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Managing Water in the West

Hydraulic Laboratory Report HL-2011-03

Hydraulic Model Study of Folsom Dam Joint Federal Project Permanent Operation Study

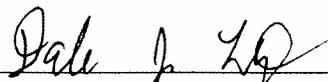


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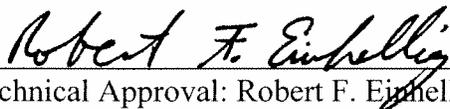
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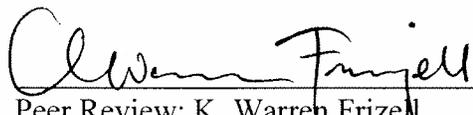
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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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APPENDICES

Appendix A. Velocity DataA1

Appendix B. Water Surface Elevation DataB1

LIST OF SYMBOLS AND ACRONYMS

COE	U.S. Army Corps of Engineers
JFP	Joint Federal Project
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
PMF	Probable maximum flood
Reclamation	Bureau of Reclamation
ft ³ /s	Cubic feet per second

Executive Summary

A 1:48-scale physical hydraulic model of the principal features of the Joint Federal Project (JFP) at Folsom Dam was constructed and tested by the Bureau of Reclamation's Hydraulic Investigations and Laboratory Services Group. The model included the main dam spillways, the auxiliary spillway and stilling basin, the confluence area of the two exit channels, and a section of the downstream river channel. This report documents model tests performed from August 2010 to January 2011 in support of the Folsom Dam Permanent Operation study. The report entitled "Hydraulic Model Study of Folsom Dam Joint Federal Project Auxiliary Spillway Confluence Area" dated February 2010 documents tests that were performed with the hydraulic model from 2007 to 2009 to address design and operational issues.

The primary objective of the permanent operations modeling was to collect information representative of pre-existing conditions to make comparisons of how conditions will change with the construction and operation of the JFP. From the data, comparisons can be made between flow conditions with and without the cofferdam and with and without the auxiliary spillway. Flow data were collected for three scenarios: with the auxiliary spillway and the cofferdam wall along the haul road, with the auxiliary spillway but without the cofferdam wall, and without the auxiliary spillway (pre-project condition). For the third scenario, the model was altered to represent topographic conditions prior to any grading or excavation for the auxiliary spillway. The haul road and exit channel to the auxiliary spillway were filled in to represent a pre-auxiliary spillway condition. Two-dimensional velocities and water surface elevations were measured at multiple locations in the model for a range of flow conditions. Photographs and video were also collected for all flow conditions.

The cofferdam wall constructed along the haul road influences flow patterns of small main dam discharges by redirecting water in front of the knob and into the river channel. When the cofferdam is not installed, some of the main dam discharge flows down the haul road to the left of the knob and into the auxiliary spillway exit channel. In general, model data show that the cofferdam affects measured velocities and observed flow patterns in the river channel when the total flow rate is 115,000 ft³/s and lower. When total flows are above 115,000 ft³/s, measured velocities and flow patterns are similar due to the submergence of the cofferdam and knob feature. Without the cofferdam wall along the haul road, the highest velocities in the notch area to the left of the knob occur when 60,000 ft³/s is released from the main dam with no flow from the auxiliary spillway.

Flow patterns without the auxiliary spillway were compared to those with the auxiliary spillway and cofferdam in place. When comparing these scenarios at total discharges of 115,000 ft³/s and lower, the flow patterns are similar except as the discharge is increased the flow enters the river channel further downstream. At discharges above 115,000 ft³/s, the flow patterns start to show significant

differences due to changes in topography pre- and post- auxiliary spillway construction. However, water surface elevations were similar for comparative flow rates.

With the exception of discharges greater than 500,000 ft³/s, the highest velocities perpendicular to a bankline for both pre- and post-auxiliary spillway constructions were measured at the condition of 7,000 ft³/s, from the main dam only. Pre-auxiliary spillway conditions noted a velocity of 15.2 ft/s perpendicular to the right bank, while post-aux spillway construction readings were 8.4 ft/s perpendicular to the right bank of the American River channel in the confluence area (cofferdam wall in place). However this condition is not likely to occur during normal operations because this discharge is typically released with some or all of the flow coming from the powerhouse. The physical model does not have the capability to release flow through the powerhouse.

Elevation Datum

Folsom Dam was originally designed and constructed using the National Geodetic Vertical Datum of 1929 (NGVD29) as an elevation reference. Design and construction documents for the current Joint Federal Project (JFP) at Folsom Dam are being prepared using the North American Vertical Datum of 1988 (NAVD88) as an elevation reference. In the vicinity of Folsom Dam, the difference in numerical value between the two elevation references is approximately 2.34 ft (i.e., 0 ft NGVD29 equals 2.34 ft NAVD88). This difference in reference elevation between the original project drawings and the JFP drawings presents a significant potential for confusion. At the request of the U.S. Army Corps of Engineers (COE), all hydraulic modeling and reporting activities related to the JFP are to be done using the original NGVD29 elevation reference. Thus, all elevations in this document, unless otherwise noted, are referenced to the NGVD29 as used in the original project design documents and drawings.

Introduction

Project Background

Folsom Dam is located on the American River about 20 miles upstream from Sacramento, California (figure 1). The dam was designed and built by the COE and transferred to the Bureau of Reclamation (Reclamation) for operation and maintenance in 1956. The existing dam and spillway are comprised of a 340-ft high and 1,400-ft long concrete gravity section flanked on each side by earthfill wing dams that extend from the gravity section to the abutments. In addition to the main section and wing dams, there is one auxiliary dam and eight smaller earthfill dikes that impound a reservoir of 1,010,000 acre-feet. The dam is operated for municipal and agricultural water supply purposes and to provide flood control protection for the city of Sacramento.

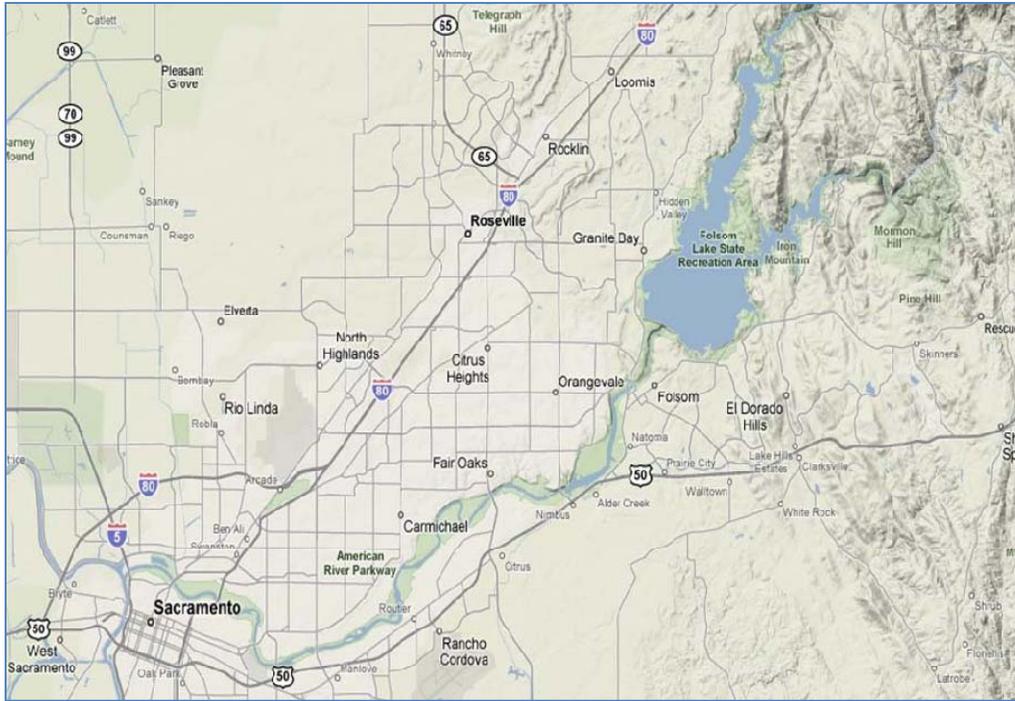


Figure 1. Location map of Folsom Dam and Lake on the American River upstream from Sacramento, California.

Components of the Joint Federal Project (JFP) are currently under construction at Folsom Dam. The JFP combines the previous efforts of Reclamation and the COE into one project that meets both Reclamation’s probable maximum flood (PMF) criteria at Folsom Dam and the COE’s flood damage reduction goals for the American River. To obtain additional discharge capacity at Folsom Dam, the JFP includes the construction of a new auxiliary spillway near the left abutment of the main dam embankment (figure 2). A detailed description of the features of Folsom Dam and background on the JFP can be found in Svoboda et al., 2010.



Figure 2. Artist's rendering of the new auxiliary spillway structure to the left of the main dam spillway structure.

Previous Model Studies

Model studies were completed in a 1:48-scale physical model of the main dam spillway, the new auxiliary spillway and stilling basin, the confluence area of the two exit channels, and a portion of the downstream river. This model was constructed and tested by Reclamation's Hydraulic Investigations and Laboratory Services Group at the Technical Service Center in Denver, Colorado from 2007 to 2011.

This report documents model tests performed from August 2010 to January 2011 in support of the Folsom Dam Permanent Operation study. The report entitled "Hydraulic Model Study of Folsom Dam Joint Federal Project Auxiliary Spillway Confluence Area" dated February 2010 documents tests that were performed from 2007 to 2009 to address design and operational issues. For detailed information on the 1:48-scale physical model features and previous test results, please reference the February 2010 report (Svoboda et al., 2010).

