMARY OF CORE DATA

ZONE AND CUTOFF DATA

ZONE:	
Identification	BROWN DOLOMITE
Top Depth	4720.0 ft
Bottom Depth	4750.0 ft
Number of Samples	30
DATA TYPE:	
Porosity	(HELIUM)
Permeability	(90 DEG) Kair
CUTOFFS:	
Porosity (Minimum)	0.0 %
Porosity (Maximum)	100.0 %
Permeability (Minimum)	0.0100 md
Permeability (Maximum)	1000. md
Water Saturation (Maximum)	100.0 %
Oil Saturation (Minimum)	0.0 %
Grain Density (Minimum)	2.00 gm/cc
Grain Density (Maximum)	3.00 gm/cc
Lithology Excluded	NONE

CHARACTERISTICS REMAINING AFTER CUTOFFS

ZONE:	
Number of Samples	30
Thickness Represented	30.0 ft
POROSITY:	
Storage Capacity	391.4 ϕ-ft
Arithmetic Average	13.0 %
Minimum	8.3 %
Maximum	18.5 %
Median	12.9 %
Standard Deviation	±2.5 %
GRAIN DENSITY:	
Arithmetic Average	2.82 gm/cc
Minimum	2.73 gm/cc
Maximum	2.86 gm/cc
Median	2.83 gm/cc
Standard Deviation	±0.02 gm/cc

PERMEABILITY:	
Flow Capacity	110.8 md-ft
Arithmetic Average	3.69 md
Geometric Average	2.27 md
Harmonic Average	1.47 md
Minimum	0.40 md
Maximum	23.6 md
Median	2.36 md
Standard Dev. (Geom)	$K \cdot 10^{\pm 0.428}$ md
HETEROGENEITY (Permeability):	
Dykstra-Parsons Var.	0.559
Lorenz Coefficient	0.459
AVERAGE SATURATIONS (Pore Volume):	
Oil	0.0 %
Water	82.0 %

Company: Terra Dynamics, Inc.
Well: ASARCO WDW-324 Plant Well No. 3
Location: Potter County, Texas

Core Lab File No.: 57161-12019
Date: 4-Nov-96
Analyst(s): Hoàng, Cantwell

Mineralog® Analysis

(Weight Percent)

Sample Depth (feet)	Grain Density (g/cm³)	Qtz	Plg	Ksp	Cal	Dol	Pyr	Anh	Gyp	Mag	Bar	Total Clay	Kao	Chl	Ill+ Smc+ Mica
2776 - 2777	2.66	47	12	3	0	7	0	0	0	0	0	31	0	8	23
2780 - 2781	2.68	33	8	3	0	15	0	0	0	0	0	41	0	8	33
2786 - 2787	2.66	50	13	5	0	3	0	0	0	0	0	29	0	6	23
2792 - 2793	2.65	52	9	6	0	1	0	0	0	0	0	32	0	11	21
2795 - 2796	2.65	56	11	7	0	0	0	0	0	0	0	26	0	5	21
2800 - 2801	2.65	42	9	3	0	2	0	0	0	0	0	44	0	13	31
3395 - 3396	2.70	12	2	3	0	18	0	0	0	0	0	65	0	10	55
3398 - 3399	2.83	6	0	2	0	5	0	66	7	0	0	14	0	2	12
3401 - 3402	2.76	8	2	2	0	4	0	5	0	20	0	59	0	12	47
3404 - 3405	2.70	15	3	5	0	2	0	6	0	5	0	64	0	12	52
4721 - 4722	2.86	2	0	0	3	90	0	5	0	0	0	0	0	0	0
4724 - 4725	2.85	2	0	0	0	60	0	33	5	0	0	0	0	0	0
4728 - 4729	2.86	2	0	0	0	87	2	5	4	0	0	0	0	0	0
4732 - 4733	2.85	4	0	0	0	92	0	2	0	0	0	2	0	0	2
4736 - 4737	2.86	1	0	0	3	93	0	3	0	0	0	0	0	0	0
4740 - 4741	2.87	0	0	0	0	97	1	2	0	0	0	0	0	0	0
4745 - 4746	2.87	0	0	0	0	79	0	19	2	0	0	0	0	0	0
4747 - 4748	2.85	0	0	0	4	95	0	1	0	0	0	0	0	0	0

Qtz = Quartz	Plg = Plagioclase	Ksp = K-Feldspar	Gyp = Gypsum	
Cal = Calcite	Dol = Dolomite	Pyr = Pyrite	Anh = Anhydrite	Bar = Barite
Mag = Magnesite	Kao = Kaolinite	Chl = Chlorite	Ill+Smc = Illite + Smectite	

Note: Grain densities are calculated based on average densities of the minerals detected.

LITHOLOGICAL ABBREVIATIONS

Anhy, anhy	anhydrite (-ic)
Ark, ark	arkose (-ic)
bnd	band (-ed)
Brec, brec	breccia
Calc, calctc	calcite (-ic)
carb	carbonaceous
crs gr	course grained
Chk, chky	chalk (-y)
Cht, cht	chert (-y)
Cgl, cgl	conglomerate (-ic)
crs xln	coursely crystaline
dns	dense
Dol, dol	dolomite (-ic)
F	randomly oriented fractures
f	slightly fractured
f gr	fine grained
foss	fossil (-iferous)
f xln	finely crystalline
Gil	gilsonite
Glauc, glauc	glauconite (-itic)
Grt	granite
Gyp, gyp	gypsum (-iferous)
hor frac	perdominantly horizontally fractured
incl	inclusion (-ded)
intbd	interbedded
lam	lamina (-tions, -ated)
Lim, lim	limestone
med gr	mediam grain
Mtrx	matrix
NA	interval not analyzed
Nod, nod	nodules (-ar)
Ool, ool	oolite (-itic)
Pisol, pisol	pisolite, pisolitic
p.p.	pin-point (porosity)
Ptg	parting
Pyr, pyr	pyrite (-itized, -itic)
Sd, sdy	sand (-y)
Sh, shy	shale (-ly)
SHR	solid hydrocarbon residue
sli	slightly
Slt, slty	silt (-y)
styl	stylolite (-itic)
suc	sucrosic
Su, su	sulphur, sulphurous
TBFA	TOO BROKEN FOR ANALYSIS
Trip, trip	tripoli (-itic)
v	very
vf	predominantly vertically fractured
vug	vug (-gy)
xbd	crossbedded
xln	medium crystalline
xtl	crystal

THE FIRST WORD IN THE DESCRIPTION COLUMN OF THE CORE ANALYSIS REPORT DESCRIBES THE ROCK TYPE. FOLLOWING ARE ROCK MODIFIERS IN DECREASING ABUNDANCE AND MISCELLANEOUS DESCRIPTIVE TERMS.

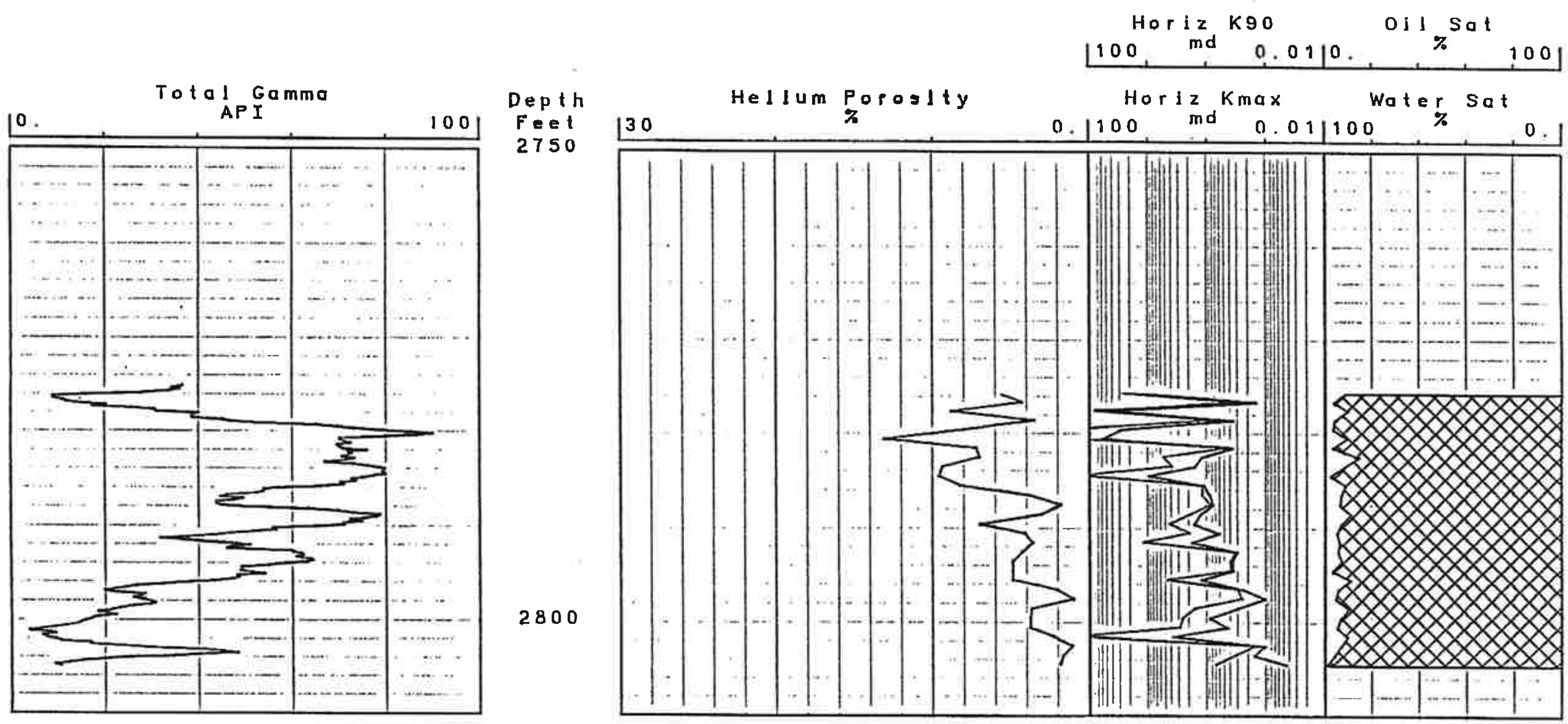
COMPLETIO.. COREGRAPH

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3
DISPOSAL WELL

TUBB (2775.0-2805.0 feet)
ZONE 1

Core Laboratories 10-30-96

Vertical Scale
5.00 in = 100.0 ft



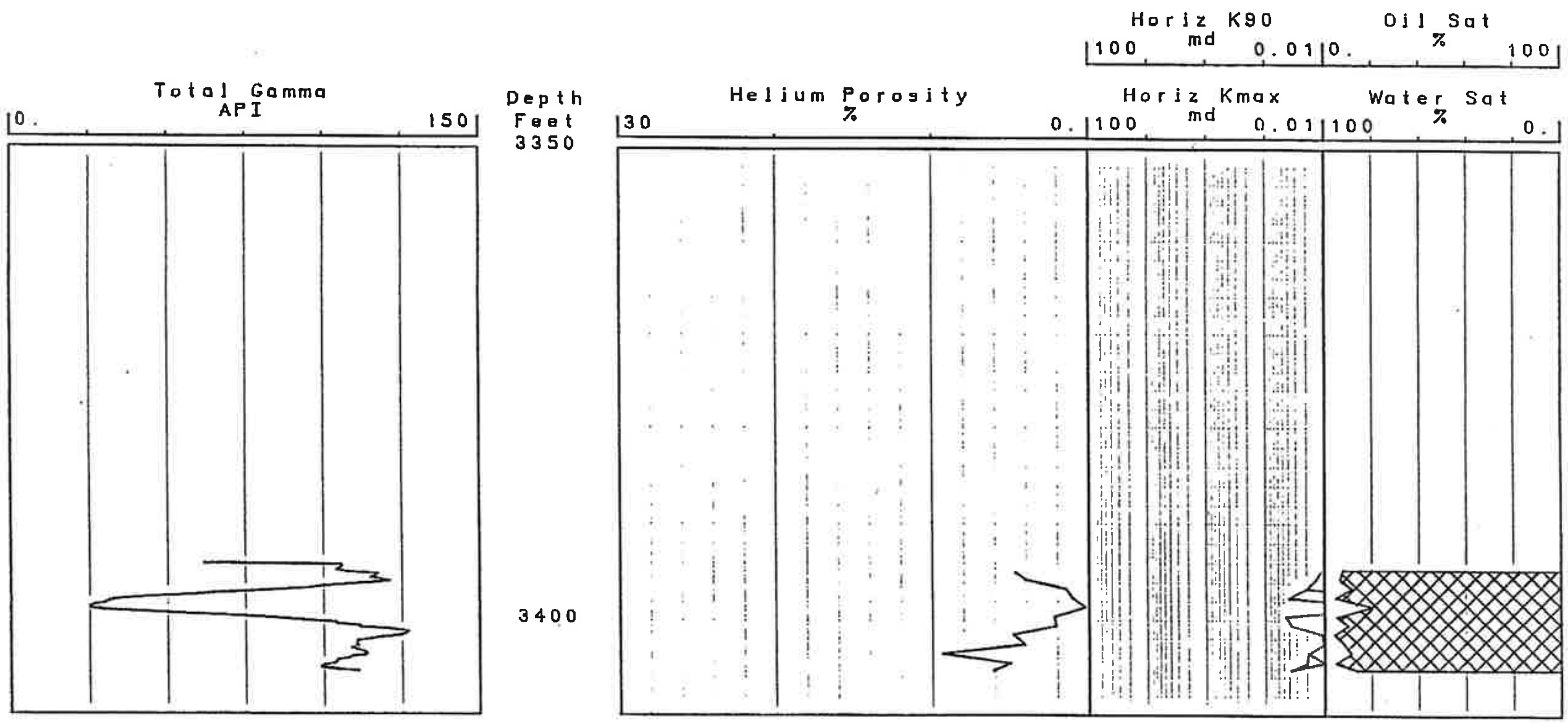
COMPLETIO. COREGRAPH

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3
DISPOSAL WELL

RED CAVE (3394.0-3405.5 feet)
ZONE 2

Core Laboratories 10-30-96

Vertical Scale
5.00 in = 100.0 ft



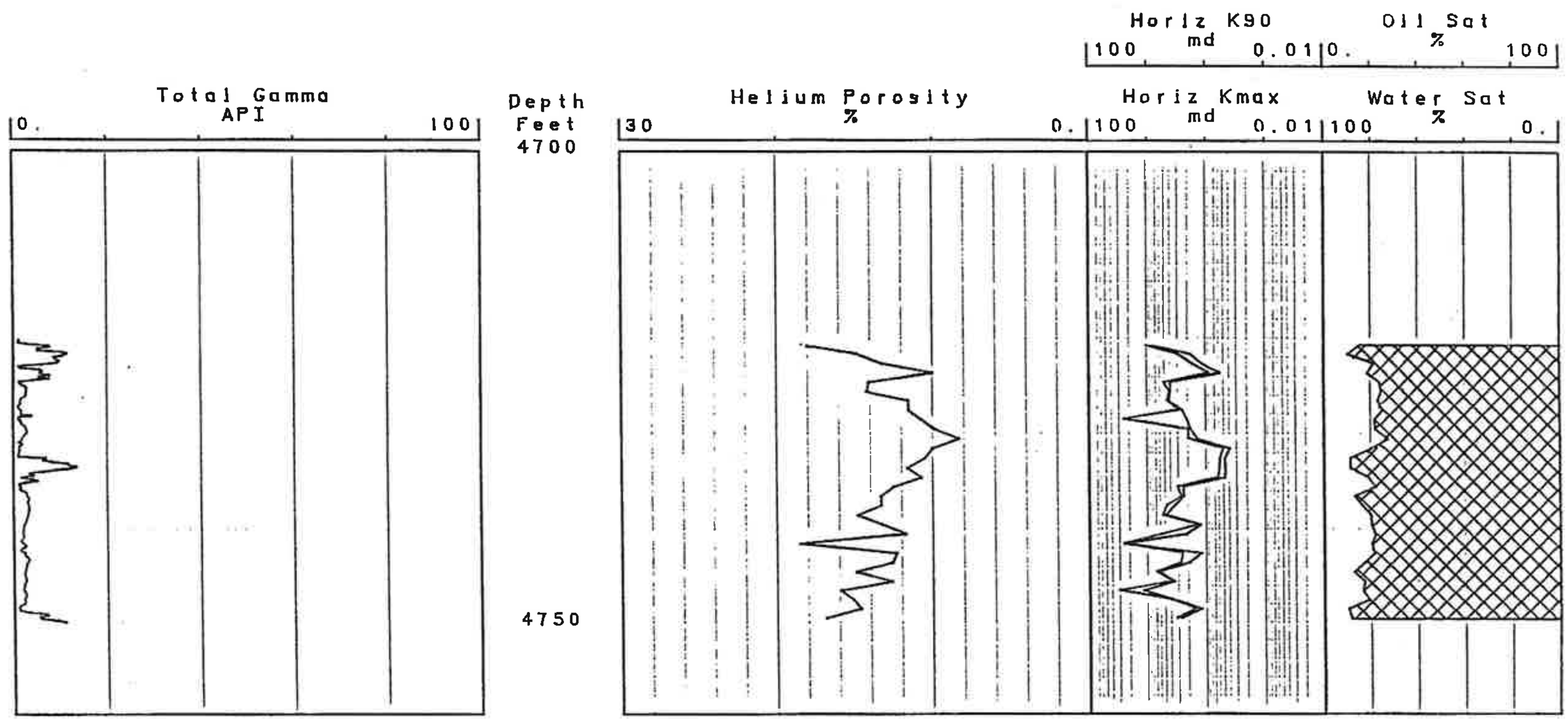
COMPLETIO. COREGRAPH

TERRA DYNAMICS, INC.
ASARCO WDW-324; PLANT WELL NO. 3
DISPOSAL WELL

BROWN DOLOMITE (4720.0-4750.0 feet)
ZONE 3

Core Laboratories 10-30-96

Vertical Scale
5.00 in = 100.0 ft



CORE LAB

CORE LABORATORIES

COMPLETE PETROGRAPHIC ANALYSIS

for

TERRA DYNAMICS, INC.
ASARCO WDW-324 PLANT WELL NO. 3
BROWN DOLOMITE

Performed For:
Terra Dynamics, Inc.

Performed By:
Core Laboratories
Reservoir Geology/Stratigraphy Group
Dallas Advanced Technology Center
1875 Monetary Lane
Carrollton, Texas 75006

CORE LAB

PETROLEUM SERVICES

January 7, 1997

Terra Dynamics, Inc.
9011 Mountain Ridge Drive, Suite 100
Austin, TX 78759-7252

Attention: Mr. Philip R. Grant

Subject: Complete Petrographic Analysis
Well: ASARCO WDW-324 Plant Well No. 3
Formation: Brown Dolomite
File: 196270

Dear Mr. Grant:

This report presents the results of the petrographic study performed on six core samples from the well mentioned above. The analyses include thin section petrography, scanning electron microscopy (SEM), and X-ray diffraction (XRD) analysis. Quantitative mineral analysis can be found in Table 2. Thin section and SEM photomicrographs are included at the end of the report, with the tabular thin section descriptions. Two original copies and eight color photocopies of this report have been forwarded to you at this time.

Thank you for choosing Core Laboratories to perform this study for you. Please feel free to contact us if you have any questions or comments concerning this report or if we can be of further service.

Sincerely,

Core Laboratories

Magell P. Candelaria

Magell P. Candelaria
Senior Geologist, Reservoir Geology/Stratigraphy

DISCUSSION

A comprehensive petrographic examination of six (6) core samples from the Brown Dolomite in the ASARCO WDW-324 Plant Well No. 3 has been completed at the request of Terra Dynamics, Inc. The ASARCO water disposal well is located in Potter County, Texas. This petrologic study involved thin section examination of all six samples, along with scanning electron microscopy (SEM) of each sample, and bulk mineral analysis by X-ray diffraction. The objectives of this study are to identify the mineralogy and characterize the pore systems in the prospective water disposal reservoir in the above referenced well. The core samples are listed by depth in Table 1, along with lithology/rock fabric, pore system descriptions and reservoir properties as determined from full diameter core analysis. Representative thin section and SEM photomicrographs with descriptions are attached as Plates 1-12. The results of the X-ray diffraction analyses are presented in weight percent, in Table 2.

Petrology

The petrographic examination performed in this study describes the mineralogy and pore systems of the Brown Dolomite reservoir in the above referenced well. All samples are pervasively dolomitized and slightly to moderately anhydritic. The dolomite fabrics range from very fine to medium crystalline, with an average fine crystal size for all samples except Sample No. 2, which is very fine crystalline dolomite. Primary depositional fabrics in the dolostones are interpretive as they are based on relic grain textures visible despite the pervasive dolomitization. Following the carbonate fabric terminology of Dunham (1962), 3 samples are classified as packstones, and 3 samples are grainstones, as described in the attached odd-numbered Plates 1-11. Scanning electron micrographs depicting high magnification views of the dolomite fabrics and pore structure are attached, as the even-numbered Plates 2-12.

The grain-supported relic fabrics characteristic of these dolostone samples indicate depositional lime mud was rare to absent from the original samples. As a result, the crystalline dolomite fabrics have preserved moderately high total porosity as shown in Table 1.

Table 1
Sample list, pore systems and petrophysical properties

Sample No.	Depth, ft	Lithology/Fabric	Pore Systems	Poro. %	k_{air} md	Res. Quality Assessment
1	**4721-22**	dolopackstone	*V >IX > mIX*	14.9	2.97	moderately low
2	**4728-29**	dolograinstone	*V > IX = mIX*	10.7	24.80	moderately high
3	**4736-37**	dolopackstone	*V = mIX > IX*	13.3	2.62	moderately low
4	**4740-41**	dolograinstone	*V >> IX >> mIX*	11.7	5.65	moderate
5	**4745-46**	dolopackstone	*IX > V >> mIX*	12.6	3.94	fair
6	**4747-48**	dolograinstone	*IX > mIX > V*	15.1	3.91	fair

V = vuggy IX = intercrystalline mIX = micro-intercrystalline

Primary Grain Types
Peloids are common as relic grains or "ghosts" in the dolostone fabrics. Peloids are typically fine sand-sized. Skeletal grain types are restricted to crinoidal debris and minor brachiopods and/or bivalves and a few calcareous algae(?) skeletal grains. Skeletal grains, primarily

crinoids, are variable in size ranging up to 1 cm in diameter. Intraclasts may be present in several samples but are indistinguishable from relic peloids owing to the pervasive dolomitization. No silt-sized terrigenous clastic grains were observed in any of the thin section samples, however, trace amounts to 1 wt.% detrital(?) potassium feldspar was detected in two samples, as shown in Table 2. Similarly, no detrital clay minerals were observed in thin section, nor were any detected by X-ray diffraction analysis.

Authigenic Minerals

Authigenic minerals are limited in diversity and abundance, consisting of minor to common pore-filling anhydrite and trace amounts to minor replacement chert and mega-quartz, in addition to the pervasive dolomitization of all samples (Table 2). The dolomitization appears to have occurred in two episodes. Turbid, very fine to medium crystalline dolomite is widespread, and typical of the dolostone matrix and relic grain fabric. Additionally, there is a fine to medium crystalline, lucid dolomite, which apparently, occurs as a later stage cement, filling local intercrystalline pores in the precursor dolomite. Anhydrite occurs as a rare to minor pore-filling cement in most samples (1-11 wt.% by X-ray analysis), however, in thin section Sample Nos. 5 and 6 (Plates 9 and 11), anhydrite is a common interparticle cement. Anhydrite also partially replaces some of the crystalline dolomite and skeletal grains locally. Trace amounts to 2 wt.% gypsum was reported by XRD analysis for all samples except Sample No. 3 (4736-37 feet), for which no gypsum was detected. These occurrences of gypsum are likely the alteration by-product of anhydrite, which is more common in these samples and throughout the Permian section in west Texas. Minor occurrences of gypsum have been reported from several shallow oil fields in west Texas, typically above 5000 feet measured well depth, such as South Cowden, Grayburg (Ruppel and Lucia, 1996) and McElroy (Harris and Walker, 1990), as a result of alteration/re-hydration of anhydrite in the burial environment. A small amount of halite was detected by XRD in Sample No. 3 (4736-37 feet)

Calcite spar was observed in trace amounts as a cement in one thin section sample, as well as under SEM examination in one sample, though 1 wt.% calcite was reported by XRD analysis in each sample (Table 2). Chert/chalcedony was observed in most samples in rare to trace amounts, as colliform replacement cement. However, XRD analysis reports 2 wt.% silica in each sample. Sample No. 6 (Plate 11) contains rare relic foraminifera(?) or spicules(?) and spicule-moldic(?) pores in which chalcedony is present as a moldic pore-filling cement. Chert/chalcedony in these pores may have originated as biogenic silica derived from siliceous sponge spicules. (Whether the siliceous sponges were endemic to this depositional environment, or were transported to it, is indeterminate). Pyrite, occurring in trace amounts, was observed in several thin section samples. Authigenic potassium feldspar(?) was observed under SEM examination in one sample (Plate 8B). No authigenic clay minerals were observed in thin section.

Pore Systems

The pore systems in these samples are quite similar, and as a result, porosity displays a relatively narrow range of moderately high values, in a sample by sample comparison. Total porosity for all samples as determined by full diameter core analysis (Table 1), ranges from 10.7 to 15.1%, with 13.0% average porosity for all samples (Core Laboratories Report File: 57181-17251). Permeability for all samples ranges from 2.62 md to 24.80 md, with 7.32 md average permeability. Pore system heterogeneity is often the cause for low permeability, owing to lack of continuity of pores. This condition appears to be the case in the Brown Dolomite reservoir. Despite pervasive dolomitization which commonly enhances porosity, particularly in

Terra Dynamics, Inc. File: 196290

Table 2
Mineral Analysis by X-ray Diffraction
(weight %)

Depth, feet	Quartz	K feldspar	Plagioclase	Calcite	Dolomite	Siderite	Halite	Anhydrite	Gypsum	Total Clay	Illite+ smectite	Kaolinite	Chlorite
4721-22	2	1	0	1	94	0	0	2	Tr	0	0	0	0
4728-29	2	Tr	0	1	89	0	0	7	1	0	0	0	0
4736-37	2	0	0	1	95	0	1	1	0	0	0	0	0
4740-41	2	0	0	1	96	0	0	1	Tr	0	0	0	0
4745-46	2	0	0	1	84	0	0	11	2	0	0	0	0
4747-48	2	0	0	1	92	0	0	4	1	0	0	0	0

primary packstone and grainstone fabrics, the limited reservoir permeability in the prospective water injection interval is the result of pore occlusion by anhydrite cement and the presence of isolated vuggy pores.

