

# Challenges of Developing Deep Brackish Water As A Source of Supply

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- Many resources are important to our culture & economy including energy, air, water, food, materials (metals, wood, chemical feedstocks, etc.)
  - Water (& air) are unique – there are no alternatives
- Objective of this presentation:
  - Consider the question – Are there new or undeveloped sources of water that may help meet future water needs for NM?
- Consider Development of Brackish Ground Water Resources
- Remember – Water rights in NM are based on consumptive use

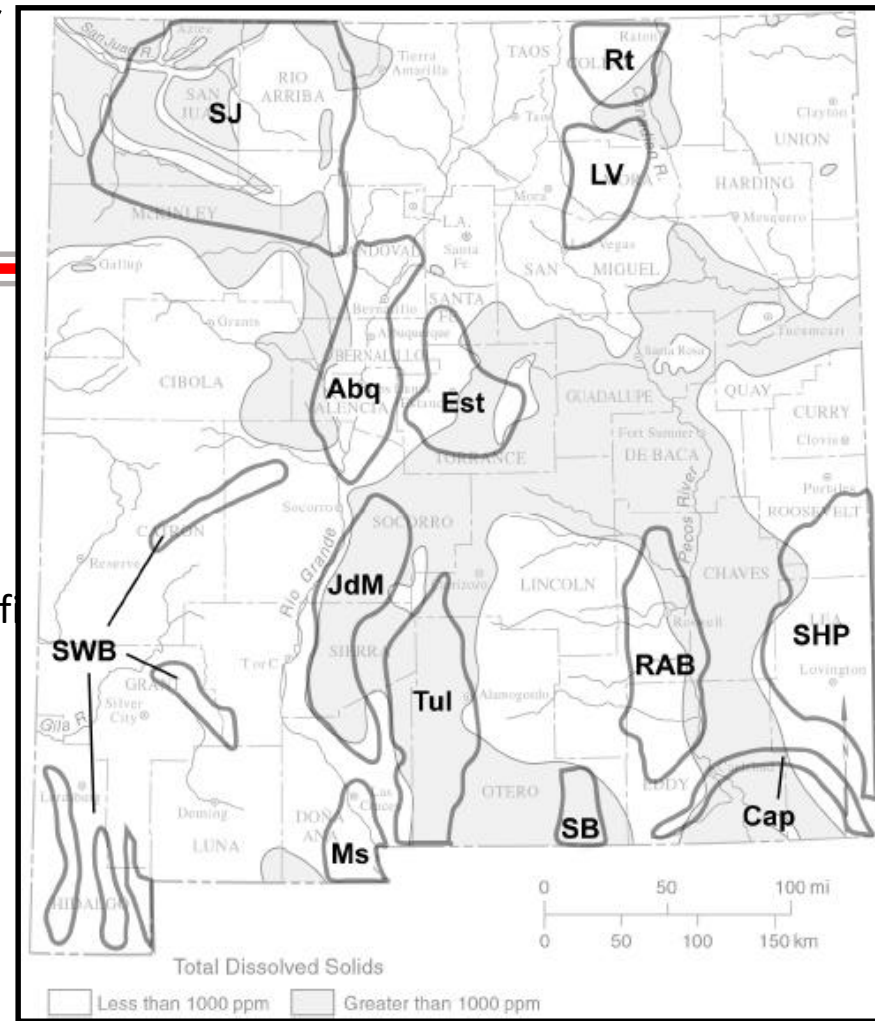
**Consumptive Use = Withdrawal – Return Flow**

- One number to remember – Consumptive Use by ABCWUA = 40,000 AF/yr



It all started with Steve Reynolds...

- Excitement is largely based on:
  - 1962 map
  - Claim that ~75% of ground water in NM is brackish/saline (Reynolds, 1962)
  - Resource was unregulated prior to 2009
- With few exceptions the resource has not been quantified
  - Little incentive because resource had little value
- However, must recognize geologic complexity



