

Brackish Groundwater in the Gulf Coast Aquifer, Lower Rio Grande Valley, Texas

by John Meyer, P.G.

Rio Grande Regional Water Authority December 3, 2014



The following presentation is based upon professional research and analysis within the scope of the Texas Water Development Board's statutory responsibilities and priorities but, unless specifically noted, does not necessarily reflect official Board positions or decisions.

Source: TWDB General Counsel

Why did we study the Lower Rio Grande Valley?

- Population will more than double in the next 50 years 1.7 to 3.9 million people
- Municipal water demand will more than double in the next 50 years 260,000 to 581,000 acre-feet per year
- Brackish groundwater use will more than quadruple in next 50 years
 20,000 to 92,000 acre-feet per year
- Highest density of desalination plants in Texas
 7 existing brackish groundwater desalination plants

Plans for additional 23 brackish groundwater desalination projects



Source: Region M statistics from 2012 State Water Plan

What did we produce?

• Published report

Brackish Groundwater in the Gulf Coast Aquifer, Lower Rio Grande Valley, Texas

by John E. Meyer, P.G. • Andrea Croskrey • Matthew R. Wise, P.G. • Sanjeev Kalaswad, Ph.D., P.G.

 Report 383
 Texas Water Development Board

 September 2014
 www.twdb.texas.gov



- GIS Datasets
- BRACS Database
- Well logs

The real value is in the data:

Stakeholders can use this to evaluate potential groundwater exploration areas.



Where is the study?





What were the study objectives?

- Collect water well reports and oil/gas geophysical well logs
- Compile all data into BRACS Database
- Map salinity areas (2-dimensional) with a unique vertical salinity profile
- Create 3-dimensional salinity zone GIS datasets
- Map sand and clay layers within the Gulf Coast Aquifer
- Determine volumes of brackish groundwater
- Water quality parameter maps
- Aquifer property maps
- Study deliverables: Report, Database, GIS Datasets, and well logs



Groundwater Salinity Classification





Source: modified from Winslow and Kister, 1956

How much groundwater is there?



Where is the brackish groundwater?

Salinity Areas A through G



Salinity Profiles

Α	В	C	D	E	F	G	Groundwater Salinity	Total Dissolved Solids
ab.	τα	po.	7(f elaite	18E 102			Classification	Concentration
				SS Shallow 2		VS Shallow 1		(units: milligrams per liter)
			8				Fresh	0 to 1,000
		MS Shallow 5		MS Intermediate	MS Shallow 4	MS Shallow 4	Slightly Saline	1,000 to 3,000
				1	60 D	22 D	Moderately Saline	3,000 to 10,000
	SS Deep	SS Deep		SS Deep	SS Deep	SS Deep	Very Saline	10,000 to 35,000
1 CD) (C D	MGD) (C D) (C D		1 C D	Brine	Greater than 35,000
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep		
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep		
	488							
BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep		
								Texas Water 🥟
Source Low	er Rio Gran	de Vallev RI	RACS Study					Development Board

How do we obtain the study report and data?

Download the study at www.twdb.texas.gov

- Report 383
- GIS Files
- BRACS Database and Data Dictionary (OF 12-02)
- Obtain digital well logs (email us for this data)





• 🖷 Gulf Coast Aquifer GIS Datasets (127.0 MB)

Decide what do you need?

- Regional plant with many wells? •
- Small plant with one or two wells? for example, North Alamo WSC ٠

for example, Southmost

Lots of information to evaluate:

- cost and financing
- project partners
- water needs
- distance to existing infrastructure
- land acquisition
- hydrogeology
- existing water well production in the area
- existing injection well disposal in the area
- concentrate disposal options
- and so on



Where do you need it? Draw a circle on the map.



Source: Lower Rio Grande Valley BRACS Study

Texas Water Composition Development Board

Qualitative review of data, using the report.



Source: Lower Rio Grande Valley BRACS Study

Iexas Water Development Board



Quantitative review of data using database and GIS files.

