UPPER GULF COAST AQUIFER PLANNING AREA (GMA 14)

Joint Planning Group Meeting

Thursday, April 26, 2018
10:00 AM

MEETING MINUTES

A regular meeting of GMA 14 was held Thursday, April 26, 2018, at 10:00 AM, in the board room of the Lone Star Groundwater Conservation District located at 655 Conroe Park North Drive, Conroe, Texas.

The meeting was called to order by Kathy Turner Jones (Lone Star GCD) at 10:06 AM with a roll call of District representatives and Interlocal Agreement Participants. Districts represented included: Kent Burkett, Brazoria County GCD, Zach Holland, Bluebonnet GCD, Kathy Turner Jones, Lone Star GCD, Gary Ashmore, Lower Trinity GCD and John Martin, Southeast Texas GCD. Interlocal Agreement Participants included: The Honorable John Brieden, Washington County Judge (joined at 10:19 AM); Robert Thompson, Fort Bend Subsidence District; Mike Turco, Harris-Galveston Subsidence District and Fort Bend Subsidence District; and Pudge Willcox, Chambers County. Also in attendance at the meeting were Larry French, Texas Water Development Board (TWDB); and members of the public. (*see* ***Attachment "A" for a list of attendees***).

Ms. Jones called for and opened the floor to public comment. No public comment was offered.

Ms. Jones proceeded with requests for and receipt of posted notices from District Representatives. Ms. Jones then asked for consideration of the approval of the minutes from the GMA 14 meeting on March 27, 2018. After discussion and upon a motion by Mr. Burkett, seconded by Mr. Martin, the minutes for the March 27, 2018 meeting were approved unanimously.

Meeting convened as a meeting of the GMA 14 Joint Planning Interlocal Agreement Participants.

The GMA 14 Joint Planning Interlocal Agreement Participants meeting was called to order at 10:08 AM.

Ms. Jones called for the presentation of information from the Texas Water Development Board and discussions of items of interest to the GMA. Mr. French provided general information from TWDB, including announcements that several projects of interest were in the process of completion, including the project that will be presented later in the agenda.

Ms. Jones noted no updates to the GMA 14 Interlocal Agreements financial report at this time. Ms. Jones called for discussion and possible action regarding path forward for GMA 14 to accomplish statutory mandates, to receive recommendation from committee on selection of consultant for professional services to support the development of desired future conditions during the current joint-planning efforts in GMA 14 as required by Texas Water Code 36.108 and authorize contracting entity to develop scope and negotiate contract. Mr. Turco provided the committee recommendation to pursue negotiations with INTERA from the committee's scoring and review criteria. A motion to pursue consultant services with INTERA for the next cycle of joint planning was made by Mr. Turco, seconded by Mr. Burkett. The motion carried 7-1 with Mr. Holland opposed and Judge Brieden absent. There was no update or action to discuss and take possible action to review and amend as necessary the Interlocal Agreement Related to Joint Planning in GMA 14.

Ms. Jones called for the presentation on Summary of an Evaluation of Subsidence Vulnerability due to Groundwater Pumping and gave the floor to Mr. Mike Keester with LRE Water, LLC for the presentation. (*see* ***Attachment "B" for LRE Presentation***).

Ms. Jones called for a short recess at 10:40 AM to pull up the next presentation not loaded on the computer. At 10:45 AM Ms. Jones reconvened the meeting.

Ms. Jones called for the presentation on GAM simulations of alternative conceptual combinations of adopted DFC and Run D of Task 3 of the Lone Star GCD Strategic Water Resources Planning Study and gave the floor to Mr. Holland and Dr. Bill Hutchison representing the work done by Bluebonnet GCD. (*see* ***Attachment "C" for Bluebonnet GCD Presentation***).

Ms. Jones called for a presentation and discussion by districts of recent activities of interest or accomplishments impacting the GMA 14 planning group. Ms. Jones noted the hearing held the previous day at Lone Star concerning a motion for summary judgement in the ongoing legal suits.

Ms. Jones adjourned the meeting of the GMA 14 Interlocal Agreement Participants and reconvening the Joint Planning Group meeting at 11:00 AM.

Meeting of the GMA 14 Joint Planning Interlocal Agreement Participants adjourned.

Ms. Jones reconvened the GMA 14 meeting and called for other business before GMA 14. Mr. Ashmore provided an update from discussions at TAGD regarding the ongoing common rules discussions and the desire to develop a template to compile information. Mr. Ashmore noted the need to clean up some of the information already gathered and working our efforts into the TAGD discussions. With no other business brought before the group, Mr. Jones called for discussion of next meeting date, location, and agenda items. The next meeting was set for May 30, 2018 at 10:00 AM to be held at the offices of the Lone Star Groundwater Conservation District, located at 655 Conroe Park North, Conroe, Texas 77303.

Without further discussion or comment and there being no further business, the meeting was adjourned at 11:07 AM.

PASSED, APPROVED, AND ADOPTED THIS 30th day of May, 2018.

Chairman

ATTEST:

Secretary

LREWater, LLC
a Leonard Rice Engineers Company

Summary of an Evaluation of Subsidence Vulnerability due to Groundwater Pumping

Presentation to Groundwater Management Area 14

By Michael Keester, P.G.

April 26, 2018

Project Funded Through TWDB Contract Number 1648302062

Outline

- Project Objectives
- Aquifer Subsidence Risk Assessment Methodology
- Summary of Subsidence Vulnerability Evaluation
- Subsidence Prediction Tool
- Questions/Discussion

Project Objectives

- Consideration of subsidence is required per Texas Water Code
  - Management plans
  - Permitting
  - Desired future conditions explanatory report
- Texas Water Development Board
  - Identify and characterize areas within Texas' major and minor aquifers that are susceptible to land subsidence related to groundwater pumping
  - Create a tool for stakeholders to use for characterizing subsidence risk
  - http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp

Aquifer Subsidence Risk Assessment Methodology

- Aquifer lithology and distribution, thickness, and compressibility of clay layers within the aquifer
- Amount and timing of water-level changes
- Lowest historical water level (that is, preconsolidation level)

Clay Distribution and Thickness

- Submitted Drillers Reports Database "WellLithology" table
- Used keywords to identify clay intervals (for example: Gumbo, Blackland, Sticky) and partial clay content
- Mapped calculated total clay thickness

Keyword	Multiple on Clay Thickness
SAND	0.5
SANDY	0.5
SHALE	0.75
SHELL	0.75
ROCK	0.25
CLAYEY	0.25
SND	0.5
SD	0.5
SILTY	0.75
SILT	0.75
SLT	0.75
GRAVEL	0.5
STONE	0.25
CALICHE	0.5

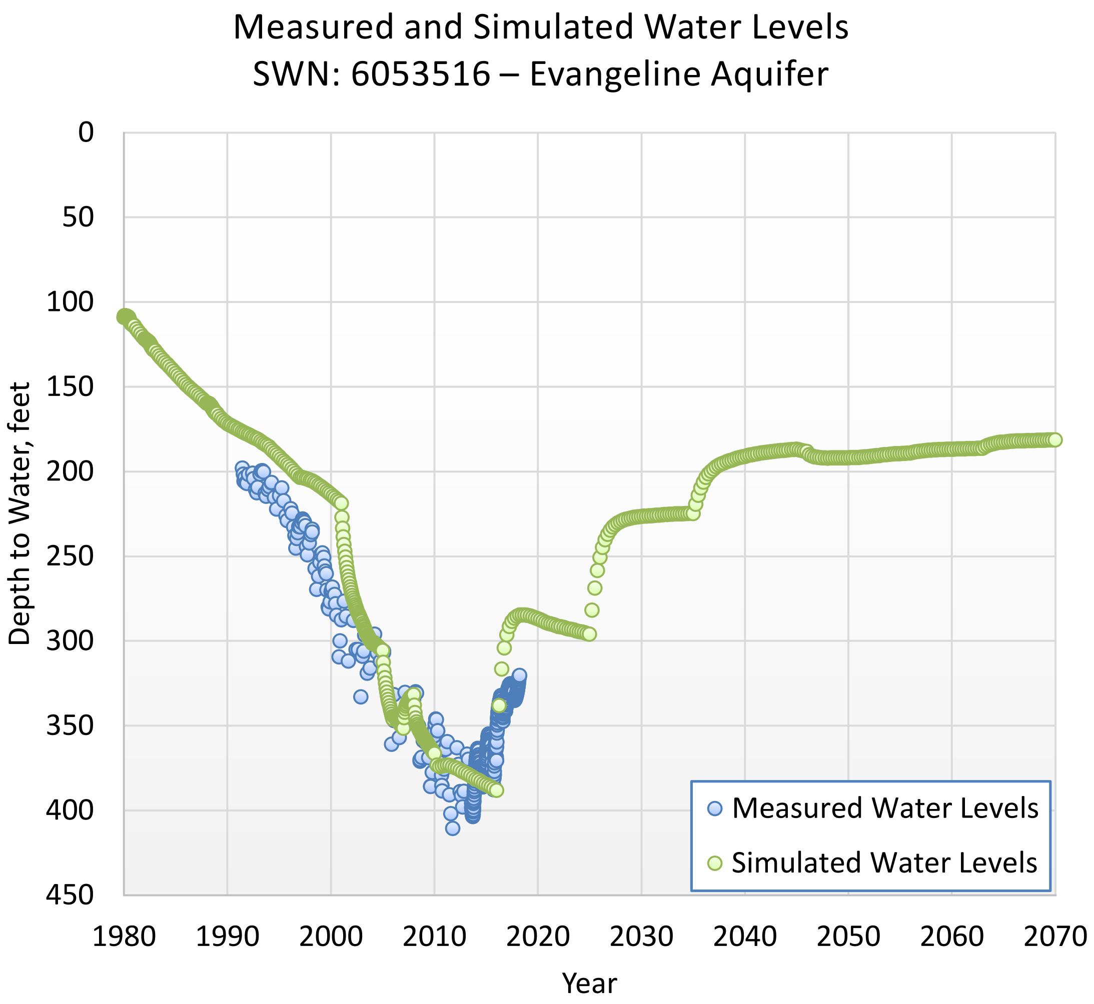
Clay Compressibility

- Very important consideration
- Typically not available
- Applied standard ranges of values

Lithologic Material	Compressibility (β), psi^{-1}
Plastic Clay	1.8×10^{-3} to 1.4×10^{-2}
Stiff Clay	9.0×10^{-4} to 1.8×10^{-3}
Medium Hard Clay	4.8×10^{-4} to 9.0×10^{-4}
Loose Sand	3.6×10^{-4} to 6.9×10^{-4}
Dense Sand	9.0×10^{-5} to 1.4×10^{-4}
Dense Sandy Gravel	3.6×10^{-5} to 6.9×10^{-5}
Rock, Fissured/Jointed	2.3×10^{-6} to 4.8×10^{-5}
Rock, Sound	Less than 2.3×10^{-6}

