DRAFT TECHNICAL MEMORANDUM

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TO:	Kinney County Groundwater Conservation District, Board of Directors
FROM:	Vince Clause, PG, Alysa Sule, PG, Freese and Nichols, Inc.
SUBJECT:	Desired Future Conditions – Demonstration with historical data
PROJECT:	KGD25636 – FY26 Hydrogeological Consulting Services
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DRAFT

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TEXAS REGISTERED GEOSCIENCE FIRM
F- 50655

1.00 INTRODUCTION

Freese and Nichols, Inc. (FNI) has prepared this technical memorandum for the Kinney County Groundwater Conservation District (KCGCD) to support continued use of best available science in the joint planning process for Desired Future Conditions (DFCs). This memorandum evaluates the historical performance of two DFC statements for the Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area (GMA) 7 in Kinney County using historical data.

This work was completed under FY26 Hydrogeological Consulting Services, Task 2: Support Desired Future Conditions Joint Planning, authorized on August 23, 2025, under the Master Services Agreement between KCGCD and FNI.

2.00 DESIRED FUTURE CONDITIONS PERFORMANCE DEMONSTRATION

FNI developed an Excel workbook-based screening tool to demonstrate how alternative DFC statements would have performed during the period from 1940 through 2025 using historical daily mean discharge measurements at Las Moras Springs and Palmer Drought Severity Index (PDSI) data for Kinney County. The tool was developed to increase transparency by establishing a repeatable evaluation method to support DFC discussions.

The tool evaluates DFC attainment on an annual basis by computing rolling averages over user-defined averaging windows and comparing those rolling averages to the selected metric(s). Additionally, the inclusion of PDSI data provides context for interpreting periods of higher or lower spring discharge relative to drought severity and supports discussion of how climate-driven variability may influence attainment under different DFC formulations.

A live demonstration of the tool will be provided at the District's February meeting to facilitate discussion of the tradeoffs among alternative DFC threshold, averaging windows, and compliance frequency. Rather than recommending a specific DFC, this memorandum summarizes high-level differences in historical performance between the two DFC statement frameworks and summarizes the primary sensitivities observed in the historical record.

2.01 ONE-TIER DESIRED FUTURE CONDITIONS STATEMENT

The one-tier desired future conditions framework evaluated with the screening tool is restated below:

> *Daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cubic feet per second (cfs) when averaged over #-years/months/days.*

For purposes of this demonstration, the tool assumes the Board selects an averaging window of at least one year and evaluates compliance on an annual basis. To illustrate how this framework would have performed historically, the tool was tested across a range of potential DFC inputs, including averaging windows from 1 to 10 years and minimum spring discharge thresholds from 1 to 35 cfs. Figure 1 summarizes the compliance logic used to evaluate attainment under the one-tier statement. Figure 2 summarizes historical performance by showing the percentage of years from 1940 to 2025 that would have met the desired future condition for each combination of averaging window and discharge threshold.

Results demonstrate that the selected averaging window materially affects attainment because longer averaging periods smooth short-term variability associated with multi-year drought cycles. For example, if the minimum rolling-average discharge was 15 cfs, this DFC would be met approximately 66% of the time if the averaging window was 1-year, compared to approximately 87% of the time if the averaging window was 4-years. This sensitivity highlights an important tradeoff: shorter averaging windows respond more quickly to changing conditions but may result in more frequent nonattainment during drought periods, while longer averaging windows reduce year-to-year variability in the compliance metric but may lag changes in underlying hydrologic conditions.

