Stakeholder Advisory Forum for Consideration of Adopting Existing Models for the Bone Spring – Victorio Peak Aquifer

Shirley Wade, Ph.D., P.G.
Groundwater Availability Modeling
Texas Water Development Board

Disclaimer

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.

Agenda

- Introduction to Groundwater Availability Modeling (GAM) Program.
- Brief overview of the three models of the Dell City Area Model (includes Bone Spring - Victorio Peak Aquifer)
- Questions, Input, Comments from Stakeholders

Groundwater Availability Modeling Program

- **Aim**: Produce groundwater flow models for the major and minor aquifers of Texas.
- **Purpose**: Develop various tools that can be used to aid in groundwater resources management by stakeholders.
- **Public process**: Stakeholder involvement during model development process and during associated aquifer related projects-as applicable.
- **Models**: Freely available, standardized, thoroughly documented. Reports available over the internet.
- **Living tools**: Periodically updated.

How we use Groundwater Models?

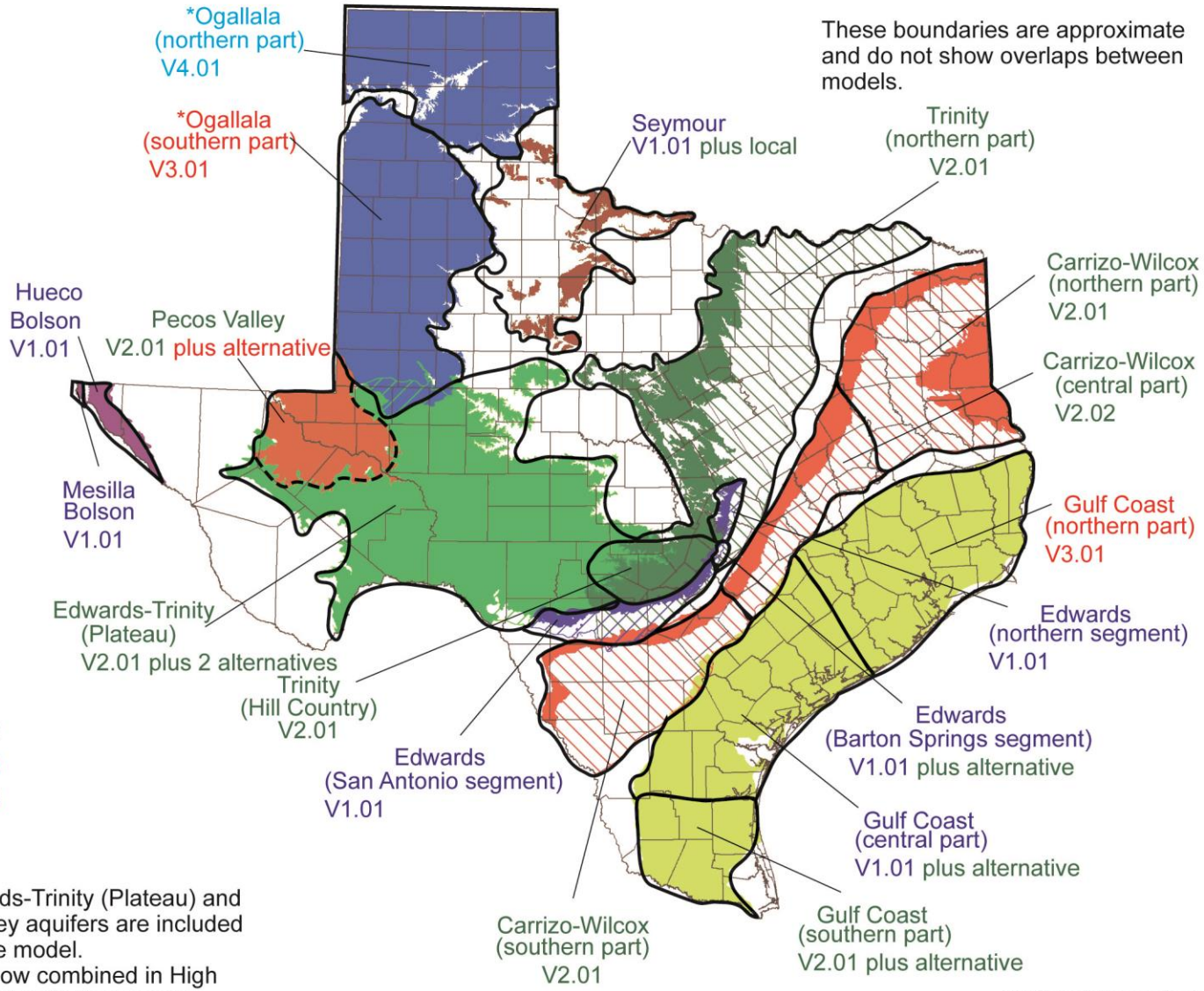
Per Statute:

- TWDB provides groundwater conservation districts with water budget data for their management plans.
- Groundwater management areas can use to assist in determining desired future conditions.
- TWDB uses when calculating estimated Modeled Available Groundwater.
- TWDB uses when calculating Total Estimated Recoverable Storage.

Why Stakeholder Advisory Forums?

- Keep stakeholders updated about progress of the model-related project
- Provide stakeholders with the opportunity to provide input and data to assist with model-related project development
- Discuss limitations and applications of the project

