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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
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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

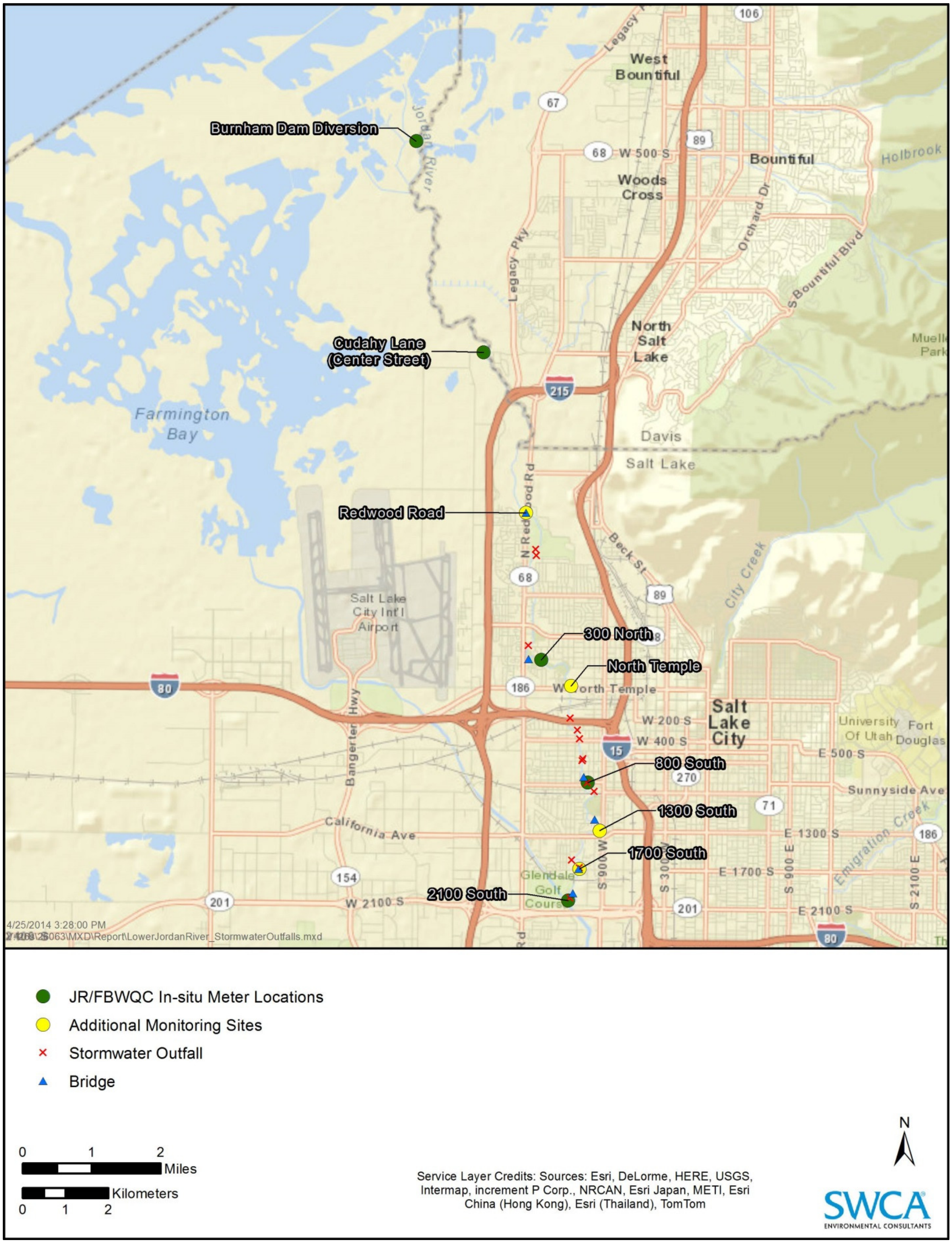

Figure 1. Locations of existing in-situ sondes and proposed handheld meters.

