You replied on 3/2/2006 7:54 PM.

**Whipple, John J., OSE**

**Fr**  Dave Trueman [DTRUEMAN@uc.usbr.gov]  **Sent:** Thu 3/2/2006 11:54 AM
**To:** Whipple, John J., OSE
**Cc:**
**Subject:** Fwd: Irrg Ag effective precip
**Attachments:**

FYI

>>> james prairie <James.Prairie@colorado.edu> 3/2/2006 11:32:44 AM
>>>
Dave,

I just wanted relay what I saw looking through the reports I have available in my office.

1. Brenda's Methods Manual states that the SCS effective precipitation method was used with a 3-inch application depth. This applies to CU&L from 1985-present. (Unless Brenda says otherwise)
2. I do not have the 1981-1985 irrigated agriculture technical appendix. This is at Brenda's office
3. The 1975-1980 technical appendix shows a 3-inch application depth was used per the output file but does not state if the SCS or BOR ˈective precip method was used.
4. _ do not have the 1971-1975 irrigated agriculture technical appendix. This is at Brenda's office
5. The 1983 draft report (which includes John Redlinger's letter) states the SCS effective precipitation method was used with a 3-inch application depth. This report covers the data from 1906-1970.

Jim

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MEMORANDUM
February 20, 2006

To: John D'Antonio, State Engineer
Estevan Lopez, Interstate Stream Engineer

Copy: DL Sanders, Chief Counsel, Office of the State Engineer
Tanya Trujillo, Chief Counsel, Interstate Stream Commission
Steve Farris, Office of the Attorney General

From: John Whipple, Staff, Interstate Stream Commission

Subject: Proposed Hydrologic Determination for the Upper Colorado River Basin

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Attached for your review is a preliminary draft proposed Hydrologic Determination that would resolve issues relating to the current update of the 1988 Hydrologic Determination and to the future accounting of consumptive uses in the Upper Colorado River Basin. The proposed Hydrologic Determination would support moving forward with the San Juan River Basin in New Mexico Navajo Nation Water Rights Settlement Agreement legislation. Our meeting scheduled for the afternoon of February 23 is for the purpose of discussing the preliminary draft proposed Hydrologic Determination and finalizing a draft proposal for distribution to the Bureau of Reclamation and the Upper Division states for their consideration.

# PROPOSED HYDROLOGIC DETERMINATION

*New Mexico proposes the following for consideration of the US Bureau of Reclamation (USBR) to resolve issues relating to the current update of the 1988 Hydrologic Determination. This proposal is for discussion purposes only, and should not be construed to prejudice the positions of the State of New Mexico. This proposal also would resolve outstanding issues relating to the accounting of Upper Basin consumptive uses for inclusion in the five-year Colorado River System Consumptive Uses and Losses reports that the USBR submits to Congress and for administration of the Upper Colorado River Basin Compact. This proposal also will be furnished to the Upper Colorado River Commission (UCRC).*

## ALLOCATION

1. The amount of water available for use by the Upper Basin states is at least 5.75 maf, on average, excluding shared Colorado River Storage Project (CRSP) reservoir evaporation.

   The USBR's 1988 Hydrologic Determination (1988 HD) concluded that the total Upper Basin yield for a 25-year critical period is at least 6.0 maf, including CRSP reservoir evaporation. This minimum yield was based on a minimum objective release of 8.23 maf from Lake Powell, a tolerable overall shortage of about 6 percent for the critical period, maintenance of the minimum power pools at CRSP units, storage capacity in Lake Powell reduced for sedimentation through the 2040 planning horizon, and inclusion of available bank storage. The UCRC by resolution accepted this minimum yield for use in planning studies even though the UCRC does not agree with the minimum objective release.

   The current Upper Basin yield study used many of the same basic assumptions as the 1988 HD to evaluate the minimum yield. The current yield study assumed a minimum objective release of 8.23 maf, a tolerable overall critical-period shortage of 6 percent, maintenance of the minimum power pools, a 2060 sedimentation condition in Lake Powell reflecting an extended planning horizon, and a 4-percent bank storage factor consistent with the USBR's Colorado River System Simulation (CRSS) model. The current yield study also includes all Upper Basin live storage in addition to CRSP active storage because all storage supports water use in the Upper Basin and impacts stream flows.

   The results of the current yield study indicate that with a long-term average use demand in the Upper Basin states of 5.75 maf, excluding shared CRSP reservoir evaporation, there would be shortages to the demand in about 4 years of the 95-year period of record (see Attachments). The computed total shortage to the demand would be about 8.3 maf, which averages less than 6 percent overall shortage for a 25-year period of critically severe hydrology and less than 2 percent overall shortage for the period of record.

The annual shortages would be about 3.2 maf in 1964, 0.4 maf in 1967, 0.4 maf in 1968 and 4.3 maf in 1977. The aggregate amount of shortage during the 1960s is about 4.0 maf, which is less than the current CRSP power pool contents of about 4.2 maf and slightly more than the projected 2060 CRSP power pool contents of 3.6 maf, excluding about 0.66 maf of storage below the minimum operating level for the Navajo Indian Irrigation Project (NIIP) at Navajo Reservoir. Therefore, should the computed shortages occur, the UCRC and the USBR could decide to address much of the shortage through use of the power pools as well as by use curtailments in the Upper Basin or reduced releases to the Lower Basin. Also, Upper Basin consumptive uses would be expected to be below average under critical-period hydrology due to physical water supply shortages in the Upper Basin, thus resulting in anticipated shortages at Lake Powell of lesser magnitude than are computed in the yield study using long-term average depletions. In particular, the computed annual shortage is 4.3 maf in 1977, but the natural flow at Lee Ferry in 1977 was only 5.4 maf and significant physical water supply shortages in the Upper Basin that year cause actual use to be much less than the long-term average.

The current yield study indicates that shared CRSP reservoir evaporation averages about 0.26 maf for a 25-year period of severe CRSP reservoir storage draw down (1953-1977). Adding the shared CRSP reservoir evaporation to 5.75 maf of use by the Upper Basin states, the total Upper Basin depletion including both Upper Basin uses and CRSP reservoir evaporation would average 6.01 maf for a 25-year critical draw down period. This total depletion is equivalent to the minimum Upper Basin yield of 6.0 maf determined for the critical period by the 1988 HD, with both yields computed for an overall shortage of about 6 percent.

Although the total Upper Basin depletion for a critical 25-year period will remain unchanged from the 1988 HD, the current yield study reflects the fact that shared CRSP reservoir evaporation during a period of critical draw down of reservoir storage will be substantially reduced from the long-term average evaporation. The 1988 HD did not take this into account when allocating Upper Basin uses and long-term average shared CRSP reservoir evaporation to the states. Thus, the current study results in an increase in the portion of the Upper Basin critical-period yield that is available for uses by the Upper Basin states.

For the period of record, the current yield study indicates that CRSP shared reservoir evaporation will average about 0.49 maf, as compared to the long-term average CRSP shared reservoir evaporation of 0.52 maf determined by the 1988 HD. Thus, the total Upper Basin depletion including both Upper Basin uses of 5.75 maf and CRSP reservoir evaporation would average about 6.24 maf for the period of record.

The amount of water available for use by the Upper Basin states is determined using the CRSS model natural flows, as was the yield estimate from the 1988 HD that the UCRC accepted for planning purposes. The USBR uses its CRSS natural flows for all its reservoir operation studies, including to determine the Long-Range Operating Criteria and to evaluate alternative mainstream reservoir operations criteria such as that proposed by the Seven Basin States via letter to the Secretary of the Interior dated February 3, 2006. The UCRC for planning purposes could accept use of the CRSS historic natural flows rather than its natural flow estimates. The UCRC and the USBR will consult on the determination of natural flows for future planning and reporting purposes.

In accordance with the current yield study, the USBR will make the determination that at least 5.75 maf is available, on average, for use by the Upper Basin states, excluding reservoir evaporation from Lake Powell, Flaming Gorge Reservoir and the Aspinall Unit. The UCRC will resolve that it does not object to the use of said determination for planning purposes, and that the UCRC disagrees with the assumed delivery of 0.75 maf annually toward the Mexican Treaty obligation. The Seven Basin States agreed that the alternative mainstream reservoir operations criteria proposed for an interim period ending 2025 via letter to the Secretary of the Interior dated February 3, 2006, is not to adversely affect the yield for development available in the Upper Basin (see page 3 of Attachment A to the letter). The Upper Basin allocation is from the flow available at Lee Ferry.

*In comparison, 5.68 maf of water would be available, on average, for use by the Upper Basin states without shortage using CRSP live storage, including the power pools, plus all other Upper Basin live storage. An Upper Basin use of 5.68 maf for a critical period would reflect an overall shortage of 1% during the critical period to a long-term average Upper Basin use demand of 5.75 maf. Also, up to 5.84 maf of water could be available, on average, for allocation for use by the Upper Basin states without use of the CRSP power pools if USBR historic assumptions of Upper Basin physical water supply shortages were considered; but, no data are available to support the specific USBR assumptions. These amounts of Upper Basin use exclude shared CRSP reservoir evaporation.*

*The following are points and counterpoints for supporting higher or lower Upper Basin demands or yields than computed in the current yield study:*

| | *Points for an Increased Yield* | *Points for a Reduced Yield* |
|---|---|---|
| *(1)* | *More Upper Basin storage will be needed to develop the full amount of yield available for Upper Basin use, and the computed yield would increase if additional storage was considered in the yield study.* | *The yield study includes all existing live storage in non-CRSP reservoirs, though some amount of inactive storage may not be fully available for meeting Upper Basin uses.* |

*(2) Storage lost to sedimentation, including in Lake Powell, may be replaced.* *Other than sedimentation through 2060 in Lake Powell, no loss in storage capacity for sediment is included in the yield study.*

*(3) Current and increased snowpack augmentation programs will increase natural flows at Lee Ferry annually.* *Future hydrology could result in a period of worse runoff than that of the historic critical period.*

*(4) Salvage by use may reduce channel losses on mainstream rivers, thus increasing flows at Lee Ferry.* *Spread of salt cedar and Russian olive may increase river channel losses and reduce flows.*

*(5) Below-average uses will be made in years of below-average runoff.* *Above-average uses will be made in years of above-average runoff.*

*The current yield study was performed using an annual water budget spreadsheet. The USBR has verified that the annual spreadsheet gives results that are consistent with those obtained using the CRSS model with monthly time steps.*

2. New Mexico's share of the Upper Basin allocation is at least 641,200 af, excluding New Mexico's share of evaporation from CRSP reservoirs other than Navajo Reservoir.

   Based on item 1, at least 5.75 maf can be made available, on average, for uses by the Upper Basin states. Assuming a long-term average of 5.75 maf for uses by the Upper Basin states, the allocation for uses by New Mexico, exclusive of CRSP shared reservoir evaporation, is computed as:

   (5.75 maf - 0.05 maf) x 0.1125 = 0.6412 maf

   The allocation represents long-term average annual depletions, not limitations on annual or short-duration uses. A long-term average Upper Basin consumptive use of 5.75 maf per year is the annual amount used each year in the current Upper Basin yield study, excluding shared CRSP reservoir evaporation; and therefore, schedules of future depletions for planning purposes will use long-term average depletions. This is a conservative approach from a planning standpoint in that the average depletions during a critical period will be less than the long-term average depletions due to below-average water supply overall for the period and physical water supply shortages.

   *In comparison, New Mexico's allocation using CRSP live storage, including the power pools, plus all other Upper Basin live storage and an average annual use by the Upper Basin states of 5.68 maf without shortage would be about 633,400 af.*

## DEPLETIONS

3. The modified Blaney-Criddle method with USBR effective precipitation is to be used to compute irrigation depletions in the Upper Basin; provided, that in some instances accounting of future irrigation depletions may be made using measured diversions less estimated returns (see item 4).

