NM WAIDS

Produced Water Mapping and Tools for New Mexico Oil and Gas Producers

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Team Members

Professional staff

- Robert Lee – Project Manager
- Martha Cather – Principal Investigator
- Abe Gundiler – Co-PI, corrosion engineer
- Andy Sung – Co-PI, fuzzy logic
- Jenny Ma – Database manager

Graduate Students

- Naomi Davidson
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Background – Why did we do it?

- Work with NMOGA Chlorides Group – Their requests included:
  - Maps of chloride content of groundwater
  - Maps of depth to groundwater
- Work with "Water Dog" project
  - Group wanted a way to collect and map water quality and volume information for produced water
- Requests for a GIS that would show both water information and oil and gas information
- Producer requests for help with corrosion issues

Background – Why did we do it?

Since we started, the biggest motivator has become the increased interest in produced water use because of the continuing drought and competing needs of so many different water users!

Major Tasks for Project

1. Create databases for produced and groundwater, including, where available, information regarding water quality and water volume
2. Collect corrosion-related data (type, location, solutions, etc.)
3. Design a web site capable of displaying this data in either a GIS interface or by text-based queries
4. Create a fuzzy logic-based, site risk assessment tool that can be used to assess the seriousness of a spill of produced water
5. Compile a corrosion management toolkit that will provide operators with data and information on produced waters that will aid them in deciding how to address corrosion issues

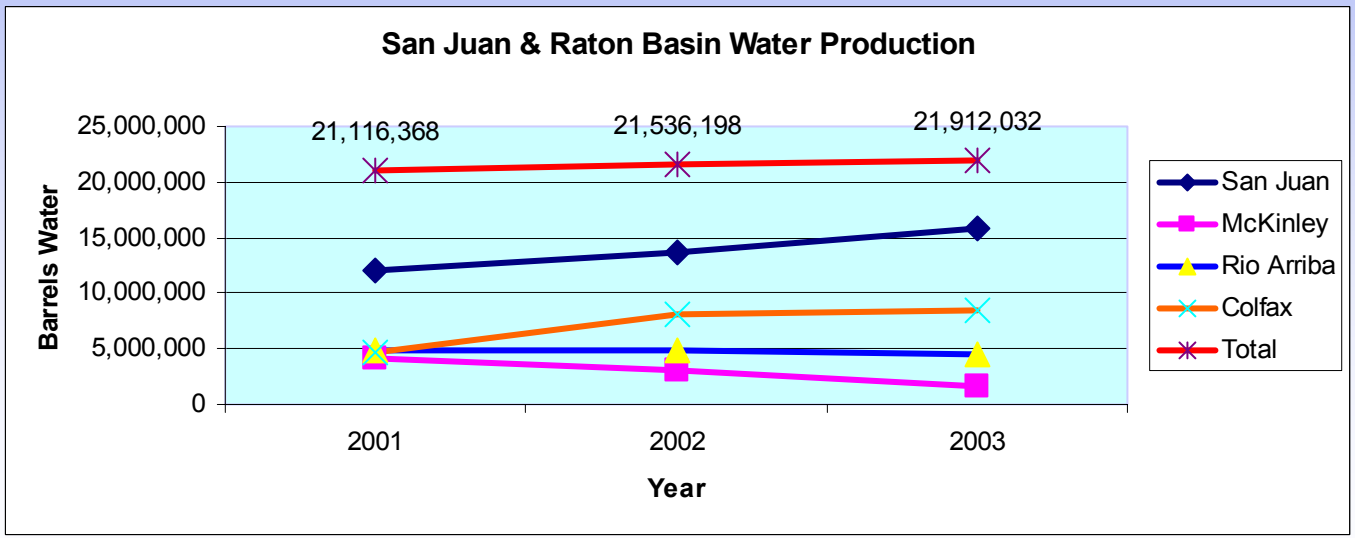
Results – Some Statistics
How much water is there?

Water Produced 2001 – Nov. 2003	
Southeast	1,722,976,804
Northwest	68,825,585
Northeast	21,294,488
Total Barrels H_2O	1,813,096,877

Water Production increasing every year

Colfax County has nearly doubled to 8 million barrels

San Juan County produced over 16 million barrels in 2003



Results – More Numbers

County	2002 Water (barrels)	Number of Wells in 2002	Amount of water per well (barrels)
COLFAX	8031965	242	33190
LEA	405138638	9125	44399
MCKINLEY	2990982	153	19549
ROOSEVELT	4515272	221	20431
SAN JUAN	13658843	6307	2166

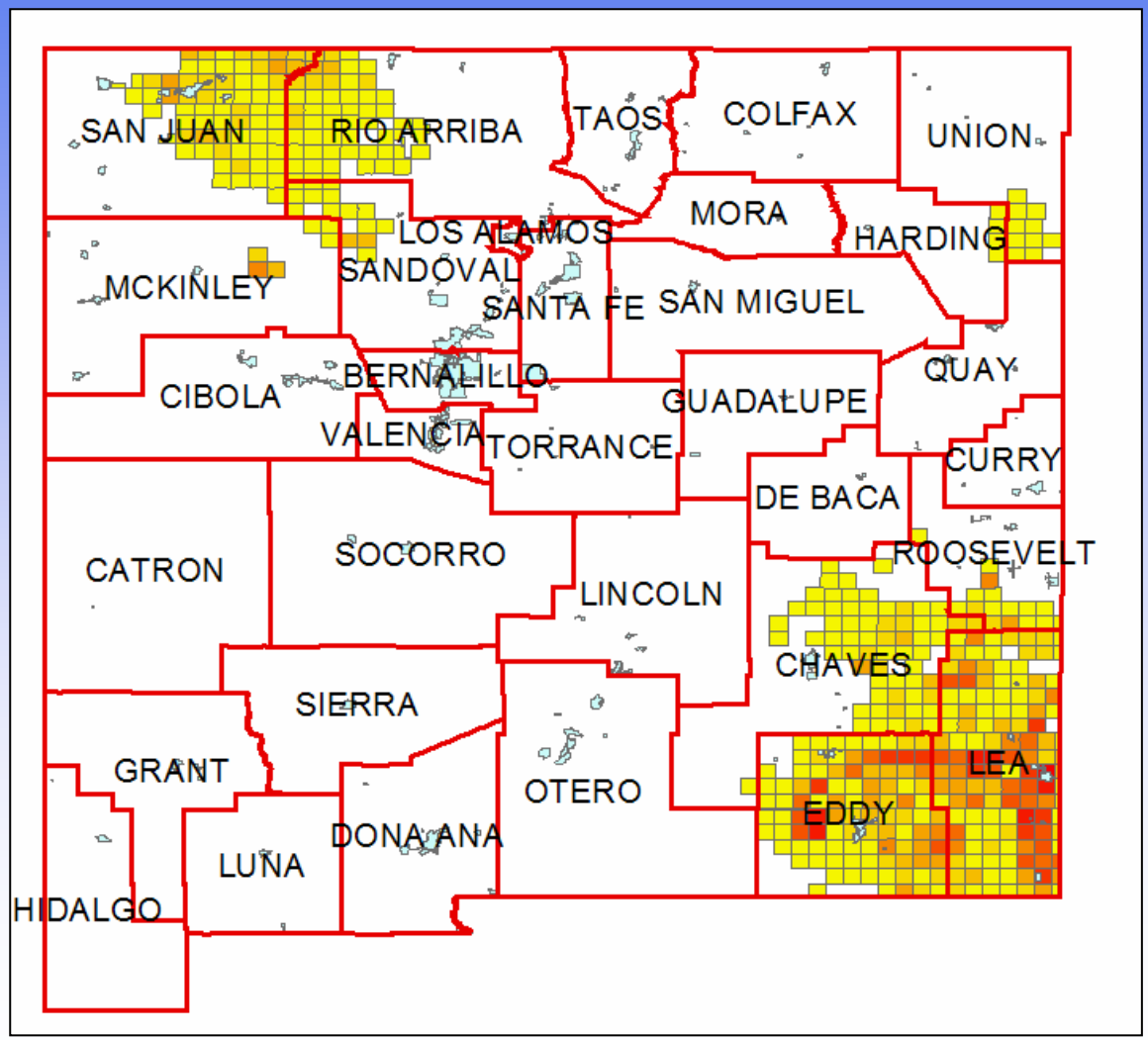
San Juan County wells produce an average of 90,000 gallons of water per well, or about .27 acre feet * 6300 wells = ~1800 acre feet per year.

