Option Descriptions

Increase Supply

Importation

4 Colorado River Augmentation - Snake River Import

This import alternative involves diverting water from the Snake River and delivering it to the Green River Basin. Under this alternative, water would be pumped from Palisades Reservoir over the basin divide to Horse Creek, which is tributary to the Green River.

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12 Surface Water Importation - Missouri River

Build water pipelines from the Missouri river to the continental divide, and let gravity take over from there

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14 Water Imports Using Ocean Routes - Tankers

Tankers could be used to transport water from Alaska to southern California. System features for the tank option would include land-based or offshore loading and unloading facilities, a terminal shore reservoir, and pipelines to transport water to and from these facilities.

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15 Water Imports Using Ocean Routes - Water Bags

This option involves filling large nylon water bags with water from available sources in Alaska or from northern California, towing the water bags to southern California and discharging the water into the distribution system. System features would include land-based or offshore loading and unloading facilities, a terminal storage reservoir, and pipelines to transport water to and from these facilities to regional treatment and distribution networks.

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16 Water Imports Using Ocean Routes - Icebergs

This option involves towing an iceberg wrapped in some type of plastic to California and capturing the meltwater. System features for this option would include a land-based or offshore facility to dock the iceberg and capture the meltwater.

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39 Import flows from the Snake River to the Green River

In 1948 when I was in a high school agriculture class we studied maps on how to get more water into the Colorado river.
This was the plan the class came up with;
Connect Green River to Snake River south of Jackson, WY

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46 Colorado River Augmentation - Bear River to Ham's Fork Creek Import

This import alternative involves diverting water from the Bear River and delivering it to the Green River Basin. Under this alternative, water would be diverted and pumped from Bear River over the basin divide to Ham's Fork Creek, upstream of Lake Viva Naughton.

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47 Colorado River Augmentation - Clark's Fork to Green River Import

This import alternative involves diverting water from Clark's Fork of the Yellowstone River in Wyoming and delivering it to the Green River Basin. Two routes were developed for this alternative. Option 1 minimizes construction within National Forest lands and in areas that may be deemed environmentally sensitive. Option 2 investigates the straightest route to the headwaters of the Green River. Consideration was also given to diverting water from Clark's Fork to the Snake River and then from the Snake River to the Green River. However, the headwaters of the two rivers are within 50 miles of each other. Consequently, this analysis assumed a direct delivery to the Green River Basin.

49 Colorado River Augmentation - Columbia River via a Submarine Pipeline

The idea of using an undersea pipeline to augment water supplies in southern California has been considered since the early 1970s when the U.S. Bureau of Reclamation (USBR) began reconnaissance studies (USBR 1971). USBR conducted a significant amount of study and evaluation although the planned feasibility studies were not completed. The undersea aqueduct idea was resurrected during the early 1990s when the governor of Alaska proposed constructing a pipeline from southeastern Alaska to northern California. This concept was evaluated by the Office of Technology Assessment (OTA 1992). The potential of using an undersea aqueduct to transport water from the Columbia River to S. California, discussed in this option, was evaluated based on the USBR and Alaska aqueducts previously proposed.

50 Missouri River Reuse Project

The Missouri River Reuse option is a diversion of up to 600,000 AFY of water from the Missouri River for reuse within the Missouri River Basin of Kansas and Colorado. Water would be diverted from the Missouri River only when flows to support navigation and municipal water diversions along the river from Leavenworth, Kansas to Saint Louis, Missouri, are not impaired.

1. Within Kansas, the water would be used to fill surface reservoirs and recharge depleted aquifers in the upper and lower Republican River Basins, Solomon River Basin, and Smoky-Hill/Saline River Basin as determined from assessment of need and feasibility by the Kansas State Water Office in cooperation with the Kansas Division of Water Resources, Army Corps of Engineers, and the States of Colorado and Nebraska. In particular, the water would be used for irrigation and municipal, commercial, and industrial use and to recharge the Ogallala aquifer in western Kansas. Each of these basins (including the Ogallala aquifer in northwest Kansas) is tributary to the Missouri River. The Ogallala aquifer discharges into the Republican River in northeast Colorado and northwest Kansas. Kansas may choose to construct new reservoirs or enlarge existing reservoirs for the project.
2. Along the Front Range of Colorado, the water (totaling 500 cfs or more as Colorado determines) would be used for municipal, commercial, and industrial use with return flows allocated for agricultural irrigation use within the South Platte River Basin (a tributary of the Missouri River). Some water could be used to recharge the bedrock aquifers of the Denver Basin. In eastern Colorado, some water could be used for irrigation and municipal use and to recharge the Ogallala aquifer. Water would likely be stored in Front Range reservoirs such as Rueter-Hess, Carter, Barr, and Chatfield and in designated alluvial storage along the South Platte River. Colorado may choose to construct new reservoirs or enlarge existing reservoirs for the project.
3. Some water may be available for use outside the Missouri River Basin, particularly that portion of the water in the Missouri River which is non-native (originating as transmountain diversions from the Colorado and Arkansas Rivers in Colorado and nontributary Denver Basin ground-water withdrawals). Some of this water could be directed to the Arkansas River in western and central Kansas and in eastern Colorado beginning near Colorado Springs. Some water could also be directed to the headwaters of the Colorado River Basin through pipelines and tunnels when there is great need to relieve drought in the basin provided the navigation and municipal supply flows in the Missouri River are plentiful and other water needs of western Kansas and eastern Colorado are being reasonably satisfied.

52 Mississippi River Supply

On average, Colorado has historically diverted around 497,000 AFY from the Colorado River basin to the Front Range of Colorado (CRC, 2008). Increased demands are expected on the Colorado River to meet growing needs for water along the Front Range. Therefore, using the largest reasonable pipeline size of 144" (12 feet) to deliver 675,000 AFY of water from the Mississippi near Memphis to the Colorado Front range could significantly reduce the need for Colorado to divert from the Colorado River Basin.

Desalination

6 Pacific Ocean Desalination

This option includes implementing ocean desalination projects that are above the current plans within the MWD service area. During years when MWD has Colorado River supply shortages, the first increment of this water would meet that demand. Any amount of water produced above that amount could be exchanged with other Colorado River water users (with the operational ability to make the exchanges).

11 Desalination in California - Subsidized by Nevada and Arizona

Arizona and Nevada to subsidize California building and operating desalination plants, in exchange for an equivalent share of the Colorado river water currently held by California.

24 Desalination of Brackish Groundwater - Yuma, AZ and Riverside County, CA

Brackish groundwater is abundant in many areas of the lower Colorado River basin. Brackish, or partially saline water, can be “de-salted” through a reverse-osmosis treatment process. This treated water can then be used to meet agricultural or municipal water supply needs depending on the level of treatment.

30 Desalination - Sea of Cortez

We propose to engineer, finance, procure, construct and operate a 500,000 AFY desalination project using seawater from the Sea of Cortez. The desalination plants(s) would be sited near the Sea of Cortez, with the desalinated water transmitted via pipeline acreoss the US border near San Luis Rio Colorado and delivered into the Imperial Dam.
Execution team includes Empresas ICA, the largest engineering and construction firm in Mexico, and Acciona SA, a Spanish conglomerate that specializes in construction and infrastructure. Between these parties and hannon Armstrong, we have the development capital, financing expertise, balance sheet support, construction capability, environmental permitting experience, and political connections in Mexico City and Washington to make this ambitious project happen.

40 Widespread Desalination - San Francisco, Salton Sea, Puerto Penase, Mexicali Mexico; Rio Grande, Houston Area

As a nation, we are losing our ability to produce enough food to feed ourselves and help third world nations. Mexico has become a bread basket for us but their water demands are not being met partially because of us. Whatever. we do as a solution must include Mexico.
1) We believe our problems will only get worse due to population growths, weather climate changes, droughts, floods, etc.
Unfortunately our problems are not limited to the West. Texas, for example, has horriblle water shortage problem. Since Texas receives much of their water from the Rio Grande and Pecos Rivers, the state must be included in the overall solution. Texas is also a bread basket state.
As a nation, we are losing our ability to produce enough food to feed ourselves and help third world nations. Mexico has become a bread basket for us but their water demands are
not being met partially because of us. Whatever we do as a solution must include Mexico.
1) We believe our problems will only get worse due to population growths, weather climate changes, droughts, floods, etc.
Since Texas receives much oftheir water from the Rio Grande and Pecos Rivers, the state must be included in the overall solution. Texas is also a bread basket state.
There is only one way to resolve the problem, desalination. The problem with desalinization is the process takes a lot of power. After desalination, you have to move the water to the demand areas. It takes lots of power to pump water. As you can see, the biggest issue is not the water, its power, and it must be green power. The technology is already there for such power. My associates and I can share this new renewable energy technology with you in confidence.
Natural water sources exist in the North and as they flow South they diminish so now we need to create a second source. Produce water in the South and move it North.
Create large desalination plants in:
1. San Francisco
2. The Salton Sea
3. Puerto Penase
4. Mexicali, Mexico
5. The mouth ofthe Rio Grande
6. Houston area.
The Salton Sea and Mexicali will supply the Imperial Valley in California. The Puerto Penase plant will serve Yuma and Phoenix. The Antelope Valley could be fully developed into farm land and served from the South.
Our Nation needs to keep as many agricultural areas intact as we can through zoning and making sure water is available. '
The Salton Sea in California is a cesspool now. It is used to support a shrimp industry. We should clean it up, make it a salt water basin again that can both support a fishing industry and a desalination plant. Pump clean salt water into the Salton sea.
The renewable power sources for all of this can be power that also helps support the power grid .
We could also supply water to Hoover Dam and Las Vegas as well. The possibilities go on and on.

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103 Desalination Augmentation

Assessment and potential implementation of additional desalination projects of three varieties throughout Colorado River Basin: (1) ocean water desalination along Baja California coast. Southern California coast, and Gulf of California; (2) surface water desalination basinwide; and (3) ground water desalination basinwide. Equitable division of obligations -- funding, technical support, etc. -- among federal government, Mexico, basin states, and relevant major water users who would benefit from these projects. Potential establishment of competitive bidding process whereby contracts would be offered to private sector entities for construction and (perhaps) operation of desalination facilities.

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108 Rosarito Beach Binational Seawater Desalination Plant

A 50-mgd seawater desalination plant located in Rosarito Beach, Baja California, Mexico. The product water from the plant could be delivered to either Mexican or U.S. water users using either a direct pipeline delivery or water exchange between Mexican and U.S. water users. In 2010, the San Diego County Water Authority, Central Arizona Water Conservation District, Metropolitan Water District of Southern California, and Southern Nevada Water Authority completed the first phase of a four-phase study of the feasibility of a Rosarito Beach Binational seawater desalination plant. This study is attached for reference and to provide additional detail.

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110 Gulf of California Desalination

Desalinated seawater from the Gulf of California is one possible solution to the demand for water in the Arizona and Sonora region. Water would be withdrawn and treated near Puerto Penasco and delivered by pipeline and canal to Imperial Dam where the treated water would augment available supplies in the Colorado River. Alternative sizing of 120,000 and 1,200,000 AFY were evaluated.

128 Water for West TM Project

The Water for West TM Project (WFW) is designed to generate 3.5 million acre feet (3.5MAF) of fresh water in the Los Angeles Basin by means of an offshore deep sea reverse osmosis system. The WFW will provide a secure, uninterruptible source of fresh water to over 80 million residents of the Colorado River Basin with a lower environmental footprint, lower energy consumption and a lower levelized cost than conventional reverse osmosis systems or additional fresh water aqueducts. Since the WFW equipment is located offshore in clean deep ocean water (an infinite watershed), it is resistant to force majeure events such as earth quakes, tidal waves, climate changes and other events which constrain other conventional fresh water delivery systems such as aqueducts or shore based reverse osmosis plants

137 Colorado River Aqueduct Desalination and Salton Sea Water Supply Project

A project to reduce the salinity of Colorado River water by desalting the water flowing in MWD's Colorado River Aqueduct (CRA) from 700 mg/l to 200 mg/l. The desalination process would recover 95% of the treated water and the desalination reject water (46,800 AF/yr at 10,913 mg/l) would be conveyed to the Salton Sea through a 23-mile long penstock with hydro-electric generation of 7.4 MW from the elevation drop of 1,598 feet (static head).

139 Salton Sea Restoration and Drainwater Reuse

Manage future flows to the Salton Sea by providing for three primary functions: (1) air quality management of the exposed playa, (2) provision of suitable shallow water habitat to support avian and aquatic species, and (3) treatment and reuse of excess inflows for agricultural, municipal, or industrial purposes. Flows to the Salton Sea in excess of that needed for Salton Sea air quality management and habitat purposes could be desalted to equivalent salinity of Colorado River at Imperial Dam salinity (from about 2,500 mg/L to less than 800 mg/L TDS). The desalted water could be provided to meet growing demands within Imperial Irrigation District's service area. Water available after meeting these other needs could be put to use within the Imperial and Coachella Valleys to meet to meet unmet demands and/or reduce California's Colorado River demands.

140 Brackish Water Desalting in Yuma Area

Irrigation using Colorado River water in the vicinity of Yuma has created a large mound of brackish groundwater. The mound holds approximately 600,000 to 800,000 acre-feet of brackish groundwater. The amount of water flowing from the groundwater mound that is excess of the needs for other purposes in the area and otherwise flows to Mexico through either surface or groundwater flow is available for use.

143 Southern California Groundwater Desalination

The 2008 Augmentation Report cited a 1991 Boyle report indicating that there was about 15 million acre-feet of brackish groundwater in the Southern California region at that time. Both the 2008 and 1991 reports indicated that not all of that water is available for groundwater mining, partially because previous overdrafting has been part of the cause of the degradation in water quality is some regions. A rough estimate from the 1991 report of the sustainable yield of brackish groundwater within the MWD service area was 200,000 AFY. Since 1991 numerous groundwater recovery programs have been implemented in the MWD service area and the MWD Integrated Resources Plan shows approximately 150,000 AFY of potential future projects.

Based on the above and discussions with the Local Resources Program staff at MWD, a general conclusion (related to CRBS options) is that there is probably some amount of brackish groundwater that could sustainably be pumped and treated (above what is already planned), but it is not readily apparent without more detailed investigation and the large amounts of easy to capture water are already included in existing plans.

For the high level CRBS option development, it is assumed that a 20,000 AFY project could be developed in the Riverside County Region (above current plans).

Reuse

3 Grey Water Recycling System

The primary concern with the water unbalance is the inablity to provide adequate potable water to the population. There are means being undertaken to serve the recycled irrigation needs but domestic use water remains unrecycled. Some industrial users are recycling using their own systems but there is no practial means currently available to recycle domestic water. It is a shame to use potable water which has been treated at significant expense to flush the toilet and to water the lawn. Statistically, nearly half the water used in a domicile is of quality to be recycled and used a second time in toilet flushing and in the system I have developed and for which a patent has been applied that serves the evaporative cooler. Any remaining recycled water serves to water the lawn trees and shrubs. Grey water recycling is allowed by statute in most of the western states. My system under the control of a logic computer accepts water from the laundry, the lavs, showers and bathtubs, filters and stores it as it is accumulated and meters it with first priority to the toilets as needed. Colored tank modules (thousand flushes as an example) overcome the reluctance to have grey colored water in the stool. As a second priority, the recycled water is cleaned with a RO filter, exposed to UV light and metered to the evaporative cooler. What is left if any is metered as irrigation. Should there be an insufficiency of available grey water, fresh water in limited amount-only enough to serve the current demand, is imported through an air break valve. There are automatic monitoring systems included that continuously present the system status to the home owner. Means are included to accommodate occasional home owner absences when certain requirements remain even though no grey water is generated because of the....

7 Mega Reuse Options

This option includes implementing large scale water reuse projects that are above the current plans within the MWD service area. During years when MWD has Colorado River supply shortages, the first increment of this water would meet that demand. Any amount of water produced above that amount could be exchanged with other Colorado River water users (with the operational ability to make the exchanges).

26 Water Reuse/ Recycling

Water recycling reuses water that normally would be discharged as treated wastewater to meet potable and nonpotable demands. Recycled water is a drought-proof, locally controlled, and highly reliable source of water supply.

98 Water Conservation and Management

All golf courses and public green spaces should use gray water and not drinking water for irrigation and watering.

104 Water Reuse/ Recycling

Water recycling reuses water that normally would be discharged as treated wastewater to meet potable and nonpotable demands. Recycled water is a drought-proof, locally controlled, and highly reliable source of water supply.

141 Water Reuse in Wyoming

Approximately 50 per cent of the water supply for Cheyenne, Wyoming, is obtained from the Little Snake River, which is part of the Colorado River system. This inter-basin diversion totals about 8,000 AFY. The water reaches Cheyenne through diversion to reservoirs in the Platte River drainage and exchanges within the Platte River system. Because the Colorado River water is used to replace diversions of Platte River water that is diverted out of priority, there is no potential to reuse this water. Instead it must be returned from the wastewater plant to the watershed to meet water right obligations.

