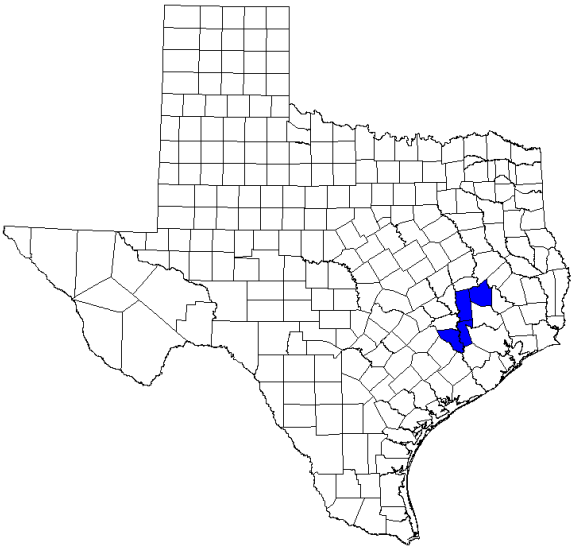
Final Report

Phase 1-b Report:
City of Katy Proposed Well Application (BWLL-0011E, Well 11)
Submitted on September 8, 2023 by ARKK Engineers



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November 13, 2023

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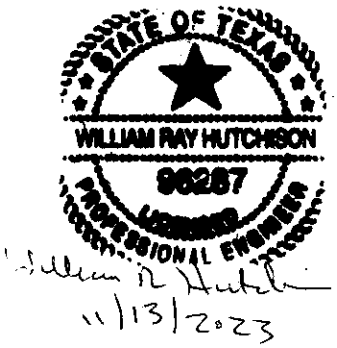
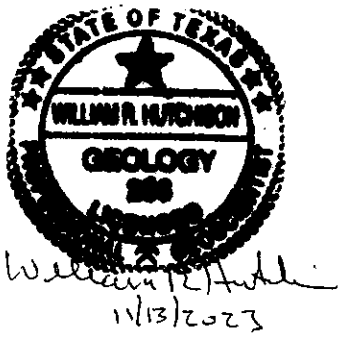




1.0 Introduction

The City of Katy has submitted a Non-Exempt Water Well Registration to the Bluebonnet Groundwater Conservation District (BGCD) for a new public water supply well. The proposed well locations and estimated total water production are summarized below:

- Well Location: northeast corner of the intersection of Pitts Road and Morton Rd.
- Latitude: 29° 49' 6.267" N (28.81841)
- Longitude: 95° 50' 21.3834" W (-95.8393)
- Estimated Annual Water Production: 262.8 million gallons.

The rules of BGCD require the applicant to submit Phase I and Phase II hydrogeologic reports for non-exempt wells with an inside diameter casing of eight inches or greater as part of the permit application process. These reports include hydrogeologic information addressing, and specifically related to, the impacts of the proposed well (e.g. area of influence, drawdown, recovery time, and potential for subsidence).

Because the requested permit amount is greater than 200 million gallons per year, a Phase I-b report is required. In general, the Phase I-b report is intended to be a preliminary report that relies on existing regional information and data, and the Phase II report is intended to be a final report that relies on site specific data, information, test results and analyses.

As required in the Guidelines for Submitting Data and Information and the Preparation of Hydrogeologic Reports in Support of Applications for the Permitted Use of Groundwater (dated April 14, 2023), this report contains the Phase I-a tables and the results of a simulation using the Groundwater Availability Model of the area that adds the proposed wells to the most recent run that was used to establish the desired future condition.

All files associated with this report are available for download at the following location:

https://www.dropbox.com/scl/fo/je0qzrri0evbmetcezpc7/h?rlkey=5rx2rrn6u91er7w3xnghnkgpu&dl=0

2.0 Phase I-a Tables

2.1 Well Locations on HAGM Grid

The latitude and longitude data provided in the application were used to convert the location data to x- and y-coordinates in the GAM coordinate system using Surfer, a commercial gridding program. In addition, registered wells within one mile of the proposed well were identified and their latitude and longitude coordinates were also converted to x- and y-coordinates. All well locations are presented in Figure 1.

The Fortran program *PointRC.exe* was used to find the HAGM cell for the x- and y-coordinates of the proposed production well. The Fortran program *PointRCReg.exe* was used to find the HAGM cells for the x- and y-coordinates of the registered wells. The results are summarized in Table 1.

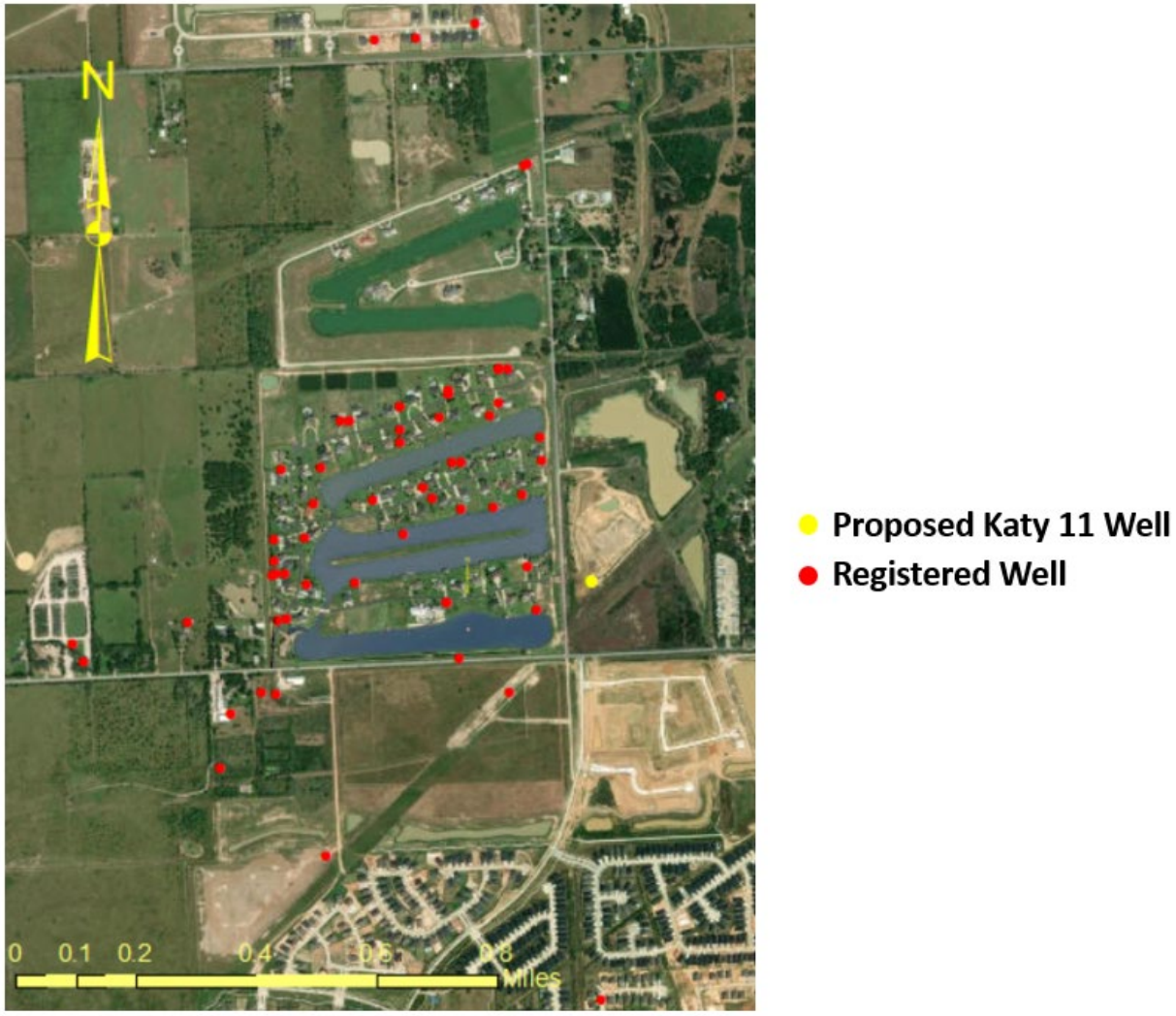


Figure 1. Well Locations

Table 1. Well Location Coordinates

Well ID	Distance to Katy 11 Well (miles)	Estimated Depth (ft)	Latitude	Longitude	GAMx	GAMy	HAGM Row	HAGM Column
Proposed Well (Katy 11)	0.00	1000	29.8184075	-95.83927317	6238066.273	19188008.58	54	80
BWLL-0072A	0.70		29.828531	-95.840619	6237501.958	19191678.28	53	80
BWLL-0072B	0.70		29.828492	-95.840744	6237462.954	19191662.6	53	80
BWLL-0074	0.64	270	29.815556	-95.849444	6234887.798	19186849.55	54	79
BWLL-0087	0.86	258	29.816937	-95.853479	6233592.485	19187304.48	53	79
BWLL-4208	0.39	264	29.82055763	-95.84527742	6236137.499	19188720	54	80
BWLL-4218	0.31	263	29.82139151	-95.84305536	6236828.998	19189050	54	80
BWLL-4222	0.32	260	29.82083093	-95.84388888	6236573	19188836	54	80
BWLL-4242	0.29	228	29.82138792	-95.84277732	6236917	19189052	54	80
BWLL-4250	0.24	260	29.81805514	-95.84333399	6236786.5	19187832	54	80
BWLL-4313	0.68	264	29.8177798	-95.85055489	6234506.001	19187646	54	79
BWLL-4329	0.37	265	29.82249925	-95.84333306	6236726	19189450	53	80
BWLL-4330	0.39	260	29.82360942	-95.84166644	6237238.001	19189874	53	80
BWLL-4338	0.43	315	29.82277725	-95.84444489	6236370.499	19189538	53	80
BWLL-4383	0.38	455	29.82361132	-95.84138816	6237326.001	19189878	53	80
BWLL-4389	0.26	260	29.81666722	-95.84305577	6236893.5	19187330	54	80
BWLL-4393	0.48	260	29.81861049	-95.84722193	6235549	19187988	54	80
BWLL-4394	0.48	460	29.82249846	-95.84583369	6235934.999	19189420	53	80
BWLL-4395	0.32	460	29.82249788	-95.84194531	6237164.999	19189466	54	80
BWLL-4406	0.55	260	29.82138632	-95.84777851	6235335.001	19188992	53	80
BWLL-4408	0.22	260	29.82138676	-95.840555	6237619.998	19189078	54	80
BWLL-4409	0.53	260	29.81971989	-95.84805598	6235269.999	19188382	53	80
BWLL-4462	0.10	265	29.8177757	-95.84083296	6237581.5	19187760	54	80
BWLL-4463	0.49	265	29.82138853	-95.84666723	6235686.501	19189006	53	80
BWLL-4506	0.24	250	29.81805514	-95.84333399	6236786.5	19187832	54	80
BWLL-4523	0.21	460	29.82027855	-95.8419449	6237195.499	19188658	54	80
BWLL-4533	0.48	460	29.82249846	-95.84583369	6235934.999	19189420	53	80
BWLL-4534	0.43	460	29.82277725	-95.84444489	6236370.499	19189538	53	80
BWLL-4547	0.32	470	29.81972291	-95.84444416	6236412.501	19188426	54	80
BWLL-4596	0.51	460	29.81888868	-95.84777743	6235369.499	19188082	54	80
BWLL-4680	0.39	460	29.82305602	-95.84305608	6236805.999	19189656	53	80
BWLL-4681	0.39	460	29.82305602	-95.84305608	6236805.999	19189656	53	80
BWLL-4705	0.48	460	29.8205571	-95.84694499	6235610.001	19188700	53	80
BWLL-4706	0.53	460	29.81916507	-95.84805623	6235277.501	19188180	54	80
BWLL-4792	0.26	465	29.82194712	-95.84055604	6237611.999	19189282	54	80
BWLL-4794	0.23	250	29.81583079	-95.84166629	6237344.5	19187042	54	80
BWLL-4795	0.53	460	29.81777524	-95.84805621	6235296.499	19187674	54	80
BWLL-4796	0.18	339	29.82055345	-95.84111108	6237455.5	19188768	54	80
BWLL-4860	0.33	240	29.82277991	-95.84166697	6237249.502	19189572	54	80
BWLL-4872	0.39	445	29.82360942	-95.84166644	6237238.001	19189874	53	80
BWLL-4955	0.53	460	29.81889037	-95.84805546	6235281.499	19188080	54	80
BWLL-4986	0.37	240	29.822778	-95.835556	6239182.255	19189644.01	54	80
BWLL-5205	0.97	255	29.83166906	-95.84472277	6236161.002	19192772	53	80
BWLL-5207	0.39	342	29.82360942	-95.84166644	6237238.001	19189874	53	80
BWLL-5212	0.50	460	29.82250204	-95.84611173	6235846.999	19189418	53	80
BWLL-5371	0.30	264	29.82055819	-95.84361142	6236664.5	19188740	54	80
BWLL-5567	0.95	260	29.831944	-95.841945	6237035.833	19192905.11	53	80
BWLL-5568	0.95	260	29.831667	-95.843611	6236512.677	19192784.46	53	80
BWLL-5571	0.49	270	29.819722	-95.847222	6235533.787	19188392.67	54	80
BWLL-5626	0.39	450	29.821944	-95.844445	6236381.86	19189234.63	53	80
BWLL-5655	0.64		29.812023	-95.846942	6235727.589	19185592.99	54	79
BWLL-5656	0.69		29.814267	-95.849789	6234796.263	19186376.17	54	79
BWLL-5657	0.58		29.816036	-95.848583	6235153.616	19187034.53	54	79
BWLL-5658	0.56		29.815989	-95.848167	6235285.858	19187022.36	54	79
BWLL-5811	0.39	265	29.823611	-95.841667	6237237.802	19189874.57	53	80
BWLL-5864	0.39	265	29.818611	-95.845834	6235988.048	19188004.67	54	80
BWLL-5876	0.70		29.808333	-95.839444	6238150.177	19184338.69	54	80
BWLL-5993	0.51	200	29.817778	-95.847778	6235384.47	19187678.31	54	80
BWLL-6134	0.87	350	29.817393	-95.853736	6233504.962	19187467.45	53	79
BWLL-6147	0.41	265	29.822222	-95.84444	6236379.639	19189335.91	53	80
BWLL-6232B	0.40	465	29.823133	-95.843083	6236796.431	19189683.71	53	80
BWLL-6369	0.53	465	29.81885	-95.84815	6235252.144	19188064.18	54	80
BWLL-6454	0.25	275	29.82026	-95.84286	6236906.277	19188640.37	54	80
BWLL-6455	0.11	280	29.818816	-95.84105	6237498.602	19188136.16	54	80

2.2 HAGM Grid Parameters

The Excel spreadsheet named *BGCD Parameters.xlsx* contains all the data needed for the review and Phase 1-a calculations. The data for the proposed well were extracted and saved in the Excel file named *Katy 11Phase I-a Tables.xlsx*. The tab named *gridparam* contains the HAGM grid data and is presented as Table 2. Please note that all model layers for the proposed well location (HAGM Row 54, Column 80) are included.