Colfax County wells produce an average of 1,393,980 gallons per well, or about 4.2 acre feet * 242 wells = ~1000 acre feet per year.

Lea County could produce 50,000 acre feet per year.

Of course much of this water is not good quality – but some is!

Statewide Distribution of Produced Water



Water Production by Township

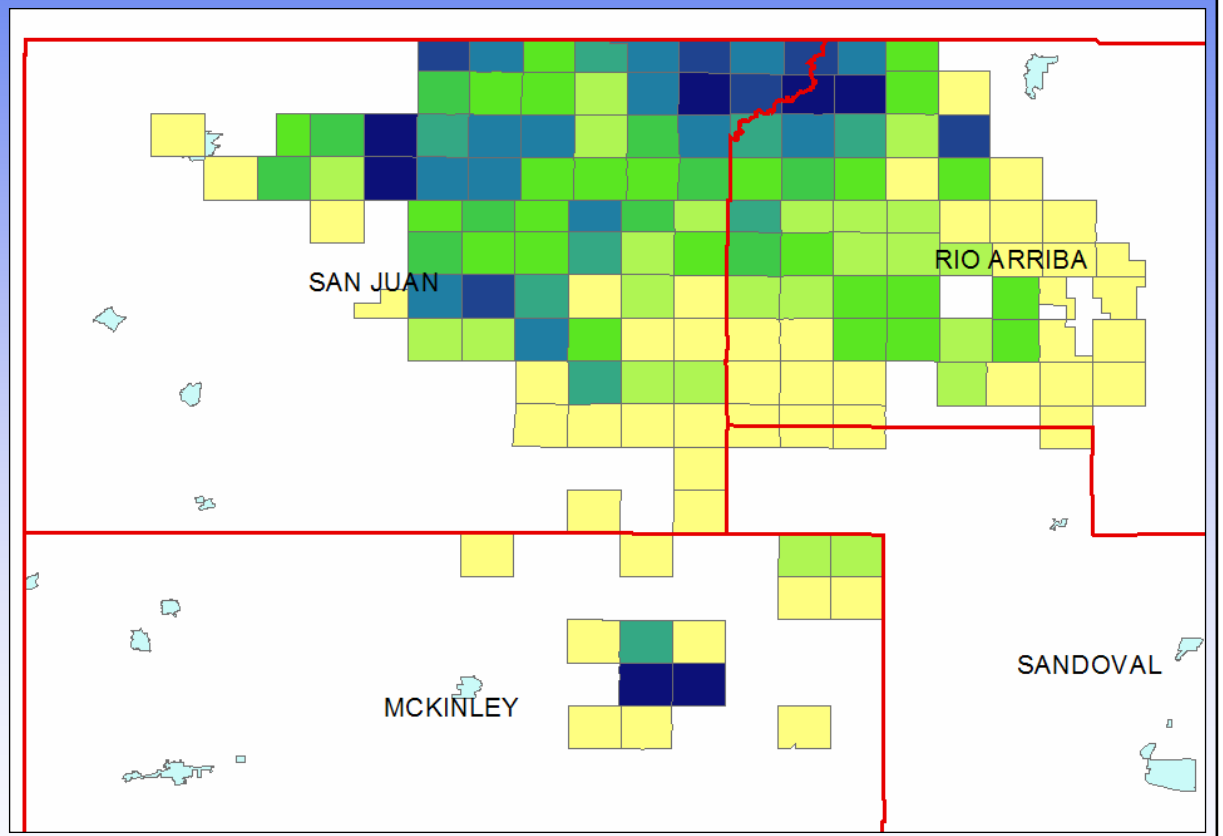
nm_townships

Sum_Water_Prod.Total_Water

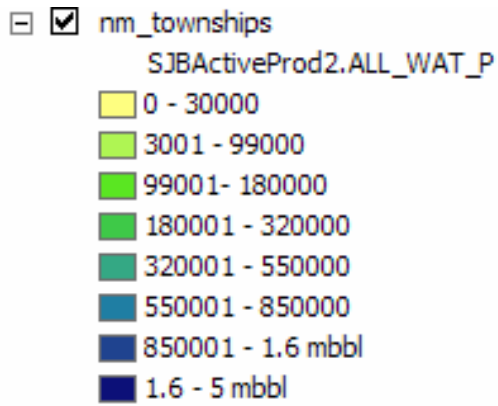
- 2.000000 - 428315.000000
- 428315.000001 - 1396062.000000
- 1396062.000001 - 2713957.000000
- 2713957.000001 - 5149625.000000
- 5149625.000001 - 8502504.000000
- 8502504.000001 - 12384882.000000
- 12384882.000001 - 22808217.000000
- 22808217.000001 - 39481751.000000
- 39481751.000001 - 119169856.000000
- 119169856.000001 - 227956309.000000

Some parts of Lea and Eddy county have produced over 100 million barrels of water in the past 30 months

Produced Water in San Juan Basin



Water Production by Township for San Juan Basin (past 30 months)



Parts of San Juan and Rio Arriba counties are producing > 500,000 barrels.