OSE, 2004

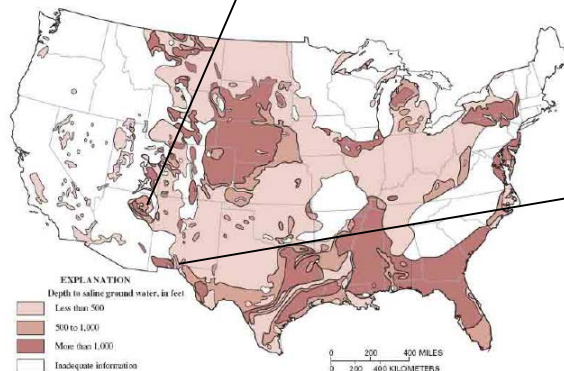
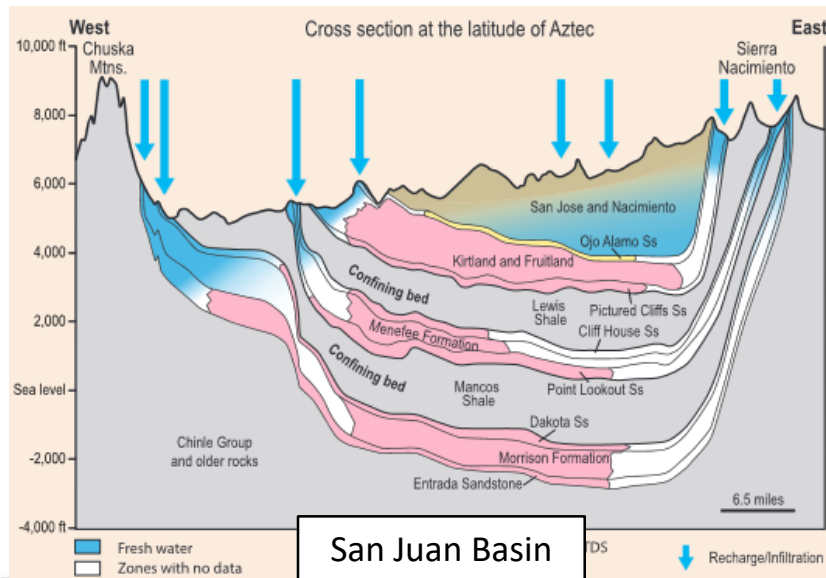
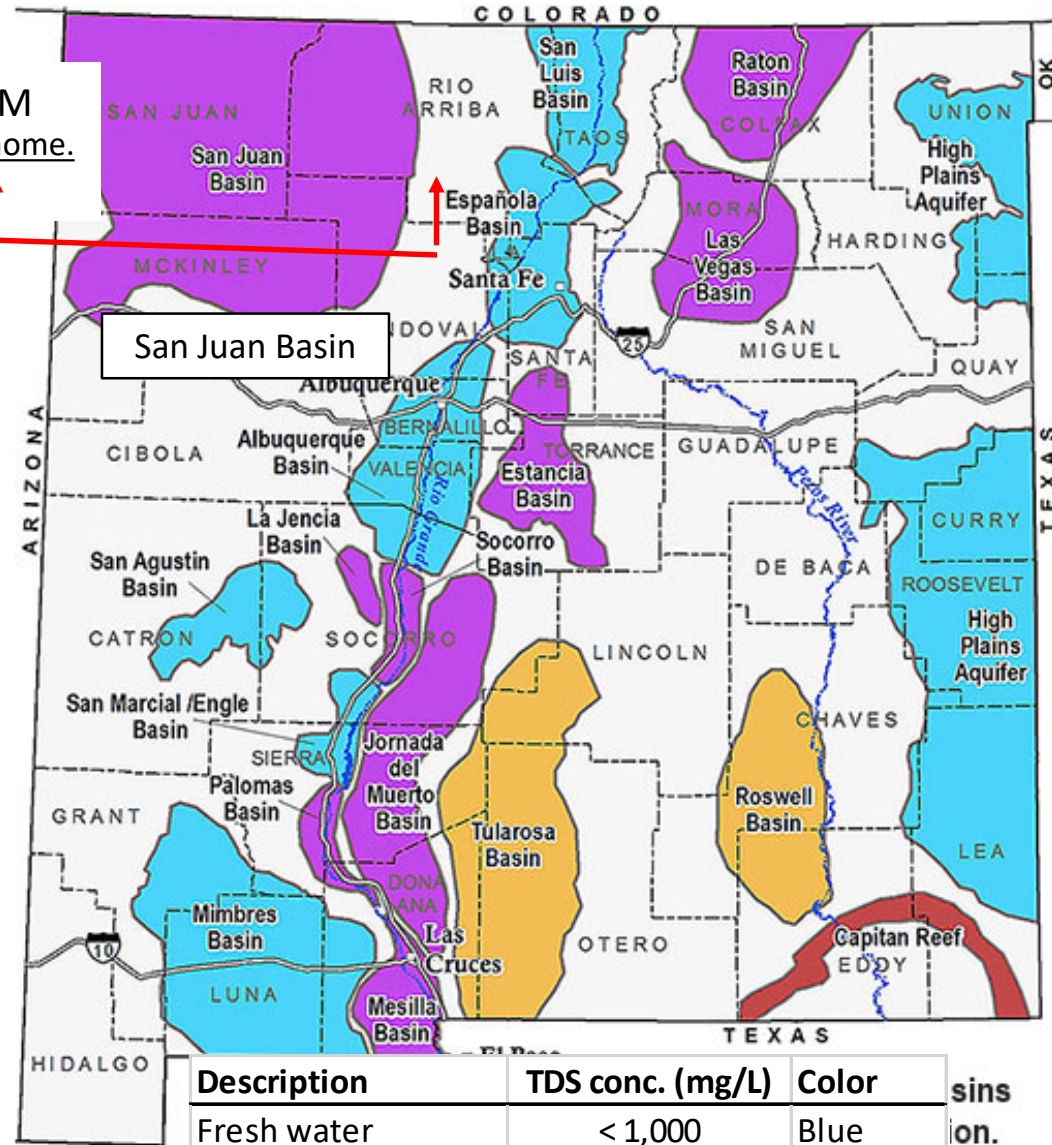


FIGURE 1-1. Depth to brackish groundwater (greater than 1,000 mg/L total dissolved solids) in the conterminous United States (generalized from Feth, 1965).



