From: Hasan Consultants [mailto:hasaneng@dslextreme.com]
Sent: Monday, March 02, 2015 2:26 PM
To: Joseph Byrne
Cc: susan.sims@water.ca.gov
Subject: Showing "not just me" example with super-regional benefits

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Dear Mr. Byrne:

You can set the bar for the magnitude of public benefit and drive home your "not just my project for me" message. You can use the super-regional *International Integrated Water Project* (IIWP) as an example of a proposal the California Water Commission hopes to see.

The first stage of the IIWP is establishing a Water+Energy+Food Technology Development Campus on the south shore of the Salton Sea. This location has stranded geothermal energy which is ideal for technologies, like WaterFX, which produce pure water and solid salt, not brine. The developed technologies will allow Central Valley and Southern Californians to wean themselves off Delta water cost-, energy-, and environment-effectively.

The second stage of the IIWP employs geothermal energy (heat storage) to desalt the saltiest water in the Salton Sea while the Sea is kept full with water from the Gulf of California. With the Sea revived, a couple MAFY of Colorado River water become available via improvements in local agricultural water efficiency. Just by keeping the Sea wet, you will avoid public health issues estimated to cost between $11-$70 billion.

Perhaps 200 MAF of the local aquifer storage would be developed as part of IIWP's third stage. The storage combined with additional desalting could fill the Colorado River Aqueduct and the Central Arizona Project with nearly 3 MAFY even during drought years. Some of this water might be diverted to Central California groundwater storage, which would further reduce drought year demand for Delta water.

We can provide more information and calculations. Please let us know how we might assist your adapting California to Climate Change.

Most Sincerely,

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Water Bond 2014 proposal concept combining the International Integrated Water Project and the Quantification Settlement Agreement

Origination

This draft proposal is from a disinterested third party, two California licensed Professional Engineers with expertise in water resources, chemistry, physics, oceans, and economics. Mohammed A. Hasan of Hasan Consultants and Mark E. Capron of Ocean Foresters do not believe the concepts herein have been considered by either the State of California (Department of Natural Resources (DNR)), or the Imperial Irrigation District (IID).

Concept summary

In this proposal the Imperial Irrigation District and perhaps other Salton Sea Authority (SSA) members would take ownership of sustainably reviving the Salton Sea even should IID's use of Colorado River water decrease to 2 MAFY. Sustainably reviving means maintaining the 1990 shoreline and maintaining area-averaged salinity below 36,000 mg/L total dissolved solids. (Allowing a couple decades to decrease salinity, depending on flows in the Colorado River.)

California would provide IID with at least $3 billion from the 2014 Water Bond. IID is left with control over what project they implement, how much additional funding is needed, etc.

IID might raise irrigation water rates from $20/AF to $120/AF to generate at least $6 billion over thirty years. Or IID could raise the necessary funds by organizing and administrating a super-regional International Integrated Water Project (IIWP). The IIWP is a Climate Change adaptation for all the people on or near the Colorado River Water System. The IIWP would cost much more, but it would spread the costs and increase the benefits to the super-region. Potential IIWP members include the U.S. Department of Interior, U.S. Department of State, Mexico's ConAgua, the States of Arizona, Nevada, and Colorado, water agencies within those states and California, and Native Americans.

Initial concepts and calculations for the IIWP are in a separate document.

Specific categories within California's 2014 Water Bond

1. The short-term proposal seeks $400 million of the $475 million in the category "fulfill obligations." The $400 million buys 200,000 AFY from the IID/SSA at $100/AF for twenty years. The participating IID/SSA members spend the money as they wish to supply the water without additional demand from the Colorado River. Options include starting the extraction component of a groundwater storage project; agriculture conservation rebates; etc. This 200,000 AFY is intended to maintain Salton Sea level until the participating SSA members can implement the long term solutions.