More Numbers

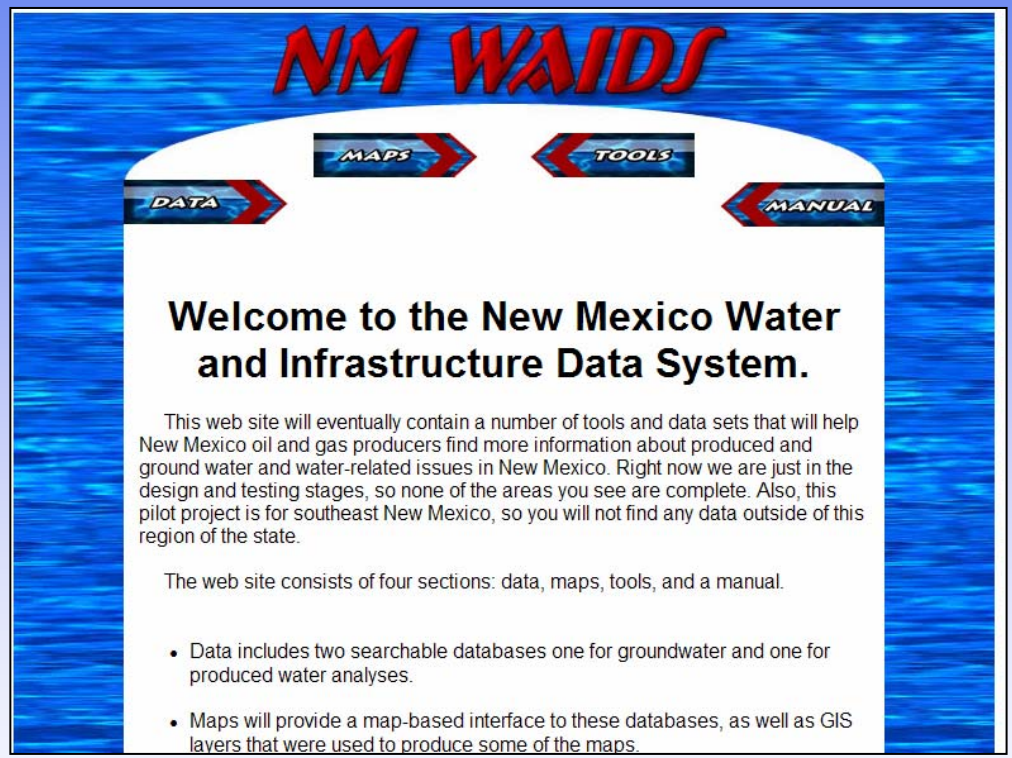
San Juan County

- 187 distinct well samples
- Average about 11,200 mg/l TDS

Rio Arriba County

- 500 distinct samples
- Average about 12,300 mg/l TDS

Results – NM WAIDS Web Site



http://daihatsu.nmt.edu/waterquality

What's on the web site?

- Produced Water Quality Database - data for all New Mexico
- Groundwater Database – data for Southeast NM only
- Maps – online map server will have many layers
- Tools – useful tools for prediction of scaling tendencies, composition of mixed waters, units conversion, etc.
- Corrosion Manual – lots of pictures and data from NM fields, along with some explanations and links to other sites
- Water quality atlas – data for SE NM by formation

Produced Water Database

Produced Water Quality Database includes:

- Identifying info – name, location, sample number
- General info – pH, hardness, specific gravity
- Cations – Ca, Mg, Na, Fe
- Anions – CO_3, Cl, SO_4
- Other – temperature, resistivity, special analyses
- Images of the forms we scanned

