No. 141, Original

In the

SUPREME COURT OF THE UNITED STATES

STATE OF TEXAS,

Plaintiff,

v.

STATE OF NEW MEXICO and
STATE OF COLORADO,

Defendants

OFFICE OF THE SPECIAL MASTER

DECLARATION OF IAN M. FERGUSON, Ph.D., P.E. IN SUPPORT OF THE UNITED STATES' OPPOSITION TO PROPOSED DECREE

I, Dr. Ian M. Ferguson, declare as follows:

1. I am over 18 years of age and have personal knowledge of the facts stated herein.

2. I earned a Bachelor of Science and Engineering degree (with Honors) in Civil and Environmental Engineering from Princeton University and a Master's and Doctorate in Civil and Environmental Engineering from the University of California at Berkeley. My Ph.D. work involved analysis of regional drought conditions.

3. From 2005 to 2008, I was a Student Employee Graduate Research Fellow at Lawrence Livermore National Laboratory, where my work focused on evaluating the influence of ocean-atmosphere interactions on regional precipitation and drought characteristics and quantifying the potential predictability of regional drought events at seasonal-to-interannual timescales.

4. From 2008 to 2009, I was a Lawrence Scholar at Lawrence Livermore National Laboratory, where my work focused on validating simulated hydroclimatic variability and ocean-atmosphere interactions in global climate models and using global climate models to evaluate potential impacts of climate change on large-scale precipitation patterns and regional drought characteristics.

5. From 2009 to 2011, I was a postdoctoral research fellow at the Colorado School of Mines, where my work focused on the development and application of integrated hydrologic models to evaluate the impacts of climate change, land use change, and water management practices on surface water and groundwater resources and groundwater/surface-water interactions.

6. Since 2011, I have been employed as a hydrologic civil engineer at the Bureau of Reclamation's Technical Service Center in Denver, Colorado. During my career with the Technical Service Center, I have provided technical support for planning and operation of Reclamation projects in California, Oregon, Washington, New Mexico, Texas, Colorado, Nebraska, Kansas, and Oklahoma. I have developed and applied surface water, groundwater, and water operations models, including models that simulate the operation of river and reservoir systems, surface water irrigation systems, and conjunctive management of surface water and groundwater.

7. Since 2011, I have provided ongoing technical support related to planning and operation of the Rio Grande Project. My technical support has included: the compilation and review of historical Project records; analysis of historical Project operations; review and evaluation of previous modeling and analysis of the Project area; development and application of models of the Project area; and review and analysis of proposed changes to Project allocation and accounting procedures, among other tasks.

8. Since 2013, I have served as Reclamation's technical lead on the development of two hydrologic models of the Rincon and Mesilla Basins in collaboration with the U.S. Geological Survey: the Rincon and Mesilla Basins Hydrologic Model (RMBHM), completed in 2015, and the Rio Grande Transboundary Integrated Hydrologic Model (RGTIHM), completed in 2018 and subsequently updated in 2020 and 2022. Both models simulate Project releases, diversions, deliveries, and return flows, groundwater pumping for irrigation and non-irrigation uses, and groundwater/surface-water interactions within the Rincon and Mesilla Basins.

9. My involvement in *Texas v. New Mexico*, Original No. 141 began in 2014, when I was assigned to provide technical support for the litigation. I was disclosed as an expert witness for the United States in 2019. My deposition was taken on February 19 and 20, 2020. The opinions and subject matter of my expected testimony are included in United States' Trial Exhibit Nos. 283, 284, 296, 297, 299, and 301. My curriculum vitae and list of my publications are United States' Trial Exhibit Nos. 302 and 303, respectively.

10. I have reviewed the Supreme Court's 2018 decision in this case and the Special Master's Order of May 21, 2021.

11. I have reviewed the filings made by the States on November 14, 2022, including the proposed consent decree and the declarations of Robert Brandes, William Hutchinson, Margaret

Barroll, Gregory Sullivan, Michael Hamman, and Robert Skov. I have also reviewed the attachments to those declarations. I am familiar with all of the technical and operational components of the proposed decree, including but not limited to the Effective El Paso Index, the Departure Limits, Management Triggers, and the changes to Project operations, allocations, and accounting outlined in Section 8 of Appendix 1. I am also familiar with the data and methods that were used to develop the Index.

12. I have been asked to provide a declaration stating my opinions regarding the hydrologic conditions and state of water use in the Rincon and Mesilla Valleys in 1930s as compared to those during the period 1951-1978, referred to as the D2 Period; impacts of those changes on Project surface water supplies; and implications of those impacts with respect to the States' proposed decree. This declaration presumes familiarity with the general history and operation of the Project as described by the Supreme Court and the Special Master's Order of May 21, 2021 Order.

