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Wyoming's Amended Proposed Findings of Fact Volume IIIA

Attorney General, State of Wyoming

BIG HORN ADJUDICATION

WYOMING'S AMENDED PROPOSED MASTER'S REPORT

CONCERNING WATER RIGHTS FOR THE

WIND RIVER INDIAN RESERVATION

1982

VOLUME III

Amended Proposed Findings of Fact

(Series 6 through 26)

PART A

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Margaret V. Hampton CLERK

DEPUTY

IN THE DISTRICT COURT OF THE

FIFTH JUDICIAL DISTRICT

STATE OF WYOMING

IN RE: THE GENERAL ADJUDICATION OF ALL RIGHTS TO USE WATER IN THE BIG HORN RIVER SYSTEM AND ALL OTHER SOURCES, STATE OF WYOMING	)))))	CIVIL NO. 4993

REPORT OF THE SPECIAL MASTER CONCERNING THE RESERVED WATER RIGHT CLAIMS BY AND ON BEHALF OF THE TRIBES OF THE WIND RIVER INDIAN RESERVATION, WYOMING

VOLUME 3

This volume contains Wyoming's Amended Proposed Findings of Fact, sections 7-1 through 26-1, inclusinve, as more fully described on p. i of the Table of Contents immediately following.

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Finding of Fact Relating to the Concept of Minimum Needs

7-1 Since no evidence was adduced to the contrary, the Court finds that the purposes of the Wind River Indian Reservation have and will continue to be satisfied by the historic levels of water usage. In other words, continuation of historic usage would not entirely defeat Congress' primary purpose when it created the reservation.

Note:

The State of Wyoming has intentionally submitted no Findings of Fact, numbered 8-1, 9-1, 10-1, 11-1, et seq.

Findings of Fact
Relating to
Domestic, Commercial and Municipal

12-1 Claims of the United States and Tribes.

The United States originally claimed a total of 3,810 acre feet of water annually for municipal, domestic and commercial uses on the Wind River Indian Reservation. The Tribes originally claimed an additional 31,000 acre-feet annually for municipal, domestic and commercial uses in addition to the claims filed by the United States. The Tribes later amended their claims, however, to conform with the evidence presented at trial by the United States.

12-1 See United States' Statement of Claim (filed March 6, 1980) at 3. See also, Statement of the Shoshone and Arapahoe Tribes Concerning the Measurement of Tribal Reserved Water Rights (filed April 4, 1980), and Amended Statement of the Shoshone and the Arapahoe Tribes concerning the Measurement of Tribal Reserved Water Rights (filed July 16, 1981).

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12-2 United States' Economic Expert for domestic, commercial and municipal.

In support of its claim, the United States presented the testimony of Mr. James P. Merchant of David Dornbush and Co. of San Francisco, California. Over objection, the Master accepted Mr. Merchant as an expert in economics. Mr. Merchant also testified in support of the United States' claims to water for mineral development and livestock purposes. Through Mr. Merchant's testimony, the United States modified its claim for municipal, commercial and industrial purposes to 1,041 acre-feet annually in 1980; 1,524 acre-feet annually in the year 2000; and 2,226 acre-feet annually in the year 2020.

12-2 Mr. Merchant's direct testimony concerning municipal, domestic and commercial water needs appears at pp. 402 through 486 of the transcript. The Master accepted the United States' tender of Mr. Merchant as an expert in economics at p. 230. Mr. Merchant's summation of the total claims of the United States for municipal, domestic and commercial water needs is given on p. 482. The United States' moved to conform its pleadings to the evidence on July 16, 1981. Tr. 7870 (Echohawk). The Master granted the motion, Tr. 7871, which reduced the United States' claims to the above specified totals.

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12-3 State's expert in water resource engineering re: domestic commercial and municipal water requirements.

The Tribes presented no expert testimony concerning municipal, domestic and commercial water needs on the Wind River Indian Reservation. The State of Wyoming presented the testimony of Mr. Gordon Fassett, who was accepted by the Court as an expert in water resource engineering. Mr. Fassett stated that the total municipal, domestic and commercial water requirements of the Reservation, based on his research of water usage in the Big Horn River Basin, were as follows: 858 acre-feet annually in 1980; 1,255 acre-feet annually in the year 2000; and 1,834 acre-feet annually in the year 2020.

12-3 Mr. Fassett's testimony concerning municipal, domestic and commercial water needs is given on Tr. 11,613 through 11,623. Mr. Fassett had previously been accepted as an expert in water resources engineering by the Court on Tr. 9,541 with years of demonstrated professional experience in municipal water supply and use studies. Wyo. Exh. MF-1. Mr. Fassett's testimony concerning total water needs for municipal, domestic and commercial purposes is given on Tr. 11,622.

12-4 Domestic, commercial and municipal needs based on current and projected Indian populations.

Both the United States and Wyoming based their studies on municipal, domestic and commercial water needs on current and projected Indian populations on the Wind River Indian Reservation; and defined Indian population as consisting of enrolled members of the Shoshone and Arapahoe tribes and their immediate families.

Mr. Merchant presented the Court with population projections for the Tribes, and the State of Wyoming accepted those projections solely for the purpose of determining municipal, domestic and commercial water needs.

12-4 The United States' development of population projections for the Tribes is described in Tr. 402 and 403 (Merchant). Wyoming's acceptance of these population projections is detailed by Mr. Merrill on p. 11,606.

12-5 Differences between positions of United States and Wyoming for Riverton.

The only differences between the positions of the United States and Wyoming on municipal, domestic and commercial water needs involved the cities of Riverton and Fort Washakie. The United States claimed 36 acre feet of water annually in 1980, rising to 78 acre feet of water annually in the year 2020 for tribal members living in Riverton. Wyoming established that Indians living in Riverton currently receive water from the Riverton Municipal Water System, which has state-awarded water rights, and thus current and future Indian residents of Riverton have no need of reserved water rights.

12-5 The United States' claim for the Indians living in Riverton is detailed at Tr. 484 (Merchant). Mr. Fassett testified that the City of Riverton has six deep wells, three of which have been adjudicated and the other three of which have valid permits from the State of Wyoming. He further testified that Indians currently receive water through Riverton's Municipal Water System, that Indians will continue to receive water through that system and it would be "very, very difficult" to administer a dual water right system. Tr. 11,618-11,620 (Fassett).

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12-6 Differences between United States and Wyoming for Fort Washakie

The United States and Wyoming also disagreed upon per capita water used for the Town of Fort Washakie; the United States claiming an average of 325 gallons per day per capita use, while Wyoming established that 220 gallons per day was an adequate per capita figure. The difference between the parties on this issue is apparently attributable to an assumption by the United States that municipal water would be used for irrigating small parcels of land in and around Fort Washakie. Based on the lower per capita usage figure, Wyoming established that a total of 308 acre feet, 451 acre feet and 658 acre feet are required to meet the needs of the Indian population of Ft. Washakie in the years 1980, 2000 and 2020, respectively.

12-6 The United States' per capita claim for Fort Washakie is detailed in U.S. Exh. WRIR C-20. Mr. Fassett's testimony concerning Wyoming's water consumption figures for the town are given on pp. 11,616 through 11,618 (Fassett).

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12-7 Court's conclusions re: Wyoming's analysis of domestic, commercial and municipal.

The United States and Tribes did not cross examine Mr. Fassett or offer any rebuttal to his testimony. Furthermore, the Court concludes that Mr. Fassett's credentials as a water resource engineer, and particularly his experience with municipal water supplies, are more pertinent to the determination of municipal, domestic and commercial water needs than are Mr. Merchant's general qualifications as an economist. Furthermore, the Court agrees with Mr. Fassett's evaluation of the difficulty of imposing a dual water right permit system for Riverton's municipal water supply, and the lack of need for irrigating land around Fort Washakie with domestic water. Therefore, the Court concludes that Wyoming's assessment of municipal, domestic and commercial water needs should form the basis of any reserved right.

12-7 As a water resource engineer, Mr. Fassett is obviously more qualified to testify concerning per capita water needs than is Mr. Merchant. The United States and Tribes implicitly admitted this point by not offering any cross examination of or rebuttal to Mr. Fassett's testimony. (See Tr. 9536-9541 for Fassett's qualifications). The Court should, thus, adopt Wyoming's position on this issue; especially in light of the fact that the parties' only area of disagreement concerned per capita usage. Wyoming agreed to the United States' position concerning future population figures for the Tribes.

12-8 Court's conclusions re: amounts of water for municipal domestic and commercial needs.

The Court concludes that the following amounts of water, stated in annual withdrawals of acre-feet, will satisfy the domestic, commercial and municipal needs of Indians in the following areas:

Population Areas	1980	2000	2020
Little Wind River (Fort Washakie)	308	451	658
Little Wind River (Ethete)	257	375	549
Popo Agie River (Boulder Flat)	26	37	56
Arapahoe	155	228	331
Pavillion	2	3	4
Other Rural	110	161	236
Total Municipal, Domestic and Commercial	858	1,255	1,834

12-8 This finding is based on U.S. Exh. WRIR C-21 as modified by Mr. Fassett, Tr. 11622 (Fassett).

Findings of Fact
Relating to
Livestock

13-1. United States' claims for livestock uses.

The United States originally claimed the use of 2,773 acre-feet of water annually, 1,854 acre-feet as historic use and 919 acre-feet as future use, for livestock operations on the Wind River Indian Reservation. The Tribes did not seek water for livestock in addition to the amounts claimed on their behalf by the United States.

13-1. See United States Statement of Claim at 6 (filed Mar. 6, 1980); Statement of the Shoshone and Arapahoe Tribes Concerning the Measurement of Tribal Reserved Water Rights (filed Apr. 4, 1980); Amended Statement of the Shoshone and Arapahoe Tribes Concerning the Measurement of Tribal Reserved Water Rights (filed July 16, 1981).

13-2. Testimony of United States' economist re: livestock claims.

In support of its claim, the United States presented the testimony of Mr. James P. Merchant of David Dornbusch & Co. of San Francisco, California. Over objection, the Master accepted Mr. Merchant as an expert in economics. Mr. Merchant also testified in support of the United States' claims to water for mineral development and municipal, domestic and commercial purposes. Through Mr. Merchant's testimony and exhibits, the United States reduced its claim to water for livestock to 2,730 acre-feet annually.

13-2. Mr. Merchant's direct testimony concerning livestock water needs appears at pages 180 through 397 of the transcript. The Master accepted the United States' tender of Mr. Merchant as an expert in economics at page 230. U.S. Exh. WRIR C-17 states a total claim to 2,730 acre-feet annually for livestock use. The United States moved to conform its pleadings to the evidence on July 16, 1981. Tr. 7870 (Echohawk). The Master granted the motion, Tr. 7871, which reduced the federal claim to 2,730 feet annually.

13-3. Testimony of Tribes' lay witnesses re: ranching operations.

While the Tribes presented no expert testimony concerning livestock, three witnesses, Mr. Robert Harris, Mr. Pius Moss, and Mr. Frank Enos testified about their own ranching operations on the Reservation.

13-3. Tr. 7907-7946 (Harris); Tr. 7946-7984 (Moss); Tr. 7985-8006 (Enos).

13-4. Testimony of Wyoming's expert in livestock operations, management and economics.

The State of Wyoming called Dr. Bob Carver to testify concerning livestock and its water needs on the Reservation. Without objection by any party, the Master recognized and accepted Dr. Carver as an expert in livestock operations, management and economics.

13-4. Dr. Carver's testimony appears at pages 11886 through 12128 of the transcript of proceedings. The Master recognized Dr. Carver as an expert at page 11893.

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13-5. Testimony of Wyoming's expert re: historical geography of the Reservation.

The State of Wyoming also presented testimony from Dr. Paul Wilson of Missoula, Montana. The Master recognized Dr. Wilson as an expert in historical geography. Dr. Wilson's doctoral dissertation, prepared in 1972, discussed the historical geography of the Wind River Indian Reservation and evaluated the success of the Indians in farming and in ranching. Dr. Wilson is personally familiar with the Reservation as a result of living there during his childhood and having returned in the period between 1966 and 1970 to research his dissertation.

13-5. Dr. Wilson's testimony appears at pages 13178 through 13248 of the transcript. His thesis, which was admitted into evidence on 13247, is Wyo. Exh. WRIR PW-2. Tr. 13187.

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13-6. Court's findings concerning livestock.

Based on the evidence, the Court finds that, in 1980, there were approximately 18,560 head of cattle, 2,250 horses and 3,900 game animals on the Wind River Indian Reservation.

13-6. Tr. 11907 (Carver); Wyo. Exh. WRIR LC-4. Dr. Carver's determination of the 1980 livestock population of the Reservation is based upon published Bureau of Indian Affairs records. (Tr. 11902). While Rich Harbour estimated that there were 25,000 head of cattle (Tr. 101), Mr. Harbour offered no facts and data to support his livestock count and the official records of his employer, the BIA, contradict his testimony. Apparently, Mr. Merchant relied on Mr. Harbour's opinion in estimating livestock population. (Tr. 327-28, 373). The record discloses no other facts and data upon which Merchant relied in this regard.

Faced with a contradiction between Mr. Harbour's unsubstantiated opinion and the official, published data of the BIA which supports Dr. Carver's opinion, the Court should adopt the latter since it is more reliable than mere opinion concerning an objective fact. Cf. Wyo. R. Evid. 803(8).

13-7. Wildlife consumption.

The current water needs for all livestock on the Reservation, using 1980 figures, is 750 acre-feet annually. While the Court recognizes that water was not reserved for wildlife or game animals (see, purposes findings), the Court acknowledges that no decree can prevent these animals from drinking from the livestock water supplies and that the amount of water consumed by game animals is de minimis. Failing to account for inevitable consumption by game would reduce the amount legally available for livestock, a result the Court declines to permit.

13-7. Wyo. Exh. WRIR LC-4; Tr. 11954 (Carver).

While Mr. Merchant's exhibits and testimony argue for a higher figure, the Court should not adopt Mr. Merchant's analysis for several reasons. Mr. Merchant bases his consumptive use requirements on undocumented water use requirements of 15 gallons per head per day. Tr. 382-83, U.S. Exh. WRIR C-17. Dr. Carver points out this discrepancy and documents from the Merck Veterinary Manual that the daily consumption varies by season from 2.5 to 12 gallons and the maximum water requirements for a mature animal should be 12 gallons per head per day. Tr. 11956, 12121 (Carver).

Mr. Merchant begins from a base of 25,000 head to determine current consumptive requirements, Tr. 382 (Merchant), while BIA records indicate that there were approximately 17,800 head of cattle on the Reservation during the year (1980) Mr. Merchant used as a base. Tr. 11907 (Carver). Mr. Merchant reports from the HKM study that the average size of stock ponds is 2 acres. He then assumes that they remain full of water throughout the year and suffer a 2.5 acre-feet/acre evaporation loss. Tr. 387-88 (Merchant). Dr. Carver points out that as these ponds undergo evaporation and seepage loss, the average size on a 12-month basis is somewhat less than 2 surface acres. Tr. 12121.

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Mr. Merchant's estimated current livestock consumptive use is inaccurate because he used incorrect figures for individual livestock use, he began with incorrect livestock numbers as a base, and he made improper assumptions relative to surface area and evaporation losses. As a result, Mr. Merchant overestimated consumptive use requirements for current livestock operations.

In determining the current consumptive use requirement, Dr. Carver begins with the average number of cattle grazing on the Reservation during the previous 8 years (1973-80). Tr. 11902-03 (Carver). This average is obtained from BIA grazing records, and is approximately 22,000 head. Tr. 11956-59, 12121 (Carver). Dr. Carver then estimates maximum daily requirements per head from the Merck Veterinary Manual. In addition he accounted for the water requirement of horses and game animals, which Mr. Merchant failed to consider. Tr. 11960-62 (Carver). Dr. Carver then uses the estimated number of stock

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ponds as reported in the Inventory of Water Resources, Wind River Indian Reservation, and estimated the average surface area of each stock pond on a 12-month basis to be three quarters of an acre. Tr. 11960-61. Using Bureau of Reclamation estimates of evaporation water loss on the reservation, Dr. Carver estimates 2.15 acre-feet evaporation loss per surface acre. Wyo. Exh. WRIR LC-4. As a result of this analysis, Dr. Carver estimates maximum current consumptive use requirements for livestock, horses and game animals on the Wind River Indian Reservation to be 750 acre-feet annually. Id.

13-8. Expansion of livestock operations.

While expansion of the livestock operations on the Reservation is economically unfeasible, the Court finds it is nonetheless likely to occur because expansion can occur in small increments without the need for substantial investment of capital. In addition, the Court finds that livestock operations do provide a net positive cash return to the owner-operator and that livestock operations are ideally suited to the heritage and lifestyles of the Arapahoe and Shoshone Indians.

13-8. Once again, Mr. Merchant and Dr. Carver reached contrary results. In adopting Dr. Carver's analysis, the Court should acknowledge that Dr. Carver is widely recognized as an expert in the area of livestock. He was reared on a wheat-cattle ranch in cental Montana, and has spent his entire professional career studying and working in agriculture in the northern plains and inter-mountain region. His experience includes reviewing and evaluating growth potential of livestock operations on the Fort Belknap and Fort Peck Indian reservations in Northeastern Montana. Tr. 11886-94; Wyo. Exh. WRIR LC-1.

In contrast, James Merchant was offered by the United States and accepted by the Court as an economist. Mr. Merchant does not claim to be an agricultural economist, nor an agricultural expert by background, training or education. His resume (U.S. Exh. WRIR C-30) reflects no special background in livestock whatsoever. Tr. 181-185, 230.

Specific weaknesses in Mr. Merchant's analysis are that he assumed a larger typical ranch (250 cows) than is allowed by tribal policy (250 animal units), Tr. 11921-22 (Carver), he assumed calf crop percentages and weights which are substantially above either state or regional averages, Tr. 190-92 (Merchant); Tr. 11927 (Carver), and he failed to include many economic costs

of the ranching operation such as the opportunity cost of rangeland grazing, Tr. 279 (Merchant); Tr. 11945-46 (Carver), fee land or the capital investment required for barns, corrals and the like. Tr. 326-356 (Merchant); U. S. Exh. WRIR C-15.

While Dr. Carver's economic analysis demonstrates the indisputable fact that livestock ranching operations are not economically feasible in the strict sense (rational, prudent investors would not invest in additional cattle ranches), Wyo. Exh. WRIR LC-2, Tr. 11926 (Carver), his financial simulation shows an annual cash return to capital, labor and management in excess of $8,000. Wyo. Exh. WRIR LC-3; Tr. 11951 (Carver). In addition, Dr. Carver's professional opinion, based on his experience of working with livestock operations in a wide area, concludes that livestock producers on the Wind River Indian Reservation will stay in business and expand their operations if given the opportunity to do so. Tr. 11902-03 (Carver).

Finally, the Court should adopt the conclusions of Dr. Paul Wilson who testified that the Arapahoe and Shoshone Indians have historically succeeded in cattle ranching because the vocation agrees with their cultural heritage and lifestyle preferences. Wyo. Exh. WRIR PW-2; Tr. 13187-13188 (Wilson).

13-9. Potential livestock operations.

At full potential, the Wind River Indian Reservation can support livestock operations approximately 25% greater than the 1973-1980 average size. Therefore, the livestock population at full potential could increase to approximately 28,900 cattle, 4,000 horses and 6,000 game animals.

13-9. Wyo. Exh. WRIR LC-4; Tr. 11954 (Carver).

Merchant's analysis projects 37,500 cattle but assumes a base population of 25,000 head instead of the lower figures reported and published by the Bureau of Indian Affairs. In addition, Merchant significantly over-estimated the expansion potential by misinterpreting information concerning the under-utilization of grazing range. Tr. 11905-06 (Carver).

Dr. Carver averaged data from the last 8 years (1973-1980) on the Wind River Indian Reservation, as reported by BIA, and concluded that a maximum 25% growth potential exists on the Reservation. He estimated that the Reservation could support a total of 28,900 head of cattle (including bulls) at full grazing potential. Wyo. Exh. WRIR LC-4; Tr. 11963 (Carver). Similar expansion is possible in the numbers of horses and game animals.

13-10. Livestock operations.

At full potential, the livestock operations on the Reservation will consume approximately 1,000 acre-feet of water annually.

13-10. Tr. 11962-63 (Carver); Wyo. Exh. WRIR LC-4. Using the same procedures as previously described in the pages accompanying Finding of Fact 13-6, supra, Dr. Carver estimates maximum consumptive use, considering potential growth in livestock number, horses and game animals to be 1,000 acre-feet. In addition to using incorrect herd sizes, consumption figures, pond sizes and evaporation losses, Mr. Merchant also assumes that if you increase cattle numbers, you must also increase stock ponds, and correspondingly the evaporation rates, in the same ratio. Dr. Carver points out that as you add additional cows to an operation, you do not need to increase stock watering ponds in the same rates. Tr. 12122 (Carver). As a result, Merchant over-estimated the amount of additional water required for the potential increased livestock operations. Tr. 12122 (Carver).

The Court should adopt Dr. Carver's professional opinion concerning future livestock water requirements for these reasons as well as those stated in conjunction with Finding of Fact 13-6, supra.

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13-11 Livestock water requirements.

Based on the year-around average distribution of cattle on the Reservation, the Court finds that full potential livestock water requirements will be distributed in the major drainages as follows:

Watershed	Amount (AFY)
Wind River	320
Little Wind River	320
Popo Agie River	20
Owl and Red Canyon Creeks	340
Total	1,000

13-11. This finding is based on Mr. Merchant's testimony (Tr. 391) concerning the year-round average distribution of cattle as reflected in U.S. Exh. WRIR C-17, using the water requirements developed by Dr. Carver and shown in Wyo. Exh. WRIR LC-4, proportionally distributed among those drainages.

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13-12 The record reflects no evidence in support of the Tribes' claims to water for livestock purposes with respect to the availability of a supply of water, its source, the location of existing or proposed diversion structures, the location of stockponds or the priority dates of water rights for these purposes.

Note:

The State of Wyoming has intentionally submitted no Findings of Fact, numbered 14-1, et seq.

Findings of Fact
Relating to
The Practicability of Irrigation

15-1 **Stipulated definition of "PIA".**

In a significant stipulation, the United States, the Tribes and the State of Wyoming agreed upon a general definition of the term "practicably irrigable acreage" during the course of the hearings. These parties agreed that "practicably irrigable acreage" (or "PIA") consists of "those acres susceptible to sustained irrigation at reasonable costs." The Court adopts this stipulation of the major parties and finds that practicably irrigable acreage consists of those acres susceptible to sustained irrigation at reasonable costs.

15-1 Wyo. Exh. JK-1; Tr. 13,160-64. This definition was prepared and filed by the United States as part of its response to Wyoming's Eighth Interrogatories and Request for Production, Tr. 13,360 (White). Wyoming and the United States readily agreed to this definition. Tr. 13,361 (White, Echohawk and Clear). The Tribes also committed themselves to the definition:

> "We agreed with those acres susceptible to sustain (sic) irrigation at reasonable cost." Tr. 13,361 (Sachse).

Although Mr. Sachse further suggested that practicably irrigable acreage could be determined in different ways, Tr. 13,361-62, the Tribes did "agree that this definition is a quick way of stating what practicably irrigable acreage amounts to." Tr. 13,361 (Sachse).

Factual stipulations among the major parties have been rare in this litigation; the Court should adopt those stipulations which have been made and avoid the unnecessary burden of additional labor on this issue. As the Master himself observed:

> ". . . I believe I am limited by prior decisions to use the stipulation that you all entered into, which was land which after being proved arable and irrigable can be put under cultivation at reasonable cost." Tr. 14,503 (Special Master).

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Since the major parties tailored the majority of their cases-in-chief to the agreed-upon definition, the Court's adoption of this definition will facilitate the Court's analysis of the factual issues.

15-2 Arability.

Although the practicability of irrigation is determined by the interaction of many complex factors, the arability of land is an integral element of the analysis. If land is not arable, it is not irrigable, and thus cannot be shown to be practicably irrigable. Sound economic and engineering analysis must rely upon the arable land base and other information provided by soil scientists. As a result, it is imperative that the information the soil scientist provides economists and engineers regarding soils, topography, and drainage be accurate and reliable in order to enable other investigators to determine matters such as drain spacing and design, cost estimates and yield projections with confidence. While exacting standards and analysis are required throughout the determination of practicable irrigability, they are particularly crucial in the analysis of arability which form the foundation upon which other disciplines build.

15-2 The United States' soil scientist, Mr. Waples, defines irrigable lands "as those arable lands for which irrigation facilities are or plan to be provided." U.S. Exh. WRIR C-226, p. 41 (emphasis supplied). The Bureau of Reclamation similarly defines irrigable land as encompassing arable land in its 1953 Instructions as follows.

> "Irrigable land is the arable land under a specific plan for which a water supply is or can be made available and which is provided with or planned to be provided with irrigation, drainage, flood protection, and other facilities as necessary for sustained irrigation. The irrigable area comprises that portion of the arable area which is subject to farm use under ultimate development of the project or unit under consideration. It is determined within the arable area by consideration of any limitations imposed by water supply, cost of facilities and service to specify tracts, and of the lands required for additional nonproductive rights-of-way and other purposes (see Subparagraph 3.1.3B). The acreage thus determined will be the irrigable land or area used in Bureau of Reclamation reports in contracts with the water users' organizations." (Section 2.2B). Wyoming Exh. WRIR SK-4. (emphasis supplied)

The more recent 1980 Instructions of the Bureau of Reclamation are even more explicit.

> "Irrigable land or irrigation service area is arable land under a specific plan for which a water supply is or can be made available and which is provided with or planned to be provided with irrigation, drainage, flood protection, and other facilities as necessary for sustained irrigation. The plan to provide irrigation service to the area must be . .

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feasible in an engineering sense and meet the justification requirements of the Water Resources Council's Principles and Standards for Water and Related Land Resources planning as adopted by the Department of the Interior for Service projects. The irrigable area comprises the portion of the arable area provided with, or to be provided with, a water supply and necessary drainage facilities under ultimate development of the project or unit under consideration. It is determined within the arable area by consideration of any limitations imposed by water supply, cost of facilities and service to specific tracts, and of the lands required for additional rights-of-way and other nonproductive purposes. The area thus determined will be the irrigable land area used in Water and Power Resources Service reports and in contracts with water users' organizations." Wyoming's Exh. WRIR SK-5 (Section 115.2.3H) (emphasis supplied).

The Bureau of Reclamation's approach to land classification for irrigation projects is the state-of-the-art. (See Finding of Fact 15-3, infra.) The Bureau's procedure is designed to provide specific and reliable information to economists, engineers, and drainage experts. Tr. 10574 (Fowkes); Wyo. Exh. WRIR SK-5 (Section 115.2.2). Soils information pertinent to irrigation development includes texture, depth to bedrock, percent gravel and cobbles, alkalinity, sodicity, salinity, structure, bulk density, permeability, consistency, infiltration rate, erodibility, available moisture, lime content, cation exchange capacity, and availability of plant essential

nutrients. Wyo. Exh. WRIR SK-5 (Section 115.3.2C). In addition, site factors such as undulating bedrock and closed basins must be considered in order to insure proper drainage. Tr. 10582, 10625 (Fowkes).