Table 2. HAGM Grid Parameters for Proposed Katy 11 Well

County Name	Waller	Waller	Waller	Waller
County Code	237	237	237	237
Outcrop Layer	1	1	1	1
Layer	1	2	3	4
Row	54	54	54	54
Column	80	80	80	80
x-coordinate (GAM-ft)	6238499	6238499	6238499	6238499
y-coordinate (GAM-ft)	19187420	19187420	19187420	19187420
Surface Elevation (ft MSL)	149	149	149	149
Cell Top Elevation (ft MSL)	149	-273	-1486	-1787
Cell Bottom Elevation (ft MSL)	-273	-1486	-1787	-2584
Cell Thickness (ft)	422	1213	301	797
Clay Thickness (ft)	210	623	176	548
Clay Thickness (% of Cell Thickness)	49.76	51.36	58.45	68.76

2.3 HAGM Aquifer Parameters

The Excel spreadsheet named *BGCD Parameters.xlsx* contains all the data needed for the review and Phase 1-a calculations. The data for the proposed well were extracted and saved in the Excel file named *Katy 11 Phase I-a Tables.xlsx*. The tab named *HAGMparam* contains the HAGM aquifer parameter data and is presented as Table 3. Please note that all model layers for the proposed well location (HAGM Row 54, Column 80) are included.

Table 3. HAGM Aquifer Parameters for Proposed Katy 11 Well

County Name	Waller	Waller	Waller	Waller
County Code	237	237	237	237
Outcrop Layer	1	1	1	1
Layer	1	2	3	4
Row	54	54	54	54
Column	80	80	80	80
Hydraulic Conductivity (ft/day)	19.68	0.90	0.01	1.88
Transmissivity (gpd/ft)	62,124	8,166	21	11,189
Leakage (1/day)	8.00E-06	5.40E-06	2.06E-08	0.00E+00
Storativity (dimensionless)	1.00E-01	3.60E-04	3.00E-04	2.20E-04
Elastic Storativity (dimensionless)	2.00E-05	1.50E-04	1.80E-07	5.23E-06
Inelastic Storativity (dimensionless)	2.00E-03	1.50E-02	1.80E-05	5.23E-04

2.4 HAGM Results

The Excel spreadsheet named *BGCD Parameters.xlsx* contains all the data needed for the review and Phase 1-a calculations. The data for the proposed well were extracted and saved in the Excel file named *Katy 11 Phase I-a Tables.xlsx*. The tab named *HAGMresults* contains the HAGM results and is presented as Table 4. Please note that all model layers for the proposed well location (HAGM Row 54, Column 80) are included.

Table 4. HAGM Results for Proposed Katy 11 Well

County Name	Waller	Waller	Waller	Waller
County Code	237	237	237	237
Outcrop Layer	1	1	1	1
Layer	1	2	3	4
Row	54	54	54	54
Column	80	80	80	80
Groundwater Elevation in 2009 (ft MSL)	0	-37	-36	69
Groundwater Elevation in 2080 (ft MSL)	-63	-144	-144	-151
DFC Drawdown (ft)	63	107	108	219
Artesian Head (ft)	-149	236	1450	1856
Subsidence in 2009 (ft)	2.01	2.01	2.01	2.01
Subsidence in 2080 (ft)	3.6	3.6	3.6	3.6
Subsidence from 2009 to 2080 (ft)	1.59	1.59	1.59	1.59
Cell Pumping in 2009 (AF/yr)	0	0	0	0
Cell Pumping in 2080 (AF/yr)	0	0	0	0

2.5 Theis Parameters

The Excel spreadsheet named *BGCD Parameters.xlsx* contains all the data needed for the review and Phase 1-a calculations. The data for the proposed well were extracted and saved in the Excel file named *Katy 11 Phase I-a Tables.xlsx*. The tab named *theisparam* contains the Theis parameters and is presented as Table 5. The Theis parameters are associated with the estimation of drawdown using the Theis equation as described below. Please note that only data from the Evangeline (Layer 2) and Jasper (Layer 4) for the proposed well location (HAGM Row 54, Column 80) are included.

Table 5. Theis Parameters for Proposed Katy 11 Well

County Name	Waller	Waller
County Code	237	237
Outcrop Layer	1	1
Layer	2	4
Row	54	54
Column	80	80
Drawdown in Production Well at 100 gpm for 36 hours	24.60	18.78
Drawdown 1/2 mile from Production Well at 100 gpm for 36 hours	1.07	1.39
Drawdown 1/2 miles from Production Well at 100 gpm for 1 year	8.25	6.85
Drawdown-Pumping Ratio for Production Well for 36 hours	0.24596	0.18779
Drawdown-Pumping Ratio for 1/2 mile from Production Well for 36 hours	0.01066	0.01391
Drawdown-Pumping Ratio for 1/2 mile from Production Well for 1 yr	0.08250	0.06849

2.6 Theis Results

Groundwater production data from the permit application were used along with the drawdown-pumping ratios contained in Table 5 to develop three estimates of drawdown:

- Scenario 1: drawdown in the production well after 36 hours of pumping at three times the average annual pumping rate.
- Scenario 2: drawdown in a well ½ mile from the production well after 36 hours of pumping at three times the average annual pumping rate.
- Scenario 3: drawdown in a well ½ mile from the production well after one year of pumping at the average annual pumping rate.

Results of these calculations for the Evangeline Aquifer (Layer 2) are presented in Table 6.

Table 6. Theis Results for Proposed Katy 11 Well

Production Summary	Value
Annual Permit Production Limit (gallons)	262,800,000
Annual Permit Production Limit (acre-feet)	806
Average Pumping Rate (gpm)	500
Average Pumping Rate (cfd)	96257
3X Average Pumping Rate (gpm)	1500

	Evangeline	
Drawdown Calculations	Drawdown-Pumping Ratios	Calculated Drawdown (ft)
Production Well - 36 hours (3X avg pumping)	0.24596	368.94
1/2 mile from Production Well - 36 hours (3X avg pumping)	0.01066	15.99
1/2 mile from Production Well - one year (avg pumping)	0.08250	41.25

3.0 Phase I-b Results

Phase I-b requirements include the results of a simulation using the HAGM for the area that adds the proposed well to the most current model simulation that was used to establish the desired future condition. The documentation of BGCD implementation of the most recent desired future condition simulation is contained in Hutchison (2021).

As required in the Phase I-b guidelines, this section of the report contains the results of the simulation:

- Drawdown hydrographs
- Subsidence hydrographs
- Summary tables of drawdown and subsidence
- A county-aquifer level groundwater budget that includes a comparison of the HAGM simulation with the proposed well and the groundwater water budget of the desired future condition simulation.

3.1 Drawdown Hydrographs

The data from individual wells in Table 1 show many wells with depths in the range of 250 to 400 feet. Data from the HAGM suggests that the Chicot Aquifer in this area is about 420 feet thick (Table 2). Based on these regional data the many of the nearby registered wells are completed in the Chicot Aquifer. Some of the registered wells are completed in the upper portion of the Evangeline Aquifer. The simple conceptualization of the HAGM layering is likely insufficient to definitively categorize the aquifer completion, and additional site-specific data (including monitoring during the aquifer test as part of Phase II) will be needed.

Drawdown hydrographs at the location of the proposed well (Row 54, Column 80) for the Chicot (the overlying formation) and the Evangeline (the production formation) are shown in Figures 2 and 3, respectively. These hydrographs present the predicted drawdown for the DFC run of the HAGM and for the run where the proposed well is added to the DFC run. Figure 4 presents the difference between the two scenarios, or the drawdown that is attributable to the proposed well in both the Chicot and the Evangeline.

Drawdown hydrographs for all the locations of wells previously presented in Table 1 are presented in Appendix A.

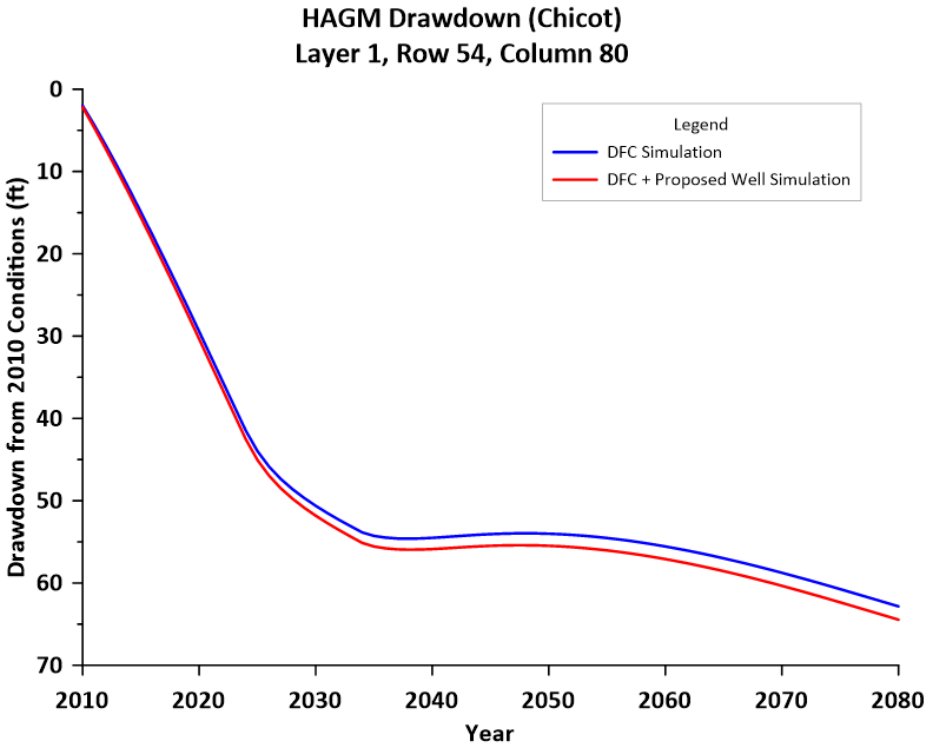


Figure 2. Drawdown Hydrograph for Row 54, Column 80 (Chicot)

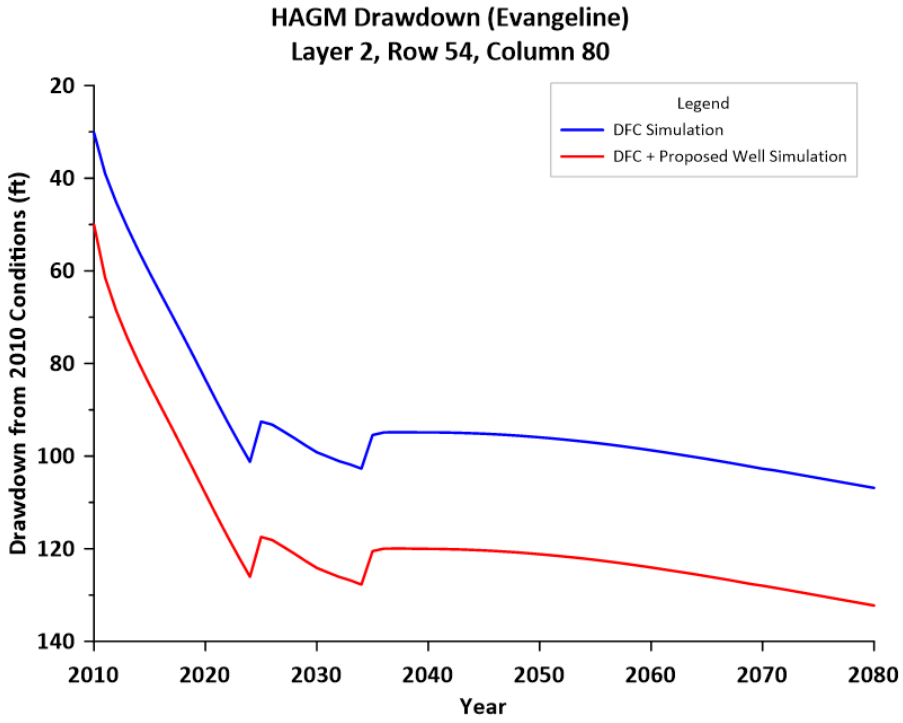


Figure 3. Drawdown Hydrograph for Row 54, Column 80 (Evangeline)

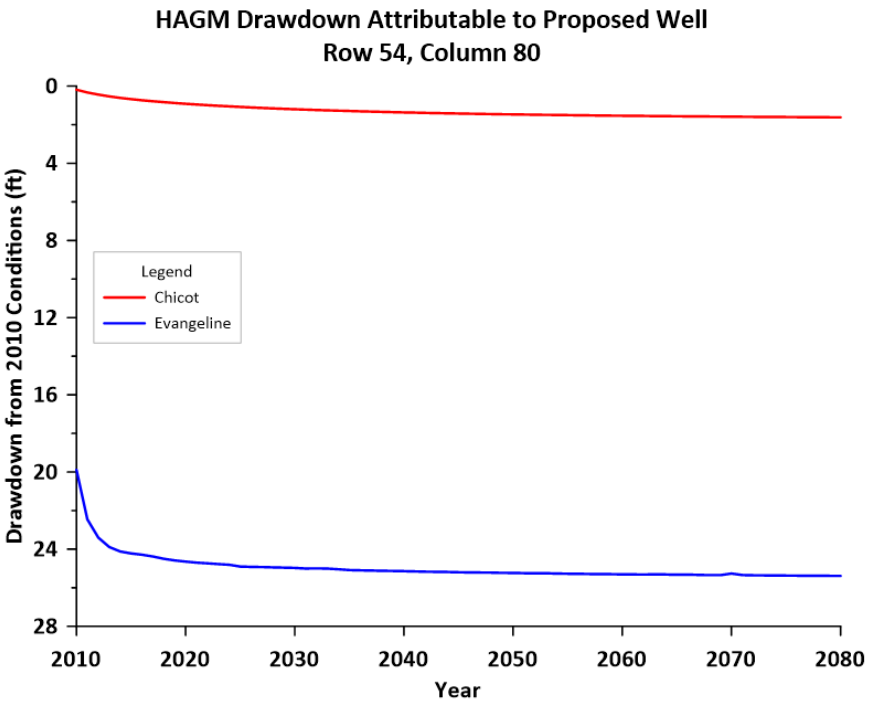


Figure 4. Drawdown Attributable to Proposed Pumping for Row 54, Column 80

3.2 Subsidence Hydrographs

The subsidence hydrograph at the location of the proposed well (Row 54, Column 80) is presented in Figure 5. This hydrograph presents the predicted subsidence for the DFC run of the HAGM and for the run where the proposed well is added to the DFC run. Figure 6 presents the difference between the two scenarios, or the subsidence that is attributable to the proposed well.

Subsidence hydrographs for all the locations of wells previously presented in Table 1 are presented in Appendix B.