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2. The long-term proposal is to transform the dying Salton Sea into a biodiverse economic engine of water, energy, and food while sustaining the profitability of existing agriculture even as Colorado River allocations are adjusted to fit reality. This proposal is designed to benefit over 44 million people with the following components:

    a. Keep the Sea full with seawater from the Gulf of California.

    b. Reduce Sea salinity to that of seawater by desalting the saltiest water with a process producing pure water and solid salt. Use the Salton Sea's geothermal energy to hold down desalting and pumping costs. Seek $400 million of the $725 million in the category "water recycling and advanced treatment technology."

    c. Increase California's water storage capacity four ways: 1) a few MAF by allowing Sea salinity to rise during drought and drop during normal years; 2) tens of MAF using aquifer storage and recovery refilling from high flows on the Colorado River, agricultural drainage, and/or pure desalted water; 3) a few MAF/yr from the always full ocean deploying the technology refined during 2b all around California; and 4) a few MAF during floods on the Colorado River captured in levees constructed primarily from the solid salt of 2b. Seek $2 billion of the $2.7 billion in the "water storage" category.

    d. One of the SSA participating members becomes the lead agency of a the International Integrated Water Project (IIWP). The IIWP, composed of many water agencies including all the lower Colorado River states and Mexico, adopts an integrated regional water management plan in 2015. Seek $200 million of the $810 million in the category "adopted integrated regional water management plan."

International Integrated Water Project©

Hasan Consultants and Ocean Foresters

Synopsis

Hasan Consultants and Ocean Foresters propose an innovation study to drought-proof Colorado River water users and increase business opportunities in the Coachella Valley and Mexico's hydrologic regions I. Baja California Peninsula and II. Northwest.

The International Integrated Water Project (IIWP) can be an infrastructure investment which resolves the Quantification Settlement Agreement while increasing water supply and efficiency for the population of the area shown in Figure 1. These joint benefits become possible because the IIWP allows the people of the Coachella Valley and Mexicali to leverage their resources for a net increase in economic productivity. The IIWP will involve:

- Operating the International Energy+Water+Food Technology Development Campus at the south end of the Salton Sea using stranded geothermal energy resources and revived aquaculture.
- Moving about a million acre-feet per year (MAFY) of Gulf of California water one-way to the Salton Sea.
- Desalting less than one MAF of Salton Sea water.
- Trading the conserved Colorado River water generated by sustainably reviving the Salton Sea and the desalted water generally within the benefiting area, Figure 1.
- Eventually, moving a few MAF of desalted Sea of Cortez water up the Colorado River using the same solid salt, no-brine, technology as used at the Salton Sea.

Figure 1 – Area benefited by IIWP

Potential regional/international benefits and issues include:

- Water storage – a) The use of about 4 billion AF of groundwater storage is currently limited by the water available to recharge groundwater; b) Allowing annual variations in the salt removed from the Salton Sea has a safe yield near 2 MAFY, even while holding area-average salinity constant.
- Renewable Energy – Geothermal electricity capacity on the order of a few thousand MW (worth nearly $1 billion/yr) is available at the south end of the Salton Sea.
- Construction – Construction of the water conveyance, desalting, energy, and aquaculture facilities may add about $3 billion/yr for ten to twenty years into the international area.
- Business – The combination of relatively inexpensive renewable energy and pure water will make the area around the Salton Sea attractive for high-tech industries, potentially adding another $1 billion/yr.
- Agriculture – During a mega-drought agriculture production will drop. Every 1 billion m^3/yr of new fresh water or equivalent in water use efficiency can maintain $300 million/yr of agriculture through droughts.
- Colorado River Delta/Estuary – Annual pulses of fresh water on the order of 30 million m^3/yr may be worth a few $100 million/yr restoring Delta fisheries, Sea of Cortez fisheries, eco-tourism, migrating bird habitat, and biodiversity.

We have commenced discussions with Mexico through Oxnard Consul Berenice Diaz Ceballos and engineers with Comisión Nacional del Aqua. We are also discussing the IIWP with the Colorado River Task Force, the Salton Sea Authority, and others. Our innovation study would better quantify, document, and suggest allocation of the benefits and costs of the IIWP. We can complete our portion of the Innovation Study within 6 months of award. Our recommended budget is $200,000.

Our team includes:

Mohammed A. Hasan, PE, FASCE, 805-218-5574, mhasan@hasanconsultants.com. 40 years of experience with water resources including planning, design, and construction.

Mark E. Capron, PE, 805-760-1967, markcapron@oceanforesters.org. 35 years of experience with U.S. Navy ocean facilities and water resources, currently organizing the Ocean Foresters. Both Hasan Consultants and Ocean Foresters are located at 2436 E. Thompson Blvd., Ventura, California, 93003.

