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December 5, 2013

Timeline of Water Wells Drilled in Brazoria County, Texas with a Comparison to Precipitation Values, 2002-2012

Introduction and Problem to Solve

Question: How does the rate and concentration of water wells drilled within Brazoria County, Texas over the last 10 years compare to drought and precipitation values over the same time span? A ten year time lapsed animation of water wells drilled and precipitation value histograms will be the final products for this project. Questions that can then be explored with this data is how the water table has been affected due to increased water well drilling during drought conditions.

Hypothesis: More water wells will be drilled during drought conditions (low precipitation). These wells will also be drilled in areas further from surface water.

Overview of Data Collection Processes

1. Import Brazoria County shapefiles
2. Import water well data for Brazoria County
3. Create Excel file containing precipitation values for Brazoria County for 2002-2012
4. Import Excel file into ArcMap; converting to usable format
5. Animate water wells drilled from 2002-2012
6. Create Yearly and Comprehensive Graphs of Precipitation for Brazoria County
7. Compare water wells drilled and precipitation value information for Brazoria County

Data Collection

Water Well Data

I imported a Brazoria County Shapefile from

http://www.gis.ttu.edu/center/DataCatalog/Download.php?County=Brazoria then imported well

location data from the Texas Water Development Board.

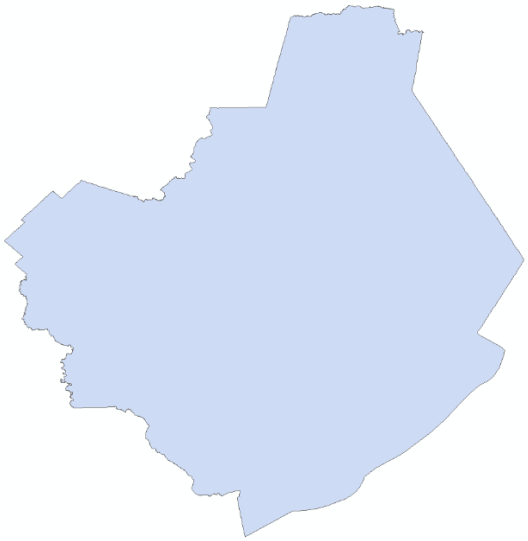
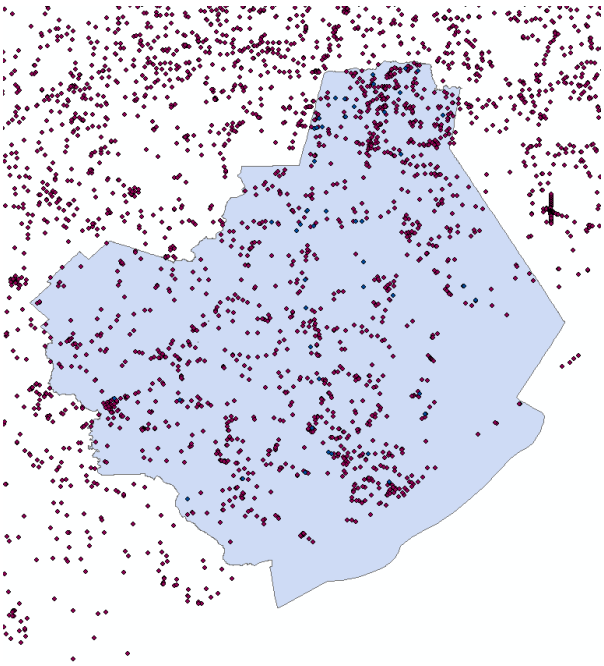


Figure 1 (left): Brazoria County, Texas

Figure 2 (below): Brazoria County, Texas overlain with water wells drilled in Texas



Once this information was imported into ArcMap, I clipped the Texas water wells to the area for Brazoria County leaving me with a total of 1417 water wells drilled in the county.

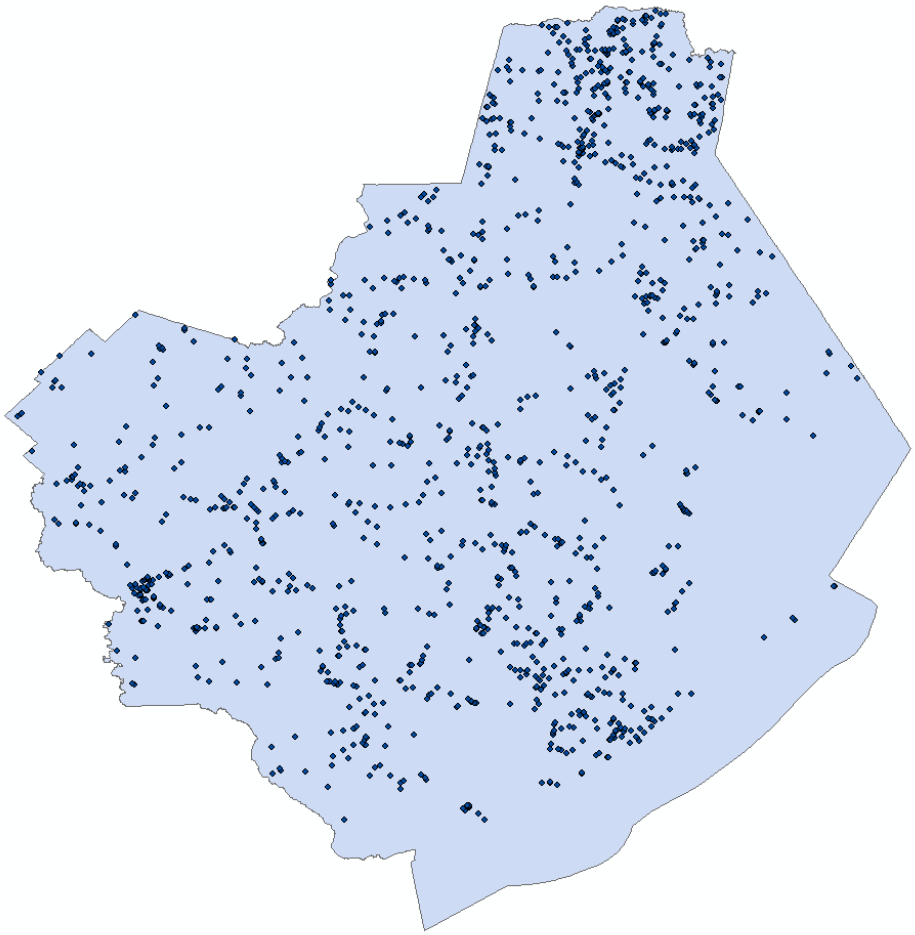


Figure 3: Brazoria County, Texas with water wells drilled within the county. Source: TWDB

I then edited the water wells shapefile to include the data in the correct format for later manipulation. Within the attribute table, I added a Drill_Date column that contains date information using proper formatting for date information and removed all wells drilled prior to January 2002.

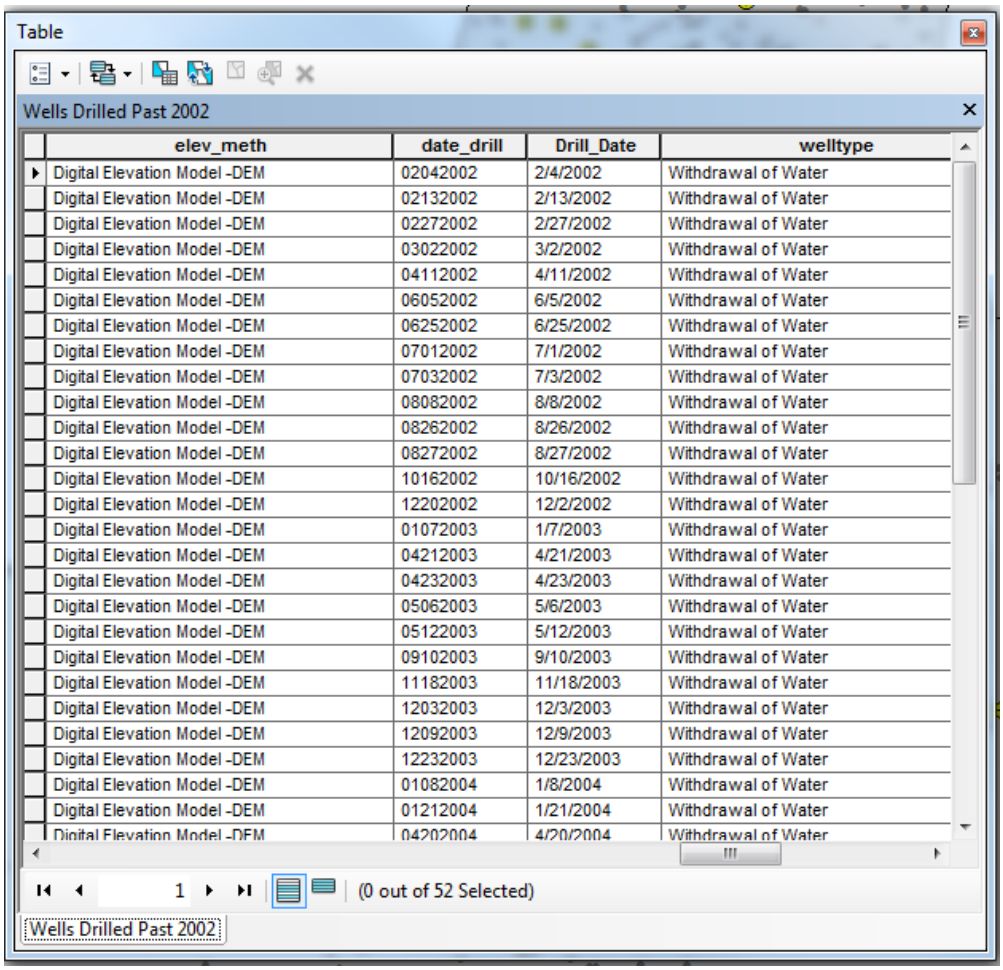


Figure 4: Inserted Drill_Date column in attribute table of water wells drilled after 2002

After removing all water wells drilled prior to 2002 from this file, I was left with only 52 water wells drilled. I know from personal experience that this information is wrong. I attempted to find other water well information from several different sources including the Texas Water Development Board and the Brazoria County Water Conservation District, but the only information online was the previously downloaded water wells shapefile. There are state regulations requiring that well drilling companies report their drilling records to the state, but

they could possibly not be reporting these records in a timely fashion and this might be the cause of lacking drill data in this shapefile. Another possibility could be that the Texas Water Development Board has not updated their online information recently. Whichever the reason, I continued progressing within my project knowing that this lack of information would skew my final results.

Within ArcMap, I created a new file and uploaded the Brazoria County shapefile, total water wells drilled for Brazoria County and water wells drilled for Brazoria County past 2002. This is the file that I used for the remainder of this project.

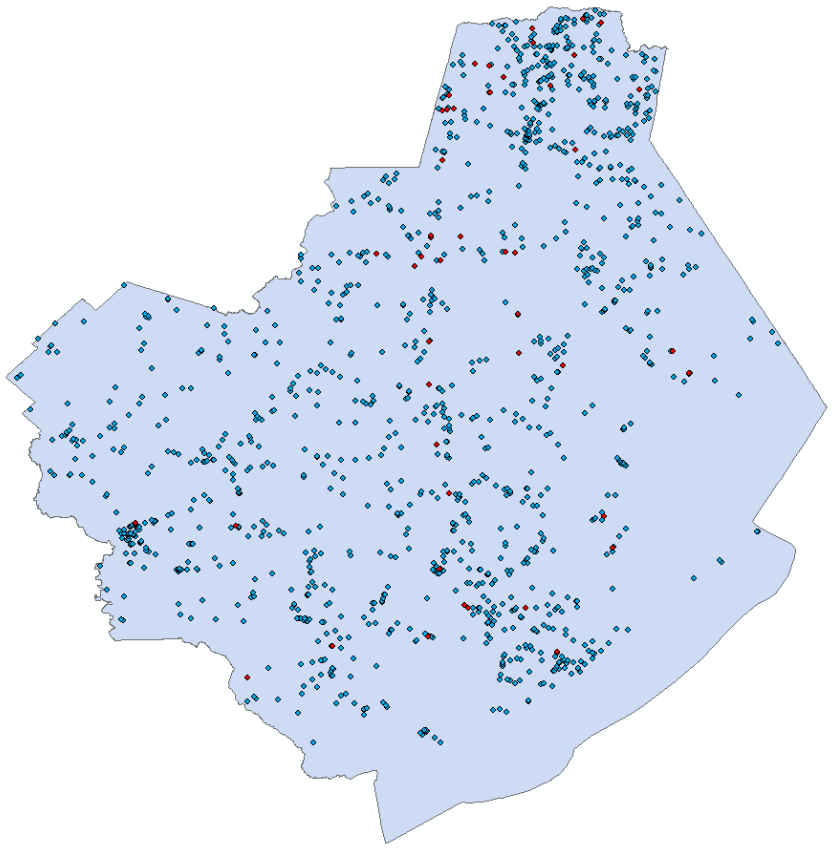


Figure 5: Water wells drilled in Brazoria County, Texas with distinctions of wells drilled prior to and past 2002. Red dots are wells past 2002.

I know that drill data for Brazoria County is incorrect because my family owns land in this county and we have drilled several new water wells within the last decade. In an attempt to create more drill information for this county, I downloaded orthophotos from TNRIS for Brazoria County.