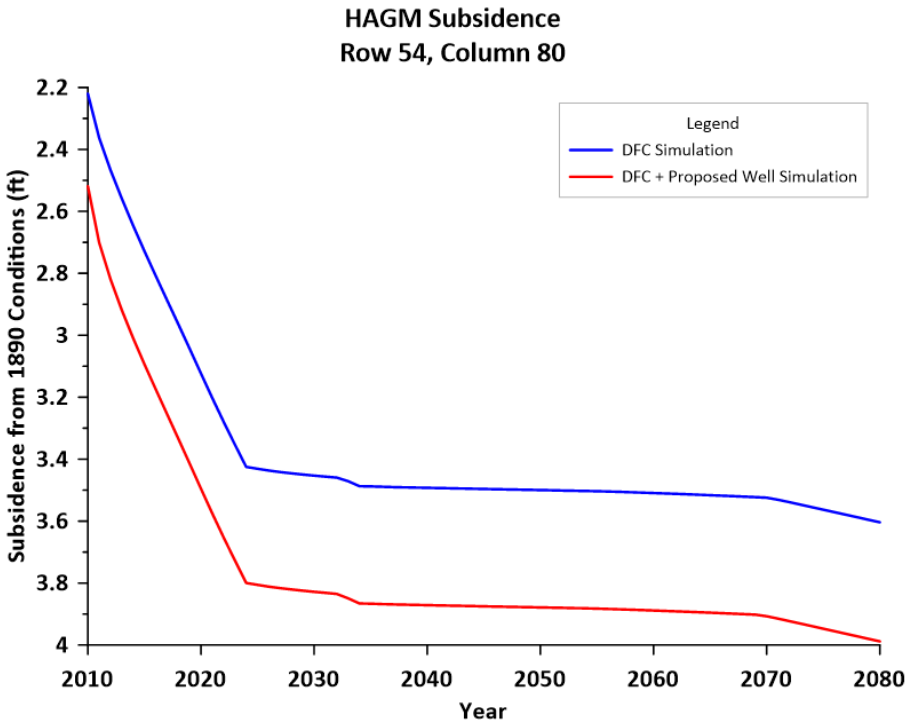


Figure 5. Subsidence Hydrograph for Row 54, Column 80

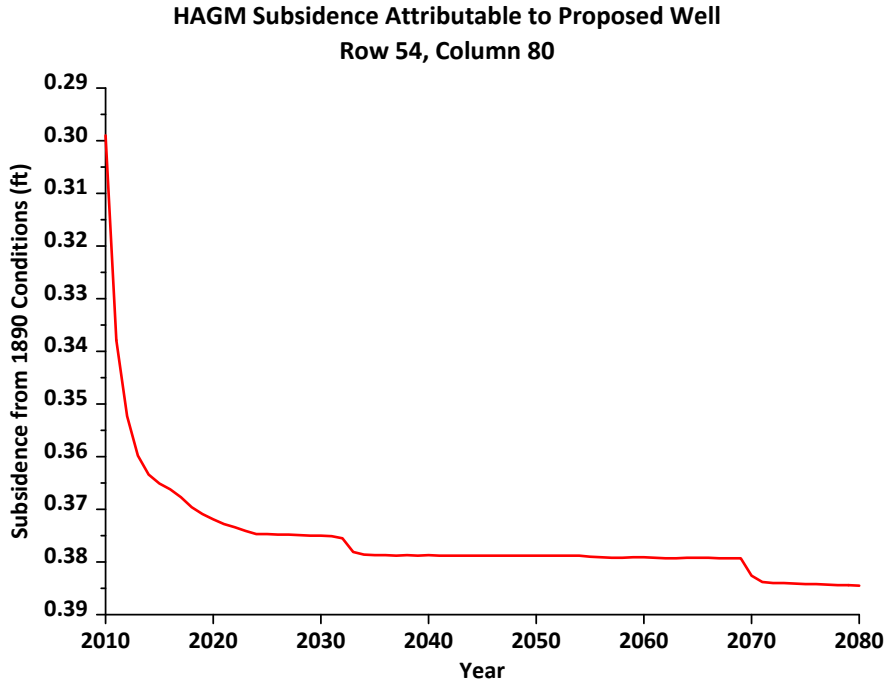


Figure 6. Subsidence Attributable to Proposed Well for Row 54, Column 80

3.3 Tabular Summary of Drawdown and Subsidence

The summary of drawdown and subsidence attributable to the proposed pumping for all well locations is presented in Table 7.

Table 7. Tabular Summary of Drawdown and Subsidence

Well ID	Distance to Katy 11 Well (mile)	Estimated Depth (ft)	HAGM Row	HAGM Column	Drawdown Attributable to Proposed Well (2010 to 2080 - ft)		Subsidence Attributable to Proposed Well (1890 to 2080 - ft)
					Chicot Aquifer	Evangeline Aquifer	
Proposed Well (Katy 11)	0.00	1000	54	80	1.6	25.4	0.4
BWLL-0072A	0.70		53	80	1.6	8.7	0.11
BWLL-0072B	0.70		53	80	1.6	8.7	0.11
BWLL-0074	0.64	270	54	79	1.5	10.5	0.09
BWLL-0087	0.86	258	53	79	1.5	6.6	0.04
BWLL-4208	0.39	264	54	80	1.6	25.4	0.4
BWLL-4218	0.31	263	54	80	1.6	25.4	0.4
BWLL-4222	0.32	260	54	80	1.6	25.4	0.4
BWLL-4242	0.29	228	54	80	1.6	25.4	0.4
BWLL-4250	0.24	260	54	80	1.6	25.4	0.4
BWLL-4313	0.68	264	54	79	1.5	10.5	0.09
BWLL-4329	0.37	265	53	80	1.6	8.7	0.11
BWLL-4330	0.39	260	53	80	1.6	8.7	0.11
BWLL-4338	0.43	315	53	80	1.6	8.7	0.11
BWLL-4383	0.38	455	53	80	1.6	8.7	0.11
BWLL-4389	0.26	260	54	80	1.6	25.4	0.4
BWLL-4393	0.48	260	54	80	1.6	25.4	0.4
BWLL-4394	0.48	460	53	80	1.6	8.7	0.11
BWLL-4395	0.32	460	54	80	1.6	25.4	0.4
BWLL-4406	0.55	260	53	80	1.6	8.7	0.11
BWLL-4408	0.22	260	54	80	1.6	25.4	0.4
BWLL-4409	0.53	260	53	80	1.6	8.7	0.11
BWLL-4462	0.10	265	54	80	1.6	25.4	0.4
BWLL-4463	0.49	265	53	80	1.6	8.7	0.11
BWLL-4506	0.24	250	54	80	1.6	25.4	0.4
BWLL-4523	0.21	460	54	80	1.6	25.4	0.4
BWLL-4533	0.48	460	53	80	1.6	8.7	0.11
BWLL-4534	0.43	460	53	80	1.6	8.7	0.11
BWLL-4547	0.32	470	54	80	1.6	25.4	0.4
BWLL-4596	0.51	460	54	80	1.6	25.4	0.4
BWLL-4680	0.39	460	53	80	1.6	8.7	0.11
BWLL-4681	0.39	460	53	80	1.6	8.7	0.11
BWLL-4705	0.48	460	53	80	1.6	8.7	0.11
BWLL-4706	0.53	460	54	80	1.6	25.4	0.4
BWLL-4792	0.26	465	54	80	1.6	25.4	0.4
BWLL-4794	0.23	250	54	80	1.6	25.4	0.4
BWLL-4795	0.53	460	54	80	1.6	25.4	0.4
BWLL-4796	0.18	339	54	80	1.6	25.4	0.4
BWLL-4860	0.33	240	54	80	1.6	25.4	0.4
BWLL-4872	0.39	445	53	80	1.6	8.7	0.11
BWLL-4955	0.53	460	54	80	1.6	25.4	0.4
BWLL-4986	0.37	240	54	80	1.6	25.4	0.4
BWLL-5205	0.97	255	53	80	1.6	8.7	0.11
BWLL-5207	0.39	342	53	80	1.6	8.7	0.11
BWLL-5212	0.50	460	53	80	1.6	8.7	0.11
BWLL-5371	0.30	264	54	80	1.6	25.4	0.4
BWLL-5567	0.95	260	53	80	1.6	8.7	0.11
BWLL-5568	0.95	260	53	80	1.6	8.7	0.11
BWLL-5571	0.49	270	54	80	1.6	25.4	0.4
BWLL-5626	0.39	450	53	80	1.6	8.7	0.11
BWLL-5655	0.64		54	79	1.5	10.5	0.09
BWLL-5656	0.69		54	79	1.5	10.5	0.09
BWLL-5657	0.58		54	79	1.5	10.5	0.09
BWLL-5658	0.56		54	79	1.5	10.5	0.09
BWLL-5811	0.39	265	53	80	1.6	8.7	0.11
BWLL-5864	0.39	265	54	80	1.6	25.4	0.4
BWLL-5876	0.70		54	80	1.6	25.4	0.4
BWLL-5993	0.51	200	54	80	1.6	25.4	0.4
BWLL-6134	0.87	350	53	79	1.5	6.6	0.04
BWLL-6147	0.41	265	53	80	1.6	8.7	0.11
BWLL-6232B	0.40	465	53	80	1.6	8.7	0.11
BWLL-6369	0.53	465	54	80	1.6	25.4	0.4
BWLL-6454	0.25	275	54	80	1.6	25.4	0.4
BWLL-6455	0.11	280	54	80	1.6	25.4	0.4

3.4 Groundwater Budget Comparison

The summary groundwater budget comparison of the DFC simulation and the simulation where the proposed well is added to the DFC simulation is presented in Table 8. Please note that about 19 percent of the production from the proposed well will come from groundwater storage (including interbed storage), and about 69 percent of proposed pumping will come from captured outflow that would have flowed to Fort Bend and Harris counties. The remaining 12 percent of the production of the proposed well is induced recharge and induced inflow from Austin County.

Table 8. Groundwater Budget Summary

	DFC Run (2010 to 2080)	Katy 11 Run (2010 to 2080)	Difference (AF/yr)	Diffference (% of Pumping Increase)
Inflow				
Recharge and Net Surface Water Inflow (GHB Boundary)	41,382	41,460	78	9.6
Interbed Storage	2,956	2,986	30	3.7
From Austin County	6,232	6,250	17	2.1
From Grimes County	1,816	1,816	0	0.0
From Washington County	1,243	1,243	0	0.0
Total Inflow	53,629	53,754		
Outflow				
Pumping	55,495	56,302	807	100.0
To Fort Bend County	10,422	10,287	-135	16.7
To Harris County	4,157	3,732	-425	52.7
To Montgomery County	5,922	5,922	0	0.0
Total Outflow	75,996	76,243		
Inflow - Outflow	-22,367	-22,489		
Model Calculated Storage Change	-22,366	-22,488	-122	15.1
Model Error	-1	-1		

4.0 Conclusions and Recommendations

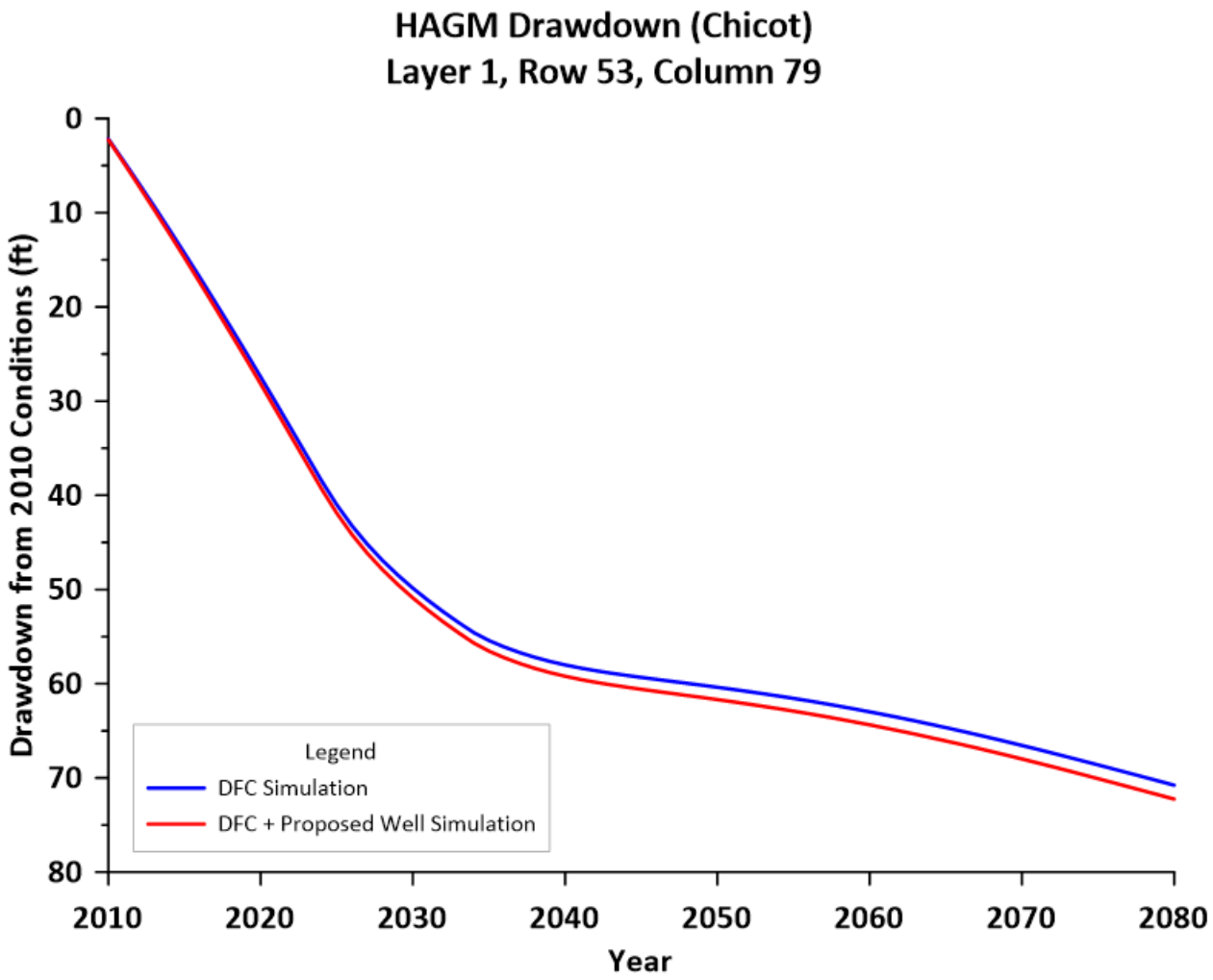
The permit application for this well should be approved to proceed to the Phase II activities. Due to the potential to affect many registered wells and the uncertainty associated with aquifer completions, it is recommended that monitoring wells be used (or constructed if no existing wells can be used) during the aquifer test. Specifically, at least one Evangeline well within ½ mile and at least one Chicot well within ½ mile are recommended. Based on the test results and an update of the analyses in this Phase I-b report, a reduction in the permitted amount of production may be recommended.