The dominant pore types observed in thin section do not display a strong relationship to carbonate fabric. Vuggy pores dominate the pore systems in 4 of the 6 samples examined. The other two samples are characterized by intercrystalline dominant pore systems as shown in Table 1. The vuggy pore dominated samples demonstrate both the highest and lowest permeabilities of all samples in this study (Sample Nos. 2 and 3, respectively), attesting to the variability of vuggy pore contribution to effective permeability. Non-touching vuggy pores, as described by Lucia (1983, 1995), contribute to total measured porosity. but commonly add little to effective porosity. Hence, permeability is variable in samples with a significant amount of separate vuggy pores. Intercrystalline pore systems can be very effective with respect to subsurface hydraulic conductivity, however, the samples with intercrystalline dominated pore systems exhibit relatively low permeability. The relatively low permeability in these samples is attributed to limited pore interconnectivity resulting largely from anhydrite cementation, and local secondary silica cementation. Sample No. 6, which is characterized by dead oil-stained micro-stylolites, possibly exhibits reduced permeability as a result of the micro-stylolites which may restrict vertical permeability, particularly.

The presence of gypsum in this reservoir may introduce spurious openhole log porosity calculations should its abundance exceed 5 wt.%. At this percent abundance, the water bound in the gypsum crystalline structure will influence the neutron log derivation of porosity and may introduce erroneously high water saturation (S_w) and porosity values. Similarly, the low density of gypsum will affect bulk density logs resulting in a false porosity calculation, as gypsum is significantly less dense than anhydrite. Fortunately, at 2 wt.% or less, as detected in these samples, gypsum poses no threat to the accuracy of log-derived calculations. However, the fact that gypsum is present raises a caution flag that should be noted, as gypsum may occur elsewhere in this reservoir in sufficient abundance to influence "net pay" and water saturation calculations.

The overall effectiveness at which the Brown Dolomite serves as a water disposal reservoir may also be influenced by fractures. Though not documented in this study, permeable fracture systems in dolomite reservoirs are common, and may afford additional effective permeability to the Brown Dolomite reservoir in this well.

ANALYTICAL PROCEDURES

A petrographic study permits characterization of reservoir rock textures, mineralogies, and porosity. X-ray diffraction analysis provides for the identification and quantification of specific rock-forming minerals. Information about the relationships among rock textures, framework grains, matrix, cements and porosity are determined from integrated thin section analyses which facilitate qualitative assessment of reservoir characteristics, storage potential and reservoir fluid deliverability. Scanning electron microscopy (SEM) provides very high-magnification views of framework grains, cements, matrix, and authigenic clays (if present), from which mineral morphologies, particularly clays, are identified and described. Scanning electron microscopy also provides high-magnification views of microporosity types and their distribution. Energy dispersive spectroscopy (EDS), used in conjunction with SEM, provides qualitative elemental analysis of mineral phases and allows for positive identification of cements, matrix, and authigenic clays observed during SEM examination.

Thin Section Petrography

The core samples were prepared for thin section analysis by first impregnating the samples with epoxy to augment sample cohesion and to prevent loss of material during the grinding procedure. A blue dye was added to the epoxy to highlight the pore spaces. Each of the samples was mounted on a frosted glass slide and then cut and ground in water to a thickness of approximately 30 microns. These samples were stained with Alizarin Red-S and potassium ferricyanide to facilitate identification of dolomite from calcite and ferroan calcite/dolomite cements, respectively. The thin sections were studied using standard petrographic techniques. Carbonate fabric terminology is after Dunham (1962). Petrographic photomicrographs are presented with descriptions, as the odd numbered Plates 1-11, at the end of this report.

X-ray Diffraction Analysis

Samples for X-ray diffraction analysis are dried and cleaned of obvious contaminants. Each sample is crushed, dried, weighed, placed in water, and treated with a sonic cell disrupter. The resultant slurry is centrifuged to fractionate the sample at 4 microns. The suspended < 4 micron sample is decanted and saved. The > 4 micron sample is dried and weighed to determine weight percent clay- and silt-sized material. The suspended < 4 micron fraction is suctioned onto a pure silver substrate to orient the clay mineral particles. The sample mount is run in an air-dried state then treated with ethylene glycol vapor for 24 hours, and run again. The > 4 micron fraction is milled and run on a Philips ADP 3600 diffractometer. Diffractograms are analyzed for mineral content using a profile fitting algorithm. The integrated areas from the profile-fitting algorithm are entered into a spreadsheet containing correction coefficients for various common minerals. Mineral coefficients were obtained according to the adiabatic method outlined by Chung (1974a, b, c). Results of the XRD analyses are reported in weight percent for the whole rock composition (Table 2).

Scanning Electron Microscopy

For scanning electron microscopy (SEM) analysis, the samples were dried and fresh surfaces were exposed. Each sample was coated with a thin film of gold-palladium (Au-Pd) alloy using a Polaron Coating Unit. SEM photomicrographs are secondary electron images taken with a Polaroid camera attached to an ISI-SX-40 Scanning Electron Microscope operating at 20kV.

Qualitative elemental data of selected phases observed during the SEM study were obtained through use of an interfaced Tracor Northern 5400 Energy Dispersive Spectroscopy (EDS) unit equipped with a Si (Li) detector. Recognition of observed authigenic clays is based on the criteria proposed by Wilson and Pittman (1977). SEM photomicrographs are presented with descriptions, as the even numbered Plates 2-12, at the end of this report.

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PHOTOMICROGRAPH SCALES

Thin Section Petrography

The scale of the included photomicrographs is a function of the magnification used. The magnifications used are identified on each photomicrograph plate description, and are listed below:

31X: Horizontal width of the photomicrograph (127 mm) represents 4.097 mm. Length between intervals on the horizontal grid is 0.258 mm.

125X: Horizontal width of the photomicrograph (127 mm) represents 1.016 mm. Length between intervals on the horizontal grid is 0.064 mm.

Scanning Electron Microscopy

Scanning electron microscopy (SEM) photomicrographs are taken at high magnifications to observed crystalline morphologies, pore types and pore throat geometries at magnifications higher that obtainable with optical petrographic microscopy. The magnification used in the enclosed SEM photomicrographs and other parameters are indicated along the lower edge of each photomicrograph. From left to right these symbols are the following: SEM accelerating potential in kilovolts (20KV), magnification (X1000), bar scale (microns, μm), and photograph exposure number.

ASARCO WDW-324
Plant Well No. 3

File: 196270

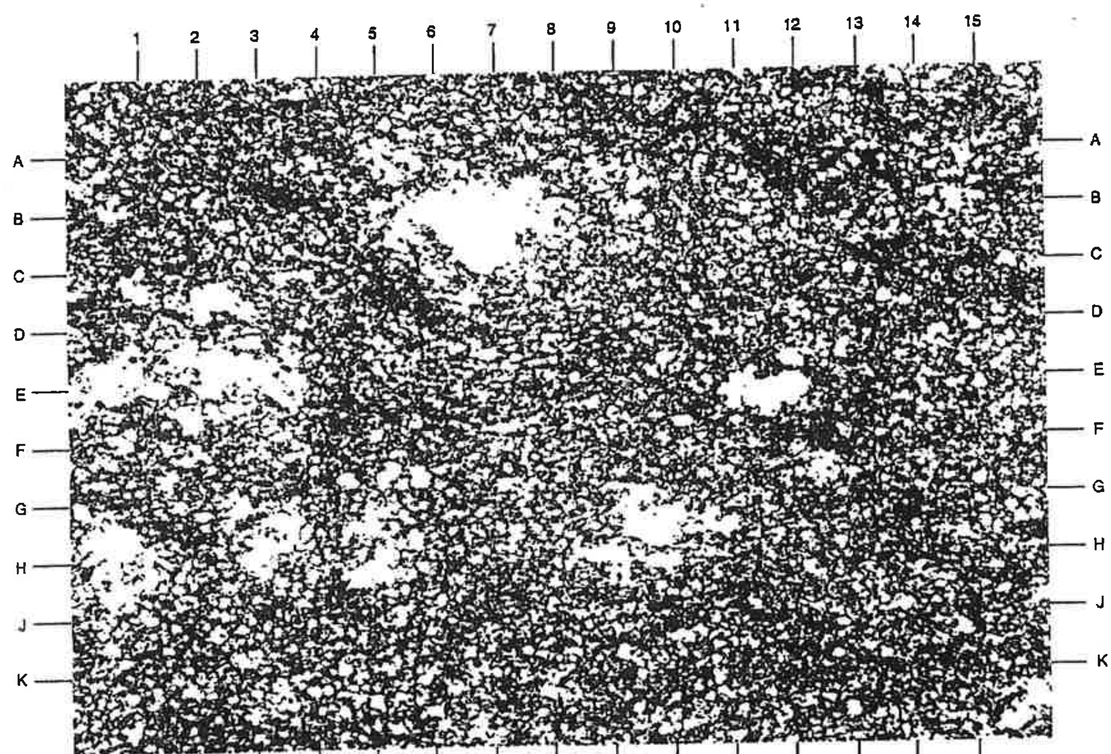
PLATE 1
Thin Section Photomicrographs
Brown Dolomite
Depth: 4721-22 feet

A

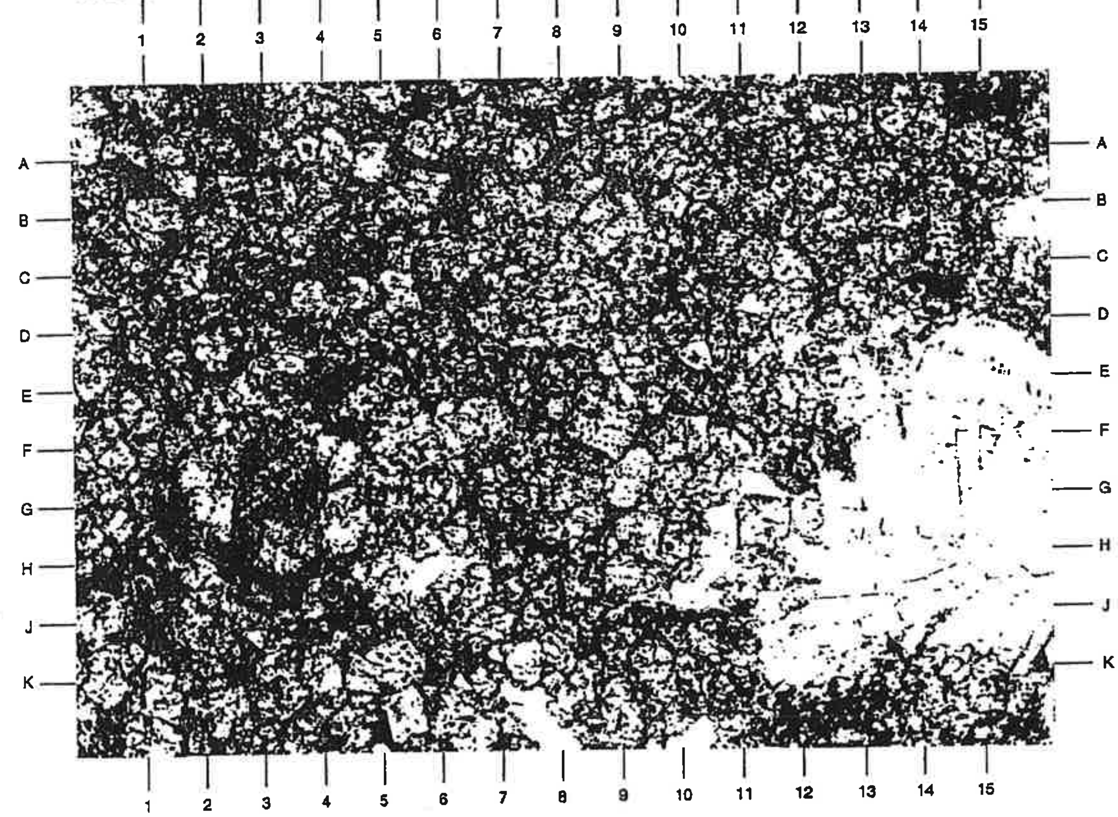
Lithology:	Dolostone
Classification:	Peloid dolopackstone
Allochemical Grains:	Common relic peloids; trace amounts of crinoids and brachiopods(?)
Avg. Dolo. Crystal Size:	0.045 mm (fine crystalline)
Terrigenous Grains:	None observed
Silt/Sand Size:	Not applicable
Authigenic Minerals:	Pervasive replacement dolomite; minor anhydrite
Features/Structures:	Wispy laminae
Visible Pore System:	Vuggy > intercrystalline > micro-intercrystalline
Core Plug Porosity:	14.9%
Core Plug Perm.:	2.97 md (k air)
Comments:	This sample is a fine crystalline peloid dolopackstone with rare crinoid and possible brachiopod fragments. Isolated "blebs" of anhydrite are visible throughout the sample (C7, F14 and H10). Poorly interconnected vugs dominate the pore system (C4, H-J6.5 and K1.5), hence, permeability is relatively low, despite high total porosity. The darker brown matter (E4, G11 and J5) consists largely of residual oil stain. Rare moldic pores (not shown) are also prsent.
Magnification:	31X, transmitted light

B

Comments:	This photomicrograph is centered near H8 in Plate 1A. Visible in this photomicrograph are the fine crystals of the dolomite matrix (C11 and D5). The white crystalline mass at E-J15 is anhydrite cement filling a vug and partially replacing the dolomite matrix.
Magnification:	125X, transmitted light



A



B

ASARCO WDW-324
Plant Well No. 3

File: 196270

PLATE 2
SEM Photomicrographs
Brown Dolomite
Depth: 4721-22 feet

A

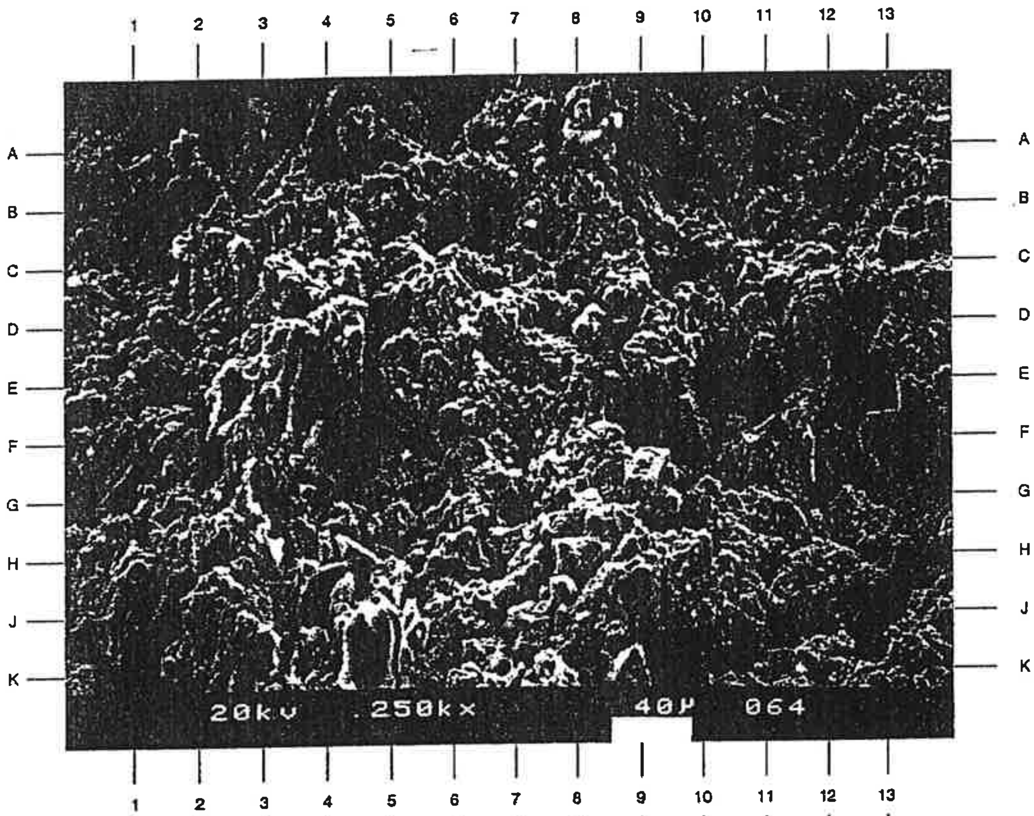
Comments: This fine crystalline dolomite is characterized by high vuggy and intercrystalline porosity but relatively low permeability, owing to limited interconnectivity of vuggy pores (A6 and E-F10-11). Intercrystalline pores are visible at E-F10, F8.5 and J13. Dolomite crystal size is somewhat variable, ranging from 6-56 microns in diameter. A patch of pore-filling anhydrite is visible at J-K4.5. No detrital clay minerals are evident in this sample.

Magnification: 250X

B

Comments: This view is centered at H-J7 in Plate 2A. In this high-magnification view, faceted dolomite crystals are clearly visible (B10, C4 and F6), as are the 5-10 micron diameter intercrystalline pores (D6, D11 and J6). Owing to the small average pore diameters, sample permeability is low, despite moderately high porosity. Micro-intercrystalline pores are visible at A2 and J7.5.

Magnification: 1500X



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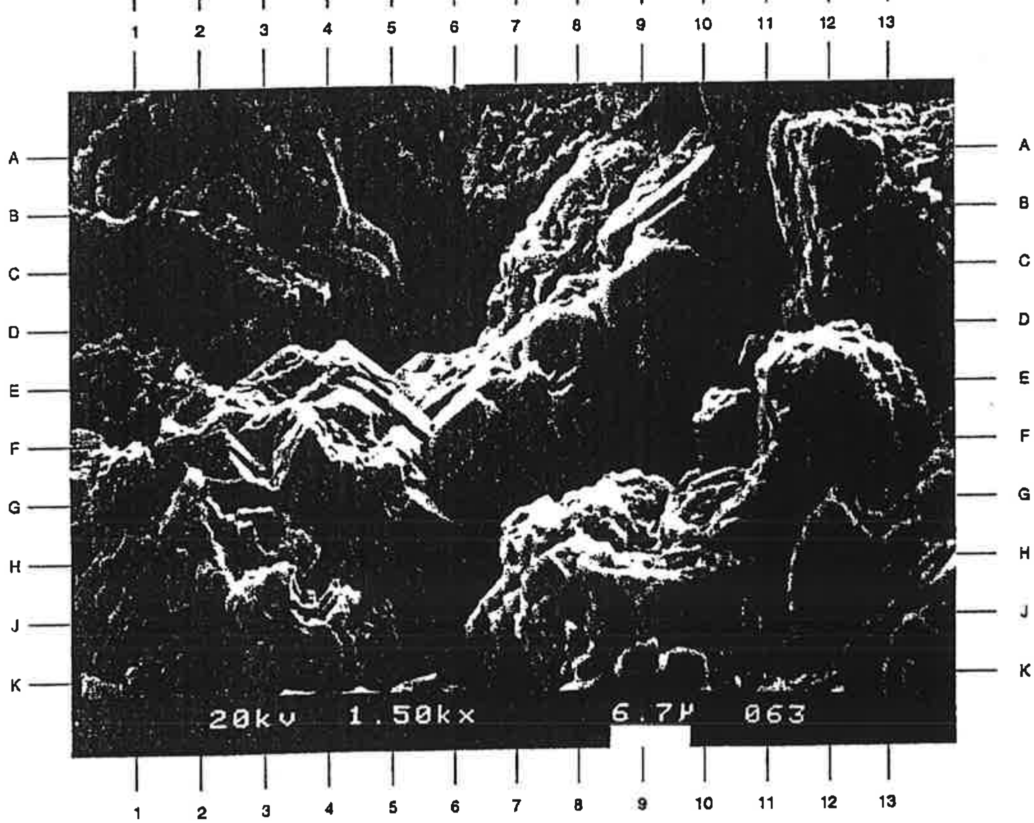
A B C D E F G H J K
20kv .250kx 40µ 064

A



1 2 3 4 5 6 7 8 9 10 11 12 13
A B C D E F G H J K
20kv 1.50kx 6.7µ 063

B

ASARCO WDW-324
Plant Well No. 3

File: 196270

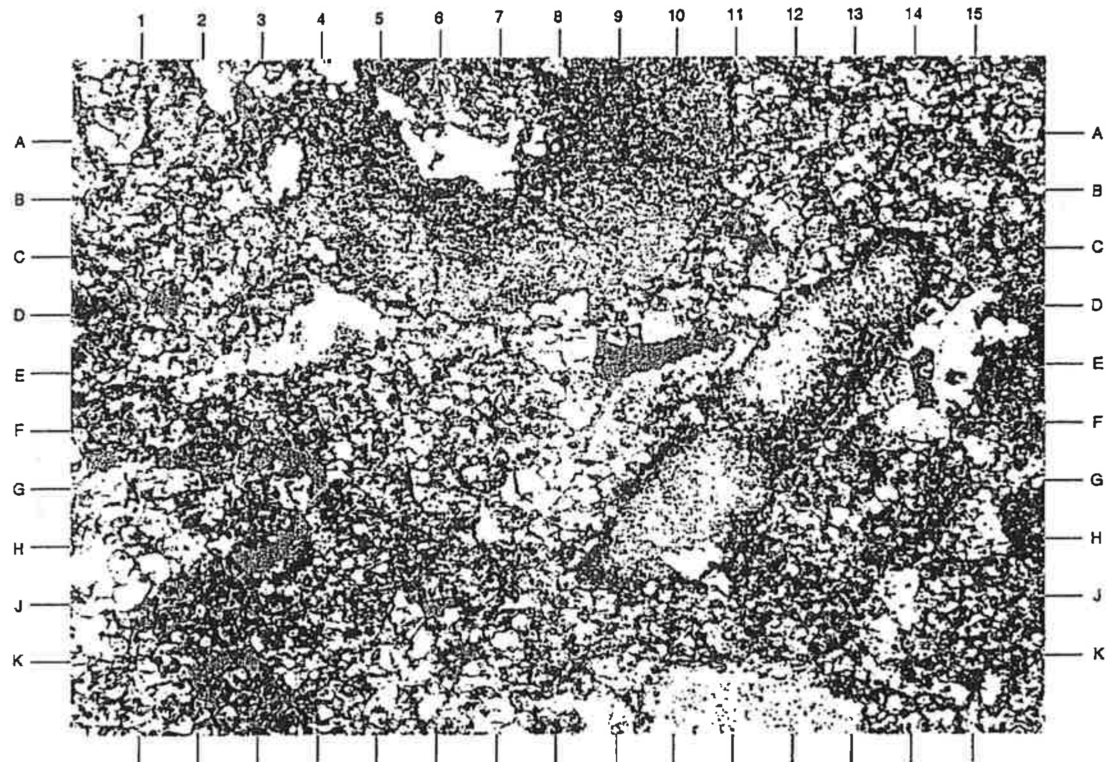
PLATE 3
Thin Section Photomicrographs
Brown Dolomite
Depth: 4728-29 feet

A

Lithology:	Dolostone
Classification:	Crinoid peloid dolograinstone
Allochemical Grains:	Common peloids; lesser crinoids
Avg. Dolo. Crystal Size:	0.010 mm (very fine crystalline)
Terrigenous Grains:	None observed
Silt/Sand Size:	Not applicable
Authigenic Minerals:	Pervasive replacement dolomite, minor anhydrite; rare chert
Features/Structures:	Micro-stylolites; abundant microporosity in crinoid fragments
Visible Pore System:	Vuggy > intercrystalline = micro-intercrystalline
Core Plug Porosity:	10.7%
Core Plug Perm.:	24.80 (k air)
Comments:	This sample is a very fine crystalline dolograinstone with relic peloids (F4, F6.5 and G-H15.5) and common crinoid fragments (A4-10, G10.5 and below K11). Vugs (F-H3 and J2-K3) dominate the pore system resulting in the highest permeability of all samples in this study, yet porosity is the lowest of all samples examined. Microporosity is high within the crinoid fragments (A5 and A8-9). Partial crinoid grain replacement by chert is visible at A-B6-7, D4 and D-E14.5.
Magnification:	31X, transmitted light

B

Comments:	This photomicrograph is centered near D11 in Plate 3A. Visible in this photomicrograph are the micropores in the crinoid grains (A4-C1, J6-K1 and F15-K13). Partial crinoid dissolution is evident along the edges of the skeletal grains as well (B15-C13 and J1-G7.5). The white, pore-bridging cement at D-E9-10 is anhydrite. Replacement chert is present at G9-J8.
Magnification:	125X, transmitted light



