

Preliminary Identification of Research Needs

Development of Water Quality Standards for Willard Spur

TO: Willard Spur Science Panel

COPIES: Willard Spur Steering Committee
Utah Department of Environmental Quality, Division of Water Quality
(DWQ)

FROM: Jeff DenBleyker

DATE: September 6, 2011

The primary objective of the Science Panel meeting on September 22, 2011 will be to finalize a list of research studies (and their objectives) to be completed to address the program objective. The objective of this memorandum is to proffer possible studies for discussion at the Science Panel's September 22, 2011 meeting.

Program Objective

As discussed, modified, and approved at the Steering Committee meeting on August 16, 2011, the Science Panel is charged with the responsibility to identify and oversee the studies required to address the following question:

What water quality standards are fully protective of beneficial uses of Willard Spur waters as they relate to the proposed POTW [publicly owned treatment works] discharge?

The Steering Committee confirmed that the focus of the efforts should be upon the influence of nutrients upon the water quality throughout Willard Spur, however the Steering Committee would also like the Science Panel to identify whether any other potential water quality issues may exist and should be addressed in future efforts.

A list of possible research questions was prepared by CH2M HILL and provided to the Steering Committee on February 17, 2011 and to the Science Panel on August 16, 2011 (see Attachment A). This document was prepared as an initial "straw man" to guide initial discussions and planning for the 2011 sampling season. Attachment A includes four key questions that followed from the overall program objective:

1. *What is the current condition of Willard Spur?* Very little data or literature exists describing the resources and condition of Willard Spur. A foundational understanding of its condition and processes is important in determining whether Willard Spur is currently at risk, may be at risk in the future, and/or if changes to water quality standards are necessary. It should be noted that the 2011 Sampling Plan was developed to work towards answering this question.

2. *Does Willard Spur currently support its beneficial uses?* Information developed as part of Question No. 1 will be used to determine if existing beneficial uses are being attained.
3. *Will the proposed Willard-Perry discharge degrade the Willard Spur ecosystem?* Nutrient cycling mechanisms will be examined and historic, current, and future nutrient impacts on Willard Spur will be determined.
4. *What changes [to water quality standards], if any, are required to ensure the protection of beneficial uses in Willard Spur?* If needed, alternative water quality standards will be identified and evaluated as part of the overall objective.

Attachment A includes further detailed questions that followed from these four questions to shape possible research.

Research Needs

The Science Panel spent some time on August 16, 2011 reviewing two draft conceptual models, discussing possible indicators, and identifying potential research. Four primary areas of research were discussed at the August 16, 2011 Science Panel meeting. They include:

1. Understanding current conditions
2. Defining the hydrologic/hydraulic characteristics
3. Understanding nutrient cycling/transformation
4. Defining the food web

Figure 1 illustrates each of these four areas as well as provides additional detail regarding possible research questions in each area. Figure 1 also includes an illustration of how these research areas link to each other and provides a linkage to a preliminary list of research projects. Table 1 includes a summary of the ten possible research projects identified to address the research needs in Figure 1.

This list of possible research projects and objectives is provided to the Science Panel as a “straw man” for its review and consideration prior to its September 22, 2011 meeting. Any comments, revisions, and/or recommendations will be discussed at the meeting. DWQ’s objective is to present the Science Panel’s final recommendations for research studies to the Steering Committee after the Science Panel meeting on September 22, 2011. Researchers will then be engaged to further develop project objectives and workplans in coordination with the Science Panel.