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.

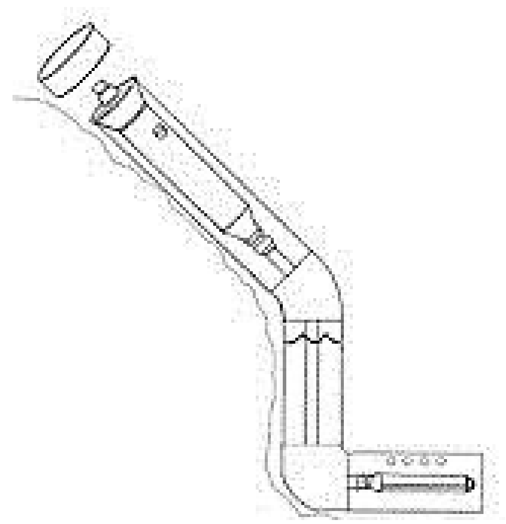

Figure 2. Installation design for the stage monitoring devices. Source: http://www.globalw.com

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).

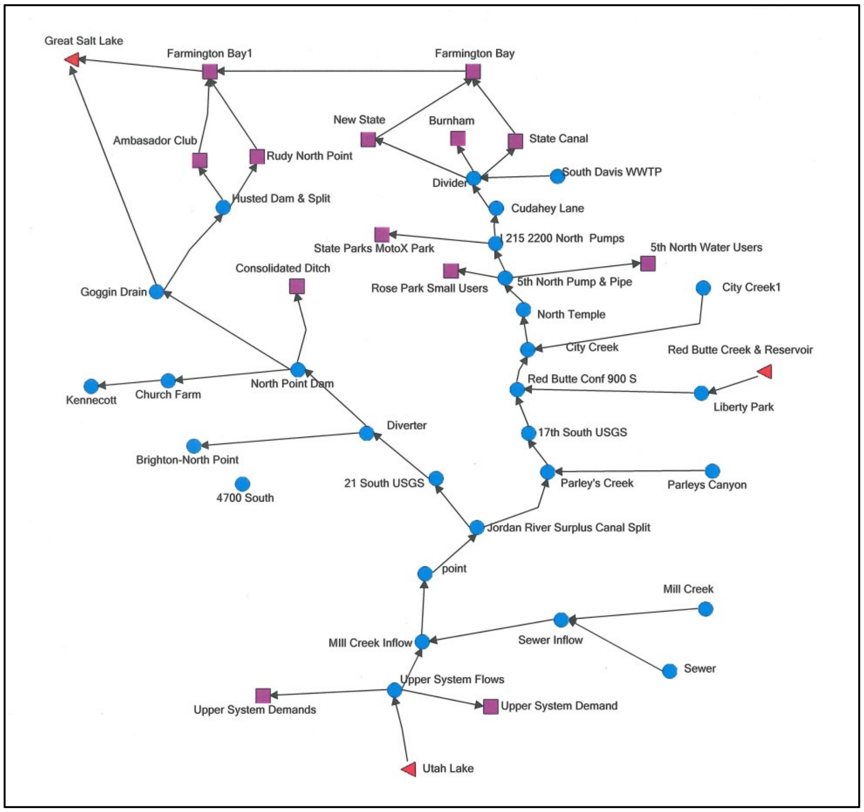

Figure 3. Network of major priority water rights and diversions in the lower Jordan River system (Mike Silva, Utah Division of Water Rights 2014).

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).