Hydrologic Conditions and Water Use during the 1930s

13. The 1930s were generally characterized by average to above average hydrologic conditions. During this time, Project releases were measured from the Rio Grande Below Elephant Butte Dam gage from 1930 to 1937, and measured from the Rio Grande Below Caballo Dam gage beginning in 1938. Analysis of daily flow records from these gages shows that annual Project releases during the 1930s ranged from approximately 636,000 acre-feet in 1934 to more than 831,000 acre-feet in 1932, with an average annual release of approximately 771,000 acre-feet. Rio Grande Project History reports from the 1930s show that Project releases were sufficient to provide a final allotment to Project lands of at least 3.0 acre-feet per acre in all years 1930 to 1939.

14. The Rio Grande Joint Investigation in the Upper Rio Grande Basin (Joint Investigation) evaluated and characterized water uses throughout the Basin in the 1930s, including water use for irrigation and non-irrigation purposes in the Rincon and Mesilla Valleys. Data collection and analysis were completed in 1936-1937 and a final report detailing the study's key findings and conclusions was published in February 1938 ("Joint Investigation Report" or "JIR").

15. At the time of the Joint Investigation, irrigation was by far the dominant water use in all sections of the Basin [JIR at p. 87]. Irrigation water in the Elephant Butte-Fort Quitman section of the Basin, which includes the Rincon and Mesilla Valleys, was supplied by the Project.

16. There was no appreciable groundwater pumping for irrigation below Elephant Butte Reservoir and "no immediate probability of extensive ground-water development as a basic supply" for irrigation in this section of the Basin [JIR at p. 55-56].

17. The JIR states that there was a small amount of groundwater pumping associated with domestic uses in the villages and towns between San Marcial, New Mexico and the Texas state line, which resulted in an estimated stream depletion of approximately 2,400 acre-feet annually [JIR at p. 105].

18. At the time of the Joint Investigation, drainage return flows were recognized and understood to be an important source of water within the Basin and specifically within the Project [JIR at p. 47-49]. During the period 1930-1936, approximately half of Project's net diversions returned to the Rio Grande as drainage return flows [JIR at Table 45] and drainage return flows made up approximately 17% of the Project's total net diversions [JIR at Table 90]. The JIR further noted that the portion of Project net diversions made up of drainage return flows

increased with distance downstream, with more than 35% of net diversions in the upper El Paso Valley (Franklin Canal) and more than 57% of net diversions in the lower El Paso Valley (Tornillo Canal) made up of drainage return flows [JIR at Table 90].

19. The Special Master's May 21, 2021 Order and the expert witnesses for the parties have also recognize that drainage return flows were an important component of the Project's water supply and that groundwater pumping for irrigation and other uses in New Mexico below Elephant Butte was minimal prior to the 1950s.

Hydrologic Conditions and Water Use during the D2 Period (1951-1978)

20. In contrast to the 1930s, the D2 Period was generally characterized by dry hydrologic conditions with below normal reservoir inflow, storage, and releases. Analysis of daily flow records for the Caballo gage shows that annual Project releases ranged from approximately 206,000 acre-feet in 1964 to 737,100 acre-feet in 1958, with an average annual release of approximately 506,000 acre-feet.

21. The D2 Period was also characterized by extensive development of groundwater in the Rincon and Mesilla Valleys. This development is characterized in the C.S. Conover reports of 1947 and 1954, in Project Histories, and in Project investigations from this era. In the 1940s, irrigators within the Project began to drill irrigation wells in response to declining inflows and storage in Elephant Butte Reservoir and Caballo Reservoirs, and projections of low surface water supplies [Conover 1954; Gunaji 1967; Expert Report of Margaret Barroll, Ph.D., October 31, 2019]. The well-drilling and development of groundwater as a source for irrigation water accelerated in 1951, when drought conditions resulted in reduced Project surface water supplies [Expert Report of Margaret Barroll, Ph.D., October 31, 2019].

22. New Mexico's modeling and expert analysis indicates that groundwater pumping for irrigation within Elephant Butte Irrigation District (EBID) exploded from less than 5,500 acre-feet in 1949 to approximately 94,000 acre-feet in 1951 and 290,000 acre-feet by 1956. Groundwater pumping remained entrenched as a source of supply even when conditions improved. Over the entire D2 period of 1951 to 1978, average annual groundwater pumping within EBID exceeded 150,000 acre-feet per year. Annual pumping exceeding 100,000 acre-feet 20 out of 28 years during this period. [Expert Report of Gregory K. Sullivan and Heidi M. Welsh (2nd Edition), July 15, 2020].