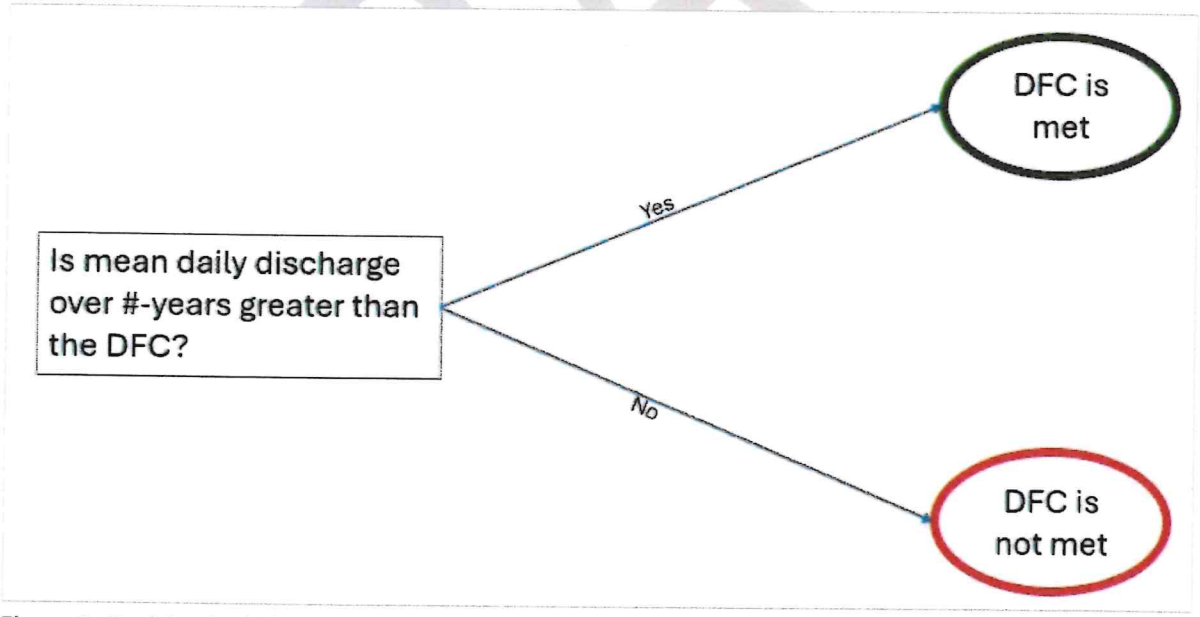

Figure 1. Decision logic for assessing compliance with the one-tier desired future conditions statement.

One-tier metric, % of time DFC is met from 1940 to 2025

Minimum spring discharge (cfs)	# years in averaging window									
	1	2	3	4	5	6	7	8	9	10
1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
3	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
4	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%
5	97%	98%	99%	100%	100%	100%	100%	100%	100%	100%
6	93%	96%	96%	98%	99%	100%	100%	100%	100%	100%
7	92%	94%	94%	96%	98%	100%	100%	100%	100%	100%
8	85%	89%	93%	95%	98%	99%	100%	100%	100%	100%
9	84%	89%	90%	94%	96%	98%	100%	100%	100%	100%
10	81%	87%	90%	93%	95%	98%	100%	100%	100%	100%
11	80%	86%	88%	92%	94%	98%	99%	100%	100%	100%
12	76%	82%	87%	89%	94%	94%	96%	100%	100%	100%
13	73%	80%	85%	89%	91%	93%	96%	97%	100%	100%
14	71%	79%	85%	87%	88%	93%	94%	96%	99%	100%
15	66%	79%	82%	87%	88%	89%	90%	94%	97%	99%
16	60%	73%	79%	81%	88%	86%	89%	91%	94%	97%
17	58%	66%	75%	76%	82%	84%	85%	87%	88%	94%
18	55%	60%	65%	75%	72%	78%	79%	82%	85%	84%
19	51%	54%	58%	60%	61%	60%	68%	72%	73%	70%
20	47%	51%	51%	51%	52%	53%	54%	57%	60%	60%
21	43%	46%	44%	43%	46%	40%	41%	48%	47%	44%
22	40%	44%	37%	39%	33%	33%	36%	33%	29%	27%
23	34%	33%	31%	31%	23%	28%	28%	23%	21%	21%
24	30%	27%	26%	22%	20%	20%	23%	16%	18%	19%
25	28%	20%	17%	14%	16%	17%	14%	15%	17%	16%
26	28%	19%	15%	13%	15%	17%	14%	14%	13%	12%
27	26%	18%	14%	12%	12%	11%	13%	10%	9%	8%
28	22%	15%	11%	11%	11%	10%	10%	9%	8%	4%
29	19%	13%	8%	10%	9%	9%	8%	6%	4%	3%
30	16%	9%	7%	6%	7%	7%	8%	5%	3%	3%
31	12%	6%	7%	6%	7%	7%	5%	4%	3%	3%
32	12%	6%	6%	6%	7%	7%	5%	3%	3%	3%
33	10%	6%	6%	6%	7%	4%	1%	1%	1%	1%
34	8%	6%	5%	5%	4%	1%	1%	1%	0%	0%
35	6%	5%	5%	5%	1%	0%	0%	0%	0%	0%

