Barton Springs
Edwards Aquifer
CONSERVATION DISTRICT

Executive Summary:

The BSEACD Trinity Aquifer Sustainability Model: A Tool for Evaluating Sustainable Yield of the Trinity Aquifer in Hays County, Texas

Executive Summary for BSEACD Report of Investigations 2023-0717

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Executive Summary

Rapid growth in central Texas is placing significant demand on existing water resources. Significant increases in water demand in conjunction with frequent droughts could cause lowering of water levels in wells plus decreasing flow from springs that are the sources of water to many of the streams that cross the Hill Country. Decreased flow in these streams can lead to degraded water quality that can impact ecological and economic resources. Decreased flow can also lead to less recharge in the Edwards Aquifer and ultimately impacts to the endangered species that live in San Marcos Springs and Barton Springs.

In addition to hydrogeologic data that have been collected over many years, numerical models are one of the best available tools for predicting responses to increased pumping and drought on the Trinity Aquifers. This executive summary outlines development of the Trinity Aquifer Sustainability model (TAS), a numerical groundwater model developed by the Barton Springs/Edwards Aquifer Conservation District to guide development of a policy framework for sustainable management of the Trinity. The full report by Watson and Smith (2023) has been published on the BSEACD website. A link to the full report PDF is provided at the end of this report. TAS model files and report were reviewed by a technical advisory committee consisting of local experts and groundwater modeling professionals who provided feedback on the details of model construction and presentation. A list of committee participants is provided at the end of this report.

The primary area of focus for the TAS model is approximately coincident with Hays County extending from the Hays/Blanco County line in the west to IH-35 in the east (Figure 1). Model cells and boundary conditions along the margins of the model domain have been extended well outside this main area of interest to reduce the influence of margin boundary conditions on modeling results. This area of focus was selected because it encompasses the most critical portions of the Trinity Aquifer for recharge and pumping as it pertains to groundwater availability within BSEACD jurisdictional boundaries. Thus, refined modeling of this area will necessarily produce more accurate estimates of groundwater budgets and simulated impacts from pumping under different scenarios.

The conceptual model for the TAS consists of the three hydrostratigraphic units in the Middle Trinity Aquifer (from top to bottom): the Lower Glen Rose, Hensel, and Cow Creek (Figure 2). Regional groundwater flow is generally from west to east over the study area. Springs discharge from the Middle Trinity Aquifer as artesian springs within the Blanco River basin upstream of the Balcones Fault Zone, including Pleasant Valley Spring (PVS) and Jacobs Well Spring (JWS), and as gravity-fed seeps and small springs along some reaches of the Pedernales River. Recharge enters the model in portions of the Blanco River and Onion Creek Basins. Pumping is represented as both discreet (non-exempt) individual pumping wells and as distributed, non-discreet pumping (exempt). Faults associated with the Balcones Fault Zone displace hydrostratigraphic units downward from west to east, and some act as barriers to lateral groundwater flow, causing localized compartmentalization of the Trinity Aquifer.

The TAS was calibrated to real data from measured water levels (4,128 measurements) and springflow measurements over a 13-year period from 2008-2020 inclusive. Overall, the model did a good job of matching simulated water levels and springflow to real data over the calibration period, particularly for low-flow (drought) time intervals which have special significance for groundwater planning purposes. Volumetric annual water budgets for pumping, recharge, and springflow simulated by the TAS were within reasonable agreement with water budget estimates from the study area.

After calibration of the TAS model was completed, predictive models were built using the calibrated model as a foundation in order to simulate Trinity Aquifer responses to different pumping and drought scenarios. These predictive models included two baseline models, one representing recharge conditions from the 2008-2020 calibration period (baseline model BL1), and another representing a recurrence of the 1950's drought of record (baseline model BL2). A total of four experimental predictive models were constructed (two for each of the two baseline models) which varied pumping magnitude and distribution over the simulation periods. Comparison of each experimental model to its respective baseline model allows evaluation of the simulated impact to water levels (modeled drawdown) and springflow. Thus, this exercise provides a high-level evaluation of the potential impacts to aquifer conditions due to varying stressors of drought and pumping. The four experimental predictive models are summarized below:

- **Scenario A:** High-capacity wellfield (six wells) producing 2.5 million gallons-per-day in the vicinity of the Rolling Oaks Neighborhood near the western boundary of BSEACD.
- **Scenario B:** Pumping increase of 2.6 times from 2020 levels across all of Hays County, following TWDB estimates growth in water demand through 2070.
- **Scenario C1:** Recurrence of 1950's drought of record with 2020 pumping.
- **Scenario C2:** Recurrence of 1950's drought of record with regional growth pumping increase scenario (Scenario B pumping regime).