23. In addition to groundwater pumping *within* EBID, groundwater development in New Mexico *outside* of EBID increased significantly during the D2 Period, both for irrigation and for other purposes. Irrigated lands outside of EBID do not receive surface water from the Project; these lands are irrigated solely using groundwater and are referred to by New Mexico as "groundwater-only lands" or "primary groundwater lands." New Mexico's modeling and expert analysis does not reflect any groundwater-only lands in the Rincon and Mesilla Valleys in New Mexico prior to 1948.

24. New Mexico's modeling and expert analysis shows that between 1948 and 1950, approximately 1,200 acres of groundwater-only lands were developed in this area, and by 1955, there were more than 4,200 acres of groundwater-only lands. New Mexico's experts estimate that the average annual groundwater pumping for irrigation of groundwater-only lands in New Mexico during the D2 Period was more than 14,800 acre-feet per year. The acreage of groundwater-only lands and corresponding consumptive use in Texas remained negligible throughout the D2 Period [Expert Report of Gregory K. Sullivan and Heidi M. Welsh (2nd Edition), July 15, 2020].

25. The New Mexico modeling and expert analysis also show that annual groundwater pumping in New Mexico in the Rincon and Mesilla Valleys for DCMI uses increased from less than 750 acre-feet per year in 1940, to approximately 2,800 acre-feet in 1950, to approximately 20,000 acre-feet per year by the end of the D2 Period in 1978 [Expert Report of Gregory K. Sullivan and Heidi M. Welsh (2nd Edition), July 15, 2020].

26. As a result of drought conditions and the reduction in Project surface water supplies due to groundwater pumping, Project releases were sufficient to provide a final allotment to Project lands of 3.0 acre-feet in only 10 out of the 28 years in the D2 Period, with reduced allotments in the remaining 18 years, as reflected in the Project Histories from this period.

Impacts on Project Water Supply

27. Groundwater pumping in the Rincon and Mesilla Valleys reduces Project surface water supplies by reducing drainage return flows and reducing seepage gains to, or increasing seepage losses from, the Rio Grande.

28. The effects of groundwater pumping on available surface water supplies were recognized in the Joint Investigation. The JIR states that "in general, extensive development of ground water for irrigation would add no new water to the Upper Rio Grande Basin and that recharge of the ground-water basins would necessarily involve a draft on surface water supplies which are now utilized otherwise" [JIR at p. 56]. The authors of the JIR thus understood that rather than providing additional supply to the basin, use of groundwater would instead reduce the available surface water supply [JIR at p. 56].

29. Table 1 (below) summarizes the impacts of New Mexico groundwater pumping in the Rincon and Mesilla Valleys on average annual gross diversions to EBID and EPCWID and average annual streamflow at the Rio Grande at El Paso gage over the D2 Period. I calculated

the figures in Table 1 using data from two simulations of New Mexico's Integrated Lower Rio Grande Model (ILRGM): "Historical Base Run" (Run 1) and "NM Pumping Off" (Run 3) [Rebuttal Expert Report of Gregory K. Sullivan and Heidi M. Welsh (2nd Edition), September 15, 2020]. The difference between Run 1 and Run 3 can be interpreted as the impact of New Mexico groundwater pumping [Expert Report of Gregory Sullivan and Heidi Welsh (2nd Edition), July 15, 2020].

30. Under the "NM Pumping Off" condition (Run 3), average annual diversions to EBID during the D2 Period increase by 52,204 acre-feet per year (+14%) and average annual diversions to EPCWID increase by 34,639 acre-feet per year (+14%) compared to the "Historical Base Run" (Run 1). Average annual streamflow at the Rio Grande at El Paso gage ("El Paso gage") increased by 63,548 per year (+25%) compared to the Historical Base Run. New Mexico's modeling results demonstrate that groundwater pumping in New Mexico substantially reduced Project diversions and streamflows at the El Paso gage during the D2 Period.

Table 1: Simulated Average Annual Diversions and Streamflows: 1951-1978

	Historical Base Run (Run 1)	NM Pumping Off (Run 3)	Difference (Run 3 - Run 1)	Percent Difference
Gross Diversion to EBID	382,246	434,450	52,204	+14%
Gross Diversion to EPCWID	247,087	281,726	34,639	+14%
Flows at El Paso gage	251,613	315,161	63,548	+25%

31. The modeling results summarized in Table 1 represent the impacts of groundwater pumping under the hydrologic conditions and water uses during the D2 Period. As discussed above, the D2 Period was characterized by dry hydrologic conditions and extensive groundwater development in New Mexico. However, New Mexico's modeling and analysis demonstrate that New Mexico groundwater pumping in the Rincon and Mesilla Valleys is not limited to dry

hydrologic conditions and also impacts Project surface water supplies under wetter hydrologic conditions.

