2013 Willard Spur Research Plan

PREPARED FOR: Willard Spur Science Panel

COPY TO: Willard Spur Steering Committee
Utah Division of Water Quality

PREPARED BY: CH2M HILL

DATE: June 10, 2013

The year 2013 represents the final year of research for the Develop of Water Quality Standards for Willard Spur project. This memorandum summarizes the questions that remain and the work that will be completed in 2013.

Research Objectives

The Science Panel was charged with the responsibility to identify and oversee the studies required to address the 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?*"

Two questions were identified that follow from the program objective, i.e., these questions must be answered for the program objective to be achieved. The questions are as follows:

1. What are the potential impacts of the Perry Willard Regional Wastewater Treatment Plant on Willard Spur?
2. What changes to water quality standards will be required to provide long term protection of Willard Spur as they relate to the proposed POTW discharge?

While significant progress has been made in answering these questions, it is evident that further work remains to:

1. Better characterize the potential impacts of the Plant on Willard Spur,
2. Complete the work that was started in 2012 to evaluate nutrient cycling in Willard Spur,
3. Continue 2012 special studies to understand ecosystem response and nutrient limitation, and
4. Confirm nutrient loads to and nutrient responses in Willard Spur in the context of addressing goals #1 and #2.

1.0 Characterizing Impacts from the Plant

The Science Panel has agreed that in general the impact from the Plant's discharge and nutrient load could be quite small given 1) the effluent may not always reach the open waters of Willard Spur, 2) there may be significant uptake of the effluent's nutrients before the effluent reaches the open water, 3) nutrient loads from other sources greatly surpass the Plant's input, and 4) Willard Spur appears to be processing the overall nutrient load with minimal impacts. A possible scenario where the Plant could have an impact is if the Plant's full nutrient load does reach the open water of Willard Spur (i.e., no evaporation and little to no uptake of nutrients between the Plant and open water) during the critical months of July – September of a very dry year (e.g., 2012).

The year 2013 presents an opportunity to assess the Plant's potential impacts in the detail required to answer this important question. Current water supply forecasts for 2013 indicate that flows could be very similar to the very low inflow conditions observed in 2012, thus there is an opportunity to further evaluate a scenario where the Plant could potentially have an impact. The following summarizes the tasks to be completed and questions to be answered in 2013.

1.1. Confirm whether the Plant will discharge its effluent in 2013 to the outfall ditch, private wetlands, or Willard Bay tailrace channel.

   a. Meet with the Plant to outline operations scenarios and anticipated schedule.

   b. Discuss possible flexibility for experiments outlined below with the Plant.

   c. Confirm existing UPDES permit requirements relating to discharge location.

1.2. How could the Plant's future nutrient load change?

   a. Confirm future scenarios with the Plant for anticipated high and low effluent flow rates and high and low nutrient concentrations. Are the scenarios documented in DWQ's memorandum dated September 30, 2010 accurate?

1.3. How could the irrigation ditch between BRMBR and the Plant contribute to possible impacts from the Plant?

   a. Confirm the source of the water in the irrigation ditch with the cities and USFWS. Is it natural drainage, irrigation return flow, and/or are there water rights associated with this water?

   b. Confirm nutrient loads from the irrigation ditch through DWQ's 2013 monitoring program.

   c. Contact the cities and USFWS to identify anyone who could speak to the historical use of and flow rates and patterns in the ditch. What do aerial photographs indicate?

   d. How are flows in the irrigation ditch expected to change in the future?

   e. Can the Plant confirm historical discharges from the lagoons into the outfall ditch?

1.4. How have the irrigation ditch and Plant outfall ditches contributed to the existing phragmites patch at the confluence of these ditches?

   a. Is there historical aerial photography that could indicate when the phragmites began to invade this site? How does this information compare with historical flow in the irrigation and outfall ditches as outlined in Task 1.3?

   b. Collect sediment samples to discern how sediment salinity and nutrient levels within the phragmites patch compare to an adjacent site that has not received a similar freshwater inflow. Can deeper sediment samples be used to discern long term impacts from the irrigation ditch vs. the Plant's recent discharge?

   c. How does this site compare to the mudflats below the HCWMA Bypass Drain discharge or HCWMA north dike? How is the phragmites cover different and how has it changed over time at these sites? How do flows/nutrient loads from sources differ? How does inundation from Willard Spur differ at sites?