Modeled drawdowns and springflow impacts are summarized in Table 1 and Table 2 respectively. Predictive model drawdown maps and a simulated JWS springflow hydrograph for Scenario A are presented in Figure 3-Figure 7 (tables and figures can be found at the end of this report). Predictive model scenarios presented in this report show that significant increases in pumping in Hays County are likely to result in significant impacts to water levels and springflow in the Middle Trinity Aquifer in Hays County. A few key takeaways from this predictive modeling exercise are presented below:

- All experimental scenarios demonstrate significant modeled drawdowns in response to pumping increases. Both the magnitude and location of these modeled drawdowns depends on the magnitude and distribution of modeled pumping. The largest drawdowns are simulated in Scenario A (232.7 feet), which concentrates a large amount of pumping over a relatively small well field. But the largest average drawdowns across BSEACD boundaries are from Scenario B (40.6 feet) and Scenario C-2 (51.8 feet), which distribute a larger amount of pumping over a more widespread area.
- Modeled drawdown for distributed pumping regional growth scenarios (Scenario B and Scenario C-2) are overall larger in BSEACD than HTGCD. This reflects generally lower hydraulic conductivity and the more confined nature of the BSEACD portion of the aquifer. Thus, groundwater stakeholders and policymakers should anticipate generally larger pumping impacts to water levels within BSEACD than HTGCD.
- Predictive simulations show that increases in pumping within western BSEACD, and especially within HTGCD nearby to the JWS spring outlet, are likely to result in substantial reductions in springflow at JWS (a simulated JWS hydrograph for Scenario A is presented in Figure 4). These flow reductions can be expected to result in an increase in the number of occurrences and duration of no-flow events at JWS. PVS was less impacted, but simulated pumping centers were further away from the PVS spring outlet. Moving these pumping centers closer to and/or

upgradient of the PVS spring outlet in the upper Blanco River basin would likely result in additional springflow capture from PVS.

- Scenario A demonstrates that large-scale pumping in the western BSEACD has the potential to impact flow at JWS. As of publication of this report, this is the first time potential for impacts to JWS by pumping within the BSEACD has been documented. However, more hydrogeologic studies and model refinement are needed to confirm that this outcome is possible from a conceptual hydrogeologic perspective. Also, it should be noted that impacts from drought, and pumping within the HTGCD, are likely to exert a much larger influence on JWS flow than more distal pumping within the BSEACD.

Completion of this first phase of modeling fills a key technical demand for guiding the BSEACD Trinity Sustainable Yield policymaking project by allowing quantitative evaluation of the impact of different pumping and recharge scenarios on aquifer levels and spring discharge. As of publication of this report, the TAS model serves as the best available tool for providing quantitative predictions of water level drawdown and impacts to springflow in response to various pumping scenarios. These quantitative model outputs will be critical in guiding sustainable groundwater management decisions for the Trinity Aquifer in Hays County. In the next phase of TAS modeling, new predictive scenarios will be constructed to answer key questions that are likely to arise during the planned BSEACD Trinity Sustainable Yield stakeholder process.

The complete TAS model report can be downloaded at the following link:
https://bseacd.org/2023/07/trinity-aquifer-sustainability-model/

Technical Advisory Committee Members

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Paul Bertetti (Edwards Aquifer Authority)
Radu Boghici (Hays Trinity Groundwater Conservation District)
Dr. Marcus Gary (Edwards Aquifer Authority)
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Ian Jones (Texas Water Development Board)
Dr. Robert Mace (Meadows Center for Water and the Environment, Texas State University)
Nick Martin (Southwest Research Institute)
Dr. Jack Sharp (Professor Emeritus, University of Texas at Austin)
Doug Wierman (Blue Creek Consulting LLC.)

Table 1. Summary of mean and maximum drawdown (baseline scenarios minus experimental scenarios) for the BSEACD and the HTGCD.

Baseline Scenario	Experimental scenario	GCD	Mean Drawdown (ft)	Max Drawdown (ft)
BL1	Scen A (BSEACD Well Field)	BSEACD	15.0	232.7
		HTGCD	5.4	167.9
BL1	Scen B (Regional Growth)	BSEACD	40.6	91.4
		HTGCD	14.64	92.0
Scen BL2 (no pumping)	Scen C1 (DOR-2020 pumping)	BSEACD	15.5	52.4
		HTGCD	4.7	45.1
Scen BL2 (no pumping)	Scen C2 (DOR regional growth)	BSEACD	51.8	111.5
		HTGCD	15.0	98.7

Table 2. Summary of simulated springflow (flux) reduction (baseline minus experimental scenarios) for the JWS and the PVS.

