

Lower Dockum river channel across Andrews, Martin, and Howard counties, Texas

Mark C. Robinson, P.G. - Texas Water Development Board
West Texas Geological Society Fall Symposium
Midland, Texas September 26, 2018

*Unless specifically noted, this presentation does not necessarily reflect
official Board positions or decisions.*

Presentation Outline

Introduction to mapping brackish groundwater in the Dockum Aquifer

- What is brackish groundwater?
- Aquifer overview/previous studies
- Middle Dockum sand channel
- Next steps
- Questions, comments, stakeholder input

Brackish Groundwater

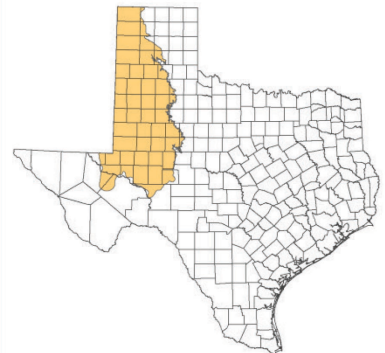
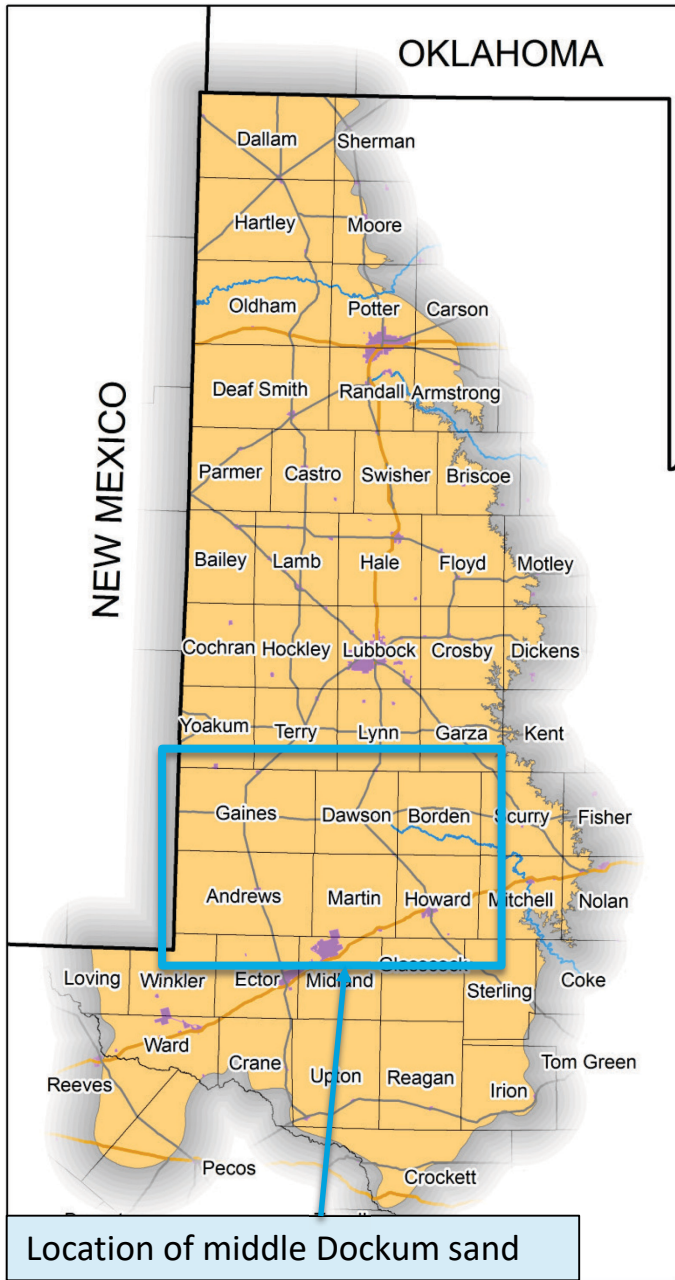
Saltier than fresh water, less salty than seawater

Groundwater Salinity Classification	Salinity Zone Code	Total Dissolved Solids Concentration in milligrams per liter (mg/L)	
Fresh	FR	0 to 1,000	← Drinking Water Limit
Slightly Saline	SS	1,000 to 3,000	
Moderately Saline	MS	3,000 to 10,000	← Major/Minor Texas Aquifers Mapped Limit
Very Saline	VS	10,000 to 35,000	
Brine	BR	Greater than 35,000	← Seawater

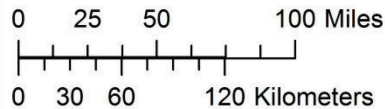
Classification modified from Winslow, A.G., and Kister, L.R., 1956, Saline-water resources of Texas: U.S. Geological Survey, Water-Supply Paper 1365, 105 p.

Dockum Aquifer BRACS Study Extent

- 57 Texas Counties
- 20 Groundwater Conservation Districts
- 5 Groundwater Management Areas
- 4 Regional Water Planning Groups



- Major river
- US highway
- Interstate highway
- 🟡 Dockum Aquifer
- 🟣 Urban area
- ▭ County
- ▭ State boundary



Results of previous studies

Bradly, R.G. and Kalaswad, S., 2003: The Groundwater Resources of the Dockum Aquifer in Texas, TWDB Report 359.

- Dockum is classified as a minor aquifer*
- Covers approximately 26,000 square miles in Texas
- 109 million acre-feet of fresh and brackish groundwater with total dissolved solids between 0 to 5,000 milligrams per liter.
- 27 million acre-feet of brackish groundwater with total dissolved solids from 5,000 to 10,000 milligrams per liter.

** Aquifers that produce minor amounts of water over large areas or large amounts of water over small areas.*



- Geologic footprint of the Dockum Group extends into four States.
- Identified as Triassic aged sediments by Cummins in 1890 who assigned the name Dockum beds.

Figure 2-1. Lateral extent of the Dockum Group in southwestern United States (modified from McKee and others, 1959; Bureau of Economic Geology, 1967, 1968, 1969, 1974, and 1983; McGowen and others, 1977).

Stratigraphic Controversy

Table 3.0.1 Summary of Triassic Dockum Group nomenclature (modified from Bradley and Kalaswad, 2003).

Author	Cummins (1890)	Gould (1907)	Hoots (1926)	Darton (1928)	Adams (1929)	McGowen and others (1975; 1977; 1979)	Hart and others (1976)	Granata (1981)	Lucas and Anderson (1992; 1993; 1994; 1995)	Lehman (1994a; 1994b)			
Region	Southern High Plains Texas & New Mexico	Northern Texas Panhandle	Southern Texas Panhandle	Eastern New Mexico	Southern Texas Panhandle	Southern High Plains Texas & New Mexico	Oklahoma Panhandle	Northern New Mexico		Southern High Plains Texas & New Mexico			
Dockum subunit distinctions vertically	Dockum Redbeds	(thin or absent)	Upper red clay	Chinle Formation	Chinle Formation	Upper Dockum ⁽²⁾	Upper Dockum ⁽²⁾	Redonda Formation	Chinle Group	Dockum Formation	Bull Canyon Member	Redonda Formation ⁽¹⁾	
		Trujillo sandstone and shale						Chinle Formation				Upper Dockum ⁽²⁾	Chinle Formation
			Tecovas basal shale	Basal red clay and sandstone	Santa Rosa Sandstone	Santa Rosa Sandstone	Lower Dockum ⁽²⁾	Lower Dockum ⁽²⁾			Santa Rosa Sandstone	Camp Springs Member	Sequence 1
		(generally absent)		(generally absent)	Basal shales								