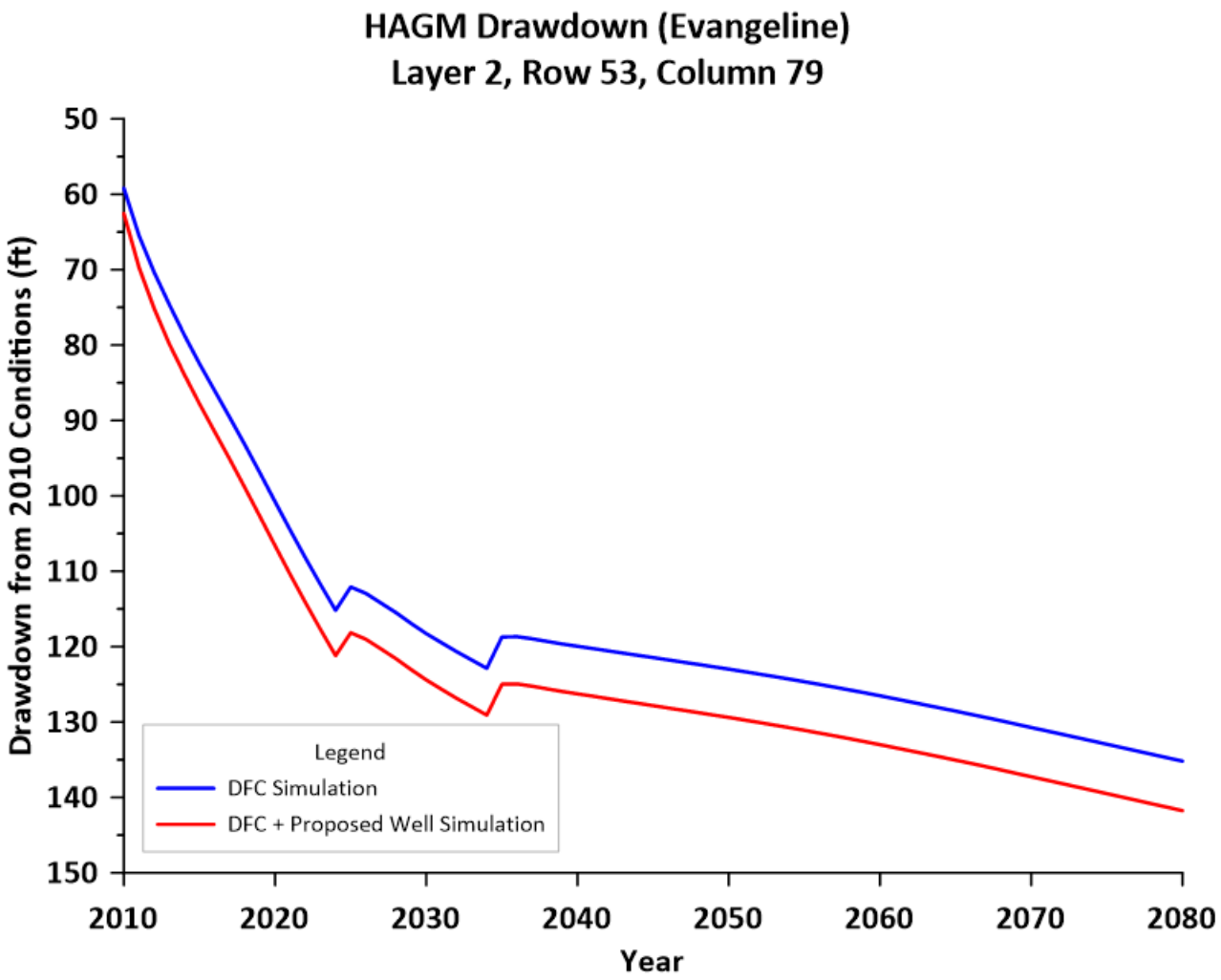
5.0 References

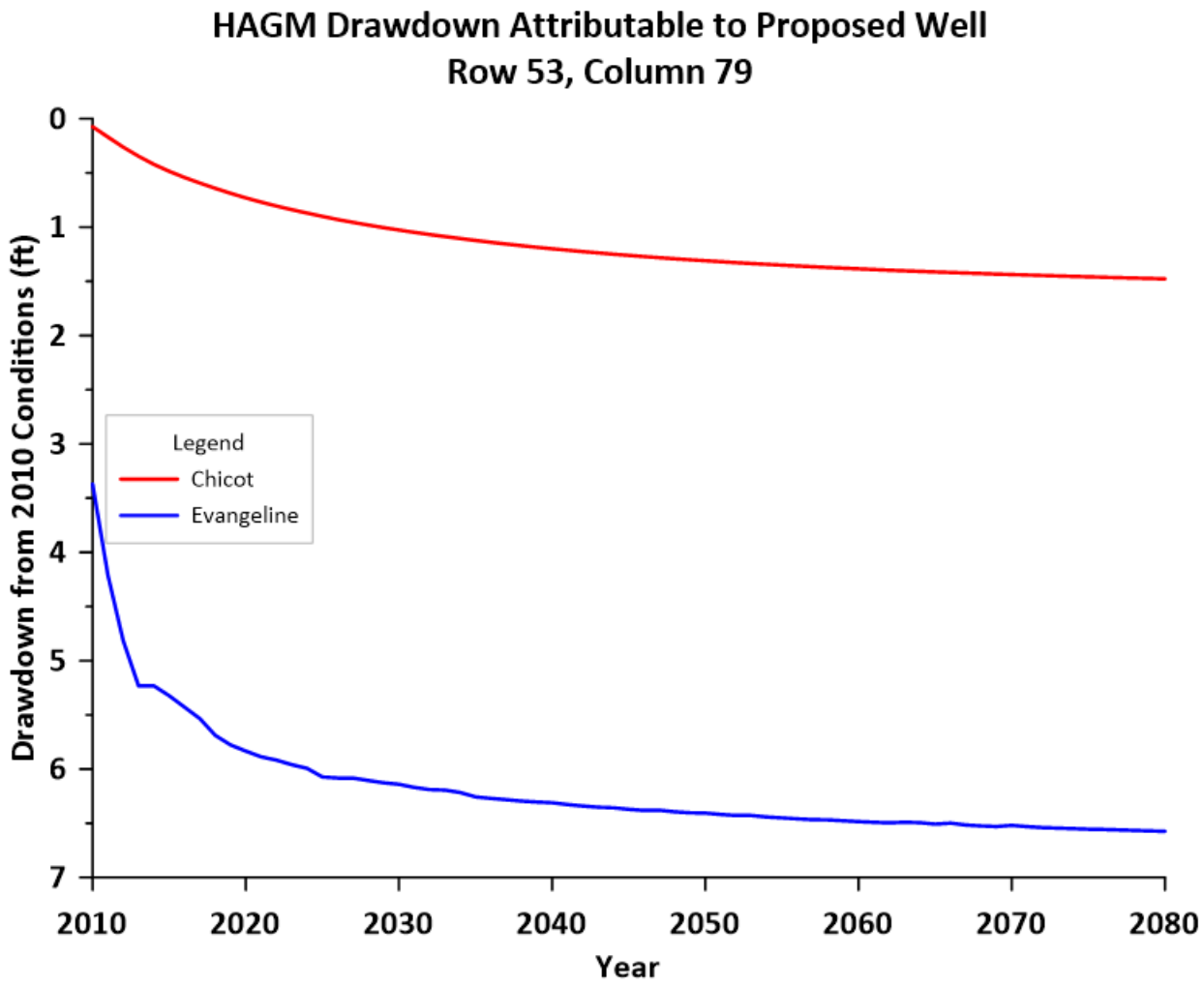
Hutchison, W.R., 2021. Implementation of GMA 14 Desired Future Condition Based on Multi-Metric Simulation (70% Available Drawdown, 1 Foot of Subsidence, 30K Pumping Limit, 2016 Pumping Distribution). Final Report to Zach Holland, General Manager of Bluebonnet Groundwater Conservation District, April 27, 2021, 54p.