Orthophotos downloaded:

- East Columbia Quarter-Quads : NW, NE, SW, SE
- Otey Quarter-Quads: SW, SE
- Brazoria County (very large file)

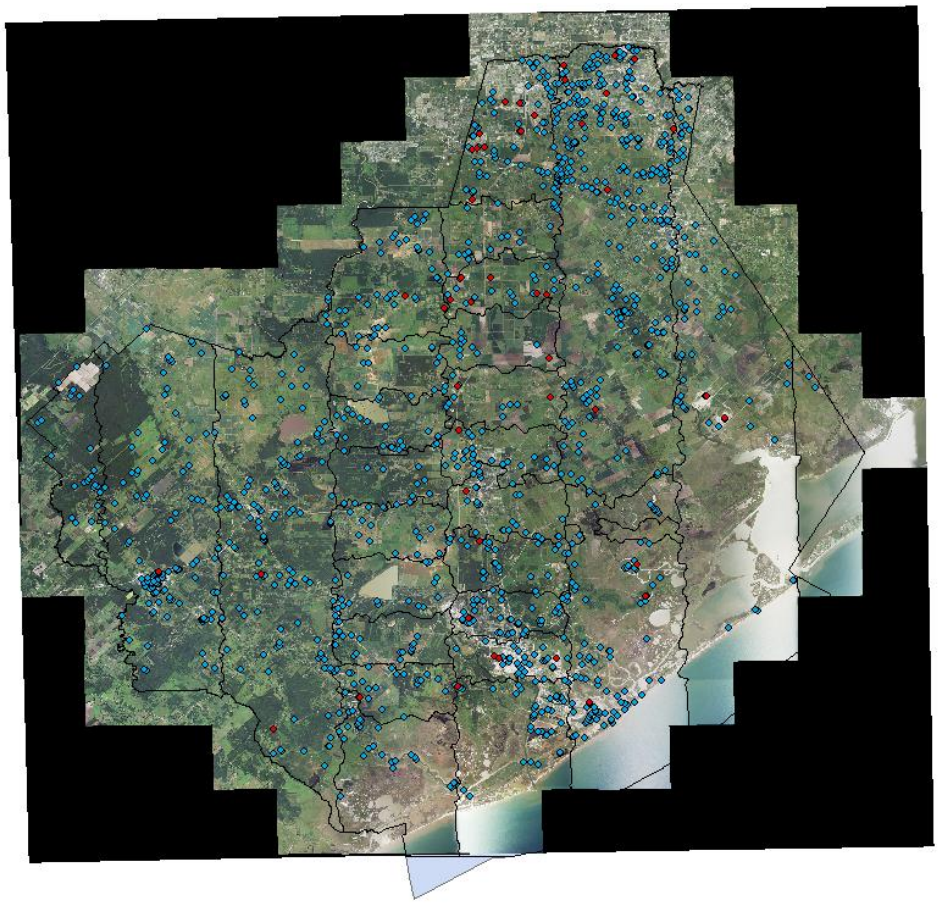


Figure 6: Brazoria County Orthophoto with water wells

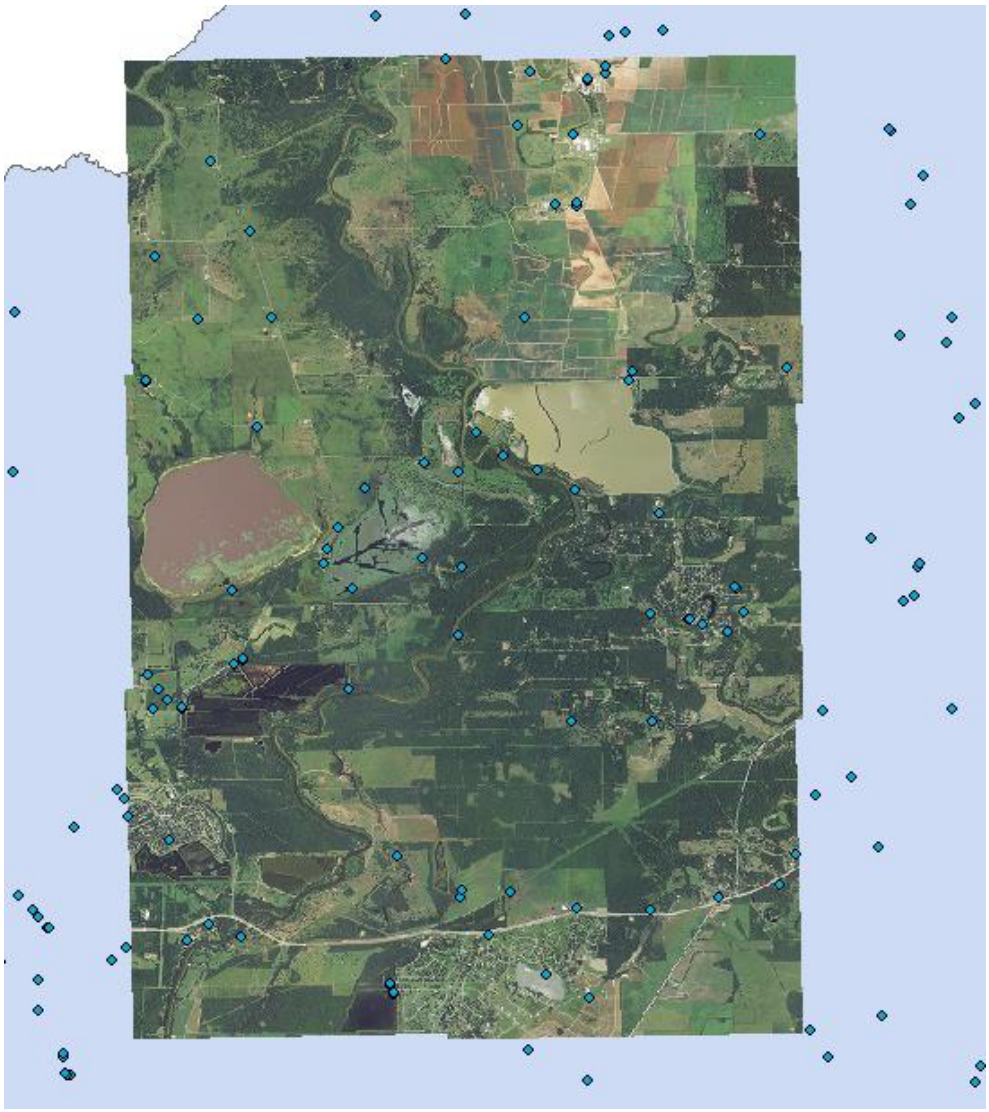


Figure 7: East Columbia and Otey Quarter-Quad Orthophotos with water wells

These downloaded orthophotos resulted in little practical use for this project. Their size alone, caused problems when trying to edit features and buffer images. The only practical use these orthophotos could provide would be for placing water well information in the database if these well locations are already known.

In an effort to obtain more water well data, I revisited http://www.gis.ttu.edu/center/DataCatalog/Download.php?County=Brazoria and downloaded several more shapefiles to see if they would give any insight as to why these wells were drilled in their specific locations.

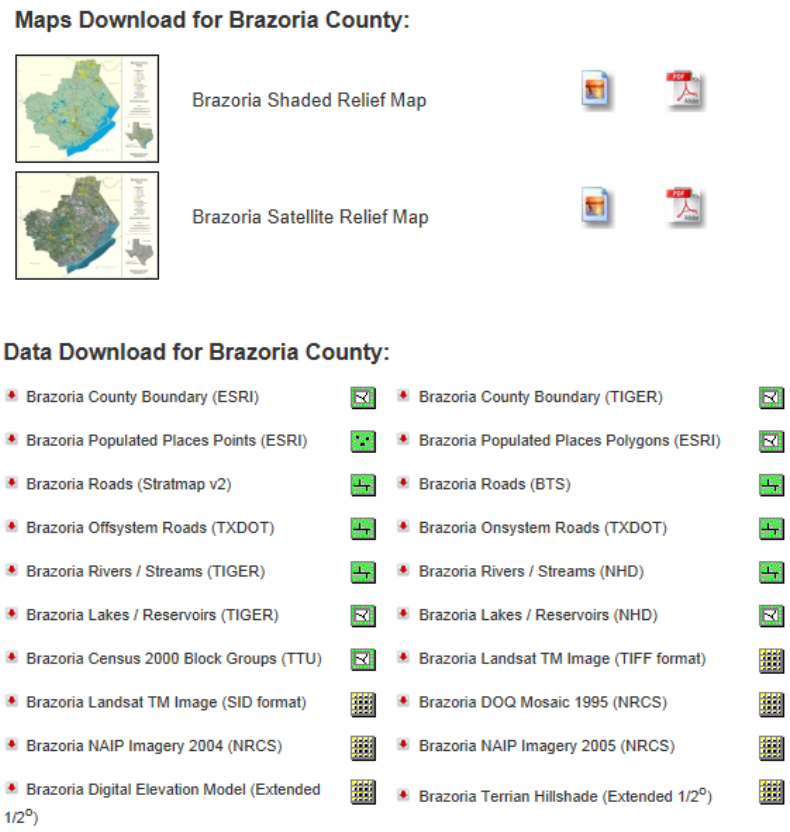


Figure 8: Shapefile and Metadata information available from Texas Tech University Center for Geospatial Technology

The most insightful shapefile downloaded was the Brazoria Roads file. This file overlaid with well data shows that water wells are typically drilled at population centers where there is a greater density of roads. In addition to the roads shapefile, I downloaded the shapefile of surface water bodies to show correlations between readily available water and regions within the county which have less water resources available at the surface.

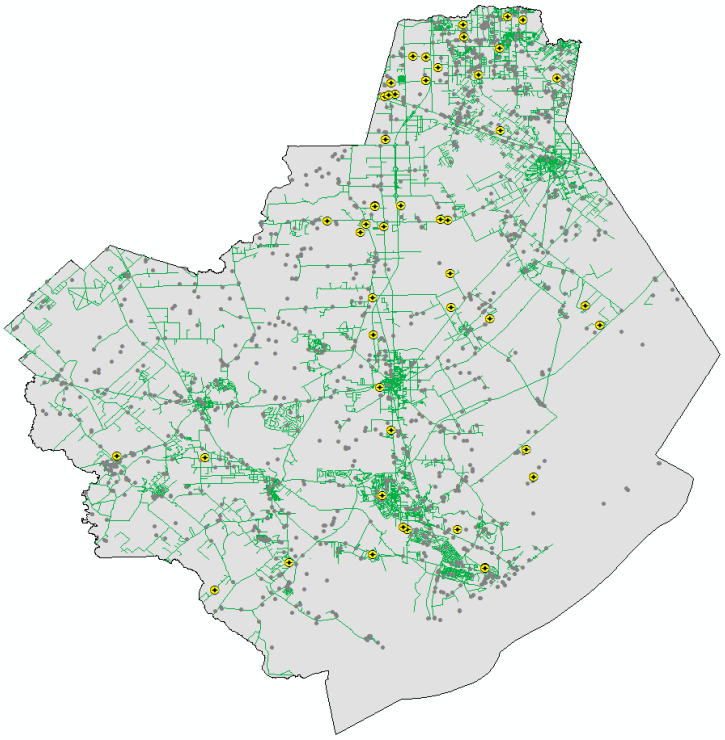
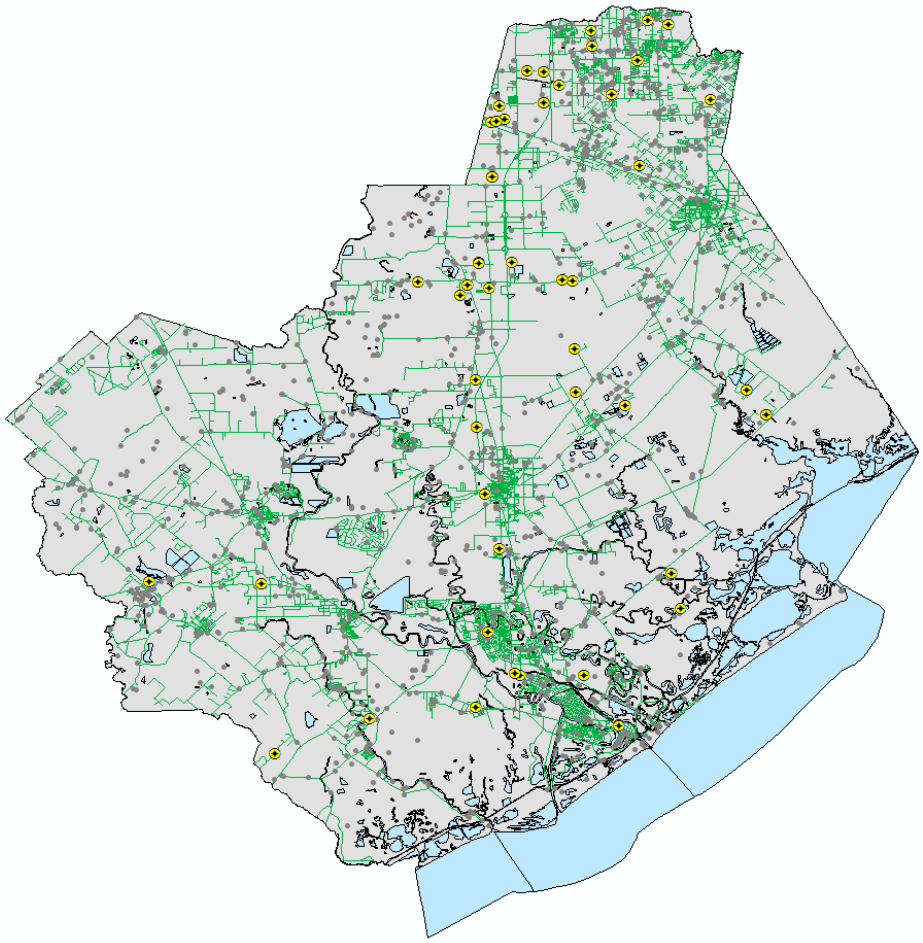


Figure 9 (left): Brazoria County showing wells drilled prior to 2002 (gray dots), wells drilled past 2002 (yellow dots) and all roads within the county (green lines)

Figure 10 (below): Brazoria County showing all information in Fig. 12 in addition to surface water bodies within the county



Next, I began to animate the water wells drilled beginning in 2002 using the animation tool within ArcMap. Before I could begin the animation process, I needed to make a tracking layer so application of animation would be viable.