142 Water Reuse in Utah

Approximately 20,000 AFY of Colorado River water is diverted for municipal use in Central Utah through the Central Utah Project. Total water use in the Salt Lake City metropolitan area averages about 86,000 AFY of which approximately 40,000 AFY is available for reuse. This water is otherwise lost through flow to the hypersaline Great Salt Lake.

145 Water Reuse in Arizona

Approximately _____ AFY of Colorado River water is diverted for municipal use in Central and Southern Arizona through the Central Arizona Project. By the year 2060, approximately 250,000 to 300,000 AFY will be available for reuse.

Local Supply

17 Individual Conservation and Storage

The snowpack in the Rockies is the primary reservoir for the Colorado River and it's tributaries. Annual precipitation is not something we can control. Long range climate forecasts indicate that the reduction in precipitation and early melt-off of the snow pack is likely not anomalous, but the new norm. If these statements are true, then the only viable management options are water conservation and storage.

Conservation strategies and technologies exist that can dramatically reduce usage on all fronts. Implementation will require a financial incentive. A smart approach would be to introduce tax credits for all levels of users to encourage implementation of these measures. All reductions of demand on the front side will pay major dividends over the long run; thus a very long range outlook and plan is essential.

Storage solutions can be implemented at every level, from rain barrels on a homes downspout to large scale underground reservoirs. Again, the greatest challenge is in breaking with business as usual and overcoming implementation challenges.

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22 Rainwater Capture Diverted to Lake Mead

With all the water wasted from soaking into the ground when we get rain. It would be cheaper and faster than pouring cement if you can put a V shape culvert overlaping end on end starting from Lake Mead to go up each wash

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51 Coal Bed Methane Produced Water

Coal Bed Methane (CBM) is natural gas associated with coal deposits. To produce gas from CBM wells, it is first necessary to reduce the hydrostatic pressure within the coal seam by pumping of some of the water from the gas-bearing coal seams. As water is pumped out of the formation and the hydrostatic pressure drops, the gas desorbs from the coal into the cleats and migrates into the well. Eventually, as pressure and water production decline, gas production increases, and a well may have a long productive period with relatively high gas production and little or no water production. Generally, as the depth of the coal deposit increases, less water is present, but the salinity/total dissolved solids (TDS) of the water is higher than for more shallow deposits.

The CBM industry has generally viewed and treated the produced water associated with gas recovery as a waste product that must be disposed at the least possible cost. In most cases, CBM produced waters are currently disposed by injection into Class II underground injection wells. This option considers treating the relatively high salinity water and using it to augment surface water supplies in the Colorado River Basin.

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97 Ute Indian Tribe Groundwater Use

The Ute Indian Tribe (Tribe) of the Uintah and Ouray Reservation (Reservation) is presently engaged in meetings with a Federal Implementation Team, and will subsequently conduct meetings with the State, in order to reach an agreement as to a clarification and common interpretation of the Ute Indian Water Compact before obtaining final ratification of the Compact by the Tribe and the State, pursuant to the 1992 Ute Indian Rights Settlement Act. The Compact recognizes the Tribe's federally reserved water rights within the Upper Colorado River Basin, amounting to 480,594 Acre-Feet (AF) of diversions and 258,943 AF of depletions. A vast majority of these rights are derived from surface supplies. However, several large aquifers underlie the Reservation, of which some may not be hydrologically connected to surface water. The Ute Tribe seeks to develop groundwater where needed and
economically feasible.
The State of Utah deducts all depletions from its apportionment of Colorado River water, whether the depletions derive from surface diversions or groundwater withdrawals. Hence, the State considers any new Tribal groundwater withdrawal as a deduction from the State's Colorado River apportionment. The Ute Tribe generally concurs with this position, but reserves the right to develop any groundwater under Tribal land that is not hydrologically connected to surface water. ("Hydrologically connected" means the interconnection of groundwater and surface water such that they constitute one water supply and the use of either results in an impact to both.) Withdrawals of non-hydrologically connected groundwater do not result in direct and measurable depletion of surface waters. Use of non-hydrologically connected groundwater should be treated as a new water source to which the Tribe has priority.
The Ute Tribe requests that Reclamation's Study adopt the option that the Ute Indian Tribe may engage in new Tribal development of groundwater that is not hydrologically connected to surface waters in the Colorado River Basin, and that groundwater that is not hydrologically connected should not be deducted from the Utah State allocation from the Colorado River. Development of such sources may augment supplies and alter demands in the Upper Colorado River Basin

Watershed Management

5 Brush Control on BLM Land

Control the prevalence of brush on BLM rangeland to improve conditions for growth of native grasses thereby increasing runoff from these rangelands. This would be an augmentation option that increases system flows.

33 Development of a Dust Mitigation Program

In this proposal, The U.S. Department of the Interior – with input from the seven basin states, the stakeholder group described in Option #1, above, other federal agencies, and appropriate Tribal governments – would oversee a program to identify and mitigate significant sources of dust accumulating on snowpack in the headwaters of the Colorado Basin. A recent National Academy of Sciences study by Painter, et al. estimated that dust accumulation is lowering basin-wide annual water yields by 2% - 7%. Several lines of evidence trace the primary sources of this dust to areas of the Colorado Plateau in northeastern Arizona and northwestern New Mexico, where land management practices could be modified to reduce airborne dust, particularly in dry years.

Although the scale of dust mitigation measures would have to be large in order to have a meaningful impact on water supplies, the potential benefits – several hundred thousand acre feet of additional water yield – would be shared widely across the full range of Colorado River water users. Accordingly, a funding mechanism could be designed that imposes a relatively minor individual burden on the roughly 33 million users of Colorado Basin water, yet still yields sufficient revenue to support a program at a scale that can appreciably reduce dust migration increase water yields, and provide additional co-benefits such as improved rangeland management. We propose funding the dust program by amending federal law to dedicate a portion of hydropower revenue generated by federal projects in the basin to the program, at a level to be determined after consultation with the seven states, the Bureau, and the stakeholder group described in Option #1, above. Alternatively, those parties could recommend another equitable mechanism for sharing the costs of the program, such as a per-acre-foot assessment on water deliveries, or some other method.

48 Forest Management

A large percentage of the runoff from the Colorado River Basin is derived from forests, particularly in Colorado. Previous studies and information have demonstrated that areas in which forest cover is reduced by clear-cutting or fires have shown dramatically increased amounts of runoff. This is the result of reduced interception, decreased evapotranspiration, and sometimes reduced permeability of the soil surface. The magnitude of increased runoff over affected areas may be as much as 100 mm, or 4 inches, per year. Forest management would entail the replacement of mature forests that have been cleared by harvesting, fires, or insect infestations with stands of replacement growth more likely to be favorable for generating runoff.

59 Dust Abatement for Colorado River Flow Recovery

Desert dust is a strong forcing of earlier snowmelt and loss of flow in the Upper Colorado River Basin through its enhancement of absorption of solar radiation (Painter et al., 2010). Present levels of dust loading are markedly greater than existed prior to the 1800s due to land surface disturbances of desert lowlands in the Colorado Plateau and Great Basin (Neff et al., 2008), darkening the snow surface and accelerating snowmelt. The accelerated melt associated with this dramatic increase in dust deposition has affected the basin hydrograph and ultimately decreased yield by increasing sublimation rates, increasing evapotranspiration, and decreasing soil moisture. Modeling suggests that the dust forcing has reduced flow an average of 5% (0.8 MAF) and up to 7% in each year, shortened snow cover duration by ~ 3 weeks, and brought peak flow 3 weeks earlier at Lee's Ferry.

This option proposes mitigation of land use activities that disturb soil surfaces and restoration of disturbed sites with mechanisms to reduce soil mobility. Such mechanisms to keep Colorado Plateau and Great Basin soils in place would prevent or diminish dust loading in UCRB snowpacks. The potential to reduce dust loading through surface stabilization in the deserts and restore more persistent snow cover, slow runoff rates, and increase water resources in the UCRB may present an important mitigation opportunity to reduce system management tensions and regional impacts of climate change.

89 Precipitation Enhancement/ Cloud Seeding

Cloud seeding activities release silver iodide to the atmosphere over areas of the western states of the U.S., Canada and some other areas around the globe to augment rainfall/snowfall or reduce hail damage. (Source: http://www.weathermodification.org/images/AGUoxicity.pd

92 Air Quality Improvement/ Reduction of Soot Causing Snow to Melt

A new report from Stanford University has found that black and brown soot is adding to the rapid melting of arctic sea ice, as well as the Sierra Nevada snow pack. The report claims black carbon is the second-leading cause of climate change. When soot lands on snow and ice it changes the reflectivity of the snow and ice, causing it to warm quickly and melt earlier. Earlier melt is a real threat to the security of the water supply in California and other western states (via the Sierra's and Colorado basin) over the long term. Water agencies could support legislation and possibly provide funding to programs that requires carbon particulate filters to reduce soot transportation onto snow and Ice. (Source: http://egpnews.com/7p=19901)

125 Securing Water Supply Resources by Reducing Risk of Catastrophic Wildfire through Risk Analysis and Forest Management Strategies

This option secures water resources and provides a reduction of significant growing risk to water suppliers. This solution is already being adopted in many places around the west.

This solution involves analysis of forest health and future disaster scenarios accounting for climate change projections. In particular focus will be on identification of habitats likely to be at greater risk of catastrophic wildfire, with associated sedimentation into downstream water supplies, loss of snow retention ability, and catastrophic debris flows. The solution responds to these challenges by adopting forest management strategies to reduce the potential for catastrophic wildfire, prioritizing those places where there is both a climate-driven risk and social vulnerability due to water supply. This solution will reduce ash and mudflow to reservoirs and rivers, and also potentially protect important water supply infrastructure, like pipes.

In the Santa Fe Watershed, this solution includes forest restoration activities that include non-commercial mechanical thinning of small-diameter trees, controlled burns to reintroduce the low-severity ground fires that historically maintained forest health, and comprehensive ecological monitoring to determine effects of these treatments on forest and stream habitats, plants, animals, habitats and soils. (other examples given at the end of this form)

Water supply impacts from catastrophic fire have been seen in a number of western places in the past, and this solution identifies forest management actions to reduce the threat to city water in places where managers want to avoid risks.
For example: A decade ago, the Cerro Grande Fire served as a wake-up call for much of the West. The fire burned for two weeks, sustained by 100 years of built-up fuel, leaving behind a wasteland of destroyed homes, dead trees and ash. After the blaze was contained and the charred earth began to cool, another disaster was set in motion. The damage from the fire was so intense that the deeply rooted trees could not hold the soil. Debris and ash poured down the mountains clogging streams, rivers and lakes—wreaking havoc on the Los Alamos water supply and causing over $9 million in damage.
Another example: Last summer Albuquerque was forced to close water intake from streams full of ash and sediment following the nearby catastrophic fire.

129 Weather Modification Program (i.e. Cloud Seeding) to Augment the Flow of the Colorado River

Congress recognized the severity of dwindling water supplies several years ago when it charged the Secretary of the Interior ("Secretary") in the Colorado River Basin Act of 1968 ("CRBA"), 43 U.S.C. § 1501(a) (1984), with augmenting Colorado River water supplies. The CRBA directed the Secretary to prepare a plan to augment current river basin supplies "to meet the future water needs of the Western United States." Id. at § 1511. It further declared that the first obligation of any water augmentation project would be satisfaction of the requirements of the Mexican Water Treaty. Id. at § 1511. Thereafter, Congress directed the Secretary to prepare a plan to improve the quality of Colorado River water. 43 U.S.C. § 1571(a) (1974).

In 1981, the House Subcommittee on Water and Power held a hearing to assess the Secretary's progress. Division of Atmospheric Resources Research, Bureau of Reclamation, U.S. Dep't of the Interior ("DOI"), CREST Program Plan (April 15, 1983) [hereinafter "CREST"]. The Subcommittee concluded that the greatest potential for augmenting the flow of the Colorado River was to perform a technique known as "weather modification" (i.e. "cloud seeding") to increase precipitation in the Colorado River's drainage basin. CREST, Id. at 10.

On May 2, 2005, the DOI issued a letter outlining the Secretary's intent to develop Lower Basin shortage guidelines and to explore management options of Lakes Mead and Powell. In response, Reclamation published a June 15, 2005 Federal Register notice to solicit comments on the Secretary's request. A meeting of the seven Basin States resulted in a letter to the Secretary that addressed three major topics to accommodate the Secretary's concerns, one of which included augmentation of supply. The states concluded that "[a] weather modification project should be pursued as a means of augmenting Colorado River System water supplies."
See Seven Basin States' Preliminary Proposal, p.11 (2006), available at http://www.usbr.gov
/lc/region/programs/strategies/consultation/Febo6SevenBasinStatesPreliminaryProposal.pdf.
Accordingly, a weather modification program (hereinafter "cloud seeding" or "weather modification") should be considered as an option to balance the supply and demand imbalances projected to occur in the Basin over the next 50 years. Not only is this a preferred option, but it mandated under our treaty with Mexico, which requires the United States to have sufficient water supplies for delivery thereto.

The concept of cloud seeding is simple. Several studies have suggested that there is a cold "temperature window" of opportunity for cloud seeding. Water droplets located in clouds can remain unfrozen at temperatures well below freezing. These droplets are called "supercooled". These water droplets must come in contact with a foreign particle ("seed") to cause them to freeze. Once a supercooled water droplet is frozen, its turns into an ice crystal, and eventually grows into a snowflake large enough to fall from the cloud and reach the ground. See The Potential Use of Winter Cloud Seeding Programs to Augment the Flow of the Colorado River, Report Prepared for Upper Colorado River Commission, pp. 8-9 (2006), available at http://www.nawcinc.com/Colorado%20River%20Seeding.pdf (hereinafter "Report").

Studies have shown that the ideal location for cloud seeding to occur is in the mountainous western states where orographic clouds are often associated with passing winter storms. Located within these orographic clouds are an abundance of supercooled water droplets that can remain suspended unless introduced to a foreign particle. Thus, the goal is to design a winter orographic cloud seeding project that will tap this reservoir of water droplets and convert them into snowflakes that otherwise would be lost through evaporation over the downwind side of a mountain barrier. Report, pp. 8-9.

In order to achieve this goal, a seeding agent must be introduced into the clouds. There are generally three main seeding agents: (1) silver iodide; (2) dry ice; and (3) liquid propane. Silver Iodide remains the preferred seeding agent due to its favorable results. Seeding must be released into the atmoshphere by some means. The most common release methods, depending on the altitude of the release location, occur via aircraft or a cannon-like module located on the ground. Report, pp. 10-13.

130 Augmentation and Protection of Colorado River Basin Water Supply Through Strategic Management of Tamarisk (Tamarix spp.)

Since its introduction into the United States, tamarisk (Tamarix spp.) has spread over many arid and semi-arid river systems and become the dominant or sub-dominant species in many of them. A conservative estimate of tamarisk cover in the Colorado River Basin is 250,000 acres. Tamarisk is expected to continue its spread in the Colorado River Basin if it is not managed. The control and restoration of tamarisk-infested lands within the Colorado River Basin presents a unique opportunity to not only gain potential water savings, but additionally enhance the health and utility of riparian corridors, benefiting wildlife and humans alike. Unless otherwise noted, the information provided here can be cited from a Tamarisk Coalition report titled, Colorado River Basin Tamarisk and Russian Olive Assessment (Tamarisk Coalition [TC] 2009).

The greatest potential opportunity for water savings through restoration of tamarisk-infested lands in the Colorado River Basin involves targeting higher elevation fluvial surfaces (upper terraces) along the river corridors. Potential water savings could be accomplished through the replacement of tamarisk in these areas with less water consumptive xeric upland species. While tamarisk is able to access deeper groundwater from these upper terraces (Shafroth et al. 2010), the priority for replacement vegetation would be on species with less ability to access deeper groundwater.

This opportunity differs from those outlined in the Augmentation Study (Gorham et al. 2007) which stated that, “the upland forest management option seemed least practicable (p ES-1).” The research cited in this option paper was compiled and/or conducted by the US Bureau of Reclamation, US Geological Survey, and Tamarisk Coalition since the completion of the Augmentation Study in 2007, and thus represents new information that should be considered.

The method of tamarisk control advocated would be dependent on site factors such as accessibility and infestation density. Options could include hand cutting with herbicide, mechanical removal, aerial herbicide application, or biological control. The method of revegetation post-control would be comprised of active revegetation using upland xeric species, or passive revegetation when it is clear that desirable species are able to colonize the site naturally.
While restoration of the tamarisk-infested upper terraces likely have the most potential for water savings, it should be noted that restoration of the entire river bottomland (not just the upper terraces) could be highly beneficial for enhancing riparian health and benefiting humans and wildlife. To the extent possible, efforts to restore the upper terraces for the purpose of potential water savings should be coordinated with those community groups focusing on restoring the lower, wetter portions of the bottomland in order to minimize costs and maximize benefits to the entire river corridor. While water savings from restoration of the wetter riparian areas is considered to be negligible as transpiration rates of typical native riparian species may be similar to that of tamarisk (Shafroth et al. 2010), coordinated restoration efforts could benefit many more users of the Colorado River Basin.

From an ecologic and economic perspective it could be important to consider managing Russian olive, another riparian invasive commonly associated with tamarisk. It is important to note that less is known about the potential water savings if Russian olive is replaced.