Baseline scenarios	Experimental scenario	JWS Avg cfs Flux Reduction	JWS Total Volume Flux reduction (%)	PVS Avg cfs Flux Reduction	PVS Total Volume Flux Reduction (%)
Scen BL1	Scen A (BSEACD Well Field)	1.5	39.5	0.0	0.3
Scen BL1	Scen B (Regional Growth)	1.6	43.3	0.6	4.3
Scen BL2 (no pumping)	Scen C1 (DOR-2020 pumping)	2.1	42.8	0.3	1.9
Scen BL2 (no pumping)	Scen C1 (DOR regional growth)	4.1	82.6	1.1	7.2

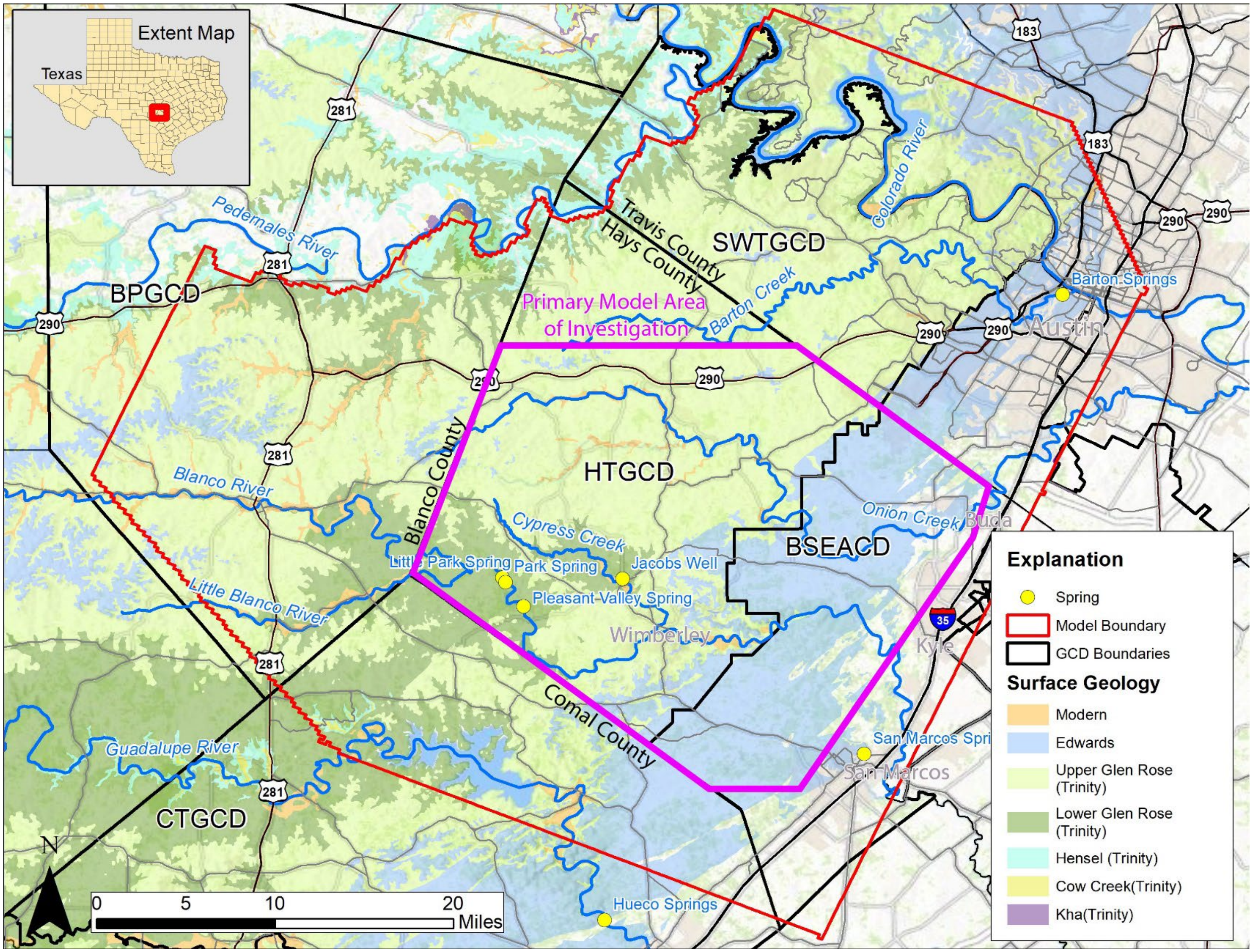

Figure 1. Study map with primary model area of investigation.

