DATA QUALITY OBJECTIVES: Willard Spur Nutrient Cycling Study

Step	DQO Guidance of Purpose and Outputs of Step	Willard Spur Nutrient Cycling Study
1. Problem Statement	**Purpose:** Clearly define the problem that requires new environmental data so that the focus of the studies will be clear and unambiguous. Identify leaders and member of the planning team/decision makers, develop the conceptual model, and determine resources (budget personnel, schedule) **Activities** • Describe the problem, develop a conceptual model of the environmental conditions to be investigated, and identify the general type of data needed; • Establish the planning team and identify the team's decision makers; • Discuss alternative approaches to investigation and solving the problem; • Identify available resources, constraints, and deadlines associated with planning, data collection, and data assessment **Outputs From This Step** • A concise description of potential threats to Willard Spur	**DESCRIPTION OF PROBLEM:** There is concern that changes in hydrology and nutrient load as the PWRWTP increases its operating capacity may negatively impact wildlife and habitat of Willard Spur. The primary research questions posed are: What are the seasonal patterns of wetland dynamics in Willard Spur and does nutrient loading affect these dynamics? The goals of this project are 1) to provide an understanding of the natural variability of biological processes and productivity related to nutrient cycling in Willard Spur and 2) to identify thresholds for nutrient response using biological indicators. **PLANNING TEAM AND DECISION MAKERS** Dr. William Johnson and Dr. Heidi Hoven (Principal Investigators); Dr. Ramesh Goel, Dr. Sam Rushforth, Dr. David Richards; Jeff DenBleyker (DWQ Project Manager); with ultimate decision authority by Utah DEQ Division of Water Quality, considering input by the Willard Spur Science Panel and the Willard Spur Steering Committee. **CONCEPTUAL MODEL** Our proposed strategy is to test wetland response metrics to ambient, mid-range, and high-range nutrient loading scenarios in a manner that reflects in-situ conditions. We will identify a minimum of three potential biological indicators and determine their threshold response ranges to nutrient loading that are meaningful for the Willard Spur aquatic system and be directly tied to beneficial uses designated for Willard Spur. Relative influences of nutrient enrichment from the water column versus sediment compartments also need to be determined. Our experiment(s) will use well defined and controlled nutrient addition(s) to three in-situ test plots under two scenarios: 1) water column only; and 2) sediment compartment only; each with a control plot (no nutrient addition). This will occur over the course of the 2012 growing season to narrow down the range(s) that trigger negative biological response and to develop threshold values for those responses. The time release nutrient compound Osmocote will be used and

	• A list of the planning team members and identification of the decision makers • A conceptual model of the environmental issue/site being addressed • A summary of available resources and relevant deadlines for the study	monitored frequently to ensure continuous regulated concentrations. We will monitor: a) sediment, pore water and surface water chemistry; b) nutrient uptake flux; c) SAV and associated macroalgae; d) phytoplankton and e) macroinvertebrates. Use of ex-situ mesocosms was considered but the likelihood of replicating environmental conditions comparable to in-situ conditions is poor. Comparing conditions with other impounded wetlands was also considered, however, impounded wetlands are managed and are not representative of Willard Spur hydrology and flushing, nor could we account for interactions between toxic effects of sulfides and / or metals found a nutrient enriched sites with nutrient responses. Thus, no viable alternatives were found. The results from the 2012 growing season will be used to define target objectives for the 2013 growing season. **AVAILABLE RESOURCES** Current estimated budget for this work is about $250,000. Technical expertise for conducting the field studies is available from nutrient cycling team members, who also will provide needed equipment. Analytical laboratory services are available from the University of Utah and the State Laboratory for completing nutrient and other analyses. Nutrient cycling expertise and project management support will be provided by DWQ and the Science Panel. An existing constraint is the relatively limited data available for providing a benchmark from which to compare when considering high to low runoff years. There are years of data from Great Salt Lake impounded wetland systems, yet they are not truly comparable to Willard Spur. Another constraint is the variability in flow and volume in Willard Spur seasonally and annually. Major project deadlines are: Refine experimental design and initiate sampling in April with monthly sampling through October of 2012; literature review draft by June 30th, 2012; final draft due Sept. 30th 2012; 1st Interim Report due January 18th, 2013, identifying at least 3 potential biological indicators. During 2013, nutrient treatment concentration ranges will be refined based on the responses of a reduced number of indicator metrics in order to develop threshold value ranges. A 2nd Interim Report (due January 17th 2014) will discuss the viability and uncertainty associated with each indicator, factors that may affect their viability, and threshold values for each indicator that would trigger a direct response to nutrients. Final Report is due June 30th 2014.