⁽¹⁾ in New Mexico only

⁽²⁾ not intended as a formal stratigraphic name

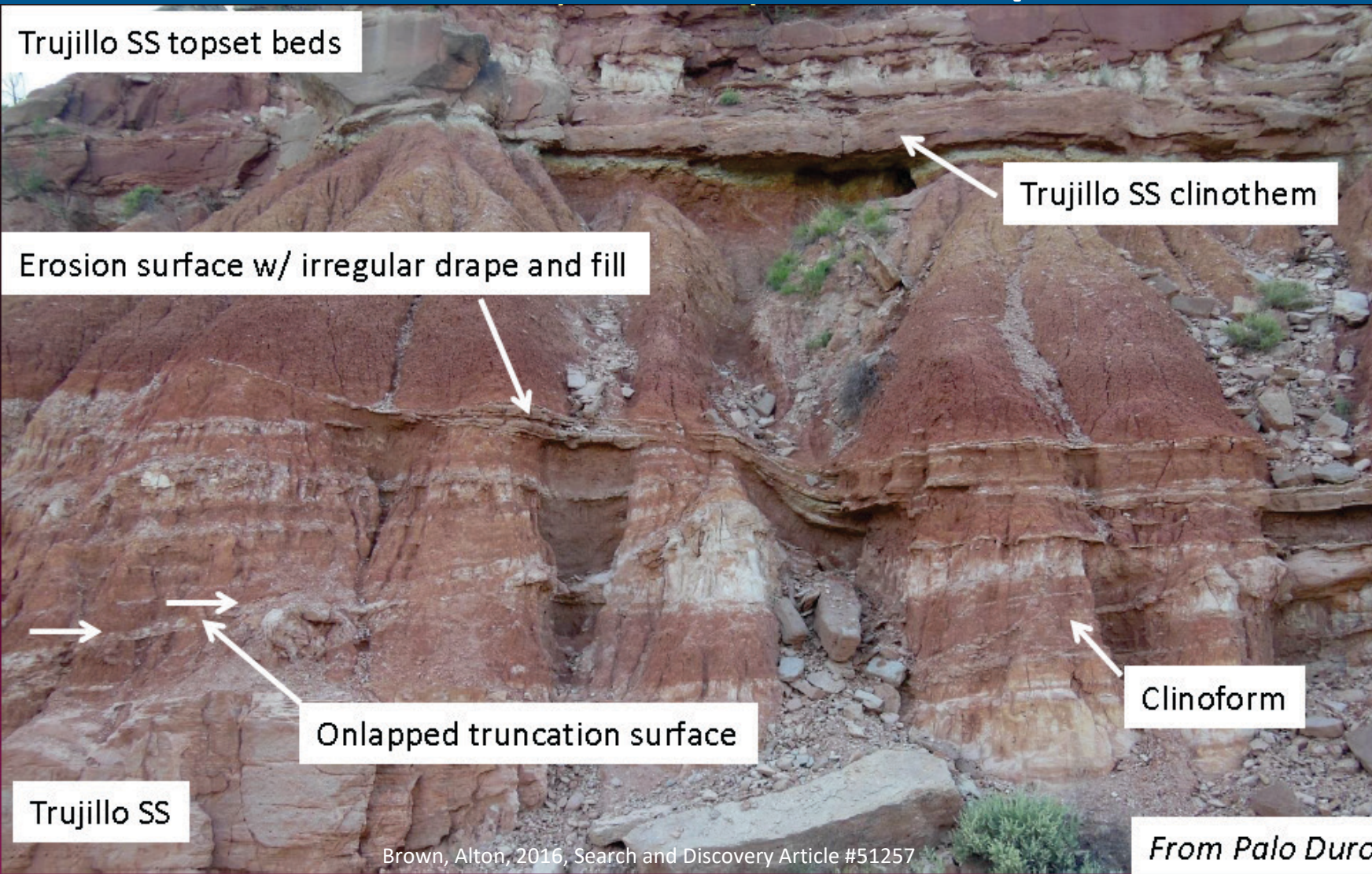
Dockum is considered a group designation by all researchers except Lucas and Anderson.

Lateral stratigraphic correlation between units depicted on this table is not intended.

Bradley and Kalaswad (2003) refer to the more prolific parts of the Dockum Aquifer as simply the "Best Sandstone".

Ewing, et al, 2008: Final Report – Groundwater Availability Model for the Dockum Aquifer, TWDB.

Dockum Outcrops



Brown, Alton, 2016, Search and Discovery Article #51257

From Palo Duro Canyon

Geophysical Well Logs

Texas Tech University, *Jeffrey W. Martz, May 2008*

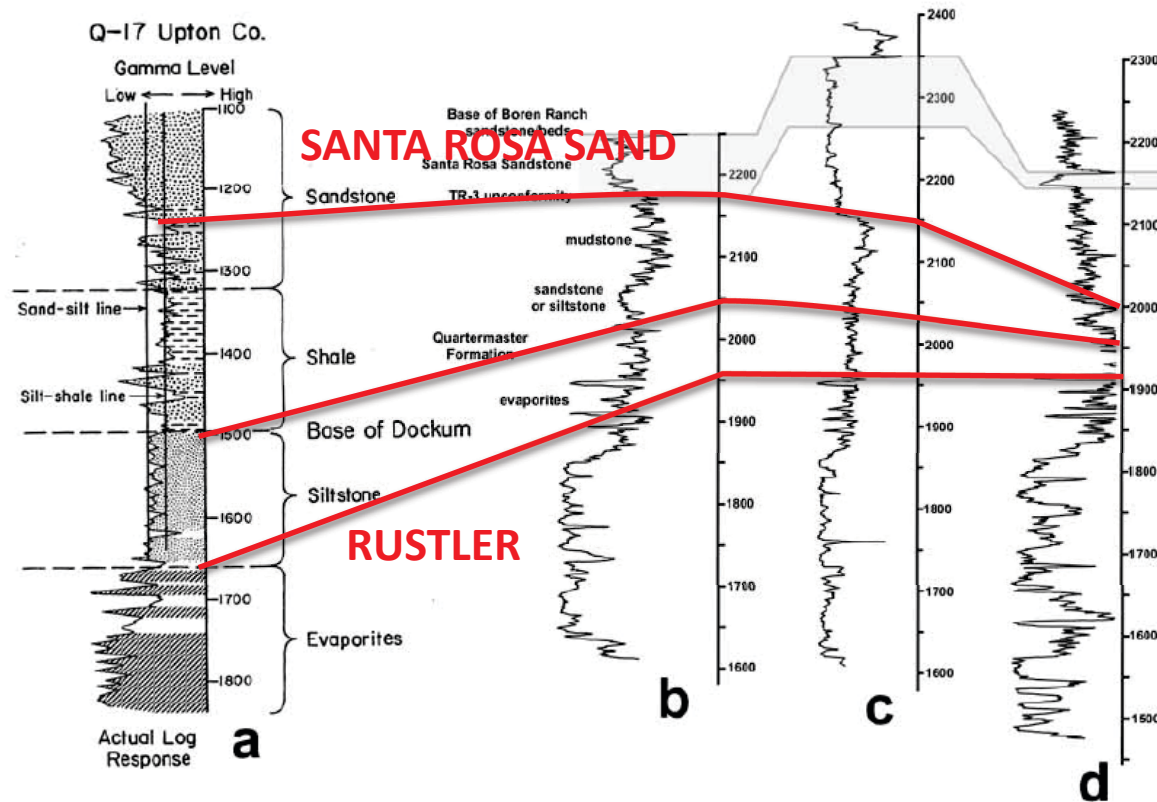
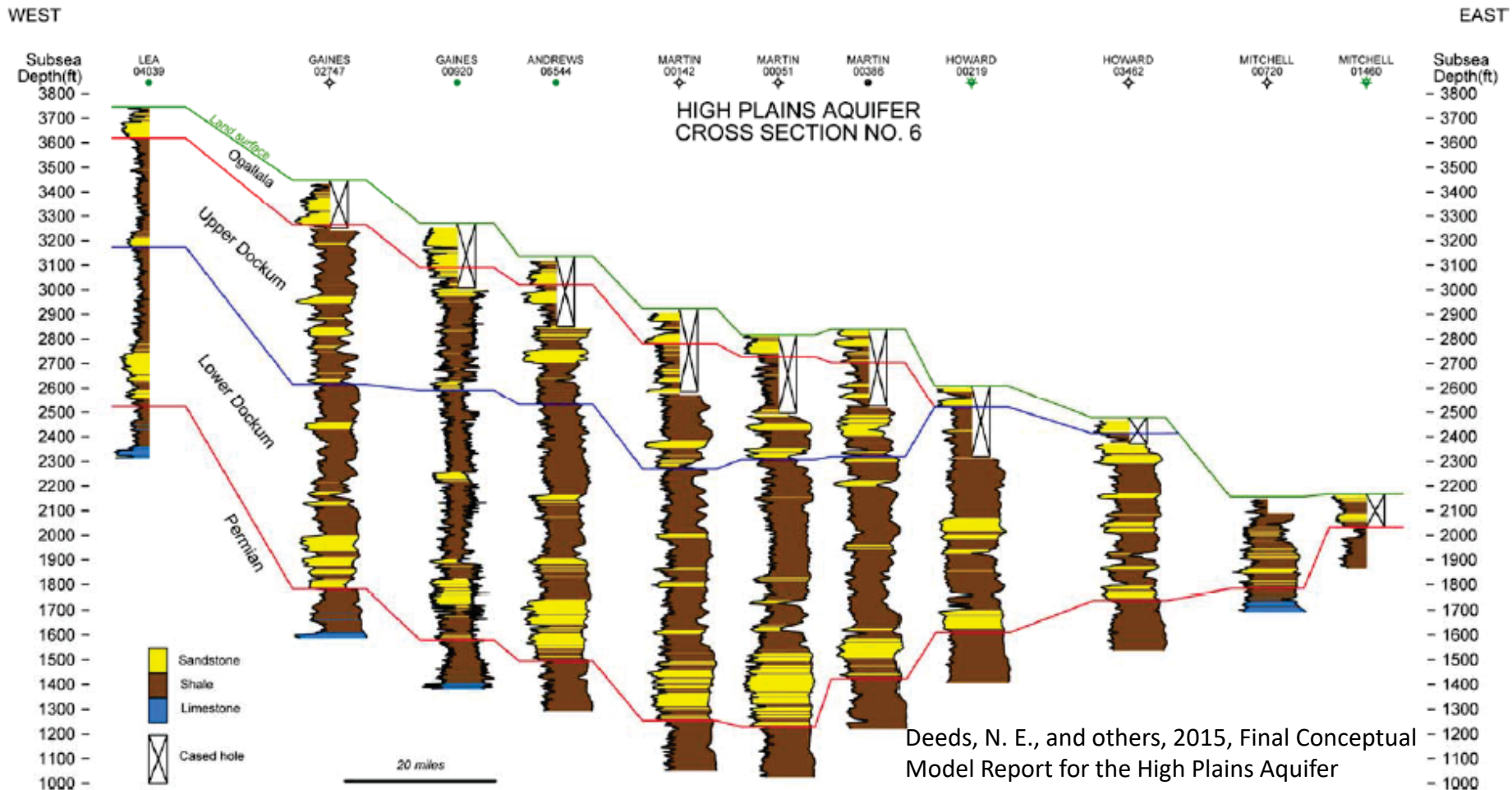


Fig. 2.32. The base of the Dockum Group in gamma-ray well logs: *a*, McGowan et al.'s (1979, fig. 32) identification of the base of the Dockum Group; *b-d* gamma-ray well logs in southern Garza County showing interpreted TR-3 unconformity, Santa Rosa Sandstone, and base of Boren Ranch Sandstone/beds; *b*, America Liberty Oil Company No. 7 I.N. McCrary; *c*, Bush Exploration No. A-2 Beggs 45; *d*, Humble Oil and Refining Company No. 1 Irene Rodgers.