Model Objectives

This phase of testing is in support of the Folsom Dam Permanent Operation study. The use of the term “cofferdam” in this report refers to the reinforced concrete wall constructed along the haul road to protect the work area during excavation and construction. Model data were collected for three scenarios:

- 1.) With the auxiliary spillway and with the cofferdam.
- 2.) With the auxiliary spillway and without the cofferdam.
- 3.) Without the auxiliary spillway (pre-existing condition).

The intent of this work is to collect information representative of pre-existing conditions to make comparisons of how conditions will change with the construction and operation of the JFP. From the data, comparisons can be made between flow conditions with and without the cofferdam and with and without the auxiliary spillway.

For the first and second scenarios, data were collected with the main dam and auxiliary spillway features represented. For the third scenario, the model was altered to represent conditions as they were prior to any grading or excavations for the auxiliary spillway. The haul road and exit channel to the auxiliary spillway were filled in to represent the pre-auxiliary spillway condition.

The following study objectives were identified:

- 1.) Collect detailed velocity data adjacent to both the right and left banks downstream of the main dam and auxiliary spillways. Collect this data for an array of flows for the three conditions listed above.
- 2.) Determine water surface elevations for an array of flows for the three conditions listed above.
- 3.) Collect video and photographs for all conditions tested.

The first scenario with the auxiliary spillway and the cofferdam was modeled in the previous testing phase and documented in the February 2010 report. In this phase of modeling, additional velocity measurements for an increased number of flows were documented. Velocity and water surface elevation data from the February 2010 report were used where applicable so that testing efforts were not duplicated.

Model Description

Model Scale

A physical hydraulic model of Folsom Dam including the main dam spillway structure, the auxiliary spillway structure, and the confluence area where the spillway releases converge was constructed in Reclamation's hydraulics laboratory in Denver, Colorado in 2007. In order to include all desired model features in the floor space available and to accommodate a discharge up to 818,000 ft³/s (corresponding to the passage of the PMF at reservoir elevation 477.5 ft with 3 ft of freeboard), the physical hydraulic model was built at a 1:48 geometric scale. Low flow features such as outlet works and power plant penstocks were not modeled because the original modeling effort included only larger releases from the dam. Under normal operations, a release of up to 7,000 ft³/s can be made entirely from power plant penstocks. Outlet works can release up to about 31,600 ft³/s at a reservoir elevation of 475.4 ft. In the physical model, all flows from the main dam, regardless of size, must be released from the spillway.

Similitude between the model and the prototype is achieved when the ratios of the major forces controlling the physical processes are kept equal in the model and prototype. Since gravitational and inertial forces dominate open channel flow, Froude-scale similitude was used to establish a kinematic relationship between the model and the prototype. The Froude number is

$$F_r = \frac{v}{\sqrt{gd}}$$

where v = velocity, g = gravitational acceleration, and d = flow depth. When Froude-scale modeling is used, the following relationships exist between the model and prototype where the r subscript refers to the ratio of the prototype to the model:

Length ratio: $L_r = 1:48$

Pressure ratio: $P_r = 1:48$

Velocity ratio: $V_r = L_r^{1/2} = (48)^{1/2} = 6.93$

Time ratio: $T_r = L_r^{1/2} = (48)^{1/2} = 6.93$

Discharge ratio: $Q_r = L_r^{5/2} = (48)^{5/2} = 15,962.58$

To avoid having viscous forces affect model performance, the minimal range for turbulent flow conditions must be achieved in the model. Turbulent flow occurs

when the Reynolds number ($Re = vd/\nu$) is larger than about 2×10^3 . At a 1:48 scale, the Reynolds number was greater than 2×10^3 for most regions of the model at the lowest tested flow rates. Although turbulence is reasonably represented, there are other concerns about model accuracy at very low flows. Leakage occurs in the model boxes and at connection points. Since the model was designed for high flows, leakage is a small overall percentage of the total flow rate. At very low flows, leakage may be more influential. Differences between estimated and actual excavation zones around the haul road and auxiliary stilling basin can influence flow patterns, particularly for low discharges when topographical features are not submerged.

Model Scenarios

Detailed descriptions of features and drawings are available in the February 2010 report. For this permanent operations study, the model was modified for the three flow scenarios shown below.

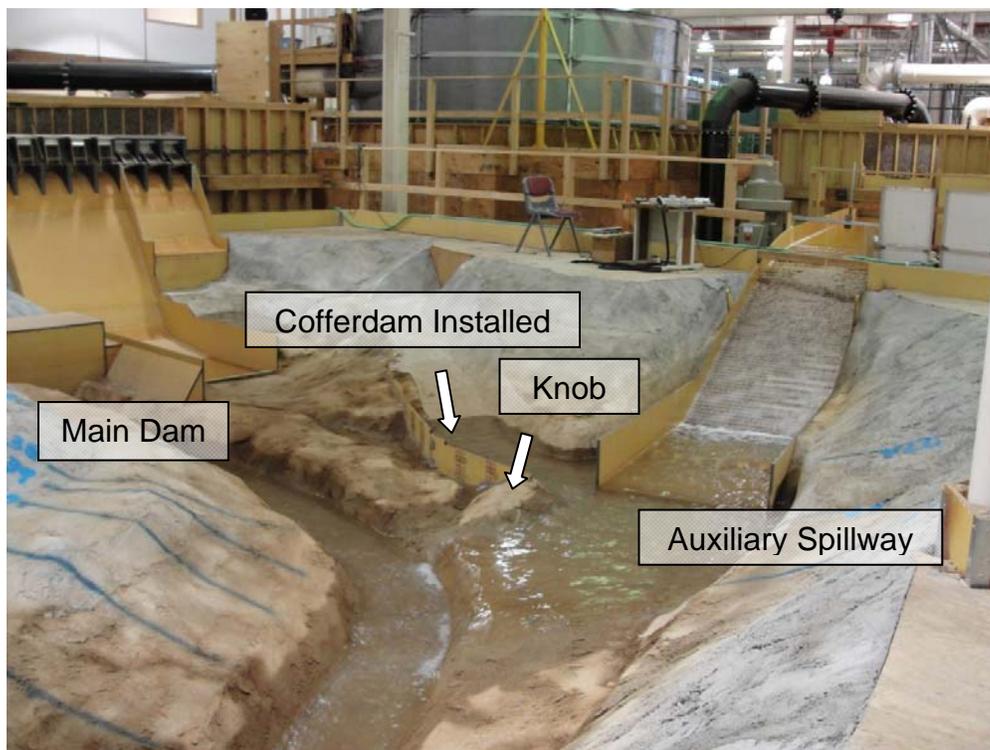


Figure 3. Folsom Dam with the auxiliary spillway and with the cofferdam.

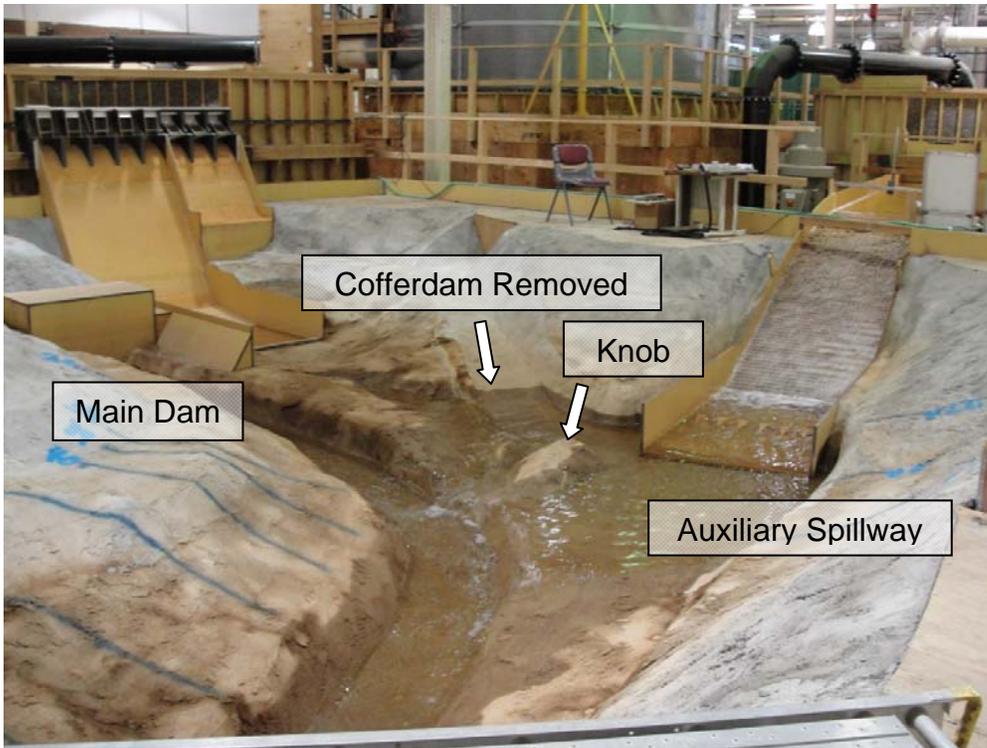


Figure 4. Folsom Dam with the auxiliary spillway and without the cofferdam.