2. Program Goals (Study Goals at project level)	**Purpose**: Identify principal program questions. • **Decision problems vs. Estimation problems**: For decision problems, develop decision statement(s), organize multiple decisions. For estimation problems, state what needs to be estimated and key assumptions. **Activities** • Identify the principal study question and define alternative actions that may be taken based upon the range of possible outcomes that result from answering the principal study question; • Use the principal study question and alternative actions to make either a decision statement or estimation statement (whichever is relevant to the particular problem); and • Organize multiple decisions into an order of sequence or priority, and organize multiple estimation problems according to their influence on each other and their contribution to the overall study goals **Outputs from this step:** • A well-defined principal study question, • A listing of alternative outcomes or actions as a result of addressing the	**KEY QUESTIONS THE PROGRAM WILL ATTEMPT TO ADDRESS** The central questions for the project are: • What are the natural, temporal changes that occur in Willard Spur submergent wetlands? • What factors drive the changes? • How do differences in nutrient conditions in the water column drive changes? • How do differences in nutrient conditions in the sediment drive changes? • How do natural variability in biological processes and productivity relate to nutrient cycling in Willard Spur? • What constitutes a negative / unacceptable response to nutrients by the SAV, macroinvertebrate community, phytoplankton, macroalgae? **POSSIBLE OUTCOMES:** • Variability in natural, temporal changes will be captured by replicate sampling in each control plot (one for water column treatments and one for sediment treatments). If the spatial variability in the control plots is high after the second month of sampling (May), we may consider increasing the sample number in all plots for metrics that show high variability (e.g., percent cover SAV) for the remaining months of the study. • Nutrient uptake flux will identify importance and role of organic matter in sediment nutrient cycling. • Nutrient uptake flux will identify whether N and/or P are limiting nutrient(s) from water versus sediment sources. • Bioavailability of sediment nutrients for uptake will be elucidated through nutrient uptake flux and SAV tissue nutrient content. • Availability of sediment nutrients for geochemical processes will be defined. • Major influences on sediment and pore water chemistry in Willard Spur will be described. • Influence of sediment sulfide and metal concentrations on nutrient flux

	principal study questions, • For decision problems, a list of decision statements that address the study question, and • For estimation problems, a list of estimation statements that address the study question	mechanisms will be identified. • Comparison of sediment sulfide and metal concentrations between Willard Spur and other wetlands of Great Salt Lake will be made to identify other potential factors associated with biological responses to the different nutrient enrichment treatments. • The contribution to the nutrient budget from SAV, phytoplankton, and algae will be preliminarily and indirectly addressed through assessment of biomass (tuber and drupelet biomass of SAV, total biomass for phytoplankton and macroalgae) and SAV tissue nutrient content. Total above-ground biomass determination of SAV is cost prohibitive and could not be completed within the scheduling constraints of the project. Biomass of SAV reproductive parts is used to assess the major dietary contribution to the majority of waterfowl guilds that include SAV in their diet. A more refined determination of the contribution of nutrients from SAV/phytoplankton/algae to the sediment and/or water could be recommended for further study during the 2nd year. • Possible negative outcomes for nutrient enrichment of the water column could be increased phytoplankton biomass for extended periods leading to increased pH and decreased ability of SAV to absorb DIC; SAV would switch to less efficient uptake of carbon in the form of HCO_3 and could result in reduced productivity (as decreased C assimilation) and ultimately a premature die-off could occur. The 1st year monitoring effort does not cover physiological assessment of SAV to confirm such a response but may be recommended as an added study during the 2nd year. Increased epiphyte biomass could also affect gas exchange between SAV and the water column in the same manner. Premature die-off is presumed to be indicative of an imbalance in the system. • A possible negative outcome for the macroinvertebrate community related to SAV die-off resulting in any of the nutrient enrichment treatments would be loss of habitat for clinging and grazing macroinvertebrates, and a concomitant shift toward a benthic macroinvertebrate community. The negative outcome is a less diverse macroinvertebrate community and loss of nutrient cycling contributions by detritivores and grazers; diminished availability of an important food source for waterfowl at an important time in their life history (e.g., while replenishing

		their plumage during the molting period, during brood rearing, during staging). A major trophic shift in the macroinvertebrate community is presumed to be indicative of an imbalance in the system. • A possible negative outcome for macroalgae is that it could become a dominant vegetative cover, providing little or no nutritional value to waterfowl that depend upon submergent wetlands during much of their life history. A shift from vascular plant to algal dominated system is presumed to be indicative of an imbalance in the system. • A possible outcome would be lack of distinction of biological responses between the control and treatment plots, in which case the experimental design will be revisited
3. Inputs to the Decision	**Purpose**: The purpose of this step is to identify the types and sources of informational inputs that will be required to resolve the decision or produce estimates, and to determine which inputs require environmental measurements. **Activities** • Identify types and sources of information needed to resolve decisions or produce estimates • Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process • Select appropriate sampling and analysis methods for generating the information	**WHAT PARAMETERS NEED TO BE MEASURED TO PRODUCE ESTIMATES (INCLUDE CONTINGENCIES – WHAT WE ARE NOT SAMPLING AND WHAT THEY COULD POSSIBLY PRODUCE)** • Water chemistry • Sediment chemistry • Nutrient uptake flux • SAV percent cover • Epiphyte percent cover • Surface mat percent cover • Light penetration through the SAV canopy • SAV tuber and drupelet biomass • SAV tissue CNP • Phytoplankton biomass and (seasonal) productivity • Phytoplankton flora • Benthic diatom samples (to be archived) • Macroalgal biomass • Need to describe water flow, preferably with a flow meter