Updated Map of Brackish Water Resources of NM  
<https://geoinfo.nmt.edu/resources/water/projects/bwa/home.html>

- Much more complicated than 2-D image
- Not as optimistic!
- 2-D map doesn't capture
  - 3-dimensional characteristics of formation
  - No info on hydraulic properties
  - No info on volume of water & sustainability



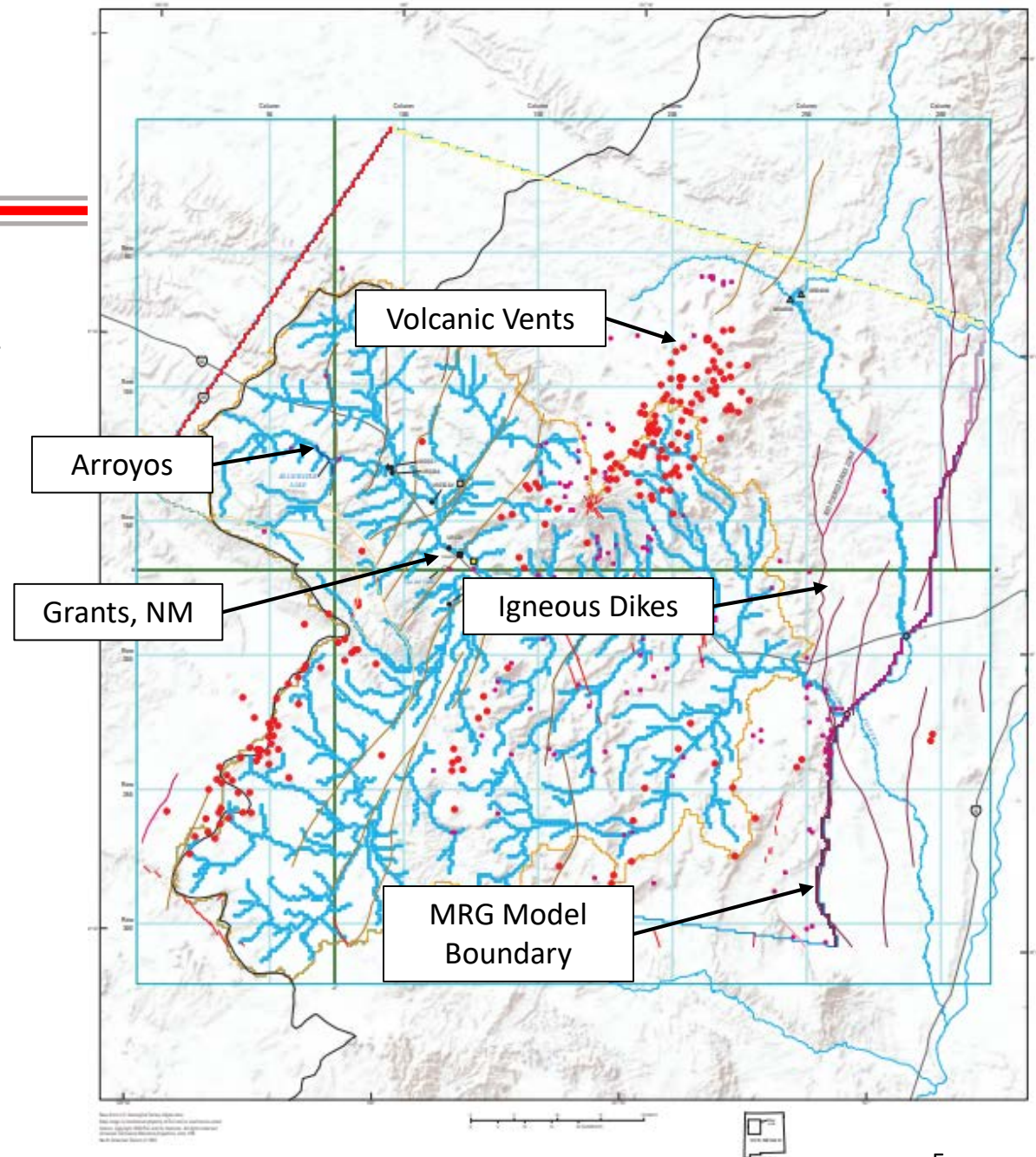
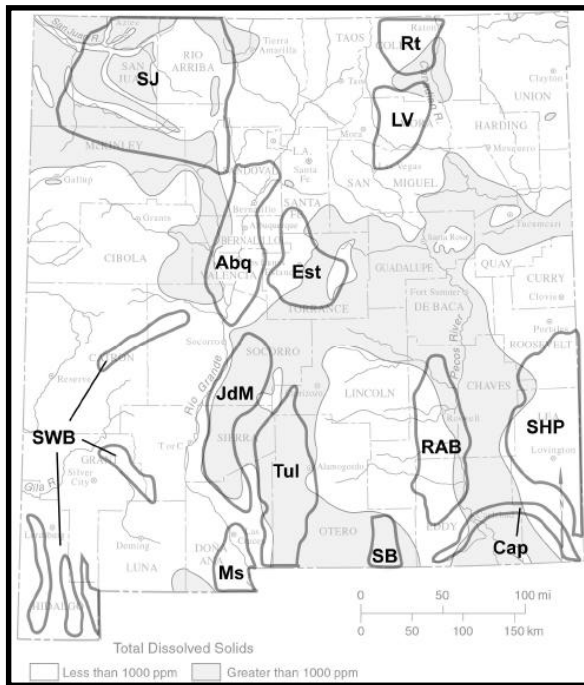
San Juan Basin