Database

- Review well control in database
- Use the salinity zone database form
- Use the net sand database form
- Review water quality data
- Review aquifer property data
- Build custom queries and display data in GIS

• GIS

- Three-dimensional salinity zone surfaces
- Additional well control in area
- Class II injection wells
- Map / air photo overlays

BRACS Database: Project salinity zone table

Every project well (>2,900 wells) can be reviewed on this form

Well ID Numbers for BRACS and Groundwater Databases

Source: BRACS program

BRACS Database: Project net sand determination tables

Every well used for sand analysis (593 wells) can be reviewed on this form Wells are in a separate table processed for salinity zones

TWDB WS	IWT BRACS Net Sand Determination														
BRACS Well	D 1737				Lower	Rio Grande Va	lley BRAC	S Study							Close Form
					N	et Sand Gulf C	oast Aqui	fer							
Net Sand	Processing Table		Top				Formation	Formation Present	Partial	Aquifer Net Sand	Aquifer Present				
Record Number	Simplified Lithologic Description		Thickness	Sand %			Sand %	Well Partial Penetration	Geology Desc	Sand %	Well Partial Penetration		Aquifer Deter	mination Table	
23	Sand with Clay		65		^	Beaumont Fm	200	Yes		Chicot Aa	uifer	Depth Well	601	B_T_D:	0
			105	0.65			-99999	No	Yes	enreorrig	aijei	Depth Hole	600	B_B_D:	406
25	Sandwith Clav		40	0.05		Lissie Fm	100	Yes		300	Yes	Screen Top	290	L_T_D:	406
25	Sand with Clay		125				-99999	Yes	No	26	Yes	Screen Bottom	531	L_B_D:	732
			50	0.65		Willis Fm	0	Yes						W_T_D:	732
27	Sand with Clay	-	191				-999999	Yes	NO					W_B_D.	1137
			205							Evangelin	a Aquifor				
			14	0.65		Upper Goliad Fm	0	Yes	No	Lvungenn	e Aquijei			UG_T_D:	2251
28	Sand		205			Louise Colind Fm	-55555	Tes	NO		Ver				2251
			215	1		Lower Gonad Fm	-99999	Yes	No	0	Vec			LG_T_D.	3270
20	Clauwith Canad		215	I		Upper Lagarto Em	0	Vec			Tes			ULTD:	3270
25			215				-99999	Yes	No					UL_B_D:	4080
			70	0.35		n 									
30	Sand	-	285			Middle Lagarto Fm	n 0	Yes		Burkeville	Confining Unit			ML_T_D:	4080
			349	_			-99999	Yes	No					ML_B_D:	4936
			64	1	-	ij									
						Lower Lagarto Fm	0	Yes		Jasper Aq	uifer			LL_T_D:	4936
							-99999	Yes	No	0	Yes			LL_B_D:	5660
						Oakville Fm	0	Yes		0	Yes			OK_T_D:	5660
							-99999	Yes	NO					OK_B_D:	6906

Source: BRACS program

BRACS Database Data Dictionary

Brackish Resources Aquifer Characterization System Database Data Dictionary

Open File Report 12-02, Second Edition

September 2014

John E. Meyer, P.G.

All database tables are available for advanced queries.

This data dictionary will help you understand the data.

2. Well location table: tblWell_Location

The well location table contains one record per well. When a new well record is appended into the BRACS Database, the record is first added to this table, which assigns its unique identification number using an autonumber data type in the field [WELL_ID]. The table contains attributes about the well, such as owner, location, source of well information, and well depth information (Table 2-1).

Table 2-1. Table tblWell Location field names, data type and size, and lookup table references.

Field Name	Data Type	Size	Lookup Table
WELL ID	Long Integer	4	and a state of the
SOURCE WELL DATA	Text	250	tblLkSourceWellData
STATE NAME	Text	50	tblLkState
COUNTY NAME	Text	13	tblLkCounty
DEPTH TOTAL	Long Integer	2	and a second of the
DEPTH_WELL	Long Integer	2	18
ELEVATION BOTTOM WELL	Long Integer	2	~
ELEVATION BOTTOM HOLE	Long Integer	2	
DRILL DATE	Text	10	
KELLY BUSHING HEIGHT	Integer	2	10
OWNER	Text	100	5
WELL TYPE	Text	50	tblLkWellType
LATDD	Double	8	2
LONGDD	Double	8	
HORIZONTAL DATUM	Text	2	tblLkHorizontalDatum
LOCATION METHOD	Text	10	tblLkLocationMethod
LOCATION DATE	Date/Time	8	
AGENCY	Text	5	tblLkAgency
GRID 25MIN	Text	15	Contract Contract Contract
ELEVATION	Long Integer	4	at the second second second
VERTICAL DATUM	Text	2	tblLkVerticalDatum
ELEVATION METHOD	Text	1	tblLkElevationMethod
ELEVATION AGENCY	Text	5	tblLkAgency
ELEVATION DATE	Date/Time	8	
REMARKS	Text	250	
INITIALS	Text	3	tblLkIntial
ADDRESS	Text	100	2
CITY	Text	50	<i>a</i>
SITE DIRECTIONS	Text	255	