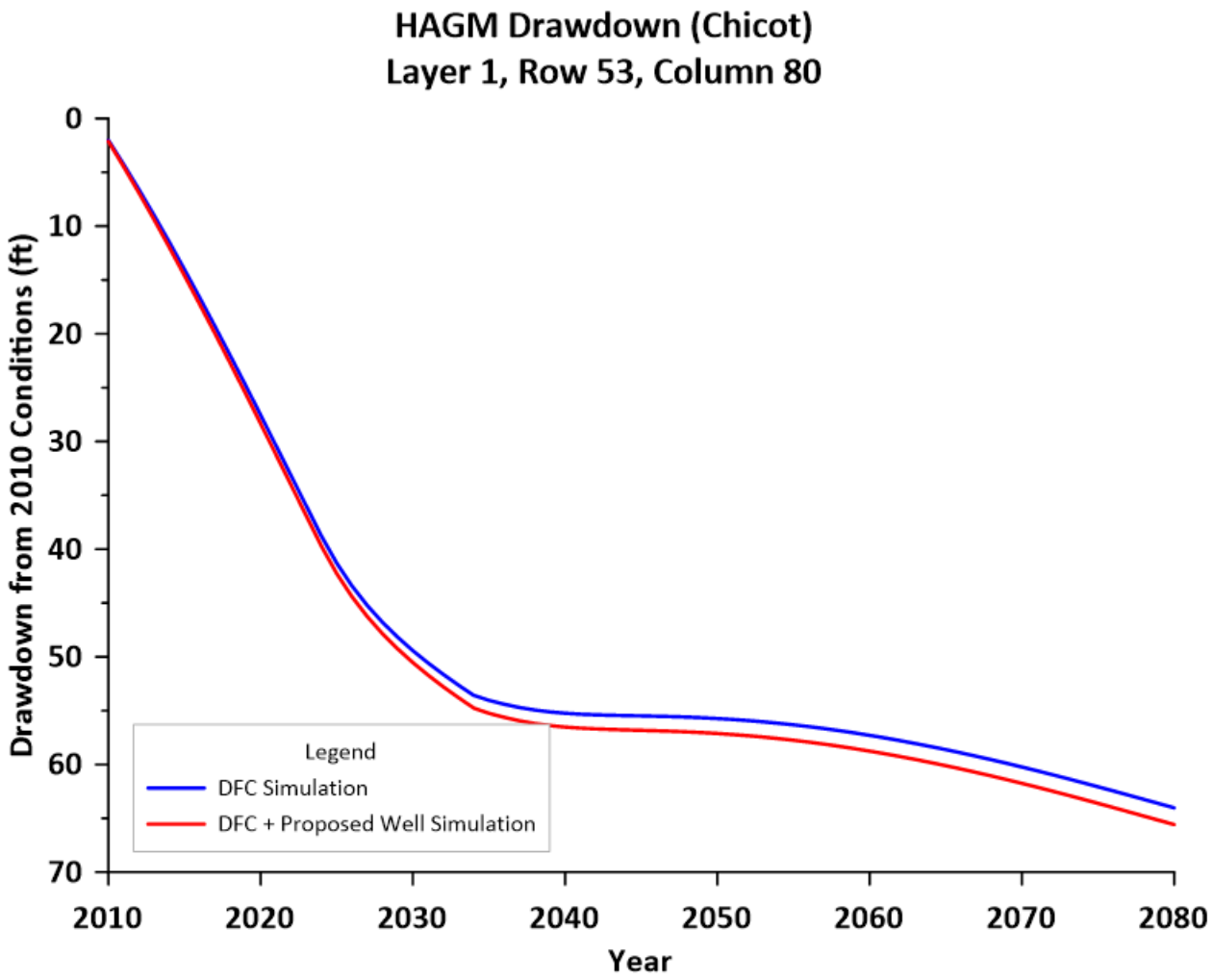
Appendix A

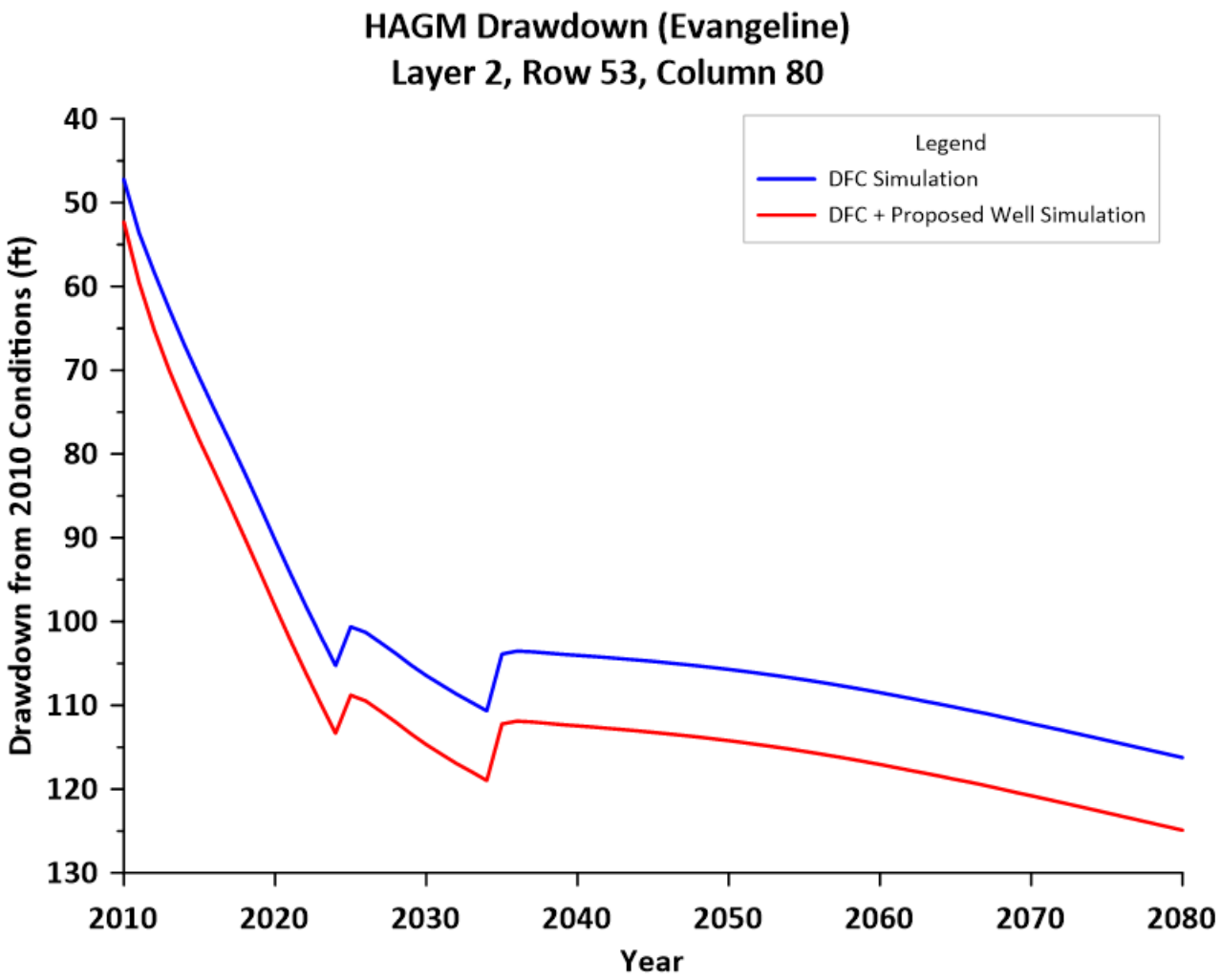
Drawdown Hydrographs

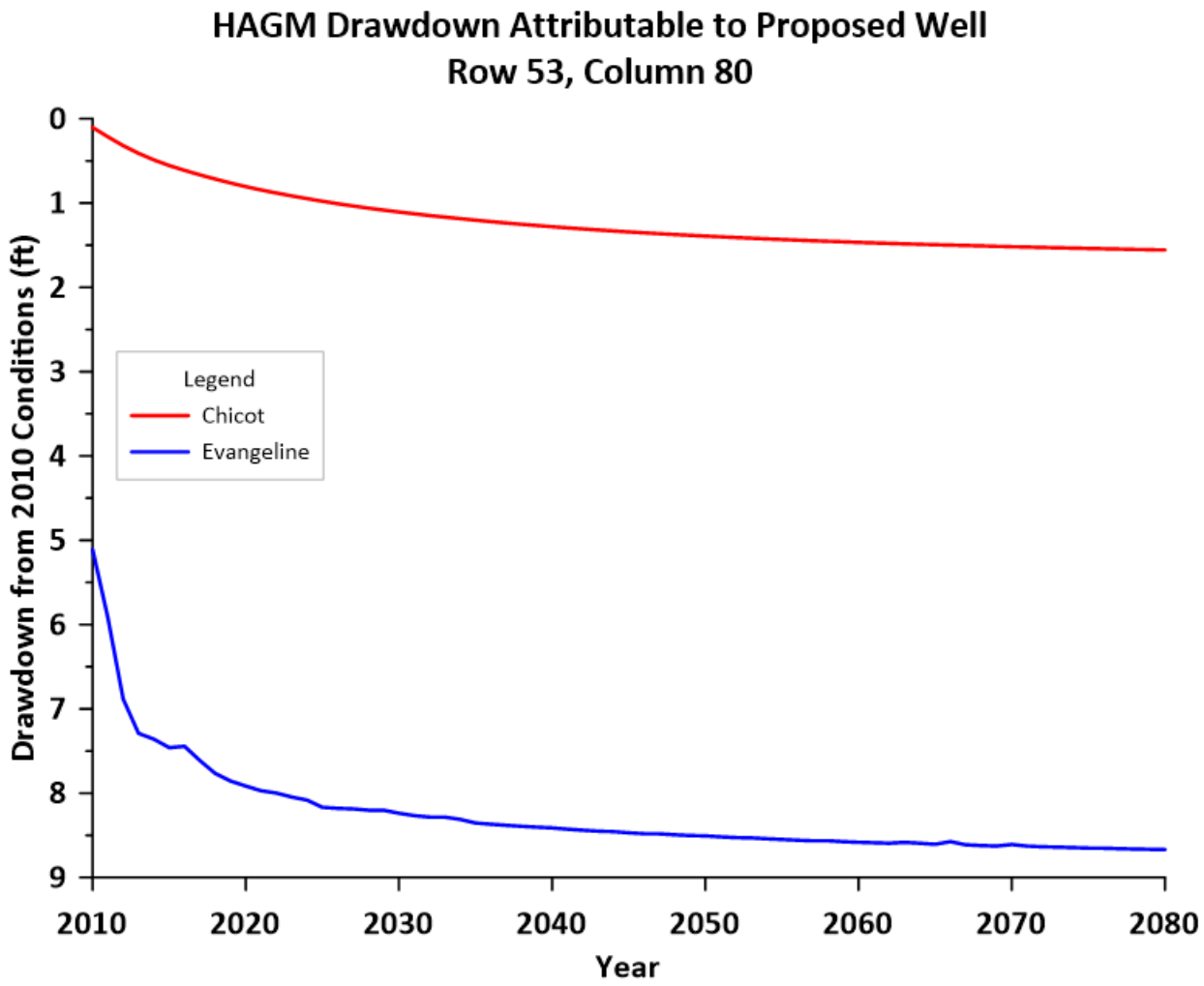

HAGM Drawdown (Chicot)
Layer 1, Row 53, Column 79
Drawdown from 2010 Conditions (ft)
0
10
20
30
40
50
60
70
80
2010
2020
2030
2040
2050
2060
2070
2080
Year
Legend
DFC Simulation
DFC + Proposed Well Simulation

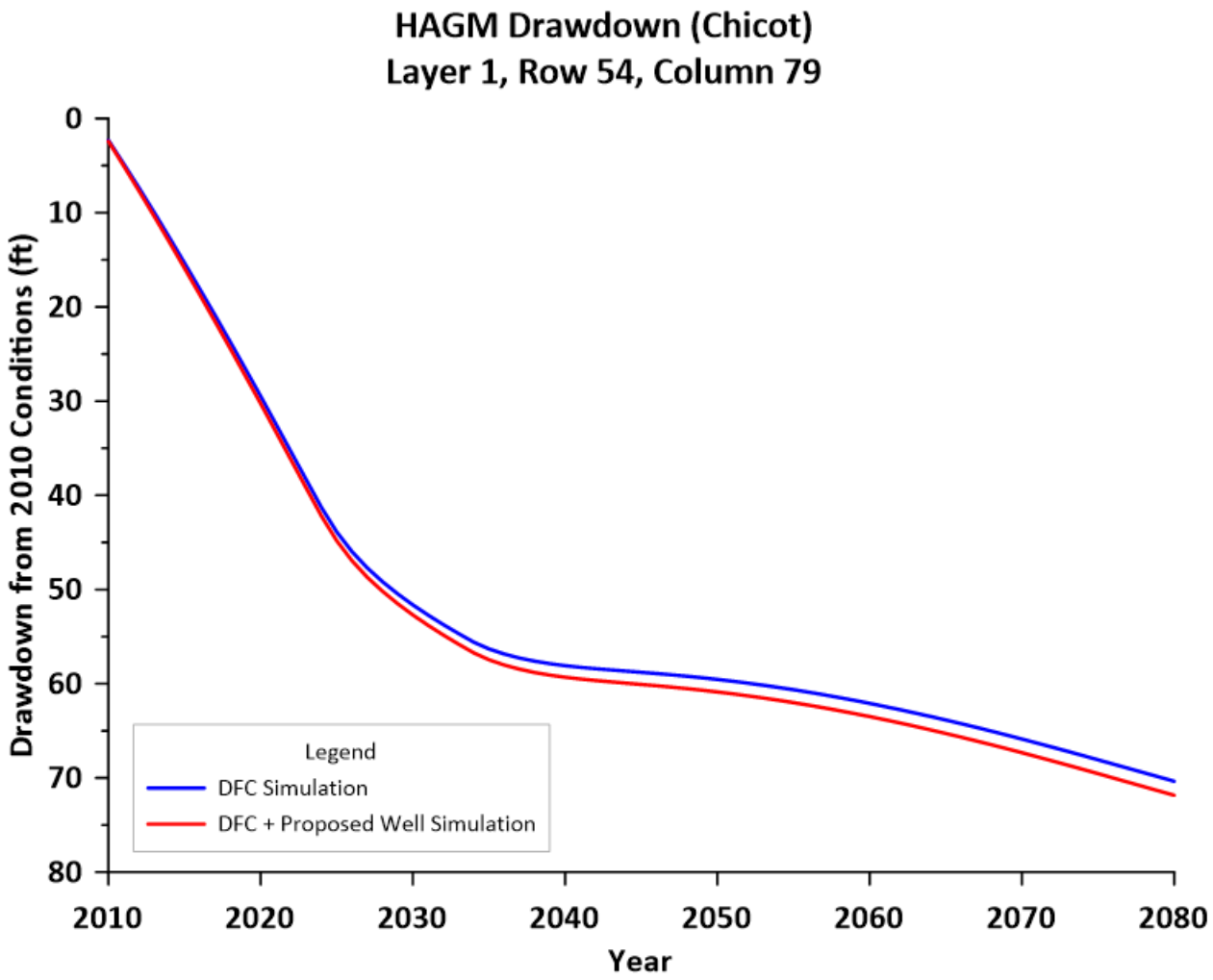

HAGM Drawdown (Evangeline)
Layer 2, Row 53, Column 79
Drawdown from 2010 Conditions (ft)
50
60
70
80
90
100
110
120
130
140
150
2010
2020
2030
2040
2050
2060
2070
2080
Year
Legend
DFC Simulation
DFC + Proposed Well Simulation

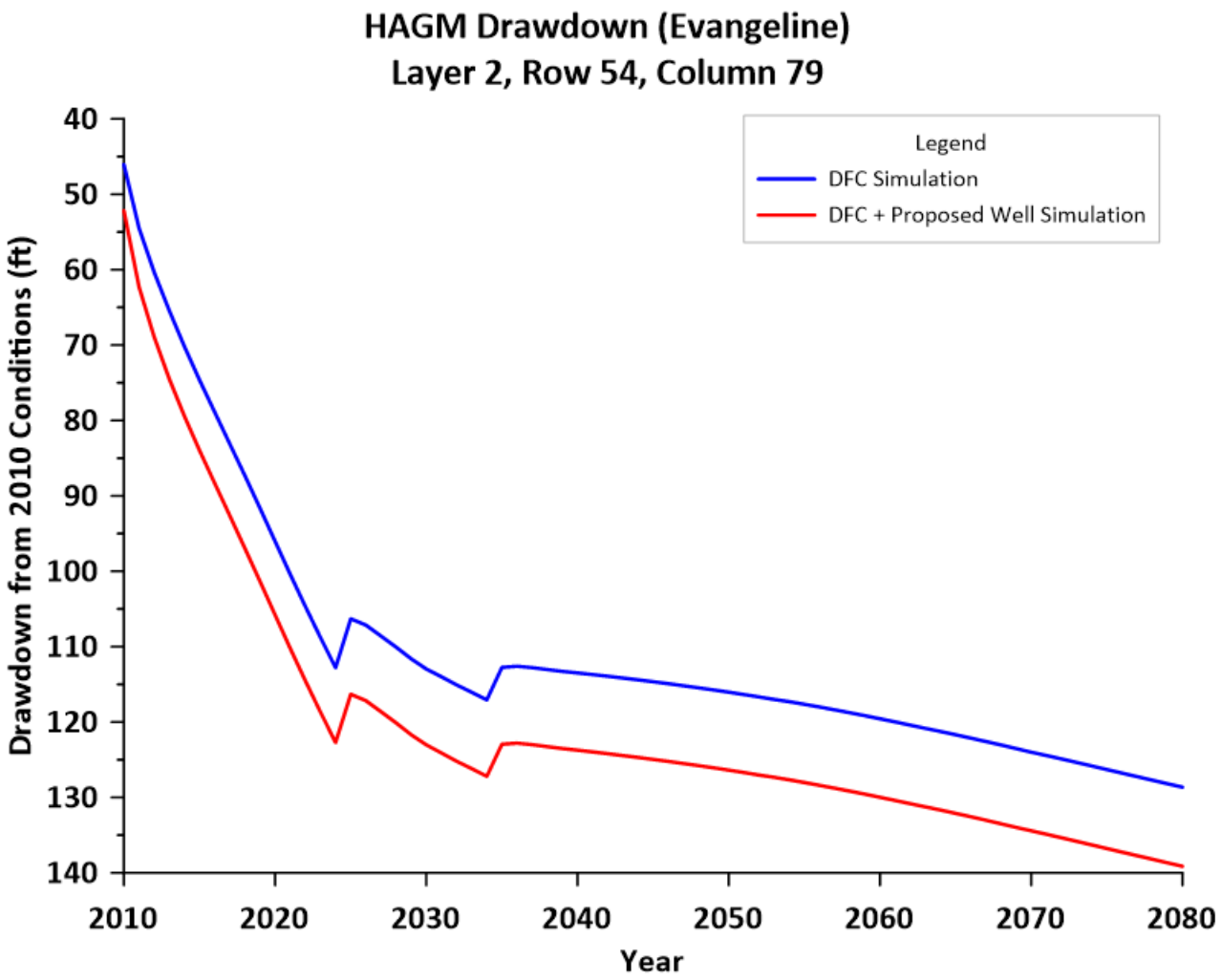

HAGM Drawdown Attributable to Proposed Well
Row 53, Column 79
Drawdown from 2010 Conditions (ft)
0
1
2
3
4
5
6
7
Legend
Chicot
Evangeline
2010
2020
2030
2040
2050
2060
2070
2080
Year

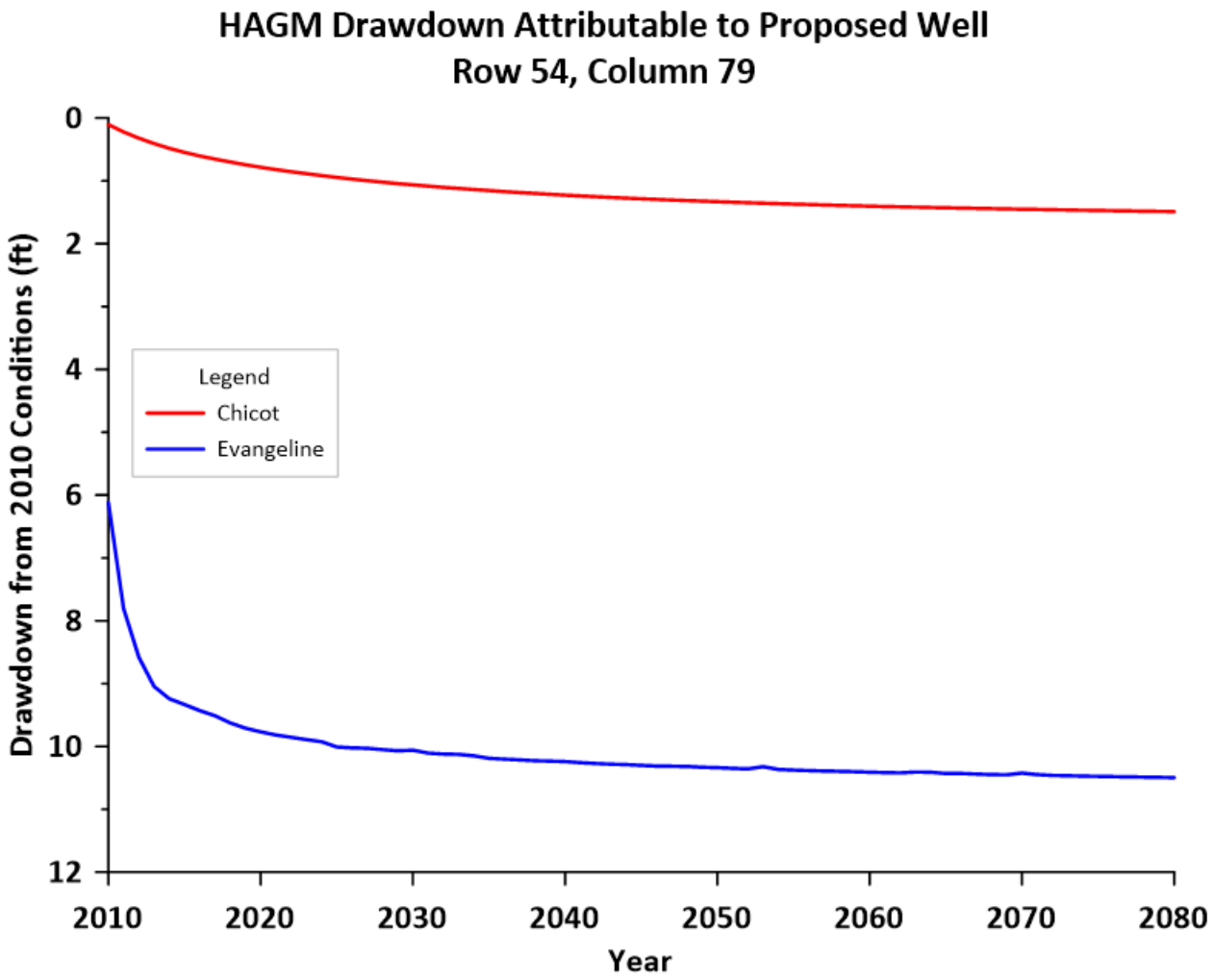

HAGM Drawdown (Chicot)
Layer 1, Row 53, Column 80
Drawdown from 2010 Conditions (ft)
0
10
20
30
40
50
60
70
2010
2020
2030
2040
2050
2060
2070
2080
Year
Legend
DFC Simulation
DFC + Proposed Well Simulation

