2014 Reassessment of Floodplain Wetland Connections in the Middle Green River, Utah

Environmental Science Division

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2014 Reassessment of Floodplain Wetland Connections in the Middle Green River, Utah

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CONTENTS

NOTATION	vii
ACKNOWLEDGMENTS	ix
EXECUTIVE SUMMARY	xi
1 INTRODUCTION	1
2 METHODS	2
3 RESULTS	5
3.1 Escalante Ranch	15
3.2 Bonanza Bridge	18
3.3 Stirrup	20
3.4 Above Brennan	21
3.5 Johnson Bottom	24
3.6 Leota Bottom	25
3.7 Results Summary	27
4 DISCUSSION	28
5 CONCLUSIONS	29
6 RECOMMENDATIONS	30
7 REFERENCES	30
APPENDIX A: USGS Stage-Flow Relationships at the Jensen and Ouray Gages	34
APPENDIX B: Middle Green River Floodplain Wetland Connection Maps for 2014	61

TABLES

1 Green River Annual Peak Peak Flow at Jensen, Utah from 2005-2014	2
2 Summary of Survey Dates and Modeled Local Flow Conditions for Six Floodplain Wetland Sites on the Middle Green River, Utah, in 2014	4

Tables (Cont.)

3	Breach and Connection Flows at Surveyed Breaches in October 2014 and Comparison to Previously Reported Connection Flows	7
4	Minimum Connection Flows at Floodplain Wetlands in 2005, 2012, and 2014 for Any Breach, Upstream Breaches, and Downstream Breaches.....	12
5	Fish Passage Flows at Surveyed Breaches in 2005, 2012, and 2014	15
A-1	USGS Stage-Flow Table for the Jensen Gage (USGS 09261000) in 2005, 2012, and 2014.....	36
A-2	USGS Stage-Flow Table for for the Ouray Gage (USGS 9272400) in 2012 and 2014.....	49

FIGURES

1	Green River Floodplain Wetland Survey Locations, October 2014	3
2	Example Floodplain Wetland Photographs, October 2014.....	6
3	Escalante Ranch Survey Locations in 2014.....	16
4	Bonanza Bridge Survey Locations in 2014	20
5	Stirrup Survey Locations in 2014	21
6	Above Brennan Survey Locations in 2014	22
7	Johnson Bottom Survey Locations in 2014	25
8	Leota Bottom Survey Locations in 2014	26
A-1	Relationship Used to Predict Jensen Flow (cfs) Based on Values in Table A-1	37
A-2	Relationship Used to Predict Jensen Stage (ft) Based on Values in Table A 1	38
A-3	Relationship Used to Predict Ouray Flow (cfs) Based on Values in Table A 2	39
A-4	Relationship Used to Predict Ouray Stage (ft) Based on Values in Table A 2.....	39
B-1	Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-3 at 18,100 cfs in 2014	63

Figures (Cont.)

B-2	Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-4 at 20,000 cfs in 2014	64
B-3	Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-5 at 19,400 cfs in 2014	65
B-4	Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-6 at 18,900 cfs in 2014	66
B-5	Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-7 at 17,600 cfs in 2014	67
B-6	Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-OUT at 8,740 cfs in 2014.....	68
B-7	Floodplain Wetland Connection Channel and Minimum Connection Flow for BB-IN-1 at 19,800 cfs in 2014.....	69
B-8	Floodplain Wetland Connection Channel and Minimum Connection Flow for BB-IN-2 at 20,500 cfs in 2014.....	70
B-9	Floodplain Wetland Connection Channel and Minimum Connection Flow for BB-IN-3 at 22,200 cfs in 2014.....	71
B-10	Floodplain Wetland Connection Channel and Minimum Connection Flow for BB-OUT at 14,900 cfs in 2014	72
B-11	Floodplain Wetland Connection Channel and Minimum Connection Flow for ST-OUT at 15,700 cfs in 2014.....	73
B-12	Floodplain Wetland Connection Channel and Minimum Connection Flow for AB-IN-1 at 15,200 cfs in 2014.....	74
B-13	Floodplain Wetland Connection Channel and Minimum Connection Flow for AB-IN-2 at 19,100 cfs in 2014.....	75
B-14	Floodplain Wetland Connection Channel and Minimum Connection Flow for AB-IN-3 at 14,600 cfs in 2014.....	76
B-15	Floodplain Wetland Connection Channel and Minimum Connection Flow for AB-OUT at 10,400 cfs in 2014	77

Figures (Cont.)

B-16	Floodplain Wetland Connection Channel and Minimum Connection Flow for JB-OUT-1 at 13,600 cfs in 2014	78
B-17	Floodplain Wetland Connection Channel and Minimum Connection Flow for JB-OUT-2 at 14,100 cfs in 2014	79
B-18	Floodplain Wetland Connection Channel and Minimum Connection Flow for LB7-IN at 14,500 cfs in 2014.....	80
B-19	Floodplain Wetland Connection Channel and Minimum Connection Flow for LB7A-IN at 12,700 cfs in 2014.....	81

NOTATION

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

Argonne	Argonne National Laboratory
Reclamation	Bureau of Reclamation
Recovery Program	Upper Colorado River Endangered Fish Recovery Program
USGS	U.S. Geological Survey
WAPA	Western Area Power Administration

UNITS OF MEASURE

cfs	cubic foot (feet) per second
cm	centimeter(s)
ft	foot/feet
h	hour(s)
km	kilometers(s)
mi	mile(s)
m ³	cubic meter(s)
s	second(s)

METRIC UNIT CONVERSIONS

1 cfs	0.0283 m ³ /s
1 ft	30 cm
1 mi	1.61 km
1 river mi	1.61 river km

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EXECUTIVE SUMMARY

The frequency, magnitude, and duration of seasonal overbank flooding in the Green River have been substantially reduced since closure of Flaming Gorge Dam. Flow recommendations (Muth et al. 2000) were developed to assist with conservation and recovery of endangered fish species in the Green River downstream from Flaming Gorge Dam. Among the objectives of these recommendations was to provide for floodplain wetland connection to the river at sufficient frequency and duration to support sustained recruitment of the endangered razorback sucker (*Xyrauchen texanus*). Although floodplain habitats are important for all four of the endangered Colorado River fishes, the inundation of floodplain wetlands along the middle Green River is particularly important for providing important nursery habitat for young-of-the-year razorback suckers. Restoring or enhancing floodplain wetland connections to the river would provide access to these productive habitats and is expected to support the recovery of the four endangered fish species in the basin.

An uncertainty identified in the Larval Trigger Study Plan (Larval Trigger Study Plan Ad Hoc Committee 2012), a report that identified priorities for geomorphology research in the Upper Colorado River Basin (LaGory et al. 2003), and the Green River Study Plan (Green River Study Plan Ad Hoc Committee 2007) was interannual variability in the flow needed to connect floodplain wetlands and the effect of peak flows on these connecting flows. To address this uncertainty, we conducted a reassessment of floodplain connections in 2012 and found considerable differences from values presented in previous reports, which presumably resulted from the effects of intervening peak flows (LaGory et al. 2016). The present study was developed to determine if changes in connection flow had occurred since 2012.

This report presents the results of floodplain wetland connection surveys conducted in 2014 at six priority floodplain wetland sites along the middle Green River between Jensen and Ouray, Utah. Surveys were conducted at levee breaches and within channels leading from the breaches to the wetlands (referred to here as connection channels) to characterize the flows needed to connect the river's main channel with the floodplain wetlands. Specific objectives of this work were to:

- Determine the minimum flow that would connect floodplain wetlands to the main channel river and allow for the entrainment of larval razorback suckers;
- Determine the minimum flow that would allow the passage of subadult and adult razorback suckers (minimum depth of 1 ft [30 cm] based on Burdick 1997) between the wetlands and the river; and
- Compare our 2014 survey results with information collected in 2012 (LaGory et al. 2016), and previously reported results from Tetra Tech (2005) and Bestgen et al. (2011), to determine if and how conditions have changed since those studies were conducted.

Our survey results will be used in conjunction with our 2012 results and the results of other studies conducted under the Larval Trigger Study Plan (Larval Trigger Study Plan Ad Hoc

Committee 2012) and Green River Study Plan to resolve uncertainties associated with razorback sucker floodplain nursery habitats and factors contributing to recruitment of this species. The evaluation summarized here also will provide important input to the Upper Colorado River Endangered Fish Recovery Program's ongoing evaluation of the Muth et al. (2000) flow recommendations.

Topographic surveys to determine the flows that would connect the main channel of the Green River to six priority floodplain wetlands were conducted along the middle Green River from October 27 through 30, 2014, between the U.S. Geological Survey (USGS) Jensen gage (USGS 09261000) and the USGS Ouray gage (USGS 9272400). At each wetland location, topographic surveys were conducted of the river surface elevation and at cross sections of the levee breaches and along the connecting channels. This topographic information was used with current USGS stage-discharge relationships to determine minimum flows needed to overtop breaches and connect the floodplain wetlands to the river main channel.

Our 2014 survey identified differences in connection flow of individual levee breaches and associated connection channels from our 2012 survey results (LaGory et al. 2016) and the values in Tetra Tech (2005) and Bestgen et al. (2011). Most of the 2014 connection flow estimates were lower than values we obtained in 2012 (mean difference -1,310 cfs), but still higher than reported values in 2005 (mean difference +3,544 cfs). All but 2 of the 19 breaches and associated connection channels surveyed had lower estimated connection flows than in 2012.

The average estimated minimum floodplain connection flow (i.e., the lowest connection flow of any breach at a particular wetland) among the six floodplain wetlands surveyed in 2014 was 12,676 cfs. This is a relatively small mean decrease (1,807 cfs) compared to estimated connection flows in 2012, and a small net decrease since 2005 (100 cfs). However, there was considerable variation among the wetlands in estimated minimum connection flow, ranging from 8,769 cfs at Escalante Ranch¹ to 15,749 cfs at Stirrup. There was a comparable level of variation in 2012 (10,422 to 17,864 cfs), but much less variation in 2005 (11,166 to 13,000 cfs).

Changes in connection flows differed between upstream and downstream breaches with upstream breaches showing a smaller decrease since 2012 than downstream breaches. The estimated mean minimum connection flow of upstream breaches in 2014 was 17,324 cfs (14,564 to 19,814 cfs) compared to 17,697 cfs (15,704 to 20,544 cfs) and 12,389 cfs (11,166 to 13,000 cfs) in 2012 and 2005, respectively. This corresponded to an overall mean decrease for minimum connection flow of upstream breaches of 373 cfs (-2,267 to +1,889 cfs) relative to 2012 and an increase of 4,935 cfs relative to 2005. The estimated mean minimum connection flow of downstream breaches in 2014 was 12,676 cfs (8,769 to 15,749 cfs) compared to 14,271 cfs (10,422 to 17,864 cfs) in 2012, and 13,056 cfs (12,433 to 13,900 cfs) in 2005. This corresponded to an overall mean decrease for minimum connection flow of downstream breaches of 1,807 cfs (-2,950 to -53 cfs) relative to 2012, and a 209 cfs decrease (-3,664 to 2,749 cfs) relative to 2005.

Estimated fish passage flows were approximately 2,500 cfs higher than connection flows in the Ouray National Wildlife Refuge wetlands (Johnson Bottom and Leota Bottom) and 3,200

¹ Escalante Ranch was referred to as Thunder Ranch in many previous reports.

to 3,400 cfs higher than connection flows in the wetlands further upstream. In 2014, the mean minimum fish passage flow for the floodplain wetlands surveyed was 19,438 cfs (11,558 to 25,831 cfs). The mean minimum fish passage flow for the floodplain wetlands surveyed (i.e., the lowest of all levee breaches in each wetland) was approximately 15,500 cfs (11,558 to 18,966 cfs).

In the wetlands studied, upstream breaches were topographically higher than the wetland, while downstream breaches were lower than the wetland. This topographic variation likely explains differences among breaches in the magnitude of changes in connection flows since 2012. Upstream breaches and their connection channels, which tend to be depositional areas, showed less decrease in connection levels than downstream breaches, which tend to scour as the wetland drains during flood recession.

The mechanism for these reductions in connection flow following the moderately high 2014 peak flow may be a result of differences in sediment concentrations during peak flows in 2011 and 2014. Although such data are not currently available for the study area, it is expected that sediment concentration would be lower during the lower magnitude 2014 flow compared to the higher magnitude 2011 peak flow. A lower sediment load would have made the 2014 flow more erosive and could have resulted in net erosion of 2011 sand deposits. Water entering breaches could have eroded old deposits within connection channels while depositing less new sand. It is not known if a series of moderately high peak flows (18,600 to 21,000 cfs) would further reduce flows needed to connect floodplain wetlands to the main channel. Study of even lower peak flows that only connect downstream wetland breaches (e.g. 11,000 to 15,000 cfs) could also increase our understanding of the effects of peak flow magnitude on floodplain wetland connection. The 2014 results confirm the need for periodic reassessments of levee breaches and connection channels following peak flows.

We recommend the following:

- Resurvey floodplain wetland breaches and their connection channels following peak flows that exceed previously determined connection flows to determine if those peak flows have altered connection flows. It would be interesting to see if the apparent reduction in connection flows that resulted from the moderately high 2014 peak would continue with subsequent moderate peak flows.
- Determine connection of floodplain wetlands annually by direct observation. Ideally, determinations would be made of initial connection flows at upstream and downstream breaches and the degree of filling and draining through the peak flow cycle.
- Measure the surface area of floodplain wetlands after peak flows recede and through the summer and winter to determine if floodplain wetlands provide suitable habitat for razorback suckers between flooding events that reconnect the wetlands to the main channel.

- Consider modification of floodplain wetland breaches and connection channels to provide connection at a return frequency of 1.5 years (probability of about 67%) to mimic pre-dam flooding frequency.
- Consider modifications of wetlands to prevent sediment deposition from blocking inflow. These modifications could include (1) actively reconfiguring levee breaches, connection channels, and wetland topography to minimize the blockage of connection channels; (2) filling or allowing the filling of upstream breaches; (3) creating control structures such as those that have been successfully deployed at Stewart Lake, Johnson Bottom, and Old Charlie Wash; and (4) managing vegetation encroachment that exacerbates sediment deposition in breaches and channels.

1 INTRODUCTION

The frequency, magnitude, and duration of seasonal overbank flooding in the Green River have been substantially reduced since closure of Flaming Gorge Dam. Flow recommendations (Muth et al. 2000) were developed to assist with conservation and recovery of endangered fish species in the Green River downstream of Flaming Gorge Dam. These recommendations identified target instantaneous annual spring peak flows in the middle Green River between the confluences of the Yampa River and White River of at least 18,600 cubic feet per second (cfs) (as measured at the Jensen gage) in 1 of 2 years, and flows of at least 18,600 cfs for at least 2 weeks in 4 of 10 years. The intent of these recommendations was to provide floodplain wetland connection to the river at sufficient frequency and duration to support sustained recruitment of the endangered razorback sucker (*Xyrauchen texanus*).

Although floodplain habitats are important for all four of the endangered Colorado River fishes, the inundation of floodplain wetlands along the middle Green River is particularly important for providing important nursery habitat for young-of-the-year razorback suckers. Restoring or enhancing floodplain wetland connections to the river would provide access to these productive habitats and is expected to improve the recovery of the four endangered fish species in the Green River Basin.

An uncertainty identified in the Larval Trigger Study Plan (Larval Trigger Study Plan Ad Hoc Committee 2012), a report that identified priorities for geomorphology research in the Upper Colorado River Basin (LaGory et al. 2003), and the Green River Study Plan (Green River Study Plan Ad Hoc Committee 2007) was interannual variability in the flow needed to connect floodplain wetlands and the effect of peak flows on these connecting flows.

Floodplain wetland connection assessments following years with peak flows that exceed previous connection flows are important to understand changes in connection flows that may result from scouring or deposition of sediments or debris. In 2012, surveys were conducted to evaluate changes in floodplain connections following the 2011 high peak flows (LaGory et al. 2016). The 2014 peak flow (Table 1) exceeded the 2012 estimated connection flow of many of the wetlands (LaGory et al. 2016), potentially resulting in deposition or erosion in breaches and connection channels.

This report presents the results of floodplain wetland connection surveys conducted in 2014 at six priority floodplain wetland sites along the middle Green River between Jensen and Ouray, Utah. Surveys were conducted at levee breaches and within channels leading from the breaches to the wetlands (referred to here as connection channels) to characterize the flows needed to connect the river's main channel with the floodplain wetlands. Specific objectives of this work were to:

- Determine the minimum flow that would connect floodplain wetlands to the main channel river and allow for the entrainment of larval razorback suckers;

TABLE 1 Green River Annual Peak Flow at Jensen, Utah from 2005-2014

Year	Peak Flow (cfs)
2005	19,900
2006	19,200
2007	12,700
2008	24,000
2009	19,600
2010	20,500
2011	32,200
2012	10,600
2013	11,000
2014	20,100

- Determine the minimum flow that would allow the passage of subadult and adult razorback suckers (minimum depth of 1 ft [30 cm] based on Burdick 1997) between the wetlands and the river; and
- Compare our 2014 survey results with information collected in 2012 (LaGory et al. 2016), as well as information reported by Tetra Tech (2005) and Bestgen et al. (2011)² to determine if and how conditions have changed since those studies were conducted.

Our survey results will be used in conjunction with our 2012 results and the results of other studies conducted under the Larval Trigger Study Plan and Green River Study Plan to resolve uncertainties associated with razorback sucker floodplain nursery habitats and factors contributing to recruitment of this species. The evaluation summarized here also will provide important input to the Upper Colorado River Endangered Fish Recovery Program's ongoing evaluation of the Muth et al. (2000) flow recommendations.

2 METHODS

Topographic surveys to determine the flows that would connect the main channel of the Green River to six priority floodplain wetlands were conducted along the middle Green River from October 27 through 30, 2014, between the U.S. Geological Survey (USGS) Jensen gage (USGS 9261000) and the USGS Ouray gage (USGS 9272400) (Figure 1). A summary of survey times and flow conditions at each of the floodplain areas is provided in Table 2. Local flow conditions were estimated using the same methods as in our 2012 study (LaGory et al. 2016),

² Bestgen (2011) reported connection flows based on several information sources including Tetra Tech (2005).

