Memo on Sufficiency of GMD 5's Augmentation-Only Plan to Resolve Quivira Impairment

Kansas Department of Agriculture – Division of Water Resources

January 4, 2019

Question: Is Big Bend Groundwater Management District No. 5's (GMD5) proposed 15 cubic feet per second (cfs) augmentation project alone sufficient to remedy the impairment of Quivira National Wildlife Refuge's (Quivira) water right currently and in the future?

Answer: No, the proposed augmentation project alone is not sufficient to remedy the impairment of Quivira's water right because the current level of groundwater pumping, if not reduced, will dry up the reliable part of the streamflow that comes from the aquifer. Reliable and total streamflow will be significantly reduced to such a degree that the impairment will continue even with the proposed augmentation project, while other uses upstream are compromised and the hydrologic health of the basin continues to deteriorate.

Background: In July 2017, GMD5 requested that the Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) provide an initial analysis of remedy requirements beyond the proposed augmentation project concept developed by GMD5 [1]. KDA-DWR's analysis determined that a 30% reduction from recent water use would be required to prevent future growth in long-term depletions to the Rattlesnake Creek streamflow. KDA-DWR committed to supporting a combination of augmentation and a lesser reduction from recent water use to remedy the impairment. KDA-DWR's conclusions were re-affirmed in a presentation of remedy requirements at GMD5's 2018 annual meeting, and in other communications since. In all such communications and presentations, KDA-DWR has consistently held that, at a minimum, a reduction of approximately 15% from recent water use must accompany GMD5's proposed 15 cubic feet per second (cfs) augmentation project to resolve the impairment long-term. The purpose of the pumping reduction is to slow the growth in depletions to streamflow from groundwater pumping and prolong the effectiveness of any augmentation project.

Despite GMD5's work with KDA-DWR since fall 2017 on a Local Enhanced Management Area (LEMA) plan to accomplish such reductions, on October 15, 2018, GMD5 asserted that "the model irrefutably shows that augmentation can solve the impairment complaint (and ultimately becomes sustainable). [2]"

On October 29, 2018, GMD5's hydrologic modeling consultant, Peter Balleau of Balleau Groundwater, Inc (BGW), presented the GMD5 board's evidence for this assertion, primarily on:

1. BGW's average-conditions future analysis showing that the ongoing declines to streamflow would eventually cease, with Rattlesnake Creek flows at Zenith stabilizing at a long-term annual average value of 13 cfs (see Attachment 1) [3]. When combined with the 15 cfs from the proposed augmentation project, the Board contends that Quivira's need for 30 cfs during high demand periods on the Refuge, from March through April and October through November, will be met; and

2. BGW analysis showing that the U.S. Fish and Wildlife Service's (Service) needs are met 90% of the days by the proposed 15 cfs augmentation project and expected remaining streamflow in the future. Balleau contends that this is acceptable based on his understanding of the Service's

willingness to accept shortages to Quivira's water right during times of significant drought, a contention that KDA-DWR does not hold.

KDA-DWR Analyses: KDA-DWR reviewed GMD5's analyses as presented by Balleau. Below is a summary of our work and findings.

1. KDA-DWR streamflow analysis

Historical streamflow analysis — KDA-DWR started with an analysis of historical streamflow, plotted with historical precipitation. The United States Geological Survey gage along the Rattlesnake Creek at Zenith shows that annual streamflow has been trending downward for decades, even though there is a long-term increase in precipitation in the area. (See Figure 1.) These trends illustrate the problem that KDA-DWR believes must be addressed as part of a long-term solution to the impairment; streamflow is being diminished by groundwater pumping, and the basin must take action towards stabilizing it. BGW modeling shows that the reductions in streamflow are due mostly to groundwater pumping.

Future streamflow analysis — BGW's average-conditions future analysis shows that streamflow will continue downward but will stabilize around 13 cfs by about 2040. Streamflow, in the real world and the model, is variable and composed of two predominant components — baseflow and runoff.