1.5. How much is the Plant's nutrient load to the open waters of Willard Spur reduced by natural uptake in the outfall ditch, private wetland, and Willard Bay tailrace channel?

   a. Evaluate nutrient uptake in the outfall ditch. Discharge effluent down the ditch for two weeks during growing season (June – August). Sample at least five sites along the ditch to determine uptake of existing loads. Evaluate nutrient uptake in the private wetland. Discharge effluent into the private wetland for two weeks during growing season (June – August). Use a dye tracer to define a flow path through the wetland, whether the wetland has an outflow, and what the residence time is. Sample at least five sites along the identified flowpath through the wetland to determine uptake of existing loads. Evaluate nutrient uptake in the Willard Bay tailrace channel. Discharge effluent into the channel for two weeks during growing season (June – August). Sample at least five sites along the channel to determine uptake of existing loads.

1.6. Does the Plant's effluent reach the open waters of Willard Spur? How does that change seasonally?

   a. Complete monthly measurement of flow and sampling of water quality in irrigation ditch and Plant outfall ditch and relate to estimated evaporation rates.

   b. Make weekly observations of how far the flow extends toward the open water of Willard Spur vs. presence of flow in the ditches at their confluence.

   c. Review aerial photography to confirm historical pattern of flow reaching open water of Willard Spur.

   d. Can we estimate evaporation rate of water flowing on the mudflat?

   e. What is the groundwater level at the confluence when the Willard Spur water level is low? Does the water infiltrate vs evaporate?

   f. If the effluent does evaporate, how much of the nutrients are deposited and left in the sediments for future mobilization?

1.7. If water from the irrigation and Plant outfall ditches does reach the open water of Willard Spur, e.g., during spring runoff, is it possible to trace its impact?

   a. As part of evaluating nutrient uptake in Task 1.5, sample water along a transect downstream of the outfall to evaluate the fate of nutrients from the Plant.

   b. Review locations of previous sediment sampling for this project to see if additional sediment sampling in the eastern zone of Willard Spur (i.e., east of WS2) has merit.

   c. Inject a dye tracer into the effluent to characterize dispersion into Willard Spur from each outfall location.

   d. Collect vegetation samples during the uptake studies completed in each of the three possible discharge locations and from emergent and SAV in the receiving waters of Willard Spur to look at isotope signatures

1.8. Can sediment be used to monitor long term trends and possible future impacts from the Plant?

   a. Establish long-term sediment sampling locations to track changes in sediment composition over time, collect/analyze samples in 2013.

   b. How does sediment in the irrigation ditch, outfall ditch, Willard Bay tailrace, HCWMA Bypass Drain, and BRMBR outflow channels differ? Do near surface (i.e., top 2cm) vs deeper samples (i.e., top 10cm) make a difference? Does this support the use of sediment as a long term indicator of change, i.e., departure from current conditions?

2.0 Complete the Nutrient Cycling Study

The goals of the two-year (2012-2013)Nutrient Cycling Study were 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. The work in 2012 made significant strides in addressing both of these goals. Work in 2013 will be completed to confirm nutrient responses observed in 2012 and focus upon specific indicators that were observed to indicate senescence of SAV in 2012.

Key tasks for 2013 include:

2.1. Establish four test plots in Willard Spur that will target three water column nutrient concentrations (via fertilizer supplements) and one background condition (no fertilizer supplement). These plots will be established in early April and maintained possibly through October. Data will be evaluated in July and a recommendation will be made whether to proceed or end the study at that time.