Database Construction - Challenges

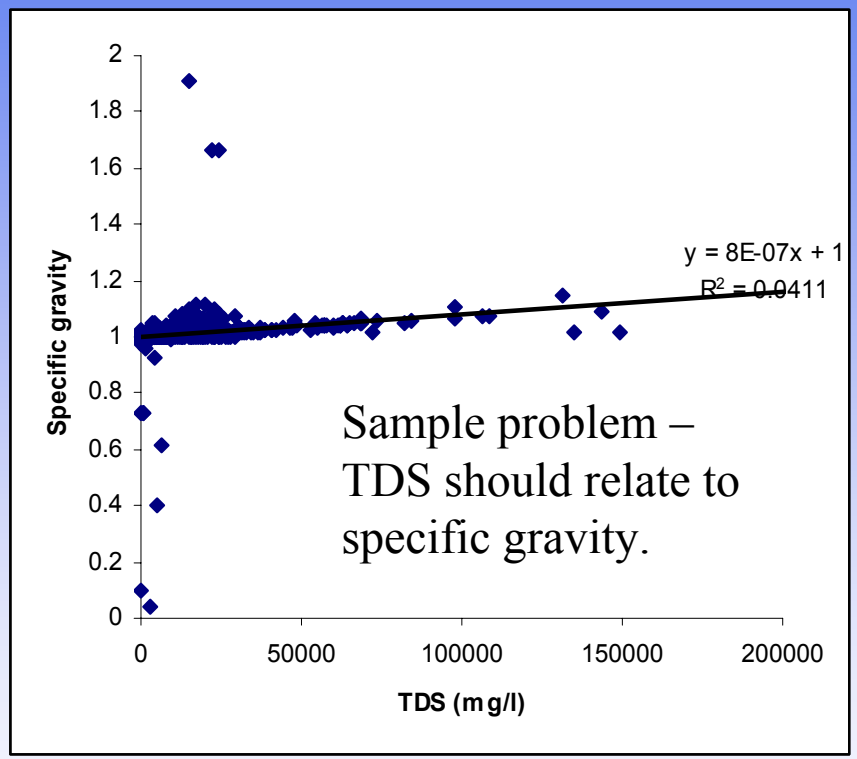
Produced Water Quality Database

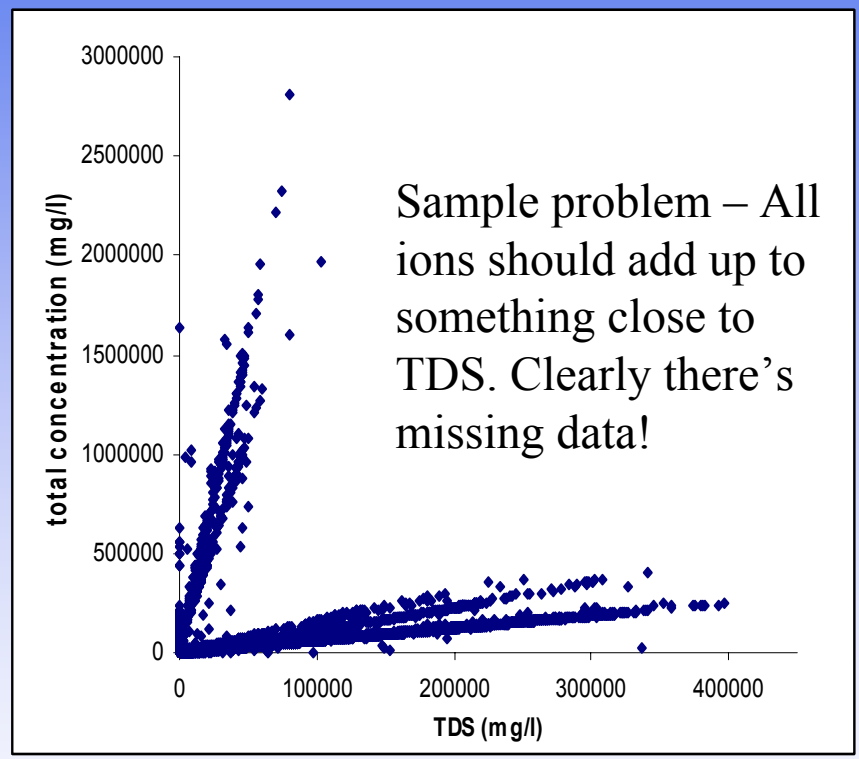
- Data Types
  - Over 40 types of sample forms
  - Dates of analyses covered over 30 years
  - Many different components analyzed
  - Different measurement units used
  - Names of fields, well, and samples often incomplete
  - Location information usually missing or incomplete
  - Data was sometimes given “fuzzy” values such as trace, or minor

Database Construction – Challenges

Scanned Data In Preliminary Database		Corrected Data in Final Database							
Formation Names	FPC M.V. FRUIT None Given	Fruitland Pictured Cliffs Mesaverde Fruitland Coal (or sandstone Try to fill in from other databases							
Well Locations		UL	Sec	Twp	Rge	Ftg N/S	N/S	Ftg E/W	E/W
	F 5 26 7	F	5	26.0N	07W	2300	N	1585	W
	SW/SW 9 26N 7W	M	9	26.0N	07W	1070	N	870	W
	11-23-7	M	11	23.0N	07W	790	S	890	w
	None Given	Try to determine location from other info such as well name and operator							

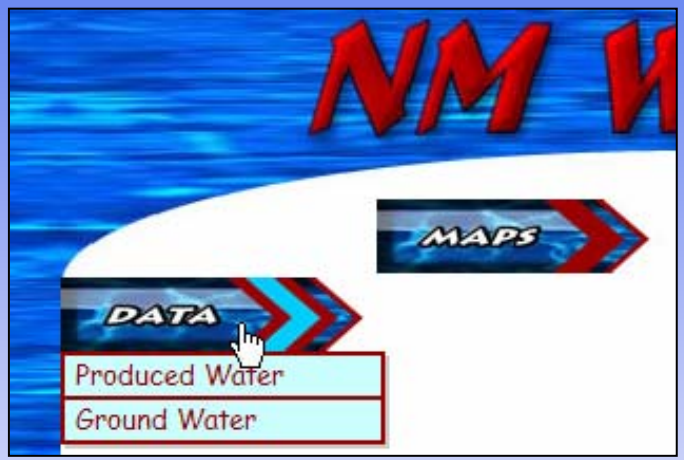
Database Construction – There were problems!



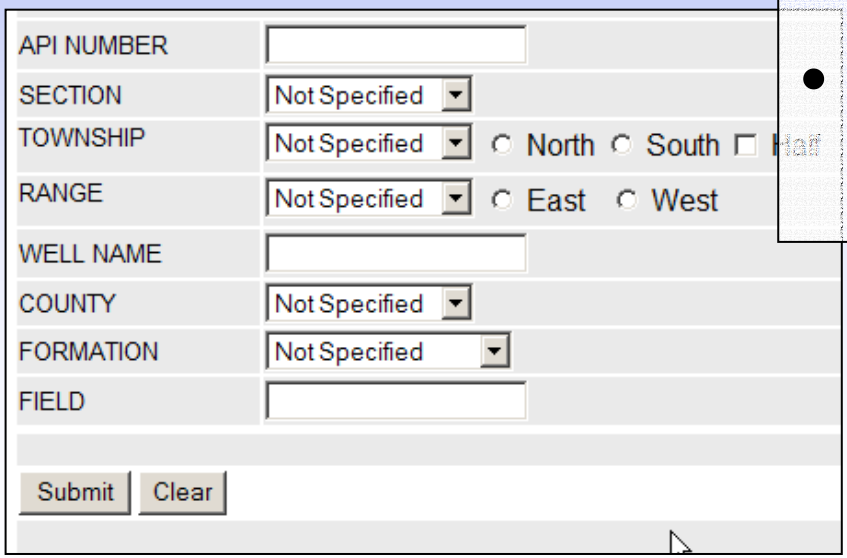


With 7000+ samples, there's plenty of opportunity for bad data. We've spent a lot of time cleaning and error checking data, but we can't fix it all. We've tried to note where the data may be questionable.

How do I access this data?



- Go to the website (http://daihatsu.nmt.edu/waterquality)
- Select either Produced Water or Ground Water
- Fill in some kind of search criteria.



How do I access this data?

128 records are available.

# of samples	API	WellName	S	T	R	County	Formation
1 sample	null	BRANTLEY GAS COM	22	23S	02E	Eddy	MOR
1 sample	3001500044	BANDANA POINT UT	13	23S	23E	Eddy	DEV
2 samples	3001500044	BANDANA POINT UT	13	23S	23E	Eddy	ELBG
1 sample	300						

Water Samples for Well 'BIG FREDDY UNIT '
API = '3001510054'
Formation = 'MOR'
Field = 'INDIAN BASIN'

Instruction:

Click  For sample analysis.

Click  For general information about this sample.

Click  To select **this water sample** for water mixing. It will lead to the main page, and add the sample ID to mixing table.

The ions are in (mg/L) units.