Complex Lithologic Model



Deeds, N. E., and others, 2015, Final Conceptual Model Report for the High Plains Aquifer System Groundwater Availability Model: report prepared for the TWDB.

Figure 4.2.8 Cross-section #6.

Simplified Lithologic Model

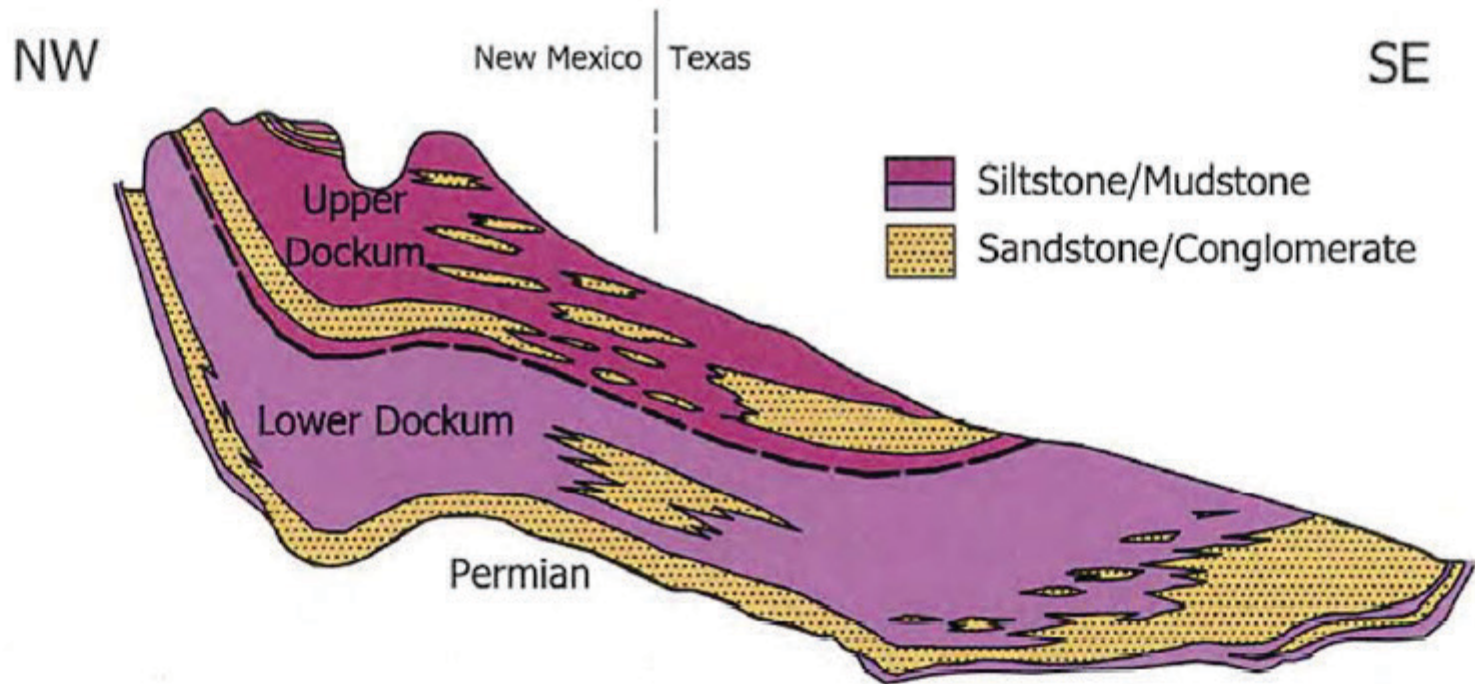
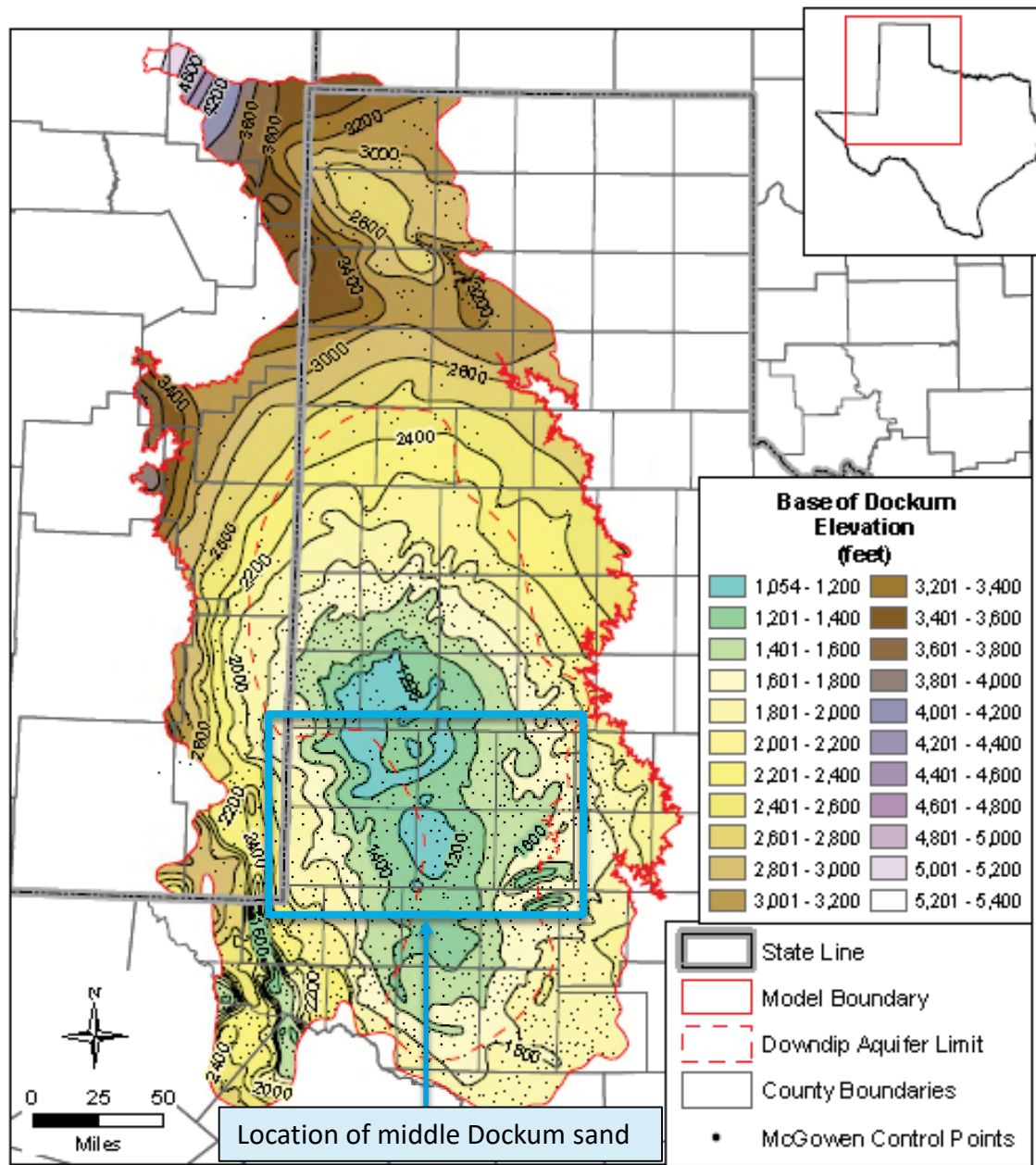


Figure 2.2.4 Schematic cross section of the Dockum Aquifer in New Mexico and Texas (modified from Ewing and others, 2008).