FIGURE 1 Green River Floodplain Wetland Survey Locations, October 2014. Note that Escalante Ranch was referred to as Thunder Ranch in many previous reports.

TABLE 2 Summary of Survey Dates and Modeled Local Flow Conditions for Six Floodplain Wetland Sites on the Middle Green River, Utah, in 2014

Site	Date	Time (h)	USGS Gage (distance, mi) ^a	Lag-Adjusted Gage Flow (cfs) ^b	Ashley Creek Flow (cfs)	Estimated Local Flow (cfs) ^c	Estimated Local Stage (ft) ^d
Escalante Ranch	October 27, 2014	12:00	Jensen (10)	2,630	NA ^e	2,630	3.15
Bonanza Bridge	October 29, 2014	10:00	Jensen (24)	2,140	75	2,215	2.85
Stirrup	October 28, 2014	13:00	Jensen (38)	2,630	75	2,705	3.20
Above Brennan	October 29, 2014	15:00	Jensen (44)	2,450	75	2,525	3.08
Johnson Bottom	October 30, 2014	15:00	Ouray (-12)	2,170	NA ^f	2,170	15.86
Leota Bottom	October 30, 2014	11:00	Ouray (-9)	2,200	NA ^f	2,200	15.88

^a Values in parentheses indicate distance (mi) away from the nearest USGS stream gage. Positive values are locations downstream from the gage; negative values are locations upstream from the nearest gage.

^b The lag-adjusted flow was determined by offsetting the gage flow by the lag time from the gage to the site. The lag time (hours [*h*]) was calculated as $h = 8.9441 \times D_w \times Q_{max}^{-0.3231}$, where D_w is the distance (mi) of the wetland from the nearest gage and Q_{max} is the maximum hourly flow (cfs) at the gage on the day of the survey.

^c For sites associated with the Jensen gage, the local estimated flow was determined by adding the lag-adjusted Jensen flow (column 5) with the Ashley Creek flow (column 6).

^d The local lag-adjusted stage was determined using the stage-discharge relationships from the most current rating curves for the Jensen and Ouray gages. Stage-flow tables are provided in Appendix A.

^e NA = not applicable; Ashley Creek is downstream of the Escalante Ranch site.

^f NA = not applicable; Ashley Creek flow is included in the Ouray gage flow.

and were based on calculated water travel times (i.e., lag-adjusted flows) and distance from the nearest Green River USGS gage sites (Jensen or Ouray; Table 2).

Flow values corresponding to the elevation of all survey points were determined based on their elevation relative to the river elevation and flow at the time of survey, and stage-flow tables provided by USGS for the nearest Green River (Jensen or Ouray gage). Stage-flow tables for each of the gages are provided in Appendix A. For wetlands closer to the Jensen gage and downstream of the Ashley Creek confluence, Ashley Creek flows (USGS 9266500) were added to Jensen flows to determine flow at the site. Flows were relatively steady during the survey period. Jensen flow ranged from 2,040 and 2,260 cfs; Ashley Creek flows were approximately 75 cfs; and Ouray flows ranged from 2,290 and 2,320 cfs.

Nineteen breach locations were surveyed at the six floodplain wetland sites following the methods described in LaGory et al. (2016). At each location, elevations were determined for the river edge and water surface elevation, and a series of cross sections of levee breaches and the intervening connection channels that separated breaches from the floodplain wetland and provided conveyance of flows between the main channel and wetland at high flows. Example photographs of survey locations are shown in Figure 2.

Using the survey data, the minimum elevation at each cross section was determined. The cross section with the greatest minimum elevation was identified as the location that most limited connection, and the flow associated with that minimum elevation was identified as the connection flow. For flows above the minimum connection flow, topographic information was used to develop relationships between flow and channel depth.

At each floodplain wetland, the minimum flows needed for connection and fish passage were determined for all breach locations and associated connection channels and compared to floodplain connection measurements made in 2012 (LaGory et al. 2016), as well as other reported estimates of connection flows (Tetra Tech 2005; Bestgen et al. 2011).

3 RESULTS

Characteristics of floodplain wetland connections in 2014 and changes since 2012 and 2005 are provided in this section. Sites are discussed in order of location along the Green River (upstream to downstream) (Figure 1). A summary of survey results, with comparisons to 2012 values (LaGory et al. 2016) and 2005 values (Tetra Tech 2005; Bestgen et al. 2011) is provided in Table 3. Appendix B contains maps of the connection channel between the river and the floodplain wetland at each location at the minimum connection flow. Tables 4 and 5 summarize minimum connection and minimum fish passage flows, respectively, at each floodplain and at upstream and downstream breaches, and compares the results to previous estimates.

In the descriptions below, the following critical elevations and associated estimated flows are identified for each levee breach and its connection channel:

- *River water surface elevation (flow)*: water surface elevation and associated flow as surveyed at river's edge nearest each levee breach.
- *Connection elevation (flow)*: minimum elevation and associated flow in the connection channel that would allow water to flow between the river and floodplain wetland as determined from a series of cross sections measured between the levee breach and the entrance to the floodplain wetland.

Stirrup Wetland

Bonanza Bridge Inlet (BB-IN-1)

Escalante Ranch Outlet (ER-OUT)

Above Brennan Inlet (AB-IN-3)
near wetland

FIGURE 2 Example Floodplain Wetland Photographs, October 2014

TABLE 3 Connection Flows at Surveyed Breaches in October 2014 and Comparison to Previously Reported Connection Flows

Floodplain Wetland and Breach Name	2014 Connection Flow (cfs)	2012 Connection Flow (cfs) ^a	2005 Connection Flow (cfs) ^b	Change from 2012 to 2014 (cfs)	Change from 2005 to 2014 (cfs) ^c	Notes
Escalante Ranch^d						
ER-IN-3	18,100	18,100	11,900	0	+6,200	Breach was well-defined, but with some loose sand deposits in breach. Mass wasting of breach was observed. Sand road crosses inflow channel, and was higher than breach. Inflow channel fairly well-defined, but with loose sand. Highest channel cross-section about two-thirds of way between breach and wetland. Russian thistle and young tamarisk choked channel.
ER-IN-4	20,000	20,300	12,933	-300	+7,067	Breach was filled with sand. Sand road crosses inflow channel, and was higher than breach. Channel to wetland was not well-defined. Highest channel cross-section near wetland edge. Dense Russian thistle and dead tamarisk in channel.
ER-IN-5	19,400	16,800	12,000	+2,600	+7,400	Loose sand deposits in breach and inflow channel to road. Highest channel cross-section near wetland edge. Loose sand decreases in inflow channel towards wetland. Tamarisk, rabbitbrush, and annual vegetation species in channel.
ER-IN-6	18,900	19,200	11,166	-300	+7,734	Breach filled with loose sand almost to height of levee. Sand road crosses inflow channel. Highest channel cross-section on wetland side of the road. Channel poorly defined with fairly dense deposits of Russian olive and patches of tamarisk and sedges.
ER-IN-7	17,600	15,300	12,000	+2,300	+5,600	Breach filled with loose sand almost to height of levee; cutbank at river edge. Sand road crosses inflow channel. Highest channel cross-section near breach. No deposits between sand road and wetland. Tamarisk and annuals in channel.

Table 3 (Cont.)

Floodplain Wetland and Breach Name	2014 Connection Flow (cfs)	2012 Connection Flow (cfs) ^a	2005 Connection Flow (cfs) ^b	Change from 2012 to 2014 (cfs)	Change from 2005 to 2014 (cfs) ^c	Notes
Escalante Ranch (cont.)						
ER-OUT	8,740	11,300	12,433	-2,560	-3,693	Hard-packed sand in channel near river and breach showing signs of scour. Scour hole with standing water (as observed in 2012) located midway up channel toward wetland. Other areas of standing water in channel with well-developed wetland vegetation (mostly sedges). Highest channel cross-section halfway between breach and wetland. Gravel road crosses channel near wetland. Apparently first connected on April 25, 2014 when flow was 9,910 cfs (Jensen gage). Outlet draining to river on June 13, 2014 (15,500 cfs). Connection reported in 2013 (peak flow 11,000 cfs).
Bonanza Bridge						
BB-IN-1	19,800	20,100	13,000 (actual >18,500)	-300	+1,300	Sand road goes through breach onto large sand bar at river edge, but road berm blocks inlet channel entrance. Another sand road (slightly higher than channel) crosses channel between breach and wetland. No new sand deposited in well-defined channel between breach and wetland suggesting little inflow in 2014. Highest channel cross-section near breach. Large deposit of sand (noted in 2012) where all three inlets feed into wetland. Russian olive and grasses in channel.
BB-IN-2	20,500	21,100	13,000 (actual >13,900)	-600	+6,600	Large deposit of sand in breach and channel, completely blocking channel, including large deposit (noted in 2012) where all three inlets feed into wetland. Highest channel cross-section halfway between breach and wetland.
BB-IN-3	22,200	24,100	13,000	-1,900	+9,200	Sand completely fills breach. Channel is without sand deposits, but choked with Russian thistle and some cut brush. Large deposit of sand (noted in 2012) where all three inlets feed into wetland. Highest channel cross-section near breach.

Table 3 (Cont.)

Floodplain Wetland and Breach Name	2014 Connection Flow (cfs)	2012 Connection Flow (cfs) ^a	2005 Connection Flow (cfs) ^b	Change from 2012 to 2014 (cfs)	Change from 2005 to 2014 (cfs) ^c	Notes
Bonanza Bridge (cont.)						
BB-OUT	14,900	17,400	13,000 (actual >13,900)	-2,500	+1,000	Two breach inlets mostly filled with sand. Sand and gravel road to breach serves as main inlet channel. Road passes through connection channel and breach; several additional small roads cross broad forest swale, which also serves to connect wetland to river at high flows. Highest channel cross-section along access road/channel halfway between the downstream breach and wetland.
Stirrup						
ST-OUT	15,700	16,900	13,000	-1,200	+2,700	Breach is packed sand with no new deposits. Area between river and breach lost since 2012 and there is a sharp drop to the river. Narrow incised channel, without sand deposits, leads from river to wetland. Young willows and annuals in channel. Highest channel cross-section just past breach. No change from 2012 in staff gage burial depth (0.8 ft). Stirrup was full on June 4, 2014 (18,600 cfs). Stirrup water level through breach was equal to river flow (15,500 cfs) on June 13, 2014.

Table 3 (Cont.)

Floodplain Wetland and Breach Name	2014 Connection Flow (cfs)	2012 Connection Flow (cfs) ^a	2005 Connection Flow (cfs) ^b	Change from 2012 to 2014 (cfs)	Change from 2005 to 2014 (cfs) ^c	Notes
Above Brennan						
AB-IN-1	15,200	16,400	13,000	-1,200	+2,200	Breach mostly filled with sand then slopes down to wetland. Wide sandy channel to wetland with some young willows and annuals. Highest channel cross-section just past breach. No change in staff gage burial depth from 2012 (0.6 ft). Above Brennan had water flowing through at least two of the inlets on June 4, 2014, at 18,600 cfs, and on June 13, 2014 at 15,500 cfs.
AB-IN-2	19,100	19,500	13,000	-400	+6,100	Breach is packed sand with no new deposits. Very narrow channel passes through dense willow thicket. No apparent deposition in channel. Highest channel cross-section one-fourth of the distance between breach and wetland. No change in staff gage burial depth from 2012 (0.9 ft). Above Brennan had water flowing through at least two of the inlets on June 4, 2014 at 18,600 cfs, and on June 13, 2014 at 15,500 cfs.
Above Brennan (cont.)						
AB-IN-3	14,600	18,500	13,000	-3,900	+1,600	Breach is packed sand with no new deposits. Very narrow channel passes through dense willow thicket. No apparent deposition in channel. Highest channel cross-section just past the breach. Above Brennan had water flowing through at least two of the inlets on June 4, 2014 at 18,600 cfs, and on June 13, 2014 at 15,500 cfs.
AB-OUT	10,400	9,990	13,000	+410	-2,600	Very narrow incised channel through a broad mud breach and wide channel vegetated with grasses. Beaver dam and large tree trunks across channel obstruct flow; no sand deposits. Highest channel cross-section two-thirds of the way between breach and wetland. No change in staff gage burial depth from 2012 (3.7 ft). Above Brennan had water flowing through at least two of the inlets on June 4, 2014 at 18,600 cfs, and on June 13, 2014 at 15,500 cfs (Jensen gage). Water filled the outlet channel on May 27, 2014 at 14,600 cfs, but water was not yet flowing into the wetland.

Table 3 (Cont.)

Floodplain Wetland and Breach Name	2014 Connection Flow (cfs)	2012 Connection Flow (cfs) ^a	2005 Connection Flow (cfs) ^b	Change from 2012 to 2014 (cfs)	Change from 2005 to 2014 (cfs) ^c	Notes
Johnson Bottom						
JB-OUT-1	13,600	16,100	13,000 ^f	-2,500	+600	Flow entry to wetland is controlled by gate that is located at the end of a connection channel. Very narrow breach was packed sand. Channel thickly overgrown with willow and sedges. Highest channel cross-section just past breach. Channel modified in 2015 prior to spring peak to enhance connection to the river. Observations during 2015 peak flows indicated connection now occurs at < 10,000 cfs.
JB-OUT-2	14,100	16,400	13,000 ^e	-2,300	+1,100	Broad sand breach approximately same height as levee with Russian olive, tamarisk, and annuals; sand road runs length of breach. Broad channel slopes downward from breach to wetland. Highest channel cross-section just past the breach. Breach modified in 2015 prior to spring peak to enhance connection to the river. JB-OUT was taking on water slowly on June 6, 2014 at 16,700 cfs.
<hr/>						
Leota Bottom						
LB7-IN	14,500	17,600	Not surveyed	-3,100	Not available	Sand road runs length of wide breach. Large deposit of sand in wetland from 2011 now mostly vegetated. Broad channel slopes downward from breach to wetland. Large sandbar at mouth of breach extends far into river. Highest channel cross-section at breach. Leota Bottom was almost full on June 5, 2014, with two active breaches (17,400 cfs); connected and draining on June 13, 2014 (14,700 cfs).
LB7A-IN	12,700	13,400	Not surveyed	-700	Not available	Portion of breach is concrete; sand road runs length of breach. Large deposit of sand in wetland from 2011 now mostly vegetated. Broad channel slopes downward from breach to wetland. Highest channel cross-section at breach. Leota Bottom was almost full on June 5, 2014 with two active breaches (17,400 cfs); connected and draining on June 13, 2014 (14,700 cfs).

Table 3 (Cont.)

Floodplain Wetland and Breach Name	2014 Connection Flow (cfs)	2012 Connection Flow (cfs) ^a	2005 Connection Flow (cfs) ^b	Change from 2012 to 2014 (cfs)	Change from 2005 to 2014 (cfs) ^c	Notes
Mean for all Breaches	16,318	16,772	13,091	-971	+3,536	

^a Values reported in LaGory et al. (2016).

^b Values reported in Tetra Tech (2005) except where noted. 2005 connection flows are the flows that were targeted for connection when levee breaches were constructed. Tetra Tech (2005) made observations during the peak runoff period of 2005 to determine if connection was actually occurring at these flows by visiting sites at the following flows: Escalante Ranch: <10,000 cfs, 14,000 cfs, 16,700 cfs, and 19,600 cfs; Bonanza Bridge: <10,000 cfs, 13,900 cfs, 18,500 cfs, and 19,700 cfs; Stirrup: <10,000 cfs, 13,900 cfs, 18,500 cfs, and 21,600 cfs; and Above Brennan: <10,000 cfs, 15,000 cfs, 18,300 cfs, and 21,800 cfs. These visits allowed verification of target flows. In some cases (as noted), actual connection flows were higher than the target.

^d Comparisons of 2014 connection flows were made to actual estimates of connection in 2005 as reported in Tetra Tech (2005) where available.

^e ER-IN-1 and ER-IN-2 were not surveyed because they had been intentionally filled to prevent connection.

^f Estimated connection flows in 2012 and 2014 were compared to Bestgen (2011) because target connection value (13,000 cfs for both breaches) was not presented in Tetra Tech (2005).

TABLE 4 Minimum Connection Flows at Floodplain Wetlands in 2005, 2012, and 2014 for Any Breach, Upstream Breaches, and Downstream Breaches^a

Floodplain Wetland	2005 Connection Flow (cfs) ^b	2012 Connection Flow (cfs)	2014 Connection flow (cfs)	Change from 2005 to 2012 (cfs) ^b	Change from 2012 to 2014 (cfs)	Change from 2005 to 2014 (cfs) ^b
Minimum Connection Flows of Any Breach						
Escalante Ranch	11,166 (ER-IN-6)	11,300 (ER-OUT)	8,740 (ER-OUT)	+134	-2,560	-2,426
Bonanza Bridge	13,000 (BB-IN-3)	17,400 (BB-OUT)	14,900 (BB-OUT)	+4,400	-2,500	+1,900
Stirrup	13,000 (ST-OUT)	16,900 (ST-OUT)	15,700 (ST-OUT)	+3,900	-1,200	+2,700
Above Brennan	13,000 (all breaches)	9,990 (AB-OUT)	10,400 (AB-OUT)	-3,010	+410	-2,600
Johnson Bottom	13,000 (all breaches)	16,100 (JB-OUT-1)	13,600 (JB-OUT-1)	+3,100	-2,500	+600
Leota Bottom	NA ^c	13,400 (LB7A-IN)	12,700 (LB7A-IN)	NA	-700	NA
Mean	12,633	14,182 (14,338) ^c	12,673 (12,668) ^c	+1,705	-1,508	+35
Minimum Connection Flow of Upstream Breaches						
Escalante Ranch	11,166 (ER-IN-6)	15,300 (ER-IN-7)	17,600 (ER-IN-7)	+4,134	+2,300	+6,434
Bonanza Bridge	13,000 (BB-IN-3)	20,100 (BB-IN-1)	19,800 (BB-IN-1)	+7,100	-300	+6,800
Above Brennan	13,000 (all breaches)	16,400 (AB-IN-1)	14,600 (AB-IN-3)	+3,400	-1,800	+1,600
Mean	12,389	17,267	17,333	+4,878	-67	+4,945
Minimum Connection Flow of Downstream Breaches						
Escalante Ranch	12,433 (ER-OUT)	11,300 (ER-OUT)	8,740 (ER-OUT)	-1,133	-2,560	-3,693
Bonanza Bridge	13,900 (BB-OUT)	17,400 (BB-OUT)	14,900 (BB-OUT)	+3,500	-2,500	+1,000
Stirrup	13,000 (ST-OUT)	16,900 (ST-OUT)	15,700 (ST-OUT)	+3,900	-1,200	+2,700
Above Brennan	13,000 (AB-OUT)	9,990 (AB-OUT)	10,400 (AB-OUT)	-3,010	+410	-2,600
Johnson Bottom	13,000 (all breaches)	16,100 (JB-OUT-1)	13,600 (JB-OUT-1)	+3,100	-2,500	+600
Leota Bottom	NA ^b	13,400 (LB7A-IN)	12,700 (LB7A-IN)	NA	-700	NA
Mean	13,067	14,182 (14,338) ^d	12,673 (12,668) ^d	+1,271	-1,508	-399

Table 4 (Cont.)