SampleID	T	R	S	SO4	CL	CO3	HCO3	K	Na	Ca	Mg
6715	23S	22E	10	25	67521	null	122	null	null	8680	443
6733	23S	22E	10	2	72846	null	122	null	null	4880	197

- For T23S there are 128 records
- Many wells have several samples
- Where possible, we tried to include formation – either using information on the analysis or assuming water was from producing formation.

How do I access this data?

General Information About: Sample 3608			
WILLIAMS GAS COM 001			
API	3001522686	Sample Number	
Unit/Section/ Township/Range	C / 25 / 23 S / 28 E	Field	CULEBRA BLUFF SOUTH
County	Eddy	Formation	ATOKA
State	NM	Depth	
Lat/Long	32.28221 / -104.04208	Sample Source	DST
TDS (mg/L)	236539	Water Type	
Sample Date (MM/DD/YYYY)	12/17/1978	Analysis Date (MM/DD/YYYY)	
Remarks/Description			
Cation Information (mg/L)		**Anion Information (mg/L)**	
Potassium (K)		Sulfate (SO)	3950
Sodium (Na)		Chloride (Cl)	138000
Calcium (Ca)		Carbonate (CO_3)	
Magnesium (Mg)		Bicarbonate (HCO_3)	2370
Barium (Ba)		Hydroxide (OH)	
Manganese (Mn)		Hydrogen Sulfide (H_2S)	
Strontium (Sr)		Carbon Dioxide (CO_2)	
Iron (Fe)		Oxygen (O)	

- Many wells have several samples
- Where possible, we tried to include formation – either using information on the analysis or assuming water was from producing formation.
- In future will make sample info available for download via .txt or .csv file format

Groundwater Database

Groundwater Database contains:

- Identifying information (well name, location, type of well)
- Depth of sample
- Formation
- Chemical information (TDS and Cl are primary fields that were obtainable).

Groundwater Database

Water Samples for Township 23 South Formation ARTESIA

Instruction:

The number represents the number of water samples of certain well. Click the number if you want to download the data.

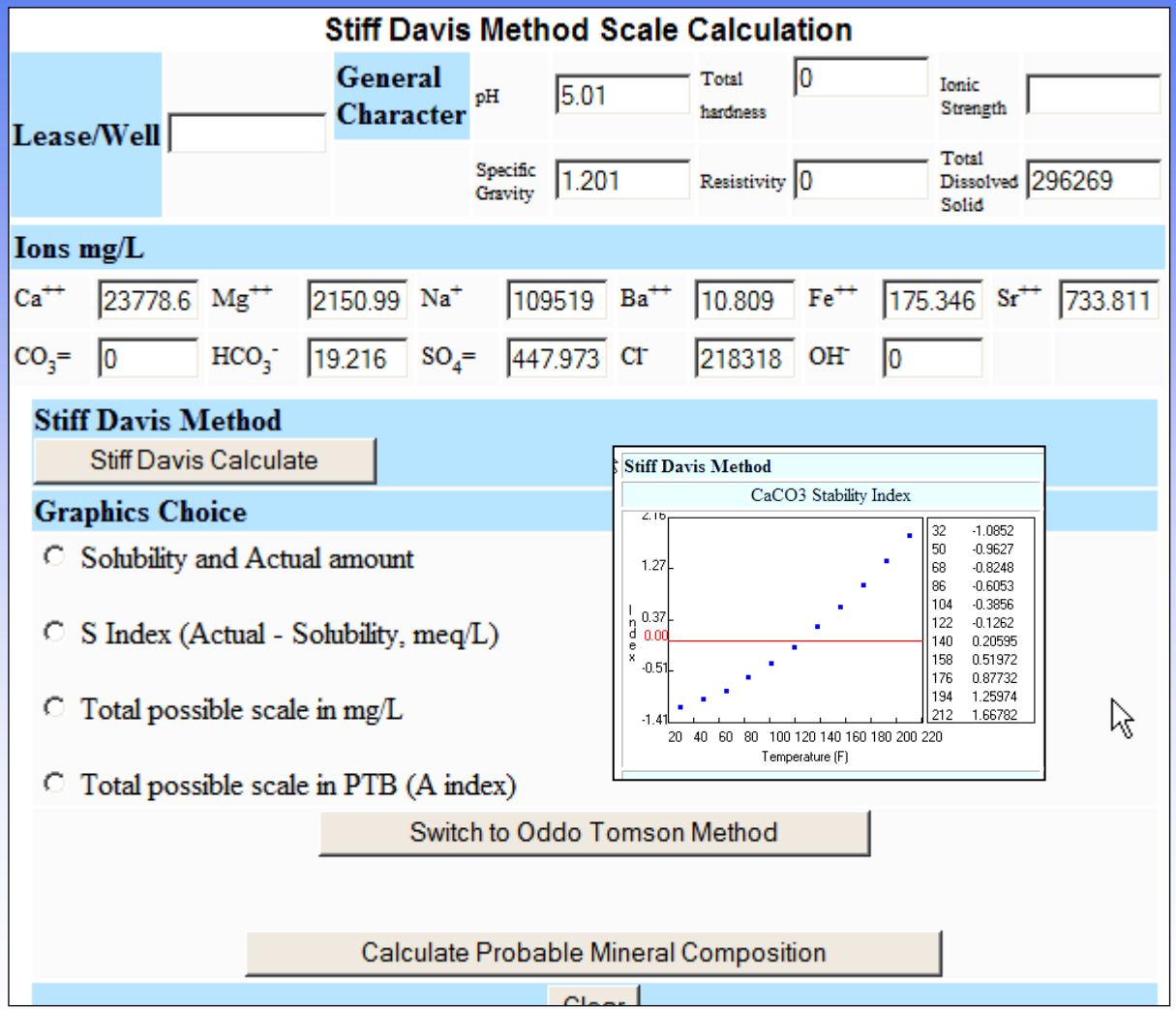
2 records are available.

# of samples	S	T	R	Formation	Date	Chloride
1 sample	09	23S	25E	ARTESIA	4/22/1992	44
1 sample	09	23S	25E	ARTESIA	8/29/1997	13

General Information About: Sample 26805			
Section/ Township/Range	09 / 23 S / 25 E	Lat/Long	32.3191 / -104.4002
Elevation	3763	Depth	
Date Collected	8/29/1997	Chlorides	13
Collector / Point of Collection	SEO / DP	Use	Stock
Formation	ARTESIA	TDS	

- Groundwater data search works the same way.
- Data is fairly sparse – locations were calculated from quarter/quarter locations.

What can I do with the data?