Field Descriptions

- WELL_ID Each well record in the database is assigned a unique well ID in this table using the Microsoff[®] Access[®] autonumber data type, which is a long integer. This is the key field in the table and serves as the primary key field linking every BRACS Database table.
- SOURCE_WELL_DATA Each well record is assigned the source of the well information. In some cases multiple sources exist; in this case, the source of the geophysical well log or water well driller report takes precedence. These field values are listed in the lookup table

tblLkSourceWellData (Table 2-2). This lookup table also contains a description of the data source, a web address if applicable, and a published report reference if applicable. The table will continue to grow with time as new sources of information are acquired, and Table 2-2 contains only a partial list of these values.

Table 2-2. Lookup table tblLkSourceWellData. A partial list of these values is presented in this table.

SOURCE WELL DATA	AGENCY
BAER Yegua Jackson Study	Baer Engineering and Environmental Consulting, Inc., with Intera, Inc.
BEG Paper/Digital Geophysical Logs	Bureau of Economic Geology, University of Texas at Austin
DBSA Capitan Reef Study	Daniel B. Stephens Assoc. et al
DBSA Llano Aquifers Study	Daniel B. Stephens Assoc. et al
GLO Paper/Digital Geophysical Logs	General Land Office
Intera Gulf Coast Aquifer Study	Intera, Inc.
Intera Rustler Aquifer Study	Intera, Inc.
NM EMNRD Geophysical Logs	New Mexico Energy, Minerals and Natural Resources Department
NM OSE Aquifer Test Information	New Mexico Office of State Engineers
NM OSE Digital Water Well Reports	New Mexico Office of State Engineers
NM OSE Paper Water Well Reports	New Mexico Office of State Engineers
RRC Digital Geophysical Logs	Railroad Commission of Texas
SL Digital Geophysical Logs	Subsurface Library
TCEQ PWS Water Wells	Texas Commission on Environmental Quality
TCEQ SC Q Paper/Digital Geophysical Logs	Texas Commission on Environmental Quality
TCEQ Water Well Images	Texas Commission on Environmental Quality
TDLR Digital Water Well Reports	Texas Department of Licensing and Regulation
TDLR Paper Water Well Reports	Texas Department of Licensing and Regulation
TWDB Aquifer Test Information	Texas Water Development Board
TWDB Geophysical Logs	Texas Water Development Board
TWDB Groundwater Database	Texas Water Development Board
TWDB Published Reports	Texas Water Development Board (and all predecessor agency names)
ULUTS Digital Geophysical Logs	University Lands, University of Texas System
USGS Brazos River Alluvium Study	U.S. Geological Survey
USGS Edwards-Trinity (Plateau) Study, Pecos Co.	U.S. Geological Survey
USGS Geophysical Logs	U.S. Geological Survey

STATE_NAME The state name based on the well location. This lookup table contains state and codes for Texas and adjacent states. These field values are listed in the lookup table toILKState.

- COUNTY_NAME The county name based on the well location. This lookup table contains state and county names for Texas and adjacent states. These field values are listed in the lookup table toILkCounty.
- DEPTH_TOTAL The total depth of the hole in units of feet below ground surface. This is reported on the water well driller report or header page on a geophysical well log. A value of -99999 is used if the value is not known.

Texas Water Development Board

Source: BRACS program

GIS analysis

- ✓ All GIS data is available on the web
- Fully documented with metadata
- ✓ Data is described in Report 383 appendices

Example tasks:

- Critically review existing well control
- Review additional well control
- Overlay maps / air photos
- Review three-dimensional salinity zones
- Build cross-sections to better understand three-dimensional sands
- Review distances to existing infrastructure

Additional well control in area.

Water wells: green dots blue dots no dots (TCEQ)

Oil / gas wells: black dots

Slightly saline zone bottom depth

Due diligence: no surprises!

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This log was downloaded from the Texas Commission on Environmental Quality website.

- ✓ > 500,000 paper well logs were scanned as pdf files.
- ✓ Difficult to use (locations ?)
- $\checkmark\,$ However, lots of information

Review spatial distribution of wells using cross-sections.

Slightly saline zone bottom depth

Hire a consultant?

