UTAH DIVISION OF WATER QUALITY
195 North 1950 West
PO Box 144870
Salt Lake City, Utah 84114-4870
Willard Bay Project Proposal Form

NOTE: Proposal must be no longer than 6 pages. Supplemental documents such as letters of support, information to demonstrate previous project implementation and other relative supportive documents may be submitted in addition to this form.

Applicant Name: Merritt Frey
Co-Applicant Name(s) (if applicable):
Project Title: Lower Jordan Flow Project
Agency or Business Name (if applicable): River Network
Mailing Address: 1985 South 500 East
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☐ Individual ☒ Non-Profit ☐ Govt. Agency ☐ Academic ☐ Commercial ☐ Other

1. Estimated Project Costs:

Labor:	$177,076 (includes River Network and contractor)
Materials:	$11,216
Equipment:	$0
Administration:	$8,000
Miscellaneous:	$67,933 (note: subcontractors and contingency)
TOTAL:	$264,255*

*Please note: This includes all the costs for 3 years of experimental flow releases found in Table 9 of the attached plan ($234,224) plus costs for labor and administration for the 2015 and 2016 seasons for project management at River Network ($30,031). Table 10 of the attached plan envisions additional, optional experimental costs if we are successful in raising additional funds elsewhere to add value to our base experiments.

Other sources of project funding:
$58,000: River Network (in-hand from SVWRD contract)
$1,360: Jordan River Commission (in-kind staff time contribution)

Total project cost including other sources of funding: $323,615*

*Please note: The attached plan includes in Table 10 a total possible cost for an expanded set of experiments that would add $188,596 to the cost of the base experiments ($234,224) as outlined in Table 9. Part of these optional costs will be contributed through the additional funds available through River Network (i.e., some of the option 2014 experiment costs). The remainder still needs to be raised from other sources, but the success or failure of that fundraising effort will not impact our ability to conduct the base experiments outlined in Table 9.

2. Describe the purpose and need of the project:

The purpose of the lower Jordan Flow management project is to demonstrate empirically how modest adjustments to flow management on the lower Jordan could help achieve dissolved oxygen (DO) criteria while also improving riparian and wetland habitat.

The problem:
The Jordan River is in northern Utah where it flows approximately 51 miles north from Utah Lake to Great Salt Lake. The Jordan River is identified as impaired for a variety of parameters along its entire length. This project focuses on the lower Jordan. The lower Jordan is made up of reaches 1–3, which include the river from 2100 South north to the river's discharge to Great Salt Lake. The three reaches are listed as impaired due to insufficient DO (along with benthic macroinvertebrate problems and *E. coli*). The DO impairment harms the river's designated use for warm water fisheries (Class 3B).

A total maximum daily load (TMDL) has been developed for the relevant reaches (i.e., reaches 1–3). The TMDL establishes loading limitations for total organic matter (OM) to reach the target endpoint for DO.

The entire Jordan River is heavily flow-managed, and the lower Jordan is particularly impacted. At the upstream boundary of the lower Jordan, the average annual flow of the river between 1980 and 2003 was 573,900 acre-feet, but was only 106,145 acre-feet at the next major road crossing (1700 South) just five blocks downstream.[1] This change reflects the impact of a large diversion just downstream of 2100 South—the Surplus Canal—which leaves as little as 10% or 20% of the natural flows in the Jordan River channel. The draft TMDL for the Jordan River notes that flows on the lower Jordan are relatively static stating: "…monthly means flows to the lower Jordan River [are] relatively constant at 190 to 320 cfs."[2]

The Surplus Canal diversion is managed by Salt Lake City. The city uses the diversion to meet the objectives of county and municipal flood control programs, minimizing risks to landowners along the lower Jordan, and for downstream water right holders. However, the city has indicated openness to the idea of modifying their management if that change could improve use support on the lower Jordan. The Division of Water Rights has also indicted willingness to help negotiate any water rights required for the proposed experiments.

Part of the solution:
In the lower Jordan flow project, we are investigating how changes to flow management can enhance efforts to achieve water quality criteria for DO, while also improving ecosystem function in the lower Jordan. The project is set up to run in four phases, and we are requesting funding for the most critical phase, Phase 3: Flow Experiments.

This project began with several hypotheses about how flow changes might help improve water quality. These included the idea that perhaps flows could "flush" OM from the system and hence improve water quality and the idea that increased flows during critical summer conditions could directly improve the DO levels in the stream (while leaving the OM in place). In this second

[1] Utah Division of Water Quality, Draft Jordan River TMDL Water Quality Study, page 23.
[2] Ibid.

scenario, simply providing a larger volume of water (and hence of DO) at the beginning of the impaired reaches would allow the entire stretch of river to comply with water quality criteria. This affect could be further enhanced by changes in temperature and reaeration rate, both of which change as a result of flow.

We gathered a group of the key players on the issue to serve as our advisory team. This technical advisory team (TAT) includes staff from Salt Lake City, which controls the diversion impacting the Jordan, and the Division of Water Quality, which developed the existing TMDL for the river. For a full list of TAT members, see question 11. Thus far, we have used this team to guide our research and, most importantly, we discussed how far Salt Lake City, Salt Lake County, and the Division of Water Rights would be willing to go in increasing flows. All parties were open to considering reasonable flow changes.

We worked with SWCA Environmental Consultants to design and implement Phase 1 of the Project. In Phase 1, we tested both the flushing and direct effects hypotheses using existing models (HEC-RAS and QUAL2k). Questions we investigated in Phase 1 included the following:

1. Could increased flows scour OM and hence help achieve water quality criteria or could increased flows directly help achieve DO water quality criteria? If so, what flows would be required?
2. What would be the best timing (e.g., spring or fall) and pattern for the flows?
3. What are the related threats and challenges (e.g., bank stability concerns, flooding, water rights implications)? What are the related benefits (e.g., improvements in habitat structure, improvements in other parameters, degradation)?

Based on the analysis of available data and output from the models, we concluded that the first hypothesis (flushing) was not likely to result in water quality benefits and that we would not continue to pursue it. However, the second (direct effects) hypothesis showed promise. Results from the modeling effort suggest increasing flows in the lower Jordan by as little as 25% should result in measurably higher DO levels, bringing the river above the chronic standard in late summer (the most critical season for impairment to the fishery use). Although there are uncertainties associated with our initial findings, we decided this hypothesis was clearly worth pursuing (see Phase 1 report, available upon request).

In Phase 2 of the project, we again worked with SWCA, this time to update our modeling effort with newer (2010–2013) data. This round of modeling was less conclusive than Phase 1's modeling; although improvements in DO were still found, the data were not as compelling in Phase 2. At that point, the TAT and our consultants agreed that we had explored the flow management ideas as much as we could using models, and that flow experiments would be required in order to test, and hopefully support, the hypothesis.

<u>The proposed project</u>

The analysis presented in Phases 1 and 2 of this project demonstrates that there is a complex relationship between DO and flow in the lower Jordan. The purpose of the flow experiments (Phase 3) proposed in this plan is to provide empirical data about the influence of flow on chronic low DO conditions in the lower Jordan during dry base flow conditions. The primary questions that guide the experimental design proposed here as follows:

1. Is there a relationship between flow and DO? If so, is the relationship predictable?

2. Is there a flow threshold, based on management at the Surplus Canal, that results in DO being maintained above the chronic (7-day) water quality standard of 5.5 milligrams per liter (mg/L) at all sites in the lower Jordan during baseflow dry conditions?

3. What is the relative importance of flow variation and pattern versus mean daily or weekly flow?

These experimental questions are designed to be answered with a series of flow experiments, under the following river conditions, in summer 2014, 2015, and 2016: 1) during the baseflow period (generally July, August, and September); 2) when no storms have resulted in runoff for 3 days before the start of the experiment; 3) when no other large changes in diversions or discharges are planned for the lower Jordan during the experiments; and 4) when the DO pattern is steady over the 3 days before the experiment.