   This will require the USBR to return to using the modified Blaney-Criddle method with USBR effective precipitation for developing its Consumptive Uses and Losses reports and for developing its CRSS natural flows as it had done prior to 1996. The USBR and the Upper Division States also will use USBR effective precipitation for computing Upper Basin irrigation depletions in any hydrologic models of the Colorado River or its tributaries used in connection with project planning, reservoir operations, and National Environmental Policy Act and Endangered Species Act (ESA) compliance activities, including in the San Juan River Basin Hydrology Model. This also will require the New Mexico Office of the State Engineer (OSE) to change its method of accounting irrigation uses in the San Juan River Basin in New Mexico to the modified Blaney-Criddle method, and the State of Colorado to change its method of accounting Upper Basin irrigation uses to reflect USBR effective precipitation (as opposed to SCS effective precipitation used in Colorado's Decision Support System modeling). The resultant irrigation depletions will be consistent with irrigation depletions used to evaluate the Upper Basin yield. The use of consistent methodologies to evaluate water supply and demands will maintain technical credibility in the future accounting of consumptive uses against the states' Upper Basin allocations.

   *To compute irrigation consumptive uses for the Consumptive Uses and Losses reports, the USBR for the 1996-2000 report changed from using USBR effective precipitation to SCS effective precipitation. The reason for the change in methodology was that a different person in the USBR's Denver Technical Center compiled the report. The USBR has completed an internal review of this matter, and has concluded that it will return to using USBR effective precipitation if the UCRC agrees.*

   *New Mexico, including the OSE, will not use Sammis' crop production function for alfalfa to set a minimum consumptive use amount for alfalfa because use of the crop production function would be inconsistent with the evaluation of Upper Basin yield using the USBR's CRSS natural flows. In addition, there is insufficient local San Juan Basin research data to support the applicability of the function on a San Juan County-wide or basin-wide basis, and county average alfalfa yields are based on mail survey responses from farmers that may not reflect an average for the county or any particular geographic area within the county. Further, using the crop production function to set a minimum consumptive use rate ignores the range of variation in state-wide data through which the function was statistically fit, and recognizing or maintaining the scatter in consumptive use data computed using Blaney-Criddle methods that is above* *the linear function but not below the function introduces bias which tends to skew the long-term average computed consumptive use in excess of the actual average use.*

*The OSE currently is using the modified Blaney-Criddle method with SCS effective precipitation for computing consumptive irrigation requirements in water rights adjudications within the Rio Grande Basin. The OSE for past five-year water use reports has used the original Blaney-Criddle method with USBR effective precipitation to compute irrigation depletions, with a minimum consumptive irrigation requirement for alfalfa determined using the Sammis' crop production function and average San Juan County alfalfa yields. The long-term average irrigation consumptive use for the San Juan River Basin in New Mexico computed using the modified Blaney-Criddle method with SCS effective precipitation is comparable to the average consumptive use computed using the past OSE approach that incorporates combined use of the original Blaney-Criddle method and the crop production function. Future average irrigation depletions in the San Juan River Basin in New Mexico would be computed to be about 4,000 af greater using the modified Blaney-Criddle method with SCS effective precipitation as compared to using the modified Blaney-Criddle method with USBR effective precipitation. Discussions with John Longworth (OSE Water Use Bureau Chief) indicate that he is sensitive to the need to evaluate basin water supplies and demands using the same or consistent methods, and to the need for the OSE and the Interstate Stream Commission to publish consistent consumptive use data for the Colorado River Basin in New Mexico.*

4. NIIP depletions will be determined based on diversions minus estimated returns.

The NIIP Biological Assessment sets forth a procedure for estimating return flows from NIIP that takes into account the build-up of ground water storage underneath the project and the consequent delay in return flows reaching the San Juan River. The procedure uses a water budget that can incorporate the use of the modified Blaney-Criddle method for estimating crop consumptive uses. The modified Blaney-Criddle method with USBR effective precipitation will be used for this purpose provided that the State of New Mexico, the Navajo Nation and the United States may later develop an alternative method for estimating crop consumptive uses on the NIIP, if appropriate, based on site-specific research on the project. Paragraph 9.10 of the San Juan River Basin in New Mexico Navajo Nation Water Rights Settlement Agreement (NNWRSA) provides for water management agencies of the United States, the State of New Mexico and the Navajo Nation to cooperatively develop necessary models for use to determine return flows and depletions for the NIIP.

*Ron Bliesner (agricultural engineering consultant to the Bureau of Indian Affairs-NIIP, hydrologic modeling consultant to the USBR, author of the Biological Assessment for the NIIP and the NGWSP, and unofficial Navajo Nation technical advisor) can accept as reasonable the use of the modified Blaney-Criddle method* *with USBR effective precipitation for estimating crop consumptive uses on the NIIP for this purpose, subject to further research and evaluation of water budgets on the project, and also for evaluating irrigation depletions throughout the San Juan River Basin, including on the Fruitland and Hogback projects.*

5. New Mexico's depletion schedule will reflect current crop patterns and irrigation practices.

   Current crop patterns reflecting the regional economy will be anticipated to occur in the San Juan River Basin in New Mexico in the future. The current crop pattern on non-Indian lands in particular reflects a regional market for alfalfa and pasture grasses, and no longer includes significant amounts of corn, orchard or truck crops for local market.

   Incidental depletions will be updated to reflect significant historic conversion since 1965 of irrigated lands in the basin from flood irrigation to sprinkler irrigation and consequent sprinkler spray evaporation losses. About 41 percent of the non-Indian land irrigated in the basin in New Mexico during 2004 was irrigated with sprinklers.

   *The attached proposed revisions to New Mexico's anticipated future depletions assume incidental depletions average 25% of crop consumptive use for sprinkler irrigation, 18% of crop consumptive use for flood irrigation, and 5% of crop consumptive use for drip irrigation. The OSE for past five-year water use reports has used for incidental irrigation depletions in the San Juan River Basin 30.6% for sprinkler irrigation and variable percentages for flood irrigation ranging from 15.4% in the La Plata River valley and Chaco River drainage, 18.4% above Navajo Dam and in the Animas River valley, and 19.4% in the San Juan River valley below Navajo Dam (all of which include 4.4% incidental depletions along ditches and waste ways). No data are available to substantiate current or future differences in below-farm losses between irrigated areas in the basin in New Mexico assumed by the OSE, and an average of 18% incidental depletions for flood irrigation is proposed basin-wide to reflect a small decrease in incidental use of canal seepage by non-cropped vegetation due to concrete lining of portions of San Juan River ditches.*

   *Discussions with Ron Bliesner about recent evaluations of sprinkler losses at the NIIP suggest that sprinkler evaporation is likely to increase incidental depletions in the basin in an amount equal to about 6-7% of crop consumptive use. There is insufficient evidence to conclude that the relative amount of non-cropped vegetative acres, as compared to irrigated acres, has changed in the irrigated areas since 1965; and therefore, above-farm and below-farm incidental depletions probably have not changed materially. Ron believes that the incidental depletions used to develop the attached proposed revised depletion estimates are reasonable in consideration of current irrigation practices in the basin and the basin water budget. This proposal does not speculate on possible changes in crop* *consumptive uses or incidental irrigation depletions that might result from future changes in crop varieties, ditch systems, non-cropped water consuming areas or irrigation methods or practices. John Longworth does not have any data that would indicate that the incidental depletions assumed by the OSE for past water use reports are more reliable than the incidental depletion factors now proposed.*

6. Evaporation from all Colorado River Storage Project reservoirs, including Navajo Reservoir, will be accounted using USBR Hydromet evaporation factors and procedures.

The USBR computes evaporation at Lake Powell using monthly evaporation factors that are then reduced for salvage of pre-reservoir losses within the reservoir basin. The amount of pre-reservoir losses salvaged each month is a function of Lake Powell storage and monthly river evaporation and vegetation consumptive use factors. The USBR computes evaporation at Flaming Gorge Reservoir, the Aspinall Unit reservoirs, and Navajo Reservoir using monthly net evaporation factors that are already reduced for salvage of pre-reservoir losses. The USBR uses the net evaporation, reduced for salvage of pre-reservoir losses, to account mainstream evaporation at CRSP units other than Navajo Reservoir in its Consumptive Uses and Losses reports, and uses the Hydromet net evaporation factors for Navajo Reservoir to estimate inflows, lake evaporation and depletions of natural flows at Navajo Reservoir in its San Juan River Basin Hydrology Model.

The Navajo-Gallup Water Supply Project Biological Assessment (NGWSPBA) used the USBR's Hydromet evaporation factors for Navajo Reservoir, and computed that future Navajo Reservoir evaporation will average about 27,900 af. About 200 af of this amount will be allocable to Arizona in association with Arizona's use of Navajo Reservoir supply for its portion of the project.

Reservoir evaporation at non-CRSP unit reservoirs in the Upper Basin also should take into account precipitation and salvage of pre-reservoir losses to determine net evaporation. The USBR Hydromet database includes net evaporation rates for Fontenelle Reservoir in Wyoming that are reduced for salvage, and salvage of pre-reservoir river channel and riparian vegetation losses at other reservoirs should be considered where sufficient data are available to determine significant amounts of salvage using the USBR's methodology.

*A proportionate share of the Navajo Reservoir evaporation may be allocated to Colorado if the evaporation increases as a result of operating the reservoir to provide ESA compliance for projects in both Colorado and New Mexico. The USBR has yet to provide New Mexico with information it has requested to determine what amount, if any, of the evaporation might be properly allocated to Colorado. This may be addressed at a later date if found to be a significant issue.*

7. Uses on certain ephemeral tributaries and from tributary ground water will be accounted only to the extent that such uses affect the flow of the San Juan River, and return flows from the NIIP or other uses to the ephemeral tributaries will be accounted only to the extent that they return to the San Juan River.

   The Upper Basin allocation is from the flow available at Lee Ferry. Consumptive uses in New Mexico, Arizona, Utah and Colorado on ephemeral tributaries and from tributary ground water within the Chaco River drainage, the Chinle Wash drainage, and other drainages tributary to the San Juan River will be accounted based on their depletion impacts to the San Juan River. The UCRC also may determine to account additional ephemeral tributary or ground water uses in the Upper Basin in a similar manner. The subject uses currently include small amounts of irrigation, municipal, livestock, reservoir evaporation and stockpond evaporation uses from surface water, and domestic ground water uses.

   Estimates of return flows from the NIIP to otherwise ephemeral tributaries will be reduced for channel losses in said tributaries to estimate irrigation depletions by the project. Estimates of return flows to the San Juan River resulting from Lake Morgan blow down releases into the Chaco River drainage will be reduced for channel losses in the tributary drainage between the point of discharge and the San Juan River. Also, estimates of return flows from uses of Dolores Project imports to the San Juan River Basin in Colorado, which uses are mostly made in the McElmo Creek drainage, will be reduced for channel losses incurred prior to reaching the San Juan River. Said channel losses on returns to ephemeral tributaries are incidental depletions.

   *This item reflects identifiable salvage of channel losses by use and identifiable channel losses on return flows in the indicated ephemeral tributaries only. This item does not include the identification and accounting of salvage by use in mainstream rivers such as the Colorado, Green and San Juan rivers. The latter may be accounted at a later date if found warranted through technical investigations.*

   *Application No. 2838 for permit to add point of diversion and place of use was approved October 9, 1981, subject to the condition that the consumptive use of water under the permit shall not exceed 39,000 af in any year, said consumptive use to be measured as the amount of diversion from the San Juan River, minus change in storage in off-stream reservoirs, minus the amount of return flows to the San Juan River, its tributaries and related underground water sources. This condition can be read to provide return flow credit for the full amount of Lake Morgan blow down releases to the tributaries in computing on-site consumptive uses for comparison to the permitted maximum consumptive use. For an on-site consumptive use of 39,000 af computed as described, the actual impact of full use on San Juan River flows could average approximately 41,000 af based on historic blow down amounts and 30% channel loss. However, it is unlikely that the full permitted amount of on-site consumptive use under Permit No. 2838 would be* *made every year. Therefore, an average annual depletion of 39,000 af will continue to be used for BHP Billiton in tabulations of New Mexico's anticipated future depletions.*

8. The New Mexico depletion schedule will assume that 5 percent of the NIIP depletion right will be unused, on average, due to land fallowing and farm management practices.