150 Flow Augmentation by Soil Stabilization

An article published in 2010 in the Proceedings of the National Academy of Sciences titled, "Response of Colorado River runoff to dust radiative forcing in snow," concluded: "The potential to reduce dust loading through surface stabilization in the deserts and restore more persistent snow cover, slow runoff, and increase water resources in the Upper Colorado River Basin may represent an important mitigation opportunity to reduce system management tensions and regional impacts of climate change."
Stabilization of the soil on portions of the Navajo reservation and nearby lands at Hopi shows promise of significantly increasing the runoff in the Colorado River system and should be supported in the report of the Basin Study.

2 Conversations to Limit Growth in Subject Area

We are near the point where no technical solutions will be possible to alleviate the problem. My suggestion is to begin a series of discussions among all concerned, about what social and economic changes will be necessary to slow and eventually halt, economic and population growth in the Colorado River Basin. I know stopping growth is impossible, yet somehow it has to be done.

9 Residential Housing Water Leak Reduction

Water Leaks Under House Slab

23 Water Conservation and Development of Water Need Plans

Ongoing programs that promote water conservation by individual households and cities of the greater Phoenix area have received attention and incentives in the past decade. I believe that additional conservation can be promoted by cities in Arizona, and the other Colorado River cities. Cities design boulevards which are commonly dressed with water-needy plants, bushes and sometimes lawn grass as well. The boulevards can maintain the trees and xeriscape plants, but should eliminate the bushes' and flowers that greedily swallow the water. The cities of Arizona can be motivated to improve water conservation and share ideas with other cities of the seven state region. Consideration of water saving devices such as a "cistern" could be used to trap rain water under city streets. (Idea from a water engineer for the City of Chandler) .
Water Needy Plants used for boulevards in the greater Phoenix area: Pittosporum Euonymus Boxleaf & Euonymus SilverKing Lycianthes Japanese Boxwood Myrtle Sage Bush

25 Municipal Efficiency: 1% per Year (Redundant with 69-81)

For the past two decades, per capita water use has decreased at an average of 1% per year across the Colorado River Basin. Given the increasing costs of water for customers, improvements in water efficiency technologies, increasingly stringent regulations of water use and waste, and utility campaigns to increase awareness about the value of water, replace turf with climate-appropriate vegetation, and a growing commitment to financially support water efficiency and conservation programs, this trend will continue into the future.
This option does not require any specific action; rather it assumes that historic and recent actions will continue, and will be adopted by more agencies, as the cost of water continues to rise and its availability continues to decline.

27 Water Efficiency Action Network of the Colorado River Basin (WEAN-CRB)

WEAN-CRB is an existing organization that may prove crucial in implementing some efficiency options proposed by the Colorado River Basin Study. The mission of WEAN-CRB is to collaboratively advance the understanding, application, and effectiveness of water use efficiency in the states of the Colorado River Basin. WEAN-CRB is currently in a pilot program phase that will operate during its first 2 years as an unincorporated ad-hoc organization with the Alliance for Water Efficiency as its fiscal agent. The Network encompasses government, non-governmental, public-private partnerships, and private interest entities from the municipal and industrial, energy, research, environmental, agricultural, and tribal government sectors. The bulk of the work of the Network is conducted by work groups organized around a specific task or work product related to advancing water use efficiency in the basin states. WEAN-CRB is managed by a 7-9 member Steering Committee with a balanced representation of basin states and types of organizations.
A White Paper that describes the feasibility/scoping assessment conducted for CRB-WEAN can be found at http://www.westernresourceadvocates.org/water/Misc/11-01-2011-Re_Revised%20DRAFT%20WHITE%20PAPER.pdf

29 Mandate Water Saving Technologies for Large Water Users

My observations of water wasting include the following points which require more stringent action toward water conservation:(MISSING TEXT)
1) drips, leaks, fountains, ponds and other such "amenities" in hotels/motels (remember one faucet dripping can waste 200,000 gallons in 24 hours)
I recommend mandating repair within 24 hours of first documentation of any water leak; ban fountains and ponds; plant flowers instead.
2) water in streets from broken lawn sprinklers; I recommend first banning all grass for landscaping use; use desert landscaping only. Ban all grass
from home landscaping; plant trees for shade & cooling.
3) too many golf courses; golf courses each use millions of gallons daily; ban new golf courses in housing developments; mandate reductions of water used on golf courses, for greens only, mandate invention offairways with other than grass which must be watered. For instance, use of wood chips, leaves and other such plant debris could allow balls to roll, bounce etc. and no water would be required. Arizona has hundreds of
these water guzzlers and a tiny percentage of population ever uses them at the expense of the majority of other residents.
4) mandate immediate replacement of all bathroom plumbing with laser flushing toilets and the auto-timed sink/faucet/soap dispensers and reduce paper waste by mandating installation of high power air hand driers.
5) mandate covering the CAP and other canals in the Phoenix area to prevent water evaporation
6) demolish all dams to allow ground water recharge by naturally flowing rivers
7) forbid anv new develooments which have no named proven source of water: an imperfect example of a community built "on air and promises

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32 Prohibit/ Eliminate New Large-Scale Diversions

Within the Colorado River Basin and “adjacent areas,” a combination of mostly non-structural options and strategies (e.g. temporary transfers of agriculturally-owned water to municipalities such as through water banking, reoperation of reservoirs, water reuse, and municipal demand management) eliminates the need for new large-scale withdrawals of Colorado River water (i.e. no Lake Powell Pipeline, no Flaming Gorge Pipeline, no CAP extension). The intent of this is option is to limit major, future depletions in streamflow within the Colorado River Basin.

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41 Urban Water Demand Management and Conservation

When confronted with an unlimited demand on a limited resource, ultimately the only remaining option is serious upfront demand reduction.*
This can be done "brutally" in emergency situations, with user regulation (no outside watering), use limits (i.e. 100 gpd per household), et cetera. But it can also be done intelligently, over an extended period of time, through education preceding regulation and limitation, so that a more enlightened populace will understand and accept the limitations of nature - especially if the education process shows that a reasonably high standard of living can still be had in a situation that "fits" natural limits.
This is not just a matter of "public education" as it is usually construed; it also has to focus on "educating the educators," especially the faculties that prepare their students for careers in public planning, engineering, landscape architecture, and business (land developers). Upfront demand reduction also must involve education at the level of county boards of commissioners, local and regional planning departments, real estate associations, and other entities intimately connected with land use policy. Maintaining "local land use control" is a maxim in much of the West, so a much greater effort has to be expended - by public utilities, state and federal government agencies (like the Bureau of Reclamation) to make
certain that the "local land use controllers" are reasonably enlightened about future water supplies. As the water suppliers in Tucson realized, we can no longer say, "let the people come, we will find the water for them." But this has to start with public entities and private developers beyond the direct control of the water providers - hence the need to enlighten those entities and developers.

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43 Evaporation Reduction by Limiting Man-made Water Bodies Including Pools, Lakes and Water Parks

According to the City of PhoenIx (1) 30 percent of the single family homes in Phoenix have pools, (2) evaporation accounts for about 40 to 60 percent of pool water usage in Phoenix, and (3) the mean annual evaporation rate In Phoenix is around 72 inches (6 feet). With global warmlng, it will just get worse. With more people moving into the state, it will just get worse.
Encourage the use of community swimming pools and do not allow construction of new swimming pools for single family homes. Create incentives for existing pools to be removed.
Do no allow the creation of man-made lakes or water parks.

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45 Reduce Outdoor Water Use

From research I have done on water use over the last few years, I have learned that the majority, perhaps 70% of water, is used outside. For example, agriculture generally consumes close to 70% of water in States or smaller areas. Urban water use follows a similar pattern, 70% of urban water is used for landscaping. With this in mind there are several suggestions that would conserve water.
1. Eliminate front and back lawns in the southwest, lawns are an unwise use of water.
2. Landscaping should be limited to plants that grow naturally in a given area, xeriscape.
3. Eliminate home swimming pools.
4. Limit the number of golf courses in a given area. The golf courses that are allowed are required to use only recycled gray water or water from sewage treatment plants.
5. With respect to agriculture: whenever possible, crops should be grown in areas that have sufficient precipitation so that irrigation using existing surface or ground water is minimal as possible.
I realize that these ideas conflict with private property rights, but the reality is that water, like air is not a private commodity. Laws recognize that air over a factory does not belong to the factory. As a society we need to come to the same realization that the water in the ground below private property does not belong to the owner, it is a community resource.

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57 Reverse Migration

Loss of jobs, rising utility costs, and diminishing quality of life throughout the rapidly warming Southwest, including most of Arizona, southern Nevada, and California's Inland Empire and Coachella Valley, upend demographic projections and lead to much lower population increases in these areas by 2025, and subsequent minor population decreases thereafter. Total populations in these areas will still be two million more than projected in 2015, but much less than projected by the Lower Basin states.

Temperature alone will not drive this option: large numbers of people already live in Phoenix, Yuma, El Centro, and other cities where summertime temperatures regularly exceed 110° F. Indirect impacts, however, may be significant. For example, in the face of rising summertime peak temperatures, the power grid increasingly will be unable to satisfy electrical demand. On August 3, 2011, in the grips of record temperatures, the grid operator in Houston imposed power cuts on industry in an effort to avoid rolling blackouts in the city. As the grid is unable to meet rising demand, rolling blackouts will discourage businesses and households from locating in these areas, and may encourage existing businesses and industries to move toward more areas with a reliable power supply. Less dramatically, the average household electricity bill in Phoenix currently is about $1,500 year; in the summertime, monthly household electric bills can exceed $500 for some customers. As utilities build new peaking-power generating stations to meet rising demand, at some point their rising costs and subsequent rising utility bills could discourage businesses from locating in these areas. Instead of moving to Las Vegas, Phoenix, or Yuma, will businesses and individuals instead choose to move to rust-belt cities with large existing capacity on the grid, ample water supplies, and under-utilized infrastructure generally?

Public perception will play a role here as well. One or more rolling summertime blackouts, where night-time temperatures – exacerbated by the urban heat island effect – do not fall below 110° F and people die, coupled with chronic water shortages and the loss of jobs, could create a general public perception that Southwestern cities are unlivable.

To date, the U.S. Census and state demographers have not incorporated climate change impacts into their population projections. Nonetheless, it is plausible that Southwestern cities will become less desirable places to live in the medium-term future.
If this is the case, the federal government could determine that it is more cost-effective and in the best overall interests of the country as a whole to incentivize business and industry to locate where water and energy supplies are less strained, than to subsidize water and energy augmentation schemes that will continually fail to meet rising demands in a hotter, drier Southwest.
Local rust-belt governments, chambers of commerce, and booster organizations also might provide incentives or campaigns to encourage people to move from the Southwest to their communities.

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58 Conservation Instead of Lake Powell Pipeline

I would like to see a comprehensive study conducted to evaluate water conservation in St. George, UT. It is my opinion that conducting the study, and implementing various water conservation measures such as those used in Las Vegas and Tucson wouldn't cost much,if any, more than what would be spent on the pipeline before one shovel of dirt is dug .

In addition, I suggest that everyone working on the Colorado River Basin Study be given a copy of the book "Compass and Gyroscope: integrating science and politics for the environment" by Kai N. Lee, and that they be encouraged to not only read it but to study it in depth. This book is the primer on Adaptive Management

61 Geyser Flow Control Device

This is a demand side application. This patented metal disk device is inserted in new and existing residential/commercial sprinkler risers of lawn and shrub irrigation systems. The design of the device limits the amount of water wasted due to sprinkler head and ri ser malfunctions (contingent benefit), and reduces the amount of lawn irrigation water wasted into the air as the result of "high pressure misting" (continuous benefrt). High pressure misting is the result of excess water psi delivered to the spray nozzle of a sprinkler head. Most residential/commercial sprinkler heads are designed for optimal performance at 25 psi, while the municipal water districts in the las Vegas Valley supply between 50 and 80 psi.

The device is currently being featured in the Southern Nevada Business Plan Competition, and the San Diego State University global new Venture Challenge and advanced by a team of UN LV MBNMIS students. It will also be entered into the Governor's Cup Competition. The device is also being tested on the UNLV grounds.

67 Leveraging Utility Scale Water Efficiency Programs to Support Local and Regional Environmental Enhancement Using the Conserve to Enhance Mechanism

Leveraging utility scale water efficiency programs to support local and regional environmental enhancement using the Conserve to Enhance mechanism

69 Municipal Efficiency: 1% per Year (Redunant with 25)

The water efficiency “tool-box” is immense, growing every day, and easily tailored to individual municipal water providers. Please see the attached, non-comprehensive list of individual water efficiency measures that could be implemented to achieve a 1% per Year reduction in per capita use. Respected water conservation experts state that current overall municipal demand can be reduced by up to 50%.

70 Water Loss Control and Reduction

Water loss control is the practice of system auditing, loss tracking, infrastructure maintenance, leak detection, and leak repair for municipal water utilities. Auditing a water distribution system for real and apparent losses and evaluating the costs of those losses is the foundation of water loss control. Real losses are actual physical losses of water due to leaks or other problems with the system. Apparent losses are due to meter inaccuracy, unauthorized consumption, and data handling errors. Water auditing and loss control give water utilities the potential to conserve significant volumes of treated water by reducing real losses and to increase revenue by reducing apparent losses. Water loss control is a foundational, cost-effective water conservation practice that should be implemented by every utility in the basin.

71 Landscape Design Regulations

The concept of design regulations is to ensure new landscapes are "water smart from the start". Across the Colorado River basin, urban landscape irrigation accouts for 50%, or more, of the total annual water demand for a utility. Decreasing the quantity of water used by choosing regionally appropriate plants, and improving the efficiency of water use through improved irrigation practices is perhaps the single most important urban water conservation effort than can be made in the basin. If all new landscapes are designed with water efficiency as a priority, there is tremendous potential to reduce future demands below what they might be otherwise.

72 Landscape Water Budgets

Across the Colorado River Basin, urban landscape irrigation typically accounts for 50%, or more, of the total annual water demand for a utility. Landscape water budgets are a powerful conservation tool for addressing landscape water use and encouraging efficiency. A landscape water budget compares actual metered consumption against the legitimate outdoor water needs of the customer based on landscape area, plant materials, and climate conditions. Because many landscapes, particularly turf, can accept excess irrigation without damage, many irrigators are not aware of whether they are using water efficiently or grossly over-irrigating. A landscape water budget provides a reasonable target level of water use that is customized for each customer and landscape. Water budgets help water users better understand their consumption patterns and make sound decisions about how to best manage irrigation properly.
Water budgets provide utilities with a powerful tool for identifying which customers are over irrigating and could most benefit from efficiency improvements. Water budgets can be incorporated into a utility rate structure but they are also useful in their own right outside of a rate structure as a tool for assessing water use.

73 Enforcement of Water Waste Ordinances

A water waste ordinance is a local regulation that explicitly prohibits the waste of water from a variety of sources including (but not limited to) excess irrigation runoff, irrigation occurring a prohibited day and/or time, excessive pavement washing, failure to repair leaks, utilizing single-pass water cooling, or improper maintenance of cooling towers.

A water waste ordinance is an important regulatory tool for water utilities that serves several useful purposes, including: 1) establishing the importance of wise water stewardship in a community and a utility's intent to put its water resources to maximum beneficial use; 2) establishing penalties for the latant waste of water; and 3) providing an important regulatory "stick" during a drought when agency-wide restrictions are put in place and enforcement is required to ensure water supplies are adequate.

74 Water Audits

Water surveys and evaluations - frequently referred to as “audits” – identify water savings opportunities and educate customers on water wise behavior. Audits are also a practical, non-regulatory approach to improving water use efficiency. During a water audit, a trained technician evaluates the efficiency of all points of water use on the property. Audits then identify concrete methods for reducing water waste, improving efficiency, and often reveal leaks and unintended water usage of which some customers are
simply unaware. Audits can be used to evaluate indoor, outdoor, and non-residential sectors, but in all cases, should be targeted first to high volume customers in order to maximize water savings and minimize program expenses.

75 Public Education and Awareness Campaigns

Public information and education are broad best practices that encompass social marketing, school education, public outreach, and other informational efforts aimed at raising awareness and fostering a culture of conservation and behavior change. Central components of a successful campaign include effectively communicating the value of water, and delivering consistent and persistent messages about the importance of conservation and efficiency efforts. Examples from Denver Water’s “Use Only What You Need” campaign are especially effective:

76 Lawns to Xeriscape

Replacement of residential and commercial turf-grass lawns with lowwater use vegetation and prohibitions on installation of new turf. Such replacement programs have been successful in several regions, with demonstrated savings in consumptive water use.
Although providing rebates for turf replacement can be relatively expensive (SNWA now offers $1.50 per square foot), water agency rebates can reduce the total cost to the end user. Combined with real-cost water pricing and creative public service messages, such rebates can incentivize people to tear out their water-hogging lawns and replace them with climate-appropriate vegetation. Additionally, local governments have prohibited turf installation in new commercial developments, in new residential front yards, and as more than 50% of backyard landscaping. The combination of incentives and regulations can effectively reduce outdoor irrigation demand and yield consumptive water savings.