Water Levels

- Primarily used GAM simulation results
  - Transient calibration water levels for preconsolidation level
  - DFC simulations for future water-level declines
  - Trend based on relatively recent conditions
- For aquifers where GAM results could not be used (such as the Hueco-Mesilla Bolson and Blossom aquifers), measured water levels used



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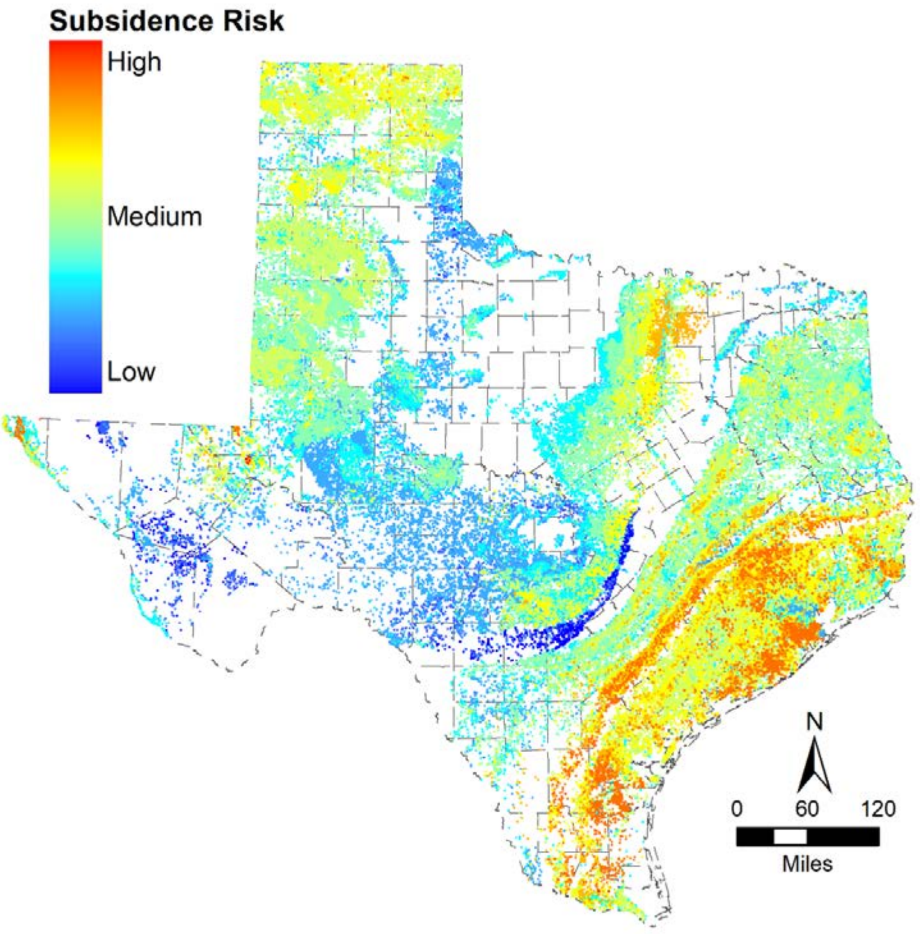
Preliminary Aquifer Subsidence Risk Matrix

- Qualitative assignment of a quantitative value of risk
- Develop classes and class values for each risk factor
- Rank risk factors and assign weights
- Values calculated on a well-by-well basis and normalized to a value between 0 and 10 (inclusive)

Subsidence Risk Factor (Weight)	Subsidence Risk Factor Class	Class Value
Clay Layer Thickness and Extent (6)	Regional Extent – Greater than 300 feet	5
	Regional Extent – 200 to 300 feet	4
	Regional Extent – 100 to 200 feet	3
	Regional Extent – Greater than 0 to 100 feet	2
	Local Extent or No Clay	1
Clay Compressibility (5)	Plastic Clay	3
	Stiff Clay	2
	Hard or No Clay	1
Aquifer Lithology (4)	Unconsolidated Clastic	4
	Consolidated Clastic	3
	Carbonate/Evaporite	2
	Igneous	1
Preconsolidation Characterization (3)	Current Static Water Level Less than Historic Low Water Level Plus 25 Feet	3
	Current Static Water Level Greater than Historic Low Water Level Plus 25 Feet and Less than Historic Low Water Level Plus 50 Feet	2
	Current Static Water Level Greater than Historic Low Water Level Plus 50 Feet	1
Predicted 50-Year Water Level Decline based on Trend (2)	Greater than 200 feet	5
	Between 100 and 200 feet	4
	Between 50 and 100 feet	3
	Between 0 and 50 feet	2
	Less than 0 feet	1
Predicted DFC Water Level Decline (1)	Greater than 200 feet	5
	Between 100 and 200 feet	4
	Between 50 and 100 feet	3
	Between 0 and 50 feet	2
	Less than 0 feet	1

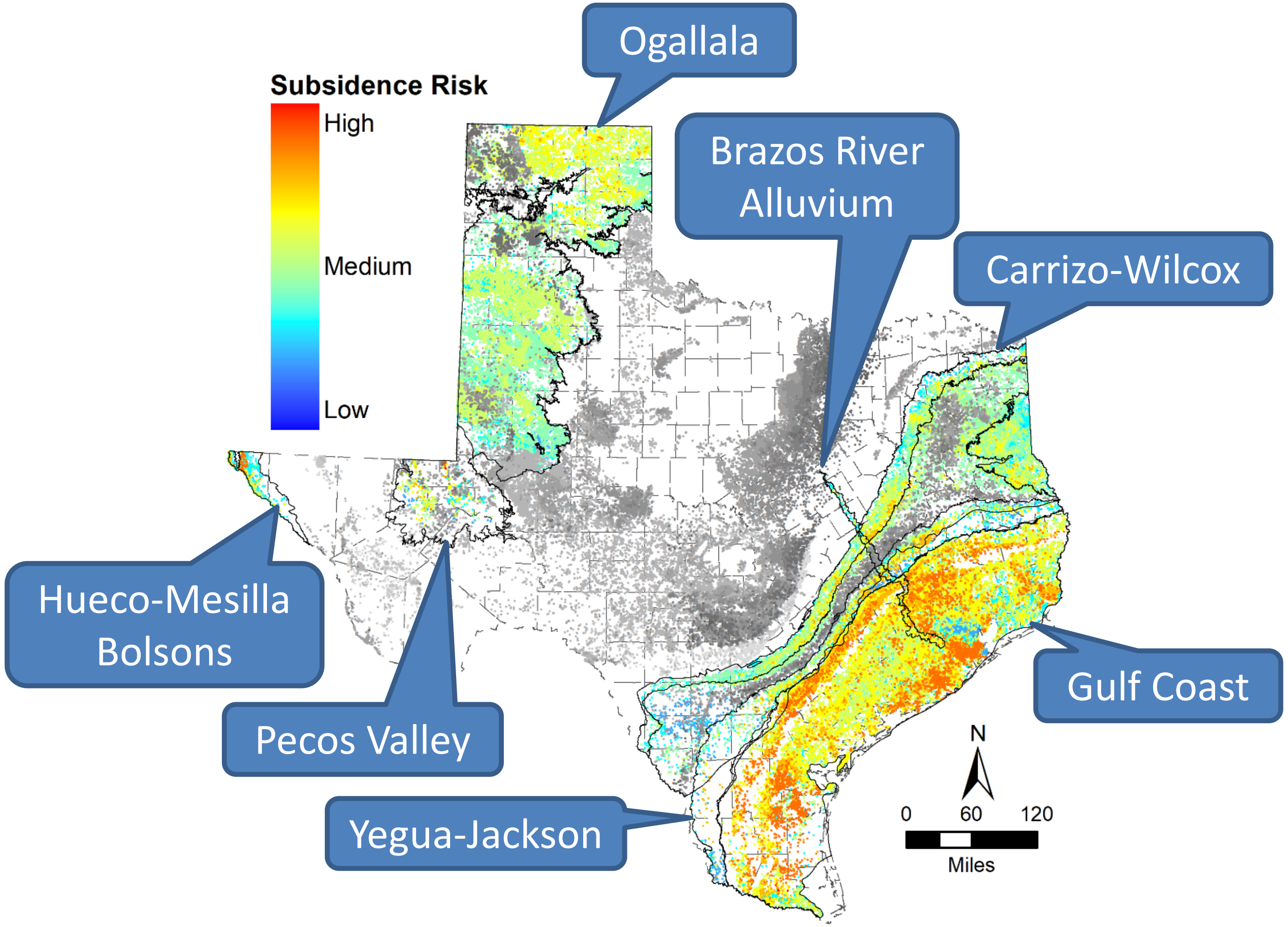
Subsidence Risk

- Risk assessed on a well-by-well basis
- Aggregate statistics calculated for each major and minor aquifer
- Each aquifer categorized as having high, medium, or low risk



High Subsidence Risk

- 7 aquifers identified to have a high subsidence risk
  - 5 major aquifers
  - 2 minor aquifers
- Primary factors in common for high subsidence risk
  - Unconsolidated clastic
  - Thick clay sections



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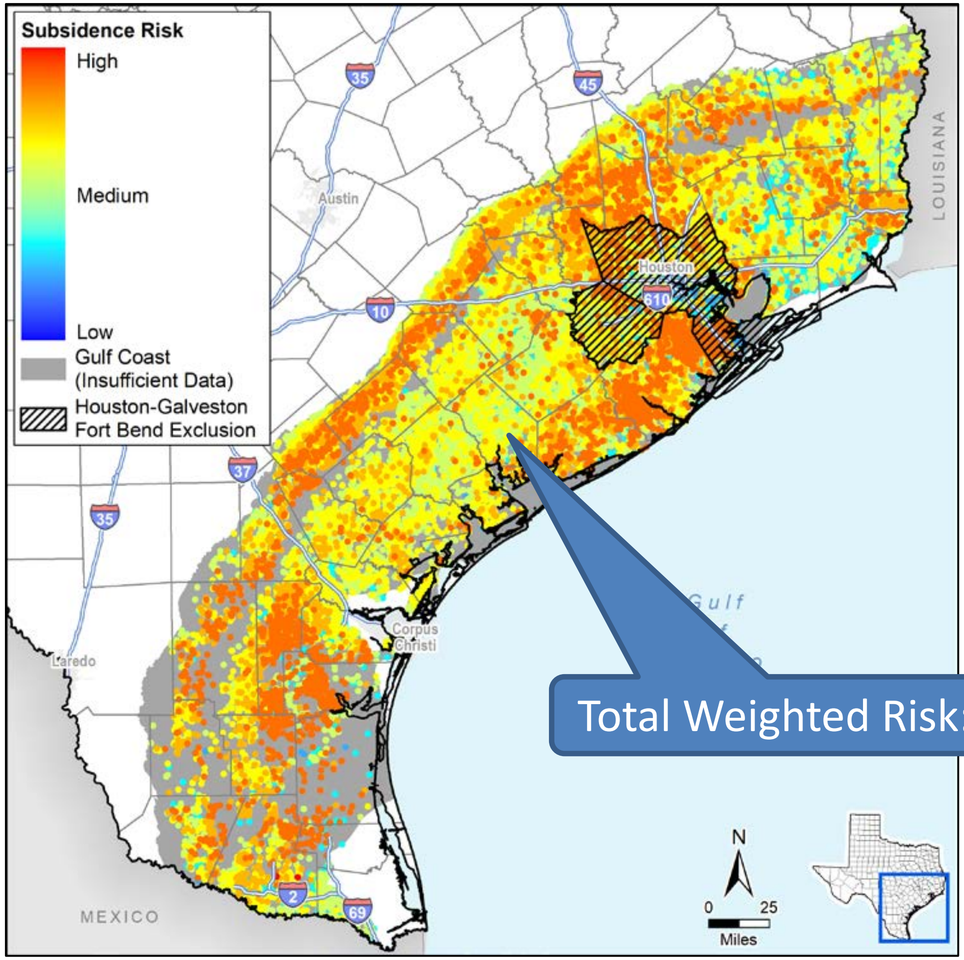
Gulf Coast Aquifer System