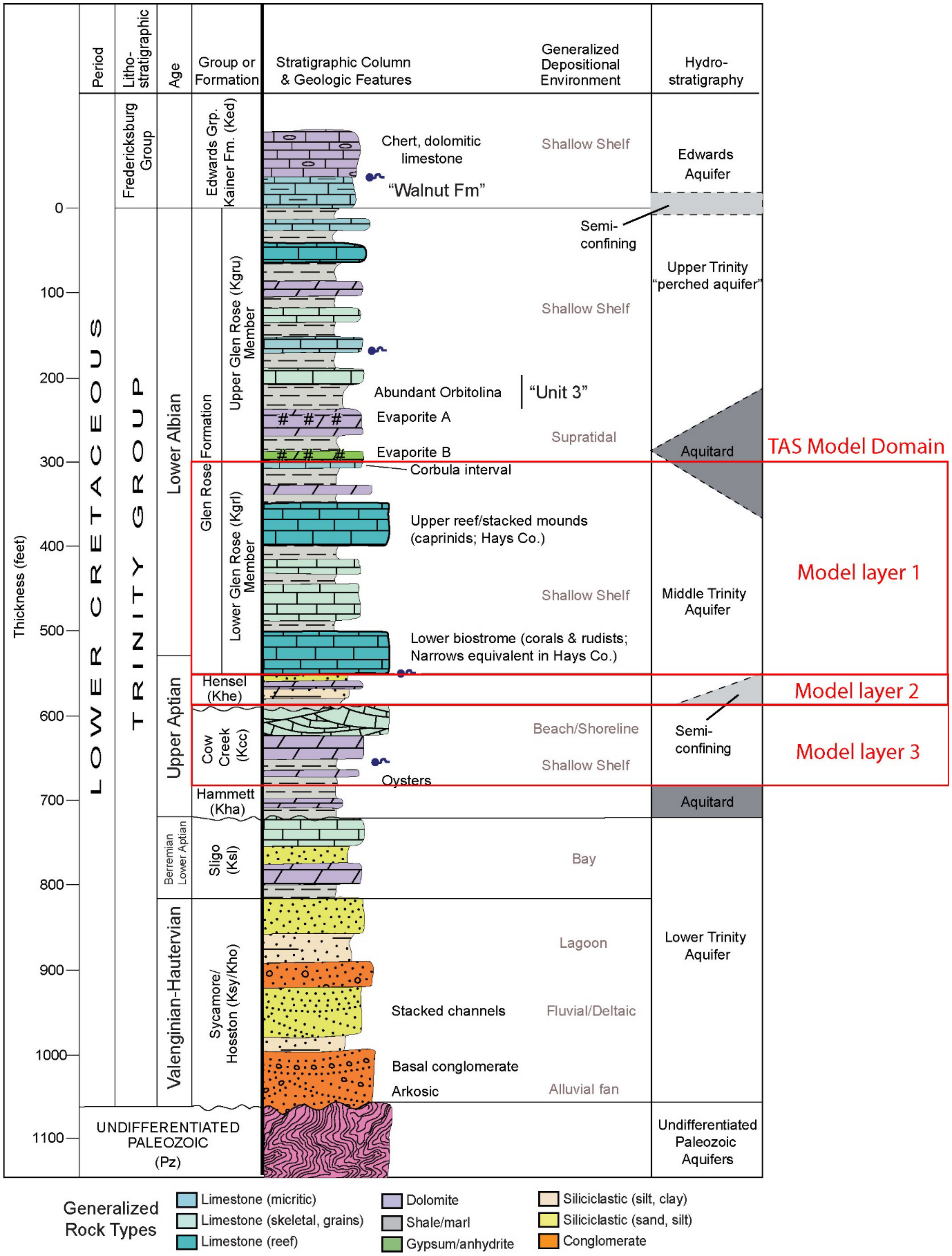

Figure 2. Lithologic and hydrostratigraphic column of Trinity Group in the study area.