Figure 2. A demonstration of the desired future conditions tool documenting the DFC attainment rate for the one-tier DFC statement at different spring discharges and different annual averaging windows.

2.02 TWO-TIER DESIRED FUTURE CONDITIONS STATEMENT

The two-tier DFC framework evaluated in the screening tool is restated below:

> *Daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cubic feet per second (cfs) when averaged over #-years/months/days, except during drought conditions. During drought conditions, as defined by a Palmer Drought Severity Index of less than # on average over a #-month period, daily mean spring discharge measured at Las Moras Springs shall not be less than ##.# cfs.*

Key Variables Evaluated

This two-tier framework introduces a drought-based decision point that determines which discharge threshold applies. As implemented, the two-tier DFC includes five user-defined variables:

- **Normal-condition discharge (cfs) threshold ("high" cfs):** minimum discharge under non-drought conditions (10 cfs to 30 cfs tested).
- **Normal-condition averaging window:** rolling period used to compute discharge under non-drought conditions (assumed 1 to 10 years)
- **Drought-condition discharge (cfs) threshold ("low" cfs):** minimum discharge under drought conditions (1 cfs to 15 cfs tested)
- **Drought metric averaging window:** rolling period used to define whether drought conditions are occurring, evaluated either monthly or annually (1 to 72 months or 1 to 10 years tested)
- **Drought trigger threshold (PDSI):** the PDSI value that determines whether the normal-condition or drought condition discharge threshold applies (PDSI -1, -2, -3, or -4 tested)

For this demonstration, PDSI was selected as the drought indicator because it provides a long period of record, is readily available at the county scale, and exhibits strong correlation with spring discharge in the historical dataset. The PDSI threshold can also be interpreted as the "drought trigger" that is, how severe drought conditions must be before the DFC shifts from the normal condition threshold to the drought condition threshold.

Compliance Logic

The compliance logic for assessing the two-tier DFC is summarized in Figure 3 and follows a two-step process.

1. **Determine Whether the District is in Drought** for the evaluation period based on the drought trigger (PDSI threshold) and the selected drought averaging window. This determination may be made on a monthly or annual basis depending on the selected drought metric window and compliance evaluation frequency.
2. **Evaluate spring discharge against the appropriate tier:**
   a. **If drought conditions are met:** calculate mean daily discharge at Las Moras Springs over the selected drought-condition discharge averaging window and compare it to the drought condition ("low") cfs threshold.
   b. **If drought conditions are not met:** calculate mean daily discharge at Las Moras Springs over the selected normal-condition discharge averaging window and compare it to the normal-condition ("high") cfs threshold.

This structure is intended to acknowledge climate-driven variability by allowing a different (lower) discharge threshold to apply during objectively defined drought conditions, while retaining a higher protective threshold during non-drought periods.

Because the two-tier framework includes five variables, there are many potential combinations (greater than 200,000 across the tested parameter ranges). Accordingly, the memorandum documents a representative subset of combinations to illustrate how key choices influence historical performance, while additional combinations can be explored during the live tool demonstration.

Use of the normal-conditions discharge threshold ("high" cfs) is essentially analogous to the one-tier DFC framework. The two-tier approach primarily affects performance by altering how often the District is considered to be operating under drought conditions versus normal conditions. Based on initial testing, the following high-level observations apply:

- **Less sensitive drought triggers result in using the normal-condition threshold more often.** For example, a trigger of PDSI < -4 is less frequently met that PDSI < -1, so the framework will remain in the normal-condition tier more often at -4 than at -1.
- **Longer drought metric averaging windows tend to reduce the frequency of drought designation.** Increasing the drought averaging windows smooths short-term drought fluctuations and requires sustained drought severity before the drought tier is activated. As a result, longer drought windows typically lead to the normal-condition tier being used more frequently than shorter drought windows.