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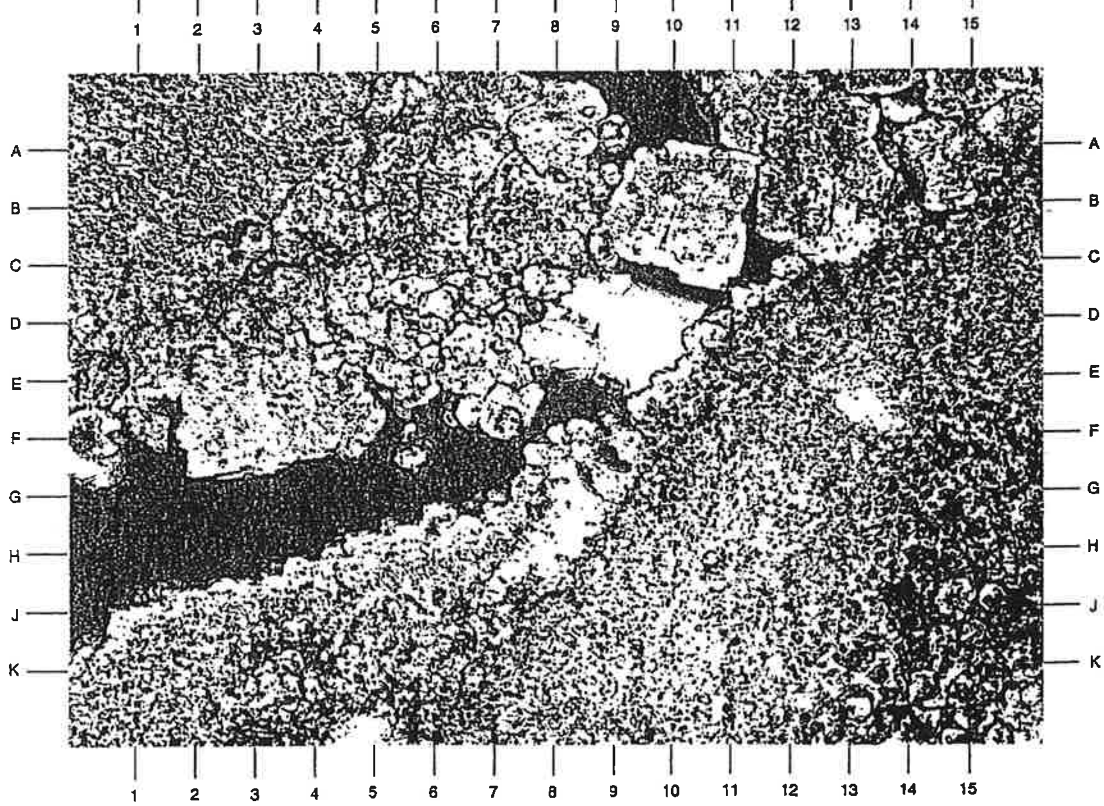


B

ASARCO WDW-324
Plant Well No. 3

File: 196270

PLATE 4
SEM Photomicrographs
Brown Dolomite
Depth: 4728-29 feet

A

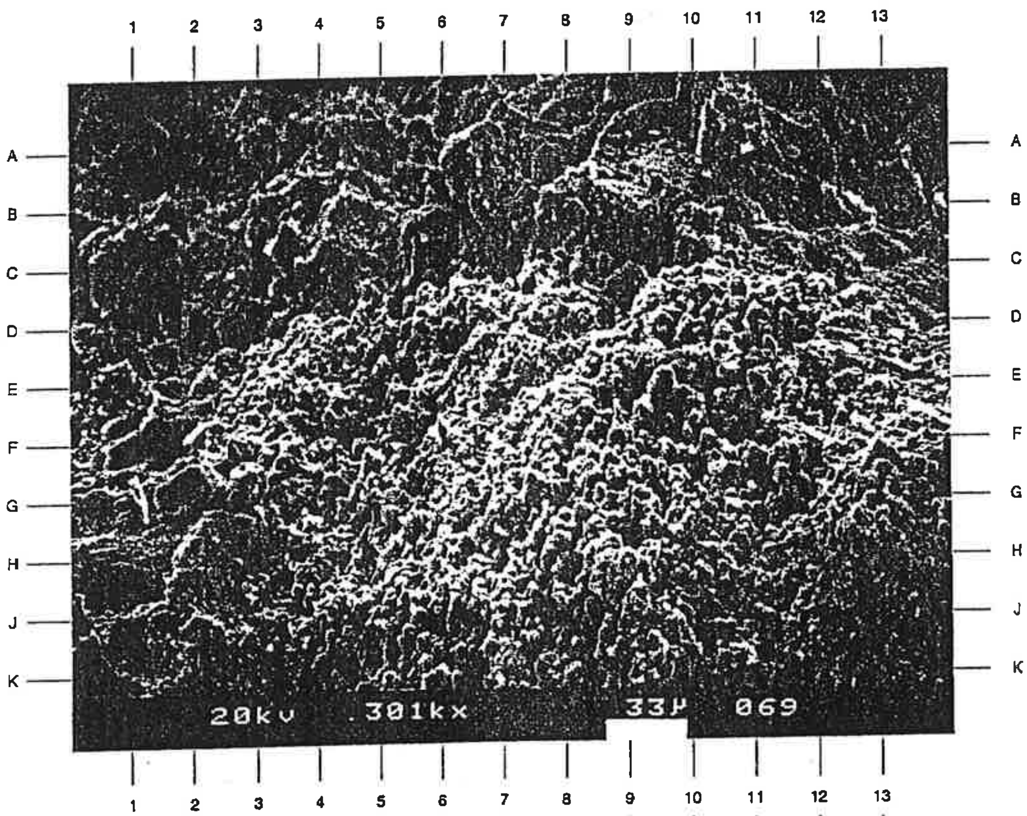
Comments: This sample is a very fine crystalline dolomite with common amounts of dolomite replaced crinoid debris. Crinoid fragments to 3 cm length have retained their monocrystalline nature but are now dolomite, instead of calcite. Crinoid fragments are visible as the large flat surfaces at B13? and H1. Solution-enlarged intercrystalline pores (vugs) and intercrystalline pores (D-E11 and H7) are common and result in the highest permeability of all samples examined in this study. Intraparticle pores within the replaced crinoid fragments are also moderately abundant (G-H1), but are volumetrically insignificant.

Magnification: 301X

B

Comments: This high magnification view is centered at E6 in Plate 4A. This view reveals micrite-sized dolomite crystals (rhombs) cemented with anhydrite (C7-E4). The dolomicrite may be replacing a crinoid fragment. Micro-intercrystalline pores in the dolomicrite are common (B10.5-G9). No detrital clay minerals are evident in this sample.

Magnification: 2250X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20kv .301kx 33μ 069

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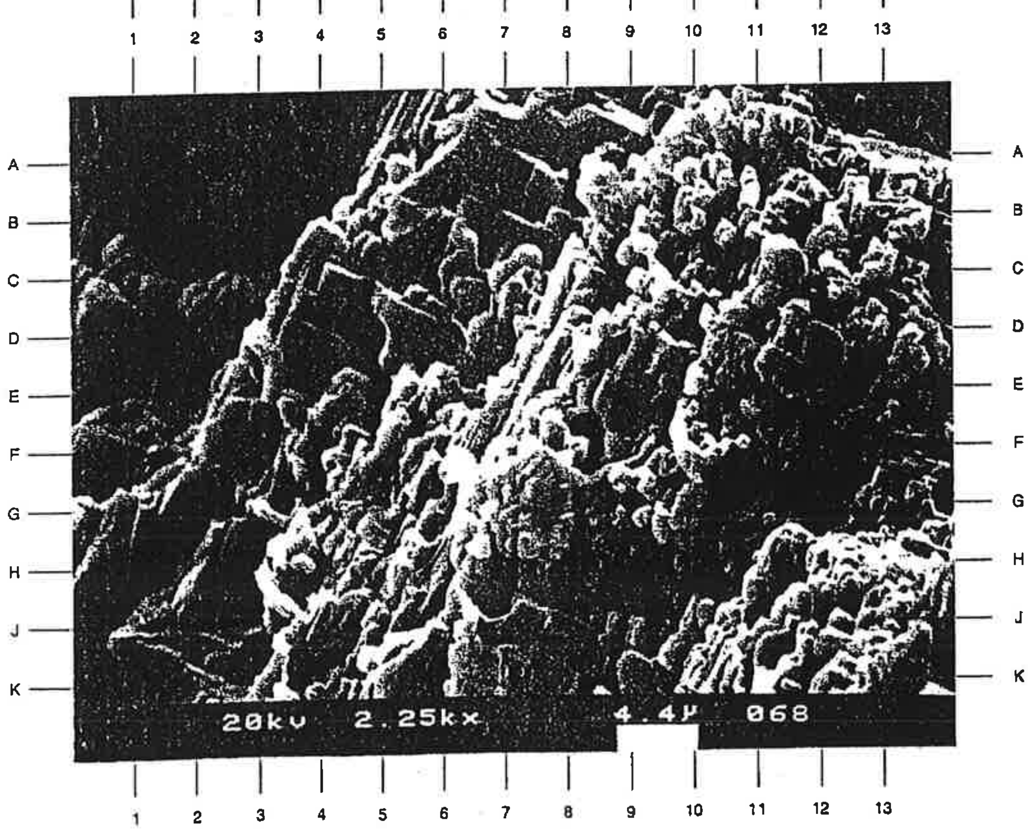
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K
20kv 2.25kx 4.4μ 068

B

ASARCO WDW-324
Plant Well No. 3

File: 196270

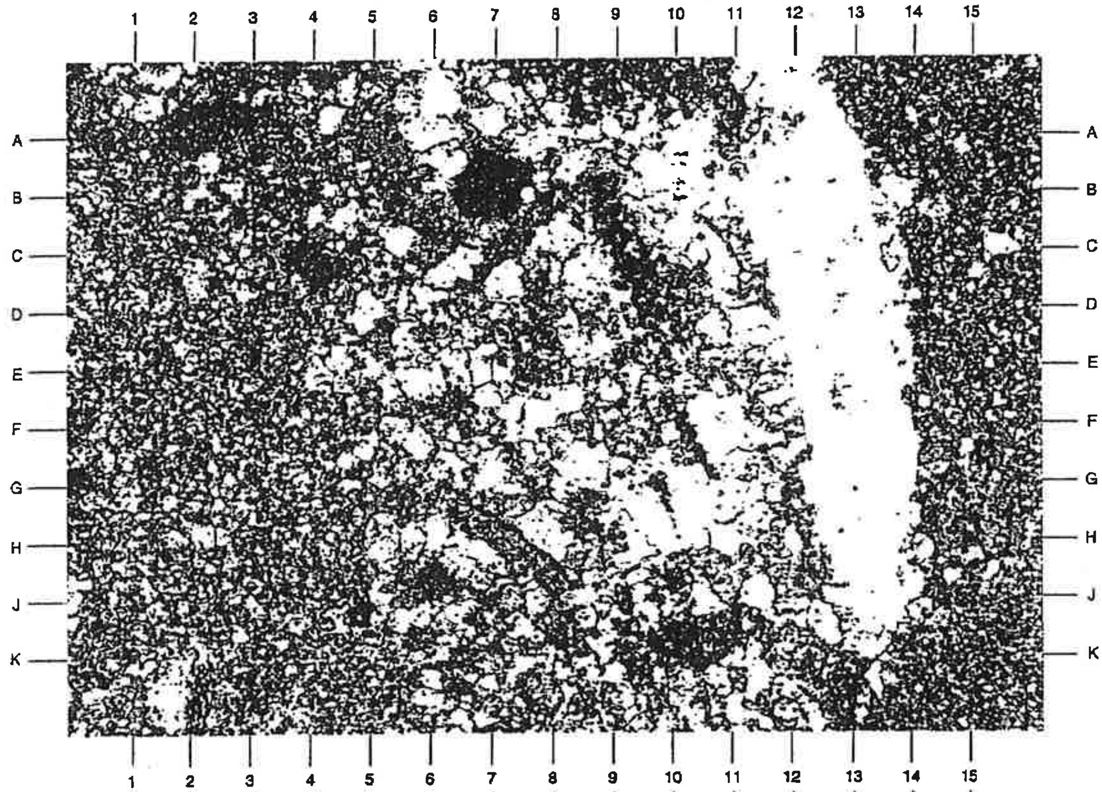
PLATE 5
Thin Section Photomicrographs
Brown Dolomite
Depth: 4736-37 feet

A

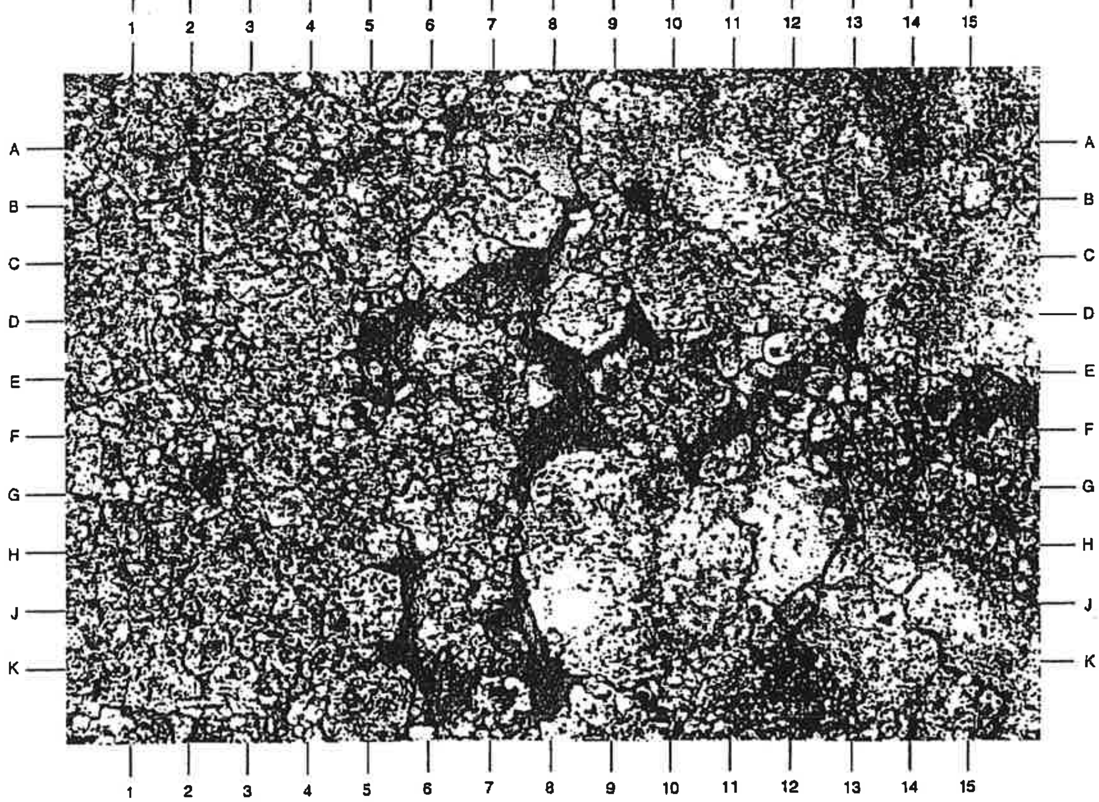
Lithology:	Dolostone
Classification:	Crinoid brachiopod peloid dolopackstone
Allochemical Grains:	Common peloids; lesser brachiopods, minor crinoids
Avg. Dolo. Crystal Size:	0.045 mm (fine crystalline)
Terrigenous Grains:	None observed
Silt/Sand Size:	Not applicable
Authigenic Minerals:	Abundant replacement dolomite; minor anhydrite
Features/Structures:	Intracrystalline dissolution pores, rare stylolites
Visible Pore System:	Vuggy = micro-intercrystalline > intercrystalline
Core Plug Porosity:	13.3%
Core Plug Perm.:	2.62 md (k air)
Comments:	This sample is characterized by a moderately wide range in dolomite crystal sizes, ranging from very fine to upper medium crystalline textures (compare A1-K5 with A6-J12). Anhydrite replacing a brachiopod grain is visible at A12-J13.5. Anhydrite cement is also present at F11 and H10. Note the wide range in pore sizes owing to the variable dolomite crystal size which results in the lowest permeability of all samples examined.
Magnification:	31X, transmitted light

B

Comments:	This photomicrograph is centered near G5 in Plate 5A. The various dolomite crystal sizes are evident in this view (compare the area around H7 with the larger crystals at G9-K15). Note also the peculiar occurrence of intracrystalline dissolution pores visible at E-F12-14.
Magnification:	125X, transmitted light


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A B C D E F G H J K

A


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A B C D E F G H J K

B

ASARCO WDW-324
Plant Well No. 3

File: 196270

PLATE 6
SEM Photomicrographs
Brown Dolomite
Depth: 4736-37 feet

A

Comments:

The striking feature of this sample is the wide range in dolomite crystals sizes visible even at low magnification (compare E-F10 to H4). Dolomite crystals range from 5-240 microns diameter (very fine to upper medium crystalline). Microporosity is fairly common in this sample as well, thus, pore sizes are heterogeneous. Consequently, permeability is the lowest of all samples examined. Anhydrite filling a brachiopod moldic-pore is visible at G13-K10.5. No detrital clay minerals are evident in this sample.

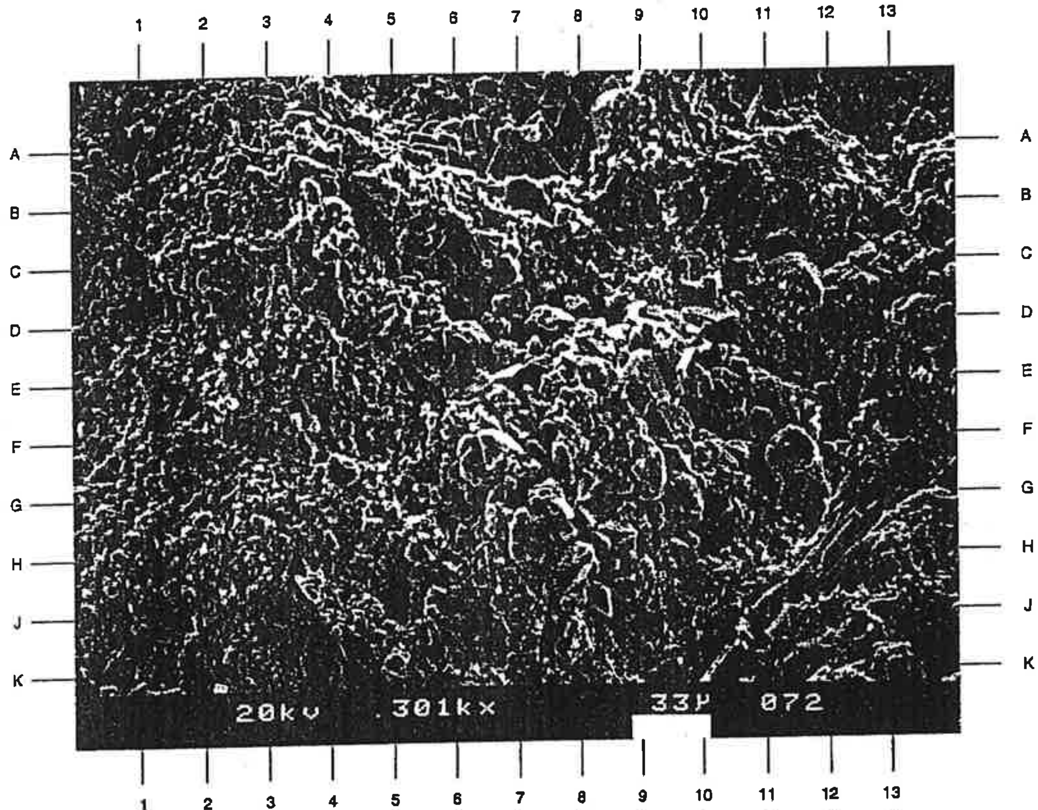
Magnification: 301X

B

Comments:

This high-magnification view is centered near E7 in Plate 6A, above. This view highlights the pore-filling calcite cement that was observed under SEM, but not observed in the thin section sample. Exquisitely preserved rhombic crystal faces of the calcite are visible at C2, F7 and F9. Dolomicrite crystals are visible at K10-12. Micro-intercrystalline porosity is fairly high in this sample (A-B6 and F-G13.5), adding to pore system heterogeneity, but resulting in low permeability.

Magnification: 2250X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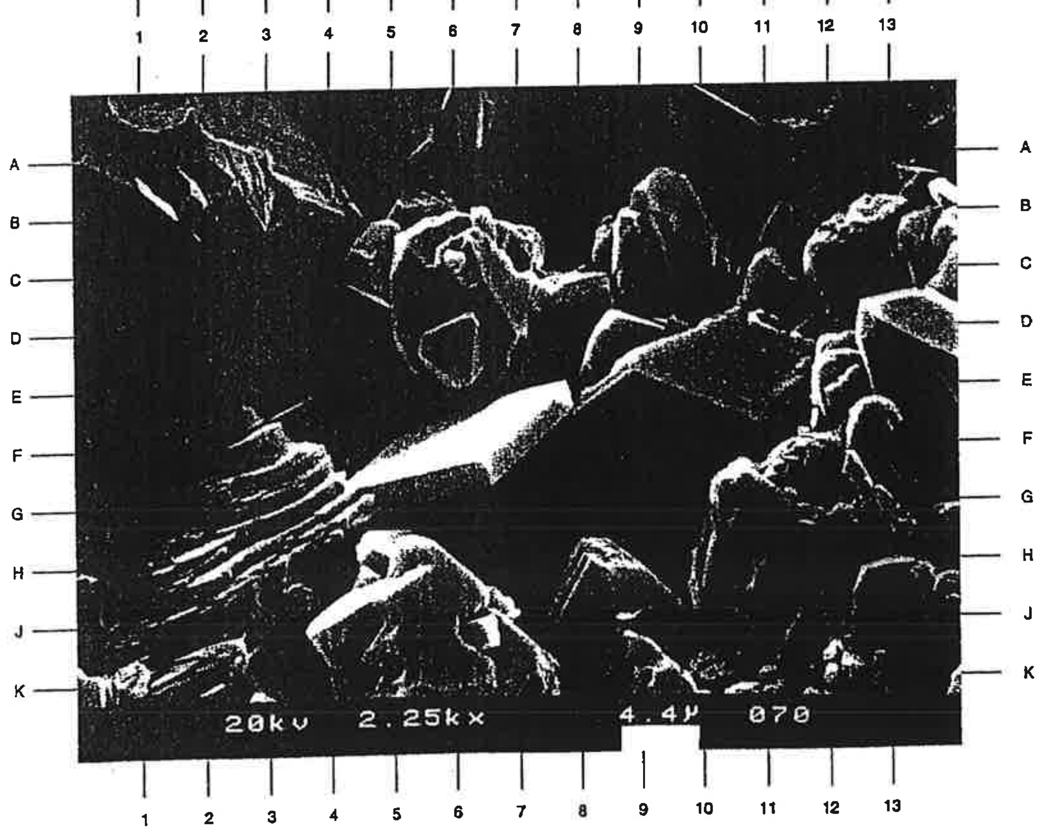
K
20kv 301kx 33μ 072

A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J
K
20kv 2.25kx 4.4μ 070

B

ASARCO WDW-324
Plant Well No. 3

File: 196270

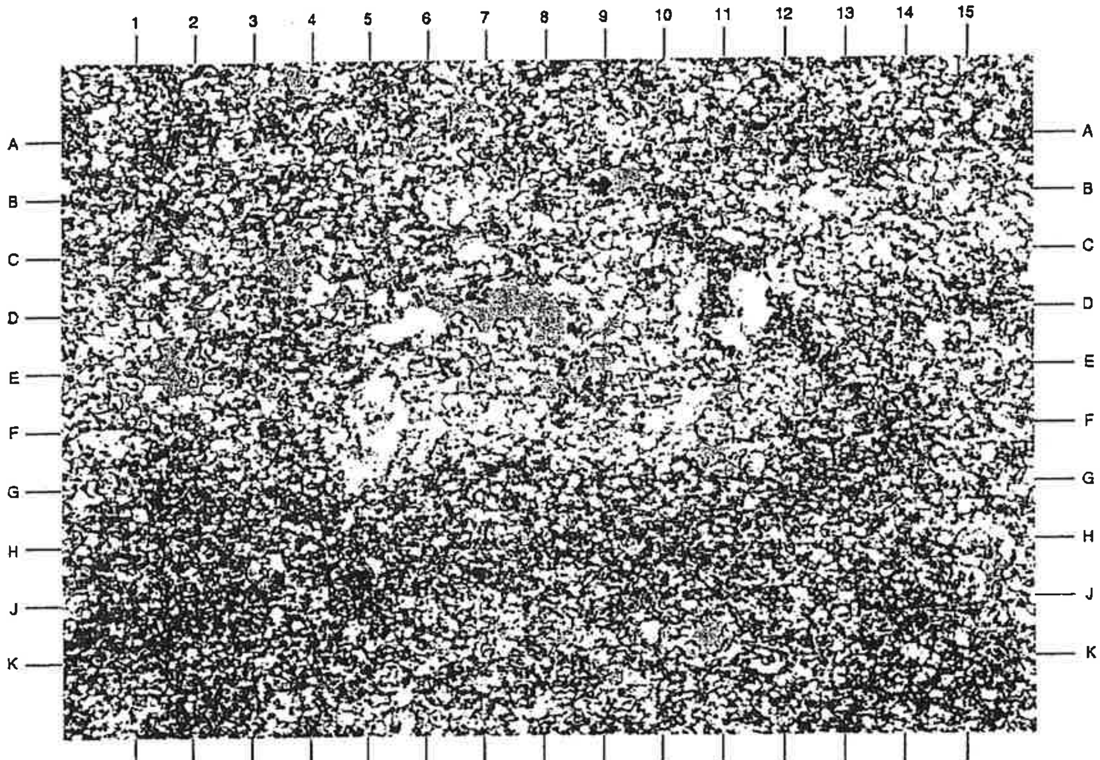
PLATE 7
Thin Section Photomicrographs
Brown Dolomite
Depth: 4740-41 feet