77 Inclining Block Rates

Consumers respond to appropriate price signals. Through an inclining block rate structure, the unit price for water increases as water use increases, as shown in the figure below. Customers who use low or moderate volumes of water are charged a modest unit price; those using significantly higher volumes pay markedly higher unit prices. When designed properly, this approach generates a strong financial incentive to conserve while ensuring that lower-income consumers are able to meet their basic water needs at a reduced cost. A 2003 survey of water rate structures in the southwest United States found that per capita water use is typically lower in cities with dramatically increasing block rates, such as Tucson and El Paso. Water agencies can structure increasing block rates to offset declining revenues associated with reduced water sales, by shifting the cost burden to high water users.

Many water agencies are moving beyond simple volumetric pricing and are beginning to more consistently implement rate structures and pricing policies that communicate the value of water and encourage efficient use. Increasing block rates are among the most common conservationoriented rate structure implemented by water agencies, though the rate structures vary across water agencies, as shown in the figure below. A greater number of tiers and steeper changes in rates between tiers, combined with low fixed charges and low or inclining block rates for wastewater, are most effective.

78 Residential Retrofits

Replacement of residential fixtures and appliances – such as toilets, showerheads, dishwashers, and clothes washers – with high-efficiency models, and installing faucet aerators. This option will reduce water demand and save energy throughout the residential sector. Municipal water agencies can offer rebates or vouchers to customer, to subsidize the cost of new, high-efficiency fixtures and appliances; such programs have proven successful in many areas using Colorado River water. Local or state governments can adopt “retrofit on resale” or “retrofit on reconnect” regulations, requiring that properties changing ownership have high-efficiency fixtures and appliances. California recently adopted such an ordinance. Such requirements shift the costs of replacement to the end-user, who benefits from lower water and energy costs. Municipal water agencies can also identify pre-1995 homes – those most likely to have low-efficiency fixtures and appliances – and target rebate and voucher programs to such homes, especially in lower-income areas that might be less able to cover the initial up-front costs.

For example, installing five million showerheads and five million faucet aerators throughout the basin states, in residences using Colorado River water, would require an initial one-time investment of about $180 million and would reduce water demand by an estimated 80,000 acrefeet annually for a period of ten to twelve years. The energy savings (from avoided water conveyance and especially from avoided water heating costs, as well as from avoided water treatment costs) would generate a very fast return on this investment, so that total costs would be negative.

79 Commercial Retrofits

Replacing conventional fixtures and appliances with high-efficiency commercial toilets, urinals, clothes washers, restaurant pre-rinse spray valves, pressurized water brooms, and cooling towers can reduce water demand and save energy throughout the commercial and institutional sectors. Municipal water agencies can offer rebates or vouchers to commercial and institutional customers, to subsidize the cost of new, high-efficiency fixtures and appliances; such programs have proven successful in many areas using Colorado River water. Local or state governments can also require high-efficiency fixtures and appliances in commercial and institutional establishments (such as schools, stadiums, and airports).

80 Metering Multi-Family Use

A simple economic principle tells us that when people must pay for a resource, they will use less of it. Most single family residences using Colorado River water are now billed according to their actual use, rather than by a flat rate. However, most multi-family residences are not metered and so cannot be billed according to actual use. Installing water meters for multi-family residential customers and charging them for the water they actually use would substantially reduce water demand, and would enable implementation of inclining rate block structures (see "Rate Structure" option). In addition to reducing household water use, meters are also critical for effective management of the water system. Water providers can use this information to target water conservation and efficiency programs to particular customer classes and determine the program's effectiveness. Meter data is also an extremely valuable audit tool that can help locate leaks within the distribution system and at the customers' homes. New ordinances could require sub-meters on all new multi-family residences, and could require the installation of sub-meters on existing multi-family residences with a reasonable period of time.

81 Pool Covers

Swimming pools are very abundant in many parts of the Southwest – more than 300,000 in metro Phoenix alone. They are water and energy intensive. Pool covers reduce evaporation, saving water. Some municipal agencies provide rebates to those purchasing pool covers. Similar programs could be implemented throughout the Southwest. To achieve greater, more permanent and verifiable water savings, water agencies could also provide rebates to homeowners who remove their swimming pools.

107 Change of Current Water Policies

It is clear that the Colorado River is close to being overstressed already. Of course this is in part due to the ongoing change in climate that we are experiencing. It is also obviously in part due to the tremendous increase in population in the region. What most people do not understand is the amount of waste of fresh that could be controlled if we so desired. We will be forced to do so eventually if we do not take preemptive steps to get ahead of the issue.

To begin with I would severely restrict the current usage of water in all of the affected States. Arizona and California in particular should be instructed to severely restrict all exposed water resulting in rapid evaporation such as in swimming pools (private especially) and fountains (as in the Las Vegas area).
Reducing reservoir surface areas by reducing their size, at least, would also be a step in the right direction.
Limiting the size of grass lawns and perhaps banning them in some areas, like subdivisions, would be extremely helpful.
Gradually converting home water systems to reuse all but toilet water onto lawn plants would help keep some lawns with less fresh water use.
Also needed to get people's attention would be a consistent water use fee schedule that would allow for a minimal fee for low usage of fresh water and ever increasing rates for use of more and more fresh water until it becomes ridiculously expensive to own, say, a private swimming pool or a huge lawn in a desert setting which is ludicrous at best anyway.
All states in the system are going to have to be restricted as to their allotment by percentage come 'hell or high water'. States that are in fact a desert should be even more severely restricted as what they are doing is counter to their
natural settings anyway.
These are just some of my thoughts on the problem and I am certain they are far from original. However I do understand that we all must take responsibility for what is happening and the changes that are necessary to sustain our futures.
The insanity of our current water policies must stop now before it is too late.

119 Colorado River Basin-Wide Per Capita Water Use Goal

NRDC recommends the creation of a Colorado River basin-wide performance based goal for improved water use efficiency. The Pacific Institute's recent report on municipal deliveries in basin states (http://www.pacinst.org/reports/co_river_municipal_deliveries/) identified a long-term, basin-wide trend toward improved efficiency. Across the basin, many water agencies have achieved average improvements in per capita water use of at least 1% per year from 1990 to 2008. Similar results have been documented nationally (See Rockaway et al, "Residential Water Use Trends in North America," AWWA Journal, February 2011). This ongoing trend should be considered the baseline for water use efficiency improvements in the basin. We recommend that a basin-wide goal should be at least as ambitious as doubling this baseline, resulting in at least a 20 percent reduction in per capita water use within a decade. As discussed below, California has established a similar goal of increasing per-capita water use 20 percent by 2020.

131 Proposal to Include Water Savings from the Implementation of New Product Standards in Baseline Water Use Projections

The Bureau of Reclamation should consider product standards that have been or are on track to be adopted when calculating projected baseline water demand for the region. Specifically, NRDC recommends that the Bureau include water savings that will result from implementation of the consensus agreements for clothes washers and dishwashers currently undergoing Department of Energy (DOE) rulemaking. The consensus agreements were negotiated by manufacturers and efficiency proponents in 2010 and a DOE final rule is expected this year (2012). Additionally, NRDC recommends that the Bureau include water savings that will result from the implementation of the California toilet standard in the baseline water demand projected for California.

The details for each standard that NRDC recommends be included in baseline water demand projections are included below:
Top-Loading Clothes Washer: 1.72MEF/8.0WF, effective 2015; and 2.0MEF/6.0WF, effective 2018
Front Loading Clothes Washer: 2.2MEF/4.5WF, effective 2015
Standard Dishwasher: 5.0 gallons/cycle, effective 2013
Compact Dishwasher: 3.5 gallons/cycle, effective 2013
Toilet (CA only): 1.28 gallons/flush, effective 2014

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132 Proposal to Include Water Savings from Proposed Product Standards in Conservation Scenario Demand Projections

The Bureau of Reclamation should consider proposed product standards when estimating conservation scenarios for projected water demand for the region. Specifically, NRDC recommends that the Bureau include potential water savings that would result from implementation of the WaterSense standards for lavatory faucets/faucet aerators, showerheads and toilets.

The details for each standard that NRDC recommends be included in conservation scenario water demand projections are included below:
Lavatory Faucets/Faucet Aerators:
Current Standard – 2.2 gallons per minute (gpm) at 60 pounds per square inch (psi)
Proposed Standard – 1.5 gpm @ 60 psi

Showerheads:
Current Standard – 2.5 gpm
Proposed Standard – 2.0 gpm

Toilets (all states except California*)
Current Standard – 1.6 gallons per flush (gpf)
Proposed Standard – 1.28 gpf
*CA already adopted the proposed standard for toilets and it will be effective in 2014. Savings from this standard should be included in the baseline projected water demand.

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149 All Communities Must Respect Limits of Available Water in System

Over the millennia of their life in what is now the American Southwest, tribal people have dealt with the limits of a highly variable water supply. The more recently settled non-Indian communities must likewise understand and deal with these limits. Future population growth and economic development in the non-Indian communities of the Colorado River Basin must be conditioned by the federal, state and local governments on the availability and sustainability of the water resources necessary to support such growth and development without impacting the terms of tribal settlements.

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151 Assisted/ Smart Irrigation and Precision Farming (fertilizer applications) in Urban Settings

In order to balance water supplies and demand, water must be measured and compared to scientific, flexible irrigation water budgets. Numerous states support weather stations whose principal purpose is to inform irrigation managers of when to irrigation. But recent research indicates that a very small portion of large water users "swallow" this now decades old best practice, best prescription (Bautista, Needham, and others). Since the early 1980's, aware, thoughtful people have known the ET methods were rife with error, demanding regular ground-truthing. This option addresses that failure in the interest of good science, and more water left or diverted back to the streams. Not pumped or treated saving huge amounts of energy.

In short, Wi-Fi mesh networks arrayed across the interface between agricultural and urban landscapes measure soil moisture at up to three depths, concurrently with valve-discrete flow monitoring, all played out in a GIS, for the whole world to observe, and contemplate. Those observers are implored to "Jump on Board", at their separate risk, to the sensor and conditions nearest and which most resemble their own situation. Watch in wonder what happens!

-Allows the transfer of water to other uses to meet critical needs for water supplies;
-Forces a reversal of the mind-set "use it or lose it"
-Decreases diversions from waterways;
-Reduces pressure on groundwater aquifers;
-Use or transfer the water conserved;
-Increases operational flexibility (constructing aquifer recharge facilities or making system optimization and management improvements); and
-Increases water flow data and improve monitoring of hydrologic conditions to allow water users to closely control water diversions and consumptive use ("Water measurement is the first rule of water management" unknown).

But, we are seriously remiss is we do not quickly add the secondary dimension of this option. Energy-dependent, groundwater tainting nitrogen fertilizer is nearly as important. It too should be discretely measured so it can be managed, and I mean relative to plant tissue concentrations through plant growth stages. Changes in vegetative quality or biomass production or yield is then attributed crop prices, water prices, and weather factors as these are the drivers (Needham, 2005), since these macro-inputs are costly, and regulated. So the escalating prices of water and energy spurs improved water delivery and management practices. Better flow monitoring and soil (or plant) monitoring reported on secure web-enabled GIS maps are designed and managed by irrigation districts and county governments, and mandated by new legislative actions if necessary, because property rights must balance with sustainability, and a new commitment by all citizens to community and sharing of the commons.

Agricultural Water Conservation

19 Assisted/ Smart Irrigation and Precision Farming (fertilizer applications) in Agricultural Settings

In order to balance water supplies and demand, water must be measured and compared to scientific, flexible irrigation water budgets. Numerous states support weather stations whose principal purpose is to inform irrigation managers of when to irrigation. But recent research indicates that a very small portion of large water users "swallow" this now decades old best practice, best prescription (Bautista, Needham, and others). Since the early 1980's, aware, thoughtful people have known the ET methods were rife with error, demanding regular ground-truthing. This option addresses that failure in the interest of good science, and more water left in the streams.

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31 Controlled Environment Agriculture (greenhouse production)

The use of hydroponic and aquaponic (aquaculture + hydroponics) production methods in greenhouses has existed since the 1970's and continues to expand world-wide as a means to feed the rapidly growing world population while aiming to improve crop yields and to more efficiently use water resources.

Controlled Environment Agriculture simply means to grow crops in greenhouses. By covering acreage with greenhouses, farmers are able to increase productivity from 3-6 times over traditionally farmed acreage. Hydroponics is the soil-less culture of plants through recirculating systems. Aquaponics is "organic" hydroponics – where fish production is combined with growing plants. Microbes convert the fish "waste" into safe, organic fertilizer for the plants in the recirculating systems. When CEA and hydroponics/aquaponics are combined, studies have shown production increases of anywhere from 10-15 times traditional farming methods.

CEH research demonstrates anywhere from 70-99+% water savings over traditional (uncovered, soil) farming practices, depending on crop type. In certain states (New Mexico, for example), 50% or more of the water usage is attributable to growing forage for livestock. Mexican hydroponic forage research demonstrates 0.2% of water use compared to traditional methods, or a water difference of about 50:1. Furthermore, these methods save land, produce uniform crops and maximize yield in an efficient and environmentally friendly way.

These tools save water by constantly recirculating the same water throughout the system. Hydroponic/aquaponic systems only require the producer to top off the water (approximately 1-2% of the total water volume) on a daily basis. The minor loss is attributed to evaporation of the water from the systems and transpiration of the water by the plants.

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53 Agricultural Conservation and Efficiency

This options calls for the implementation of a suite of agricultural conservation and efficiency strategies to decrease the agricultural sector's total demand for water and total consumptive use. These strategies include:

1. Efficient Irrigation Technology – shifting from flood to sprinkler and drip irrigation;
2. Improved Irrigation Scheduling - using local climate and soil information to help farmers irrigate more precisely to meet crop water needs;
3. Improved Salinity Management – using soil salinity assessments and crop salt-tolerance information to help farmers more precisely determine the volume required for leaching;
4. Regulated Deficit Irrigation – applying less water to crops during drought-tolerant growth stages to reduce crop consumptive use;
5. System Efficiency – lining canals and laterals, tailwater pump-back systems, real-time irrigation water scheduling and delivery, and regulatory reservoirs; and
6. Crop Shifting – farmers shift from more water-intensive crops (such as alfalfa) to less water-intensive crops.

Note that some of the six strategies listed above will reduce consumptive use, while others reduce demand for total applied water, with limited consumptive use savings. To avoid distracting arguments about the appropriate scale for determining water savings, this option assumes that only strategies #4 and #6 will be implemented within the Colorado River basin as part of this option, and that all six strategies will be implemented in adjacent areas relying at least in part on water exported from the basin. For these adjacent areas, any reduction in water demand translates into a one-for-one reduction in exports, making all that water available for other users, inside or outside of the basin.

This option does not include any reduction in irrigated acreage beyond that shown in the states' own basin study projections.

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54 Irrigation Infrastructure Modernization Program to Improve Efficiency

It is widely understood that irrigation for agriculture in the Colorado River Basin accounts for 85%-90% of water use. Modernization of antiquated irrigation delivery systems with technology can dramatically improve delivery efficiency of irrigated water by 20%. The improvement in efficiency results in water that is measured, managed and controlled. Water that would previously be lost in operational spills, overages to farmers beyond their water right & needs, and overtopping ditch banks can be controlled through improved infrastructure and new technology. Operational costs to irrigation districts can be reduced and farmers can realize improved service levels.
The Colorado River Basin Study mirrors a similar exercise done for the Goulburn- Murray River Basin in Australia. This basin covers an area of 26,200 square miles in an arid region similar to the American Southwest. The 2.4 million acre feet of water within this basin are distributed to more than 16,000 farmers over 4,100 miles of canals.
In 2007, in the midst of the worst drought on record, the Australian Federal Government explored options to reduce water use for irrigation through conservation, similar to the QSA agreement between Imperial ID and MWD in California. The Federal Government committed $1billion as the first stage of a complete implementation of technology across the irrigation delivery system infrastructure. Rubicon Water was selected to supply this unique and revolutionary technology throughout the Goulburn-Murray Basin.(MISSING TEXT)

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83 Reduction of On-farm and Conveyance Evaporative Losses and Deep Percolation

A significant portion of water applied to crops is lost to the system through evaporation and deep percolation that does not return to the stream. Under traditional flood or furrow irrigation, up to 30% of water applied to a field may be lost to evaporation.

1. Similarly, while some water that is not consumed by crops infiltrates into the soil and makes its way back to the river system in the form of return flows, other water infiltrates below the root systems and does not return to the river (deep percolation). Water may also be lost in these ways during conveyance, especially when delivered through open and unlined canal systems.
These losses can be minimized in a variety of ways:
(1) Conversion to more efficient irrigation, particularly subsurface drip irrigation
(2) Precision application and timing of irrigation water
(3) Conservation tillage and mulching
(4) Conversion of open canals to pipes
In different ways, each of these tools can reduce the amount of water consumed by evaporation or deep percolation and lost to the system. The percentage of applied water lost to evaporation depends on the irrigation system and frequency of water application as well as the ground covered either by crop foliage or conservation mulch and tillage systems. Conservation tillage practices and water applications that match soil moisture conditions can reduce evaporation by up to 80%.

