Restoration of the Salton Sea

Volume 1: Evaluation of the Alternatives

Appendix 1D: Executive Summary, Eutrophication/Selenium Viability Workshop, July 25–27, 2005

Executive Summary (July 25–27, 2005)

Eutrophication/Selenium Viability Workshop

A project team with a broad range of expertise in water quality issues affecting the Salton Sea was assembled to evaluate risks from proposed alternatives with respect to eutrophication and selenium issues. The team members and their expertise included:

- Chris Amrhein, University of California-Riverside: geochemical cycling of nutrients and salts, sediment oxygen demand
- Michael Anderson, University of California-Riverside: sediment re-suspension, eutrophication
- Chris Holdren, Bureau of Reclamation, Denver (Workshop organizer): eutrophication, geochemical modeling
- Dale Robertson, USGS, Madison, WI: hydrodynamic modeling, eutrophication
- Geoff Schladow, University of California-Davis: hydrodynamic and geochemical modeling
- Jim Setmire, USGS (Retired), Madison, WI: Selenium issues affecting the Salton Sea

The team was joined by:

- Doug Barnum, USGS, Salton Sea Science Office, La Quinta, CA: avian issues, Salton Sea management
- Michael Cohen, Pacific Institute, Boulder, CO: biological processes, Salton Sea restoration
- Paul Weghorst, Reclamation, Denver, CO: Project Manager of the Salton Sea Value Engineering Study

Chris Holdren convened the meeting and Paul Weghorst gave an overview of the Value Engineering Study with a description of how workshop results would be related to other aspects of the process. Team members presented results of their studies relating to the project. A separate report was be provided by each team member and is included in this appendix.

Jim Setmire began by giving an overview of selenium issues. Selenium has consistently been one of the most critical factors affecting Salton Sea restoration alternatives. Setmire indicated Se levels would increase in all canals, shallow ponds, and rivers as water conservation measures are implemented. Se concentrations could eventually reach the current median tailwater concentration of 28 ug/L in all canals, shallow ponds, and rivers as water use is reduced. Areas with anoxic sediments would continue to have Se concentrations below 2 ug/L. Selenium concentrations in sediment will probably increase and Se will be reintroduced to the water column as the Sea recedes, which will cause oxidation of exposed sediments and greater exposure to wildlife.

It is likely that Se concentrations will accumulate through the food chain with any option that decreases Sea because Se levels are expected to increase in the inflows. The main risks are to the larger fish-eating birds, but breeding birds are also of concern. Some fish (mollies, which may be a good surrogate for pupfish) are already nearing threshold concentrations for toxicity concerns.

Geoff Schladow presented results of model runs using a one-dimensional thermodynamic model that was the basis of DLM-WQ model which was recently used to model the eutrophic state of the current Salton Sea on behalf of the Regional Water Quality Control Board. The extent of thermal stratification predicted by the model allows informed decisions about the likelihood and extent of anoxia, hydrogen sulfide (H_2S) and ammonia (NH_4) formation. Schladow has successfully used this model on a large number of other lakes with excellent success.

The effect of dividing the Sea with a dam or barrier, a common element of many alternatives, was explored by reducing the lake volume by 50% at all depths. While particular Reclamation scenarios are a little different than this, the differences due to the physics of the Sea are expected to be small. The results are expected to be similar whether the remnant Sea was in the north or the south. The effect of halving the area of the Sea was dramatic. Thermal stratification was intense and persistent, with the formation of a very sharp and intense thermocline commencing at a depth of about 4 m below the surface and lasting for all but 1-2 months of the year. The development of such an intense and persistent stratification will have extreme and profound effects on the Sea. It will lead to prolonged anoxia, which will in turn lead to extensive formation of H_2S and NH_4. There will be little opportunity for venting during the stratification period, so concentrations will build up to unprecedented levels. The predicted rapid breakdown of the stratification will lead to a sudden redistribution of anoxia, H_2S and NH_4 throughout the water column and to gaseous NH_3 and H_2S to the air. The net effect could be an annual die-off of all fish in the Sea and serious odor problems. There are also potential human health impacts, including headache and nausea, as well as more serious problems for sensitive individuals. While no other depths were examined, this result should be the same for all depths greater than 10 m.