ATSI (provides the engineering and fabrication for WaterFX who has piloted an absorption solar thermal desalting technology costing less than $0.41/$m^3$ and rock salt by-product, not brine)

Pacific Northwest National Laboratory and Genifuel (hydrothermal liquefaction biomass-to-energy as part of the nutrient and minerals recovery process)

PRD Tech, Inc. (commercial grade liquid ammonia fertilizer recovered from the clear water produced by hydrothermal liquefaction or wastewater treatment)

Dr. Kurt Rosentrater, Iowa State University with other Ocean Foresters (the economics, chemistry, and biology of nutrient remediation, marine agronomy, and aquiculture processes in the restored Salton Sea)

Initial Phasing and Financing

Phase 1a – Water-Energy-Food Technology Campus

The Water-Energy-Food Technology Campus would host technology developers who would sell their product while demonstrating their process at commercial scale. The Campus would provide the environmental documentation and connections to geothermal heat, electricity, salt water, etc. The Campus would buy and transport produced product and accept byproducts at an agreed rate. Potential products from selected technologies:

a. Several water technology developers might demonstrate with the Campus buying 500,000 AF over ten years for less than $500/AF. The by-product of this technology will be solid salt, not liquid brine. The water developers would lease space for solar energy or purchase geothermal heat or purchase electricity from the Campus.

b. Several groundwater storage and recovery technology developers would participate in the Campus from locations around or under the Sea. They would sell poor quality water to the Campus for the purpose of keeping the Sea full while creating space for groundwater recharge. Up to about 200,000 AFY, this poor quality groundwater could substitute for the direct use of Colorado River water which is slowing the rate of Sea drying. The hydraulic fracturing technology developed for oil and gas extraction is directly applicable to both geothermal energy and groundwater recharge and recovery.

c. Several salt mining and salt stabilizing technology developers might coordinate with the Campus to extract products and stabilize the salt produced by the water technology developers.

d. Several geothermal energy developers might demonstrate well drilling and heat energy production with the Campus buying the produced heat energy and selling the heat to the water technology developers.

e. Several thermal-to-electricity developers might demonstrate solar thermal and geothermal electricity production with the Campus buying the electricity. The thermal electricity developers could purchase single pass cooling water from the Campus. That warmed water might be sold to the water technology developers.

f. Several marine agronomy developers might provide nutrient remediation of the Salton Sea while the Campus buys their biomass products until the Sea is rejuvenated.

g. A dozen biomass-to-energy developers might transform biomass from the Sea, local agriculture, wastewater treatment plants, and municipal solid wastes to energy. The Campus might have several sites to include existing wastewater treatment plants or landfills.

Campus construction and operation might be financed over the long term by:

a. The California Department of Natural Resources.
b. Many water agencies through the Water Environment Research Foundation and the Water Research Foundation.
c. The U.S. Department of Energy.
d. The U.S. Department of Agriculture.
e. The U.S. Bureau of Reclamation.
f. Mexico's Comisión Nacional del Aqua.

It is our understanding the California Department of Natural Resources will request competitive proposals for funding via California's Water Bond 2014. We would like to assist others in submitting proposals for seed funding of the Water-Energy-Food Technology Campus. We should discuss the proposal process and the appropriate categories which might include:

- A portion of the $475 million "… to support projects that fulfill the obligations of the State of California."
- A portion of the $810 million "… projects included in and implemented in an adopted integrated regional water management plan consistent with Part 2.2 (commencing with Section 10530) of Division 6 and respond to climate change and contribute to regional water security…" Must the plan have been adopted before the Water Bond became law?
- A portion of the $2.7 billion "… associated with water storage projects …"
- A portion of the $725 million "… for water recycling and advanced treatment technology projects."

For example, both Salton Sea and Westlands have the same long-term need to remove salt from soil and prevent toxic dust storms. The Water-Energy-Food Technology Campus can be a forum for more rapidly improving the economics and sustainability of pure water and solid salt production, storage, and reuse than can be achieved by Westlands operating alone.

Phase 1b – Starting aquifer storage and recovery

Per the 2008 Lawrence Livermore National Laboratory study, "As a whole, groundwater storage in the basin is very large, potentially as high as 4.5 to 6.5 billion acre-feet in current estimates, yet much of this confined to greater depths where quality is poor (high salinity), producibility is low (poor permeability and accessibility) and natural recharge, required for sustained use as a supply, in not well demonstrated from available data."