The United States' engineering consultants, the Bureau of Reclamation and State of Wyoming's experts agree that complete, reliable soil information is essential to sound irrigation design. On behalf of the United States, Mr. Toedter testified that a drainage engineer needs data concerning depth to barrier and hydraulic conductivity in order to determine drain spacing and drainage design. Tr. 3822-3825 (Toedter). Another federal witness, Mr. Stetson, stated that an engineer requires information about depth to water table, hydraulic conductivity, depth to barrier, and sodicity to determine drainage requirements. Tr. 5538 (Stetson). Dr. Mesghinna stated that soil data such as texture and gravel content is needed to calculate intake rates and available water holding capacity. Tr. 4111, 4514 (Mesghinna). Dr. Mesghinna also testified to the need for knowledge of land classes in order to design irrigation and drainage systems because lower land classes need better drainage. Tr. 4154-4155 (Mesghinna).

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The United States' economist, Mr. Dornbusch, also agrees that soil information is important. Economists need soils information to develop yield projections. Tr. 6022-6023 (Dornbusch). Mr. Dornbusch also testified that unexpected soil problems will undoubtedly raise costs and that precise and reliable information is essential to accurately estimate costs. Tr. 5736 (Dornbusch).

15-3 <u>BOR arable land classification methodology represents the state-of-the-art methodology in that it considers economics as well as physical and chemical characteristics</u>.

The Court finds that the Bureau of Reclamation's methods represent the state-of-the-art of arable land classification for irrigation projects. While other agencies have studied lands on and near the Wind River Indian Reservation, these other studies were not directed to determining the arability of lands for irrigation.

In its approach and standards, the Bureau of Reclamation explicitly considers economics and also requires careful examination of the numerous physical and chemical characteristics of land pertinent to irrigated agriculture. The Bureau integrates soils, agronomic and economic factors in order to determine the arability of land.

15-3 The Bureau of Reclamation's work has long been recognized as, and continues to represent, the state-of-the-art in land classification work for determining arability and irrigability. The Bureau of Reclamation has performed the majority of land classification work for irrigation on and adjacent to the Wind River Indian Reservation. Land classification and drainage investigations for irrigated agriculture are primary activities of the Bureau. The United States' and the State of Wyoming's soils experts agreed that Bureau of Reclamation procedures for determining arable land are the most widely used and accepted methods for irrigation development. Tr. 3487 (Waples); Tr. 10821-22 (Sommers). Other agencies of the United States continue to recognize the Bureau of Reclamation work as the authoritative source for guidance in determining arability and irrigability. In a recent request for proposal for work to be done in New Mexico, the Bureau of Indian Affairs included instructions for land resources investigations parallelling the Bureau of Reclamation's Instructions Part 115. Wyo. Exh. WRIR SS-A14 (Appendix B).

There is a long and thorough history of Bureau of Reclamation soil and land investigations within the Wind River Basin. Between 1917 to 1978, the Bureau conducted nine soil and land investigations of varying detail pertinent to irrigated agriculture within the Wind River Basin. The Bureau began soil and land investigations in the Wind River Basin with a reconnaissance survey in 1917 prior to the construction of the Riverton Project. A semi-detailed investigation of the Riverton Project was conducted in 1925-26 with additional work on selected portions in 1929. The Third Division Riverton Project was the subject of a detailed land classification in 1947 which was determined to be inadequate, and the area was reclassified in 1951-53. A reconnaissance land classification of the entire Wind River Basin including the Wind River Indian Reservation, was performed in 1948-49. The Third Division and Midvale Irrigation District were reclassified in 1961 and 1962, respectively. The Muddy Ridge and Cottonwood Bench portion of the Third Division were initially classified in 1951-53 and more recently reclassified in 1978 using both gravity and sprinkler land classification standards. U.S. Exh. WRIR C-43 (pp. 4-5); Wyo. Exh. WRIR SF-1 (pp. 14-15).

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In addition to the Bureau of Reclamation studies adjacent to the Wind River Indian Reservation and general land classification of the entire Wind River Basin, the Bureau of Reclamation report on the Wind Division specifically addresses new project lands on the Wind River Indian Reservation. This survey is directed towards irrigated agriculture and provides a basis for feasibility studies and irrigability of Wind River Indian Reservation lands. The Wind Division Report, Missouri River Basin Project, 1966, represents the Bureau of Reclamation's most recent land classification on the Wind River Indian Reservation. The Bureau conducted a comprehensive review and inventory of land and water resources, paying particular attention to the capability of lands to support a sustained irrigation economy. The Bureau inspected presently irrigated areas and their need for additional water or drainage. The semi-detailed land classification provided information concerning suitability of lands for irrigation.

This survey was designed to provide verification and refinement of previous findings and to provide a basis for feasibility studies. Ultimately, the study

defined the extent and suitability of land resources for future irrigation development. Classification of land in this study is economics oriented because physical characteristics of the land affect net farm income. To allow accurate land classification, the Bureau developed and applied a rigorous set of standards. In addition, the Bureau conducted a drainage investigation to determine construction and field costs and requirements of surface and subsurface drainage systems that would sustain successful irrigation of project lands. The complex nature of drainage problems in parts of the Wind River Basin required these investigations to be made in greater detail than is normally required. Wyo. Exh. WRIR SS-A7 (pp. 1-6, 9-11); Wyo. Exh. WRIR SF-1 (pp. 1-2, 13-23); Wyo. Exh. WRIR SF-2 (pp. 1-13).

The Bureau of Indian Affairs Soil and Range Resources Inventory of the Wind River Indian Reservation published in 1962 did not evaluate arability or irrigability of Wind River Indian Reservation lands. This survey recorded the quality, quantity, extent, and distribution of soil resources. The 1962 Report covers much of the non-irrigated land on the

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Reservation but it did not evaluate and was not intended to evaluate irrigation potential. Information contained within a mapping unit related specific information about soils, but did not classify it in terms of arability or irrigability. Irrigated land within the Wind River Indian Reservation was also covered. Although not intended as an arability or irrigability survey, the 1962 report is a usable appraisal of the response of land to irrigation under then-existing practices. Wyo. Exh. WRIR SF-1, (pp. 14-15).

The Bureau of Indian Affairs Inventory of Water Resources, Wind River Indian Reservation, Phase II - Needs and Uses report published in 1972 is a compendium of reservation history, economy, sociology and resources. No field investigations were conducted and all information contained in this report is from pre-existing studies. It was also not intended to evaluate irrigation potential but only to provide information pertinent to the protection of Indian water rights.

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The study is essentially a state-of-the reservation report, providing a comprehensive review of Wind River Indian Reservation history, sociology, economy and resources. In the report, economic need for development on the Wind River Indian Reservation was established and natural resources were inventoried. In performing its land classification, the Bureau of Indian Affairs adopted Bureau of Reclamation standards, as established in 1953, with certain modifications. Estimations of irrigable acres were made solely from prior studies by the Bureau of Indian Affairs, Bureau of Reclamation and Missouri River Basin Investigation Unit. Irrigable acreage determinations between these agencies were different due to dissimilar land classification criteria. U.S. Exh. WRIR C-50 (Sections I, II, III, V, and X).

The Soil Conservation Service conducted a soil survey of the Riverton area in 1963-67. This report <u>does not</u> contain information necessary to determine arability or irrigability of new lands. In 1974, the Soil Conservation Service (SCS) published the Soil Survey of the Riverton Area. The majority of the field work was performed in 1963-67. The primary intent of this

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publication was to provide information concerning the use and management of soils which occur within part of the Wind River Basin. Part of this report is devoted to management of irrigated soils and the general response of soils to irrigation. Capability groupings were also provided showing the general suitability of soils for most kinds of field crops. This system does not take into account landforming or reclamation projects which may be required. U.S. Exh. WRIR CF-1 (pp. 1-2, 31-40).

The Bureau of Reclamation's standards and procedures to determine arability require careful examination of the many physical and chemical characteristics of soils through observation and sampling. Soil physical and chemical characteristics are important determining factors relevant to irrigation management and crop production. Soils information that is important to irrigation management includes texture, depth to bedrock, percent gravel and cobbles, alkalinity, sodicity, salinity, structure, bulk density, permeability, consistency, infiltration rate, erodibility, available moisture, lime content, cation exchange capacity, and availability of plant essential

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nutrients. Wyo. Exh. WRIR SK-5 (Section 115.3.2C). Evaluation of soil horizons is important in the determination of these characteristics and the behavioral characteristics of the soil, crop production and irrigation management. Wyo. Exh. WRIR SK-5 (115.3.2C); Tr. 10627 (Fowkes).

The Bureau of Reclamation's arable land classification integrates land, agronomic and economic relationships in delineating land suitable for irrigation. The Bureau of Reclamation determines arable land using the following process:

1. Evaluation of the land resources and economic experiences in a fully developed area of similar physical and climatic character.
2. Evaluation of the likely effect of specific soil, topographic and drainage characteristics on the economics of production.
3. Development of land classification standards which categorize the soil, topographic and drainage factors into classes having similar economic value.

4. Application of the standards through observation, mapping and sampling.

5. Modification of the results subsequent to receiving additional hydrologic, economic and engineering data.

Wyo. Exh. WRIR SK-5 (Section 115.3.1); Wyo. Exh. WRIR SK-4 (Section 2.2.1).

The Bureau of Reclamation bases its system of arable land classification on a number of basic principles. The most important of these are:

1. Prediction,

2. Economic correlation,

3. Permanent-changeable factors.

Each principle is based, in part, on economic evaluations. The economic correlation principle is one of the most important aspects of the Bureau of Reclamation arable land classification system. Wyo. Exh. WRIR SS-A3 (pp. 9, 11, 12 and 15); Wyo. Exh. WRIR SS-A4 (pp. 1, 2, 3, 5, and 12); Wyo. Exh. WRIR SS-A6 (pp. 2, 3, and 10); Wyo. Exh. WRIR SS-A7 (p. 10); Wyo. Exh. WRIR SK-5 (Section 115.3.1).

The Bureau of Reclamation explicitly uses economics and site-specific information in developing standards for land investigations to meet specific definitions. The history of land classification and drainage problems in the Wind River Basin demonstrates the need for strict land classification standards. The Bureau of Reclamation's evolution to more strict procedures and standards acknowledges this need. Specifically, the Bureau of Reclamation uses farm budget studies as economic input in defining land classes and developing standards. Their standards in the Riverton Area do not include Class 4. The standards include depth to barrier of 7 feet, 40-acre minimum field size and 8 percent maximum slope for sprinkler irrigation. Wyo. Exh. WRIR SF-1 (p. 20), SK-10; Tr. 11051 (Sommers). The Bureau of Reclamation used a dual set of classification standards to determine arable sprinkler and gravity lands on the Muddy Ridge study. Wyo. Exh. WRIR SK-10.

The standards used on the Wind River Indian Reservation by the Bureau of Reclamation during their studies in the 1960's closely parallel the more recent standards used by the Bureau of Reclamation on Muddy

Ridge in the late 1970's. These standards include consideration of local engineering and economic constraints. Tr. 10912-13 (Sommers). Wyo. Exhs. SF-1 and SK-10.

The Bureau of Reclamation defines arable land and land classes with specific reference to economics. These terms have considerable importance in land resource investigations. The Bureau of Reclamation defines arable land as:

> "land which when farmed in adequate size units for the prevailing climatic and economic setting and provided with the essential onfarm improvements of removing vegetation, leveling, soil reclamation, drainage, and irrigation related facilities will generate sufficient income under irrigation to pay all farm production expenses; provide a reasonable return to the farm family's labor, management, and capital; and at least pay the operation, maintenance, and replacement costs of associated project irrigation and drainage facilities. The arable area comprises all land delineated in the land classification that will provide sufficient income to warrant consideration for irrigation development."

Wyo. Exh. WRIR SK-4 (Section 2.1.2A). Wyo. Exh. WRIR SK-5 (Section 115.2.3G) includes virtually the same definition. The Bureau of Reclamation has used essentially the same definition of arable land for nearly 30 years.

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Land classes are developed based on economic factors but distinguished by physical and chemical characteristics. Wyo. Exh. WRIR SK-5 (Section 115.3.2). The Bureau of Reclamation definition of land class is:

> "a designation for a body of land, within a specific project, having soil, topography, and drainage characteristics which result in a similar economic level of suitability for irrigation. Land classes are mutually exclusive; i.e., pertinent factors are arranged in discrete, nonoverlapping, and determinate groups or divisions in the classification and represent relative levels of payment capacity."

Wyo. Exh. WRIR SK-5 (Section 115.2.3M). The definition contained in Wyo. Exh. WRIR SK-4 (Section 2.1.2G) is very similar.

The Bureau of Reclamation recognizes three levels of land classification, differentiated by the amount of detail and the accuracy of results. The three levels are reconnaissance, semidetailed and detailed investigations. They define these levels as follows:

> Reconnaissance land classification involves a general outline of land features of conspicuous importance in preliminary planning of irrigation development in a particular region. Generally, Classes 1, 2, and 3 and the

pertinent subclasses are delineated with other lands designated as Class 6. Classes 4 and 5 and their subclasses may be delineated if the specific project conditions warrant. The survey examines large areas to determine the extent of arable land.

Semidetailed land classification involves careful examination of land features at about one-half mile intervals on potentially irrigable areas. Nonarable areas are covered in a more general manner. The boundaries between arable and nonarable lands are identified with considerable accuracy, but boundaries between classes and subclasses are delineated in less detail. Generally Classes 1, 2, 3 and 6 and their subclasses are mapped. Special subclasses under Classes 4 and 5 are differentiated when conditions warrant. Semidetailed classifications will be made when more detail than contained in a reconnaissance survey is required.

Detailed land classification involves the examination of land features in sufficient detail to provide information as to the extent and character of the various lands in each 40-acre tract. Basic data with respect to various soil and subsoil conditions, topography, and drainage are therefore obtained in detail for the purpose of determining proper land use, size of farm units, payment capacity or assessments, irrigable area, irrigation requirements, land appraisal, irrigation and drainage systems, land development, costs and benefits. Under such conditions the degree of accuracy resulting from a detailed survey is obtainable by meeting the general requirements of a semidetailed survey provided necessary modifications are

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made, such as in intensity of sampling. All classes and subclasses are considered and mapped as necessary to meet the objectives of the survey. Detailed land classification is used in feasibility investigations and reappraisals of Bureau of Reclamation operating projects.

Wyo. Exh. WRIR SK-4 (Sections 2.6.2, .3, and .4).

The Bureau of Reclamation defines land classes 1, 2, 3, 4, 5 and 6 in its land classification instructions as follows:

Class 1 - Arable. Class 1 land is project land which meets the various parameters and specifications established for that class within a particular agricultural economic setting having relatively the highest level of suitability for continuous, successful irrigation farming measured in terms of net income generated. Net income reflects productivity (productive capacity minus the cost of production) and land development costs. As such, class 1 lands have the highest relative potential payment capacity for the particular setting.

Class 2 - Arable. Class 2 is used when a second class is required. It is that land in the same project setting as described for class 1 but having a relatively lower level of suitability for continuous, successful irrigation farming in terms of net income generated.

Class 3 - Arable. Class 3 is used when a third class is required. It is that land in the same project setting as described for classes 1 and 2 but having the next lower level of suitability for continuous, successful irrigation farming in terms of net income generated.

Class 4 - Limited Arable. Class 4 is used when a fourth class is required. It is that land which has certain excessive deficiencies that result in restricted utility but which has been shown to be of limited suitabilit· for irrigation as a result of special economic and engineering studies.

Class 5 - Nonarable. Lands in this class are nonarable under existing conditions but have potential value sufficient to warrant tentative segretation for special study prior to completion of the classification. The designation of class 5 is tentative and is normally changed to the proper arable class or class 6 prior to completion of the land classification.

If not resolved, they should be considered nonarable for project formulation purposes. In all instances, class 5 lands are segregated only when the conditions existing in the area require consideration of such lands for competent appraisal of the project possibilities. This class is normally reserved for instances where problems related to land development, drainage, rehabilitation, and resettlement are involved.

Class 6 - Nonarable. Lands in this class include those considered nonarable under the existing project or project plan because of failure to meet the minimum requirements of paying OM&R

costs as required for arable classes of land, and class 5 land when the extent of such lands or the detail of the particular investigation does not warrant additional investigation. Class 6 irrigated land with water rights encountered in the classification will be delineated and designated class 6W. Whenever class 6 irrigated or water right land is encountered in the classification of supplemental water projects and operating projects, every effort will be made to obtain consent for its retirement from irrigation and release or transfer of any water right to which it may be entitled. If this cannot be accomplished, such land will be shown as class 6W land, except as otherwise required by State law (e.g., Wyoming), and provision made for supplying the amount of water normally available to it under existing rights and project operation.

Generally, class 6 comprises steep, rough, broken, or badly eroded lands; land with soils of very coarse or very fine texture; shallow soils over gravel, shale, sandstone, till, or hardpan; and lands that have inadequate drainage and high concentrations of soluble salts or sodium. Class 6 lands do not have sufficient payment capacity to warrant consideration for irrigation.

Wyo. Exh. WRIR SK-5 (Section 115.4.2B-1(a) (d) and (f)). Wyo. Exh. WRIR SK-4 (Section 2.5.1.2 .5 and .7) includes the same definitions with only slight inconsequential differences in wording. The Bureau of Reclamation has used the same definitions of land classes 1, 2, 3, 4, 5 and 6 for nearly 30 years.

The Bureau of Reclamation, for their arable land determination on the Wind River Indian Reservation, used the following land class definitions, which are based on farm budget studies and experience on the Riverton Project:

> Class 1 - Land in this class is highly suitable for irrigation farming, being capable of producing high yeilds of adaptable crops.
>
> Class 2 - This land is not as suitable for sustained irrigation farming as Class 1 because of some deficiency of soil, topography, or surface drainage, that may or may not be correctable, but is of only moderate intensity. Any single adverse factor affecting development may reduce the suitability from Class 1 to Class 2, with an associated reduction in payment capacity.
>
> Class 3 - Class 3 land is the least desirable of arable classes for sustained irrigation farming because of marked deficiencies in soil, topography, and/or drainage, to an extent greater than may be acceptable for Class 2 land.
>
> Class 6 This land fails to meet minimum requirements of the next higher class because of one or more deficiencies of soil, topographhy, or drainage, which would limit the payment capacity to such an extent that consideration for irrigation is not warranted. Class 6 land may be steep, broken, or shallow over bedrock or incoherent gravel. It may be seriously eroded. It may be waterlogged, saline, or alkaline. It may have tree cover. This class also includes land in rights-of-way, airports, townsites, or other permanent non-agricultural uses.

Wyo. Exh. WRIR SF-1 (pp. 16-19).

15-4 Climate affects arability.

In addition to the physical and chemical nature of the land, the Court finds that climate must also be considered in determining arability.

15-4 Climate affects soil, drainage and topographic considerations. Arable lands display different characteristics and minimum standards in different climatic settings. Wyo. Exh. WRIR SK-5 (Section 115.3.2C(1)). Specific microclimatic factors such as the effect of air drainage on frost hazard in crops are now included as Bureau of Reclamation land classification criteria. Wyo. Exh. WRIR SS-A8 (Section 511.2.3E). In addition, soil and air temperature affects length of growing season, maturation of crop, and, subsequently, irrigation water requirements. Tr. 4660-4661 (Mesghinna).

15-5 Arable lands studies are important and must be intensive.

The importance of an arable lands study in determining PIA cannot be overemphasized as pointed out previously.

The intensity that must be required of the study depends in large part upon the geological complexity of the area involved. The Court finds that an intense investigation must be conducted of the arable lands for the Wind River Indian Reservation because of the geologic complexity of the area and the history of problems associated with irrigation development on and adjacent to the Wind River Indian Reservation.

15-5 Geologic complexity occurs where several geologic materials, such as sandstone and shale, vary in thickness and continuity within short distances. Geologic complexity creates complex land characteristics. Since geologic materials such as sandstone and shale form the parent materials from which soil is developed, complex geology creates complex soils. Tr. 10560 (Fowkes). Site factors are tract-specific characteristics of the land and geology which may cause problems under irrigation, and site factors are a result of complex local geology. Tr. 10582 (Fowkes). Landforms, generally described as portions of the landscape with similar distinctive features, are also complex within a geologically complex area. Tr. 11116 (Sommers).

A sufficient land classification study must include consideration of complex land and soil characteristics. Site factors which should be considered in an arability study include rock outcrops, undulation of bedrock, bowed terraces, sideslopes of alkali flats, and closed basins. Landforms should be accurately identified and their variety and complexity should be characterized and understood. Tr. 11116-18 (Sommers); Tr. 10564, 10571, 10582-93 (Fowkes).

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The more complex an area in terms of geology and resultant soil and land characteristics, the more intense the field study must be for a sufficient land classification study. In other words, the intensity of the investigation must be commensurate with the geologic complexity. Tr. 10564-5, 10581 (Fowkes). The intensity of investigation is determined by the number of acres represented by each observation, and is expressed as the number of acres represented by each logged hole or pit. Tr. 10915 (Sommers). In fact, the Bureau of Reclamation specifically instructs land classifiers that "the number of examinations and analyses should be increased as necessary to meet specific objectives or with the complexity of the area." Wyo. Exh. WRIR SK-4 (Section 2.6.5).

The Bureau of Reclamation presents its description of the <u>minimum</u> intensity and accuracy of results required for reconnaissance, semi-detailed and detailed studies as follows:

<u>Minimum Requirements by Types of Classification</u>

	Reconnaissance	Semi-detailed	Detailed New Lands
Land classes recognized	1-2-3-6	1-2-3-6	1-2-3-4-5-6
Scale of base maps	1:24,000	1:12,000	1:4,800

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	Recon-naissance	Semi-detailed	Detailed New Lands
Maximum distances between traverse-miles	1	.5	.25
Accuracy-percent	75	90	97
Field progress per day (one land classifier and crew) - square miles	3-5	1-3	.25-1
Minimum area of Class 6 to be segregated from larger arable areas - acres	4	.5	.2
Minimum area for change to lower class of arable land - acres	40	10	2
Minimum area for change to higher class of arable land - acres	40	20	10
Minimum soil and substrata examination			
Borings or pits (5 ft. deep) per square mile	1	4	16
Deep holes (10 ft. or more) per township	1	2	4

As can be seen from the tabulation above, the Bureau of Reclamation requires a greater degree of accuracy as the level of detail increases in land classification. Wyo. Exh. WRIR SK-4 (Section 2.6.5). Accuracy refers to the degree of allowable error in identifying land classes and subclasses and locating the boundaries of these units on maps. Wyo. Exh. WRIR SK-5 (Section 115.2.3P). As intensity increases the percentage of error decreases; that is, as intensity increases the accuracy increases. Wyo. Exh. WRIR SK-4 (Section 2.6.5).

The geologic complexity of the Wind River Basin is widely recognized and has necessitated intense investigations. Mr. Fowkes states that the proposed and existing projects in the Wind River Basin, specifically those on the Wind River Indian Reservation, Third Division and Riverton areas, have great geological complexity. Tr. 10561-2 (Fowkes).

Mr. Laymon, the Bureau of Reclamation drainage engineer in the Riverton area, found that bedrock patterns are very complex in the area. This complexity makes predictions concerning geologic material and depth to barrier difficult. Wyo. Exh. WRIR SF-29.

Because of the complex nature of drainage problems in the Wind River Basin, the Bureau of Reclamation used a much greater intensity during their investigations in the Riverton area than elsewhere in the western United States. Wyo. Exh. WRIR SF-2 (p.1). For example, Appendix VII, Project Land, Third Division, Riverton Project, Wyoming, dated May 1957, states on page 8:

> "A large number of borings were necessary because of complex soils. One to four recorded field borings to 20 acres of arable land were located on the map. In determining delineations between land classes, numerous other non-recorded field borings were made. Routine 5-foot borings were made on an average of every 200 to 500 feet. Additional holes were dug where the character of soils surfaces, position, or vegetation warranted. To inspect and evaluate the deeper soil and drainage conditions, this survey included numerous 10-foot holes and pits." Wyo. Exh. WRIR SK-9A (p. 8).

The Bureau's numerous reclassifications before 1978 serve as testimony to the complexity and difficulty of land classification within the Wind River Basin.

As would be expected, similar geologic complexity and land characteristics occur on the Wind River Indian Reservation as within adjacent areas of the Wind River Basin. Over 90% of the study areas identified in the HKM drainage investigation on the Wind River Indian

Reservation contain the same landforms as contained in the Third Division. Tr. 3956 (Toedter). Lands on the Wind River Indian Reservation are very similar to those of other presently irrigated land in the Riverton Project with the exception of the highly permeable gravel beds under the Winchester Unit land which was identified in the United States' claim as the Big Horn Flats Unit. Wyo. Exh. WRIR SF-2 (p. 6).

The site factors found on the North Crowheart area are common to the Big Horn River and Wind River Basins. Tr. 10582-83 (Fowkes). Mr. Fowkes' exhibits SF-2A and -2B are representative of site factors on arable land areas in North Crowheart under the United States' claim. The North Crowheart lands are similar to irrigated lands in the Third Division which have experienced problems of bowed terraces, undulating bedrock, slope breaks and soil textural changes. These site factor characteristics contributed to drainage problems in the Third Division. Wyo. Exh. WRIR SK-9A (pp. 40-46); Wyo. Exh. WRIR SF-2A and SF-2B; Wyo. Exh. WRIR BT-10 (p. 2).

The Bureau's arable land classification on the reservation characterized the South Crowheart unit as having slopes which "are not uniform within any single tract, and depth to shale and permeabilities are variable." Wyo. Exh. WRIR SF-2 (p. 15). Mr. Toedter acknowledged that landforms in portions of the North Crowheart Unit were variable throughout. Tr. 3797-3798 (Toedter). The number of terraces on the Wind River Indian Reservation also contributes to the area's geological complexity. Tr. 10564 (Fowkes).

The Bureau of Reclamation has minimum requirements for several types of classifications and specifies a more intense examination of the land as the complexity of an area increases. Recent arable land investigations by the Bureau on and adjacent to the Wind River Indian Reservation have required an intense investigation. Intensity has ranged from one recorded hole every one to four acres to one per 160 acres. Drainage investigations alone have been as intense as one recorded hole or pit about every 20 to 30 acres on the Wind River Indian Reservation with a hole greater than six feet every 40 to 80 acres.

The Bureau of Reclamation characterizes its 1964 drainage studies on the Reservation as follows: "Although this investigation is of a semi-detailed nature, every effort was made to find the depth of soil to the shale or sandstone barrier and to determine the permeability of the soil." Wyo. Exh. WRIR SF-2 (p. 6). Greater intensity than usual was employed for semi-detailed investigations due to the complex nature of drainage problems on Wind River Indian Reservation. For example, the drainage investigation intensity for the North Crowheart area was about 40 arable acres per hole or pit based on 18,631 acres and 468 holes and pits, nearly all of which are 6 feet or deeper. The Bureau's drainage investigation for the five areas roughly corresponding to the HKM study areas for future projects has an intensity of about 57 acres per hole. Wyo. Exh. WRIR SS-9; Wyo. Exh. WRIR SK-9A (p. 8); Wyo. Exh. WRIR SF-1 (pp. 14 and 16); Wyo. Exh. WRIR SF-2 (pp. 14, 24, 33, 39, 49); Wyo. Exh. WRIR SS-6 (pp. 3, A1).