FIGURE 1
Research Needs & Linkages

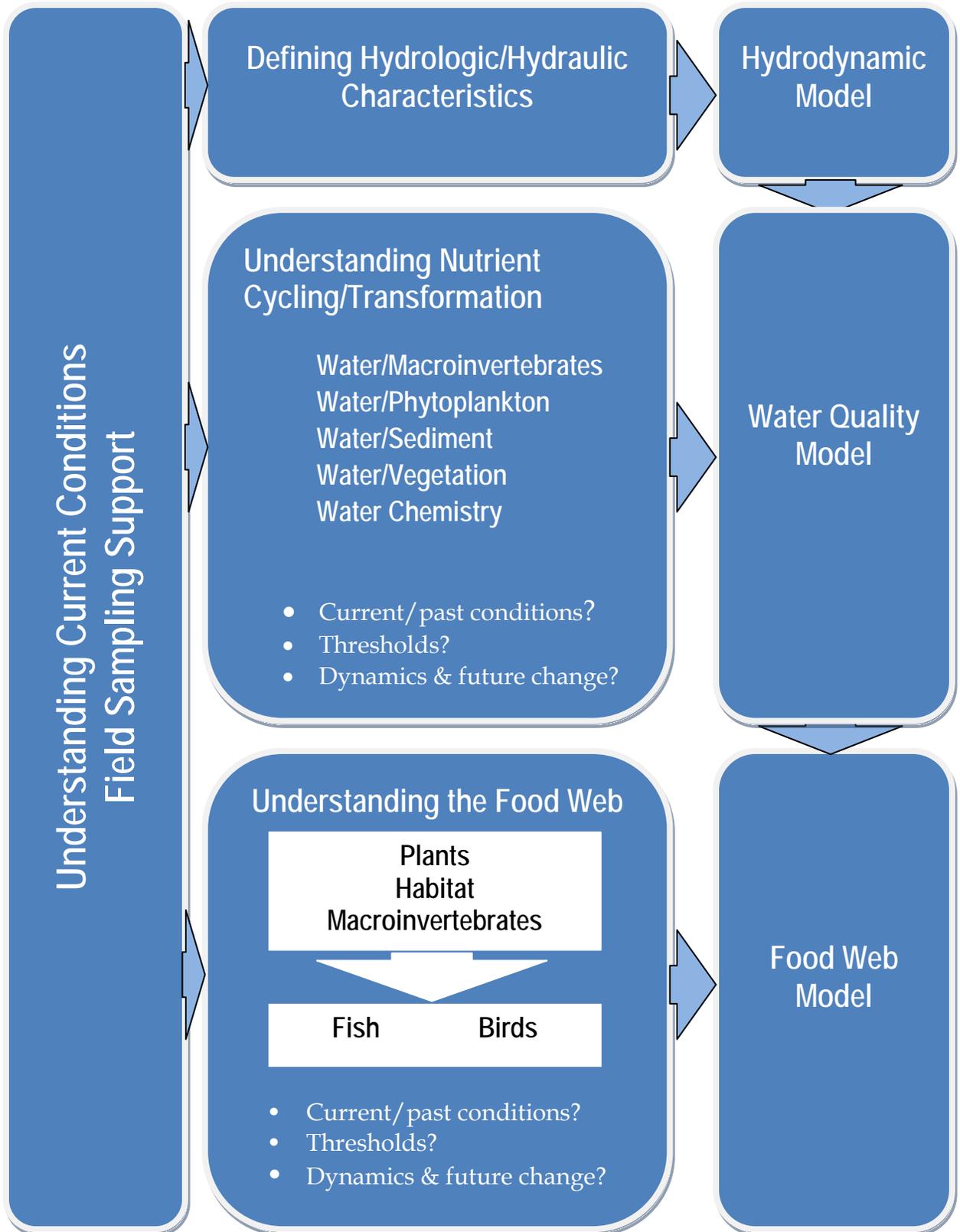


TABLE 1
Research Study Descriptions – Preliminary

1. Hydrology and Nutrient Loads

Objectives

1. Consolidate and review available hydrologic and nutrient data for inputs to Willard Spur,
2. Estimate nutrient loads for each input to and outflow from Willard Spur
3. Develop hydrographs for each input to and outflow from Willard Spur
4. Identify critical flow regimes for use in evaluations
5. Develop hydrodynamic model of Willard Spur to link inputs with changes in flow patterns and water levels

Notes:

1. Use available flow/weather/water level data from USGS and DWQ and nutrient data from DWQ
 2. Determine relationships between inflows and water levels in Willard Spur; recurrence intervals
 3. Determine relationship between PWRWTP outflow, adjacent tributaries, weather, water level - when does the outflow not reach open water
-

2. Fish Use

Objectives

1. Identify fish species that use Willard Spur
2. Estimate fish population by species
3. Identify preferred habitat and location
4. Identify food items
5. Identify existing concentrations of toxic metals in fish
6. Do fish species/numbers vary with habitat, water level, salinity, dissolved oxygen (DO)?
7. Determine fish carrying capacity of Willard Spur at different water levels

Notes:

1. No known data exists
 2. Possible partnership with Utah Division of Wildlife Resources (DWR)
 3. Link with Project 3
-

3. Bird Use

Objectives

1. Identify bird species that use Willard Spur and how they use it
2. Estimate bird population by species and time of year
3. Identify preferred feeding and nesting habitat and location
4. Identify food items
5. Identify existing concentrations of toxic metals
6. Do bird species/numbers vary with habitat, water level, salinity, DO?
7. Determine bird carrying capacity for Willard Spur at different water levels

Notes:

1. Use U.S. Fish & Wildlife Service (USFWS) and DWR databases for species/population/timing and link to habitat and water level
 2. Complete bird surveys to link USFWS/DWR surveys to field conditions
 3. Complete required diet studies
 4. Collect samples of bird eggs, food items
 5. Possible partnership with DWR/USFWS
 6. Are there other factors that influence or impair bird use?
 7. Link with Project 2
-

TABLE 1
Research Study Descriptions – Preliminary

4. Habitat/Vegetation

Objectives

1. Identify existing distribution of vegetation and relationship to water level, flow inputs, and water quality
2. Identify existing distribution of invasive species and algae
3. Complete literature review to determine if a link between invasive species and nutrients
4. Classify habitat types for Willard Spur and how they change with water level
5. Determine feasibility of developing relationship describing evolution of habitat with water level, nutrients, and salinity

Notes:

1. Use work by Dr. Kettenring to map existing emergent vegetation and invasive species
 2. Field surveys to map SAV not addressed by Dr. Kettenring
 3. Investigate the use of historical aerial/satellite imagery to map vegetation changes
 4. Use 2007 Ducks Unlimited wetlands habitat survey
 5. Link to DWQ's preliminary assessment framework for Great Salt Lake (GSL) impounded wetlands
 6. Link to Projects 2, 3, and 5
-

5. Macroinvertebrates

Objectives

1. Identify macroinvertebrate taxa using Willard Spur and locations
2. Determine how taxa change spatially, temporarily, and with water level, water quality, and habitat

Notes:

1. Use DWQ data
 2. Link to DWQ's preliminary assessment framework for GSL impounded wetlands
 3. Link to Projects 2, 3, 4, 6, and 8
-

6. Phytoplankton

Objectives

1. Identify phytoplankton using Willard Spur and locations
2. Determine effect of nutrients

Notes:

1. Use DWQ data
 2. Link to DWQ's preliminary assessment framework for GSL impounded wetlands
-

7. Nutrient Cycling – Sediment

Objectives

1. Determine existing sediment/water exchange
2. Determine sediment burial rates/composition
3. Look at long term nutrient deposition rates
4. Look at changes in diatoms in sediment

Notes:

1. Use DWQ samples
 2. Link to Project 6
 3. Possibly combine with Project 1 to link water chemistry with sediment
-

TABLE 1
Research Study Descriptions – Preliminary

8. Nutrient Cycling – Vegetation

Objectives

1. Determine nutrient/algal thresholds
2. Determine nutrient/submerged aquatic vegetation thresholds

Notes:

1. Use DWQ data augmented as needed
 2. Possible combined with Project 4
 3. Link to DWQ's preliminary assessment framework for GSL impounded wetlands
-

9. Water Quality Model

Objectives

1. Link hydrodynamic model with nutrient cycling in a comprehensive water quality model

Notes:

1. Possibly combined with Project 1
 2. Link to all other projects
-

10. Food Web Model

Objectives

1. Link bird and fish diet needs in a food web model to investigate carrying capacity/impairment
2. Link to water quality model

Notes:

1. Possibly combined with Project 2 and/or 3
-

11. Current Conditions/Field Sampling

Objectives

1. Complete 2011 field sampling
2. Complete field sampling as needed to support other projects

Notes:

1. Sampling plan changed to address needs of other projects
 2. Specialized sampling may need to be completed by others
-

Attachment A
Research Questions

The questions below represent a summary of the issues that may be relevant to the proposed study of Willard Spur. It is not intended to be a comprehensive list but is intended to stimulate discussion, prioritization, and identification of questions to be addressed by the Willard Spur Steering Committee and Science Panel. It is assumed that this list of questions will be part of initial discussions by the Science Panel and will help frame overall program Data Quality Objectives.

The questions highlighted in italics are questions that the 2011 flow monitoring and sampling program will help to start to address.

PROGRAM OBJECTIVE

What water quality standards are appropriately protective of beneficial uses of Willard Spur waters as they relate to the proposed POTW discharge?

RESEARCH QUESTIONS

1. What is the current condition of Willard Spur?

1.1. Develop a conceptual model of ecosystem

1.1.1. What are the assessment endpoints, i.e., valued ecosystem characteristics, that are desired to be protected?

1.1.1.1. What are the key driver, stressor, non-stressor variables and linkages in this ecosystem?

1.1.1.2. What are the indicator variables, both causal and response, specific to the classification of waters in Willard Spur?

1.1.1.3. What are the linkages and functional relationships between these indicator variables?

1.1.2. What are the biological endpoints most sensitive to nutrient inputs?

1.1.2.1. Do we have sufficient data to describe these endpoints through stressor-response relationships or a water quality model? Are these data sensitive to environmental changes? What are some other covariates that may affect the stressor-response relationships?

1.1.2.2. If data gaps exist, what steps are necessary to procure the data?

1.2. *What are the hydraulic/hydrologic characteristics of Willard Spur?*

1.2.1. *Where are the inputs/outputs and what is their timing?*

1.2.2. *What is the annual hydrograph (mass balance) for water entering/leaving Willard Spur?*

1.2.3. *How does the water surface elevation change in relation to inputs/outputs?*

1.2.4. *How does the volume and residence time of water change in relation to inputs/outputs?*

1.3. *What are the sources of waterborne contaminants entering Willard Spur, and what is the relative significance of the various sources?*

1.3.1. *What are contaminant concentrations and loads in water entering Willard Spur? In water leaving Willard Spur to Bear River Bay?*

1.3.1.1. *What is mass balance of contaminants in Willard Spur?*

1.3.1.2. *What are the sources for nutrients entering Willard Spur (isotope analysis)?*

1.3.1.3. What processes could potentially explain any differences observed in contaminants entering and leaving Willard Spur?