   The April 2005 New Mexico depletion schedule assumed that 5 percent of the NIIP acreage would be fallow, on average, and that the corresponding amount of the NIIP depletion right (13,500 af) would not be utilized. This planning assumption for irrigation use on the NIIP will be maintained.

   *The 1988 HD assumed that NIIP would be fully utilized, and the Jicarilla Apache Nation's water rights Settlement Contract subsequently required the United States to buy-out private water rights or make other satisfactory arrangements to reconcile total commitments of depletion from the San Juan River stream system in New Mexico, including the full NIIP depletion amount, with the state's allocation of Upper Colorado River Basin water as reflected in the 1988 HD. The NGWSPBA makes the assumption that the Navajo Nation will fully utilize the NIIP right pending possible applicability of ESA constraints, and the Navajo Nation has indicated that it intends to fully utilize the NIIP right by lease or other uses if not by irrigation on the project.*

   *To decrease risk that uses in New Mexico may exceed the state's Upper Basin allocation, use of about 13,500 af of the NIIP depletion right could be conditioned such that it would be used only if, and for so long as, the State Engineer determines that it may be used without detriment to other water uses in New Mexico. If so conditioned, average NIIP depletions above 256,500 af would depend on future increases in the Upper Basin yield, the resolution of water rights in the San Juan River Adjudication, the future disposition or non-use of water rights in the San Juan River Basin in New Mexico, and the future non-use of other states' Upper Basin allocations. The State Engineer could approve use of the conditioned amount for permanent use or for use during a limited term as appropriate, which approval would not be unreasonably withheld, and could require payback in the event of curtailment of use of water by New Mexico pursuant to Article IV of the Upper Colorado River Basin Compact.*

   *The NGWSPBA commits the Navajo Nation to forgo use of up to 21,000 af of the NIIP depletion right for periods of five years as may be necessary to prevent impingement of future water development on the San Juan River Basin Recovery Implementation Program's flow recommendations for endangered fish habitat in the San Juan River. The NGWSPBA commitment is dependent, however, on each of the baseline depletions in New Mexico shown in the far right column of the attached tabulation and each of the baseline depletions in Colorado not being exceeded in the previous five-year period. Therefore, the reduced annual water* *usage at NIIP will not be in effect at all times, and the average amount of depletion forgone on NIIP as a result of the NGWSPBA commitment will be less than 21,000 af, on average. A commitment to condition use of 13,500 af of the average NIIP right subject to State Engineer approval could provide improved protection against New Mexico consumptive uses exceeding its Upper Basin allocation. Conditioning of this portion of the NIIP depletion right would be to deal with the NGWSPBA planning assumption of full NIIP usage, the uncertainty in the final determination of the depletion rights for the Fruitland and Hogback projects, and other uncertainties in future depletions.*

*Under paragraph 5(e) of the NNWRSA, the Navajo Nation may transfer portions of the NIIP right to other uses on Navajo trust lands in New Mexico, such as for use at the proposed Navajo thermal electric power plant near Burnham, without State Engineer approval; but, the State Engineer must approve, and could condition, transfers of portions of the NIIP right to uses outside of Navajo trust lands in New Mexico and any changes in point of diversion in accordance with state law. It would be difficult to negotiate with the Navajo Nation additional conditions on the use of part of the NIIP depletion right if the amount of remaining allocation in the revised New Mexico depletion schedule is significantly greater than that in the April 2005 depletion schedule, thus indicating reduced risk of over-allocation as compared to the risk existing at the time of execution of the Settlement Agreement. Seeking to condition a portion of the NIIP right in this manner might not be warranted if the UCRC and the USBR accept this proposal package. If this proposal package is not accepted, the OSE might consider negotiating conditions on the use of part of the NIIP depletion right or other options.*

9. The United States will agree to relinquish or retire presently unused Echo Ditch Decree irrigation rights that it acquired in connection with construction and filling of Navajo Dam and Reservoir.

   The decreed rights acquired by the USBR amount to about 2,325 acre-feet of consumptive irrigation use according to USBR records, and have remained largely unused since they were acquired in the late 1950s and early 1960s. The 1948 Echo Ditch Decree provides that said rights are subject to forfeiture for non-use in accordance with state law. No records are available to show that after acquisition the United States' Echo Ditch Decree water rights have been used for irrigation or transferred to other purposes or places of use. The April 2005 New Mexico depletion schedule and attached proposed revised depletions do not include increases in future uses for the subject rights owned by the United States. Also, some portion of the subject rights claimed to be owned by the United States may have been severed from the land and transferred by previous landowners prior to the United States acquiring lands for construction of Navajo Dam and Reservoir.

If needed, the New Mexico OSE and the Department of the Interior may negotiate a settlement to allow use of a small portion of the acquired rights to cover existing uses made at New Mexico state park facilities at Navajo Unit recreational sites, including on Navajo Reservoir and on the San Juan River immediately below Navajo Dam. In such instance, the State of New Mexico and the United States could agree to execute a consent order in the San Juan River Adjudication that recognizes such settlement as a settlement in full for the Secretary of the Interior's rights deriving from the Echo Ditch Decree rights that the USBR claims it acquired in connection with construction of Navajo Dam and Reservoir. The consent order would be submitted to the Court for entry in the adjudication after Congress approves the NNWRSA and the Secretary of the Interior executes the NNWRSA on behalf of the United States.

*The New Mexico State Parks does not have a contract with the USBR for water from the Navajo Reservoir supply, and a review of the OSE water right files does not indicate that State Parks has otherwise acquired a water right for recreational uses at or below Navajo Reservoir. The USBR may claim that a small amount of water use from Navajo Reservoir for recreational purposes (for example, for New Mexico state parks) could be treated as supplied out of the subject rights. However, no application has been filed with the State Engineer to transfer said rights to recreation or other uses. A small amount of the acquired rights might be transferred to cover historic and existing recreational uses at the reservoir. The remainder of the rights should be forfeited or cancelled, which would partially offset depletions of stream flow that result from Navajo Reservoir evaporation or that may result from operating the reservoir for ESA purposes.*

*Relinquishing the rights also would provide additional protection to Indian trust assets (that is, the Jicarilla Apache Nation and Navajo Nation settlement contracts for water from the Navajo Reservoir supply) in accordance with the United States' trust responsibilities to Indian tribes, and to the Animas-La Plata Project (ALP). Pursuant to paragraph 9.3 of the NNWRSA, the Navajo Nation agrees to curtail its uses if and when necessary to prevent curtailment of ALP uses in New Mexico under certain provisions of the Upper Colorado River Basin Compact, which agreement is conditioned, in part, on the amount of water rights either adjudicated as abandoned or forfeited by the Court in the San Juan River Adjudication or cancelled, retired or otherwise terminated by the State of New Mexico after the NNWRSA is executed by the Secretary of the Interior.*

10. New Mexico will not make additional allocations of water use from the San Juan River stream system at this time.

Paragraph 8.2 of the NNWRSA provides for the Interstate Stream Commission (ISC) to determine additional allocations of water available for use in New Mexico if the Upper Basin yield is increased above 6.0 maf, which additional allocations would be shared equally between the Navajo Nation and non-Navajo water users. This yield amount is based on the minimum yield for a 25-year critical period from the 1988 HD and includes CRSP reservoir evaporation. Under the current Upper Basin yield study, the Upper Basin yield for a critical 25-year period is not increased above 6.0 maf including CRSP reservoir evaporation, though long-term depletions in the Upper Basin may average 6.2 maf, including CRSP reservoir evaporation, over the period of record (see item 1). The ISC will determine that no additional allocations could be made at this time under the current yield study, and that adjustments to New Mexico's depletion schedule at this time will be limited to updating the accounting of uses as described for items 1 through 9 above. Additional allocations of consumptive use within New Mexico pursuant to paragraph 8.2 of the NNWRSA may become available at a later date pending an increase in the Upper Basin yield for critical period hydrology.

11. The UCRC will update its schedules of anticipated Upper Basin depletions for each Upper Division state to reflect items 1 through 10, as appropriate.

    The states' Upper Basin depletion schedules should be updated to reflect the revised allocations of water for use in each state, the application of consistent methodologies throughout the Upper Basin for determining irrigation and other depletions, and an updated projection of the timing of future increases in consumptive uses in each state.

12. The USBR will incorporate items 1 through 11, as appropriate, into its hydrology models and other water planning tools and documents for the Colorado River Basin, including for the San Juan River subbasin.

    Water planning studies, including hydrologic modeling, for the Colorado River Basin should use consistent methodologies and planning assumptions to the extent possible. This also applies to subbasins, including water planning studies in the San Juan River subbasin and the San Juan River Basin Hydrology Model.

    *This could result in the USBR revising the NGWSP Biological Assessment prior to completion of the ESA section 7 consultation on the project and the NGWSP draft Environmental Impact Statement. Depending on the outcome of the section 7 consultation on the NGWSP, re-consultations under section 7 of the ESA for other San Juan River Basin projects, including Navajo Reservoir operations, might be required. This in large part will depend on the effects of changed irrigation depletion assumptions on natural flow calculations and simulated flow impacts to the critical habitat reach of the San Juan River, and on the development of reasonable and prudent alternatives for the NGWSP.*

13. The United States and the State of New Mexico will agree that this proposal in its entirety satisfies the contractual obligation of the United States under paragraph 4(i) of the Settlement Contract between the United States and the Jicarilla Apache Tribe to reconcile total commitments of depletion from the San Juan River stream system in New Mexico with the state's allocation of Upper Colorado River Basin water.

Paragraph 4(i) of the Jicarilla Apache Nation's water rights Settlement Contract provides that the United States will buy-out private water rights aggregating 11,000 af of depletion of the San Juan River stream system in order to reconcile total commitments of depletion from the system in New Mexico with the state's allocation of Upper Colorado River Basin water as reflected at page 23 of the 1988 HD, or will make other satisfactory provision to reconcile those commitments with New Mexico's allocation. Implementation of this proposal will constitute satisfactory reconciliation of water use commitments in New Mexico with the state's Upper Basin allocation. Based on the attached proposed revised New Mexico future depletions tabulation, anticipated future water uses in New Mexico do not exceed the state's allocation.

*The 1988 HD assumed that the total depletion on the NIIP in 2040 and beyond would average 267,000 af (full NIIP use without fallowing). This proposal would use a future average depletion of 256,500 af for NIIP assuming 5 percent fallowed acreage, on average. The difference between the full NIIP right of 270,000 af proposed by the NNWRSA and the average anticipated NIIP depletion with 5 percent average fallowing, a difference of 13,500 af, is within the remaining allocation reserved for uncertainties in the attached proposed revised New Mexico depletions tabulation.*

## PROPOSED REVISED NEW MEXICO FUTURE DEPLETIONS

Changes to New Mexico's April 2005 Upper Basin depletion schedule needed to account for items 2 through 10 are indicated in the proposed revised New Mexico depletions tabulation attached, including the resultant full use of the Navajo Nation's proposed Fruitland and Hogback project depletion rights. It is assumed that all water rights in the San Juan River Adjudication will be adjudicated consistent with the consumptive irrigation requirements and farm duties previously decreed in the Echo Ditch Adjudication, and that the Fruitland and Hogback project rights therefore will not be increased above the depletions proposed using new methodologies.

## FUTURE MODIFICATIONS

Increases in the Upper Basin yield and in the states' Upper Basin use allocations may be made at a later date if appropriate to reflect: (1) a reduction in the minimum objective release from Lake Powell based on quantification of the Colorado River Compact Article III(c) requirement or other operational considerations; (2) an increase in Upper Basin storage capacity; (3) varying annual Upper Basin uses if sufficient technical analysis supports a specific relationship that can be used to reliably project annual uses as a function of natural flows at Lee Ferry; or (4) a decision by the UCRC and the USBR to not maintain the CRSP power pools. Credits or apportionments to each state for salvage by use of river channel losses in mainstream or perennial rivers may be determined at a later date if technical investigations reliably indicate that future on-site depletion amounts should be reduced to account a significant amount of salvage by use in said rivers so as to better determine depletions of the flow at Lee Ferry caused by Upper Basin uses.