Other possible storage options in California have the same issue. When the storage is too big, there will not be enough water to fill it. The IIWP has two water sources for supply and groundwater recharge: the Colorado River, and the Ocean (actually the saltiest water in the Salton Sea). As an initial Climate Change adaptation, the IIWP members might target 60 MAF of groundwater storage. That would yield 2 MAFY for a 30-year drought. Ideally, the system could recharge several MAF during each wet year. The geothermal desalting operation might operate at a steady 1 MAFY. During wet to normal years it enables 1 MAFY of recharge. During dry years, 2 MAFY supply is half from desalting and half from stored groundwater.

Phase 2 – Salton Sea Restoration and Water Storage/Conservation

Essentially none of California's allocation of Colorado River water can be conserved unless the Salton Sea is kept full and its salinity managed. This because the Salton Sea can only be fully restored and sustained with water input equal to evaporation and salt removal initially in excess of salt input. One way to accomplish both is by bringing saltwater from the Gulf of California (aka Sea of Cortez) and removing salt from the Salton Sea. Table 1 shows a mass balance over a single year for four situations with different volumes of Colorado River water, Gulf water, and desalted Salton Sea water.

All four situations maintain Sea level with the same 7.6 million acre-feet (MAF, 1 MAF = 1.2 billion cubic meters) at the beginning and the end of the year. All four situations reduce the Sea's average salinity. Situation D would reduce salinity below the 35,000 mg/L of Gulf water at the end of the fifth year. SSA refers to the Salton Sea Authority.

Table 1 – Annual mass balance of Salton Sea level and salinity for four situations

Parameter - **Year 1**	units	A - Min desalting	B-Minor conserving	C - Max conserving	D - Max desalting
Start of year average Sea salinity	mg/L TDS	50,000	50,000	50,000	50,000
Volume of Salton Sea, beginning of year	MAF	7.6	7.6	7.6	7.6
Total mass of dry salt in Salton Sea	M tonnes	473	473	473	473
Annual evaporation from Salton Sea	MAF	1.4	1.4	1.4	1.4
Average salinity of fresh water drainage into Salton Sea	mg/L TDS	2,400	2,400	2,400	2,400
Fresh water diverted from Colorado River	**MAF**	**3.6**	**3.0**	**1.8**	**3.6**
Desalted Sea water used locally (mixed with Colorado River water)	MAF	0.3	0.4	0.8	0.8
Fraction of desalted and River water returning to Sea	%	30%	25%	15%	25%
Fresh water drainage volume	MAF	1.2	0.9	0.4	1.1
Dry mass of salt in fresh water drainage	M tonnes	3.5	2.5	1.2	3.3
Gulf salt water import salinity	mg/L TDS	35,000	35,000	35,000	35,000
Gulf water import volume	MAF	0.2	0.5	1.0	0.3
Dry mass of salt in imported Gulf water	M tonnes	8	22	42	11
Salt removed as rock salt when desalting Salton Sea water of average salinity	M tonnes	19	25	50	50
Volume of Salton Sea, end of year	MAF	7.6	7.6	7.6	7.6
End of year average Sea salinity	**mg/L TDS**	**49,271**	**49,986**	**49,327**	**46,282**

The Phase 2 restoration and water conservation might be financed by water trades among members of the Colorado River Water Users Association or as part of the Secretary of Interior's

adjusting allocations to better fit the safe yield of the Colorado River System. Table 2 shows possible arrangements for water trades in each of the four Situations of Table 1. The four situations of Tables 1 and 2 bracket a more likely arrangement wherein the participating agencies treat the IIWP as if it were a water storage or a water supply insurance project. That is a semi-fixed budget adjusted each decade to fit current understandings of the Colorado River system's safe yield.

The five years of Situation D, maximum desalting, need not be consecutive, but returning Salton Sea salinity and chemistry near that of Gulf water is essential to realizing the aquaculture income mentioned in Table 3. Situation C would be employed during droughts and may be employed indefinitely as an infinite reservoir with a sustainable safe yield of 1.8 MAF per year, relative to 2014 Colorado River water allocations.