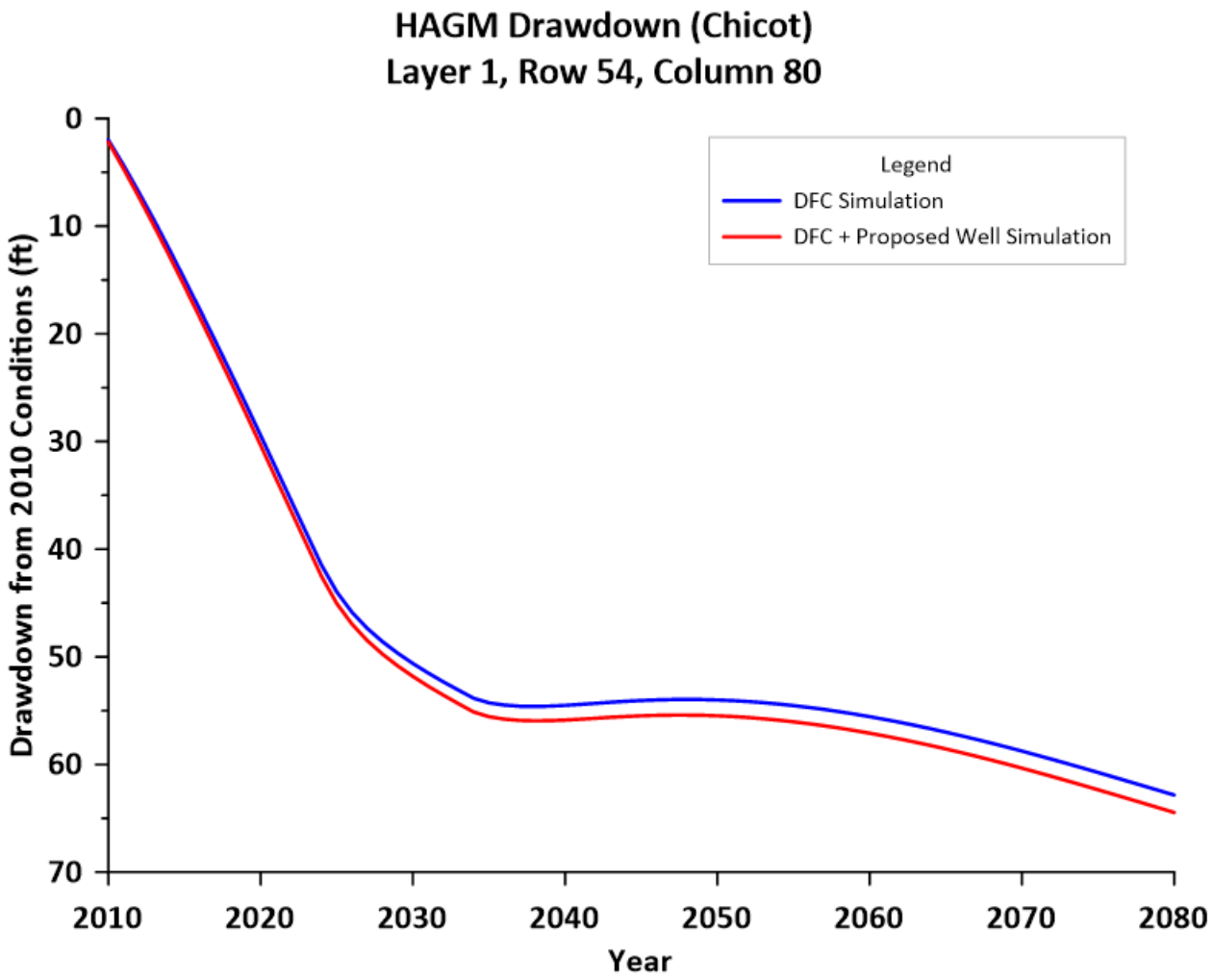

HAGM Drawdown (Evangeline)
Layer 2, Row 53, Column 80
Legend
DFC Simulation
DFC + Proposed Well Simulation
Drawdown from 2010 Conditions (ft)
40
50
60
70
80
90
100
110
120
130
2010
2020
2030
2040
2050
2060
2070
2080
Year

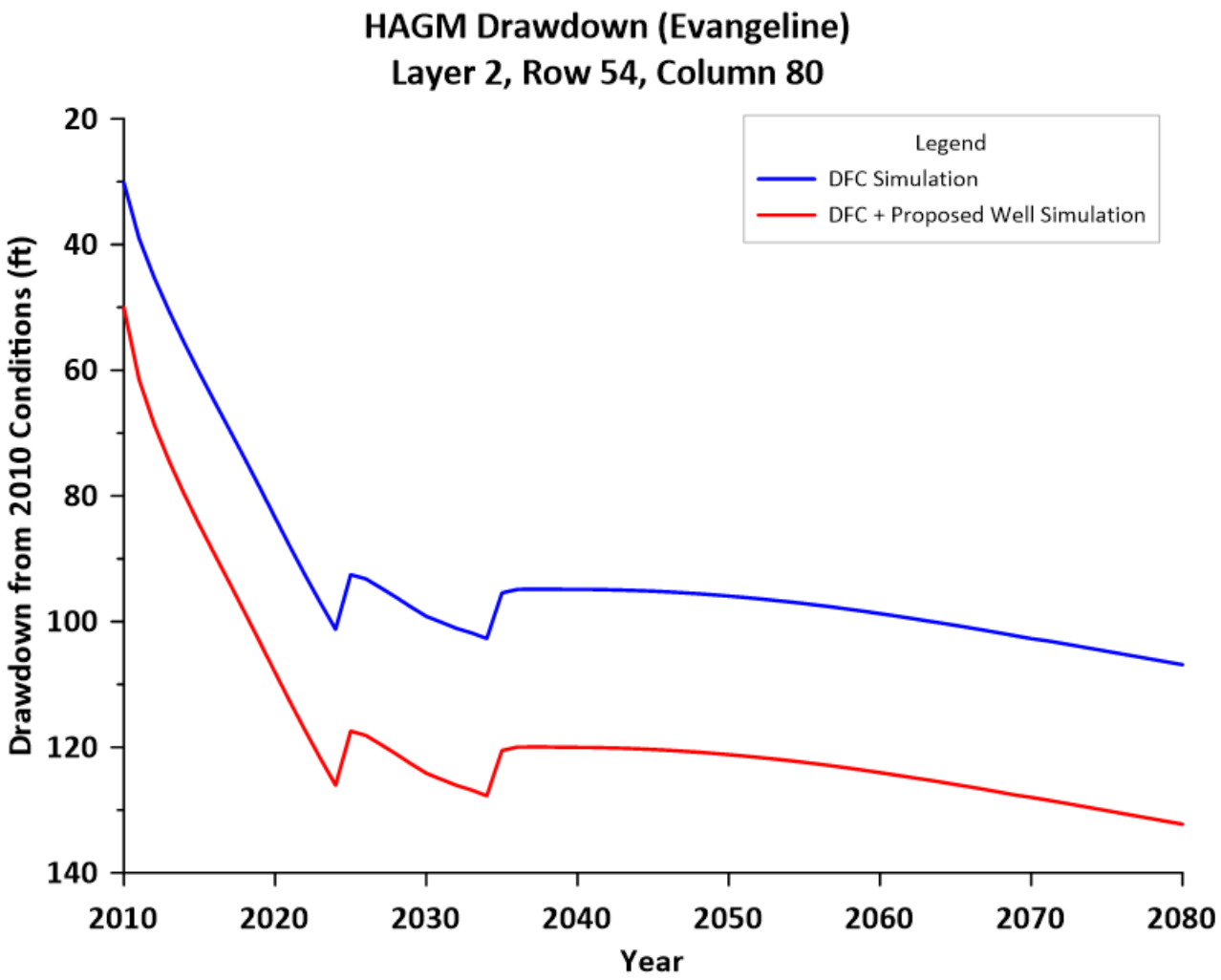

HAGM Drawdown Attributable to Proposed Well
Row 53, Column 80
Drawdown from 2010 Conditions (ft)
0
1
2
3
4
5
6
7
8
9
Legend
Chicot
Evangeline
2010
2020
2030
2040
2050
2060
2070
2080
Year

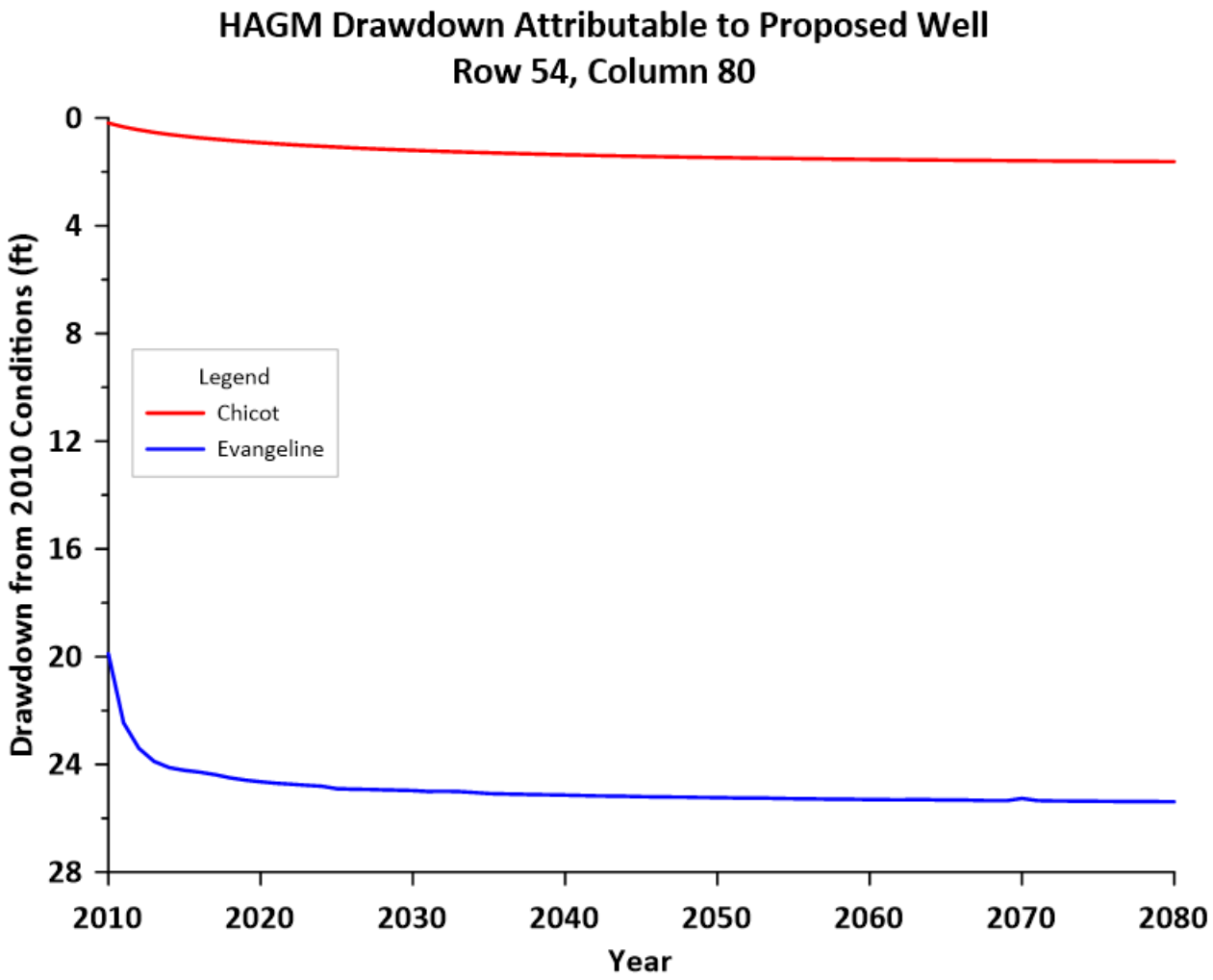

HAGM Drawdown (Chicot)
Layer 1, Row 54, Column 79
Drawdown from 2010 Conditions (ft)
0
10
20
30
40
50
60
70
80
2010
2020
2030
2040
2050
2060
2070
2080
Year
Legend
DFC Simulation
DFC + Proposed Well Simulation


HAGM Drawdown (Evangeline)
Layer 2, Row 54, Column 79
Legend
DFC Simulation
DFC + Proposed Well Simulation
Drawdown from 2010 Conditions (ft)
40
50
60
70
80
90
100
110
120
130
140
2010
2020
2030
2040
2050
2060
2070
2080
Year


HAGM Drawdown Attributable to Proposed Well
Row 54, Column 79
Drawdown from 2010 Conditions (ft)
0
2
4
6
8
10
12
Legend
Chicot
Evangeline
2010
2020
2030
2040
2050
2060
2070
2080
Year

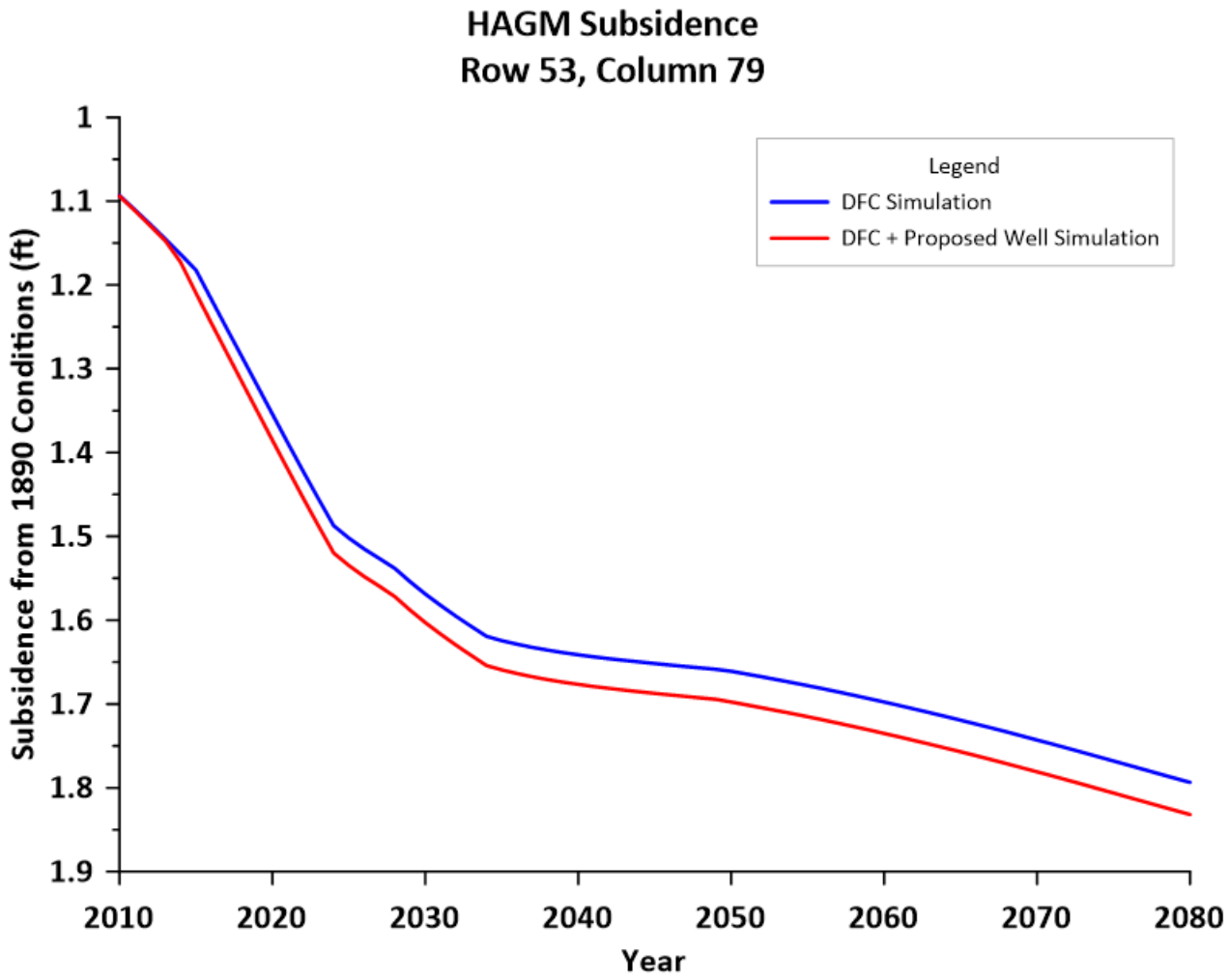

HAGM Drawdown (Chicot)
Layer 1, Row 54, Column 80
Legend
DFC Simulation
DFC + Proposed Well Simulation
Drawdown from 2010 Conditions (ft)
0
10
20
30
40
50
60
70
2010
2020
2030
2040
2050
2060
2070
2080
Year