Major Aquifers

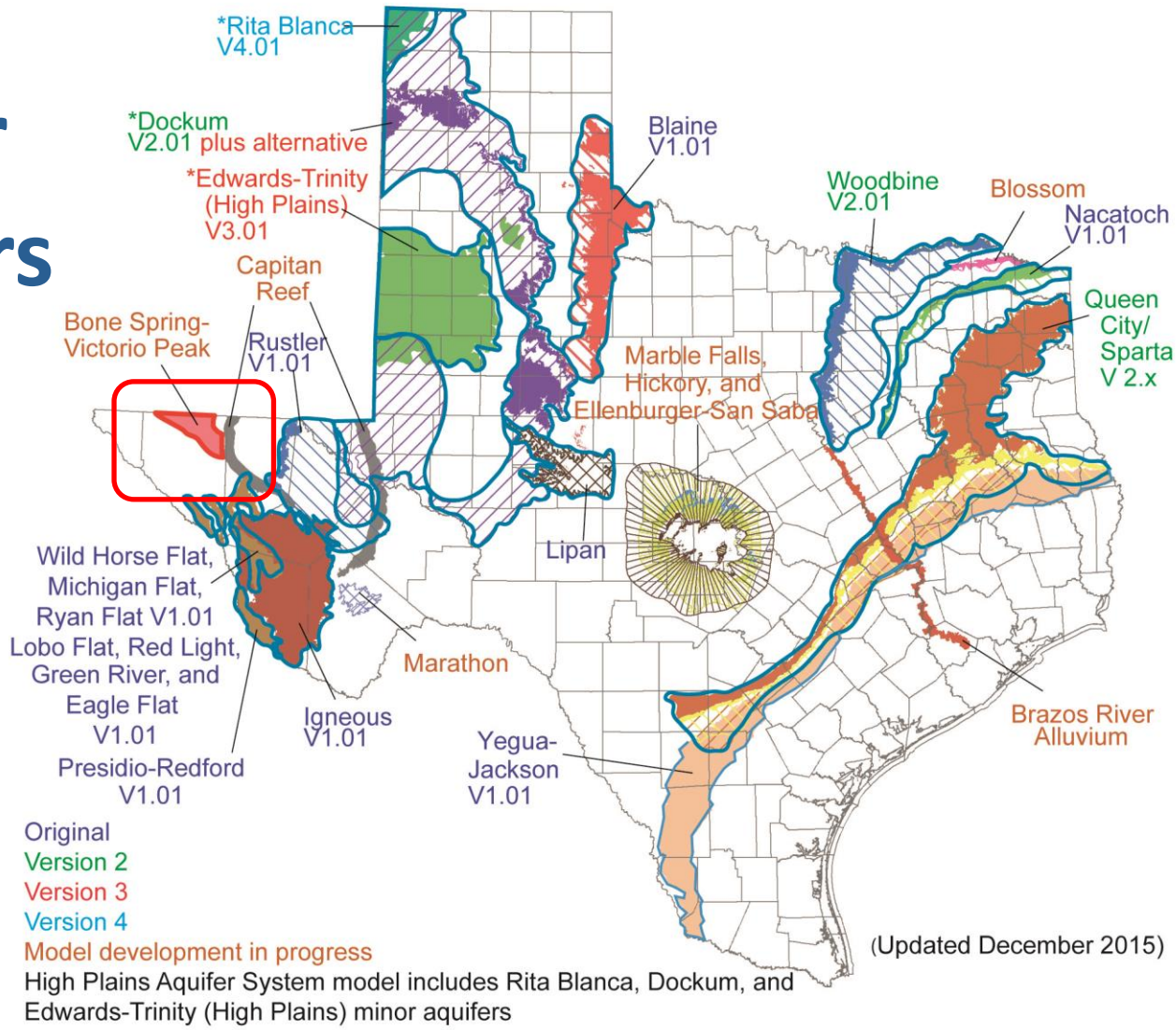


Note:
The Edwards-Trinity (Plateau) and Pecos Valley aquifers are included in the same model.
*Ogallala now combined in High Plains Aquifer System model