Attachment "B" for LRE Presentation

Subsidence Risk Factor Variable	Data Source	Value	3rd Quartile SRV
Clay Layer Thickness and Extent	SDR lithology table	1.4 to 3,645 feet	2
Clay Compressibility	Estimated based on lithology	Plastic Clay	3
Aquifer Lithology	Kasmarek and Robinson (2004)	Unconsolidated Clastic	4
Preconsolidation Characterization	Preconsolidation and static water level from transient model calibration and final MAG simulations	-353 to 798 feet mean sea level	3
Predicted Water Level Decline based on Trend	Trend in simulated water levels – Northern GAM: 1981 – 2021 (Wade, 2016); Central GAM: 2000 – 2020 (Goswami, 2017b); Southern GAM: 2000 – 2020 (Goswami, 2017c)	Less than 1-foot decline	2
Predicted DFC Water Level Decline	Difference in head as described in final MAG simulations	Average 28 feet decline	2



Total Weighted Risk: 5.9

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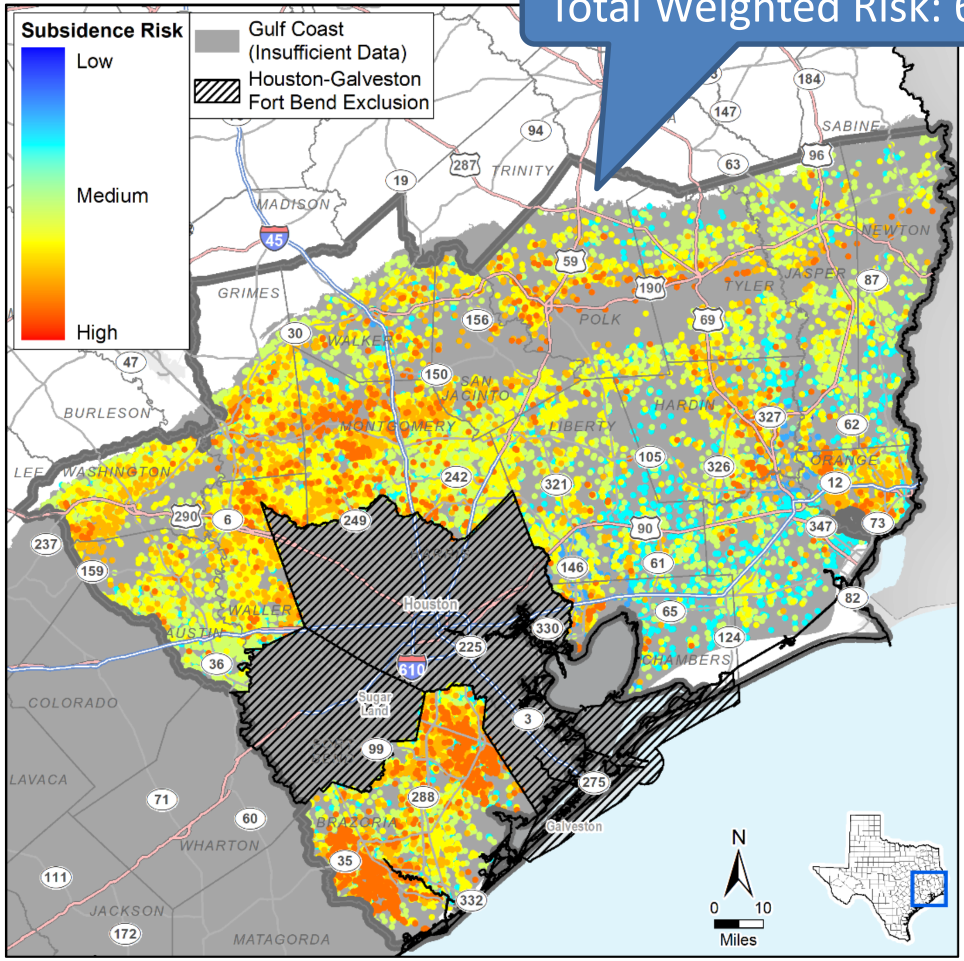
Gulf Coast Aquifer System – GMA 14

Subsidence Risk Factor Variable	Data Source	Value	3rd Quartile SRV
Clay Layer Thickness and Extent	SDR lithology table	1.4 to 3,234 feet	3
Clay Compressibility	Estimated based on lithology	Plastic Clay	3
Aquifer Lithology	Kasmarek and Robinson (2004)	Unconsolidated Clastic	4
Preconsolidation Characterization	Preconsolidation and static water level from transient model calibration and final MAG simulations	-228 to 450 feet mean sea level	3
Predicted Water Level Decline based on Trend	Trend in simulated water levels – Northern GAM: 1981 – 2021 (Wade, 2016)	Less than 1-foot decline	2
Predicted DFC Water Level Decline	Difference in head as described in final MAG simulations	Average 21 feet decline	2

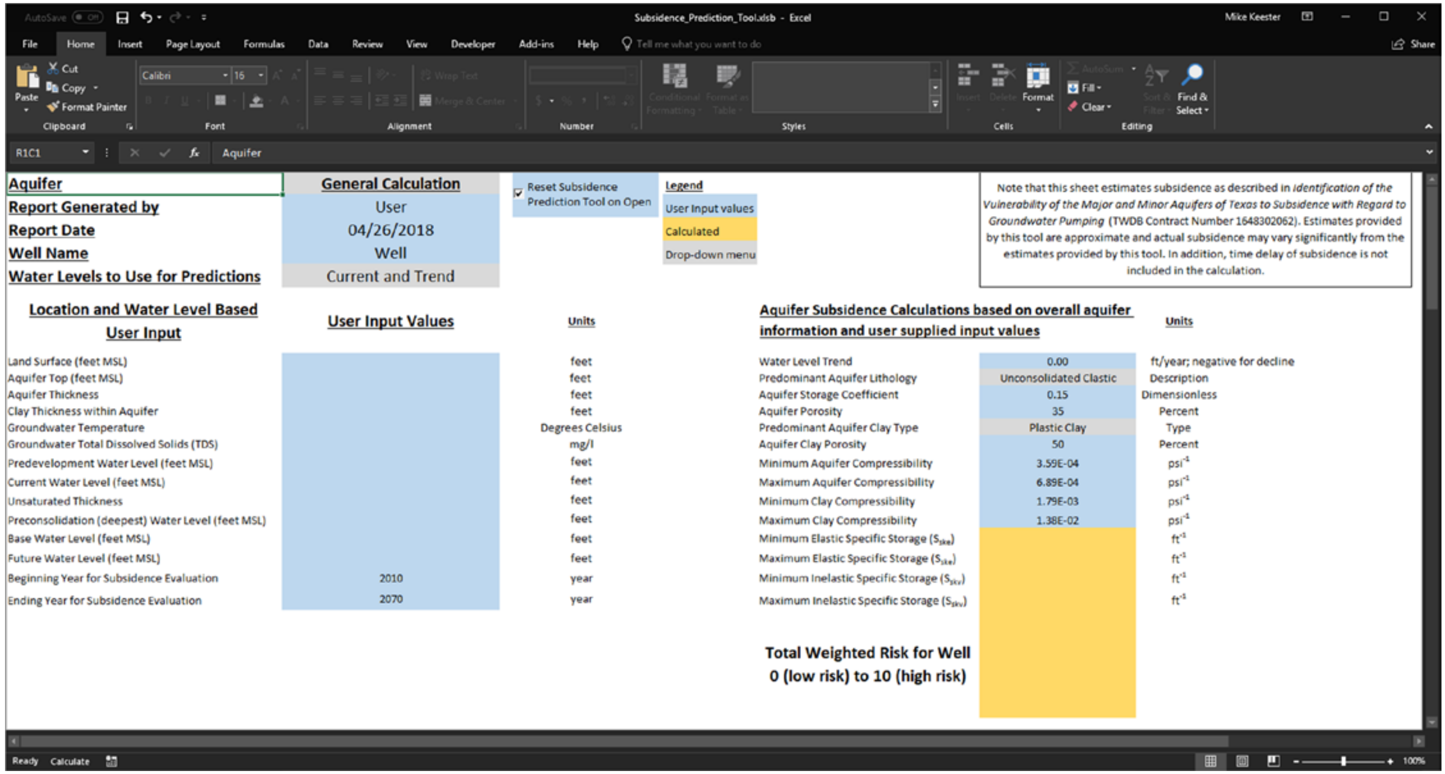
Total Weighted Risk: 6.7



Subsidence Prediction Tool

Attachment "B" for LRE Presentation

- Uses same method as MODFLOW SUB-WT package
- User inputs site specific information
- Provides subsidence risk value and potential subsidence based on inputs