Description	TDS conc. (mg/L)	Color	ions on.
Fresh water	< 1,000	Blue	
Slightly brackish	1,000 - 3,000	Purple	
Brackish	3,000 - 10,000	Orange	
Saline	> 10,000	Red	
Seawater	35,000		
Produced water	35,000 - > 300,000		



# Rio San Jose Ground Water Model (Ritchie, et al., 2023)

- Illustrates complexity of ground water systems compared to 1962 map



## Challenges of Brackish Water Recovery

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- Hydrogeology – Hydraulic characteristics
  - Low values of Transmissivity & Storativity
  - Deep formations
  - Requires many wells & long surface pipe lines to collect water
- No recharge in most basins hence resource is not sustainable
- Chemistry is more complicated than seawater
  - Greater fouling potential (mineral formation)
  - Concentrate may be hazardous and/or radioactive
- Disposal of concentrate (desal waste) is difficult
  - Deep well injection is only option



## Development of Deep Brackish Water Supplies

- Ground water development depends on hydraulic properties of aquifer
  - Compare two wells each pumped at 1 Mgal/d in Albuquerque Basin:

Property	Deep Aquifer	Ridgecrest No. 5 <sup>2</sup>
Transmissivity	700 ft <sup>2</sup> /d <sup>1</sup>	3,500 ft <sup>2</sup> /d <sup>2</sup>
Storage Coefficient	.0014 <sup>3</sup>	.01

Note:

<sup>1</sup>Kernodle, 1996

<sup>2</sup>Kernodle et al, 1995

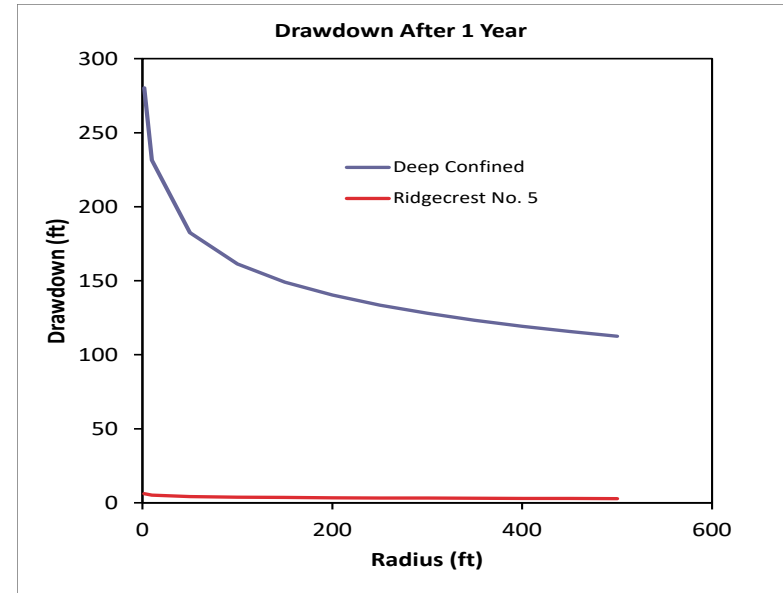
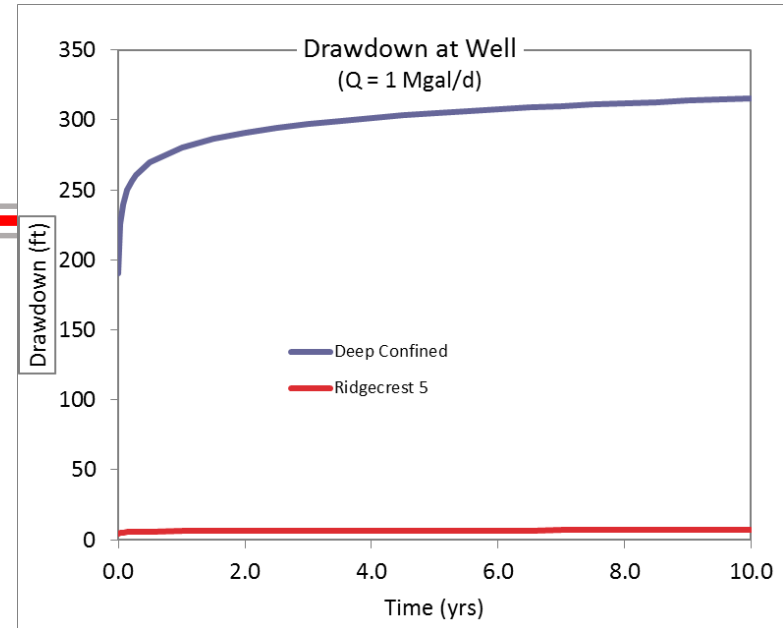
<sup>3</sup>Lohman approximation

- USGS just completed a study of hydrogeology of Rio San Jose basin west of Albuquerque (Ritchie et al., 2023).
  - 3-D model with 9 layers
  - Most hydraulic properties are from studies > 30 years old– illustrates cost of generating data & lack of interest in lousy aquifers