- **Baseflow** is the portion of precipitation that soaks into the ground, moves along the slope of the underground water table and eventually discharges from the aquifer system into the stream system. Because groundwater moves slowly through the pore spaces of the aquifer, baseflow is slow to rise, stays steady for significant periods and is slow to wane. This is the most reliable and constant source of streamflow.
- **Runoff** is the portion of precipitation that flows overland and makes it to the stream to add to streamflow. Runoff is event-driven and not reliable enough to meet Quivira and other needs on a real-time basis, particularly as there are periods, especially in the summer and fall, between events that produce significant runoff.

At a very high conceptual level, a groundwater model takes inputs (streamflow records, precipitation records, etc.) then runs calculations on them to produce outputs (future water levels, pumping impacts to streamflow, etc.) KDA-DWR separated streamflow from BGW's 2008-2075 Baseline A future projection into its baseflow and runoff components [4]. The runoff component of streamflow is an input to the model and varies with precipitation. As determined by BGW, runoff remains relatively constant over long periods of time. In contrast, the baseflow component of streamflow is an output calculated by the model and shows a significant downward trend. Historically, the Rattlesnake Creek above Zenith has gained streamflow from baseflow, but this has been in decline over time. Our analysis of BGW's future runs shows that baseflow transitions in the near future from a positive value (where the groundwater system adds to the streamflow) to a negative value indicating a losing stream. With no baseflow and increasing portions of the streamflow (runoff) captured by the aquifer system over time, total streamflow is significantly reduced. BGW projects that the system will stabilize at the point when Rattlesnake Creek has no baseflow and on average 18-20 cfs of the runoff that makes it to the stream soaks into the streambed and never makes it downstream. (See Figure 2.)

While BGW's average-conditions future analysis shows that streamflow eventually stabilizes at 13 cfs, at that point in time it is composed entirely of runoff. On a real-time, seasonal basis, the Refuge cannot rely solely on rainfall — and by extension runoff — to be available when water is needed for specific management activities like growing forage crops and providing habitat.

The Refuge uses its limited capacity to store and regulate water to make use of untimely runoff, but the largest, most reliable source available to the refuge has been the aquifer system's relatively steady discharge of baseflow into the stream. Diminishing the baseflow to the point where the Service is unable to exercise its water right is impairment. The Service's water right remains impaired unless and until those shortages to its water right, caused by junior water right operation, are replaced in time, location, and amount.

Conclusion: Balleau's modeling work shows the current level of groundwater pumping, if unchecked, will dry up baseflow and significantly reduce the amount of runoff that remains streamflow to the detriment of Quivira's water right and other in-stream needs, including MDS. The 13 cfs future projected long-term streamflow is not reliable to meet Quivira's needs because it is not regularly available, particularly in times of the Service's greatest need.

2. KDA-DWR analysis of future impairment with augmentation in place

Regarding BGW's second assertion that shortages to the Service's needs will occur 10% of the days in the future with augmentation in place, KDA-DWR reviewed BGW's impairment analysis to assess the impact of the proposed augmentation project on future impairment. KDA-DWR's impairment analysis was first completed over the period of record through 2007 and showed, at that level of depleted streamflow, the refuge was impaired 3,000-5,000 acre-feet on a regular basis, with impairment levels above 5000 acre-feet in 8 years and reaching 8,000 acre-feet in one year. Given that streamflow has been decreasing over the past 11 years and will continue to decrease for years to come, it is reasonable to conclude that the magnitude and frequency of impairment will increase correspondingly.

Figure 3 shows KDA-DWR's impairment analysis applied to the historical record and continued through BGW's future projection 2008-2075. Even as precipitation increases through the future projection, the frequency and magnitude of impairment also increase: impairment of 8,000 acre-feet on a regular basis and going as high as 14,000 acre-feet. Figure 4 shows the same analysis as in Figure 3 but accounts for the mitigating effect of a 15 cfs augmentation project with no annual limit on its quantity. Impairment will continue to occur regularly and outside drought periods. Relying on the proposed augmentation project only will not provide the volume of water necessary to overcome the shortages caused by junior pumping to the Refuge's water right and will allow the impairment to become worse over time.

Conclusion: While GMD 5 's proposed 15 cfs of augmentation would significantly reduce current and future impairment, if the current level of pumping is allowed to continue, augmentation only will not provide the 30 cfs needed to address the impairment in critical times when streamflow is being lost to the aquifer because of zero or negative baseflow, and there is no runoff available.