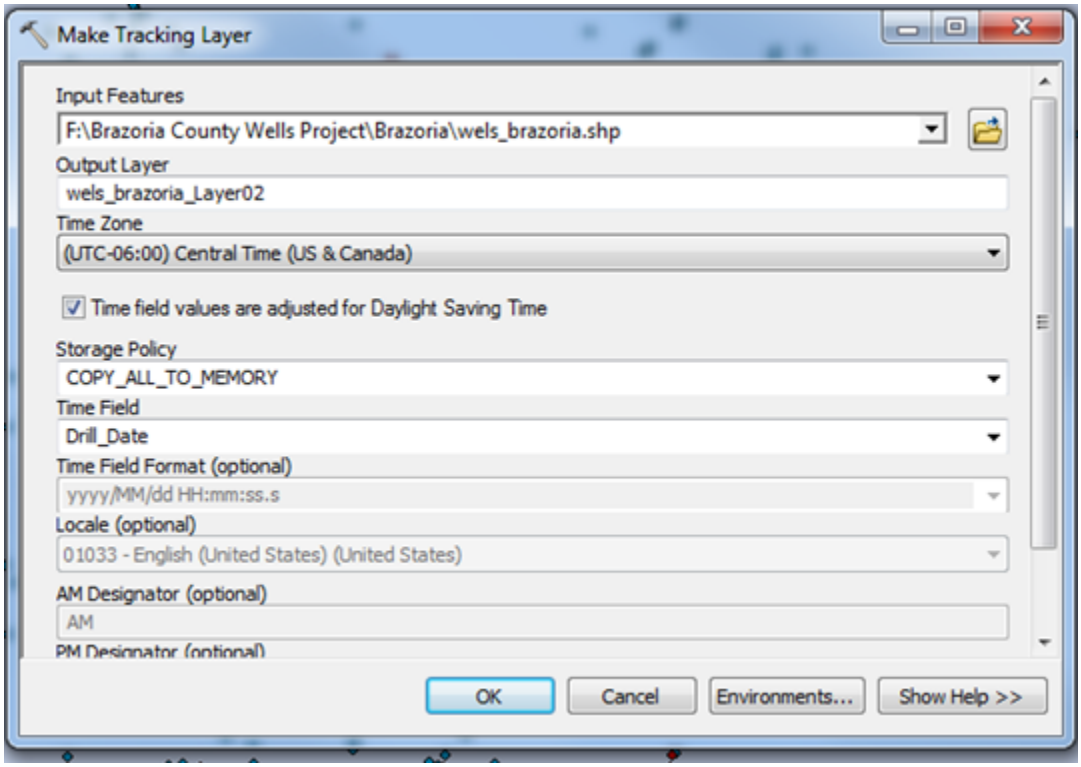


Figure 11: Tracking Layer window

Creating this tracking layer allowed me to specify the data source that is to be animated and to set its source information.

The animation tool in ArcMap is able to specify the time range and frames desired for the final movie file. A downside to the animation tool is that once an animation is created it is impossible to change the field of view, frame information or date range without generating a new animation. Due to this fact, I created several animations with different parameters.

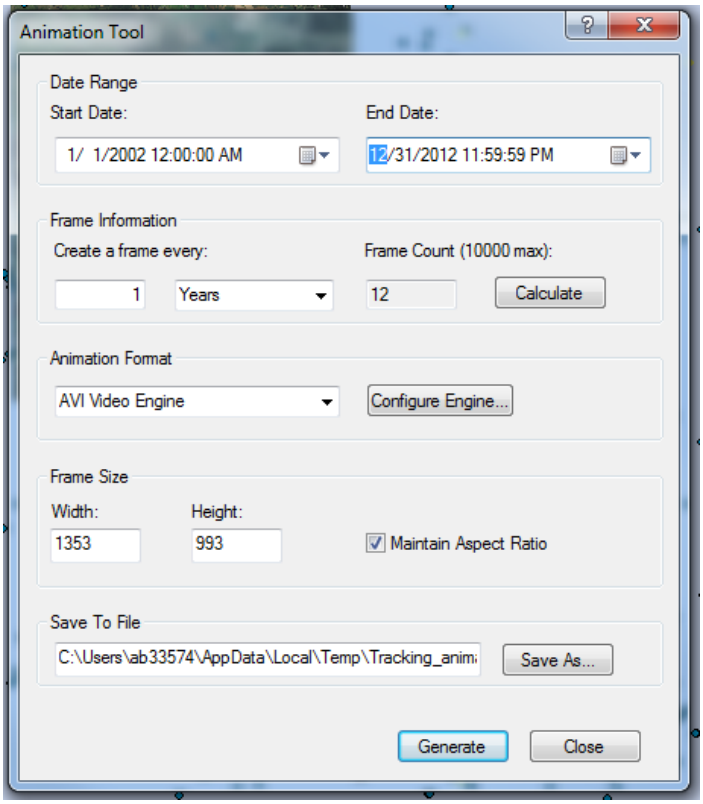


Figure 12 (top): Animation Tool window showing specifications for animation

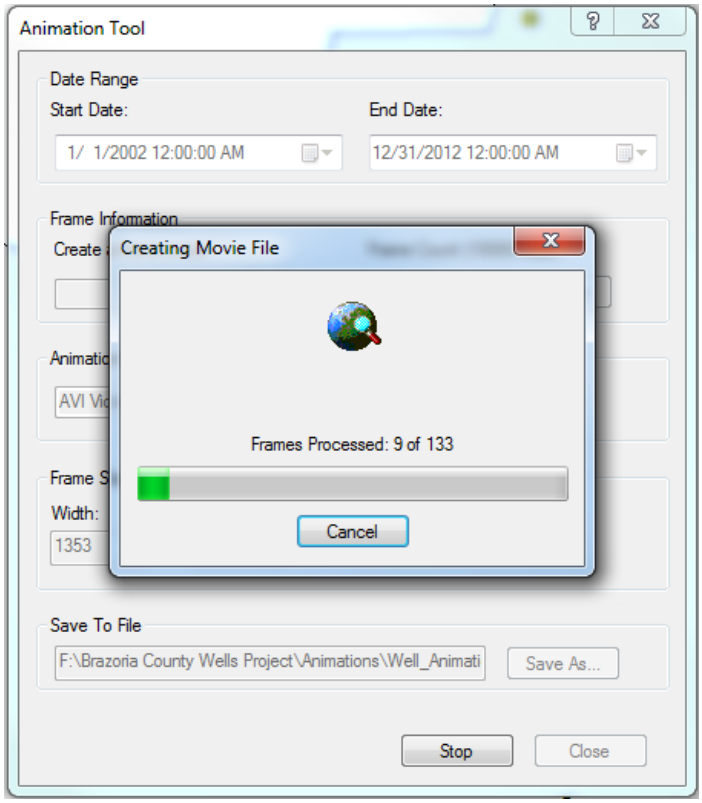


Figure 13 (bottom): View of animation creation. Each frame must be processed individually

The final animations contain one frame per second so for animations that have months as the time span, 133 seconds of material is generated, whereas only 11 seconds of material is generated when using years as the time unit. Because precipitation information will be in months, the desired outcome of this animation will be one where the time frame is in months.

Final animation products for this project:

- Wells_Monthly: video of wells drilled by month from 2002 to 2012
- Wells_Yearly: video of wells drilled by year from 2002 to 2012
- Wells_Roads_Water_Yearly: video of wells drilled by year from 2002 to 2012 with all county roads and surface water bodies visible in county view

Precipitation Data

The NOAA website contained precipitation information for Brazoria County from http://www.ncdc.noaa.gov/cag/time-series/us. This online database allowed me to specify precipitation information (while disregarding temperature information) for the time scale and date range desired.

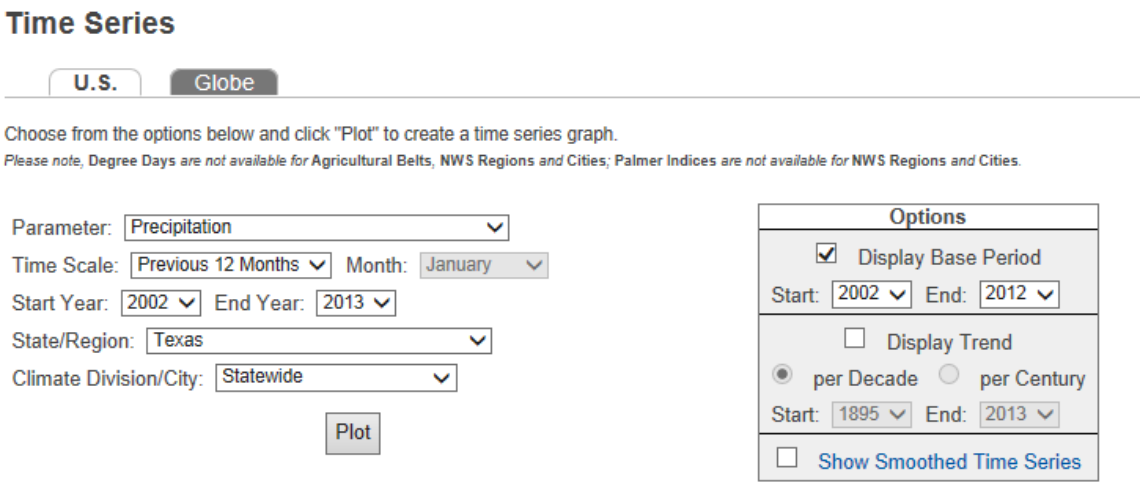
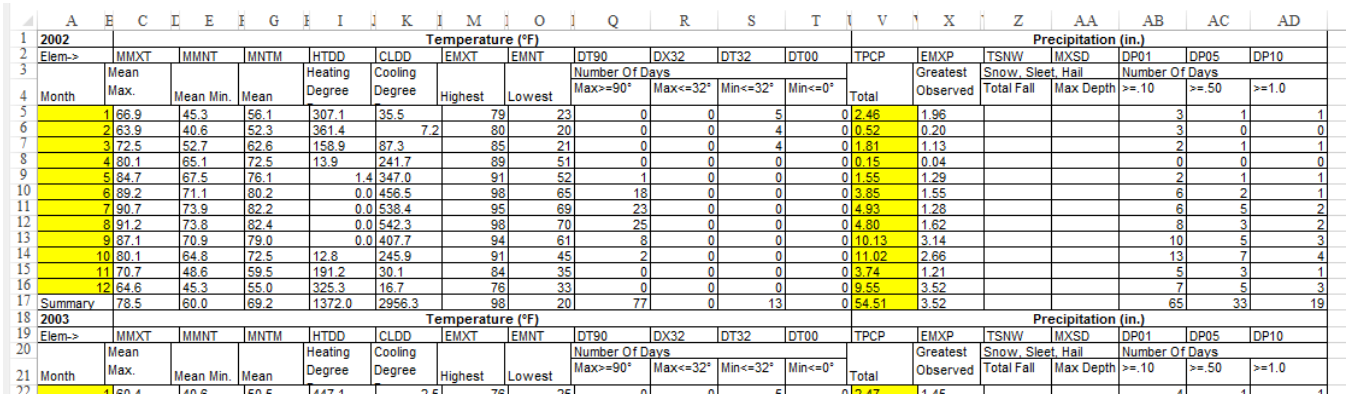


Figure 14: View of window seen when requesting precipitation data from NOAA

The information obtained from this database was exported into an excel file for January 2002 thru December 2012. There is a feature within NOAA that allowed me to request county specific information (http://www1.ncdc.noaa.gov/pub/orders/cdo/237579.pdf); my request was granted and I received several pdf files of monthly climatological summaries for 2002-2012. These files contained information for several different weather stations throughout the county. Some of these weather stations did not contain information for the time range desired, so I decided to use the information available from the **Angleton Lake Jackson Brazoria Co Airport** based on its location and the precipitation data available at this site. I converted these pdf files into excel files where I then extracted only the precipitation information over this time span.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Z	AA	AB	AC	AD
1	2002							Temperature (°F)																	Precipitation (in.)					
2	Elem->	MMXT		MMNT		MNTM		HTDD	CLDD		EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP		EMXP	TSNW	MXSD	DP01	DP05	DP10			
3		Mean						Heating	Cooling						Number Of Days						Greatest	Snow, Sleet, Hail		Number Of Days					
4	Month	Max.		Mean Min.		Mean		Degree	Degree		Highest		Lowest		Max>=90°	Max<=32°	Min<=32°	Min<=0°	Total		Observed	Total Fall	Max Depth	>=.10	>=.50	>=1.0			
5	1	66.9		45.3		56.1		307.1	35.5		79		23		0	0	5	0	2.46		1.96			3	1	1			
6	2	63.9		40.6		52.3		361.4		7.2	80		20		0	0	4	0	0.52		0.20			3	0	0			
7	3	72.5		52.7		62.6		158.9	87.3		85		21		0	0	4	0	1.81		1.13			2	1	1			
8	4	80.1		65.1		72.5		13.9	241.7		89		51		0	0	0	0	0.15		0.04			0	0	0			
9	5	84.7		67.5		76.1		1.4	347.0		91		52		1	0	0	0	1.55		1.29			2	1	1			
10	6	89.2		71.1		80.2		0.0	456.5		98		65		18	0	0	0	3.85		1.55			6	2	1			
11	7	90.7		73.9		82.2		0.0	538.4		95		69		23	0	0	0	4.93		1.28			6	5	2			
12	8	91.2		73.8		82.4		0.0	542.3		98		70		25	0	0	0	4.80		1.62			8	3	2			
13	9	87.1		70.9		79.0		0.0	407.7		94		61		8	0	0	0	10.13		3.14			10	5	3			
14	10	80.1		64.8		72.5		12.8	245.9		91		45		2	0	0	0	11.02		2.66			13	7	4			
15	11	70.7		48.6		59.5		191.2	30.1		84		35		0	0	0	0	3.74		1.21			5	3	1			
16	12	64.6		45.3		55.0		325.3	16.7		76		33		0	0	0	0	9.55		3.52			7	5	3			
17	Summary	78.5		60.0		69.2		1372.0	2956.3		98		20		77	0	13	0	54.51		3.52			65	33	19			
18	2003							Temperature (°F)																	Precipitation (in.)					
19	Elem->	MMXT		MMNT		MNTM		HTDD	CLDD		EMXT		EMNT		DT90	DX32	DT32	DT00	TPCP		EMXP	TSNW	MXSD	DP01	DP05	DP10			
20		Mean						Heating	Cooling						Number Of Days						Greatest	Snow, Sleet, Hail		Number Of Days					
21	Month	Max.		Mean Min.		Mean		Degree	Degree		Highest		Lowest		Max>=90°	Max<=32°	Min<=32°	Min<=0°	Total		Observed	Total Fall	Max Depth	>=.10	>=.50	>=1.0			
22	1	69.4		40.6		59.5		447.1		2.5	78		25		0	0	5	0	2.47		1.45			4	1	1			