- Critically review existing well control
- Evaluate sand character (log shape, continuity between wells, ...)
- ✓ Site visit: verify well locations, sample more wells, ...
- ✓ Class II well location and history of injection
- Class V well location and history of injection
- Drill test and monitor wells.
 - pumping test
 - evaluate sand character
 - water quality samples
- ✓ Construct groundwater model
- ✓ Share well data with TWDB ???

Summary

- There is substantial brackish groundwater for development
- This study can support the identification of favorable exploration sites
- Well field drilling and testing is required to provide site-specific details that this study cannot provide
- BRACS study deliverables available on TWDB website
- Geophysical well log files available upon request
- Additional contract reports and deliverables available on TWDB website
- Future efforts:
 - TWDB will solicit contractor to build a new groundwater model in study area to evaluate effect of brackish groundwater pumping on freshwater aquifers and land subsidence
 - TWDB is very interested in obtaining new well data in study area

www.twdb.texas.gov

Conservation and Innovative Water Technologies Division

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Additional slides to answer questions

Recommended Desalination Plants

Source: 2011 Recommended Innovative Strategies of the Regional Water Planning Groups

Existing Desalination Plants

ID	Plant Name	Potential Plant Capacity (MGD)	
1	North Alamo Water Supply Corporation (Donna)	2.25	MS I
2	North Alamo Water Supply Corporation (Doolittle)	3.50	SS D
3	North Alamo Water Supply Corporation (Lasara)	1.20	SS D
4	North Alamo Water Supply Corporation (Owassa)	2.00	SS D
5	North Cameron/Hidalgo WA	2.50	MS I
6	Southmost Regional Water Authority	7.50	SS D
7	Valley MUD #2	1.00	MS I

MS = Moderately Saline

Deep eep and MS Deep)eep)eep Deep)eep Deep Texas Water Development Board

Salinity zones used by plants

Water Well Logs

ATTENTION OWNER: Confidentia Privilege Notice on Reverse	lity Side	STATE OF TEXAS Water Well Report			
1) DWHER: MERCEDES. CITY DF 2) ADDRESS OF WELL	ADDRESS: P.O. SEE ATTACHED MAP	BOX 837 CIT GRID 1	Y: MERCEDES STATE: TX _ZIP: 78570 ; 5)		
3) TYPE OF WORK: NEW WELL 4) PROPOSED USE: PUBLIC SUPPLY					
6) WELL LOG: 28276 ;	DIAMETER OF HOLE	(7) DRILLING METHOD:	8) BOREHOLE COMPLETION:		
DI	AMETER FROM TO				
STARTED: 05/06/96 3	0 0 48 0 48 400	NUD RUTART	IF GRAVEL FROM 180 FT. TO 400 FT.		
COMPLETED: 05/30/96		<u>i</u>	FROM FT. TO FT.		
CASING, BLANK PIPE, AND WEL DIA NEW/USED DESCRIPT	L SCREEN DATA: (CONTIN Ton From 1	IUED ON NEXT PAGE) To gage casing scree			
36 N STEEL CA	SING 0	.375	,		
16 N STEEL CA	SING 0	215 .375			
16 N STRINLES	SING 255	255 .025			
16 N STAINLES	S ST. SCREEN 273	.025			
16 N STEEL CA	SING 335	365 .375			
GEOLOGICAL DESCRIPTION:			Cemented from No. of Sacks Used		
FROM TO DESCRIPTION			0 FT. TO 180 FT. 750		
0 10 SURFACE SOIL	N/SMALL GRAVEL		FT. TO FT. Method used: TRINNY LINE		
35 50 RED SHALE			Cemented by: RICHARDSON WATER WEL		
50 175 BROWN SAND FINE			Distance to septic field lines: ft.		
175 215 RED SHALE 215 255 MEDTUM COURSE RE	D SAND		Hethod of verification of above distance:		
255 273 SANDY SHALE			10) SURFACE COMPLETION:		
273 335 COURSE RED SAND	GRAVEL		SURFACE SLAB INST.		
335 365 SANDY SHALE 365 395 MEDTUM COURSE RE	D SAND		STATIC LEVEL: 32 FT. DATE: 05/30/96		
395 400 SANDY SHALE	e onne		BKIESIAN FLUM: GPR. DAIL:		
			12) PACKERS: TYPE DEPTH		
13) TYPE PUMP:	14) WELL	TEST:			
DEPTH TO PUMP: 140	YIEL	.D: 1400 GPH WITH 48 FT 0	DRANDOWN AFTER 36 HRS		
15) WATER QUALITY: TYPE OF WATER: 6000	DEDTH (F STRATA:	CHENICAL ANALYSIS MADE		
NO STRATA OF UNDESIRAB	LE WATER PENETRATED		f also ar e f 2 b		
ADDRESS: BOB LINCOLN	CITY: ALICE	STATE: TX ZIP COL	E: 78332 : WELL NO.		
			LOCATED ON MAP		
T HEDERY CERTICY THAT THIS H	ELL MAS OPTILED BY ME (THAT FACH AND ALL OF THE STATEMENTS HERETN		
ARE TRUE TO THE BEST OF MY K	NOWLEDGE AND BELIEF. I	UNDERSTAND THAT FAILURE 1	TO COMPLETE ITEMS 1 THRU 15 WILL RESULT IN THE		
LOG(S) BEING RETURNED FOR CO	MPLETION AND RESUBMITTA	L.			
(signed)		(signed)			
(LICENSED	WATER WELL DRILLER)		(REGISTERED DRILLER TRAINEE)		