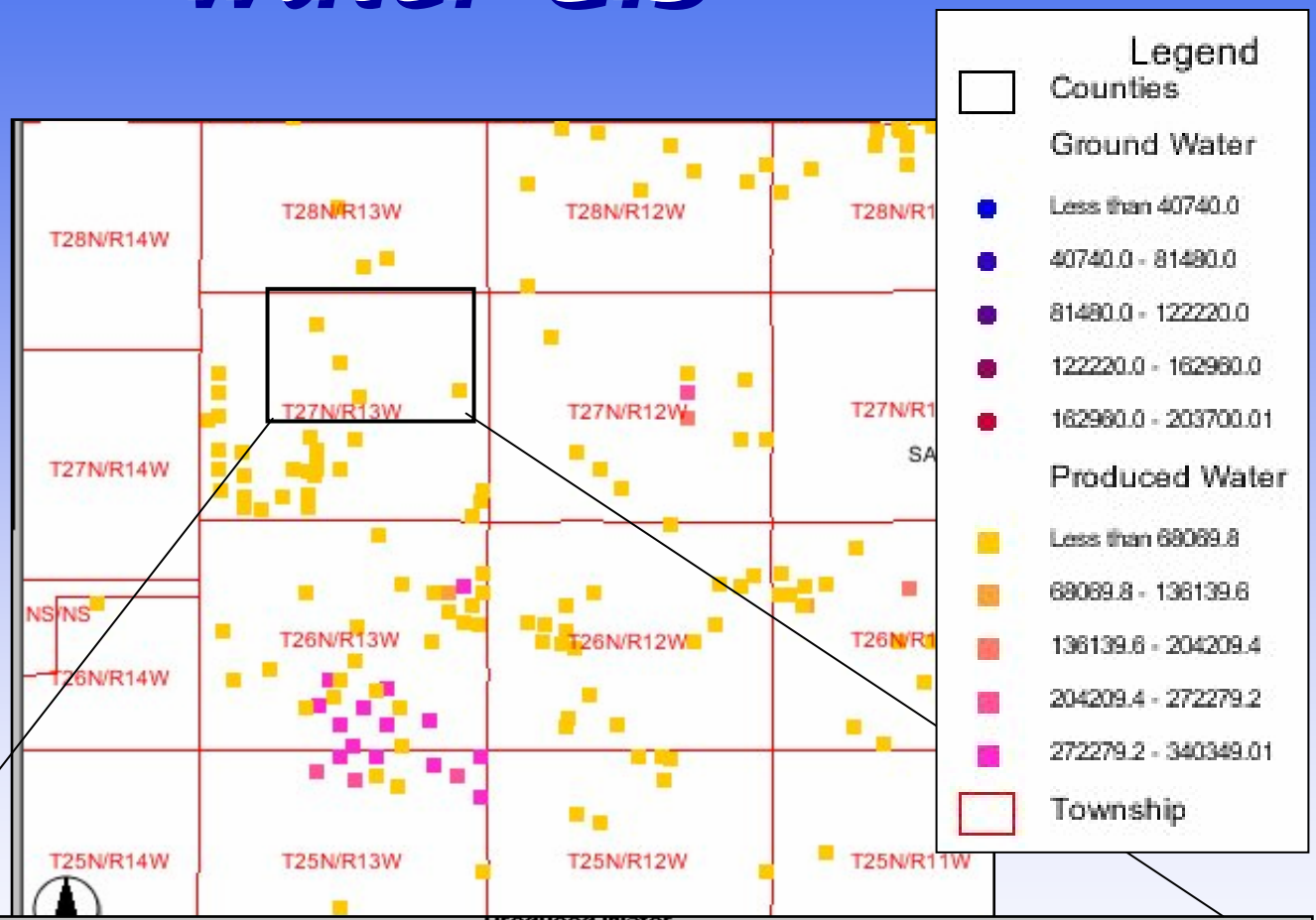


- Scale calculation by Stiff Davis or Oddo Tomson
- Probable mineral composition
- Mix water samples to determine final composition
- Eventually we will have more mapping capability

Water GIS

Select either produced or groundwater data points using the map.

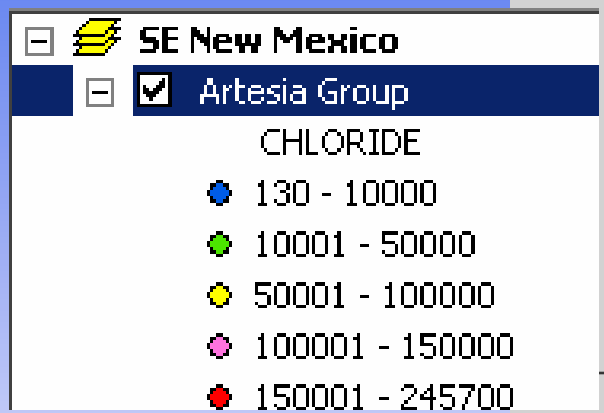
Information table contains some data, links to full sample analysis.