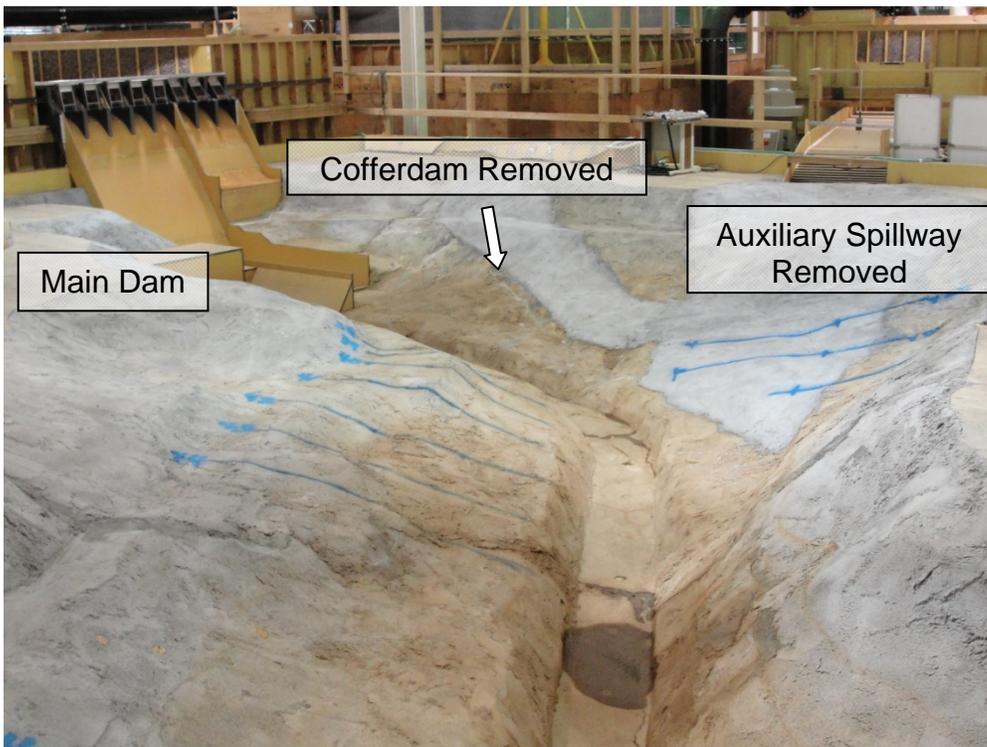


Figure 5. Folsom Dam without the auxiliary spillway and without the cofferdam (pre-existing condition). The blue plus signs in the vicinity of the proposed auxiliary spillway represent the velocity measurement stations 11-15.

Excavation for the haul road leaves a knob-like topographic feature near the confluence of the two hydraulic structures as seen in Figures 3 and 4. In the model, the knob slopes upward to a top elevation of approximately 162.0 ft. It is possible that the actual excavation at the construction site will leave a knob feature that is different in slope, shape, or elevation.

The third scenario without the auxiliary spillway and without the cofferdam represents the pre-auxiliary spillway condition (Figure 5). Topography was added to the model to fill in the haul road, auxiliary spillway, auxiliary spillway exit channel, and other excavated areas. The knob feature does not exist in the pre-project topography. The model was originally constructed with topography collected by Reclamation's Mid-Pacific Region via aerial photography in 2007. Orthophotos were converted to AutoCAD drawings and re-contoured to NGVD29 datum. This same topography was used to alter the model to the pre-auxiliary spillway condition.



Figure 6. Templates used for topography on the haul road and auxiliary spillway in altering the model to a pre-auxiliary spillway condition.

Data Collection

Instrumentation and methods for collecting velocities and water surface elevations are identical to the previous study. Velocities were measured with a handheld two-dimensional SonTek FlowTracker acoustic Doppler velocimeter mounted on a 6 ft wading rod. The instrument measures two-dimensional velocity vectors in a small remote sampling volume (about 0.1 in³) by emitting sound pulses (pings) at a specific frequency that reflect off of particles present in the water. The FlowTracker is a side-looking instrument with a 10 cm (3.94 in) sample distance to the sample volume. The FlowTracker has an instrument accuracy of $\pm 1\%$ of the measured velocity with a velocity range from ± 0.003 to 13 ft/s. All velocity measurements in this report are referred to in prototype units unless noted otherwise.

Flow velocities were measured in various locations in the American River channel and auxiliary spillway exit channel. Velocities were measured at 0.6 times the total depth from the water surface at a sample rate of 1 Hz for 30 seconds. Figure 7 shows the measurement stations and velocity orientations. Measurement stations 1-10 were located near the right bank in the American River channel. One additional measurement location was added between the stations previously designated as station 1 and station 2. Station 1 was renamed station 1A and station 1B was added. Due to the 10 cm (3.94 inch) offset of the sampling volume from the probe position for the FlowTracker instrument, velocity data were collected approximately 5 inches from the right bankline in the model, corresponding to 20 ft prototype. The velocimeter was oriented with the bankline so that the positive X velocity vector pointed downstream and the positive Y velocity vector pointed toward the left bank (Figure 7).

Stations 11-15 were located in the auxiliary spillway stilling basin and exit channel as shown in Figure 7. The velocity meter was aligned with the axis of the stilling basin such that the positive X velocity vector pointed downstream and the positive Y velocity vector pointed toward the left bankline. When the model was altered to represent the pre-project topography, velocity measurements were taken at stations 11-15, however the elevation of the ground surface was higher due to the topography of the pre-project condition (compare Figure 4 and Figure 5). Stations 16-20 were located in the confluence area along the left bank. Due to instrument geometry, measurements were collected 1 inch (4 ft prototype) from the left bankline. Like stations 1-10, the velocity meter was oriented with respect to the bankline.

Stations 21 and 22 were collected in a region designated as the “notch through the knob” formed by the haul road passing to the left of the knob feature. Data were collected with respect to the knob orientation. When water is released from the main dam and the cofferdam is in place, this area is dewatered at low flows and experiences some flow as the cofferdam is overtopped at high flows. When water is released from the main dam and the cofferdam wall is not installed, water can

flow to the left and right of the knob, producing measurable velocities in the notch through the knob. When the model was altered to represent the pre-project topography, the notch through the knob does not exist.

Water surface elevations were measured with a series of piezometer taps mounted flush with the model surface. Clear Poly-Flow tubing was run from a metal fitting at the model surface to a manometer board where readings of water surface elevation could be taken. Water levels were visually averaged to the nearest 0.001 ft model (0.048 ft prototype). Water surface elevations were recorded at the piezometer taps nearest the velocity measurement locations. Table 1 lists the velocity measurement station number and corresponding tap number at which water surface elevations were recorded during this study. Stations 13, 21, and 22 did not have a nearby piezometer tap. Piezometer tap numbers are the same as in the first phase of modeling (Svoboda et al., 2010). Tailwater elevations for a specific river flow were provided by a HEC-RAS numerical river model by the COE. Tailwater elevations were set by averaging the water surface elevations at piezometer taps 54 and 55.

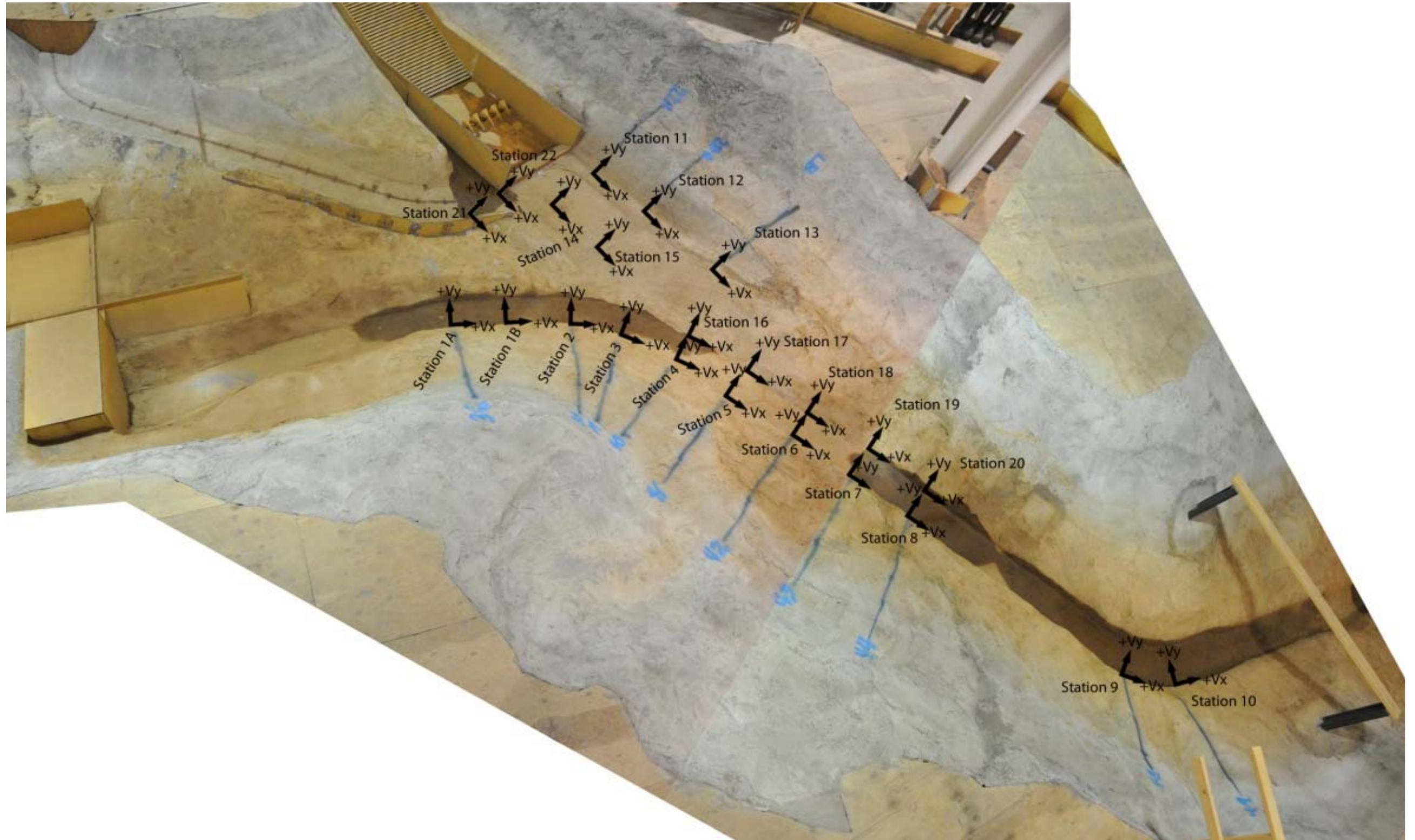


Figure 7. Velocity measurement locations and instrument orientation.