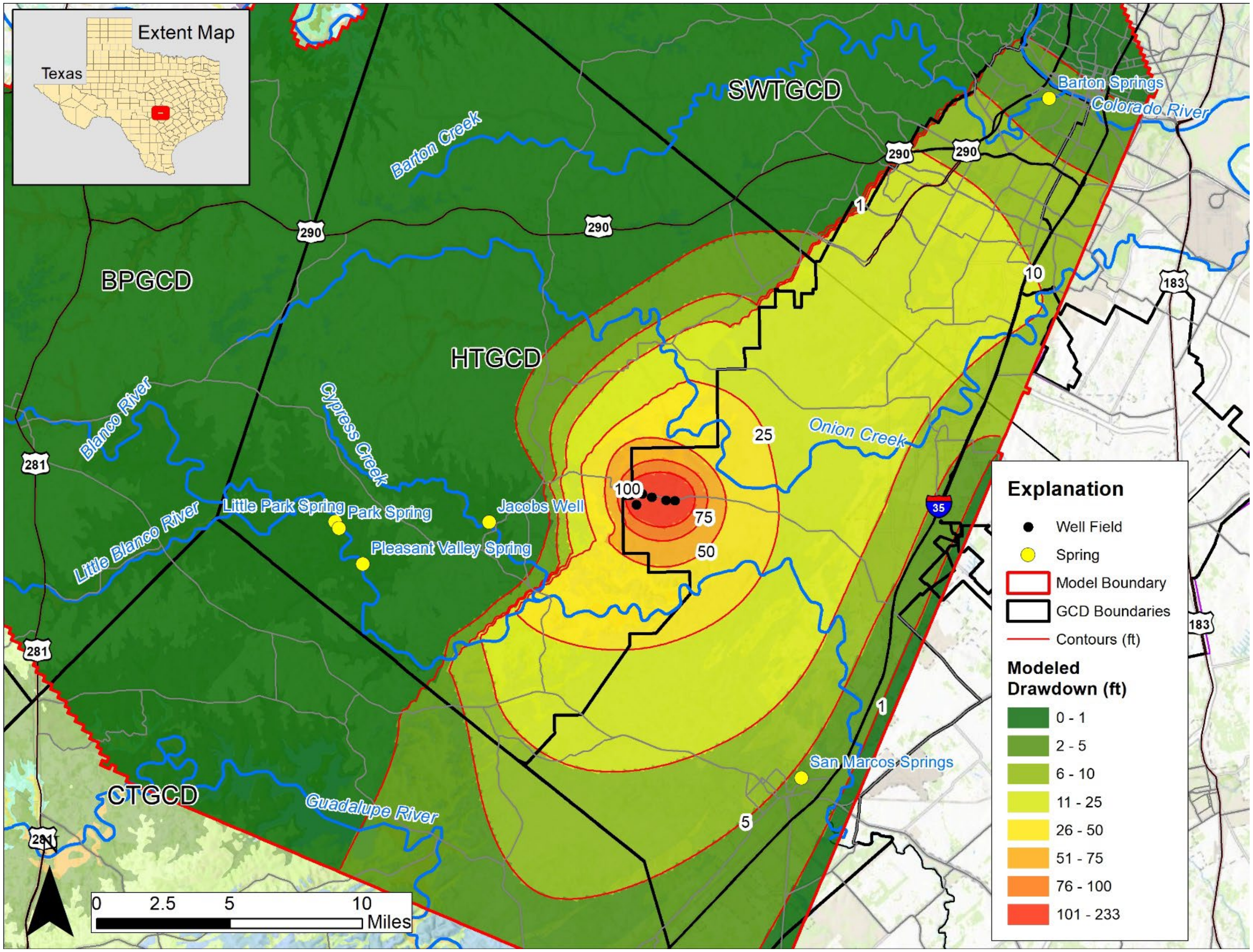

Figure 3. Modeled drawdown (difference between test scenario and baseline scenario) for predictive scenario A: High-capacity wellfield pumping 2.5 million gallons-per-day in western BSEACD.