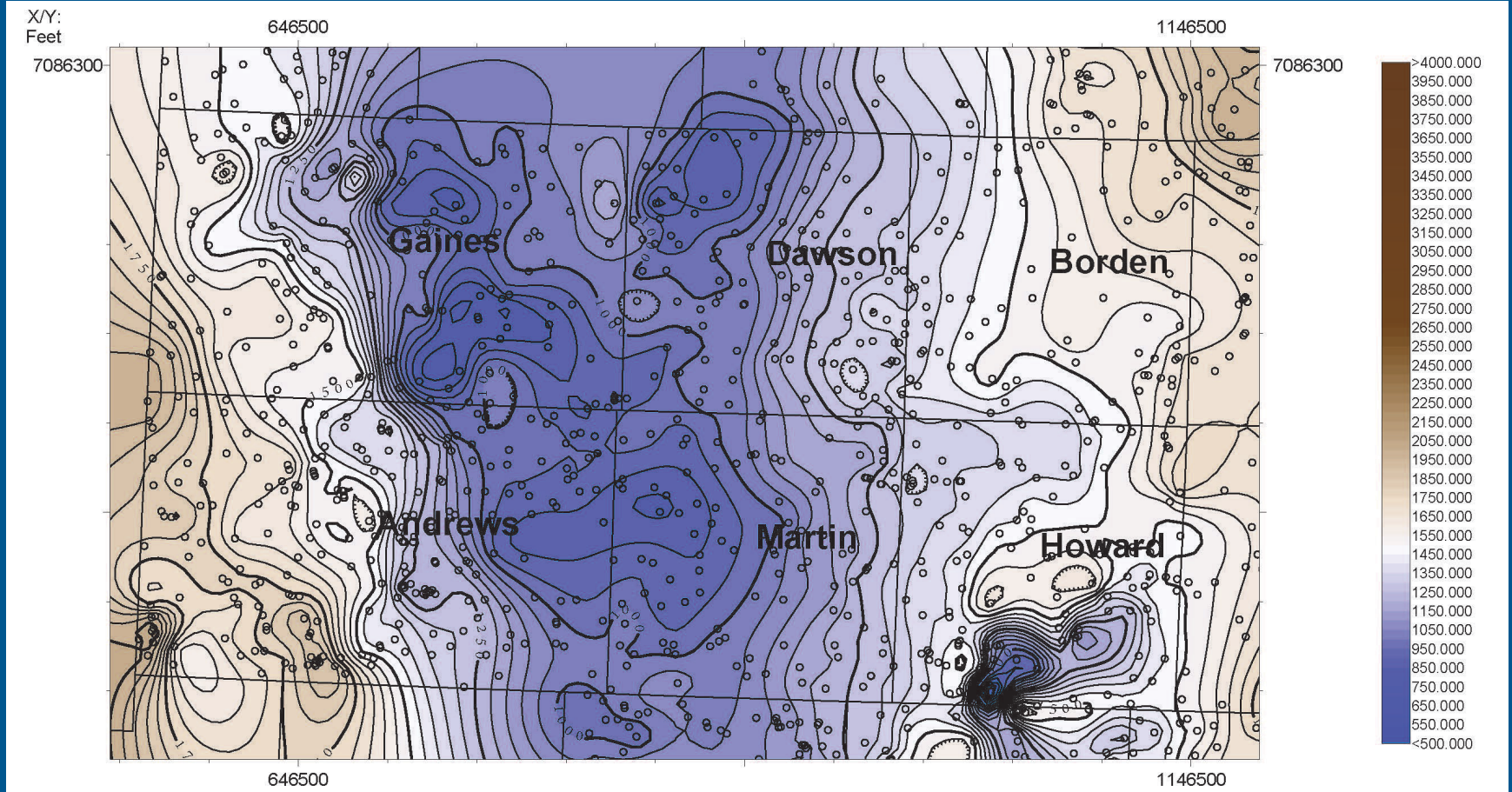


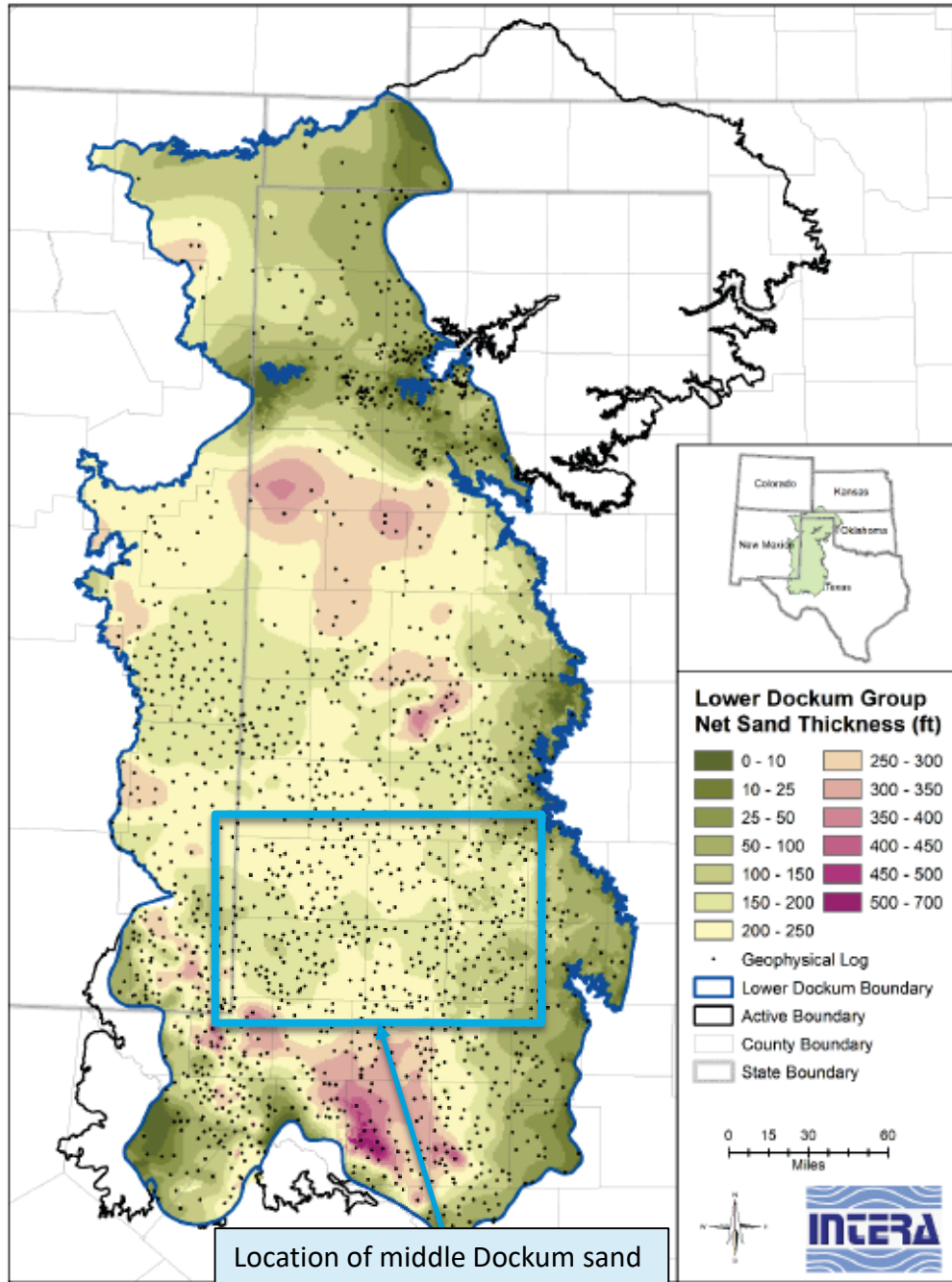
Source: McGowen and others (1977)

- Base of Dockum generally follows trend of Permian Basin structural low as defined by the Permian-Triassic boundary.

Figure 4.2.2 Base of Dockum Aquifer.

Top of Rustler Formation Structure Map



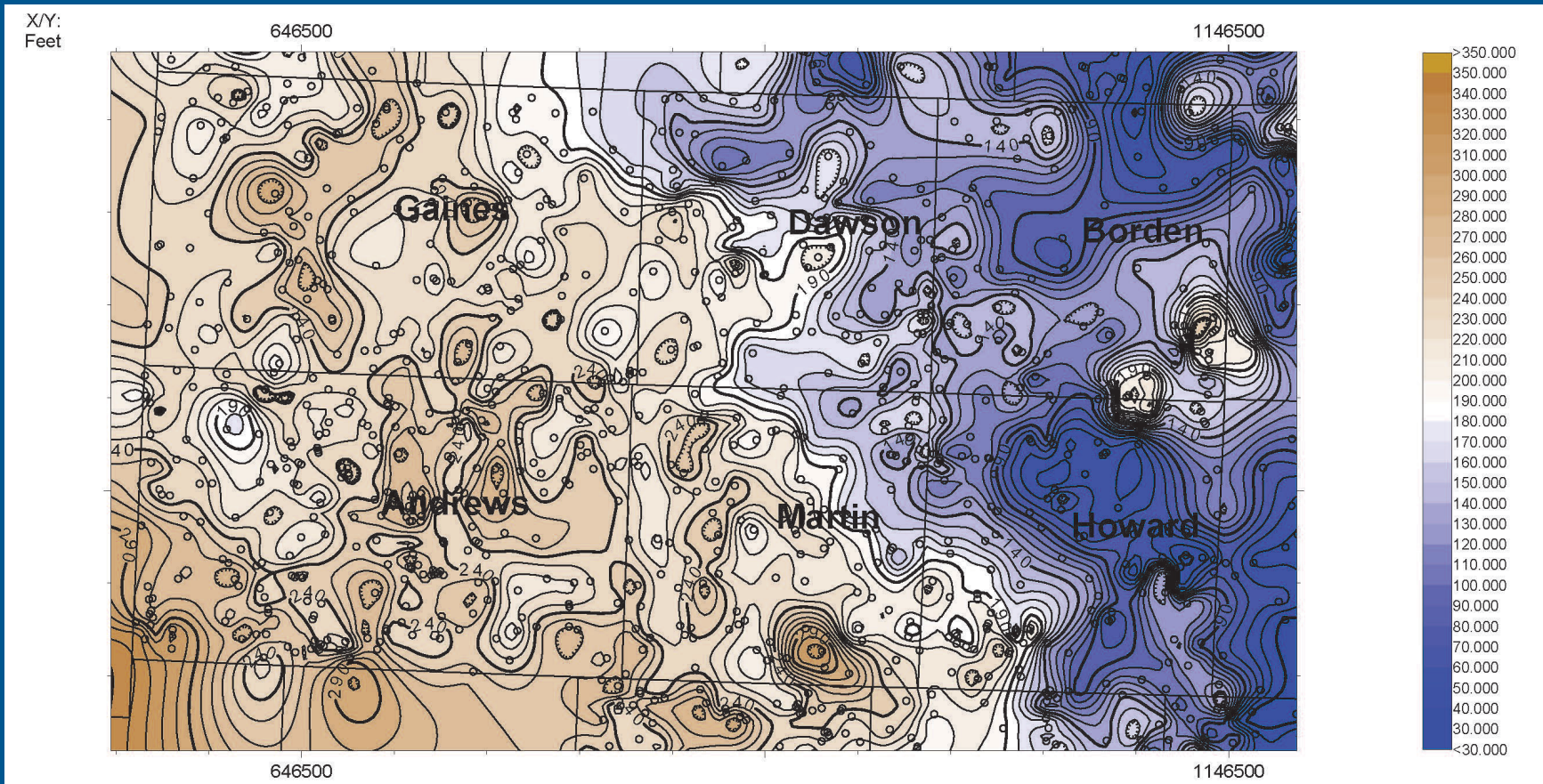


- Net sand map of “Lower Dockum”
- Sand thicknesses generally less than 200 feet in area of the middle Dockum sand.
- No significant trend.
- Slight thinning across center of middle Dockum sand area.