15-6 Drainage is a regional problem.

The Court finds that, as a result of geological complexity and insufficient studies prior to construction of irrigation projects, drainage problems have been pervasive throughout the Wind River Basin.

Since the earliest land survey in 1917, the drainage situation in the Wind River Basin has been recognized as the area's most devastating problem. This has compelled the Bureau of Reclamation to continually revise, update, and strengthen its standards to best understand and evaluate land for irrigation.

Consequently, any study seeking to demonstrate the practicability of irrigating lands in the Wind River Basin must be of increased intensity and improved standards to ensure that land claimed in this case are indeed capable of "sustained irrigation at reasonable cost."

15-6 Drainage problems have been recognized in the Riverton Area adjacent to the Reservation since the first reconnaissance survey by the Bureau of Reclamation in 1917. Wyo. Exh. WRIR SK-9A (p. 4). In the adjacent Third Division of the Riverton Project, the Board of Consultants, in a report to the Regional Director of the Bureau of Reclamation, stated: "Seepage and drainage problems developed almost immediately in both areas. These difficulties apparently arose from excessive water losses from the canal and laterals of the system, and from the application of irrigation water to the land of the Third Division. Many of these lands became unproductive, and some of the original settlers had to leave the project." Wyo. Exh. WRIR BT-10 (p. 1).

Careful consideration must be given to drainage of the claimed irrigable lands lest future observers make the same type of comment as did Representative Hadley of Florida, who, after viewing the Third Division said "the lands should be abandoned and let the ducks paddle around." Wyo. Exh. WRIR SF-3 (p. 12).

Drainage problems of the Third Division, Powell, and Hanover Bluff Projects were a result of a lack of intensity of investigation for the complexity of soils and geology; in other words, the pre-construction soil investigations were inadequate as evidenced by problems which have subsequently occurred under irrigation. Tr. 10614-10619 (Fowkes).

The Honorable Leslie A. Miller reported in the Wyoming Supreme Court's Reports (78 Wyo. 469-470) that at the time of the organization of the Third Division by virtue of State law ". . . water users do not know the true character of many project lands. . . . it appears that the technicians have been persuaded to place questionable land in an irrigable class to obtain the greatest possible project acreage and thus obtain lower per acre costs." Wyo. Exh. WRIR SF-3 (p. 57).

Mr. Sommers agreed with the Special Master that two of the most important reasons for Third Division failures are insufficient drainage and the tradition of the United States to first build and then install drainage as the problems show up. Tr. 10923 (Sommers).

Much of the currently irrigated land on the Wind River Indian Reservation is experiencing similar drainage problems as the Third Division. It is recognized to be in need of "full scale reclamation" including weed and sagebrush removal, structure rehabilitation and replacement, canal lining and installation of drainage. U.S. Exh. WRIR C-150 (Page IX.14).

Soil science and land classification standards have progressively improved and become more stringent over time due to refinements motivated by historic problems in irrigation. Tr. 10757-10758 (Fowkes). Land classification has become more rigorous as a result of the failure of early surveys to provide adequate data for the complex soils, topography, and drainage in the Wind River Basin and adjacent regions. Wyo. Exh. WRIR SK-9A (p. 4).

15-7 Engineering.

During the course of these proceedings, the United States, the Tribes and the State of Wyoming agreed that, in addition to an investigation concerning the arability of land, an engineering analysis is a necessary component in determining practicably irrigable acres. The Court finds that in classifying land as practicably irrigable there must be a showing that using current technology, engineers can design systems capable of delivering irrigation water to the lands and capable of draining excess irrigation water from them and that these systems can be designed, built, operated and maintained at costs not exceeding the returns realized by sale of the crops grown on the land. This is necessary if substantive meaning is to be given to the phrase "susceptible to sustained irrigation at reasonable costs" used to define practicably irrigable acreage. In addition, sound engineering analysis is necessary to determine the water requirements for irrigation and thus provide benchmark data for an investigation into the adequacy of water supplies.

15-7 While no party to this action disputed the relevance of engineering, the central role of the engineer in determining the practicability of irrigation is perhaps best underscored by the fact that the United States, the Tribes and Wyoming presented the testimony of nine engineers concerning the practicability of irrigating land:

For the United States:

Mr. Ron Billstein;

Dr. Woldezion Mesghinna; and

Mr. Tom Stetson

For the Tribes:

Mr. Keith Higginson;

Mr. Jack Keller;

Mr. Ron Bliesner; and

Dr. Lyman Williardson

For Wyoming:

Mr. Floyd Bishop

Mr. Henry Sostrom

15-8 Nature of a complete engineering analysis.

The Court finds that a complete engineering analysis generally examines the location of an appropriate and adequate water source, designing capable on-farm, conveyance and drainage systems or establishing the existence thereof, determining water requirements and estimating construction, operation and maintenance costs. The analysis can be broken down into an eleven step process:

1. Evaluate Climatic Data;
2. Select Cropping Patterns;
3. Determine Evapotranspiration and Net Irrigation Requirement;
4. Design On-Farm Systems;
5. Design Pipe Network;
6. Design Pumps And Pumping Plants;
7. Design Canals And Related Structures;
8. Evaluate and Plan Drainage;
9. Estimate Operation And Maintenance Costs;
10. Determine Gross Water Requirements; and
11. Estimate Construction Costs.

Information developed as a result of this analysis must be supplied to economists and hydrologists, as appropriate.

15-8 Tr. 4017-4023 (Mesghinna).

15-9 Economics.

During these proceedings, the United States and State of Wyoming agreed that, in addition to arability and engineering, economics is an integral component in determining the practicability of irrigation.

15-9 The United States clearly recognized the role of economics in the determining the practicability of irrigation. Prior to Mr. Dornbusch's testimony, Mr. Echohawk stated:

> "I'd again like to set the stage for where we're at in the Government's case. So far we've had testimony on the arable land base for both the future and historic, specifically the future. We've had Dr. Mesghinna just conclude his testimony as to engineering designs and associated costs to serve a certain portion of those arable lands, and some design projects.
>
> Testimony presented by Mr. Dornbusch will determine whether or not the project (sic), as designed by Dr. Mesghinna and his associates are economically feasible, and as such that will conclude the Government's case on the future portions of the future lands, as to the practicably irrigable acres or economically feasible acres." (Tr. 4,890-91) (Echohawk) (emphasis supplied).

The United States did not claim that the practicability of irrigation can be determined by an arable land base or even by an engineering design. In his statement quoted above, Mr. Echohawk used the terms "practicably irrigable acres" and "economically feasible acres" interchangeably.

The State of Wyoming, through the testimony of Dr. David Brookshire, a natural resource economist, agreed that economics is central to the determination of reasonable costs and thus the practicability of irrigation. Tr. 14,502-09 (Brookshire).

15-10 Significance and relevance of economics.

Through Dr. Ron Cummings, the Tribes argued briefly that economics is irrelevant to the determination of PIA. The Court cannot accept this argument for several reasons. First, Dr. Cummings himself presented extensive evidence concerning the results of his own economic feasibility analysis. This testimony is tantamount to an admission on the Tribes' part that economic feasibility studies help determine reasonable costs, and thus the practicability of irrigation. Furthermore, economics is undeniably implicated in the determination of reasonable costs, a concept the Tribes themselves agreed was a component of PIA. Third, excluding economics would viscerate the significance of "practicably" in the phrase "practicably irrigable acres." Fourth, the Court notes that in Arizona v. California, where the concept of PIA was born, both Special Master Rifkind and Special Master Tuttle relied on economics in order to determine practicably irrigable lands. Finally, the subject matter of this entire adjudication is water, a scarce and precious resource in Wyoming. This Court's task in this case involves the allocation of a scarce resource among competing users. The relevance of economics to this allocation process cannot be

denied. The Court therefore finds that economics is an indispensible component of the analysis which determines the practicability of irrigation.

15-10 In his opening statement on behalf of the Tribes, Mr. Sachse stated that economics was irrelevant to the determination of practicably irrigable acreage and declared that economics was not considered in Arizona v. California by Special Master Rifkind. Tr. 7894 (Sachse). Dr. Cummings also stated:

> I must confess that -- that I am very uneasy with the economist's role in this notion of practicably irrigable acreage." (Tr. 8,848).

Undoubtedly, a part of Dr. Cummings' discomfort stemmed from his belief that economic analysis was not a part of the determination of practicably irrigable acreage in Arizona v. California. Tr. 8,849 (Cummings). Mr. Sachse and Dr. Cummings were mistaken. In his recent Report to the United States Supreme Court in Arizona v. California, Special Master Elbert P. Tuttle stated:

> "After studying the record of the proceedings before the former Special Master, I conclude that 'practicably irrigable,' as used by the parties and Court in the prior proceedings, very nearly means 'economically feasible.' The testimony at the prior hearings reveals that the United States submitted for consideration only lands that its experts believed to possess the characteristics necessary for the benefits from irrigated farming to exceed costs. In fact, the Master and

the witnesses called their anlaysis a study of 'economics' or 'economic feasibility.'"

* * *

"The past analysis accepted by the former Master and the Court clearly was a non-Indian economic analysis measuring total benefits against total costs for water without regard to the special considerations available to the Tribes. I simply do not believe as do the Quechans that the very few details of the actual calculations introduced in the testimony means that economics were not considered."

Special Master's Report at 94 and 96 (Feb. 22, 1982) Arizona v. California (Oct. 1981 term, No. 8, Orig.) (footnotes omitted) (emphasis supplied).

Even a casual reading of Master Tuttle's Report reveals the importance of economics to the concept of practicably irrigable lands. On pages 93 through 100, the Master set forth an extensive analysis concerning the role of economics in the original proceedings as well as the current proceedings in Arizona v. California. And, in Appendix 2 to his Report, Master Tuttle sets forth a detailed analysis of the payment capacity of lands under different cropping scenarios.

In this case, Dr. Cummings also admitted that:

> "We go ahead and use these tools primarily because we don't have a better alternative." (Tr. 8,850) (emphasis supplied).

And that is just what Dr. Cummings did. Dr. Cummings presented the Court with a lengthy, detailed report describing the results of his benefit-cost analysis of proposed future irrigation projects. Tribes' Exh. 24.

The Tribes agreed that PIA encompasses the notion of reasonable costs. Tr. 13,361 (Sachse). The Court must presume that when he coined the phrase "practicably irrigable acreage" in Arizona v. California, Special Master Rifkind did so advisedly. Deleting "practicably" leaves only "irrigable acres," a concept which addresses only land, water and engineering.

15-11 Feasibility established by benefit-cost analysis.

The Court finds that the United States and Wyoming agreed that, within economics, benefit-cost analysis is the most appropriate method of determining the reasonableness of costs or economic feasibility for purposes of determining practicably irrigable acreage.

15-11 With respect to economic method, Mr. Dornbusch testified that benefit-cost analysis was an appropriate method for determining practicably irrigable acreage because it would evaluate those projects "using the true value of resources the same way the World Bank would evaluate the project, the same way the United Nations would, and using the same principles that are recommended by the Water Resources Council." Tr. 4,937-38 (Dornbusch).

It is significant that the United States offered Mr. Dornbusch as an expert in economics and economic feasibility analysis. Tr. 4,908 (Echohawk). Over objection, the Master accepted Mr. Dornbusch as an expert in these fields. Tr. 4,930-31. Mr. Dornbusch presented the results of his economic feasibility studies using benefit-cost analysis for the five proposed future projects at varying discount rates. U. S. Exh. C-268 and C-274. Later in his testimony, Mr. Dornbusch also presented the results of his economic feasibility studies (also using benefit-cost analysis) of Type VII (historically irrigated but idle) and Type VIII (future Federal Indian Irrigation Project) lands. U. S. Exh. C-278.

On behalf of the State of Wyoming, Dr. Brookshire agreed with Mr. Dornbusch that benefit-cost analysis is the most appropriate economic tool for the determination of practicably irrigable acreage. Tr. 14,514 (Brookshire). Another of Wyoming's expert witnesses, Dr. Jim Jacobs, presented the results of his benefit-cost analyses of the future projects proposed by the United States and Tribes (Wyo. Exhs. EJ-2, EJ-3, EJ-4), the Type VII lands (Wyo. Exhs. EJ-14, EJ-15) and the Type VIII lands (Wyo. Exhs. EJ-3 and EJ-4).

Finally, even the United States' rebuttal witness, Dr. Steven Goldfeld, stated in response to a question from the Master that benefit-cost analysis was useful to the determination of PIA on the Wind River Reservation:

> "It is clearly well-enough established that as a useful framework, we are focusing on what the issues are. And even if something doesn't necessarily answer the question by itself, it is a technique that gets you to ask the right questions, what do I need to know in order to make a sensible decision. And in that sense I think it is very hard to argue that is a bad thing that should be done away with." Tr. 15,541 (Goldfeld).

15-12 Contemporary standards used for feasibility determination.

The Tribes, through Dr. Cummings, expressed some reservations concerning the use of benefit-cost analysis in determining PIA. Mr. Sachse, representing the Tribes, also argued that alternative methods should be considered to give the Tribes

> ". . . the same fair shake in terms of what's practicably irrigable as the white farmers in the West have had over a period of 40 to 50 years." (Tr. 13,362) (Sachse).

The Court finds, however, that it would be an impractical task to attempt to determine what practicably irrigable acreage was 40 or 50 years ago. Further, the Court notes that such a determination might not be in the Tribes' favor since past standards for evaluating project feasibility have not always been more lenient than current standards. The Court thus agrees with Special Master Tuttle in Arizona v. California that practicably irrigable acreage should be determined using contemporary technology and contemporary standards for evaluating project feasibility. Special Masters report at 97, 98 (Feb. 22, 1982) Arizona v. California (Oct. 1981 Term, No. 8, Orig.).

The Court further finds that benefit-cost analysis is the most appropriate method for determining economic feasibility for several reasons. First, Dr. Cummings performed such an analysis and presented the results to the Court. Second, Wyoming and the United States agreed that benefit-cost analysis is the best approach. Third, virtually all other federal water development projects have been and are today evaluated using this type of analysis. Fourth, both Special Master Rifkind and Special Master Tuttle used benefit-cost concepts in Arizona v. California. Finally, in addition to the fact that there is no other convincing evidence in the record by which the Court can determine the reasonableness of costs, stipulated by the Tribes to be relevant, abandoning benefit-cost analysis would trivialize much of the efforts and testimony of Dr. Mesghinna, Mr. Dornbusch, Mr. Bliesner, Mr. Sostrom and Dr. Jacobs. This, the Court declines to do.

15-12 While Dr. Cummings expressed doubts concerning the appropriateness of benefit-cost analysis, Tr. 8,848-49, he nevertheless summarizes the results of his own analysis using benefit-cost analysis. Tr. 8,912-13, Tribes' Exh. 24, p. 15-11. See also Finding of Fact 15-10 and reasons in support thereof.

As an alternative to benefit-cost analysis, Mr. Sachse argued that:

> "To the extent, for instance, that land in North Crowheart is more or less like some land in the Riverton Reclamation District or is more or less like land that's being irrigated elsewhere in the West, then the Indians should get the same fair shake in terms of what is practicably irrigable acreage as the white farmers in the West have had over a period of 40 or 50 years." (Tr. 13,362) (Sachse).

At first blush, this argument appears to contain both economic and ethical support. The economic argument is that if it is economically feasible to irrigate land in the Riverton Reclamation District, then by implication it must be economically feasible to irrigate lands in the North Crowheart units. The ethical argument is that even if farming the Riverton Reclamation District is not economically feasible, the Tribes should receive water for North Crowheart

because fairness or equity suggests that they should be treated identically with non-Indian irrigators.

There are compelling reasons why the Court should reject both of these arguments. First, the North Crowheart and the other proposed future project areas are not "more or less like" the Riverton Reclamation District or any other irrigation projects in the West. Each area has its own unique attributes such as soils, climatic conditions, drainage requirements, and other factors which affect both the costs of putting these lands to irrigation and the returns to irrigation. To ignore this information and arbitrarily assume the lands are economically feasible to irrigate because they are claimed to be more or less like other lands elsewhere would be a disservice to the adjudication because it would render meaningless substantial bodies of evidence gathered, analyzed and presented to the Court at great expense by all three major parties.

Second, benefit-cost analysis was the only economic methodology used to present factual results to the Court concerning the extent of practicably irrigable

acreage on the Wind River Indian Reservation. Although the Court as noted earlier, heard arguments concerning the appropriateness of other methods, no systematic study using other methods was presented to the Court.

The argument that the Tribes should receive water for the future projects even if they are not economically feasible, out of a sense of equity, really isn't an argument at all. It is a plea for the Court to ignore the stipulation of the major parties, including the Tribes, that the practicability of irrigation is constrained by reasonable cost. While is is entirely possible that certain past projects were built when construction costs were lower, and would not be economically feasible today, the Court was presented with absolutely no evidence that the proposed future projects would have been feasible had they been built 40 or 50 years ago. To the contrary, the Tribes' economist, Dr. Cummings, suggested under cross examination that some of the projects might not even be technically irrigable because modern sprinkler technology was not available then. Tr. 9014.

The equity argument also ignores the unique characteristics of the water rights the Tribes and United States seek here. The reserved right claimed has a priority date senior to every other appropriator in the Wind River and Big Horn basins and further, these rights cannot be lost because of non-use. Even a finding in the future that the projects are not feasible (for instance, if they were built and failed) might not be sufficient grounds for a forfeiture of the reserved rights sought here.

Finally, the interjection of equity arguments into the litigation would needlessly complicate an already complicated issue. As Special Master Tuttle observed in his recent report on Arizona v. California:

> "My reading of the transcript [of the prior proceedings] reveals that the evidence of 'practicable irrigability' was determined by then current standards. I am similarly convinced that my determination of practicable irrigability should be based on present standards. Reference to past standards would introduce an additional complication into an already complex case. Given that these issues are to be litigated presently, the most sensible method of determining feasibility is by using present standards."

Special Master Report at p. 98 (Feb. 22, 1982) Arizona v. California (Oct. 1981 Term, No. 8, Orig.) (footnotes omitted) (emphasis added).

Also in support of the Tribes' "theory," Mr. Jack Keller testified that the irrigation system design costs for the proposed future projects on the Wind River Indian Reservation are reasonable. Tr. 8803 (Keller). On behalf of the State of Wyoming, Mr. Floyd Bishop, rebutted Keller's opinions concerning reasonable system costs for irrigation projects in the State of Wyoming. Tr. 12191-12194 (Bishop). Although their opinions differed significantly, both of these witnesses testified concerning the "reasonableness" of the engineering costs necessary to place new lands under irrigation on the Wind River Indian Reservation.

This line of testimony is a variation of Mr. Sachse's argument that the economic feasibility of irrigating new lands can be determined by reference to existing projects elsewhere. In essence, the Tribes argue that the Court can assess feasibility of these projects by looking only at the cost side of the equation, a situation not unlike assessing the reasonableness of the amount of checks one has written on one's bank account without reference to the deposits.

This approach completely ignores the potential returns projected for the proposed future projects. The Tribes presented no evidence concerning cropping patterns or yields for the Navajo Irrigation Project with which Keller is familiar, but it is certainly conceivable that they are substantially different from and, thus not comparable with, those on the Wind River Indian Reservation. Returns to projects reviewed by the Wyoming Farm Loan Board of which Mr. Bishop was a member may be more comparable to those projected for the Wind River Indian Reservation, but, again, the Court has no basis for a precise determination. The Court should evaluate the projects on their own merits and economic feasibility should be determined by a comparison of the contemporary costs and returns estimated for these projects as was done by both Masters in Arizona v. California.

15-13 Accepted guidelines for benefit-cost analyses.

The Court also finds that there exist generally accepted guidelines for conducting benefit-cost analyses. These practices, which were agreed to by the U.S. and Wyoming, include consideration of the Water Resources Council (WRC) principles and standards for evaluation of federally funded water development projects. While the Court is not bound by the WRC principles and standards, the Court does find that they provide a useful framework for evaluating the benefit-cost analyses submitted to the Court by the major parties.

15-13 Mr. Dornbusch testified on behalf of the United States that his benefit-cost analysis used:

> ". . . essentially the principles prescribed by the Water Resources Council." Tr. 4,938 (Dornbusch).

On cross-examination, Mr. Dornbusch argued that the WRC principles should, in general, apply to the determination of PIA on the WRIR, but that their recommended methods must be applied with some judgment. Tr. 5,978-82 (Dornbusch).

The State of Wyoming did not dispute this contention. In fact, Dr. Jim Jacobs, who presented the State's benefit-cost analysis to the Court stated that he reviewed various WRC publications as a part of his analysis. Tr. 14,993 (Jacobs). Furthermore, Dr. David Brookshire, on behalf of the State, urged the Court to adopt concepts involving opportunity costs, sensitivity analysis and the exclusion of secondary benefits which are consistent with the WRC guidelines. Tr. 14,517, 14,538 (Brookshire).

Only Dr. Cummings testifying on behalf of the Tribes, argued against the applicability of current WRC guidelines, Tr. 8,866 (Cummings) and Tribes' Exh. 24,

pp. 3-8. Dr. Cummings' argument against using WRC guidelines is that they were not promulgated until 1973, and thus use of them penalizes the Tribes for not exercising their water rights earlier.

> "On its face you penalize the Indians for not -- for not exercising their reserved right prior to 1973. Again, it relates to the statement I made just a second ago. If the Indians had known in the 1930's and '40's and '50's and '60's that, you know, in 1973 an economist was going to come to them with this NED benefit-cost ratio, they would surely exercise that right or considered execising that right earlier." Tr. 8,866 (Cummings).

The Court should reject this argument because had the Indians exercised their water right in earlier years, it is not clear that any of the proposed future projects would have been even technically feasible, much less economically feasible. Dr. Cummings admitted this under cross-examination:

Q. (By Mr. Merrill) "Let me try it again.

> I'm speaking of highland areas, mesa tops, things like this, such as are found in the Big Horn Flats area, the North Crowheart.
>
> My question is: Would it have been possible to irrigate those types of lands with the irrigation and pumping technology that was available 20 to 40 years ago?"

A. "Certainly you wouldn't be using sprinklers. I simply have not studied the topography of that area to the point -- I'm not aware.

Is there some way you can use some sort of a head system to get water there or not? I just can't respond. I'm sorry." Tr. 9,014 (Cummings) (emphasis supplied).

There is no evidence before the Court that the Tribes have penalized themselves by not exercising their rights at an earlier date. To the contrary. Dr. Cummings testified that prior to 1939 the principle for evaluating project feasibly was ability to repay project costs. Tr. 8850-51 (Cummings). Regardless, the Court has no basis for determining what would have been practicable at any earlier date. Thus, the Court must find that the practicability of irrigation is determined by modern irrigation technology and contemporary guidelines for evaluating the feasibility of employing that technology on Indian lands.

It is clear that the United States did not include secondary benefits in its benefit-cost analysis for PIA on the Wind River Indian Reservation. This fact was brought out in Mr. Echohawk's cross-examination of Dr. Cummings.

Q. (By Mr. Echohawk) "In your review of Mr. Dornbusch's work, would you say it's quite clear that Mr. Dornbusch did not include any secondary benefits, is that right?

A. "I see no evidence of secondary benefits." Tr. 8,930 (Cummings).

The State of Wyoming also argued against the inclusion of secondary elements in benefit-cost analyses through the testimony of Dr. Brookshire:

> "One should probably not include secondary elements, but if one does, one must consider secondary benefits and secondary costs. You must balance the ledger. To do otherwise, it would be like putting all the deposits in your checkbook and never writing in any of the checks. You are obviously going to get a distorted view of what is happening financially to yourself." Tr. 14,532 (Brookshire).

The Court should note, however, the following:

(a) There is no reason to believe secondary benefits (if any) would accrue to members of the Tribes, Tr. 8,943 (Cummings).

(b) If secondary benefits do exist and do accrue to non-Tribal members, they constitute a positive "impact" that would be inappropriate to consider without also considering negative impacts. Tr. 14,532 (Brookshire). Furthermore, as noted by the Special

Master, the historical use of secondary benefits itself was not necessarily appropriate.

> ". . . they were much more liberal in those years and rationalized a lot of benefit-cost ratios in those years." Tr. 9,005 (Special Master).

15-14 "PIA" - benefits exceed costs.

The Court also finds that benefits must be shown to exceed costs for a parcel of land to be determined practicably irrigable.

15-14 Mr. Dornbusch testified that the appropriate criterion for judging practicably irrigable acreage is that a benefit-cost ratio should be greater than one:

> "I would throw out only those projects that have a benefit-cost ratio of under one, and any benefit-cost ratio over one is clearly feasible." Tr. 6017 (Dornbusch).

The Tribes' witness, Dr. Cummings, and Wyoming's witness Dr. Jacobs, also refer to benefit costs ratios approaching one or greater when discussing feasibility Tr. 8909 (Cummings); tr. 14755 (Jacobs)

The Court should further note that the requirement that benefits should exceed costs was adopted by both Special Masters in Arizona v. California. Special Master's Report at 99 (Feb. 22, 1982) Arizona v. California. (Oct. 1981 Term, No. 8, Orig.).

15-15 "PIA" - true costs appropriate.

Subsidies that may be available to the Tribes through the Leavitt Act, or other sources, for the construction of irrigation systems should not be considered in a benefit-cost analysis to determine PIA. Although there was no disagreement on this point among the major parties, the Court feels compelled to emphasize that the economic criterion for the determination of PIA should rest upon the true economic costs and benefits of irrigated agriculture to the Tribes and not upon arbitrary funds transfer mechanisms.

15-15 All three major parties agree on this issue. Dr. Brookshire, testifying on behalf of the Wyoming, stated, on direct examination:

> Question: (by Mr. Merrill) "Okay. Can you describe for the Court what role, if any, subsidies should play in an economic benefit-cost analysis?"
>
> Answer: None. Tr. 14,512.

Dr. Brookshire stated further that:

> ". . . the benefit-cost analysis is taking a societal perspective. It is evaluating whether we should commit resources to a particular project, thus implicitly taking them away from some other potential project or leaving them idle. So implicitly it is trying to evaluate whether society will be better off by pursuing this project. To introduce a subsidy would confound the analysis." Tr. 14,513 (Brookshire).

Mr. Dornbusch, testifying on behalf of the United States, agreed:

> "In our analysis we eliminate such things as subsidies, and we would eliminate other values that are really not an expression of the creation or the consumption of resources. I guess a telling way to show you to demonstrate the difference between the financial and economic, and in my case I'm choosing the economic, is that in the case of the Indian tribes they have a very unique subsidy available to them in the Leavitt Act that would permit them to borrow money to finance the construction of really the main cost components of the system." Tr. 4,934 (Dornbusch) (emphasis supplied).

Although the Tribe's economist, Dr. Cummings, made no mention of subsidies or the Leavitt Act, he did rely upon Dr. Dornbusch's analysis and thus, by this action, affirmed his agreement. Tr. 8,968-69 (Cummings).