*Estimates of salvage by use computed using the channel loss relationships of the 1948 Engineering Advisory Committee report to the Upper Colorado River Basin Compact Commission are conservatively high because they do not reflect the incremental effects on seasonal streamflows and river evaporation losses of water development in the Upper Basin made via diversion and storage of spring snowmelt runoff. On the other hand, estimates of salvage by use computed considering seasonal flow effects of Upper Basin development and using flow rating measurements at mainstream gaging stations to determine incremental river channel evaporation losses are conservatively very low due to using cross-sections that are constrained in comparison to other sections of the rivers, thus reducing the sensitivity of channel surface area versus flow relationships. River cross-section and hydraulic data between gaging stations that might suggest significant amounts of salvage by use on mainstream rivers are not available at this time. The use of the USBR's Hydromet reservoir evaporation factors does give the Upper Basin credit for salvage by inundation of pre-reservoir losses within the CRSP reservoir basins.*

## Upper Basin Yield Study - February 2006 Draft

| Storage Capacity Used | Period | Average Annual Upper Basin Demand (maf) | Average Annual Shared CRSP Evap (maf) | Total Annual Upper Basin Depletion, inc. CRSP Evap (maf) | New Mexico Allocation, exc. Shared CRSP Evap (af) | Computed Annual Amounts of Shortage (maf) 1963 | 1964 | 1967 | 1968 | 1977 | Total Shortage Amount (maf) | Percent Shortage over Period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CRSP Active + All Other Live: | 1953-1977 | 5.70 | 0.28 | 5.98 | 635,625 | 0.00 | 1.93 | 0.23 | 0.34 | 3.92 | 6.42 | 4.5 |
| | 1931-1977 | 5.70 | 0.38 | 6.08 | | | | | | | | 2.4 |
| | 1906-2000 | 5.70 | 0.50 | 6.20 | | | | | | | | 1.2 |
| | 1953-1977 | 5.75 | 0.26 | 6.01 | 641,250 | 0.00 | 3.16 | 0.37 | 0.39 | 4.33 | 8.25 | 5.7 |
| | 1931-1977 | 5.75 | 0.37 | 6.12 | | | | | | | | 3.1 |
| | 1906-2000 | 5.75 | 0.49 | 6.24 | | | | | | | | 1.5 |
| | 1953-1977 | 5.80 | 0.25 | 6.05 | 646,875 | 1.06 | 3.32 | 0.52 | 0.44 | 4.74 | 10.08 | 7.0 |
| | 1931-1977 | 5.80 | 0.35 | 6.15 | | | | | | | | 3.7 |
| | 1906-2000 | 5.80 | 0.49 | 6.29 | | | | | | | | 1.8 |
| Evap sensitivity (note 5)- | 1953-1977 | 5.75 | 0.25 | 6.00 | 641,250 | 0.17 | 3.27 | 0.34 | 0.39 | 4.12 | 8.29 | 5.8 |
| | 1931-1977 | 5.75 | 0.37 | 6.12 | | | | | | | | 3.1 |
| | 1906-2000 | 5.75 | 0.50 | 6.25 | | | | | | | | 1.5 |
| *Physical shortages (note 7)-* | *1953-1977* | *5.84* | *0.32* | *6.16* | *651,375* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.00* | *0.0* |
| | *1931-1977* | *5.84* | *0.43* | *6.27* | | | | | | | | *0.0* |
| | *1906-2000* | *5.84* | *0.53* | *6.37* | | | | | | | | *0.0* |
| CRSP Live + All Other Live: | 1953-1977 | 5.68 | 0.24 | 5.92 | 633,375 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 |
| | 1931-1977 | 5.68 | 0.35 | 6.03 | | | | | | | | 0.0 |
| | 1906-2000 | 5.68 | 0.47 | 6.15 | | | | | | | | 0.0 |

Notes:

(1) The New Mexico Interstate Stream Commission staff prepared this table using the annual water balance spreadsheet and CRSP evaporation equations developed for the current yield study. The ISC and USBR jointly developed the spreadsheet and evaporation equations. The spreadsheet and historic CRSP evaporation correlations are attached.

(2) The Upper Basin yields shown in this table assume a delivery of 8.25 maf per year to the Lower Basin at Lee Ferry. The yields can be increased by 0.1 maf for each 0.1 maf decrease in the delivery at Lee Ferry. The yields would be 0.75 maf greater than those shown assuming a delivery to the Lower Basin of 7.5 maf per year.

(3) If CRSP Live storage is used instead of CRSP Active storage, either the Upper Basin demands can be increased or computed shortages can be reduced. Using CRSP Live + All Other Live storage, a firm Upper Basin demand of 5.68 maf can be met, on average, without shortage. The evaporation amounts using CRSP Live storage are less than the evaporation amounts using CRSP Active storage due to storage draw downs below minimum power pools.

(4) The 1988 Hydrologic Determination concluded that the yield to the Upper Basin with tolerable shortages is at least 6.0 maf per year over a 25-year critical period, including CRSP evaporation. In the current Upper Basin yield study, the draw down in reservoir storage from full storage conditions begins at the end of 1930, and full storage conditions are next attained in 1985. Under a firm yield analysis using only CRSP Active storage, full storage conditions almost exist at the end of 1952 (0.44 maf vacant capacity) and would likely be attained during 1952 with a monthly study. Under a firm yield analysis using CRSP Active + All Other Live storage, reservoir storage at the end of 1952 returns to the same level as at the end of 1932, which is about 2.90 maf short of full capacity. Under both assumptions, increasing the average annual Upper Basin demand above the firm yield demand first results in the occurrence of computed shortage in 1977, and further increases in demand cause shortages to also be computed in the 1960s. It is not important here to define whether the critical period is the 25-year period 1953-1977, the 24-year period 1931-1964, or the 47-year period 1931-1977. What is important is recognizing that CRSP reservoir evaporation changes with reservoir storage. CRSP reservoir storage is maintained at significantly lower levels, on average, during the 1953-1977 period as compared to the 1931-1964 period, primarily because CRSP storage is maintained at under 10 maf for most of twenty years beginning the early 1960s. CRSP storage rarely dips below 10 maf for the remainder of the period of record. The average annual evaporation amounts shown in this table for different periods illustrate the effects of storage on evaporation. To account for this, the current yield study segregates CRSP reservoir evaporation from the Upper Basin demand.

(5) Evaporation amounts were determined using CRSP storage. For the CRSP + All Other storage conditions, inclusion of the additional Upper Basin storage amount in the yield study generally increases the yield by 0.1 maf. Therefore, the evaporation amounts for the latter storage conditions and a given Upper Basin demand were assumed to be the same as the evaporation amounts for the CRSP storage conditions with an Upper Basin demand equal to 0.1 maf less than the given demand under the CRSP + All Other storage conditions. The CRSP reservoirs will operate in about the same manner as they have historically operated regardless of whether all other Upper Basin storage is considered in the analysis, although other Upper Basin reservoirs are generally upstream from CRSP reservoirs and therefore will likely fill first. This upstream storage effect may cause the CRSP evaporation amounts to be slightly overstated for the CRSP + All Other storage conditions. The sensitivity of CRSP reservoir evaporation and computed yields to other assumptions was tested by alternatively assuming that CRSP reservoir storage and other Upper Basin reservoir storage increased or declined in equal proportions relative to their storage capacity (that is, CRSP active storage and non-CRSP live storage were assumed to be the same percent full each year).

(6) The 1988 Hydrologic Determination assumed that a total shortage of 6 percent overall for a 25-year critical period was tolerable. This table indicates that an Upper Basin use of 5.75 maf, on average, would result in a total shortage of less than 6 percent for a 25-year period of critical draw down. Prior to 1977, the cumulative shortage would not exceed the amount of storage in the CRSP minimum power pools. In 1977, the computed shortage of up to 4.3 maf would not actually materialize because Upper Basin uses in that year would be substantially lower than the average Upper Basin demand of 5.75 maf. The natural flow of the Colorado River at Lee Ferry during 1977 was only 5.4 maf. In below--average periods of runoff during which reservoir storage will be substantially drawn down, physical water supply shortages will cause Upper Basin uses to be less, on average, than the long-term average consumptive use of 5.75 maf by Upper Basin states. The current yield study does not incorporate annual variations in Upper Basin consumptive uses caused by annual variations in water supply availability and physical water shortages in the Upper Basin. To this extent, the computed shortages appear to be overstated.

*(7) The following is an excerpt from "Water Supplies of the Colorado River Available for Use by the States of the Upper Division and for Use from the Main Stem by the States of Arizona, California and Nevada in the Lower Basin," Part I - Text, Tipton and Kalmbach, Inc., July 1965, page 15: "A depletion factor was used to modify the assumed basic depletions by the States of the upper division of the Colorado River Basin. The philosophy of the depletion factor is based on the fact that during periods of low water supply in the Upper Basin all projects in operation will not receive a full water supply. Most of them will not have reservoirs, and some that have reservoirs will not have water in some years to fill those reservoirs. No rational means have been derived for varying the estimated uses by the States of the upper division because of varying water supply. The means used by the U.S. Bureau of Reclamation in its past studies, which it is assumed it is still using, are based on the assumption that the uses would vary from the normal use in a particular year by one-half of the percent that the virgin flow at Lee Ferry in that particular year varies from a long-time average of virgin flow." Using this assumption, the sensitivity of the amount of water available, on average, for Upper Basin uses to possible annual variations in physical water supplies and actual uses in the Upper Basin is illustrated for a normal Upper Basin demand of 5.84 maf (firm demand). Under this scenario, actual Upper Basin uses would average 5.41 maf during 1953-1977, 5.51 maf during 1931-1977, and 5.84 maf over the period of record, and the physical shortages to the normal demand would average about 7 percent for the 1953-1977 period and 6 percent for the 1931-1977 period.*