2. Flood and furrow irrigation systems may result in overwatering which leads to high rates of evaporative loss during the irrigation event. These consumptive losses can be reduced significantly through the use of subsurface drip irrigation or other more efficient mechanisms. Measurement and precision application of the quantity and timing of irrigation events to match soil moisture conditions and crop water needs have also been shown to reduce evaporative losses.

3. Regulated deficit irrigation practices during drought tolerant growth stages of some plants will also reduce both total water demand and evaporative losses from over-watering.

4. Evaporation and seepage losses may also occur during conveyance. These evaporative losses are relatively small but in aggregate across the Basin account for a significant amount of water lost to the system.

5. Water trusts in the Pacific Northwest have begun to pipe open canal systems to provide more reliable water delivery to irrigators and negate transmission losses, including evaporation.

6. Such a practice, if appropriately applied to negate impacts on downstream users that rely on return flows, may also be applicable in the Basin.

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90 Watershed Management Improvements (Soil Grouting, Irrigation Practices, Utilizing Stock Ponds and Small Diversions)

Soil Grouting - Soil grouting is the injection of slurry or grout into the subsurface profile of soil. The grout fills cracks and voids in the soil and is used to make the soil more water resistant/impermeable. Soil grouting could reduce the amount of water seepage around dams and water delivery systems and consequently, trim down water losses. In addition, soil grouting can increase soil stability in areas where water flow control is a problem.

Irrigated agriculture - The use of Colorado River water could be much more efficient via better practices. improving irrigation practices could be achieved by effecting changes in the ways farmers use water in semi-arid deserts like the Imperial Valley. The science surrounding water conservation for irrigation practices is constantly improving. Providing funding and incentives for irrigation conservation in local watersheds could improve the use efficiency of imported water during times of critical need.
Removing illegal small diversions and unnecessary stock ponds. In local catchments of the San Diego area, upstream of reservoirs, there are a lot of stock ponds and small diversions. These supply relatively valueless livestock and agricultural operations. Losses in these probably account for significant water. The elimination of these stock ponds and small diversions could allow us to retain more runoff for our reservoirs and increase our local suoolies for more beneficial uses. Other iurisdictions could beain us this same tactic and imorove their watershed suoolies.

99 Water Pricing Reform

Comprehensive review of Bureau of Reclamation's rates charged for water deliveries to contract holders throughout the Colorado River Basin. Potential adjustment of rates to bring them in closer alignment with market conditions (and thereby promote water conservation). This option would extend to holders of BCPA section 5 contracts for mainstem water deliveries in the Lower Basin (e.g., Imperial Irrigation District, Metropolitan Water District) -- who currently are charged nominal or no fees for these deliveries - and also to holders of contracts for water deliveries from reclamation projects located in the Upper Basin and on the Lower Basin tributaries .

118 Reduce Cattle Production and Beef Demand

According to the USDA, per capita beef consumption has been falling for more than 20 years, and total beef production has been falling since 2008, as shown in the following graph. Under this option, these trends will accelerate, through a combination of federal actions, continuing non-federal public campaigns such as “Meatless Mondays” and municipal water agency payments to incentivize shifting from water-intensive forage crops to less water-intensive crops.

138 Agricultural Field Restoration Utilizing Native Grasses

Native grasses require approximately 50% or less total volume of water per acre than many traditional agricultural crops such as alfalfa and cotton. The native grass crop can be used as forage, cover or harvested for hay for feed or seed banking. Conversion of existing crops to native grasses will result in; reduced consumptive use of water, reduction of long term expense and operational resiliency in the face of drought.

13 Power Plant Air Cooling Conversion - Navajo Generating Station

The retrofit would be limited to decommissioning the existing wet cooling system and would require installation of 6 air cooled condenser units. Expansion of the Navajo Generating Station's site footprint would be required to accommodate for the larger dry cooling system equipment.

18 Reform of Gas and Oil Industry

The gas industry is wreaking havoc on surface and groundwater resources across the west. In the Raton Basin where I live, over 16,000 acre feet of produced water is pumped out of the ground annually. This saline and potentially contaminated groundwater is then dumped into the live waters of the State or deep injected if it is exceptionally nasty. In either event, its contribution to the watershed is negative and or deleterious.

Two studies have been done in our area that both conclude that streams and rivers will experience reduced flows in the future due to the massive scale water withdrawals being done now. The water table is being negatively affected. Domestic water wells have been impacted and many that have been reliable producers for decades are running dry.

Produced water must be cleaned up to potable standards and injected into the shallow domestic aquifers currently being impacted.

28 Demand Management at Thermoelectric Power Plants

Thermoelectric power plant consumptive demand can be significantly reduced and/or eliminated through aggressive demand side management and a transition to more water-efficient power supplies (e.g., wind, solar PV, and combined cycle gas facilities).

126 Understanding and Reducing the Energy Industry's Consumption of Colorado River Basin Water

The energy industry is evolving rapidly across the West. Investments made by this industry will have significant implications for future water use. We offer the following recommendations to understand and reduce the amount of Colorado River water used by the energy industry and to reduce related impacts on the environment and other water users.

1. Renewable energy investments are growing rapidly. Some renewable energy sources (e.g. thermoelectric solar) can require significant amounts of water. However, different solar technologies have different water requirements. For example, photovoltaic projects have very low water use. Dry-cooled thermoelectric solar can require some "make up" water for boiler systems and water to wash heliostats. By contrast, wet-cooled thermoelectric solar has dramatically greater water requirements. We recommend that basin states establish a priority for dry-cooled solar thermoelectric projects and solar PV. In particular, we recommend that basin states consider adopting the California Energy Commission's policy (32 California Energy Commission, Preliminary Staff Assessment, Beacon Solar Energy Project, Application For Certification (08-AFC-2), Kern County (Posted April 1, 2009), p. 4.9-5.), which represents a de facto prohibition on wet cooling for solar facilities in California's desert regions, except in very limited circumstances. Such policies would encourage renewable investment in less water intensive technologies, producing significant water savings.

2.We recommend that state and federal regulators require the operators of oil and gas drilling operations to submit a plan for cumulative water use over the life of the project. The plan should take into account other activities that will draw water from the same sources, such as agricultural or industrial activities; seasonal and longer timescale variations in water availability; and historical drought information. Elements of the plan should include but are not limited to:
-The anticipated source, timing, and volume of withdrawals and intended use, over the life of the project.
-Potential impacts on other water users.
-A description of methods the operator will use to maximize the use of non-potable water sources including reuse and recycling of wastewater.
-An evaluation of potential adverse impacts to aquatic species and habitat, surface water, groundwater, and wetlands.

3. The Bureau of Reclamation should complete, as a part of the Basin Study, an estimate of potential total water use by the oil shale industry, based on a range of assumed levels of future development. This effort should include an analysis of the potential impacts of such water use on other water users and on aquatic resources, particularly in light of the Bureau's current projections of possible future water shortages.

System Evaporation Reduction

1 Evaporation Reduction via Floatovoltaics Systems

Using floating solar photovoltaic panels (Floatovoltaics®) , open surfaces of water bodies can be transformed into generating green energy and saving water from evaporation in addition. This option uses no land, improves water quality and maximizes return on investment.

For Colorado River basin, a basin-wide application of the option would lead to water savings which can be used in reducing longer term water shortfall. In addition, installing Floatovoltaics® would increase water security in times of drought.

Both the sale of the electricity generated form previously non-revenue generating surface area of water, and water savings from reduced evaporative losses, make this proposal most attractive.

Here, I suggest conducting a preliminary assessment and cost/benefit analysis of reducing evaporation losses from open surfaces of water bodies in the entire Colorado River basin using solar Floatovoltaics® systems. I also request developing a stake holder participation-based business model for this option.

10 Evaporation Reduction at Canals by Covering with Solar Panels

Solar Paneling over all of the Arizona and California (All American Canal) canals

37 Optimization Study of Evaporation Loss

This proposal calls on the Basin Study to model a water management scenario in which the water storage and delivery infrastructure of Colorado River Basin system is managed to minimize evaporation loss, without regard for effects on hydropower or other resources.
This proposal is not intended as a plausible operational scenario that would be implemented in the real world, but instead as a modeling exercise that would place an upper bound on the amount of water that could potentially be saved by minimizing evaporation. This information could then be used to inform the development of more realistic operational scenarios in which tradeoffs are made with potentially competing uses such as hydropower and environmental flows.

44 Evaporation Reduction from Reservoirs and Canals

Evaporation rates at Colorado River reservoirs (Powell, Mead, etc.) constitute major losses of water in the Colorado River system - losses that are not put to 'beneficial use', as defined by most water users. In fact, evaporation rates at Lake Powell and Lake Mead (330,000 acre-feet (af) and 740,000 af, respectively) are greater than water amounts transported to Las Vegas and Salt Lake City metro areas (290,000 af and 140,000 af, respectively).
Evaporation rates of these two major reservoirs are so high primarily because of the desert environments in which they are located. These environments have high summer temperatures, low relative humidity, and intense solar inputs.
In an effort to reduce evaporation rates at these reservoirs, while also producing clean, renewable energy, the BOR and other land and water management agencies should consider covering many portions of Lake Powell and Lake Mead will solar panels. Solar panels would simultaneously utilize solar inputs to create electricity and prevent evaporation. Electricity produced could be transported by existing lines from Hoover and Glen
Canyon Dams. Solar panels could be mounted to dry land and span arms of reservoirs, or could be harnessed on floating 'piers'.
This solution would turn an existing problem (solar inputs and evaporation) into a financial benefit (clean energy) and increase water supplies in the Colorado River Basin. The project would meet the President's goal to create sustainable, clean energy & would meet Colorado River compact users' goals of increasing capacity in the Basin. (MISSING TEXT)

86 Reduce Surface Water Evaporation via Floating Photovoltaics or Plastic Balls

By installing solar panels floating on lakes, lagoons or ponds, the panels are naturally cooled, resulting in improved power production. In turn, the solar panels shade the water, limiting algae growth and helping reduce evaporation. (Source: http://www.waterworld.com/index/display/articledisplay/291 84266091articIes/waterworld/water-utiIity _management/2011 109/floati ng-solar-systems-provide-power-envlronmental-benefits.htm 17cmpid=EnIWaterWorldCISCRMOctober272011)
High surface area coverage Is achieved by placing a sufficient amount of plastic balls on the surface of the liquid. The balls arrange themselves to provide coverage of up to 91 %. The result is a thermal insulation barrier which combines the insulation factor of the air held in each ball with the poor heat conductivity of plastic. While the air pockets between the balls are not sealed, they also contribute to this insulation system, which dramatically reduces heat loss and light transfer. The cover also reduces liquid loss through evaporation and prevents odor problems. (Source: http://www.paradisenw.com/armocball_cover.php)

133 Eliminating Water Loss by Cutting Evaporation by 50%

Every year the Colorado Basin Reservoirs lose 2,466,000 acre-feet of water to evaporation. Lake Mead accounts for over 900,000 acre-feet or around 7.5 feet depth loss to surface level. From the start of the recent drought in 2000, if the water loss strictly to evaporation was added together, a total of 82 feet of water loss would have occurred during this 11 year period. This is if no water was going out of the reservoir and no water was coming into the reservoir. Evaporation cannot be ignored any longer. Using all the tools for water conservation is the best avenue to having this water last beyond 2050. In 2003, a new solution to decrease evaporation was invented and has been used on reservoirs with great success. The product branded, Aquatain reduces evaporation by 50%. Thus if Aquatain had been used from the year 2000, it would have saved 41 feet of water depth from the Lake. Aquatain is a liquid based on silicone that can be poured onto a body of water where it will form a very, very thin layer right across the top, hence retarding the ability of the sun, wind and weather to evaporate the water – reducing losses by 50%. The inventor, Graham Strachan, invented this anti-evaporation liquid to combat the droughts in Australia.
Evaporation is more complex than you might think: it's not just about the sun heating the water, but also the action of the wind along with several other factors. When molecules of water get energetic enough (because of sun or wind energy, or their ambient temperature in relation to the external temperature) and they're at the surface of the water body, then they can cross the liquid/gas threshold and literally escape into the atmosphere as a gas.

Reservoirs such as Lake Mead have a great depth to the water which actually decreases the amount of surface area available thus reducing evaporative losses. Evaporation can be retarded by building dams deeper to reduce the surface area in proportion to the total volume of the dam, and by building wind breaks to shade the reservoir from the action of wind. However, this isn't any good for an already established reservoir that's losing thousands of acre-feet of water into the air. What is the solution then?

Since the 1950s attempts have been made to use anti-evaporation liquids to stop water from evaporating, but all solutions to this time have needed almost daily re-application. At their best these anti-evaporation liquids have reduced evaporation by 30% or 40% and require special storage specifications.

Lake Havasu, a reservoir used for drinking water, uses its own anti-evaporation method shown below by trying to cover its lake surface by as many boats as possible. Using the anti-evaporation liquid, Aquatain is a solution that is much less resource-intensive than covering the lake surface with boats.
Aquatain is the first anti-evaporation film that is based on silicone as a polydimethylsiloxane. The basic idea is that if you could create a film or monolayer (layers that are one molecule thick) over the surface of the water, the action of evaporation (water turning into water vapor) could be decreased.

Simple to apply, Aquatain will be poured onto the surface of Lake Mead to cut evaporation dramatically. Rain water falls straight through Aquatain into the reservoir and the Aquatain film re-forms above it.

136 Reservoir Evaporation Control

The evaluation of this option addresses methods for evaporation control at the two largest Colorado River reservoirs: Lake Mead, located in southern Nevada, and Lake Powell, located in southern Utah and northern Arizona. The former covers 250 square miles behind Hoover Dam, and the latter covers 260 square miles behind Glen Canyon Dam. Both lakes are located in arid climates, with evaporation rates estimated to be 80 inches per year and 50 inches per year, respectively (United States Bureau of Reclamation [USBR] 2006b). This comes to an approximate loss of 1.7 million acre-feet per year (AFY) through evaporation for both reservoirs when Lake Powell is at elevation 3,700 feet (24.3 million AF) and Lake Mead is at elevation 1,221.4 feet (26.2 million AF).

The method considered to control evaporation is the use of preferential storage in Lake Powell.

Evaporation control could be achieved by managing changes between Lake Mead and Lake Powell. When the stored water in these reservoirs is significantly low, evaporation can be reduced by allowing all reductions in stored volume to be taken from Lake Mead. While maintaining a full Lake Powell, the lowering of Lake Mead would reduce the surface area and would reduce the water lost to evaporation for that stretch of the Colorado River.

20 The One-Dam Solution - Lake Powell Removal, Underground Storage and Sediment Removal in Lake Mead

With current demand for Colorado River water nearly at the river's historical annual flow of 13.5 million-acre feet (MAF) and rising, and government-sponsored scientists anticipating average annual flows to decline 18 percent by 2040, the prospect of ongoing low water conditions for Colorado River reservoirs is a near certainty. The average flow of 60 percent into the system for the past six years is firm evidence of this.
For more than 25-years, government scientists and administrators have warned that shortages would be occurring now. This action is the first to reexamine the flawed operational strategies that have been in place as far back as 1922 when the Colorado River Compact allocated 11 percent more water than the Colorado River has to give. Reexamining these two reservoirs is critical, as they constitute more than two-thirds of the system's storage capacity,which with declining inflows and increased demand are proving excessive. Meanwhile, these two reservoirs can cause the loss of upwards of ten percent of the river's average annual flow due to evaporation—valuable water for critical habitats and water users downstream. Furthermore, the challenges facing the future operations of these reservoirs go beyond water allocation and storage inefficiencies. Sediment entering Lake Powell will eventually compromise Glen Canyon Dam's safety. Despite recent warnings that this could happen sooner than the 40-year-old estimate of 2060, there has been no comprehensive monitoring or analysis conducted to address this inevitable problem. Lastly, despite more than $200 million already spent, no gains have been made to restore the critical habitat for endangered species in Grand Canyon National Park impacted by Glen Canyon Dam's operations. The mandates of the Grand Canyon Protection Act and the Endangered Species Act in particular are being ignored to maintain LakePowell even though it is proving to be both wasteful and unnecessary for water storage.
It is therefore critical that the Bureau of Reclamation broadly reexamine the operations of these facilities in accordance with preparing an Environmental Impact Statement to address the following:
1) Pursue transfers of Lake Powell and Lake Mead storage to groundwater aquifers.
2) Develop a sustainable sediment management program for Lake Powell and Lake Mead.
3) Determine the costs and benefits of decommissioning Glen Canyon Dam to restore natural flows through Glen and Grand Canyons.

36 Mutual Forbearance by Upper and Lower Basins

This option proposes a negotiated agreement between the Upper and Lower Basin states. The Upper Basin States would agree to forbear annual consumption of water beyond some specified amount, and in exchange the Lower Basin states would agree to forbear making an inter-basin shortage call under the 1922 Compact. The precise level of the cap on Upper Basin consumptive use would be agreed to via interstate negotiations, as would the apportionment of the development cap among the four Upper Basin states – with appropriate input on both issues from the stakeholder governance process described in Proposal #1, above. This agreement could be negotiated on a permanent basis or (more likely) with a fixed sunset date on which it would expire if not renewed.