Deeds, N. E., and others, 2015, Final Conceptual Model Report for the High Plains Aquifer System Groundwater Availability Model: report prepared for the TWDB.

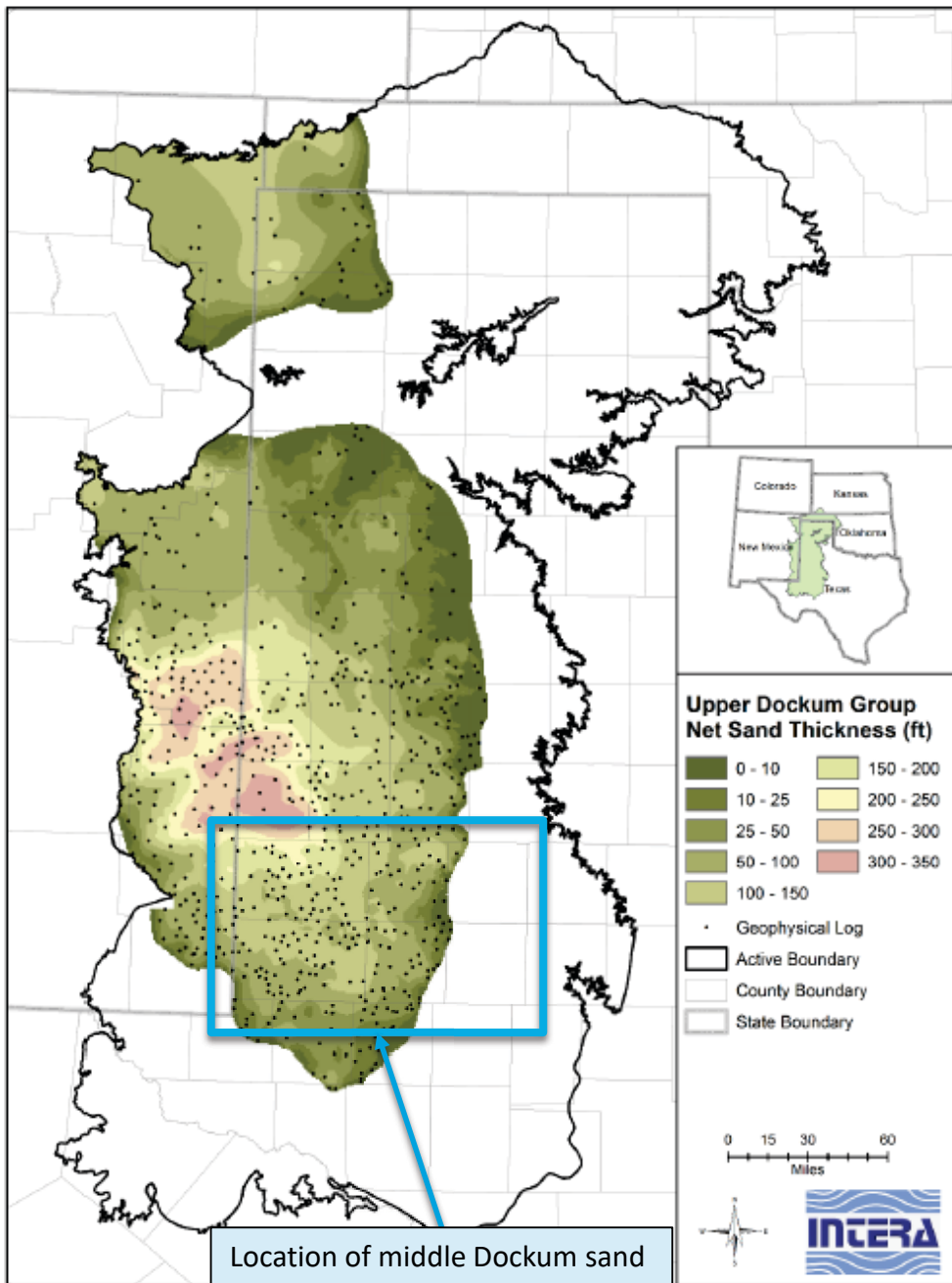
Figure 4.2.29 Net sand thickness of the lower Dockum Group in feet.

Santa Rosa Sand Isopach Thickness Map



- Santa Rosa Sand has well defined trend ranging from 350 feet to less than 100 feet west to east.

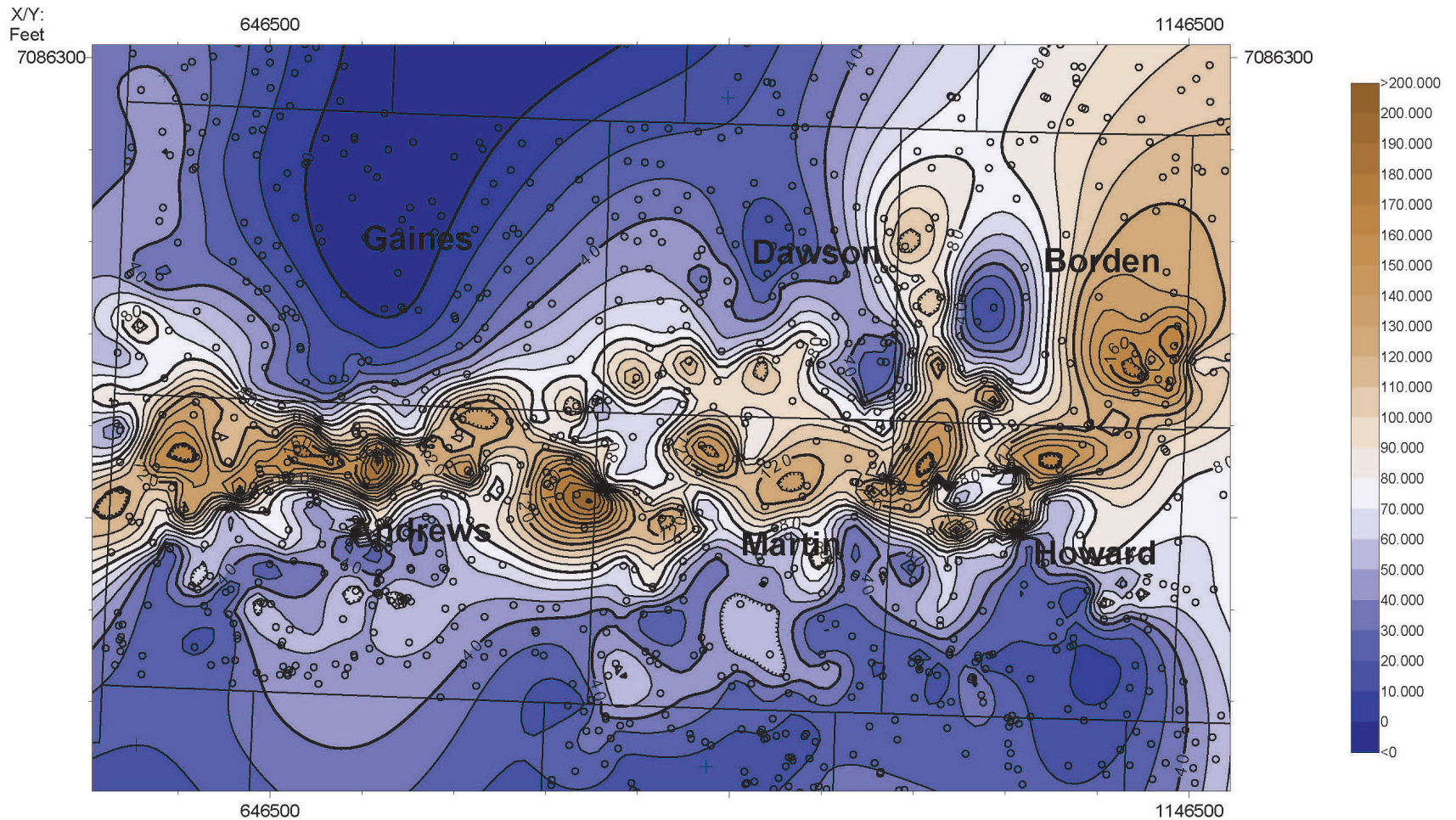
- Net sand map of “Upper Dockum”
- Up to 300 feet thick in the northwest edge, but generally 100 feet thick at location of channel.



Deeds, N. E., and others, 2015, Final Conceptual Model Report for the High Plains Aquifer System Groundwater Availability Model: report prepared for the TWDB.