## Example: Two Wells Pumped at 1 Mgal/d (My analysis)

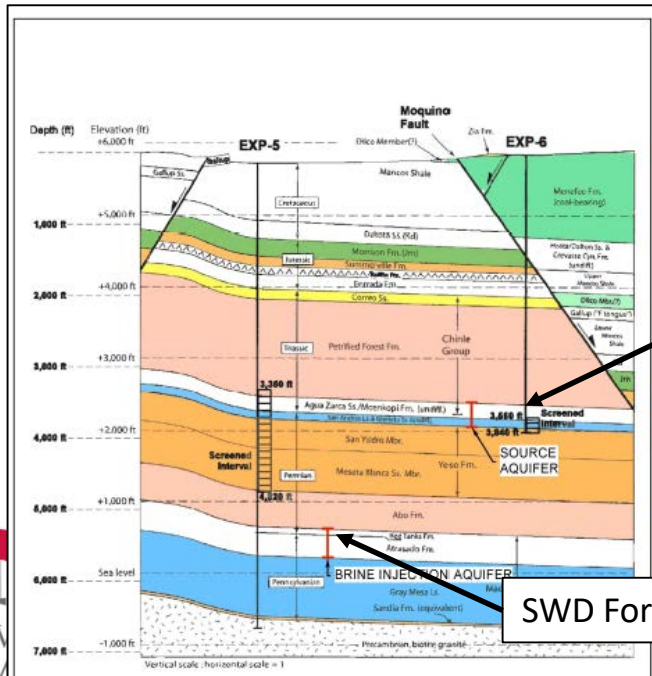
- Consequences
  - Very large drawdown in deep confined well
  - Will require large spacing between wells hence long pipe runs to treatment plant
  - Additional pumping costs due to large drawdown
    - 50 extra hp required to pump extra 300 ft of drawdown
    - \$90/d extra power cost @ \$0.10/kWh
  - Long pipe to convey concentrate to disposal wells
  - Challenge of siting salt water disposal wells





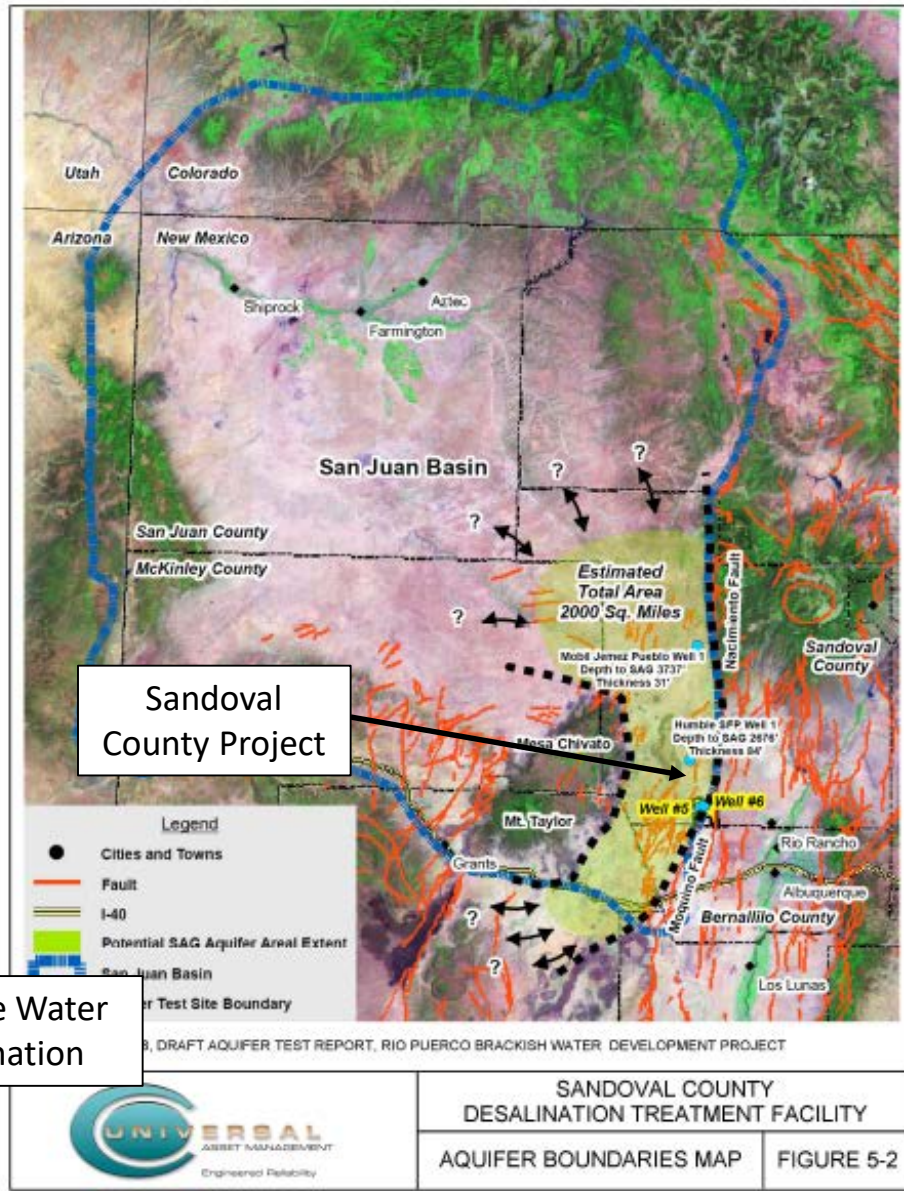
# Sandoval County Project (1) (Sandoval Co., 2011)

- Aquifer volume estimated between 576,000 AF & 2,600,000 AF by 2 very competent hydrogeologists
- Proposed 5 Mgal/d plant, must pump 6.7 Mgal/d brackish water (7,500 AF/yr). Future demand of 36 Mgal/d
- TDS ~ 12,000 mg/L
- Report claims aquifer life of 77 yrs to 350 yrs.



