2.0 Program Background

2.1 Historical Perspective

Great Salt Lake and its shores have been the subject of management deliberations arguably since the first Mormon pioneers settled near its shores in 1847. These deliberations historically centered primarily upon resource use and allocation. Increasing development of those resources in the latter part of the 20th century shifted that focus towards defining the ecological resources of Great Salt Lake and protecting them. What was first considered a relatively simple ecosystem composed of algae, brine shrimp, brine flies, and bird life, was discovered to be a very complex and dynamic ecosystem. It rapidly became apparent that the lack of a comprehensive database describing the complex ecosystem made it very difficult to make management decisions resulting in its protection (Atwood et al., 1999).

State and federal agencies historically have collected a significant amount of information characterizing lake level fluctuations, water balance, and salt balance throughout Great Salt Lake. While appropriate for some management decisions, additional information was needed to understand the ramifications of those decisions on the Great Salt Lake ecosystem. The State of Utah completed the Great Salt Lake Comprehensive Management Plan in 1997 and updated it again in 2000 (UDNR, Great Salt Lake Planning Team, 2000). The State of Utah initiated the Great Salt Lake Ecosystem Project in 1994 to work towards understanding the ecology of Great Salt Lake (Stephens and Birdsey, 2002).

The Ecosystem Project and other efforts have worked to understand:

- How the algal growth rate, competitive interactions, abundance, and species composition fluctuate as they relate to salinity, temperature, and nutrient influxes
- How brine shrimp survival and reproduction fluctuate with salinity, temperature, nutrient influxes, algal abundance and species composition, and predation from other zooplankton
- Great Salt Lake bird species—both their numbers and how they use lake resources
- The complex limnology of Great Salt Lake as it relates to salinity, temperature, lake levels, water balance and mixing, and contaminant and nutrient influxes

It has been found that these processes do not operate independently but interact and seem to vary—sometimes significantly—from year to year (Atwood et al., 1999). These studies confirmed that Great Salt Lake's ecosystem is unique and much more complex than previously thought.

2.2 Existing Regulatory Framework

The federal Water Pollution Control Act Amendments of 1972—also known as the Clean Water Act—established the institutional structure for the U.S. Environmental Protection Agency (EPA) to regulate discharges of pollutants into the waters of the United States,

establish water quality standards, conduct planning studies, and provide funding for specific grant projects. The Clean Water Act has been amended by Congress several times since 1972. The EPA has provided most states with the authority to administer many of the provisions of the Clean Water Act.

The UDWQ has specified appropriate beneficial uses for waters of the State and achieve and protect those uses through the development and enforcement of water quality standards (40 *CFR* §131.11). Due to the unique geochemistry of Great Salt Lake, the application of national fresh-water selenium water quality criteria to Great Salt Lake is inappropriate (EPA 1987, 2004). The open waters of Great Salt Lake have instead been protected for their beneficial uses through the application of the following narrative criteria clause in the State water quality standards (R317-2-7):

> *7.2 Narrative Standards*
> *It shall be unlawful, and a violation of these regulations, for any person to discharge or place any waste or other substance in such a way as will be or may become offensive such as unnatural deposits, floating debris, oil, scum or other nuisances such as color, odor or taste; or cause conditions which produce undesirable aquatic life or which produce objectionable tastes in edible aquatic organisms; or result in concentrations or combinations of substances which produce undesirable physiological responses in desirable resident fish, or other desirable aquatic life, or undesirable human health effects, as determined by bioassay or other tests performed in accordance with standard procedures.*

The beneficial uses designated for Great Salt Lake are listed in R317-2-6, Use Designations and summarized in Table 2-1.

TABLE 2-1
Beneficial Uses of Waters of Great Salt Lake

Beneficial Use
Primary Contact Recreation
Secondary Contact Recreation
Waterfowl, Shorebirds, and Other Water-Oriented Wildlife
Aquatic Food Chain Organisms
Mineral Extraction

The narrative standard has been implemented by the State of Utah in part through requiring that any discharges to fresh water tributaries must meet fresh water numeric water quality standards. Any discharges directly to Great Salt Lake are required to meet background concentrations in the lake, or the State has required the discharger to complete site-specific studies to establish a protective numeric standard (Ostler, 2004).