Technology and Cost Issues related to Phase 2:

1) Because Gulf water is more corrosive before desalting, Hasan Consultant's innovation study includes seawater conveyance without metal in contact with the water or excavation deeper than about 60 feet.
2) Desalting at the Sea takes advantage of the Salton Sea's geothermal resources.
3) Desalting at the Sea allows for importing more Gulf water than is desalted.
4) The full desalting cost in Table 2 of $700/AF is conservative in that it does not include: a) WaterFX has indicated the $450/AF they predict for their solar thermal desalting would be less expensive with geothermal heat; b) Table 2 contains few of the potential incomes made possible when conveying Gulf water to the sea.

Table 2 – Financing Phase 2 restoration with water conservation

Parameter	units	A - Min desalting	B-Minor conserving	C - Max conserving	D - Max desalting
Fresh water diverted from Colorado River	MAF	3.6	3.0	1.8	3.6
Desalted Sea water used locally (mixed with Colorado River water)	MAF	0.3	0.4	0.8	0.8
Gulf water import volume	MAF	0.2	0.5	1.0	0.3
Conserved water volume	**MAF**	**0.0**	**0.6**	**1.8**	**0.0**
Full cost of importing Gulf water, desalting Sea water, distributing pure water, and storing solid salt	$/AF	$700	$700	$700	$700
Water trade cost rate (purchase of conserved water by non-SSA members)	$/AF	$300	$300	$300	$300
Annual desalting cost of SSA members ('-' indicates a net income to SSA members)	$M/yr	$210	$100	$20	$560
Annual cost of non-SSA members	$M/yr	$0	$180	$540	$0

Table 3 is a more optimistic estimate of the net cost of new water on a per acre-foot basis which may be viewed as the lowest likely cost of new water.

Table 3 – Expenses and Revenues for Salton Sea Restoration and Water Storage/Conservation

Expenses ($/AF)		
	Gulf to Sea water conveyance for Phase 2	$200
	Desalting, salt reuse, local product water distribution after a few years of Phase 1 – Campus operation	$700
	Total expenses	**$900**
Revenue ($/AF)		
	Payments from electricity producers using the cooler single-pass condensing water	$200
	Lease fees from the Marine Agronomy operations	$100
	Windfall tax on improved property values and recreation	$30
	Payments from water trades	$300
	California & Federal funding for hazard prevention and environment restoration	$100
	Total revenue	**$730**
Total of expenses minus revenue		**$170**

It is our understanding the California Department of Natural Resources will request competitive proposals for funding via California's Water Bond 2014. We would like to assist others in submitting proposals for Phase 2: Salton Sea Restoration and Water Storage/Conservation. We should discuss the proposal process and the appropriate categories which might include:

- A portion of the $475 million "… to support projects that fulfill the obligations of the State of California."
- A portion of the $810 million "… projects included in and implemented in an adopted integrated regional water management plan consistent with Part 2.2 (commencing with Section 10530) of Division 6 and respond to climate change and contribute to regional water security…" Must the plan have been adopted before the Water Bond became law?
- A portion of the $2.7 billion "… associated with water storage projects …"
- A portion of the $725 million "… for water recycling and advanced treatment technology projects."

Phase 3 – Moving pure water or distributed desalting

The technologies discovered and refined during a decade or two of operating the Phase 1 International Energy-Water-Food Campus will be constantly evaluated in light of the local and global situation for water, energy, and food. The technologies will make two options increasingly viable:

A) San Diego, Los Angeles, Las Vegas, Phoenix, and Tucson arrange to have pure water delivered directly to the Colorado River Aqueduct and the Central Arizona Project at Lake Havasu or the high point of the Colorado River Aqueduct near the Salton Sea. The combined capacity of the Colorado River Aqueduct and the Central Arizona Project is 2.8 MAF/yr.
   The desalting for export may occur in Mexico with its abundant solar thermal energy, tidal energy in the Sea of Cortez, existing salt flat storage space (Laguna Salada), and need for solid salt to build barriers to the rising Sea of Cortez. Desalting for export might also occur at the south end of the Salton Sea with its geothermal heat resource.

B) San Diego, Los Angeles, and Mexicali desalt ocean water locally while Phoenix and Tucson desalt used Colorado River water.

In either case, the Phase 3 desalting and transportation might be financed by water trades among members of the Colorado River Water Users Association or as part of the Secretary of Interior's adjusting allocations to better fit the safe yield of the Colorado River System.

In addition to the area of Figure 1, the technologies of the International Campus can be employed at cities such as La Paz, Valparaiso, Abu Dhabi, Melbourne, Alicante, Nouakchott, and others.