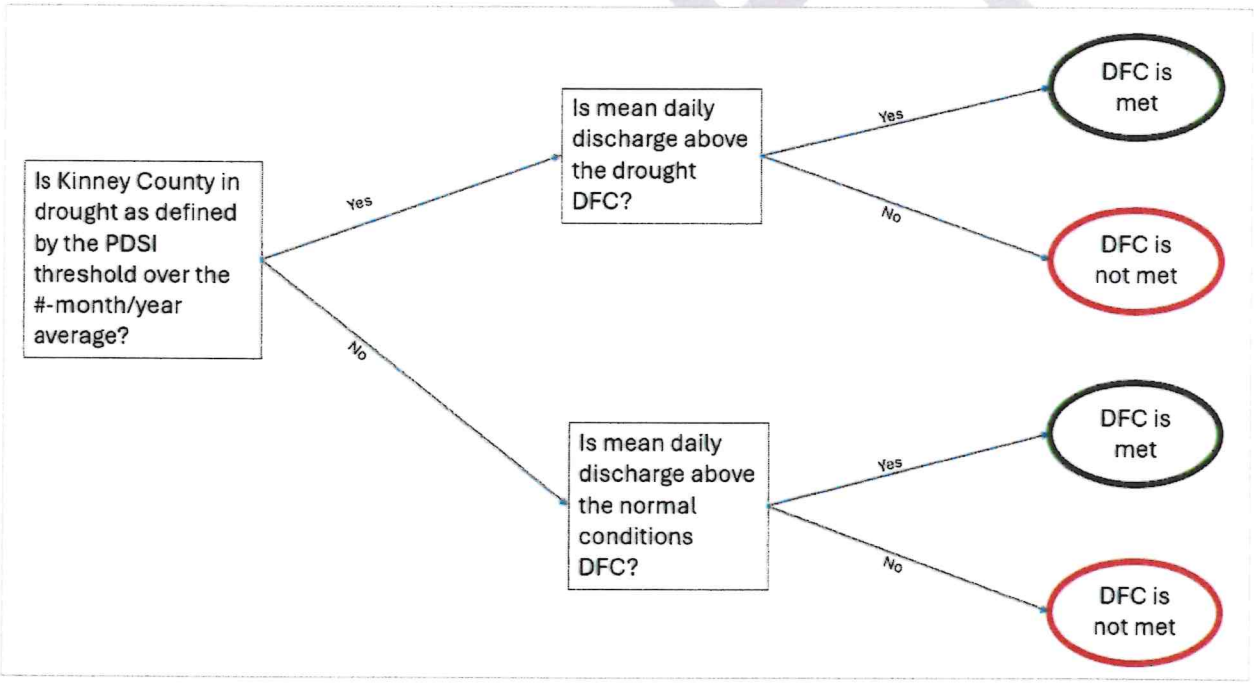

Figure 3. Decision logic for assessing compliance with the two-tier desired future conditions statement.

3.00 COMPARISON OF THE DESIRED FUTURE CONDITIONS FRAMEWORKS

Figure 4 below demonstrates the performance of different DFC statements. For this comparison, we selected 15 cfs as the one-tier or normal conditions in the two-tier value, as 15 cfs appears to be an achievable target (one of the nine DFC factors, see Section 4) under a drying climate as predicted by climate projection models (AdaptWest Project, 2022). Figure 4 compares the performance of the one-tier and two-tier DFC statement if 15 cfs is the normal conditions target and 5 cfs is the drought target.