- ^a Breaches associated with connection flows are presented in parentheses
- ^b 2005 connection flows are from Tetra Tech (2005) for all wetlands except for Johnson Bottom, which are from Bestgen et al. (2011). When 2005 target connection flows were known to be incorrect (based on Tetra Tech 2005 observations noted in Table 3), comparisons were made to observed connection flows.
- ^c NA = not available because connection flow for Leota Bottom was not reported for 2005.
- ^d Value in parentheses represents the mean of flows without Leota Bottom to enable comparison with the 2005 mean.
-

TABLE 5 Fish Passage Flows^a at Surveyed Breaches in 2005, 2012, and 2014

Floodplain Wetland/ Breach Name	2005 Fish Passage Flow (cfs) ^b	2012 Fish Passage Flow (cfs)	2014 Fish Passage Flow (cfs)	Change from 2005 to 2012 (cfs)	Change from 2012 to 2014 (cfs)	Change from 2005 to 2014 (cfs)
Escalante Ranch						
ER-IN-3	15,100	21,500	21,400	+6,400	-100	+6,300
ER-IN-4	16,200	23,900	23,400	+7,700	-500	+7,200
ER-IN-5	15,200	20,100	22,800	+4,900	+2,700	+7,600
ER-IN-6	14,200	22,600	22,200	+8,400	-400	+8,000
ER-IN-7	15,200	18,500	20,900	+3,300	+2,400	+5,700
ER-OUT	15,600	14,300	11,500	-1,300	-2,800	-4,100
Bonanza Bridge						
BB-IN-1	22,300	23,700	23,200	+1,400	-500	+900
BB-IN-2	17,300	24,700	23,900	+7,400	-800	+6,600
BB-IN-3	16,300	27,900	25,700	+11,600	-2,200	+9,400
BB-OUT	17,300	20,800	18,100	+3,500	-2,700	+800
Stirrup						
ST-OUT	16,300	20,200	19,000	+3,900	-1,200	+2,700
Above Brennan						
AB-IN-1	16,300	19,700	18,400	+3,400	-1,300	+2,100
AB-IN-2	16,300	23,000	22,500	+6,700	-500	+6,200
AB-IN-3	16,300	21,900	17,700	+5,600	-4,200	+1,400
AB-OUT	16,300	13,000	13,300	-3,300	+300	-3,000
Johnson Bottom						
JB-OUT-1	15,400	18,700	16,000	+3,300	-2,700	+600
JB-OUT-2	15,400	19,000	16,500	+3,600	-2,500	+1,100
Leota Bottom						
LB7-IN	NA ^c	20,300	17,000	NA	-3,300	NA
LB7A-IN	NA	15,800	15,100	NA	-700	NA
<hr/>						
Mean	16,294	20,505 (20,794) ^d	19,400 (19,794)	+4,500	-1,105	+3,500

^a Based on minimum fish passage depth of 1 ft reported in Burdick (1997).

^b Fish passage flows for 2005 were estimated by the authors using the elevations associated with reported 2005 connection flows in Tetra Tech (2005) and Bestgen et al. (2011), adding 1 ft to the elevation, and determining the associated flow in the stage-flow table provided by USGS for 2005. Since the Ouray gage was not in place in 2005, we used the 2012 stage flow table for the Ouray gage to estimate fish passage flows for Johnson Bottom and Leota Bottom in that year.

^c NA = not available.

^d Value in parentheses represents the mean of flows without Leota Bottom to enable comparison with the 2005 mean.

- *Fish passage elevation (flow)*: minimum water surface elevation and associated flow that would provide at least 1 ft (30 cm) of depth along the entire connection channel. This is considered to be the minimum depth that would allow subadult and adult razorback suckers to swim between the wetland and river (Burdick 1997).

3.1 ESCALANTE RANCH

The Escalante Ranch wetland, formerly known as Thunder Ranch, was surveyed on October 27, 2014. The local flow at Escalante Ranch at the time of the survey was estimated to be 2,630 cfs (Table 2).

Six locations were surveyed at Escalante Ranch: five upstream breaches and one downstream breach (Figure 3). Two additional former upstream breaches are present at Escalante Ranch (ER-IN-1 and ER-IN-2). These breaches were not surveyed in 2014 because they had been intentionally filled with rip-rap and no longer served as inlets except at flows higher than 22,000 cfs (LaGory et al. 2016). Characterization of levee breaches and connection channel elevations at each of the surveyed locations is provided below.

The 2014 minimum connection flow at Escalante Ranch occurred at the downstream breach (ER-OUT), and was estimated to be 8,740 cfs, which was approximately 2,560 cfs and 2,426 cfs lower than the minimum connection flow estimates made in 2012 and 2005, respectively (Table 4). In 2014, the estimated minimum upstream breach connection flow was 17,600 cfs (ER-IN-7), which was 2,300 cfs and 6,434 cfs higher than the estimated minimum upstream connection flow in 2012 and 2005, respectively. In 2014, the estimated minimum downstream breach connection flow was 8,740 cfs (ER-OUT), which was 2,560 cfs and 3,693 cfs lower than the estimated minimum downstream connection flow in 2012 and 2005, respectively. Estimated minimum fish passage flows for Escalante Ranch showed the same pattern as connection flows, but were on average 3,243 cfs higher than connection flows (Table 5).

On April 29, 2014, USFWS field staff observed connection of the Escalante Ranch wetland with the Green River main channel, and, at this time, the wetland was draining to the river (T. Jones, USFWS, personal communication); flow at the Jensen gage on this day averaged 9,090 cfs. The maximum flow prior to this date was 9,910 cfs on April 25 when the river apparently first connected. On June 13, 2014, USFWS noted that the floodplain was draining and appeared to be equalizing with the Green River stage level; flow at the Jensen gage on this day averaged 15,500 cfs. Connection was also reported in 2013 when the peak flow was 11,000 cfs.

ER-IN-3. A total of 235 locations were surveyed at ER-IN-3 in 2014. The estimated mean river water surface elevation near ER-IN-3 was 4,733.6 ft. ER-IN-3 was a well-defined sandy breach with some Russian thistle growing in the breach. The breach was approximately 6 ft (2 m) deeper than the levee, and some erosion and slumping of the breach and levee edge were observed. The sand road intersecting the floodplain connection channel was higher than the

FIGURE 3 Escalante Ranch Survey Locations in 2014. The date of the aerial imagery differs from the date of the survey; aerial imagery does not depict exact conditions at the time of the survey.

breach near the river edge. Based on our 2014 survey, the connection flow was 18,100 cfs (Table 3), and the highest channel cross-section was about two-thirds of the way between the breach and the wetland (Figure B-1). The 2014 estimated connection flow is the same as that recorded in 2012, and 6,200 cfs higher than in 2005. Estimated fish passage flow for ER-IN-3 in 2014 was 21,400 cfs, which is 100 cfs lower than in 2012 (Table 5).

ER-IN-4. A total of 364 locations were surveyed at ER-IN-4 in 2014. The estimated mean river water surface elevation near ER-IN-4 was 4,733.2 ft. At the time of the survey, ER-IN-4 was completely filled with sand with no apparent cut in the levee. The sand road crossing the channel between the breach and wetland was higher than the breach. Based on our 2014 survey, the connection flow for ER-IN-4 was 20,000 cfs (Table 3), and the highest channel cross-section was near the wetland edge (Figure B-2). The 2014 estimated connection flow is 300 cfs lower than in 2012 and 7,067 cfs higher than in 2005. Estimated fish passage flow for ER-IN-4 in 2014 was 23,400 cfs, which is 500 cfs lower than in 2012 (Table 5).

ER-IN-5. A total of 393 locations were surveyed at ER-IN-5 in 2014. The estimated mean river water surface elevation at ER-IN-5 was 4,733.0 ft. At the time of the survey, ER-IN-5 was a shallow breach (approximately 3 ft [1 m] in depth) of loose sand. Based on our 2014 survey, the connection flow for ER-IN-5 was 19,400 cfs (Table 3), and the highest channel cross-section was near the wetland edge (Figure B-3). The 2014 estimated connection flow is 2,600 cfs higher than in 2012 and 7,400 cfs higher than in 2005. Estimated fish passage flow for ER-IN-5 in 2014 was 22,800 cfs, which is 2,700 cfs higher than in 2012 (Table 5).

ER-IN-6. A total of 249 locations were surveyed at ER-IN-6 in 2014. The estimated mean river water surface elevation at ER-IN-6 was 4,732.8 ft. At the time of the survey, ER-IN-6 was a shallow breach (approximately 3 ft [1 m] in depth) of loose sand. Based on our 2014 survey, the connection flow for ER-IN-6 was 18,900 cfs (Table 3), and the highest channel cross-section was near the road on the wetland side (Figure B-4). The 2014 estimated connection flow is 300 cfs lower than in 2012 and a 7,734 cfs higher than in 2005. Estimated fish passage flow for ER-IN-6 in 2014 was 22,200 cfs, which is 400 cfs lower than in 2012.

ER-IN-7. A total of 248 locations were surveyed at ER-IN-7 in 2014. The estimated mean river water surface elevation at ER-IN-7 was 4,732.7 ft. At the time of the survey, ER-IN-7 was a broad, low, sandy breach, which was filled with sand to the height of the levee. New sand deposits were observed between the river and the sand road. Based on our 2014 survey, the connection flow for ER-IN-7 was 17,600 cfs (Table 3), and the highest channel cross-section was near the breach (Figure B-5). The 2014 estimated connection flow is 2,300 cfs higher than in 2012 and 5,600 cfs lower than in 2005. Estimated fish passage flow for ER-IN-7 in 2014 was 20,900 cfs, which is 2,400 cfs higher than in 2012 (Table 5).

ER-OUT. A total of 150 locations were surveyed at ER-OUT in 2014. The estimated mean river water surface elevation at ER-OUT was 4,731.8 ft. At the time of the survey, ER-OUT was a long broad channel extending from the river to the wetland. Hard-packed sand in the channel near the river and breach showed signs of scour. There was a scour hole with standing water (as observed in 2012) located midway up the channel toward the wetland. Other areas of standing water in the channel supported well-developed wetland vegetation (mostly sedges). A gravel road crossed the channel near the wetland. Based on our 2014 survey, the connection flow

for ER-OUT was 8,740 cfs (Table 3), and the highest channel cross-section was half way between the breach and the wetland (Figure B-6). The 2014 estimated connection flow is 2,560 cfs lower than in 2012 and 3,693 cfs higher than in 2005. Estimated fish passage flow for ER-OUT in 2014 was 11,500 cfs, which is 2,800 cfs lower than in 2012 (Table 5).

3.2 BONANZA BRIDGE

The Bonanza Bridge wetland was surveyed on October 29, 2014. The local flow at Bonanza Bridge at the time of the survey was estimated to be 2,215 cfs (Table 2).

Four locations were surveyed at Bonanza Bridge: three upstream breaches and one downstream breach (Figure 4). Characterization of levee breaches and connection channel elevations at each of these locations is provided below. The 2014 minimum connection flow at Bonanza Bridge occurred at the downstream breach (BB-OUT), and was estimated to be 14,900 cfs, which was 2,500 cfs lower and 1,900 cfs higher than the minimum connection flow estimates made in 2012 and 2005, respectively (Table 4). In 2014, the estimated minimum upstream breach connection flow was 19,800 cfs (BB-IN-1), which was 300 cfs lower and 6,800 cfs higher than the estimated minimum upstream connection flow in 2012 and 2005, respectively. In 2014, the estimated minimum downstream breach connection flow was 14,900 cfs (BB-OUT), which was 2,500 cfs lower and 1,000 cfs higher than the estimated minimum downstream connection flow in 2012 and 2005, respectively. Fish passage flow estimates for Bonanza Bridge showed the same pattern as connection flow, but were on average 3,600 cfs higher than connection flows (Table 5).

Observations of Bonanza Bridge connection during peak flows were not available for 2014.

BB-IN-1. A total of 436 locations were surveyed at BB-IN-1 in 2014. The estimated mean river water surface elevation at BB-IN-1 was 4,699.0 ft. At the time of the survey, BB-IN-1 was partially blocked with loose sand, and led to a well-defined vegetated channel. A sand access road crossed and partially blocked the connection channel near the breach. Another road crossed near the channel's midpoint and was slightly higher elevation than the channel. There was a very large deposit of sand at the wetland end of the channel that had been deposited during peak flows in 2008 and 2011 (LaGory et al. 2016). Based on our 2014 survey, the estimated connection flow for BB-IN-1 was 19,800 cfs (Table 3), and the highest channel cross-section was near the breach (Figure B-7). The 2014 connection flow is 300 cfs lower than in 2012 and 1,300 cfs higher than in 2005. Estimated fish passage flow for BB-IN-1 in 2014 was 23,200 cfs, which is 500 cfs lower than in 2012 (Table 5).

BB-IN-2. A total of 425 locations were surveyed at BB-IN-2 in 2014. The estimated mean river water surface elevation at BB-IN-2 was 4,700.9 ft. At the time of the survey, BB-IN-2 and its connection channel were mostly blocked with loose sand, and there was a very large deposit of sand at the wetland end of the channel that had been deposited during peak flows in 2008 and 2011 (LaGory et al. 2016). A sand road led to the breach and provided river access; the

FIGURE 4 Bonanza Bridge Survey Locations in 2014. The date of the aerial imagery differs from the date of the survey; aerial imagery does not depict exact conditions at the time of the survey.

road did not cross the connection channel. Based on our 2014 survey, the estimated connection flow for BB-IN-2 was 20,500 cfs (Table 3), and the highest channel cross-section was located halfway between the breach and wetland (Figure B-8). The 2014 connection flow is 600 cfs lower than in 2012 and 6,600 cfs higher than in 2005. Estimated fish passage flow for BB-IN-2 in 2014 was 23,900 cfs, which is 800 cfs lower than in 2012 (Table 5).

BB-IN-3. A total of 184 locations were surveyed at BB-IN-3 in 2014. The estimated mean river water surface elevation at BB-IN-3 was 4,699.9 ft. At the time of the survey, BB-IN-3 was completely filled with loose sand. Although the breach contained sand deposits, the connection channel was relatively free of obstruction with the exception of some vegetation and cut brush. Based on our 2014 survey, the estimated connection flow for BB-IN-3 was 22,200 cfs (Table 3), and the highest channel cross-section was located near the breach (Figure B-9). The 2014 connection flow is 1,900 cfs lower than in 2012 and 9,200 cfs higher than in 2005. Estimated fish passage flow for BB-IN-3 in 2014 was 25,700 cfs, which is 2,200 cfs lower than in 2012 (Table 5).

BB-OUT. A total of 829 locations were surveyed at BB-OUT in 2014 (Figure 14). The estimated mean river water surface elevation near BB-OUT was 4,700.0 ft. BB-OUT consists of two breaches, but these were mostly filled with sand with no depression in elevation relative to the levees. The breaches lead to a network of unimproved dirt and gravel roads that serve as connection channels to the wetland through a broad low woodland. Based on our 2014 survey, the estimated connection flow at BB-OUT was 14,900 cfs (Table 3), and the highest channel cross-section was along an access road/channel halfway between the downstream breach and wetland (Figure B-10). The 2014 estimated connection flow is 2,500 cfs lower than in 2012 and 1,000 cfs higher than in 2005. Estimated minimum fish passage flow for BB-OUT in 2014 was 18,100 cfs, which is 2,700 cfs lower than in 2012 (Table 5).

3.3 STIRRUP

The Stirrup wetland was surveyed on October 28, 2014. The local flow at Stirrup at the time of the survey was estimated to be 2,705 cfs (Table 2).

There is only one breach location (downstream) at Stirrup (ST-OUT, Figure 5). A total of 220 locations were surveyed at ST-OUT in 2014. The estimated mean river water surface elevation at ST-OUT was 4,680.1 ft. At the time of the survey, ST-OUT was a narrow incised channel in the middle of a breach of packed sand and silt; the connection channel was narrow, but did not have any apparent obstructions to flow. Based on our 2014 survey, the minimum connection flows at ST-OUT was estimated to be 15,700 cfs (Table 3), and the highest channel cross-section was located just past the breach (Figure B-11). The 2014 connection flow is 1,200 cfs lower than in 2012 and 2,700 cfs higher than in 2005 (Table 4). Estimated minimum fish passage flow for ST-OUT in 2014 was 19,000 cfs, which is 1,200 cfs lower than in 2012 (Table 5).

FIGURE 5 Stirrup Survey Locations in 2014. The date of the aerial imagery differs from the date of the survey; aerial imagery does not depict exact conditions at the time of the survey.

On June 4, 2014, USFWS personnel observed connection of the Stirrup wetland to the Green River main channel (T. Jones, USFWS, personal communication) at a flow of 18,600 cfs. On June 13, 2014, the water level in the Stirrup was observed to be equal to river flow (15,500 cfs).

3.4 ABOVE BRENNAN

The Above Brennan wetland was surveyed on October 29, 2014. The local flow at Above Brennan at the time of the survey was estimated to be 2,525 cfs (Table 2).

