Data Quality Objectives for Developing a Site-specific Selenium Standard for Great Salt Lake

Step	DQO Guidance of Purpose and Outputs of Step	Great Salt Lake Project
1. Problem Statement	**Purpose:** Clearly define the problem that requires new environmental data so that the focus of the study will be clear and unambiguous. **Outputs From This Step** • A concise description of the problem. • A list of the planning team members and identification of the decision maker. • A summary of available resources and relevant deadlines for the study.	**Problem:** The open waters of the GSL are protected for their current beneficial uses (identified as "Aquatic Wildlife") through the application of a narrative criteria clause, rather than a numerical value. Due to the highly individual nature of the Great Salt Lake's water, the Utah Department of Environmental Quality (DEQ) has not yet identified a numeric water quality standard (i.e., selenium concentration) specific to the GSL. The goal of this project is to complete a group of interrelated studies that will contribute to the establishment of an interim standard for selenium by the third quarter of 2007. Essential components of the GSL ecosystem, as related to the establishment of the site-specific standard, have been identified in a detailed conceptual model for selenium cycling in the GSL (Bill Johnson et al., CWECS, University of Utah). These DQOs (including those for each of the individual projects) and the accompanying scopes of work describe the approach for obtaining information that is needed for establishment of the site-specific standard. The main focus of the work is to determine loading of selenium to GSL, its distribution within the lake, and transfer factors from one medium to another (e.g., from diet to bird eggs). **Planning team members:** Dr. Mike Conover, Clay Perschon, Dr. Wayne Wurtsbaugh, Brad Marden, Dr. David Naftz, and Dr. William Johnson (Principal Investigators); Dr. Harry Ohlendorf, Dr. Earl Byron, Gary Santolo, and Daniel Moore (Project Advisors); Jeff DenBleyker (Project Manager); with ultimate decision authority by Utah DEQ, considering input by the GSL Steering Committee and GSL Science Panel. **Resources:** Current estimated budget for this work is about $1,342,000 (plus $124,000 in USGS cost-sharing). Technical expertise for conducting the field studies is available from the CWECS team members, who also will provide needed equipment. Analytical laboratory services are available from a limited number of commercial laboratories for completing the selenium and other analyses. Selenium-related expertise and project management support will be provided by CH2M HILL project advisors and the project manager. **Deadlines:** Although deadlines vary among the individual projects, the initial focus is to provide sufficient information by late 2006 or early 2007 for Utah DEQ to establish an interim standard for selenium by the third quarter of 2007. It is expected that initial results will be available for selenium concentrations (and their significance) in bird eggs (California gulls, American avocets, black-necked stilts), common invertebrates (brine flies and brine shrimp), inflowing waters from various sources, ambient waters (as waterborne selenium concentration and also as dissolved gas) of Gilbert Bay (i.e., the "open waters" of GSL), and sediment (including bed sediment and material being deposited to the sediment).