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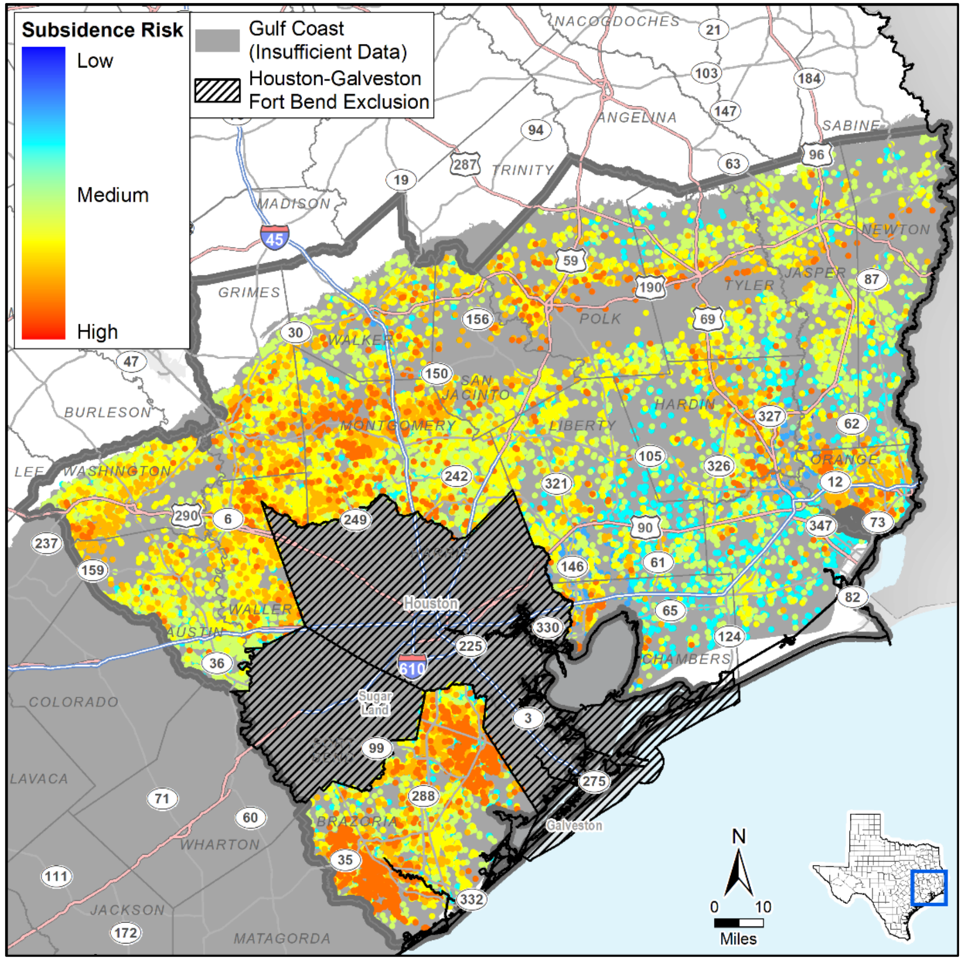
Subsidence Prediction Tool – Example

- [Excel-based Subsidence Prediction Tool]
- [Example Calculation]
  - SDR Tracking Number 429169
  - Evangeline Aquifer
  - 127 feet clay

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	64	Top Soil & Clay
64	98	Coarse Sand
98	106	Clay
106	212	Gravel
212	234	Rocky
234	256	Sand
256	311	Clay
311	353	Sand



Summary of an Evaluation of Subsidence Vulnerability due to Groundwater Pumping

Presentation to Groundwater Management Area 14
April 26, 2018

QUESTIONS/DISCUSSION

Mike Keester, P.G.
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(512) 962-7660

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GAM Simulations of Alternative Conceptual Combinations of Adopted DFC and Run D of Task 3 of the Lone Star GCD Strategic Water Resources Planning Study

Bill Hutchison, Ph.D., P.E., P.G.

GMA 14 Meeting

April 26, 2018

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Groundwater Conservation District

DFCs and MAGs

- Desired Future Condition (DFC)
  - Set by districts in GMA after formal process
    - Consideration of 9 factors
    - Proposed DFC
    - Public hearings in each District
    - Final adoption by GMA
    - Submitted to TWDB for administrative completeness review
    - Final adoption by each District
  - Mainly a policy goal
- Modeled Available Groundwater (MAG)
  - Pumping that will achieve DFC
  - Calculated by TWDB

March 27, 2018 GMA 14 Meeting

- Motion to approve formal consideration of Run D as an amended DFC on an accelerated schedule defeated (Vote: 2 for, 3 against)
- Affirmed a vote taken at the December 8, 2017 GMA 14 meeting to consider Run D as part of "3rd round" of Joint Planning (deadline May 1, 2021 for proposed DFC)

Compatibility of DFC and Run D Drawdowns

- Can Montgomery County have Run D average drawdowns as DFCs with Run D pumping while rest of GMA 14 have DFC drawdowns as its DFCs with original MAGs (pumping)?
- Simple answer is no
  - As pumping is increased in Montgomery County, drawdown will extend into neighboring counties
    - Data
    - Model simulations
    - Groundwater budget analysis

Proposed Increased Pumping in Montgomery County

- Less than 1/3 comes from storage/interbed storage in Montgomery County
- Over 2/3 comes from other counties
  - Highlights reason changing LSGCD DFCs would result in changes to neighboring county DFCs
- Need further analysis to evaluate significance of impacts to surrounding counties
  - Increased inflow from Grimes, Liberty, San Jacinto, Walker
  - Decreased outflow to Harris, Waller

Run D Impacts on BGCD

- Primarily Jasper Aquifer Drawdown:

County	Jasper Aquifer Average Drawdown 2010 to 2070 (ft)	
	DFC Run of GAM	Corrected Run D
Austin	76	121
Grimes	53	89
Walker	42	62
Waller	101	202

Pumping Adjustments

- Can Montgomery County have Run D average drawdowns as DFCs with Run D pumping while rest of GMA 14 have DFC drawdowns as its DFCs with adjusted (lower) pumping?
- Need to complete model simulations to answer
  - BGCD completed this analysis
  - Results presented in report dated April 16, 2018
- Review how a GAM run is completed

GAM Simulations

- Input and Output
  - Among simulation inputs: pumping
  - Among simulation outputs: drawdown
- Model run type
  - Forward run: specify pumping and calculate drawdown
  - Inverse run: specify drawdown and find pumping that will achieve it (requires many runs)
- DFC Run and Run D are forward runs of the GAM
- Pending question requires inverse runs of the model

7 Scenarios Completed

- Scenario 1 (forward run): Corrected Run D (only change in pumping from DFC Run is in Montgomery County)
- Scenario 2 to 7 (inverse runs)
  - Montgomery County pumping fixed at Run D levels, drawdown targets are Run D drawdowns
  - Subsidence District Counties (Fort Bend, Harris, Galveston)
    - Pumping calculated (2, 3, 5, and 6) or fixed at Run D levels (4 and 7)
    - Drawdown targets are DFC (2 and 5), Run D (3 and 5), or unconstrained (4 and 7)
  - All other GMA 14 counties pumping calculated and drawdown targets are DFC

Scenarios 2 to 4 vs. Scenarios 5 to 7

- Scenarios 2 to 4: pumping can increase or decrease
- Scenarios 5 to 7: pumping can only decrease

Simulations

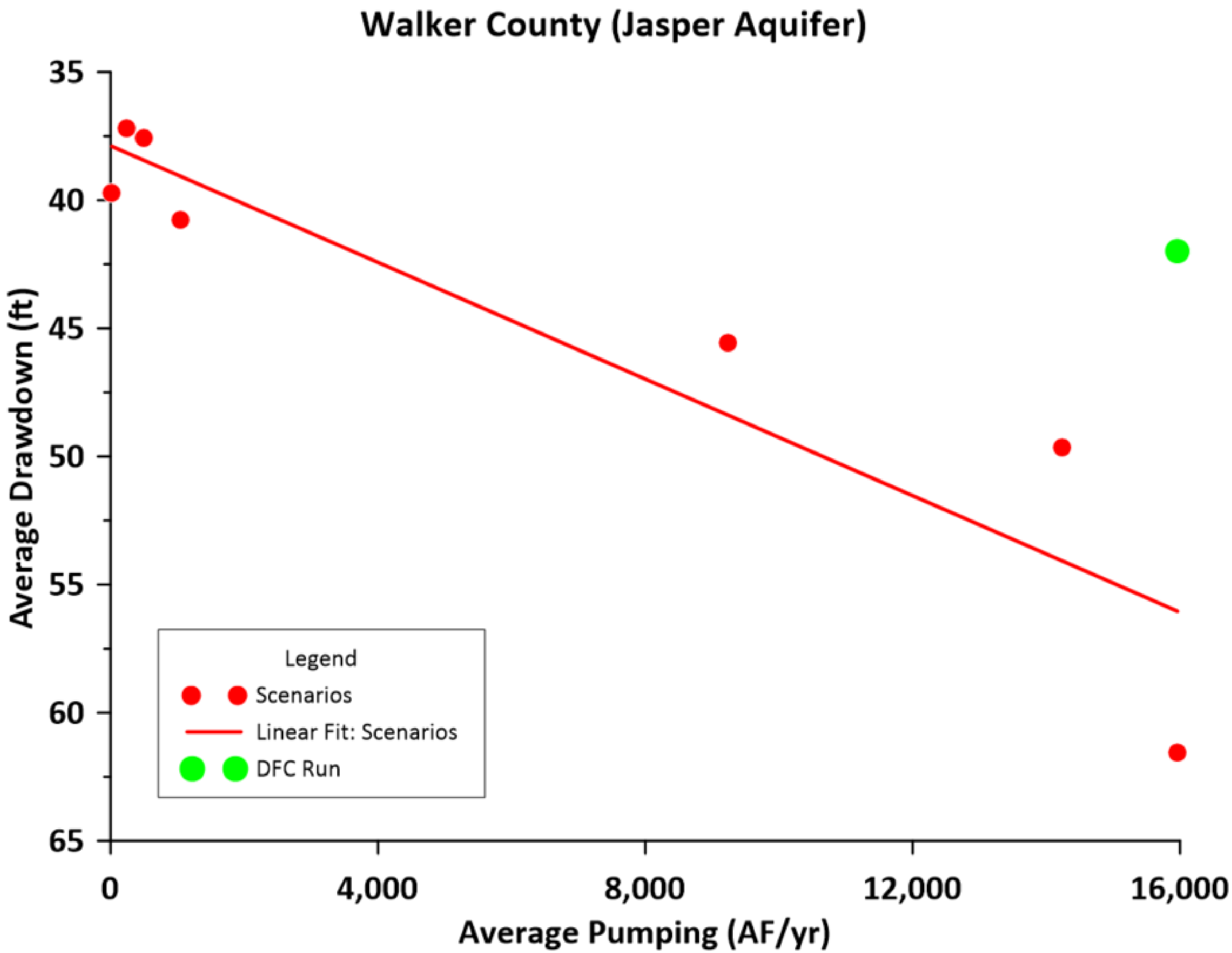
- About 3,500 runs of the model completed
- Inverse runs controlled by parameter estimation software (PEST)
- None of the scenarios were successful in achieving all of the target drawdowns