Four breach locations were surveyed at Above Brennan in 2014: three upstream breaches and a downstream breach (Figure 6). Characterizations of levee breach and connection channel elevations at each of these locations are provided below. The 2014 minimum connection flow at

FIGURE 6 Above Brennan Survey Locations in 2014. The date of the aerial imagery differs from the date of the survey; aerial imagery does not depict exact conditions at the time of the survey.

Above Brennan occurred at the downstream breach (AB-OUT), and was estimated to be 10,400 cfs, which was 410 cfs higher and 2,600 cfs lower than the minimum connection flow estimates made in 2012 and 2005, respectively (Table 4). In 2014, the estimated minimum upstream breach connection flow was 14,600 cfs (AB-IN-3), which is 1,800 cfs lower and 1,600 cfs higher than the minimum upstream connection flow in 2012 and 2005, respectively. Fish passage flow estimates for Above Brennan showed the same pattern as connection flow, but were on average 3,300 cfs higher (Table 5).

On June 4, 2014, USFWS observed connection of the Above Brennan wetland with at least two upstream breaches connected to the Green River main channel (T. Jones, USFWS, personal communication) at 18,600 cfs. River water was still flowing into upstream breaches on June 13, 2014 when flow at the Jensen gage was 15,500 cfs.

AB-IN-1. A total of 647 locations were surveyed at AB-IN-1 in 2014. The estimated mean river water surface elevation at AB-IN-1 was 4,671.5 ft. At the time of the survey, AB-IN-1 was nearly filled with loose sand; elevation along the connection channel sloped downward from the breach to the floodplain wetland. Based on our 2014 survey, the estimated connection flow at AB-IN-1 was 15,200 cfs (Table 3), and the highest channel cross-section was located just past the breach (Figure B-12). The 2014 connection flow was 1,200 cfs lower than in 2012 and 2,200 cfs higher than in 2005. Estimated fish passage flow for AB-IN-1 in 2014 was 18,400 cfs, which is 1,300 cfs lower than in 2012 (Table 5).

AB-IN-2. A total of 518 locations were surveyed at AB-IN-2 in 2014. The estimated mean river water surface elevation at AB-IN-2 was 4,671.1 ft. At the time of the survey, AB-IN-2 was a narrow cut through packed sand and silt with no apparent signs of erosion or deposition. The connection channel was narrow (approximately 3 ft [1 m] wide), and passed through a dense willow thicket before opening into a wide channel with less vegetation. Based on our 2014 survey, the estimated connection flow for AB-IN-2 was 19,100 cfs (Table 3), and the highest channel cross-section was approximately one fourth of the distance between the breach and the wetland (Figure B-13). The 2014 connection flow was 400 cfs lower than in 2012 and 6,100 cfs higher than in 2005. Estimated fish passage flow for AB-IN-2 in 2014 was 22,500 cfs, which is 500 cfs lower than in 2012 (Table 5).

AB-IN-3. A total of 122 locations were surveyed at AB-IN-3 in 2014. The estimated mean river water surface elevation at AB-IN-3 was 4,671.0 ft. At the time of the survey, AB-IN-3 was a narrow cut through packed sand and silt with no apparent signs of erosion or deposition. The connection channel was narrow (approximately 3 ft [1 m] wide), and passed through a dense willow thicket before opening into a wide channel with less vegetation. Based on our 2014 survey, the estimated connection flow for AB-IN-3 was 14,600 cfs (Table 3), and the highest channel cross-section was just past the breach (Figure B-14). The 2014 connection flow was 3,900 cfs lower than in 2012 and 1,600 cfs higher than in 2005. Estimated fish passage flow for AB-IN-3 in 2014 was 17,700 cfs, which was 4,200 cfs lower than in 2012 (Table 5).

AB-OUT. A total of 121 locations were surveyed at AB-OUT in 2014. The estimated mean river water surface elevation at AB-OUT was 4,670.7 ft. At the time of the survey, AB-OUT was a narrow incised channel through a broad mud breach, with a wide connection channel

that was vegetated with grasses. An old beaver dam and large tree trunks that cross the channel could obstruct flow, but there were no sand deposits observed in the connection channel. Based on our 2014 survey, the estimated minimum connection flow for AB-OUT was 10,400 cfs (Table 3), and the highest channel cross-section was two-thirds of the way between the breach and the wetland (Figure B-15). The 2014 connection flow was 410 cfs higher than in 2012 and 2,600 cfs lower than in 2005. Estimated fish passage flow for AB-OUT in 2014 was 13,300 cfs, which was 300 cfs higher than in 2012.

3.5 JOHNSON BOTTOM

The Johnson Bottom wetland was surveyed on October 30, 2014. The local flow at Johnson Bottom at the time of the survey was calculated to be 2,170 cfs (Table 2).

Two downstream breach locations were surveyed at Johnson Bottom (Figure 7). Characterizations of levee breach and connection channel elevations at each of these locations are provided below. The 2014 estimated minimum connection flow at Johnson Bottom was 13,600 cfs (JB-OUT-1), which was about 2,500 cfs lower than in 2012 and 600 cfs higher than the value reported in Bestgen et al. (2011) (Table 4). Fish passage flow estimates for Johnson Bottom showed the same pattern as connection flow, but were on average 2,400 cfs higher (Table 5).

Both JB-OUT-1 and JB-OUT-2 were modified in 2015 prior to the spring peak to enhance connection to the river. Observations during the 2015 peak flow indicated connection at JB-IN-1 occurred at flows lower than 10,000 cfs. JB-OUT-2 was taking on water slowly on June 6, 2014 when flows at the Ouray gage were 16,700 cfs.

JB-OUT-1. JB-OUT-1 is a concrete and metal gated drain structure and fish kettle that was constructed in 1999 (Heitmeyer and Fredrickson 2005). A total of 324 locations were surveyed at JB-OUT-1 in 2014. The estimated mean river water surface elevation at JB-OUT-1 was 4,667.4 ft. At the time of the survey, JB-OUT-1 was narrow (approximately 3 ft [1 m] wide). The control gate at the wetland edge was connected to the breach by a narrow channel that passed through dense willow and other wetland vegetation, but did not contain obvious obstructions to flow. Based on our 2014 survey, the connection flow for JB-OUT-1 was 13,600 cfs (Table 3), and the highest channel cross-section was just past the breach (Figure B-16). The 2014 connection flow was 2,500 cfs lower than in 2012 and 600 cfs higher than in 2005. Estimated minimum fish passage flow for JB-OUT-1 in 2014 was 16,000 cfs, which was 2,700 cfs lower than in 2012 (Table 5).

JB-OUT-2. A total of 190 locations were surveyed at JB-OUT-2 in 2014. The estimated mean river water surface elevation at JB-OUT-2 was 4,668.0 ft. At the time of the survey, this broad low sandy breach led to a wide complex connection channel and the wetland. A sand road crossed the length of the breach. Based on our 2014 survey, the connection flow for JB-OUT-2 was 14,100 cfs (Table 3), and the highest channel cross-section was just past the breach (Figure B-17). The 2014 connection flow was 2,300 cfs lower than in 2012 and 1,100 cfs higher

FIGURE 7 Johnson Bottom Survey Locations in 2014. The date of the aerial imagery differs from the date of the survey; aerial imagery does not depict exact conditions at the time of the survey.

than in 2005. Estimated fish passage flow for JB-OUT-2 in 2014 was 16,500 cfs, which was 2,500 cfs lower than in 2012 (Table 5).

3.6 LEOTA BOTTOM

The Leota Bottom wetland was surveyed on October 30, 2014. The local flow at Leota Bottom at the time of the survey was calculated to be 2,200 cfs (Table 2).

Two downstream breach locations were surveyed at Leota Bottom: LB7-IN and LB7A-IN (Figure 8). Characterizations of levee breach and connection channel elevations at each of these locations are provided below. The 2014 estimated minimum connection flow at Leota Bottom was 12,700 cfs (LB7A-IN), which was about 700 cfs lower than in 2012 (Table 4); no estimates of connection are available from 2005. Minimum fish passage flow estimates for

FIGURE 8 Leota Bottom Survey Locations in 2014. The date of the aerial imagery differs from the date of the survey; aerial imagery does not depict exact conditions at the time of the survey.

Leota Bottom showed the same pattern as connection flow, but were on average 2,450 cfs higher (Table 5).

Leota Bottom was observed to be almost full on June 5, 2014 with two active breaches (flow at the Ouray gage was 17,400 cfs). On June 13, 2014, USFWS noted that the Leota Bottom floodplain wetland was connected and was at an elevation slightly higher than the river stage, as water was flowing out of the downstream breach into the river (T. Jones, USFWS, personal communication) at an Ouray gage flow of 14,700 cfs.

LB7-IN. A total of 593 locations were surveyed at LB7-IN in 2014. The estimated mean river water surface elevation at LB7-IN was 4,666.0 ft. At the time of the survey, LB7-IN was a broad breach of loose sand that led to a wide connection channel to the wetland; a sand road traversed the length of the breach. There was a large sandbar between the breach and the river edge. Based on our 2014 survey, the connection flow for LB7-IN was 14,500 cfs (Table 3), and

the highest channel cross-section was one half of the distance between the breach and the wetland (Figure B-18). The 2014 estimated connection flow was 3,100 cfs lower than in 2012; no estimates were available for 2005. Estimated minimum fish passage flow for LB7-IN in 2014 was 17,000 cfs, which was 3,300 cfs lower than in 2012 (Table 5).

LB7A-IN. A total of 325 locations were surveyed at LB7A-IN in 2014. The estimated mean river water surface elevation at LB7A-IN was 4,664.5 ft. At the time of the survey, LB7A-IN was a broad breach of mostly loose sand that led to a wide connection channel to the wetland; a road traversed the length of the breach, part of which was concrete. There was a large sandbar between the breach and the river edge. Based on our 2014 survey, the connection flow for LB7A-IN was 12,700 cfs (Table 3), and the highest channel cross-section was at the breach (Figure B-19). The 2014 minimum connection flow was 700 cfs lower than in 2012; no estimates were available for 2005. Estimated minimum fish passage flow for LB7A-IN in 2014 was 15,100 cfs, which was 700 cfs lower than in 2012 (Table 5).

3.7 RESULTS SUMMARY

Our 2014 survey identified differences in connection flow from our 2012 survey results (LaGory et al. 2016) and other reported values from previous surveys (Tetra Tech 2005; Bestgen et al. 2011; Table 3). Most of the 2014 connection flow estimates were lower than values we obtained in 2012 (mean difference -971 cfs), but still higher than reported values in 2005 (mean difference +3,536 cfs). All but 4 of the 19 breaches and associated connection channels surveyed had lower estimated connection flows than in 2012.

The average estimated minimum floodplain connection flow (i.e., the lowest connection flow of any breach at a particular wetland) among the six floodplain wetlands surveyed in 2014 was 12,673 cfs (Table 4). This value is 1,508 cfs lower than the estimate in 2012, and essentially the same (+35 cfs) as in 2005. However, there was considerable variation among the wetlands in estimated minimum connection flow, ranging from 8,740 cfs at Escalante Ranch to 15,700 cfs at Stirrup. There was a comparable level of variation in 2012 (9,990 to 17,400 cfs), but much less variation in 2005 (11,166 to 13,000 cfs).

Changes in connection flows differed between upstream and downstream breaches with upstream breaches showing a smaller decrease since 2012 than downstream breaches (Table 4). The estimated mean minimum connection flow of upstream breaches in 2014 was 17,333 cfs (14,600 to 19,800 cfs) compared to 17,267 cfs (15,300 to 20,100 cfs) and 12,389 cfs (11,166 to 13,000 cfs) in 2012 and 2005, respectively. These values corresponded to an overall mean decrease for minimum connection flow of upstream breaches of 67 cfs (-1,800 to +2,300 cfs) relative to 2012 and an increase of 4,945 cfs (+1,600 to +6,800) relative to 2005. The estimated mean minimum connection flow of downstream breaches in 2014 was 12,673 cfs (8,740 to 15,700 cfs) compared to 14,182 cfs (9,990 to 17,400 cfs) in 2012, and 13,067 cfs (12,433 to 13,900 cfs) in 2005. These values corresponded to an overall mean decrease for minimum connection flow of downstream breaches of 1,508 cfs (-2,560 to +410 cfs) relative to 2012, and a 399 cfs decrease (-3,693 to +2,700 cfs) relative to 2005.

Estimated fish passage flows in 2014 were approximately 2,400 cfs higher than connection flows in the Ouray National Wildlife Refuge wetlands (Johnson Bottom and Leota Bottom) and 3,150 to 3,375 cfs higher than connection flows in the wetlands further upstream. In 2014, the mean minimum fish passage flow for the floodplain wetlands surveyed was 19,400 cfs (11,600 to 27,900 cfs; Table 5). In 2014, the mean minimum fish passage flow for the floodplain wetlands surveyed (i.e., the lowest of all levee breaches in each wetland) was approximately 15,500 cfs (11,500 to 19,000 cfs).

4 DISCUSSION

We reassessed floodplain wetland connection of six priority wetlands in the Middle Green River in 2014 to estimate connection flows following the moderately high peak flow (20,100 cfs) of 2014 and determine if this high flow resulted in changes in the levee breaches and connection channels of these wetlands. Knowing the actual connection flows in any given year is critical to defining the target peak flows during the runoff season to meet the biological objectives identified in Muth et al. (2000) and in the Larval Trigger Study Plan (Larval Trigger Study Plan Ad Hoc Committee 2012).

Our 2014 survey identified changes since our 2012 survey (LaGory et al. 2016), and documented an overall decrease (mean 971 cfs) in connection flows since 2012. There was variability in the amount of change among breaches; the greatest increase in connection flow was 2,600 cfs (ER-IN-5) while the greatest decrease was 3,900 cfs (AB-IN-3). Only 3 breaches experienced an increase in connection flow (ER-IN-5, ER-IN-7, and AB-OUT) after the 2014 peak flow, and one (ER-IN-3) showed no change; the other 15 breaches experienced a decrease. Despite these overall reductions, the 2014 peak flow did not completely reverse the increases in connection flows caused by the high magnitude peak flows of 2008 and 2011.

In the wetlands studied, upstream breaches were topographically higher than the wetland, while downstream breaches were lower than the wetland (LaGory et al. 2016). This topographic variation likely explains differences among breaches in the magnitude of changes in connection flows since 2012. Upstream breaches and their connection channels, which tend to be depositional areas, showed less decrease in connection levels than downstream breaches, which tend to scour as the wetlands drain during flood recession.

Although suspended sediment concentration data are not currently available for the study area, it is expected that concentrations would have been lower during the lower magnitude 2014 flow compared to the higher magnitude 2011 peak flow. A lower sediment load would have made the 2014 flow more erosive and could have resulted in net erosion of 2011 sand deposits. Water entering breaches could have eroded old deposits while depositing less new sand. It is not known if a series of moderately high peak flows (18,600 to 21,000 cfs) would further reduce flows needed to connect floodplain wetlands to the main channel. Study of even lower peak flows that only connect downstream wetland breaches (e.g. 11,000 to 15,000 cfs) could also yield interesting results that would increase our understanding of the effects of peak flow

magnitude on floodplain wetland connection. The 2014 results confirm the need for periodic reassessments of levee breaches and connection channels following peak flows.

5 CONCLUSIONS

- Changes from 2012 and 2005 in estimated connection flows at levee breaches of six priority floodplain wetlands in the middle Green River were observed in 2014, and these changes resulted mostly from erosion of sediment in breaches and connection channels during intervening high peak flows.
- Mean minimum connection flow for surveyed wetlands in 2014 was 12,673 cfs compared to 14,182 cfs in 2012, a decrease of 1,508 cfs.
- Most individual breaches showed a decrease in connection flow compared to 2012; the mean change was a decrease of 971 cfs. Only three breaches showed an increase in connection flow. This general reduction in connection flow after the 2014 peak flow suggests that moderately high peak flows (18,600 to 21,000 cfs) can reverse the buildup of sediment in levee breaches and connection channels caused by deposition at very high peak flows (>30,000 cfs).
- Both upstream and downstream breaches showed decreases in connection flow, but the mean decrease for upstream breaches (67 cfs) was less than that for downstream breaches (1,508 cfs). In 2014, mean minimum connection flow of upstream breaches was 17,333 cfs compared to 17,267 cfs in 2012. In 2014, mean minimum connection flow of downstream breaches was 12,673 cfs compared to 14,182 cfs in 2012.
- Estimated fish passage flows (those flows needed to allow passage of subadult and adult razorback suckers) were approximately 2,400 cfs higher than connection flows in the Ouray National Wildlife Refuge wetlands (Johnson Bottom and Leota Bottom) and 3,150 to 3,375 cfs higher for the wetlands further upstream. The mean estimated fish passage flow for the floodplain wetlands surveyed in 2014 was approximately 19,400 cfs (11,500 to 25,700 cfs). The mean estimated minimum fish passage flow for the floodplain wetlands surveyed (i.e., the lowest of all levee breaches in each wetland) was approximately 15,500 cfs (11,500 to 19,000 cfs).

6 RECOMMENDATIONS

- Resurvey floodplain wetland breaches and their connection channels following peak flows that exceed previously determined connection flows to determine if those peak flows have altered connection flows.
- Surveys should be conducted to determine if the apparent reduction in connection flows that resulted from the moderately high 2014 peak would continue with subsequent moderate peak flows.
- Determine connection of floodplain wetlands annually by direct observation. Ideally, determinations would be made annually of initial connection flows at upstream and downstream breaches and the degree of filling and draining through the peak flow cycle.
- Measure the surface area of floodplain wetlands after peak flows recede and through the summer and winter to determine if floodplain wetlands provide suitable habitat for razorback suckers between flooding events that reconnect the wetlands to the main channel.
- Consider modification of floodplain wetland breaches and connection channels to provide connection to the main channel river at a return frequency of 1.5 years (probability of about 67%) to mimic pre-dam flooding frequency.
- Consider modifications of wetlands to prevent sediment deposition from blocking inflow. These modifications could include (1) actively reconfiguring levee breaches, connection channels, and wetland topography to minimize the blockage of connection channels; (2) filling or allowing the filling of upstream breaches; (3) creating control structures such as those that have been successfully deployed at Stewart Lake, Johnson Bottom, and Old Charley Wash; and (4) managing vegetation encroachment that exacerbates sediment deposition in breaches and channels.