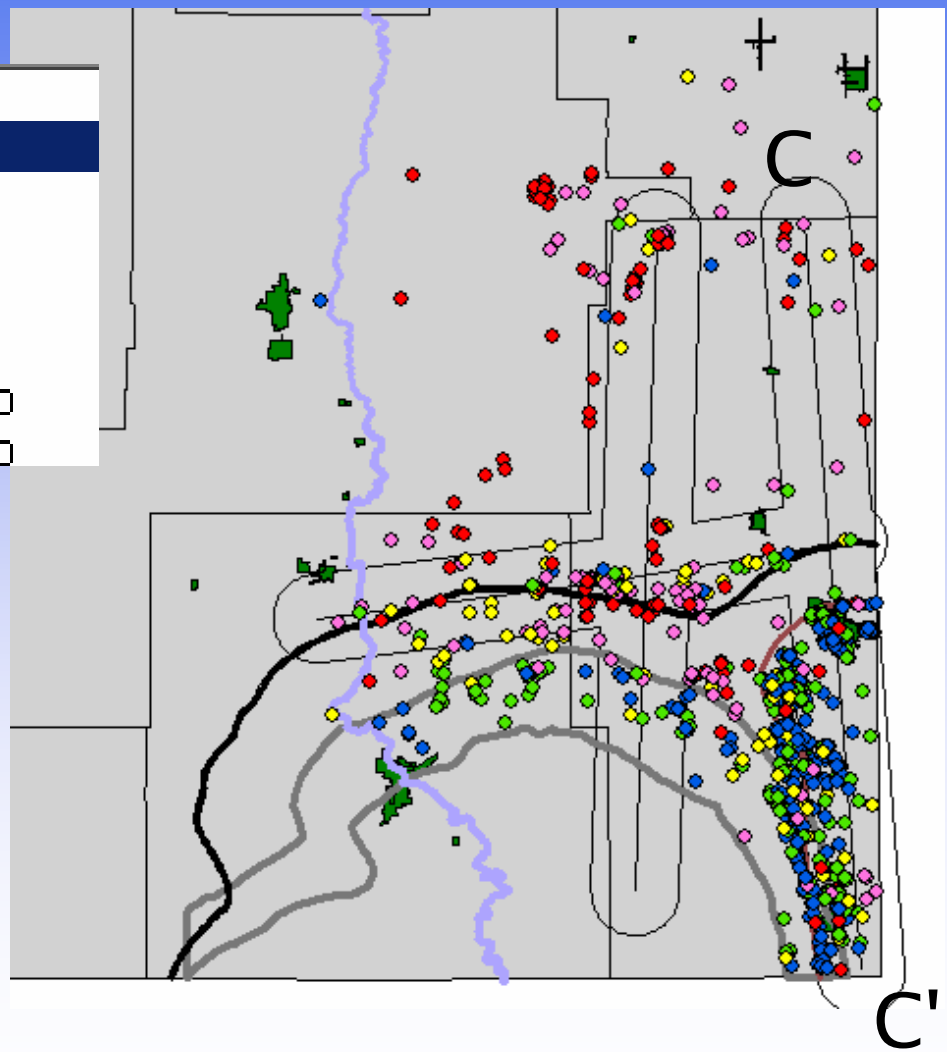


Produced Water

Rec	CHLORIDE_M	DEPTH	FORMATION	LAT	LONG	RANGE	SAMPLE_ID	SECTION	TOWNSHIP	WELL_ID	WELLNAME	#SHAPE#	#ID#
1	16848		DK	36.57163	-108.21029	13W	2584	15	27N	001	F A SCHULTZ	[point]	3211
2	16100		DK	36.57163	-108.21029	13W	2573	15	27N	001	F A SCHULTZ	[point]	3250
3	2529		DK	36.57163	-108.21029	13W	2585	15	27N	001	F A SCHULTZ	[point]	4744
4	0		FT SND/PC	36.59919	-108.22673	13W	6136	4	27N	001	PINEY	[point]	6974

Water GIS (SE NM)





Produced Water and Groundwater Chemistry maps for Southeast New Mexico

Water GIS (SE NM)

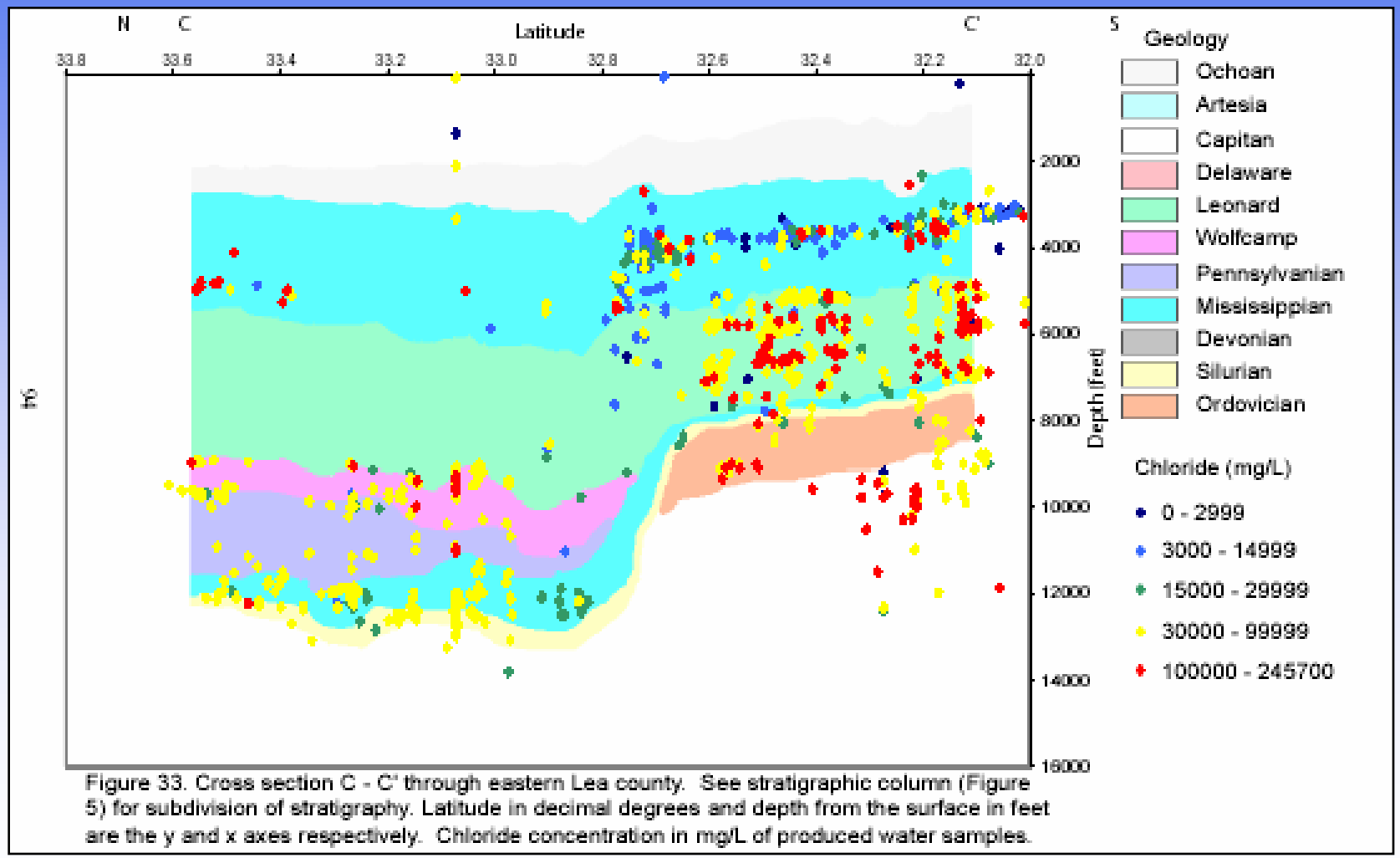


Figure 33. Cross section C - C' through eastern Lea county. See stratigraphic column (Figure 5) for subdivision of stratigraphy. Latitude in decimal degrees and depth from the surface in feet are the y and x axes respectively. Chloride concentration in mg/L of produced water samples.