Table 1. Piezometer tap number corresponding to station. Stations 13, 21, and 22 did not have corresponding piezometer taps.

Measurement Station	Piezometer Tap Number
1A	36
1B	37
2	38
3	39
4 & 16	40
5 & 17	41
6 & 18	42
7 & 19	43
8 & 20	44
9	48
10	49
11 & 12	27
14 & 15	28
Tailwater	54
Tailwater	55

Data were collected for 38 flow combinations with the auxiliary spillway and the cofferdam and then the same 38 flow combinations were tested with the auxiliary spillway without the cofferdam. Where possible, data from the previous phase of modeling was used. After the model was modified, data were collected for 13 flow conditions with the pre-project topography.

Table 2. Flow conditions tested with the auxiliary spillway and cofferdam. Highlighted runs represent flow combinations documented in the previous modeling phase.

Test #	Main Dam Flow Rate (ft ³ /s)	Auxiliary Spillway Flow Rate (ft ³ /s)	Total Flow Rate (ft ³ /s)	Measurement Location	Tailwater Elevation (ft)
1	4,000	0	4,000	1 - 22	125.0
2	0	4,000	4,000	1 - 22	125.0
3	7,000	0	7,000	1 - 22	127.1
4	0	7,000	7,000	1 - 22	127.1
5	15,000	0	15,000	1 - 22	133.1
6	0	15,000	15,000	1 - 22	133.1
7	25,000	0	25,000	1b, 16 - 22	140.0
8	0	25,000	25,000	1b, 16 - 22	140.0
9	30,000	0	30,000	1 - 22	143.0
10	29,000	22,000	51,000	1 - 22	152.5
11	60,000	0	60,000	1b, 16 - 22	156.5
12	0	60,000	60,000	1b, 16 - 22	156.5
13	29,000	47,000	76,000	1 - 22	161.8
14	0	90,000	90,000	1b, 16 - 22	166.6
15	90,000	0	90,000	1b, 16 - 22	166.6
16	115,000	0	115,000	1b, 16 - 22	174.3
17	30,000	85,000	115,000	1 - 22	174.3
18	0	115,000	115,000	1b, 16 - 22	174.3
19	0	135,000	135,000	1 - 22	180.0
20	30,000	115,000	145,000	1 - 22	181.6
21	10,000	135,000	145,000	1 - 22	181.6
22	0	145,000	145,000	1 - 22	181.6
23	115,000	45,000	160,000	1 - 22	184.3
24	45,000	115,000	160,000	1 - 22	184.3
25	31,000	129,000	160,000	1 - 22	184.3
26	25,000	135,000	160,000	1b, 16 - 22	184.3
27	15,000	145,000	160,000	1 - 22	184.3
28	0	160,000	160,000	1b, 16 - 22	184.3
29	45,000	135,000	180,000	1 - 22	187.8
30	75,000	115,000	190,000	1 - 22	189.3
31	45,000	145,000	190,000	1 - 22	189.3
32	30,000	160,000	190,000	1 - 22	189.3
33	60,000	160,000	220,000	1 - 22	193.7
34	115,000	141,000	256,000	1 - 22	199.1
35	300,000	0	300,000	1b, 16 - 22	205.8
36	115,000	237,000	352,000	1 - 22	213.0
37	238,266	297,851	536,117	1 - 22	231.1
38	528,090	313,640	841,730	1 - 22	253.8

Table 3. Flow conditions tested with the auxiliary spillway without the cofferdam.

Test #	Main Dam Flow Rate (ft ³ /s)	Auxiliary Spillway Flow Rate (ft ³ /s)	Total Flow Rate (ft ³ /s)	Measurement Location	Tailwater Elevation (ft)
1	4,000	0	4,000	1 - 22	125.0
2	0	4,000	4,000	1 - 22	125.0
3	7,000	0	7,000	1 - 22	127.1
4	0	7,000	7,000	1 - 22	127.1
5	15,000	0	15,000	1 - 22	133.1
6	0	15,000	15,000	1 - 22	133.1
7	25,000	0	25,000	1b, 16 - 22	140.0
8	0	25,000	25,000	1b, 16 - 22	140.0
9	30,000	0	30,000	1 - 22	143.0
10	29,000	22,000	51,000	1 - 22	152.5
11	60,000	0	60,000	1b, 16 - 22	156.5
12	0	60,000	60,000	1b, 16 - 22	156.5
13	29,000	47,000	76,000	1 - 22	161.8
14	0	90,000	90,000	1b, 16 - 22	166.6
15	90,000	0	90,000	1b, 16 - 22	166.6
16	115,000	0	115,000	1b, 16 - 22	174.3
17	30,000	85,000	115,000	1 - 22	174.3
18	0	115,000	115,000	1b, 16 - 22	174.3
19	0	135,000	135,000	1 - 22	180.0
20	30,000	115,000	145,000	1 - 22	181.6
21	10,000	135,000	145,000	1 - 22	181.6
22	0	145,000	145,000	1 - 22	181.6
23	115,000	45,000	160,000	1 - 22	184.3
24	45,000	115,000	160,000	1 - 22	184.3
25	31,000	129,000	160,000	1 - 22	184.3
26	25,000	135,000	160,000	1b, 16 - 22	184.3
27	15,000	145,000	160,000	1 - 22	184.3
28	0	160,000	160,000	1b, 16 - 22	184.3
29	45,000	135,000	180,000	1 - 22	187.8
30	75,000	115,000	190,000	1 - 22	189.3
31	45,000	145,000	190,000	1 - 22	189.3
32	30,000	160,000	190,000	1 - 22	189.3
33	60,000	160,000	220,000	1 - 22	193.7
34	115,000	141,000	256,000	1 - 22	199.1
35	300,000	0	300,000	1b, 16 - 22	205.8
36	115,000	237,000	352,000	1 - 22	213.0
37	238,266	297,851	536,117	1 - 22	231.1
38	528,090	313,640	841,730	1 - 22	253.8

Table 4. Flow conditions tested without the auxiliary spillway and without the cofferdam.

Test #	Main Dam Flow Rate (ft ³ /s)	Auxiliary Spillway Flow Rate (ft ³ /s)	Total Flow Rate (ft ³ /s)	Measurement Location	Tailwater Elevation (ft)
1*	4,000	0	4,000	1 - 20	125.0
2*	7,000	0	7,000	1 - 20	127.1
3*	15,000	0	15,000	1 - 20	133.1
4*	25,000	0	25,000	1 - 20	140.0
5*	30,000	0	30,000	1 - 20	143.0
6	45,000	0	45,000	1 - 20	150.0
7*	60,000	0	60,000	1 - 20	156.5
8	75,000	0	75,000	1 - 20	161.5
9*	90,000	0	90,000	1 - 20	166.6
10*	115,000	0	115,000	1 - 20	174.3
11	238,266	0	238,266	1 - 20	196.4
12	300,000	0	300,000	1 - 20	205.8
13	528,090	0	528,090	1 - 20	239.6

Results

Comparative velocity and water surface elevation data are graphically displayed for all conditions below. Photos of all model scenarios are also presented. All tabular data is compiled in Appendices A and B. If there is not a data point for a given station, there was either no water at that station or the water was too shallow or too turbulent to obtain a velocity measurement. Descriptions of data gaps in the graphs (no water, too shallow, etc.) are found in the appendices.

Main Dam flow rate 4,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 4,000 ft³/s with a tailwater elevation of 125.0 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

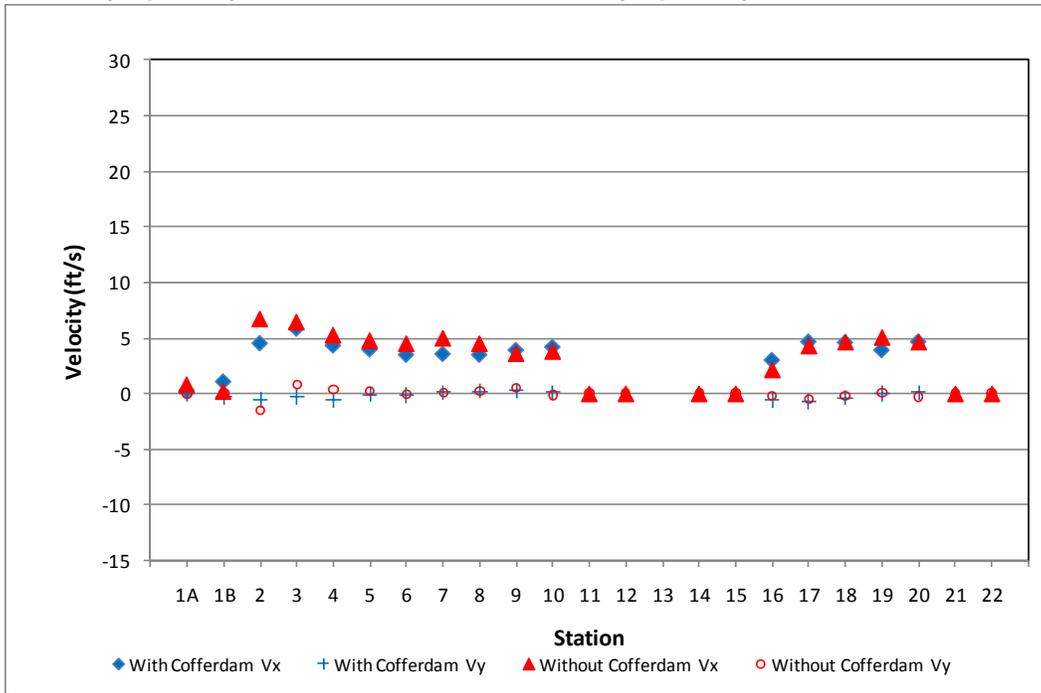


Figure 8. Main dam 4,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 125.0 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