32. The period 1979-2002, for example, was characterized by persistently wet conditions with above normal reservoir inflow, storage, and releases. Despite persistent wet conditions, New Mexico's modeling and expert analysis shows that New Mexico groundwater pumping in the Rincon and Mesilla Valleys remained prevalent throughout this period. New Mexico modeling and expert analysis show that the average annual groundwater pumping within EBID during this period was greater than 47,000 acre-feet per year. While this is far less than the average annual pumping within EBID during the D2 Period (which exceeded 150,000 acre-feet per year), it is far greater than the amount of pumping within EBID during the 1930s, which was negligible and potentially nonexistent. Moreover, New Mexico groundwater pumping for irrigation of groundwater-only lands in the Rincon and Mesilla Valleys increased from approximately 14,800 acre-feet per year during the D2 Period to approximately 17,250 acre-feet per year during the period 1979-2002, an increase of 2,450 acre-feet per year (+16%). Average annual groundwater pumping in New Mexico for DCMI uses showed an even greater increase from approximately 11,000 acre-feet per year during the D2 Period to approximately 30,000 acre-feet per year during the period 1979-2002, an increase of 19,000 acre-feet per year (+173%).

33. Under the "NM Pumping Off" condition (Run 3), average annual diversions to EBID during the period 1979-2002 increase by 2,049 acre-feet per year and average annual diversions to EPCWID increase by 11,105 acre-feet per year compared to the "Historical Base Run" (Run 1). New Mexico's modeling results thus demonstrate that New Mexico groundwater pumping in

the Rincon and Mesilla Valleys substantially reduced Project surface water supplies even under persistently wet hydrologic conditions.

Implications for the States' Proposed Consent Decree

34. The proposed consent decree defines the Compact apportionments to New Mexico and Texas below Elephant Butte based on the Effective El Paso Index ("EEPI" or "Index") [Decree at Appendix 1, Section 1]. The EEPI consists of the Index Obligation, Index Delivery, Index Departures, and other provisions.

35. Under the proposed decree, Texas's entitlement to water is defined by the Index Obligation, subject to Index Departures and other provisions of the decree [Decree at II.B.ii.b], and New Mexico's entitlement to water below Elephant Butte is the balance of water released from Caballo Dam and any other inflows in excess of the Index Obligation.

36. The Index Obligation was developed based on a regression analysis of measured and estimated data for the D2 Period of 1951-1978, including measured streamflows at the Rio Grande below Caballo Dam gage and at the El Paso gage [Decree at II.B.ii.e]. The Index Obligation is intended to reflect "the hydrologic conditions and the state of water use and groundwater development during the baseline D2 Period" [Declaration of Margaret Barroll, Ph.D., November 14, 2022 at ¶ 24], including the extensive development of groundwater for irrigation and non-irrigation uses in New Mexico during this period [Declaration of Margaret Barroll, Ph.D., November 14, 2022 at ¶ 26-27].

37. As discussed above, New Mexico groundwater pumping in the Rincon and Mesilla Valleys significantly reduced annual streamflow at the El Paso gage during the D2 Period of 1951-1978. Texas's entitlement to water under the proposed decree based on the Index Obligation therefore excludes the water that Texas would have received during the D2 Period but

for the impacts of New Mexico groundwater pumping. Conversely, New Mexico's entitlement to the "balance" of the water includes an entitlement to the post-Compact depletions of streamflow associated with New Mexico groundwater pumping during the D2 Period of 1951-1978.

38. Since 2003, the Project has experienced persistent dry conditions similar to – and by some measures, worse than – those during the D2 Period. New Mexico modeling and expert analysis show that, while groundwater pumping within EBID has returned to levels similar to the D2 Period, groundwater pumping by non-Project water users for irrigation of groundwater-only lands and for DCMI use have remained far above those during the D2 Period. New Mexico modeling results demonstrate that groundwater pumping by non-Project water users in New Mexico continues to reduce the Project surface water supply, including diversions to EBID and EPCWID and streamflows at the El Paso gage.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed this 20th day of January, 2023, at Golden, Colorado

Ian M. Ferguson, Ph.D., P.E.