Updated December 2015

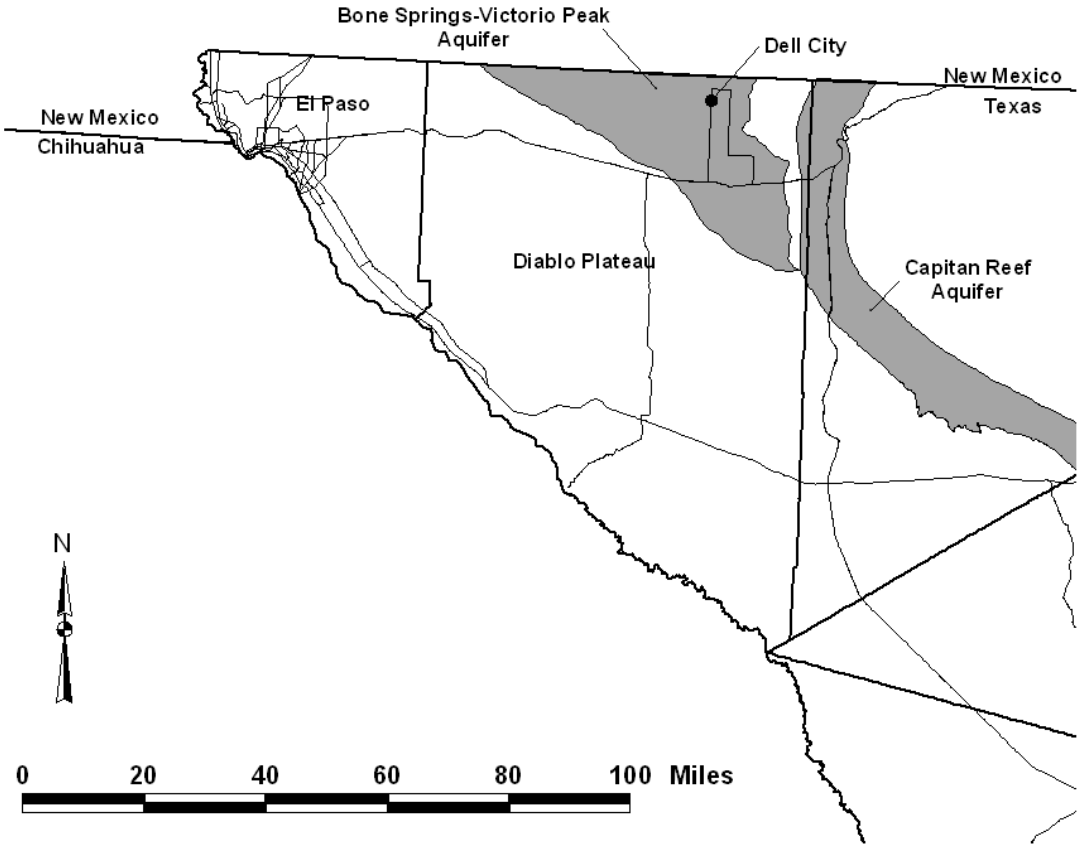
Texas Water Development Board

Minor Aquifers

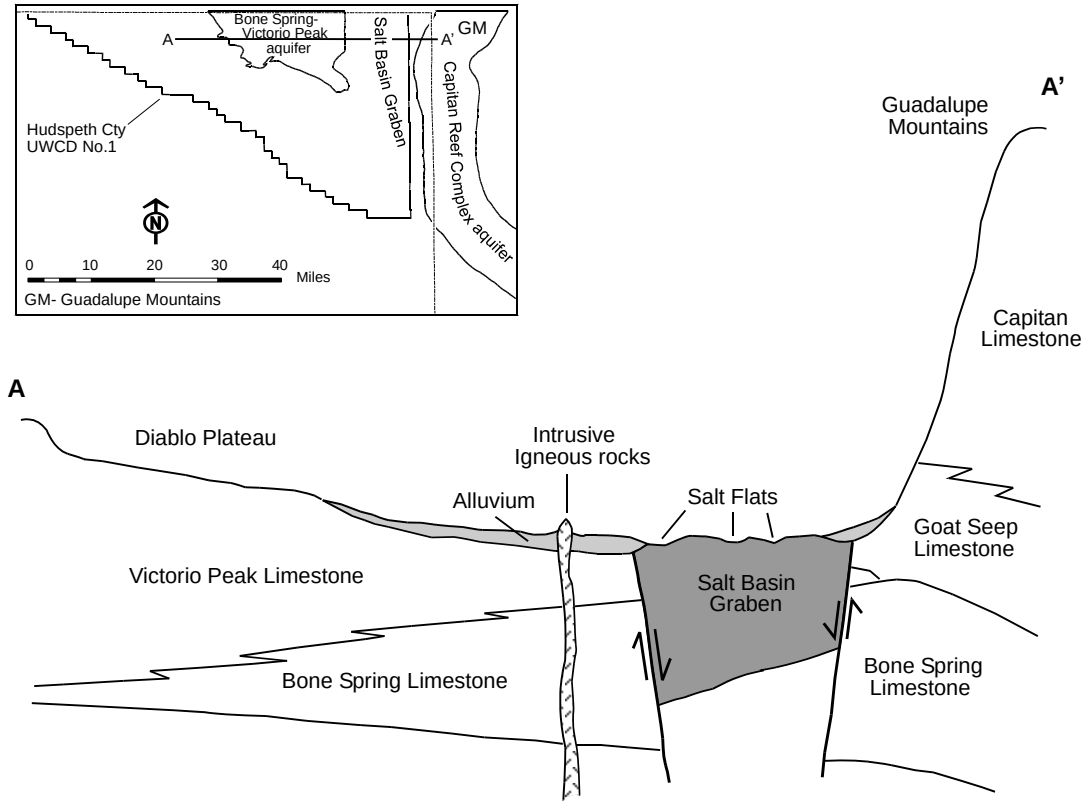


Three Models of the Bone Spring – Victorio Peak Aquifer

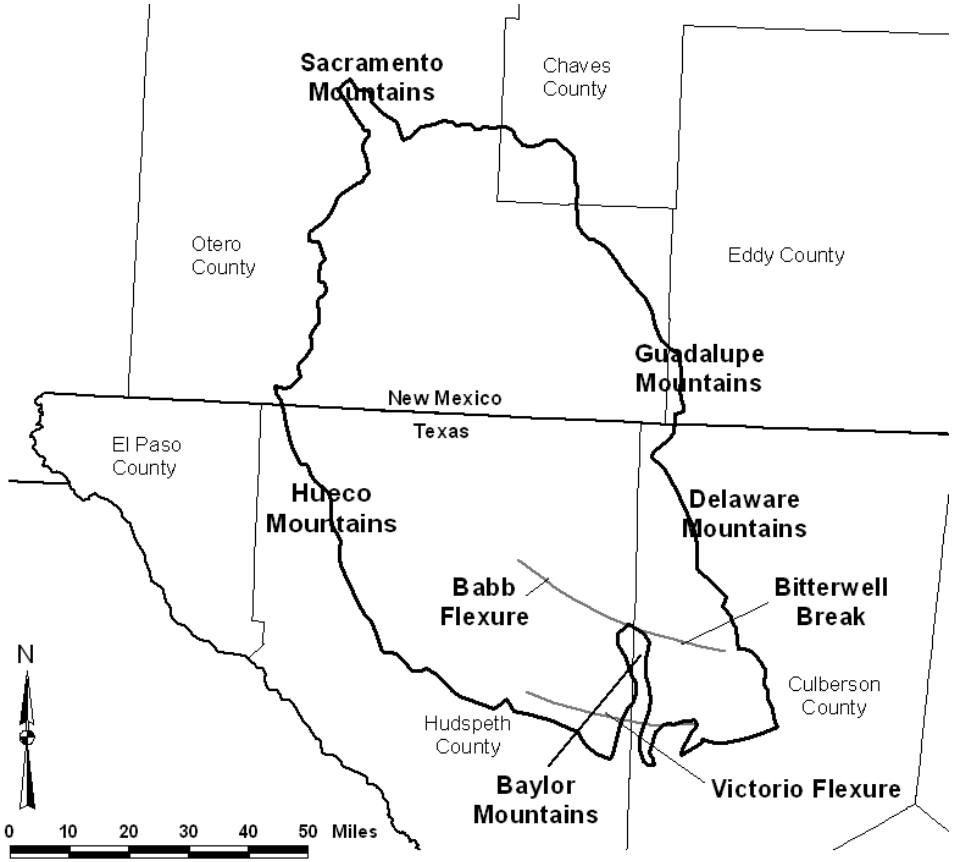
Overview



Location of Bone Spring-Victorio Peak Aquifer and Capitan Reef Aquifer (Hutchison, 2008)



Generalized Cross-Section of Dell City Area
(Hutchison, 2008; from Ashworth, 1995 as modified by George and others, 2005, pg. 22)



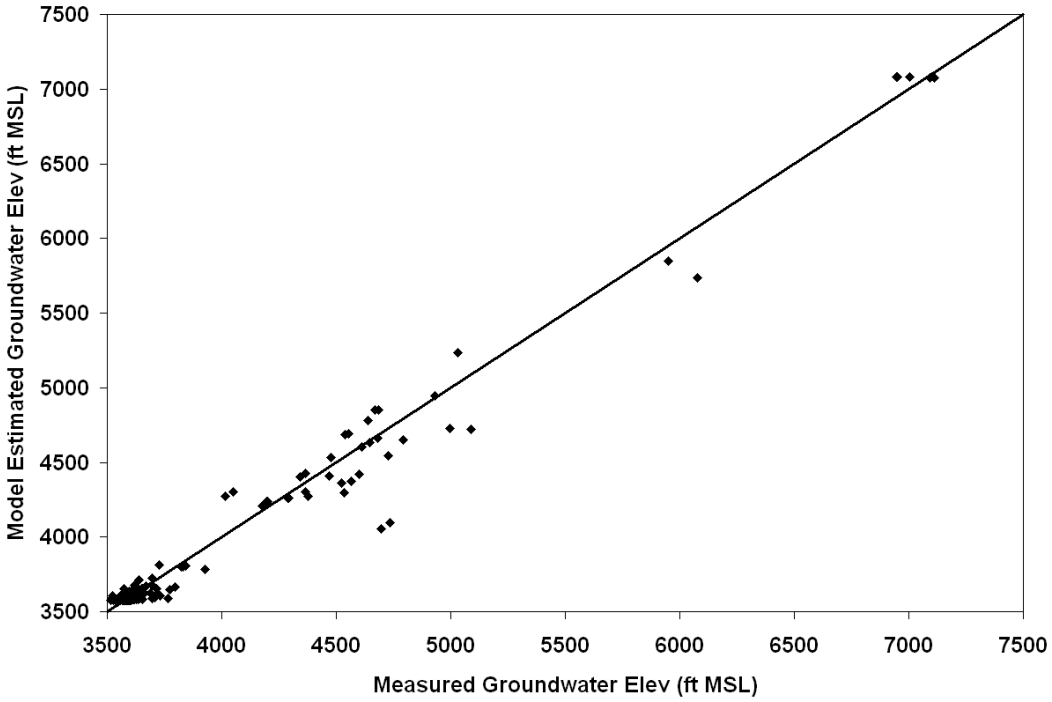
Domain of Groundwater Flow System (Hutchison, 2008)