The Court should further note that Special Master Tuttle also ruled out use of the Leavitt Act in determining PIA in his recent report on Arizona v. California:

> "17. . . . Thus, the deferred repayment provisions of the Leavitt Act, 25 U.S.C. 386a (1976), should not be considered to increase the feasibility of the projects on the issue of whether water rights should be decreed. The rejection of the consideration of the Leavitt Act in the prior proceedings makes untenable the Tribes' suggestions. This determination, of course, has no effect on other cases in which the quanitification standard used might incorporate general reclamation standards along with such matters as the Leavitt Act in order to give the Indians sufficient water to make a particular reservation livable. See Ranquist, supra note 15, at 660-61. There have also been theoretical economics arguments along these lines. See Burness, Cummings, Gorman & Landsford, United States Reclamation Policy and Indian Water Rights, 20 Nat. Resources J. 807, 822-24 (1980).

The later Article has been brought to my attention by the Four Tribes. The authors' theme is that the Leavitt Act deferment provisions should be compared to power revenues generated by reclamation projects in which the power revenues are used as a societal benefit to offset the costs of the project. Id. The analogy, however, seems imperfect because the Leavitt Act benefits to Indians are not generated by Indian irrigation projects as power revenues are generated by reclamation projects. Perhaps the Leavitt Act provisions might be viewed as quantifying the intangible benefits accruing to society when the Indians utilize such benefits to provide for themselves in a constructive manner. Because of the prior practice in this case, such concerns are, however, not presently relevant." .

Arizona v. California, at 96, fn. 17.

15-16 Discount rate.

One of the most controversial topics to face the Court during the entire hearing concerned the selection of an appropriate discount rate for economic feasibility studies. The Court heard testimony from five witnesses on this matter, all of whom disagreed with each other and at times with themselves. The first witness to present testimony on the discount rate was Mr. David Dornbusch, testifying on behalf of the United States. Mr. Dornbusch first told the Court that the proper rate to use was a real rate, net of inflation, of 4 percent. Mr. Dornbusch later clarified this statement by saying that, in his opinion, the correct rate was in the range of 2 to 4 percent, but not over 4 percent.

Under cross-examination, however, Mr. Dornbusch admitted he began his feasibility analysis for the United States using a rate of 7-1/8 percent, the rate then recommended by the Water Resources Council for federally-funded projects. Mr. Dornbusch also admitted that it is standard procedure to continue to use the rate in effect at the time the analysis is

begun, although he did not follow this practice. Mr. Dornbusch presented the Court with results of cost benefit analyses evaluating the United States' proposed future projects for varying discount rates between 4 and 7 1/8 percent.

15-16 Mr. Dornbusch, testifying on behalf of the United States, admitted that when he first began his benefit cost studies he used a discount rate of 7 1/8 percent, and was aware that that was the rate called for by the Water Resources Council. Tr. 6071 (Dornbusch). Mr. Dornbusch further admitted that it is standard procedure to stick with the rate in effect when you began an analysis:

> "Yes, I think what I was talking about is the fact that an analysis can take quite a bit of time, can take more than a year, and that my understanding is that the standard practice is to use the rate that is in effect at the time be you began your analysis, whether or not your analysis continues into the next fiscal year." Tr. 6073 (Dornbusch).

By the time Mr. Dornbusch presented his benefit-cost results to the Court, he had changed his mind concerning the appropriate discount rate:

> ". . . I performed some research to determine what that rate is, the proper rate to use, which is net of inflation, and the answer is the answer to your question earlier, is the 4 percent, and that's the rate which I determined to be the proper rate to use in the circumstances, . . ." Tr. 5042 (Dornbusch).

Later in his testimony after a recess, Mr. Dornbusch qualified his opinion even further by stating:

> "I should clarify that. In my professional opinion, the correct rate is in the range of 2 to 4 percent, and it's probably not over 4 percent." Tr. 5049 (Dornbusch).

Mr. Dornbusch initially presented his results to the Court only in terms of a 4 percent discount rate. U.S. Exh. WRIR C-268. Under questioning by the Special Master, however, it became apparent that Mr. Dornbusch had prepared results for his feasibility analysis at a series of discount rates between 4 and 7 1/8 percent. Tr. 5094-5096 (Dornbusch). These results were later submitted to the Court as U.S. Exh. WRIR C-274 and Wyo. Exhs. ED-12, ED-13 and ED-14.

15-17 Lower discount rate evidence.

The next witness to present testimony concerning the discount rate was Dr. Ron Cummings, representing the Arapahoe and Shoshone Tribes. Dr. Cummings first stated that he was not sure discounting was even applicable to determining practicable irrigable acreage, a position tantamount to using a discount rate of zero. Dr. Cummings then testified that if a non-zero discount rate were to be used, it should be in the range testified to by Mr. Dornbusch; of 2 to 4 percent. Mr. Cummings then presented the results of his economic feasibility analysis to the Court using a 4 percent discount rate.

15-17 Dr. Cummings first told the Court that he was uncomfortable about the role of discounting in determining an Indian water right. Tr. 8870-8874 (Cummings). The Court should note, as pointed out earlier, that much of Dr. Cummings' discomfort apparently was based upon the mistaken belief that economics was not a part of Arizona v. California:

> ". . . There was no economist that could testify, to my knowledge, in Winters nor in Arizona v. California . . ." Tr. 8849 (Cummings).

Dr. Cummings went on to testify that:

> "If you are going to discount, you've got to get at a real discount, that is an interest rate that's inflation free." Tr. 8875.

Dr. Cummings also stated, however:

> ". . . There is no (sic) objective ways of choosing a real discount rate, we can get a range of economists in here and some will argue high and some will argue low." Tr. 8877 (Cummings)(emphasis supplied).

Dr. Cummings then went on to argue low, stating that:

> ". . . I think an appropriate range for a real discount would be 2 to 4 percent." Tr. 8878.

Dr. Cummings presented the Court with the results of his economic feasibility analysis, which essentially added his estimate of secondary benefits to Mr.

Dornbusch's analysis, and made some adjustments to on-farm costs (See Finding of Fact 15-12 and support therefor).

15-18 Real rate of return as discount rate.

On behalf of the State of Wyoming, Dr. David Brookshire, stated that the appropriate discount rate should be based upon the real rate of return to capital in various sectors of the American economy. He further testified that such rates of return range from -1 to +24 percent. He stated, however, that in his professional opinion, the most appropriate range to use for a real discount rate is 4 to 11 percent.

15-18 Dr. Brookshire argued that it would be arbitrary at best to evaluate the feasibility of the proposed future projects at a single discount rate. He instead suggested that a sensitivity analysis be conducted over a range of discount rates. Tr. 14520-21 (Brookshire).

Dr. Brookshire further argued that the appropriate way to determine a reasonable range of discount rates is to examine real rates of return in the American economy which range from a negative 1.5 percent to a positive 24 percent. Tr. 14524 (Brookshire).

Dr. Brookshire went on to testify, however, that the majority of rates of return in the economy fall in the range of 4 to 11 percent, and he recommended that range of discount rates for use in evaluating the feasibility of the proposed future projects. Tr. 14526.

The Special Master agreed with the central theme of Dr. Brookshire's testimony as follows:

> "Alright. There is one thing for certain, and I read it from one of your exhibits, there is no single real rate of return in the private sector that can be utilized in our search for a social discount rate, and I agree with that." Tr. 14643 (The Special Master).

15-19 Using a range of discount rates.

The fourth witness to testify concerning appropriate discount rates was Dr. Jim Jacobs. Dr. Jacobs testified that the most appropriate procedure for evaluating practicably irrigable acreage would be to assess the projects over a range of discount rates, including 4, 7-1/8 and 11 percent. Dr. Jacobs then presented the Court with the results of his analyses evaluated at 4 and 7-1/8 percent; he stated that further evaluation at 11 percent would be futile since none of the projects were feasible at a 7-1/8 percent discount rate.

15-19 Dr. Jacobs conducted his feasibility studies at discount rates of 4 and 7 1/8 percent. Tr. 14706 (Jacobs). He agreed with Dr. Brookshire that an appropriate range for evaluating project feasibilities was from 4 to 11 percent. Tr. 14794 (Jacobs). He concluded, however, that there is no reason to actually use an 11 percent discount rate because the results of his analysis at 7 1/8 percent clearly demonstrated the infeasibility of the proposed future projects. Tr. 14795.

15-20 Marginal cost of capital approach.

The final witness to testify concerning an appropriate discount rate was Dr. Steven Goldfeld, a rebuttal witness, who testified on behalf of the United States. Dr. Goldfeld told the Court that, in effect, all of the previous witnesses had been misguided in their determinations of an appropriate discount rate because they did not consider the "marginal cost of capital approach." Under cross examination, Dr. Goldfeld admitted that there is no empirical evidence concerning what the marginal return to capital is, but nevertheless proceeded to tell the Court that the appropriate range of discount rates for evaluating irrigation projects should be 1 to 4%. He justified this range by stating that figures lower in the range are consistent with the so-called "social time preference" and "opportunity cost of consumption" approaches, while the higher figures in this range are more consistent with the opportunity cost of capital approach.

15-20 Dr. Goldfeld testified that the proper approach for determining the opportunity cost of capital and, thus a discount rate, is a marginal approach, not an average approach. Tr. 15505 (Goldfeld).

This directly contradicts the approach taken by the other United States economist, Mr. Dornbusch, who testified that he used <u>average</u> rates of return to capital in establishing his range of discount rates. Tr. 5084 (Dornbusch). By inference it also contradicts Dr. Cummings, who adopted the same range as Dr. Dornbusch. Tr. 8877 (Cummings); and Dr. Brookshire who testified that a range of average sectorial rates of from 4 to 11 percent should be utilized in establishing a discount rate. Tr. 14526 (Brookshire). Dr. Goldfeld admitted under cross-examination that there is no empirical data to indicate the marginal rate of return to capital at any particular time. Tr. 15543 (Goldfeld).

Dr. Goldfeld even appeared confused concerning the relationship of marginal rates of return to average rates of return. At one point, he indicated that marginals are generally much greater than the average, Tr. 15505, and a few minutes later, he argued that

marginal rates of return are below average rates of return. Tr. 15512. Nevertheless, Dr. Goldfeld argued that the opportunity cost of consumption approach, which had not been mentioned by any other witnesses, led to a discount rate of 1 percent and that a combination of the opportunity cost of consumption approach and the marginal rate of return of capital approach led to a range of 1 to 4 percent for a discount rate. Tr. 15516-18 (Goldfeld).

He further argued that the social time preference approach to discount rates would also lead to a discount rate within the above-mentioned range. Tr. 15518-15520

The Court should accept Dr. Goldfeld's testimony for what it is; one expert opinion on a matter in which experts differ greatly. As Dr. Cummings testified:

> ". . . you can get some experts that will tell you it's very high and you'll get some experts that will tell you its very low." Tr. 8875 (Cummings).

For this reason, the Court should not consider Dr. Goldfeld's testimony as binding; rather, it should adopt Dr. Brookshire's position, testifying on behalf of Wyoming that:

> ". . . I would argue that one cannot pick a single rate." Tr. 14522 (Brookshire).

15-21 Discount rates actually used.

Despite the conflicting evidence presented to the Court by various experts, the only economic feasibility analyses presented to the Court used discount rates ranging from 4 to 7-1/8%. Thus, as a practical matter, the Court is forced to deal with discount rates within this range in making its determinations. Furthermore, the Court is inclined to agree with Dr. Brookshire, who testified that decisions as important as those faced by the Court here should not arbitrarily hinge upon the choice of a single discount rate.

15-21 As noted previously, the only benefit cost analyses in the Record evaluated the proposed future projects at discount rates ranging from 4 to 7 1/8 percent. U.S. Exh. WRIR C-274 shows the results of the federal analysis at rates ranging from 7 1/8 to 4 percent. Dr. Jacobs presented the results of his analysis to the Court using discount rates of both 4 and 7 1/8 percent. Tr. 14,795 (Jacobs).

Finally, Dr. Cummings presented the results of his adjustments to Mr. Dornbusch's analysis using a 4 percent discount rate. See Finding of Fact 15-17.

The United States and Tribes obviously hope to convince the Court that it would be very safe to use a 4 percent discount rate in evaluating the proposed projects. Wyoming believes that it would be unwise of the Court to make a decision of the magnitude involved in this adjudication based upon one arbitrarily selected discount rate. Tr. 14518-14524 (Brookshire).

An award based upon a single arbitrary choice of discount rate, a concept about which even the experts agree that they disagree, would add nothing but controversy to the Court's decision for years to come. Unless economic feasibility can be demonstrated over a range of reasonable discount rates which are

agreeable not only to the parties to this adjudication, but also comparable with rates used in other Indian water rights cases as well as other large water projects, the Court should find that the lands are not practicably irrigable.

15-22 A range of discount rates is more appropriate.

The Court thus finds it useful to evaluate the economic feasibility of proposed projects at discount rates ranging from 4 to 7 1/8 percent. Based on the evidence, the Court considers discount rates at the higher end of this range to be more representative of what might be termed contemporary standards in that discount rates of approximately 7 percent place the proposed projects on a equivalent basis with federally-funded water projects and on comparable terms with other Indian water rights cases such as Arizona v. California.

Discount rates at the lower end of this range are more consistent with the point of view that the average rate of return to capital in our economy has not been high in recent years.

15-22 The United States began its analysis of the feasibility of the proposed future projects using 7 1/8 percent as a discount rate. Tr. p. 6071 (Dornbusch). 7 1/8 percent was the Water Resources Council's recommended discount rate to be used by all federal agencies involved in water development at the time the United States' analysis began. Id. Furthermore, in the recent Arizona v. California proceeding, the State parties and the United States used discount rates of 7 and 7 1/8 percent, respectively, in their analyses. Report of the Special Master, Arizona v. California, No. 8, Orig. (Feb. 22, 1982). And the Tribes' engineer in this case, Mr. Bliesner, stated that he has never, until this action, used a rate as low 4 percent and that, in a recent Indian water rights case in New Mexico, he used a rate of 6 7/8 percent. Tr. 8513-14 (Bliesner). Thus, the Court must conclude that a discount rate in the range of 7 percent is clearly a representative comparative standard for evaluating federal water resource projects in general and other Indian water rights cases in particular.

The Court could, on the other hand, conclude that a weighted average real rate of return for the entire United States economy is closer to 4 7/8 or 5 percent. Tr. 15500 (Goldfeld). The Court should note, however, that there is far from unanimous opinion that using a weighted average rate of return

for the entire United States economy is an appropriate way of determining a discount rate. Tr. 14524-28 (Brookshire).

15-23 PIA requires that benefits exceed costs at discount rate ranging from 4% to 7-1/8%.

The Court further concludes that an economic feasibility analysis, which is in all other aspects acceptable to the Court, should show benefits exceeding costs at discount rates in the range of 4 to 7 1/8 percent to clearly demonstrate the existence of practicably irrigable acreage. Furthermore, the Court concludes that a similar analysis which shows costs to exceed benefits at discount rates of both 4 and 7 1/8 percent would clearly demonstrate the lack of feasibility associated with practicably irrigable acreage. To assess the results of studies which show feasibility at some discount rates within the 4 to 7-1/8% discount range, but not others, the Court must address other questions such as where the burden of persuasion lies among the parties, and the extent to which the applicability of comparable standards with other projects is relevant to the detemination of practicably irrigable lands on the Wind River Indian Reservation.

15-23 The Court can easily resolve its dilemma concerning the appropriate discount rate to use by adopting the following rule. First, by stating that practicably irrigable acreage most certainly exists when credible, undisputed analyses show benefit cost ratios of greater than one at both 4 and 7 1/8 percent discount rates. Secondly, by declaring that practicably irrigable acreage certainly does not exist when credible benefit cost analyses result in ratios of less than unity at both 4 and 7 1/8 percent discount rates. Finally, if the Court were to find a credible benefit cost analyses showed benefit cost ratios of greater than unity at some discount rates in this range, and ratios of less than unity at other discount rates, the Court should ask whether the burden of proof placed upon the United States and Tribes in this case has been squarely met.

15-24 Water availability important "PIA" component.

During these proceedings, the United States, the Tribes and Wyoming agreed that water availability is an important component in determining practicably irrigable lands. The Court finds that in classifying land as practicably irrigable there must be a showing that there exists a reliable source of irrigation water upon which prudent farmers, investors, engineers and economists would rely, when the water supply is administered in accordance with applicable law. This requirement is necessary if substantive meaning is to be given to the terms "sustained irrigation" and "reasonable cost" used to define practicably irrigable lands in this case.

15-24 The United States, Tribes and Wyoming all recognized the role of hydrology and the need for water availability studies in the indentification of practicably irrigable lands. In all, these parties presented the testimony of eight witnesses concerning matters related to water supply:

For the United States:

Mr. Robert Toedter
Mr. Michael Keene
Mr. Ron Billstein

For the Tribes:

Mr. Keith Higginson
Mr. Ron Bliesner

For Wyoming:

Mr. George Christopulos
Mr. Leonard Rice
Mr. Gordon Fassett

Each party's evidence addressed the availability of water to serve lands claimed to be practicably irrigable.

15-25 Water short areas.

Those areas determined by a properly conducted water availability study to be significantly water short cannot properly be classified as practicably irrigable.

15-25 In order for land to be classified as practicably irrigable there must be a reasonably reliable source of water to fully irrigate the land. If the land is water short or if the owner must spend great amounts of money to achieve a full water supply, economics makes it impracticable to farm the land. In light of the fundamental importance of economics and water supply to the determination of practicably irrigable lands, it would be erroneous to include significantly water short areas in the determination of practicably irrigable lands.

15-26 Water availability essential to "PIA".

The Court concludes that a determination of water availability is essential to establishing the existence of practicably irrigable acres and that a comprehensive river systems operation study is the most appropriate hydrologic tool available to evaluate water availability.

15-26 During their cases-in-chief, all three major parties presented the results of their river systems operation studies. Although all parties criticized their opponents' analyses, none questioned the fundamental need for a showing of water availability through the operation of a river systems operation study.

15-27 Criteria to be satisfied for a determination of "PIA".

Based on the foregoing discussion, the Court finds, for purposes of this adjudication, that practicably irrigable lands are those lands which satisfy all of the following criteria:

1. The lands are arable in that they are capable of supporting sustained irrigation;
2. Using current technology, engineers can design systems capable of delivering sufficient irrigation water to the lands and capable of draining excess irrigation water from them;
3. These systems and the farming units can be designed, built, operated and maintained at costs which do not exceed the returns which will be realized from the land, and
4. There exists a reliable source of irrigation water upon which prudent farmers, investors, engineers and economists would rely, when the water supply is administered in accordance with applicable law.

15-27 See Findings of Fact 15-1 through 15-26, supra.

Findings of Fact Relating to the Specific Irrigation Claims of The United States and Tribes

16-1 General Claims

In its Statement of Claims, dated March 6, 1980, the United States claimed the right to divert 570,304 acre-feet of water annually to serve 147,529 acres, resulting in an average diversion requirement of 3.87 acre-feet per acre. In their Statement of Claims, filed April 4, 1980, the Tribes increased their claim for irrigated lands by 175,508 acres above the United States' acreage and asserted an average annual diversion requirement of 4.24 acre-feet per acre. They also identified additional lands as being subject to full, rather than partial, irrigation, further increasing their irrigation claims an additional 814,998 acre-feet per annum above the amount claimed by the United States.

16-1 United States Statement of Claims, pp. 1-3, 15; Shoshone and Arapahoe Tribes Statement of Claims.

16-2 Types of land for which reserved water rights claimed

During these proceedings, the United States and Tribes claimed water for the following types of land:

1. Future Lands -

These lands have never been irrigated.

A. Future Projects - United States' Claims

These trust lands are five large units of allegedly irrigable acres to be served in a common geographical area, generally from one diversion and conveyance system. The land type is referred to as "Future." See Appendix 3.

B. Future Projects - Tribes' Claims

These trust lands are two large units of allegedly irrigable acres claimed by the Tribes in addition to the United States' projects. The land type is referred to as "Future." See Appendix 4.

C. Type VIII Lands

These trust lands are relatively small tracts of allegedly irrigable land within the boundaries of existing Federal Irrigation Projects on the Reservation, except for a tract near the Arapahoe Ranch. These lands are claimed by the United States. The land type is referred to as "Type VIII." See Appendix 5.

D. Indian-Owned Fee "P" Lands

These lands are allegedly "potentially irrigable" acres occurring in specific tracts identified as Indian-owned fee. These lands are claimed by the Tribes. The land type is referred to as "Potential" or "P." See Appendix 6.

2. Historic Lands

These lands fall into three major groups: (1) those which are alleged to be currently irrigated; (2) those which are alleged to have been previously irrigated but are now idle; and, (3) those which are the subject of a Certificate of Appropriation issued by the State of Wyoming.

A. Type VII Lands

These trust lands are allegedly irrigable tracts which are claimed to have been previously irrigated but are now idle. These lands are claimed by the United States. The land type is referred to as "Type VII." See Appendix 7.

B. Unadjudicated In-Use Lands

These trust lands are alleged to be currently irrigated without the benefit of an adjudicated state-awarded water right. These lands are claimed by the United States. The land type is referred to as "I, II, III, IV, V, or VI;" for an

explanation of these designations, see Irrigated Land Types below. See Appendix 8.

C. Indian-Owned Fee "I" Lands

These lands are allegedly currently irrigated acres identified as Indian-owned fee. These lands are claimed by the Tribes. The land type is referred to as "Irrigated." See Appendix 9.

D. Adjudicated Lands

These trust lands have been identified as subject to an adjudicated state-awarded water right. They may be wholly or partially under current irrigation, previously irrigated but now idle, or never irrigated. These lands are claimed by the United States. See Appendix 10.

For the sake of organization, the Court will address these claims in the order listed above. While the Court's general Findings of Fact concerning these claims are set forth in the succeeding sections, more specific information concerning these claims is presented in Appendices 3 through 10 hereto. The information in these Appendices is hereby incorporated as if fully set forth herein. Any discrepancies between the following Findings and the Appendices should be resolved in favor of the latter.

Note: The State of Wyoming has intentionally submitted no Findings of Fact, numbered 17-1, et seq.

Findings of Fact

Relating to

United States' Proposed Future Projects

18-1 United States' testimony re: arable future lands.

As a result of the future land study performed by HKM, the United States presented testimony at trial claiming 84,469 acres of future lands were arable.

18-1 The arable land classification of future project areas under the United States' (and Tribes') claims was performed by the firm of HKM Associates. Mr. Kersich testified concerning the results of the land classification for future project areas in the North Crowheart, South Crowheart, Arapahoe, Bighorn Flats, Riverton East and Owl Creek Units. Mr. Robert Toedter testified to the drainage study of these lands. Mr. Kersich concluded that 84,469 acres of future lands were arable. U.S. Exh. WRIR C-43 (p. 27, Table 8).

18-2 <u>The United States' experts lack of qualifications</u>. The United States' expert witnesses who testified regarding the arability of future lands, Mr. Kersich and Mr. Toedter, were not properly qualified to render the opinions to which they testified. Mr. Kersich was admitted as an agricultural engineer, but he was not qualified to testify about soil science and land classification. Mr. Toedter was admitted as a drainage engineer but admitted that he performed no drainage engineering in the course of his analysis. Therefore, the Court finds that although Mr. Kersich and Mr. Toedter may be qualified in their respective fields of agricultural and drainage engineering, they were not qualified to render the opinions to which they testified. Accordingly their testimony must be disregarded.

18-2 Mr. Kersich was admitted as an expert in agricultural engineering. Tr. 1224-25 (Kersich). There is no indication in the record that Mr. Kersich has any previous field experience in soil science or land classification prior to his limited involvement in this case. Tr. 1221-1222 (Kersich). Also Mr. Kersich admitted that he did not possess knowledge of the geology of the area. Tr. 1723 (Kersich). He was also confused about the exact standards that were used in arable land study. Tr. 10847 (Sommers); Tr. 1139-1149 (Kersich).

Mr. Kersich testified that he, as an agricultural engineer, is able to make arability determinations based on his input into the program. However, the agricultural engineer's normal input into the land classification program is only one of assistance in the creation and review of standards, not in the actual determination of arable lands. Wyo. Exh. WRIR SK-4 (Section 2.7.3) The determination of arability requires a subjective decision by a soil scientist based on his knowledge of the physical and chemical properties of the land in question as modified by the standards created with the interaction of soil scientists, engineers and economists. Tr. 1116-1119

(Kersich). According to Mr. Dick Piper, director of land classification for the Bureau of Reclamation, soil scientists, not agricultural engineers, certify the arable lands for the Bureau of Reclamation. Wyo. Exh. WRIR SS-A13 (Item 2). Yet in HKM's study, Mr. Kersich, who is not a soil scientist, made the final land classification determinations for future tracts in a questionable status. Tr. 3311 (Waples).

Mr. Kersich relied on the opinions of his staff experts in land classification and drainage in forming his opinion. Specifically, he relied on Mr. Waples, who was admitted as an expert in land classification and soil science; Mr. Toedter, admitted as an expert in agricultural engineering; Mr. Billstein, who was admitted as an expert in water resources engineering; and Mr. Hanson, Mr. Smith, and Mr. Olson, land classifiers for HKM, none of whom testified. Tr. 1127, 1255 (Kersich). Mr. Chick Smith of HKM was party chief and made changes in class or boundaries. Tr. 1174 (Kersich). Mr. Waples did much of the work on newly classified lands but he did not testify concerning the classification of these lands. Mr. Kersich did only limited field work for this litigation, and admitted that he needed Mr. Waples to interpret soils data. Tr. 1175, 1222-23 (Kersich).

Mr. Robert Toedter was admitted as an expert for the United States in agricultural engineering, specializing in drainage. Tr. 3732 (Toedter). Mr. Toedter's responsibility in the land classification program on the Wind River Indian Reservation involved developing drainage standards of subsurface hydraulic conductivity, soil depth to barrier, and drain spacing. Tr. 3735 (Toedter). He also determined whether the drainage standards were met for lands classified as arable. Tr. 3822-23 (Toedter). Although admitted as an agricultural engineer specializing in drainage, Mr. Toedter did no specific drainage engineering in his investigations. He only provided Stetson Engineers with average hydraulic conductivity and soil depth to barrier information for their use in drainage engineering and design. Mr. Toedter delineated the drainage investigation study areas for the future and historic lands, and determined the average hydraulic conductivity and depth to barrier for each of the study areas. This information was provided to Stetson Engineers for drainage engineering and design. Tr. 3754-55, 3823-30 (Toedter).

Prior to this litigation, Robert Toedter had no experience evaluating hydraulic conductivity and depth

to barrier in Wyoming. Tr. 3717-3918 (Toedter). His only experience in the State of Wyoming was as Irrigation Management Services coordinator for Bureau of Reclamation at the regional office in Billings, Montana. This position gave Mr. Toedter only very limited exposure to Wyoming since it involved activities in four states and lasted only 10 months. Tr. 3705-3707 (Toedter); U.S. Exh. WRIR C-230.

18-3 Deficiencies in analysis by United States' consulting firm.