A

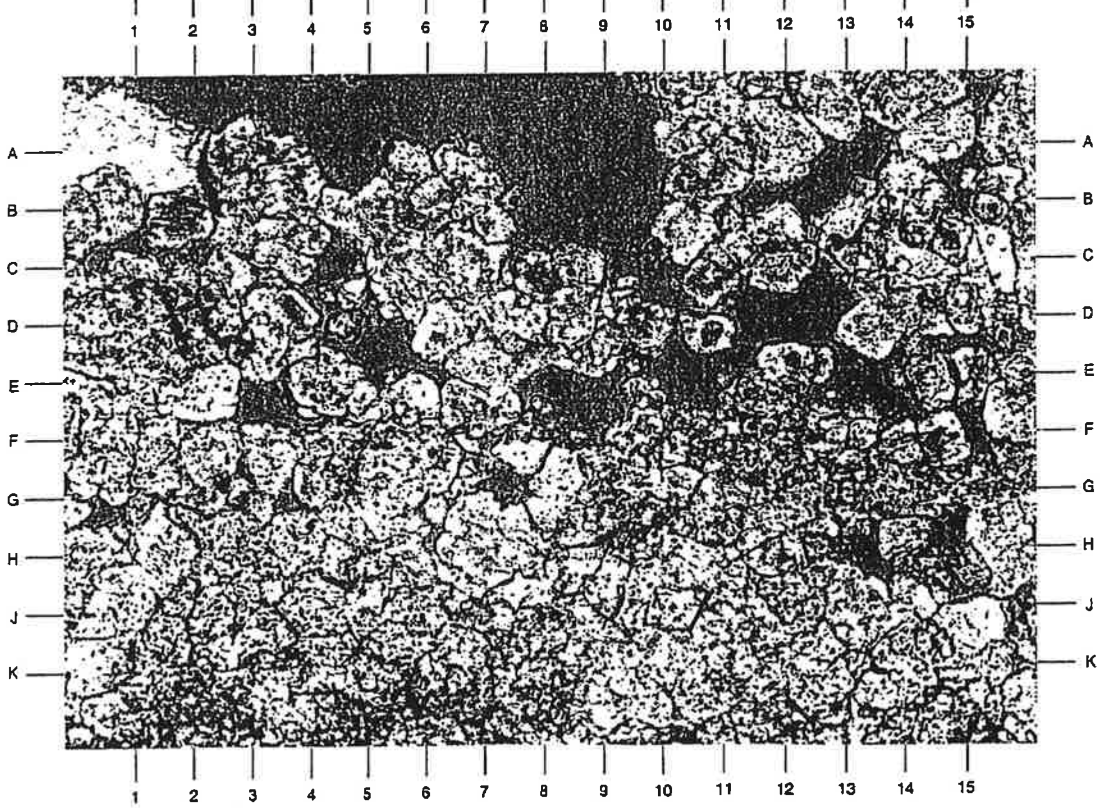
Lithology:	Dolostone
Classification:	Crinoid brachiopod peloid dolopackstone
Allochemical Grains:	Common peloids; lesser brachiopods, minor crinoids
Avg. Dolo. Crystal Size:	0.045 mm (fine crystalline)
Terrigenous Grains:	None observed
Silt/Sand Size:	Not applicable
Authigenic Minerals:	Abundant replacement dolomite; minor anhydrite; rare chert
Features/Structures:	Intracrystal dissolution pores; burrow mottled(?)
Visible Pore System:	Vuggy >> intercrystalline >> micro-intercrystalline
Core Plug Porosity:	11.7%
Core Plug Perm.:	5.65 md (k air)
Comments:	This sample is characterized by a fairly uniform sized crystalline matrix, however, intercrystalline pores (B15 and K1) are subordinate to vugs (C4, D8 and E2). Micro-intercrystalline pores are rare. Anhydrite cement is present (D11.5, D-E6 and F5) but not common. Owing to the abundance of well interconnected vugs, permeability is the second highest of all samples examined, despite porosity ranking as second lowest among all samples.
Magnification:	31X, transmitted light

B

Comments:	This photomicrograph is centered near E-F8 in Plate 7A. This view highlights a vuggy pore (A4-9) and intercrystalline pores (A13, D5, E13 and H14). The white cement at A1 is anhydrite. Dolomite crystals with dissolved centers are visible at C7.5, D10.5 and F9-14. Note the tightly interlocking crystalline matrix from J1-K15.
Magnification:	125X, transmitted light


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A B C D E F G H J K

A


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A B C D E F G H J K

B

ASARCO WDW-324
Plant Well No. 3

File: 196270

PLATE 8
SEM Photomicrographs
Brown Dolomite
Depth: 4740-41 feet

A

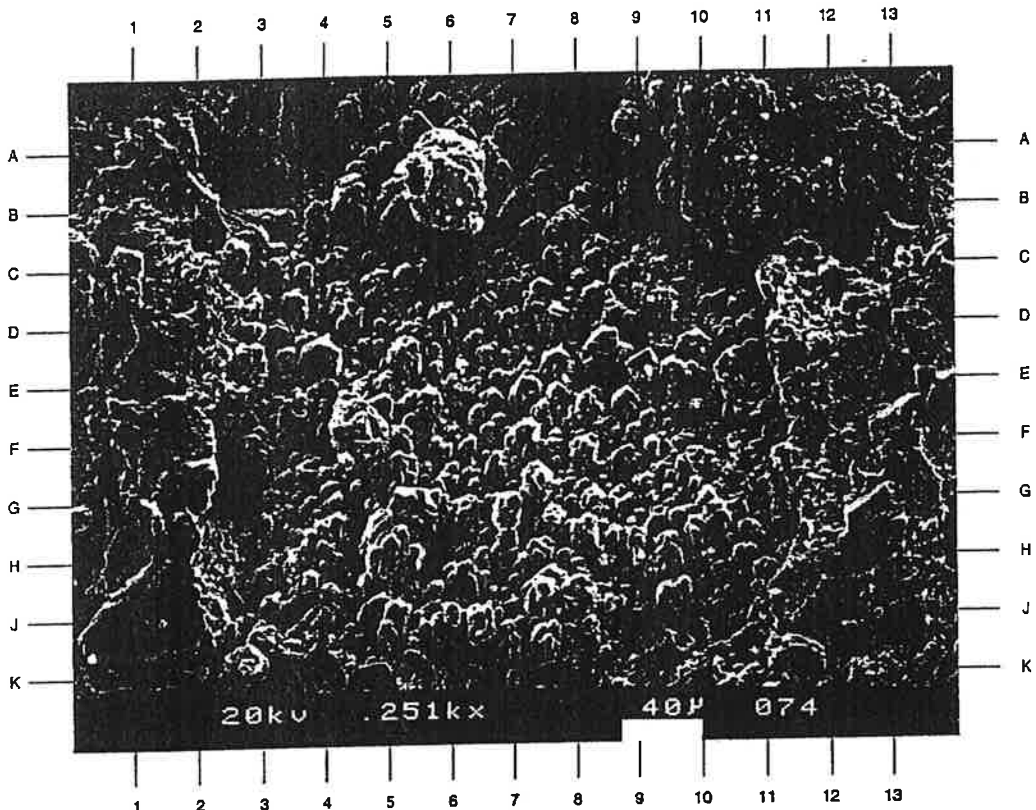
Comments: This sample is characterized by moderately well interconnected vuggy pores and minor intercrystalline pores (A4, H6 and J10). As a result, this sample exhibits the second lowest porosity of all samples examined, but the second highest permeability. Anhydrite (A3-J1) is present locally, but is largely restricted to only the bigger vugs. No detrital clay minerals are evident in this sample.

Magnification: 251X

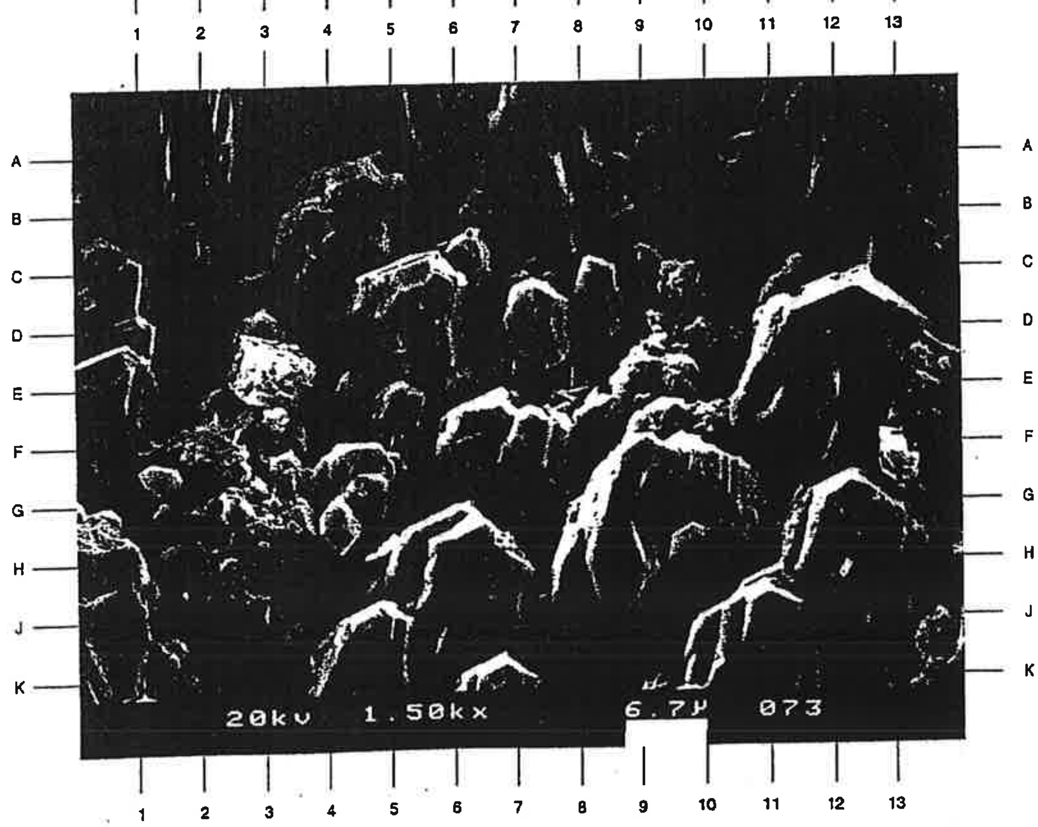
B

Comments: This high-magnification view is centered near E6.5 in Plate 8A. Multi-faceted dolomite rhombohedra are visible in this view (D5, D12, G9 and H6). Micro-intercrystalline pores are common in this very fine crystalline fabric (A-B3, C7.5, F4 and G5.5). A trace occurrence of authigenic potassium feldspar(?) is visible at D-E3. This crystal exhibits partial dissolution (E3.5) and was shown by energy dispersive analysis to be composed of K, Ca, Al, Fe, Si and S. The Ca and S are probably derived from anhydrite elsewhere in this sample.

Magnification: 1500X



A



B

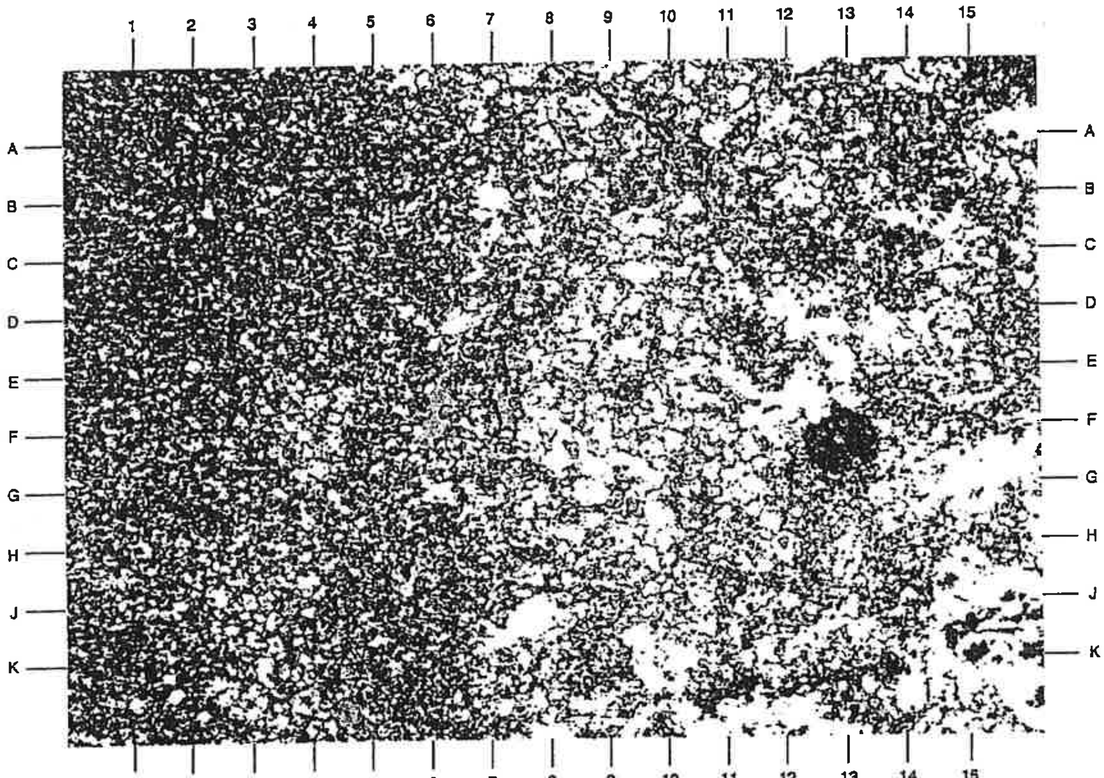
PLATE 9
Thin Section Photomicrographs
Brown Dolomite
Depth: 4745-46 feet

A

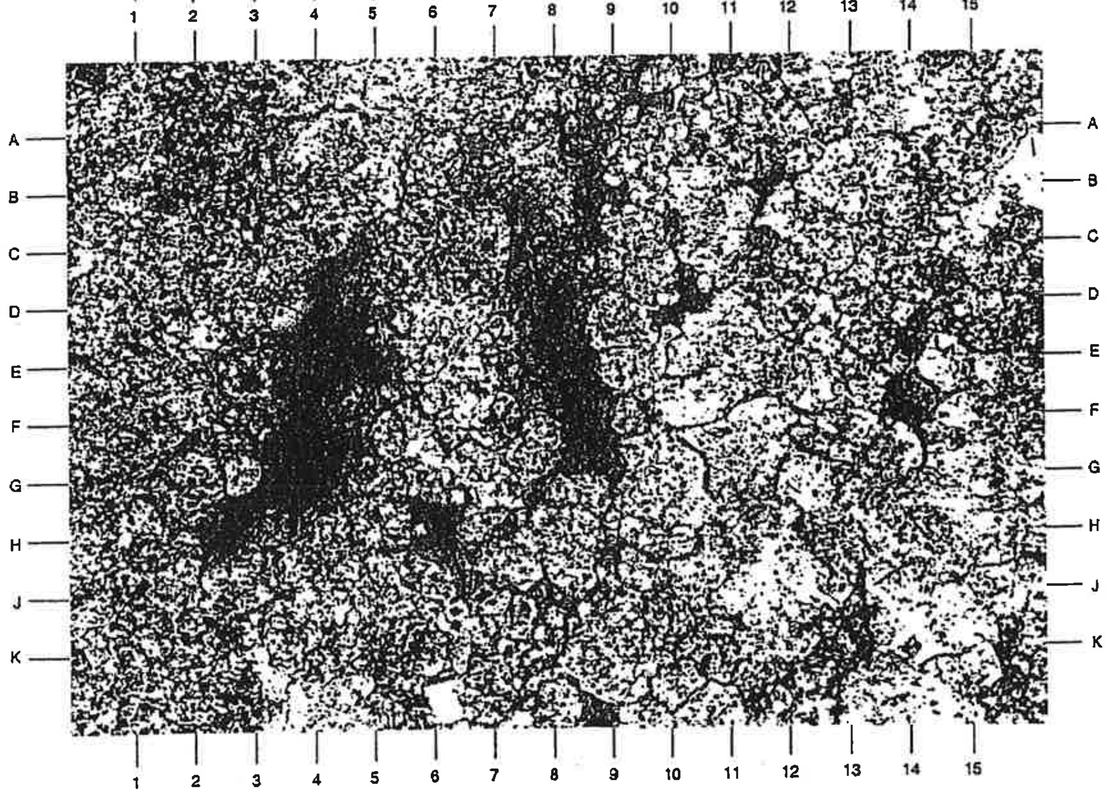
Lithology:	Dolostone
Classification:	Crinoidal dolopackstone
Allochemical Grains:	Common peloids; rare crinoids
Avg. Dolo. Crystal Size:	0.090 mm (fine crystalline)
Terrigenous Grains:	None observed
Silt/Sand Size:	Not applicable
Authigenic Minerals:	Abundant replacement dolomite; common anhydrite; minor chert/chalcedony and rare mega-quartz
Features/Structures:	Intracrystalline dissolution pores
Visible Pore System:	Intercrystalline > vuggy >> micro-intercrystalline
Core Plug Porosity:	12.6%
Core Plug Perm.:	3.94 md (k air)
Comments:	Intercrystalline pores (A-B8-10, D4.5 and G-J12) dominate the pore system in this sample. Crinoid fragments (F12.5) are present but rare, and are replaced by very fine crystalline dolomite or chert. Anhydrite cement (white, D12-13, F-G15 and J-K15) is common in this sample. Local patches of tightly interlocking dolomite crystals (A6-K1) add to fabric heterogeneity.
Magnification:	31X, transmitted light

B

Comments:	This photomicrograph is centered near F7 in Plate 9A. Vuggy and intercrystalline pores are visible (E4 and F15, respectively) in this view. The essentially nonporous, tightly interlocking crystalline fabric is evident from A1-K3. Local intracrystalline dissolution pores are visible within individual dolomite crystals (E-F3, J7.5 and K14). Anhydrite is visible as intercrystalline cement at B15.5.
Magnification:	125X, transmitted light


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A B C D E F G H J K

A


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A B C D E F G H J K

B

PLATE 10
SEM Photomicrographs
Brown Dolomite
Depth: 4746 feet

A

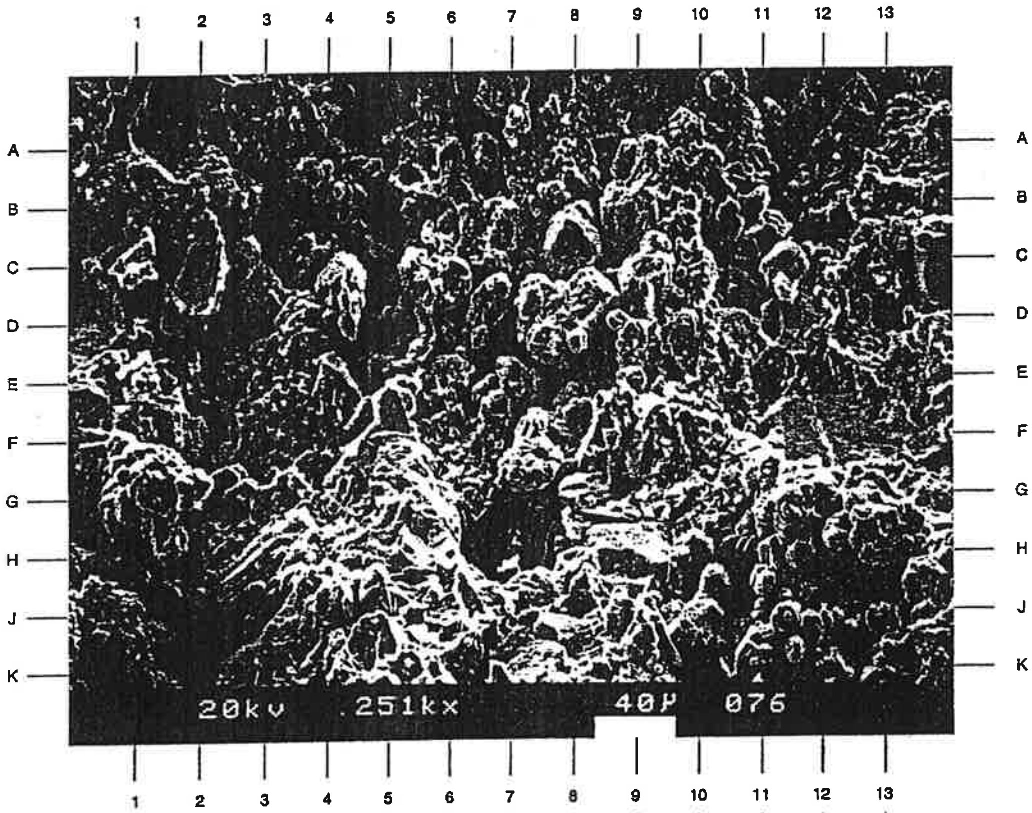
Comments: This sample is characterized by a heterogeneous dolomite fabric (very fine to upper medium crystalline). Porosity is heterogeneously distributed as well, with patches of tightly interlocked dolomite with little intercrystal porosity (E-F3 and E10-13), while elsewhere, intercrystal pores are common (B11.5, B-C5 and H-J7). Anhydrite (F5 and F12) is more common in this sample than in any of the other samples examined. No detrital clay minerals are evident in this sample.

Magnification: 251X

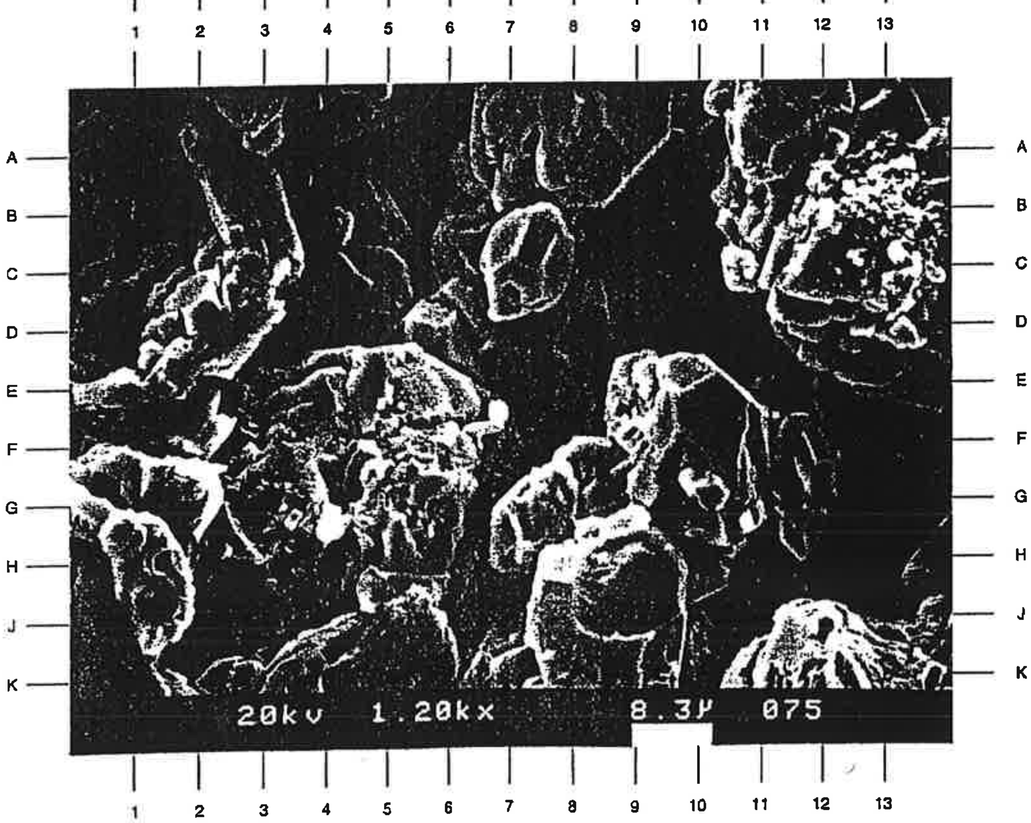
B

Comments: This high-magnification view is centered near E6.5 in Plate 10A, above. In this view, euhedral mega-quartz crystals (A8, C7 and F10) are visible filling a large intercrystalline or vuggy pore. Intracrystal dissolution(?) pores are visible at B-C7.5 and C7. Alternatively, these apparent dissolution pores may be the product of crystal growth interference resulting from competition between adjacent crystals. Intercrystalline pores are well developed locally (B5.5, D9 and H13).