For the complete project plan and design, including stakeholder outreach, monitoring, and experimental coordination, please see the attached *Lower Jordan River: Plan for Flow Experiments (2014-2016)*.

After the flow experiments are conducted, the experiment results will be used to generate a set of management recommendations for flow on the lower Jordan. These recommendations will be 1) based on good, sound science and 2) designed with input from the entities that will most need to embrace them: the water managers. After the grant period, we will work with water managers to implement the recommendations to improve water quality and downstream habitat.

3. Estimated time frame of the project with significant milestones (Note: Project must be completed with final reports filed by January 1, 2018):

This project is proposed to run from June 2014 through June 2017. Significant milestones are listed below; for details please see the attached *Lower Jordan River: Plan for Flow Experiments (2014-2016)*:

- August 2014: Pulse experiments conducted (3)
- July 2015-August 2015: Pulse (1) and ramp-up (2) experiments conducted
- July-August 2016: Pulse (1) and ramp-up (2) experiments conducted
- September 2016-December 2016: Analysis and draft report/recommendations produced
- January 2017-March 2017: Stakeholder review of analysis and report/recommendations
- June 2017: Final experimental report/water management recommendations
- December 2017: Final grant report to Division of Water Quality

4. Describe the location of the project with attached location map, including details on the total area that will be directly enhanced by the project:

This project is on the lower Jordan, from the gates of the Surplus Canal diversion near 2100 South to the wetlands along Farmington Bay at the outlet of the river. See attached map.

5. Describe how the project will specifically enhance and protect waterways affected by the Willard Bay diesel release and improve the conditions of one or more of the following: wildlife, habitat, natural vegetation, water quality or emergency response:

This project will have benefits for wildlife, habitat, natural vegetation, and water quality. The most direct benefits will accrue to the lower Jordan and its associated habitats. Most explicitly, the project seeks to improve DO in the lower Jordan. Associated benefits may include improvements in other water quality parameters (e.g., temperature), to in-stream habitat, and to riparian habitat as increased flows provide much needed water to restoration vegetation at a critical time. The project also seeks to improve water quality and habitat in the rich and diverse wetlands at the end of the lower Jordan system. Through improved flow regimes, water management efforts may be better tailored to vegetation needs in the wetlands and wetland water quality can be improved (e.g., providing some flow through these wetlands at a critical time can help improve DO). These improvements will provide habitat benefits (e.g., nesting and feeding) to wildlife that also use the Willard Bay area and surrounding Great Salt Lake wetlands.

6. Describe project's connectivity to other natural areas or projects that further enhance wildlife, habitat, natural vegetation, water quality or emergency response:

The project area is part of the larger Farmington Bay and Great Salt Lake ecosystem. Enhancements on the lower Jordan and its associated wetlands will benefit the birds and other wildlife that frequent areas like Willard Bay by providing improved habitat and water quality. The lower Jordan and impounded wetland provide refuge habitat to many bird species when other habitat is unavailable. An important part of the Phase 3 flow experiments is to investigate how the flow changes would improve water flow and quality in the downstream Farmington Bay wetlands, hence improving wildlife habitat in the overall region. For details please see the attached *Lower Jordan River: Plan for Flow Experiments (2014-2016).*

7. Describe any additional social benefits of implementing this project:

Improving flow management may allow the lower Jordan to achieve water quality standards (and hence support healthy aquatic life) much sooner than would otherwise be possible under the existing implementation plan for the TMDL. It may also present a lower cost strategy than other proposed solutions. Lastly, but importantly, this strategy may be able to deliver additional benefits (e.g., improve other water quality parameters, benefit riparian habitat, and improve wetland health), and create recreation opportunities that other strategies are not predicted to provide.

8. Project plans and details, including rights to work on specified piece of land:

For the complete project plan and design, including stakeholder outreach, monitoring, experimental coordination, please see the attached *Lower Jordan River: Plan for Flow Experiments (2014-2016)*. Please note that we are coordinating closely with Salt Lake City (diversion manager), Salt Lake County (instream work manager), Jordan River Commission, the Division of Water Rights, and research scientists to ensure all users are engaged and protected.

9. Describe your experience in implementing projects of similar scope and magnitude:

River Network will serve as the project manager. River Network is a national nonprofit organization with a mission to “empower and unite people and communities to protect and restore rivers and other waters that sustain the health of our country.” Our staff has extensive experience managing budgets of this size, and working with technical consultants on these types of analysis. Recent work in this vein includes a restoration project on the Willamette River in Oregon, a riparian buffer targeting effort in the Root River Basin in Wisconsin, and several other efforts. More importantly perhaps, River Network staff has deep experience coordinating diverse groups of stakeholders to come together to agree on actions that improve water quality.

10. Describe how ongoing maintenance of the project will be funded and carried out:

Salt Lake City and Salt Lake County have expressed willingness to implement flow management changes if they are supported by sound science and show a water quality benefit. The Division of Water Rights has indicated a willingness to work with the Project and water right holders to implement management changes within existing law.

11. List consultants or agency partners that have participated in project development:

This project involves a standing TAT who has and will continue to help guide the project. Several participants are leaders in terms of implementing the proposed flow changes (e.g., Salt Lake City, State Engineer, and Salt Lake County), whereas others are researchers knowledgeable about the study design. Others represent concerned citizens and interest groups.

Name	**Organization**	**Phone**
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Tom Ward [Jesse Stewart]	Salt Lake City	801-483-6900
Hilary Arens	Division of Water Quality	801-536-4332
Nick von Stackelberg	Division of Water Quality	801-536-4374
Mike Silva	State Engineer’s Office	801-538-7240
Scott Baird	Salt Lake County	385-468-6600
Theron Miller	Jordan River/Farmington Bay Water Quality Coalition	435-640-3772
Laura Hanson	Jordan River Commission	801-536-4158
Ramesh Goel	University of Utah	801-581-6110
Mitch Hogsett	University of Utah	801-581-6931
Dave Epstein [Michelle Baker]	Utah State University	510-908-1825
Juan Arce-Larreta	Friends of Great Salt Lake	801-583-5593
Jeff Denbleker	CH2M Hill	801-350-5215
Jake Diamond and Erica Gaddis	SWCA	801-322-4307
Greg Poole	Hansen, Allen, and Luce	801-566-5599

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Lower Jordan River: Plan for Flow Experiments (2014–2016)

Prepared for

River Network

Prepared by

SWCA Environmental Consultants

May 2014

LOWER JORDAN RIVER:
PLAN FOR FLOW EXPERIMENTS
(2014–2016)

Prepared for

River Network
1985 South 500 East
Salt Lake City, Utah 84105
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May 1, 2014

CONTENTS

1. Introduction 3
2. Proposed Flow Experiments 3
2.1. Pulse 3
2.2. Ramp-up 4
2.3. Impounded Wetland Management 4
3. Experimental Monitoring 5
3.1. Dissolved Oxygen and Water Quality 5
3.2. Reaeration 7
3.3. Sediment Oxygen Demand ..... **Error! Bookmark not defined.**
3.4. Sediment Fate and Transport ..... **Error! Bookmark not defined.**
3.5. Stage and Flow 7
3.6. Inundation of Mitigation Wetlands and Riparian Restoration 8
4. Coordination Plan 9
4.1. Salt Lake City 9
4.2. Salt Lake County Flood Control 9
4.3. Jordan River Commissioner and Water Rights Holders 9
4.4. River Users 11
4.5. Research Partners 11
4.6. Coordination Summary 12
5. Analysis and Reporting 12
6. Schedule 13
7. Budget 15
8. Literature Cited 18