Kennecott Utah Copper Corporation completed studies from 2000 to 2002 establishing a site-specific water quality standard for selenium that would be included as part of their Utah Pollution Discharge Elimination System (UPDES) discharge permit to Great Salt Lake (Brix et al., 2004). These studies evaluated the potential bioaccumulation of selenium in aquatic-dependent birds (such as shorebirds and waterfowl) from their diet of brine shrimp,

and indicated that the bird diet (for example, brine shrimp) should not exceed 5 milligrams of selenium per kilogram (mg Se/kg) to be protective. Applying that dietary selenium threshold for aquatic birds to the relationship between water and brine shrimp tissue levels resulted in an estimate of 27 micrograms selenium per liter (µg Se/L) as a safe concentration in water for this exposure pathway. Therefore, the narrative standard is interpreted to mean that a "de facto" chronic numeric standard for selenium in Great Salt Lake is 27 µg Se/L. This is the value the UDWQ currently uses in assessing and enforcing UPDES discharge permits to Great Salt Lake (UDWQ fact sheet, 2004a).

2.3 Need for a Site-Specific Standard

Mining and other activities in the southwestern Salt Lake Valley have resulted in groundwater with elevated sulfate concentrations that threaten the integrity of an important municipal water supply. Under federal Superfund Law and provisions of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), the State of Utah and its partners developed a joint proposal to develop and construct a groundwater extraction and treatment project, with groundwater remedial functions, to provide treated municipal-quality water to the public in southwestern Salt Lake Valley. The proposed reverse osmosis (RO) treatment processes that remove the contaminants also generate a concentrated brine requiring disposal.

Some of the RO concentrate was initially proposed to be discharged to the Jordan River. A UPDES discharge permit to do so was obtained from the State of Utah. Under its UPDES permit, remaining RO concentrate was to be recycled by the Kennecott Utah Copper Corporation with excess water discharged to Great Salt Lake. As a result of public comments focusing primarily upon selenium concentrations in the RO concentrate, the UPDES permit for discharge to the Jordan River was withdrawn and efforts were renewed to find an alternative disposal location for concentrate waters to be produced from the treatment process (Jordan Valley Water Conservancy District, 2006).

After evaluating 15 alternatives, the stakeholder forum recommended that discharge of the concentrate to Great Salt Lake be considered following additional research and verification that discharge of such concentrate will not be harmful to the Great Salt Lake ecosystem. Selenium was the primary constituent of concern. The State of Utah subsequently convened the Great Salt Lake Water Quality Steering Committee (Steering Committee), consisting of key stakeholders similar in structure to the stakeholder forum discussed previously, and an expert Science Panel to recommend a new selenium water quality standard for the Great Salt Lake. Information developed from that process will serve as the basis for further public comment and to determine if regulatory approval of a UPDES permit for discharge of the concentrate to Great Salt Lake is feasible. The stakeholder forum is expected to reconvene and make its final recommendation after a site-specific water quality standard is in place (Jordan Valley Water Conservancy District, 2006).

2.4 Development of a Site-Specific Standard

Site-specific water quality standards that reflect the unique biota, habitat, and geochemistry of a water body are allowed by federal and state regulations. The Clean Water Act provides states with the opportunity to adopt water quality standards that are "…modified to reflect

site specific conditions" (40 *CFR* §131.11[b][1][ii]). Site-specific standards are intended to account for species composition and water quality characteristics at the site and result in better levels of protection to aquatic life at the site than national criteria. The State of Utah rules also provide for the development of site-specific numeric water quality standards:

> *The Board may allow site-specific modifications based upon bioassay or other tests performed in accordance with standard procedures determined by the Board* (State of Utah, 2007b).