The Court finds that the HKM land classification and drainage investigation suffer from innumerable deficiencies. Of paramount concern is the lack of consideration of explicit economics in the standards. Specifically, HKM did not conduct any independent economic analysis for use in the development of their standards. The Court finds this to be a significant shortcoming since the Bureau of Reclamation considers economics an integral part of arability definitions and determinations.

Beyond economics, the Court finds many other aspects of the HKM standards that are deficient relative to the Bureau of Reclamation. Specific areas of inadequacy include definitions, depth to barrier, minimum tract size for sprinkler irrigation, slope percentage, Class 4 land, hydraulic conductivity, and minimum drain spacing. Each of these HKM standard components is more lenient than their recent Bureau of Reclamation counterparts which reflect the complexity of the Wind River Indian Reservation and adjacent Riverton area lands.

Further, the Court finds that HKM did not apply their standards uniformly. Many specific examples have been cited from the evidence where HKM violated its own standards. In effect, the standards have been reduced to general guidelines. The HKM standard for depth to barrier for use on the Wind River Indian Reservation represents a major variation from the standard used on the Crow Reservation by HKM. The inappropriate application of standards by HKM sheds much doubt upon the reliability of their arability conclusions.

18-3 The HKM definition of arable land is deficient relative to the Bureau of Reclamation definition which has evolved from use in numerous irrigation projects throughout the West. The Bureau of Reclamation definition is "state-of-the-art" in arable land determinations for irrigation. The HKM definition does not include the determination that sufficient income will be generated to warrant further consideration for irrigation development, which the Bureau of Reclamation considers necessary. See Finding of Fact 15-3.

HKM's arable land and land class definitions do not include explicit economics as does the Bureau of Reclamation definition, and are ambiguous with respect to "sustained nature of irrigation" and "relatively high yields." Both Mr. Kersich and Mr. Waples agree that the HKM definition of arable land differs from the Bureau of Reclamation definition. Tr. 1134, 1303 (Kersich); Tr. 3487 (Waples). Mr. Kersich and Mr. Waples both define arable land as "those lands capable of sustained irrigation." U.S. Exh. WRIR C-43 (p. 28); Tr. 1101, 1145, 1152, 1295 (Kersich); U.S. Exh. WRIR C-226 (p. 40). Mr. Waples and Mr. Kersich further define sustained irrigation as the ability of a soil to produce a relatively high yield of crops under

irrigation over a long period of time without deterioration. U.S. Exh. WRIR C-43 (p. 31); U.S. Exh. WRIR C-226 (p. 45). Mr. Kersich further states that sustained and long-term are synonymous. However, Mr. Waples was unable to define long-term or sustained irrigation explicitly. He used a circular definition that if land met the standards it will sustain irrigation. He was also unable to define relatively high yield. Tr. 3568-70 (Waples).

Mr. Kersich and Mr. Waples define land class as "a category of lands having similar physical and economic characteristics which affect the suitability of land for sustained irrigation." U.S. Exh. WRIR C-43 (p. 29); U.S. Exh. WRIR C-226 (p. 41). Mr. Kersich and Mr. Waples define land class specifications as "a list of land deficiencies and ranges of severity of these deficiencies which are allowed in each land class." U.S. Exh. WRIR C-43 (p. 29). U.S. Exh. WRIR C-226 (p. 42).

Mr. Kersich and Mr. Waples define arable land classes 1, 2, 3, 4, 5 and nonarable class 6 as follows:

Class 1. Class 1 lands are of high quality for irrigation, and will yield high returns with minimum production and management costs.

Class 2. Class 2 lands are good quality lands with only minor deficiencies.

Class 3. Class 3 consists of fair quality lands having more serious deficiencies than Class 2 lands.

Class 4. Class 4 lands are of marginal quality for irrigation and are used mainly for shallow rooted crops or pasture.

Class 5. Class 5 lands are those lands which have been placed into a deferred status pending further investigation. There were no lands included in a deferred status.

Class 6. Class 6 lands do not meet the minimum requirements for an arable rating under the land classification standards used in this study.

U.S. Exh. WRIR C-43 (pp. 8 - 9); U.S. Exh. WRIR C-226 (p. 3).

Mr. Waples describes Class 4 lands as the "least suitable type of land that was deemed arable . . ." Tr. 3536-37 (Waples). Though Class 4 lands may include lands of very high productivity under special circumstances, none of these type lands occur on the Wind River Indian Reservation. Wyo. Exh. WRIR SK-4 (Section 2.5.1); Tr. 3545 (Waples).

Substantial disagreement exists among the parties on the definitions of arable land, land classes and standard development. Considerable controversy arose over the inclusion of economics in arable land classification. The United States and the Tribes suggest that economics need not be included in the evaluation of arability, even though on cross-examination they acknowledge that some economic considerations were included in their own standards. Tr. 3488-3490 (Waples). The State's position was that economic considerations should go into the arable land determination. Had economics been included, as is done by the Bureau of Reclamation, a much more stringent evaluation of arability would undoubtedly have resulted.

HKM did not use explicit economics in developing their land classification standards. Specifically, they did not make any farm budget determinations during the development of standards. Tr. 3082, 3099 (Kersich). They modified Bureau of Reclamation standards but did no independent economic analysis. Tr. 3490-91 (Waples). No economist was included in the team which developed the standards used by HKM. Tr. 1127 (Kersich). No determination of the amount of economic returns was mentioned in their land definitions. Tr. 1320 (Kersich). Mr. Waples admits that the Bureau of Reclamation definition of Class 4 land which requires special economic and engineering studies was not met by HKM. Tr. 3546 (Waples); Wyo. Exh. WRIR SK-4 (Section 2.5.5).

Mr. Kersich stated that HKM land classification standards parallel Bureau of Reclamation standards. Tr. 1134, 1303 (Kersich). These standards were said to be based, in part, on 1978 Muddy Ridge standards. Tr. 3484 (Waples); Tr. 1442 (Kersich). However, closer examination reveals significant difference between those standards and the ones employed by HKM on the newly classified lands.

In addition to their failure to consider economics, HKM's standards vary from the Bureau of Reclamation's in several other significant aspects, including:

1. Depth to barrier of seven feet in the Bureau of Reclamation standards versus six feet for the HKM standards. Wyo. Exh. WRIR SK-10; U.S. Exh. WRIR C-36A.

2. The maintenance of a 40-acre minimum size for sprinkler irrigation; 40 acres was also used as a minimum by HKM but later relaxed when hand-moved or solid set sprinklers were considered. Wyo. Exh. WRIR SK-10; U.S. Exh. WRIR C-36A.

3. The maximum slopes allowed as a general rule for the Bureau of Reclamation were 5 to 8 percent for sprinkler and gravity with the exception that minor areas of steeper topography could be included for sprinkler irrigation. The HKM land classification standard for slope ranged as high as 20 percent under sprinkler irrigation. Wyo. Exh. WRIR SK-10; U.S. Exh. WRIR C-36A; Tr. 11043-11044 (Sommers).

4. The Bureau of Reclamation only used Classes 1, 2 and 3 on the Muddy Ridge Area; the Bureau of Reclamation did not include Class 4, though HKM did. Wyo. Exh. WRIR SK-10; U.S. Exh. WRIR C-36A; Tr. 1442 (Kersich).

5. The Bureau of Reclamation drainage manual sets forth a minimum standard for hydraulic conductivity of 0.2 inches per hour. Tr. 3912 (Toedter); Wyo. Exh. WRIR SS-A-15 (p. 118). Mr. Toedter established a hydraulic conductivity standard of 0.1 inch per hour as a minimum to maintain the water table below the root zone. Tr. 3737-38 (Toedter).

6. The Bureau of Reclamation defines barrier as any stratum having one-fifth of the weighted average hydraulic conductivity of the strata above it. Tr. 10781-2 (Sommers); Wyo. Exh. WRIR SS-A15 (p. 118). Mr. Toedter defined barrier as hard sandstone, shale or a stratum with one-tenth of the weighted average hydraulic conductivity of the strata above it. Tr. 3759, 3762 (Toedter).

7. The Bureau of Reclamation in the Riverton area has found that drain spacing of less than 350 feet is generally uneconomical. Tr. 11157 (Sommers); Wyo. Exhs. WRIR SF-2 and SF-29. Considering the parameters of depth to barrier and hydraulic conductivity, Mr. Toedter established a drain spacing minimum of 200 feet. Tr. 3739 (Toedter). Lands which cannot meet the 200 foot drain spacing minimum standard cannot, in Mr. Toedter's opinion,

economically support lower valued crops. Tr. 3898 (Toedter). The drainage costs for land with a 200 foot drain spacing are $1600 per acre. Tr. 3893-3898 (Toedter). In addition, the cost for the five future projects was considered a project cost instead of an on-farm cost and resulted in an increase of the classification of some lands by one or two classes. Tr. 3898-3911 (Toedter).

The Bureau of Reclamation used a 7 foot minimum depth to barrier standard in the 1961 arable land determination on the Wind River Indian Reservation. Wyo. Exh. WRIR SF-1 (p. 20). Jack Christopher, the drainage engineer with the United States Bureau of Reclamation Engineering and Research Center in Denver, prefers an 8 foot to bedrock standard and stated that the use of a 7 to 8 foot depth to barrier standards is a result of his experience in what land has successfully sustained irrigation. Wyo. Exh. WRIR SS-A13 (Items 8 and 11).

HKM's standard for depth to barrier not only violates the Bureau of Reclamation's standards, but it also represents a drastic variation from the depth to barrier standard used in similar projects. On the Crow

Reservation, which lies on the Big Horn River approximately 300 miles north of the Wind River Indian Reservation, HKM used 20 feet to barrier for Class 1 and 15 feet to barrier for Class 2. The arable lands studied on the Crow Reservation were similar to those studied on the Wind River Indian Reservation. Tr. 1481-1483 (Kersich); Kersich testimony regarding Wyo. Exh. WRIR SK-7; Tr. 1779 (Kersich). Mr. Sommers used rigorous standards on the one reservation where he helped develop the basis for arability determinations. In those standards the depth to barrier for Class 1 ranged from 20 to 25 feet, for Class 2 from 15 to 20 feet, and for Class 3 from 6 to 8 feet. The shallower depths were to sandstone or non-saline shale with the greater depths for saline shale. These standards were developed in part by Mr. Sommers for the Ute Mountain Indian Reservation. Tr. 10776 (Sommers). Mr. Sommers prefers a minimum depth to barrier standard of 7 feet for the Wind River Indian Reservation. Tr. 10842 (Sommers).

The complexity of the Wind River Indian Reservation and Riverton area lands are discussed in Finding of Fact 15-5.

HKM did not follow their land classification standards closely. Even if their standards as set forth had been adequate, HKM's application of the standards as merely general guidelines rather than specific criteria exacerbates the unreliability of HKM's results.

As an example, Mr. Sommers cites slope percentage where the land classification standards were not followed and were even exceeded 4 to 5 times over the allowable range. Although standard application needs flexibility, extreme deviations cannot be tolerated. Tr. 11043-44 (Sommers).

Drainage standards were not always met by HKM. A soil with the combination of the minimum hydraulic conductivity and minimum depth to barrier will not meet the 200 feet drain spacing minimum. As hydraulic conductivity decreases, depth to barrier must increase. For example, a soil with 0.1 inch per hour hydraulic conductivity would require a depth to barrier of about 30 feet to meet the 200 foot minimum drain spacing. Likewise, a soil with a 6 foot depth to barrier would require a hydraulic conductivity of 1.0 inch per hour to meet the 200 foot drain spacing minimum. Tr. 3739-40 (Toedter).

However, Mr. Toedter could not determine any other combinations of depth to barrier and hydraulic conductivity that would result in 200 foot drain spacing. Tr. 3740, 3770 (Toedter). Also, HKM land classifiers were unable to determine in the field that the 200 foot drain spacing standard would be met, and in some cases the standard was not met. Tr. 3415 (Toedter), Finding of Fact 18-5.

18-4 Insufficient study intensity by United States' consulting firm.

The Court finds that HKM's arable lands study of the proposed future projects lacks sufficient intensity to serve as an accurate basis for a federal reserved water right. The study was insufficiently intense to satisfy the Bureau of Reclamation's semi-detailed study requirements in the Riverton area and lacked a sufficient number of holes for the drainage investigation and backhoe pits for detailed soil examination.

18-4 The minimum study requirements, claimed to be used by HKM, are the same as the general requirements of the Bureau of Reclamation for semi-detailed classification. U.S. Exh. WRIR C-226 (p. 9); Wyo. Exh. WRIR SK-4 (Section 2.6.5). However, no determination was made by HKM of the specific accuracy of their study other than to state that it meets the general Bureau of Reclamation standards for semi-detailed investigations. Tr. 3512-13 (Waples).

The reservation is so geologically complex that one cannot assume a particular parcel to be arable based solely on field observation without augered holes. HKM did not auger a hole in every major parcel. Tr. 3509 (Waples). Further, it is questionable that even one hole per parcel would suffice. One hole would undoubtedly not suffice unless it was drilled by someone with extensive working experience in the area who has made several studies of similar situations from which he could extrapolate the information he observes. Tr. 10602-03 (Fowkes).

For a land investigation on the Wind River Indian Reservation, observations to six feet and deeper are necessary for the determination that land does meet the

HKM standards for arable lands. These observations are also necessary to characterize the root zone and to determine the hydraulic conductivity and soil characteristics below the root zone. Tr. 11102-04 (Sommers); U. S. Exh. WRIR C-226 (page 7).

HKM classified as arable about 30,745 acres previously classified as arable by the Bureau of Reclamation. For the HKM drainage investigation to determine arability and average hydraulic conductivity and depth to barrier on these lands, Mr. Toedter relied on about 379 Bureau of Reclamation drainage investigation holes and pits six feet or deeper and about 96 HKM holes six feet or deeper. This converts to an intensity of about 65 acres per hole. These lands were classified as arable by HKM and Bureau of Reclamation and were also determined arable by the State of Wyoming.

HKM classified as arable about 22,170 acres (gravity) previously classified <u>nonarable</u> by Bureau of Reclamation. For the HKM drainage investigation, Mr. Toedter relied on about 62 HKM holes six feet or deeper on these lands. This converts to an intensity of about 358 acres per hole. These lands, classified as arable by HKM but nonarable by the Bureau of Reclamation, have

less than one-fifth the investigation intensity of lands classified arable by both HKM and Bureau of Reclamation. HKM classified as arable about 20,499 acres (gravity) which are not within the Bureau of Reclamation study areas. For the HKM drainage investigation, Mr. Toedter relied on about 30 HKM holes six feet or deeper on these lands. This converts to an intensity of about 684 acres per hole six feet or deeper. These lands, classified as arable by HKM but outside of Bureau of Reclamation study area, have less than one tenth the investigation intensity of lands classified arable by both HKM and Bureau of Reclamation. The State of Wyoming determined about 19,715 of these 42,669 acres to be arable under gravity irrigation. U.S. Exh. WRIR C-241A; Wyo. Exh. WRIR SS-9; Wyo. Exhs. WRIR SS-44-A through E, SS-46-A through E, SS-48-A through E, SS-50-A through E, SS-53-A through E; U.S. Exhs. WRIR C-147A, C-147B, C-147C; U.S. Exhs. WRIR C-148-1 through C-148-30.

Intensive studies are required on the Wind River Indian Reservation. See Finding of Fact 15-5.

Backhoe pits are needed as well as augered holes for a sufficient soil classification study. Tr. 10649 (Fowkes). Backhoe pits are necessary in order to evaluate the soil profile and natural soil horizons. They also enable one to determine the percentage of cobble and gravel and the texture of the soil in the matrix. Drilling holes with a hand or power auger is not, by itself, sufficient. True bedrock contact cannot always be located with an augered hole. Tr. 10617, 10626-27 (Fowkes). Additionally, augering holes destroys many soil characteristics which must be accurately identified. Tr. 10627 (Fowkes). HKM used only nine backhoe pits to examine the soil strata of their entire arable land base of 84,000 acres. Tr. 1516 (Kersich). The State used twenty-five backhoe pits to examine about one thousand acres on North Crowheart. Wyo. Exh. WRIR SF-24. The Bureau of Reclamation used at least 40 backhoe pits in its evaluation of arable land and drainage on the Wind River Indian Reservation. Wyo. Exh. WRIR SF-2 (pp. 14 and 24).

18-5 <u>The United States' arable lands study failed to apply minimum drain spacing standard</u>.

The Court is unable to accept the results of HKM's arable land study because the minimum 200 foot drain spacing standard was not applied to all the lands classified as arable by HKM.

18-5 Mr. Toedter could not determine the combinations of hydraulic conductivity and depth to barrier that would result in a 200 foot drain spacing other than when either depth to barrier or hydraulic conductivity were at their minimums. Tr. 3740, 3770 (Toedter). Neither were the HKM land classifiers able to determine in the field that the 200 foot drain spacing standard would be met. Tr. 3916 (Toedter). In fact, some areas classified as arable have drain spacing designs which do not meet the HKM standard of a 200 foot minimum. For example, the area immediately east of Crowheart Butte, North Crowheart Area 61, has a drain spacing design by Stetson Engineers of 150 feet. Tr. 11156-57 (Sommers); U.S. Exh. WRIR C-231; U.S. Exh. WRIR C-257; and U.S. Exh. WRIR CS-3A. Another study area with drain spacing design of less than 200 feet is Big Horn Flats Area 3b. U.S. Exhs. WRIR C-235, C-259.

18-6 Deficiencies in drainage analysis by United States' expert.

The Court finds that the drainage analysis performed by Mr. Toedter of HKM was an integral portion of the United States' arable lands study for future projects and was deficient in the following aspects:

1. The inadequacy of the land classification standards relating to drainage.
2. The lack of application of the minimum drain spacing standard and the resultant substandard drain spacing design.
3. The unreasonably inadequate intensity of investigation on lands not classified as arable by the Bureau of Reclamation.
4. The lack of uniformity within study areas.
5. The inaccuracy of some data.
6. The reliance of HKM on information not supportive of final conclusions.
7. The consideration by HKM of select information.
8. The subjective selection of some information to support arability of lands which would have been classified nonarable.
9. The reliance on information from nonarable land to support arability and the occurrence of areas with no data to support arability.
10. The occurrence of areas which may require additional drainage but which were not actually considered in the final drainage design.

18-6 Arable land must be drainable land. Wyo. Exh. WRIR SS-A8 (Section 511.2.3C).

The HKM drainage investigation involved the development of drainage standards and the determination that the drainage standards were met for lands classified as arable. The drainage standards are considerably less stringent than standards currently applied by the Bureau of Reclamation and HKM on other reservations. See Finding of Fact 18-3. The evidence also shows that the drainage standards were not applied on lands with drainage designs of less than the minimum 200 foot drain spacing. See Finding of Fact 18-5.

Although the drainage standards are less stringent than standards currently in use, this deficiency alone would not render the overall drainage investigation unreliable. A consideration of the geologic complexity of the Wind River Indian Reservation with an intensive investigation and strict application of the standards would likely result in an arable land base without many of the drainage problems which are otherwise certain to occur. However, other than lands classified as arable by the Bureau of Reclamation, the

investigation intensity is considerably less than previously required and currently necessary. See Findings of Fact 18-4, 15-5.

Lands within a given study area should be relatively uniform throughout; lands within a given study area should contain similar landforms and soils. The drainage study areas delineated by Mr. Toedter do not contain similar landforms and soils throughout. Mr. Toedter admitted that there is a great deal of range in the Bureau of Reclamation information within North Crowheart Areas 18 and 19. Tr. 3873-74 (Toedter). Fifty future project study areas (42 percent) contain 2 or more landforms or geologic types within the study area. Ten of the study areas (12 percent) contain 3 or more landforms or geologic types. U.S. Exh. WRIR C-33; U.S. Exh. WRIR C-231 through 235.

To obtain a uniform study area, Mr. Toedter stated that he established and delineated boundaries of the drainage investigation study areas by grouping soils with similar hydraulic conductivities and depths to barriers. However, a review of the holes considered representative and relied upon to determine the averages for the study areas reveals a considerable

variation in the individual values of hydraulic conductivity and depth to barrier. For example, Arapahoe Study Area 7 contains holes with weighted hydraulic conductivity ranging from 0.5 to 10.0 inches per hour, and depth to barrier ranging from 5 to 15 feet. Another area, North Crowheart Area 27, contains holes with depth to barrier ranging from 5 to 32 feet, and weighted hydraulic conductivity ranging from 0.13 to 13.8 inches per hour. Tr. 3799-3800 (Toedter); U.S. Exh. WRIR C-241A. Of the 24 study areas (20 percent) with hydraulic conductivity values of less than 1 inch per hour, the average low hydraulic conductivity within each study area is 0.46 inch per hour and the average high hydraulic conductivity within each study area is 7.7 inches per hour. Thus the average range in hydraulic conductivity is over 7 inches per hour. This range represents soil textures of silt loam through loamy sand. U.S. Exh. WRIR C-241A. Wyo. Exh. WRIR BT-1. Finally, there are a total of ninety-nine future project study areas (83 percent) which contain two or more holes relied upon by HKM to determine hydraulic conductivity. The HKM data indicates an average hydraulic conductivity range of 6.9 inches per hour within each study area. U.S. Exh. WRIR C-241A.

In some cases the data upon which Mr. Toedter relied is inaccurate. Tr. 10936-38 (Sommers). For example, the information used in the determination of the average hydraulic conductivity and depth to barrier in Arapahoe Area 11, contains one hole relied upon by Mr. Toedter and this hole does not appear within the study area. Tr. 10940 (Sommers); U.S. Exh. WRIR C-241A; U.S. Exh. WRIR C-234A; Wyo. Exh. WRIR SS-53 D and E; U.S. Exh. 147A and B; U.S. Exhs. WRIR C-148-1 through C-148-30. In North Crowheart Area 25, the description of hole 17/C is actually from another hole 17/C over one mile from Study Area 25. U.S. Exh. WRIR C-241A; U.S. Exh. WRIR C-231A. Another example occurs in Riverton East Area 5; hole 75/A (used to compute hydraulic conductivity) is actually in Section 15, T4N R2E, which is 25 miles from the study area. U.S. Exh. WRIR C-241A; U.S. Exh. WRIR C-247 A and B; U.S. Exhs. WRIR C-148-1-30.

In many cases, the information upon which Mr. Toedter relied is not supportive of his final conclusions of depth to barrier. Forty-three percent of the study areas (51 study areas) contain no holes within arable lands greater than the average depth to barrier determined for the study area. Thirty-four percent of

the study areas (41 study areas) contain no holes within the study area greater than the average depth to barrier. U.S. Exh. WRIR C-241A; U.S. Exhs. WRIR C-231A through C-235A. For example, the average depth to barrier for North Crowheart area 12 was determined to be 15 feet but only one hole is deeper than 12 feet and there are no holes deeper than 15 feet. Five of the eleven holes used by Toedter to determine the average depth to barrier actually reached barrier at depths of 7.5 feet, 10 feet, 12 feet, 9 feet and 15 feet. This information is useful for the determination of arability, but does not support Mr. Toedter's conclusions of average depth to barrier. Tr. 3783-84 (Toedter); U.S. Exh. WRIR C-241A.

HKM considered only select information in the drainage investigation study for the arable lands in future projects on the Wind River Indian Reservation. This is evidenced by the fact that of the 78 Bureau of Reclamation and HKM holes with barrier less than 6 feet within lands classified as arable by HKM, only 6 of these holes were considered in the determination of arability and average depth to barrier. U.S. Exh. WRIR C-241A; Wyo. Exhs. WRIR SS-45 A-E through SS-54 A-E; U.S. Exhs. WRIR C-147 A and B; U.S. Exhs.

WRIR C-148-1 through C-148-30. In addition, only select information provided in the Bureau of Reclamation 1961 semidetailed drainage investigation was used by HKM in their drainage study. Only 392 holes out of 925 total Bureau of Reclamation drainage borings and pits were used by Toedter in his analysis. U.S. Exh. WRIR C-241A and B; Wyo. Exh. WRIR SF-2.

In many cases, the information upon which Mr. Toedter relied is subjectively selected to support conclusions of arability. Had all available information been considered in the drainage investigation to determine arability, many areas classified as nonarable by the Bureau of Reclamation, and subsequently by the State of Wyoming, would have been classified as Class 6 by HKM. Many holes outside arable lands were used to determine the average hydraulic conductivity and depth to barrier and Mr. Toedter stated that these holes occurred in the same land form as the arable lands. However, holes within arable lands which did not meet standards or were below the averages were called "statistical outlyers" and were not considered in determining arability and average depth to barrier. No mention was made that these holes do, or do not,

represent the landform within the arable lands. Tr. 3784, 3870, 3875-7, 3886 (Toedter).

Mr. Toedter testified that if there were several holes in an area which definitely indicated that barrier was shallower than 6 feet, the parcel was classified as nonirrigable. Tr. 3784 (Toedter). He also stated that he was not aware of any areas classified as arable by HKM with hydraulic conductivity or depth to barrier less than the minimum standards. Tr. 3785 (Toedter). However, Mr. Sommers found that many of the 72 holes with barriers less than six feet not considered by HKM, actually occur within a concentrated area. For example, South Crowheart Area 5 lists 7 holes which were relied upon by Mr. Toedter to determine the average hydraulic conductivity and depth to barrier. Most of these holes are around the perimeter of arable land or outside of arable land. A review of the information which was available to Mr. Toedter reveals that there were a total of 4 holes which were ignored, 2 of which are HKM land classification holes logged under Mr. Kersich's supervision, and 2 of which are Bureau of Reclamation drainage investigation holes, all of which have depths to shale or hard sandstone between 48 and 68 inches.

These holes are concentrated within lands classified as arable in an area with no deeper holes. Had Mr. Toedter considered this information, the area of shallow holes would have been separated from the remainder of the study area. Tr. 10951 (Sommers); U.S. Exh. WRIR C-241A; U.S. Exh. WRIR C-232A; U.S. Exh. WRIR C-147 A and B; U.S. Exh. WRIR C-148-1 through C-148-30.

Had all information been considered for North Crowheart Area 34, Mr. Toedter would have determined the area nonarable. However, only select information was used by Mr. Toedter to determine the average depth to barrier for North Crowheart Area 34, and the area was classified as arable. There are 4 holes listed as relied upon by Toedter to determine the average depth to barrier and these holes are shown in U. S. Exhibit WRIR C-241A. In addition, there are 4 Bureau of Reclamation drainage investigation holes within the arable land which were not considered in determining the average depth to barrier. This area is classified as nonarable by the Bureau of Reclamation.

Holes Toedter Relied Upon	Depth to Barrier
HKM Land Class Hole 14	Greater than 5.0 feet
HKM Land Class Hole 41	Greater than 5.0 feet
HKM Drainage Investigation Hole 44	4.5 feet to silty clay
BOR Drainage Investigation Hole 2	8.0 feet to shale

Holes Toedter Did Not Consider	Depth to Barrier
BOR Drainage Investigation Hole 1	4.0 feet to shale
BOR Drainage Investigation Hole 3	4.0 feet to shale
BOR Drainage Investigation Hole 4	5.0 feet to shale
BOR Drainage Investigation Hole 5	4.0 feet to shale

In summary, the information relied upon by Mr. Toedter contains a Bureau of Reclamation hole with barrier greater than 6 feet and an HKM hole with barrier less than 6 feet and two holes with inconclusive data. This information alone is not sufficient to render an opinion as to depth to barrier and arability. Had Mr. Toedter considered all the available information he would have found these 4 additional Bureau holes for a total of 5 holes with barrier less than 6 feet and one

hole with barrier greater than 6 feet. Thus, a consideration of all the available information would result in overwhelming support for the nonarability determination made by the Bureau of Reclamation and subsequently by the State of Wyoming. Wyo. Exh. WRIR SS-45C, D and E; U.S. Exh. WRIR C-241A; U.S. Exh. WRIR C-231A.