References:

[1] Quivira Impairment: DRAFT KDA-DWR analysis on remedy requirements beyond 3,000-5,000 AF/year of augmentation, July 6, 2017, PowerPoint presentation.

[2] Preheim email of October 15, 2018 to KDA. Posted on KDA web site dedicated to the GMD 5 proposed LEMA as an attachment to Secretary McClaskey' s October 17, 2018 correspondence to GMD 5.

[3] Figure 7B from Appendix H to BGW's June 2010 Hydrologic Model of Big Bend Groundwater Management District No. 5.

[4] BGW presented on October 29 a graphic from its Baseline B-prime future, which provided for smoothed results based on average inputs in each timestep. DWR's analysis is based on BGW's Baseline A future, smoothed with 20-year running averages of these output components.

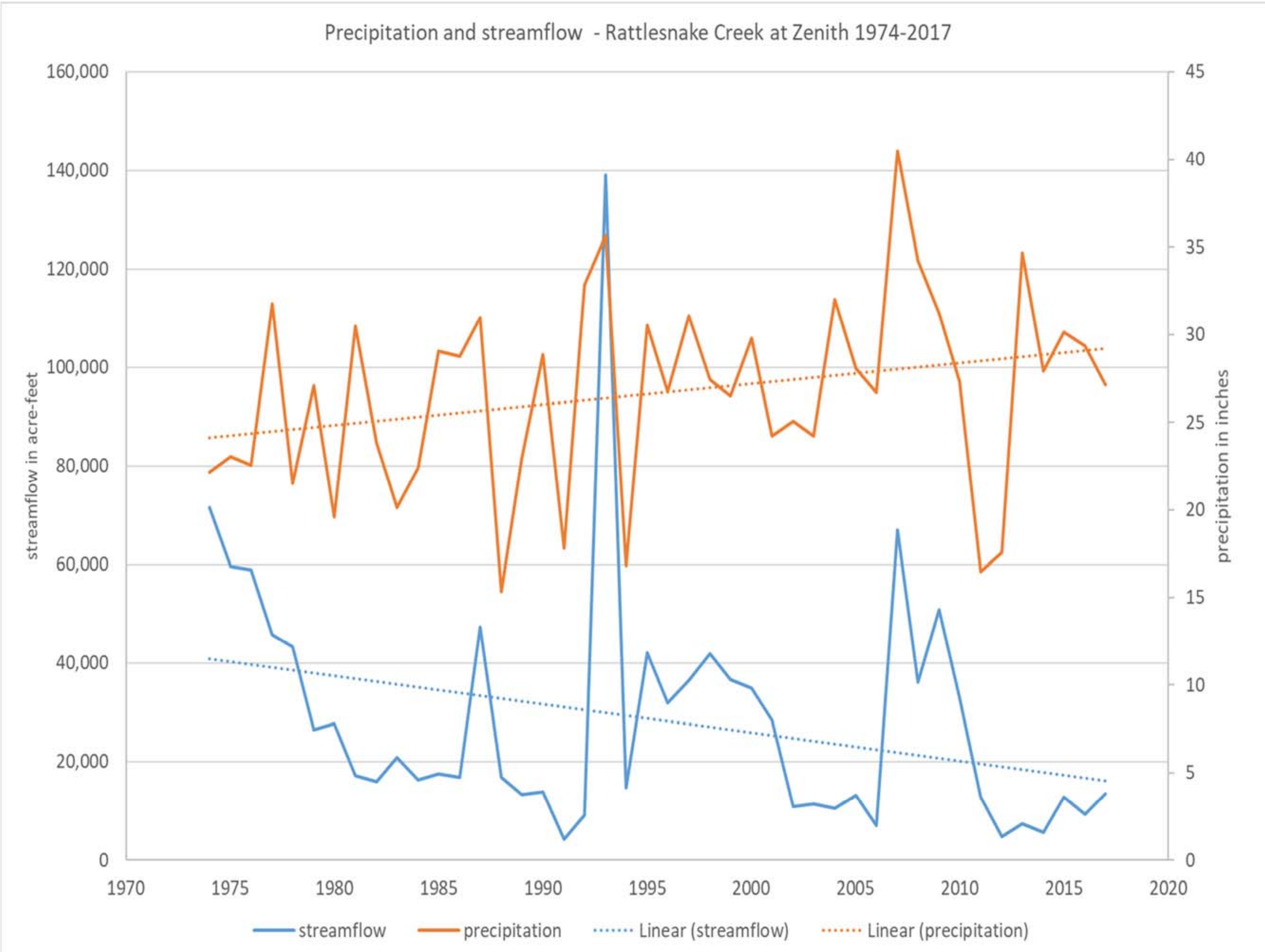


Figure 1 - Precipitation and streamflow - Rattlesnake Creek at Zenith 1974-2017.
Source: streamflow from United States Geological Survey; precipitation from PRISM Climate Group, Oregon State University