Magnification: 1200X


1 2 3 4 5 6 7 8 9 10 11 12 13
A B C D E F G H J K
20kv .251kx 40µ 076

A


1 2 3 4 5 6 7 8 9 10 11 12 13
A B C D E F G H J K
20kv 1.20kx 8.3µ 075

B

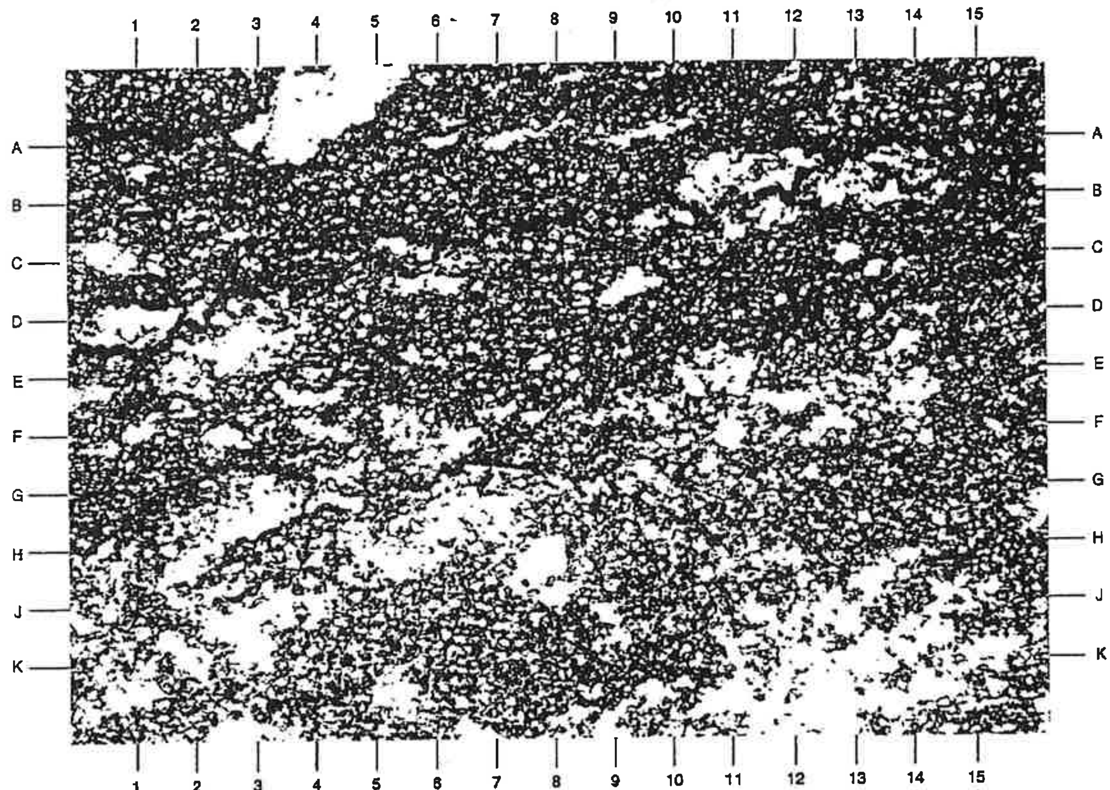
PLATE 11
Thin Section Photomicrographs
Brown Dolomite
Depth: 4747-48 feet

A

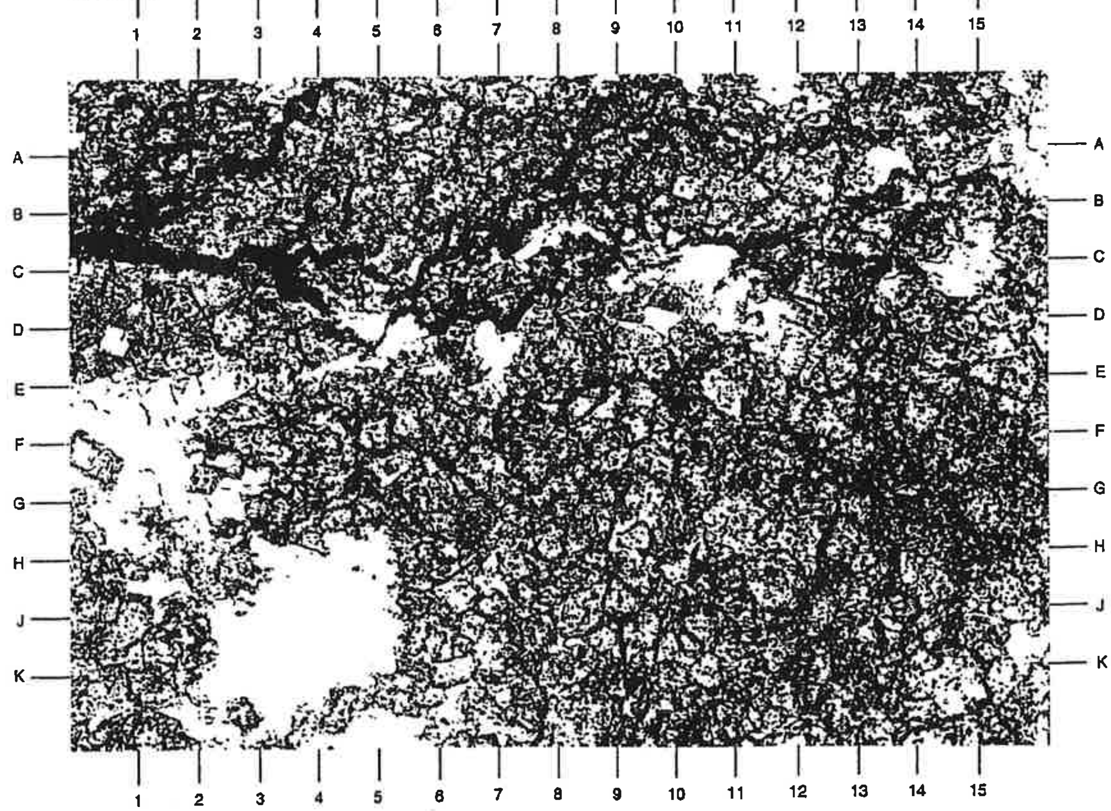
Lithology:	Dolostone
Classification:	Skeletal peloid dolopackstone
Allochemical Grains:	Common peloids; minor crinoids, rare brachiopods and calcareous algae(?)
Avg. Dolo. Crystal Size:	0.045 mm (fine crystalline)
Terrigenous Grains:	None observed
Silt/Sand Size:	Not applicable
Authigenic Minerals:	Abundant replacement dolomite; common chert/chalcedony and anhydrite, rare mega-quartz
Features/Structures:	Micro-stylolites with dead oil stain; chert nodule
Visible Pore System:	Intercrystalline >> micro-intercrystalline > vuggy
Core Plug Porosity:	15.1%
Core Plug Perm.:	3.91 md (k air)
Comments:	This sample exhibits a uniformly fine crystalline dolomite fabric, with common micro-stylolites with dead oil stain (D2-A14 and G2-D14). Anhydrite is common as replacement and pore-filling cement (A4-5, J3-G7 and K11-15). The presence of anhydrite and micro-stylolites inhibit permeability in this highly porous sample. Relic peloids are visible in the dolomite, and relic skeletal grains are visible in the chert/chalcedony nodule(?) that occupies 1/4 of the thin section sample (not shown).
Magnification:	31X, transmitted light

B

Comments:	This photomicrograph is centered near G9 in Plate 11A. Dead oil (brown) is visible along the micro-stylolites from B-C1 to A-B15. Intercrystalline pores are well developed in this sample (D1, E-F15, F5.5 and H8.5) and result in the highest porosity of all samples examined. The white patches (C10.5, F1 and J4) consist of anhydrite which is both a pore-filling and replacement cement. Relic dolomite crystals are visible in the anhydrite at E2 and G1.
Magnification:	125X, transmitted light


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A B C D E F G H J K

A


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
A B C D E F G H J K

B

ASARCO WDW-324
Plant Well No. 3

File: 196270

PLATE 12
SEM Photomicrographs
Brown Dolomite
Depth: 4747-48 feet

A

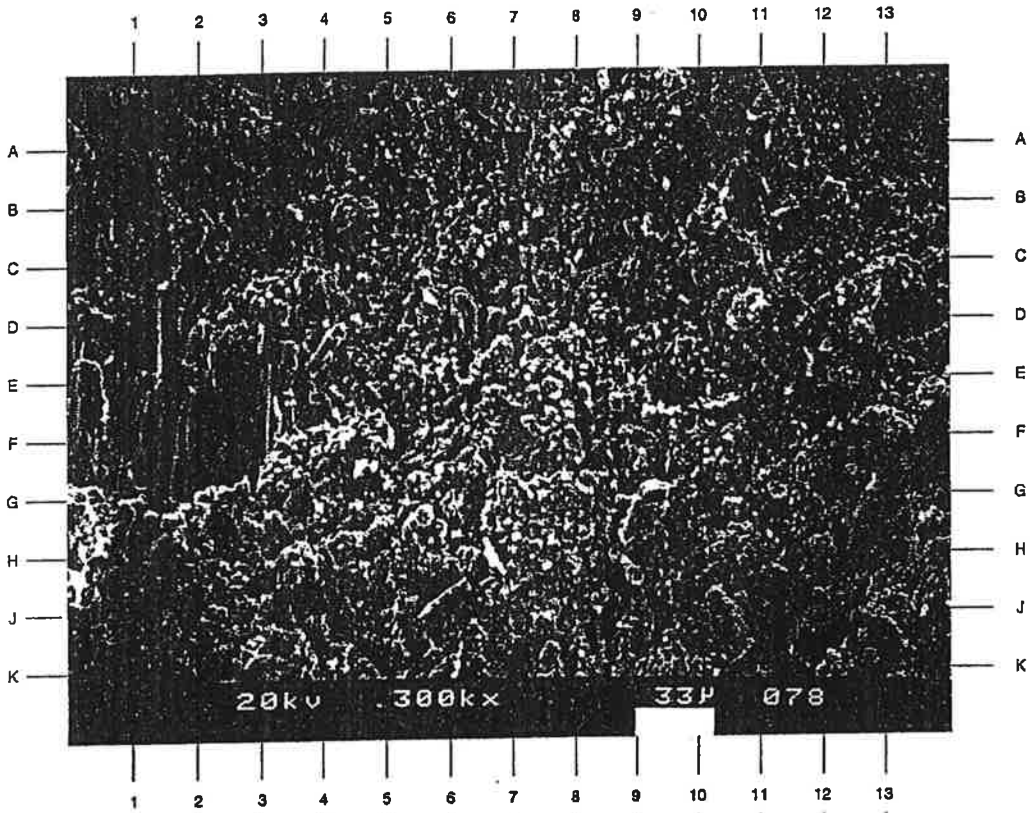
Comments: Dolomite crystal size is fine crystalline, averaging 45 microns in diameter. Large patches of pore-filling anhydrite are present throughout the sample (D1-F3). This sample is unique among all samples examined in this study in that it is characterized by a moderate amount of intracrystal dissolution micropores. As a result, total microporosity is moderately high, but permeability is moderately low.

Magnification: 300X

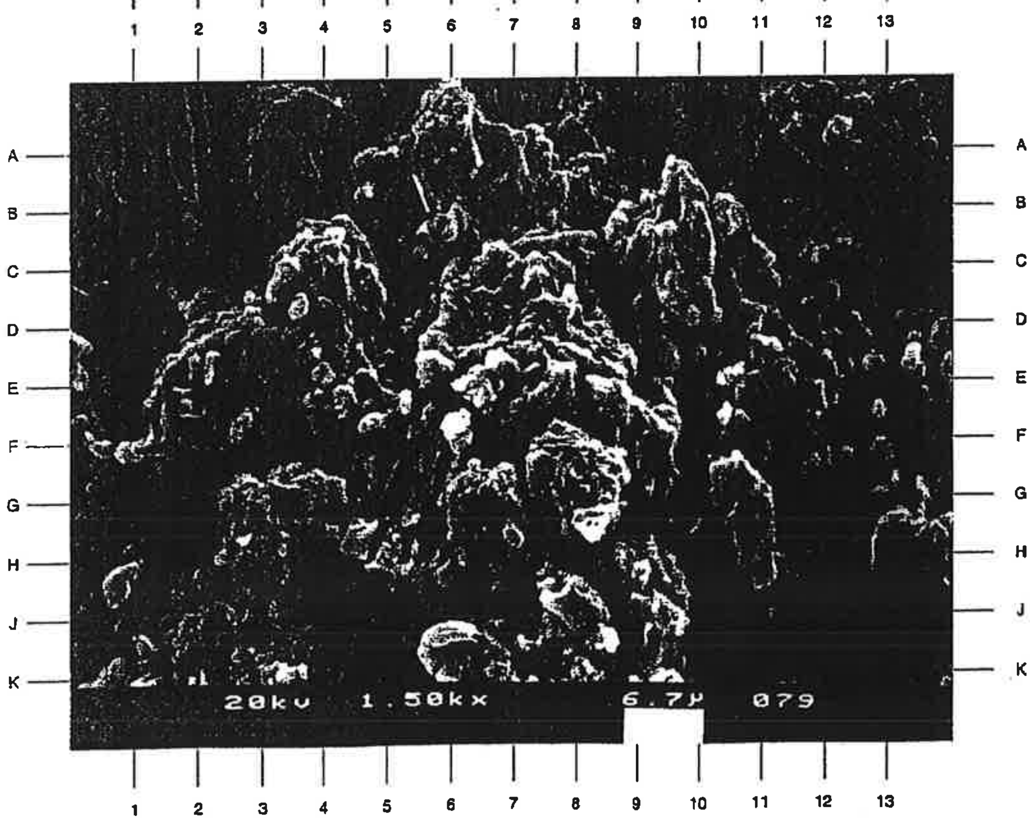
B

Comments: This high magnification view is centered near E6.5 in Plate 12A, above. Anhydrite cement is visible in this view (A1 and D7). Dolomite is visible from E4-K2. Intercrystal porosity bordering on microporosity is high in this sample. Micro-intercrystalline pores nearly fully occluded with anhydrite are visible at (D-E10, E4 and J2.5). No detrital clay minerals are evident in this sample.

Magnification: 1500X



A



B

WDW-325 Granite Wash Whole Core Analysis

CORE LABORATORIES

Company : SUBSURFACE TECHNOLOGY, INC.
Well : WDW-325

Field : PLANT-BORGER TEXAS FIELD
Formation : ARKOSIC

-File No.: 57181-18226
Date : 10-25-00

C O R E   A N A L Y S I S   R E S U L T S

SAMPLE NUMBER	DEPTH	PERMEABILITY			POROSITY (HELIUM)	SATURATION (PORE VOLUME)		GRAIN DENSITY	DESCRIPTION
		(MAXIMUM) Kair	(90 DEG) Kair	(VERTICAL) Kair		OIL	WATER		
	ft	md	md	md	%	%	%	gm/cc	
49	3835.0- 36.0	1.49	0.63	0.25	1.6	0.0	81.8	2.71	Lm, sl frac, sty, 0% flu no cut
50	3836.0- 37.0	1.91	0.93	0.11	1.8	6.8	88.4	2.71	Lm, sl frac, sty, 0% flu no cut
51	3837.0- 38.0	0.28	0.26	0.10	2.9	3.4	74.3	2.72	Lm, sl frac, 0% flu no cut
52	3838.0- 39.0	0.09	0.03	0.05	2.8	0.0	96.1	2.71	Lm, sl frac, sty, 0% flu no cut
	3839.0- 45.0								Lost core
	DRILLED INTERVAL 3845-4313								
	CORE NO. 3 4313-4340 CUT 27' REC 0'								
	4313.0- 40.0								NO RECOVERY
	CORE NO. 4 4340-4368 CUT 28' REC 20'								
53	4340.0- 41.0	1.39	0.37	0.02	10.0	0.0	95.3	2.65	Sd mot grn, crse gr, cly, lam, 0% flu no cut
54	4341.0- 42.0	2.23	2.20	1.24	12.2	0.0	96.2	2.66	Sd mot grn, crse gr, cly-mtx fill, lam, 0% flu no cut
55	4342.0- 43.0	2.80	2.11	0.38	8.3	0.0	96.7	2.66	Sd mot grn, crse peb gr, cly, lam, 0% flu no cut
56	4343.0- 44.0	2.64	2.48	1.27	8.2	0.0	96.8	2.64	Cgl mot grn, crse gr sd mtx, cly, lam, 0% flu no cut
57	4344.0- 45.0	5.79	5.67	2.91	11.9	0.0	93.1	2.67	Cgl mot grn, crse gr sd mtx, cly, lam, 0% flu no cut
58	4345.0- 46.0	13.0	13.0	6.91	15.5	0.6	88.8	2.67	Sd mot grn, crse-peb gr, cly, 0% flu no cut
59	4346.0- 47.0	0.30	0.18	0.16	9.2	0.0	99.6	2.68	Sd mot grn, f-crse-peb gr, cly, 0% flu no cut
60	4347.0- 48.0	3.51	3.51	1.53	10.1	0.0	92.6	2.66	Cgl mot grn, sd mtx, gr, cly, 0% flu no cut
61	4348.0- 49.0	0.68	0.62	0.35	10.1	0.0	98.8	2.71	Cgl mot grn, sd mtx, gr, cly, 0% flu no cut
62	4349.0- 50.0	1.95	1.30	0.17	15.9	0.0	95.0	2.67	Sd gry-grn, vf-f gr, cly, 0% flu no cut
63	4350.0- 51.0	5.57	2.58	0.03	13.0	0.0	99.4	2.67	Sd gry-grn, vf-f gr, cly, lam, 0% flu no cut
64	4351.0- 52.0	2.71	2.71	0.54	19.9	0.0	98.8	2.68	Sd gry, vf-fgr, cly, lam, 0% flu no cut
65	4352.0- 53.0	94.7	90.7	41.8	17.7	0.0	92.2	2.63	Sd tn gry, f-cse gr, cly, lam, 0% flu no cut
66	4353.0- 54.0	197.	160.	184.	20.0	0.0	92.7	2.64	Sd tn gry, f-cse gr, cly, lam, 0% flu no cut

GRANITE WASH

CORE LABORATORIES

Company : SUBSURFACE TECHNOLOGY, INC.
Well : WDW-325

Field : PLANT-BORGER TEXAS FIELD
Formation : ARKOSIC

File No.: 57181-18226
Date : 10-25-00

C O R E A N A L Y S I S R E S U L T S

	SAMPLE NUMBER	DEPTH ft	PERMEABILITY (MAXIMUM) Kair md	PERMEABILITY (90 DEG) Kair md	PERMEABILITY (VERTICAL) Kair md	POROSITY (HELIUM) %	SATURATION (PORE VOLUME) OIL %	SATURATION (PORE VOLUME) WATER %	GRAIN DENSITY gm/cc	DESCRIPTION
	67	4354.0- 55.0	67.4	56.9	47.6	9.8	0.0	90.3	2.62	Cgl mot, sd mtx, 0% flu no cut
	68	4355.0- 56.0	134.	99.5	103.	12.8	0.0	93.9	2.62	Cgl mot, sd mtx, 0% flu no cut
	69	4356.0- 57.0	243.	238.	285.	17.9	0.0	89.2	2.63	Sd gry-rd, f-crse gr, 0% flu no cut
*	70	4357.0- 58.0		137.		24.6	0.0	79.1	2.63	Sd gry-blk, crse gr, 0% flu no cut
*	71	4358.0- 59.0		0.53		2.1	0.0	54.6	2.61	Sd gry-blk, crse gr, 0% flu no cut
	72	4359.0- 60.0	2258.	1454.	746.	20.5	0.0	89.4	2.64	Sd gry-blk, crse gr, 0% flu no cut
		4360.0- 68.0								Lost core
					CORE NO. 5 4368-4397 CUT 29' REC 24'					
*	73	4368.0- 69.0		609.		22.2	0.0	83.1	2.62	Sd gry-blk, crse gr, 0% flu no cut
	74	4369.0- 70.0	39.1	13.5	5.52	9.7	0.0	92.3	2.64	Sd gry, m gr, cgl lam, 0% flu no cut
	75	4370.0- 71.0	521.	512.	417.	24.4	0.0	96.6	2.65	Sd gry, m gr, cgl lam, 0% flu no cut
	76	4371.0- 72.0	499.	481.	209.	25.4	0.0	94.9	2.66	Sd gry, m gr, cgl lam, 0% flu no cut
	77	4372.0- 73.0	144.	129.	63.7	23.1	0.0	97.4	2.71	Sd gry, m gr, cgl lam, 0% flu no cut
	78	4373.0- 74.0	5.78	3.30	0.25	10.1	0.0	97.7	2.79	Sd gry, m gr, cgl lam, 0% flu no cut
	79	4374.0- 75.0	27.2	25.9	11.1	25.3	0.0	96.7	2.66	Sd tn-gry, f gr, 0% flu no cut
	80	4375.0- 76.0	30.9	28.2	10.8	25.6	0.0	95.0	2.63	Sd tn-gry, f gr, 0% flu no cut
	81	4376.0- 77.0	10.4	9.49	3.75	19.9	0.0	85.2	2.59	Sd tn-gry, f gr, 0% flu no cut
	82	4377.0- 78.0	1014.	965.	448.	23.9	0.0	83.9	2.63	Sd pnk, crse gr, 0% flu no cut
	83	4378.0- 79.0	967.	946.	591.	24.4	0.0	88.6	2.61	Sd pnk, crse gr, 0% flu no cut
	84	4379.0- 80.0	1024.	892.	914.	25.3	0.0	89.2	2.62	Sd pnk, crse gr, 0% flu no cut
	85	4380.0- 81.0	1362.	1320.	972.	24.8	0.0	89.5	2.62	Sd pnk, crse gr, 0% flu no cut
	86	4381.0- 82.0	1954.	1954.	1517.	24.7	0.0	85.0	2.62	Sd pnk, crse gr, 0% flu no cut
	87	4382.0- 83.0	1336.	1288.	1073.	23.3	0.0	81.4	2.61	Sd pnk, crse gr, 0% flu no cut
	88	4383.0- 84.0	1488.	1430.	1122.	25.2	0.0	81.8	2.62	Sd pnk, crse gr, 0% flu no cut
	89	4384.0- 85.0	1452.	1396.	1438.	22.8	0.0	73.1	2.61	Sd pnk, crse gr, 0% flu no cut
	90	4385.0- 86.0	1262.	1113.	735.	24.1	0.0	87.3	2.61	Sd pnk, crse gr, 0% flu no cut
	91	4386.0- 87.0	1412.	1314.	866.	23.6	0.0	82.7	2.61	Sd pnk, crse gr, 0% flu no cut

CORE LABORATORIES

SUBSURFACE TECHNOLOGY, INC.
WDW-325

Field : PLANT-BORGER TEXAS FIELD
Formation : ARKOSIC

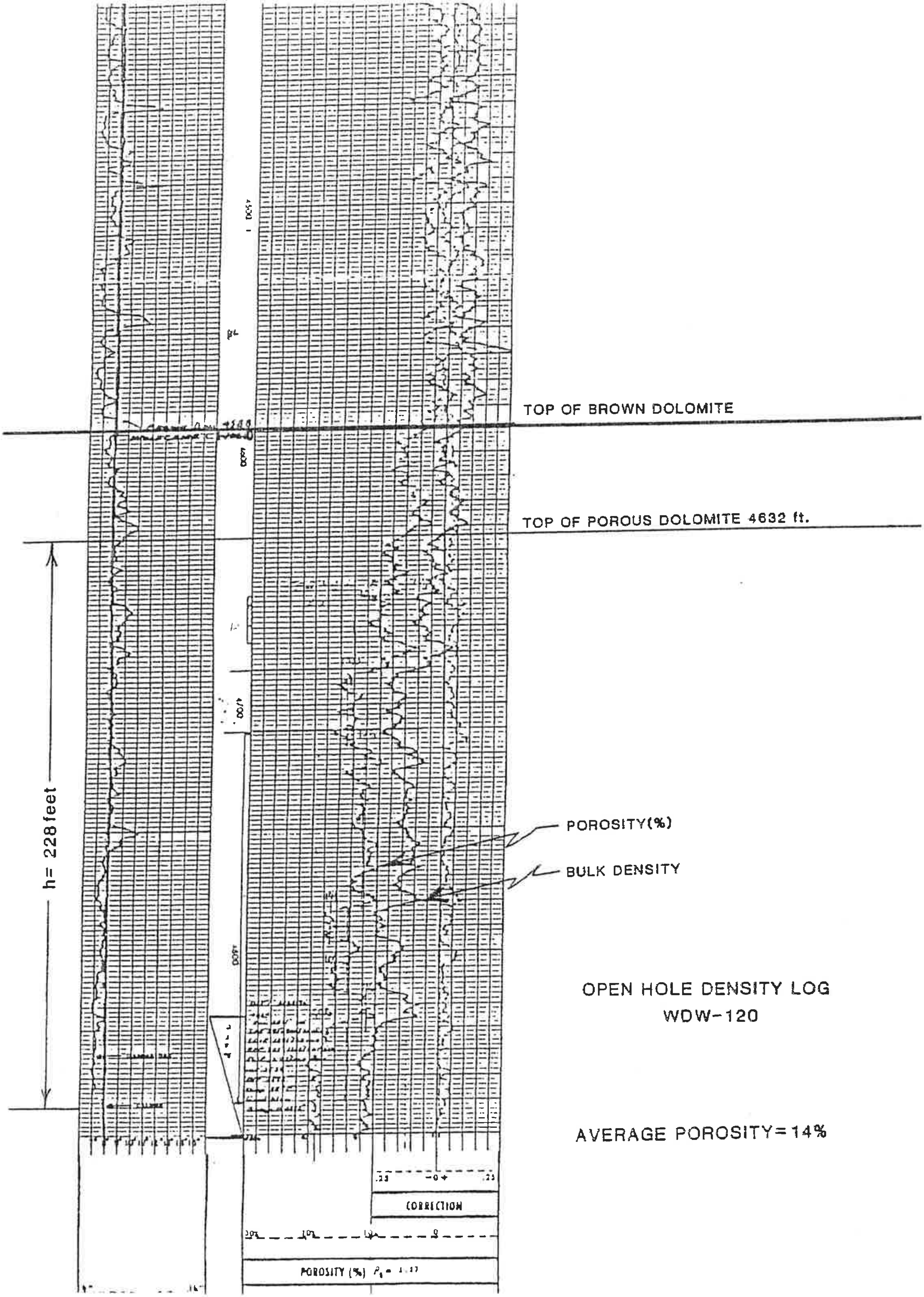
File No.: 57181-18226
Date : 10-25-00

C O R E A N A L Y S I S R E S U L T S

SAMPLE NUMBER	DEPTH	PERMEABILITY			POROSITY (HELIUM)	SATURATION		GRAIN DENSITY	DESCRIPTION
		(MAXIMUM) Kair	(90 DEG) Kair	(VERTICAL) Kair		(PORE VOLUME) OIL	WATER		
	ft	md	md	md	%	%	%	gm/cc	
92	4387.0- 88.0	2086.	2086.	755.	22.0	0.0	73.3	2.63	Sd pnk, crse gr, 0% flu no cut
93	4388.0- 89.0	1340.	1288.	998.	22.4	0.0	78.7	2.62	Sd pnk, crse gr, 0% flu no cut
94	4389.0- 90.0	1099.	1010.	826.	19.0	0.0	77.9	2.62	Sd pnk, crse gr, 0% flu no cut
95	4390.0- 91.0	851.	758.	326.	17.7	0.6	88.9	2.63	Sd pnk, crse gr, 0% flu no cut
96	4391.0- 92.0	1587.	1383.	500.	22.9	0.0	56.7	2.63	Sd pnk, crse gr, 0% flu no cut
	4392.0- 97.0								Lost core