The primary purpose of the mutual forbearance arrangement would be to provide certainty to both the Upper and Lower Basin states and users therein. The Lower Basin would receive a much more certain level of flows from Lake Mead under the drier conditions expected in coming decades due to climate change, and the Upper Basin would be free from the fear of a compact call. Neither side would need to proceed with litigation to resolve the major disputed issues under the 1922 Compact, e.g. the Upper Basin delivery obligation/ obligation not to deplete, the status of the Lower Basin tributaries, and the apportionment of the delivery obligation to Mexico. This would allow all parties to concentrate on resolving any remaining supply/demand imbalances through conservation, reallocation, temporary storage/ banking, and other appropriate measures.

56 Integrated Options to Maintain and Restore Healthy River Flows (Redundant with 65 and 124)

This water management option is to maintain and restore the healthy river flows thought to provide a materially higher degree of river ecosystem and economic benefits. Where such benefits may be provided within current flow regimes, the option is to develop appropriate legal and policy mechanisms that protect enough of the current regimes. Such mechanisms include the continued and adaptive re-operation of major federal reservoirs and other water projects. Where a materially higher degree of river ecosystem and economic benefits depends on the restoration of current flow regimes, this option will again include the continued and adaptive re-operation of water projects, should be integrated with options for water banking and improving irrigation efficiency, and entails protection of restored flows by appropriate mechanisms. The integration of this option with an extensive set of options for demand management should reduce the potential for conflict between meeting such water demands and realizing the river ecosystem and economic benefits from maintaining and restoring more of the targeted flow regimes.

Because these benefits are generated by maintaining or restoring river flows instead of consuming them, the quantity and timing of the target flows for upstream reaches need not be added to the flow targets in downstream reaches and are not necessarily added to consumptive demands when assessing water supply and demand imbalances. An important example is meeting flow targets in the Upper Basin by piggybacking on the flows that should not be depleted to keep from dropping below the flow threshold at Lee Ferry imposed by the 1922 Compact, where the blue line (including when it is under the green line) in the figure below could represent much of the flows that should not be depleted to meet Compact obligations.

60 Fill Mead First

The Fill Mead First option would designate Lake Mead as the primary water storage and distribution facility for the upper and lower Colorado River basins. Operation of Glen Canyon Dam would be changed to allow water to flow through the power plant and outlet works at Glen Canyon Dam,filling Lake Mead reservoir before impounding water in Lake Powell. Lake Powell would be generally kept close to the power pool elevation level of 3,490 and the dam used primarily for seasonal flow variations, flood control, and sediment distribution purposes. The Fill Mead First option could be enhanced by the addition of other strategies as appropriate. This includes mechanical sediment augmentation and addition of a temperature control device.

63 Improved Groundwater Management

Groundwater throughout the Basin and in adjacent areas served by the Colorado River is managed to (1) control overdraft or “mining” of groundwater resources to promote long-term sustainability; (2) prevent groundwater pumping from depleting rivers, streams, springs, and other groundwater-dependent resources in the Basin, reducing long-term conflicts between surface water users and groundwater users and preventing degradation of environmental values (such as riparian vegetation and base flows); and (3) allow for underground storage of water supplies and/or strategic recharge of groundwater where appropriate.

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This water management option is to maintain and restore the healthy river flows thought to provide a materially higher degree of river ecosystem and economic benefits. Where such benefits may be provided within current flow regimes, the option is to develop appropriate legal and policy mechanisms that protect enough of the current regimes. Such mechanisms include the continued and adaptive re-operation of major federal reservoirs and other water projects. Where a materially higher degree of river ecosystem and economic benefits depends on the restoration of current flow regimes, this option will again include the continued and adaptive re-operation of water projects, should be integrated with options for water banking and improving irrigation efficiency, and entails protection of restored flows by appropriate mechanisms. The integration of this option with an extensive set of options for demand management should reduce the potential for conflict between meeting such water demands and realizing the river ecosystem and economic benefits from maintaining and restoring more of the targeted flow regimes. Because these benefits are generated by maintaining or restoring river flows instead of consuming them, the quantity and timing of the target flows for upstream reaches need not be added to the flow targets in downstream reaches and are not necessarily added to consumptive demands when assessing water supply and demand imbalances. An important example is meeting flow targets in the Upper Basin by piggybacking on the flows that should not be depleted to keep from dropping below the flow threshold at Lee Ferry imposed by the 1922 Compact, where the blue line (including when it is under the green line) in the figure below could represent much of the flows that should not be depleted to meet Compact obligations.

85 Reservoirs such as Drop 2

The Drop 2 Reservoir has allowed for the capture of water supplies that have been released from Lake Mead but are no longer needed because of changed weather conditions, high runoff into the river, or other factors. An average of about 70,000 acre-feet of this formerly non-storable water is conserved each year by the Drop 2 Storage Project for use in the United States, resulting in a similar reduction in necessary water releases from Lake Mead. Funding for the Drop 2 Reservoir was provided by 3 agencies. In return, these entities shared 600,000 acre-feet of "Intentionally-Created Supply" ICS water credits in Lake Mead. The potential of these types of recovery projects could help bridge the gap between water supply and demand by creating a greater supply and limiting losses.

102 Single Reservoir Water Storage

Assessment of relying exclusively on only one of the two existing major reservoirs in the Colorado River System - Lake Powell or Lake Mead - for water storage purposes. Retention of dams located at both reservoirs - either in existing or modified forms -- for flood control purposes. The primary goal underlying this option is mitigation of current reservoir evaporation losses. The decision of which of the two major reservoirs to rely on forthis option would hinge on (among other things) a comparison of evaporation and seepage loss rates at Lake Powell and Lake Mead

111 Aspinall Unit Bypass Reduction Option

Current operation at the Aspinall Unit (Blue Mesa, Morrow Point, and Crystal power plants) results in periods when water bypasses the power plants and is not used to generate hydro power. This option would explore alternatives to current operations that would reduce or eliminate power plant bypasses but would still fulfill downstream water delivery obligations. Such operational changes could include a combination of changes to up or down ramp rates, timing of releases, and reservoir elevations.

113 Crystal Reservoir Bypass Reduction Option

Crystal Reservoir, due to the size of the existing reservoir and the existing single generating unit, has been unable to use the entire yearly water runoff to generate hydro power in many higher runoff years. This option would increase the generating capability at Crystal power plant to enable generation from some or all releases that currently would bypass the power plant. There might also be operational changes that could be implemented to reduce bypasses.

114 Flaming Gorge Bypass Reduction Option

Current operation at Flaming Gorge Dam and Power plant results in periods when water bypasses the power plant and is not used to generate hydro power. This option would explore alternatives to current operations that would reduce or eliminate power plant bypasses but would still fulfill downstream water delivery obligations. Such operational changes could include a combination of changes to up or down ramp rates, timing of releases, and reservoir elevations.

115 Fontenelle Reservoir Bypass Reduction Option

Fontenelle Reservoir, due to the size of the existing reservoir and the existing single generating unit, has been unable to use the entire yearly water runoff to generate hydro power in many higher runoff years. This option would increase the generating capability at Fontenelle power plant to enable generation from some or all releases that currently bypass the power plant. There might also be operational changes that could be implemented to reduce bypasses.

116 Hydropower Minimum Generation Elevation Protection Option

This option maintains hydropower production at main stem Colorado River hydro plants by prohibiting reservoir elevations from dropping below the point where generation is possible.

117 Upper Basin Voluntary Demand Cap

In this scenario, the states of the Upper Basin agree to implement policies that maintain maximum total Upper Basin consumptive use in all years at a level that does not exceed a given negotiated threshold (assumed in this illustrative example to be 5.5 MAF), and maintain releases at Glen Canyon at 8.23 MAF (rising when storage in Lake Powell exceeds 70% of capacity to 9.5 MAF [or higher if required for flood control]). The percentages used in the Upper Basin Compact are used to determine each Upper Basin state's voluntary depletion cap (considering evaporation losses and Arizona's fixed share of the Upper Basin apportionment). While this example uses a demand cap of 5.5 MAF (see attached table), values from 5 to 6 MAF should be considered in modeling.

In exchange, the federal government and the states of the Lower Basin agree to not request or support administration of an inter-basin compact call in any period when storage in Lake Powell is insufficient to maintain the 8.23 MAF release objective (given the agreed-upon level of ongoing Upper Basin consumption). This trade of a voluntary Upper Basin "cap" for immunity from an inter-basin compact call constitutes the heart of the proposal.

Once agreed to, this operating regime would remain in effect for a term of 40 years, subject to renewal (no later than 10 years prior to expiration) by affirmative action by a minimum of 5 of 7 states. The agreement can be modified or terminated at any time by unanimous agreement of the states. Once terminated, the Law of the River, as it currently exists, provides the default legal and operational regime.

124 Integrated Options and Strategies to Maintain and Restore Healthy River Flows (Redundant with 56 and 65)

This water management option is to maintain and restore the healthy river flows thought to provide a materially higher degree of river ecosystem and economic benefits. Where such benefits may be provided within current flow regimes, the option is to develop appropriate legal and policy mechanisms that protect enough of the current regimes. Such mechanisms include the continued and adaptive re-operation of major federal reservoirs and other water projects. Where a materially higher degree of river ecosystem and economic benefits depends on the restoration of current flow regimes, this option will again include the continued and adaptive re-operation of water projects, should be integrated with options for water banking and improving irrigation efficiency, and entails protection of restored flows by appropriate mechanisms. The integration of this option with an extensive set of options for demand management should reduce the potential for conflict between meeting such water demands and realizing the river ecosystem and economic benefits from maintaining and protecting more of the targeted flow regimes.

Because these benefits are generated by maintaining or restoring river flows instead of consuming them, the quantity and timing of the target flows for upstream reaches need not be added to the flow targets in downstream reaches and are not necessarily added to consumptive demands when assessing water supply and demand imbalances. An important example is meeting flow targets in the Upper Basin by piggybacking on the flows that should not be depleted to keep from violating the flow threshold at Lee Ferry imposed by the 1922 Compact, where the blue line (including when it is under the green line) in the figure below could represent much of the flows that should not be depleted to meet Compact obligations.

Water Banking

35 Lower Basin Water Banking

This proposal would establish a water bank in which all water in the Lower Basin mainstem, plus water in agreed-upon tributaries outside the Gila River system, would be available for intra-state or interstate sale or lease of entitlements to water between willing buyers and sellers. The transferred amount of water would be charged to the allocation of the state in which the seller has the right to use the water. The purpose of the water bank would be to provide a means for willing Lower Basin water users to temporarily or permanently re-allocate water among themselves as a tool for coping with anticipated chronic shortages caused by increasing demand and decreasing flows over the coming decades.

The water bank would be established via a two-part process. First, negotiations including representatives of the states, the Bureau of Reclamation, and the various Tribes would be convened to establish the basic policies governing the bank. These would include, at a minimum:

-Which (if any) tributaries are included in the bank in addition to the mainstem
-Uses for which water may be transferred
-Basic rules for accounting for water (evaporation loss, etc.)
-How to mitigate for third-party impacts (e.g., impacts to rural economies)
-Any other general restrictions on transfers: e.g., maximum term of leases, any cap on total transfers, any maximum price restrictions, etc.
The makeup of a governing body to oversee the operation of the bank and set more-specific rules governing transactions

Once the governmental representatives agreed on a proposed package of basic policies, the proposal would be submitted to the stakeholder group (see Option #1, above), for comment and proposed revision. The package would go to the states and Reclamation for final approval.

Second, after the general policies were approved, a governing body would be appointed to adopt specific rules governing water transactions and oversee the operation of the bank. Its membership would include federal, state, and tribal representatives, as well as representatives of major affected stakeholders including environmental groups, farm workers, and major water users. The actual administration of the bank, including approval of transactions and accounting for delivered water would be handled by the Bureau of Reclamation, which, as water master for the Lower Basin, is already responsible for managing the reservoirs and delivery contracts.

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55 ICS in the Upper Basin

Similar to the ICS concept in the Lower Basin, allow intentionally conserved water to be banked in the Upper Basin CRSP reservoirs for use during drought conditions or during a curtailment call on the Colorado River.

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64 Individual State-based Water Banks in the Upper Basin (Redundant with 123)

Institutional arrangements allow for municipal and other users of Colorado River water with junior rights in an Upper Basin State to pay to exchange pre-1922 water rights from that same Upper Basin State for critical municipal needs in the event of a "call" on the Colorado River Compact. Banking could entail proactive or year-of-"call" following or deficit irrigation, via storage or by direct exchange.

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68 Lower Basin Water Bank

Increasing flexibility using existing infrastructure and institutional arrangements (e.g., storage of water in Lake Mead under domestic and/or international rules) to allow for voluntary and compensated conservation and storage of Colorado River entitlements for the benefit of critical junior uses of Colorado River water, in the event of shortage and/or as a means to augment
supply. As part of a larger, cooperative effort, Lower Basin water users in the U.S. and Mexico would voluntarily work together to conserve water under a U.S. federal Intentionally Created Surplus (ICS) program and anticipated future Intentionally Created Mexican Allocation (ICMA) program and/or other arrangements to develop a substantial, ongoing Lower Basin storage
account in Lake Mead that could be used to offset shortage risks to critical junior uses, provide augmented supplies during normal and above-normal conditions, and meet other river management objectives in the United States and Mexico. This bank could be operated on an interstate and even international basis and/or as multiple banks within distinct jurisdictions.

82 Recognition of the Ute Tribe's Reserved Water Right in Storage

The Ute Indian Tribe (Tribe) of the Uintah and Ouray Reservation (Reservation) is presently engaged in meetings with a Federal Implementation Team, and will subsequently conduct meetings with the State, in order to reach an agreement as to a clarification and common interpretation of the Ute Indian Water Compact before obtaining final ratification of the Compact by the Tribe and the State, pursuant to the 1992 Ute Indian Rights Settlement Act. The Compact recognizes the Tribe's federally reserved water rights within the Upper Colorado River Basin, amounting to 480,594 Acre-Feet (AF) of diversions and 258,943 AF of depletions. A vast majority of these rights are derived from direct natural flow of Reservation streams for irrigation. Natural flows are insufficient to provide needed irrigation water on many Reservation streams, resulting in frequent and severe water shortages. Storage of the Tribe's natural flow rights during high-flow periods (e.g. spring runoff) for later release during low-flow periods (e.g. late summer) will improve Tribal irrigation. In addition, as the Reservation continues to develop, non-irrigation water demands (e.g. municipal and industrial demands) are expected to increase. The Tribe anticipates the ability to convert irrigation rights to non-irrigation
rights, but requires storage to convert seasonal water use to year-round water use. Storage is also needed to permit off-Reservation leases of Tribal water.

The Ute Tribe requests that the Bureau of Reclamation's Study consider the storage of Tribal natural flow water rights in new or existing reservoirs for improved irrigation and/or conversion to year-round use in order to model the impacts of increasing Tribal storage. It also seeks Reclamation's affirmation of the Department's 1995 position that the Tribe has the right to store Its Federally Reserved Tribal Water Rights. See Field Solicitor Memorandum to the Program Director of the Central Utah Project Completion Act, Office of the Secretary, dated October 13, 1995 (concluding that the authority for such rights is found in the 1906 Congressional Act authorizing the Uintah Indian Irrigation Project and the 1923 Federal Court decrees, adjudicating some of the Tribe's reserved water rights). Storing Tribal water will alter the timing and magnitude of Colorado River supplies and demands, and should be a
studied option.

87 Groundwater Banking Credits

Developing water "banks" whereby an entity could "bank" or divert water to groundwater storage projects when there is a surplus or reduced need. When there is a critical or increased need, the entity could then "withdraw" an amount of equivalent water from the Colorado River that it previously banked. Where space is available in aquifers, storing water underground can be a cost-effective way to save water for dry years.
In addition, the possibility and potential for banking recycled wastewater is significant. This could be a great strategy to increase awareness and feasibility of recycled water recharge. Some examples of groups already participating in groundwater banking:
http://www.azwaterbank.gov/ http://www.semitropic.com/index.htm

94 Upper Basin Accounting

CO, NM, UT, and WY improve state-level procedures for determining water use in all sectors. Specifically, the Upper Basin states would agree to common standards for water accounting, which in turn would be implemented via programs of each state. These standards would:
- Result in timely, annual reporting of consumptive use; ;
- Encourage adoption of appropriate technologies, such as metering, or remote sensing;
- Facilitate improved administration of water rights within each state;
- Facilitate improved administration of water transfers within each state;
- Facilitate improved administration of compact obligations, both within each state and among the four states; and
- Facilitate implementation of an Upper Basin Water Bank.

95 Upper Basin Water Bank (Redundant with 127)

This option involves creating an Upper Basin Water Bank that would Increase flexibility using existing infrastructure and institutional arrangements to allow exchange of pre-1922 water rights to critical junior water rights users of Colorado River water in the event of curtailment pursuant to the Colorado River Compact. Banking could entail proactive or last-minute fallowing via storage or by direct exchange. This option envisions an Upper Basin bank as a whole versus individual water banks in each state. For an Upper Basin Bank, Upper Basin states would need to receive credit in Lake Powell to account for their contributions to the bank.