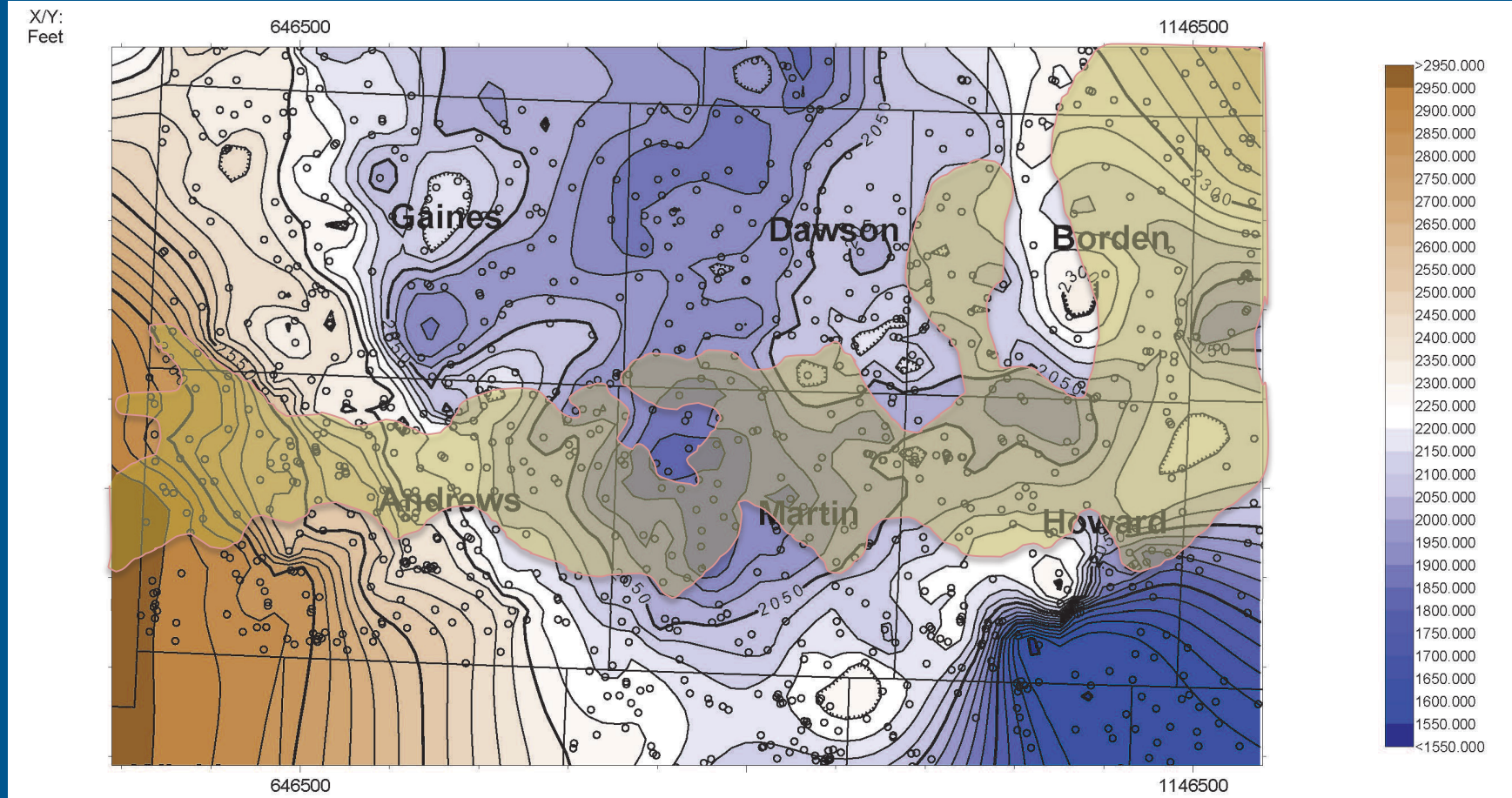
Figure 4.2.28 Net sand thickness of the upper Dockum Group in feet.

Middle Dockum Sand Thickness Map

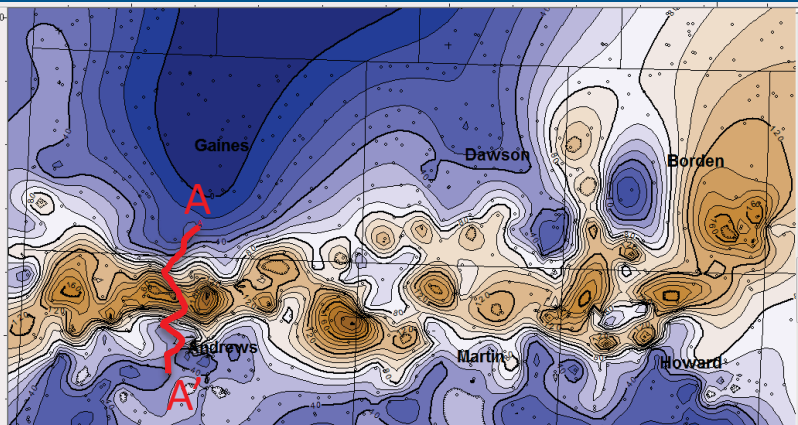


- Well defined sand body, 50 to 200 feet in thickness.

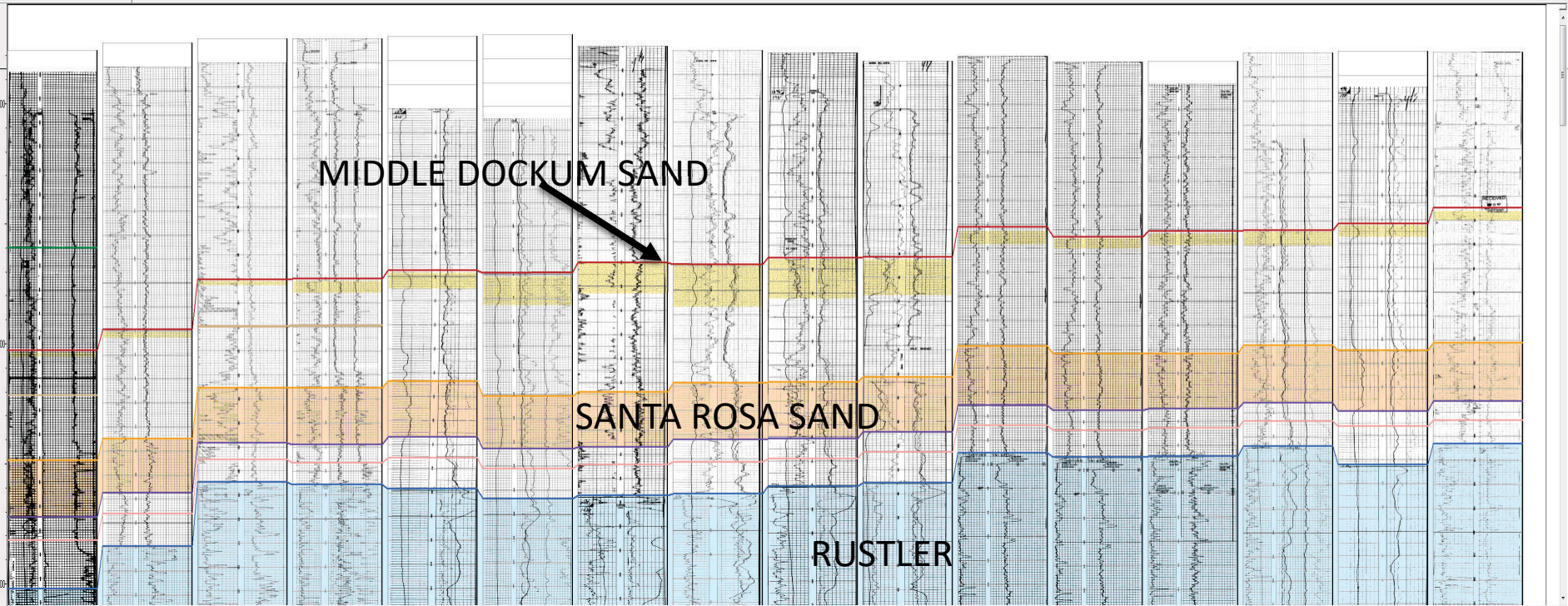
Top of Middle Dockum Sand Structure Map



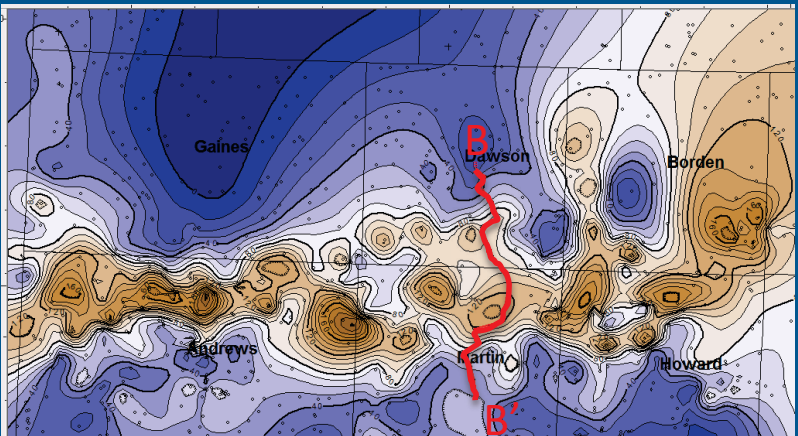
Cross-section A-A' North-South Andrews County Structural – referenced msl