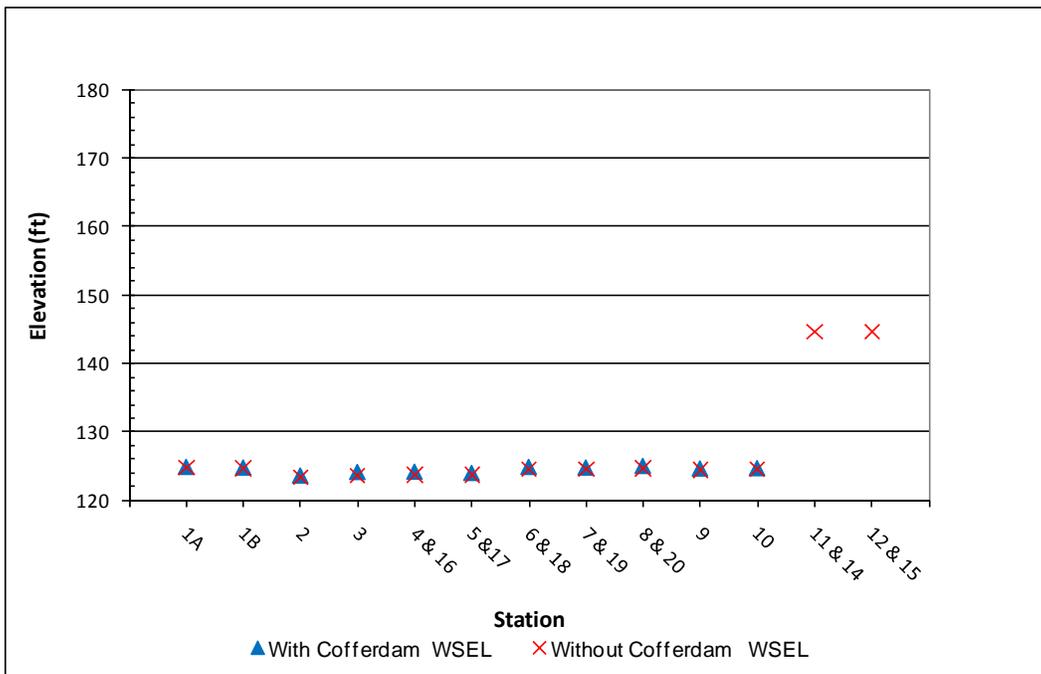


Figure 9. Main dam 4,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 125.0 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

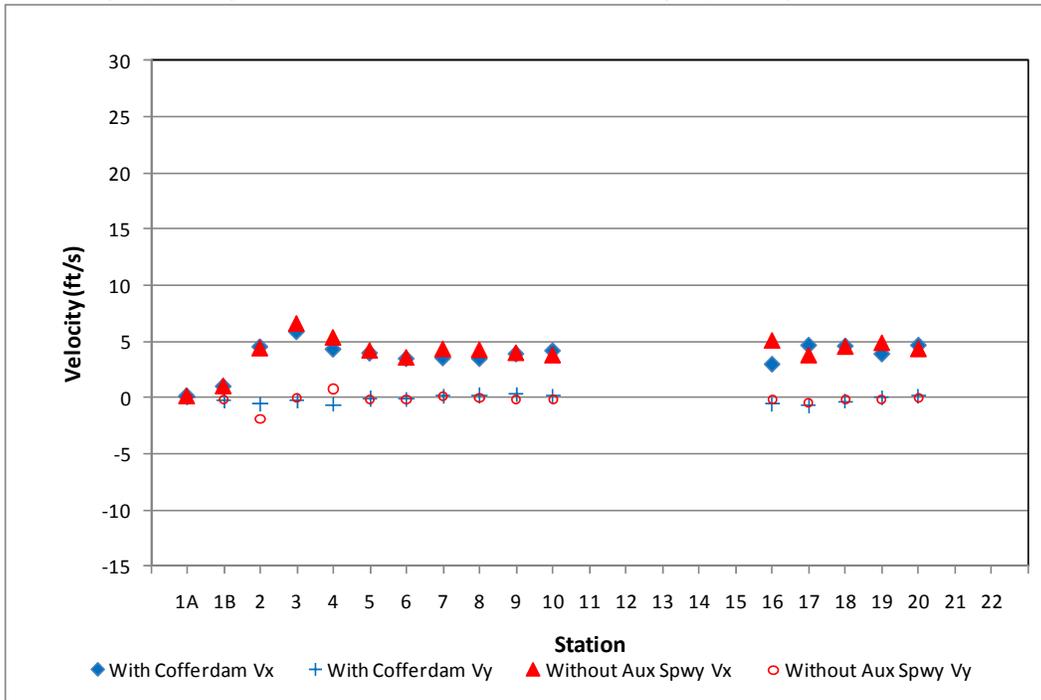


Figure 10. Main dam 4,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 125.0 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

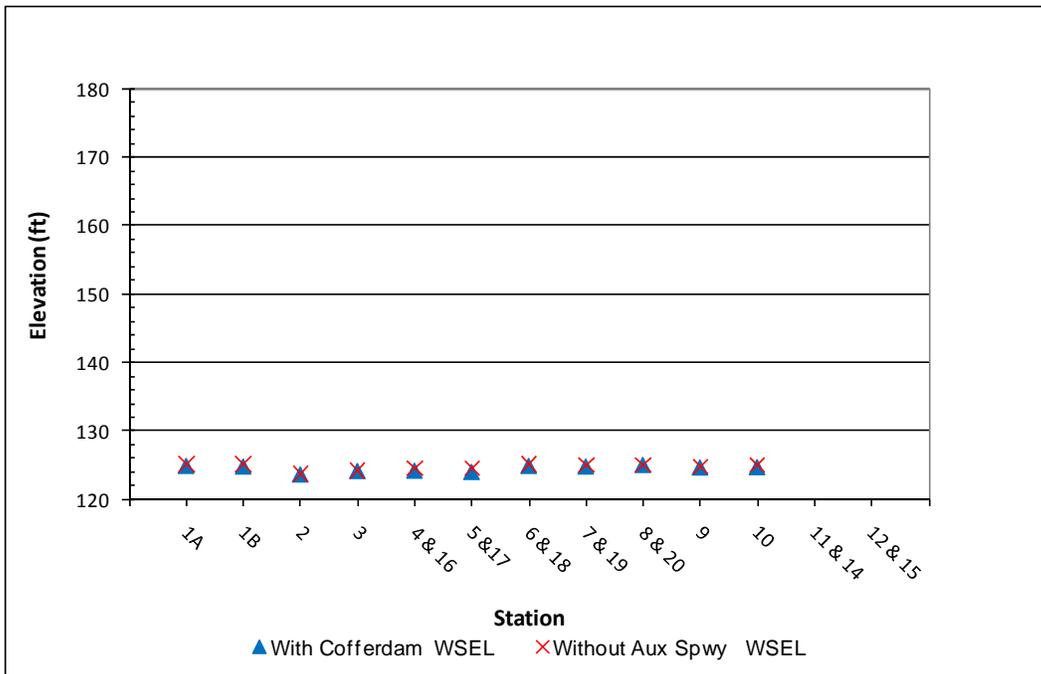


Figure 11. Main dam 4,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 125.0 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 12. Main dam $4,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ with the cofferdam. The cofferdam deflects all water into the main channel.



Figure 13. Main dam $4,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the cofferdam. Water pools on the access road and in the auxiliary stilling basin exit channel.

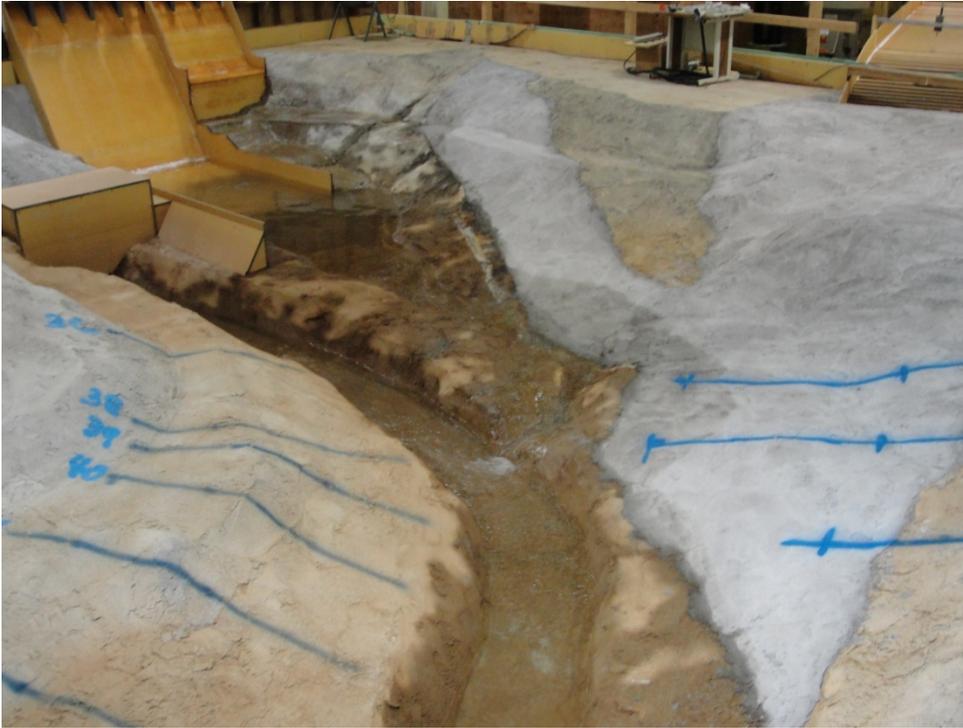


Figure 14. Main dam $4,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the auxiliary spillway.