	A	B	C	D
1	Texas	Precipitation		
2	Units: Inches			
3	Base Period: 2002-2012			
4	Date	Value	Anomaly	
5	200201	0.98	-1.32	
6	200202	1.04	-1.26	
7	200203	2.13	-0.17	
8	200204	1.82	-0.48	
9	200205	2.03	-0.27	
10	200206	2.41	0.11	
11	200207	4.85	2.55	
12	200208	1.78	-0.52	
13	200209	3.04	0.74	
14	200210	6.25	3.95	
15	200211	1.77	-0.53	
16	200212	3.26	0.96	
17	200301	0.58	-1.72	
18	200302	2.47	0.17	
19	200303	1.13	-1.17	
20	200304	0.78	-1.52	
21	200305	1.51	-0.79	
22	200306	4.58	2.28	

Figure 15 (top): Excel columns interested in from NOAA weather information for Brazoria County 2002-20012

Figure 16 (left): Excel information imported into separate file of desired precipitation information for 2002-2012

I then saved this excel file as .csv and a .txt files so that I could then import them into ArcMap for manipulation. In order for this to be successfully done, I first needed to create a personal geodatabase in ArcCatalog where I then imported the .csv file on precipitation values. Before importing this excel file into ArcCatalog and my geodatabase, I first needed to create a formatted date column within the workbook, ensuring the dates would be read properly in further steps of the project.

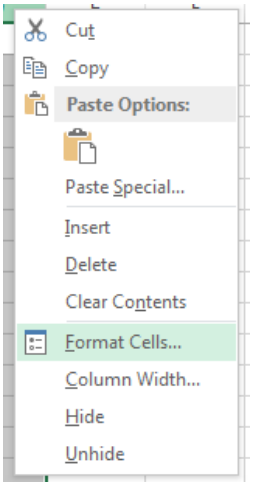
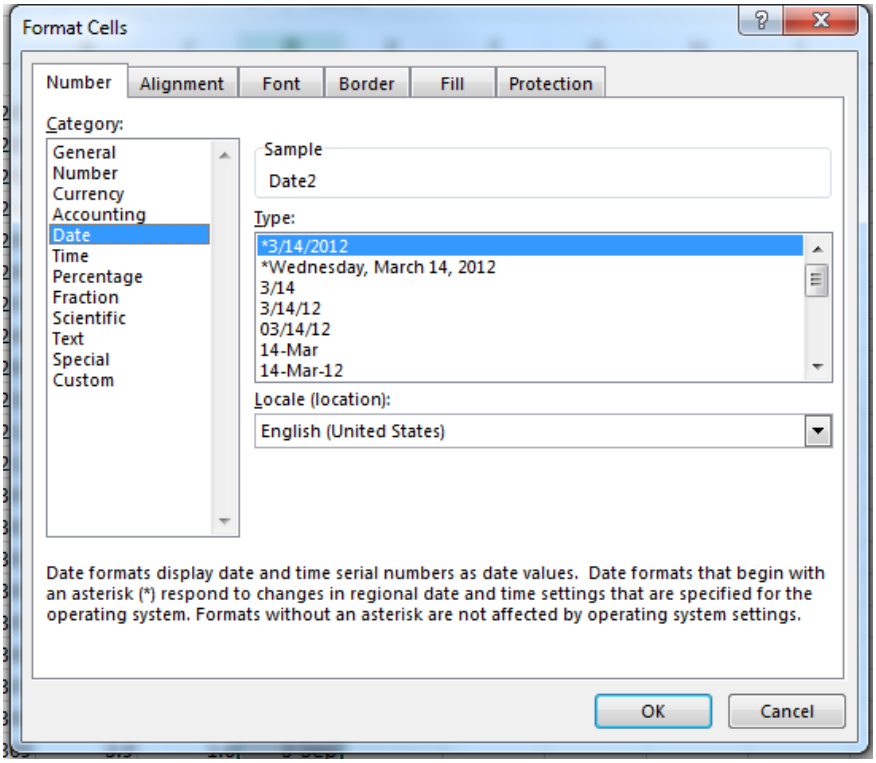


Figure 17 (left): View of right click column options within excel- this is how to determine their formatting options

Figure 18 (below): formatting cell options, specifically date information



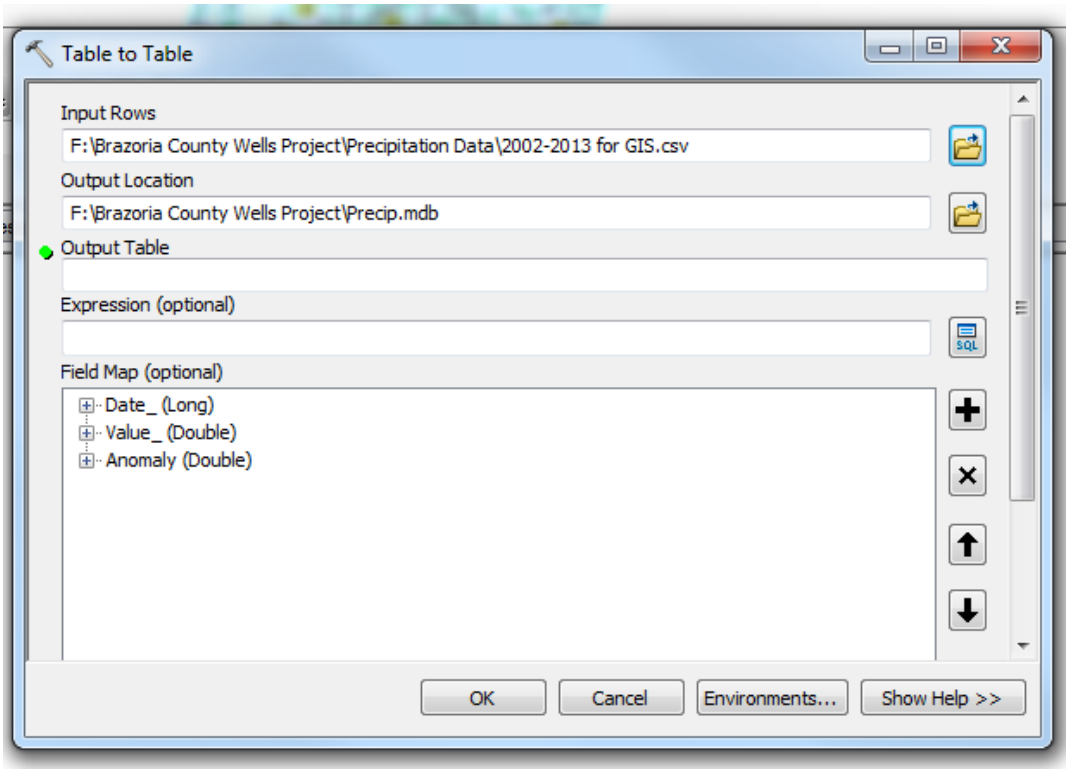


Figure 19 (top): View of importing .csv file into geodatabase

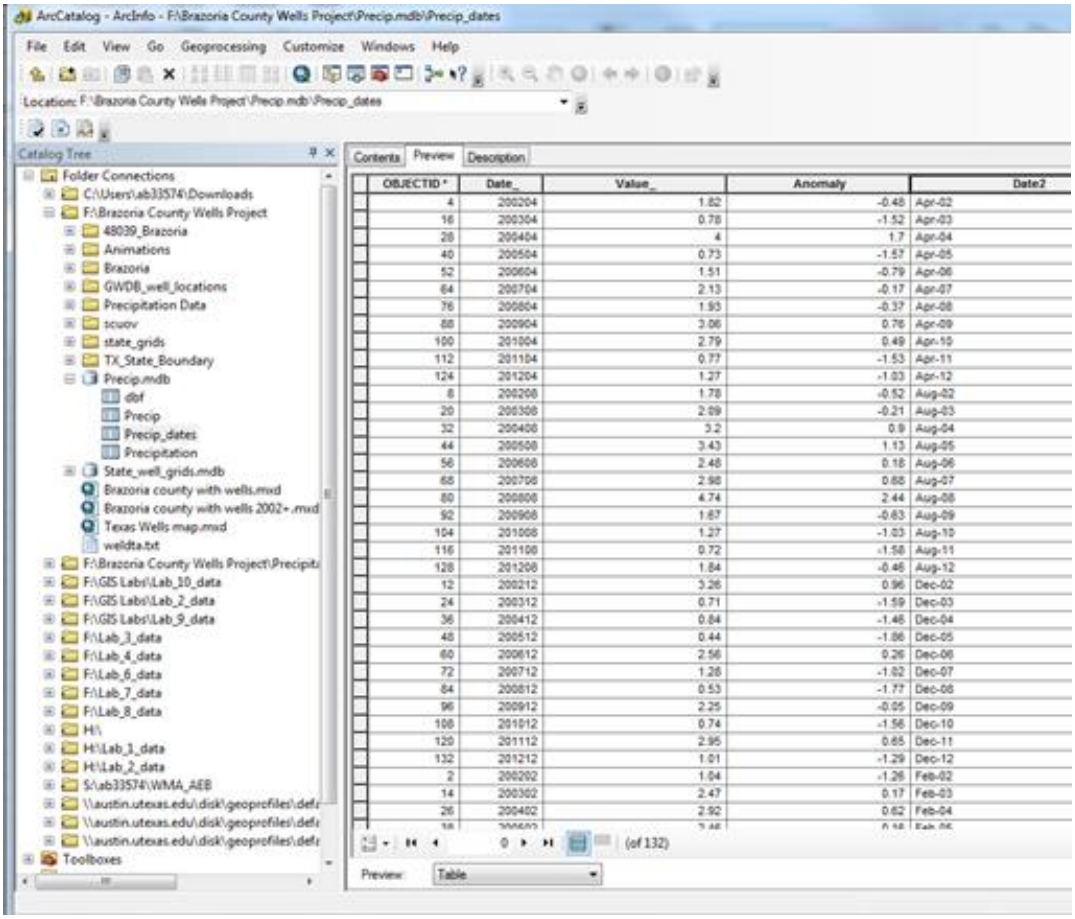
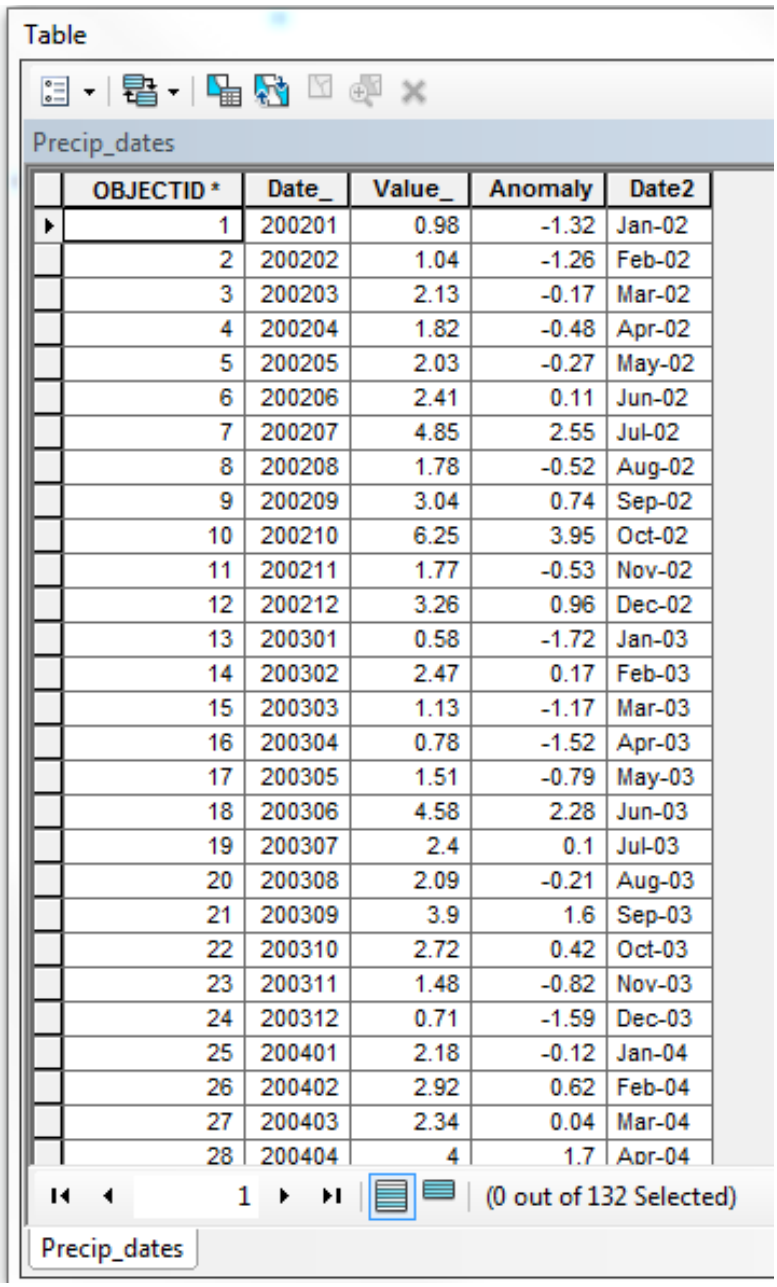