FIGURES

Figure 1. Locations of existing in-situ sondes and proposed handheld sondes. 6
Figure 2. Installation design for the stage monitoring devices. 8
Figure 3. Network of major priority water rights and diversions in the lower Jordan River system (Mike Silva, Utah Division of Water Rights 2014). 10
Figure 4. Proposed 2014 flow experiment schedule and other scheduled research and activities in the lower Jordan River. 13
Figure 5. Proposed 2015 and 2016 flow experimental schedule. 14

TABLES

Table 1. Proposed Flow Experiments 3
Table 2. Pulse Experiment Design 4
Table 3. Ramp-up Experiment Design 4
Table 4. Proposed Dissolved Oxygen Sampling Sites 5
Table 5. Water Quality Sampling Design 7
Table 6. Jordan River Surplus Canal Priority Schedule 10
Table 7. Flow Availability by Month (2008–2013) 11
Table 8. Coordination and Research Partners 12

1. INTRODUCTION

The analysis presented in previous reports demonstrates that there is a complex relationship between dissolved oxygen (DO) and flow in the lower Jordan River (SWCA Environmental Consultants [SWCA] 2013, 2014). The purpose of the flow experiments proposed in this plan is to provide empirical data about the influence of flow on chronic low DO conditions in the lower Jordan River during dry baseflow conditions. The primary questions that guide the experimental design proposed herein are as follows:

1. Is there a relationship between flow and DO? If so, is the relationship predictable?
2. Is there a flow threshold, based on management at the Surplus Canal, that results in DO being maintained above the chronic (7-day) water quality standard of 5.5 milligrams per liter (mg/L) at all sites in the lower Jordan River during baseflow dry conditions?
3. What is the relative importance of flow variation and pattern versus mean daily or weekly flow?

These experimental questions are designed to be answered with a series of flow experiments, under the following river conditions, in summer 2014, 2015, and 2016: 1) during the baseflow period (generally July, August, and September); 2) when no storms have resulted in runoff for 3 days before the start of the experiment; 3) when no other large changes in diversions or discharges are planned for the lower Jordan River during the experiments; and 4) when the DO pattern is steady over the 3 days before the experiment.

2. PROPOSED FLOW EXPERIMENTS

Two categories of flow experiments are proposed: a pulse experiment and a ramp-up experiment. They were selected based on input from the Jordan River technical advisory team (TAT) regarding practicality, management utility, and scientific value. The experiments are summarized in Table 1 and described in greater detail in the following sections. All experiments will be performed during the critical late-summer period (July–September).

Table 1. Proposed Flow Experiments

Experiment Type	Flow Target (cfs)	Duration	Frequency	Years
Pulse	190–300	3 days	3× per season	2014, 2015, and 2016
Ramp-up	130–300	2 weeks	2× per season	2015 and 2016

Note: cfs = cubic feet per second.

2.1. Pulse

The pulse experiments are proposed based on the hypothesis that short-term variation in flow (which the lower Jordan River currently lacks during late summer) is important to river systems (e.g., Arthington et al. 2006; Lytle and Poff 2004; Poff et al. 1997; Richter et al. 1996) and may have an indirect biological influence on DO as well as the more direct physical influence. If evidence from the experiments suggests that pulses of several days provide a benefit to the lower Jordan River, then such pulses could be used as a management measure to maintain an intermediate level of disturbance in the lower Jordan River.

Three pulse experiments will be conducted in the summer of 2014 and one pulse each in 2015 and 2016 at varying flow rates (Table 2). Each event will last for 3 days, and monitoring will occur before, during, and after the flow pulse. Coordination between major researchers will occur to capture multiple measurements during each experiment.

Table 2. Pulse Experiment Design

Date	Flow Target (cfs)	Duration	Measurements
8/4/2014	300	3 days	DO, reaeration, and inundation of mitigation and restoration sites Optional: water quality and stage
8/18/2014	190	3 days	
9/1/2014	250	3 days	
8/12/2015	TBD	3 days	
8/12/2016	TBD	3 days	

Note: cfs = cubic feet per second.

2.2. Ramp-up

The ramp-up experiment is proposed to test the hypothesis that at higher flows, DO exceedances are less common. This experiment is proposed to extend for 15 days, with flows increasing on a regular time-step (e.g., 10 cubic feet per second [cfs] each day). The ramp-up will occur over the course of 5 days and will be followed by a 5-day period with water maintained at the flow target (200 cfs or 250 cfs). Water levels will then be drawn down over the course of 5 days. This methodology will allow for measurements across a consistent range of increasing "high" flows, which will facilitate correlation between high flows and DO concentrations (Table 3). The ramp-up experiment will first be conducted in the summer of 2015 and repeated in 2016.

Table 3. Ramp-up Experiment Design

Date	Flow Start (cfs)	Flow Target (cfs)	Duration	Daily Increase (cfs/day) for 5 days	Flow Held for 5 days (cfs)	Daily Decrease (cfs/day) for 5 days
7/20/2015	150	250	15 days	20	250	20
8/24/2015	150	200	15 days	10	200	10
7/18/2016	150	250	15 days	20	250	20
8/15/2016	150	200	15 days	10	200	10

Note: cfs = cubic feet per second.

2.3. Impounded Wetland Management

Increasing flow to the lower Jordan River in the late summer months could have additional benefits to the health of impounded wetlands near Farmington Bay. Water management for many of Great Salt Lake's impounded wetlands is largely a function of the available water supply and how it can be used to create optimal habitat for migratory waterfowl and shorebirds. Rather than a primary objective, water quality in these wetlands is often simply the result of how the water is managed and the natural processes within the wetland. Thus, the wetland manager may create conditions in an impounded wetland that favor its habitat objectives but at the expense of degraded water quality.

As part of the flow experiments, we propose to evaluate how water management and flow augmentation could be used to strategically balance and/or meet both habitat and water quality objectives in Great Salt Lake's impounded wetlands. This portion of the project will evaluate the assimilative capacity of a series of up to three impounded wetlands in conjunction with the flow experiment planned for the lower Jordan River. Water quality (nutrients, total suspended solids, and organic matter [OM]) samples will be collected at the entrance and exit points for each of the three impoundments for two flow events (total of 12 samples per year). A dye study will be completed concurrently for each of the two flow events in 2014 to define the residence time in each impoundment and for one event in 2015. The assimilative capacity for each flow event will then be estimated based on existing models of assimilation rates and the characteristics observed during this study. It is assumed that one flow event will be evaluated before and the other during the flow release completed for the lower Jordan River study. The result will be a case study in how increased flows and reduced residence times may affect water quality in the wetlands and lead to a more intensive evaluation and development of water quality objectives that are compatible with habitat objectives.

3. EXPERIMENTAL MONITORING

3.1. Dissolved Oxygen and Water Quality

For each experiment, in-situ continuous monitoring of DO is proposed for at least 1 day leading up to the experiment and at least 3 days after the end of the pulse experiments and 1 week after the ramp-up experiments. This will allow for baseline comparison and observation of possible "resetting" effects. Before the first experimental run, cross-sectional DO measurements will be collected at each monitoring site to assess the representativeness of sonde measurements compared to the entire river channel.

Continuous monitoring will be performed by five in-situ sondes currently operated by the Jordan River and Farmington Bay Water Quality Council (JR/FBWQC) and the Utah Division of Water Quality (DWQ) at five sites along the lower Jordan River. Four additional sites are proposed to be continuously monitored by handheld meters: 1700 South, 1300 South, North Temple, and Redwood Road (Table 4; Figure 1). This yields a total of 9 sites, with 4 being measured with hand-held meters, and 5 being measured with in-situ sensors.