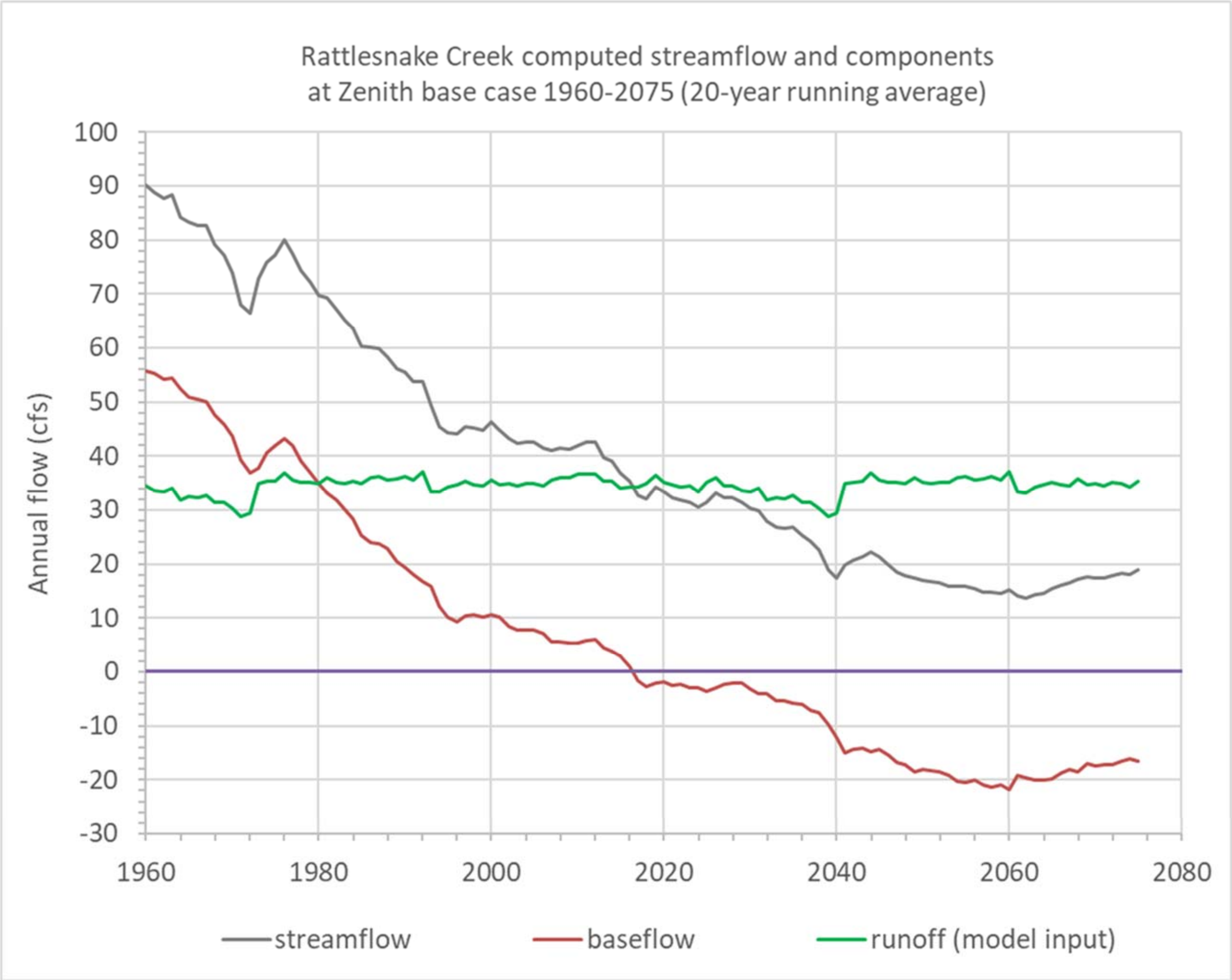


Figure 2 - Rattlesnake Creek computed streamflow and component at Zenith
Source: Big Bend Groundwater District #5 Groundwater Model