* INDICATES PLUG ANALYSIS

WDW-120 Density Log



OPEN HOLE DENSITY LOG
WDW-120

AVERAGE POROSITY=14%

QUARTERLY WELL CORROSION TEST AT WDW-120

DATE	WGT IN GRAMS	DIFFERENCE	EXPLANATION OF DIFFERENCE	INITIALS
03/13/02	8.04	-0.07	CLEANED OFF DEPOSITS	S.M.
06/12/02	8.04	0.00	NO CHANGE	R.C.
09/11/02	8.05	0.01	MINERAL DEPOSITS	R.C.
12/11/02	8.05	0.00	NO CHANGE	R.C.
3/12/2003	8.06	0.00	MINERAL DEPOSITS	R.C.
6/11/2003	8.05	-0.01	Mineral Deposit	G.R.
9/10/2003	8.02	-0.03	CLEANED OFF DEPOSITS	R.P.
12/10/2003	8.04	0.02	Mineral Deposit	R.C.
3/11/2004	8.01	-0.03	Mineral Deposits	G.R.
6/10/2004	8.01	0.00	NO CHANGE	G.R.
9/9/2004	8.01	0.00	NO CHANGE	G.R.
12/9/2004	8.23	0.22	Mineral Deposits	R.P.
3/9/2005	8.00	-0.23	Cleaned off deposits	R.P.
6/8/2005	8.01	0.01	Cleaned off deposits	G.R.
9/7/2005	7.98	-0.03	Cleaned off deposits	G.R.
12/7/2005	8.01	0.03	Cleaned off deposits	G.R.
3/6/2006	7.95	-0.06	Cleaned off deposits	G.R.
6/6/2006	7.95	0.00	Cleaned off deposits	R.P.
910/2006	7.93	-0.02	Cleaned off deposits	G.R.
1/3/2007	7.97	0.04	Cleaned off deposits	R.C.
4/18/2007	7.94	-0.03	Cleaned off deposits	J.R.
7/1/2007	7.93	-0.01	Cleaned off deposits	R.C.
10/23/2007	7.93	0.00	NO CHANGE	R.P.
1/3/2008	7.96	0.03	Mineral Deposits	S.D.
3/27/2008	7.94	-0.02	Cleaned off deposits	S.D.
6/8/2008	8.00	0.06	Mineral Deposits	S.D.
9/22/2008	7.91	-0.09	Cleaned off deposits	S.D.
1/6/2009	7.90	-0.01	Cleaned off deposits	S.D.
3/17/2009	7.93	0.03	Mineral Deposits	TR
6/12/2009	7.91	-0.02	Cleaned off deposits	JR
9/22/2009	7.90	-0.01	Cleaned off deposits	JR
1/13/2010	7.88	-0.02	Cleaned off deposits	JR
3/25/2010	7.88	0.00	NO Change	BV
6/14/2010	7.90	0.02	mineral deposites	JR
9/7/2010	7.89	-0.01	Cleaned off deposites	JR
1/3/2011	7.89	0.00	NO Change	JR
3/10/2011	7.90	0.01	mineral deposites	JR
6/13/2011	7.89	-0.01	cleaned off deposites	JR
9/15/2011	7.89	0.00	no change	JR
1/2/2012	7.89	0.00	no change	JR

3/10/2012	7.32	0.01	New Block Installed	PK
6/13/2012	7.32	-0.01	no change	PK

9/15/2012	7.34	0.00	mineral deposits	PK
1/2/2013	7.34	0.00	no change	PK
03/13/13	7.34	0.01	no change	PK
06/12/13	7.34	0.00	no change	PK
09/11/13	7.33	-0.01	cleaned of depsoit	PK
12/11/13	7.32	-0.01	cleaned of depsoit	PK
03/13/14	7.34	-0.28	cleaned of deposits	SM
06/12/14	7.06	0.00	no change	SM
09/11/14	7.06	0.00	no change	SM
12/11/14	7.32	-0.28	cleaned of deposits	SM
3/28/2015	7.04	-0.28	cleaned deposits	SM
06/14/15	7.04	0.00	no change	SM
09/21/15	7.04	0.00	no change	SM
12/14/15	7.02	-0.02	Cleanded Deposits	SM
03/12/16	7.02	0.00	no change	SM
06/20/16	7.02	0.00	no change	SM
09/21/16	6.64	0.38	sample lost	SM
12/23/16	6.64	0.00	no change	SM
03/20/17	6.64	0.00	no change	SM
05/31/17	6.64	0.00	no change	SM
09/15/17	6.64	0.00	no change	SM
12/29/17	6.64	0.00	no change	SM
03/14/18	6.64	0.00	no change	SM
06/12/18	6.64	0.00	no change	SM
09/27/18	6.72	0.08	clean deposits	SM
12/16/18	6.64	-0.08	cleaned deposits	SM
01/07/19	6.64	0.00	no change	SM
04/05/19	6.65	0.01	did not scrub surface	SM
07/09/19	6.65	0.00	no change	SM
10/11/19	6.64	-0.01	cleaned deposits	SM
02/10/20	6.66	0.01	Did not scrub surface	AD
04/07/20	6.64	-0.02	cleaned deposits	AD
07/24/20	6.65	0.01	Did not scrub surface	AD
11/22/20	6.64	-0.01	cleaned deposits	AD
02/23/21	6.65	0.01	did not scrub surface	AD
06/30/21	6.69	0.04	did not scrub surface	AD
09/28/21	6.65	-0.04	cleaned deposits	AD
11/22/21	6.65	0.00		AD
02/15/22	6.65	0.00		AD
05/08/22	6.64	-0.01	cleaned deposits	AD
07/06/22	6.65	0.01		AD
11/15/22	6.65	0.00		AD
02/07/23	6.67	0.02	did not clean deposits	AD
05/17/23	6.69	0.02	did not clean deposits	AD
09/11/23	6.74	0.05	did not clean deposits	AD
12/06/23	6.65	-0.09	cleaned deposits	AD

AOR SEARCH PROTOCOL

SOURCES OF IDENTIFICATION OF NON-FRESHWATER ARTIFICIAL PENETRATIONS

Tyson Fresh Meats, Inc.
Amarillo, Texas

SOURCE	*TYPE OF INFORMATION ACQUIRED*
Railroad Commission of Texas (RRC)	State Repository for oil and gas well records.
Maps	Commercially prepared oil and gas base maps which show operator, well name, approximate drilling data and field name.
County Maps	Commercially prepared oil and gas base maps compiled from "scout" tickets (completion information received from individual oil companies).
Field Maps	Maps prepared by TRC personnel for commercial base maps. Data include survey name, fee name, acreage configuration of tracts of land, operator name, and well location data.
Microfiche and Microfilm Records	Records filed with the TRC prior to 1973 are on microfiche and microfilm. Some TRC districts records are filmed through 1980.
Unit Cards	Microfiche records for wells which had records filed with the TRC prior to 1962.
Well Records; Folder Rolls	Duplicate copies of unit cards which sometimes contain information that was not included in the initial filming of the unit cards.
Well Records: Run 20 to 30 and A to I	Folder rolls which encompass a period of time from 1945 to 1960 and commonly have three to five rolls for a specific year and operator number.
Well Records: Major Runs	Special set of film that contains only information on records filed by major operators.
Well Records: Old Warehouse Film	Film set which contains some of the very earliest information filed with the TRC and includes oil and gas well records filed from 1919 to 1939.
Well Records: K, L, and M Film	Film set which includes portions of oil and gas well records filed with the TRC from 1963 to March 1966.
Potential Film	Filing system currently used at the TRC which contains film records of all wells that produce oil and/or gas and were placed in a designated oil or gas field.
Wildcat and Suspense Film	The wells on this set of film differ in that they were to be drilled in wildcat fields or fields which were not producing at the time the Application to Drill was submitted to the TRC.
Well Records Files	Hard copy files of data not yet placed on microfilm.
Suspense Files	These files contain the most recent information to be filed with the Central Records Department.
Balcones Research Center University of Texas	The Balcones Research Center maintains a well sample library that contains approximately 750,000 drillers' logs from the 1920s to the early 1960s. Drillers' logs contain well location data, formation records, casing records, initial production potential, and sometimes the plugging information.
Commercial Log Libraries	Commercial libraries maintain extensive electric log collections as well as scout ticket files.
Scout Tickets	Scout tickets or "completion cards" usually include information on well name, location, drilling dates, total depth, elevation of ground surface, casing records, results of well, and completion data if the well was completed. Today, scout tickets of wells from a certain geographical area are sold by commercial companies which provide scout ticket data.

Tabulation of Water Wells Within 1 Mile of Tyson Fresh Meats, Inc. Facility

MAP ID #	STATE ID #	LEGAL DESCRIPTION	OWNER	TOTAL DEPTH (FT.)	DATE DRILLED	SCREEN DEPTH (FT.)	WATER LEVEL DEPTH (FT.)	WELL USE
06-43-901	06-43-901	A&BM Survey, Blk. 2, Sec. 4	-	-	-	-	209.7	domestic
9A	06-43-9A	A&BM Survey, Blk. 2, Sec. 4	E. Locke	288	04/24/78	244-288	200	domestic
9B	06-43-9B	A&BM Survey, Blk. 2, Sec. 3	L. Robinson	400	12/26/78	240-400	240	domestic
9(1)	06-43-9(1)	A&BM Survey, Blk. 2, Sec. 3	R. Cuttrell	358	12/30/87	258-358	250	domestic
100329	100329	A&BM Survey, Blk. 2, Sec. 3	Dee King	400	11/16/06	350-390	-	domestic
221577	221577	A&BM Survey, Blk. 2, Sec. 4	Oakwood Homes/Battis	380	04/27/10	330-350	211	domestic
234777	234777	A&BM Survey, Blk. 2, Sec. 19	Lawrence Rose	275	11/22/07	227-275	215	domestic
06-44-702	06-44-702	A&BM Survey, Blk. 2, Sec. 4	George Rafe	-	-	-	-	domestic
06-51-302	06-51-302	A&BM Survey, Blk. 2, Sec. 27	-	190	-	-	173.5	Monitor
06-51-303	06-51-303	A&BM Survey, Blk. 2, Sec. 27	-	190	-	-	-	Monitor
06-51-304	06-51-304	A&BM Survey, Blk. 2, Sec. 27	-	185	-	-	180	Monitor
06-51-306	06-51-306	A&BM Survey, Blk. 2, Sec. 27	-	200	-	-	-	Monitor
3A	06-51-3A	A&BM Survey, Blk. 2, Sec. 18	T. Garrison	280	07/25/80	180-270	-	domestic
3(8)	06-51-3(8)	A&BM Survey, Blk. 2, Sec. 18	Leonard	318	04/09/90	218-318	200	domestic
3(9)	06-51-3(9)	A&BM Survey, Blk. 2, Sec. 18	R. Dugan	325	02/27/86	240-305	215	domestic
3(10)	06-51-3(10)	A&BM Survey, Blk. 2, Sec. 18	B. Barton	325	11/14/85	220-300	216	domestic
138336	138336	A&BM Survey, Blk. 2, Sec. 18	Corhy Cambell	310	09/13/04	250-310	240	domestic
176089	176089	A&BM Survey, Blk. 2, Sec. 5	Chris Gable	305	01/12/09	240-300	229	domestic
1	496121	A&BM Survey, Blk. 2, Sec. 3	Dee King	325	11/14/2018	260-320	240	domestic
2	321221	A&BM Survey, Blk. 2, Sec. 3	Judy Deshong	425	5/22/2013	275-335, 375-41	240	domestic
3	609670	A&BM Survey, Blk. 2, Sec. 4	Greg Wyatt	330	6/22/2022	280-320	-	domestic
4	653595	A&BM Survey, Blk. 2, Sec. 4	Greg Wyatt	315	11/1/2023	265-305	225	domestic
5	660504	A&BM Survey, Blk. 2, Sec. 4	Amarillo Home Center	278	1/26/2024	233-273	-	domestic
6	660501	A&BM Survey, Blk. 2, Sec. 4	Amarillo Home Center	300	1/24/2024	255-295	-	domestic
7	660503	A&BM Survey, Blk. 2, Sec. 4	Amarillo Home Center	300	1/25/2024	255-295	-	domestic

Tabulation of Water Wells Within 1 Mile of Tyson Fresh Meats, Inc. Facility (Continued)

MAP ID #	STATE ID #	LEGAL DESCRIPTION	OWNER	TOTAL DEPTH (FT.)	DATE DRILLED	SCREEN DEPTH (FT.)	WATER LEVEL DEPTH (FT.)	WELL USE
8	651546	A&BM Survey, Blk. 2, Sec. 4	Amarillo Home Center	285	9/15/2023	240-280	218	domestic
9	442000	A&BM Survey, Blk. 2, Sec. 19	Raul Vega	280	01/02/17	260-280	240	domestic
10	654526	A&BM Survey, Blk. 2, Sec. 19	Raul Vega	283	10/21/23	238-278	220	domestic
11	334077	A&BM Survey, Blk. 2, Sec. 18	Sam Coffer	280	08/30/06	260-280	180	domestic
12	479132	A&BM Survey, Blk. 2, Sec. 5	Sergio Mendoza	330	05/10/18	260-320	210	domestic

Map ID #1

STATE OF TEXAS WELL REPORT for Tracking #496121

Owner:	**Dee King**	Owner Well #:	**No Data**
Address:	**17601 St Francis** **Amarillo, TX 79108**	Grid #:	**06-43-9**
		Latitude:	**35° 16' 31.51" N**
Well Location:	**St. Francis & Nehbut Rd** **Amarillo, TX 79108**	Longitude:	**101° 37' 55" W**
Well County:	**Potter**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **11/14/2018** Drilling End Date: **11/14/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
9	0	325

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
22	325	Gravel	

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
2	22	Cement 5 Bags/Sacks

Seal Method: **Positive Displacement**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Pitless Adapter Used** **Surface Completion by Driller**

Water Level: **240 ft.** below land surface on **2018-11-14**

Packers: **No Data**

Type of Pump: **Submersible**

Well Tests: **Pump** **Yield: 17 GPM with 0 ft. drawdown after 1 hours**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **K-Ran Drilling, LLC**

PO Box 32383
Amarillo, TX 79120

Driller Name: **Andrew Bay Wilson** License Number: **50676**

Apprentice Name: **Jorge Gonzales-Resendiz**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**top soil**
5	**9**	**caliche**
9	**75**	**brown sandy clay**
75	**182**	**light brown loose sand with s/s**
182	**255**	**coarse sand with big and small gravel**
255	**261**	**gravel (big)**
261	**272**	**red clay**
272	**315**	**red clay with fine brown sand**
315	**325**	**red and green clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	**Blank**	**New Plastic (PVC)**	**200**	**0**	**260**
5	**Perforated or Slotted**	**New Plastic (PVC)**	**200**	**260**	**320**
5	**Blank**	**New Plastic (PVC)**	**200**	**320**	**325**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Map ID #2

STATE OF TEXAS WELL REPORT for Tracking #321221

Owner:	**Judy Deshong**	Owner Well #:	**No Data**
Address:	**7614 Catskin Amarillo, TX 79121**	Grid #:	**06-43-9**
Well Location:	**17801 St Francis Amarillo, TX**	Latitude:	**35° 15' 58" N**
		Longitude:	**101° 37' 48" W**
Well County:	**Potter**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **5/22/2013** Drilling End Date: **5/22/2013**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
9	**0**	**425**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
22	**425**	**Gravel**	**8/16**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
2	**22**	**5 cement**

Seal Method: **Unknown**

Sealed By: **Mark**

Distance to Property Line (ft.): **50+**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **measured**

Surface Completion: **Pitless Adapter Used**

Water Level: **240 ft.** below land surface on **2013-05-22** Measurement Method: **Unknown**

Packers: **No Data**

Type of Pump: **Submersible**

Well Tests: **Unknown** **Yield: 4-5 GPM with 170 ft. drawdown after 1 hours**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **K-Ran Drilling**

5230 Hester
Amarillo, TX 79124

Driller Name: **Mark Randall** License Number: **2848**

Apprentice Name: **Lupe Limas** Apprentice Number: **57597**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**4**	**top soil**
4	**9**	**caliche**
9	**41**	**reddish sandy clay**
41	**68**	**light brown sandy clay**
68	**145**	**brown and light brown sand & s/s**
145	**197**	**coarse sand & gravel**
197	**216**	**red clay**
216	**229**	**light brown fine sand**
229	**245**	**red & yellow clay**
245	**257**	**red clay**
257	**271**	**white clay with light brown fine sand**
271	**294**	**red clay with limestone strks**
294	**301**	**white clay with light brown fine sand**
301	**315**	**red light green & yellow clay**
315	**362**	**pink clay**
362	**384**	**red & white clay with light brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.) New/Used Type Setting From/To (ft.)
5 new pvc 0-275 200 cl
5 new pvc 335-375 200 cl
5 new perf .035 275-335 200 cl
5 new perf .035 375-415 200 cl
10 blank on bottom

384	**399**	**red & purple clay with brown s/s**
399	**411**	**red clay & brown sandstone strks**
411	**425**	**red sticky clay**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Map ID #3

STATE OF TEXAS WELL REPORT for Tracking #609670

Owner:	**GREG WYATT**	Owner Well #:	**No Data**
Address:	**561 COUNTY RD A PANHANDLE, TX 79068**	Grid #:	**06-44-7**
Well Location:	**561 COUNTY RD A PANHANDLE, TX 79068**	Latitude:	**35° 15' 29.11" N**
		Longitude:	**101° 37' 06.79" W**
Well County:	**Carson**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **6/21/2022** Drilling End Date: **6/22/2022**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
9	**0**	**330**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
20	**330**	**Gravel**	**8/16**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
3	**22**	**Cement 7 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Pitless Adapter Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

The driller did certify that while drilling, deepening or otherwise altering the above described well, injurious water or constituents was encountered and the landowner or person having the well drilled was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Currie Drilling Co. Inc.**

3001 N. 23rd St.
Canyon, TX 79015

Driller Name: **SHANE CURRIE** License Number: **54499**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**TOPSOIL**
5	**15**	**CALICHE**
15	**105**	**SANDY CLAY & SAND STONE**
105	**160**	**SAND & SAND STONE**
160	**240**	**SAND & STREAKS OF GRAVEL**
240	**285**	**SANDY CLAY & SAND STONE**
285	**315**	**WHITE CLAY & STREAKS OF SAND**
315	**320**	**RED SANDY CLAY**
320	**330**	**RED CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	**Blank**	**New Steel**		**-2**	**3**
5	**Blank**	**New Plastic (PVC)**		**3**	**280**
5	**Perforated or Slotted**	**New Plastic (PVC)**	**0.035**	**280**	**320**
5	**Blank**	**New Plastic (PVC)**		**320**	**330**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Map ID #4

STATE OF TEXAS WELL REPORT for Tracking #653595

Owner:	**GREG WYATT**	Owner Well #:	**No Data**
Address:	**3418 LEWIS LANE** **AMARILLO, TX 79107**	Grid #:	**06-43-9**
Well Location:	**SAME AS COORDINATES** **AMARILLO, TX**	Latitude:	**35° 15' 16.88" N**
	SAME AS COORDINATES	Longitude:	**101° 38' 07" W**
Well County:	**Potter**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **10/30/2023** Drilling End Date: **11/1/2023**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
9	**0**	**315**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
22	**315**	**Gravel**	**8/16**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
2	**22**	**Cement 8 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **> 50**

Distance to Septic Field or other concentrated contamination (ft.): **> 100**

Distance to Septic Tank (ft.): **> 50**

Method of Verification: **MEASURED**

Surface Completion: **Pitless Adapter Used** **Surface Completion by Driller**

Water Level: **225 ft.** below land surface on **2023-11-01** Measurement Method: **Unknown**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Currie Drilling Co., Inc.**

3001 N. 23rd St.
Canyon, TX 79015

Driller Name: **SHANE CURRIE** License Number: **54499**

Apprentice Name: **ISAAC DELUNA** Apprentice Number: **61028**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**TOPSOIL**
5	**30**	**CALICHE, CLAY**
30	**160**	**SAND, SANDSTONE**
160	**200**	**SAND, STREAKS OF GRAVEL**
200	**215**	**SANDY CLAY**
215	**280**	**SAND, SANDSTONE**
280	**305**	**SAND, STREAKS OF CLAY**
305	**315**	**RED CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	**Blank**	**New Steel**		**-2**	**3**
5	**Blank**	**New Plastic (PVC)**		**3**	**265**
5	**Perforated or Slotted**	**New Plastic (PVC)**	**0.035**	**265**	**305**
5	**Blank**	**New Plastic (PVC)**		**305**	**315**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Map ID #5

STATE OF TEXAS WELL REPORT for Tracking #660504

Owner:	**Amarillo Home Center**	Owner Well #:	**No Data**
Address:	**4634 E Amarillo Blvd Amarillo, TX 79107**	Grid #:	**06-43-9**
Well Location:	**11.6 mi NE of Amarillo S of Highway 60 Amarillo, TX 79108**	Latitude:	**35° 15' 13.26" N**
		Longitude:	**101° 37' 56.55" W**
Well County:	**Potter**	Elevation:	**3523 ft. above sea level**

Type of Work: **New Well**   Proposed Use: **Domestic**

Drilling Start Date: **1/26/2024**   Drilling End Date: **1/26/2024**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
9	**0**	**278**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**278**	**Gravel**	**#1 Fines**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
3	**23**	**Cement 5 Bags/Sacks**

Seal Method: **Hand Mixed**

Sealed By: **Driller**

Distance to Property Line (ft.): **98**

Distance to Septic Field or other concentrated contamination (ft.): **NA**

Distance to Septic Tank (ft.): **NA**

Method of Verification: **Tape**

Surface Completion: **Pitless Adapter Used**   **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

	Strata Depth (ft.)	Water Type
Water Quality:	**No Data**	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

The driller did certify that while drilling, deepening or otherwise altering the above described well, injurious water or constituents was encountered and the landowner or person having the well drilled was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Howell Drilling Services, LLC**

19001 W DOWLEN RD
HAPPY, TX 79042

Driller Name: **Ethan Howell** License Number: **60872**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**3**	**Topsoil**
3	**40**	**Caliche**
40	**124**	**Sand & SS w/ Clay Strips**
124	**150**	**Green Sand & SS w/ Small Gravel Strips**
150	**195**	**Red Clay & Shale**
195	**273**	**Sand & SS**
273	**278**	**Red Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
5	**Blank**	**New Steel**		**-2**	**3**
5	**Blank**	**New Plastic (PVC)**		**3**	**233**
5	**Perforated or Slotted**	**New Plastic (PVC)**		**233**	**273**
5	**Blank**	**New Plastic (PVC)**		**273**	**278**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Map ID #6

STATE OF TEXAS WELL REPORT for Tracking #660501

Owner:	**Amarillo Home Center**	Owner Well #:	**No Data**
Address:	**4634 E Amarillo Blvd Amarillo, TX 79107**	Grid #:	**06-43-9**
Well Location:	**11.5 mi NE of Amarillo S of Highway 60 Amarillo, TX 79108**	Latitude:	**35° 15' 10.72" N**
		Longitude:	**101° 38' 08.35" W**
Well County:	**Potter**	Elevation:	**3531 ft. above sea level**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **1/24/2024** Drilling End Date: **1/24/2024**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
9	**0**	**300**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**300**	**Gravel**	**#1 Fines**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
3	**23**	**Cement 4 Bags/Sacks**

Seal Method: **Hand Mixed**

Sealed By: **Driller**

Distance to Property Line (ft.): **100**

Distance to Septic Field or other concentrated contamination (ft.): **NA**

Distance to Septic Tank (ft.): **NA**

Method of Verification: **Tape**

Surface Completion: **Pitless Adapter Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

The driller did certify that while drilling, deepening or otherwise altering the above described well, injurious water or constituents was encountered and the landowner or person having the well drilled was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Howell Drilling Services, LLC**

19001 W DOWLEN RD
HAPPY, TX 79042

Driller Name: **Ethan Howell** License Number: **60872**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**3**	**Topsoil**
3	**40**	**Caliche**
40	**60**	**Sand & SS**
60	**124**	**Tan Sand w/ Clay Strips**
124	**150**	**Green Sand & SS w/ Small Gravel Strips**
150	**195**	**Red Clay & Shale**
195	**285**	**Sand & SS**
285	**295**	**Red Sandy Clay**
295	**300**	**Red Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	**Blank**	**New Steel**		**-2**	**3**
5	**Blank**	**New Plastic (PVC)**		**3**	**255**
5	**Perforated or Slotted**	**New Plastic (PVC)**		**255**	**295**
5	**Blank**	**New Plastic (PVC)**		**295**	**300**

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Map ID #7

STATE OF TEXAS WELL REPORT for Tracking #660503

Owner:	**Amarillo Home Center**	Owner Well #:	**No Data**
Address:	**4634 E Amarillo Blvd Amarillo, TX 79107**	Grid #:	**06-43-9**
Well Location:	**11.5 mi NE of Amarillo S of Highway 60 Amarillo, TX 79108**	Latitude:	**35° 15' 08.4" N**
		Longitude:	**101° 38' 08.28" W**
Well County:	**Potter**	Elevation:	**3529 ft. above sea level**

Type of Work: **New Well**

Proposed Use: **Domestic**

Drilling Start Date: **1/25/2024** Drilling End Date: **1/25/2024**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
9	**0**	**300**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
3	**23**	**Gravel**	**#1 Fines**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
3	**23**	**Cement 5 Bags/Sacks**

Seal Method: **Hand Mixed**

Sealed By: **Driller**

Distance to Property Line (ft.): **84**

Distance to Septic Field or other concentrated contamination (ft.): **NA**

Distance to Septic Tank (ft.): **NA**

Method of Verification: **Tape**

Surface Completion: **Pitless Adapter Used**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

The driller did certify that while drilling, deepening or otherwise altering the above described well, injurious water or constituents was encountered and the landowner or person having the well drilled was informed that such well must be completed or plugged in such a manner as to avoid injury or pollution.