Table 4. Proposed Dissolved Oxygen Sampling Sites

Sample Site	Rationale
Burnham Dam Diversion	Location of in-situ DO sensor
Cudahy Lane/West Center Street Bridge	Location of in-situ DO sensor
300 North	Location of in-situ DO sensor
800 South	Location of in-situ DO sensor; downstream of Parleys, Red Butte, and Emigration Creeks' outfalls
2100 South	Location of in-situ DO sensor
1300 South	Location of Parleys Creek outfall (and portions of Emigration and Red Butte)
1700 South	U.S. Geological Survey gage and availability of other water quality data
North Temple	Downstream of City Creek outfall
Redwood Road	Long stretch between North Temple and Cudahy Lane

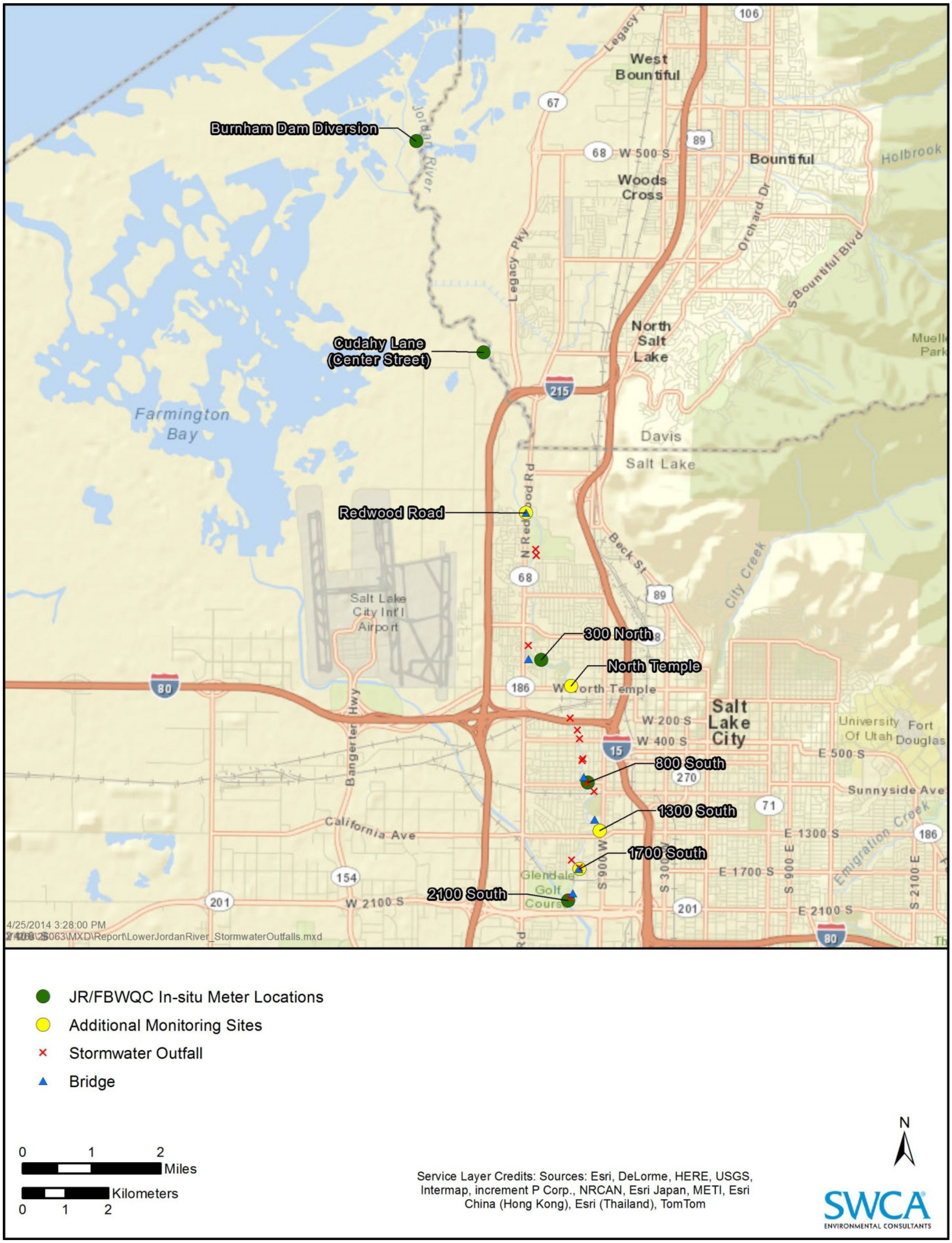

Figure 1. Locations of existing in-situ sondes and proposed handheld meters.

Two days before each experiment, handheld sondes will be calibrated to in-situ sondes operated by the JR/FBWQC to ensure consistency in results. Handheld sensors will be deployed at each of the four sampling sites on the day before the experiment to begin baseline measurements. Sensors will be programmed to collect every 15 minutes to align with in-situ sensor measurements. Sensors will be securely located in the center of the river, if conditions allow, within a wire frame to prevent tampering and damage from debris.

In addition to measurements collected by sondes, water quality grab samples will also be collected at three sites: 1700 South, 500 North, and Cudahy Lane. For each experiment, these samples will be taken every 30 minutes for the hour before the experiment starts, the first hour after the start of the experimental run, and then every 12 hours after that until 1 day after flow has been reduced to baseline levels (Table 5).

Table 5. Water Quality Sampling Design

Sample Site	Medium-Pulse Measurement Frequency	Total Grab Sample Count per Site per Pulse Experiment	Total Grab Sample Count per Ramp Experiment	Sample Analysis
1700 South	30 minutes for 2 hours, then every 6 hours	12	36	Dissolved OM (DOM), nitrate, phosphate, total suspended solids (TSS)
500 North	30 minutes for 2 hours, then every 6 hours	12	36	DOM, nitrate, phosphate, TSS
Cudahy Lane	30 minutes for 2 hours, then every 6 hours	12	36	DOM, nitrate, phosphate, TSS
Total		**36**	**108**	

For each experiment, it is assumed that two personnel will be needed to manage the handheld sensors and take grab samples and one person will be needed to coordinate field efforts. The two field personnel will also be available to help with other experimental monitoring. The two field personnel will be stationed either at the upstream sites (1700 South and North Temple) or the downstream sites (Redwood Road and Cudahy Lane) and will move back and forth between sites for sample collection. The field coordinator will also be available to help with samples if circumstances require it.

In addition, water quality samples will be collected from impounded wetlands (entrance and exit) during two of the flow experiments in 2014. Samples will be collected for nutrients, total suspended solids, and DOM.

3.2. Reaeration

Direct measurements of reaeration rates are proposed for each experiment so that a more conclusive relationship between flow and reaeration can be determined. Direct measurement will be performed with both the floating dome method and the non-reactive tracer method. The floating dome method is less costly and technical to perform than the tracer method, and has already been performed on the lower Jordan River, providing for more direct comparison to past measurements. However, the tracer method (which relies on a non-volatile, non-reactive tracer [e.g., rhodamine] and a volatile, non-reactive tracer [e.g., krypton], as well as equipment to measure these tracers) is currently the most accurate method available to measure reaeration. The more accurate tracer method will be used to validate the results from the floating dome method.

The tracer method will be performed once during the 2014 sampling period by Utah State University (USU). USU will coordinate all technical details of the tracer experimental design. The general design will employ two stations: an upstream tracer release station, and a downstream measurement station. The stations will likely be set up at Redwood Road and Cudahy Lane/Center Street in order to determine reaeration in the critical reach. The floating dome method will be performed twice, once during the 2014 pulse experiments and once during the 2015 ramp-up experiments, by the University of Utah (UofU). UofU will coordinate all technical details of the floating dome experimental design. The 2014 floating dome experiment will be coordinated to coincide with the tracer experiment to provide validation and comparison between the two approaches.