Three Conceptual Models

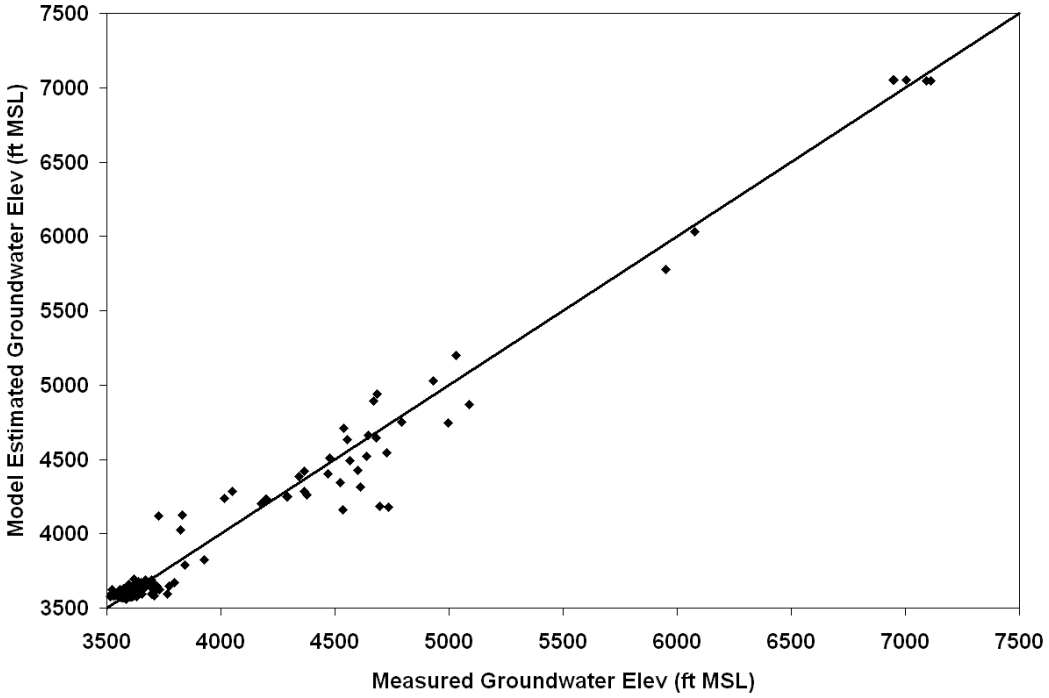
- Structural geology – groundwater moves preferentially along fracture alignments from the Sacramento Mountains to the Dell City Area
- Isotope geochemistry – isotopic signatures suggest that there is also a significant portion of recharge in the Texas portion from the Diablo Plateau, west of Dell City
- Hybrid of the structural geology and isotope geochemistry

Statistical Summary of the Calibration of All Three Models

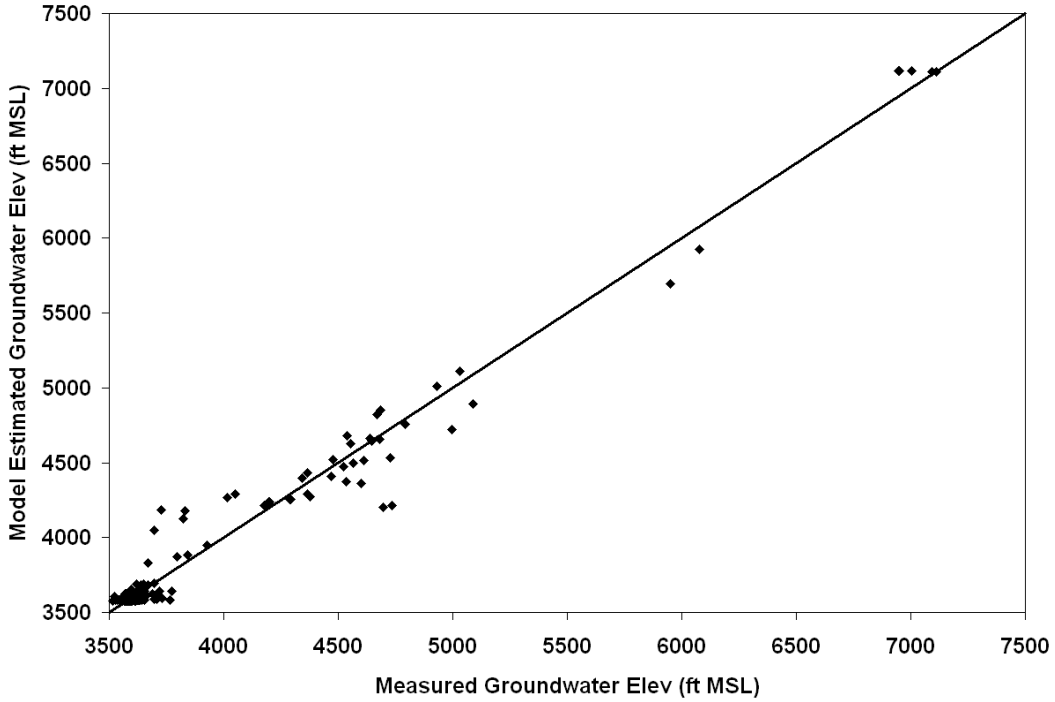
Calibration Statistic	Structural Geology Model	Isotope Geochemistry Model	Hybrid Model
Minimum Residual (ft)	-256.65	-394.96	-458.24
Maximum Residual (ft)	642.67	557.22	518.65
Average Residual (ft)	4.00	2.37	4.79
Standard Deviation of Residuals	30.84	30.40	30.60
Range of Measured Groundwater Elevations (ft)	3,595	3,595	3,595
Standard Deviation/Range	8.58E-03	8.45E-03	8.51E-03
Sum of Squared Residuals	2.36E+06	2.27E+06	2.34E+06
Percentage of Residuals Within:			
± 10 ft	56.4	61.7	63.4
± 25 ft	94.5	93.1	92.5
± 50 ft	98.4	98.3	98.4



Measured Groundwater Elevations vs. Model Estimated Groundwater Elevations
Structural Geology Model (Hutchison, 2008)



Measured Groundwater Elevations vs. Model Estimated Groundwater Elevations
Isotope Geochemistry Model (Hutchison, 2008)



Measured Groundwater Elevations vs. Model Estimated Groundwater Elevations
Hybrid Model (Hutchison, 2008)

Simulation of Potential Future Conditions

And 2010 Desired Future Conditions

Summary of Future Scenarios (Hutchison, 2008)

Model Scenario Code	Scenario Description
M1	Structural Geology
M2	Isotope Geochemistry
M3	Hybrid