Michael Anderson presented results of his studies on sediment distribution and re-suspension. Sediment re-suspension is an important mechanism for advective transport of nutrients, sulfide, and oxygen demand. There are three sediment zones within the Sea: an erosive zone, with no accumulation of sediment; a transportation zone, where sediment periodically accumulates; and a depositional zone, where sediments are never re-suspended. Anderson presented predictions of changes in the three zones for the various alternatives under consideration based on a model developed by Hakanson (1982).

Dale Robertson presented results from two empirical models (BATHTUB, and WiLMS), which were used to determine how changes in the morphometry and the phosphorus loading to the Sea should affect the average annual phosphorus concentration. For each alternative, modeling results indicated that phosphorus concentrations in Salton Sea should have a linear response to a linear change in phosphorus loading (or a linear change in the fraction of the present loading). Changes in phosphorus concentrations were different for each alternative; however, the linear response consistently varied as a function of the fraction of the original total volume of the Sea. Predicted concentrations were highest for the alternatives which had the smallest fraction of the original volume of the Sea. For almost all alternatives, phosphorus concentrations in the Sea should increase from present conditions, except for the lowest projected flows for the deepest alternatives. These models simulate steady-state conditions in the Sea; therefore, the simulated changes would be expected to take place several years after load reductions occur.

Chris Amrhein presented results of his studies on H_2S production and sediment oxygen demand (SOD) in the Sea. H_2S is formed during the sulfate reduction process and is re-oxidized to sulfate when it reacts with oxygen. The sulfide cycle in the Sea is dominated by bacteria, which currently generate an estimated 75,000 to 78,000 metric tons of H_2S/yr. If all of this is contained in the hypolimnion of the Salton Sea, it is more than enough to consume all of the oxygen in the Sea during a mixing event following a period of prolonged stratification.

Amrhein also presented a proposal for a smaller marine sea with a surface area about 10% of the size of the current Sea. This is a variation of the Evolving Sea currently included as an alternative, but with a marine lake instead of habitat pond. This proposal was based on expected, continuing reductions in inflow. Amrhein’s concept was based on an estimated inflow of 210,000 acre-ft/yr, the minimum needed to sustain agriculture and the only arguable water right that the Sea has. This volume would be enough to create a 27,000 acre marine lake at a salinity of 35,000 mg/L, assuming an inflow salinity of 10,000 mg/L. The salinity and lake level would be maintained by the expected evaporation rate of 150,000 acre-ft/year from the 27,000 acre surface and by wasting 11,000 acre-ft/year to the brine pool. Lake size could be adjusted for different inflows.

Following the presentations, the team developed a matrix for eutrophication and selenium threats for water features associated with each of the 8 alternatives under consideration (see file Viability Screening_072905.xls). As in the Value Engineering Study, the No Salton Sea with Land Reclaimed for Agriculture alternative was not evaluated because this alternative would not include federal construction. One additional alternative, Alternative 8C, Evolving Sea with Marine Lake, was included in the evaluation based on Amrhein's presentation.

The team also revisited the screening matrix developed as part of the Value Planning Study in light of results presented during the workshop. The only significant change occurred under Environmental Impacts and Benefits, Environmental Habitat Acreage, 2. Deep water marine. As a result of the serious potential biological impacts and human health effects resulting from prolonged stratification of the Sea, the team recommended revising the ratings from the Value Engineering Study, which provided higher values for deeper systems. This change will significantly reduce the total points for the three alternative that currently have the highest ratings (1A, 2A, and 3A), shrinking differences between alternatives and dropping all alternatives to less than 500 points (50% of the total available points).

Because water depth may be a fatal flaw, additional model runs using a three-dimensional model were recommended to confirm the results presented by Schladow. Additional evaluations of Amrhein's suggestion for a smaller marine lake were also recommended to determine the optimum size and depth of that water body once modeling results are completed.