Figure 20 (bottom): Attribute table of imported .csv file with edited date column



OBJECTID *	Date_	Value_	Anomaly	Date2
1	200201	0.98	-1.32	Jan-02
2	200202	1.04	-1.26	Feb-02
3	200203	2.13	-0.17	Mar-02
4	200204	1.82	-0.48	Apr-02
5	200205	2.03	-0.27	May-02
6	200206	2.41	0.11	Jun-02
7	200207	4.85	2.55	Jul-02
8	200208	1.78	-0.52	Aug-02
9	200209	3.04	0.74	Sep-02
10	200210	6.25	3.95	Oct-02
11	200211	1.77	-0.53	Nov-02
12	200212	3.26	0.96	Dec-02
13	200301	0.58	-1.72	Jan-03
14	200302	2.47	0.17	Feb-03
15	200303	1.13	-1.17	Mar-03
16	200304	0.78	-1.52	Apr-03
17	200305	1.51	-0.79	May-03
18	200306	4.58	2.28	Jun-03
19	200307	2.4	0.1	Jul-03
20	200308	2.09	-0.21	Aug-03
21	200309	3.9	1.6	Sep-03
22	200310	2.72	0.42	Oct-03
23	200311	1.48	-0.82	Nov-03
24	200312	0.71	-1.59	Dec-03
25	200401	2.18	-0.12	Jan-04
26	200402	2.92	0.62	Feb-04
27	200403	2.34	0.04	Mar-04
28	200404	4	1.7	Apr-04

Figure 21: Attribute table for precipitation information with corrected date column information

Once this file was successfully imported into ArcMap, I changed the symbology formatting so that when viewing the precipitation values, it makes graphical sense when paired with the well data.

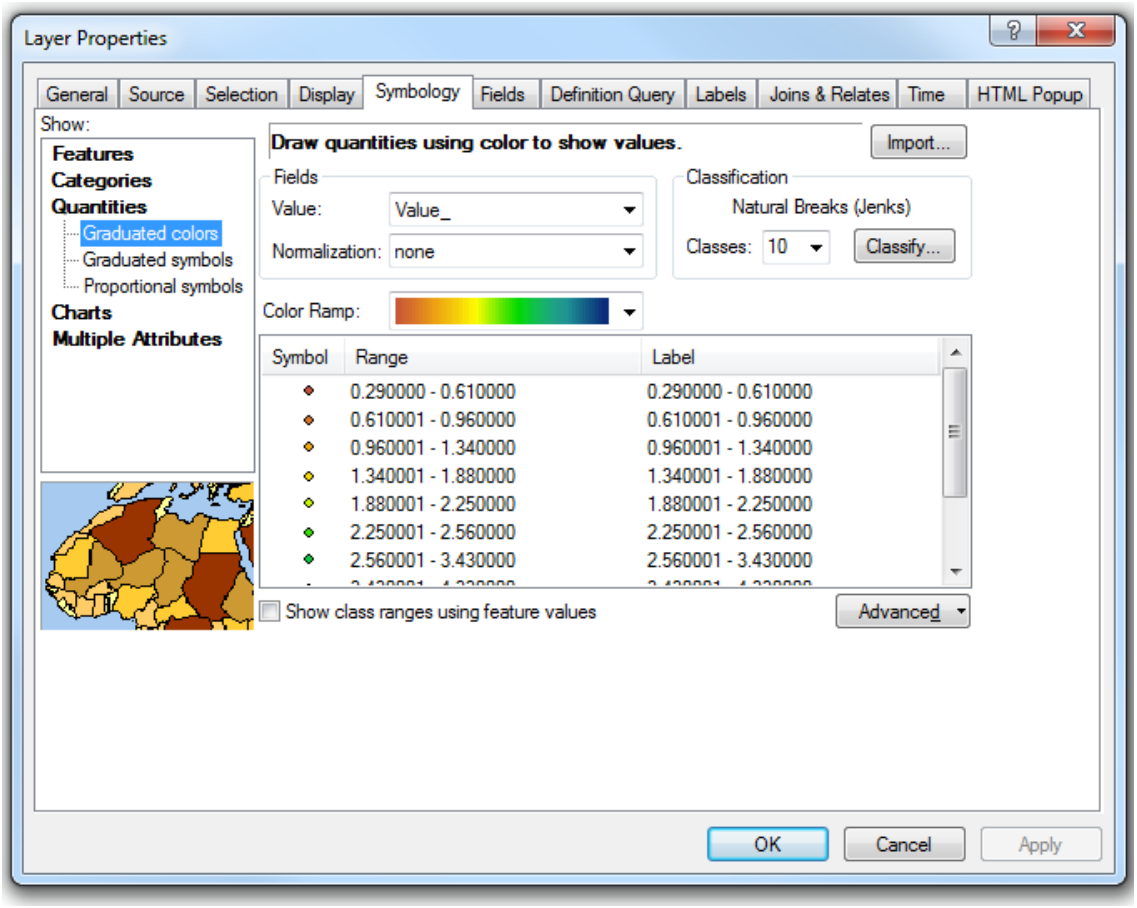


Figure 22: Breaking the precipitation value symbology into 10 subdivisions

After breaking apart precipitation symbology values, I attempted using the graphing feature within ArcMap. I had mixed results in regards to useful information representation for this project.

To create graphs within ArcMap, first I opened the attribute table for my precipitation information, then under the table options tab on the top left side of the table toolbar, I selected the “Create Graph…” feature to create a histogram of precipitation information.

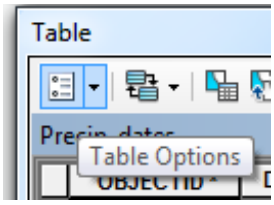


Figure 23: Table Options tab on attribute table

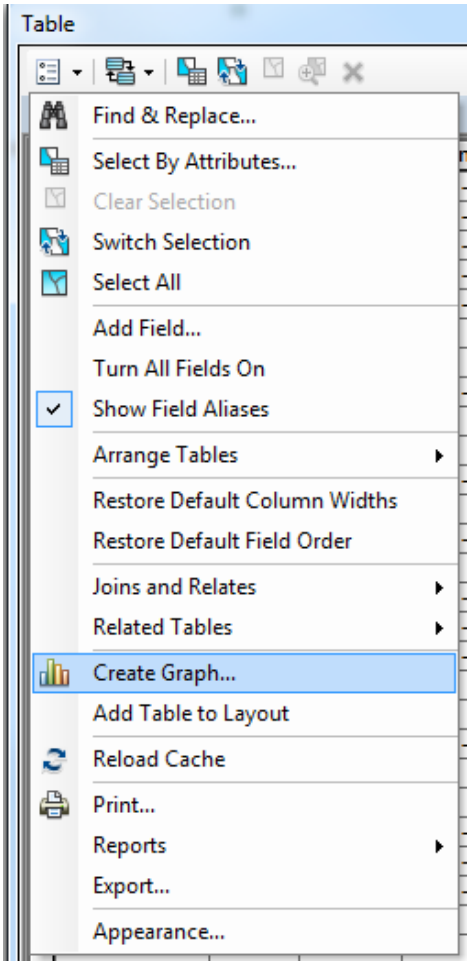


Figure 24: "Create Graph…" option under table options tab within ArcMap attribute table

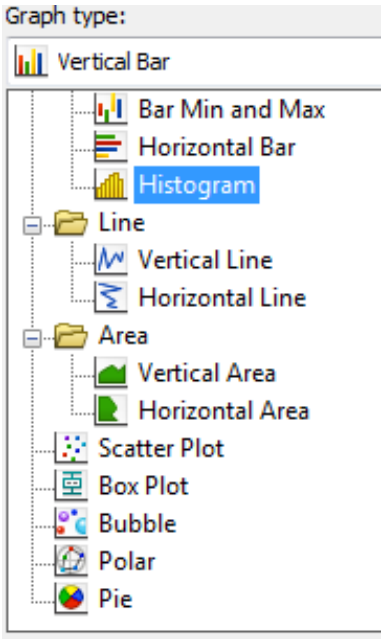


Figure 25: Choose histogram graph option to best represent precipitation data

Once within the graph formatting screen, I entered in the appropriate graphing information including the source and axes data as seen below.

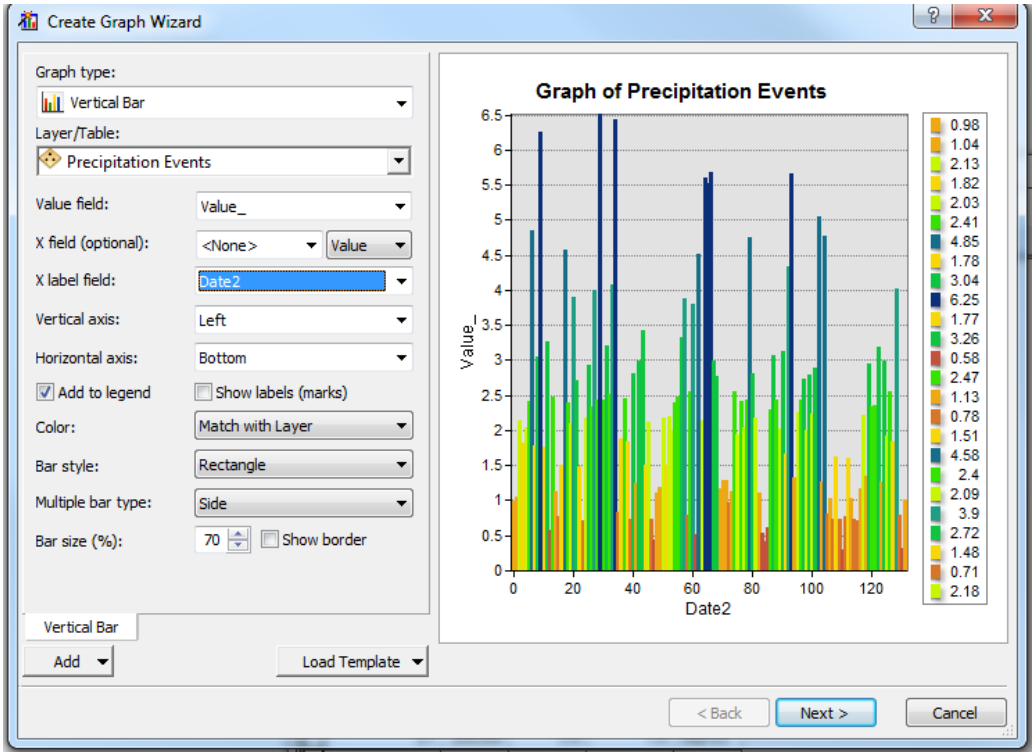


Figure 26 (top): First page of graphing manipulation

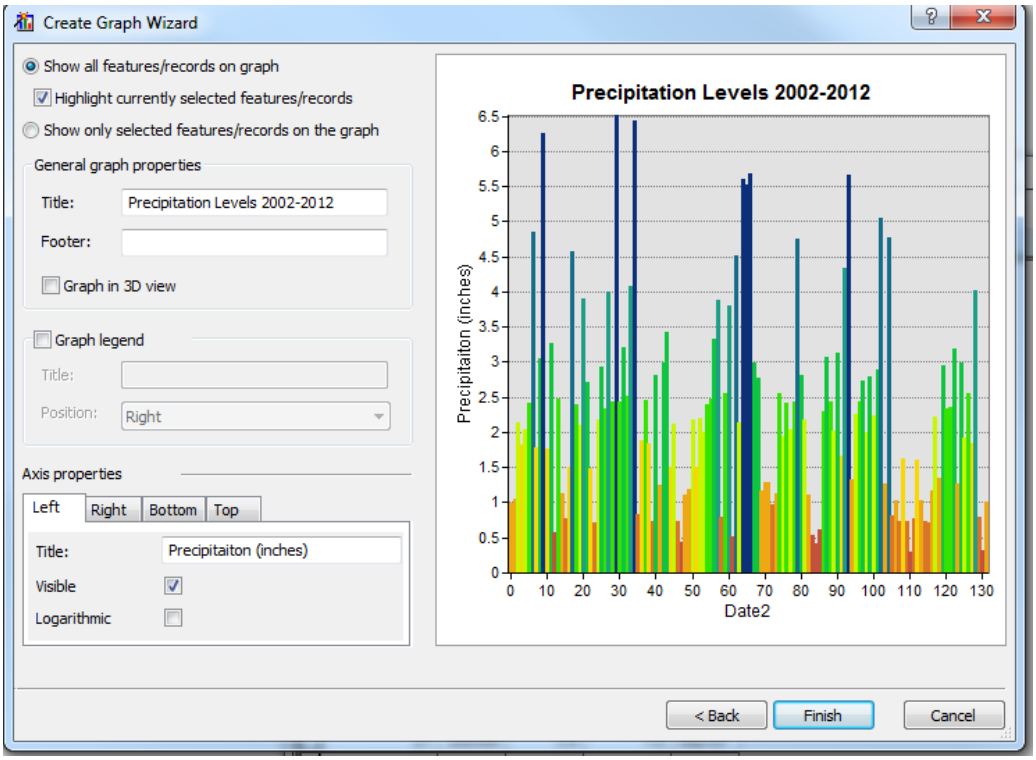


Figure 27 (bottom): Final page for graphing manipulation

To ensure that the color scheme remained the desired precipitation ramp values, it was necessary to select “Match with Layer” under the color options on the first Create Graph Wizard screen.