Most of the study areas contain holes in nonarable lands which were used to determine average depth to barrier and hydraulic conductivity of the arable lands within the study area. Tr. 3840 (Toedter). There are 16 of 118 study areas with no holes within the arable lands upon which Mr. Toedter relied, and 6 of these have no holes within the study area. For example, South Crowheart Area 12 and Arapahoe Area 11 do not have any holes within the study area. Big Horn Flats Areas 4, 5, and 13 contain no holes; the average hydraulic conductivity and depth to barrier for these areas was based on observation only. Riverton East Area 11 contains 3 holes within the study area but these holes are not within the arable lands and there is no indication these holes are representative of the landform within which the arable land occurs. Tr. 3869-70 (Toedter); U.S. Exh. WRIR C-232A, 235A, 233A, and 241A.

Within the drainage investigation study areas are lands which may require additional drainage. However, Dr. Mesghinna, the engineer responsible for drainage design, did not receive information regarding areas within arable lands which may require additional drainage. Mr. Toedter testified that holes within a study area which were substandard or below the average values for hydraulic conductivity and depth to barrier for that study area (referred to as "statistical outlyers") were not totally ignored. He stated that there are techniques in drainage to accommodate the condition represented by the substandard holes, and that some consideration would have to be given to the placement of drains around these areas. Tr. 3870-71, 3886 (Toedter). However, Dr. Mesghinna stated that the drain spacing analysis was based upon the drainage investigation study areas developed by HKM, and that within these study areas the drain spacings would be the same throughout the study area. Tr. 4640-4643 (Mesghinna). The documentation in Mr. Toedter's field notes or worksheets which could be used to determine those lands which include statistical outlyers, was not provided to Dr. Mesghinna. Tr. 3887-8 (Toedter).

18-7 Flaws in United States' claims for future arable lands. The United States claims that 84,469 acres of future lands are arable. Within this acreage there are many specific tracts containing thousands of acres which have insufficient or no evidence upon which the Court can determine arability. Tracts are also included which do not meet HKM's own land classification standards. For all parcels of land in which there is either no evidence of arability or insufficient evidence of arability, all such lands must be excluded in determining the number of practicably irrigable acres. With regard to all other parcels of land where the evidence is in dispute, the Court finds these lands not arable.

18-7 See Findings of Fact 18-3 to 18-8, 18-10. Mr. Kersich, the United States' agricultural engineering expert, testified that 84,469 acres of future lands were arable. U.S. Exh. WRIR C-43 (p. 27, Table 8). The accuracy of the HKM arable land study is from 90 to 100 percent according to HKM, therefore, admitting they could have overestimated by as much as 8,400 acres. By this admission, there may only be about 76,000 acres of arable land in future project areas. U.S. Exh. WRIR C-43 (p. 14); U.S. Exh. WRIR C-43 (Table 8).

Mr. Kersich admitted on cross-examination that HKM classified as arable at least 14 tracts comprising 1,823 acres which contained a logged hole which did not equal or exceed 6 feet in depth. Tr. 1737-1825 (Kersich). He also admitted that HKM classified as arable at least 54 tracts containing 3,998 acres which did not contain a logged hole by HKM within its boundaries. Tr. 1498-1685 (Kersich). See Finding of Fact 18-10 for additional tracts with no or insufficient HKM evidence.

Mr. Kersich classified as arable a 69-acre parcel in Township 1 South, Range 4 East, Section 13 which does

. . . .

not meet the minimum standards. This land, in the Riverton East Unit, and classified as Class 3 gravity and Class 3 sprinkler, has one probe hole by HKM with sandstone at five feet and one logged hole by the Bureau of Reclamation with sandstone at 24 inches. Both holes do not meet the minimum standard of 6 feet to barrier. This parcel must be excluded from acreage totals. Tr. 1599-1603 (Kersich); Wyo. Exh. WRIR SK-30; U.S. Exh. WRIR C-43.

Within Township 4N, Range 1E, Section 9 (NE 1/4), HKM classified 395 arable acres; the Bureau of Reclamation classified 68 arable acres. Investigation of the area by HKM did not reveal depth of barrier greater than 6 feet except within the 68 acres found to be arable by the Bureau of Reclamation. Therefore, the HKM determination should be reduced to 68 arable acres (Class 3 gravity), since HKM only substantiated the Bureau of Reclamation arable delineation. Tr. 1834-1850 (Kersich).

Thirty acres of Class 3 gravity, Class 2 sprinkler, arable land should be excluded from Bighorn Flats acreage testified to by Mr. Kersich on Exhibits C-48 and C-49 and in the tables of Exhibit C-43. This land

was claimed as parcel 25-3X by Mr. Waples as Type VII land. Tr. 3676-82 (Waples).

Mr. Kersich testified that at least 26 acres of Class 1 sprinkler land in the South Crowheart Unit was held in fee and improperly included. Subtracting 26 acres changes total Class 1 land from 1,487 acres to 1,461 acres for the South Crowheart Unit. Mr. Kersich agrees that a 26-acre Class 1 sprinkler parcel is fee land included in Section 23, T2N, R1E, as shown on Exhibit C-47, should be removed from acreage totals. Tr. 3172-73 (Kersich).

The Bureau of Reclamation mapped approximately half the number of arable acres as HKM in virtually the same study areas. Tr. 10840 and 10846 (Sommers) (NOTE: pages 10841 through 10845 are out of order, page 10846 follows 10840); Wyo. Exh. WRIR SS-9. The HKM study areas differ somewhat from the Bureau of Reclamation study areas for several reasons. The HKM study areas were arrived at using the techniques outlined in Wyo. Exh. ED-15 which utilized financial criteria including subsidies such as the Leavitt Act to suggest maximum lift and distance water could be conveyed. Sprinkler irrigation was also considered by

HKM. On the other hand, the Bureau of Reclamation confined its study areas to lands lying below or adjacent to a proposed gravity diversion in each of the units. It is interesting to note that economics plays an important role in the selection of the study areas by HKM and Bureau of Reclamation but did not become an explicit consideration in the HKM land classification standards and land class definitions. Wyo. Exhs. WRIR ED-15, SF-1 and SF-2.

Mr. Kersich relied on the Bureau of Reclamation work in developing his specifications and standards but made no specific reference to its use in the arable land study. Mr. Toedter relied on the Bureau of Reclamation but only on that portion which supports his conclusions. In any case, HKM could only have relied on the Bureau of Reclamation arable land investigations for the 30,745 acres on which HKM and the Bureau of Reclamation agree. Tr. 11127 (Sommers).

In some cases there is no evidence upon which the Court can conclude that lands are arable. Therefore, all the land included in the future land study area that does not have logged holes by HKM or Bureau of Reclamation must be excluded from the arable land

base. Tr. 10643 (Sommers); Finding of Fact 18-8. In other cases, there is insufficient evidence upon which the Court can conclude that the lands are arable. Therefore, all lands within the future land study area with HKM holes less than six (6) feet must be excluded from the arable land base unless also classified by the BOR as arable. Tr. 10645 (Sommers); Finding 18-10.

18-8 Inadequacies of United States' arability study.

The Court finds that the arability study performed by HKM regarding future lands suffers from numerous deficiencies. The Court finds that the effect of these deficiencies is to render the United States' arable land analysis for future land insufficient to serve as the basis for a reserved right claim based on practicable irrigability. This result is particularly troubling to the Court because, as was previously indicated, it is the United States' burden as claimant of a federal reserved water right to establish the arability of the lands claimed as practicably irrigable.

The Court finds that it cannot reasonably rely on the arability conclusions of HKM due to the following inadequacies:

1. Lack of explicit economics in the definitions of arable land and land classes.
2. Failure to adopt appropriate standards.
3. Improper application of those standards.
4. Lack of investigative intensity commensurate with the geologic complexity and history of the area.

5. Qualification of Mr. Kersich and Mr. Toedter.

6. The drainage investigation.

7. Miscellaneous flaws in the HKM studies.

18-8 The inadequacies of the HKM arable lands study have been described in detail in Findings 18-2 through 18-8. The unrealibility of the HKM study is perhaps best illustrated by the fact that even an HKM expert could not rely on results of the HKM study. As a result of Mr. Kersich's testimony, Mr. Toedter, the HKM expert responsible for ensuring that the drainage standards were met, could not determine the arability of some lands which Mr. Kersich testified were, in fact, arable. Further, Mr. Toedter found it necessary to conduct more field investigation after Mr. Kersich testified. However, this field effort is not supported by any field notes, logs or other evidence. Tr. 3751, 3808-14, 3827-30 (Toedter).

Mr. Toedter stated that his conclusions regarding hydraulic conductivity and depth to barrier were incorporated into the conclusions of Mr. Kersich and Mr. Waples about which they had already testified. However, as a result of Mr. Kersich's testimony, Mr. Toedter was unable to reach a conclusion regarding some of the hydraulic conductivity and depth to barrier information upon which Mr. Kersich had relied to base his conclusions. Mr. Toedter felt it necessary to do additional field work in order to gain

more information on the lands to which Mr. Kersich had already testified met the drainage standards. Tr. 3751, 3808-09, 3813-14, 3827-30 (Toedter).

Mr. Toedter stated that another purpose for his field work after Mr. Kersich's testimony was to determine whether some lands to which Mr. Kersich had testified did in fact meet the HKM 6' depth to barrier standard. Tr. 3827 (Toedter). The drainage investigations conducted by Mr. Toedter subsequent to Mr. Kersich's testimony resulted in changes regarding the average depth to barrier and average hydraulic conductivity. Tr. 3813-17 (Toedter).

One of the areas identified by Mr. Toedter as having potential problems with depth to barrier is the study area of North Crowheart 34. Mr. Toedter stated that his conclusion prior to Mr. Kersich's testimony was that there was no problem with the depth to barrier for this area and the field work subsequent to Mr. Kersich's testimony verified that previous conclusion. Had Mr. Toedter considered all information pertaining to North Crowheart Area 34 available at the time of Mr. Kersich's testimony he would not have accepted the land as arable. There was

insufficient evidence at the time of Mr. Kersich's testimony and there has been no evidence since to support arability of land within North Crowheart Area 34. Tr. 3827-3830 (Toedter), Finding of Fact 18-6.

There are also numerous miscellaneous flaws in the HKM studies regarding lack of evidence and failure to meet standards. See Finding 18-7.

18-9 State's Experts re: land classification.

In response to the United States arability testimony for future lands, the State of Wyoming presented the testimony of Mr. Clarence Fowkes and Mr. Craig Sommers. The Court finds that Mr. Fowkes and Mr. Sommers are well qualified to present opinions on arable land classification on the Wind River Indian Reservation.

18-9 Mr. Sommers was admitted as an expert in soil science and agronomy. Tr. 10770 (Sommers). Agronomy is the study of soils and crops primarily addressing soil, water and crop relationships and agricultural economics. Tr. 10784 (Sommers).

Mr. Sommers is well-qualified to present opinions on arable land classification on the Wind River Indian Reservation. His work as an agronomist and soil scientist has included land classification, soil science, and economics as principal areas of investigation. Tr. 10770 (Sommers). He has participated in the soil evaluation, land classification or agronomic analysis of over 400,000 acres during his career. Previous to this litigation Mr. Sommers has mapped over 80,000 acres in the State of Wyoming, much of it at a detailed level. Wyo. Exh. WRIR SS-A2; Tr. 10770 (Sommers). Mr. Sommers' more recent experience has been primarily soil surveys and land classification on mine lands. These recent land classifications involved grouping soils according to their suitability for reclamation. Tr. 10780-81 (Sommers). This experience is directly applicable to land classification for irrigated agriculture. Tr. 3287 (Waples).

Mr. Sommers has been previously retained to work on other Indian reservations as a soil scientist and agronomist. His previous experience was primarily on the Ute Mountain Ute, Mescalero, and Crow Reservations. Wyo. Exh. WRIR SS-A1; Tr. 10766-10769 (Sommers). Mr. Sommers encountered various problems doing land classification work on the Mescalero Reservation. The major reasons were due to inadequate standard development and inadequate field work. These factors were beyond Mr. Sommers' control, the decisions having been made by his superiors. The study was begun by an engineer, with only a small portion completed by Mr. Sommers. Tr. 10778-80, 10783-84 and 10788 (Sommers).

As a soil scientist, Mr. Sommers is competent to evaluate the soils data of concern to drainage engineering. He is not a drainage engineer and he did not perform any drainage engineering. Tr. 10770, 10936-37 (Sommers). A soil scientist acts as an advisor to drainage experts. Tr. 10569-70 (Fowkes). Soil scientists are capable of evaluating and providing information on texture, depth to barrier, the representativeness of holes, the evidence of a water table, and the intensity of observations, all of

which are important to a drainage investigation. Tr. 10876, 10937 and 10996-7 (Sommers).

The soil characteristics identified and used in the HKM drainage investigation are depth to barrier, hydraulic conductivity and soil texture. U.S. Exh. WRIR C-43 (p. 16). The information provided to Stetson Engineers for use in drainage engineering and design is soils data concerning average depth to barrier and hydraulic conductivity for delineated study areas. The 23 hydraulic conductivity rates are based on tests run by HKM for four soil textures; the remaining 19 values are estimated for other soil textures. U.S. Exh. WRIR C-43; Wyo. Exh. WRIR BT-1. Tr. 3913-14 (Toedter). Mr. Sommers did not determine hydraulic conductivity, but evaluated soil texture and used the corresponding hydraulic conductivity values derived by Mr. Toedter. Tr. 10953 (Sommers).

Mr. Fowkes was admitted as an expert in soil science. Tr. 10541 (Fowkes). Mr. Fowkes worked as a soil scientist for the Soil Conservation Service prior to his retirement in 1976. His experience includes eleven (11) years as the State's soil correlator and assistant state soil scientist for the Soil

Conservation Service office in Casper, Wyoming; eight years as Soil Conservation Service Soil Survey Supervisor for western Wyoming, including the Big Horn Basin; and seven years as Soil Conservation Service soil scientist in the Riverton area, much of it in the field. Tr. 10537, 10556 (Fowkes).

Mr. Fowkes is eminently qualified to review work done on the Wind River Indian Reservation. His role as the Soil Conservation Service soil correlator for Wyoming was to review field work and classification for quality, accuracy and sufficiency of data. Tr. 10608 (Fowkes).

Mr. Fowkes reviewed the study performed by HKM Associates. He examined the specific portion of the HKM investigation regarding North Crowheart plus an overview of the other areas. Mr. Fowkes' role in the State evaluation was to evaluate the quality, accuracy, and adequacy of the HKM arable land investigations and recommend a process to develop the most accurate arable land determination given the available facts and data. Tr. 10624-10625, 10643 (Fowkes).

18-10 Findings by State's Expert re: arable lands.

The State of Wyoming maintains the position that the United States, as claimant, has the burden to prove that lands for future irrigation projects are indeed arable. Operating from this posture, the Court finds that Mr. Sommers, an expert in soil science for the State of Wyoming, conducted a comprehensive investigation of all the information available pertinent to arable lands on the Wind River Indian Reservation. He applied this information, field work conducted by State experts, and his expertise to the HKM arable land base. Mr. Sommers' evaluation determined the amount of acreage that should be included in or excluded from the HKM arable land base depending upon the sufficiency of evidence, or lack thereof, to conclude arability.

18-10 Mr. Sommers, of ERO Resources Corporation, evaluated all of the arable land information for the areas testified to by Mr. Kersich. This evaluation included information developed by HKM, Bureau of Reclamation and the State concerning soils, topography and drainage. In addition, Mr. Sommers evaluated the soils data of concern to drainage engineering. Tr. 10869-70, 10912, 10937 (Sommers).

Mr. Sommers' objective in his work regarding arable land was to evaluate the accuracy and information content of the work done by the U.S. experts. He evaluated data to decide if it was verifiable or reproducible and if the conclusions reached by HKM were accurate. He used the scientific method of testing hypotheses in his work. Tr. 10793-94 (Sommers). Mr. Sommers did no different analysis for arability under sprinkler irrigation because sprinkler and gravity application systems are generally best suited for exactly the same kinds of lands. Tr. 11168-1169 (Sommers).

A reliable evaluation must include a consideration of relevant definitions. The State's preferred definition of arable land and land classes is based on

the Bureau of Reclamation definition which includes on-farm economics. The State adopts the HKM assertion that arable land must be able to sustain long-term irrigation, but the HKM definition does not include on-farm economics. In the preferred Bureau of Reclamation definition of arable land, references to "farm" and "farm family" can be deleted without altering the important elements. The modified definition preferred by the State experts follows:

> Arable land is land which, when farmed in adequate size units for the prevailing climatic and economic setting and provided with the essential on-farm improvements of removing vegetation, leveling, soil reclamation, drainage, and irrigation related facilities, will generate sufficient income under irrigation to pay production expenses; provide a reasonable return to labor, management and capital; and at least pay the operation, maintenance and replacement costs of associated project irrigation and drainage facilities.

Also preferred is the Bureau of Reclamation definition of land classes described in the Reclamation Instructions. Unlike the HKM definition, the Bureau definition includes an economic determination using farm budget analysis. Tr. 10647 (Fowkes); Tr. 10810-13, 10826, 10835-38 (Sommers).

The State evaluation of arable lands is a synthesis of many work products on the Wind River Indian Reservation. This includes information from HKM, the Bureau of Reclamation, and field work conducted by State experts. For informational purposes, Mr. Sommers reviewed many published studies and references of the Bureau of Reclamation including Wyo. Exhs. WRIR SS-A3, SS-A4, SS-A5, SS-A6, SS-A7, SS-A8, and SS-A9; Tr. 10794-10801 (Sommers).

Mr. Sommers evaluated the data and conclusions of HKM using standards and definitions of both HKM and the Bureau of Reclamation. Although the standards were considered inappropriate, Mr. Sommers implicitly used HKM standards and definitions to evaluate the HKM arable lands which do not coincide with arable lands classified by the Bureau. There was inadequate information to apply more rigorous standards and definitions. By the use of HKM standards and definitions in the State evaluation of arable lands, the benefit of the doubt was given to the HKM arable land determinations. In addition, the HKM land class designations were retained throughout the State analysis since these land classes roughly depict the relative quality of lands. Tr. 10835-38, 10897 (Sommers).

The Bureau land classification and logs were incorporated and evaluated per Bureau standards and definitions. The Bureau arability determinations were considered more reliable than HKM determinations due to the Bureau's site-specific standards, number of logged holes, intensity of investigation and general level of information. Tr. 10870, 10912-15 (Sommers); Wyo. Exh. WRIR SS-9.

In the absence of an opportunity to perform a new study, a procedure was recommended by Mr. Fowkes and followed by Mr. Sommers. The procedure involved evaluating the HKM arable land base by taking their data and supporting information at face value and supplementing that with additional information from Bureau of Reclamation and State investigations, then comparing those three sets of information. This included the Bureau of Reclamation maps and logged hole information as well as all of the HKM and State information. Thus, Mr. Sommers considered all available information, not just that to support a particular desired result. Tr. 10643-48 (Fowkes); 10869-70, 10912-14 (Sommers).

Land was included or excluded from the arable land base depending upon the sufficiency of evidence. The total acreage is shown on Wyo. Exh. WRIR SS-255, with a total of 50,460 arable acres gravity and 48,910 arable acres sprinkler. The location of these arable lands are depicted on Wyo. Exhs. SS-245 to SS-254.

The land evaluation process resulted in:

A. All land classified as arable by HKM and the Bureau of Reclamation was included.

B. Land classified by the Bureau as Class 6 or not classified by the Bureau was included if land:

   1. had more logged holes with barrier 6 feet or greater than logged holes with barrier less than 6 feet.

   2. was determined arable through investigations of state experts.

C. Land classified by the Bureau as Class 6 or not classified by the Bureau was excluded if land had:

   1. no logged holes.

   2. no logged holes with barrier 6 feet or greater.

3. more logged holes with barrier less than 6 feet than logged holes with barrier 6 feet or greater.

4. overlap with fee or government land was excluded.

Tr. 10894, 10985, 11059-60 (Sommers). Wyo. Exhs. WRIR SS-145A to 154A reflect changes in the initial office analysis of arable land. Additional acres were included where field investigations conducted by State experts determined the land as arable. HKM arable land was deleted wherever the field work confirmed the office analysis of nonarability. Arable land coincidental with fee or government land was also deleted. Tr. 10898-10900 (Sommers); Wyo. Exhs. WRIR SS-145A-154A.

Mr. Sommers used a criteria of holes greater than or equal to 6 feet because it helped determine depth to barrier and root zone characteristics of the soil. Information is needed to this depth in order to provide sufficient information that the engineers and economists need in order to derive their conclusions. Tr. 10955-56, 11102-03 (Sommers).

One of Mr. Sommers' rationale for concluding that some lands were not arable was that insufficient information exists to conclude they are arable. Tr. 10894, 11062, 11057-60, and 11125 (Sommers).

From Mr. Sommers' analysis, several thousands of acres were excluded from the HKM arable land case due to the lack of information. There are 8,909 acres classified as gravity arable with no HKM logged holes. There are 11,143 acres classified sprinkler arable with no logged holes. There are no logged holes by HKM greater than or equal to 6 feet in 14,351 acres classified as gravity arable land. There are 16,128 acres with no logged holes 6 feet or greater classified as sprinkler arable land by HKM. The total gravity arable land classified by HKM with no logged holes and no logged holes greater than or equal to 6 feet is 23,260 acres. A total of 27,271 acres were classified as sprinkler arable land by HKM with no logged holes and no logged holes greater than or equal to 6 feet. Tr. 10935-36 (Sommers).

Wyo. Exhs. SS-45B through 54B depict those arable land delineations of HKM which have no logged holes whatsoever. For example, the total acreage on the

North Crowheart sprinkler land classification having no holes is 4,517 acres. Wyo. Exhs. SS-45A through 54A depict the arable land areas of HKM which have no logged holes six feet or greater. Again, as an example, the total acres on the North Crowheart sprinkler land classification having no logged holes 6 feet or greater is 9,987 acres. Thus, HKM had classified as arable 14,504 acres for sprinkler irrigation in North Crowheart with <u>insufficient or no information</u> upon which to determine arability. Tr. 10890-91 (Sommers).

It must be emphasized that of the total acreage lacking sufficient HKM information, the State only excluded land which has no additional supporting information from the Bureau of Reclamation or HKM studies.

18-11 Findings re: arable acres within future projects.

The Court accepts the State of Wyoming analysis and finds that about 50,000 arable acres exist within the future project areas. The Court adopts the conclusions of the State arable land evaluation with the following breakdown of acreage:

	Arable Acres	
Unit	Gravity	Sprinkler
North Crowheart	30,190	27,730
South Crowheart	5,010	5,310
Big Horn Flats	10,820	10,090
Riverton East	2,280	3,000
Arapahoe	2,160	2,780
TOTAL	50,460	48,910

18-11 On direct examination, Mr. Sommers presented his evaluation of arable lands on the Wind River Indian Reservation within HKM study areas. His total acreages of 50,460 arable acres gravity and 48,910 arable acres sprinkler are posted on Wyo. Exh. WRIR SS-255. Tr. 10912 (Sommers); Wyo. Exh. WRIR SS-255. Mr. Sommers' evaluation included a 10% plus or minus error factor due to:

1. the numerous transfers of maps onto one base at one scale,
2. inherent error due to the level of detail of the various studies, and
3. the high degree of complexity present in the arable land areas.

Tr. 10880 (Sommers).

18-12 United States' engineering expert for proposed irrigation projects.

Dr. Mesghinna testified for the United States with respect to the engineering analysis performed for the United States' five proposed irrigation projects. Dr. Mesghinna was admitted as an expert in irrigation design engineering although, previous to this case, he had done no irrigation design work in Wyoming and none of the irrigation systems which he has designed have actually become operational.

18-12 Tr. 4008-4018 (Mesghinna).

18-13 Tribes engineering experts for United States' proposed irrigation projects.

Mr. Bliesner testified for the Tribes with respect to his revised project component costs and redesign of pumping plants for the United States' five proposed irrigation projects. Mr. Bliesner was admitted as an expert in irrigation engineering. Mr. Willardson testified for the Tribes with respect to his redesign of Dr. Mesghinna's drainage system and was admitted as an expert in irrigation and drainage engineering although prior to this litigation he had no experience in Wyoming and he has never designed a large scale drainage system and carried it through to construction.

18-13 Tr. 8260, 8452-8458 (Bliesner); Tr. 8573-8575, 8578-8581 (Willardson).

18-14 Wyoming's engineering experts for proposed irrigation projects.

Mr. Sostrom and Mr. Bishop testified for Wyoming with respect to the engineering analysis performed by the state for the United States' five proposed irrigation projects. Mr. Sostrom was admitted as an expert in engineering design and construction and construction cost estimating and has had many years of experience in both these areas in Wyoming. Mr. Bishop was admitted as an expert in water resources engineering and has an extensive background in determining water requirements for irrigated agriculture in Wyoming as a result of his working experience and years as the Wyoming State Engineer.

18-14 Tr. 12568-12577, 12611, 13253-13255 (Sostrom); Wyo. Exh. WRIR HSO-1; Tr. 12134-12140, 12152, 13691-13693, 13702-13705 (Bishop); Wyo. Exh. WRIR HFB-1.

18-15 United States' conclusions re: acreage, water requirements and cost for proposed irrigation projects. Dr. Mesghinna's conclusions with respect to acreage, water requirements and capital construction costs may be summarized as follows:

	North Crowheart	South Crowheart	Arapahoe	Riverton East	Big Horn Flats
Net Acreage	38,773	4,695	3,808	3,814	2,670
Diversion Requirements (Acre-ft.)	147,767	20,137	16,720	17,536	7,212
*Capital Construction Costs/acre	1,837	2,033	2,030	2,006	2,067

* Costs not annualized and do not include annual operation and maintenance costs.

18-15 U.S. Exh. WRIR C-245 at p. 42. The acreage and diversion requirements for Riverton East were revised by Dr. Mesghinna during his cross-examination. Dr. Mesghinna relied on the arable land base supplied him by HKM Associates. At trial, however, Mr. Kersich of HKM testified to a different arable land base which excluded fields 46 and 49 through 56 of the Riverton East project designed by Dr. Mesghinna (Tr. 4461-4470, 4881 (Mesghinna); U.S. Exhs. WRIR C-51, C-249 through C-255). Apparently HKM had modified the arable land base between the time Dr. Mesghinna was supplied a copy and the time Mr. Kersich testified. The combined net irrigable acres of and diversion requirements for these fields were calculated by Dr. Mesghinna to be 478 acres and 2170 acre-feet respectively. Therefore the figures for Riverton East printed in U.S. Exh. WRIR C-245 at p. 42 were accordingly reduced (Tr. 4479-4486 (Mesghinna)).