4. OPTIONAL TASKS

4.1. Stage and Flow

During the flow experiments, stage will be monitored at five locations in the lower Jordan River. This information will be used to recalibrate the HEC-RAS model used to evaluate the potential for sediment transport under high flow conditions (SWCA 2013). The work will include installation of water level sensors and data loggers at five locations: Burnham Dam, Cudahy Lane, Redwood Road, 300 North, and 800 South.

The sensors and data loggers will be WL16U Water Level Loggers as manufactured by Global Water (or another comparable brand) and will be installed in a 2-inch PVC pipe similar to that shown in Figure 2. Water level data will be collected automatically with the built-in data recorder and will be downloaded at the conclusion of each experiment.

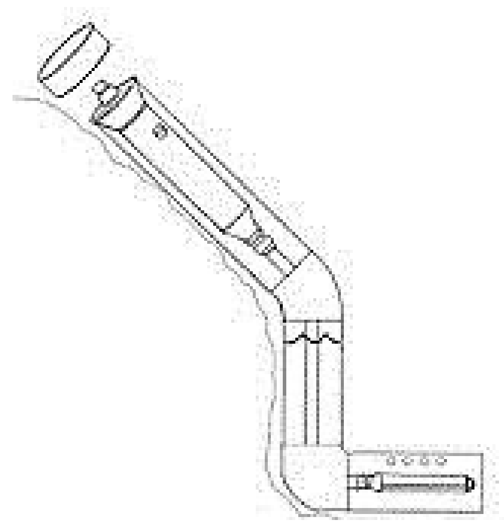

Figure 2. Installation design for the stage monitoring devices. Source: http://www.globalw.com

4.2. Inundation of Mitigation Wetlands and Riparian Restoration

Increasing the flow in the lower Jordan River could benefit wetlands and riparian areas though periodic inundation in the late summer. The benefits may be especially valuable at recent restoration sites where young plants are still establishing. These benefits will be monitored by measuring the presence and extent of inundation at two restoration sites along the lower Jordan River.

The Salt Lake Regional Athletic Complex (RAC) Wetland Mitigation project comprises three wetlands totaling 3.08 acres on the west bank of the Jordan River. The wetlands were constructed in 2011 as mitigation for wetlands impacted as part of the RAC site development. As part of the ongoing monitoring for the site, four groundwater wells were installed at the site (two each in emergent marsh and wet meadow areas of the complex). The groundwater wells will be used to measure change in the shallow aquifer, and associated wetland inundation, during the flow experiments. Measurements will be made the day before each experiment, daily during each experiment, and for 3 days following each experiment.

The Jordan River Trailside Restoration Project is also currently underway between 1800 North and 2500 North. Bank stabilization is being achieved through construction of soil lifts (4 to 5 steps). Inundation of soil lifts would help wetland and riparian vegetation further establish and will be monitored by marking river stage during the flow experiments and the number of soil lifts that are inundated as a result.

5. COORDINATION PLAN

5.1. Salt Lake City

Salt Lake City will begin construction on the 900 South Oxbow Restoration and Enhancement Project in June 2014. Construction should be completed on streambanks and the interior wetland complex by the end of July 2014 (personal communication, Brian Nicholson, SWCA, project manager for the 900 South Oxbow Restoration and Enhancement Project, April 2014). To accommodate the construction schedule, no flow experiments will be conducted before August 1, 2014. To accommodate fall seeding of the wetland complex at low-river flow and to prevent germination of seeds prior to winter, no flow experiments will be conducted after September 7, 2014. One week before each flow experiment, SWCA's Brian Nicholson and Salt Lake City's Lani Eggertsen-Goff will be notified.

Coordination with Salt Lake City will also be required to ensure that debris has been removed from the 2100 South radial gate opening prior to the release. In addition, Salt Lake City is planning several experiments to simulate the effects of storms on DO in the lower Jordan River in 2014. The scheduling for those experiments will be outside of the period planned for the pulse experiments, most likely in late July, between experiments in August, or in mid-September.

5.2. Salt Lake County Flood Control

Experiments will be coordinated with Salt Lake County Flood Control to avoid interfering with dredging activities. As long as Flood Control is given notice a few weeks before the proposed experiments, there should be no problems in avoiding dredging activities (personal communication, Scott Baird, Salt Lake County Flood Control, to Jake Diamond, SWCA, April 2014).

5.3. Jordan River Commissioner and Water Rights Holders

The ability to deliver flow to the lower Jordan River is dependent on the amount of water available above the Surplus Canal diversion structure and on priority water rights along the Surplus Canal and at downstream duck clubs around Great Salt Lake. Figure 3 shows the network of major priority water rights diversions on the Surplus Canal and lower Jordan River. Together, water rights on the Surplus Canal side require 182 cfs to be diverted at the Surplus Canal diversion in the summer months (Table 6).

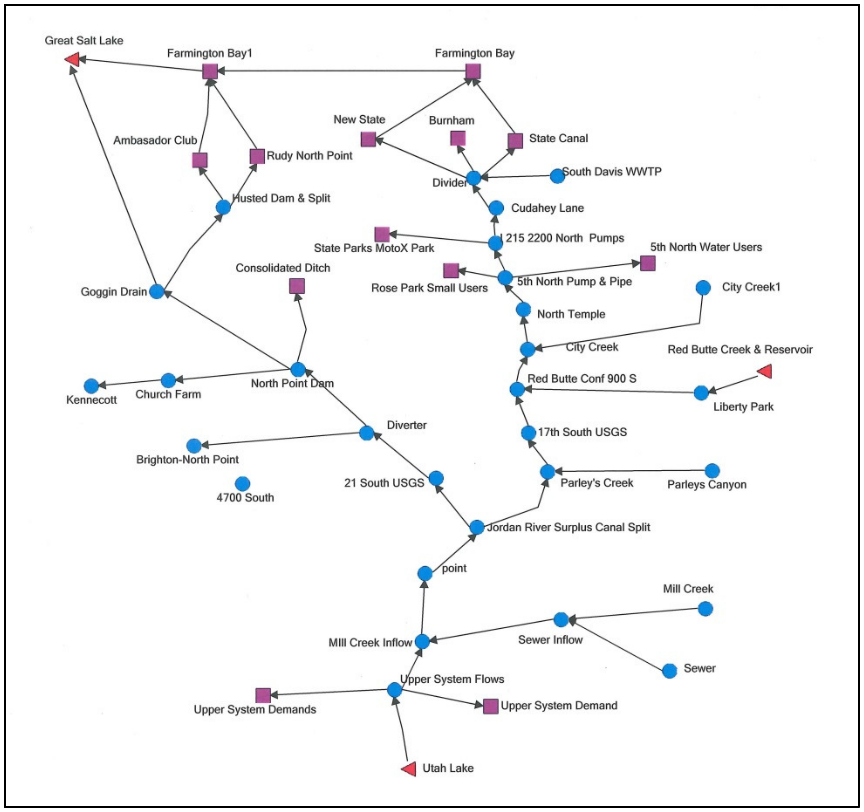

Figure 3. Network of major priority water rights and diversions in the lower Jordan River system (Mike Silva, Utah Division of Water Rights 2014).