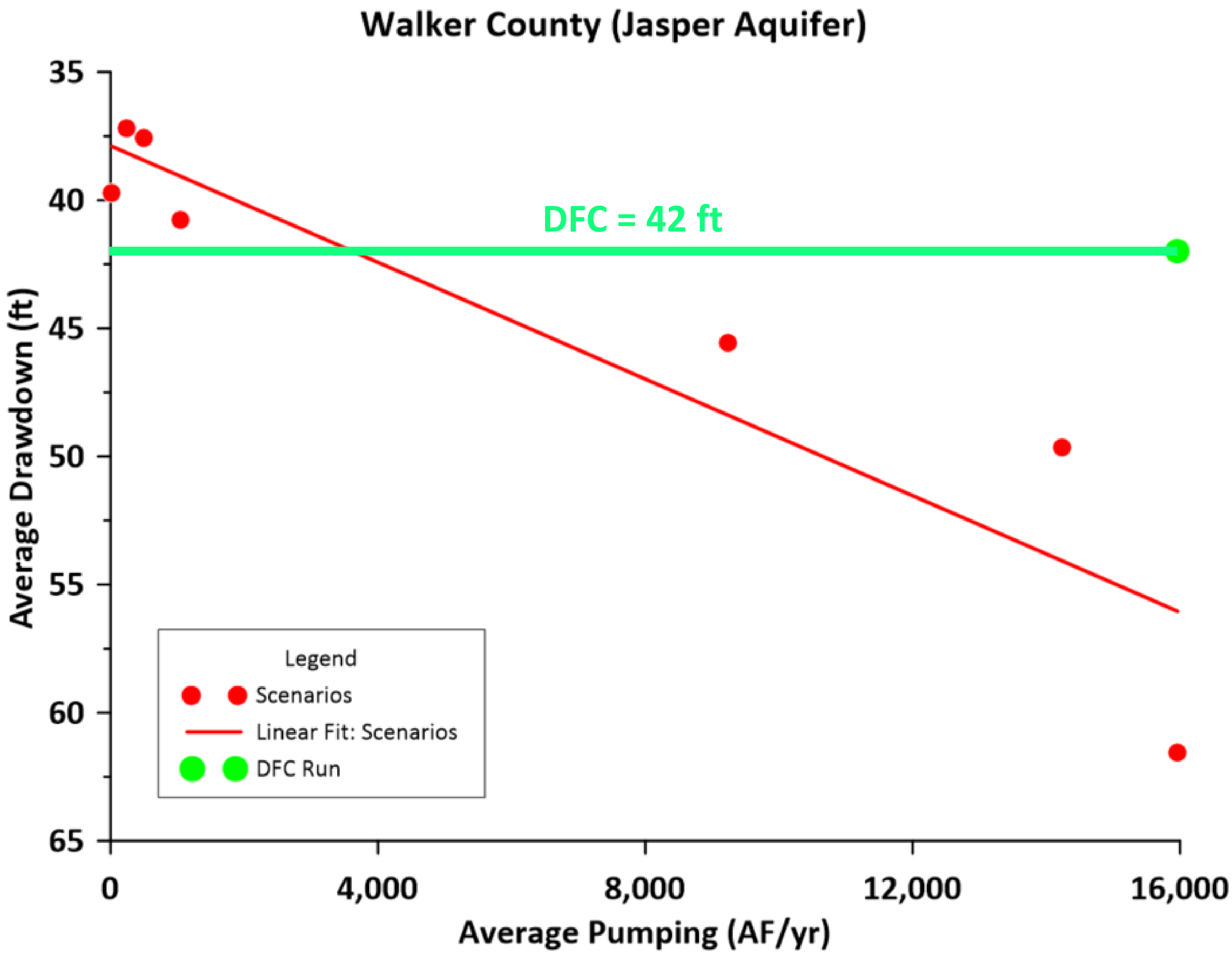
Results

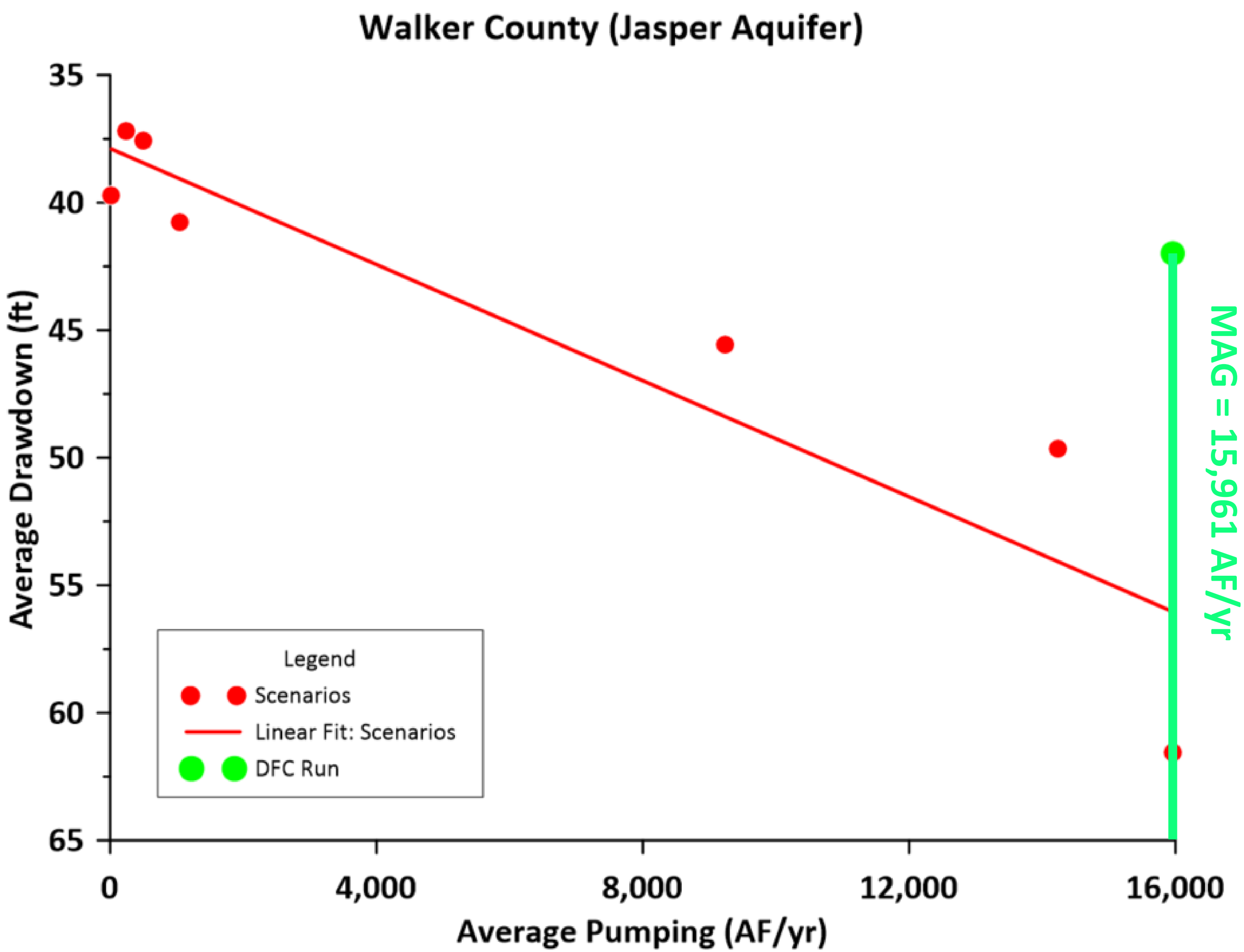
- None of the scenarios are recommended for formal consideration
- Results provide context and frame future discussions