18-16 Court reduces acreage within future projects based on Wyoming's arable land base determination.

The Court, having previously accepted Wyoming's arable land base determination hereby reduces the acreage within the United States' five future projects to coincide with that finding. The Court finds that irrigable acres in the following amounts exist in the United States' five future projects:

Project	Acreage
North Crowheart	21,064.8
South Crowheart	3,347.3
Arapahoe	2,485.4
Riverton East	1,876.6
Big Horn Flats	1,169.1
	29,943.2

18-16 In addition to Findings of Fact 18-1 through 18-11 indicating the reliability of the State's arable land base over that of the United States, the Court notes additional problems in the arable land base specific to the United States' five proposed projects. These problems include: (1) the arable land base relied upon by Dr. Mesghinna in designing the projects was not the same one testified to by Mr. Kersich of HKM. Apparently HKM made modifications of which Dr. Mesghinna was not informed (Tr. 4461-4470, 4881 (Mesghinna)); (2) of the five projects, the following percentages of fields within those projects contained land classified by HKM as Class 6 or non-arable:

	Project	Percentage
1.	North Crowheart	51%
2.	South Crowheart	39%
3.	Arapahoe	57%
4.	Riverton East	69%
5.	Big Horn Flats	50%

(Tr. 4449-4461 (Mesghinna); Wyo. Exhs. WRIR FM-1249 through FM-1255A; U.S. Exh. WRIR C-249 through C-255); (3) included within the projects are lands not held in trust by the United States for the Tribes (Tr.

4498-4509); and (4) the on-farm system design of Dr. Mesghinna included many fields with topographical or cultural features which reduce the actual number of acres under irrigation (Tr. 4612-4618 (Mesghinna), 13255-13260, 13268-13296 (Sostrom); Wyo. Exhs. WRIR FM-1252-A, FSO-1, FSO-2A through 2G, FSO-12 and FSO-13).

Mr. Sostrom prepared maps and tabulations indicating those acres within the United States' five proposed projects which fall within the State's arable land base. See Tr. 13295-13297 (Sostrom); Wyo. Exhs. WRIR FSO-2A, 2B, 2C, 2D, 2E, 2F, 2G and FSO-3.

Some of the figures for acreage in Finding of Fact 18-16 do not coincide with the values listed in Wyo. Exh. WRIR FSO-3. Generally these changes reflect clerical or mathematical errors or roundoff in the original exhibits. Any additional changes will be reflected in Appendix 11 which details changes in exhibits and the reasons for those changes.

18-17 Accurate climatological data important.

The Court finds that the first step in performing a complete engineering feasibility analysis for an irrigation project is the gathering of accurate climatological data. Accuracy of the data is of utmost concern since it serves as the foundation for all steps that follow. Climate affects cropping pattern and climate combined with cropping pattern determines evapotranspiration. These factors combine to determine water requirements which in turn governs irrigation system design and costs. If inaccurate climatic data is used, the entire analysis from water requirements to design to costs will be faulty. The climatic factors of prime concern are those which affect crop evapotranspiration, specifically, temperature, precipitation and solar radiation.

18-17 Tr. 4023-4025, 4591 (Mesghinna).

18-18 Unreliability of United States' climatological data. The Court finds that the accuracy of the climatological data used by Dr. Mesghinna is questionable and as a result, his conclusions with respect to water requirements and costs are unreliable. Consequently, in order to compensate for the questionable accuracy of the water requirements, the system design and the predicted costs, the Court finds it necessary to increase the engineering and contingency costs.

18-18 Dr. Mesghinna relied on climatological data gathered from seven weather stations in or near the Wind River Indian Reservation. Based only on the microclimates existing around these seven stations, Dr. Mesghinna established climatic zones to cover all the land within the five proposed irrigation projects (Tr. 4026, 4042-4043 (Mesghinna); U.S. Exh. WRIR C-244).

One of the key elements of climatic data necessary to determine evapotranspiration, and in turn crop consumptive use, is solar radiation (Tr. 4027 (Mesghinna)). The sole basis for the solar radiation analysis performed by Dr. Mesghinna was data gathered from the Lander Airport on the ratio of actual to possible sunshine. Dr. Mesghinna did not even receive the actual data from the Airport but rather received an interpretation of that data prepared by HKM. Dr. Mesghinna did not know who gathered the original data or what calculations were done in interpreting it nor did he know that the Lander Airport stopped gathering this type of data in 1972 because the National Weather Service considered the accuracy of it questionable (Tr. 4592-4608 (Mesghinna); Wyo. Exh. WRIR FM-6).

Dr. Mesghinna then proceeded to apply the solar radiation values he derived from this analysis to all seven of the climatic zones based solely on his conclusion that since this data is hard to come by, you use what you can find (Tr. 4610-4611 (Mesghinna)).

Using the climatological data and Mr. Dornbusch's cropping patterns, Dr. Mesghinna determined crop evapotranspiration, i.e., crop consumptive water use (Tr. 4074-4089 (Mesghinna)). In light of the questionable accuracy of the climatic data it would have been advisable for Dr. Mesghinna to verify the accuracy of his crop consumptive use estimates by conducting field tests with instruments such as a lysimeter or neutron probe which directly measure evapotranspiration. Unfortunately, this was not done. (Tr. 4631-4634 (Mesghinna)). Crop consumptive use minus effective precipitation then leads to the net irrigation requirement. (Tr. 4091 (Mesghinna)). The irrigation system design is then based on the water requirements. The interrelationship of climatic data with water requirements, design and costs thus becomes obvious. If the climatic data is questionable the water requirements and costs become questionable.

18-19 Court cannot accept United States' conclusions re: diversion requirements and construction costs.

The Court finds that the overall system designs of Dr. Mesghinna are generally very acceptable. However, due to the questionable accuracy of the climatic data, arable land base and cropping patterns he was forced to rely on and Dr. Mesghinna's failure to include lined canals in his designs, the Court is unable to accept Dr. Mesghinna's conclusions with respect to diversion requirements and capital construction costs.

18-19 The problems with respect to climatic data and the arable land base have been detailed above. Dr. Mesghinna failed to include within his design lined canals (Tr. 4665-4670 (Mesghinna)); Wyo. Exh. WRIR FM-6; Tr. 13535-13541 (Sostrom). As a result, efficiency is decreased, water is lost to crops and water demand increases. This approach is simply unacceptable at a time when water is in such short supply and of such vital importance to the economy of much of the West. To expend great sums of money on massive irrigation projects which will be built during a period when water is in critically short supply and do so without expending every effort possible to eliminate waste is simply unacceptable and should not be tolerated by the Court.

Aside from these problems, the Court found that Dr. Mesghinna's design for on-farm system, pipe network, pumps and pumping stations, canals and related structures and drainage were quite reasonable for a feasibility level analysis. Tr. 12817 (Bishop). Dr. Mesghinna repeatedly recognized the problem of designing irrigation projects with inadequate or no drainage and very much agrees with him on the necessity of including at least the quantity of

drainage he did. Again, however, Dr. Mesghinna was forced to rely on questionable data in determining drainage requirements. The depth to barrier data provided to Dr. Mesghinna by HKM was averaged so he was unaware that in many instances, the actual depth to barrier was significantly less than the average. Tr. 4686-4720 (Mesghinna); Wyo. Exhs. WRIR FM-10 and FM-15. As a result, it may well be that more drainage than was designed will be required, a problem which will have to be taken care of by increasing engineering and contingency cost. Tr. 12166 (Bishop).

18-20 Court adopts 50% overall efficiency.

The Court adopts a 50% overall efficiency for calculating the water requirements of irrigable lands within the United States' five proposed projects.

18-20 Mr. Bishop, former Wyoming State Engineer and a person with a great deal of experience in determining water requirements in Wyoming, agrees with this assumption, and used it in calculating the water requirements for the United States' five projects. Tr. 12168, 13719-13724 (Bishop); Wyo. Exh. WRIR FFB-3.

Achieving an overall efficiency of 50% is realistic. Mr. Bishop testified that a 50% overall efficiency could easily be achieved for the irrigation systems designed for the five proposed projects. Tr. 12168, 13719-13724 (Bishop). This opinion finds support from Mr. Billstein, Mr. Bliesner and Dr. Mesghinna. Although the results of Dr. Mesghinna's work as exhibited in U.S. Exh. C-245 show an overall efficiency of about 35% (Tr. 12167 (Bishop)), his earlier work product showed overall efficiencies of 43% to 64% for the five proposed projects (Wyo. Exh. FM-106 submitted at Tr. 4850 is a copy of Deposition Exhibit 22 from the January 20, 1981 Deposition of Dr. Mesghinna). Mr. Billstein and Mr. Bliesner both testified that efficiencies within the Reservation could be easily increased anywhere from 10 to 15% above the efficiencies used to quantify the United States and Tribal claims. Both testified that

efficiencies of 50% were achievable. Tr. 7277-7283, 7303-7304 (Billstein); Tr. 8543-8545 (Bliesner). The Court finds that efficiencies of 50% are not only achievable, but should be a minimum requirement in this age of critical water shortage and the necessity to conserve water.

18-21 Court's findings re: water requirements for proposed projects

The Court finds that the water requirements for irrigable lands within the United States' five proposed projects are as follows:

Project	Net Irrigation Requirement (Acre-Feet)	Diversion Requirement (Acre-Feet)
North Crowheart	37,795.5	75,591.0
South Crowheart	6,215.1	12,429.5
Arapahoe	4,629.2	9,257.9
Riverton East	3,516.3	7,031.9
Big Horn Flats	2,057.0	4,114.0
Totals	54,213.1	108,424.3

18-21 Mr. Bishop used the assumption listed in the previous finding and applied it to the State arable land base located within the United States' five proposed projects. Mr. Bishop's results are listed in Wyo. Exh. WRIR FFB-3. Tr. 13693-13694, 13723-13726 (Bishop). Some of the figures for water requirements in Finding of Fact 18-21 do not coincide with the values listed in Wyo. Exh. WRIR FFB-3. Generally these changes reflect clerical or mathematical errors or rounding off in the original exhibits. Any additional changes will be reflected in Appendix 11 which details changes in exhibits and the reasons for those changes.

18-22 Court's findings re: per acre capital construction costs.

The Court finds that the per acre capital construction costs to be used to determine the practicable irrigability of the United States' five proposed projects are as follows:

Project	Capital Construction* Costs/Acre
North Crowheart	2,448
South Crowheart	2,722
Arapahoe	2,902
Riverton East	2,413
Big Horn Flats	2,046

* Costs are not annualized and do not include annual operation and maintenance costs.

18-22 These costs were derived by taking the per acre capital construction costs calculated by Mr. Sostrom, found in Wyo. Exh. WRIR FSO-4, and adding to these figures additional costs for canal lining and road construction as stated in Wyo. Exh. WRIR FSO-4B.

Although the costs calculated by Dr. Mesghinna and Mr. Sostrom for on-farm system, pipe network, pumps and pumping plants, canals and related structures and drainage were virtually the same, a variation from (-)15% to (+)16%, the Court should find Mr. Sostrom's overall figures more reliable for the following reasons: (1) Mr. Sostrom included in his costs a mobilization fee of 6.17% which represents the cost of mobilization, bonding and insurance and is a real construction cost which must be considered. Dr. Mesghinna failed to include this in his costs. Tr. 13352-13353 (Sostrom); Wyo. Exh. WRIR FSO-4A at pp. 2, 24, 28, 36 and 41; (2) Mr. Sostrom included costs for canal lining and road construction which were both ignored by Dr. Mesghinna. Tr. 13328-13335 (Sostrom); (3) Dr. Mesghinna failed to include any contingency costs for the on-farm system, a very questionable decision for a feasibility level design. Tr. 13574-13575 (Sostrom); (4) Dr. Mesghinna's

relatively low figure of 25% for engineering and contingencies was not supported by any rationale or justification and is probably just a reflection on his lack of experience in actual large project construction. Mr. Sostrom used a figure of 35% for engineering and contingency and based this on ASCE Guide No. 45, consultation with a Mr. Goldman, an instructor at a construction management cost estimating seminar, and with Mr. Floyd Bishop and finally his many years of experience cost estimating large construction projects in Wyoming. (Tr. 13251-13255, 13351-13355, 13447-13483 (Sostrom). Mr. Sostrom's 35% figure is probably more reflective of local construction conditions but even his figure may be low in light of the questionable accuracy of the climatic data and arable land base upon which Dr. Mesghinna was forced to rely.

As part of Mr. Bliesner's work for the Tribes, he redesigned the pump stations, substantially lowering their cost and effectiveness, and estimated costs for on-farm systems, pipe network and energy for the United States' five proposed projects which were substantially lower than both Dr. Mesghinna and Mr. Sostrom. Compare Tribes' Exh. 13 with U.S. Exh. WRIR

C-245 at p. 42 and Wyo. Exh. WRIR FSO-4. The Court finds Mr. Bliesner's redesign and recosting unreliable since Mr. Bliesner developed his new figures without ever investigating Dr. Mesghinna's designs for South Crowheart, Arapahoe and Big Horn Flats and with only a limited investigation of about 15% of the land in the North Crowheart and Riverton East Units. This very cursory review may explain why his cost figures are so divergent from those of Dr. Mesghinna and Mr. Sostrom.

Dr. Willardson, who also testified for the Tribes, eliminated a substantial portion of the drainage designed by Dr. Mesghinna. Dr. Willardson did this despite the fact that he originally assisted Dr. Mesghinna in developing the procedure and design criteria Dr. Mesghinna used for the drainage system. Tr. 8575-8577, 8635 (Willardson). Dr. Willardson spent a total of approximately 20 hours on the Wind River Indian Reservation observing the United States' five proposed projects, a coverage of 2,500 acres per hour, before deciding to completely revamp the drainage system Dr. Mesghinna had designed over a period of two years of intensive work. Tr. 8694, 8706-8707, 8712 (Willardson). The Court should find Mr. Willardson's redesigns totally unpersuasive because of the abbreviated analysis.

Although the reduction in size of the irrigation system designs of Dr. Mesghinna to conform to the State arable land base will likely result in an increase in per acre capital construction costs, the Court should conclude the increase will not be significant and therefore feel comfortable relying on Mr. Sostrom's per acre costs. Tr. 4486-4492 (Mesghinna); Wyo. Exh. WRIR FSO-4 and FSO-4B.

18-23 Expert testimony re: economic feasibility of future projects

All three major parties to the adjudication presented the Court with the results of benefit-cost analyses of proposed future irrigation projects on the Wind River Indian Reservation. Testifying on the behalf of the United States was Mr. David Dornbusch, of David Dornbusch and Associates, San Francisco, California. Mr. Dornbusch was qualified as an expert in economics and economic feasibility analysis; although an experienced consultant, Mr. Dornbusch does not have extensive credentials as an agricultural economist and he was neither offered nor qualified as an agricultural economist in this case.

Testifying on behalf of the State of Wyoming were Dr. Jim Jacobs and Mr. Doug Agee, both on the faculty of the Department of Agricultural Economics at the University of Wyoming. Dr. Jacobs was accepted by the Court as an expert in agricultural economics, and Mr. Agee was accepted as an expert in both agricultural economics and farm management. Both men have impressive credentials concerning farm management and crop budgeting related to irrigated agriculture in Wyoming.

Testifying on behalf of the Tribes was Dr. Ronald Cummings, a water resource economist on the faculty of the University of New Mexico. Dr. Cummings has extensive experience in evaluating water resource development projects in western states.

18-23 Mr. Dornbusch was offered as an expert in economics and economic feasibility analysis and was tendered as an expert in these fields over the objection of the State of Wyoming. Tr. 4908-4932 (Dornbusch). In fact, the record shows that Mr. Dornbusch's undergraduate degree is in civil engineering and his masters degree in business administration. Tr. 4893 (Dornbusch). Although Mr. Dornbusch has extensive experience as a consultant (U.S. Exh. WRIR C-266, pp. 1-7), the majority of the projects he has worked on were not related to irrigated agriculture, and he had never testified as an expert witness prior to this case.

Although Mr. Dornbusch may have become self-trained in some phases of economics though his consulting experience, he is clearly not an agricultural economist or farm management specialist and the Court should not rely upon his opinions concerning cropping patterns, potential yields, on-farm production costs and other detailed matters pertinent to the operation of irrigation projects in the State of Wyoming.

Dr. Jacobs, on the other hand, is a tenured associate professor of agricultural economics at the University of Wyoming. Tr. 14662 (Jacobs). Dr. Jacobs was raised on a farm, has an undergraduate degree in agricultural education, a masters degree in agricultural economics, and a doctorate in economics from Iowa State University where his thesis was on the impact of soil and phosphorous losses on farm income. Tr. 14663-14666 (Jacobs). Prior to joining the University of Wyoming faculty, Dr. Jacobs worked at Cornell University for three years on studies of the impact on farm income of reducing sediment and phosphate losses to surface water, and for one year in a research position for the U. S. Department of Agriculture.

Since joining the faculty of the University of Wyoming in 1975, Dr. Jacobs has had responsibilities in teaching, research and extension in the area of irrigation and water resources management. As part of his teaching responsibilities, Dr. Jacobs teaches a senior level course entitled "Water Resource Economics," and a graduate level course in "Advanced Natural Resource Economics." The nature of these courses require that Dr. Jacobs have a clear

understanding of the assumptions and procedures of benefit-cost analysis in water resource planning and development. Wyo. Exh. WRIR EJ-1, 1-9.

Dr. Jacobs has published numerous journal articles as well as experiment station and extension bulletins pertinent to crop budgeting, irrigation and water management in Wyoming. Wyo. Exh. WRIR EJ-1, 2-5. In particular, Dr. Jacobs has published a report entitled Economic and Agronomic Effect of High Irrigation Levels on Alfalfa and Barley, which reports the results of a research study conducted on the Midvale Irrigation Project near Riverton, Wyoming. As a part of this study, Dr. Jacobs had to develop crop budgets for alfalfa and malting barley to determine the effects of alternative levels of irrigation on returns to the operator.

Dr. Jacobs has also presented numerous extension programs throughout the State of Wyoming related to water resource development and irrigated agriculture. Wyo. Exh. WRIR EJ-1, pp. 7-9.

Mr. Doug Agee, who also testified for Wyoming, is one of the most respected farm management specialists and agricultural economists in the State of Wyoming. For the past 20 years, he has been on the faculty of the Department of Agricultural Economics at the University of Wyoming, as well as a farm management specialist for the Agricultural Extension Service. During this period, he has spent approximately 80% of his time working with Wyoming farmers and ranchers on production cost studies and farm management problems in Wyoming. Wyo. Exh. WRIR EA-1, p. 1.

The Tribes' economic expert, Dr. Ron Cummings, was endorsed as both an agricultural economist and water resource economist. Tr. 8846 (Cummings). Although Wyoming did not question Dr. Cummings' qualifications as a water resource economist, he himself later disavowed his credentials as an agricultural economist in the following exchange on cross-examination:

> Question: (By Mr. Merrill) "Dr. Cummings, as an agricultural economist, are you generally familiar with the modern techniques of sprinkler irrigation and when they were developed?"
>
> Answer: "I am not what is typically referred to as an agricultural economist, so we are keeping everything clean. In general terms, I am familiar with sprinkler irrigation. I do not know when we began using them, you know." Tr. 9009. (emphasis added)

Based upon the evidence presented to the Court, it is clear that only two agricultural economists testified concerning the feasibility of the proposed future projects, Dr. Jim Jacobs and Mr. Doug Agee.

18-24 Benefit-cost analysis procedures.

The United States and the State of Wyoming both followed the same general procedures in the benefit-cost analyses they presented to the Court. Both parties indexed costs and returns for the proposed future projects to a current year, net of any inflationary effects. Both parties agreed that a "real" discount rate should be used in determining feasibility, and that secondary effects and subsidies should be excluded.

The Tribes' benefit-cost analysis was simply an expansion of the United States' analysis to show the effects of including secondary benefits, as well as some adjustments to on-farm costs. Both of these adjustments resulted in significantly higher benefit-cost ratios than those presented to the Court by the United States. As stated in Finding of Fact 15-13, the Court finds little merit in the argument that secondary benefits, but not secondary costs, should be included in a benefit-cost analysis.

18-24 The United States' and Wyoming's general methodological agreement is detailed in Findings of Fact 15-9 through 15-15. The Court should take notice that the United States' primary source of information on crops, yields and production costs was from a study prepared by Mr. Doug Agee. Tr. 4942; 4952; 4974 (Dornbusch). Mr. Dornbusch testified on behalf of the United States that he made a number of adjustments to Mr. Agee's data. Tr. 4975 (Dornbusch).

The scope of Dr. Cummings' analysis was clearly spelled out under cross-examination:

> Question: "As I understand it, the only modifications that you have made to Mr. Dornbusch's analysis involved the placement of on-farm costs and secondary benefits; is that correct?"
>
> Answer: "I believe so."
>
> Question: "Is it correct then to say that the prices, the cropping patterns, the elevation breakpoints, the yields, the production costs, labor costs and all the other items in Mr. Dornbusch's analysis you accepted without modification; is that correct?"
>
> Answer: "That's correct."

Tr. 8969. Dr. Cummings further stated:

> "I was not asked to nor did I have the - given the time nor did I take the time to analyze Dornbusch's work."

Tr. 8970. Based upon the record, it is clear that Dr. Cummings' analysis is nothing more than a rehash of Mr. Dornbusch's analysis, which Dr. Cummings did not have the time nor inclination to verify for its accuracy or completeness. Thus, in the final analysis, the Tribes' economic analysis consists of nothing more than two sets of adjustments made by non-agricultural economists to a study prepared by an agricultural economist who testified for the State of Wyoming.

18-25 Differences in economic feasibility results.

Although the State of Wyoming and the United States were in general methodological agreement, the results of their analyses as presented to the Court were strikingly different. These parties predicated their analyses on different assumptions concerning crop yields and the effects of elevation on those yields; whether reduced yields could be expected during an initial start-up period when new lands were put under production; the prices at which certain crops could be sold; and the level of on-farm production and management costs that would be incurred.

18-25 Dr. Jacobs detailed the differences between his analysis and Mr. Dornbusch's on transcript pages 14773 through 14787. The major points made by Dr. Jacobs are:

1. The discount rate does not play a major role in differences since both parties used discount rates of both 4 and 7-1/8% in their respective analyses;

2. Differences in water delivery system costs proposed by the United States and Wyoming do not play a significant role since Dr. Jacobs evaluated the future projects using the United States', the Tribes' and Wyoming's projected water delivery system costs;

3. Wyoming assumed average malt barley yields of 90 bushels per acre in lowland areas under superior management, while the United States assumed 100 bushels per acre in lowland areas in its analysis;

4. The economic analyses presented by Dr. Jacobs used reduced yields at elevations above 5,500 feet while Mr. Dornbusch reduced yields above 5,900 feet.

5. Mr. Dornbusch assumed full yields will be realized during the first year of irrigation on the proposed projects. Dr. Jacobs assumed crop yield will be slightly lower over a five-year start-up period on the proposed projects.

6. The State of Wyoming used an average price for barley straw of $23.75 per ton, while the United States used $35.00 per ton, ignoring the very limited market for barley straw in the Riverton area which is reflected in Agee's crop budget publication for the Riverton Area (Wyo. Exh. WRIR ED-8);

7. The State of Wyoming used a management charge of approximately $11.88 per acre for the future projects, while the United States used $1.32 per acre. This difference is based upon an assumption by the United States that management labor would come completely from the unemployed ranks after a 10-year training period; while Wyoming's assumption was that management should be fully costed. The State of Wyoming costed farm labor at 20, 75 and 100% for the future projects, while the United States costed farm labor at only 20% in their analysis;

8. The United States used an indexing procedure for input prices, which in many cases resulted in 1979 prices being lower than actual 1977 prices; and

9. The United States used figures for farm equipment life that are overly optimistic given the annual usage of the equipment.

18-26 Court accepts Wyomings' economic feasibility results. Based upon a careful scrutiny of the record and the qualifications of the experts involved, the Court concludes that the preponderance of evidence on these issues lies in favor of the State of Wyoming's analysis. Although Mr. Dornbusch has extensive experience in economic feasibility studies, his background in agricultural economics and farm management and budgeting in Wyoming is limited. Since the significant issues which divide the two parties deal almost exclusively with crop budgeting and farm management topics, the Court adopts Wyoming's position on these issues because Wyoming's experts are more qualified in those particular fields. Both Dr. Jacobs and Mr. Agee were raised on farms, educated in agricultural economics, and have extensive professional experience in irrigated agriculture in Wyoming.

The Court also notes that much of Mr. Dornbusch's work on crop budgets was based upon publications by Mr. Agee, to which Mr. Dornbusch made various adjustments. Based upon Mr. Dornbusch's extensive use of Mr. Agee's crop budgets, it is apparent that he

regards Mr. Agee as an expert in crop budgeting and farm management practices in Wyoming. In the view of this evidence, the Court has little choice but to accept the findings of Wyoming with regard to economic feasibility.

18-26 The respective qualifications of the economists are discussed thoroughly above. Based upon the record, it is obvious that Dr. Jacobs and Mr. Agee are much more qualified to conduct analyses concerning farm costs and returns in Wyoming than is Mr. Dornbusch.

Furthermore, Mr. Dornbusch relied upon a crop production study prepared by Mr. Doug Agee for crops and cropping patterns (Tr. 5824-5826), crop yields (Tr. 4952) and production practices (Tr. 4974-4985). By his extensive reliance upon Mr. Agee's work, Mr. Dornbusch implicitly recognizes Mr. Agee as authoritative on matters concerning crop budgeting in Wyoming. Mr. Dornbusch, however, testified that he made a number of adjustments to Agee's data (Tr. 4975).

Mr. Agee later testified that he did not agree with the adjustments and assumptions made by Mr. Dornbusch. Tr. 15313. The Court cannot, in good conscience, adopt Mr. Dornbusch's analysis, which relies heavily on Mr. Agee's work, and at the same time ignore Mr. Agee's repudiation of Mr. Dornbusch's work. Either Mr. Agee is a competent expert in his field, or he is not. If he is, then Mr. Dornbusch's

work stands repudiated. If he is not, then Mr. Dornbusch's work is of little consequence because it relied so heavily upon Mr. Agee's work.

18-27 Court accepts Wyoming's findings re: cropping patterns. Both parties were in general agreement concerning the crops that could be grown on the proposed future projects, citing malt barley and alfalfa hay as the major crops. The United States also included corn for silage and corn for grain in its cropping pattern, while the State of Wyoming substituted beans because the irrigation system proposed by the United States was not conducive to irrigating corn. Although the differences between the two parties on this issue is not significant, the Court adopts the cropping patterns proposed by Wyoming as more realistic based upon the superior qualifications of its experts and the evidence presented to the Court concerning the impracticality of irrigating corn with hand-move sprinklers.

18-27 The cropping patterns proposed by the United States and Wyoming for the future projects are compared in Wyo. Exh. WRIR EJ-8. The cropping patterns proposed by the two parties are similar with the following exceptions:

(1) Wyoming proposed the planting of dry beans instead of corn and corn silage, because it is impractical to grow corn using hand-move sprinkler systems as proposed by the United States. Tr. 14719-14720 (Jacobs).