Table 6. Jordan River Surplus Canal Priority Schedule (cfs)

Priority Date	Water User	1/1–1/15	1/16–3/31	4/1–9/15	9/16–10/31	11/1–12/31
1862	North Point Cons IC	90 (47.85)	90 (14.44)	90 (71.76)	90 (82.68)	90 (47.85)
1878	Rudy Rec and Sport	18.819	7.797	16.536	19.864	18.819
1886	Brown Invest. Co.	2.169	0.234	1.154	2.169	2.169
1886	Irvine Ranch and Pet.	13.016	3.783	8.166	13.016	13.016
1886	Richard S. Johnson	0.556	0.556	0.556	0.556	0.556
1886	No Point Fur and Rec	15.65	5.051	14.601	16.218	15.65
1886	Powers Duck Club	0.46	0.188	0.46	0.46	0.46
1886	Utah Duck Club	1.435	0.667	1.31	1.435	1.435
1886	Chennault/Janke	0.1	0.1	0.1	0.1	0.1
1901	Harrison Reclamation	15.11	3.98	13.96	15.11	15.11
1915	North Point Cons IC	0	0	35.22	35.22	0
Total		**157.315**	**112.356**	**182.063**	**194.148**	**157.315**

Source: Mike Silva, Utah Division of Water Rights (2014).

Data from the combined flow of the lower Jordan River and the Surplus Canal (U.S. Geological Survey gage 10170490) from 2008 through 2013 and the water rights priority schedule for the Surplus Canal (personal communication, Mike Silva, Utah Division of Water Rights, to Jake Diamond, SWCA, April 2014) were used to determine the average available flow to the lower Jordan River (Table 7). The average available flow is simply the total flow available less the water rights priorities. The availability of surplus flow for the lower Jordan River system is highly variable and generally lowest in August (see Table 7).

Table 7. Flow Availability by Month (2008–2013)

Month	Average Available Flow (cfs)						Average Number of Days with Available Flow*	
	2008	2009	2010	2011	2012	2013	190 cfs	300 cfs
June	619	1,635	874	2,569	225	238	25	21
July	281	505	318	2,152	174	280	24	9
August	194	205	296	1,213	169	161	16	2
September	260	251	287	989	210	243	27	5

*Excluding 2011

Based on this analysis, there should be sufficient water to run the proposed pulse experiments in August 2014. The water that would be required for the ramp-up experiments in 2015 and 2016 will require temporary acquisition of water rights from a holder on the Surplus Canal side. This negotiation will be facilitated through Mike Silva, Utah Division of Water Rights, in coordination with interested water rights holders and the Jordan River Commissioner.

Coordination with the Jordan River Commissioner will also be required before each experiment. The commissioner will need to manage gates before and after the experiments on the lower Jordan River to ensure that water needs are met and that there is no backflow into the system. Budget has been allocated to accommodate the additional labor that would be required by the commissioner during the experiments. Coordination with other water rights holders that depend on a constant river flow during the summer season will also be required (e.g., the duck clubs and PacifiCorp).

5.4. River Users

Two weeks before each flow experiment, a notice will be posted on the Jordan River Commission website letting recreation groups know about the flow experiments and their purpose. In addition to the commission, other recreation groups will be notified 1 week in advance of each flow experiment and once the flow experimental is completed. These groups include the Wasatch Mountain Club, Utah Whitewater Club, and Utah Crew.

5.5. Research Partners

Research partners for this experimental work include members of academia and local and state government. Utah State University is planning on sampling three times this summer for DOM composition through isotope analysis. Though no specific dates have been set, there is a plan to measure in late July, and then in September and October, with each measurement taking place over 2 days (personal communication, Julie Kelso, Utah State University, to Jake Diamond, SWCA, April 2014). Similarly, the University of Utah is planning research activities in early summer 2014, but there are no plans for research activities during the scheduled flow experiments. The flow experiments will also be closely coordinated with DEQ's planned synoptic sampling on the lower Jordan River in summer 2014.

5.6. Coordination Summary

Success of flow experiments in the lower Jordan River depends in large part on effective coordination between water managers, researchers, municipalities, and the contractor. Table 8 provides a summary of key coordination needs.

Table 8. Coordination and Research Partners

Last Name	First Name	Organization	Coordination
Arens	Hilary	Utah Division of Water Quality	Review of analysis results and integration with other total maximum daily load–related research
Baird	Scott	Salt Lake County Engineering and Flood Control	Ensure no dredging activities are planned during experiments.
Eggertsen-Goff	Lani	Salt Lake City	Ensure that flow experiments will not interfere with construction of the 900 South Oxbow Restoration and Enhancement Project.
Epstein	Dave	Utah State University	Coordination for tracer reaeration study
Goel	Ramesh	University of Utah	Reaeration
Hanson	Laura	Jordan River Commission	Notify at least 1 week before each experiment and provide explanatory text that can be used on the Jordan River Commission website.
Miller	Theron	JR/FBWQC	Research
Myers	Matt	South Davis Sewer District	Obtain DO data from in-situ sondes.
Poole	Greg	Hansen, Allen & Luce	Install stage recorders before first experiment.
Silva	Mike	Utah Division of Water Rights	Coordinate with Jordan River Commissioner to negotiate water rights and flow management.
von Stackelberg	Nick	Utah Division of Water Quality	Synoptic sampling planned for summer 2014
Ward	Tom	Salt Lake City Department of Public Utilities	Remove debris from gate before flow experiments.

6. ANALYSIS AND REPORTING

All DO data and water quality data will be compiled into a Microsoft Excel spreadsheet for analysis. Statistics relating flow to changes in DO will be run using the R statistical package and reported in tabular and graphical form. Water quality data will be used to further explore the major covariates between flow and DO and to quantify the strength of those relationships.

Water level data collected during the river flow tests will be used to calibrate a dynamic (unsteady) water surface profile model of the lower Jordan River. The available Jordan River HEC-RAS steady state water surface model will be used as a basis to prepare and calibrate an unsteady model using the water level sensor data collected during the flow tests. This model could serve to further analyze sediment transport and bed mobilization once the critical shear stresses for the bed sediments are quantified.

All data will be summarized in a technical report with graphics, tables, and maps as well as written conclusions. All data will be delivered to the River Network and the Jordan River TAT in a Microsoft Excel database. A separate report will be drafted summarizing recommendations for changes in longerterm flow management in the lower Jordan River resulting from the findings of the flow experiments. This report will reflect further discussions about the practicality of changing the way flow is managed in the lower Jordan River with the Utah Division of Water Rights, interested water rights holders, and the Jordan River Commissioner.

7. SCHEDULE

The flow experiments for 2014 are scheduled for the month of August to prevent inundation of the 900 South Oxbow Restoration and Enhancement Project site in June and July (Figure 4). There is currently no other experimental research planned for the lower Jordan River during this time. Each experiment will last for 3 days with 10 days of recovery between experiments. The schedule for 2015 (and 2016) will be finalized as part of the overall coordination of the flow experiments in spring 2015. The proposed schedule is for a ramp-up experiment (to 250 cfs) in late July, a pulse experiment for mid-August, and a shorter ramp-up and pulse experiment in late August. All experiments will be separated by a 2-week recover period (Figure 5).