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APPENDIX A:
USGS STAGE-FLOW TABLES FOR THE JENSEN AND OURAY GAGES

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APPENDIX A:

USGS STAGE-FLOW TABLE FOR THE JENSEN AND OURAY GAGES

This appendix presents the stage-flow tables for the Jensen gage (USGS 09261000) and Ouray gage (USGS 9272400) developed by the U.S. Geological Survey (USGS) (Tables A-1 and A-2, respectively). These tables were used as the basis for determining the flows that would connect wetlands and allow passage of fish at surveyed levee breaches and connection channels.

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TABLE A-1 USGS Stage-Flow Table for the Jensen Gage (USGS 09261000) in 2005, 2012, and 2014

Stage (ft)	Flow (cfs)			Stage (ft)	Flow (cfs)		
	2005	2012	2014		2005	2012	2014
1.87	795	1,080	1,150	2.25	1,110	1,500	1,510
1.88	803	1,090	1,160	2.26	1,120	1,510	1,520
1.89	811	1,100	1,160	2.27	1,130	1,520	1,530
1.90	818	1,110	1,170	2.28	1,140	1,530	1,540
1.91	826	1,120	1,180	2.29	1,150	1,540	1,560
1.92	834	1,130	1,190	2.30	1,160	1,560	1,570
1.93	842	1,140	1,200	2.31	1,170	1,570	1,580
1.94	850	1,150	1,210	2.32	1,180	1,580	1,590
1.95	858	1,160	1,220	2.33	1,190	1,590	1,600
1.96	865	1,170	1,230	2.34	1,200	1,600	1,610
1.97	873	1,180	1,240	2.35	1,210	1,620	1,620
1.98	881	1,190	1,250	2.36	1,220	1,630	1,630
1.99	889	1,200	1,260	2.37	1,230	1,640	1,640
2.00	898	1,210	1,270	2.38	1,240	1,650	1,650
2.01	906	1,220	1,270	2.39	1,250	1,670	1,660
2.02	914	1,230	1,280	2.40	1,260	1,680	1,670
2.03	922	1,240	1,290	2.41	1,270	1,690	1,690
2.04	930	1,260	1,300	2.42	1,280	1,700	1,700
2.05	939	1,270	1,310	2.43	1,290	1,720	1,710
2.06	947	1,280	1,320	2.44	1,290	1,730	1,720
2.07	955	1,290	1,330	2.45	1,300	1,740	1,730
2.08	964	1,300	1,340	2.46	1,310	1,750	1,740
2.09	972	1,310	1,350	2.47	1,330	1,770	1,750
2.10	981	1,320	1,360	2.48	1,340	1,780	1,760
2.11	989	1,330	1,370	2.49	1,350	1,790	1,780
2.12	998	1,340	1,380	2.50	1,360	1,810	1,790
2.13	1,010	1,360	1,390	2.51	1,370	1,820	1,800
2.14	1,020	1,370	1,400	2.52	1,380	1,830	1,810
2.15	1,020	1,380	1,410	2.53	1,390	1,850	1,820
2.16	1,030	1,390	1,420	2.54	1,400	1,860	1,830
2.17	1,040	1,400	1,430	2.55	1,410	1,870	1,850
2.18	1,050	1,410	1,440	2.56	1,420	1,890	1,860
2.19	1,060	1,420	1,450	2.57	1,430	1,900	1,870
2.20	1,070	1,440	1,460	2.58	1,440	1,910	1,880
2.21	1,080	1,450	1,470	2.59	1,450	1,930	1,890
2.22	1,090	1,460	1,480	2.60	1,460	1,940	1,900
2.23	1,100	1,470	1,490	2.61	1,470	1,950	1,920
2.24	1,100	1,480	1,500	2.62	1,480	1,970	1,930
				2.63	1,490	1,980	1,940

Stage (ft)	Flow (cfs)		
	2005	2012	2014
2.64	1,500	1,990	1,950
2.65	1,510	2,010	1,960
2.66	1,520	2,020	1,980
2.67	1,540	2,030	1,990
2.68	1,550	2,050	2,000
2.69	1,560	2,060	2,010
2.70	1,570	2,080	2,030
2.71	1,580	2,090	2,040
2.72	1,590	2,100	2,050
2.73	1,600	2,120	2,060
2.74	1,610	2,130	2,080
2.75	1,620	2,150	2,090
2.76	1,640	2,160	2,100
2.77	1,650	2,170	2,110
2.78	1,660	2,190	2,130
2.79	1,670	2,200	2,140
2.80	1,680	2,220	2,150
2.81	1,690	2,230	2,170
2.82	1,700	2,240	2,180
2.83	1,720	2,260	2,190
2.84	1,730	2,270	2,200
2.85	1,740	2,290	2,220
2.86	1,750	2,300	2,230
2.87	1,760	2,320	2,240
2.88	1,780	2,330	2,260
2.89	1,790	2,350	2,270
2.90	1,800	2,360	2,280
2.91	1,810	2,380	2,300
2.92	1,820	2,390	2,310
2.93	1,840	2,410	2,320
2.94	1,850	2,420	2,340
2.95	1,860	2,440	2,350
2.96	1,870	2,450	2,360
2.97	1,880	2,470	2,380
2.98	1,900	2,480	2,390
2.99	1,910	2,500	2,400
3.00	1,920	2,510	2,420
3.01	1,930	2,530	2,430
3.02	1,950	2,540	2,450
3.03	1,960	2,560	2,460
3.04	1,970	2,570	2,470

Stage (ft)	Flow (cfs)		
	2005	2012	2014
3.05	1,980	2,590	2,490
3.06	2,000	2,600	2,500
3.07	2,010	2,620	2,520
3.08	2,020	2,630	2,530
3.09	2,030	2,650	2,540
3.10	2,050	2,670	2,560
3.11	2,060	2,680	2,570
3.12	2,070	2,700	2,590
3.13	2,090	2,710	2,600
3.14	2,100	2,730	2,620
3.15	2,110	2,740	2,630
3.16	2,130	2,760	2,640
3.17	2,140	2,780	2,660
3.18	2,150	2,790	2,670
3.19	2,160	2,810	2,690
3.20	2,180	2,820	2,700
3.21	2,190	2,840	2,720
3.22	2,200	2,860	2,730
3.23	2,220	2,870	2,750
3.24	2,230	2,890	2,760
3.25	2,250	2,900	2,780
3.26	2,260	2,920	2,790
3.27	2,270	2,940	2,810
3.28	2,290	2,950	2,820
3.29	2,300	2,970	2,840
3.30	2,310	2,990	2,850
3.31	2,330	3,000	2,870
3.32	2,340	3,020	2,880
3.33	2,350	3,040	2,900
3.34	2,370	3,050	2,910
3.35	2,380	3,070	2,930
3.36	2,400	3,090	2,940
3.37	2,410	3,100	2,960
3.38	2,420	3,120	2,970
3.39	2,440	3,140	2,990
3.40	2,450	3,150	3,010
3.41	2,470	3,170	3,020
3.42	2,480	3,190	3,040
3.43	2,500	3,200	3,050
3.44	2,510	3,220	3,070
3.45	2,520	3,240	3,080

Stage (ft)	Flow (cfs)		
	2005	2012	2014
3.46	2,540	3,260	3,100
3.47	2,550	3,270	3,120
3.48	2,570	3,290	3,130
3.49	2,580	3,310	3,150
3.50	2,600	3,320	3,160
3.51	2,610	3,340	3,180
3.52	2,630	3,360	3,200
3.53	2,640	3,380	3,210
3.54	2,660	3,390	3,230
3.55	2,670	3,410	3,250
3.56	2,690	3,430	3,260
3.57	2,700	3,450	3,280
3.58	2,720	3,460	3,300
3.59	2,730	3,480	3,310
3.60	2,750	3,500	3,330
3.61	2,760	3,520	3,340
3.62	2,780	3,520	3,360
3.63	2,790	3,540	3,380
3.64	2,810	3,550	3,400
3.65	2,820	3,570	3,410
3.66	2,840	3,590	3,430
3.67	2,850	3,610	3,450
3.68	2,870	3,630	3,460
3.69	2,890	3,640	3,480
3.70	2,900	3,660	3,500
3.71	2,920	3,680	3,510
3.72	2,930	3,700	3,530
3.73	2,950	3,720	3,550
3.74	2,960	3,730	3,570
3.75	2,980	3,750	3,580
3.76	3,000	3,770	3,600
3.77	3,010	3,790	3,620
3.78	3,030	3,810	3,630
3.79	3,040	3,830	3,650
3.80	3,060	3,850	3,670
3.81	3,080	3,860	3,690
3.82	3,090	3,880	3,710
3.83	3,110	3,900	3,730
3.84	3,120	3,920	3,760
3.85	3,140	3,920	3,780
3.86	3,160	3,940	3,800

Stage (ft)	Flow (cfs)		
	2005	2012	2014
3.87	3,170	3,960	3,820
3.88	3,190	3,980	3,840
3.89	3,210	4,000	3,860
3.90	3,220	4,010	3,890
3.91	3,240	4,030	3,910
3.92	3,260	4,050	3,930
3.93	3,270	4,070	3,950
3.94	3,290	4,090	3,970
3.95	3,310	4,110	4,000
3.96	3,320	4,130	4,020
3.97	3,340	4,150	4,040
3.98	3,360	4,170	4,060
3.99	3,370	4,190	4,080
4.00	3,390	4,210	4,110
4.01	3,410	4,230	4,130
4.02	3,420	4,240	4,150
4.03	3,440	4,260	4,170
4.04	3,460	4,280	4,200
4.05	3,480	4,300	4,220
4.06	3,490	4,320	4,240
4.07	3,510	4,340	4,260
4.08	3,530	4,340	4,280
4.09	3,550	4,360	4,310
4.10	3,560	4,380	4,330
4.11	3,580	4,400	4,350
4.12	3,600	4,420	4,370
4.13	3,620	4,440	4,400
4.14	3,630	4,460	4,420
4.15	3,650	4,480	4,440
4.16	3,670	4,500	4,460
4.17	3,690	4,520	4,490
4.18	3,700	4,540	4,510
4.19	3,720	4,560	4,530
4.20	3,740	4,580	4,550
4.21	3,760	4,600	4,580
4.22	3,780	4,620	4,600
4.23	3,790	4,640	4,620
4.24	3,810	4,660	4,650
4.25	3,830	4,680	4,670
4.26	3,850	4,700	4,690
4.27	3,870	4,720	4,710

Stage (ft)	Flow (cfs)		
	2005	2012	2014
4.28	3,890	4,740	4,740
4.29	3,900	4,760	4,760
4.30	3,920	4,790	4,780
4.31	3,940	4,790	4,810
4.32	3,960	4,810	4,830
4.33	3,980	4,830	4,850
4.34	4,000	4,850	4,880
4.35	4,020	4,870	4,900
4.36	4,030	4,890	4,920
4.37	4,050	4,910	4,950
4.38	4,070	4,930	4,970
4.39	4,090	4,950	4,990
4.40	4,110	4,970	5,020
4.41	4,130	4,990	5,040
4.42	4,150	5,010	5,060
4.43	4,170	5,040	5,090
4.44	4,190	5,060	5,110
4.45	4,210	5,080	5,130
4.46	4,230	5,100	5,160
4.47	4,240	5,120	5,180
4.48	4,260	5,140	5,200
4.49	4,280	5,160	5,230
4.50	4,300	5,180	5,250
4.51	4,320	5,210	5,270
4.52	4,340	5,230	5,300
4.53	4,360	5,250	5,320
4.54	4,380	5,250	5,340
4.55	4,400	5,270	5,370
4.56	4,420	5,290	5,390
4.57	4,440	5,310	5,420
4.58	4,460	5,330	5,440
4.59	4,480	5,360	5,460
4.60	4,500	5,380	5,490
4.61	4,520	5,400	5,510
4.62	4,540	5,420	5,530
4.63	4,560	5,440	5,560
4.64	4,580	5,470	5,580
4.65	4,600	5,490	5,610
4.66	4,620	5,510	5,630
4.67	4,640	5,530	5,650
4.68	4,660	5,550	5,680

Stage (ft)	Flow (cfs)		
	2005	2012	2014
4.69	4,680	5,580	5,700
4.70	4,700	5,600	5,730
4.71	4,720	5,620	5,750
4.72	4,740	5,640	5,770
4.73	4,760	5,660	5,800
4.74	4,780	5,690	5,820
4.75	4,810	5,710	5,850
4.76	4,830	5,730	5,870
4.77	4,850	5,730	5,900
4.78	4,870	5,750	5,920
4.79	4,890	5,780	5,940
4.80	4,920	5,800	5,970
4.81	4,940	5,820	5,990
4.82	4,960	5,840	6,020
4.83	4,980	5,870	6,040
4.84	5,000	5,890	6,070
4.85	5,030	5,910	6,090
4.86	5,050	5,940	6,120
4.87	5,070	5,960	6,140
4.88	5,090	5,980	6,160
4.89	5,120	6,000	6,190
4.90	5,140	6,030	6,210
4.91	5,160	6,050	6,240
4.92	5,180	6,070	6,260
4.93	5,210	6,100	6,290
4.94	5,230	6,120	6,310
4.95	5,250	6,140	6,340
4.96	5,280	6,170	6,360
4.97	5,300	6,190	6,390
4.98	5,320	6,210	6,410
4.99	5,340	6,230	6,440
5.00	5,370	6,230	6,460
5.01	5,390	6,260	6,490
5.02	5,410	6,280	6,510
5.03	5,440	6,300	6,540
5.04	5,460	6,330	6,560
5.05	5,480	6,350	6,590
5.06	5,510	6,380	6,610
5.07	5,530	6,400	6,640
5.08	5,550	6,420	6,660
5.09	5,580	6,450	6,690

Stage (ft)	Flow (cfs)		
	2005	2012	2014
5.10	5,600	6,470	6,710
5.11	5,620	6,490	6,740
5.12	5,650	6,520	6,760
5.13	5,670	6,540	6,790
5.14	5,700	6,570	6,810
5.15	5,720	6,590	6,840
5.16	5,740	6,610	6,860
5.17	5,770	6,640	6,890
5.18	5,790	6,660	6,910
5.19	5,820	6,690	6,940
5.20	5,840	6,710	6,960
5.21	5,860	6,730	6,990
5.22	5,890	6,760	7,010
5.23	5,910	6,780	7,040
5.24	5,940	6,780	7,060
5.25	5,960	6,810	7,090
5.26	5,990	6,830	7,120
5.27	6,010	6,860	7,140
5.28	6,030	6,880	7,170
5.29	6,060	6,900	7,190
5.30	6,080	6,930	7,220
5.31	6,110	6,950	7,240
5.32	6,130	6,980	7,270
5.33	6,160	7,000	7,290
5.34	6,180	7,030	7,320
5.35	6,210	7,050	7,350
5.36	6,230	7,080	7,370
5.37	6,260	7,100	7,400
5.38	6,280	7,130	7,420
5.39	6,310	7,150	7,450
5.40	6,330	7,180	7,470
5.41	6,360	7,200	7,500
5.42	6,380	7,230	7,530
5.43	6,410	7,250	7,550
5.44	6,430	7,280	7,580
5.45	6,460	7,300	7,600
5.46	6,490	7,330	7,630
5.47	6,510	7,330	7,660
5.48	6,540	7,350	7,680
5.49	6,560	7,380	7,710
5.50	6,590	7,400	7,730

Stage (ft)	Flow (cfs)		
	2005	2012	2014
5.51	6,610	7,430	7,760
5.52	6,640	7,450	7,790
5.53	6,670	7,480	7,810
5.54	6,690	7,500	7,840
5.55	6,720	7,530	7,860
5.56	6,740	7,550	7,890
5.57	6,770	7,580	7,920
5.58	6,800	7,610	7,940
5.59	6,820	7,630	7,970
5.60	6,850	7,660	8,000
5.61	6,870	7,680	8,020
5.62	6,900	7,710	8,050
5.63	6,930	7,730	8,070
5.64	6,950	7,760	8,100
5.65	6,980	7,790	8,130
5.66	7,010	7,810	8,150
5.67	7,030	7,840	8,180
5.68	7,060	7,860	8,210
5.69	7,090	7,890	8,230
5.70	7,110	7,890	8,260
5.71	7,140	7,920	8,290
5.72	7,170	7,940	8,310
5.73	7,190	7,970	8,340
5.74	7,220	7,990	8,370
5.75	7,250	8,020	8,390
5.76	7,280	8,050	8,420
5.77	7,300	8,070	8,450
5.78	7,330	8,100	8,470
5.79	7,360	8,130	8,500
5.80	7,380	8,150	8,530
5.81	7,410	8,180	8,550
5.82	7,440	8,210	8,580
5.83	7,470	8,230	8,610
5.84	7,490	8,260	8,630
5.85	7,520	8,290	8,660
5.86	7,550	8,310	8,690
5.87	7,580	8,340	8,710
5.88	7,610	8,370	8,740
5.89	7,630	8,390	8,770
5.90	7,660	8,420	8,790
5.91	7,690	8,450	8,820