Main Dam flow rate 0 ft³/s and auxiliary spillway 4,000 ft³/s for a total of 4,000 ft³/s with a tailwater elevation of 125.0 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

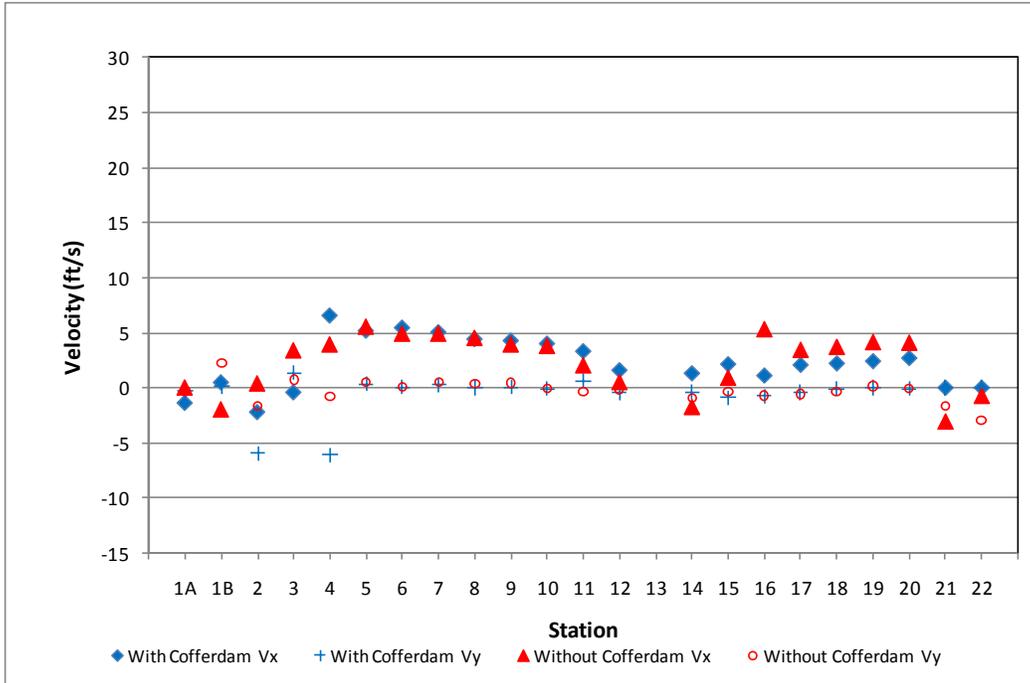


Figure 15. Main dam 0 ft³/s and auxiliary spillway 4,000 ft³/s with tailwater 125.0 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

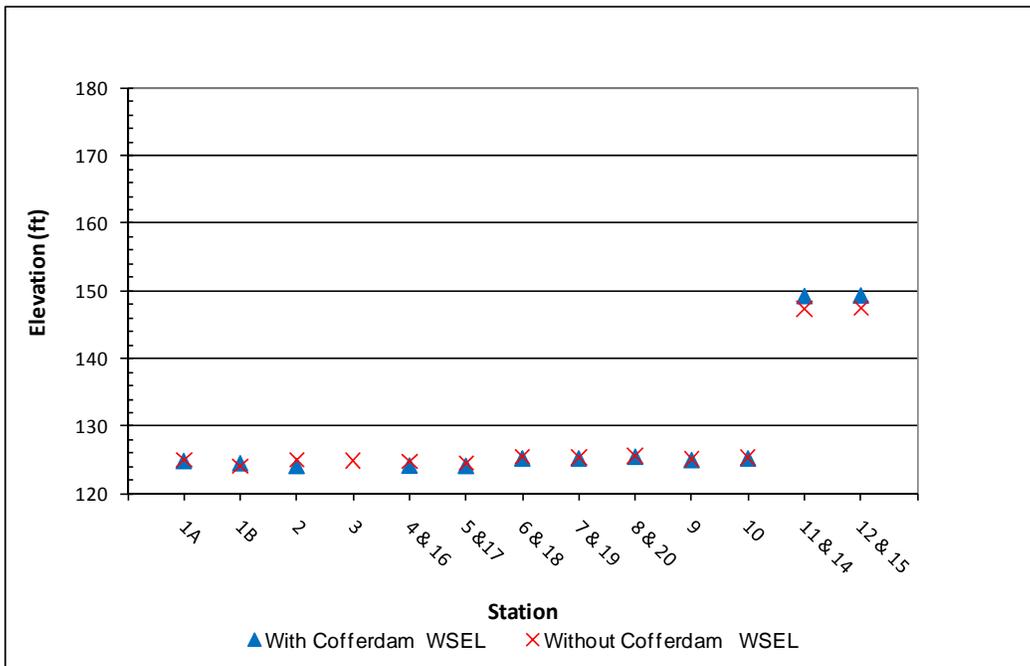


Figure 16. Main dam 0 ft³/s and auxiliary spillway 4,000 ft³/s with tailwater 125.0 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam. The data point at station 3 with the cofferdam was removed because it was in error.



Figure 17. Main dam 0 ft³/s and auxiliary spillway 4,000 ft³/s with the cofferdam. Water is backwatered on the access road.



Figure 18. Main dam 0 ft³/s and auxiliary spillway 4,000 ft³/s without the cofferdam. Water flows up the access road between the knob and the auxiliary spillway then down to the main channel.

Main Dam flow rate 7,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 7,000 ft³/s with a tailwater elevation of 127.14 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

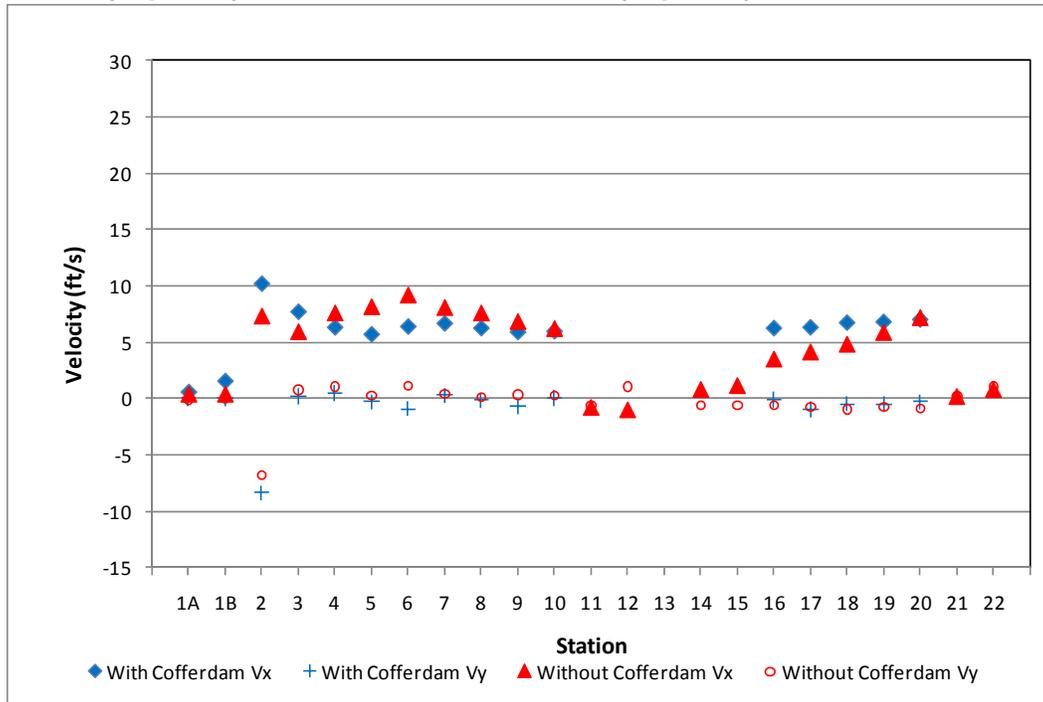


Figure 19. Main dam 7,000 ft³/s and aux spillway 0 ft³/s with tailwater 127.14 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