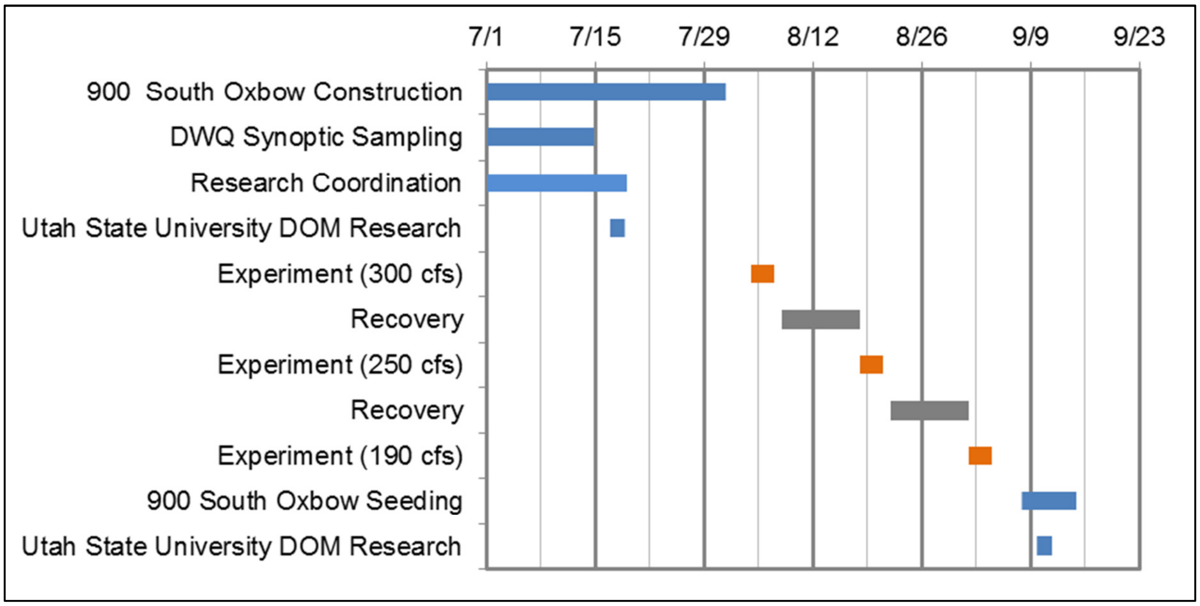

Figure 4. Proposed 2014 flow experiment schedule and other scheduled research and activities in the lower Jordan River.

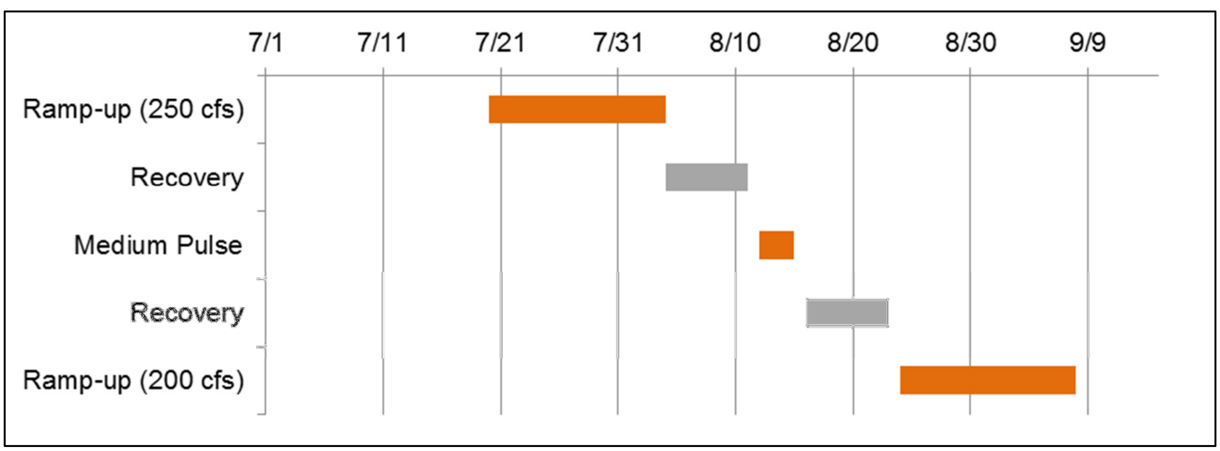

Figure 5. Proposed 2015 and 2016 flow experimental schedule.

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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