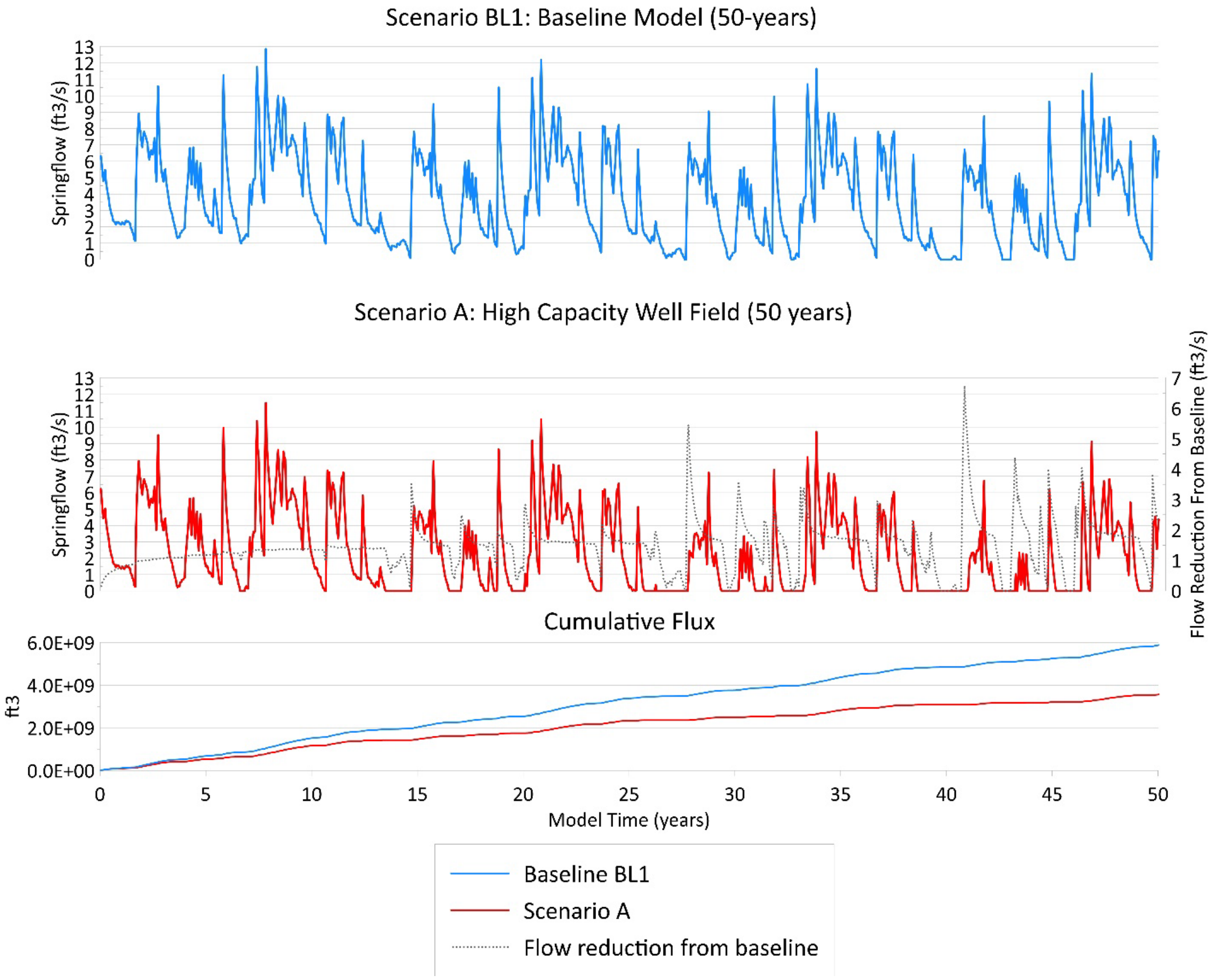

Figure 4. Simulated JWS flow comparison between drought of record baseline (BL1) and predictive scenario A.