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2. Decision Statements	**Purpose**: Define the decision(s) that will be resolved using data to address the problem. **Approach**: Identify the key question that the study attempts to address and alternative actions that may be taken, depending on the answer to the key study question. **Outputs From This Step** • A statement of the decision that must be resolved using data in order to address or solve the problem. • A list of possible actions or outcomes that would result from each resolution of the decision statement. *Note from EPA guidance on DQO: If the principal study question is not obvious and specific alternative actions cannot be identified, then the study may fall in the category of exploratory research, in which case this particular step of the DQO Process may not be needed.*	**Decisions:** The overall question to be resolved can be stated as "What is the acceptable waterborne concentration of selenium that will be appropriately protective of beneficial uses of Great Salt Lake waters?" More specific questions that support this overall decision are presented in the individual project-specific DQOs. In general, they include the following: • What are the transfer factors that describe relationships between selenium concentrations in bird diets and the concentrations found in bird eggs? • What is the relative importance (based on selenium concentrations and their availability) of various food-chain exposure pathways for aquatic wildlife? • Are significant ecological effects occurring in aquatic wildlife? If so, to which ones and at which locations? What are the associated selenium concentrations in tissues (including bird blood, liver, and eggs)? • What are the sources of waterborne selenium entering GSL, and what is the relative significance of each of the various sources? • What are the most important processes that affect the partitioning, cycling, and release of selenium in the GSL open waters? **Possible outcomes:** • Information is adequate to quantify relationships among trophic levels and to conclude that current selenium loadings to GSL have a measurable adverse effect on aquatic wildlife in the open-water GSL ecosystem. Steps should be taken to reduce present and future selenium loadings by establishing a more protective site-specific standard for selenium. • Information is adequate to quantify relationships among trophic levels and to conclude that current selenium loadings to GSL have no measurable adverse effect on aquatic wildlife in the open-water GSL ecosystem. Future selenium loadings to GSL can be maintained at this level or increased concurrent with low-intensity water-quality and biological monitoring. • Information is not adequate to quantify relationships among trophic levels or to determine whether current selenium loadings to GSL have a measurable adverse effect on aquatic wildlife in the open-water GSL ecosystem. Further studies are needed to make a defensible conclusion about the significance of effects.

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3. Inputs to the Decision	**Purpose**: The purpose of this step is to identify the informational inputs that will be required to resolve the decision, and to determine which inputs require environmental measurements. **Activities** • Identify the information that will be required to resolve the decision. • Determine the sources for each item of information identified. • Identify the information that is needed to establish the action level for the study. • Confirm that appropriate field sampling techniques and analytical methods exist to provide the necessary data. **Outputs From This Step** • A list of informational inputs (including sources and potential action levels) needed to resolve the decision. • The list of environmental variables or characteristics that will be measured.	**Informational inputs:** • Trophic transfer factors from diet to birds and ecological significance of selenium to avian aquatic wildlife at representative locations; Project 1 • Selenium bioaccumulation in brine flies (including larvae, pupae, and adults) and brine shrimp (including cysts as well as whole-body tissue) and the seasonal and spatial availability of these food-chain organisms for aquatic wildlife; Project 2 • Selenium concentrations and flow volume from sources entering GSL; Project 3 • Selenium flux from the water column to the atmosphere and to the lake bottom as well as remobilization from sediment to the water column; Project 4 **Variables/characteristics to be measured:** • Selenium in the following media (see project-specific DQOs for more details): – Gull, avocet, and stilt blood, liver, and eggs – Eared grebe tissues (blood and liver) – Duck tissues (blood and liver) – Periphyton and brine flies (larvae, pupae, and adults) – Seston and brine shrimp (whole-body tissues and cysts) – Inflow water – Ambient waters of Gilbert Bay (as waterborne total, dissolved volatile, and vapor selenium concentrations) – Particulate phase in water column – Sediment (submerged sediment cores and exposed sediment) • Other variables (see project-specific DQOs for more details): – Incidence of embryo mortality and abnormalities in nesting birds – Body condition of grebes and ducks – Periphyton/detrital biomass – Brine fly larval and pupal density – Brine shrimp population characteristics (e.g., biomass, abundance, age structure) – ^{13}C and ^{15}N to correlate with selenium concentrations in seston and brine shrimp – Flow of water from various sources – Sediment flux (via sediment traps) – Mixing of Deep Brine Layer with Shallow Layer between and during storm and wind events (using turbidimeter and thermistor strings)