Stage (ft)	Flow (cfs)		
	2005	2012	2014
5.92	7,720	8,470	8,850
5.93	7,750	8,470	8,870
5.94	7,770	8,500	8,900
5.95	7,800	8,530	8,930
5.96	7,830	8,550	8,960
5.97	7,860	8,580	8,980
5.98	7,890	8,610	9,010
5.99	7,920	8,640	9,040
6.00	7,940	8,660	9,060
6.01	7,970	8,690	9,090
6.02	8,000	8,720	9,120
6.03	8,030	8,740	9,150
6.04	8,060	8,770	9,170
6.05	8,090	8,800	9,200
6.06	8,120	8,830	9,230
6.07	8,140	8,850	9,250
6.08	8,170	8,880	9,280
6.09	8,200	8,910	9,310
6.10	8,230	8,940	9,340
6.11	8,260	8,970	9,360
6.12	8,290	8,990	9,390
6.13	8,320	9,020	9,420
6.14	8,350	9,050	9,450
6.15	8,380	9,080	9,470
6.16	8,410	9,080	9,500
6.17	8,440	9,100	9,530
6.18	8,460	9,130	9,560
6.19	8,490	9,160	9,580
6.20	8,520	9,190	9,610
6.21	8,550	9,220	9,640
6.22	8,580	9,240	9,670
6.23	8,610	9,270	9,690
6.24	8,640	9,300	9,720
6.25	8,670	9,330	9,750
6.26	8,700	9,360	9,780
6.27	8,730	9,380	9,800
6.28	8,760	9,410	9,830
6.29	8,790	9,440	9,860
6.30	8,820	9,470	9,890
6.31	8,850	9,500	9,920
6.32	8,880	9,530	9,940

Stage (ft)	Flow (cfs)		
	2005	2012	2014
6.33	8,910	9,560	9,970
6.34	8,940	9,580	10,000
6.35	8,970	9,610	10,000
6.36	9,000	9,640	10,100
6.37	9,030	9,670	10,100
6.38	9,060	9,700	10,100
6.39	9,090	9,700	10,100
6.40	9,120	9,730	10,200
6.41	9,140	9,760	10,200
6.42	9,170	9,780	10,200
6.43	9,200	9,810	10,200
6.44	9,220	9,840	10,300
6.45	9,250	9,870	10,300
6.46	9,280	9,900	10,300
6.47	9,300	9,930	10,400
6.48	9,330	9,960	10,400
6.49	9,360	9,990	10,400
6.50	9,380	10,000	10,400
6.51	9,410	10,000	10,500
6.52	9,440	10,100	10,500
6.53	9,460	10,100	10,500
6.54	9,490	10,100	10,600
6.55	9,520	10,200	10,600
6.56	9,540	10,200	10,600
6.57	9,570	10,200	10,600
6.58	9,600	10,300	10,700
6.59	9,620	10,300	10,700
6.60	9,650	10,300	10,700
6.61	9,680	10,300	10,800
6.62	9,710	10,400	10,800
6.63	9,730	10,400	10,800
6.64	9,760	10,400	10,800
6.65	9,790	10,500	10,900
6.66	9,810	10,500	10,900
6.67	9,840	10,500	10,900
6.68	9,870	10,500	11,000
6.69	9,900	10,600	11,000
6.70	9,920	10,600	11,000
6.71	9,950	10,600	11,000
6.72	9,980	10,700	11,100
6.73	10,000	10,700	11,100

Stage (ft)	Flow (cfs)		
	2005	2012	2014
6.74	10,000	10,700	11,100
6.75	10,100	10,800	11,200
6.76	10,100	10,800	11,200
6.77	10,100	10,800	11,200
6.78	10,100	10,800	11,200
6.79	10,200	10,900	11,300
6.80	10,200	10,900	11,300
6.81	10,200	10,900	11,300
6.82	10,300	11,000	11,400
6.83	10,300	11,000	11,400
6.84	10,300	11,000	11,400
6.85	10,300	11,100	11,400
6.86	10,400	11,100	11,500
6.87	10,400	11,100	11,500
6.88	10,400	11,100	11,500
6.89	10,500	11,200	11,600
6.90	10,500	11,200	11,600
6.91	10,500	11,200	11,600
6.92	10,500	11,300	11,600
6.93	10,600	11,300	11,700
6.94	10,600	11,300	11,700
6.95	10,600	11,400	11,700
6.96	10,600	11,400	11,800
6.97	10,700	11,400	11,800
6.98	10,700	11,400	11,800
6.99	10,700	11,500	11,800
7.00	10,800	11,500	11,900
7.01	10,800	11,500	11,900
7.02	10,800	11,600	11,900
7.03	10,800	11,600	12,000
7.04	10,900	11,600	12,000
7.05	10,900	11,700	12,000
7.06	10,900	11,700	12,100
7.07	11,000	11,700	12,100
7.08	11,000	11,700	12,100
7.09	11,000	11,800	12,100
7.10	11,000	11,800	12,200
7.11	11,100	11,800	12,200
7.12	11,100	11,900	12,200
7.13	11,100	11,900	12,300
7.14	11,200	11,900	12,300

Stage (ft)	Flow (cfs)		
	2005	2012	2014
7.15	11,200	12,000	12,300
7.16	11,200	12,000	12,300
7.17	11,200	12,000	12,400
7.18	11,300	12,000	12,400
7.19	11,300	12,100	12,400
7.20	11,300	12,100	12,500
7.21	11,400	12,100	12,500
7.22	11,400	12,200	12,500
7.23	11,400	12,200	12,600
7.24	11,500	12,200	12,600
7.25	11,500	12,300	12,600
7.26	11,500	12,300	12,600
7.27	11,500	12,300	12,700
7.28	11,600	12,300	12,700
7.29	11,600	12,400	12,700
7.30	11,600	12,400	12,800
7.31	11,700	12,400	12,800
7.32	11,700	12,500	12,800
7.33	11,700	12,500	12,800
7.34	11,700	12,500	12,900
7.35	11,800	12,600	12,900
7.36	11,800	12,600	12,900
7.37	11,800	12,600	13,000
7.38	11,900	12,600	13,000
7.39	11,900	12,700	13,000
7.40	11,900	12,700	13,100
7.41	12,000	12,700	13,100
7.42	12,000	12,800	13,100
7.43	12,000	12,800	13,100
7.44	12,000	12,800	13,200
7.45	12,100	12,900	13,200
7.46	12,100	12,900	13,200
7.47	12,100	12,900	13,300
7.48	12,200	12,900	13,300
7.49	12,200	13,000	13,300
7.50	12,200	13,000	13,400
7.51	12,300	13,000	13,400
7.52	12,300	13,100	13,400
7.53	12,300	13,100	13,400
7.54	12,300	13,100	13,500
7.55	12,400	13,100	13,500

Stage (ft)	Flow (cfs)		
	2005	2012	2014
7.56	12,400	13,200	13,500
7.57	12,400	13,200	13,600
7.58	12,500	13,200	13,600
7.59	12,500	13,300	13,600
7.60	12,500	13,300	13,700
7.61	12,600	13,300	13,700
7.62	12,600	13,300	13,700
7.63	12,600	13,400	13,700
7.64	12,700	13,400	13,800
7.65	12,700	13,400	13,800
7.66	12,700	13,500	13,800
7.67	12,700	13,500	13,900
7.68	12,800	13,500	13,900
7.69	12,800	13,500	13,900
7.70	12,800	13,600	14,000
7.71	12,900	13,600	14,000
7.72	12,900	13,600	14,000
7.73	12,900	13,700	14,000
7.74	13,000	13,700	14,100
7.75	13,000	13,700	14,100
7.76	13,000	13,800	14,100
7.77	13,100	13,800	14,200
7.78	13,100	13,800	14,200
7.79	13,100	13,800	14,200
7.80	13,100	13,900	14,300
7.81	13,200	13,900	14,300
7.82	13,200	13,900	14,300
7.83	13,200	14,000	14,400
7.84	13,300	14,000	14,400
7.85	13,300	14,000	14,400
7.86	13,300	14,000	14,400
7.87	13,400	14,100	14,500
7.88	13,400	14,100	14,500
7.89	13,400	14,100	14,500
7.90	13,500	14,200	14,600
7.91	13,500	14,200	14,600
7.92	13,500	14,200	14,600
7.93	13,600	14,300	14,700
7.94	13,600	14,300	14,700
7.95	13,600	14,300	14,700
7.96	13,600	14,300	14,800

Stage (ft)	Flow (cfs)		
	2005	2012	2014
7.97	13,700	14,400	14,800
7.98	13,700	14,400	14,800
7.99	13,700	14,400	14,800
8.00	13,800	14,500	14,900
8.01	13,800	14,500	14,900
8.02	13,800	14,500	14,900
8.03	13,900	14,600	15,000
8.04	13,900	14,600	15,000
8.05	13,900	14,600	15,000
8.06	14,000	14,600	15,100
8.07	14,000	14,700	15,100
8.08	14,000	14,700	15,100
8.09	14,100	14,700	15,200
8.10	14,100	14,800	15,200
8.11	14,100	14,800	15,200
8.12	14,200	14,800	15,200
8.13	14,200	14,900	15,300
8.14	14,200	14,900	15,300
8.15	14,300	14,900	15,300
8.16	14,300	15,000	15,400
8.17	14,300	15,000	15,400
8.18	14,400	15,000	15,400
8.19	14,400	15,000	15,500
8.20	14,400	15,100	15,500
8.21	14,500	15,100	15,500
8.22	14,500	15,100	15,600
8.23	14,500	15,200	15,600
8.24	14,600	15,200	15,600
8.25	14,600	15,200	15,700
8.26	14,600	15,300	15,700
8.27	14,600	15,300	15,700
8.28	14,700	15,300	15,700
8.29	14,700	15,400	15,800
8.30	14,700	15,400	15,800
8.31	14,800	15,400	15,800
8.32	14,800	15,400	15,900
8.33	14,800	15,500	15,900
8.34	14,900	15,500	15,900
8.35	14,900	15,500	16,000
8.36	14,900	15,600	16,000
8.37	15,000	15,600	16,000

Stage (ft)	Flow (cfs)		
	2005	2012	2014
8.38	15,000	15,600	16,100
8.39	15,000	15,700	16,100
8.40	15,100	15,700	16,100
8.41	15,100	15,700	16,200
8.42	15,100	15,800	16,200
8.43	15,200	15,800	16,200
8.44	15,200	15,800	16,200
8.45	15,200	15,800	16,300
8.46	15,300	15,900	16,300
8.47	15,300	15,900	16,300
8.48	15,300	15,900	16,400
8.49	15,400	16,000	16,400
8.50	15,400	16,000	16,400
8.51	15,400	16,000	16,500
8.52	15,500	16,100	16,500
8.53	15,500	16,100	16,500
8.54	15,500	16,100	16,600
8.55	15,600	16,200	16,600
8.56	15,600	16,200	16,600
8.57	15,600	16,200	16,700
8.58	15,700	16,300	16,700
8.59	15,700	16,300	16,700
8.60	15,700	16,300	16,800
8.61	15,800	16,300	16,800
8.62	15,800	16,400	16,800
8.63	15,800	16,400	16,800
8.64	15,900	16,400	16,900
8.65	15,900	16,500	16,900
8.66	16,000	16,500	16,900
8.67	16,000	16,500	17,000
8.68	16,000	16,600	17,000
8.69	16,100	16,600	17,000
8.70	16,100	16,600	17,100
8.71	16,100	16,700	17,100
8.72	16,200	16,700	17,100
8.73	16,200	16,700	17,200
8.74	16,200	16,800	17,200
8.75	16,300	16,800	17,200
8.76	16,300	16,800	17,300
8.77	16,300	16,900	17,300
8.78	16,400	16,900	17,300

Stage (ft)	Flow (cfs)		
	2005	2012	2014
8.79	16,400	16,900	17,400
8.80	16,400	17,000	17,400
8.81	16,500	17,000	17,400
8.82	16,500	17,000	17,500
8.83	16,500	17,100	17,500
8.84	16,600	17,100	17,500
8.85	16,600	17,100	17,600
8.86	16,600	17,100	17,600
8.87	16,700	17,200	17,600
8.88	16,700	17,200	17,700
8.89	16,700	17,200	17,700
8.90	16,800	17,300	17,700
8.91	16,800	17,300	17,700
8.92	16,800	17,300	17,800
8.93	16,900	17,400	17,800
8.94	16,900	17,400	17,800
8.95	17,000	17,400	17,900
8.96	17,000	17,500	17,900
8.97	17,000	17,500	17,900
8.98	17,100	17,500	18,000
8.99	17,100	17,600	18,000
9.00	17,100	17,600	18,000
9.01	17,200	17,600	18,100
9.02	17,200	17,700	18,100
9.03	17,200	17,700	18,100
9.04	17,300	17,700	18,200
9.05	17,300	17,800	18,200
9.06	17,300	17,800	18,200
9.07	17,400	17,800	18,300
9.08	17,400	17,900	18,300
9.09	17,400	17,900	18,300
9.10	17,500	17,900	18,400
9.11	17,500	18,000	18,400
9.12	17,600	18,000	18,400
9.13	17,600	18,000	18,500
9.14	17,600	18,100	18,500
9.15	17,700	18,100	18,500
9.16	17,700	18,100	18,600
9.17	17,700	18,200	18,600
9.18	17,800	18,200	18,600
9.19	17,800	18,200	18,700

Stage (ft)	Flow (cfs)		
	2005	2012	2014
9.20	17,800	18,300	18,700
9.21	17,900	18,300	18,700
9.22	17,900	18,300	18,800
9.23	17,900	18,400	18,800
9.24	18,000	18,400	18,800
9.25	18,000	18,400	18,900
9.26	18,100	18,500	18,900
9.27	18,100	18,500	18,900
9.28	18,100	18,500	19,000
9.29	18,200	18,600	19,000
9.30	18,200	18,600	19,000
9.31	18,200	18,600	19,000
9.32	18,300	18,700	19,100
9.33	18,300	18,700	19,100
9.34	18,300	18,700	19,100
9.35	18,400	18,800	19,200
9.36	18,400	18,800	19,200
9.37	18,500	18,800	19,200
9.38	18,500	18,900	19,300
9.39	18,500	18,900	19,300
9.40	18,600	18,900	19,300
9.41	18,600	19,000	19,400
9.42	18,600	19,000	19,400
9.43	18,700	19,000	19,400
9.44	18,700	19,100	19,500
9.45	18,700	19,100	19,500
9.46	18,800	19,100	19,500
9.47	18,800	19,200	19,600
9.48	18,900	19,200	19,600
9.49	18,900	19,200	19,600
9.50	18,900	19,300	19,700
9.51	19,000	19,300	19,700
9.52	19,000	19,300	19,700
9.53	19,000	19,400	19,800
9.54	19,100	19,400	19,800
9.55	19,100	19,400	19,800
9.56	19,200	19,500	19,900
9.57	19,200	19,500	19,900
9.58	19,200	19,500	19,900
9.59	19,300	19,600	20,000
9.60	19,300	19,600	20,000

Stage (ft)	Flow (cfs)		
	2005	2012	2014
9.61	19,300	19,600	20,000
9.62	19,400	19,700	20,100
9.63	19,400	19,700	20,100
9.64	19,500	19,700	20,100
9.65	19,500	19,800	20,200
9.66	19,500	19,800	20,200
9.67	19,600	19,800	20,200
9.68	19,600	19,900	20,300
9.69	19,600	19,900	20,300
9.70	19,700	19,900	20,300
9.71	19,700	20,000	20,400
9.72	19,800	20,000	20,400
9.73	19,800	20,000	20,400
9.74	19,800	20,100	20,500
9.75	19,900	20,100	20,500
9.76	19,900	20,100	20,500
9.77	19,900	20,200	20,600
9.78	20,000	20,200	20,600
9.79	20,000	20,200	20,600
9.80	20,100	20,300	20,700
9.81	20,100	20,300	20,700
9.82	20,100	20,300	20,700
9.83	20,200	20,400	20,800
9.84	20,200	20,400	20,800
9.85	20,200	20,500	20,800
9.86	20,300	20,500	20,900
9.87	20,300	20,500	20,900
9.88	20,400	20,600	20,900
9.89	20,400	20,600	21,000
9.90	20,400	20,600	21,000
9.91	20,500	20,700	21,000
9.92	20,500	20,700	21,100
9.93	20,500	20,700	21,100
9.94	20,600	20,800	21,100
9.95	20,600	20,800	21,200
9.96	20,700	20,800	21,200
9.97	20,700	20,900	21,200
9.98	20,700	20,900	21,300
9.99	20,800	20,900	21,300
10.00	20,800	21,000	21,400
10.01	20,900	21,000	21,400

Stage (ft)	Flow (cfs)		
	2005	2012	2014
10.02	20,900	21,000	21,400
10.03	20,900	21,100	21,500
10.04	21,000	21,100	21,500
10.05	21,000	21,100	21,500
10.06	21,000	21,200	21,600
10.07	21,100	21,200	21,600
10.08	21,100	21,300	21,600
10.09	21,200	21,300	21,700
10.10	21,200	21,300	21,700
10.11	21,200	21,400	21,700
10.12	21,300	21,400	21,800
10.13	21,300	21,400	21,800
10.14	21,400	21,500	21,800
10.15	21,400	21,500	21,900
10.16	21,400	21,500	21,900
10.17	21,500	21,600	21,900
10.18	21,500	21,600	22,000
10.19	21,600	21,600	22,000
10.20	21,600	21,700	22,000
10.21	21,600	21,700	22,100
10.22	21,700	21,700	22,100
10.23	21,700	21,800	22,100
10.24	21,700	21,800	22,200
10.25	21,800	21,900	22,200
10.26	21,800	21,900	22,200
10.27	21,900	21,900	22,300
10.28	21,900	22,000	22,300
10.29	21,900	22,000	22,300
10.30	22,000	22,000	22,400
10.31	22,000	22,100	22,400
10.32	22,100	22,100	22,400
10.33	22,100	22,100	22,500
10.34	22,100	22,200	22,500
10.35	22,200	22,200	22,500
10.36	22,200	22,200	22,600
10.37	22,300	22,300	22,600
10.38	22,300	22,300	22,600
10.39	22,300	22,300	22,700
10.40	22,400	22,400	22,700
10.41	22,400	22,400	22,700
10.42	22,500	22,500	22,800