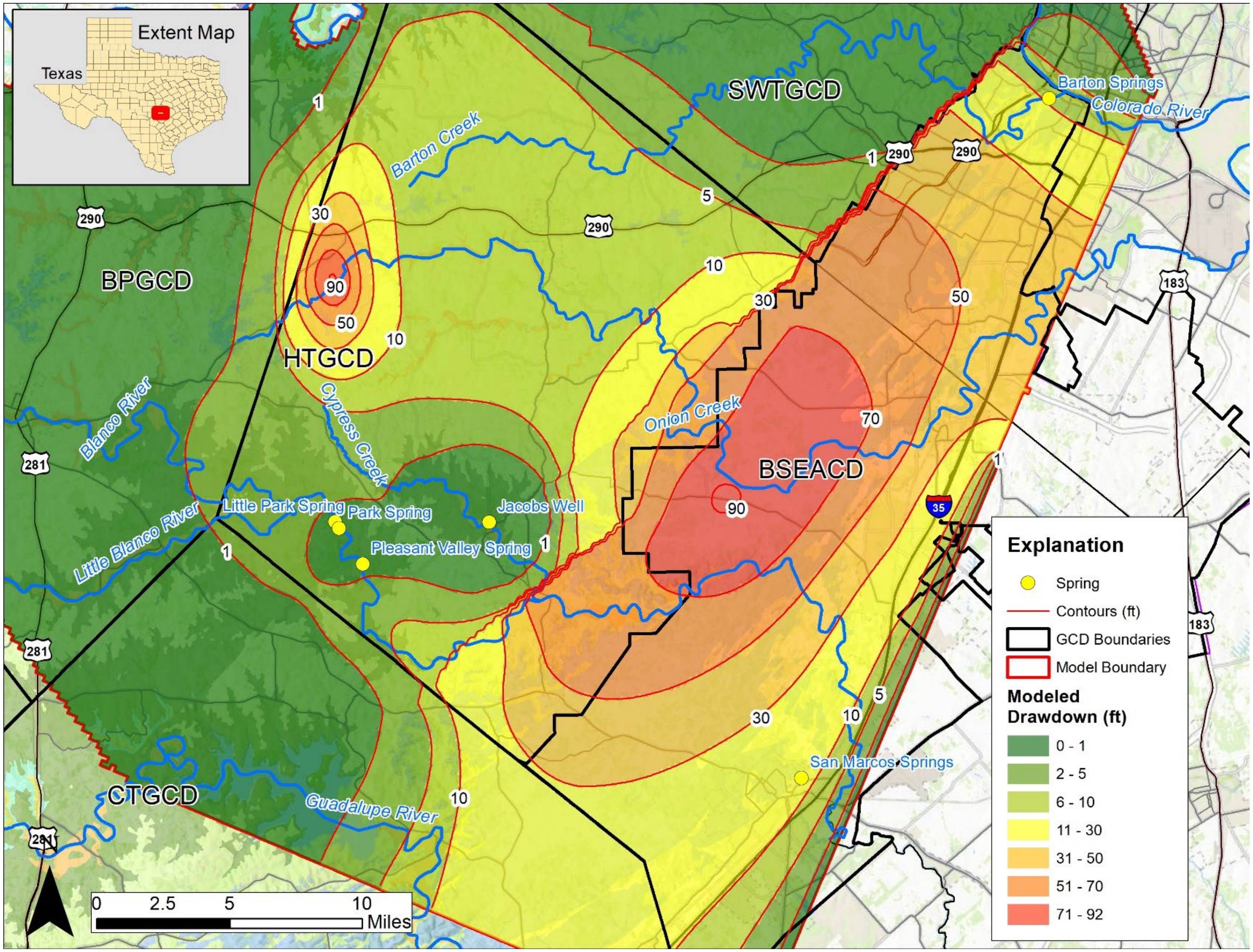

Figure 5. Modeled drawdown (difference between test scenario and baseline scenario) for predictive scenario B: pumping increase of 2.6 times due to estimated Hays County water demand increase through 2070.

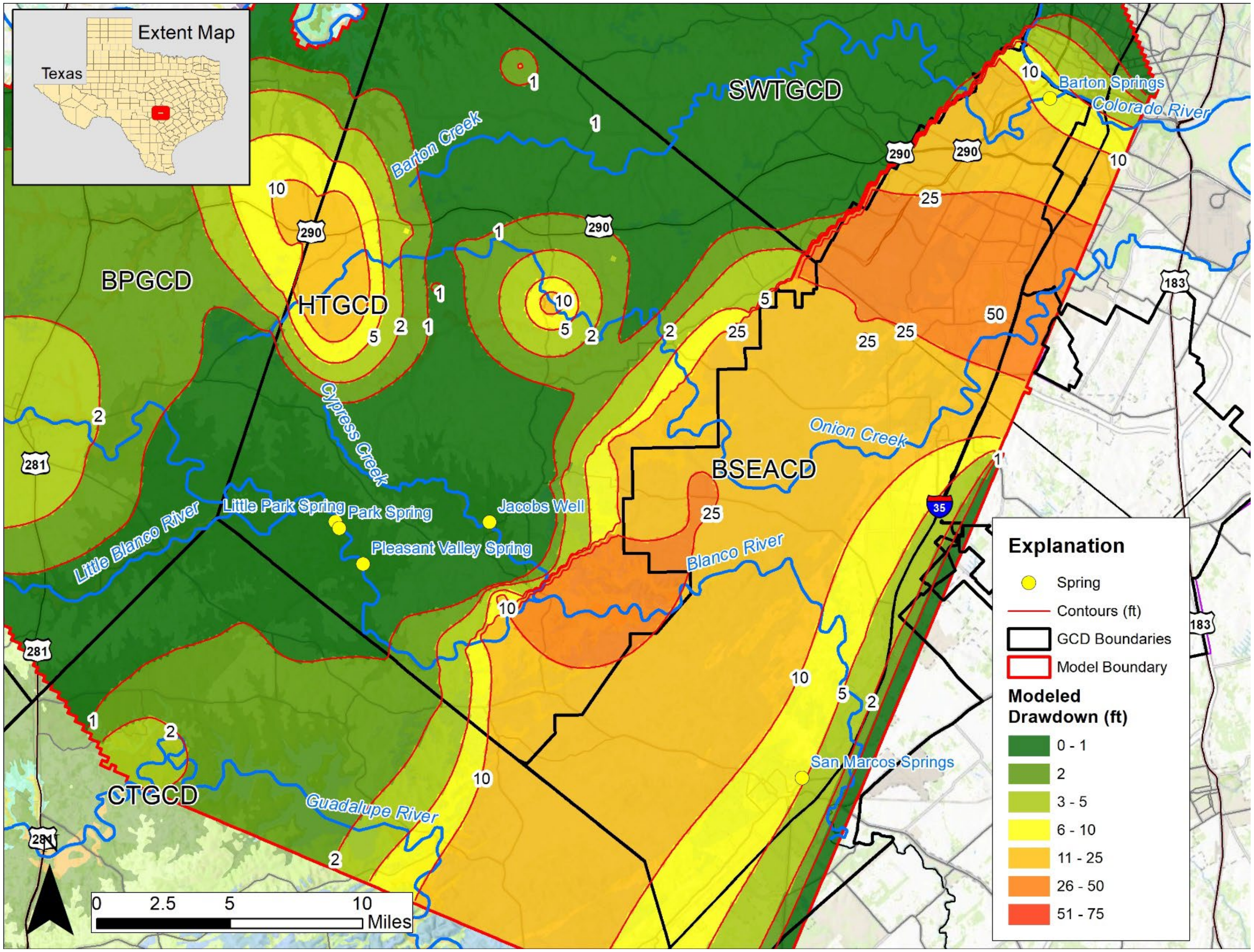

Figure 6. Modeled drawdown (difference between test scenario and baseline scenario) for predictive scenario C-1: recurrence of 1950's drought of record (10-years) with 2020 pumping.