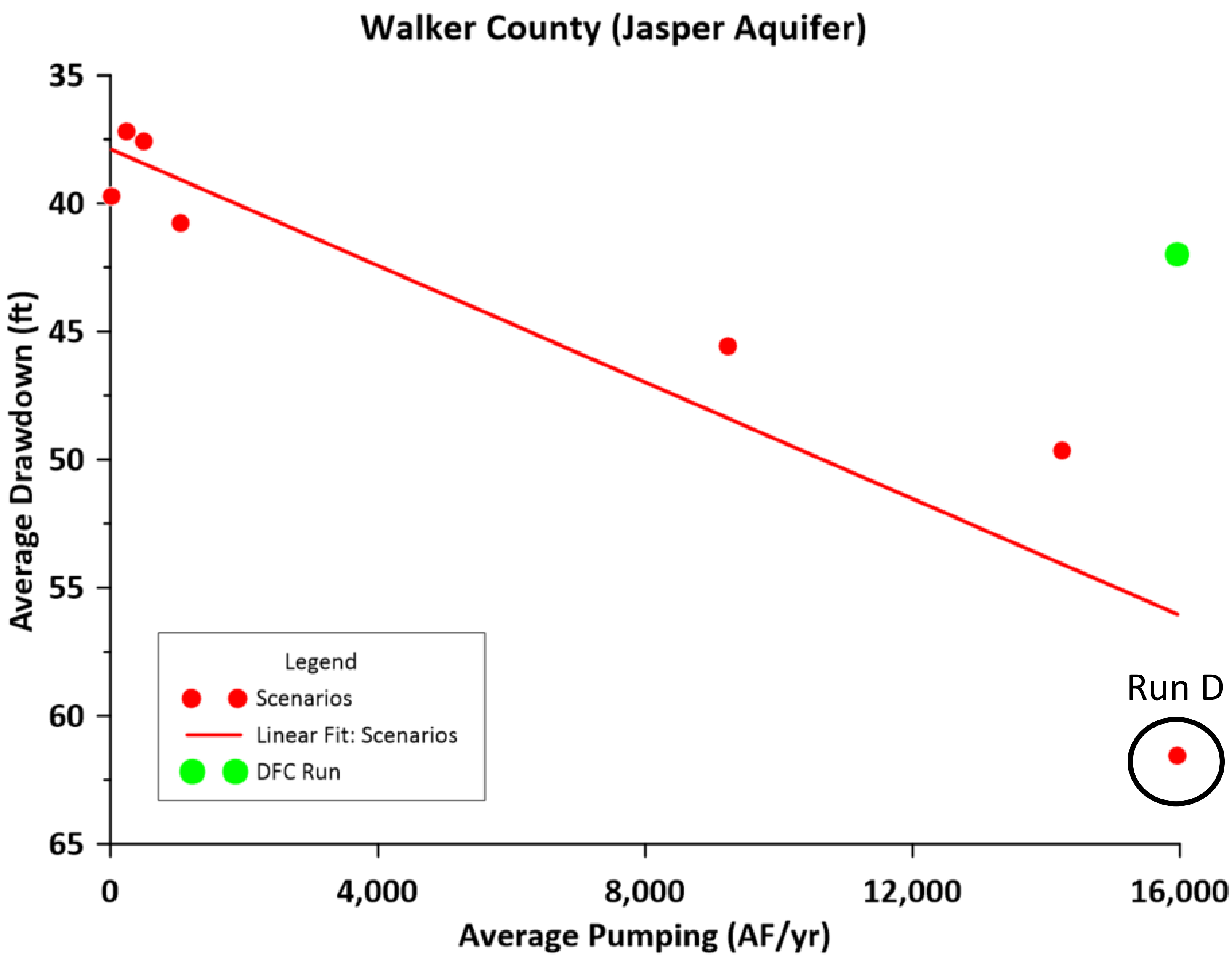
BGCD Jasper Aquifer Results

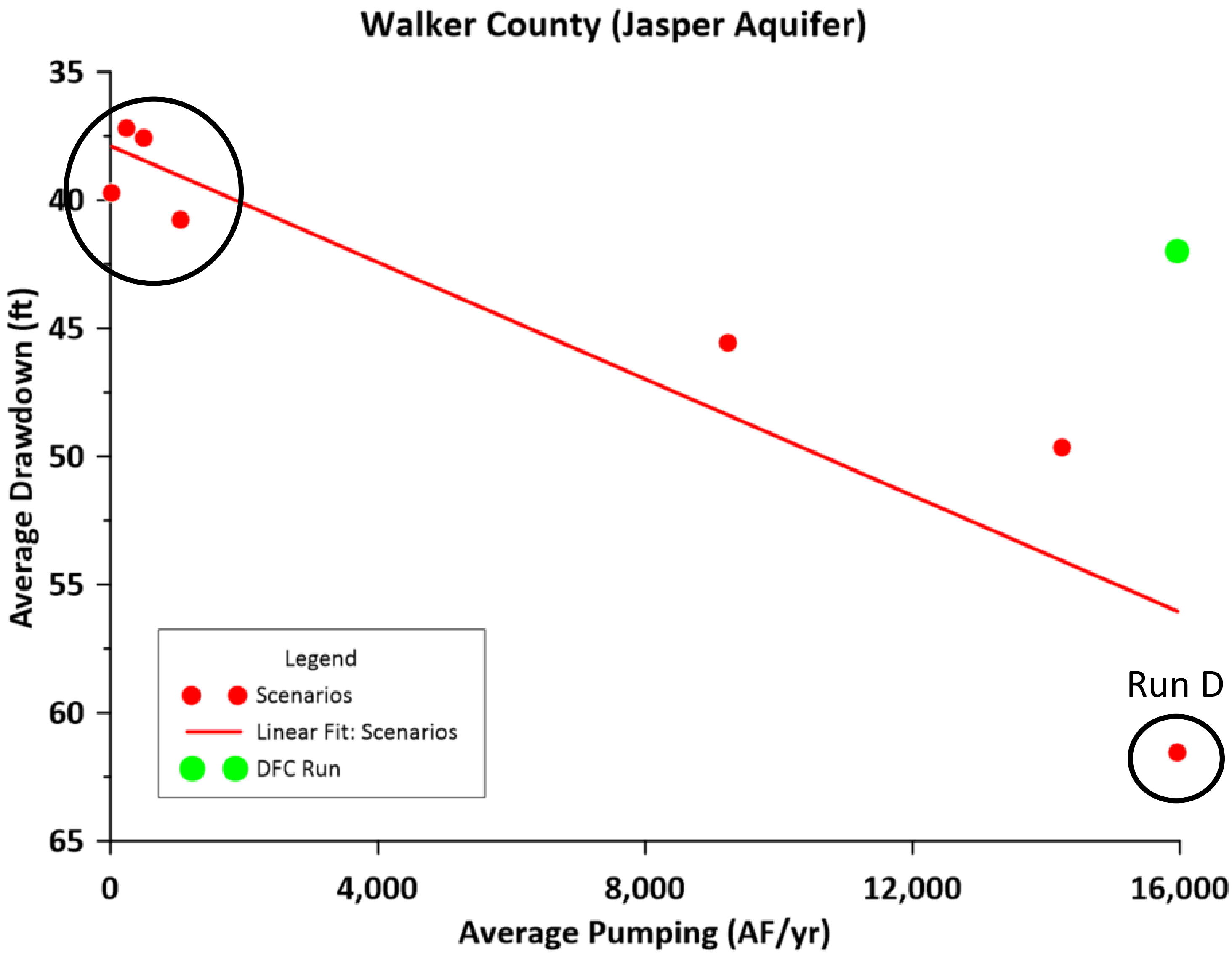
- Austin County
- Grimes County
- Walker County (example shown)
- Waller County (example shown)

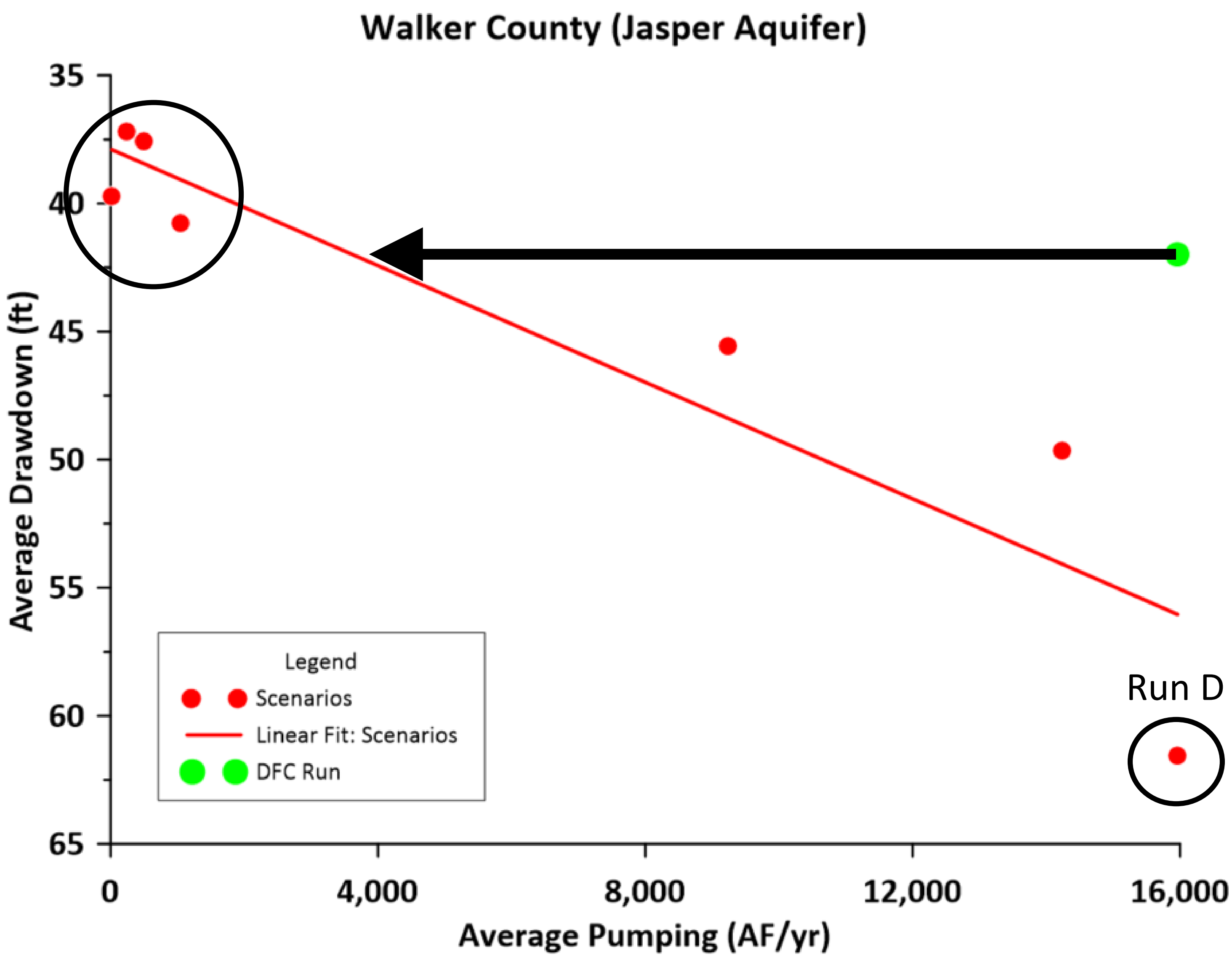

Walker County (Jasper Aquifer)
35
40
45
50
55
60
65
Average Drawdown (ft)
0
4,000
8,000
12,000
16,000
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run

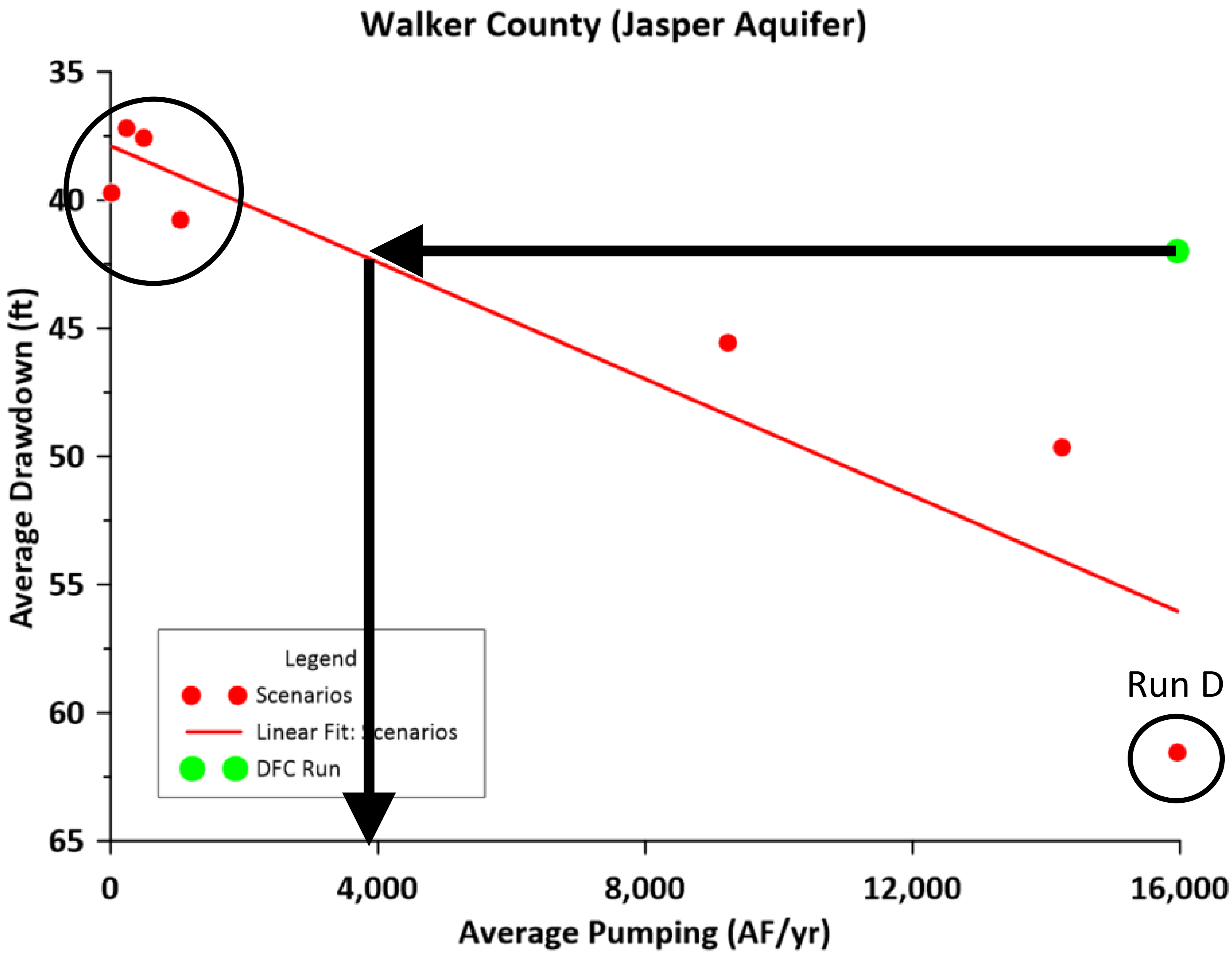

Walker County (Jasper Aquifer)
DFC = 42 ft
Average Drawdown (ft)
35
40
45
50
55
60
65
0
4,000
8,000
12,000
16,000
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run