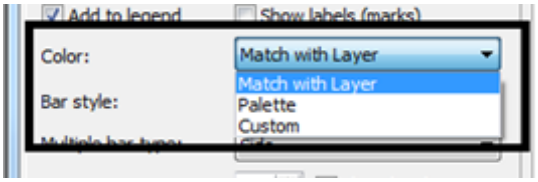


Figure 28: Match with Layer option

The final graph produced using this method is seen below:

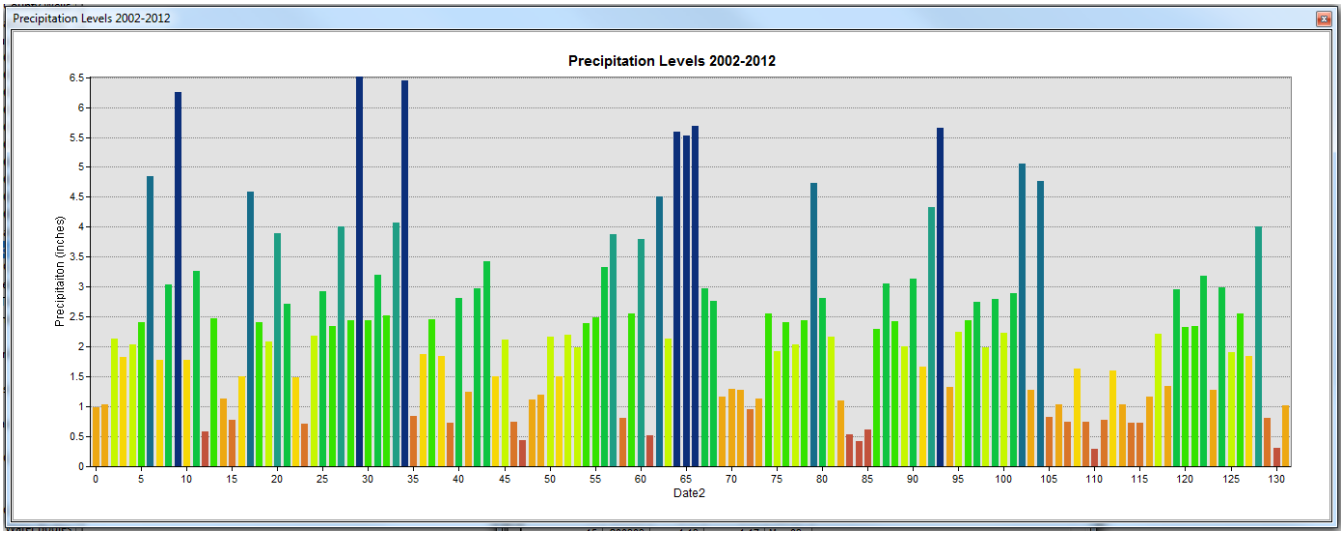


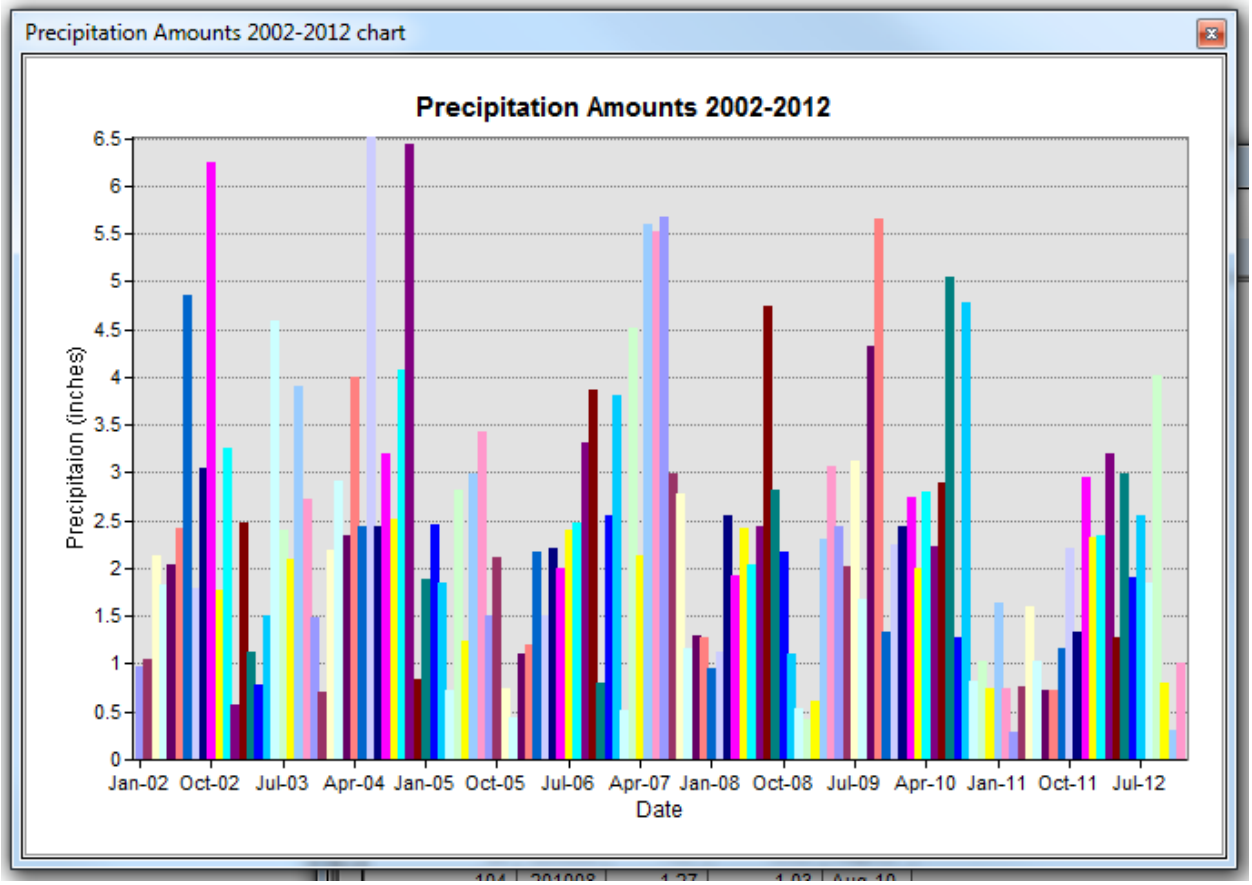
Figure 29: Graph of precipitation values in Brazoria County, TX for 2002-2012

This graph gives clear representations of when there were drought conditions and when Brazoria County received a good amount of precipitation. Unfortunately this graph’s x-axis is giving the dates in occurrences by month and not using subdivisions of years and month names. By further manipulating options within graph creation, I was able to isolate the dates entered and create a graph with dates on the x-axis; unfortunately when this process was applied, the precipitation color ramp (match with layer) was excluded from color options. The palette

option divided each month using different colors, but the color differentiations make no graphical sense when coupled with precipitation information.

Figure 30 (left): Color options available when specific dates are shown on x-axis

Figure 31 (below): Graph of monthly precipitation in Brazoria County 2002-2012

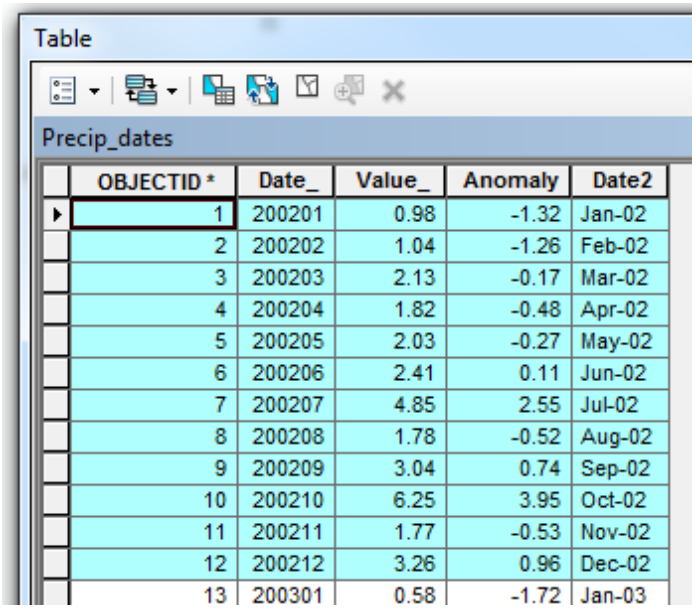


Next, I isolated one year's worth of precipitation information and created a graph with monthly divisions of precipitation for Brazoria County. This process was done the same way that the entire precipitation histogram information was created. And here again, the color options did not give the precipitation ramp under match with layer. But instead of having appropriate date

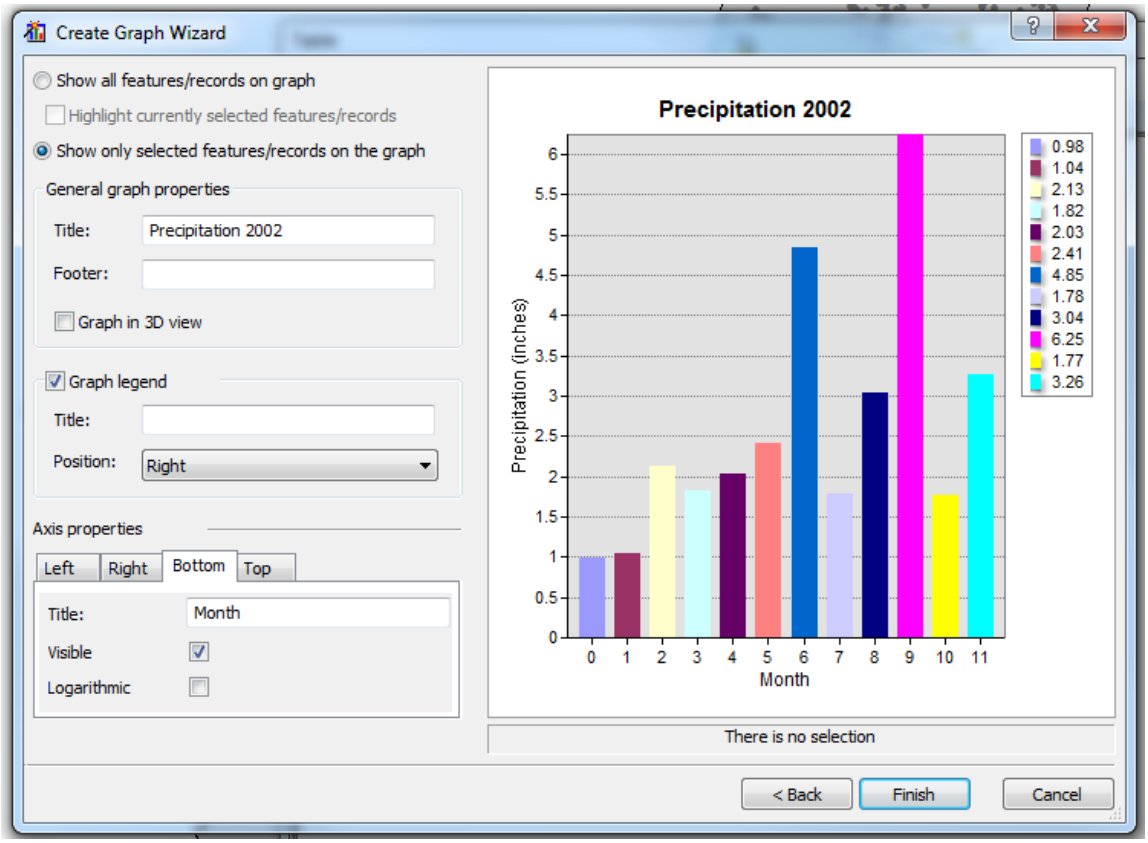
labels on the x-axis, the month values began at a 0 value and ended on 11 instead of 1 (January) and 12 (December).