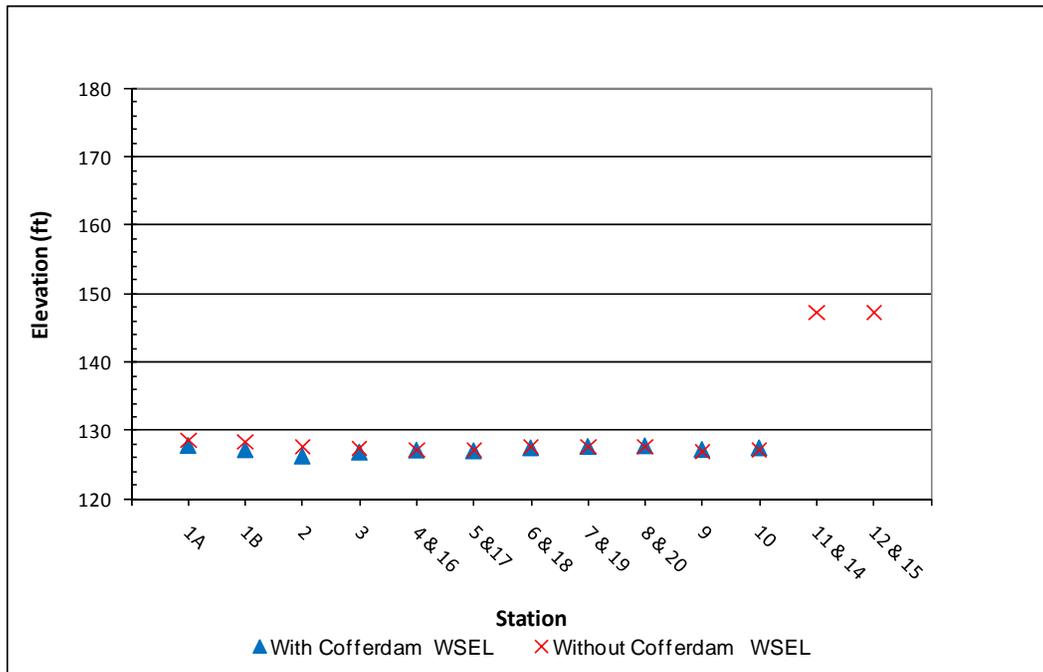


Figure 20. Main dam 7,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 127.14 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

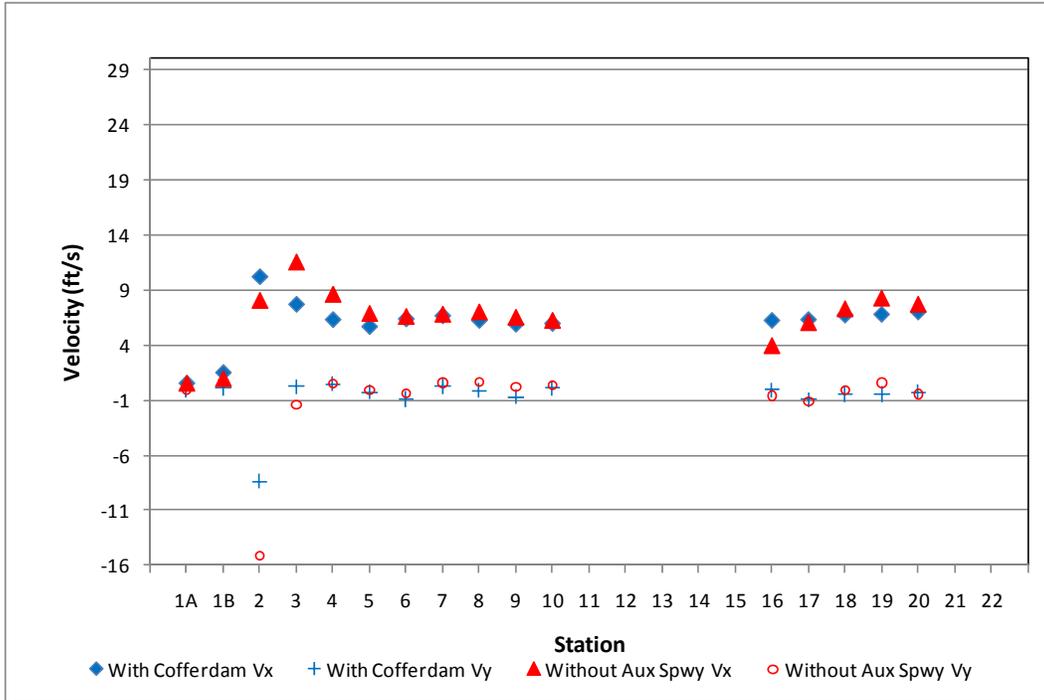


Figure 21. Main dam 7,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 127.14 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

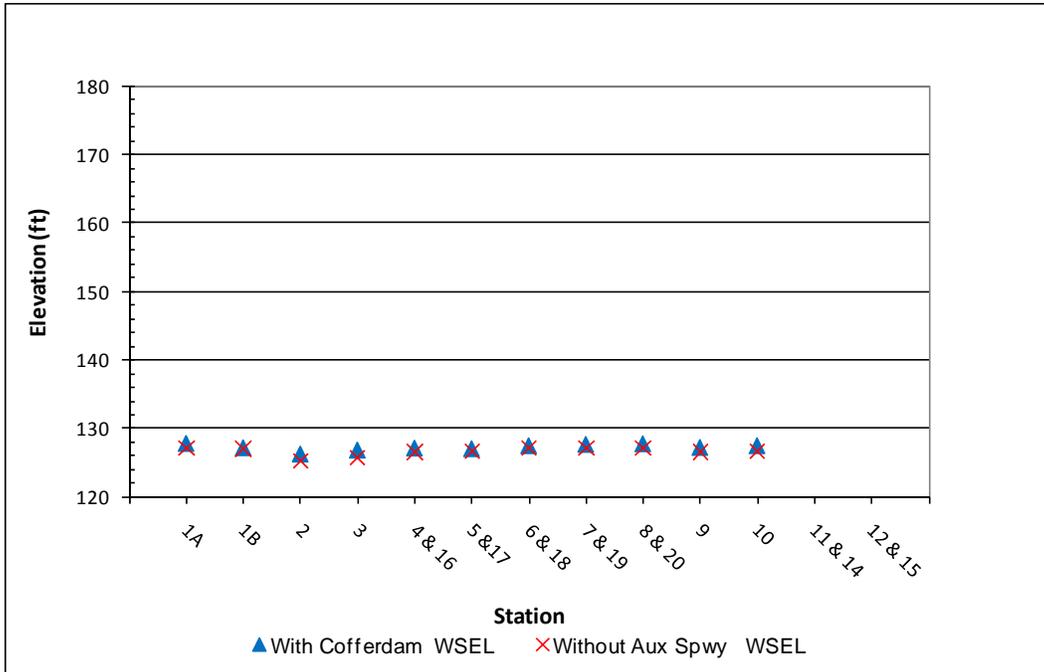


Figure 22. Main dam 7,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 127.14 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 23. Main dam $7,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ with the cofferdam. The cofferdam deflects all water into the main channel.



Figure 24. Main dam $7,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the cofferdam. Water pools on the haul road and in the auxiliary stilling basin exit channel.



Figure 25. Main dam $7,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the auxiliary spillway.

Main Dam flow rate 0 ft³/s and auxiliary spillway 7,000 ft³/s for a total of 7,000 ft³/s with a tailwater elevation of 127.14 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

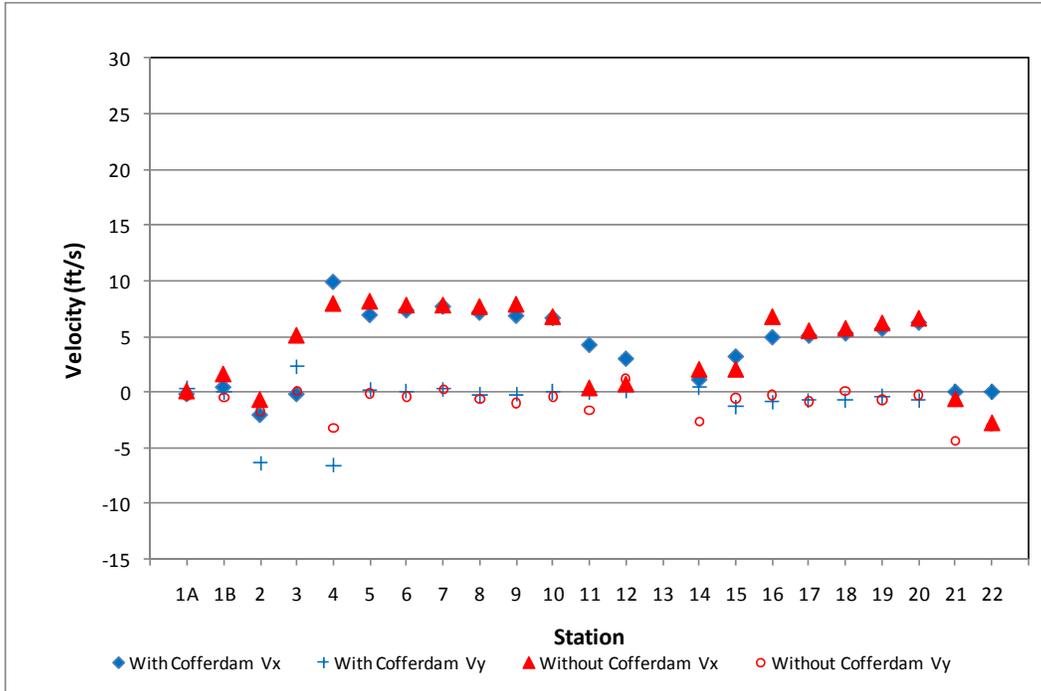


Figure 26. Main dam 0 ft³/s and auxiliary spillway 7,000 ft³/s with tailwater 127.14 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