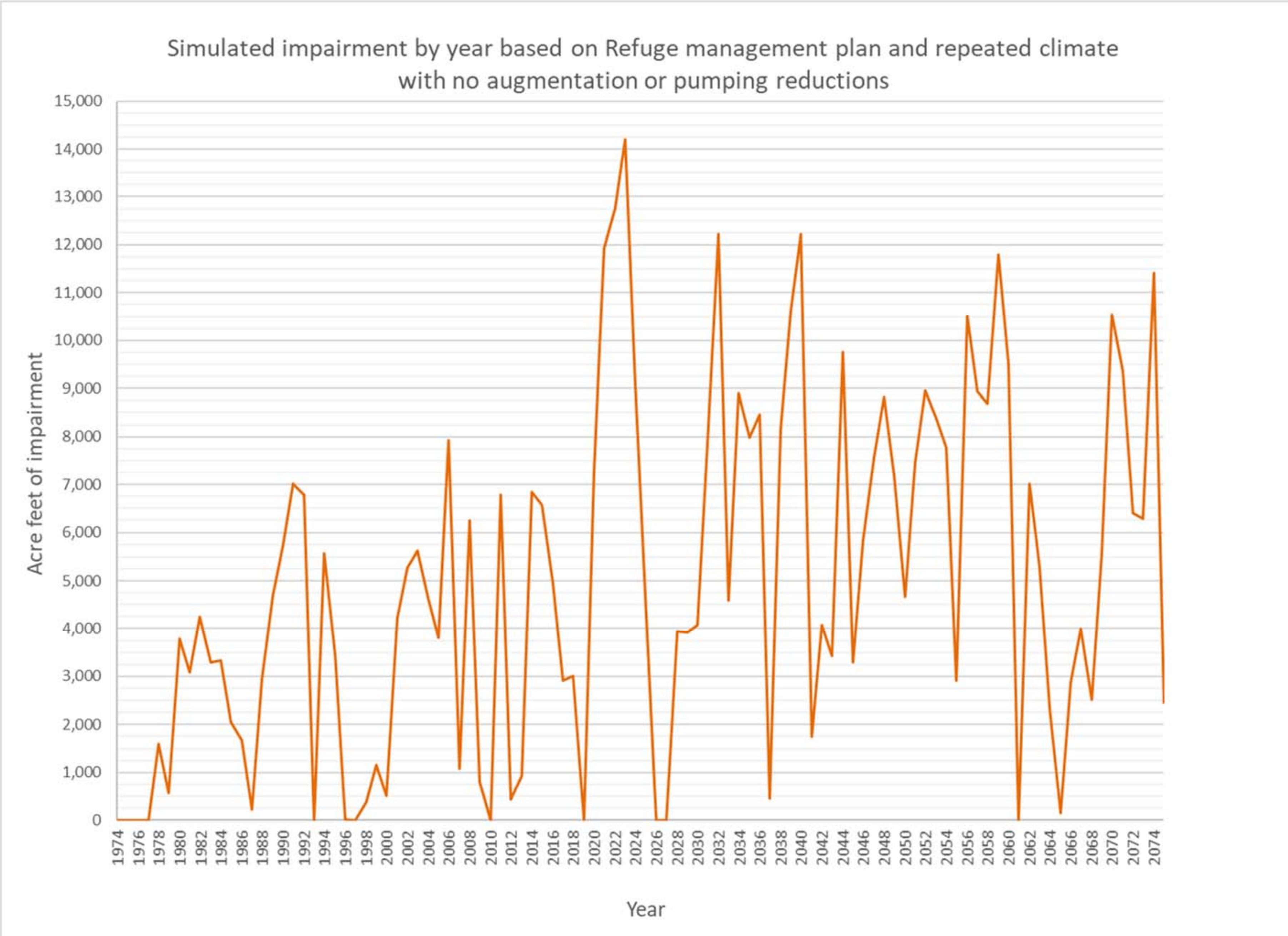


Figure 3 - Simulated impairment with no management actions
Source: streamflow and pumping depletions - BBGMD #5 Groundwater Model; Refuge needs – USF&W Service