Figure 32 (right): Attribute table with selected features spanning one year

Figure 33 (below): Graph Wizard window for one year of precipitation information



OBJECTID *	Date_	Value_	Anomaly	Date2
1	200201	0.98	-1.32	Jan-02
2	200202	1.04	-1.26	Feb-02
3	200203	2.13	-0.17	Mar-02
4	200204	1.82	-0.48	Apr-02
5	200205	2.03	-0.27	May-02
6	200206	2.41	0.11	Jun-02
7	200207	4.85	2.55	Jul-02
8	200208	1.78	-0.52	Aug-02
9	200209	3.04	0.74	Sep-02
10	200210	6.25	3.95	Oct-02
11	200211	1.77	-0.53	Nov-02
12	200212	3.26	0.96	Dec-02
13	200301	0.58	-1.72	Jan-03



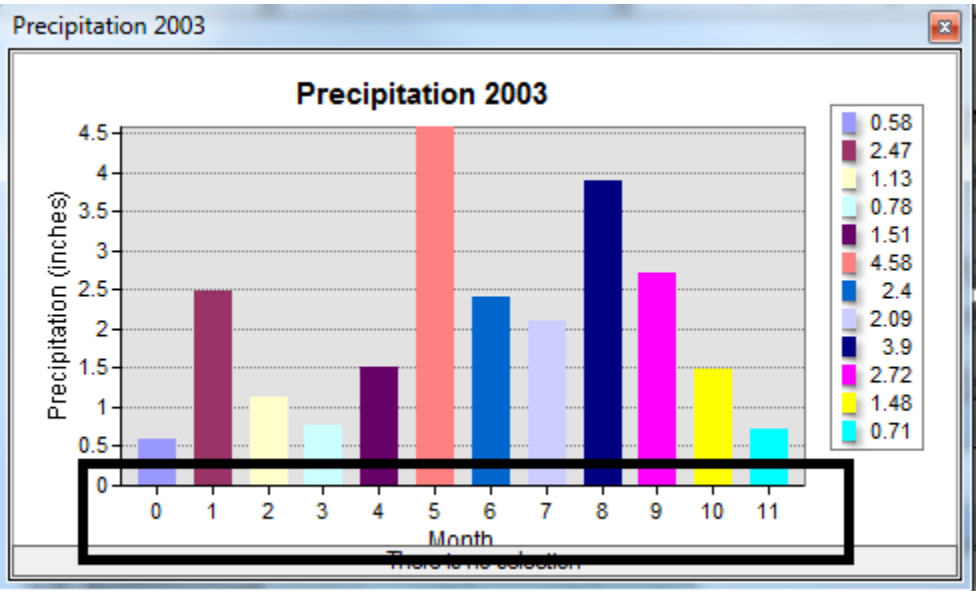
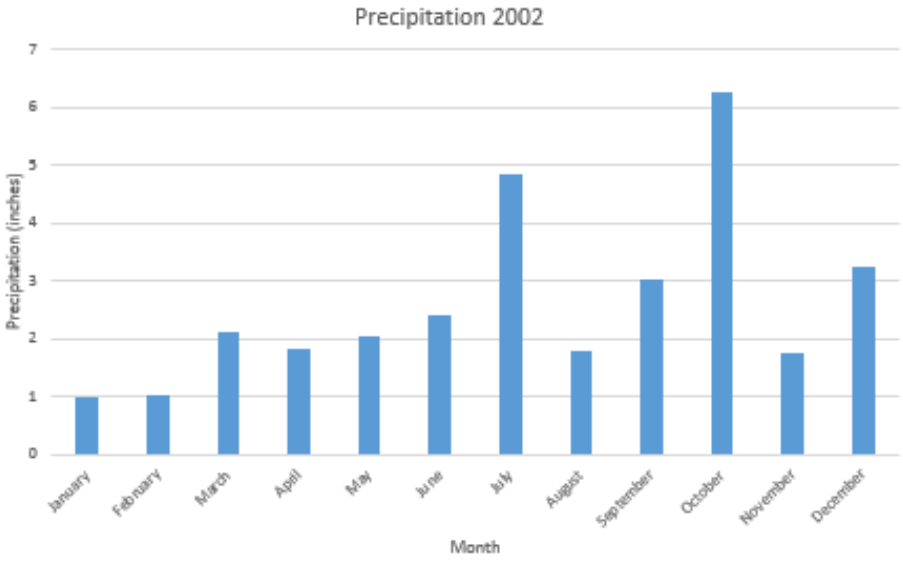


Figure 34: This figure is highlighting the misrepresentation of month numbers.

Because the graphing feature of ArcMap was not accurately displaying my results, I decided to created individual histograms using PowerPoint. I used the same legend of precipitation values as seen in figure 34, and manually corrected the coloring of the bar displays on the graphs.

Color	Precipitation range (inches)
	0.29-0.61
	0.611-0.96
	0.961-1.34
	1.341-1.88
	1.881-2.25
	2.251-2.56
	2.561-3.43
	3.431-4.33
	4.331-5.05
	5.051-6.51

Figure 35: Color legend used in yearly and comprehensive precipitation histograms



	A	B
1	Precipitation (inches)	Series 1
2	January	0.98
3	February	1.04
4	March	2.13
5	April	1.82
6	May	2.03
7	June	2.41
8	July	4.85
9	August	1.78
10	September	3.04
11	October	6.25
12	November	1.77
13	December	3.26
14		
15		

Figure 36 (top): Monthly precipitation histogram for 2002 before applying precipitation color scheme

Figure 37 (left): Excel information entered through PowerPoint for 2002 Precipitation information

Shown below are the final histograms of precipitation values for Brazoria County from 2002 to 2012; divided by individual year and a comprehensive histogram of precipitation information.