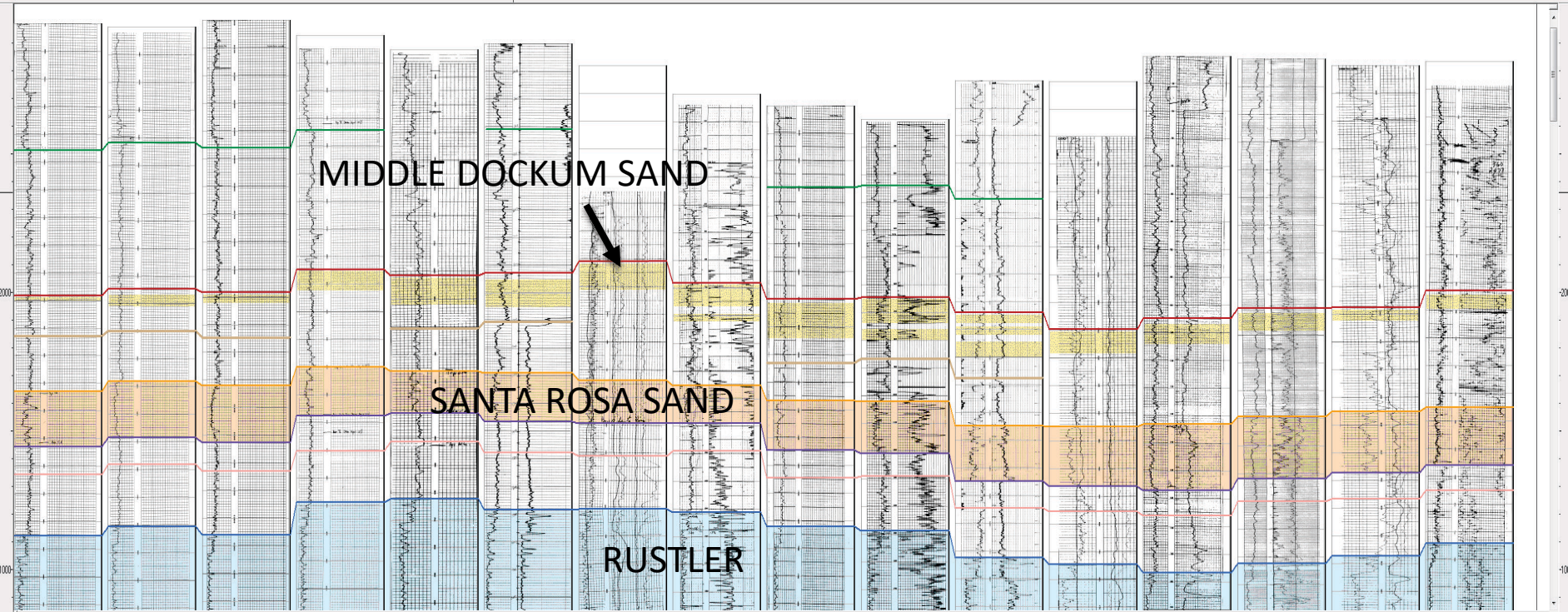
C. THOMPSON 1 30720' STATE 1 12500' WHITE NO. 1 30730' H.G. BARRIS 2 17100' WILLIAMSON 1 5760' BETTIE COX 1 13015' J.L. CRUMP 1 3080' UNIVERSITY C-25-1 8034' UNIVERSITY 1 7330' M.M. FISHER 1 20094' UNIVERSITY 1435 2803' UNIVERSITY 1435 1334' UNIVERSITY 1434 1906' UNIVERSITY BC 1 14700' W. CRENSHAW A 1 15223' M.C. PEATH NO. 1



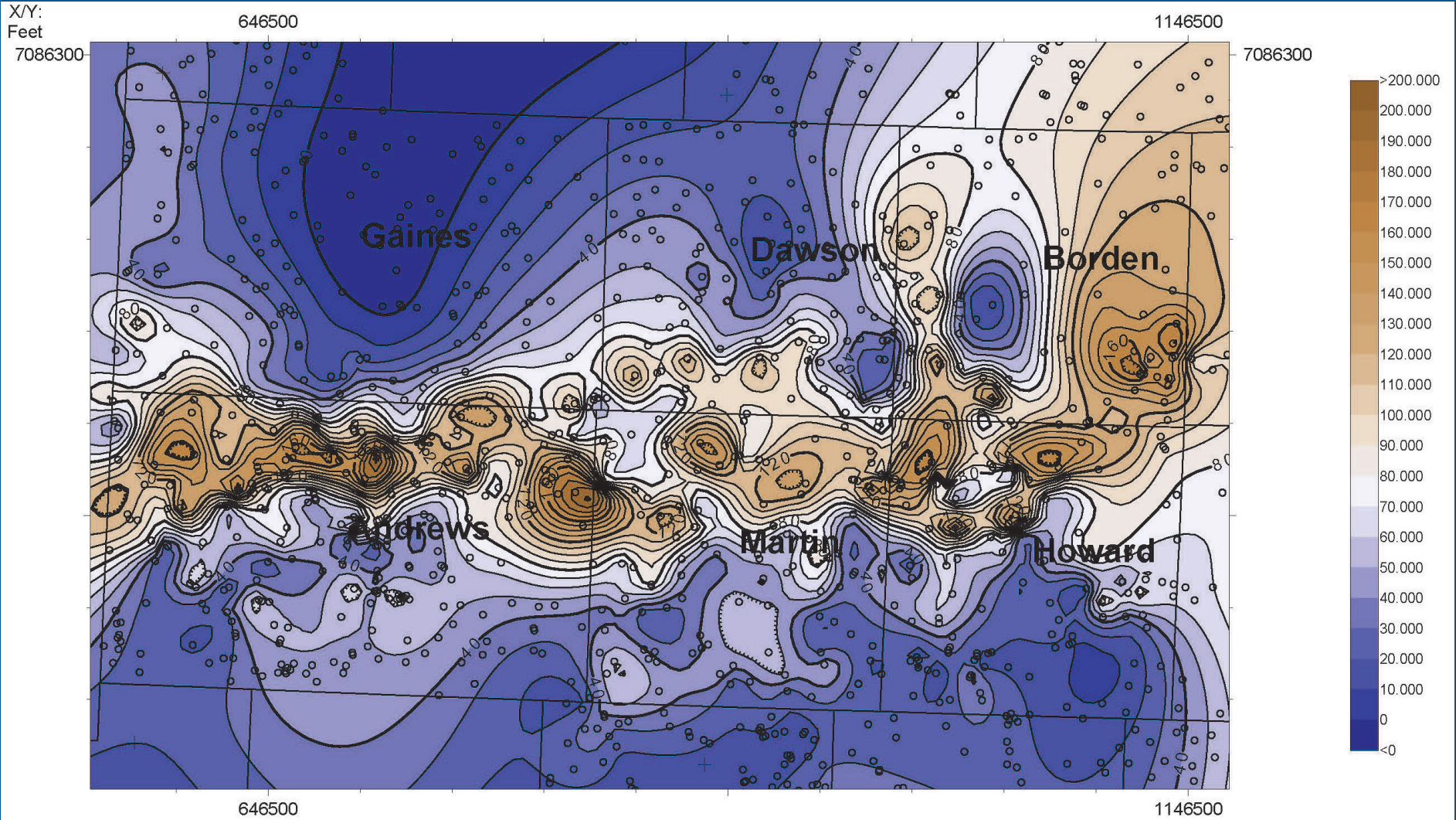
Cross-section B-B' North-South Dawson/Martin Counties Structural – referenced msl



MATTIE OPAL DURHAM 1 10440 ft HILEMAN 1 7819 ft JOHN DELL BARRON A-1 10241 ft BERRY 1-39 12253 ft O. WILLIAMS 1 15466 ft ANDERSON A-1 24000 ft R.C. ROBERT 1 25379 ft RUFUS GREEN 1 24674 ft E. D. HOLCOMB NO. 1 6324 ft HOLCOMB 1 21154 ft WOODWARD B-3 13044 ft BROWN 1 15530 ft LOWDER 1 10407 ft STANDEFER 1 13430 ft LENDRAH EPLEY 1 14763 ft EPLEY ET AL. 1



Middle Dockum Sand Thickness Map



Recent water wells

<http://www2.twdb.texas.gov/apps/WaterDataInteractive/GroundwaterDataViewer/>

STATE OF TEXAS WELL REPORT for Tracking #352563															
Owner:	DIAMOND BACK ENERGY	Owner Well #:	1												
Address:	14301 CALIBER STE. 300 OKLAHOMA, OK 73134	Grid #:	27-39-4												
Well Location:	07-04 WSW #1 TX	Latitude:	32° 25' 01" N												
Well County:	Andrews	Longitude:	102° 13' 01" W												
		Elevation:	2893 ft. above sea level												
This well has been plugged		Plugging Report Tracking #165863													
Type of Work:	New Well	Proposed Use:	Rig Supply												
Drilling Start Date: 12/27/2013 Drilling End Date: 1/3/2014															
Borehole:	<table border="1"> <thead> <tr> <th>Diameter (in.)</th> <th>Top Depth (ft.)</th> <th>Bottom Depth (ft.)</th> </tr> </thead> <tbody> <tr> <td>22</td> <td>0</td> <td>40</td> </tr> <tr> <td>18</td> <td>0</td> <td>360</td> </tr> <tr> <td>12.25</td> <td>0</td> <td>1080</td> </tr> </tbody> </table>	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)	22	0	40	18	0	360	12.25	0	1080		
Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)													
22	0	40													
18	0	360													
12.25	0	1080													
Drilling Method:	Mud (Hydraulic) Rotary														
Borehole Completion:	Filter Packed														
Filter Pack Intervals:	<table border="1"> <thead> <tr> <th>Top Depth (ft.)</th> <th>Bottom Depth (ft.)</th> <th>Filter Material</th> <th>Size</th> </tr> </thead> <tbody> <tr> <td>400</td> <td>1080</td> <td>Gravel</td> <td>3/8</td> </tr> </tbody> </table>	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size	400	1080	Gravel	3/8						
Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size												
400	1080	Gravel	3/8												
Annular Seal Data:	<table border="1"> <thead> <tr> <th>Top Depth (ft.)</th> <th>Bottom Depth (ft.)</th> <th>Description (number of sacks & material)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>40</td> <td>45</td> </tr> <tr> <td>0</td> <td>100</td> <td>50</td> </tr> <tr> <td>0</td> <td>360</td> <td>250</td> </tr> </tbody> </table>	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)	0	40	45	0	100	50	0	360	250		
Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)													
0	40	45													
0	100	50													
0	360	250													
Seal Method:	PRESSURE CEMENT	Distance to Property Line (ft.):	6.8 MILES												
Sealed By:	EPIFANIO HINOSOSA	Distance to Septic Field or other concentrated contamination (ft.):	NA												
Variance Number:	NA	Distance to Septic Tank (ft.):	No Data												
		Method of Verification:	OWNER												
Surface Completion:	Surface Sleeve Installed														
Water Level:	600 ft. below land surface on 2014-01-04 Measurement Method: Unknown														