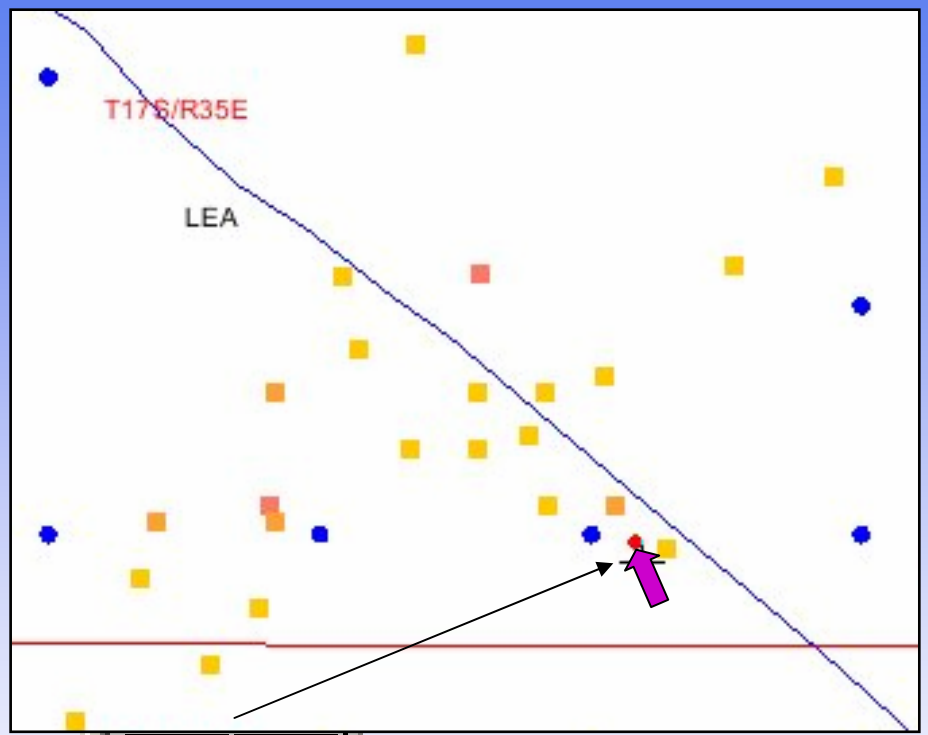
Risk Analysis Tool

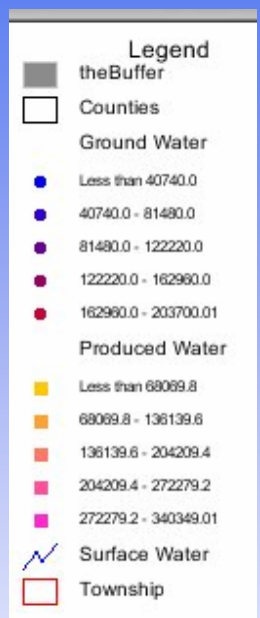
Basic idea for tool:

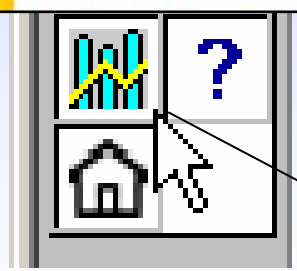
Click on map in a location or type one in.

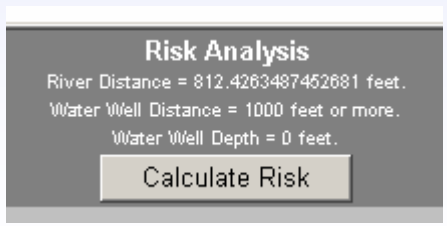
Tool returns distance to nearest surface water, distance to nearest wells, and depth to groundwater.

From this info, a relative “risk” for a brine spill is calculated.

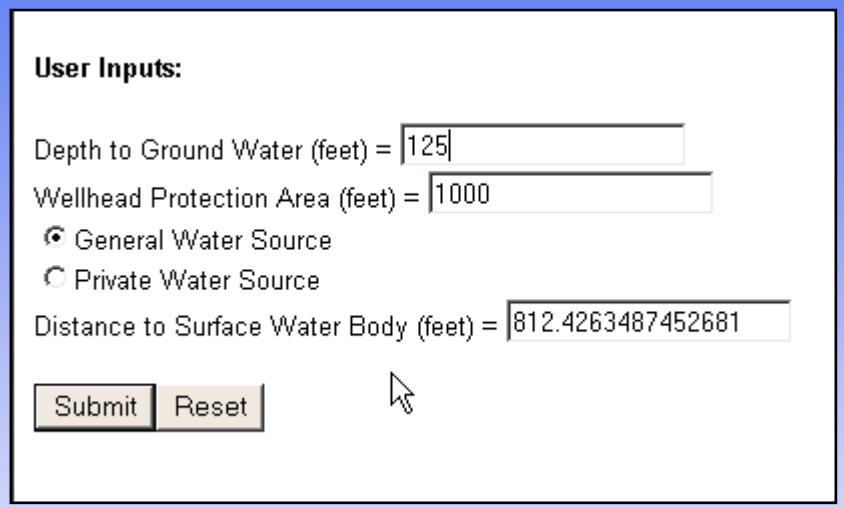








Risk Analysis Tool



Currently depth to groundwater, distance to any surface water and distance to and type of water well are only the guidelines. We are waiting on more guidance from NMOGA chlorides working group

Depth to Ground Water		Shallow	Medium	Deep	
125		0	0	1	
Wellhead Protection Area	Type	Near	Medium	Far	
1000	General Water Source	1	0	0	
Distance to Surface Water Body		Near	Medium	Far	
812		0	0.626666666666667	0.373333333333333	

Risk Score
43

Other factors such as soil permeability, aquifer thickness, or amount spilled can be taken into account. Tool fuzzifies these values and returns a “relative risk.”

Corrosion Toolkit

Final product will include:

- Atlas of formation water quality in SE New Mexico broken down by formation
- Relative corrosivity assessment of each formation
- Known problem areas, along with problem types
- Pictures and graphics for helping to diagnose corrosion/scale problems
- Suggestions for mitigation and best practices based on problems encountered in this area
- Contact information for service providers in the area

What's left to do?

Lots!

Corrosion Manual:

- Atlas of formation water quality in SE New Mexico broken down by formation – publish on web
- Relative corrosivity assessment of each formation
- Known problem areas, along with problem types

Map:

- More detail on water displays (by formation, pools, quality, etc.)
- Try to get a handle on amount of decent-quality water
- Depths to groundwater in a larger area

Database:

- More data cleaning & problem notation
- Downloadable format for data (.txt or .csv file for data, .shp for maps)