

APPENDIX D

**STUDY OF THE EFFECTS OF THE PROVISIONS OF
SUBPARAGRAPHS 9.1 AND 9.2 OF THE SETTLEMENT AGREEMENT
ASSUMING HISTORIC HYDROLOGY FOR THE
AVAILABLE PERIOD OF RECORD 1956-2003**

**Annual Summary of Amounts of Water Released from Navajo Reservoir Storage
to Provide a Minimum Direct Flow of 225 cfs as per Subparagraph 9.1 of the
Agreement and to Meet the Alternate Water Source Provisions for
Navajo Nation San Juan River Diversions, including the Fruitland and Hogback
Irrigation Projects, as per Subparagraph 9.2 of the Agreement**

Study of the Effects of the Provisions of Subparagraphs 9.1 and 9.2 of the Settlement Agreement Assuming Historic Hydrology for the Available Period of Record 1956-2003

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Year	Modeled May 31 Navajo Reservoir Storage (1) (af)	Release from Storage to Maintain 225 cfs Minimum Direct Flow (af)	Release from Storage for Alternate Water Source Demands for Fruitland and Hogback (2) (af)	Ten-year Running Average of Releases per Alternate Water Source Provisions (af)	Depletion of Release from Storage for Alternate Water Source Demands for Fruitland and Hogback Projects (3) (af)	Ten-year Running Average of Depletions per Alternate Water Source Provisions (af)	Shortage to Direct-Flow Uses Not Met by Alternate Water Source Provisions (4) (af)	Period of Shortage to Direct-Flow Uses (dates)
1956	944,200	0	12,000		5,184		19,864	9/11-10/31
1957	891,700	0	0		0		0	
1958	1,685,700	0	222		96		0	
1959	1,388,300	690	12,000		5,184		7,109	9/12-9/30
1960	1,377,700	0	4,979		2,151		0	
1961	1,269,600	0	212		92		0	
1962	1,440,500	0	3,855		1,665		0	
1963	1,424,400	0	2,383		1,029		0	
1964	1,173,100	0	726		314		0	
1965	1,145,600	0	0	3,638	0	1,571	0	
1966	1,670,900	0	683	2,506	295	1,083	0	
1967	1,360,200	0	0	2,506	0	1,083	0	
1968	1,281,300	0	10	2,485	4	1,073	0	
1969	1,393,300	0	0	1,285	0	555	0	
1970	1,481,900	0	113	798	49	345	0	
1971	1,506,000	0	1,210	898	523	388	0	
1972	1,372,200	0	9,025	1,415	3,899	611	0	
1973	1,374,000	0	0	1,177	0	508	0	
1974	1,591,500	0	10,179	2,122	4,397	917	0	
1975	1,325,300	0	0	2,122	0	917	0	
1976	1,530,600	0	0	2,054	0	887	0	
1977	1,188,900	216	10,203	3,074	4,408	1,328	0	
1978	1,085,000	0	7,560	3,829	3,266	1,654	0	
1979	1,204,500	0	0	3,829	0	1,654	0	
1980	1,451,900	0	0	3,818	0	1,649	0	
1981	1,432,300	0	651	3,762	281	1,625	0	
1982	1,502,800	0	0	2,859	0	1,235	0	
1983	1,468,100	0	0	2,859	0	1,235	0	
1984	1,654,300	0	0	1,841	0	795	0	
1985	1,567,400	0	0	1,841	0	795	0	
1986	1,429,500	0	0	1,841	0	795	0	
1987	1,571,400	0	0	821	0	355	0	
1988	1,543,400	0	0	65	0	28	0	
1989	1,511,800	0	1,229	188	531	81	0	
1990	1,278,400	0	0	188	0	81	0	
1991	1,523,100	0	0	123	0	53	0	
1992	1,542,500	0	0	123	0	53	0	
1993	1,616,900	0	0	123	0	53	0	
1994		0	9	124	4	53	0	
1995		0	0	124	0	53	0	
1996		0	4,622	586	1,997	253	0	
1997		0	0	586	0	253	0	
1998		0	0	586	0	253	0	
1999		0	0	463	0	200	0	
2000		0	11,059	1,569	4,777	678	0	
2001		0	121	1,581	52	683	0	
2002		0	6,000	2,181	2,592	942	63,758	6/25-10/25
2003		0	6,000	2,781	2,592	1,201	8,542	multiple (5)
Average		19	2,189		945		2,068	

Notes:

- (1) Modeled storage is from the draft Navajo Reservoir operations EIS. Navajo Reservoir gaged inflow records are available daily beginning 1956, and the modeling period used in the EIS ended 1993. The total depletion in New Mexico used in the model was 610,600 acre-feet, as compared to 609,800 acre-feet projected in New Mexico's Upper Basin depletion schedule. The total depletion served from the Navajo Reservoir water supply is also similar between documents. It is assumed that May 31 storage in 2002 and 2003 would be modeled under full development conditions to be less than 1 million acre-feet due to the severity of the recent drought, and in particular, the 10% of average runoff that occurred in 2002.
- (2) Model results showed no shortages to the amount of depletions modeled while operating Navajo Dam to make contract deliveries and to meet flows for endangered fish habitat in the San Juan River recommended by the San Juan River Basin Recovery Implementation Program. Under full development, shortages may have occurred during 2002 and 2003, and a 10% shortage to the Navajo Indian Irrigation Project diversion demand is assumed for both years.
- (3) The depletion of the releases from storage for delivery to the Fruitland and Hogback projects is computed assuming an incremental river channel loss of 2%, a project efficiency of 38% (38% of the diversion satisfies the consumptive irrigation use after accounting for canal and irrigation efficiencies), and incidental depletions equal to 16% of the consumptive use. Possible re-diversion and re-use at Hogback of incremental return flows from the Fruitland project resulting from diversion of alternate source water at Fruitland is not included in this calculation.
- (4) Return flows from diversions by the Fruitland and Hogback projects under the alternate water source provisions might be credited towards meeting the habitat flow needs of endangered fish in the San Juan River and might be released from Navajo Dam to maintain such habitat flows without the alternate water source provisions. The amount of release chargeable to the NIIP contract right might vary depending on the recommended flows for endangered fish habitat, Navajo Dam operations to meet such flows, whether any portions of the return flows bypass gages used to measure performance under the flow recommendations, and the extent to which dam releases for endangered fish habitat might be considered as carriage water. To the extent that Navajo Dam releases made to meet the flow recommendations can be considered as carriage water and not as a delivery chargeable against the NIIP contract diversion right, the periods of shortage could be shortened and the depletions associated with alternate water sourcing for 1956, 1959, 2002 and 2003 chargeable to the NIIP contract right would exceed those shown, and the releases from storage specifically for use at Fruitland and Hogback for other years would be less than those shown. The flow recommendations for endangered fish habitat are subject to change through adaptive management.
- (5) Periods of shortage to direct-flow users include July 26-28, August 4-14, August 20-23, and September 27-October 31. Based on provisional flow data for 2003.

Summary of findings:

- (1) The provisions of subparagraph 9.1 of the Settlement Agreement do not affect contract deliveries from runoff above Navajo Dam.
- (2) Under the alternate water source provisions of subparagraph 9.2 of the Settlement Agreement, the years of shortage experienced by the direct-flow users below Navajo Dam are reduced from 46% of the years (22 years out of 48, excluding total shortages of 10 acre-feet or less in 1968 and 1994) to 8% of the years (4 years out of 48) for the period of record. If historic hydrology patterns repeated, about two years of shortage would occur every 45 years or so, or in about 4% of years, pursuant to subparagraph 9.2. If releases made from Navajo Dam to benefit endangered fish species in the San Juan River can be used as carriage water to and through the Fruitland and Hogback projects, the releases from Navajo Dam made pursuant to subparagraph 9.2 can provide greater coverage against the occurrence or extent of priority calls. Actual accounting of alternate water source deliveries would be determined based on conditions at the times of delivery.

Assumptions generally used in study:

- (1) Analysis considers only water rights in New Mexico.
- (2) Hogback and Fruitland projects combined divert about 325 cfs every day during April through October (includes municipal and domestic use diversions at Shiprock pursuant to subparagraph 3(d) of the proposed Partial Final Decree).
- (3) Rate of daily average direct flow needed to satisfy all demands of direct flow users during April-September:
 - (a) combined direct flow of the Animas River near Cedar Hill and the San Juan River at Archuleta of 700 cfs, with direct flow of the San Juan River at Archuleta of 250 cfs; or
 - (b) direct flow of the San Juan River at Archuleta of 450 cfs, with direct flow of the Animas River near Cedar Hill of 250 cfs or less.
- (4) Rate of daily average direct flow needed to satisfy all demands of direct flow users during October:
 - (a) combined direct flow of the Animas River near Cedar Hill and the San Juan River at Archuleta of 500 cfs, with direct flow of the San Juan River at Archuleta of 250 cfs; or
 - (b) direct flow of the San Juan River at Archuleta of 250 cfs, with direct flow of the Animas River near Cedar Hill of 250 cfs or less.
- (5) Direct flow of the San Juan River at Archuleta equals the maximum of:
 - (a) the inflow to Navajo Reservoir computed using a water budget computation for the reservoir, averaged over three consecutive days; and
 - (b) the sum of the gaged inflows to Navajo Reservoir at four gaging stations (San Juan River at Carracas, Piedra River near Arboles, Los Pinos River at La Boca, and Spring Creek at La Boca), plus 20 cfs for intervening inflow between the gages and Navajo Dam under pre-dam conditions, averaged over three consecutive days.
 Provided, that the direct flow, if computed pursuant to (a) and (b) to be less than 225 cfs, will be determined for the purpose of water rights administration as a minimum of 225 cfs if Navajo Reservoir storage exceeds 1 million acre-feet at the end of May.

Sensitivity of results to study factors:

Factor:

- (a) Peak irrigation consumptive use and river loss conditions apply during April-September
- (b) Irrigation, including at Fruitland and Hogback, is at maximum cfs rates with no annual volume limits
- (c) No inflows occur below Cedar Hill and Navajo Dam, including from the La Plata River, except return flows
- (d) Historic flows repeat on the Animas River near Cedar Hill and in the drainage above Navajo Dam

Impact on estimated shortages and the amounts of release pursuant to the alternate water source provisions:

- tends to over-estimate
- tends to over-estimate
- tends to over-estimate
- impact depends on future hydrology and uses in Colorado

Other remarks:

State Engineer administration of the rights to divert from the direct flow and from stored water is expected to follow approval of statewide rules and regulations for active water resource management. It is anticipated that a draft water resources administration manual for the San Juan River Basin may be released for public review and comment in 2005. The assumptions made in this study regarding the determination of the direct flow at Navajo Dam and administration of the direct flow should not be viewed to pre-determine the outcome of the public review process on basin-specific administrative criteria. Regardless of differences that may occur between study assumptions and actual administration conditions, it can be concluded from the study that the alternate water source provisions provide significant protection to direct-flow users in the San Juan River Basin in New Mexico against the occurrence of curtailment by priority call when the direct flow is insufficient to meet all the demands under the rights to divert and use direct flow in New Mexico. The Navajo Nation and non-Navajo water users in the Basin will still need to cooperatively address severe drought conditions from time to time in the future.