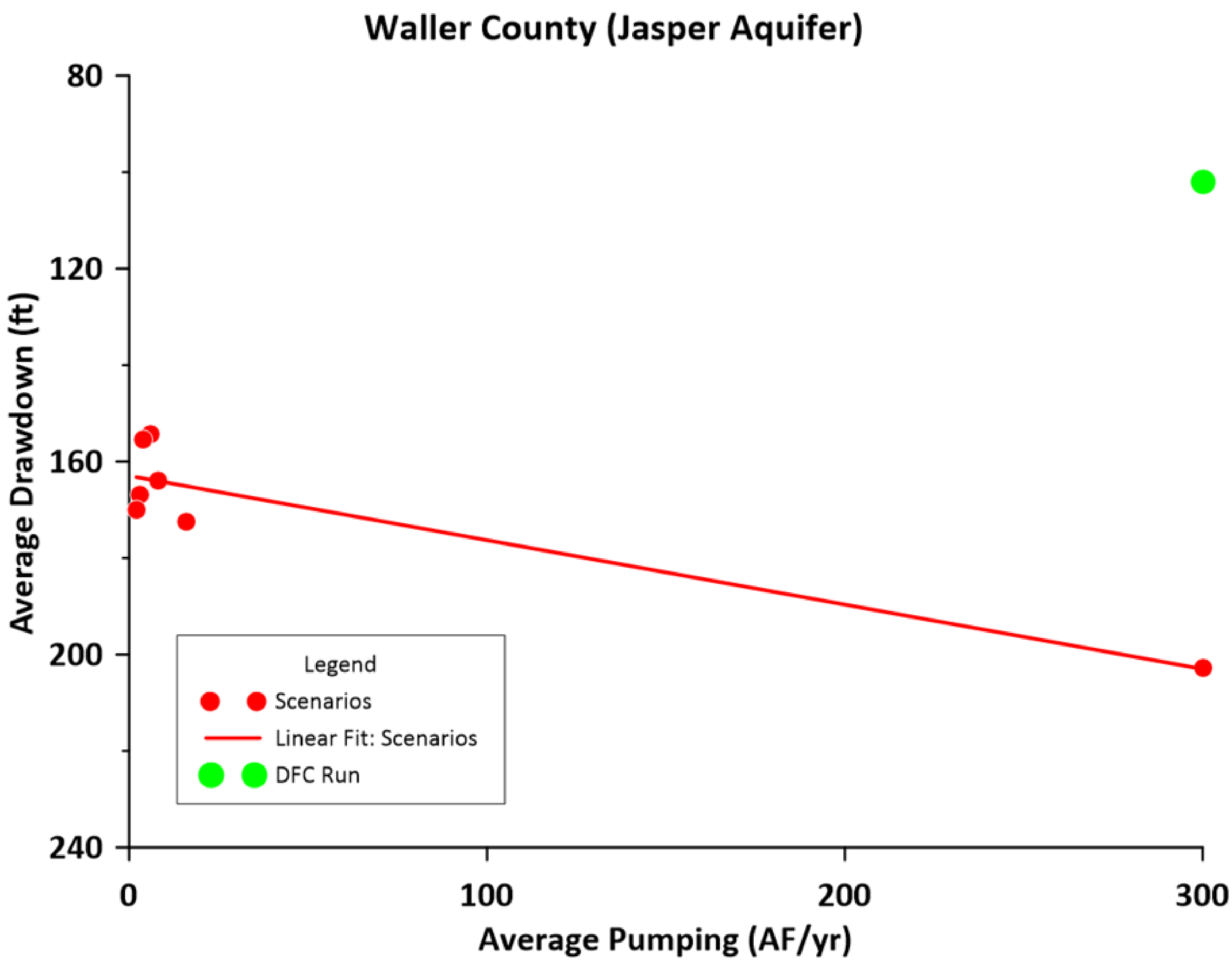

Walker County (Jasper Aquifer)
Average Drawdown (ft)
35
40
45
50
55
60
65
0
4,000
8,000
12,000
16,000
Average Pumping (AF/yr)
MAG = 15,961 AF/yr
Legend
Scenarios
Linear Fit: Scenarios
DFC Run

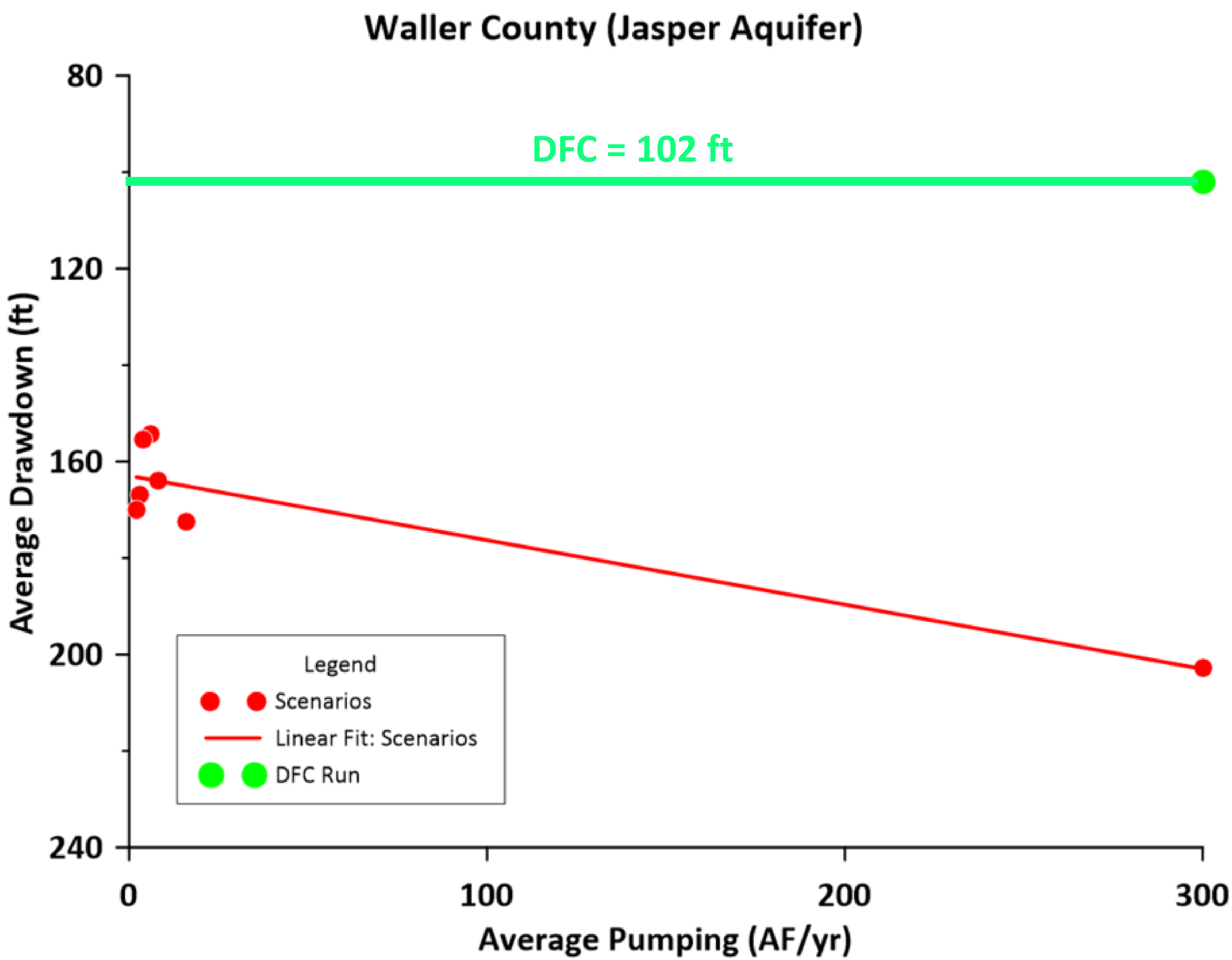

Walker County (Jasper Aquifer)
Average Drawdown (ft)
35
40
45
50
55
60
65
0
4,000
8,000
12,000
16,000
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run
Run D


Walker County (Jasper Aquifer)
Average Drawdown (ft)
35
40
45
50
55
60
65
0
4,000
8,000
12,000
16,000
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run
Run D