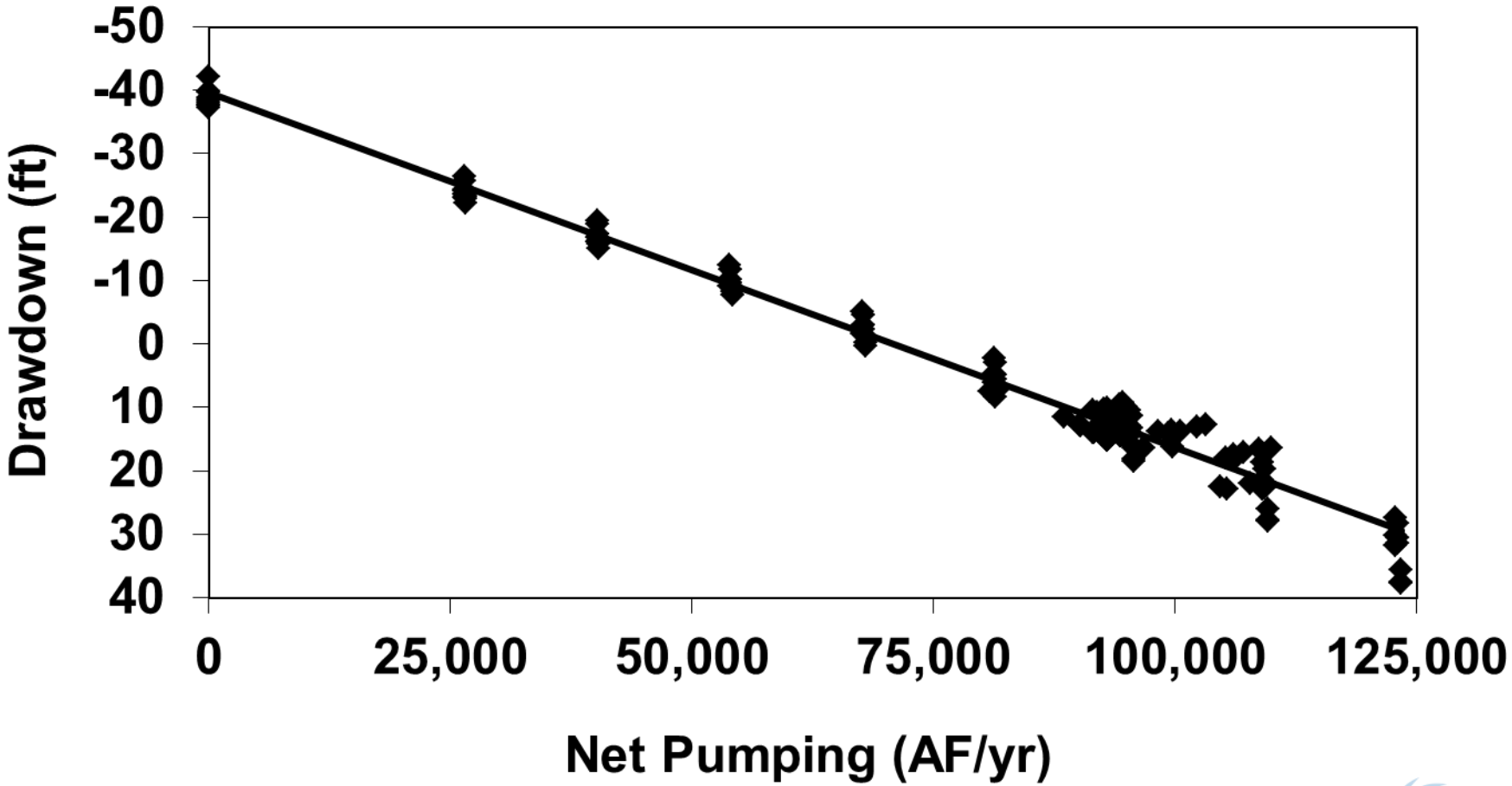
Pumping Scenario Code	Scenario Description
P1	Constant Pumping - "Corrected" HCUWCD Duty
P2	Constant Pumping - Historic Duties (2001 Conditions)
P3	Constant Pumping - High Dutues
P4	Decreasing Pumping - "Corrected" HCUWCD Duty
P5	Decreasing Pumping - Historic Duties (2001 Conditions)
P6	Decreasing Pumping - High Duties
P7	Decreasing Pumping - "Corrected" HCUWCD Duty, Elevation Control -2 feet
P8	Decreasing Pumping - "Corrected" HCUWCD Duty, Elevation Control -4 feet
P9	Decreasing Pumping - "Corrected" HCUWCD Duty, Elevation Control +2 feet
P10	Decreasing Pumping - "Corrected" HCUWCD Duty, Elevation Control +4 feet
P11	Decreasing Pumping - Maximum Duty = 1.17 AF/acre/year
P12	Decreasing Pumping - Maximum Duty = 1.78 AF/acre/year
P13	Decreasing Pumping - Maximum Duty = 2.39 AF/acre/year
P14	Decreasing Pumping - Maximum Duty = 3.00 AF/acre/year
P15	Decreasing Pumping - Maximum Duty = 3.61 AF/acre/year

Climatic Scenario Code	Scenario Description
C1	Driest
C2	Wettest
C3	Lowest Standard Deviation
C4	Highest Standard Deviation
C5	Average - Low Standard Deviation
C6	Average - Intermediate Standard Deviation
C7	Average - High Standard Deviation