100 Aquifer Storage and Recovery

Comprehensive assessment of potential for increased use of natural and man-made underground aquifers for storage and recovery of water from the Colorado River System - i.e., beyond current aquifer storage and recovery efforts in the Lower Basin. Depending upon assessment outcome, potential implementation of most feasible aquifer storage and recovery projects via joint federal-state funding. Also depending upon assessment outcome (and other factors), potential increased reliance on aquifer storage and recovery in lieu of existing on-stream dams and reservoirs.

101 Water Banking and Transfer Scheme

Development of integrated scheme whereby select parties located throughout Colorado River Basin (i.e., on a basinwide scale) are capable of transferring and/or banking portions of unused water entitlements for future use by themselves or other select parties. Alternatively, if a basinwide scheme of this type is deemed infeasible, development of such a scheme within the Upper Basin and/or evolution of existing mechanisms in the Lower Basin (water banking, QSA transfer provisions, ICS program) to implement such a scheme in that sub-basin. "Select parties" authorized to participate in this basinwide (or, alternatively, sub-basinwide) scheme should at a minimum include sovereigns who possess entitlements under the current framework of the Law of the River -- namely. Mexico, basin states, and tribes. Participation by non-sovereign parties - e.g., major water users holding BCPA section 5 contracts in the Lower Basin --likewise should be considered. Also worth considering is authorization of parties seeking to secure (augment) instream flows through participation in the scheme. The design ofthis scheme should be informed by reference to
the related (innovative) measures developed in the Lower Basin in recent years (as noted above).

123 Individual State-based Water Banks in the Upper Basin (Redundant with 64)

Institutional arrangements allow for municipal and other users of Colorado River water with junior rights in an Upper Basin State to pay to exchange pre-1922 water rights from that same Upper Basin State for critical municipal needs in the event of a “call” on the Colorado River Compact. Banking could entail proactive or year-of-“call” fallowing or deficit irrigation, via storage or by direct exchange.

127 Upper Basin Water Bank (Redundant with 95)

This option involves creating an Upper Basin Water Bank that would Increase flexibility using existing infrastructure and institutional arrangements to allow exchange of pre-1922 water rights to critical junior water rights users of Colorado River water in the event of curtailment pursuant to the Colorado River Compact. Banking could entail proactive or last-minute fallowing via storage or by direct exchange. This option envisions an Upper Basin bank as a whole versus individual water banks in each state. For an Upper Basin Bank, Upper Basin states would need to receive credit in Lake Powell to account for their contributions to the bank.

146 Beneficial Water Use of All Tribal Waters by Tribes

Tribes with Adjudicated water rights, including the mainstem tribes, are not always in a position to divert all the water to which they have rights. When the Interim Shortage Guidelines were finalized in 2007, states were provided with a mechanism – Intentionally Created Surplus (ICS) that encouraged them to conserve water which they were able to draw down in future years. Tribes have been given no comparable incentive to conserve water. There should be an incentive for tribes to conserve water to which they have rights. The incentive might be created as a demonstration program for a Tribal Conservation Reserve (TCR). For purposes only of illustrating the concept, such details might include the following:
- In accordance with a plan, developed voluntarily by a tribe, a portion of the water that the tribe is eligible to divert in a given year would be held in Lake Mead in the form of TCR credits. The tribe could then divert that water in a future year by calling on its credits.
- A tribe with TCR credits could use its credits for the diversion of water to its own reservation. In addition, by mutual consent with another tribe with mainstem rights, a tribe with storage credits could elect to exchange its credits with another tribe for that tribe's use.
- Such exchanges would be permitted only among tribes, and only involving water accounted for in the same state's apportionment.
- The release of water reducing TCR credits would not be considered as "surplus" water as its withdrawal in the future year would be in lieu of its withdrawal in the year in which the credits were accrued.
Tribes currently return very significant amounts of irrigation water to the River. This is water that the tribes have a right to divert and put to their own use for agricultural or non-agricultural purposes, but instead is considered as non-tribal water as soon as it flows into the River. In non-Indian communities, agricultural water reuse is regarded as one of a variety of options for obtaining additional water to support future community needs. This is not currently the case with respect to tribal communities.
Creating a Tribal Agricultural Water Reuse demonstration project would address this issue. The details of such a plan should be worked out by interested tribes and BOR. For purposes only of illustrating the concept, such details might include the following:
- In accordance with a plan, developed voluntarily by the tribe, the amount of agricultural drainage water produced in any given year would be given storage credits in an on-River reservoir. The tribe could redeem those credits in a future year for community and economic development purposes within the reservation's borders.

- Storage credits for agricultural reuse water would be accrued year by year based on the calculated volume of such water.
- The tribe could redeem its credits in any future year in accordance with its plan, for purposes described in that plan. Eligible purposes might include: municipal needs in communities within the exterior boundaries of the reservation, on-reservation economic development, including power generation, on-reservation development of additional agricultural land, transfer of the use of credits to other tribes with the consent of all the tribes involved

62 Guided Water Markets (Redundant with 121)

Assuming that some water uses will have to be reduced in the Upper Basin during prolonged droughts to ensure compliance by Upper Basin States with the Colorado River Compact, this option would: (1) seek to maximize opportunities for using economically beneficial market transactions to secure necessary reductions; and (2) where possible, employ related federal programs to maximize environmental and agricultural benefits throughout the Upper Basin. Strict adherence to prior appropriation in implementation of any curtailment scenario could require some junior water right holders (including some farmers and ranchers) to forego use of Colorado River water. With a more strategic, guided approach, water market transactions could be proactively used to meet demand reduction goals. In essence, such guided markets would seek to allow irrigators who have low profit margins or who have less productive lands within their operation early opportunities to participate in the market, reducing pressure on more profitable irrigation operations that might otherwise be subject to cutbacks. Guided water markets might be coupled with other programs such as Farm Bill conservation programs, the Salinity Control Program, species Recovery Programs, as well as state-specific programs to help provide funding and expand the range of benefits created by guided markets. For example, in coordination with the Salinity Control Program, market-based, compensated transactions with willing sellers could be structured to prioritize reductions in irrigation on lands that contribute high levels of salinity to further reduce salinity loading in the Basin.

66 Inter-Basin (Upper Basin to Lower Basin) Leasing of Ute Indian Tribal Water

The Ute Indian Tribe (Tribe) of the Uintah and Ouray Reservation (Reservation) is presently engaged in meetings with a Federal Implementation Team, and will subsequently conduct meetings with the State, in order to reach an agreement as to a clarification and common interpretation of the Ute Indian Water Compact before obtaining final ratification of the Compact by the Tribe and the State, pursuant to the 1992 Ute Indian Rights Settlement Act. The Compact recognizes the Tribe's federally reserved water rights within the Upper Colorado River Basin, amounting to 480,594 Acre-Feet (AF) of diversions and 258,943 AF of depletions. Of this quantity, the Tribe holds water rights to 142,359 AF of diversions (77,311 AF by depletion) sourced from the Green River. A large majority of these Tribal rights (113,378 AF by diversion; 57,948 AF by depletion) were transferred to the Green River from other
Reservation streams through past agreements with the U.S. and State of Utah, in part to allow development of non-Indian trans-basin diversions. However, on its way through the Reservation, the Green River flows within a deep canyon. As a result, the Tribe is physically limited in its ability to use transferred Green River water rights on Tribal lands. Thus, in transferring the Tribe's rights to the Green River to the benefit of non-Indians, it was assured that the Tribe would hold "paper" water rather than "wet" water for any real use on Tribal lands. Currently, the only feasible option for the Tribe to make beneficial use of its "paper" Green River water is through water leasing. Colorado River water is in high demand, especially in the Lower Colorado River Basin states of Nevada and California. Less demand exists with the State of Utah, although the Tribe proposes to permit Utah the first right of refusal for any marketed Tribal water. Inter-basin leasing of Tribal water may provide a dependable, secure supply to Lower Basin States, as well as provide a valuable means for the Tribe secure benefits from its federal reserved water rights. At present, the Tribe is precluded from inter-basin leases by interstate agreements.

The Tribe requests that Tribal inter-basin leases (leases from the Upper Basin to the Lower Basin) be a studied option to resolve future Colorado River water imbalances. Particularly, the study should consider how Tribal leases can secure future water supplies and reduce water deficits for Lower Basin states.

96 Upper Basin, Interstate Leasing of Ute Indian Tribal Water

The Ute Indian Tribe (Tribe) of the Uintah and Ouray Reservation (Reservation) is presently engaged in meetings with a Federal Implementation Team, and will subsequently conduct meetings with the State, in order to reach an agreement as to a clarification and common interpretation of the Ute Indian Water Compact before obtaining final ratification of the Compact by the Tribe and the State, pursuant to the 1992 Ute Indian Rights Settlement Act. The Compact recognizes the Tribe's federally reserved water rights within the Upper Colorado River Basin, amounting to 480,594 Acre-Feet (AF) of diversions and 258,943 AF of depletions. Of this quantity, the Tribe holds water rights to 61,598 AF of diversion (30,796 AF by depletion) in the White River and 142,359 AF of diversion (77,311 AF by depletion) in the Green River. Both the White and Green Rivers are entirely contained within the Upper Colorado River Basin. The White River flows from Colorado, through the Reservation in Utah, before joining the Green River near Ouray, UT. The Green River flows from Wyoming into Utah, then into Colorado before again entering Utah. After entering Utah from Colorado, the Green flows through the Reservation. Most Tribal White and Green River rights are currently unused. A large amount of these rights (113,378 AF by diversion; 57,948 AF by depletion) were transferred to the Green River from other Reservation streams through past agreements with the U.S. and State of Utah, in part to allow development of non-Indian trans-basin diversions. However, the Tribe is physically limited in its ability to use transferred Green River water rights on Tribal lands. Thus, in transferring the Tribe's rights to the Green River to the benefit of non-Indians, it was assured that the Tribe would hold "paper" water rather than "wet" water for any real use on Tribal lands. Currently, the only feasible option for the Tribe to make beneficial use of its "paper" Green River water is through water leasing.

There is increasing interest in developing additional Upper Colorado River Basin water, particularly in Colorado (for example, Wyco Power and Water Inc.'s proposal to pipe Flaming Gorge water to Colorado's Front Range). One option for the Tribe to make beneficial use of its Tribal water rights in the White and Green Rivers is through interstate leases of Tribal water to users outside the State of Utah, but within the Upper Colorado River Basin. The Tribe proposes to permit Utah the first right of refusal for any Tribal water marketed within the Upper Colorado River Basin. Such interstate leases would secure water availability in the Upper Basin and reduce potential future water deficits. However, there are legal hurdles to overcome in conducting interstate leases. For example, there currently exists no interstate agreement between Colorado and Utah pertaining to the White River.

The Tribe requests that leases of Tribal water between Upper Basin states be a studied option to resolve future Colorado River water imbalances. Particularly, the study should consider how Tribal White and Green River water leases can contribute to equable apportionment, secure future water supplies, and reduce water deficits among Upper Basin states.

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106 Yuma Island Wildlife, Irrigation and Improvement

Bard is requesting permission from USBR to extend our service boundaries to include Quechan tribal lands, farm land (patented) in Arizona and Arizona trust lands located in the "Yuma Island". We would also service Quechan Ranch 1, Ranch 5, and the Quechan Duke-Mitchell Ranch. We feel that 35,000 acre feet of water will be conserved for lower priority users in California. We are only interested in serving lands that are currently irrigated.

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109 Tribal Efficiencies and Voluntary Water Transfers

This option proposes to create improvements in the utilization of the Basin water supply by enhancing system flexibility to better meet demands in the future. This will occur by recognizing that water legally available to Indian tribes within the Colorado River Basin can be incorporated into the Colorado River system management so that tribal water rights can serve the demands of other water users in the Basin, as well as the tribes themselves.
The option is based on the premise that BOR must protect water legally available to tribes and is developed to facilitate providing benefits to tribes for any use of their undeveloped water by others. The option would support and implement public and private discussions of specific possibilities for use of tribal water in voluntary water transfers that increase the efficiency of the Colorado River system management, as well as recognize tribal water in the management of the system so that the use of tribal water, and any water transfers, can be tracked. The water transfers are expected to include, but not be limited to, water banks, water marketing, and forbearance agreements. The tracking of water is expected to include incorporation of tribal water in CRSS by individual tribes, and also as part of a greater tribal accounting pool. Ideally this option would be implemented on a state-by-state basis that protects compact allocations and would be consistent with federal law, state law, compacts and the United States' trust obligations to tribes.
This option is largely conceptual at this time. The Southern Ute Indian Tribe expects to develop more specific details as discussions among involved groups proceed over time.

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120 Facilitating Voluntary Transfers of Federal Project Water

This option calls for the U.S. Bureau of Reclamation to ensure that its policies and procedures provide appropriate flexibility to facilitate voluntary transfers of water that stored in federal reservoirs and delivered pursuant to federal contracts with water users. Additionally, this would include ensuring that Reclamation has the ability to facilitate water banking. Currently, it is not clear whether water banking is allowed throughout the federal facilities. Reclamation should assess this and determine if it can be explicit that water banking is permissible without having to change project authorization. Several of the relevant policies are currently undergoing public comment and revision. (http://www.usbr.gov/recman/)

121 Guided Water Market (Redundant with 62)

Assuming that some water uses will have to be reduced in the Upper Basin during prolonged droughts to ensure compliance by Upper Basin States with the Colorado River Compact, this option would: (1) seek to maximize opportunities for using economically beneficial market transactions to secure necessary reductions; and (2) where possible, employ related federal programs to maximize environmental and agricultural benefits throughout the Upper Basin.

Strict adherence to prior appropriation in implementation of any curtailment scenario could require some junior water right holders (including some farmers and ranchers) to forego use of Colorado River water. With a more strategic, guided approach, water market transactions could be proactively used to meet demand reduction goals. In essence, such guided markets would seek to allow irrigators who have low profit margins or who have less productive lands within their operation early opportunities to participate in the market, reducing pressure on more profitable irrigation operations that might otherwise be subject to cutbacks. Guided water markets might be coupled with other programs such as Farm Bill conservation programs, the Salinity Control Program, species Recovery Programs, as well as state-specific programs to help provide funding and expand the range of benefits created by guided markets. For example, in coordination with the Salinity Control Program, market-based, compensated transactions with willing sellers could be structured to prioritize reductions in irrigation on lands that contribute high levels of salinity to further reduce salinity loading in the Basin.

144 Voluntary Tribal Water Transfers

Assuming that BOR has adequately modeled or otherwise accounted for full tribal ownership of each water entitlement and has identified the potential use of any undeveloped tribal water by others, the Ten Tribes Partnership proposes that BOR assess how voluntary transfers of tribal water might be used to assist in meeting future imbalances. This assessment should not be constrained by any particular interpretation of existing law and policy in the Colorado River Basin.

Governance and Implementation

21 The One-Dam Solution - Re-examine the Colorado River Compact

Identify new water allocation guidelines to reflect the amount of water the Colorado River actually provides, how it should be distributed and what amounts are needed to protect critical habitats in Grand Canyon and elsewhere.

34 Informal Basin-wide Stakeholder Governance Process

The purpose of this option is to establish an informal governance mechanism by which a broad range of non-governmental stakeholders can engage with each other with regard to long-term, basin-scale solutions for water supply and management challenges in the Colorado River Basin, and provide collective input into formal governmental decision making processes. This option would establish a process designed to build on the findings of the Basin Study and carry that work forward following its completion.

In this option, Colorado Basin stakeholders would, on their own initiative, establish a "parallel process" that would serve as a forum for discussing long-term water solutions for the basin. All interested non-governmental Colorado Basin stakeholders, as well as Native American tribes, would be welcome to participate in the process. Meetings would be open to the interested public, and to representatives of the basin states and the Bureau, although participation would be limited to representatives of the various stakeholder groups. The participants would meet regularly to discuss ongoing issues and proposals, including the options and opportunities analyzed in the Basin Study. The group would function as a forum for sharing views on issues in Colorado Basin water management, for developing proposals related to water management, and for providing input to the basin states and Bureau as appropriate opportunities arise. The group would set its own rules for decision making, which could be by consensus, by majority vote, by supermajority, or any other model the group chose to adopt. The group would set its own rules for decision making, which could be by consensus, by majority vote, by supermajority, or any other model the group chose to adopt.

The "parallel process" would not have any formally recognized status in statute or regulation, and its recommendations would be advisory only. That said, any recommendations that emerged from a broad and inclusive stakeholder group would likely be highly influential. Moreover, some existing regulatory mechanisms provide a direct avenue for agencies to consider input from such a group. See, e.g., 43 CFR § 46.110 (providing that in decisions subject to the NEPA process, the Bureau must consider alternatives produced by consensus-based processes).

A variety of politically neutral public or private institutions could serve as the instigator/ convener of the stakeholder process. This could be public universities – as was done in the case of the Universities Consortium on Columbia River Governance - or an appropriate charitable foundation or non-governmental organization, similar to an entity, for example, such as the Great Lakes Coalition. The process could be funded through various mechanisms, including public and private grants.