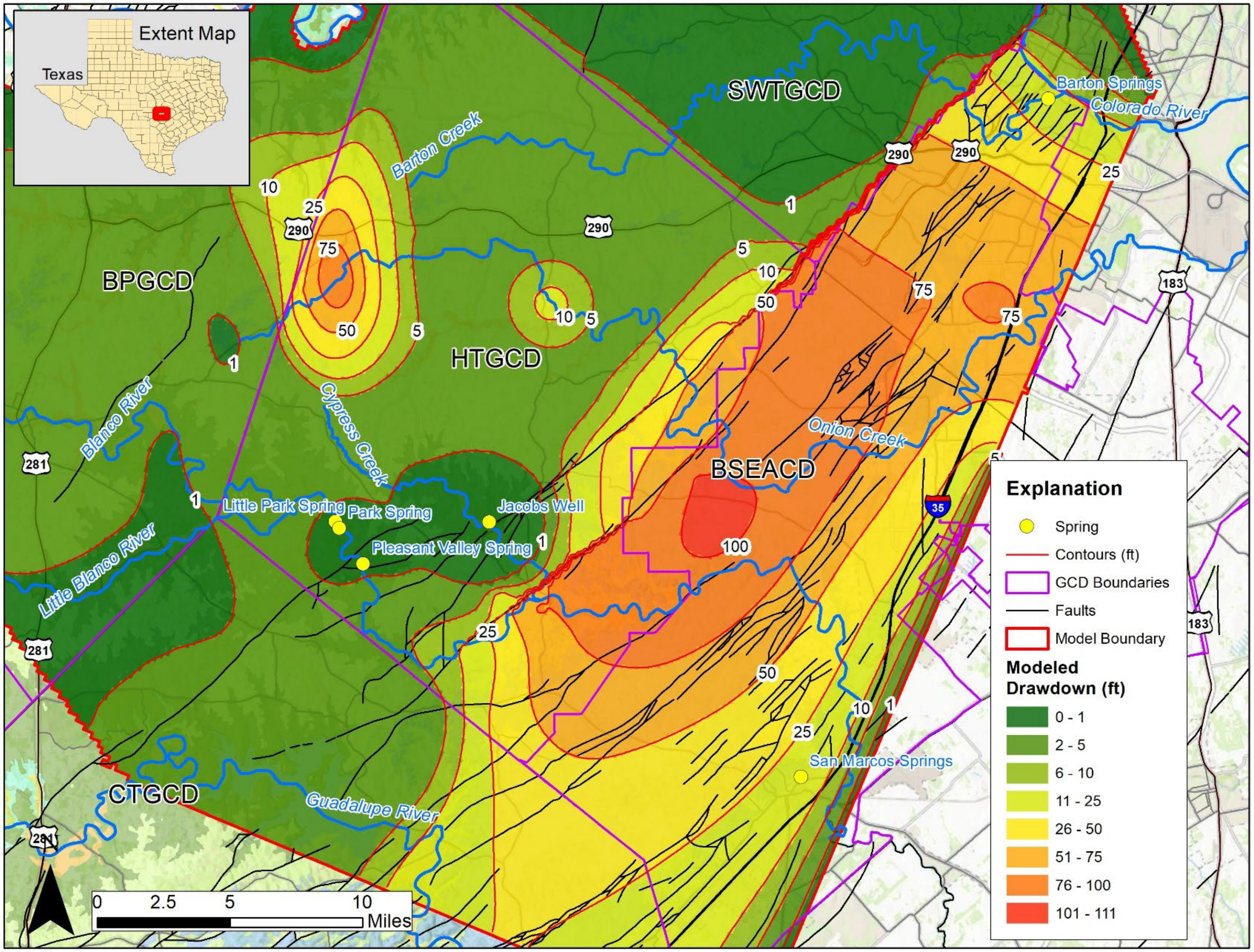

Figure 7. Modeled drawdown (difference between test scenario and baseline scenario) for predictive scenario C-2: recurrence of 1950's drought of record (10-years) with 2.6 times estimated 2020 pumping (regional growth).