



**United States Department of the Interior  
Geological Survey**

Utah Water Science Center  
2329 West Orton Circle  
Salt Lake City, Utah 84119

January 31, 2006

Mr. Richard Bay  
Jordan Valley Water Conservancy District  
8215 South 1300 East  
West Jordan, UT 84008

**Re: Technical review comments on report entitled “Selenium interactions in the Open Waters of Great Salt Lake: Considerations for additional loading”**

Dear Mr. Bay;

Thank you for the opportunity to review the subject report. I am unsure on the previous technical review that this report has undergone; however, during my review, I have found a number of errors and the need for additional qualifying information. My summary comments are listed below:

1. The statement on p. 1 of the report “The fate of selenium in a wetland ecosystem is much more complex than that associated with the open waters of Great Salt Lake,” is an oversimplification of the dynamic biogeochemical system that exists in Great Salt Lake. We are just beginning to study the geochemical system of the open water and have found it to be a complex system as well. This should be clarified in the report.
2. The average lake depth of 35 feet that is noted on p. 2 is incorrect. At the current lake stage, some of the deepest areas of the lake are only 27 feet. The USGS bathymetric map of the south arm of Great Salt Lake (Bathymetric map of the south part of Great Salt Lake, Utah, 2005, R.L. Baskin, U.S. Geological Survey Scientific Investigations Map 2005-2894) should be used to determine the average lake depth (much less than 35 feet). The corrected depth should be used.
3. On p. 2 the statement “...the Lake often stratifies during the summer and winter months, ...” suggests that this is the only time the lake is stratified. This suggestion is not correct. Certain parts of GSL are stratified for multiple annual cycles. Although the deep brine disappeared from the south arm in 1991, it has since reappeared (see Gwynn, 2002)

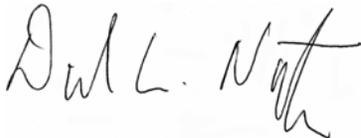
4. When discussing selenium chemistry at the bottom of p. 3, the statement is made that “selenates are more common in flowing water systems, while selenite tends to be the dominant form in slow-moving or impounded water systems.” This is not correct. The rate of water movement has little bearing on the distribution of selenate vs. selenite. The geochemical conditions are much more important.
5. On p. 4 under the Environmental Fate and Persistence section the following statement is made “In slack water or slow-moving systems such as Great Salt Lake, selenium in the upper sediments and detritus layer can be immobilized over time by the accretion of additional “clean” sediments and organic matter over the top, thus effectively locking the selenium-enriched sediments in place.” No reference is provided showing the data to support this statement. A 300-year sediment core from Farmington Bay collected by the USGS in 1998 shows a sharp increase (over 4 times the background selenium levels) in selenium concentration in the sediment record beginning in the early 1900s and continuing to the top of the core. These data would suggest that the “clean” sediment layer to isolate the selenium-rich sediments does not exist, at least in the Farmington Bay sediment core example.
6. I agree with the statement on p. 4 stating that “In deep water, high sulfate and anaerobic conditions occurring near the sediment-water interface act to decrease the potential for resuspension of the deposited selenium.” However, this statement needs to be further qualified by the documented fact that the spatial extent of the deep brine layer shrinks and expands under certain conditions and can disappear entirely over long time periods. The dynamics of this deep brine system point to the potential that selenium accumulated over relatively long time periods can then be released under a changing redox regime depending on the hydrodynamics of the deep brine.
7. In addition to the deep brine dynamics, no mention is made about selenium remobilization during resaturation of previously exposed sediments along the lake shore. These areas provide a potentially large source of accumulated selenium input to Great Salt Lake during increasing lake stages.
8. On page 5, a study by Souza and others is cited as an example of plant remediation of selenium contamination. Alternate references showing examples of the failure of plants to remediate selenium in contaminated wetlands should also be provided. For example, prolific plant growth in the selenium contaminated Stewart Lake wetlands in northeastern Utah was not successful in decreasing the selenium in the soils. Instead, a geochemical based passive remediation scenario was imposed (Naftz and others, 2005, Selenium mobilization during a flood experiment in a contaminated wetland: Stewart Lake Waterfowl Management Area, Utah: Applied Geochemistry, vol. 20).

9. In section 1.24, considerable text is devoted to the interaction of selenium with sulfate, yet no mention is made on the documented interactions of selenium with mercury. In light of the significant mercury issues associated with the Great Salt Lake ecosystem the past two years, additional information on the interaction between mercury and selenium should be added to the “white paper.”
10. The selenium data summaries for each of the river sites presented on p. 7-10, only make use of EPA Storet data. USGS data should also be added to these data summaries for each river site. These data are also available via the internet.
11. On page 8, a mean selenium concentration of 0.59 ug/L is calculated for the Bear River site. It is not technically correct to calculate a mean from a highly censored data set such as this one. Based on the data that are presented (does not include USGS data), 19 of the 27 values are below the analytical detection limit. The median value is a more appropriate measure of the central tendency of a highly censored data set. The median value for the Bear River data would be below the analytical detection level, which is not given in the report. The USGS data set for this same gage site includes over 120 samples of total and dissolved selenium, and should be added to the analysis. This same comment applies to the mean selenium calculations for the Weber River site, as this is also a highly censored data set.
12. Although the individual selenium concentration data are shown for the Bear, Jordan, and Weber River sites, no selenium concentration data are shown for the KUCC outfall. These concentration data need to be presented and treated similar to the data from each river site. In addition, the data prior to 2001 should also be included because GSL is a closed system and the higher loadings contributed during earlier years are also important to the objective of the white paper”– Selenium interactions in the open waters of GSL. Obviously, the lake does not know or care if the selenium was contributed in 1990 or 2005.

13. Beginning on page 10, the methods used to calculate selenium loadings to Great Salt Lake are too simplistic and do not adequately represent the potential variability in selenium concentration over a hydrologic cycle. As noted in comment 11, the use of a mean selenium concentration for the Bear and Weber River data set is not valid, hence the associated loading values using the incorrect values are also suspect. An accepted and technically sound method to determine river loadings is the use of the USGS software LOADEST (Runkl and others, 2004). This software uses daily streamflow conditions to construct a multivariate chemical loading model that considers the loading variability introduced by a number of independent variables. This model can also work with a certain percentage of censored values. This type of modeling approach needs to be applied to all surface-water discharges to Great Salt Lake. The current estimates of selenium loads from surface-water sources are not correct and should be deleted.

Thanks again for the opportunity to review the white paper. Please feel free to contact me (801-908-5053) if you need further clarification on my review comments.

Sincerely,

A handwritten signature in black ink, appearing to read "David L. Naftz". The signature is written in a cursive style with a large, sweeping initial "D".

David L. Naftz, Ph.D., P.G.  
Research Hydrologist