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| CY | CR Natural Flow (plus) | Total Carry-Over Storage (plus) | LB Delivery 8.25MAF (minus) | Upper Basin Demand Level (minus) | Shared CRSP Evap (minus) | UB Drought Shortage (plus) | Net Available to Store (subtotal) | Spill to LC (minus) | Shortage (plus) | UC Basin Year-end Storage (equals) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1906 | 18,550,021 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,330,761 | 3,800,731 | 0 | 29,530,030 |
| 1907 | 21,201,694 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 35,982,434 | 6,452,404 | 0 | 29,530,030 |
| 1908 | 12,218,817 | 29,530,030 | 8,250,000 | 5,750,000 | 719,512 | 0 | 27,029,335 | 0 | 0 | 27,029,335 |
| 1909 | 22,356,301 | 27,029,335 | 8,250,000 | 5,750,000 | 719,512 | 0 | 34,666,124 | 5,136,093 | 0 | 29,530,030 |
| 1910 | 14,650,616 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 29,431,356 | 0 | 0 | 29,431,356 |
| 1911 | 15,499,729 | 29,431,356 | 8,250,000 | 5,750,000 | 749,290 | 0 | 30,181,795 | 651,765 | 0 | 29,530,030 |
| 1912 | 18,623,410 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,404,150 | 3,874,120 | 0 | 29,530,030 |
| 1913 | 14,536,373 | 29,530,030 | 8,250,000 | 5,750,000 | 747,907 | 0 | 29,318,497 | 0 | 0 | 29,318,497 |
| 1914 | 21,354,814 | 29,318,497 | 8,250,000 | 5,750,000 | 747,907 | 0 | 35,925,404 | 6,395,374 | 0 | 29,530,030 |
| 1915 | 13,623,277 | 29,530,030 | 8,250,000 | 5,750,000 | 736,720 | 0 | 28,416,588 | 0 | 0 | 28,416,588 |
| 1916 | 20,142,892 | 28,416,588 | 8,250,000 | 5,750,000 | 736,720 | 0 | 33,822,760 | 4,292,730 | 0 | 29,530,030 |
| 1917 | 22,942,804 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 37,723,544 | 8,193,514 | 0 | 29,530,030 |
| 1918 | 15,865,939 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 30,646,679 | 1,116,649 | 0 | 29,530,030 |
| 1919 | 12,651,369 | 29,530,030 | 8,250,000 | 5,750,000 | 724,812 | 0 | 27,456,587 | 0 | 0 | 27,456,587 |
| 1920 | 22,287,632 | 27,456,587 | 8,250,000 | 5,750,000 | 724,812 | 0 | 35,019,408 | 5,489,377 | 0 | 29,530,030 |
| 1921 | 22,526,781 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 37,307,521 | 7,777,491 | 0 | 29,530,030 |
| 1922 | 18,447,198 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,227,938 | 3,697,908 | 0 | 29,530,030 |
| 1923 | 19,024,046 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,804,786 | 4,274,756 | 0 | 29,530,030 |
| 1924 | 13,877,798 | 29,530,030 | 8,250,000 | 5,750,000 | 739,838 | 0 | 28,667,990 | 0 | 0 | 28,667,990 |
| 1925 | 14,430,701 | 28,667,990 | 8,250,000 | 5,750,000 | 727,939 | 0 | 28,370,752 | 0 | 0 | 28,370,752 |
| 1926 | 15,213,731 | 28,370,752 | 8,250,000 | 5,750,000 | 732,700 | 0 | 28,851,783 | 0 | 0 | 28,851,783 |
| 1927 | 19,539,212 | 28,851,783 | 8,250,000 | 5,750,000 | 744,598 | 0 | 33,646,397 | 4,116,367 | 0 | 29,530,030 |
| 1928 | 16,954,334 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 31,735,074 | 2,205,044 | 0 | 29,530,030 |
| 1929 | 21,829,585 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 36,610,325 | 7,080,295 | 0 | 29,530,030 |
| 1930 | 14,621,041 | 29,530,030 | 8,250,000 | 5,750,000 | 748,944 | 0 | 29,402,127 | 0 | 0 | 29,402,127 |
| 1931 | 8,474,134 | 29,402,127 | 8,250,000 | 5,750,000 | 672,949 | 0 | 23,203,312 | 0 | 0 | 23,203,312 |
| 1932 | 17,422,187 | 23,203,312 | 8,250,000 | 5,750,000 | 633,136 | 0 | 25,992,363 | 0 | 0 | 25,992,363 |
| 1933 | 12,183,500 | 25,992,363 | 8,250,000 | 5,750,000 | 639,745 | 0 | 23,536,119 | 0 | 0 | 23,536,119 |
| 1934 | 6,178,192 | 23,536,119 | 8,250,000 | 5,750,000 | 508,432 | 0 | 15,205,879 | 0 | 0 | 15,205,879 |
| 1935 | 12,630,349 | 15,205,879 | 8,250,000 | 5,750,000 | 385,811 | 0 | 13,450,417 | 0 | 0 | 13,450,417 |
| 1936 | 14,648,873 | 13,450,417 | 8,250,000 | 5,750,000 | 369,976 | 0 | 13,729,314 | 0 | 0 | 13,729,314 |
| 1937 | 14,306,056 | 13,729,314 | 8,250,000 | 5,750,000 | 375,061 | 0 | 13,660,309 | 0 | 0 | 13,660,309 |
| 1938 | 18,148,319 | 13,660,309 | 8,250,000 | 5,750,000 | 422,895 | 0 | 17,385,733 | 0 | 0 | 17,385,733 |
| 1939 | 11,164,059 | 17,385,733 | 8,250,000 | 5,750,000 | 431,062 | 0 | 14,118,730 | 0 | 0 | 14,118,730 |
| 1940 | 9,931,657 | 14,118,730 | 8,250,000 | 5,750,000 | 338,359 | 0 | 9,712,027 | 0 | 0 | 9,712,027 |
| 1941 | 20,116,678 | 9,712,027 | 8,250,000 | 5,750,000 | 357,615 | 0 | 15,471,091 | 0 | 0 | 15,471,091 |
| 1942 | 17,225,136 | 15,471,091 | 8,250,000 | 5,750,000 | 465,757 | 0 | 18,230,470 | 0 | 0 | 18,230,470 |
| 1943 | 13,731,401 | 18,230,470 | 8,250,000 | 5,750,000 | 493,018 | 0 | 17,468,853 | 0 | 0 | 17,468,853 |
| 1944 | 15,369,422 | 17,468,853 | 8,250,000 | 5,750,000 | 496,874 | 0 | 18,341,401 | 0 | 0 | 18,341,401 |
| 1945 | 14,140,528 | 18,341,401 | 8,250,000 | 5,750,000 | 505,649 | 0 | 17,976,280 | 0 | 0 | 17,976,280 |
| 1946 | 11,095,453 | 17,976,280 | 8,250,000 | 5,750,000 | 461,845 | 0 | 14,609,888 | 0 | 0 | 14,609,888 |
| 1947 | 16,439,486 | 14,609,888 | 8,250,000 | 5,750,000 | 447,280 | 0 | 16,602,094 | 0 | 0 | 16,602,094 |
| 1948 | 15,139,294 | 16,602,094 | 8,250,000 | 5,750,000 | 482,617 | 0 | 17,258,770 | 0 | 0 | 17,258,770 |
| 1949 | 16,933,584 | 17,258,770 | 8,250,000 | 5,750,000 | 523,142 | 0 | 19,669,212 | 0 | 0 | 19,669,212 |
| 1950 | 13,140,416 | 19,669,212 | 8,250,000 | 5,750,000 | 538,184 | 0 | 18,271,444 | 0 | 0 | 18,271,444 |
| 1951 | 12,505,894 | 18,271,444 | 8,250,000 | 5,750,000 | 498,610 | 0 | 16,278,728 | 0 | 0 | 16,278,728 |
| 1952 | 20,805,422 | 16,278,728 | 8,250,000 | 5,750,000 | 553,916 | 0 | 22,530,234 | 0 | 0 | 22,530,234 |
| 1953 | 11,165,419 | 22,530,234 | 8,250,000 | 5,750,000 | 591,444 | 0 | 19,104,209 | 0 | 0 | 19,104,209 |
| 1954 | 8,496,102 | 19,104,209 | 8,250,000 | 5,750,000 | 477,239 | 0 | 13,123,072 | 0 | 0 | 13,123,072 |
| 1955 | 9,413,908 | 13,123,072 | 8,250,000 | 5,750,000 | 344,374 | 0 | 8,192,606 | 0 | 0 | 8,192,606 |
| 1956 | 11,426,874 | 8,192,606 | 8,250,000 | 5,750,000 | 250,672 | 0 | 5,368,807 | 0 | 0 | 5,368,807 |
| 1957 | 21,500,963 | 5,368,807 | 8,250,000 | 5,750,000 | 307,356 | 0 | 12,562,415 | 0 | 0 | 12,562,415 |
| 1958 | 15,862,511 | 12,562,415 | 8,250,000 | 5,750,000 | 416,995 | 0 | 14,007,931 | 0 | 0 | 14,007,931 |
| 1959 | 9,598,169 | 14,007,931 | 8,250,000 | 5,750,000 | 378,116 | 0 | 9,227,984 | 0 | 0 | 9,227,984 |
| 1960 | 11,524,160 | 9,227,984 | 8,250,000 | 5,750,000 | 287,036 | 0 | 6,465,108 | 0 | 0 | 6,465,108 |
| 1961 | 10,010,259 | 6,465,108 | 8,250,000 | 5,750,000 | 203,238 | 0 | 2,272,129 | 0 | 0 | 2,272,129 |
| 1962 | 17,377,609 | 2,272,129 | 8,250,000 | 5,750,000 | 193,208 | 0 | 5,456,530 | 0 | 0 | 5,456,530 |
| 1963 | 8,840,900 | 5,456,530 | 8,250,000 | 5,750,000 | 183,412 | 0 | 114,018 | 0 | 0 | 114,018 |
| 1964 | 10,863,586 | 114,018 | 8,250,000 | 5,750,000 | 132,876 | 0 | -3,155,272 | 0 | 3,155,272 | 0 |
| 1965 | 19,875,027 | 0 | 8,250,000 | 5,750,000 | 204,453 | 0 | 5,670,574 | 0 | 0 | 5,670,574 |
| 1966 | 10,679,844 | 5,670,574 | 8,250,000 | 5,750,000 | 233,196 | 0 | 2,117,222 | 0 | 0 | 2,117,222 |
| 1967 | 11,670,830 | 2,117,222 | 8,250,000 | 5,750,000 | 161,618 | 0 | -373,567 | 0 | 373,567 | 0 |
| 1968 | 13,739,932 | 0 | 8,250,000 | 5,750,000 | 132,876 | 0 | -392,944 | 0 | 392,944 | 0 |
| 1969 | 15,272,159 | 0 | 8,250,000 | 5,750,000 | 148,060 | 0 | 1,124,099 | 0 | 0 | 1,124,099 |
| 1970 | 15,344,136 | 1,124,099 | 8,250,000 | 5,750,000 | 178,936 | 0 | 2,289,299 | 0 | 0 | 2,289,299 |
| 1971 | 15,290,433 | 2,289,299 | 8,250,000 | 5,750,000 | 209,281 | 0 | 3,370,451 | 0 | 0 | 3,370,451 |
| 1972 | 12,959,652 | 3,370,451 | 8,250,000 | 5,750,000 | 209,667 | 0 | 2,120,436 | 0 | 0 | 2,120,436 |
| 1973 | 18,397,816 | 2,120,436 | 8,250,000 | 5,750,000 | 248,115 | 0 | 6,270,137 | 0 | 0 | 6,270,137 |
| 1974 | 13,089,042 | 6,270,137 | 8,250,000 | 5,750,000 | 287,206 | 0 | 5,071,973 | 0 | 0 | 5,071,973 |
| 1975 | 16,825,996 | 5,071,973 | 8,250,000 | 5,750,000 | 306,082 | 0 | 7,591,888 | 0 | 0 | 7,591,888 |
| 1976 | 11,140,311 | 7,591,888 | 8,250,000 | 5,750,000 | 300,619 | 0 | 4,431,580 | 0 | 0 | 4,431,580 |
| 1977 | 5,438,897 | 4,431,580 | 8,250,000 | 5,750,000 | 197,768 | 0 | -4,327,291 | 0 | 4,327,291 | 0 |
| 1978 | 15,183,722 | 0 | 8,250,000 | 5,750,000 | 146,976 | 0 | 1,036,746 | 0 | 0 | 1,036,746 |
| 1979 | 17,671,870 | 1,036,746 | 8,250,000 | 5,750,000 | 205,315 | 0 | 4,503,300 | 0 | 0 | 4,503,300 |
| 1980 | 17,765,183 | 4,503,300 | 8,250,000 | 5,750,000 | 293,852 | 0 | 7,974,631 | 0 | 0 | 7,974,631 |
| 1981 | 9,015,200 | 7,974,631 | 8,250,000 | 5,750,000 | 274,160 | 0 | 2,715,671 | 0 | 0 | 2,715,671 |
| 1982 | 17,489,400 | 2,715,671 | 8,250,000 | 5,750,000 | 251,571 | 0 | 5,953,500 | 0 | 0 | 5,953,500 |
| 1983 | 24,361,989 | 5,953,500 | 8,250,000 | 5,750,000 | 417,562 | 0 | 15,897,927 | 0 | 0 | 15,897,927 |
| 1984 | 25,359,376 | 15,897,927 | 8,250,000 | 5,750,000 | 645,721 | 0 | 26,611,583 | 0 | 0 | 26,611,583 |
| 1985 | 21,246,109 | 26,611,583 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,108,401 | 3,578,371 | 0 | 29,530,030 |
| 1986 | 23,013,446 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 37,794,186 | 8,264,156 | 0 | 29,530,030 |
| 1987 | 15,640,478 | 29,530,030 | 8,250,000 | 5,750,000 | 749,290 | 0 | 30,421,219 | 891,188 | 0 | 29,530,030 |
| 1988 | 11,456,357 | 29,530,030 | 8,250,000 | 5,750,000 | 710,171 | 0 | 26,276,216 | 0 | 0 | 26,276,216 |
| 1989 | 9,921,847 | 26,276,216 | 8,250,000 | 5,750,000 | 614,090 | 0 | 21,583,973 | 0 | 0 | 21,583,973 |
| 1990 | 9,639,803 | 21,583,973 | 8,250,000 | 5,750,000 | 498,107 | 0 | 16,725,669 | 0 | 0 | 16,725,669 |
| 1991 | 12,170,021 | 16,725,669 | 8,250,000 | 5,750,000 | 412,511 | 0 | 14,483,179 | 0 | 0 | 14,483,179 |
| 1992 | 10,895,580 | 14,483,179 | 8,250,000 | 5,750,000 | 344,397 | 0 | 11,034,361 | 0 | 0 | 11,034,361 |
| 1993 | 18,160,118 | 11,034,361 | 8,250,000 | 5,750,000 | 351,343 | 0 | 14,843,136 | 0 | 0 | 14,843,136 |
| 1994 | 11,125,503 | 14,843,136 | 8,250,000 | 5,750,000 | 360,935 | 0 | 11,607,703 | 0 | 0 | 11,607,703 |
| 1995 | 20,047,166 | 11,607,703 | 8,250,000 | 5,750,000 | 393,413 | 0 | 17,261,457 | 0 | 0 | 17,261,457 |
| 1996 | 14,502,293 | 17,261,457 | 8,250,000 | 5,750,000 | 466,466 | 0 | 17,297,284 | 0 | 0 | 17,297,284 |
| 1997 | 21,622,438 | 17,297,284 | 8,250,000 | 5,750,000 | 557,030 | 0 | 24,362,692 | 0 | 0 | 24,362,692 |
| 1998 | 16,798,378 | 24,362,692 | 8,250,000 | 5,750,000 | 673,505 | 0 | 26,487,565 | 0 | 0 | 26,487,565 |
| 1999 | 15,934,210 | 26,487,565 | 8,250,000 | 5,750,000 | 717,435 | 0 | 27,704,340 | 0 | 0 | 27,704,340 |
| 2000 | 10,646,526 | 27,704,340 | 8,250,000 | 5,750,000 | 684,917 | 0 | 23,665,949 | 0 | 0 | 23,665,949 |
| **Total** | | | | | | | | | 8,249,074 | |
| **Averages:** | | | | | | | | | | |
| **1953-1977** | 13,032,181 | | 8,250,000 | 5,750,000 | 263,354 | 0 | | 0 | 329,963 | 5,438,099 |
| **1931-1977** | 13,564,565 | | 8,250,000 | 5,750,000 | 365,655 | 0 | | 0 | 175,512 | 11,035,216 |
| **1906-2000** | 15,264,965 | | 8,250,000 | 5,750,000 | 494,700 | 0 | | 918,825 | 86,832 | 17,417,870 |