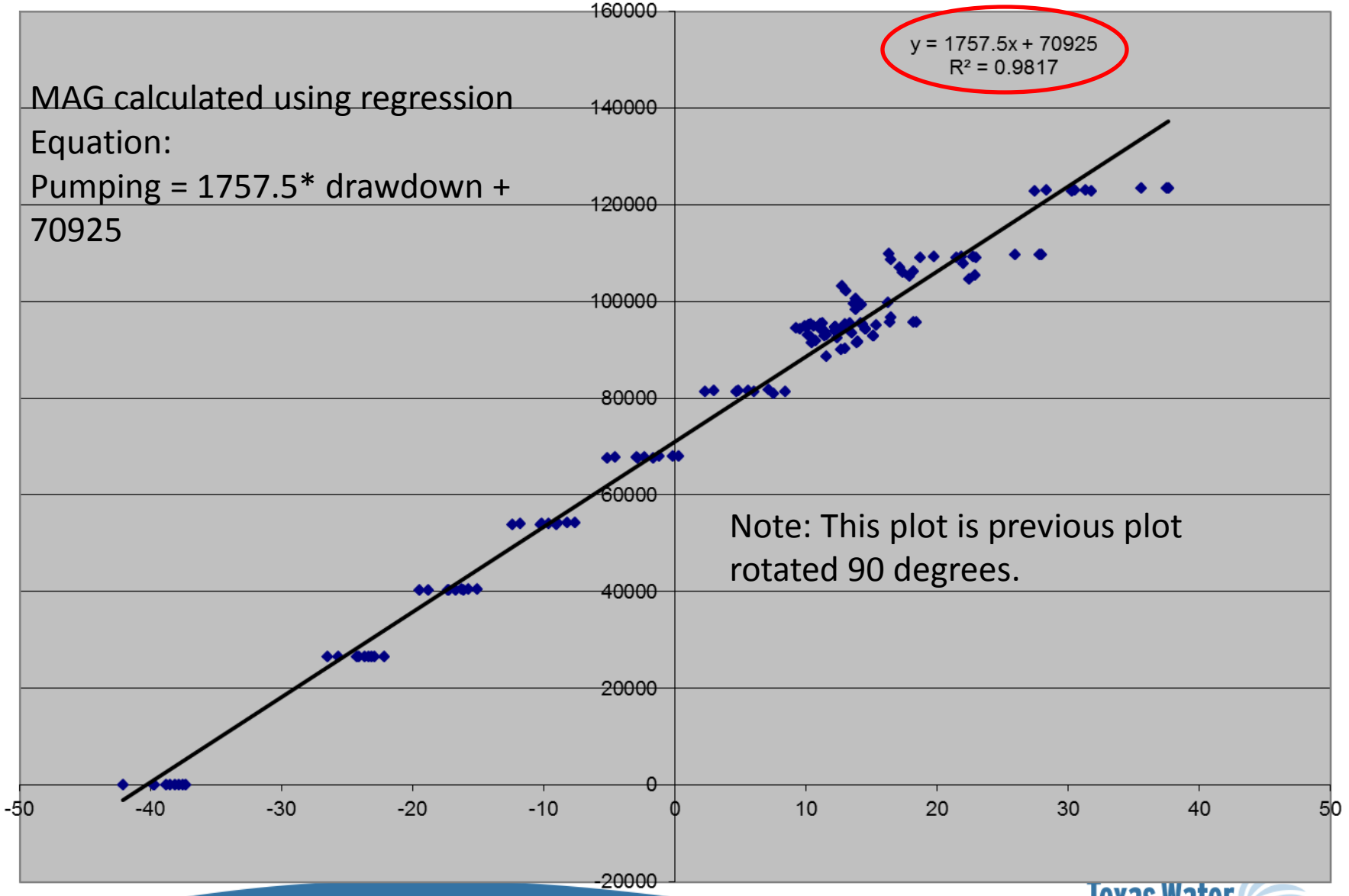
2010 Desired Future Conditions

- Combination of 3 models, 16 pumping scenarios, and 7 climate scenarios results in 336 scenarios.
- 2010 desired future condition for the Bone Spring – Victorio Peak Aquifer was based on a subset of 144 of the 336 scenarios.
- The subset consisted of scenarios involving average climate conditions.

Net Pumping vs. Drawdown after 50 Years
Average Recharge in Irrigated Area of HCUWCD



MAG calculated using regression Equation:
Pumping = 1757.5* drawdown + 70925



Note: This plot is previous plot rotated 90 degrees.

Based on the regression equation presented above, net pumping was estimated for several average drawdown amounts. Note that pumping amounts are rounded to the nearest thousand.

Drawdown after 50 years (feet)	Net pumping (acre-feet per year)
0	71,000
5	80,000
10	89,000
15	97,000
20	106,000

Comments:

- Things to consider – adopt 1, 2, or all 3 of the models
- All public comments should be received no later than February 16, 2016
- If adopted all comments will be addressed and noted in an appendix
- Meeting materials will be posted on the Bone Spring – Victorio Peak webpage in 7 to 10 days

Contact Information

Cindy Ridgeway, P.G.
Groundwater Availability Modeling Section
512-936-2386
Cindy.ridgeway@twdb.texas.gov
Or
Shirley Wade
Groundwater Availability Modeling Section
512-936-0883
Shirley.wade@twdb.texas.gov

Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

Web information (includes meeting information):
http://www.twdb.texas.gov/groundwater/models/alt/bsvp/bsvp.asp

Stakeholder Advisory Forum
Models for the
Bone Springs – Victorio Peak Aquifer
January 14, 2016 – page 1

Name	Affiliation
Shirley Wade	TWDB
Radu Boghici	TWDB
Steve Finch	JSAI
Randy Barker	Hudspeth County UWCD#1
Alyson McDonald	Texas A&M AgriLife Extension
Rudy Garcia	Presidio County UWCD
Talley Davis	Hudspeth County UWCD
Janet Adams	Jeff Davis County UWCD
Mick Lynch	C.C. Ranch
Robert Bradley	TWDB
Summer Webb	Culberson County GCD

Transcript Q&A after the BSVP SAF

[Hudspeth County UWCD presented written comments.]

Q: What proposed alternatives [to the BSVP GAM] are there?

A: Right now, for non-modeled aquifers across the state we do a budget analysis using existing geology, assuming certain drawdowns. Robert Bradley's group does that.

Q: Is this [approach] fairly well-accepted?

A: The GMA was happy with this model to use it for planning last time. This is the purpose of the meeting – to find out how people feel about this.

Q: If it [the model] was previously used, then why the public forum now?

A: Ideally, it would have been before it was used, but last time there was a lot to do in a little time, a lot of aquifers did not have models, and everyone was trying to meet their deadlines, and certain steps did not take place. We had other models for these aquifers that we decided were the best tools (for example, the Kinney County area we used an in-house model).

Q: Have you allocated resources to refine the portions you are not happy with?

A: No, we have limited resources this time, and a lot of projects. Right now, we don't have plans for that, but it can change if a lot of people express interest in an area. The way we prioritize the model updates is through stakeholders' concerns. If we receive no feedback, we assume the model is adequate for their planning purposes.

Q: How long has this been available for people to use? *[Interjected comment:] I did a model in 2003, and then shared it with Bill [Hutchison], and he [unintelligible], and that was in 2008, and we worked with the USGS and New Mexico Tech, and did a more refined geologic model and recharge analysis for the same model extent, and ended up with the same results. It's a good, representative model as is, it's simple, and Bill did a good job, and it's already endured the test of time.*

Q: Is the pumping in the model the total pumping minus the irrigation return flow?

A: Yes.

Q: The lithology here describes a limestone, so the porosity that holds this water is in fractures?

A: The report talks about that, and the model uses an assumed porosity that represents both the porosity of the fractures and that of the interstitial. This is such a large scale that is represented as an equivalent porous media, rather than the details of the fractures. They do now have versions of Modflow that take into account both separate kinds of porosity, but this model doesn't. We found that at this particular scale works pretty well.

Q: So, until more people use it, we won't know where the issues are, for scaling-down basically…

A: Right, like with all the other GAMs, if there is a local problem, then it [the model] may need to be refined to address the local, well-by-well, issues.

Q: So, the recharge is pretty similar for all three models, is that correct?

A: The hydraulic property zones are different, but I believe the recharge is the same. It uses the modified Maxey-Eakin, where below a certain threshold is uniform, and above that threshold it assigns different percentages.

Q: [to member of audience]: The vertical and horizontal hydraulic conductivities – when you went back through, did you start there and made any adjustments? A: our collaborative research was focused on three issues: geologic framework, and the recharge. The recharge was approached three different ways, and then, with the model, we did look at various ways to represent the fracturing and hydraulic conductivity might be affected by that. But, what we found that there were very large karst features at the Otero Break – not just fractures. Sacramento River formed a giant alluvial fan, and also there's a huge sinkhole. We mapped out a lot of other feature. We used a different distribution for the recharge, but came up with the same number.

Q: Do you think that, with the inception of our pivot irrigation, the recharge is not what it used to be [when there was flood irrigation]? It was estimated at 30 percent – could it be now, say, 10 percent?

A: [from the audience] I'm sure that would change things.

A: that's an important thing to point out, because in the estimation of the MAG we used 30 percent.

Comment: Maybe a little bit of isotope work would help tighten down that number.

Hudspeth County Underground Water Conservation District

To: TWDB Staff at January 14, 2016 Stakeholder Meeting , Van Horn, Texas

RE: Comments Regarding Proposed GAM for Bone-Springs / Victorio Peak Aquifer

The District appreciates TWDB work on modeling of the Bone-Springs / Victorio Peak Aquifer. Overall, the technical work presented in the documentation of the proposed GAM (El Paso Water Utilities Hydrogeology Report 08-01) is of high quality. Because of the geologic nature of the Bone-Springs / Victorio Peak Aquifer, numerical modeling of the aquifer is complex and difficult. The author's work is commendable.

The District does have concern regarding the estimate of groundwater discharged to the Salt Basin playa for the years 1948 through 2002 as used in the model, and the analysis and data presented in the Appendix E regarding groundwater discharge (please see the attached two pages from the report highlighting some of questioned data).