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Howell Drilling Services, LLC**

19001 W DOWLEN RD
HAPPY, TX 79042

Driller Name: **Ethan Howell** License Number: **60872**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	3	Topsoil
3	40	Caliche
40	60	Sand & SS
60	124	Tan Sand w/ Clay Strips
124	150	Green Sand & SS w/ Small Gravel Strips
150	195	Red Clay & Shale
195	285	Sand & SS
285	295	Red Sandy Clay
295	300	Red Clay

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	Blank	New Steel		-2	3
5	Blank	New Plastic (PVC)		3	255
5	Perforated or Slotted	New Plastic (PVC)		255	295
5	Blank	New Plastic (PVC)		295	300

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Map ID #8

STATE OF TEXAS WELL REPORT for Tracking #651546

Owner:	**AMARILLO HOME CENTER**	Owner Well #:	**No Data**
Address:	**4634 E AMARILLO BLVD** **AMARILLO, TX 79107**	Grid #:	**06-43-9**
Well Location:	**4300 RAEF ROAD** **AMARILLO, TX**	Latitude:	**35° 15' 06" N**
		Longitude:	**101° 38' 08" W**
Well County:	**Potter**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **9/15/2023** Drilling End Date: **9/15/2023**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
9	0	285

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
23	285	Gravel	#1 FINE

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	3	NATURAL FILL
3	23	Cement 7 Bags/Sacks

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **50**

Distance to Septic Field or other concentrated contamination (ft.): **100**

Distance to Septic Tank (ft.): **50**

Method of Verification: **TAPE MEASURE**

Surface Completion: **Pitless Adapter Used** **Surface Completion by Driller**

Water Level: **218 ft.** below land surface on **2023-09-15** Measurement Method: **Electric Line**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **Bailer** **Yield: 10 GPM with 0 ft. drawdown after 1 hours**

Water Quality:

Strata Depth (ft.)	Water Type
218 - 285	**GOOD**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **4-M Drilling**

Po Bx 701
Claude, TX 79019

Driller Name: **JOE MORROW** License Number: **54360**

Apprentice Name: **DILLON MORROW** Apprentice Number: **59130**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**3**	**TOPSOIL**
3	**40**	**CALICHE**
40	**60**	**SAND AND SS**
60	**120**	**SAND WITH TAN CLAY STRIPS**
120	**150**	**GREEN SAND AND SS WITH GRAVEL STRIPS**
150	**190**	**RED CLAY AND SHALE**
190	**200**	**SAND WITH RED CLAY STRIPS**
200	**240**	**SAND WITH GRAVEL STRIPS**
240	**280**	**SAND**
280	**285**	**YELLOW AND RED CLAY STRIPS IN SAND**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	**Blank**	**New Steel**	**SCH40**	**2**	**3**
5	**Blank**	**New Plastic (PVC)**	**SDR21**	**3**	**240**
5	**Perforated or Slotted**	**New Plastic (PVC)**	**SDR21 0.035**	**240**	**280**
5	**Blank**	**New Plastic (PVC)**	**SDR21**	**280**	**285**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Map ID #9

STATE OF TEXAS WELL REPORT for Tracking #442000

Owner:	**RAUL VEGA**	Owner Well #:	**No Data**
Address:	**210 FAIRWAY DRIVE** **BORGER, TX 79007**	Grid #:	**06-43-9**
Well Location:	**17137 E US HWY 66** **AMARILLO, TX** **17137 E US HWY**	Latitude:	**35° 15' 09.22" N**
		Longitude:	**101° 38' 13" W**
		Elevation:	**No Data**
Well County:	**Potter**		

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **1/2/2017** Drilling End Date: **1/2/2017**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
10	**0**	**280**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**280**	**Gravel**	**8/16**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**23**	**Concrete 5 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Pitless Adapter Used** **Surface Completion by Driller**

Water Level: **240 ft.** below land surface on **2017-01-03** Measurement Method: **Steel Tape**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **Pump** **Yield: 10 GPM with 0 ft. drawdown after 1 hours**

	Strata Depth (ft.)	Water Type
Water Quality:	**240 - 280**	**GOOD**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **4-M Drilling**

Po Bx 701
Claude, TX 79019

Driller Name: **JOE MORROW** License Number: **54360**

Apprentice Name: **DILLON MORROW** Apprentice Number: **59130**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**40**	**CALICHE AND TAN CLAY**
4	**60**	**ORANGE CLAY AND ROCK**
60	**100**	**SAND**
100	**120**	**LIGHT BROWN CLAY**
120	**140**	**SAND**
140	**160**	**GRAY AND LIGHT BROWN CLAY WITH SS STRIPS**
160	**180**	**RED CLAY WITH LIGHT BROWN SHALE**
180	**280**	**SAND**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dla (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	**Blank**	**New Galvanized Steel**	**SCH 80**	**2**	**3**
5	**Blank**	**New Plastic (PVC)**	**SDR 21**	**3**	**260**
5	**Perforated or Slotted**	**New Plastic (PVC)**	**SDR 21 0.035**	**260**	**280**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Map ID #10

STATE OF TEXAS WELL REPORT for Tracking #654526

Owner:	**RAUL VEGA**	Owner Well #:	**No Data**
Address:	**17137 RAEF ROAD AMARILLO , TX 79108**	Grid #:	**06-43-9**
Well Location:	**17137 RAEF ROAD AMARILLO, TX 79108**	Latitude:	**35° 15' 01" N**
		Longitude:	**101° 38' 15" W**
Well County:	**Potter**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **10/21/2023** Drilling End Date: **10/21/2023**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
9	**0**	**283**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**283**	**Gravel**	**#1 FINE**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**3**	**NATURAL FILL**
3	**23**	**Cement 7 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **50**

Distance to Septic Field or other concentrated contamination (ft.): **100**

Distance to Septic Tank (ft.): **50**

Method of Verification: **TAPE MEASURE**

Surface Completion: **Pitless Adapter Used** **Surface Completion by Driller**

Water Level: **220 ft.** below land surface on **2023-10-21** Measurement Method: **Electric Line**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **Bailer** **Yield: 10 GPM with 1 ft. drawdown after 1 hours**

Water Quality:

Strata Depth (ft.)	Water Type
220 - 283	**GOOD**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **4-M Drilling**

Po Bx 701
Claude, TX 79019

Driller Name: **JOE MORROW** License Number: **54360**

Apprentice Name: **DILLON MORROW** Apprentice Number: **59130**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**3**	**TOPSOIL**
3	**40**	**CALICHE**
40	**60**	**SAND AND SS**
60	**120**	**SAND WITH TAN SANDY CLAY STTRIPS**
120	**140**	**LOOSE SAND**
140	**160**	**SAND WITH RED CLAY STRIPS**
160	**180**	**YELLOW SHALE WITH SAND STRIPS**
180	**200**	**SAND WITH RED AND GRAY CLAY STRIPS**
200	**245**	**SAND**
245	**280**	**RED AND BLUE CLAY STRIPS IN SAND AND SS**
280	**283**	**RED CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	**Blank**	**New Steel**	**SCH40**	**2**	**3**
5	**Blank**	**New Plastic (PVC)**	**SDR21**	**3**	**238**
5	**Perforated or Slotted**	**New Plastic (PVC)**	**SDR21 0.035**	**238**	**278**
5	**Blank**	**New Plastic (PVC)**	**SDR21**	**278**	**283**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Map ID #11

STATE OF TEXAS WELL REPORT for Tracking #334077

Owner:	**Sam Coffer**	Owner Well #:	**1**
Address:	**P.O. Box 19351** **Amarillo, TX 79114**	Grid #:	**06-43-9**
Well Location:	**off US Hwy 66 & Hwy 60 edge of city** **Amarillo, TX**	Latitude:	**35° 15' 00" N**
		Longitude:	**101° 38' 17" W**
Well County:	**Potter**	Elevation:	**No Data**

Type of Work: **New Well**   Proposed Use: **Domestic**

Drilling Start Date: **8/30/2006**   Drilling End Date: **8/30/2006**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
10	**0**	**280**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
100	**280**	**Gravel**	**#1 fine**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
2.5	**100**	**28 cement**

Seal Method: **Pressure**

Sealed By: **Magic Circle**

Distance to Property Line (ft.): **40**

Distance to Septic Field or other concentrated contamination (ft.): **no septic**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **measure**

Surface Completion: **Pitless Adapter Used**

Water Level: **180 ft.** below land surface on **2006-08-30**   Measurement Method: **Unknown**

Packers: **No Data**

Type of Pump: **Submersible**   Pump Depth (ft.): **260**

Well Tests: **Bailer**   **Yield: 7 GPM with 12 ft. drawdown after 3 hours**

	Strata Depth (ft.)	Water Type
Water Quality:	**No Data**	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information:

Driller Name: **Charles Horner** License Number: **2614**

Comments: **NE corner Sec 18 Block 2 AB & M Town East unplatted subdiv. ^ch**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**35**	**topsoil**
35	**65**	**clay**
65	**96**	**sandstone**
96	**126**	**red fine sand**
126	**157**	**red sand & clay**
157	**187**	**red sand & clay**
187	**218**	**red & blue clay, white sand mix, sandstone**
218	**248**	**red sand, white sandstone, yellow clay**
248	**280**	**white sand chunks, red clay, white sandy clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.) New/Used Type Setting From/To (ft.)
5 New PVC - 20 Perf 260-280 .100

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Map ID #12

STATE OF TEXAS WELL REPORT for Tracking #479132

Owner:	**SERGIO MENDOZA**	Owner Well #:	**1145**
Address:	**7851 SOUTH EASTERN AMARILLO, TX 79118**	Grid #:	**06-51-3**
Well Location:	**7851 SOUTH EASTERN AMARILLO, TX 79118**	Latitude:	**35° 14' 26.83" N**
	AB&M BLK 2 SEC 5	Longitude:	**101° 38' 08.06" W**
Well County:	**Potter**	Elevation:	**4512 ft. above sea level**

Type of Work: **New Well**　　Proposed Use: **Domestic**

Drilling Start Date: **5/10/2018**　　Drilling End Date: **5/10/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.75	**0**	**330**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
20	**330**	**Gravel**	**#1 FINE**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**20**	**Cement 12 Bags/Sacks**

Seal Method: **Hand Mixed**

Sealed By: **Driller**

Distance to Property Line (ft.): **118**

Distance to Septic Field or other concentrated contamination (ft.): **N/A**

Distance to Septic Tank (ft.): **N/A**

Method of Verification: **GPS**

Surface Completion: **Pitless Adapter Used**　　**Surface Completion by Driller**

Water Level: **210 ft.** below land surface on **2018-05-10**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
210 - 320	**CLEAN WATER**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **ETTER WATER WELL LLC**

PO BOX 977
CACTUS, TX 79013

Driller Name: **DANIEL MURGA** License Number: **60143**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	200	TOPSOIL CALICHI BROWN CLAY SAND
200	240	FINE SAND
240	260	FINE SAND WITH CLAY STRIPES
260	280	FINE SAND WITH RED CLAY STREAKS
280	320	FINE SAND WITH MINOR CLAY
320	330	RED CLAY SOILD

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
5	Blank	New Plastic (PVC)	#200	3	260
5	Perforated or Slotted	New	0.032	260	320
5	Blank	Plastic (PVC)	#200	320	330

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04 January 2024

Work Order: 1603128

SERGIO MARTINEZ
TYSON FOODS LABORATORIES - 6904
PO BOX 30500
AMARILLO, TX 79120-

RE: Annual Injection Well

Enclosed are the results of analyses for samples received by the laboratory on 2023-12-22 10:05. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Kerri Stanek
Project Manager
kstanek@midwestlabs.com

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TYSON FOODS LABORATORIES - 6904
PO BOX 30500
AMARILLO, TX 79120-

Project: Annual Injection Well
Project Manager: SERGIO MARTINEZ

Reported:
2024-01-04 16:15

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Injection Well	1603128-01	Aqueous	2023-12-21 08:25	2023-12-22 10:05

Containers used for the following analyses:

#	1603128-01 A:	EPA 1664B
	1603128-01 B:	SM 2320 B-2011, SM 2540 B+E-2015, SM 2540 D+E-2015, SM 4500-CL- E-2011, SM 4500-H+ B-2011, SM 5210 B-2016
	1603128-01 C:	PAI-DK 01, SM 4500-NH3 C-1997
#	1603128-01 D:	Total Metals per EPA 200.7

Note: Indicates container was received outside the acceptable pH range and was preserved at the laboratory.

Analysis Results Reviewed by:

Total Metals per EPA 200.7 reviewed by kkh9.

EPA 1664B reviewed by jdb5.

PAI-DK 01 reviewed by jdb5.

SM 2320 B-2011 reviewed by jdb5.

SM 2540 B+E-2015 reviewed by jdb5.

SM 2540 D+E-2015 reviewed by jdb5.

SM 4500-CL- E-2011 reviewed by jdb5.

SM 4500-NH3 C-1997 reviewed by jdb5.

SM 5210 B-2016 reviewed by jdb5.

SM 4500-H+ B-2011 reviewed by jdb5.

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AMARILLO, TX 79120-

Project: Annual Injection Well
Project Manager: SERGIO MARTINEZ

Reported: 2024-01-04 16:15

Sample ID: Injection Well
Laboratory ID: 1603128-01
Sampled Date/Time: 2023-12-21 08:25

Analyte	Result	Reporting Limit	Units	Method	Prepared	Analyzed	Analyst	(Container) / Notes
Total Metals								
Chromium	1.86	0.01	mg/L	EPA 200.7	2023-12-26	2023-12-28	erw9	(D)
Sodium	10990	2.00	mg/L	EPA 200.7	2023-12-26	2024-01-02	ras7	(D)
Environmental Chemistry								
Alkalinity to pH 4.5 (endpoint)	1230	80	mg CaCO3/L	SM 2320 B-2011	2024-01-03	2024-01-03	mgn8	(B)
Ammonia-N	280	5.00	mg/L	SM 4500-NH3 C-1997	2023-12-26	2023-12-26	pes0	(C)
Biochemical Oxygen Demand	1260	119	mg/L	SM 5210 B-2016	2023-12-22/13:00	2023-12-27/12:13	lkm2	(B)
Carbonaceous BOD	1060	131	mg/L	SM 5210 B-2016	2023-12-22/13:00	2023-12-27/12:22	lkm2	(B)
Chloride	9190	200	mg/L	SM 4500-CL-E-2011	2023-12-27	2023-12-27	nam7	(B)
Hexane Extractable Material (HEM)	26.9	5.0	mg/L	EPA 1664B	2024-01-03	2024-01-03	gas9	(A)
Total Kjeldahl Nitrogen	435	10.0	mg/L	PAI-DK 01	2023-12-26	2023-12-26	pes0	(C)
Total Solids	26400	10	mg/L	SM 2540 B+E-2015	2023-12-27	2023-12-28	ppj2	(B)
Total Volatile Solids	6500	10	mg/L	SM 2540 B+E-2015	2023-12-27	2023-12-28	ppj2	(B)
Total Suspended Solids	244	4	mg/L	SM 2540 D+E-2015	2023-12-28	2023-12-28	ppj2	(B)
Total Volatile Suspended Solids	69	4	mg/L	SM 2540 D+E-2015	2023-12-28	2023-12-28	ppj2	(B)
Environmental Chemistry (in lab, exceeds regulatory hold time)								
pH @ 19.1°C	8.24		S.U.	SM 4500-H+ B-2011	2023-12-26	2023-12-26	cvn2	(B)

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TYSON FOODS LABORATORIES - 6904	Project: Annual Injection Well	
PO BOX 30500		**Reported:**
AMARILLO, TX 79120-	Project Manager: SERGIO MARTINEZ	2024-01-04 16:15

Total Metals - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B938953										
Blank (B938953-BLK1)				Prepared: 2023-12-26 Analyzed: 2023-12-28						
Chromium	<	0.01	mg/L							
Sodium	<	0.10	mg/L							
LCS (B938953-BS1)				Prepared: 2023-12-26 Analyzed: 2023-12-28						
Chromium	0.88	0.01	mg/L	1.00		87.9	85-115			
Sodium	5.72	0.10	mg/L	6.00		95.4	85-115			
Matrix Spike (B938953-MS1)	**Source: 1603128-01**			Prepared: 2023-12-26 Analyzed: 2023-12-28						
Chromium	2.53	0.01	mg/L	1.00	1.86	66.9	70-130			MI
Matrix Spike Dup (B938953-MSD1)	**Source: 1603128-01**			Prepared: 2023-12-26 Analyzed: 2023-12-28						
Chromium	2.51	0.01	mg/L	1.00	1.86	64.8	70-130	0.832	20	MI

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TYSON FOODS LABORATORIES - 6904
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AMARILLO, TX 79120-

Project: Annual Injection Well
Project Manager: SERGIO MARTINEZ

Reported: 2024-01-04 16:15

Environmental Chemistry - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B938942										
Blank (B938942-BLK1)				Prepared: 2023-12-22 Analyzed: 2023-12-27						
Biochemical Oxygen Demand	<	2.0	mg/L							
LCS (B938942-BS1)				Prepared: 2023-12-22 Analyzed: 2023-12-27						
Biochemical Oxygen Demand	184.3	2.0	mg/L	198		93.1	84.6-115.4			
Duplicate (B938942-DUP1)	**Source: 1602212-01**			Prepared: 2023-12-22 Analyzed: 2023-12-27						
Biochemical Oxygen Demand	732.6	102	mg/L		841.7			13.9	20	
Batch B938944										
Blank (B938944-BLK1)				Prepared: 2023-12-22 Analyzed: 2023-12-27						
Carbonaceous BOD	<	2.0	mg/L							
LCS (B938944-BS1)				Prepared: 2023-12-22 Analyzed: 2023-12-27						
Carbonaceous BOD	160.3	2.0	mg/L	173		92.8	82.4-117.6			
Duplicate (B938944-DUP1)	**Source: 1602940-02**			Prepared: 2023-12-22 Analyzed: 2023-12-27						
Carbonaceous BOD	22.6	3.3	mg/L		20.9			7.59	20	
Batch B938962										
Blank (B938962-BLK1)				Prepared & Analyzed: 2023-12-26						
Ammonia-N	<	0.10	mg/L							
LCS (B938962-BS1)				Prepared & Analyzed: 2023-12-26						
Ammonia-N	8.050	0.10	mg/L	8.00		101	90-110			

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AMARILLO, TX 79120-

Project: Annual Injection Well
Project Manager: SERGIO MARTINEZ

Reported:
2024-01-04 16:15

Environmental Chemistry - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B938962										
Matrix Spike (B938962-MS1)	**Source: 1602228-01**			Prepared & Analyzed: 2023-12-26						
Ammonia-N	444.8	5.00	mg/L	400	51.44	98.3	90-110			
Matrix Spike Dup (B938962-MSD1)	**Source: 1602228-01**			Prepared & Analyzed: 2023-12-26						
Ammonia-N	454.6	5.00	mg/L	400	51.44	101	90-110	2.17	10	
Batch B938963										
Blank (B938963-BLK1)				Prepared & Analyzed: 2023-12-26						
Total Kjeldahl Nitrogen	<	10.0	mg/L							
LCS (B938963-BS1)				Prepared & Analyzed: 2023-12-26						
Total Kjeldahl Nitrogen	100.4	10.0	mg/L	100		100	90-110			
Matrix Spike (B938963-MS1)	**Source: 1603067-01**			Prepared & Analyzed: 2023-12-26						
Total Kjeldahl Nitrogen	309.0	10.0	mg/L	100	204.8	104	90-110			
Matrix Spike Dup (B938963-MSD1)	**Source: 1603067-01**			Prepared & Analyzed: 2023-12-26						
Total Kjeldahl Nitrogen	310.0	10.0	mg/L	100	204.8	105	90-110	0.348	10	
Batch B939003										
Blank (B939003-BLK1)				Prepared & Analyzed: 2023-12-27						
Chloride	<	1	mg/L							
LCS (B939003-BS1)				Prepared & Analyzed: 2023-12-27						
Chloride	9.1	1	mg/L	10.0		90.7	90-110			

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Project: Annual Injection Well
Project Manager: SERGIO MARTINEZ

Reported:
2024-01-04 16:15

Environmental Chemistry - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B939003										
Matrix Spike (B939003-MS1)	**Source: 1603237-02**			Prepared & Analyzed: 2023-12-27						
Chloride	209.3	5	mg/L	50.0	159.0	101	90-110			
Matrix Spike Dup (B939003-MSD1)	**Source: 1603237-02**			Prepared & Analyzed: 2023-12-27						
Chloride	208.1	5	mg/L	50.0	159.0	98.1	90-110	0.590	10	
Batch B939025										
Blank (B939025-BLK1)				Prepared & Analyzed: 2023-12-28						
Total Suspended Solids	<	4	mg/L							
Total Volatile Suspended Solids	<	4	mg/L							
LCS (B939025-BS1)				Prepared & Analyzed: 2023-12-28						
Total Suspended Solids	105.0	4	mg/L	100		105	90-110			
Total Volatile Suspended Solids	<	4	mg/L	1.65			0-200			
Batch B939044										
Blank (B939044-BLK1)				Prepared: 2023-12-27 Analyzed: 2023-12-28						
Total Solids	<	10	mg/L							
Total Volatile Solids	<	10	mg/L							
LCS (B939044-BS1)				Prepared: 2023-12-27 Analyzed: 2023-12-28						
Total Solids	972.5	10	mg/L	1000		97.2	90-110			
Total Volatile Solids	750.0	10	mg/L	700		107	80-120			
Duplicate (B939044-DUP1)	**Source: 1603128-01**			Prepared: 2023-12-27 Analyzed: 2023-12-28						
Total Solids	25500	10	mg/L		26400			3.47	10	
Total Volatile Solids	5600	10	mg/L		6500			14.9	20	

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PO BOX 30500
AMARILLO, TX 79120-

Project: Annual Injection Well
Project Manager: SERGIO MARTINEZ

Reported:
2024-01-04 16:15

Environmental Chemistry - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B939086										
Blank (B939086-BLK1)				Prepared & Analyzed: 2024-01-03						
Hexane Extractable Material (HEM)	<	5.0	mg/L							
Blank (B939086-BLK2)				Prepared & Analyzed: 2024-01-03						
Hexane Extractable Material (HEM)	<	5.0	mg/L							
LCS (B939086-BS1)				Prepared & Analyzed: 2024-01-03						
Hexane Extractable Material (HEM)	35.60	5.0	mg/L	40.0		89.0	78-114			C
LCS (B939086-BS2)				Prepared & Analyzed: 2024-01-03						
Hexane Extractable Material (HEM)	40.30	5.0	mg/L	40.0		101	78-114			C
Matrix Spike (B939086-MS1)	**Source: 1603045-01**			Prepared & Analyzed: 2024-01-03						
Hexane Extractable Material (HEM)	43.20	5.0	mg/L	40.0	<	108	78-114			
Batch B939126										
Blank (B939126-BLK1)				Prepared & Analyzed: 2024-01-03						
Alkalinity to pH 4.5 (endpoint)	<	20	mg CaCO3/L							
Blank (B939126-BLK2)				Prepared & Analyzed: 2024-01-03						
Alkalinity to pH 4.5 (endpoint)	<	20	mg CaCO3/L							
LCS (B939126-BS1)				Prepared & Analyzed: 2024-01-03						
Alkalinity to pH 4.5 (endpoint)	1005	20	mg CaCO3/L	1000		100	90-110			
LCS (B939126-BS2)				Prepared & Analyzed: 2024-01-03						
Alkalinity to pH 4.5 (endpoint)	999.0	20	mg CaCO3/L	1000		99.9	90-110			

Midwest Laboratories
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P 402-334-7770
F 402-334-9121
www.midwestlabs.com

TYSON FOODS LABORATORIES - 6904
PO BOX 30500
AMARILLO, TX 79120-

Project: Annual Injection Well
Project Manager: SERGIO MARTINEZ

Reported: 2024-01-04 16:15

Environmental Chemistry - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B939126										
Duplicate (B939126-DUP1)	**Source: 1603128-01**		Prepared & Analyzed: 2024-01-03							
Alkalinity to pH 4.5 (endpoint)	1290	80	mg CaCO3/L		1230			4.72	10	

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TYSON FOODS LABORATORIES - 6904
PO BOX 30500
AMARILLO, TX 79120-

Project: Annual Injection Well
Project Manager: SERGIO MARTINEZ

Reported:
2024-01-04 16:15

Environmental Chemistry (in lab, exceeds regulatory hold time) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B938979										
LCS (B938979-BS1)				Prepared & Analyzed: 2023-12-26						
pH @ 19.8°C	10.07		S.U.	10.0		101	90-110			
Duplicate (B938979-DUP1)	**Source: 1597256-01**			Prepared & Analyzed: 2023-12-26						
pH @ 19.4°C	6.73		S.U.		6.74			0.148	10	
Duplicate (B938979-DUP2)	**Source: 1603128-01**			Prepared & Analyzed: 2023-12-26						
pH @ 19.4°C	8.26		S.U.		8.24			0.242	10	

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TYSON FOODS LABORATORIES - 6904
PO BOX 30500
AMARILLO, TX 79120-

Project: Annual Injection Well

Project Manager: SERGIO MARTINEZ

Reported:
2024-01-04 16:15

Certified Analyses included in this Report

Method	Analyte	Certifications
EPA 1664B in Aqueous	Hexane Extractable Material (HEM)	KS,FL,TX,UT,IA
EPA 200.7 in Aqueous	Chromium	KS,TX,FL,UT,OK,IA
	Sodium	FL,KS,TX,UT,OK,IA
PAI-DK 01 in Aqueous	Total Kjeldahl Nitrogen	FL,KS,IA,TX,UT,OK
SM 2320 B-2011 in Aqueous	Alkalinity to pH 4.5 (endpoint)	FL,TX,KS,UT,IA,OK
SM 4500-CL- E-2011 in Aqueous	Chloride	KS,TX,FL,IA,OK,UT
SM 4500-H+ B-2011 in Aqueous	pH	FL,KS
SM 4500-NH3 C-1997 in Aqueous	Ammonia-N	FL,KS,TX,UT,IA,OK
SM 5210 B-2016 in Aqueous	Biochemical Oxygen Demand	KS,TX,FL,UT,IA,OK
	Carbonaceous BOD	KS,TX,FL,UT,IA,OK

Non-Certified Analyses included in this Report

Method	Analyte
SM 2540 B+E-2015 in Aqueous	Total Solids
	Total Volatile Solids
SM 2540 D+E-2015 in Aqueous	Total Suspended Solids
	Total Volatile Suspended Solids

Code	Description	Number	Expires
FL	Florida Department of Health	E87918	06/30/2024
IA	Iowa Department of Natural Resources	064	05/01/2025
KS	Kansas Department of Health and Environment	E-10402	04/30/2024
NE	State of Nebraska Dept of Health & Human Services	NE-04-05	06/30/2024
OK	Oklahoma Department of Environmental Quality	2022-068	08/31/2023
TX	Texas Commission on Environmental Quality	T104704416-23-17	07/31/2024
UT	State of Utah Department of Health	NE000012023-13	07/31/2024
WA	State of Washington Department of Ecology	C912	06/07/2024

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TYSON FOODS LABORATORIES - 6904	Project: Annual Injection Well	
PO BOX 30500		**Reported:**
AMARILLO, TX 79120-	Project Manager: SERGIO MARTINEZ	2024-01-04 16:15

Notes and Definitions

MI	Matrix interference suspected in matrix spiked sample.
C	RPD of LCS and LCS Dup > 10%
<	Less than reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

EPA 524.2, EPA 624, EPA 8260, OA-1, TCLP VOC, GRO, and all microbiological analyses are conducted in the facility located at 13606 B Street, Omaha, NE 68144. All other analyses are conducted in the main facility located at 13611 B Street, Omaha, NE 68144.