		# of years in normal averaging window									
	one-tier or normal cfs = 15 cfs	1	2	3	4	5	6	7	8	9	10
One-tier met rate		66%	79%	82%	87%	88%	89%	90%	94%	97%	99%
Two-tier met rate	PDSI < -1; drought cfs = 5; drought window = 1 month	65%	71%	72%	72%	72%	70%	70%	70%	73%	71%
	PDSI < -4; drought cfs = 5; drought window = 1 month	66%	78%	81%	84%	84%	85%	86%	87%	91%	91%
	PDSI < -1; drought cfs = 5; drought window = 6 month	72%	80%	81%	81%	81%	80%	80%	80%	82%	81%
	PDSI < -4; drought cfs = 5; drought window = 6 month	66%	79%	82%	87%	85%	85%	88%	89%	92%	92%
	PDSI < -1; drought cfs = 5; drought window = 1 year	92%	93%	93%	94%	95%	94%	94%	94%	96%	95%
	PDSI < -4; drought cfs = 5; drought window = 1 year	70%	82%	86%	90%	90%	91%	93%	95%	99%	99%
	PDSI < -1; drought cfs = 5; drought window = 5 year	78%	91%	98%	99%	100%	99%	99%	99%	100%	100%
	PDSI < -4; drought cfs = 5; drought window = 5 year	65%	78%	82%	87%	88%	89%	90%	94%	97%	99%

Figure 4. A demonstration of the DFC tool comparing the attainment rate for the one- and two-tier DFC statements.

From this analysis, the following observations were made:

- **Compliance evaluation is simpler under a one-tier DFC.** The one-tier framework relies on a single discharge threshold and averaging window, resulting in a straightforward annual compliance determination.
- **A two-tier DFC does not necessarily increase annual DFC performance.** Introducing a drought tier may increase, decrease, or have little effect on the percent of years meeting the DFC depending on how the drought trigger and drought averaging window are defined and how frequently tier selection is reassessed
- **When drought status is evaluated using monthly averages:**
    - The DFC is generally met less often compared to annual averaging windows because historically spring discharge is also low on a monthly basis during drought
    - Selecting a less sensitive drought trigger (PDSI = -4) has a higher percent of years that met the DFC because the long-term spring discharge averages are assessed

- **When drought status is evaluated using annual averages:**
    - Compliance determination is simpler than under monthly evaluation because tier selection and compliance assessment occur once per year rather than requiring month-by-month drought classification.
    - A more sensitive drought trigger (PDSI -1) can result in a higher percentage of years meeting the DFC because low spring discharge is typically concentrated in specific months while the annual average also considered higher springflow months.

Alternative two-tier approach. An alternative two-tier framework could be implemented without an explicit drought trigger. Under this approach, the District would evaluate Las Moras Springs discharge against two concurrent discharge thresholds, a normal condition ("high") cfs target and a minimum ("low") cfs threshold, rather than switching between tiers based on a drought index.

Conceptually, the "high" cfs threshold would represent the desired performance under typical conditions, while the "low" cfs threshold would define a minimum acceptable discharge during periods of reduced springflow. Depending on how the statement is structured, compliance could be assessed by requiring discharge to remain above the "high" threshold over a specified period of time while not falling below the "low" threshold on a monthly or annual basis. This structure removes the need to define and defend a specific drought trigger, while still distinguishing between normal conditions and low-flow periods in a transparent way.

4.00 DESIRED FUTURE CONDITIONS – NINE FACTORS

Any newly adopted DFC statement will need to be voted on by GMA 7. As they consider the desired future conditions statement, per Texas Water Code Sec. 36.108(d), "before voting on the desired future conditions of the aquifers under Subsection (d-2), the districts shall consider" nine factors:

1. "aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another"
2. "the water supply needs and water management strategies included in the state water plan"
3. "hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge"
4. "other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water"
5. "the impact on subsidence"
6. "socioeconomic impacts reasonably expected to occur"
7. "the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002"
8. "feasibility of achieving the desired future condition"
9. "any other information relevant to the specific desired future conditions"

Of these factors, Factor 8 (feasibility) may become a key consideration during GMA 7 deliberations because it directly links the proposed DFC statement(s) to (1) the ability to evaluate compliance using available data and (2) whether the DFC can realistically be achieved and maintained given historical aquifer trends, climatic variability, and available management tools.

5.00 REFERENCES

AdaptWest Project. 2022. Gridded current and projected climate data for North America at 1km resolution, generated using the *ClimateNA v7.30* software (T. Wang et al., 2022). Available at adaptwest.databasin.org.

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