Source Water Formation

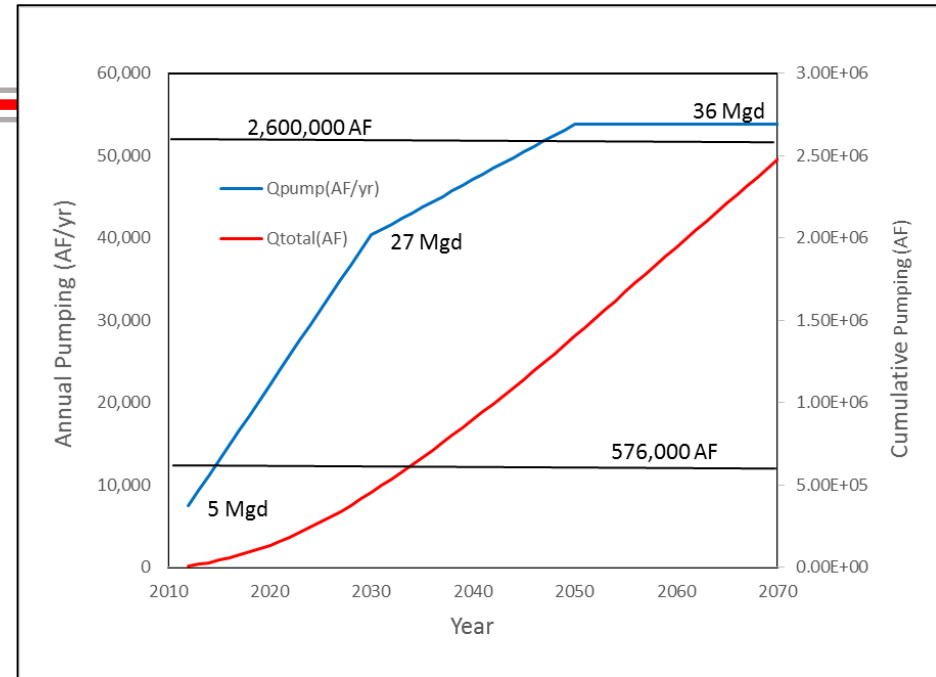
SWD Formation



Sandoval County Project

## Sustainability of Sandoval County Supply – My Analysis (Sandoval Co., 2011)

- Assume demand for desalinated water increases linearly with development
- Projected demand 36 Mgal/d by 2050
  - 48 Mgal/d must be pumped (54,000 AF/yr) at 75% recovery
  - Concentrate disposal = 13,400 AF/yr
- Will provide supply for 20 to 60 years depending on actual aquifer volume
  
- What happens to community when aquifer is depleted?





# Sustainability of Sandoval County Supply Contd.

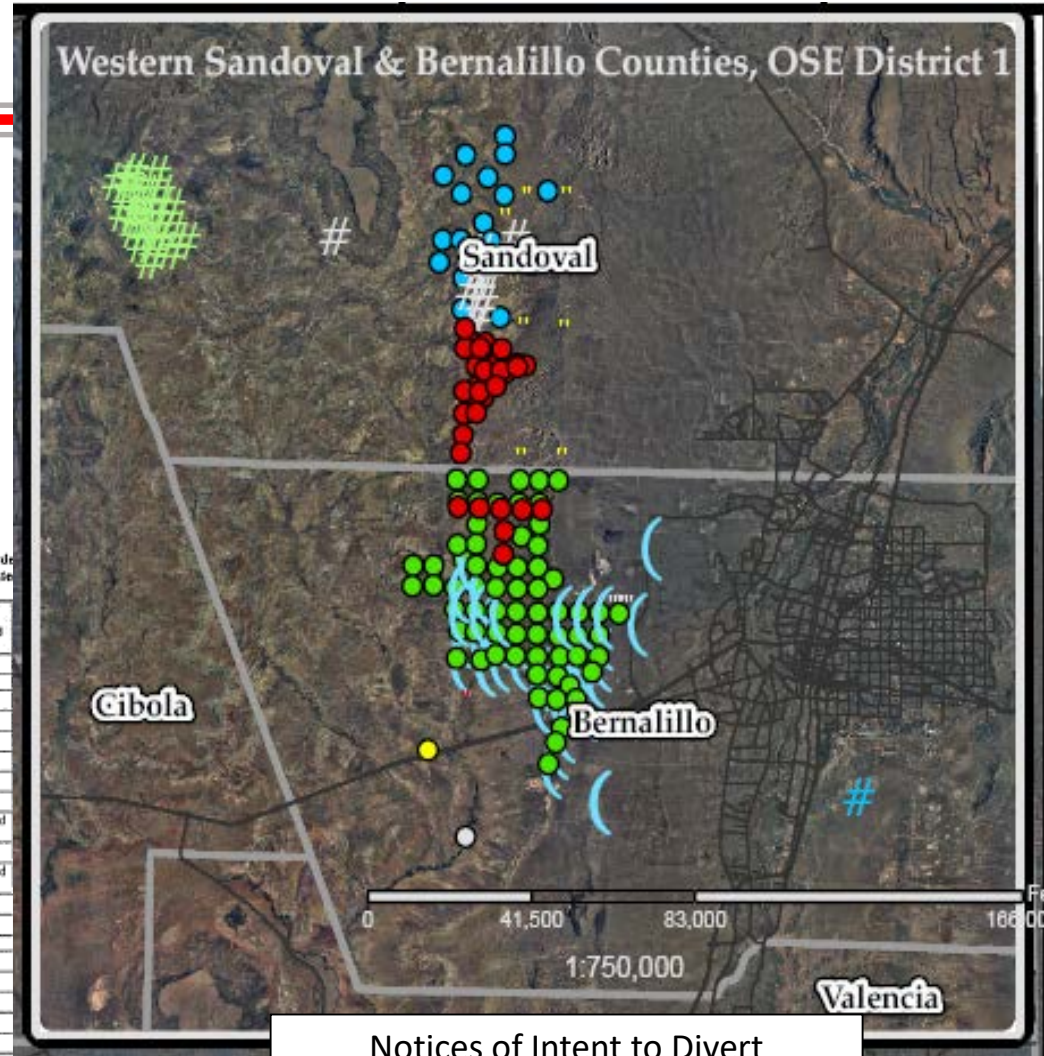
- Study didn't consider effects of other development
- Current statewide status (11/22):
  - 763 Notices of Intent filed by 2009
  - ~60 wells drilled – Most for O&G
  - No apparent expiration date on NOIs