(2) The State of Wyoming used slightly different proportions of alfalfa to correspond with the present cropping patterns in the region. Tr. 14721 (Jacobs).

Although differences in the assumed cropping patterns are not major, the Court should adopt the cropping pattern proposed by Wyoming based upon the superior qualifications of its experts in this area. Furthermore, the Court should consider the following:

(1) Mr. Dornbusch's cropping pattern is based solely upon a published report by Mr. Doug Agee and interviews in the Riverton area. Tr. 5824-26, 5855 (Dornbusch, cross examination).

(2) However, Mr. Agee testified that Mr. Dornbusch assumes corn being grown at elevations where growing seasons are not adequate. Tr. 15313 (Agee).

(3) The only record of Mr. Dornbusch's interviews are depicted in Wyo. Exh. WRIR ED-16. Tr. 5826 (Dornbusch, cross examination).

(4) Mr. Dornbusch could not even testify as to the cropping distribution of the people he did interview. Tr. 5833 (Dornbusch, cross examination).

18-28 Court accepts Wyoming's findings re: yields by elevation.

The United States and Wyoming were at odds concerning what overall yields could be obtained from the various crops proposed for the future projects, and how these yields would vary as a function of elevation. Both parties agreed that reductions in yields should be anticipated at higher elevations due to shorter growing seasons, but the parties were unable to agree on a break point above which reduced yields should be consistently expected.

The State of Wyoming established that reduced yields should be expected at elevations above 5,500 feet on the proposed future projects, while the United States claimed that full yields could be obtained at elevations up to 5,900 feet.

The United States' claim of full yields up to 5,900 feet is based primarily upon field interviews and a BIA planning document. Wyoming's position on this issue stems from a number of sources including Soil Conservation Service personnel; reports by HKM Engineering, a consultant to the United States; and analysis of weather data and degree days in the Riverton area.

The Court finds by far the preponderance of evidence on this issue lies in favor of Wyoming's position that reduced yields will occur above 5,500 feet in elevation.

18-28 The United States' contention that the proper break point between highland and lowland areas is based solely upon Mr. Dornbusch's interpretation of one page in a BIA report (Wyo. Exh. ED-17, p. 19) and the scantily documented interviews referred to in the previous finding. Tr. 5846-5854. The evidence supporting Wyoming's proposed break point of 5,500 feet is overwhelming. Dr. Jacobs testified that he based this break point upon extensively documented farm interviews, conversations with Soil Conversation Service personnel, reports from HKM Engineers, and an analysis of climatological data concerning degree days needed to grow corn at higher elevations. Tr. 14722. Furthermore, Dr. Jacobs testified that the same report used by Mr. Dornbusch to justify 5,900 feet, if properly interpreted, suggests that 5,500 feet is a more appropriate break point. Tr. 14913.

Furthermore, Clarence Fowkes, the soils expert on behalf of Wyoming, testified that the proper break point between highland and lowland areas should be 5,500 feet. Tr. 10638-10641. Mr. Doug Agee, testifying on behalf of Wyoming, also suggested it would be difficult to grow corn at elevations above 5,500 feet as proposed by the United States. Tr. 15324.

Finally, Wyo. Exh. ED-15, "Criterion for Selection of Project Study Areas" prepared by HKM Associates on behalf of the United States, used 5,500 feet as the dividing line between highland and lowland areas.

Based upon this overwhelming evidence, the Court has no recourse but to conclude that 5,500 feet is a more reasonable break point between highland and lowland areas for purposes of analysis than the 5,900 feet proposed by the United States.

18-29 Court accepts Wyoming's findings re: yields for specific crops.

The United States and Wyoming were also at odds concerning the yields that could be obtained from specific crops proposed for the future projects. The United States analyzed the feasibility of the projects using malt barley yields of 100 and 90 bushels, respectively, for lowland and highland areas. Wyoming analyzed the feasibility of the project using two different sets of malt barley yields; one assuming good management practices and another assuming superior management practices.

Under good management practices, Wyoming's assumptions for malt barley yields were 80 and 75 bushels, respectively, for lowland and highland areas. Wyoming's corresponding assumptions for superior management were 90 and 80 bushels, respectively.

The Court notes with interest that the long-term malt barley yields used by both parties are significantly higher than the historical average for either Fremont County or the nearby Midvale Irrigation District. The Court also heard evidence that some individual farmers, in individual years, may have achieved yields even higher than those proposed by any of the parties.

The Court must conclude, however, based upon the preponderance of evidence and the qualifications of the expert witnesses involved, that the yields proposed by Wyoming under superior management are the highest that could be expected to be achieved on a long-term basis over large numbers of acres.

The parties were also at odds concerning appropriate nurse barley yields to use in evaluating project feasibility and the Court adopts the yields proposed by Wyoming under superior management for reasons similar to those cited above. There was virtually no difference between the alfalfa yields proposed by the United States and Wyoming under superior management, but for purposes of consistency, the Court also finds in favor of Wyoming's yields under superior management.

18-29 In comparing the positions of the parties concerning malt barley yields for the proposed future projects, the Court should consider the qualifications of the witnesses. Wyoming's experts are clearly more qualified in this area to make judgments than the United States' witness. Furthermore, the Court should take note of the following:

(1) Mr. Dornbusch began his feasibility analysis using 80 bushel per acre yields for lowland areas. Tr. 5869-5870 (Dornbusch).

(2) At a later date, Mr. Dornbusch increased his malt barley yields to 100 bushels per acre in the lowlands, claiming he obtained new information based upon telephone interviews with farmers. Tr. 4953 (Dornbusch).

(3) Mr. Dornbusch, however, could not recall how many farmers he interviewed or what the average yields from those interviews were. Tr. 5855-5866 (Dornbusch).

(4) The only evidence concerning the results of those interviews is constituted by Wyo. Exh. WRIR ED-16, which gives no factual basis for assuming average malt barley yields of 100 bushels per acre.

(5) Mr. Dornbusch admitted he didn't even know what irrigators in Fremont County are currently getting for average malt barley yields. Tr. 5861-63 (Dornbusch).

(6) Mr. Doug Agee noted that Mr. Dornbusch's yields are not being achieved by most farmers in the Riverton area now and if nurse barley were planted to achieve the yields anticipated by Mr. Dornbusch, it's entire purpose (starting a healthy stand of alfalfa) would be defeated. Tr. 15313, 15324-15326 (Agee).

The Court should also note that the malt barley yields proposed by Wyoming under both good and superior management options are distinctly higher than historical averages for Fremont County and the Midvale Irrigation District (Wyo. Exh. WRIR EJ-6).

Wyo. Exh. WRIR ED-8 clearly indicates that progressive farmers in the Riverton area were achieving yields of approximately 80 bushels per acre on malt barley in 1977. Furthermore, Dr. Jacobs' interviews of above average producers in the Riverton area in 1980 indicated an average malt barley yield of 86.3 bushels per acre. Tr. 14921 (Jacobs). These yields for above average producers are clearly more in line with Wyoming's yield assumptions than those of the United States.

18-30 Court accepts Wyoming's findings re: yield reductions. The United States assumed that full yields would be obtained for all crops on future project lands the first year they were put into production. Wyoming, on the other hand, maintained that slightly lower yields would be incurred during the first few years the lands were in production. The Court heard only one witness, Mr. Dornbusch, who testified in favor of full yields from the first year of production. The Court further notes that Mr. Dornbusch was not qualified as an agricultural economist.

The preponderance of evidence testified to by other witnesses clearly indicates that some yield reductions must be expected during the first few years land is put under production, and for that reason the Court has no choice but to adopt Wyoming's findings in this matter.

18-30 Mr. Dornbusch, under cross-examination, clearly indicated that he did not allow for any reductions in yields during the first few years the proposed future projects would be under operation. Tr. 5870-5871 (Dornbusch).

Dr. Jacobs, testifying on behalf of the State of Wyoming, indicated that slightly lower yields must be anticipated during early years of bringing new land, equipment and management into production. Tr. 14716 (Jacobs). This contention is clearly supported by Mr. Agee, who testified that a period of approximately five years would be required to bring the new lands into full production. Tr. 15389 (Agee). This testimony was collaborated by interviews conducted by Craig Sommers with producers in Fremont County. Tr. 14990 (Sommers). One such interview inferred that ten years were required to reach full production of alfalfa. Tr. 14991 (The Special Master).

The Court should also note that Special Master Tuttle also used reduced yields over a three to five year period for all major cash crops considered in the most recent Arizona v. California hearing. Special Master Report at 306-315, Arizona v. California (October 1981 Term, No. 8, Orig.).

18-31 Court accepts Wyoming's findings re: crop prices.

Both the United States and Wyoming used indexed historical prices to arrive at estimates of crop prices for the proposed future projects. The United States used normalized prices for the period 1974-78, while Wyoming used an average of prices for the period 1975-79 indexed to 1979. The resulting prices were quite similar with the exception that Wyoming's price for malt barley was approximately 20% higher than that used by the United States. Based upon the qualifications of the witnesses involved, and the fact that Wyoming's crop prices are based upon more recent data, the Court adopts Wyoming's position concerning crop prices for evaluating the proposed future projects.

The Court also notes that testimony was presented by Wyoming to the effect that future crop prices in the area might fall due to increased production of local crops such as alfalfa. While neither party attempted to quantify any potential price drops due to increased production, the Court notes that the prices and, as a result, returns used by both parties might be considered optimistic relative to what could be projected for the future projects.

18-31 Mr. Dornbusch, testifying on behalf of the United States, used normalized crop prices published by the Water Resources Council for the period 1974 through 1978 with the exception of malt barley prices. For malt barley prices, Mr. Dornbusch computed normalized prices using Water Resource Council weights. Tr. 4961 (Dornbusch). Dr. Jacobs, testifying on behalf of Wyoming, computed normalized crop prices for the period 1975 through 1979. Tr. 14726 (Jacobs). Dr. Jacobs' resulting prices are quite similar to Mr. Dornbusch's, with the exception of malt barley prices, which are 19 or 20% higher than Dornbusch's. Tr. 14727 (Jacobs).

Based upon the qualifications of the experts involved (see Finding of Fact 18-23, supra), and the fact that the only differences in Wyoming's crop prices tend to favor the position of both the Tribes and the United States, the Court should adopt the crop prices suggested by Wyoming and depicted in Wyo. Exh. WRIR EJ-8.

The Court should also note that Mr. Dornbusch admitted under cross-examination that the proposed future

projects would approximately double malt barley production in the area. Tr. 5798-5802 (Cross-Dornbusch). Mr. Dornbusch maintained, however, that these production increases would have insignificant effects upon local prices. Tr. 5785-5789 (Cross-Dornbusch). Both Dr. Jacobs and Dr. Agee, testifying on behalf of Wyoming, expressed concern about the effects of increased production on malt barley prices in the area. Tr. 14792-14793 (Jacobs); Tr. 15342-15344 (Agee).

Dr. Carver, a livestock specialist who testified on behalf of Wyoming, also expressed concern about the effect of increased alfalfa production on local prices. Tr. 11895-11897 (Carver). Nevertheless, neither Wyoming nor the United States took the possibility of decreased prices due to increased production into account in their analysis. Thus the Court should find that the potential prices and therefore benefits attributable to the proposed future projects are, if anything, overstated. Dr. Brookshire testified to this effect on Tr. 14533-14534 (Brookshire).

18-32 Court accepts Wyoming's evidence re: production costs. The United States and Wyoming also presented conflicting testimony concerning the on-farm production costs that would be experienced on the proposed projects. Specifically, the production costs utilized by the United States in their analysis are significantly lower than those used by Wyoming.

The United States, in their cross-examination of Wyoming's experts, attempted to make the point that the major differences in production costs are attributable to the fact that the United States assumed large economies of scale in projecting their production costs, while Wyoming did not. Wyoming, on the other hand, argued that there are relatively few economies of scale inherent in irrigated agricultural enterprises above a certain level. Wyoming's experts testified that most of the differences in on-farm costs are attributable to the fact that the United States used inappropriate indexing procedures for costs and unrealistic life for machinery relative to the hours of annual use.

In weighing the evidence on both sides, the Court takes note of the fact that the United States on-farm production costs were all based upon adjustments made to production cost data published by Mr. Douglas Agee, of the University of Wyoming. The Court further notes that Mr. Agee stated that production costs used in Wyoming's analysis were more realistic than those used by the United States. Since Mr. Agee, along with Wyoming's other witness, Dr. Jacobs, have impeccable credentials in that area, and the United States relied upon Mr. Agee's work as input to its own analysis, the Court has no alternative but to adopt the State of Wyoming's analysis on on-farm production costs as being more authoritative.

The Court further notes that although the United States claims its lower production costs may be attributable to increased efficiencies due to larger farm units, the record contains no mention at any point of the proposed unit size the United States would use to operate the future projects. To the contrary, the record contains conflicting evidence as to whether the Tribes would operate the proposed

future projects as large tribal enterprises or small family farms. In either case, the Court finds the evidence presented by Wyoming on the insignificance of economies of scale in irrigated agriculture to be convincing.

18-32 Major differences in on-farm production costs between the United States and Wyoming are presented in Wyo. Exhs. EA-4 and EA-5, and summarized in Wyo. Exhs. EA-6 and EA-7. Exhibits EA-6 and EA-7 show total on-farm production costs per acre for both malt barley and alfalfa budgets as presented by the United States and Wyoming. The exhibits also show, for purposes of comparison, published on-farm production costs for these crops from agricultural extension bulletins prepared by Mr. Agee in 1977 and 1980.

The figures in exhibits in EA-6 and EA-7 show that the United States' on-farm production costs for malt barley are approximately 15% lower per acre than Wyoming's costs, while the United States' production costs for alfalfa are an astounding 43% lower than the corresponding production costs presented by Wyoming. Exhibit EA-6 further shows that 1979 per acre on-farm production costs used by Mr. Dornbusch for malt barley are 10% below Mr. Agee's documented 1977 costs, and 20% below Mr. Agee's 1980 costs. This occurs in spite of the fact the United States claims a 25% higher yield per acre. Exhibit EA-7 shows that 1979 per acre on-farm production costs used by Mr. Dornbusch for alfalfa are 24% below Mr. Agee's documented 1977 costs and 48% below Mr. Agee's 1980 costs for the same yield per acre.

For the above comparison, results are presented in terms of fully costed labor and a 4% discount rate. The Court should note, however, that the United States included only 20% of the full labor charge in its analysis. Wyoming conducted its analysis assuming labor costed at 20%, 75% and 100% of full value.

During their cross-examination of Dr. Jacobs, the United States attempted to establish that its lower production costs are attributable to assumptions of larger operating units. Tr. 14840-14842 (Cross-Jacobs). Dr. Jacobs refuted this inference with the following points:

1. It's not necessarily true that running more equipment over more acreage necessarily results in greater efficiencies because of management and timing problems. Tr. 14849-14850 (Cross-Jacobs).

2. Mr. Dornbusch never did state what size operational unit he assumed in his analysis. Tr. 14841 (Cross-Jacobs).

3. Published studies in agricultural economics do not show great efficiencies in production costs with expanded farm size. Tr. 14854, 14864 (Cross-Jacobs).

In conclusion, Dr. Jacobs testified that changing his farm size from 320 acres to a larger size would not have changed the results of his analysis. Tr. 14862 (Cross-Jacobs).

Mr. Agee, testifying on behalf of Wyoming, further corroborated Dr. Jacobs' testimony through the introduction of Wyo. Exh. WRIR EA-8, an excerpt from a study entitled Economies of Size in U. S. Field Crop Farming, published by the U. S. Department of Agriculture in July, 1981. Quoting from the fourth page of that exhibit, paragraph No. 6:

> "Since medium-size commercial farms with gross incomes from $41,000 to $76,000 achieve most technical efficiencies, society benefits little in terms of lower real food costs from further increases in farm size. Actually, many commercial farms now exceed the size necessary to achieve all available cost efficiencies. With current crop production technology, further growth in medium-size and larger farms will not likely improve overall food production efficiency."

Dr. Agee further testified that a 320-acre farm in the Riverton Area would likely gross between $70,000 and $90,000 annually, clearly placing it at the point where most technical cost efficiencies have been achieved according to the U. S. Department of Agriculture. Tr. 15372 (Agee).

Based upon this testimony, the Court must look elsewhere for an explanation for the differences between Wyoming's production costs and those of the United States. Part of the answer is found in the management charges assumed by both parties. Tr.

14780-14781 (Jacobs). Mr. Dornbusch assumed that the management of these irrigation projects would come from the unemployed ranks (Tr. 4990-4992 (Dornbusch)), while Wyoming maintained that management charges over the life of the project should be fully costed. Tr. 14734 (Jacobs).

The other difference in the two analyses is that the United States used a normalization procedure for production input prices that resulted in unrealistically low costs. In fact, Mr. Dornbusch (Tr. 5808) admits that his so-called normalized 1979 price is actually an average for the period 1974 through 1978, and isn't much different from 1977 prices. Dr. Jacobs pointed out an example of this difference in price indexing under cross-examination on Tr. 14781 through 14782. This example shows that Mr. Dornbusch's indexing procedure gave a 1979 price for diesel fuel of $.45 per gallon, compared to Dr. Jacobs' 1979 price of $.61 per gallon. A further comparison of input prices between Wyoming and the United States is given in Wyo. Exh. WRIR JJ-2.

A third difference between Wyoming and the United States production costs involves assumed equipment life and equipment prices. Mr. Dornbusch took estimated equipment life figures from Mr. Agee's publication, yet increased his equipment usage figures significantly without accelerated depreciation of the equipment. Tr. 14783-14785. This procedure clearly understates the costs that would be incurred in on-farm production. U.S. Exh. WRIR JJ-5 shows some of 1979 equipment prices used by Dr. Jacobs. It also shows the equipment prices used by Mr. Agee in his 1977 extension bulletin 619-R (Wyo. Exh. WRIR ED-8). In the above exhibit, Mr. Agee's 1977 equipment prices are indexed to 1979 and normalized to 1979. If all the equipment prices presented in Dr. Jacobs' budgets had been presented in U.S. Exh. WRIR JJ-5, the Court would find some of Dr. Jacobs' prices are higher, some lower and some equal to Mr. Agee's 1977 equipment prices indexed to 1979. However, if Mr. Agee's 1977 equipment prices normalized to 1979 are used (see last column of U.S. Exh. WRIR JJ-5), the equipment prices are all lower than Mr. Agee's 1977 equipment prices indexed to 1979. Mr. Dornbusch in his analysis normalized Mr. Agee's 1977 equipment prices to 1979.

Tr. 14894-14900. The use of these lower indexed equipment prices by Mr. Dornbusch results in lower on-farm production costs.

In summary, the Court should reject the United States' contention that the difference in on-farm production costs between the parties are attributable to assumed economies of scale on the part of the United States. In fact, the differences are attributable directly to differences in procedural methods used by the two parties to arrive at production costs. Based upon the record and the testimony of the experts involved, it is clear that the United States used unrealistically low management charges, improper indexing procedure for production input prices, and unrealistic assumptions concerning equipment life for major farm implements.

Thus, the Court, after carefully reviewing the on-farm production cost figures shown in Wyo. Exhs. EA-6 and EA-7, should conclude that Wyoming's figures as testified to by Dr. Jacobs and Mr. Agee are more realistic.

18-33 Water Delivery System Costs

The other element involving project feasibility about which the United States and Wyoming disagreed were water delivery system costs. The Court notes, however, that Wyoming conducted its feasibility analysis using both its own water delivery system costs and those proposed by the United States and Tribes. The Court further notes that the use of the lower water delivery system costs did not significantly change the results of Wyoming's analysis, so the Court considers the point moot.

18-33 A comparison of the relative merits of the United States' and Wyoming's water delivery system cost estimates is contained elsewhere in these findings and will not be repeated here. It is sufficient to point out that Mr. Dornbusch, the United States' economist, obtained irrigation system cost figures from Dr. Mesghinna for the five proposed future U. S. projects and made various adjustments to these costs as described on Tr. 5011 through 5033 (Dornbusch).

Dr. Jacobs, testifying on behalf of Wyoming, revealed that he conducted his feasibility analysis for the future projects using system costs developed by Banner Associates, as well as those developed by Dr. Mesghinna, and Bliesner & Keller. Tr. 14739, 14741 (Jacobs).

Dr. Jacobs further testified that regardless of whose construction costs figures are used in the feasibility analysis, the results of his analysis were essentially the same. Tr. 14774 (Jacobs).

Based upon Dr. Jacobs' testimony, it is obvious that the real differences in the feasibility analyses conducted by the United States and Wyoming do not involve differences in system design costs. The significant differences between the analyses, instead, are in terms of on-farm production costs.

18-34 Summary of Differences.

After a careful review of the benefit-cost analyses submitted to the Court by the United States and Wyoming, the Court concludes that the major differences between the parties lie in the area of on-farm production costs, particularly those associated with alfalfa. Wyo. Exh. EA-7 places both analyses on a comparable basis involving a 4 percent discount rate and fully costed labor for alfalfa production in lowland areas. The figures in the exhibit show that the Unites States' projected on-farm production costs are $86.69 per acre, contrasted with Wyoming's projection of $151.43 per acre (in 1979 dollars). Both parties assumed alfalfa yields of 4.5 tons per acre. Thus, these production cost figures correspond to $19.26/ton for the United States and $33.65/ton for Wyoming.

Wyo. Exh. EA-7 also gives alfalfa production costs published by the Agricultural Extension Service of the University of Wyoming for the Powell, Wyoming area for 1980. These costs are $166.56 per acre or $37.01 per ton, approximately 10 percent higher than Wyoming's costs. Given the proximity of Powell to the Reservation, the Court should conclude that Wyoming's

production costs are reasonable, and that the costs projected by the United States are unreasonably low.

18-34 To explain differences between the United States' and Wyoming's analysis, the Court should note Dr. Jacobs' testimony on the following points (Tr. 14773-14787):

1. Both parties conducted their analyses at discount rates ranging from 4 to 7 1/8 percent; and

2. Dr. Jacobs evaluated the projects using the United States', the Tribes' and Wyoming's water delivery system costs.

Thus, these factors cannot explain the different results achieved by the parties.

Wyo. Exhs. EA-6 and EA-7 show that the gross returns projected by both parties are similar; less than 1 percent different for alfalfa and 2 percent different for malt barley. The differences between the parties must thus be explained by on-farm production costs.

The United States' assertion that it could produce alfalfa for $19.26/ton (fully costed) or $17.18/ton (economic cost) is totally without foundation other than the testimony of Mr. Dornbusch who is not an agricultural economist. Wyoming's cost estimates are

not only far more reasonable when compared to published data (see Wyo. Exhs. EA-6 and EA-7), but are backed by the testimony of two eminently qualified agricultural economists, Dr. Jacobs and Mr. Agee (see Finding of Fact 18-23 and reasons therefor).

18-35 Benefit Cost Analyses.

The results of the United States' benefit cost analyses of the five future projects are given in Table 5 of U. S. Exhibit WRIR C-268 for a discount rate of 4%, and depicted graphically in United States Exhibit C-274 for discount rates ranging from 4 to 7-1/8%. The results of the United States' own analyses show that none of the proposed projects are feasible at discount rates of 7% or greater, and that the discount rate must be below 5% for all five projects to be feasible using the United States' own calculations.

The results of Wyoming's benefit cost analyses are depicted in Exhibits WRIR EJ-10, EJ-11, EJ-12 and EJ-13. The Court notes that Wyoming calculated benefit cost ratios for the proposed projects at two discount rates 4 and 7-1/8%; two levels of yields (represented by good and superior management); three sets of assumptions concerning on-farm labor costs (fully-costed, 75% costed, and 20% costed); and for three different sets of water delivery systems costs (the United States, the Tribes and Wyoming). The results of Wyoming's analyses constitute overwhelming evidence that the proposed future projects are not economically feasible. Of the 132 benefit cost ratios

calculated by the State, only one has a value in excess of 1.0. That benefit cost ratio is for the proposed Arapahoe Area, assuming superior management, a 4% discount rate, using Mr. Keller's system design costs and costing on-farm labor at only 20% of its full value; a highly favorable set of assumptions.

The Court is aware that the United States' analysis presents conflicting results for discount rates of 5% or less, and that the United States argued vigorously that an even lower discount rate should be employed in evaluating the projects. Nevertheless, the Court finds Wyoming's argument that the United States' on-farm production costs are unrealistically low as convincing, and attributes the results of the United States' analysis largely to this factor. Qualifications of Wyoming's experts concerning appropriate on-farm production costs are clearly superior to those of the United States witness in this matter.

The Court further notes that the United States began its analysis of project feasibility using a 7-1/8% discount rate, and that using this discount rate all the projects are infeasible even using the United States' own analysis. The Court further notes that discount rates of 7 and 7-1/8% were used by parties in the recent Arizona v. California hearing, and that evaluating the proposed projects on the same basis shows that the proposed future projects are clearly infeasible regardless of whether the United States' or Wyoming's results are used.

18-35 The Court should note that the real difference between the benefit-cost ratios presented by the United States and the State of Wyoming are attributable almost solely to differences in on-farm production costs as depicted in Wyo. Exhs. EA-6 and EA-7. From these exhibits the Court can see that the gross returns projected by Mr. Dornbusch on behalf of the United States and Dr. Jacobs on behalf of Wyoming are virtually identical.

In terms of gross returns per acre to alfalfa, both parties assumed essentially the same long-term prices and yields. The fact that Wyoming's gross returns per acre are slightly lower reflects slightly lower yields assumed during an initial start-up period. Both sets of returns, however, are within approximately 1% of each other.

Gross returns to malt barley are also virtually identical even though the United States assumed higher yields than Wyoming for this crop. Wyoming, on the other hand, assumed a higher malt barley price than did the United States, making returns virtually identical.

The real differences between the parties are highlighted by an examination of on-farm production costs. For malt barley, Mr. Dornbusch's costs are 15% lower per acre than those used by Wyoming. (Computed from total specified costs, columns 1 and 2, Wyo. Exh. WRIR EA-6). The United States' on-farm production costs for alfalfa are an astounding 43% lower than the corresponding costs used by Wyoming (computed from total specified cost, columns 1 and 2, Wyo. Exh. WRIR EA-7).

As argued above, there is absolutely no evidence to indicate that differences of this magnitude can be attributed to economies of scale as suggested by the United States and Tribes. In fact, the evidence on the record is to the contrary. The evidence in the record indicates that:

1. The United States used indexing procedures for production costs that resulted in supposed 1979 cost levels that are in reality lower than actual 1977 costs;

2. In addition to costing on-farm labor at only 20% of its full value, the United States assumed virtually no direct management charges for management of the projects; and

3. The United States assumed equipment lifetimes that are totally unrealistic given their projected use of on-farm equipment.

The Court should note that Wyoming, far from taking advantage of every assumption that would reduce cost benefit ratios in its analysis, actually gave the United States and Tribes the benefit of the doubt on a large number of issues as detailed by Mr. Merrill on Tr. 15047-15052. In the final analysis, however, the Court simply cannot agree that the on-farm production costs proposed by the United States are in any way realistic and must conclude that the projects when evaluated under any reasonable set of contemporary standards are simply not economically feasible.