	Outputs From This Step • Lists of environmental characteristics that will resolve the decision or estimate and potential sources for the desired information inputs; • Information on the number of variables that will need to be collected; • The type of information needed to meet performance or acceptance criteria; • Information on the performance of appropriate sampling and analysis methods	**POSSIBLE OUTCOMES:** • Flow rates will be vitally important for monitoring and adjusting nutrient concentrations DWQ may have an available flow meter through June but it is not certain whether the project team can locate another for the remainder of the study. It may not be necessary data for this purpose after flow from runoff subsides. • Flow rates will be important in determining whether phytoplankton are effectively being "washed downstream". Without flow data, we may not be able to discern the amplitude of a phytoplankton response. DWQ may have an available flow meter through June but it is not certain whether the project team can locate another for the remainder of the study. • Certain species of benthic diatoms have shown significant relationships with environmental factors in other studies of Great Salt Lake and other wetlands. While diatom analysis has not been proposed for the current workplan, they could be considered as an additional bioindicator. Monthly samples will be collected from each treatment during 2012 for archival purposes. • Emergent vegetation is not included in the current nutrient cycling study because the submergent (SAV) community is solely connected with the aquatic environment and serves as an appropriate platform from which to assess the role of nutrients in Willard Spur. The role of emergent vegetation in nutrient cycling in Willard Spur could be recommended for subsequent research as emergent species are highly productive (high biomass), contribute to nutrient cycling (though uptake and decomposition), and likely have different nutrient uptake and cycling capacity than SAV. The literature review during the first year will help identify any additional research needs relative to emergent vegetation in Willard Spur. • "Dry year" responses / trends are assumed different than wet (2011) year responses, and may make data comparisons between different hydrologic regimes difficult. • Outcome of effects/responses from sediment nutrient enrichment may not truly reflect a 20+ year old system: it may not account for effects of flushing or lack of flushing on organic matter build up. • The Willard Spur flow and depth conditions are variable; hence, while utmost efforts will be made, it is possible that the planned nutrient additions may not achieve the intended water and sediment nutrient concentrations, or may

		overshoot the intended concentrations. If insufficient concentrations are obtained, we will work with the science panel to determine options within budgetary constraints. If nutrient levels rise consistently higher than goal, nutrients can be removed from the water or sediment by removing nutrient-filled mesh bags until the appropriate levels are achieved.
4. Study Boundaries	**Purpose**: Specify the spatial and temporal circumstances that are covered by the decision. **Activities:** • Define the target population of interest and its relevant spatial boundaries • Define what constitutes a sampling unit • Specify temporal boundaries and other practical constraints associated with sample/data collection. Specify the smallest unit on which decisions or estimates will be made. **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	**GEOGRAPHIC AREA:** The study area is located within an area of submergent wetlands believed to be permanently inundated within the DWQ defined Willard Spur Study Boundary. It is located approximately half way down the northern Willard Bay dike and approximately 300m offshore just within the BRMBR boundary. **SCALE OF DECISION MAKING/ESTIMATION:** • Dimension of treatment plots are 6 x 20m (water column nutrient treatments) and 2 x 20m (sediment nutrient treatments) • Study area confined to a permanent pool of Willard Spur • Area must sustain an SAV community **TEMPORAL BOUNDARIES:** Biological and chemical data will be collected from April through October of 2012. A draft interim report summarizing the environmental parameters that lead to different biological responses among treatments will be prepared by January 17, 2013. A refined focus on nutrient concentrations that drive observed biological responses will be implemented from April through October of 2013. A draft interim report summarizing key findings and potential threshold values for a minimum of three biological indicators will be prepared by January 18th, 2014. A final report will be prepared by June 30th, 2014. **PRACTICAL CONSTRAINTS:** • Setting up and meeting desired nutrient regimes in the water column and sediment treatments • Effects of flow / lack of flow • Complete drying / draw-down of site • The need to extrapolate results from a smaller pool to large-scale effects, which