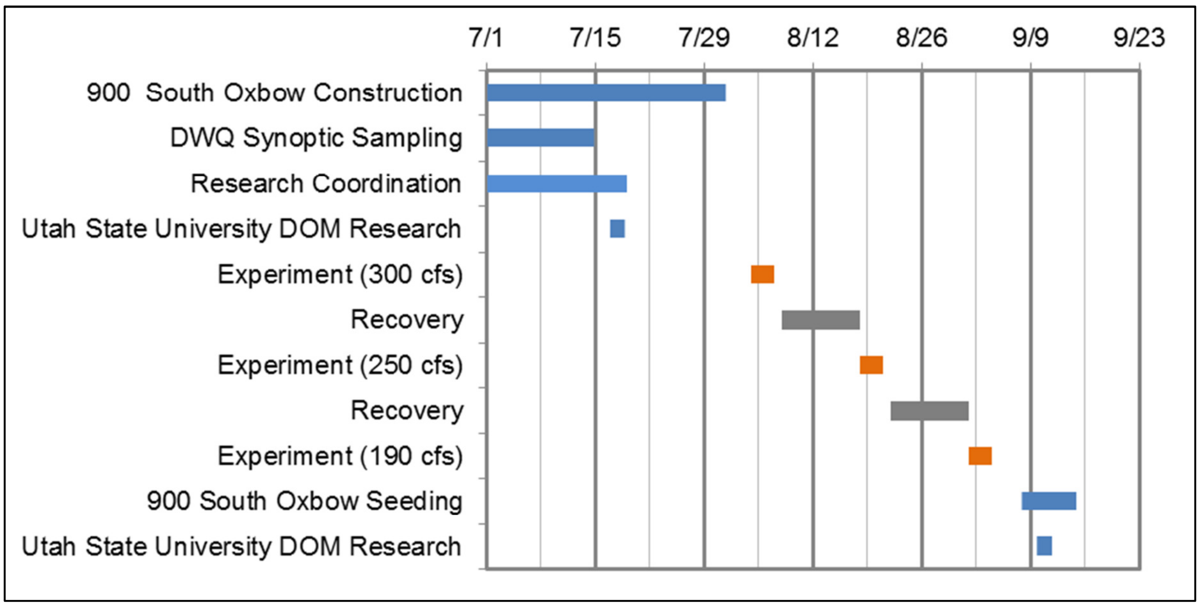

Figure 4. Proposed 2014 flow experiment schedule and other scheduled research and activities in the lower Jordan River.

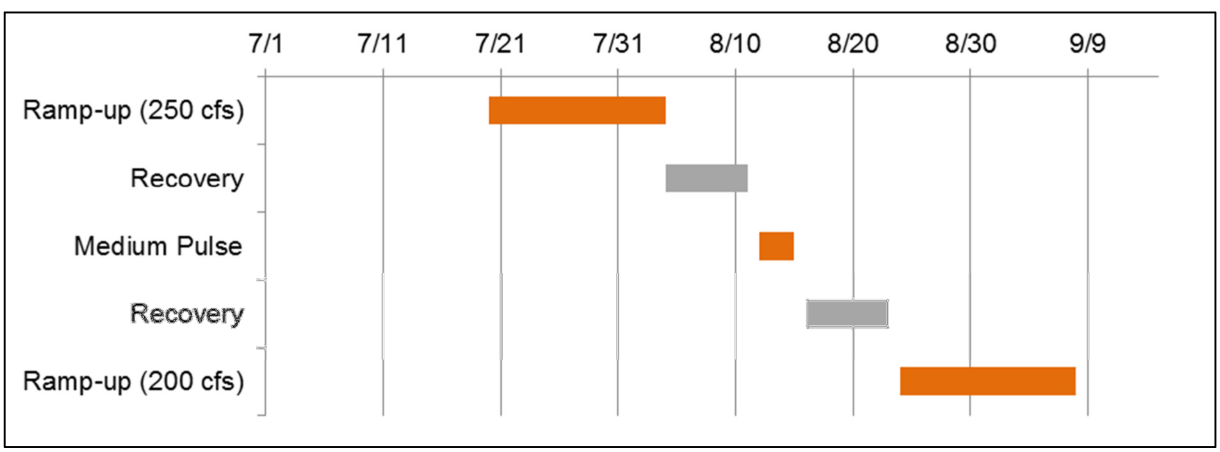

Figure 5. Proposed 2015 and 2016 flow experimental schedule.

8. BUDGET

Table 9. Estimated Project Costs

Task	Subtask	Labor Cost	Materials Cost	Subcontractor Cost	TOTAL
Coordination					
	Project management	$6,847	$0	$0	$6,847
	Safety	$2,149	$1	$0	$2,151
	Field Coordination 2014	$4,299	$14	$0	$4,313
	Field Coordination 2015	$5,250	$14	$0	$5,264
	Field Coordination 2016	$5,250	$14	$0	$5,264
	Water rights coordination	$8,288	$0	$0	$8,288
	Recreation outreach	$1,732	$0	$0	$1,732
	TAT meetings	$13,284	$0	$0	$13,284
	Subtotal	**$47,100**	**$44**	**$0**	**$47,143**
2014 Field Experiments					
	Dissolved oxygen monitoring	$10,792	$1,512	$0	$12,304
	Reaeration experiment	$0	$0	$31,900	$31,900
	Wetland/Riparian monitoring	$1,704	$0	$0	$1,704
	Impounded Wetland Management	$11,412	$1,701	$-	$13,113
	Subtotal	**$23,908**	**$3,213**	**$31,900**	**$59,021**
2015 Field Experiments					
	Dissolved oxygen monitoring	$16,005	$3,024	$0	$19,029
	Reaeration experiment	$0	$0	$14,740	$14,740
	Wetland/Riparian monitoring	$852	$0	$0	$852
	Impounded Wetland Management	$7,608	$1,701	$-	$9,309
	Wetland/Riparian monitoring	$1,150	$0	$0	$1,150
	Subtotal	**$25,615**	**$4,725**	**$14,740**	**$45,080**

Table 9. Estimated Project Costs

Task	Subtask		Labor Cost	Materials Cost	Subcontractor Cost	TOTAL
2016 Field Experiments						
	Dissolved oxygen monitoring		$16,005	$3,024	$0	$19,029
	Wetland/Riparian monitoring		$852	$0	$0	$852
		Subtotal	**$16,857**	**$3,024**	**$0**	**$19,881**
Data Analysis						
	DO – flow analysis		$14,480	$0	$0	$14,480
	Reaeration analysis		$1,150	$0	$0	$1,150
	Impounded Wetland Management		$11,640	$0	$0	$11,640
		Subtotal	**$27,270**	**$0**	**$0**	**$27,270**
Reporting						
	Technical Report		$7,412	$105	$-	$7,517
	Management Recommendations Report		$6,914	$105	$-	$7,019
		Subtotal	**$14,326**	**$210**	**$0**	**$14,536**
TOTAL						**$212,931**
10% Contingency						**$21,293**
GRAND TOTAL						**$234,224**

Table 10. Costs for Additional Tasks

Task	Subtask	Labor Cost	Materials Cost	Subcontractor Cost	TOTAL
Coordination					
	Project management	$2,351	$0	$0	$2,351
	Safety	$738	$0	$0	$738
	Field Coordination 2014	$1,476	$5	$0	$1,481
	Field Coordination 2015	$1,802	$5	$0	$1,807
	Field Coordination 2016	$1,802	$5	$0	$1,807
	Subtotal	**$8,169**	**$15**	**$0**	**$8,184**
2014 Field Experiments					
	River stage monitoring	$0	$0	$8,525	$8,525
	Water quality sampling	$6,128	$15,309	$0	$21,437
	Subtotal	**$17,540**	**$18,711**	**$8,525**	**$44,776**
2015 Field Experiments					
	River stage monitoring	$748	$0	$0	$748
	Water quality sampling	$13,252	$20,412	$-	$33,664
	Subtotal	**$14,000**	**$20,412**	**$0**	**$34,412**
2016 Field Experiments					
	River stage monitoring	$748	$0	$0	$748
	Water quality sampling	$13,252	$20,412	$0	$33,664
	Subtotal	**$30,005**	**$23,436**	**$0**	**$53,441**
Data Analysis					
	Recalibrate HEC-RAS model	$-	$-	$4,400	$4,400
	Water Quality Data Analysis	$9,880	$-	$-	$9,880
	Subtotal	**$21,250**	**$0**	**$4,400**	**$25,650**
Reporting					
	Incorporation of Additional Items into Technical Report and Management Recommendations	$4,988	$-	-	$4,988

Table 10. Costs for Additional Tasks

Task	Subtask		Labor Cost	Materials Cost	Subcontractor Cost	TOTAL
		Subtotal	**$4,988**	**$0**	**$0**	**$4,988**
TOTAL						**$171,451**
10% Contingency						**$17,145**
GRAND TOTAL						**$188,596**

9. LITERATURE CITED

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———. 2014. *Lower Jordan River Flow Management and Water Quality Technical Report (Phase 2).* Prepared for River Network. May 2014.