Table 6. Summary of Notices of Intention (NOIs) to appropriate "d" Section 72-12-25 NMSA 1978 from wells within the study area. Date

NMOSSE File No.	name of filer	number of wells	appropriation, ac-8/yr	depth or depth range, ft	notices filed
RG-67855	Midway Ranch Ltd.	1	400	2,794	8-20-97
RG-88934	Recept NM Assoc., LP, Butera, Carivas, and Tesoro Properties, LLCs	14	16,000	3,000 – 6,000	6-16-06
RG-88934	Recept NM Assoc., Marasa Properties	7	8,000	3,000 – 6,000	2-22-07
RG-88934	Sandoval Co., Recept. Butera, Carivas, Tesoro Properties	14	16,000	3,000 – 10,000	1-16-08
RG-90730	Communities Utilities Corp.	1	110,000	5,000	7-16-08
RG-90739	Atrisco Oil & Gas, LLC	25	12,000	3,500 – 10,000	3-23-08
RG-91042	Westland DevCo, LP	46	15,000	2,500 – 10,000	10-29-08
RG-91086	King Brothers Ranch	17	25,000	2,500 – 10,000	11-26-08
RG-91113	I. Bar Energy, LLC	20	10,000	3,000 – 3,500	12-8-08 and 1-3-11
RG-91157	Sandoval Co. and NM Commissioner of Public Lands	11	32,000	3,000 – 10,000	1-2-09
RG-91195	Graveland & Pulte, LLC	3	15,000	2,500 – 10,000	1-28-09 and 3-1-09
RG-91216	Rio Puerto Development	1	100,000	2,500 – 6,500	2-10-09
RG-91218	Sandoval Co. and NM Commissioner of Public Lands	10	18,000	3,000 – 10,000	2-18-09
RG-91317	The Not So Dead Sea, LLC	4	15,000	3,500 – 10,000	2-18-09
RG-90739	Atrisco Oil & Gas, LLC	31	15,000	3,500 – 10,000	2-18-09
RG-90739	Atrisco Oil & Gas, LLC	24	15,000	3,500 – 10,000	2-18-09
RG-91236	Armiño Land, LLC	3	1,000	3,000 – 10,000	2-24-09
RG-91237	Painted Desert, LLC	6	2,000	1,000 – 12,000	2-24-09
RG-91265	Natural Blue Resources, Inc.	12	25,000	2,500 – 10,000	3-12-09
RG-91267	San Juan Pecos, LLC	10	30,000	2,500 – 10,000	3-12-09
RG-91268	Monument Valley, LLC	17	85,000	2,500 – 10,000	3-13-09
RG-91265	Natural Blue Resources, Inc.	38	25,000	2,500 – 10,000	3-13-09 and 4-28-09
RG-91265	Natural Blue Resources, Inc.	52	25,000	2,500 – 10,000	3-16-09
RG-91278	Mesa del Sol, LLC	5	14,500	2,600 – 12,000	3-17-09
RG-91311	Breezy Point, LLC	1	15,000	2,500 – 10,000	3-23-09
RG-91153	Sandoval Co. and NM Commissioner of Public Lands	25	48,000	3,000 – 10,000	4-22-09
Totals		329	705,000		

NMOSSE – New Mexico Office of the State Engineer  
ac-ft/yr – acre-feet per year  
O&G – Oil and Gas