- Geology (sand, clay, ... depositional environment)
- Well screen
- Aquifer productivity
- Water quality
- Static water level

What is a Geophysical Well Log?

A tool or combination of tools lowered into a borehole on a wireline and retrieved to the surface.

Also known as: electrical logging; wireline logging.

Logs must be corrected for a number of parameters.

Tool response recorded in left and right tracks.

Logs can be used to evaluate the entire aquifer, whereas data from water wells typically ends at the base of fresh to slightly saline water zones

Log Analysis

What did we find?

21 Salinity Areas Labeled A - U

Salinity Profiles

	A	B	C	D	E	F	G	Groundwater S
								Classificat
					SS Shallow 2		VS Shallow 1	
				rë.		101 301		Fresh
			MS Shallow 5		MS Intermediate	MS Shallow 4	MS Shallow 4	Slightly Sa
					1	I		Moderately S
		SS Deep	SS Deep		SS Deep	SS Deep	SS Deep	Very Sali
								Brine
	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	
	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	
			DARK .					
	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	
L				-				

Groundwater Salinity	Total Dissolved Solids
Classification	Concentration
	(units: milligrams per liter)
Fresh	0 to 1,000
Slightly Saline	1,000 to 3,000
Moderately Saline	3,000 to 10,000
Very Saline	10,000 to 35,000
Brine	Greater than 35,000

H	Ι	J	K	L	M	N	Groundwater Salinity	Total Dissolved Solids
		ar a		201 (1)	2	201	Classification	Concentration
	VS Shallow 3	3		SS Shallow 1	VS Shallow 2			(units: milligrams per liter)
							Fresh	0 to 1,000
MS Shallow 2	MS Shallow 2		MS Shallow 1	MS Intermediate	MS Intermediate	MS Intermediate	Slightly Saline	1,000 to 3,000
				2	1	1	Moderately Saline	3,000 to 10,000
SS Intermediate	SS Intermediate		SS Deep	SS Deep	SS Deep	SS Deep	Very Saline	10,000 to 35,000
							Brine	Greater than 35,000
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep		
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep		
BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep		Texas Water 🦱
Source Low	er Rio Grand	de Vallev RR	RACS Study					Development Board

Salinity Profiles

0	P	Q	R	S	Т	U
VS Shallow 4			VS Shallow 4			
MS Intermediate 1		2	MS Intermediate 1	MS Shallow 3	Brine Shallow	
SS Deep	VS Shallow 4		SS Deep	VS Shallow 4	VS Intermediate	
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	0
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep
BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep

Groundwater Salinity	Total Dissolved Solids				
Classification	Concentration				
	(units: milligrams per liter)				
Fresh	0 to 1,000				
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Very Saline	10,000 to 35,000				
Brine	Greater than 35,000				

Texas Water Composition Development Board

Source: Lower Rio Grande Valley BRACS Study

Texas Water Composition Development Board

Source: Lower Rio Grande Valley BRACS Study

Datum: North American 1983

BRACS Database Tables

- Microsoft Access Database
- Available on the TWDB web site (with data dictionary)
- Relational table design
- All wells are assigned a unique well id, linking (red line) records together Texas Water Development Board Source: BRACS program

TWDB WIID website: http://wiid.twdb.texas.gov/

WIID: Water Information Integration and Dissemination

Can use this site see / query well locations in an area. Other data is also available by checking the *Visible box*.