The June and July months of 2002 were very wet for Hudspeth County and during one or more storm events, surface water flooded the playa a few weeks prior to the authors of Appendix E doing their field investigation. This surface water saturation of the playa soils and the normally low amount of rainfall in the area likely resulted in the authors incorrectly concluding that the source of water in playa was from groundwater seepage.

The hydrograph for groundwater levels in Well 48-07-904 shown on page 362 of Report 08-01indicates that for much of the time period from the 1960 to 2000 that the groundwater level in the playa was approximately 25 feet below the ground elevation of 3616 feet (MSEL). The average elevation of the floor of the playa is approximately 3613 feet. The 20 to 25 depth to groundwater suggests that there is minimal or no groundwater above the ET extraction depth of 15 feet.

The District would appreciate it if the TWDB would evaluate the estimate of groundwater discharged to the Salt Basin playa as used in the proposed GAM and advise the District if this value is accurate.

9.0 SUMMARY AND CONCLUSIONS

The Dell City area may become a source of municipal water supply for El Paso. In order to better understand the area and develop estimates of groundwater yields from the area, this study was completed by El Paso Water Utilities for internal analysis. The study included a review of previous work, the development of three numerical groundwater flow models to test various aspects of the conceptual model of groundwater flow in the area, and the application of the three groundwater flow models under various climatic and pumping scenarios to estimate groundwater yields in the area. This report and the model files have been forwarded to the Texas Water Development Board for their future use. As such, this report and the associated models are not official TWDB Groundwater Availability Models (GAMs). However, it is hoped that this effort will assist the TWDB in their development of GAMs for the area.

Significant conclusions of this study are:

- Total inflow (recharge plus boundary flows) estimates for the entire model domain under predevelopment conditions ranged between 79,000 and 104,000 AF/yr, depending on the model used
- Average total inflow (recharge plus boundary flows) estimates from 1948 to 2002 ranged between 87,000 and 114,000 AF/yr, depending on the model used. Note that total inflow increased as a result of a combination of pumping and high recharge in latter years of the simulation period.
- The recharge estimates are generally consistent with and slightly higher than previous estimates as documented in the literature.
- Evapotranspiration from the playa area east of Dell City prior to 1948 ranged from 79,000 to 104,000, depending on the model used to make the estimate.
- Average evapotranspiration from the playa from 1948 to 2002 ranged from 49,000 to 67,000 AF/yr.
- Average total consumptive pumping in the area from 1948 to 2002 was about 88,000 AF/yr
- Irrigated acreage in the area rose from less than 10,000 acres in 1948 to about 25,000 acres in the mid 1950s. From the mid 1950s to the mid 1980s, irrigated acreage fluctuated between about 20,000 acres to as high as 45,000 acres. From the early 1980s to 2002, irrigated acreage was relatively constant at slightly over 20,000 acres, except for declines in 1993 and 1994.
- Prior to 1993 and the widespread use of center pivot irrigation, consumptive duty on irrigated lands was about 3 AF/ac. After 1993, consumptive duty on irrigated lands was about 5 AF/ac. Due to the nature of the modeling approach used, it is not possible to make any estimates or draw any conclusions regarding total pumping (consumptive pumping plus leaching fraction), or estimate the leaching fraction.
- Historic groundwater pumping from 1948 to 2002 in the new boundary of HCUWCD averaged about 80,000 AF/yr. This pumping resulted in:
    - Between 3,000 and 19,000 AF/yr of increased inflow from New Mexico (depending on the model used).
    - Between 2,000 and 9.000 AF/yr of increased inflow from the Diablo Plateau, southwest of HCUWCD (depending on the model used).
    - Between 0 and 1,000 AF/yr of increased inflow from the area in Hudspeth County east of HCUWCD (depending on the model used).

Table 6. Values for playa discharge calculated using band 5 and the relationships defined by cardinal points.

Year	Pixels	Area of Discharge (Ac)	Discharge (AF/yr)	Av. Rate (ft/yr)
2002	44,052	8,857	12,472	1.41
2001	27,634	5,553	12,176	2.19
1998	62,687	12,615	25,805	2.05
1992	64,637	13,006	26,282	2.02
1989	42,520	8,530	19,662	2.31
1988	90,080	18,070	44,089	2.44
1985	70,696	14,182	40,101	2.83
1984	80,281	16,104	38,852	2.41

The general concurrence for these snapshots suggests that the method tracks regional patterns of recharge: low during intensive regional drought, and high during intensive regional wet. This was checked by graphing the estimates of ET against the antecedent precipitation for the prior two water years (back to October 1) measured at Dell City 5SSW. This is shown on Figure 12.

There are a number of indications that the methods used here to estimate ET discharge are tracking Playa ET correctly. The strong concurrence between the low playa discharge estimates for 2001 and 2002 concur with late years in a multi-year regional drought: water pressures beneath the playa have probably been reduced to a minimum. Another corroboration is the positive relationship of the estimated total playa discharge and the regional precipitation. That the data appear two-ranked may be an indicator that, although Dell City precipitation is a competent indicator of regional precipitation, there are much larger patterns of recharge that it does not capture. The early-to-mid-1980's are known throughout the Southwest as a relatively wet period while the late 1990's into summer, 2002 are known as a significantly dry period.