Federal regulations require that states submit to the EPA the "methodologies used for site-specific criteria development, any general policies applicable to water quality standards, and any revisions to the standards" (40 *CFR* §131.20[c]). In addition, water quality criteria must be based on "sound scientific rationale" (40 *CFR* §131.11). Lastly, states should establish numeric standards "based on Clean Water Act Section 304(a) Guidance modified to reflect site-specific conditions, or other scientifically defensible methods" (40 *CFR* §131.11[ii],[iii]; see also the EPA's Water Quality Standards Handbook [1994], Chapter 3, Water Quality Criteria).

The approach for development of a site-specific standard for selenium in the open waters of Great Salt Lake is atypical for several reasons. The EPA typically derives water quality criteria for aquatic organisms (that is, it does not directly address aquatic-dependent wildlife), the EPA applies toxicity data that are based on water-column concentrations and result in direct effects on test organisms (that is, it does not directly address dietary exposure), and it derives criteria that are presented as water column concentrations (Wuerthele, 2004). For selenium in Great Salt Lake, there are a number of factors that are not ideally addressed by the typical EPA protocol, such as the following:

- Selenium is a bioaccumulative toxicant, with dietary exposure as a key pathway.
- Chronic selenium criteria, therefore, are appropriately presented as threshold tissue-based values.
- Although the aquatic community in Great Salt Lake is rather limited, it is an important resource for aquatic-dependent birds.
- For Great Salt Lake, potential effects on aquatic-dependent birds must be a key consideration in standard development.
- The chemistry of Great Salt Lake is unique.

Furthermore, the EPA's typical approach to aquatic life criteria development requires a minimum dataset with data to include a range of functional groups and sensitive taxa (such as a salmonid, a second recreationally or commercially important fish family, another aquatic vertebrate, a planktonic crustacean [for example, cladoceran], a benthic crustacean [for example, amphipod, an aquatic insect, etc.]) to derive acute and chronic criteria (Wuerthele, 2004).

The current national ambient water quality criteria (EPA, 1987) are based on a number of studies at Belews Lake, North Carolina, with the chronic criterion set at 5 µg Se/L (total recoverable selenium). More recently (EPA, 2004), EPA has proposed draft criteria that are based on whole-body fish tissue (chronic value equals 7.91 µg Se/g dry weight) based on a winter stress study with bluegill. That chronic value is not appropriate for

Great Salt Lake for a number of reasons (absence of fish, etc.), so the site-specific standard must be based on conditions applicable to the lake (as described in Section 3.0).

Past efforts to develop water quality standards for selenium for Great Salt Lake have focused on dietary exposure as a key pathway to waterfowl and shorebirds that feed there. As described previously, this is due to the bioaccumulative nature of selenium, and resulted in a suggested chronic selenium criterion that was expressed as a threshold tissue-based value (Brix et al., 2004). Potential effects of selenium concentrations in these kinds of birds will play an important role in the development of a new Great Salt Lake site-specific selenium standard. Given the unique chemistry and limited dataset describing the Great Salt Lake's ecology, site-specific selenium standards will have to consider other factors, such as the following (Wuerthele, 2004):

- A key aquatic organism will need to be identified for which a tissue-based value may be developed.
- A tissue-based toxicity threshold value for the aquatic organism will need to be evaluated and determined that will protect wildlife dependent on that aquatic organism as a food resource.
- The evaluation should include an assessment of whether the whole-body toxicity threshold value will be protective of critical endpoints in wildlife, such as reproductive success.
- A relationship will need to be derived to allow the translation of a tissue-based toxicity threshold concentration to a water column concentration. This will be required for use as a basis for regulating discharges to Great Salt Lake.
- Accurate and precise methods will be needed to measure selenium in Great Salt Lake water and in tissues of aquatic organisms.

Pursuant to the lack of an adequate understanding of the fate of selenium in Great Salt Lake and the requirements identified above, the State of Utah initiated the current program to complete the requisite scientific research to develop a numeric water quality standard for the open waters of Great Salt Lake.

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