Utah State University
DEPARTMENT OF BIOLOGY

2-May-2014

To Whom It May Concern:

Please accept this letter in support of the Aquatic Biogeochemistry Laboratory (ABL) at Utah State University for The River Network's Lower Jordan River Flow Experiment plan. The project would provide valuable information in the effort to solve the dissolved oxygen impairment in the lower Jordan River.

Dave Epstein
Research Technician III
Aquatic Biogeochemistry Laboratory
Utah State University

5305 Old Main Hill   Logan, UT 84322-5305   Tel: 435.797.2485   Fax: 435.797.1575   www.biology.usu.edu

JORDAN RIVER COMMISSION

Jordan River Commission
195 North 1950 West, P.O. Box 91095
Salt Lake City, Utah 84109-1095
801.536.4158
www.jordanrivercommission.org

Merritt Frey
Habitat Program Director
River Network
209 SW Oak St., Suite 300
Portland, Oregon 97204

May 5, 2014

Dear Ms. Frey:

The Jordan River Commission was created in fall of 2010 to implement the concepts outlined in a long-range, regional vision for the 50-mile long Jordan River corridor. This vision, called the Blueprint Jordan River, reflects the collective imagination of over 3,000 Wasatch Front residents. It includes ambitious recommendations for the river corridor including open space preservation, expanded recreation, water quality improvements, and economic development that embraces and protects the river ecosystem.

Over the past century the Jordan River has been neglected and abused, and has earned itself a negative stigma. Recent years have demonstrated a significant movement to restore and rehabilitate the river corridor, and many agencies, organizations and individuals are taking action to improve its conditions. Projects like the River Network's ***Lower Jordan River Flow Experiments*** are critical to maintaining this momentum. The Jordan River Commission is pleased to support the River Network on this project, and is encouraged by the possibilities that the results of these experiments may hold for improving aquatic habitat and the quality of water within the Lower Jordan River.

The Jordan River Commission has committed to support this project through an in-kind donation of 40 hours of staff time, or $1,360.00 to facilitate coordination among local governments and to support policy changes as appropriate to implement the most successful and promising strategies to improve water quality that emerge from this project.

Warm Regards,

Laura Hanson
Executive Director

SALT LAKE COUNTY

Ben McAdams
Salt Lake County Mayor

Russ Wall
Public Works and Regional Development Department Director

Patrick W. Leary
Township Executive

ENGINEERING AND FLOOD CONTROL DIVISION

Scott R. Baird, P.E.
Division Director

Government Center
Engineering and Flood Control
Salt Lake County, Suite N-3100
2001 South State Street
PO Box 144575
Salt Lake City, UT 84114-4575

385/468-6600
385/468-6603 fax
pwengineering@slco.org
www.pweng.slco.org

May 5, 2014

Merritt Frey
River Network
1985 South 500 East
Salt Lake City, Utah 84105

RE: Letter of Support for Lower Jordan River Flow Experiments

Dear Ms. Frey,

I am writing on behalf of the Salt Lake County's Flood Control & Engineering Division and Watershed Planning & Restoration Program to express our support for the project entitled "Lower Jordan River: Plan for Flow Experiments (2014-2016)".

Salt Lake County supports scientifically sound ecological monitoring and assessment of water and riparian resources. This project and its goals are directly related to the priority targets and recommendations of the 2009 Salt Lake Countywide Water Quality Stewardship (WaQSP). The WaQSP is a planning document published by Salt Lake County that identified fifteen priority implementation tasks, including "Task 7: Evaluate current Lower Jordan River flow management strategies for impact to water quality".

We greatly support this project for the many potential benefits to the Jordan River ecosystem including environmental stewardship and direct water quality benefits. Specifically, we will coordinate with the project in terms of dredging, flood control, and water rights discussions.

Sincerely,

Scott R. Baird, P.E.
Division Director


Burnham Dam Diversion
Cudahy Lane (Center Street)
Redwood Road
300 North
North Temple
800 South
1300 South
1700 South
2100 South
Farmington Bay
West Bountiful
Bountiful
Woods Cross
North Salt Lake
Davis
Salt Lake
Salt Lake City
Salt Lake City Int'l Airport
University Of Utah
Fort Douglas
Legacy Pky
N Redwood Rd
Beck St
City Creek
Orchard Dr
S Bountiful Blvd
Bangerter Hwy
California Ave
W 500 S
W 200 S
W 400 S
W 2100 S
E 500 S
E 1300 S
E 1700 S
E 2100 S
Sunnyside Ave
Emigration Creek
Glendale Golf Course
JR/FBWQC In-situ Meter Locations
Additional Monitoring Sites
Stormwater Outfall
Bridge
0 1 2 Miles
0 1 2 Kilometers
N
Service Layer Credits: Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom
SWCA ENVIRONMENTAL CONSULTANTS

JEFFRY T. NIERMEYER
DIRECTOR

SALT LAKE CITY CORPORATION

DEPARTMENT OF PUBLIC UTILITIES
WATER SUPPLY AND WATERWORKS
WATER RECLAMATION AND STORMWATER

RALPH BECKER
MAYOR

May 2, 2014

Mr. Walt Baker, P. E.
Utah Division of Water Quality
P.O. Box 144870
Salt Lake City, Utah 84114-4870

Subject: Grant Application
Letter of Support for the *Lower Jordan River Plan for Flow Experiments* Project
Submitted by the River Network and SWCA

Dear Mr. Baker,

This letter is to document Salt Lake City Department of Public Utilities' support of the project proposal being submitted by the River Network and SWCA Environmental Consultants for ongoing research experiments and study of impacts and potential flow management approaches in the Jordan River to address the dissolved oxygen (DO) and the Jordan River TMDL.

The City strongly supports this project and encourages your funding consideration. The work that they propose builds upon the initial phase of research, and appears to be leading to not only a better understanding of the impacts and variables influencing DO and River impairment, but the flow experiments may lead to actual implementation strategies to mitigate or potentially solve the DO problems associated with sediment transport, accumulation, re-suspension and respective sediment oxygen demand (SOD) processes that are believed to be a significant factor in the DO impairment.

As a stakeholder and partner with this and other projects related to the Jordan River, Salt Lake City will continue to provide support to this project. Please feel free to contact me should you have any questions.

Sincerely

Tom Ward, P.E.
Deputy Director

c: Merritt Fry/River Network, Erica Gaddis/SWCA,
Jesse Stewart/ SLCDPU, Bridget Elliott/SLCDPU

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THE UNIVERSITY OF UTAH
Department of Civil & Environmental Engineering
110 South Central Campus Drive, Suite 2000 Salt Lake City, Utah 84112 (801)581-6931 FAX (801) 585-5477

May 2, 2014

Merritt Frey
River Network
1985 South 500 East
Salt Lake City, UT 84105

Dear Merritt:

It gives me great pleasure to write this letter of support for your proposal to the Utah Division of Water Quality. Your project, which aims to evaluate the effect of increased flows in the lower Jordan River is much needed. It will provide useful data for phased TMDL for the Jordan River. As a partner in this project, my lab will share all the data with you as appropriate as long as it is permissible by UDWQ. I am excited to be a part of this effort and looking forward to seeing the outcomes of this project.

Sincerely,

Ramesh Goel, Ph.D.
Associate Professor