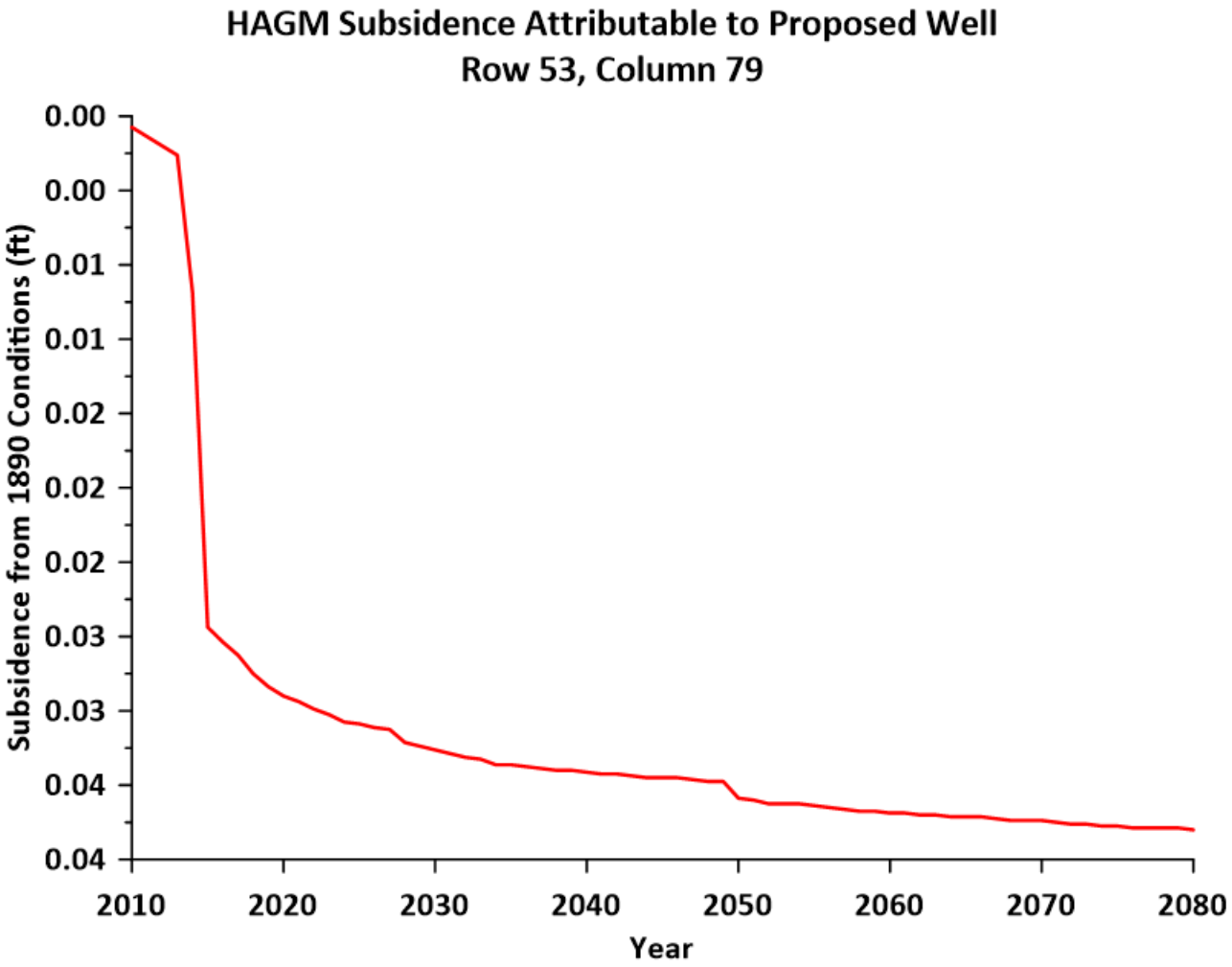

HAGM Drawdown (Evangeline)
Layer 2, Row 54, Column 80
Legend
DFC Simulation
DFC + Proposed Well Simulation
Drawdown from 2010 Conditions (ft)
20
40
60
80
100
120
140
2010
2020
2030
2040
2050
2060
2070
2080
Year

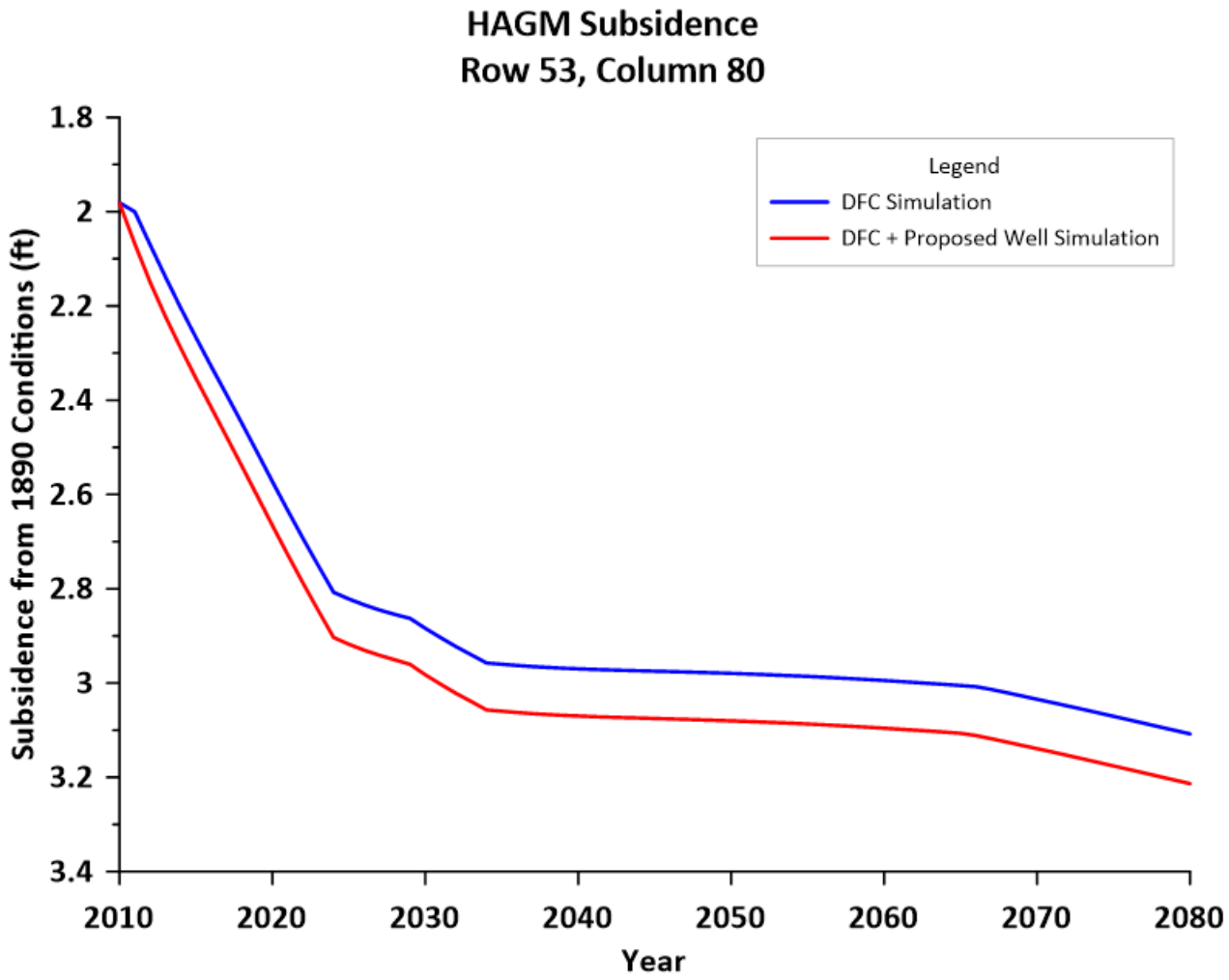

HAGM Drawdown Attributable to Proposed Well
Row 54, Column 80
Drawdown from 2010 Conditions (ft)
0
4
8
12
16
20
24
28
Legend
Chicot
Evangeline
2010
2020
2030
2040
2050
2060
2070
2080
Year