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4. Study Boundaries	**Purpose**: Specify the spatial and temporal circumstances that are covered by the decision. **Activities** • Define the domain or geographic area within which all decisions must apply. • Specify the characteristics that define the population of interest. • When appropriate, divide the population into strata that have relatively homogeneous characteristics. • Define the scale of decision making. • Determine when to collect data. • Determine the time frame to which the study data apply. • Identify any practical constraints on data collection. **Outputs From This Step** • Characteristics that define the domain of the study. • A detailed description of the spatial and temporal boundaries of the decision. • A list of any practical constraints that may interfere with the study.	**Spatial:** The project area is defined as the open waters of the Great Salt Lake (also referred to as Gilbert Bay) located north and west of Farmington Bay, west of the Weber River input, and south of Promontory Point, Bear River Bay, and the North Arm (bounded by the railroad causeway). **Temporal:** The maximum period of data collection will be from mid-April 2006 through March 2007 for Project 1 and through February 2008 for Project 3. However, it is expected that other projects will provide initial results by late 2006 and will be completed in 2007. **Practical constraints on data collection:** Weather is the major constraint for all of the projects, because storms can limit our ability to conduct any of the sampling and measurement activities on the lake. Availability of boats and other field equipment, as well as equipment functionality, also may limit some activities. Methodology for quantitative sampling of brine fly larvae and pupae has not yet been tested on the lake.
5. Decision Rules	**Purpose**: The purpose of this step is to integrate the outputs from previous steps into a single statement that describes the logical basis for choosing among alternative actions. **Activities** • Specify the parameter that characterizes the population of interest. • Specify the action level for the study. • Combine the outputs of the previous DQO steps into an "if...then..." decision rule that defines the conditions that would cause the decision maker to choose among alternative actions. **Outputs From This Step** • An "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative courses of action.	• If information is adequate to quantify relationships among trophic levels and to conclude that current selenium loadings to GSL have a measurable adverse effect on aquatic wildlife in the open-water GSL ecosystem, then the Science Panel will assist the Utah DEQ and the Steering Committee in establishing a site-specific selenium standard to reduce selenium loading. • If information is adequate to quantify relationships among trophic levels and to conclude that current selenium loadings to GSL have no measurable adverse effect on aquatic wildlife in the open-water GSL ecosystem, then the Science Panel will assist the Utah DEQ and the Steering Committee in establishing a site-specific selenium standard, presumably maintaining the current level or increasing it, concurrent with low-intensity water-quality and biological monitoring. • If information is not adequate for the Science Panel to quantify relationships among trophic levels or to determine whether current selenium loadings to GSL have a measurable adverse effect on aquatic wildlife in the open-water GSL ecosystem, then further studies will be recommended to provide the needed information for the Science Panel.

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6. Tolerable Limits on Decision Rules	**Purpose**: Specify the decision maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in the data. **Activities** • Determine the possible range of the parameter of interest. • Define both types of decision errors and identify the potential consequences of each. • Specify a range of possible parameter values where the consequences of decision errors are relatively minor (gray region). • Assign probability values to points above and below the action level that reflect the acceptable possibility for the occurrence of decision errors. • Check the limits on decision errors to ensure that they accurately reflect the decision maker's concern about the relative consequences for each type of decision error. **Outputs From This Step** • The decision maker's acceptable decision error rates based on a consideration of the consequences of making an incorrect decision.	These outputs are more applicable to specific studies than to the overall DQOs, and are presented as the study-specific limits applicable to the precision, accuracy, representativeness, completeness, and comparability of the data, including an appropriate quality assurance/quality control plan, for Projects 1, 2, 3, and 4.
7. Optimization of the Sampling Design	**Purpose**: Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs. **Activities** • Review the DQO outputs and existing environmental data. • Translate the information from the DQOs into a statistical hypothesis. • Develop general sampling and analysis design alternatives. • For each design alternative, formulate the mathematical expressions needed to solve the design problems. • For each design alternative, select the optimal sample size that satisfies the DQOs. • Select the most resource-effective design that satisfies all of the DQOs. • Document the operational details and theoretical assumptions of the selected design in the Sampling and Analysis Plan. **Outputs From This Step** • The most resource-effective design for the study that is expected to achieve the DQOs, selected from a group of alternative designs generated during this step.	These outputs are more applicable to specific studies than to the overall DQOs, and are presented as the study-specific limits applicable to the precision, accuracy, representativeness, completeness, and comparability of the data, including an appropriate quality assurance/quality control plan, for Projects 1, 2, 3, and 4.