**Variables**

| | |
|---|---|
| Storage | 30,167,576 af |
| Sedimentation Rate (Active) | 24,292 af/yr |
| Bank Storage | 4% |
| Adjusted Storage (2060) | 29,530,030 af |
| UB Demand Level | 5,750,000 af/yr |
| UB Drought Shortage Trigger | 10,000,000 af/yr |
| UB Drought Shortage | 0% |
| LB Delivery | 8,250,000 af/yr |

**Results**

| | |
|---|---|
| Critical Period CRSP Evap | 263,354 af/yr |
| Average CRSP Evap | 494,700 af/yr |
| Total Yield (w/ CRSP evap) | 6,244,700 af/yr |
| NM allocation(w/o evap) | 641,250 af/yr |

| Shortage Years | Shortage |
|---|---|
| 1961 | 0 af |
| 1963 | 0 af |
| 1964 | 3,155,272 af |
| 1967 | 373,567 af |
| 1968 | 392,944 af |
| 1977 | 4,327,291 af |

Note: NM allocation is exclusive of its portion of CRSP evaporation. Navajo evaporation would be primarily charged against NM's allocation. Shared CRSP evaporation is already removed from UC demands.

Total Upper Basin depletion, inc. CRSP evap:

| | |
|---|---|
| 1953-1977 | 6,013,354 af |
| 1931-1977 | 6,115,655 af |
| 1906-2000 | 6,244,700 af |