The parallel process would provide important benefits. A wide range of stakeholders - including environmental groups, Tribes, rural farm communities, and others - have a strong interest in the outcome of Colorado Basin water management decisions, but no direct representation in the negotiations among the basin states and Bureau of Reclamation through which most such decisions are typically made. A governance mechanism would provide a forum in which these stakeholders could discuss various solutions options in a structured way, with the goal of producing a set of solutions that enjoy public support among a broad range of interests. The stakeholder group would be an important source of input for the basin states and Bureau to consider in negotiations involving long-term water management. Solutions vetted through a diverse stakeholder group will be less likely to undergo litigation, more likely to receive public funding, and will be easier to implement effectively.

38 Colorado River Basin Flow Re-distribution Based on Population

Given the growing populations of Colorado River Basin States, "it is preposterous and illogical to lock into perpetuity a system of water distribution that ignores population shifts and other Colorado River Basin changes, and, "Because there exists a need to restore reason, common sense, and sanity to management of the Colorado River, "The areas of the seven Basin States and the Republic of Mexico within the Colorado River Basin should seek to create a new entity administratively independent of their federal and state governments and other special interests". To accomplish this, the seven Basin States:
"Should create, using Section 19 of the Boulder Canyon Project Act (of 1928), a Colorado River Basin Authority or other entity independent of the U.S. secretary of the Interior, and invite Mexican water users to cooperate". [See footnote 1 below]
"(Should the Basin States meet to create a Colorado River Basin Authority, Section 19 permits the U.S. president to name a representative to `participate' and to `report to Congress of the proceedings and of any compact or agreements entered into.' The States and the Congress have to approve any agreement, but the Interior secretary has no role unless named by the president". (The Interior secretary should not be named.)
"Powers of the Authority should include:
1) Use of eminent domain to reallocate water from farmers or others, both on and off Indian reservations, for urban purposes. There should be one-time compensation to anyone giving up water. (Reservation Indians are citizens of the U.S. and should be treated as all other citizens, i.e., the special privileges awarded reservation Indians by the U.S. Congress at the expense of other citizens should end.)
2) Own and operate the river dams.
3) Construct additional dams and diversion works.
4) Augment the river supply"
Other considerations:
"The Authority should urge the U.S. Congress to:
"1) Repeal the U.S. Supreme Court's `practicably irrigable acreage' (PIA) ruling as the measure of water for Indian reservations (PIA ignores reality, from climate to location, and awards execessive quantities of water to some tribes). (See footnote for two such tribes in Arizona)
"2) Repeal language in Section 5, Boulder Canyon Project Act, which the U.S. Supreme Court purposefully misinterpreted to give the U.S. secretary of the Interior power to distribute water to Arizona, California and Nevada, and to users within these states.
"3) Repeal all laws based upon PIA.
"4) Repeal all laws that conflict with powers given the Colorado River Basin Authority.
"5) End the reservation system for Indians and assure `the equal protection of the laws' for all citizens as provided in the 14th Amendment to the U.S. Constitution."
Footnote 1: "Ideally, as noted by John Wesley Powell, river basins should be operated as a unit. For the Colorado River Basin, options include: 1)
The U.S. should acquire the portion of Mexico receiving Colorado River water; 2) Mexico should acquires areas of the seven basin states within the basin; 3) The Colorado River Basin, including the area in the U.S. and Mexico, should create an independent Colorado River Basin Republic. None of these are likely to occur, which means the present messy management of the river will continue unless the seven Basin States unite and act to change the system."
Footnote 2: "With implementation of the Arizona Water Settlements Act of 2004, two Arizona Indian reservations, with less than one-half of 1% of Arizona's 5,130,632 people in 2000, are supposed to have yearly almost 1 million acre-feet of Arizona's Colorado River water entitlement. These two are the Gila River Indian Community (GRIC), 328,800 acre-feet (including 17,000 acre-feet from ASARCO, Inc., that remains unsettled), and the Colorado River Indian Tribes, 662,402 acre-feet. With fewer than 19,000 residents, these two reservations will have 991,202 acre-feet (including the 17,000 acre-feet). Add in the Gila River tribe's other water, and the two reservations yearly will have 1,315,902 acre-feet. Not morally,
ethically, or historically are these tribes entitled to that much water. These tribes no doubt will be founding members of the Organization of Water Exporting Tribes (OWET)."
All of the quoted material above was sent April 05, 2007, to the "Regional Director, Lower Colorado Region, Bureau of Reclamation, Attention: BC00-1000, Box 61470, Boulder City, Nevada 89006-1470," in connection with "Guidelines for Lower Basin Shortages, etc." The points made are as valid today as then, and the seven Basin States should do everything in their power to return control of the water to the people using it, which means taking it out of the hands of the Washington, D.C., bureaucrats and influential special interests, including Indian tribes. As noted elsewhere, it is preposterous that the City of Las Vegas and Clark County, Nevada, and the City of San Diego and San Diego County, California, should be forced to seek water for their populations when water is available from the Colorado River. For the peoples of the Basin States to forever be locked into the Colorado River Compact is disrespect for them and for common sense.
Who benefits by this nonsense? Look to the special interests that swarm to Washington, D.C., be they Democrats, Republicans, Greens, etc., and the bureaucracy.
With the 2010 census, the Arizona population rose to 6,392,017 people, with the combined population of the Gila River Indian Community and the Colorado River Indian Tribes continuing at about 19,000 people and representing about one-third of 1 (one) percent of the State of Arizona's 2010 population. That these two tribes continue to, in effect, own and control almost a million acre-feet of Arizona's Colorado River entitlement is an assault upon common sense and the U.S. Constitution, which is supposed to provide for "the equal protection of the laws." When are we going to get "the equal protection of the laws" in our republic?

42 Consider Adequate Supplies to Oil and Gas Industries in the Future

We are writing to urge the Bureau of Reclamation to consider water supplies needed for oil and gas and other industrial uses in its Colorado River Basin Water Supply and Demand Study. While oil and gas uses very little water compared to agricultural and municipal uses, reliable access to water used in drilling and completion is critical to the industry, our economy and the nation.

Energy and power have long been inexorably linked to water supplies. Irrigation has transformed the West into productive and healthy landscapes that supply food, fiber and drinking water to millions of people while providing benefits to recreation and wildlife. Energy from hydroelectric and from oil and gas has: heated homes and businesses in the wintertime, cooled them in the summer; produced electricity and moved people and goods domestically and abroad.

Oil and gas contributes over $600 million of annual revenue to Colorado and local governments from severance and ad valorem taxes on production. According to University of Colorado, Leeds School of Business, in 2010, oil and gas generated $3.1 billion in direct labor income; 43,836 direct jobs; and $32 billion of economic activity in the State of Colorado alone.

Water is required for drilling and completion of oil and gas wells. During drilling, water is used to cool the drill bit and to help bring drill cuttings to the surface. Water is also used for hydraulic fracturing which pumps water down the wellbore under pressure to create fractures to release oil and gas. Water sources include municipalities, water districts, agricultural water right holders and leased or purchased effluent as well as nontributary groundwater. When practicable, flowback and produced water from oil and gas is also recycled for use in future operations.

We urge the Bureau of Reclamation to carefully consider current and future needs for water for industrial purposes. If you would like further information, please contact Kent Holsinger of Holsinger Law, LLC at (303) 722-2828. Thank you.

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84 Establishment of a “Safety Net” to Ensure the Ute Indian Tribe’s Reserved Water Rights are Protected from Overallocation of the State of Utah's Apportionment of CR Water

The Ute Indian Tribe (Tribe) of the Uintah and Ouray Reservation (Reservation) is presently engaged in meetings with a Federal Implementation Team, and will subsequently conduct meetings with the State, in order to reach an agreement as to a clarification and common interpretation of the Ute Indian Water Compact before obtaining final ratification of the Compact by the Tribe and the State, pursuant to the 1992 Ute Indian Rights Settlement Act. The Compact recognizes the Tribe’s federally reserved water rights within the Upper Colorado River Basin, amounting to 480,594 Acre-Feet (AF) of diversions and 258,943 AF of depletions. This amount is included within the State of Utah’s apportionment of the Colorado River, which amounts to some 1,368,500 AF (23% of the Upper Basin apportionment). Utah’s current use of Colorado River water, estimated at approximately 1,007,500 AF, is 361,500 AF less than its entitlement (by depletion). The State reports that all the remaining water from its total allocation is covered under prior applications approved by the State. Thus, it is highly likely that the future use of Colorado River water within Utah will increase to the point that Utah’s entire entitlement will be used. However, the State acknowledges that with the ratification of the Ute Indian Water Compact, the Tribe’s Colorado River water rights, specifically to the Green River, will be recognized and the State Engineer will distribute Green River rights in accordance with the respective priority dates of the water rights. The Tribe will have the senior priority rights to Green River water.

Currently, the Ute Tribe does not use the entire amount of water reserved under its Compact, partially because much of its water was transferred to the Green River from other Reservation streams, where its use on Tribal lands is currently physically impossible. Such transfers were made under past agreements with the U.S. and State of Utah, in part to allow development of non-Indian trans-basin diversions. Although the Tribe retains rights to unused water, it is concerned that the State of Utah views its unused, unallocated water rights as surplus supply to be used by non-Indians to fulfill the State’s apportionment of Colorado River water. Tribal water is reserved to ensure the long term sustainability of the Reservation for generations to come, and is not lost by nonuse. Utah must not allocate its full share of Colorado River water without first recognizing the Tribe’s reserved water rights.

Both current and future Tribal water use must be reserved from Utah’s Colorado River apportionment. Failure to do so risks over-allocating this valuable water supply. The State and Tribe should protect against over-allocation by entering into agreements for any non-Indian water use allocated from the Tribe’s reserved quantity. That is, the State must agree to payment for any non-Indian water use made possible by allocating the Ute Tribe’s unused, unallocated water right that impacts or infringes upon the Tribe’s water right. Any non-Indian water right application made after the total non-Indian allocation exceeds 1,109,557 AF (the difference between Utah’s allocation – 1,368,500 AF – and the Ute Tribe’s depletion right – 258,943) must be denied unless agreement is reached between the State and Tribe. Exceptions are those other Utah Tribes with similar reserved water rights. Ute Tribe water rights may be available for leasing to fulfill Utah’s full apportionment.

The Ute Tribe requests that the Study consider the above in developing options to meet future demands within the Colorado River Basin. Reclamation’s Study should establish a “safety net” that reserves the total Ute Tribal water right from Utah’s apportionment, and must not treat unused, unallocated Tribal water as surplus supply to be developed by the State of Utah. The Study should consider leasing agreements for any future demands in Utah fulfilled by allocating currently unused Tribal water rights.

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88 Financial Tools Allowing New Development to Pay for the Development of New Local Supplies

Water agencies can draft resolutions that would require that new growth would pay for new water supplies. Fiscal requirements could go into funding for local water improvement projects. These contributions would be made to the supply system.

91 Removal of Invasive Plants Species

Encourage funding for conservation programs that protect native species and habitats.

112 Colorado River Climate Change Adaptation & Environmental Trust Fund

Create a basin-wide trust fund that provides funding to preserve critical "services" provided by a healthy environment and to help pay for basin-wide climate change adaptation. Climate change adaptation needs to be tackled at a scale beyond an individual state, water provider or district. Creating a fund from water customers (water bills), recreational users, hydropower and others who will benefit from a healthy river and climate change adaptation will allow the Basin to adapt more holistically and comprehensively to a changing climate.

For example, funds could be raised from all municipal water users by charging .03 per 1000 gallons. For a household using 100,000 gallons in a year would pay $3/year. Recreational users could include flat water recreation users, permitted and commercial river trips. The fee could be calculated by a day use fee, such as $.50 - $1 per day/per person. For example, someone going down a commercial or private trip through the Grand Canyon might pay between $4-18 depending on how long their trip lasts. Hydropower users already pay a surcharge that supports recovery programs in the Basin, but it would be worth assessing hydropower fees to ensure they are on par with a municipal fee if one were imposed.

This fund could likely generate up to $50M per year for climate change adaptation and environmental purposes. It could be used to help prevent listing of species that are currently imperiled and expedite existing recovery program efforts through habitat improvement and purchase of water rights. It could also be used to implement land use practices to minimize dust on snow or tamarisk and Russian olive removal. It could be used to match Farm Bill monies to maximize on-farm efficiency. It could be used to construct wetlands in the Upper Basin to minimize the impacts of flooding in wet years and increase water coming back to the river in dry years.

122 Inclusion of USGS Stream Gages in Colorado River Basin Supply and Demand Study

To help address current and future imbalances between supply and demands in the basin, it is critical that the Basin Study consider all flow-data available, including U.S Geological Survey (USGS) Streamflow monitoring information. Impacts to Basin resources, such as recreational whitewater and river boating cannot be comprehensively assessed using the limited Colorado River Simulation System model outputs. Inclusion of streamflow information provided by USGS monitoring is necessary to establish baseline reference values for Recreational resources, as well as to evaluate effects on non-consumptive demands across the basin and the foundation these demands provide for tourism and recreation economies.
This Option is non-structural and is proposed as a means to improve limitations of CRSS modeling of deliveries for consumptive demands under future scenarios, on non-consumptive demands. Inclusion of USGS streamflow data will inform a broader view of Basin-wide impacts or improvements to Non-consumptive demands, and assist in demonstrating the specific timing, magnitude, and potential changes to whitewater recreational resources from options and strategies to address future imbalances.

134 Expeditious Resolution of All Tribal Claims

Description: All discussion of water on the River must take into account the fact that tribes have claims to the River's water that have yet to be quantified. Expediting the resolution of tribal claims must be a major priority. The Interior Department must take all necessary steps to facilitate this process.
A major barrier to resolution involves the acquisition of water needed to settle tribal claims. The U.S Bureau of Reclamation and the affected tribes should work together to develop a water acquisition strategy and implementation plan to provide water to satisfy all currently unquantified tribal rights. This might involve the creation of an entity to pursue this goal. The affected tribes should have a majority representation on the governing body of such an entity. It should have the legal power to acquire water rights, and as appropriate, develop the infrastructure to make it available for tribal use.
The limitation on the amount of CAP NIA water available for future settlements has the effect of constraining negotiations to resolve pending claims and should be increased. Moreover, simply awarding CAP NIA water under the current priority system is not a guarantee that tribes will have access to "wet" water in the future. With the very real risk of a shortage of water on the River in future years, the supply available to CAP may be curtailed. Current law provides that the US Secretary of Interior, in consultation with Arizona Indian tribes and the state, prepare a report to Congress by December 31, 2016. That report is to contain, among other things, an assessment of critical water needs on reservations without settlements. Interior and tribes need to start preparations to meet this reporting requirement and use it as an opportunity to examine an increase in the ceiling set in Section 104(a)(1)(A)(iii) of AWSA.

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135 Colorado River Basin Blue Ribbon Committee

We recommend the creation of a Colorado River Blue Ribbon Committee. The Bureau has determined that, based on current trends and the potential impact of climate change, future annual shortages of Colorado River water could reach 3.5 million-acre feet or more. An ambitious effort will be required to meet this challenge. An independent blue ribbon committee should be established by the Bureau of Reclamation or by participating states to recommend a vision for the future of water use in the basin that helps to meet future water needs and restores a healthy Colorado River ecosystem. The committee should be charged with developing a plan that would:

-Help restore the health of the Colorado River ecosystem and its fish and wildlife.
-Review available supply and demand options to address the potential water supply shortages identified by the BOR Colorado River Basin Study.
-Produce water supply and demand reduction recommendations that are:
Cost-effective
Based on proven technology and policies.
Helpful in restoring ecosystem health.
Reliable over the long-term, including in a warmer and drier future.

A Blue Ribbon Task Force should should include independent scientists, NGOs, Native American representatives, business and other interests.

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147 Affordability of Tribal Waters via the CAP Canal

The steady and substantial increase in the cost of CAP water to which tribes have rights is a serious issue. Future federal policy on the Colorado River water must insure that CAP water in all tribal settlements is affordable.
Environmental requirements, imposed through no fault of the tribes, must not be allowed to deprive tribes of the water to which they have rights. The federal government must not permit such requirements to go forward or, alternatively, provide a funding stream or other arrangement that insures that tribes can afford to use all the water to which they have rights

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148 Remove Barriers On Tribal Access to Programs Impacting Water Management

Water conservation and increases in the efficiency of agricultural, municipal and other water use in reservation areas are high priority issues for all tribes. With a limited tax base, funding is a serious obstacle for tribes. Tribal governments need to draw on a variety of federal programs to provide that funding. However, federal and state programs that could provide the necessary resources impose requirements that make them hard to access or put them completely out of the reach of tribes. Barriers to tribal participation include: requirements for explicit waivers of sovereign immunity, cost sharing requirements with limited or no possibility of exceptions for needy communities, inability to support preliminary engineering and environmental review reports required to apply for construction financing, lack of preference for communities with the most severe need and least ability to pay.
BOR should support a technical study of barriers to tribal participation in federal programs that support water resource management and the development of water infrastructure