Midwest Laboratories®

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Phone 402-334-7770
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CHAIN OF CUSTODY

Lab Work Order Number: 1603128
Date Generated: 12/14/2023

Client Name: TYSON FOODS LABORATORIES - 6904	Project Name: Annual Injection Well
Client Contact: SERGIO MARTINEZ	Project Description:
Address: PO BOX 30500	Purchase Order Number:
City: AMARILLO	Midwest Labs Contact: Kerri Stanek
State/Zip: TX, 79120-	Regulatory (Circle One): Yes No
Phone: 8063357359 Fax: 8063357317	Regulatory Agency:
Sampler Name (printed):	Sample Type (Circle One - See Below): D G W S/H U P

Requested Analyses (Test Names): Alkalinity, BOD, CBOD, Chloride-Discrete, pH, Total and Volatile Solids, Total Solids, TSS, TSS, | Ammonia-Titration, TKN-Titration | Cr, Na | HEM

Copy To:

Email to:

Lab ID	Sample Name or Field ID	Sampled Date	Sampled Time	Sample Code	Matrix Code	Container Count	Preservation Code 1	4	3	6	Sample Comments
01	Injection Well	12-21-23	08:25		A	4	1	1	1	1	

WORKORDER: 1603128 COC Sticker #: 1

Relinquished By	Date/Time	Received By	Date/Time
Carter V. Smith III	12-21-23 08:25		
Relinquished By	Date/Time	Received By: ST	12/22/23 10:05

Comments:

Lab Internal Use Only:
Temperature Upon Receipt: 4.2°C
Cooler Numbers:
Notes:

Matrix Codes: A=Aqueous

Preservation Codes: 1=Cool 6°C,3=pH<2; HNO3,4=pH<2; H2SO4,6=pH<2; HCL

Sample Type Codes: D = Drinking Water (Safe Drinking Water Act), G = Groundwater, W = Wastewater (Clean Water Act), S/H = Solid/Hazardous Waste (RCRA), U = Underground Storage Tank (UST), P = Process Water

Chain of Custody will have a signature upon receipt but no subsequent signatures.

RC Form 15 - Effective 10/31/2013

1603128
Work Order

Midwest Laboratories®

13611 B STREET, OMAHA, NE 68144
402-334-7770 | CONTACTUS@MIDWESTLABS.COM

REGULATORY FORM

This sheet MUST be filled out before samples can be processed. To ensure that holding times are met, it is your responsibility that a completed form comes attached to the Chain of Custody. Samples must be received on ice.

Is this sample for regulatory/permit reporting? ☑ Yes ☐ No

What city/state was your sample collected in? Amarillo Tx

WORKORDER: 1603128 COC Sticker #: 2

What agency/state are you reporting? Midwest Lab

What type of sample? (Circle One)

Drinking Water
For human consumption, 30 hr hold time for E. coli and total coliform testing

Ground Water **Hazardous Waste** **Livestock** **Process Water**

Solid Waste **Storm Water** **UST** **Wastewater**

SEE REVERSE SIDE FOR SAMPLING INSTRUCTIONS

Midwest Laboratories®

Sample Acceptance Checkl

Document Number: RC CHKLIST
Revision No
Effective Date: 04/25
Page 1

Lab Number:

Thermometer Used: ☐ Therm Fisher IR 24

Sample Temperature (°C): 4.2°C

Cooler Intact: ☑ Yes ☐ No
Received on Ice: ☑ Yes ☐ No
Hand Delivered: ☐ Yes ☑ No

Date & Initials of person accepting samples: ST 12/22/23

	Yes	No	N/A	Comments
Chain of Custody present?	☑	☐	☐	
Sample ID(s):	☑	☐	☐	
Sample Location(s):	☑	☐	☐	
Client contact:	☑	☐	☐	
Analysis Requested:	☑	☐	☐	
Date & Time of collection:	☑	☐	☐	
Sampler name on COC?	☐	☑	☐	
Chain of custody relinquished with signature?	☑	☐	☐	
Chain of custody complete?	☐	☑	☐	
Sample labels match COC?	☑	☐	☐	
Written in indelible ink?	☑	☐	☐	
Labels indicate proper preservation?	☑	☐	☐	
Samples arrived within hold time?	☑	☐	☐	
Samples arrived within correct temperature?	☑	☐	☐	
Samples arrived frozen?	☐	☑	☐	
Sufficient volume?	☑	☐	☐	
Appropriate containers used?	☑	☐	☐	
Filtered volume received for dissolved tests?	☐	☐	☑	
Headspace in VOA vials?	☐	☐	☑	
Trip Blank present?	☐	☑	☐	

Client Notification/Resolution: Date/Time Contacted: ____________

Person Contacted: ____________ Contacted By: ____________

Comments/Resolution: ____________

WORKORDER: 1603128
COC
Sticker #: 3

HALLIBURTON

TERRA DYNAMICS INC-EBUS
2300 GREENHILL DRIVE
ROUND ROCK, TX, 78664-2775
US

Generic 001

TBD County, OK, US

CEMENT PROPOSAL S/I/DL/PL

Surface, Intermediate, Drilling Liner, Production Liner
Proposal 519343 - Version 1.0
October 21, 2024

Prepared for:
Valeria Suarez

Submitted by:
Kevin Aldridge
210 Park Ave
Oklahoma City, OK - 731025621
USA

HALLIBURTON

Contents

Halliburton appreciates the opportunity to present this cost estimate and looks forward to being of service to you.

1 Foreword

Enclosed is our cost estimate for cementing the casing strings in the referenced well. The information in this cost estimate includes well data, calculations, materials requirements, and cost estimates. This cost estimate is based on information from our field personnel and previous cementing services in the area.

The selection and use of non-Halliburton plugs and casing attachments often compromises the holistic approach and may jeopardize the overall objective for effective zonal isolation. Furthermore, Halliburton is not involved in the design, manufacture or use of plugs and casing attachments supplied by other manufacturers and assumes no liability for their installation and operation. For this reason we recommend Halliburton plugs and casing attachments be used when Halliburton performs any zonal isolation operation.

Halliburton Energy Services recognizes the importance of meeting society's needs for health, safety, and protection of the environment. It is our intention to proactively work with employees, customers, the public, governments, and others to use natural resources in an environmentally sound manner while protecting the health, safety, and environmental processes while supplying high quality products and services to our customers.

We appreciate the opportunity to present this cost estimate for your consideration and we look forward to being of service to you. Our Services for your well will be coordinated through the Service Center listed below. If you require any additional information or additional designs, please feel free to contact myself or our field representative listed below.

2 Service Center Contacts

District Cement Coordinators: 580.251.2829

Account Representative Kevin Aldridge 281.728.9915

3 Surface Casing

3.1 Job Information Surface Casing

Job Criticality Status: GREEN
Well Name: Generic   Well #: 001

Conductor Casing	0 - 60 ft (MD)
Outer Diameter	20 in
Inner Diameter	19.166 in
Linear Weight	90 lbm/ft
17 1/2" Open Hole	60 - 1,500 ft (MD)
Inner Diameter	17.5 in
Excess Factor	20 %
Surface Casing	0 - 1,500 ft (MD)
Outer Diameter	13.375 in
Inner Diameter	12.615 in
Linear Weight	54.5 lbm/ft
Casing Grade	J-55
Shoe Joint Length	42 ft
Thread Type	STC
Mud Type	Water Based Mud
Mud Weight	8.5 lbm/gal

3.2 Estimated Calculations Surface Casing

Stage 1

CEMENT: (1,000 ft fill)	
60 ft * 1.0278 ft3/ft * 0 %	= 61.67 ft3
940 ft * 0.6946 ft3/ft * 20 %	= 783.55 ft3
Lead Cement	= 845.22 ft3
	= 184.6 bbl
Total Lead	= 515.14 sack
CEMENT: (500 ft fill)	
500 ft * 0.6946 ft3/ft * 20 %	= 416.78 ft3
Tail Cement	= 416.78 ft3
	= 78.3 bbl
Shoe Joint Volume: (42 ft fill)	
42 ft * 0.868 ft3/ft	= 36.45 ft3
	= 6.5 bbl
Tail plus shoe joint	= 476.12 ft3
	= 84.8 bbl
Total Tail	= 354.78 sack
Total Pipe Capacity:	
60 ft * 0.868 ft3/ft	= 52.08 ft3
1,440 ft * 0.868 ft3/ft	= 1,249.87 ft3
	= 231.9 bbl
Displacement Volume to Shoe Joint:	
Capacity of Pipe - Shoe Joint	= 231.9 bbl - 6.5 bbl
	= 225.4 bbl

3.3 Job Volume Estimates Surface Casing

Stage 1

Fluid 1: Water Based Spacer

Mud Flush III (Powder)	Fluid Density:	8.4 lbm/gal
42 gal/bbl FRESH WATER	**Volume:**	**20 bbl**

Fluid 2: Lead Slurry

SBM CEM VARICEM™ LEAD	Fluid Weight:	12.8 lbm/gal
0.25 lbm/sk Poly-E-Flake	Slurry Yield:	2.012 ft3/sack
1 % Calcium Chloride, Pellet	Total Mixing Fluid:	11.25 Gal/sack
11.25 Gal/sk FRESH WATER	**Calculated Volume:**	**150.5 bbl**
	Proposed Volume:	**184.6 bbl**
	Top Of Fluid:	0 ft
	Calculated Fill:	1,000 ft
	Calculated sack:	513.81 sack
	Proposed sack:	515 sack

Fluid 3: Tail Slurry

SBM CEM HALCEM™ SYS	Fluid Weight:	14.8 lbm/gal
6.43 Gal/sk FRESH WATER	Slurry Yield:	1.342 ft3/sack
	Total Mixing Fluid:	6.43 Gal/sack
	Calculated Volume:	**80.7 bbl**
	Proposed Volume:	**84.8 bbl**
	Top Of Fluid:	1,000 ft
	Calculated Fill:	500 ft
	Calculated sack:	350.8 sack
	Proposed sack:	355 sack

Fluid 4: Water Based Mud

Water Based Mud	Fluid Density:	8.5 lbm/gal
	Volume:	**225.4 bbl**

3.4 Volume Estimate Table Surface Casing

Calculations are used for volume estimation. Well conditions will dictate final cement job design.

Stage 1

Fluid #	Fluid Type	Fluid Name	Surface Density lbm/gal	Estimated Avg Rate	Downhole Volume
1	SPACER	Mud Flush III (Powder)	8.4		20 bbl
2	CEMENT	Lead Cement	12.8		184.6 bbl
3	CEMENT	Tail Cement	14.8		84.9 bbl
4	MUD	Water Based Mud	8.5		225.4 bbl

NOTE: These slurries and spacers will require lab testing. The additives and concentrations are estimates based on field experience in the area and may need to be modified prior to the job. The proposed spacer is designed to be generally compatible with water base mud systems. Compatibility testing with field mud samples used may indicate changes in the additive package and the related costs.

4 Intermediate

4.1 Job Information Intermediate

Job Criticality Status: GREEN

Well Name: Generic	Well #: 001
13 3/8" Surface Casing	0 - 1,500 ft (MD)
Outer Diameter	13.375 in
Inner Diameter	12.615 in
Linear Weight	54.5 lbm/ft
Casing Grade	J-55
Thread Type	STC
12 1/4 Open Hole	1,500 - 4,000 ft (MD)
Inner Diameter	12.25 in
Excess Factor	20 %
9 5/8" Intermediate Casing	0 - 4,000 ft (MD)
Outer Diameter	9.625 in
Inner Diameter	8.835 in
Linear Weight	40 lbm/ft
Casing Grade	J-55
Shoe Joint Length	42 ft
Thread Type	LTC
Mud Type	Water Based Mud
Mud Weight Range	8.9 - 9.8 lbm/gal

4.2 Estimated Calculations Intermediate

Stage 1

CEMENT: (3,500 ft fill)	
2,000 ft * 0.3132 ft3/ft * 20 %	= 751.65 ft3
1,500 ft * 0.3627 ft3/ft * 0 %	= 544.03 ft3
Lead Cement	= 1,295.68 ft3
	= 230.8 bbl
Total Lead	= 461.98 sack
CEMENT: (500 ft fill)	
500 ft * 0.3132 ft3/ft * 20 %	= 187.91 ft3
Tail Cement	= 187.91 ft3
	= 33.5 bbl
Shoe Joint Volume: (42 ft fill)	
42 ft * 0.4257 ft3/ft	= 17.88 ft3
	= 3.2 bbl
Tail plus shoe joint	= 206.06 ft3
	= 36.7 bbl
Total Tail	= 155.4 sack
Total Pipe Capacity:	
1,500 ft * 0.4257 ft3/ft	= 638.6 ft3
2,500 ft * 0.4257 ft3/ft	= 1,064.34 ft3
	= 303.3 bbl
Displacement Volume to Shoe Joint:	
Capacity of Pipe - Shoe Joint	= 303.3 bbl - 3.2 bbl
	= 300.1 bbl

4.3 Job Volume Estimates Intermediate

Stage 1

Fluid 1: Rheologically Enhanced Spacer

10.5 lb/gal Tuned Prime Spacer		Fluid Density:	10.5 lbm/gal
37.58 gal/bbl FRESH WATER		**Volume:**	**40 bbl**
88.7 lbm/bbl BARITE			
4 lbm/bbl D-AIR 5000			
0.25 gal/bbl D-AIR 3000L			
0.25 lbm/bbl Poly-E-Flake			
0.2 lbm/bbl WellLife 1094 - 15 lb bag			
0 gal/bbl SEM-1265, 330 GAL TOTE			

Fluid 2: Lead Slurry

SBM CEM VARICEM™ LEAD	Fluid Weight:	11.5 lbm/gal
0.25 lbm/sk Poly-E-Flake	Slurry Yield:	2.805 ft3/sack
17.21 Gal/sk FRESH WATER	Total Mixing Fluid:	17.21 Gal/sack
	Calculated Volume:	**230.8 bbl**
	Proposed Volume:	**230.8 bbl**
	Top Of Fluid:	0 ft
	Calculated Fill:	3,500 ft
	Calculated sack:	461.92 sack
	Proposed sack:	465 sack

Fluid 3: Tail Slurry

SBM CEM HALCEM™ SYS	Fluid Weight:	14.8 lbm/gal
6.34 Gal/sk FRESH WATER	Slurry Yield:	1.326 ft3/sack
	Total Mixing Fluid:	6.34 Gal/sack
	Calculated Volume:	**36.7 bbl**
	Proposed Volume:	**36.7 bbl**
	Top Of Fluid:	3,500 ft
	Calculated Fill:	500 ft
	Calculated sack:	155.2 sack
	Proposed sack:	160 sack

Fluid 4: Water Based Mud

Displacement	Fluid Density:	8.33 lbm/gal
	Volume:	**300.1 bbl**

4.4 Volume Estimate Table Intermediate

Calculations are used for volume estimation. Well conditions will dictate final cement job design.

Stage 1

Fluid #	Fluid Type	Fluid Name	Surface Density lbm/gal	Estimated Avg Rate bbl/min	Downhole Volume
1	SPACER	10.5 lb/gal Tuned Prime Spacer	10.5	4	40 bbl
2	CEMENT	Lead Cement	11.5		232.3 bbl
3	CEMENT	Tail Cement	14.8		37.8 bbl
4	MUD	Displacement	8.33		300.1 bbl

NOTE: These slurries and spacers will require lab testing. The additives and concentrations are estimates based on field experience in the area and may need to be modified prior to the job. The proposed spacer is designed to be generally compatible with water base mud systems. Compatibility testing with field mud samples used may indicate changes in the additive package and the related costs.

5 Drilling Liner

5.1 Job Information Drilling Liner

Job Criticality Status: GREEN

Well Name: Generic	Well #: 001
9 5/8" Intermediate Casing	0 - 4,000 ft (MD)
Outer Diameter	9.625 in
Inner Diameter	8.835 in
Linear Weight	40 lbm/ft
8 3/4" Open Hole	4,000 - 6,200 ft (MD)
Inner Diameter	9.5 in
Excess Factor	20 %
5" Drill Pipe	0 - 3,750 ft (MD)
Outer Diameter	5 in
Inner Diameter	4.276 in
Linear Weight	22.6 lbm/ft
Casing Grade	K-55
7 5/8" Liner	3,750 - 6,200 ft (MD)
Outer Diameter	7.625 in
Inner Diameter	6.968 in
Linear Weight	25.59 lbm/ft
Casing Grade	L-80
Shoe Joint Length	42 ft
Mud Type	Oil Based
Mud Weight	11.5 lbm/gal
Mud Weight Range	10 - 11.5 lbm/gal

5.2 Estimated Calculations Drilling Liner

Stage 1

SPACER: (528 ft fill)	
528 ft * 0.4257 ft3/ft * 0 %	= 224.58 ft3
Total Spacer	= 224.58 ft3
	= 40 bbl
CEMENT: (2,450 ft fill)	
2,200 ft * 0.1751 ft3/ft * 20 %	= 462.34 ft3
250 ft * 0.1086 ft3/ft * 0 %	= 27.16 ft3
IsoBond System	= 489.5 ft3
	= 87.2 bbl
Shoe Joint Volume: (42 ft fill)	
42 ft * 0.2648 ft3/ft	= 11.12 ft3
	= 2 bbl
Tail plus shoe joint	= 500.82 ft3
	= 89.2 bbl
Total Tail	= 308.01 sack
Total Pipe Capacity:	
2,200 ft * 0.2648 ft3/ft	= 582.59 ft3
3,750 ft * 0.0997 ft3/ft	= 373.97 ft3
250 ft * 0.2648 ft3/ft	= 66.2 ft3
	= 182.2 bbl
Displacement Volume to Shoe Joint:	
Capacity of Pipe - Shoe Joint	= 182.2 bbl - 2 bbl
	= 180.2 bbl

5.3 Job Volume Estimates Drilling Liner

Stage 1

Fluid 1: Rheologically Enhanced Spacer

Tuned Prime Cement Spacer	Fluid Density:	10.5 lbm/gal
42 gal/bbl FRESH WATER	**Volume:**	**40 bbl**
85.914 lbm/bbl BARITE		
1 lbm/bbl FE-2		
0 gal/bbl SEM-1265, 330 GAL TOTE		

Fluid 2: Lead Slurry

SBM CEM ISOBOND SYSTEM	Fluid Weight:	13.6 lbm/gal
12 % Salt	Slurry Yield:	1.626 ft3/sack
0.8 % CHEM, ISOGUARD, 50 LB BAG	Total Mixing Fluid:	8.03 Gal/sack
8.03 Gal/sk FRESH WATER	**Calculated Volume:**	**89.2 bbl**
	Proposed Volume:	**89.2 bbl**
	Top Of Fluid:	3,750 ft
	Calculated Fill:	2,450 ft
	Calculated sack:	307.89 sack
	Proposed sack:	310 sack

Fluid 3: Fresh Water

Displacement	Fluid Density:	8.33 lbm/gal
	Volume:	**108.9 bbl**

Fluid 4: Rheologically Enhanced Spacer

Tuned Prime Cement Spacer	Fluid Density:	10.5 lbm/gal
42 gal/bbl FRESH WATER	**Volume:**	**14.1 bbl**
85.914 lbm/bbl BARITE		
1 lbm/bbl FE-2		
0 gal/bbl SEM-1265, 330 GAL TOTE		

Fluid 5: Fresh Water

Displacement	Fluid Density:	8.33 lbm/gal
	Volume:	**57.2 bbl**

5.4 Volume Estimate Table Drilling Liner

Calculations are used for volume estimation. Well conditions will dictate final cement job design.

Stage 1

Fluid #	Fluid Type	Fluid Name	Surface Density lbm/gal	Estimated Avg Rate bbl/min	Downhole Volume
1	SPACER	Tuned Prime Cement Spacer	10.5	5	40 bbl
2	CEMENT	IsoBond System	13.6	4	89.8 bbl
3	MUD	Displacement	8.33		108.9 bbl
4	SPACER	Tuned Prime Cement Spacer	10.5	5	14.1 bbl
5	MUD	Displacement	8.33		57.2 bbl

NOTE: These slurries and spacers will require lab testing. The additives and concentrations are estimates based on field experience in the area and may need to be modified prior to the job. The proposed spacer is designed to be generally compatible with water base mud systems. Compatibility testing with field mud samples used may indicate changes in the additive package and the related costs.

6 Production Liner

6.1 Job Information Production Liner

Job Criticality Status: GREEN

Well Name: Generic	Well #: 001
9 5/8" Intermediate Casing	0 - 3,750 ft (MD)
Outer Diameter	9.625 in
Inner Diameter	8.835 in
Linear Weight	40 lbm/ft
7 5/8" Liner	3,750 - 6,200 ft (MD)
Outer Diameter	7.625 in
Inner Diameter	6.875 in
Linear Weight	25.59 lbm/ft
6 3/4" Open Hole	6,200 - 9,000 ft (MD)
Inner Diameter	6.75 in
Excess Factor	20 %
4-1/2 Drill Pipe	0 - 5,900 ft (MD)
Outer Diameter	4.5 in
Inner Diameter	3.826 in
Linear Weight	16.6 lbm/ft
5 1/2" Production Casing	5,900 - 9,000 ft (MD)
Outer Diameter	5.5 in
Inner Diameter	4.901 in
Linear Weight	16.89 lbm/ft
Casing Grade	K-55
Shoe Joint Length	84 ft
Mud Type	Oil Based
Mud Weight Range	9.6 - 10.1 lbm/gal

6.2 Estimated Calculations Production Liner

Stage 1

SPACER: (1,089 ft fill)	
1,089 ft * 0.2578 ft3/ft * 0 %	= 280.73 ft3
Total Spacer	= 280.73 ft3
	= 50 bbl
CEMENT: (3,100 ft fill)	
2,800 ft * 0.0835 ft3/ft * 20 %	= 280.62 ft3
300 ft * 0.0928 ft3/ft * 0 %	= 27.84 ft3
IsoBond System	= 308.46 ft3
	= 54.9 bbl
Shoe Joint Volume: (84 ft fill)	
84 ft * 0.131 ft3/ft	= 11 ft3
	= 2 bbl
Tail plus shoe joint	= 319.47 ft3
	= 56.9 bbl
Total Tail	= 219.42 sack
Total Pipe Capacity:	
300 ft * 0.131 ft3/ft	= 39.3 ft3
3,750 ft * 0.0798 ft3/ft	= 299.4 ft3
2,800 ft * 0.131 ft3/ft	= 366.82 ft3
2,150 ft * 0.0798 ft3/ft	= 171.65 ft3
	= 156.2 bbl
Displacement Volume to Shoe Joint:	
Capacity of Pipe - Shoe Joint	= 156.2 bbl - 2 bbl
	= 154.3 bbl

6.3 Job Volume Estimates Production Liner

Stage 1

Fluid 1: Rheologically Enhanced Spacer

10.5 lb/gal Tuned Spacer III	Fluid Density:	10.5 lbm/gal
37.58 gal/bbl FRESH WATER	**Volume:**	**50 bbl**
88.7 lbm/bbl BARITE		
16.54 lbm/bbl Potassium Chloride		

Fluid 2: Tail Slurry

SBM CEM ISOBOND SYSTEM	Fluid Weight:	13.8 lbm/gal
5 % Potassium Chloride	Slurry Yield:	1.456 ft3/sack
0.8 % CHEM, ISOGUARD, 50 LB BAG	Total Mixing Fluid:	6.89 Gal/sack
6.89 Gal/sk FRESH WATER	**Calculated Volume:**	**56.9 bbl**
	Proposed Volume:	**56.9 bbl**
	Top Of Fluid:	5,900 ft
	Calculated Fill:	3,100 ft
	Calculated sack:	219.41 sack
	Proposed sack:	220 sack

Fluid 3: Water Based Mud

Displacement	Fluid Density:	8.33 lbm/gal
	Volume:	**69.2 bbl**

Fluid 4: Rheologically Enhanced Spacer

10.5 lb/gal Tuned Spacer III	Fluid Density:	10.5 lbm/gal
37.58 gal/bbl FRESH WATER	**Volume:**	**16.7 bbl**
88.7 lbm/bbl BARITE		
16.54 lbm/bbl Potassium Chloride		

Fluid 5: Water Based Mud

Displacement	Fluid Density:	8.33 lbm/gal
	Volume:	**68.4 bbl**

6.4 Volume Estimate Table Production Liner

Calculations are used for volume estimation. Well conditions will dictate final cement job design.

Stage 1

Fluid #	Fluid Type	Fluid Name	Surface Density lbm/gal	Estimated Avg Rate bbl/min	Downhole Volume
1	SPACER	10.5 lb/gal Tuned Spacer III	10.5	5	50 bbl
2	CEMENT	IsoBond System	13.8		57.1 bbl
3	MUD	Displacement	8.33		69.2 bbl
4	SPACER	10.5 lb/gal Tuned Spacer III	10.5	5	16.7 bbl
5	MUD	Displacement	8.33		68.4 bbl

NOTE: These slurries and spacers will require lab testing. The additives and concentrations are estimates based on field experience in the area and may need to be modified prior to the job. The proposed spacer is designed to be generally compatible with water base mud systems. Compatibility testing with field mud samples used may indicate changes in the additive package and the related costs.