Completed in Middle Dockum Sand 50gpm

9/19/2010 9:51:46 AM

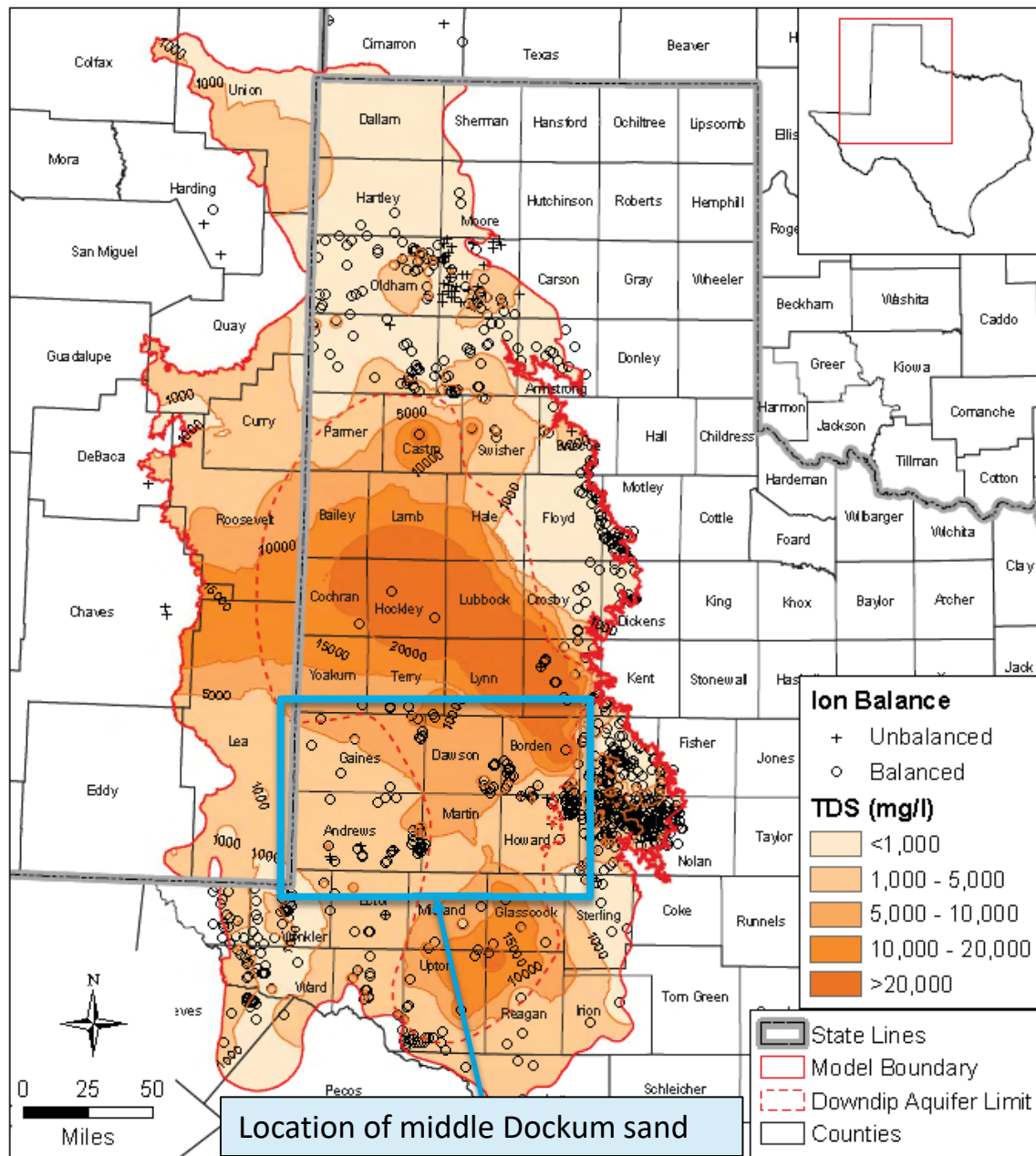
Well Report Tracking Number 352563
Submitted on: 1/28/2014

Page 1 of 3

STATE OF TEXAS WELL REPORT for Tracking #374606																																																				
Owner:	QEP	Owner Well #:	7-28-1																																																	
Address:	6100 YALE TULSA, OK 74136	Grid #:	27-39-9																																																	
Well Location:	CO RD 349 TARZAN, TX	Latitude:	32° 24' 06" N																																																	
Well County:	Martin	Longitude:	102° 09' 51" W																																																	
		Elevation:	No Data																																																	
Type of Work:	New Well	Proposed Use:	Fracking Supply																																																	
Drilling Start Date: 8/7/2014 Drilling End Date: 8/16/2014																																																				
Borehole:	<table border="1"> <thead> <tr> <th>Diameter (in.)</th> <th>Top Depth (ft.)</th> <th>Bottom Depth (ft.)</th> </tr> </thead> <tbody> <tr> <td>17.5</td> <td>0</td> <td>1820</td> </tr> </tbody> </table>	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)	17.5	0	1820																																													
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Lithology: DESCRIPTION & COLOR OF FORMATION MATERIAL		Casing: BLANK PIPE & WELL SCREEN DATA																																																		
<table border="1"> <thead> <tr> <th>Top (ft.)</th> <th>Bottom (ft.)</th> <th>Description</th> <th>Dia. (in.)</th> <th>New/Used</th> <th>Type</th> <th>Setting From/To (ft.)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>20</td> <td>TOPSOIL</td> <td>13</td> <td>3/8</td> <td>N STEEL BLANK</td> <td>+2-988</td> </tr> <tr> <td>20</td> <td>220</td> <td>LIMESTONE</td> <td>8</td> <td>5/8</td> <td>N STEEL BLANK</td> <td>+3-1084</td> </tr> <tr> <td>220</td> <td>320</td> <td>SAND</td> <td>8</td> <td>5/8</td> <td>N SS SCREEN</td> <td>1084-1190 .020</td> </tr> <tr> <td>320</td> <td>1000</td> <td>RED SHALE</td> <td>8</td> <td>5/8</td> <td>N STEEL BLANK</td> <td>1190-1442</td> </tr> <tr> <td>1000</td> <td>1700</td> <td>BROKEN SAND /RED SHALE</td> <td>8</td> <td>5/8</td> <td>N SS SCREEN</td> <td>1442-1692 .020</td> </tr> <tr> <td>1700</td> <td>1820</td> <td>SHALE</td> <td>8</td> <td>5/8</td> <td>N STEEL BLANK</td> <td>1692-1713</td> </tr> </tbody> </table>	Top (ft.)	Bottom (ft.)	Description	Dia. (in.)	New/Used	Type	Setting From/To (ft.)	0	20	TOPSOIL	13	3/8	N STEEL BLANK	+2-988	20	220	LIMESTONE	8	5/8	N STEEL BLANK	+3-1084	220	320	SAND	8	5/8	N SS SCREEN	1084-1190 .020	320	1000	RED SHALE	8	5/8	N STEEL BLANK	1190-1442	1000	1700	BROKEN SAND /RED SHALE	8	5/8	N SS SCREEN	1442-1692 .020	1700	1820	SHALE	8	5/8	N STEEL BLANK	1692-1713			
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1700	1820	SHALE	8	5/8	N STEEL BLANK	1692-1713																																														
Water Level:	662 ft. below land surface on 2014-08-16 Measurement Method: Unknown																																																			
Packers:	No Data																																																			
Type of Pump:	Submersible	Pump Depth (ft.):	1239																																																	
Well Tests:	Estimated	Yield:	130 GPM with 290 ft. drawdown after 24 hours																																																	

Completed in Middle Dockum Sand and Santa Rosa Sand 130gpm

- Total dissolved solids from GAM study



Source: TWDB, Panhandle GCD; USGS/New Mexico; Hart and others (1976)

Figure 4.8.1 Total dissolved solids concentrations in milligrams per liter in groundwater in the Dockum Aquifer.

Next Steps: Multi-year study

- Hosted stakeholder meetings (Midland, Lubbock, *other*).
- Map stratigraphy, lithology, measured water quality, calculated water quality, aquifer properties, and existing use.
- Calculate the volume of fresh, slightly saline, moderately saline, and very saline groundwater
- Solicit stakeholder comments on final reports
- Evaluate areas for future zone designation and conduct modeling (possible)
- Designate brackish groundwater production zones by the Board (possible)
 - www.twdb.texas.gov/innovativewater/bracs/HB30.asp

Stakeholder Input Needed

- Additional Dockum Well Data
 - Aquifer Tests
 - Water chemistry
- Injection well data
- Current use of brackish groundwater for domestic, agricultural, and public supply.