		will play an important role in informing interpretation of DWQ's overall sampling effort throughout the Spur and vise versa. • Other upstream sources of Bear River nutrients may overshadow impacts from increased effluent discharge from Perry POTW (PWRWTP). • Unfortunately the remoteness of the site makes the test plots vulnerable to vandalism. We will place the test plots within the boundary of the Bear River Refuge in the hope of dissuading vandalism. • Waterfowl and other aquatic birds may make use of the poles and float lines either for resting purposes or nesting. We don't expect water column nutrients to be affected during bird usage, however regular monitoring will determine whether there are issues. If (for example) coots construct nests on the float lines, care will be taken to not disturb them. • If weather precludes sampling events (due to safety issues or sunlight interference), sampling events will be rescheduled for the next best day. If dangerous weather conditions build during a sampling event (e.g., electrical storm, high winds) field personnel will abort the sampling event and continue once conditions are safe. We will strive for 95% completeness following the project quality assurance program plan (DRAFT_DWQ_QAPP_12192011, (QAPP)). • Water levels will likely become progressively shallow during the summer months. In the event the water levels are prohibitively shallow so that the site is not accessible without major disturbance to the plants or sediment, we will reconsider the sampling schedule and approach with the Science Panel and DWQ. • Water flow will likely vary in direction with depth and seasonally, highlighting the need to monitor flow and it's affect on nutrient concentrations and phytoplankton distribution within the plots. We will keep the Science Panel and DWQ informed of any major changes in flow considered to have negative consequences and seek consultation.

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. For studies: Specify the population parameter (mean, median, percentile) considered to be important to make inferences about the population **Activities** • specify the population parameter (e.g., mean, median or percentile) considered to be important to make inferences about the target population; • for decision problems, choose an Action Level (using information identified in Step 3) that sets the boundary between one outcome of the decision process and an alternative, and verify that there exist sampling and analysis methods that have detection limits below the Action Level; • for decision problems, construct the theoretical "If...then...else..." decision rule by combining the true value of the selected population parameter; the Action Level; the scale of decision making (Step 4), and the alternative actions (Step 2); • for estimation problems, develop the specification of the estimator by combining the true value of the selected population parameter with	**DECISION RULES** • Conditions that lead to changes in biological responses that differ from natural variation (i.e., natural variation in control plots) will be viewed as potential drivers of change and will be used to identify potential biological indicators (using 1st year results). • 2nd year will target conditions that drive changes in biological response with a focused series of treatments and monitoring with the intent of identifying threshold values for a minimum of three biological indicators. • Year 2 is not as well defined because it relies upon results of 1st year. If different biological responses occur among the nutrient treatments, then the focus of the 2nd year will be on key thresholds or triggers of those responses. However, if no discernable responses occur between controls and treatments, the research team, Project Manager, Science Panel and DWQ will need to determine an alternative pathway. • Possible reasons for no observed change: o Inability to establish a nutrient gradient among treatments and controls o Flow of water through study area did not dissipate appreciably after runoff o The nutrient levels added to the treatment plots did not exceed the assimilation capacity of the wetland sediment and vegetation

	the scale of estimation and other boundaries (Step 4) **Outputs From This Step** • Identification of the population parameters most relevant for making inferences and conclusions on the target population; • For decision problems, the "if..., then...else..." theoretical decision rule based upon a chosen Action Level (the conditions that would make the decision maker choose among alternative courses of action) and • For estimation problems, the specification of the estimator to be used.	
6. Specify Performance or Acceptance Criteria (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. • For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test and place limits on the likelihood of making decision errors • For estimation problems, specify acceptable limits on uncertainty **Activities** : See Manual* • Determine the possible range of the parameter of interest. • Define both types of decision errors	**TOLERABLE LIMITS ON DECISION RULES** • Tolerance limits for laboratory analysis data quality are defined in the Quality Analysis Project Plan (QAPP) where acceptable criteria are presented. All quality assurance (QA) and quality control (QC) objectives are outlined for sample measurements in the QAPP.

	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.	
7. Detailed Plan for Obtaining Data	**Purpose**: Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs. **Activities** • Gathering information that you will need in developing an acceptable and efficient sampling and analysis design; • Identifying constraints that will impact the sampling and analysis design;	**OPTIMIZATION OF THE SAMPLING DESIGN** • Collaborate with the Science Panel, project manager and DWQ regularly. • Coordinate with the Airboat Association for assistance in the field when necessary. • Use established (published and/or approved SOPs) field and laboratory protocols. • Notify and discuss unexpected outcomes with project manager and Science Panel as they happen; recommend adjustments or changes and / or request input from the Science Panel; follow up with results from new approach and continue to make adjustments accordingly.

	• Providing details on the sampling and analysis methods you will use to generate the data; • Identifying one or more candidate designs from which to select; • Determining an "optimal" amount of information to collect for the potential design using statistical and cost considerations; • Preparing a resource-effective information collection plan that will meet your needs and requirements **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.	