2.2. Complete intensive sampling from April – June to refine our understanding of biological indicators that lead toward the senescence of SAV. Various factors to be tracked include:

- Percent cover of SAV,
- SAV branch density
- Percent cover of epiphytes
- Percent cover surface mat
- Percent cover BDS
- Light penetration
- Leaf tissue CNP and $\delta^{15}N$
- Epiphyte $\delta^{15}N$

2.3. Sample water and sediment from April – October to evaluate changes in water, sediment, and sediment pore water chemistry and isotopic signatures. Results to be evaluated in July and a recommendation will be made whether to proceed or end the study at that time.

2.4. Analyze sediment diatom assemblages from 2012 to determine if there is any correlation to responses observed

2.5. Identify limiting nutrients in the water column and in both the water column and sediment

2.6. Evaluate the fate of nutrients in Willard Spur through the addition of nutrients to the water column and determine nitrification and denitrification rates

3.0 Open Water Special Studies

The UDWQ completed several special studies in 2012 that helped inform the interpretation of Willard Spur's nutrient responses. Two of these special studies will be continued and expanded upon in 2013 by UDWQ and a third will be added:

3.1. Deployment of sondes to closely monitor water dissolved oxygen, temperature, pH and salinity fluctuations and evaluate gross primary production and community respiration.

   a. Deploy sondes at WS4 and WS6 during May 1 – July 30 to compare results to 2012 and provide context to nutrient cycling study

   b. Evaluate gross primary production and community respiration

3.2. Evaluation of nutrient limitation

   a. Repeat pelagic nutrient limitation experiments on monthly basis – evaluate nutrient limitation of algae

      i. Evaluate influence of different forms of N and P on results for pelagic nutrient limitation experiments

   b. Complete a detailed mesocosm experiment to evaluate the following questions (note that nutrient cycling study is evaluating similar questions in the context of real-world, open water conditions, this experiment utilizes mesocosms to more strictly control experimental conditions):

i. If Willard Spur is a nutrient limited system and currently has the capacity to absorb nutrients, what is the point where Willard Spur is not limited anymore?

ii. What are the rates of nutrient assimilation and what are the dominant sinks for nutrient removal processes?

iii. How important is SAV (and associated algal/invertebrate communities) and epiphytic growth to N and P removal from the water column?

iv. Do sediment nutrient pools differ between areas with and without SAV? Does the lack of SAV affect the dynamics of sediment OM and nutrient cycling?

4.0 Sampling & Monitoring for 2013

A key objective of this overall project has been to understand the biological, chemical, and physical characteristics of Willard Spur and how they vary during the year. Hydrologic conditions in 2011 allowed for the characterization of a high flow year and hydrologic conditions in 2012 allowed for the characterization of a low flow year. Discussion at the January 28-29, 2013 Science Panel meeting indicated that 2012 likely included the critical condition that is of most concern with respect to the project objective.

Current water supply forecasts for 2013 indicate that this year may be similar to 2012 and thus provide an opportunity to confirm and augment the understanding gained for the critical dry conditions of 2012. Monitoring of inflow and open water sites will provide important context for the detailed experiments in Task 1.0 and 2.0. The following tasks will be completed in 2013 as funds are available (listed with key objective and in order of priority, see Table 1 for additional detail):

4.1. Monitor water level changes in open water at WS2, WS6, and WS12

- Relate results from nutrient cycling study and monitoring in 2013 to work completed in 2011-2012, important indicator of condition

4.2. Measure outflow from Willard Spur at WS12

- Refine understanding of linkage between water level and outflow/export of nutrients from Willard Spur, important means to improve nutrient budgets for 2011-2012
- Sample water and collect debris washing out of Willard Spur

4.3. Monitor changes in condition (SAV, macroinvertebrates, water, and sediment) at open water sites

- Provide context for Tasks 1.0 and 2.0 and document nutrient responses as compared to 2011-2012
- Confirm methods for monitoring condition of epiphytes with Nutrient Cycling Study

4.4. Monitor flow rates and sample water at inflow sites to Willard Spur

- Will measure inflow rates and sample incoming water. A possible cost-saving option is to significantly curtail water sampling, i.e., will only collect water samples at limited sites during March – July to capture spring runoff and estimate loads during focus period of nutrient cycling study