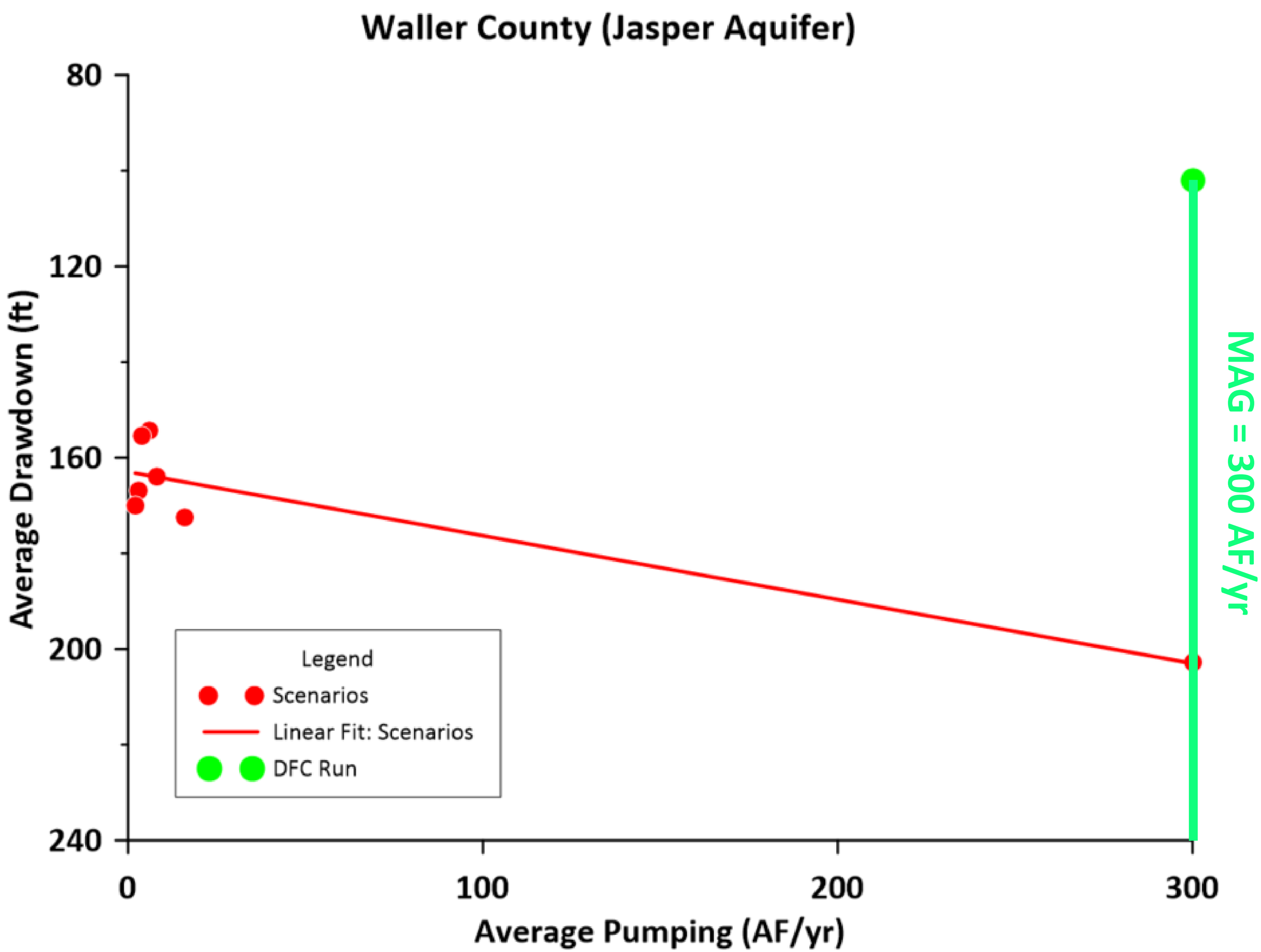

Walker County (Jasper Aquifer)
Average Drawdown (ft)
35
40
45
50
55
60
65
0
4,000
8,000
12,000
16,000
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run
Run D

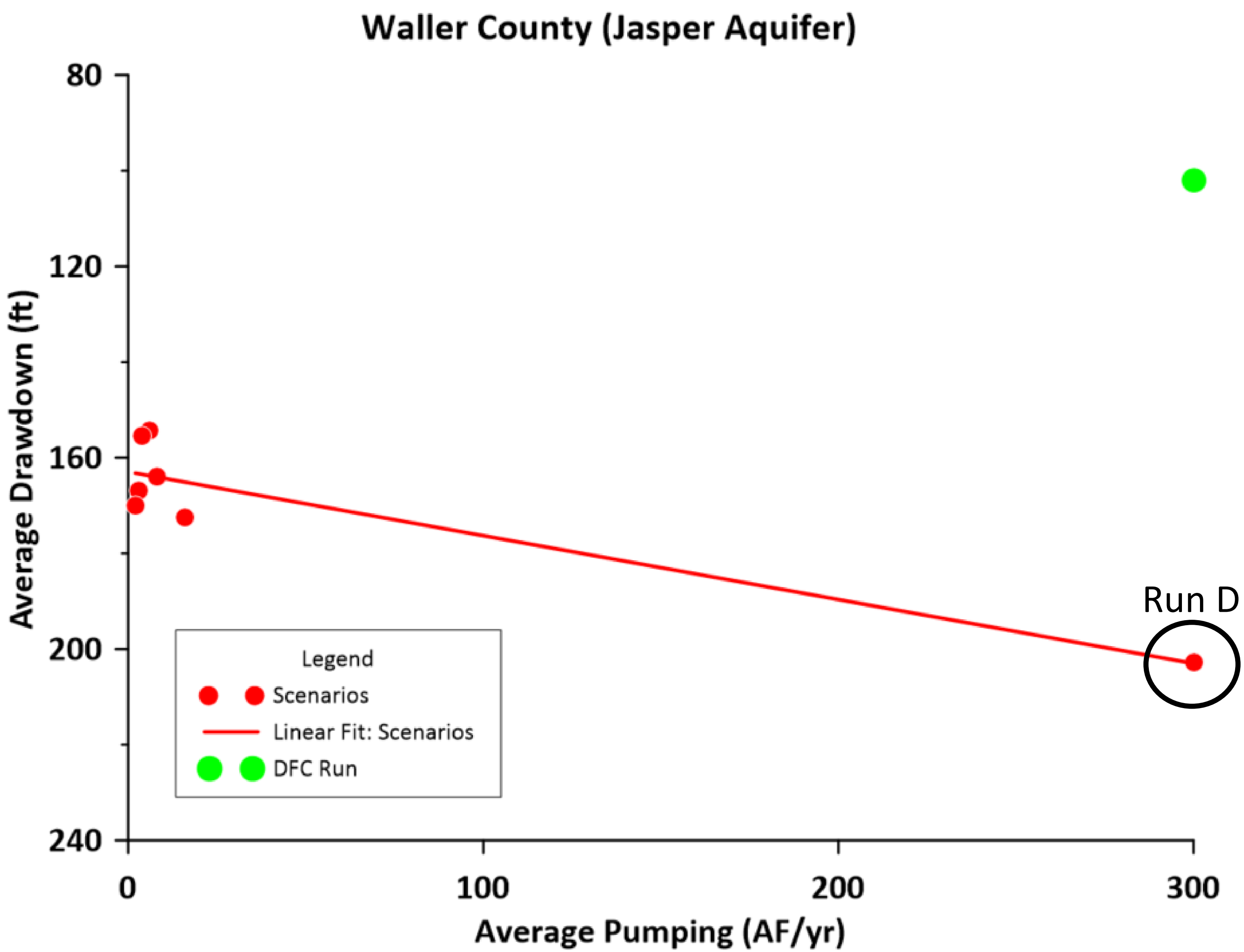

Walker County (Jasper Aquifer)
Average Drawdown (ft)
35
40
45
50
55
60
65
0
4,000
8,000
12,000
16,000
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run
Run D


Waller County (Jasper Aquifer)
80
120
160
200
240
0
100
200
300
Average Drawdown (ft)
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run

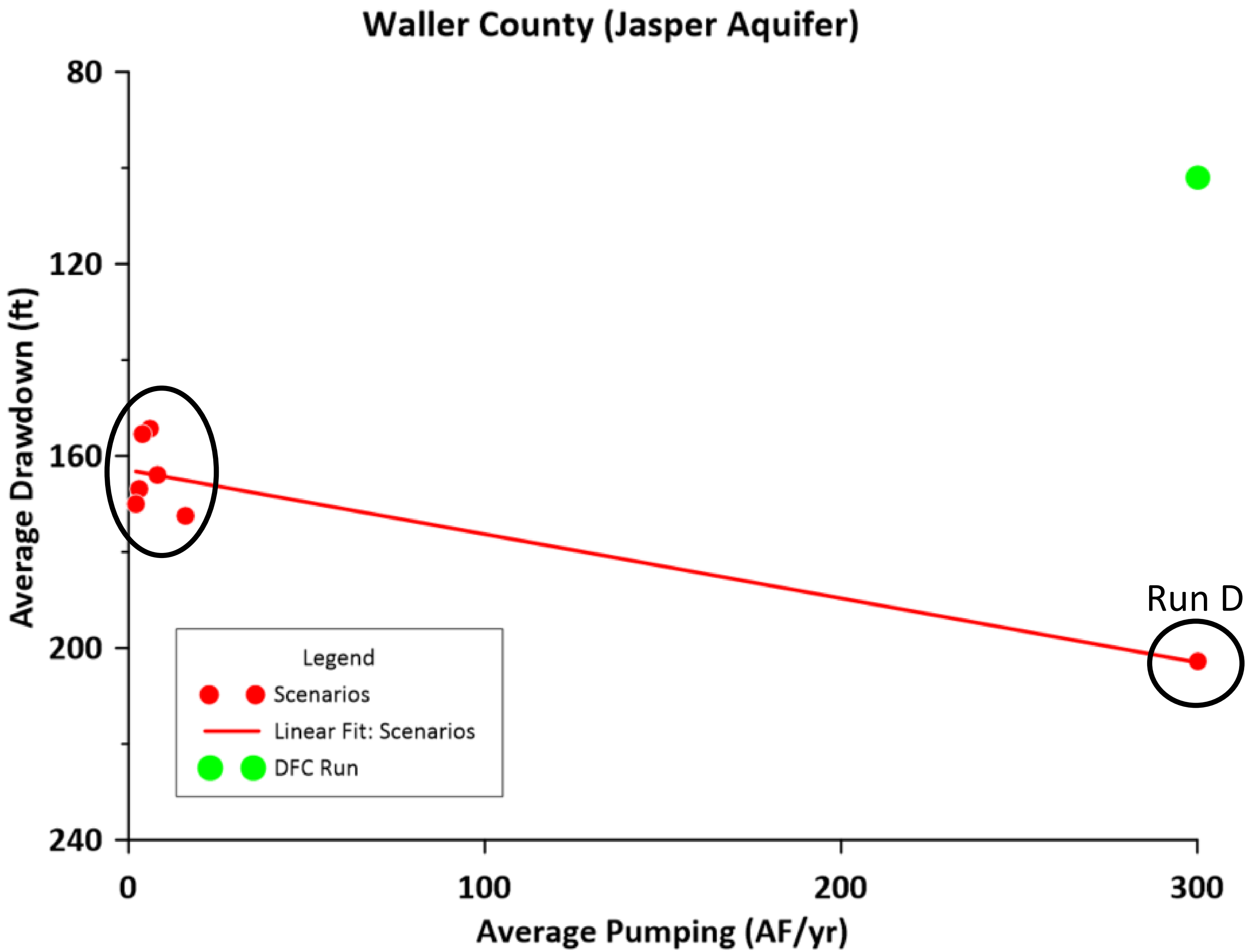


Waller County (Jasper Aquifer)
80
120
160
200
240
0
100
200
300
DFC = 102 ft
Average Drawdown (ft)
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run


Waller County (Jasper Aquifer)
Average Drawdown (ft)
80
120
160
200
240
0
100
200
300
Average Pumping (AF/yr)
Legend
Scenarios
Linear Fit: Scenarios
DFC Run
MAG = 300 AF/yr



Waller County (Jasper Aquifer)
80
120
160
200
240
Average Drawdown (ft)
0
100
200
300
Average Pumping (AF/yr)
Run D
Legend
Scenarios
Linear Fit: Scenarios
DFC Run


Waller County (Jasper Aquifer)
Average Drawdown (ft)
80
120
160
200
240
Average Pumping (AF/yr)
0
100
200
300
Run D
Legend
Scenarios
Linear Fit: Scenarios
DFC Run

Use of Results

- Report (hopefully) will be useful to GMA 14 consultant
  - Need to focus on model limitations
  - Particular attention should be given to Jasper Aquifer

Questions and Discussion

Bill Hutchison, Ph.D., P.E., P.G.

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BLUEBONNET
Groundwater Conservation District