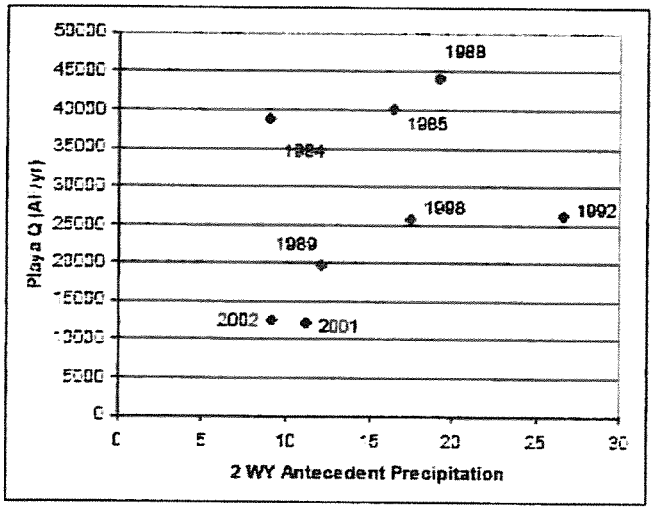
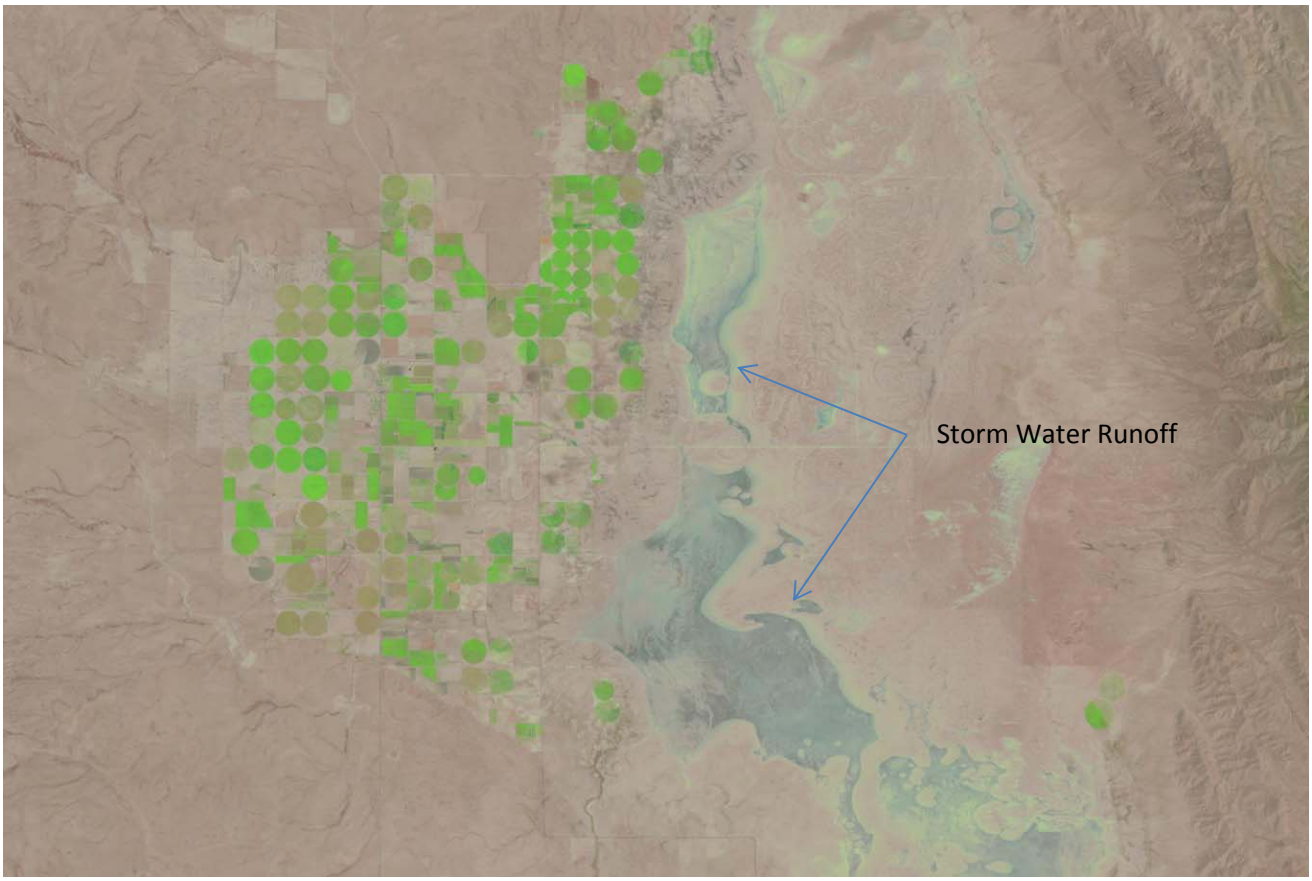
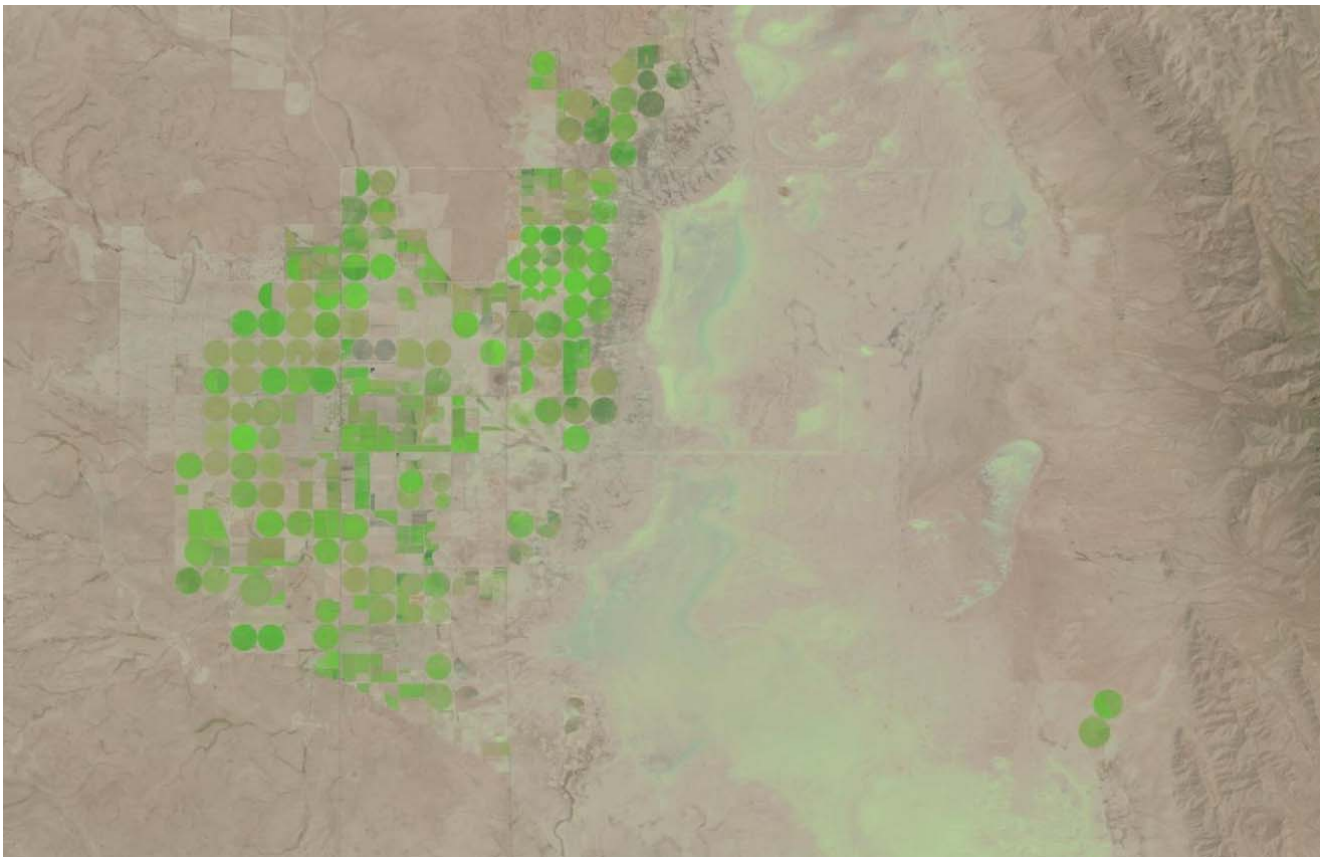


Figure 12. Calculated total playa groundwater discharge graphed against total Dell City precipitation. This precipitation sum is intended as a general indicator of regional recharge that is positively correlated to playa discharge. The data appear two-ranked possibly following drought: 1988-2002, and wet, 1984-1988, regional conditions.



Natural Color LANDSAT 7 Image JUNE 2002 - Dell Valley, Texas



Natural Color LANDSAT 7 Image May 2003 - Dell Valley, Texas