Stage (ft)	Flow (cfs)		
	2005	2012	2014
10.43	22,500	22,500	22,800
10.44	22,500	22,500	22,900
10.45	22,600	22,600	22,900
10.46	22,600	22,600	22,900
10.47	22,700	22,600	23,000
10.48	22,700	22,700	23,000
10.49	22,700	22,700	23,000
10.50	22,800	22,700	23,100
10.51	22,800	22,800	23,100
10.52	22,900	22,800	23,100
10.53	22,900	22,900	23,200
10.54	22,900	22,900	23,200
10.55	23,000	22,900	23,200
10.56	23,000	23,000	23,300
10.57	23,100	23,000	23,300
10.58	23,100	23,000	23,300
10.59	23,100	23,100	23,400
10.60	23,200	23,100	23,400
10.61	23,200	23,100	23,400
10.62	23,300	23,200	23,500
10.63	23,300	23,200	23,500
10.64	23,300	23,300	23,500
10.65	23,400	23,300	23,600
10.66	23,400	23,300	23,600
10.67	23,500	23,400	23,600
10.68	23,500	23,400	23,700
10.69	23,500	23,400	23,700
10.70	23,600	23,500	23,800
10.71	23,600	23,500	23,800
10.72	23,700	23,500	23,800
10.73	23,700	23,600	23,900
10.74	23,800	23,600	23,900
10.75	23,800	23,700	23,900
10.76	23,800	23,700	24,000
10.77	23,900	23,700	24,000
10.78	23,900	23,800	24,000
10.79	24,000	23,800	24,100
10.80	24,000	23,800	24,100
10.81	24,000	23,900	24,100
10.82	24,100	23,900	24,200
10.83	24,100	23,900	24,200

Stage (ft)	Flow (cfs)		
	2005	2012	2014
10.84	24,100	24,000	24,200
10.85	24,200	24,000	24,300
10.86	24,200	24,100	24,300
10.87	24,300	24,100	24,300
10.88	24,300	24,100	24,400
10.89	24,300	24,200	24,400
10.90	24,400	24,200	24,500
10.91	24,400	24,200	24,500
10.92	24,400	24,300	24,500
10.93	24,500	24,300	24,600
10.94	24,500	24,400	24,600
10.95	24,600	24,400	24,600
10.96	24,600	24,400	24,700
10.97	24,600	24,500	24,700
10.98	24,700	24,500	24,700
10.99	24,700	24,500	24,800
11.00	24,700	24,600	24,800
11.01	24,800	24,600	24,800
11.02	24,800	24,600	24,900
11.03	24,900	24,700	24,900
11.04	24,900	24,700	24,900
11.05	24,900	24,800	25,000
11.06	25,000	24,800	25,000
11.07	25,000	24,800	25,000
11.08	25,000	24,900	25,100
11.09	25,100	24,900	25,100
11.10	25,100	24,900	25,200
11.11	25,200	25,000	25,200
11.12	25,200	25,000	25,200
11.13	25,200	25,100	25,300
11.14	25,300	25,100	25,300
11.15	25,300	25,100	25,300
11.16	25,300	25,200	25,400
11.17	25,400	25,200	25,400
11.18	25,400	25,200	25,400
11.19	25,500	25,300	25,500
11.20	25,500	25,300	25,500
11.21	25,500	25,400	25,500
11.22	25,600	25,400	25,600
11.23	25,600	25,400	25,600
11.24	25,700	25,500	25,600

Stage (ft)	Flow (cfs)		
	2005	2012	2014
11.25	25,700	25,500	25,700
11.26	25,700	25,500	25,700
11.27	25,800	25,600	25,800
11.28	25,800	25,600	25,800
11.29	25,800	25,700	25,800
11.30	25,900	25,700	25,900
11.31	25,900	25,700	25,900
11.32	26,000	25,800	25,900
11.33	26,000	25,800	26,000
11.34	26,000	25,900	26,000
11.35	26,100	25,900	26,000
11.36	26,100	25,900	26,100
11.37	26,100	26,000	26,100
11.38	26,200	26,000	26,100
11.39	26,200	26,000	26,200
11.40	26,300	26,100	26,200
11.41	26,300	26,100	26,300
11.42	26,300	26,200	26,300
11.43	26,400	26,200	26,300
11.44	26,400	26,200	26,400
11.45	26,500	26,300	26,400
11.46	26,500	26,300	26,400
11.47	26,500	26,300	26,500
11.48	26,600	26,400	26,500
11.49	26,600	26,400	26,500
11.50	26,600	26,500	26,600
11.51	26,700	26,500	26,600
11.52	26,700	26,500	26,600
11.53	26,800	26,600	26,700
11.54	26,800	26,600	26,700
11.55	26,800	26,700	26,800
11.56	26,900	26,700	26,800
11.57	26,900	26,700	26,800
11.58	27,000	26,800	26,900
11.59	27,000	26,800	26,900
11.60	27,000	26,800	26,900
11.61	27,100	26,900	27,000
11.62	27,100	26,900	27,000
11.63	27,200	27,000	27,000
11.64	27,200	27,000	27,100
11.65	27,200	27,000	27,100

Stage (ft)	Flow (cfs)		
	2005	2012	2014
11.66	27,300	27,100	27,200
11.67	27,300	27,100	27,200
11.68	27,300	27,200	27,200
11.69	27,400	27,200	27,300
11.70	27,400	27,200	27,300
11.71	27,500	27,300	27,300
11.72	27,500	27,300	27,400
11.73	27,500	27,300	27,400
11.74	27,600	27,400	27,400
11.75	27,600	27,400	27,500
11.76	27,700	27,500	27,500
11.77	27,700	27,500	27,500
11.78	27,700	27,500	27,600
11.79	27,800	27,600	27,600
11.80	27,800	27,600	27,700
11.81	27,900	27,700	27,700
11.82	27,900	27,700	27,700
11.83	27,900	27,700	27,800
11.84	28,000	27,800	27,800
11.85	28,000	27,800	27,800
11.86	28,100	27,900	27,900
11.87	28,100	27,900	27,900
11.88	28,100	27,900	27,900
11.89	28,200	28,000	28,000
11.90	28,200	28,000	28,000
11.91	28,200	28,000	28,100
11.92	28,300	28,100	28,100
11.93	28,300	28,100	28,100

Stage (ft)	Flow (cfs)		
	2005	2012	2014
11.94	28,400	28,200	28,200
11.95	28,400	28,200	28,200
11.96	28,400	28,200	28,200
11.97	28,500	28,300	28,300
11.98	28,500	28,300	28,300
11.99	28,600	28,400	28,300
12.00	28,600	28,400	28,400
12.01	28,600	28,400	28,400
12.02	28,700	28,500	28,500
12.03	28,700	28,500	28,500
12.04	28,800	28,600	28,500
12.05	28,800	28,600	28,600
12.06	28,800	28,600	28,600
12.07	28,900	28,700	28,600
12.08	28,900	28,700	28,700
12.09	29,000	28,800	28,700
12.10	29,000	28,800	28,700
12.11	29,000	28,800	28,800
12.12	29,100	28,900	28,800
12.13	29,100	28,900	28,900
12.14	29,200	29,000	28,900
12.15	29,200	29,000	28,900
12.16	29,200	29,000	29,000
12.17	29,300	29,100	29,000
12.18	29,300	29,100	29,000
12.19	29,400	29,200	29,100
12.20	29,400	29,200	29,100
12.21	29,400	29,200	29,100

TABLE A-2 USGS Stage-Flow Table for the Ouray Gage (USGS 9272400) in 2012 and 2014

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
14.94	930	15.34	1,370	15.74	1,860
14.95	940	15.35	1,380	15.75	1,870
14.96	951	15.36	1,390	15.76	1,880
14.97	961	15.37	1,400	15.77	1,900
14.98	972	15.38	1,420	15.78	1,910
14.99	982	15.39	1,430	15.79	1,920
15.00	992	15.40	1,440	15.80	1,930
15.01	1,000	15.41	1,450	15.81	1,950
15.02	1,010	15.42	1,460	15.82	1,960
15.03	1,020	15.43	1,470	15.83	1,970
15.04	1,030	15.44	1,490	15.84	1,990
15.05	1,050	15.45	1,500	15.85	2,000
15.06	1,060	15.46	1,510	15.86	2,010
15.07	1,070	15.47	1,520	15.87	2,030
15.08	1,080	15.48	1,530	15.88	2,040
15.09	1,090	15.49	1,550	15.89	2,050
15.10	1,100	15.50	1,560	15.90	2,060
15.11	1,110	15.51	1,570	15.91	2,080
15.12	1,120	15.52	1,580	15.92	2,090
15.13	1,130	15.53	1,590	15.93	2,100
15.14	1,140	15.54	1,610	15.94	2,120
15.15	1,150	15.55	1,620	15.95	2,130
15.16	1,160	15.56	1,630	15.96	2,140
15.17	1,180	15.57	1,640	15.97	2,160
15.18	1,190	15.58	1,660	15.98	2,170
15.19	1,200	15.59	1,670	15.99	2,180
15.20	1,210	15.60	1,680	16.00	2,200
15.21	1,220	15.61	1,690	16.01	2,210
15.22	1,230	15.62	1,710	16.02	2,220
15.23	1,240	15.63	1,720	16.03	2,240
15.24	1,250	15.64	1,730	16.04	2,250
15.25	1,270	15.65	1,740	16.05	2,270
15.26	1,280	15.66	1,760	16.06	2,280
15.27	1,290	15.67	1,770	16.07	2,290
15.28	1,300	15.68	1,780	16.08	2,310
15.29	1,310	15.69	1,790	16.09	2,320
15.30	1,320	15.70	1,810	16.10	2,330
15.31	1,330	15.71	1,820	16.11	2,350
15.32	1,350	15.72	1,830	16.12	2,360
15.33	1,360	15.73	1,840	16.13	2,370

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
16.14	2,390	16.56	2,990	16.98	3,630
16.15	2,400	16.57	3,000	16.99	3,650
16.16	2,420	16.58	3,020	17.00	3,660
16.17	2,430	16.59	3,030	17.01	3,680
16.18	2,440	16.60	3,050	17.02	3,690
16.19	2,460	16.61	3,060	17.03	3,710
16.20	2,470	16.62	3,080	17.04	3,730
16.21	2,490	16.63	3,090	17.05	3,740
16.22	2,500	16.64	3,110	17.06	3,760
16.23	2,510	16.65	3,120	17.07	3,770
16.24	2,530	16.66	3,140	17.08	3,790
16.25	2,540	16.67	3,150	17.09	3,810
16.26	2,560	16.68	3,170	17.10	3,820
16.27	2,570	16.69	3,180	17.11	3,840
16.28	2,580	16.70	3,200	17.12	3,850
16.29	2,600	16.71	3,210	17.13	3,870
16.30	2,610	16.72	3,230	17.14	3,890
16.31	2,630	16.73	3,240	17.15	3,900
16.32	2,640	16.74	3,260	17.16	3,920
16.33	2,660	16.75	3,270	17.17	3,930
16.34	2,670	16.76	3,290	17.18	3,950
16.35	2,680	16.77	3,310	17.19	3,970
16.36	2,700	16.78	3,320	17.20	3,980
16.37	2,710	16.79	3,340	17.21	4,000
16.38	2,730	16.80	3,350	17.22	4,010
16.39	2,740	16.81	3,370	17.23	4,030
16.40	2,760	16.82	3,380	17.24	4,050
16.41	2,770	16.83	3,400	17.25	4,060
16.42	2,780	16.84	3,410	17.26	4,080
16.43	2,800	16.85	3,430	17.27	4,100
16.44	2,810	16.86	3,440	17.28	4,110
16.45	2,830	16.87	3,460	17.29	4,130
16.46	2,840	16.88	3,470	17.30	4,140
16.47	2,860	16.89	3,490	17.31	4,160
16.48	2,870	16.90	3,510	17.32	4,180
16.49	2,890	16.91	3,520	17.33	4,190
16.50	2,900	16.92	3,540	17.34	4,210
16.51	2,920	16.93	3,550	17.35	4,230
16.52	2,930	16.94	3,570	17.36	4,240
16.53	2,950	16.95	3,580	17.37	4,260
16.54	2,960	16.96	3,600	17.38	4,280
16.55	2,970	16.97	3,620	17.39	4,290

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
17.40	4,310	17.82	5,020	18.24	5,770
17.41	4,330	17.83	5,040	18.25	5,790
17.42	4,340	17.84	5,060	18.26	5,810
17.43	4,360	17.85	5,080	18.27	5,820
17.44	4,380	17.86	5,090	18.28	5,840
17.45	4,390	17.87	5,110	18.29	5,860
17.46	4,410	17.88	5,130	18.30	5,880
17.47	4,430	17.89	5,150	18.31	5,900
17.48	4,440	17.90	5,160	18.32	5,920
17.49	4,460	17.91	5,180	18.33	5,930
17.50	4,480	17.92	5,200	18.34	5,950
17.51	4,490	17.93	5,220	18.35	5,970
17.52	4,510	17.94	5,230	18.36	5,990
17.53	4,530	17.95	5,250	18.37	6,010
17.54	4,540	17.96	5,270	18.38	6,030
17.55	4,560	17.97	5,290	18.39	6,040
17.56	4,580	17.98	5,300	18.40	6,060
17.57	4,590	17.99	5,320	18.41	6,080
17.58	4,610	18.00	5,340	18.42	6,100
17.59	4,630	18.01	5,360	18.43	6,120
17.60	4,640	18.02	5,370	18.44	6,140
17.61	4,660	18.03	5,390	18.45	6,150
17.62	4,680	18.04	5,410	18.46	6,170
17.63	4,700	18.05	5,430	18.47	6,190
17.64	4,710	18.06	5,450	18.48	6,210
17.65	4,730	18.07	5,460	18.49	6,230
17.66	4,750	18.08	5,480	18.50	6,250
17.67	4,760	18.09	5,500	18.51	6,270
17.68	4,780	18.10	5,520	18.52	6,280
17.69	4,800	18.11	5,540	18.53	6,300
17.70	4,820	18.12	5,550	18.54	6,320
17.71	4,830	18.13	5,570	18.55	6,340
17.72	4,850	18.14	5,590	18.56	6,360
17.73	4,870	18.15	5,610	18.57	6,380
17.74	4,880	18.16	5,620	18.58	6,400
17.75	4,900	18.17	5,640	18.59	6,420
17.76	4,920	18.18	5,660	18.60	6,430
17.77	4,940	18.19	5,680	18.61	6,450
17.78	4,950	18.20	5,700	18.62	6,470
17.79	4,970	18.21	5,720	18.63	6,490
17.80	4,990	18.22	5,730	18.64	6,510
17.81	5,010	18.23	5,750	18.65	6,530

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
18.66	6,550	19.08	7,360	19.50	8,190
18.67	6,570	19.09	7,370	19.51	8,210
18.68	6,590	19.10	7,390	19.52	8,230
18.69	6,600	19.11	7,410	19.53	8,250
18.70	6,620	19.12	7,430	19.54	8,270
18.71	6,640	19.13	7,450	19.55	8,290
18.72	6,660	19.14	7,470	19.56	8,310
18.73	6,680	19.15	7,490	19.57	8,330
18.74	6,700	19.16	7,510	19.58	8,350
18.75	6,720	19.17	7,530	19.59	8,370
18.76	6,740	19.18	7,550	19.60	8,390
18.77	6,760	19.19	7,570	19.61	8,410
18.78	6,780	19.20	7,590	19.62	8,440
18.79	6,790	19.21	7,610	19.63	8,460
18.80	6,810	19.22	7,630	19.64	8,480
18.81	6,830	19.23	7,650	19.65	8,500
18.82	6,850	19.24	7,670	19.66	8,520
18.83	6,870	19.25	7,690	19.67	8,540
18.84	6,890	19.26	7,710	19.68	8,560
18.85	6,910	19.27	7,730	19.69	8,580
18.86	6,930	19.28	7,750	19.70	8,600
18.87	6,950	19.29	7,770	19.71	8,620
18.88	6,970	19.30	7,790	19.72	8,640
18.89	6,990	19.31	7,810	19.73	8,660
18.90	7,010	19.32	7,830	19.74	8,680
18.91	7,020	19.33	7,850	19.75	8,700
18.92	7,040	19.34	7,870	19.76	8,720
18.93	7,060	19.35	7,890	19.77	8,740
18.94	7,080	19.36	7,910	19.78	8,760
18.95	7,100	19.37	7,930	19.79	8,780
18.96	7,120	19.38	7,950	19.80	8,810
18.97	7,140	19.39	7,970	19.81	8,830
18.98	7,160	19.40	7,990	19.82	8,850
18.99	7,180	19.41	8,010	19.83	8,870
19.00	7,200	19.42	8,030	19.84	8,890
19.01	7,220	19.43	8,050	19.85	8,910
19.02	7,240	19.44	8,070	19.86	8,930
19.03	7,260	19.45	8,090	19.87	8,950
19.04	7,280	19.46	8,110	19.88	8,970
19.05	7,300	19.47	8,130	19.89	8,990
19.06	7,320	19.48	8,150	19.90	9,010
19.07	7,340	19.49	8,170	19.91	9,030

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
19.92	9,060	20.34	9,950	20.76	10,900
19.93	9,080	20.35	9,970	20.77	10,900
19.94	9,100	20.36	9,990	20.78	10,900
19.95	9,120	20.37	10,000	20.79	10,900
19.96	9,140	20.38	10,000	20.80	10,900
19.97	9,160	20.39	10,100	20.81	11,000
19.98	9,180	20.40	10,100	20.82	11,000
19.99	9,200	20.41	10,100	20.83	11,000
20.00	9,220	20.42	10,100	20.84	11,000
20.01	9,240	20.43	10,100	20.85	11,100
20.02	9,260	20.44	10,200	20.86	11,100
20.03	9,290	20.45	10,200	20.87	11,100
20.04	9,310	20.46	10,200	20.88	11,100
20.05	9,330	20.47	10,200	20.89	11,100
20.06	9,350	20.48	10,200	20.90	11,200
20.07	9,370	20.49	10,300	20.91	11,200
20.08	9,390	20.50	10,300	20.92	11,200
20.09	9,410	20.51	10,300	20.93	11,200
20.10	9,430	20.52	10,300	20.94	11,300
20.11	9,450	20.53	10,400	20.95	11,300
20.12	9,480	20.54	10,400	20.96	11,300
20.13	9,500	20.55	10,400	20.97	11,300
20.14	9,520	20.56	10,400	20.98	11,400
20.15	9,540	20.57	10,400	20.99	11,400
20.16	9,560	20.58	10,500	21.00	11,400
20.17	9,580	20.59	10,500	21.01	11,400
20.18	9,600	20.60	10,500	21.02	11,400
20.19	9,620	20.61	10,500	21.03	11,500
20.20	9,650	20.62	10,600	21.04	11,500
20.21	9,670	20.63	10,600	21.05	11,500
20.22	9,690	20.64	10,600	21.06	11,500
20.23	9,710	20.65	10,600	21.07	11,600
20.24	9,730	20.66	10,600	21.08	11,600
20.25	9,750	20.67	10,700	21.09	11,600
20.26	9,770	20.68	10,700	21.10	11,600
20.27	9,800	20.69	10,700	21.11	11,600
20.28	9,820	20.70	10,700	21.12	11,700
20.29	9,840	20.71	10,800	21.13	11,700
20.30	9,860	20.72	10,800	21.14	11,700
20.31	9,880	20.73	10,800	21.15	11,700
20.32	9,900	20.74	10,800	21.16	11,800
20.33	9,920	20.75	10,800	21.17	11,800