1.3.2. How does interaction with Bear River Bay/GSL affect conditions in Willard Spur?

- 1.3.2.1. What are effects of high lake levels and salinity?
- 1.3.3. Develop a hydrodynamic model to represent current condition
- 1.4. What are the most important processes that affect the partitioning, cycling, and release of potential contaminants in Willard Spur?
 - 1.4.1. *What are the relative concentrations of potential contaminants in water, sediment, and macro-invertebrates throughout Willard Spur?*
 - 1.4.1.1. *What potential contaminants are of concern for Willard Spur (i.e., nutrients, selenium, mercury, etc.)?*
 - 1.4.1.2. *What are concentrations now, pre-POTW discharge? How do they change after POTW begins operation in February 2011?*
 - 1.4.1.3. What biogeochemical processes determine the relative water and sediment concentrations of these potential contaminants?
 - 1.4.1.4. *How do they vary spatially in comparison to sources of water?*
 - 1.4.1.5. *How do concentrations vary throughout the year for different seasons/hydroperiods?*
 - 1.4.1.6. *How do they vary per other co-located variables sampled?*
 - 1.4.2. How do sediment/water column interact?
 - 1.4.3. What is the potential of increased nutrients, also increasing methylation of mercury?
 - 1.4.4. Couple water quality model with hydrodynamic model to represent current condition
- 1.5. What are the current vegetation, macroinvertebrate, phytoplankton compositions in Willard Spur?
 - 1.5.1. Classify wetland types and aerial extent of types in Willard Spur
 - 1.5.1.1. How does hydrology affect wetland types? Invasive species?
 - 1.5.2. What are current concentrations of contaminants in wetlands biota?
 - 1.5.2.1. How do they vary per water/moisture condition?
 - 1.5.2.2. How do they vary per trophic position of the biota?
 - 1.5.2.3. How do they vary per month during growing season?
 - 1.5.2.4. How do they vary per other co-located variables sampled?
 - 1.5.3. How do nutrient concentrations affect algal mat, SAV, and macroinvertebrate population characteristics?
 - 1.5.3.1. Develop MMI for Willard Spur wetlands
 - 1.5.3.2. How does the Willard Spur MMI compare to current MMI for other GSL wetlands?
- 1.6. What are the bird use patterns in Willard Spur?
 - 1.6.1. What bird species currently use Willard Spur for feeding, nesting, and rearing their broods? What are their numbers?
 - 1.6.2. What are current concentrations of contaminants in bird eggs laid along Willard Spur?
 - 1.6.3. What are birds eating and where? What are concentrations of contaminants in food items?
 - 1.6.4. What is the hatching success of birds nesting at Willard Spur?
- 1.7. What are the fish use patterns in Willard Spur?

1.7.1. What fish species currently use Willard Spur and what are their numbers?

1.7.2. What are current concentrations of contaminants in fish?

2. Does Willard Spur currently support its beneficial uses?

2.1. What are the current beneficial uses?

2.2. How do Willard Spur wetlands compare to reference condition?

2.2.1. What wetlands characteristics would determine a reference condition for Willard Spur? What sites could serve as reference wetlands?

2.2.2. Collect information to complete MMI to determine Willard Spur condition

2.2.3. How does MMI for Willard Spur compare to other GSL wetlands?

2.2.4. Is Willard Spur currently at risk? What characteristics are at risk?

2.3. Do stressor response relationships in Willard Spur indicate impairment?

2.4. How do characteristics of Willard Spur compare to established nutrient/algal thresholds for similar wetlands (published literature)?

2.5. How does the current condition represented in the hydrodynamic/water quality model translate to the current narrative standard?

3. Will the proposed Willard-Perry discharge degrade the Willard Spur ecosystem?

3.1. What are historical nutrient inputs?

3.1.1. Paleo-limnology study to evaluate historical nutrient deposition and condition of Willard Spur using biological endpoints (diatoms?)

3.1.2. What was the pre-settlement condition of Willard Spur?

3.1.3. Utilize hydrodynamic model coupled with water quality model to look at water quality conditions in Willard Spur without Willard-Perry discharge

3.1.3.1. What is sensitivity of Willard Spur to Willard-Perry as compared to other nutrient inputs?

3.1.4. Is there evidence of a trend?

3.2. How will proposed and future Willard-Perry discharges change condition in Willard Spur?

3.2.1. What is the relative significance of the proposed discharge for various hydrologic conditions?

3.2.2. Define scenarios for future POTW operation and effluent quality

3.2.3. Utilize hydrodynamic model coupled with water quality model to look at water quality conditions in Willard Spur with Willard-Perry discharge at various effluent concentrations

3.2.3.1. Compare anticipated water quality from model to other GSL wetlands and their MMI

3.2.3.2. Evaluate stressor response relationships

3.3. Are current water quality standards protective of beneficial uses of Willard Spur for current condition and proposed discharge?

4. What changes, if any, are required to ensure the protection of beneficial uses in Willard Spur?

THIS PAGE INTENDED TO BE BLANK

DRAFT