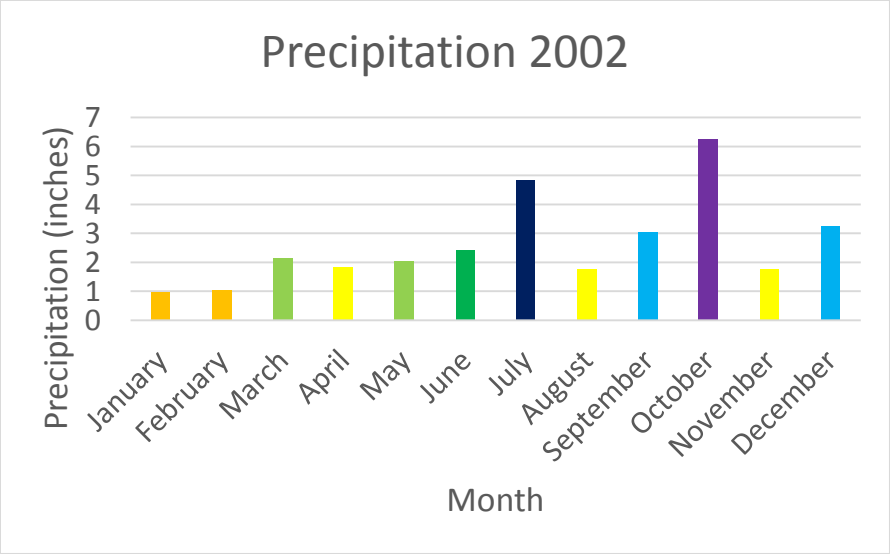


Figure 38: 2002 Precipitation histogram

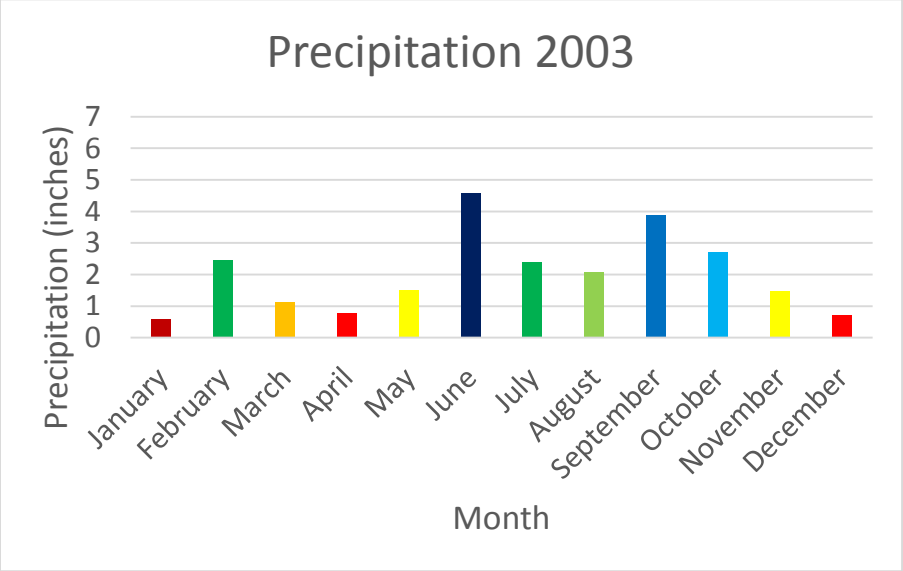


Figure 39: 2003 Precipitation histogram

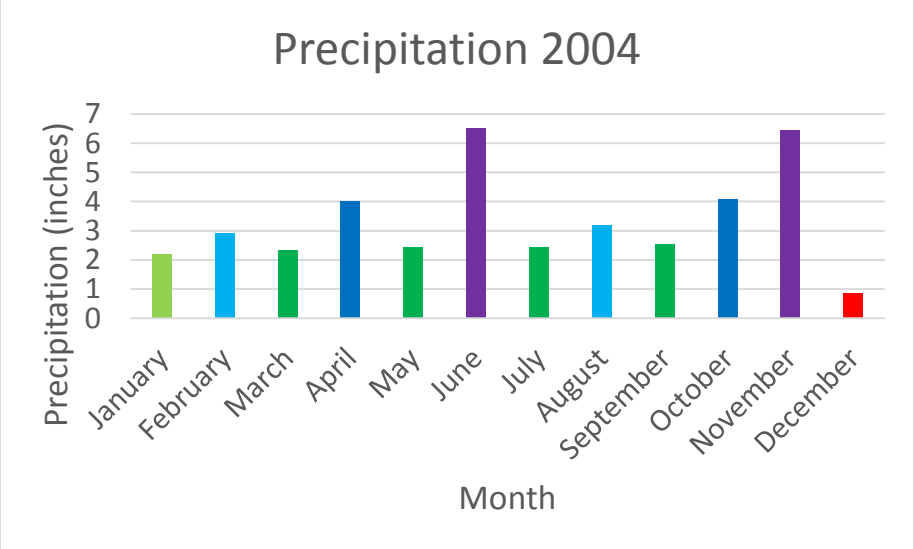


Figure 40: 2004 Precipitation histogram

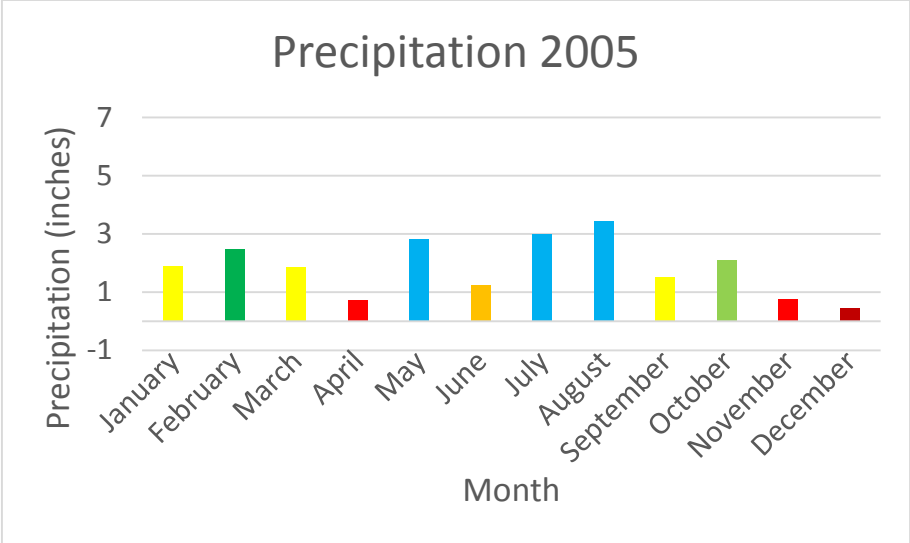


Figure 41: 2005 Precipitation histogram

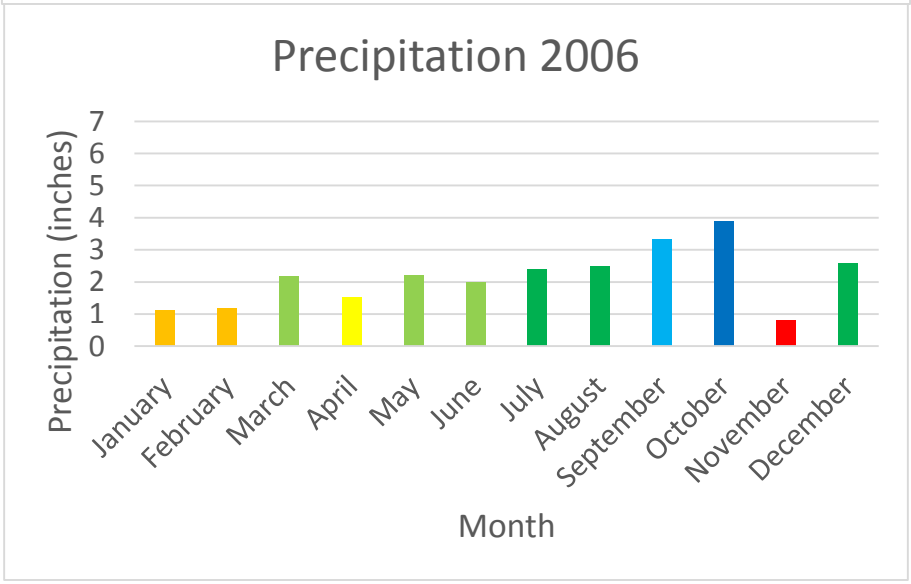


Figure 42: 2006 Precipitation histogram

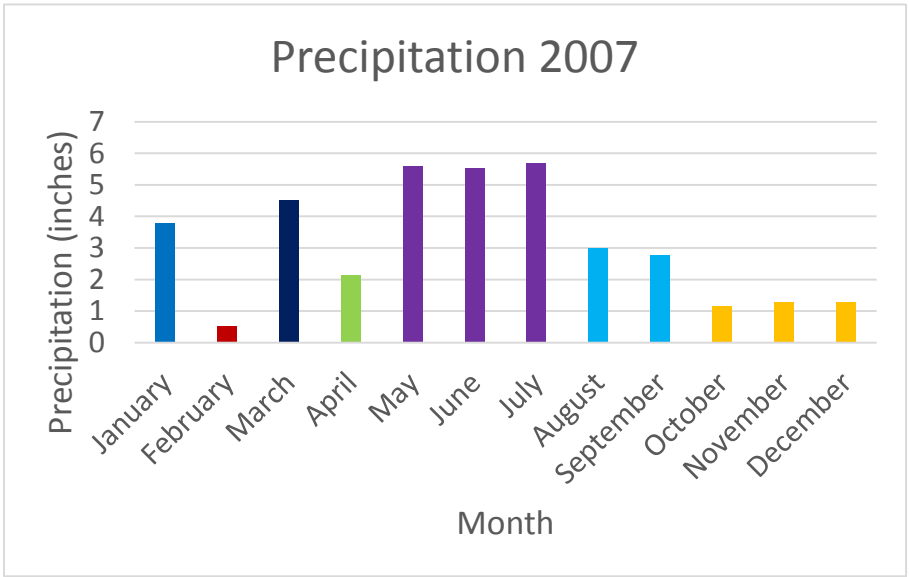


Figure 43: 2007 Precipitation histogram

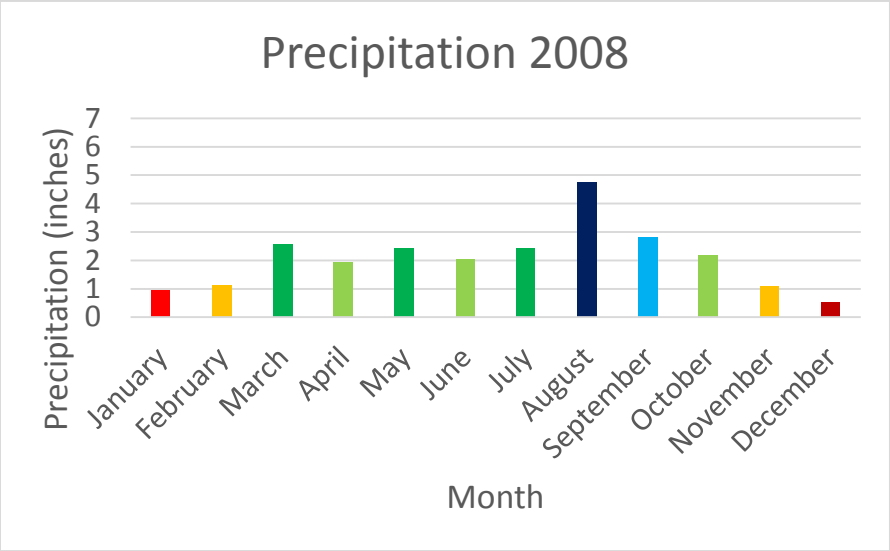


Figure 44: 2008 Precipitation histogram

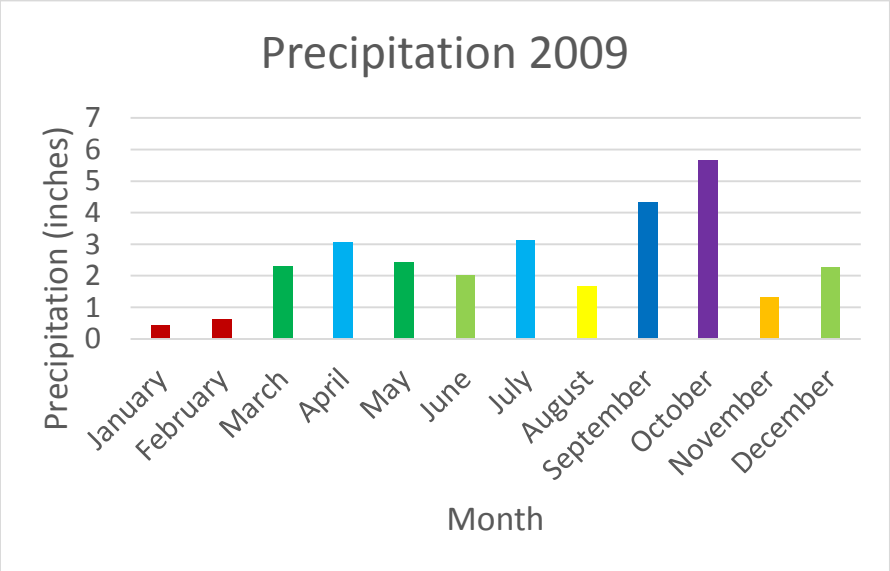


Figure 45: 2009 Precipitation histogram

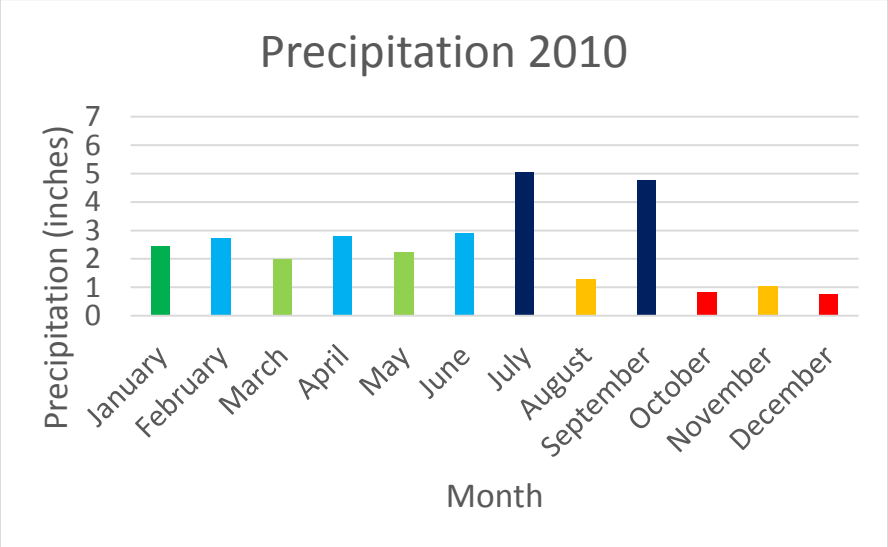


Figure 46: 2010 Precipitation histogram

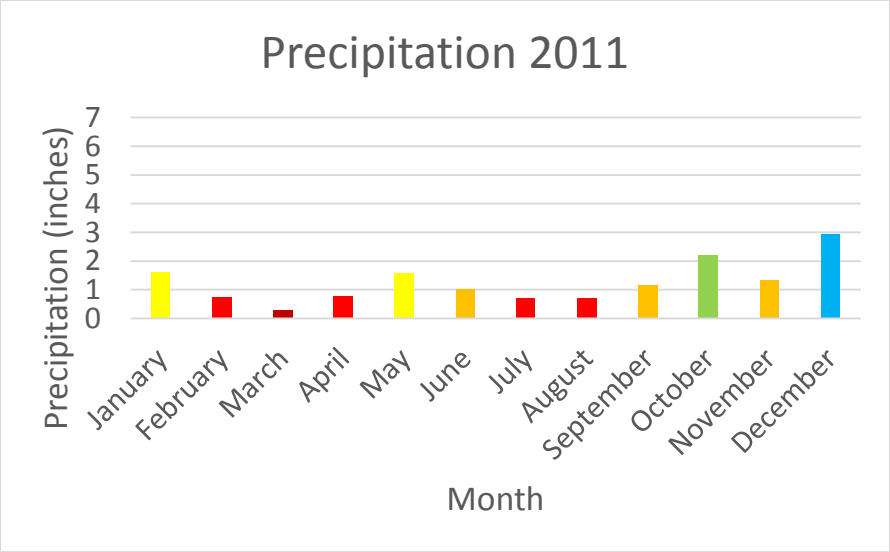


Figure 47: 2011 Precipitation histogram

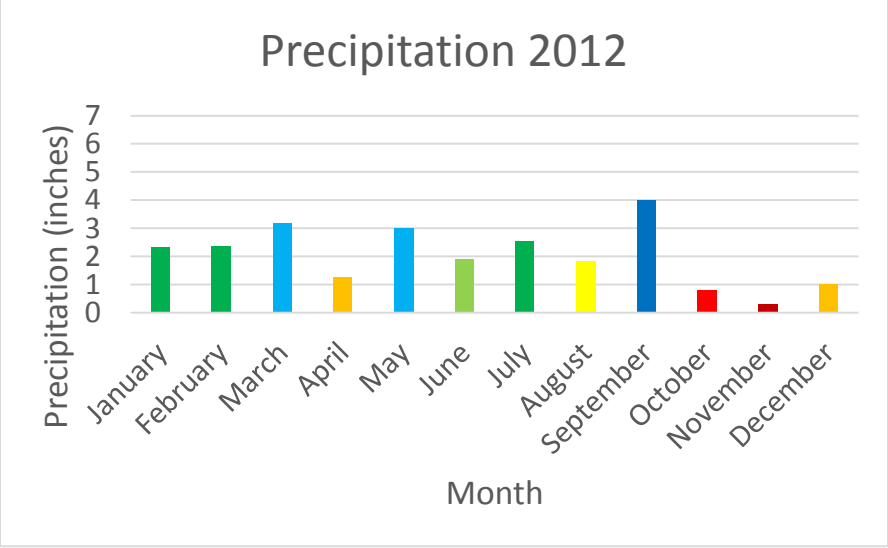


Figure 48: 2012 Precipitation histogram

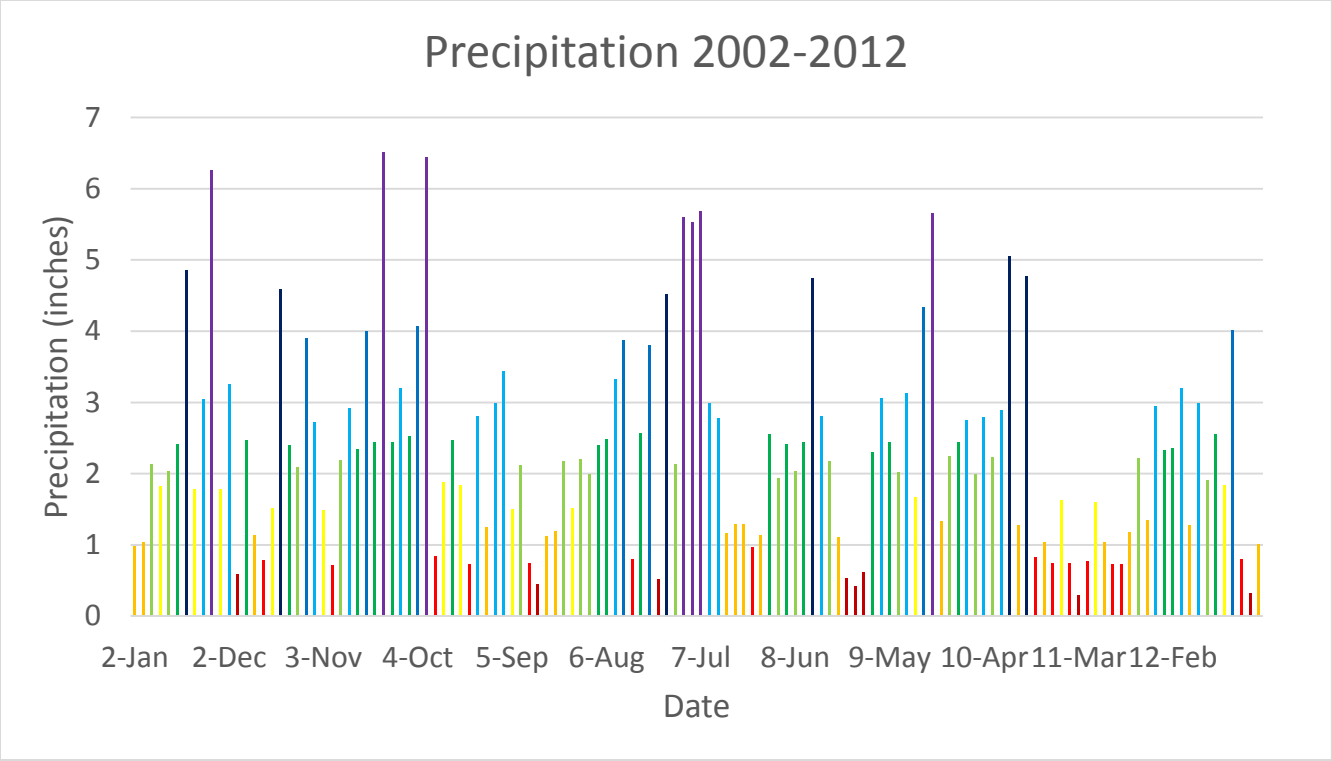


Figure 49: Comprehensive precipitation histogram generated in PowerPoint 2002-2012

Conclusion

By looking at the comprehensive precipitation graph, a clearer picture of drought conditions in Brazoria County during this time period appears. Based on my hypotheses that more water wells would be drilled during drought conditions, 2011 should have a high volume of wells drilled. Because there is insufficient water well data, I cannot declare my hypothesis correct or incorrect. But should my hypothesis be true, there would also be a higher volume of wells drilled between 2004 and 2006 when average monthly precipitation rarely exceeded 3.4 inches.

One hypothesis I can conclude true is that there was a greater frequency of water wells drilled in areas of greater population densities and in locations further from surface water features. Further water well information will be able to provide stronger proof for this hypothesis.