Shomaker, 2013

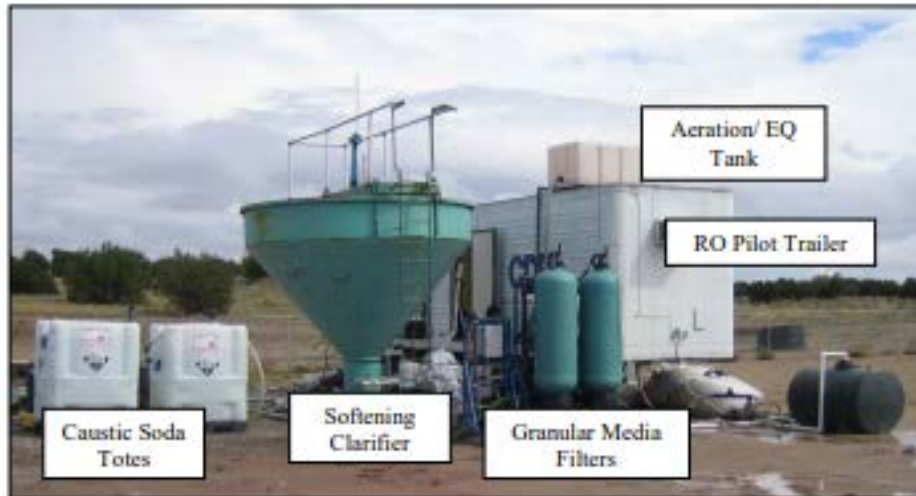
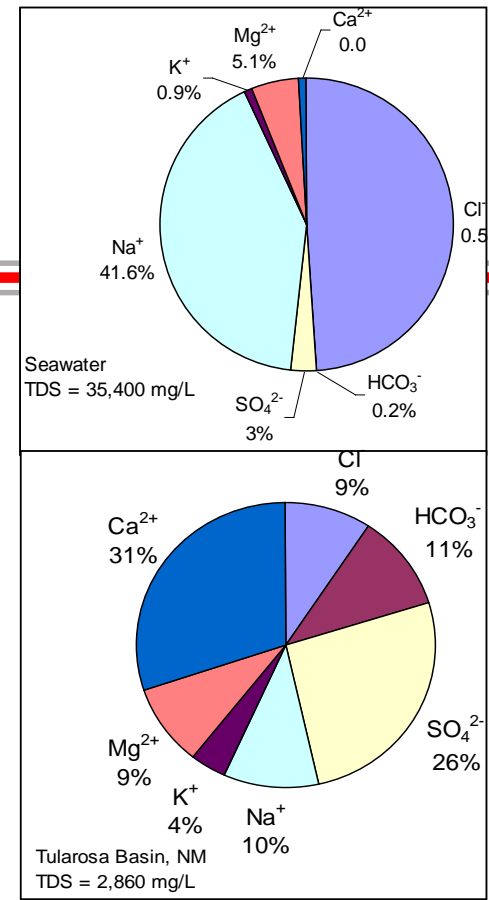


Notices of Intent to Divert Brackish Ground Water in 2009

Bernalillo	0	Concentrated in 3 spots
Sandoval	0	Widely distributed locations
Sandoval	0	Widely distributed locations
Bernalillo	0	
Sandoval	0	Top of Dakota may be >10,000 ft.
Sandoval	0	

# Challenges of Desalinating Brackish Water

- Chemistry of ground water is more complicated than sea water
  - Scale forming minerals limit performance of desal processes
    - Fouling of RO & EDR membranes
    - Scale deposits on surfaces of distillation processes
  - Hazardous (e.g. As, Se, PFAS/PFOA, TCE) or radioactive (Ra, U) compounds may cause waste to be hazwaste or radwastes
  - Waste streams are very corrosive
- Desalination is expensive, energy intensive & complicated
- Large volumes of wastes from desal are difficult to manage & dispose
  - KBH desal plant in El Paso pipes wastes 22 miles to disposal wells



## Common scale forming minerals

- Calcite –  $\text{CaCO}_3$
- Dolomite –  $\text{CaMg}(\text{CO}_3)_2$
- Gypsum –  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
- Silica –  $\text{SiO}_2$
- Diopside –  $\text{CaMgSi}_2\text{O}_6$

- Deep (> 2,500 ft) non-potable (TDS > 1,000 mg/L) ground water basins were not regulated before 2009.
  - Notice of Intent (NOI) to drill was only requirement to appropriate water
  - Did not require a water right
- Water law amended in 2009 (72-12-25 through 72-12-28 NMSA) gives State Engineer jurisdiction of declared deep non-potable basins
  - Top of aquifer > 2,500 ft deep & contains non-potable water
  - Aquifer must not be connected to overlying formations or surface water
  - Certain uses remain unregulated – oil & gas, mining, roads, ag, industrial uses, etc.
  - I don't think OSE has declared any deep non-potable basins
- Current statewide status (11/22):
  - 763 Notices of Intent filed by 2009
  - ~60 wells drilled – Most are to provide frack water for O&G development
  - No apparent expiration date on NOIs





## When is Brackish Ground Water Feasible

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- If technically feasible. But must consider
  - Complexity & cost of developing the resource
    - Deep wells
    - Low well productivity from individual wells
    - Long surface pipelines
  - Complexity, energy requirements & complexity of desalination
  - Waste management & disposal
- If economically feasible
  - Capital & operating costs
  - Availability of qualified operators
- Not for public water supply unless can document sustainability



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