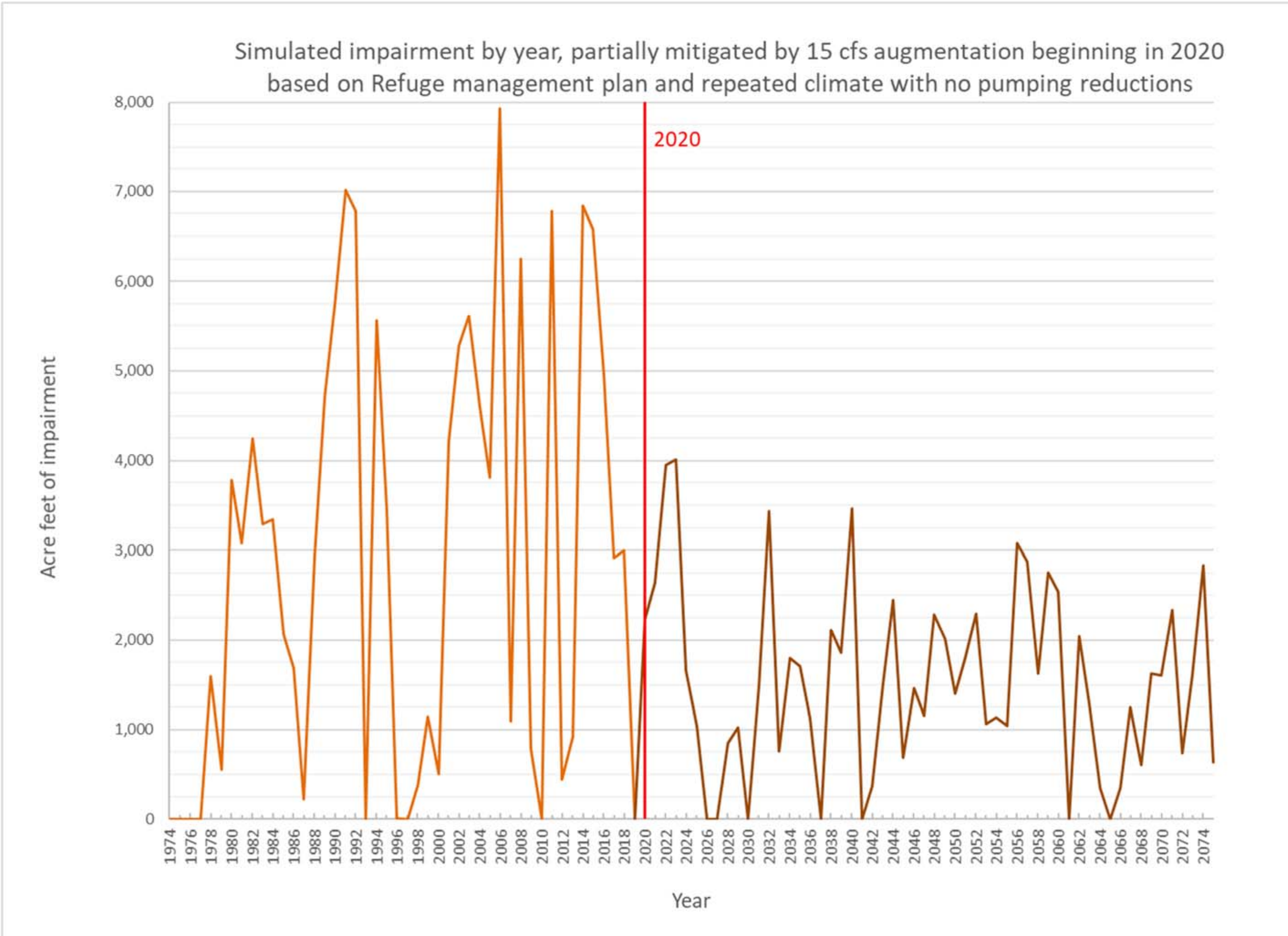
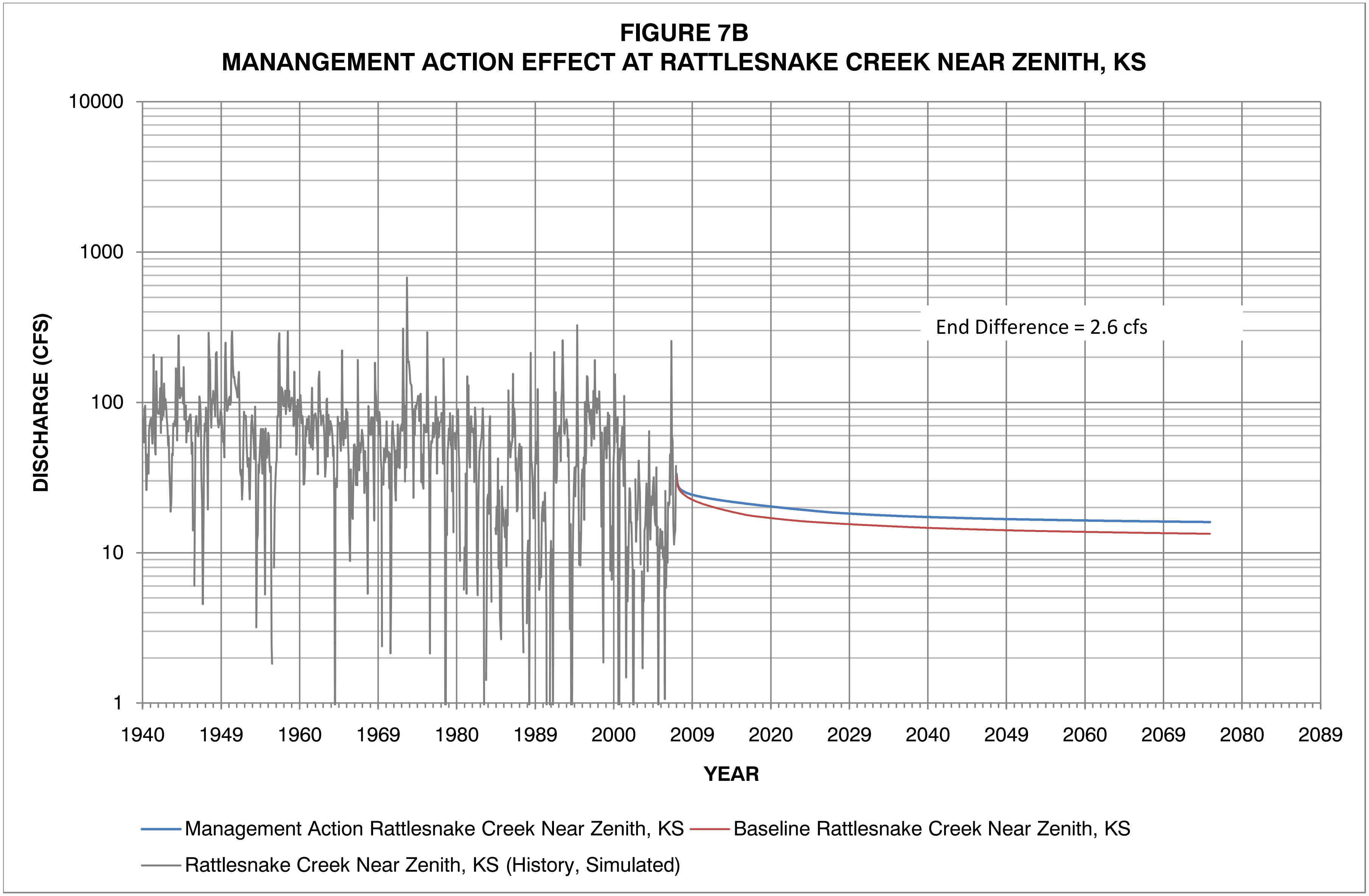


Figure 4 - Simulated impairment with augmentation available in 2020
Source: streamflow and pumping depletions - BBGMD #5 Groundwater Model; Refuge needs – USF&W Service

Attachment 1

GMD #5

MODEL



ScenarioPlotsBprime.xlsb
BY
6/14/2010

BALLEAU GROUNDWATER, INC.