OSE-0300

## Upper Basin Yield Study - February 2006 Draft

| CY | CR Natural Flow (plus) | Total Carry-Over Storage (plus) | CRSP Carry-Over Storage | LB Delivery 8.25MAF (minus) | Upper Basin Demand Level (minus) | Shared CRSP Evap (minus) | UB Drought Shortage (plus) | Net Available to Store (subtotal) | Spill to LC (minus) | Shortage (plus) | UC Basin Year-end Storage (equals) | CRSP Year-end Storage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1906 | 18,550,021 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,330,761 | 3,800,731 | 0 | 29,530,030 | 24,847,704 |
| 1907 | 21,201,694 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 35,982,434 | 6,452,404 | 0 | 29,530,030 | 24,847,704 |
| 1908 | 12,218,817 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 723,152 | 0 | 27,025,695 | 0 | 0 | 27,025,695 | 22,740,460 |
| 1909 | 22,356,301 | 27,025,695 | 22,740,460 | 8,250,000 | 5,750,000 | 723,152 | 0 | 34,658,844 | 5,128,813 | 0 | 29,530,030 | 24,847,704 |
| 1910 | 14,650,616 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 748,271 | 0 | 29,432,375 | 0 | 0 | 29,432,375 | 24,765,534 |
| 1911 | 15,499,729 | 29,432,375 | 24,765,534 | 8,250,000 | 5,750,000 | 748,271 | 0 | 30,183,833 | 653,803 | 0 | 29,530,030 | 24,847,704 |
| 1912 | 18,623,410 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,404,150 | 3,874,120 | 0 | 29,530,030 | 24,847,704 |
| 1913 | 14,536,373 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 747,091 | 0 | 29,319,312 | 0 | 0 | 29,319,312 | 24,670,398 |
| 1914 | 21,354,814 | 29,319,312 | 24,670,398 | 8,250,000 | 5,750,000 | 747,091 | 0 | 35,927,036 | 6,397,005 | 0 | 29,530,030 | 24,847,704 |
| 1915 | 13,623,277 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 737,659 | 0 | 28,415,648 | 0 | 0 | 28,415,648 | 23,910,020 |
| 1916 | 20,142,892 | 28,415,648 | 23,910,020 | 8,250,000 | 5,750,000 | 737,659 | 0 | 33,820,881 | 4,290,850 | 0 | 29,530,030 | 24,847,704 |
| 1917 | 22,942,804 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 37,723,544 | 8,193,514 | 0 | 29,530,030 | 24,847,704 |
| 1918 | 15,865,939 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 30,646,679 | 1,116,649 | 0 | 29,530,030 | 24,847,704 |
| 1919 | 12,651,369 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 727,620 | 0 | 27,453,779 | 0 | 0 | 27,453,779 | 23,100,667 |
| 1920 | 22,287,632 | 27,453,779 | 23,100,667 | 8,250,000 | 5,750,000 | 727,620 | 0 | 35,013,791 | 5,483,761 | 0 | 29,530,030 | 24,847,704 |
| 1921 | 22,526,781 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 37,307,521 | 7,777,491 | 0 | 29,530,030 | 24,847,704 |
| 1922 | 18,447,198 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,227,938 | 3,697,908 | 0 | 29,530,030 | 24,847,704 |
| 1923 | 19,024,046 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 33,804,786 | 4,274,756 | 0 | 29,530,030 | 24,847,704 |
| 1924 | 13,877,798 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 740,288 | 0 | 28,667,540 | 0 | 0 | 28,667,540 | 24,121,972 |
| 1925 | 14,430,701 | 28,667,540 | 24,121,972 | 8,250,000 | 5,750,000 | 728,182 | 0 | 28,370,059 | 0 | 0 | 28,370,059 | 23,871,660 |
| 1926 | 15,213,731 | 28,370,059 | 23,871,660 | 8,250,000 | 5,750,000 | 730,124 | 0 | 28,853,666 | 0 | 0 | 28,853,666 | 24,278,585 |
| 1927 | 19,539,212 | 28,853,666 | 24,278,585 | 8,250,000 | 5,750,000 | 742,231 | 0 | 33,650,647 | 4,120,617 | 0 | 29,530,030 | 24,847,704 |
| 1928 | 16,954,334 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 31,735,074 | 2,205,044 | 0 | 29,530,030 | 24,847,704 |
| 1929 | 21,829,585 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 36,610,325 | 7,080,295 | 0 | 29,530,030 | 24,847,704 |
| 1930 | 14,621,041 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 747,965 | 0 | 29,403,106 | 0 | 0 | 29,403,106 | 24,740,905 |
| 1931 | 8,474,134 | 29,403,106 | 24,740,905 | 8,250,000 | 5,750,000 | 681,850 | 0 | 23,195,390 | 0 | 0 | 23,195,390 | 19,517,494 |
| 1932 | 17,422,187 | 23,195,390 | 19,517,494 | 8,250,000 | 5,750,000 | 646,035 | 0 | 25,971,542 | 0 | 0 | 25,971,542 | 21,853,455 |
| 1933 | 12,183,500 | 25,971,542 | 21,853,455 | 8,250,000 | 5,750,000 | 649,274 | 0 | 23,505,767 | 0 | 0 | 23,505,767 | 19,778,657 |
| 1934 | 6,178,192 | 23,505,767 | 19,778,657 | 8,250,000 | 5,750,000 | 536,305 | 0 | 15,147,655 | 0 | 0 | 15,147,655 | 12,745,820 |
| 1935 | 12,630,349 | 15,147,655 | 12,745,820 | 8,250,000 | 5,750,000 | 430,284 | 0 | 13,347,719 | 0 | 0 | 13,347,719 | 11,231,285 |
| 1936 | 14,648,873 | 13,347,719 | 11,231,285 | 8,250,000 | 5,750,000 | 413,950 | 0 | 13,582,642 | 0 | 0 | 13,582,642 | 11,428,958 |
| 1937 | 14,306,056 | 13,582,642 | 11,428,958 | 8,250,000 | 5,750,000 | 415,262 | 0 | 13,473,436 | 0 | 0 | 13,473,436 | 11,337,068 |
| 1938 | 18,148,319 | 13,473,436 | 11,337,068 | 8,250,000 | 5,750,000 | 452,694 | 0 | 17,169,061 | 0 | 0 | 17,169,061 | 14,446,709 |
| 1939 | 11,164,059 | 17,169,061 | 14,446,709 | 8,250,000 | 5,750,000 | 456,898 | 0 | 13,876,222 | 0 | 0 | 13,876,222 | 11,675,987 |
| 1940 | 9,931,657 | 13,876,222 | 11,675,987 | 8,250,000 | 5,750,000 | 376,143 | 0 | 9,431,736 | 0 | 0 | 9,431,736 | 7,936,226 |
| 1941 | 20,116,678 | 9,431,736 | 7,936,226 | 8,250,000 | 5,750,000 | 389,530 | 0 | 15,158,884 | 0 | 0 | 15,158,884 | 12,755,269 |
| 1942 | 17,225,136 | 15,158,884 | 12,755,269 | 8,250,000 | 5,750,000 | 477,977 | 0 | 17,906,043 | 0 | 0 | 17,906,043 | 15,066,834 |
| 1943 | 13,731,401 | 17,906,043 | 15,066,834 | 8,250,000 | 5,750,000 | 498,642 | 0 | 17,138,802 | 0 | 0 | 17,138,802 | 14,421,248 |
| 1944 | 15,369,422 | 17,138,802 | 14,421,248 | 8,250,000 | 5,750,000 | 499,711 | 0 | 18,008,513 | 0 | 0 | 18,008,513 | 15,153,056 |
| 1945 | 14,140,528 | 18,008,513 | 15,153,056 | 8,250,000 | 5,750,000 | 504,984 | 0 | 17,644,057 | 0 | 0 | 17,644,057 | 14,846,389 |
| 1946 | 11,095,453 | 17,644,057 | 14,846,389 | 8,250,000 | 5,750,000 | 466,002 | 0 | 14,273,508 | 0 | 0 | 14,273,508 | 12,010,279 |
| 1947 | 16,439,486 | 14,273,508 | 12,010,279 | 8,250,000 | 5,750,000 | 451,571 | 0 | 16,261,422 | 0 | 0 | 16,261,422 | 13,682,987 |
| 1948 | 15,139,294 | 16,261,422 | 13,682,987 | 8,250,000 | 5,750,000 | 479,209 | 0 | 16,921,508 | 0 | 0 | 16,921,508 | 14,238,408 |
| 1949 | 16,933,584 | 16,921,508 | 14,238,408 | 8,250,000 | 5,750,000 | 511,379 | 0 | 19,343,713 | 0 | 0 | 19,343,713 | 16,276,545 |
| 1950 | 13,140,416 | 19,343,713 | 16,276,545 | 8,250,000 | 5,750,000 | 522,237 | 0 | 17,961,892 | 0 | 0 | 17,961,892 | 15,113,827 |
| 1951 | 12,505,894 | 17,961,892 | 15,113,827 | 8,250,000 | 5,750,000 | 487,137 | 0 | 15,980,649 | 0 | 0 | 15,980,649 | 13,446,733 |
| 1952 | 20,805,422 | 15,980,649 | 13,446,733 | 8,250,000 | 5,750,000 | 531,935 | 0 | 22,254,136 | 0 | 0 | 22,254,136 | 18,725,486 |
| 1953 | 11,165,419 | 22,254,136 | 18,725,486 | 8,250,000 | 5,750,000 | 561,962 | 0 | 18,857,592 | 0 | 0 | 18,857,592 | 15,867,504 |
| 1954 | 8,496,102 | 18,857,592 | 15,867,504 | 8,250,000 | 5,750,000 | 464,222 | 0 | 12,889,472 | 0 | 0 | 12,889,472 | 10,845,698 |
| 1955 | 9,413,908 | 12,889,472 | 10,845,698 | 8,250,000 | 5,750,000 | 350,410 | 0 | 7,952,970 | 0 | 0 | 7,952,970 | 6,691,935 |
| 1956 | 11,426,874 | 7,952,970 | 6,691,935 | 8,250,000 | 5,750,000 | 269,222 | 0 | 5,110,622 | 0 | 0 | 5,110,622 | 4,300,274 |
| 1957 | 21,500,963 | 5,110,622 | 4,300,274 | 8,250,000 | 5,750,000 | 314,561 | 0 | 12,297,024 | 0 | 0 | 12,297,024 | 10,347,190 |
| 1958 | 15,862,511 | 12,297,024 | 10,347,190 | 8,250,000 | 5,750,000 | 404,780 | 0 | 13,754,755 | 0 | 0 | 13,754,755 | 11,573,780 |
| 1959 | 9,598,169 | 13,754,755 | 11,573,780 | 8,250,000 | 5,750,000 | 370,189 | 0 | 8,982,735 | 0 | 0 | 8,982,735 | 7,558,419 |
| 1960 | 11,524,160 | 8,982,735 | 7,558,419 | 8,250,000 | 5,750,000 | 291,500 | 0 | 6,215,395 | 0 | 0 | 6,215,395 | 5,229,873 |
| 1961 | 10,010,259 | 6,215,395 | 5,229,873 | 8,250,000 | 5,750,000 | 218,693 | 0 | 2,006,961 | 0 | 0 | 2,006,961 | 1,688,734 |
| 1962 | 17,377,609 | 2,006,961 | 1,688,734 | 8,250,000 | 5,750,000 | 207,853 | 0 | 5,176,717 | 0 | 0 | 5,176,717 | 4,355,889 |
| 1963 | 8,840,900 | 5,176,717 | 4,355,889 | 8,250,000 | 5,750,000 | 186,906 | 0 | -169,289 | 0 | 169,289 | 0 | 0 |
| 1964 | 10,863,586 | 0 | 0 | 8,250,000 | 5,750,000 | 132,876 | 0 | -3,269,290 | 0 | 3,269,290 | 0 | 0 |
| 1965 | 19,875,027 | 0 | 0 | 8,250,000 | 5,750,000 | 192,188 | 0 | 5,682,839 | 0 | 0 | 5,682,839 | 4,781,759 |
| 1966 | 10,679,844 | 5,682,839 | 4,781,759 | 8,250,000 | 5,750,000 | 214,608 | 0 | 2,148,075 | 0 | 0 | 2,148,075 | 1,807,473 |
| 1967 | 11,670,830 | 2,148,075 | 1,807,473 | 8,250,000 | 5,750,000 | 155,296 | 0 | -336,391 | 0 | 336,391 | 0 | 0 |
| 1968 | 13,739,932 | 0 | 0 | 8,250,000 | 5,750,000 | 132,876 | 0 | -392,944 | 0 | 392,944 | 0 | 0 |
| 1969 | 15,272,159 | 0 | 0 | 8,250,000 | 5,750,000 | 144,644 | 0 | 1,127,515 | 0 | 0 | 1,127,515 | 948,735 |
| 1970 | 15,344,136 | 1,127,515 | 948,735 | 8,250,000 | 5,750,000 | 168,680 | 0 | 2,302,971 | 0 | 0 | 2,302,971 | 1,937,808 |
| 1971 | 15,290,433 | 2,302,971 | 1,937,808 | 8,250,000 | 5,750,000 | 192,409 | 0 | 3,400,995 | 0 | 0 | 3,400,995 | 2,861,728 |
| 1972 | 12,959,652 | 3,400,995 | 2,861,728 | 8,250,000 | 5,750,000 | 191,017 | 0 | 2,169,629 | 0 | 0 | 2,169,629 | 1,825,610 |
| 1973 | 18,397,816 | 2,169,629 | 1,825,610 | 8,250,000 | 5,750,000 | 221,751 | 0 | 6,345,694 | 0 | 0 | 6,345,694 | 5,339,511 |
| 1974 | 13,089,042 | 6,345,694 | 5,339,511 | 8,250,000 | 5,750,000 | 253,187 | 0 | 5,181,550 | 0 | 0 | 5,181,550 | 4,359,956 |
| 1975 | 16,825,996 | 5,181,550 | 4,359,956 | 8,250,000 | 5,750,000 | 267,737 | 0 | 7,739,809 | 0 | 0 | 7,739,809 | 6,512,573 |
| 1976 | 11,140,311 | 7,739,809 | 6,512,573 | 8,250,000 | 5,750,000 | 261,858 | 0 | 4,618,262 | 0 | 0 | 4,618,262 | 3,885,983 |
| 1977 | 5,438,897 | 4,618,262 | 3,885,983 | 8,250,000 | 5,750,000 | 181,077 | 0 | -4,123,919 | 0 | 4,123,919 | 0 | 0 |
| 1978 | 15,183,722 | 0 | 0 | 8,250,000 | 5,750,000 | 143,730 | 0 | 1,039,991 | 0 | 0 | 1,039,991 | 875,089 |
| 1979 | 17,671,870 | 1,039,991 | 875,089 | 8,250,000 | 5,750,000 | 190,916 | 0 | 4,520,945 | 0 | 0 | 4,520,945 | 3,804,097 |
| 1980 | 17,765,183 | 4,520,945 | 3,804,097 | 8,250,000 | 5,750,000 | 263,791 | 0 | 8,022,337 | 0 | 0 | 8,022,337 | 6,750,303 |
| 1981 | 9,015,200 | 8,022,337 | 6,750,303 | 8,250,000 | 5,750,000 | 245,744 | 0 | 2,791,793 | 0 | 0 | 2,791,793 | 2,349,122 |
| 1982 | 17,489,400 | 2,791,793 | 2,349,122 | 8,250,000 | 5,750,000 | 225,221 | 0 | 6,055,972 | 0 | 0 | 6,055,972 | 5,095,728 |
| 1983 | 24,361,989 | 6,055,972 | 5,095,728 | 8,250,000 | 5,750,000 | 363,643 | 0 | 16,054,318 | 0 | 0 | 16,054,318 | 13,508,721 |
| 1984 | 25,359,376 | 16,054,318 | 13,508,721 | 8,250,000 | 5,750,000 | 580,496 | 0 | 26,833,198 | 0 | 0 | 26,833,198 | 22,578,486 |
| 1985 | 21,246,109 | 26,833,198 | 22,578,486 | 8,250,000 | 5,750,000 | 721,143 | 0 | 33,358,163 | 3,828,133 | 0 | 29,530,030 | 24,847,704 |
| 1986 | 23,013,446 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 37,794,186 | 8,264,156 | 0 | 29,530,030 | 24,847,704 |
| 1987 | 15,640,478 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 749,290 | 0 | 30,421,219 | 891,188 | 0 | 29,530,030 | 24,847,704 |
| 1988 | 11,456,357 | 29,530,030 | 24,847,704 | 8,250,000 | 5,750,000 | 715,277 | 0 | 26,271,110 | 0 | 0 | 26,271,110 | 22,105,524 |
| 1989 | 9,921,847 | 26,271,110 | 22,105,524 | 8,250,000 | 5,750,000 | 632,102 | 0 | 21,560,855 | 0 | 0 | 21,560,855 | 18,142,133 |
| 1990 | 9,639,803 | 21,560,855 | 18,142,133 | 8,250,000 | 5,750,000 | 531,881 | 0 | 16,668,777 | 0 | 0 | 16,668,777 | 14,025,750 |
| 1991 | 12,170,021 | 16,668,777 | 14,025,750 | 8,250,000 | 5,750,000 | 456,954 | 0 | 14,381,844 | 0 | 0 | 14,381,844 | 12,101,437 |
| 1992 | 10,895,580 | 14,381,844 | 12,101,437 | 8,250,000 | 5,750,000 | 396,545 | 0 | 10,880,879 | 0 | 0 | 10,880,879 | 9,155,590 |
| 1993 | 18,160,118 | 10,880,879 | 9,155,590 | 8,250,000 | 5,750,000 | 399,257 | 0 | 14,641,739 | 0 | 0 | 14,641,739 | 12,320,123 |
| 1994 | 11,125,503 | 14,641,739 | 12,320,123 | 8,250,000 | 5,750,000 | 404,289 | 0 | 11,362,953 | 0 | 0 | 11,362,953 | 9,561,226 |
| 1995 | 20,047,166 | 11,362,953 | 9,561,226 | 8,250,000 | 5,750,000 | 428,708 | 0 | 16,981,411 | 0 | 0 | 16,981,411 | 14,288,813 |
| 1996 | 14,502,293 | 16,981,411 | 14,288,813 | 8,250,000 | 5,750,000 | 487,503 | 0 | 16,996,201 | 0 | 0 | 16,996,201 | 14,301,258 |
| 1997 | 21,622,438 | 16,996,201 | 14,301,258 | 8,250,000 | 5,750,000 | 561,354 | 0 | 24,057,285 | 0 | 0 | 24,057,285 | 20,242,725 |
| 1998 | 16,798,378 | 24,057,285 | 20,242,725 | 8,250,000 | 5,750,000 | 657,397 | 0 | 26,198,266 | 0 | 0 | 26,198,266 | 22,044,229 |
| 1999 | 15,934,210 | 26,198,266 | 22,044,229 | 8,250,000 | 5,750,000 | 692,700 | 0 | 27,439,776 | 0 | 0 | 27,439,776 | 23,088,883 |
| 2000 | 10,646,526 | 27,439,776 | 23,088,883 | 8,250,000 | 5,750,000 | 663,730 | 0 | 23,422,572 | 0 | 0 | 23,422,572 | 19,708,653 |
| **Total** | | | | | | | | | | 8,291,832 | | |
| **Averages:** | | | | | | | | | | | | |
| **1953-1977** | 13,032,181 | 6,248,629 | 5,257,837 | 8,250,000 | 5,750,000 | 254,020 | 0 | | 0 | 331,673 | 5,358,463 | 4,508,817 |
| **1931-1977** | 13,564,565 | 11,508,915 | 9,684,044 | 8,250,000 | 5,750,000 | 366,585 | 0 | | 0 | 176,422 | 10,883,317 | 9,157,642 |
| **1906-2000** | 15,264,965 | 17,387,551 | 14,630,554 | 8,250,000 | 5,750,000 | 495,155 | 0 | | 921,381 | 87,282 | 17,323,262 | 14,576,459 |

| Variables | | |
|---|---|---|
| Storage | 30,167,576 | af |
| Sedimentation Rate (Active) | 24,292 | af/yr |
| Bank Storage | 4% | |
| Adjusted Storage (2060) | 29,530,030 | af |
| UB Demand Level | 5,750,000 | af/yr |
| UB Drought Shortage Trigger | 10,000,000 | af/yr |
| UB Drought Shortage | 0% | |
| LB Delivery | 8,250,000 | af/yr |

**Results**

| | | |
|---|---|---|
| Critical Period CRSP Evap | 254,020 | af/yr |
| Average CRSP Evap | 495,155 | af/yr |
| Total Yield (w/ CRSP evap) | 6,245,155 | af/yr |
| NM allocation(w/o evap) | 641,250 | af/yr |

| Shortage Years | Shortage |
|---|---|
| 1961 | 0 af |
| 1963 | 169,289 af |
| 1964 | 3,269,290 af |
| 1967 | 336,391 af |
| 1968 | 392,944 af |
| 1977 | 4,123,919 af |

Note: NM allocation is exclusive of its portion of CRSP evaporation. Navajo evaporation would be primarily charged against NM's allocation. Shared CRSP evaporation is already removed from UC demands.