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
21.18	11,800	21.60	12,800	22.02	13,800
21.19	11,800	21.61	12,800	22.03	13,800
21.20	11,800	21.62	12,800	22.04	13,800
21.21	11,900	21.63	12,800	22.05	13,800
21.22	11,900	21.64	12,900	22.06	13,800
21.23	11,900	21.65	12,900	22.07	13,900
21.24	11,900	21.66	12,900	22.08	13,900
21.25	12,000	21.67	12,900	22.09	13,900
21.26	12,000	21.68	13,000	22.10	13,900
21.27	12,000	21.69	13,000	22.11	14,000
21.28	12,000	21.70	13,000	22.12	14,000
21.29	12,100	21.71	13,000	22.13	14,000
21.30	12,100	21.72	13,000	22.14	14,000
21.31	12,100	21.73	13,100	22.15	14,100
21.32	12,100	21.74	13,100	22.16	14,100
21.33	12,100	21.75	13,100	22.17	14,100
21.34	12,200	21.76	13,100	22.18	14,100
21.35	12,200	21.77	13,200	22.19	14,200
21.36	12,200	21.78	13,200	22.20	14,200
21.37	12,200	21.79	13,200	22.21	14,200
21.38	12,300	21.80	13,200	22.22	14,200
21.39	12,300	21.81	13,300	22.23	14,300
21.40	12,300	21.82	13,300	22.24	14,300
21.41	12,300	21.83	13,300	22.25	14,300
21.42	12,300	21.84	13,300	22.26	14,300
21.43	12,400	21.85	13,300	22.27	14,400
21.44	12,400	21.86	13,400	22.28	14,400
21.45	12,400	21.87	13,400	22.29	14,400
21.46	12,400	21.88	13,400	22.30	14,400
21.47	12,500	21.89	13,400	22.31	14,400
21.48	12,500	21.90	13,500	22.32	14,500
21.49	12,500	21.91	13,500	22.33	14,500
21.50	12,500	21.92	13,500	22.34	14,500
21.51	12,600	21.93	13,500	22.35	14,500
21.52	12,600	21.94	13,600	22.36	14,600
21.53	12,600	21.95	13,600	22.37	14,600
21.54	12,600	21.96	13,600	22.38	14,600
21.55	12,600	21.97	13,600	22.39	14,600
21.56	12,700	21.98	13,700	22.40	14,700
21.57	12,700	21.99	13,700	22.41	14,700
21.58	12,700	22.00	13,700	22.42	14,700
21.59	12,700	22.01	13,700	22.43	14,700

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
22.44	14,800	22.86	15,800	23.28	16,800
22.45	14,800	22.87	15,800	23.29	16,900
22.46	14,800	22.88	15,800	23.30	16,900
22.47	14,800	22.89	15,900	23.31	16,900
22.48	14,900	22.90	15,900	23.32	16,900
22.49	14,900	22.91	15,900	23.33	17,000
22.50	14,900	22.92	15,900	23.34	17,000
22.51	14,900	22.93	16,000	23.35	17,000
22.52	15,000	22.94	16,000	23.36	17,000
22.53	15,000	22.95	16,000	23.37	17,100
22.54	15,000	22.96	16,000	23.38	17,100
22.55	15,000	22.97	16,100	23.39	17,100
22.56	15,100	22.98	16,100	23.40	17,200
22.57	15,100	22.99	16,100	23.41	17,200
22.58	15,100	23.00	16,100	23.42	17,200
22.59	15,100	23.01	16,200	23.43	17,200
22.60	15,200	23.02	16,200	23.44	17,300
22.61	15,200	23.03	16,200	23.45	17,300
22.62	15,200	23.04	16,200	23.46	17,300
22.63	15,200	23.05	16,300	23.47	17,300
22.64	15,300	23.06	16,300	23.48	17,400
22.65	15,300	23.07	16,300	23.49	17,400
22.66	15,300	23.08	16,300	23.50	17,400
22.67	15,300	23.09	16,400	23.51	17,400
22.68	15,300	23.10	16,400	23.52	17,500
22.69	15,400	23.11	16,400	23.53	17,500
22.70	15,400	23.12	16,400	23.54	17,500
22.71	15,400	23.13	16,500	23.55	17,500
22.72	15,400	23.14	16,500	23.56	17,600
22.73	15,500	23.15	16,500	23.57	17,600
22.74	15,500	23.16	16,500	23.58	17,600
22.75	15,500	23.17	16,600	23.59	17,600
22.76	15,500	23.18	16,600	23.60	17,700
22.77	15,600	23.19	16,600	23.61	17,700
22.78	15,600	23.20	16,600	23.62	17,700
22.79	15,600	23.21	16,700	23.63	17,700
22.80	15,600	23.22	16,700	23.64	17,800
22.81	15,700	23.23	16,700	23.65	17,800
22.82	15,700	23.24	16,700	23.66	17,800
22.83	15,700	23.25	16,800	23.67	17,800
22.84	15,700	23.26	16,800	23.68	17,900
22.85	15,800	23.27	16,800	23.69	17,900

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
23.70	17,900	24.12	19,000	24.54	20,100
23.71	17,900	24.13	19,000	24.55	20,200
23.72	18,000	24.14	19,100	24.56	20,200
23.73	18,000	24.15	19,100	24.57	20,200
23.74	18,000	24.16	19,100	24.58	20,200
23.75	18,000	24.17	19,100	24.59	20,300
23.76	18,100	24.18	19,200	24.60	20,300
23.77	18,100	24.19	19,200	24.61	20,300
23.78	18,100	24.20	19,200	24.62	20,300
23.79	18,200	24.21	19,300	24.63	20,400
23.80	18,200	24.22	19,300	24.64	20,400
23.81	18,200	24.23	19,300	24.65	20,400
23.82	18,200	24.24	19,300	24.66	20,500
23.83	18,300	24.25	19,400	24.67	20,500
23.84	18,300	24.26	19,400	24.68	20,500
23.85	18,300	24.27	19,400	24.69	20,500
23.86	18,300	24.28	19,400	24.70	20,600
23.87	18,400	24.29	19,500	24.71	20,600
23.88	18,400	24.30	19,500	24.72	20,600
23.89	18,400	24.31	19,500	24.73	20,600
23.90	18,400	24.32	19,500	24.74	20,700
23.91	18,500	24.33	19,600	24.75	20,700
23.92	18,500	24.34	19,600	24.76	20,700
23.93	18,500	24.35	19,600	24.77	20,700
23.94	18,500	24.36	19,600	24.78	20,800
23.95	18,600	24.37	19,700	24.79	20,800
23.96	18,600	24.38	19,700	24.80	20,800
23.97	18,600	24.39	19,700	24.81	20,900
23.98	18,600	24.40	19,800	24.82	20,900
23.99	18,700	24.41	19,800	24.83	20,900
24.00	18,700	24.42	19,800	24.84	20,900
24.01	18,700	24.43	19,800	24.85	21,000
24.02	18,800	24.44	19,900	24.86	21,000
24.03	18,800	24.45	19,900	24.87	21,000
24.04	18,800	24.46	19,900	24.88	21,000
24.05	18,800	24.47	19,900	24.89	21,100
24.06	18,900	24.48	20,000	24.90	21,100
24.07	18,900	24.49	20,000	24.91	21,100
24.08	18,900	24.50	20,000	24.92	21,200
24.09	18,900	24.51	20,000	24.93	21,200
24.10	19,000	24.52	20,100	24.94	21,200
24.11	19,000	24.53	20,100	24.95	21,200

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
24.96	21,300	25.38	22,400	25.80	23,600
24.97	21,300	25.39	22,400	25.81	23,700
24.98	21,300	25.40	22,500	25.82	23,700
24.99	21,300	25.41	22,500	25.83	23,700
25.00	21,400	25.42	22,500	25.84	23,800
25.01	21,400	25.43	22,600	25.85	23,800
25.02	21,400	25.44	22,600	25.86	23,800
25.03	21,500	25.45	22,600	25.87	23,900
25.04	21,500	25.46	22,600	25.88	23,900
25.05	21,500	25.47	22,700	25.89	23,900
25.06	21,500	25.48	22,700	25.90	24,000
25.07	21,600	25.49	22,700	25.91	24,000
25.08	21,600	25.50	22,700	25.92	24,000
25.09	21,600	25.51	22,800	25.93	24,100
25.10	21,600	25.52	22,800	25.94	24,100
25.11	21,700	25.53	22,800	25.95	24,100
25.12	21,700	25.54	22,900	25.96	24,200
25.13	21,700	25.55	22,900	25.97	24,200
25.14	21,800	25.56	22,900	25.98	24,200
25.15	21,800	25.57	22,900	25.99	24,200
25.16	21,800	25.58	23,000	26.00	24,300
25.17	21,800	25.59	23,000	26.01	24,300
25.18	21,900	25.60	23,000	26.02	24,300
25.19	21,900	25.61	23,100	26.03	24,400
25.20	21,900	25.62	23,100	26.04	24,400
25.21	21,900	25.63	23,100	26.05	24,400
25.22	22,000	25.64	23,100	26.06	24,500
25.23	22,000	25.65	23,200	26.07	24,500
25.24	22,000	25.66	23,200	26.08	24,500
25.25	22,100	25.67	23,200	26.09	24,600
25.26	22,100	25.68	23,300	26.10	24,600
25.27	22,100	25.69	23,300	26.11	24,600
25.28	22,100	25.70	23,300	26.12	24,700
25.29	22,200	25.71	23,400	26.13	24,700
25.30	22,200	25.72	23,400	26.14	24,700
25.31	22,200	25.73	23,400	26.15	24,800
25.32	22,200	25.74	23,400	26.16	24,800
25.33	22,300	25.75	23,500	26.17	24,800
25.34	22,300	25.76	23,500	26.18	24,900
25.35	22,300	25.77	23,500	26.19	24,900
25.36	22,400	25.78	23,600	26.20	24,900
25.37	22,400	25.79	23,600	26.21	25,000

Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Flow (cfs)
26.22	25,000	26.59	26,200	26.96	27,800
26.23	25,000	26.60	26,200	26.97	27,800
26.24	25,100	26.61	26,200	26.98	27,900
26.25	25,100	26.62	26,300	26.99	27,900
26.26	25,100	26.63	26,300	27.00	28,000
26.27	25,200	26.64	26,400	27.01	28,000
26.28	25,200	26.65	26,400	27.02	28,100
26.29	25,200	26.66	26,500	27.03	28,100
26.30	25,300	26.67	26,500	27.04	28,200
26.31	25,300	26.68	26,600	27.05	28,200
26.32	25,300	26.69	26,600	27.06	28,200
26.33	25,300	26.70	26,600	27.07	28,300
26.34	25,400	26.71	26,700	27.08	28,300
26.35	25,400	26.72	26,700	27.09	28,400
26.36	25,400	26.73	26,800	27.10	28,400
26.37	25,500	26.74	26,800	27.11	28,500
26.38	25,500	26.75	26,900	27.12	28,500
26.39	25,500	26.76	26,900	27.13	28,600
26.40	25,600	26.77	26,900	27.14	28,600
26.41	25,600	26.78	27,000	27.15	28,700
26.42	25,600	26.79	27,000	27.16	28,700
26.43	25,700	26.80	27,100	27.17	28,700
26.44	25,700	26.81	27,100	27.18	28,800
26.45	25,700	26.82	27,200	27.19	28,800
26.46	25,800	26.83	27,200	27.20	28,900
26.47	25,800	26.84	27,300	27.21	28,900
26.48	25,800	26.85	27,300	27.22	29,000
26.49	25,800	26.86	27,300	27.23	29,000
26.50	25,900	26.87	27,400	27.24	29,100
26.51	25,900	26.88	27,400	27.25	29,100
26.52	25,900	26.89	27,500	27.26	29,200
26.53	26,000	26.90	27,500	27.27	29,200
26.54	26,000	26.91	27,600	27.28	29,200
26.55	26,000	26.92	27,600	27.29	29,300
26.56	26,000	26.93	27,700	27.30	29,300
26.57	26,100	26.94	27,700	27.31	29,400
26.58	26,100	26.95	27,700	27.32	29,400

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APPENDIX B:

MIDDLE GREEN RIVER FLOODPLAIN WETLAND CONNECTION MAPS FOR 2014

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APPENDIX B:**MIDDLE GREEN RIVER FLOODPLAIN WETLAND CONNECTION MAPS FOR 2014**

This appendix presents overlays of modeled flow connections on aerial imagery of levee breaches and connection channels for floodplain wetlands surveyed in October 2014. The flow and cross section at which connection is estimated to occur is presented on each figure. For all images shown in the following figures, the date of the aerial imagery differs from the date of the survey, and aerial imagery does not depict exact conditions at the time of the survey.

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Escalante Ranch ER-IN-3

Floodplain connection
location

0 40 80

Feet

0 20 40

Meters

Imagery: Source: Esri,
DigitalGlobe, GeoEye, I-cubed,
Earthstar Geographics,
CNES/Airbus DS, USDA,
USGS, AEX, Getmapping,
Aerogrid, IGN, IGP, swisstopo,
and the GIS User Community

f116

FIGURE B-1 Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-3 at 18,100 cfs in 2014

Escalante Ranch ER-IN-4

Floodplain connection
location

0 30 60
Feet
0 10 20
Meters

Imagery: Source: Esri, DigitalGlobe,
GeoEye, i-cubed, Earthstar
Geographics, CNES/Airbus DS,
USDA, USGS, AEX, Getmapping,
Aerogrid, IGN, IGP, swisstopo, and the
GIS User Community

f117

FIGURE B-2 Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-4 at 20,000 cfs in 2014

FIGURE B-3 Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-5 at 19,400 cfs in 2014

Escalante Ranch ER-IN-7

Floodplain connection
location

0 40 80

Feet

0 20 40

Meters

Imagery: Source: Esri, DigitalGlobe,
GeoEye, i-cubed, Earthstar
Geographics, CNES/Airbus DS,
USDA, USGS, AEX, Getmapping,
Aerogrid, IGN, IGP, swisstopo, and
the GIS User Community

f119

FIGURE B-4 Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-6 at 18,900 cfs in 2014

FIGURE B-5 Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-IN-7 at 17,600 cfs in 2014

FIGURE B-6 Floodplain Wetland Connection Channel and Minimum Connection Flow for ER-OUT at 8,740 cfs in 2014

FIGURE B-7 Floodplain Wetland Connection Channel and Minimum Connection Flow for BB-IN-1 at 19,800 cfs in 2014

FIGURE B-8 Floodplain Wetland Connection Channel and Minimum Connection Flow for BB-IN-2 at 20,500 cfs in 2014

FIGURE B-9 Floodplain Wetland Connection Channel and Minimum Connection Flow for BB-IN-3 at 22,200 cfs in 2014

FIGURE B-10 Floodplain Wetland Connection Channel and Minimum Connection Flow for BB-OUT at 14,900 cfs in 2014

FIGURE B-11 Floodplain Wetland Connection Channel and Minimum Connection Flow for ST-OUT at 15,700 cfs in 2014

FIGURE B-12 Floodplain Wetland Connection Channel and Minimum Connection Flow for AB-IN-1 at 15,200 cfs in 2014

FIGURE B-13 Floodplain Wetland Connection Channel and Minimum Connection Flow for AB-IN-2 at 19,100 cfs in 2014

FIGURE B-14 Floodplain Wetland Connection Channel and Minimum Connection Flow for AB-IN-3 at 14,600 cfs in 2014

FIGURE B-15 Floodplain Wetland Connection Channel and Minimum Connection Flow for AB-OUT at 10,400 cfs in 2014

Johnson Bottom JB-OUT-1

Floodplain connection
location

0 50 100

Feet

0 25 50

Meters

Imagery: Source: Esri,
DigitalGlobe, GeoEye, i-cubed,
Earthstar Geographics,
CNES/Airbus DS, USDA, USGS,
AEX, Getmapping, Aerogrid, IGN,
IGP, swisstopo, and the GIS User
Community

f136

FIGURE B-16 Floodplain Wetland Connection Channel and Minimum Connection Flow for JB-OUT-1 at 13,600 cfs in 2014

Johnson Bottom JB-OUT-2

Floodplain connection
location

0 30 60
Feet
0 10 20
Meters

Imagery: Source: Esri,
DigitalGlobe, GeoEye, i-cubed,
Earthstar Geographics,
CNES/Airbus DS, USDA, USGS,
AEX, Getmapping, Aerogrid, IGN,
IGP, swisstopo, and the GIS User
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FIGURE B-17 Floodplain Wetland Connection Channel and Minimum Connection Flow for JB-OUT-2 at 14,100 cfs in 2014

FIGURE B-18 Floodplain Wetland Connection Channel and Minimum Connection Flow for LB7-IN at 14,500 cfs in 2014

Leota Bottom LB7A-IN

Floodplain connection
location

0 30 60
Feet
0 10 20
Meters

Imagery: Source: Esri,
DigitalGlobe, GeoEye, Earthstar
Geographics, CNES/Airbus DS,
USDA, USGS, AEX, Getmapping,
Aerogrid, IGN, IGP, swisstopo,
and the GIS User Community

f139

FIGURE B-19 Floodplain Wetland Connection Channel and Minimum Connection Flow for LB7A-IN at 12,700 cfs in 2014

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