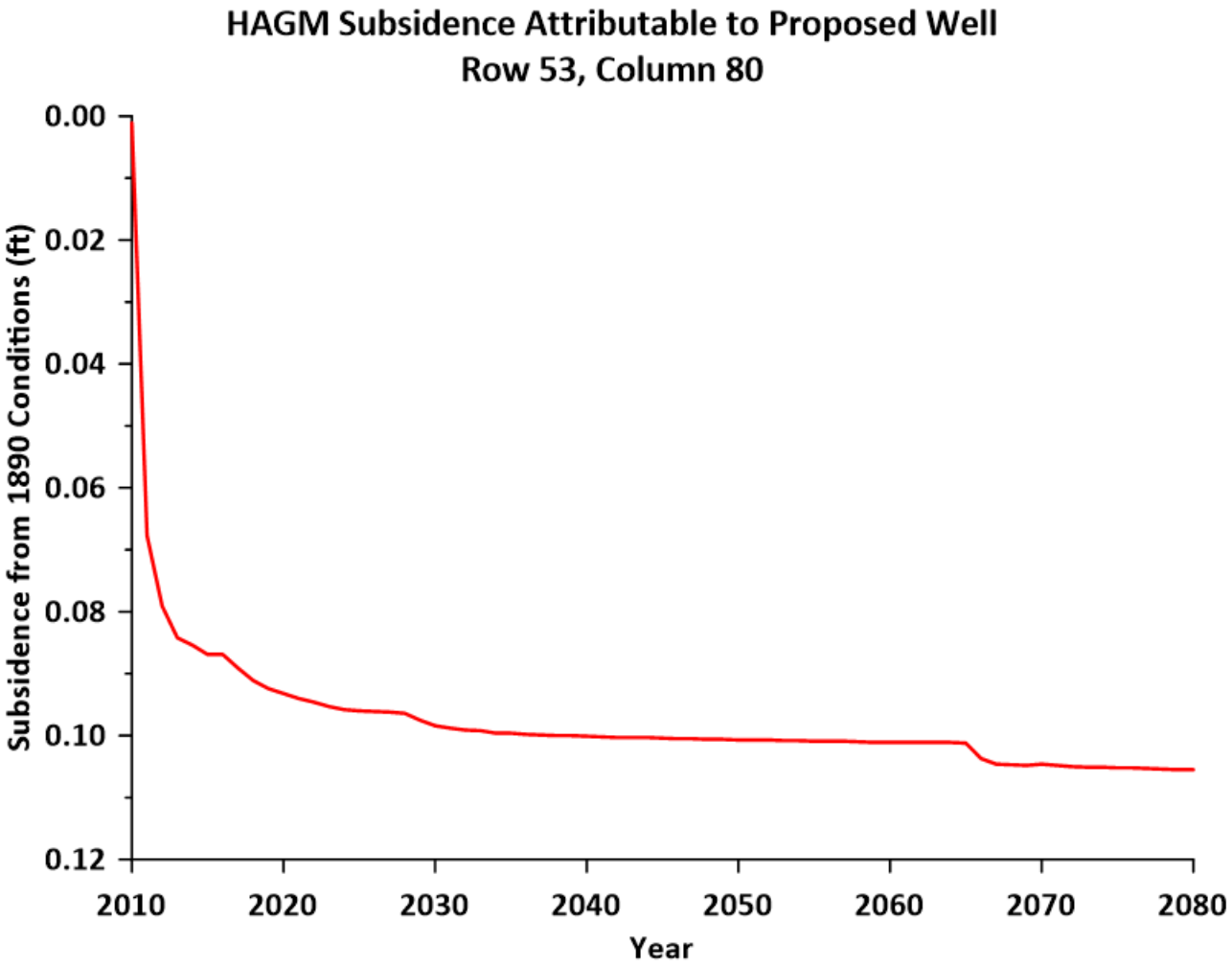
Appendix B

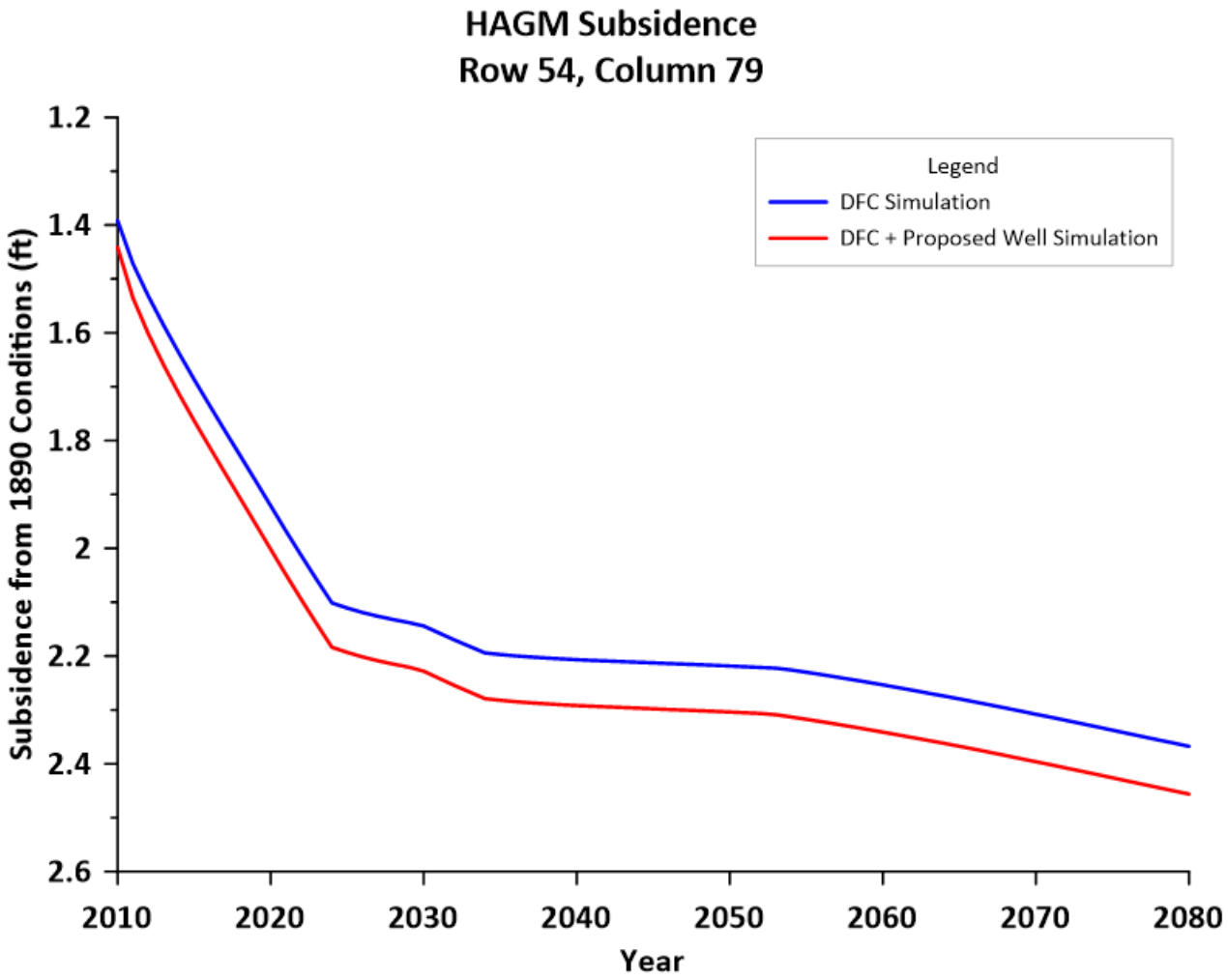
Subsidence Hydrographs

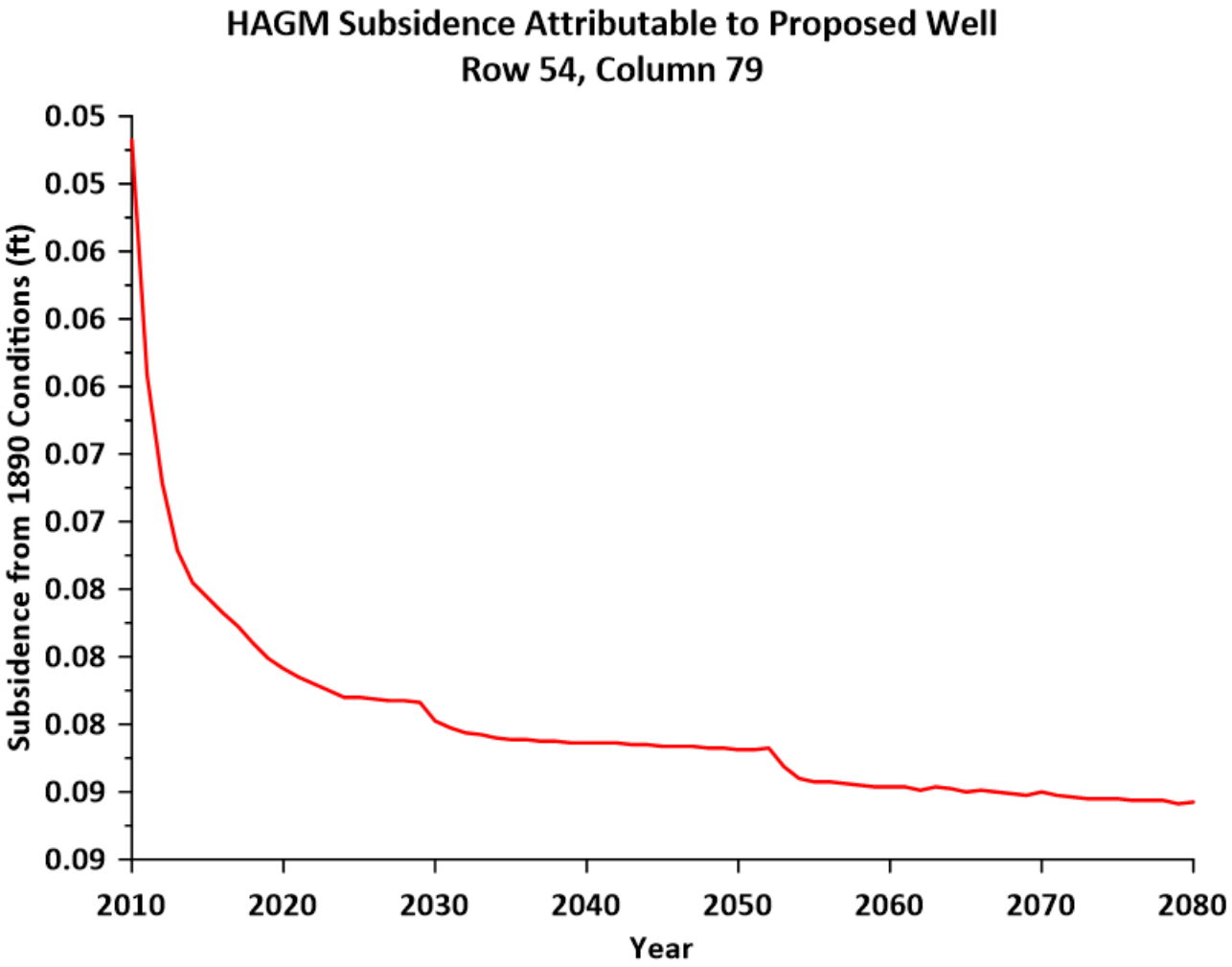

HAGM Subsidence
Row 53, Column 79
Legend
DFC Simulation
DFC + Proposed Well Simulation
Subsidence from 1890 Conditions (ft)
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2010
2020
2030
2040
2050
2060
2070
2080
Year

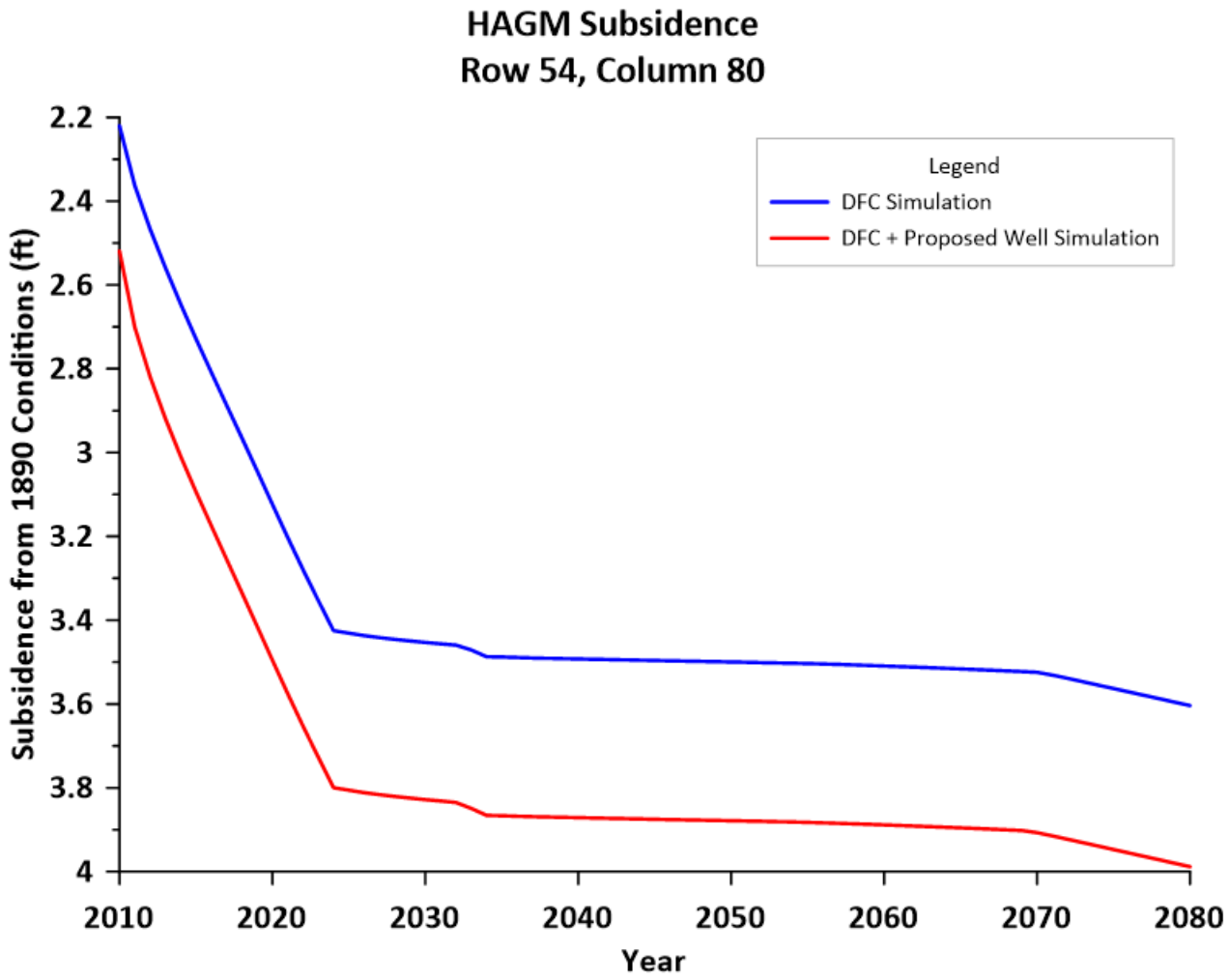

HAGM Subsidence Attributable to Proposed Well
Row 53, Column 79
Subsidence from 1890 Conditions (ft)
0.00
0.00
0.01
0.01
0.02
0.02
0.02
0.03
0.03
0.04
0.04
2010
2020
2030
2040
2050
2060
2070
2080
Year

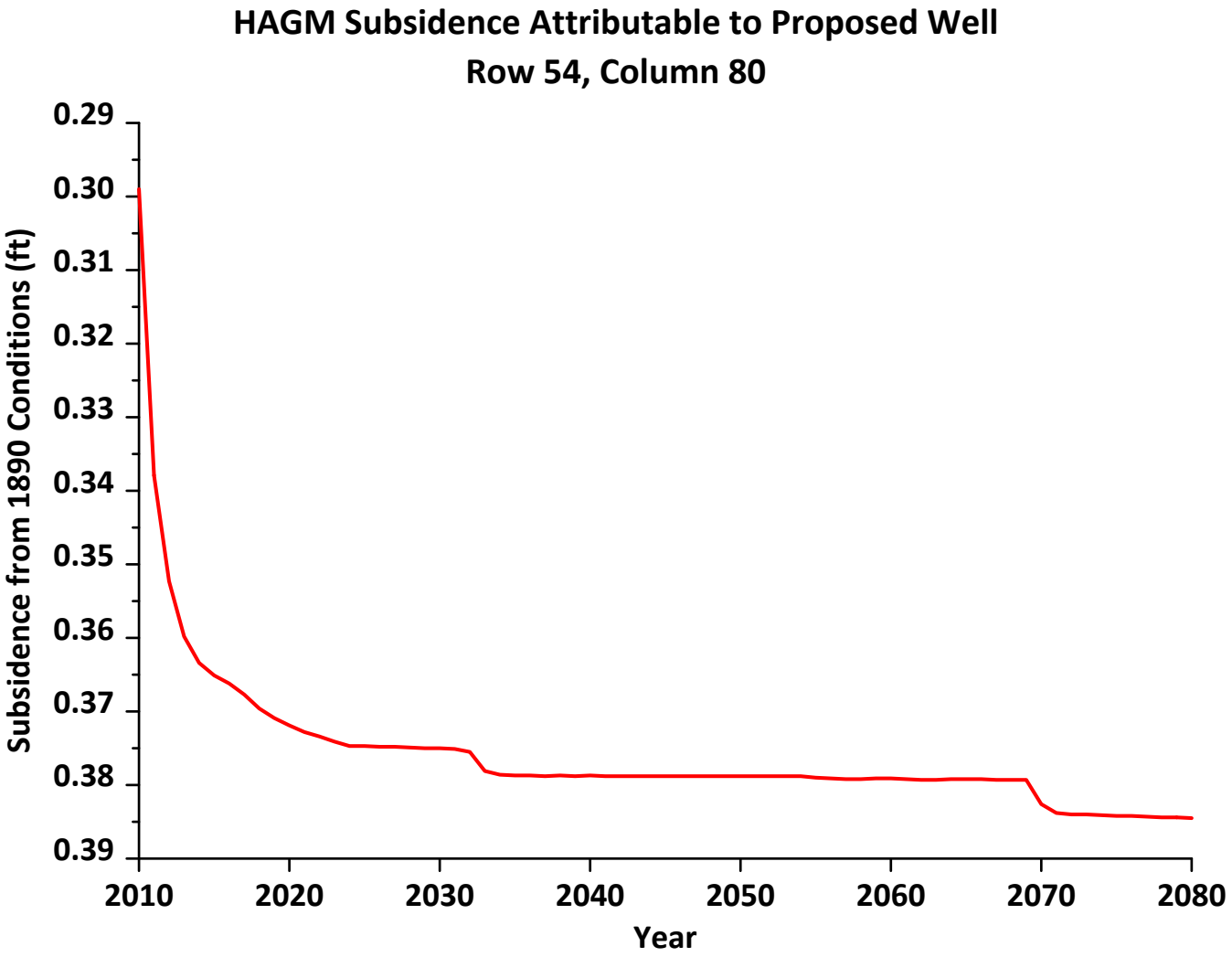

HAGM Subsidence
Row 53, Column 80
Legend
DFC Simulation
DFC + Proposed Well Simulation
Subsidence from 1890 Conditions (ft)
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
2010
2020
2030
2040
2050
2060
2070
2080
Year


HAGM Subsidence Attributable to Proposed Well
Row 53, Column 80
Subsidence from 1890 Conditions (ft)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
2010
2020
2030
2040
2050
2060
2070
2080
Year


HAGM Subsidence
Row 54, Column 79
Legend
DFC Simulation
DFC + Proposed Well Simulation
Subsidence from 1890 Conditions (ft)
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2010
2020
2030
2040
2050
2060
2070
2080
Year


HAGM Subsidence Attributable to Proposed Well
Row 54, Column 79
Subsidence from 1890 Conditions (ft)
0.05
0.05
0.06
0.06
0.06
0.07
0.07
0.08
0.08
0.08
0.09
0.09
2010
2020
2030
2040
2050
2060
2070
2080
Year


HAGM Subsidence
Row 54, Column 80
Legend
DFC Simulation
DFC + Proposed Well Simulation
Subsidence from 1890 Conditions (ft)
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
2010
2020
2030
2040
2050
2060
2070
2080
Year


HAGM Subsidence Attributable to Proposed Well
Row 54, Column 80
Subsidence from 1890 Conditions (ft)
0.29
0.30
0.31
0.32
0.33
0.34
0.35
0.36
0.37
0.38
0.39
2010
2020
2030
2040
2050
2060
2070
2080
Year