Total Upper Basin depletion, inc. CRSP evap:

| | |
|---|---|
| 1953-1977 | 6,004,020 af |
| 1931-1977 | 6,116,585 af |
| 1906-2000 | 6,245,155 af |

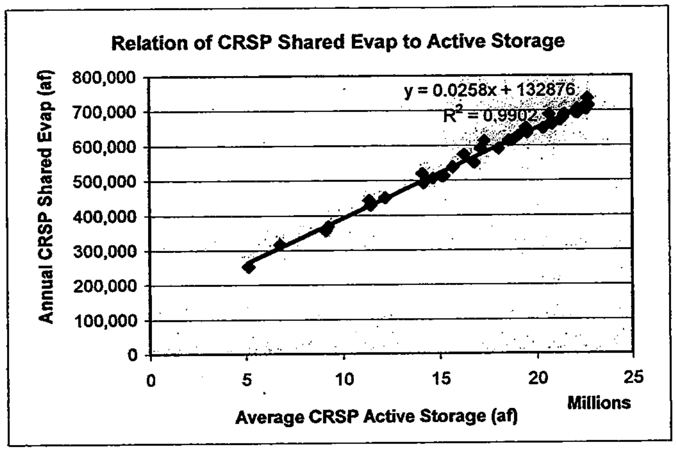
OSE-0301

## Relationships of CRSP Shared Reservoir Evaporation to Total CRSP Storage

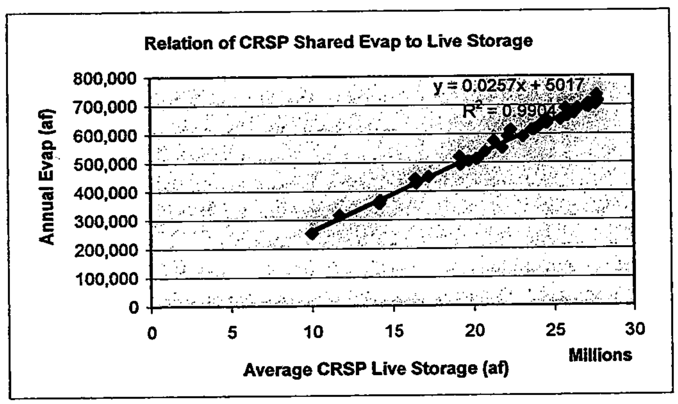
| Year | Average CRSP Live Storage (af) | Average CRSP Active Storage (af) | CRSP Shared Evap (af) |
|---|---|---|---|
| 1968 | 10,006,534 | 5,123,250 | 251,646 |
| 1969 | 11,701,142 | 6,764,000 | 315,083 |
| 1970 | 14,222,401 | 9,231,741 | 367,164 |
| 1971 | 16,417,858 | 11,354,088 | 442,260 |
| 1972 | 17,229,715 | 12,165,945 | 449,544 |
| 1973 | 19,703,066 | 14,639,296 | 504,409 |
| 1974 | 22,158,563 | 17,094,793 | 590,940 |
| 1975 | 23,634,096 | 18,570,326 | 613,612 |
| 1976 | 24,105,743 | 19,041,973 | 626,694 |
| 1977 | 20,730,592 | 15,672,536 | 537,406 |
| 1978 | 19,158,480 | 14,106,380 | 519,065 |
| 1979 | 22,336,514 | 17,284,414 | 612,639 |
| 1980 | 25,709,770 | 20,657,670 | 688,502 |
| 1981 | 25,392,305 | 20,340,205 | 648,525 |
| 1982 | 25,835,729 | 20,783,629 | 666,691 |
| 1983 | 27,692,454 | 22,640,354 | 734,416 |
| 1984 | 27,759,568 | 22,707,468 | 714,727 |
| 1985 | 27,619,938 | 22,567,838 | 702,973 |
| 1986 | 27,414,909 | 22,362,809 | 706,131 |
| 1987 | 27,153,464 | 22,101,364 | 705,172 |
| 1988 | 26,465,639 | 21,413,539 | 689,455 |
| 1989 | 24,540,351 | 19,488,251 | 634,821 |
| 1990 | 21,806,134 | 16,754,034 | 549,702 |
| 1991 | 20,141,572 | 15,089,472 | 510,689 |
| 1992 | 19,208,740 | 14,156,640 | 491,352 |
| 1993 | 21,297,564 | 16,245,464 | 573,884 |
| 1994 | 23,080,796 | 18,028,696 | 589,440 |
| 1995 | 24,500,724 | 19,448,624 | 649,206 |
| 1996 | 26,252,053 | 21,199,953 | 671,123 |
| 1997 | 26,416,641 | 21,364,541 | 681,115 |
| 1998 | 27,174,302 | 22,122,202 | 693,294 |
| 1999 | 27,050,819 | 21,998,719 | 694,007 |
| 2000 | 25,830,330 | 20,778,230 | 660,675 |
| 2001 | 23,802,258 | 18,750,158 | 614,593 |
| 2002 | 20,256,954 | 15,204,854 | 512,030 |
| 2003 | 16,472,537 | 11,420,437 | 427,526 |
| 2004 | 14,160,551 | 9,108,451 | 355,545 |

### Regression Analyses

Active Storage:




Live Storage:




Notes:

(1) Historic calendar year data from Bureau of Reclamation. Average storage values are based on the average of the end-of-year storage amounts for the year indicated and for the previous year. Storage amounts include storage in all CRSP units, including Lake Powell, Flaming Gorge Reservoir, Navajo Reservoir and the Aspinall Unit (Blue Mesa, Morrow Point and Crystal reservoirs).

(2) CRSP shared evaporation includes lake evaporation for Lake Powell, Flaming Gorge Reservoir and the Aspinall Unit reservoirs, and is shared between the Upper Division States in proportions to their Upper Colorado River Basin Compact Article III(a) apportionments. CRSP shared evaporation is approximately 10,000 af at zero live CRSP storage (5,000 af based on the regression analyses) and approximately 130,000 af if storage in all CRSP reservoirs were at the top of the inactive pools (133,000 af based on the regression analysis). Lake evaporation for Navajo Reservoir is not included in CRSP shared evaporation.

(3) Data for the period 1968-2004 were used in the regression analyses. Data prior to 1968 do not reflect a normal distribution of storage between CRSP unit reservoirs under future operational conditions (for example, Navajo Reservoir storage remained below the top of the inactive pool required for operation of the Navajo Indian Irrigation Project diversion from 1962 when it began storing water until 1968, and Morrow Point Reservoir began operation in 1968). For the period 1968-1977, the historic average end-of-year CRSP storage and annual CRSP evaporation amount were increased to reflect the average storage of 15,670 af and average evaporation amount of 340 af occurring at Crystal Reservoir after its initial filling in 1978.

STATE OF NEW MEXICO ANTICIPATED FUTURE UPPER BASIN DEPLETIONS
(Units: 1000 acre-feet per year)

| | April 2005 Depletion Schedule | Proposed Revised Schedule | NGWSP Biological Assessment, Baseline plus NGWSP |
|---|---|---|---|
| IRRIGATION USES (1) | | | |
| Navajo Nation Irrigation: | | | |
| Navajo Indian Irrigation Project (2) | 256.5 | 256.5 | 280.6 |
| Fruitland-Cambridge Irrig. Project *(3)* | 7.6 | 8.0 | 7.9 |
| Hogback-Cudei Irrigation Project *(3)* | 20.2 | 21.3 | 13.0 |
| Chaco River drainage irrigation *(4)* | 3.1 | 2.8 | 2.8 |
| Crystal area irrigation *(4)* | 0.3 | 0.2 | 0.5 |
| Navajo Irrigation Subtotal | 287.7 | 288.8 | 304.8 |
| Non-Navajo Irrigation: | | | |
| Above Navajo Dam (including Jicarilla) | 1.7 | 1.7 | 2.8 |
| Upper San Juan (excluding Hammond) | 8.2 | 9.0 | 9.1 |
| Hammond Irrigation Project | 9.2 | 11.8 | 10.3 |
| Animas River ditches | 31.7 | 39.1 | 36.7 |
| La Plata River ditches *(5)* | 5.1 | 6.4 | 9.8 |
| Farmers Mutual Ditch | 8.8 | 10.7 | 9.6 |
| Jewett Valley Ditch | 2.8 | 3.6 | 3.1 |
| Chaco River drainage irrigation *(4)* | 0.7 | 0.5 | 0.0 |
| Non-Navajo Irrigation Subtotal | 68.2 | 82.8 | 81.4 |
| Irrigation Total | 355.9 | 371.6 | 386.2 |
| STOCKPOND EVAPORATION AND STOCK USE *(6)* | 4.3 | 3.2 | 2.2 |
| MUNICIPAL AND DOMESTIC USES (1) | | | |
| Current Municipal and Industrial Uses (7) | 9.7 | 9.7 | 8.5 |
| Animas-La Plata Project: | | | |
| San Juan Water Commission (8) | 10.4 | 10.4 | 10.4 |
| Navajo Nation | 2.3 | 2.3 | 2.3 |
| La Plata Conservancy District | 0.8 | 0.8 | 0.8 |
| Ridges Basin Res. Evap. - New Mexico share | 0.1 | 0.1 | 0.1 |
| Animas-La Plata Project Subtotal | 13.6 | 13.6 | 13.6 |
| Navajo-Gallup Water Supply Project: (9) | | | |
| Navajo Nation | 12.5 | 12.5 | 12.5 |
| Jicarilla Apache Nation | 1.2 | 1.2 | 1.2 |
| Navajo-Gallup Project Subtotal (within Basin) | 13.7 | 13.7 | 13.7 |
| Navajo Nation Municipal Use, Future (exc. NGP) | 2.0 | 2.0 | 0.0 |
| Jicarilla Apache Nation Municipal Use (exc. NGP) | 0.6 | 0.6 | 0.0 |
| Scattered Rural Domestic (including Jicarilla) | 1.2 | 1.2 | 1.4 |
| Municipal and Domestic Total | 40.8 | 40.8 | 37.2 |
| POWER AND INDUSTRIAL USES | | | |
| PNM - Navajo Reservoir contract (10) | 16.2 | 16.2 | 16.2 |
| BHP Billiton (11) | 39.0 | 39.0 | 39.0 |
| Bloomfield Industrial | 2.5 | 2.5 | 2.5 |
| Navajo Nation - Shiprock (12) | 0.3 | 0.3 | 0.0 |
| Navajo-Gallup Project - NAPI (13) | 0.7 | 0.7 | 0.7 |
| Small Navajo Reservoir Contracts | 0.1 | 0.1 | 0.0 |
| Power and Industrial Total | 58.8 | 58.8 | 58.4 |