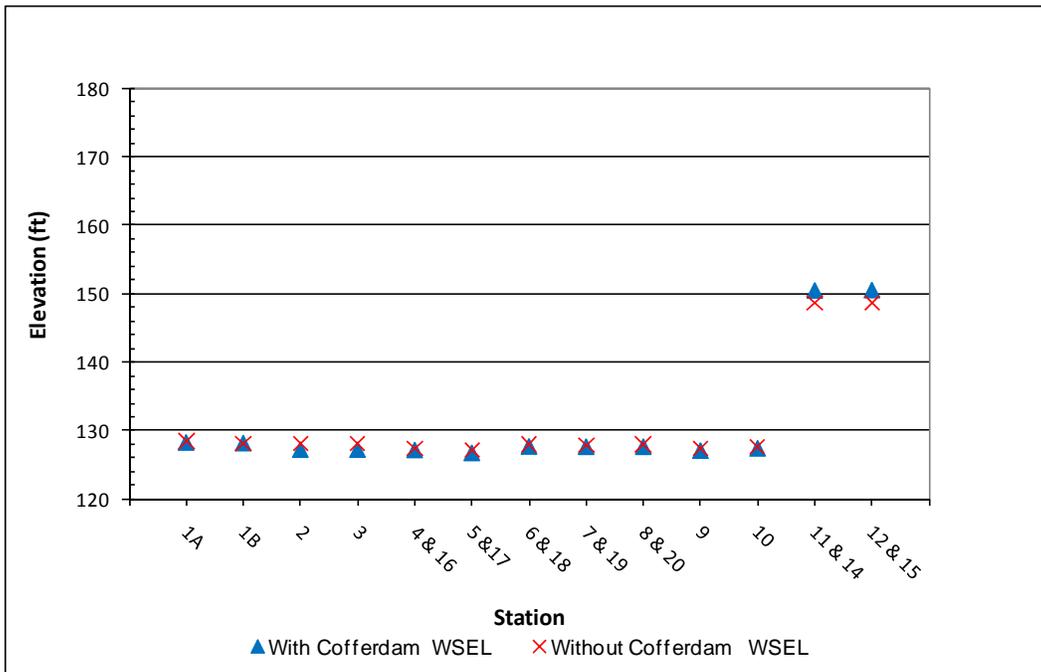


Figure 27. Main dam 0 ft³/s and auxiliary spillway 7,000 ft³/s with tailwater 127.14 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 28. Main dam $0 \text{ ft}^3/\text{s}$ and auxiliary spillway $7,000 \text{ ft}^3/\text{s}$ with the cofferdam. Water is backwatered on the access road.



Figure 29. Main dam $0 \text{ ft}^3/\text{s}$ and auxiliary spillway $7,000 \text{ ft}^3/\text{s}$ without the cofferdam. Some water flows up the access road between the knob and the auxiliary spillway then down to the main channel.

Main Dam flow rate 15,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 15,000 ft³/s with a tailwater elevation of 133.14 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

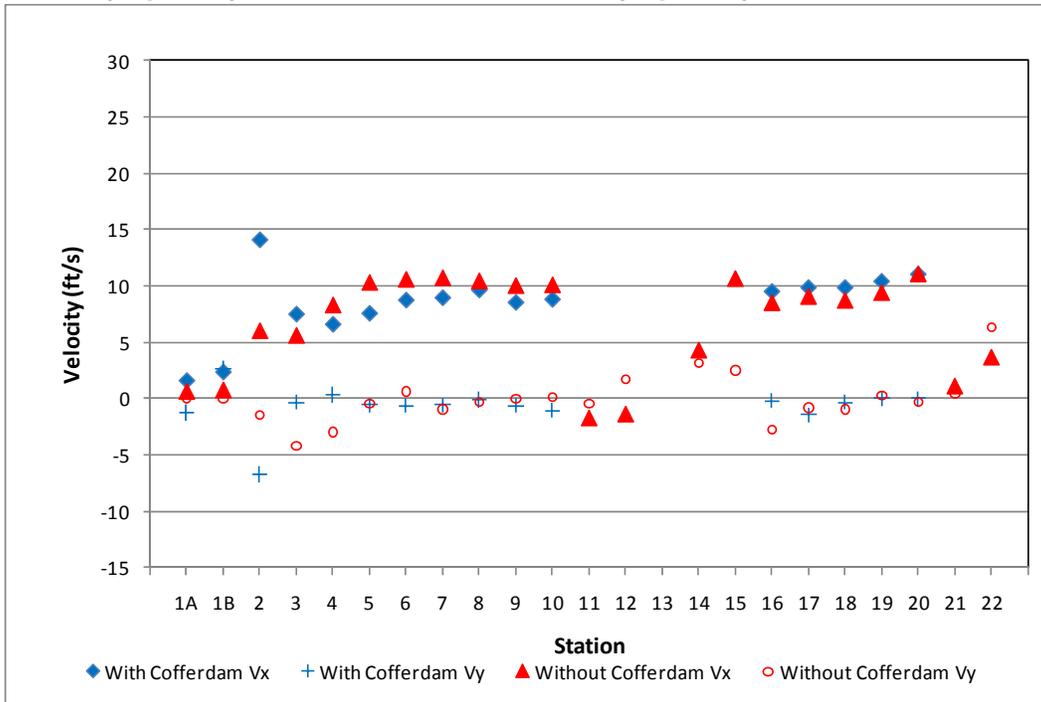


Figure 30. Main dam 15,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 133.14 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

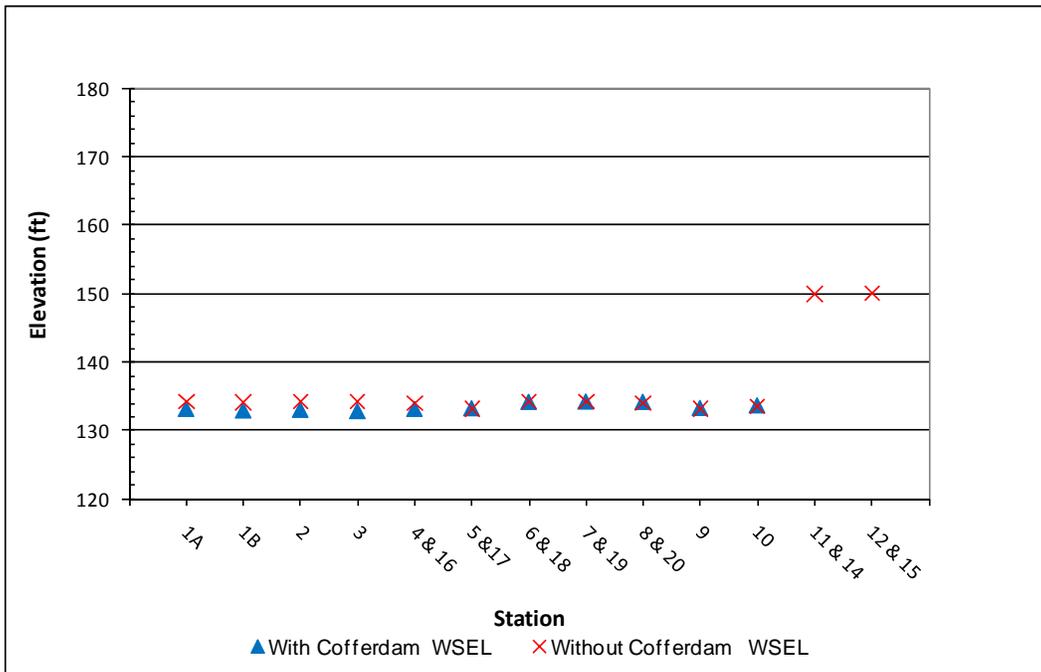


Figure 31. Main dam 15,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 133.14 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

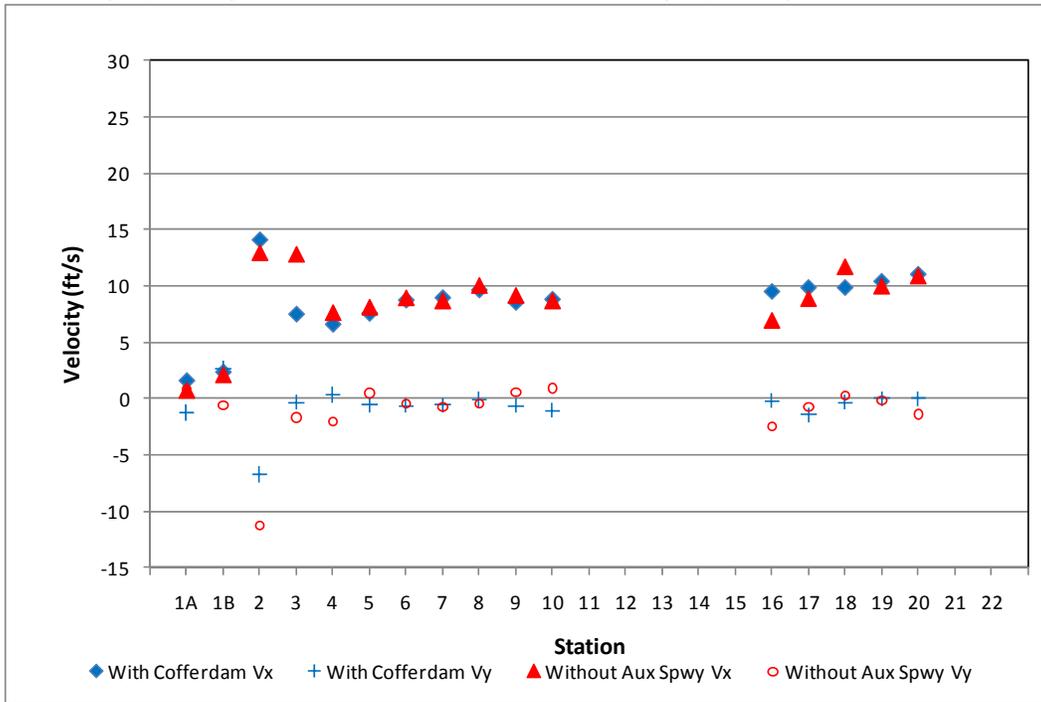


Figure 32. Main dam 15,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 133.14 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

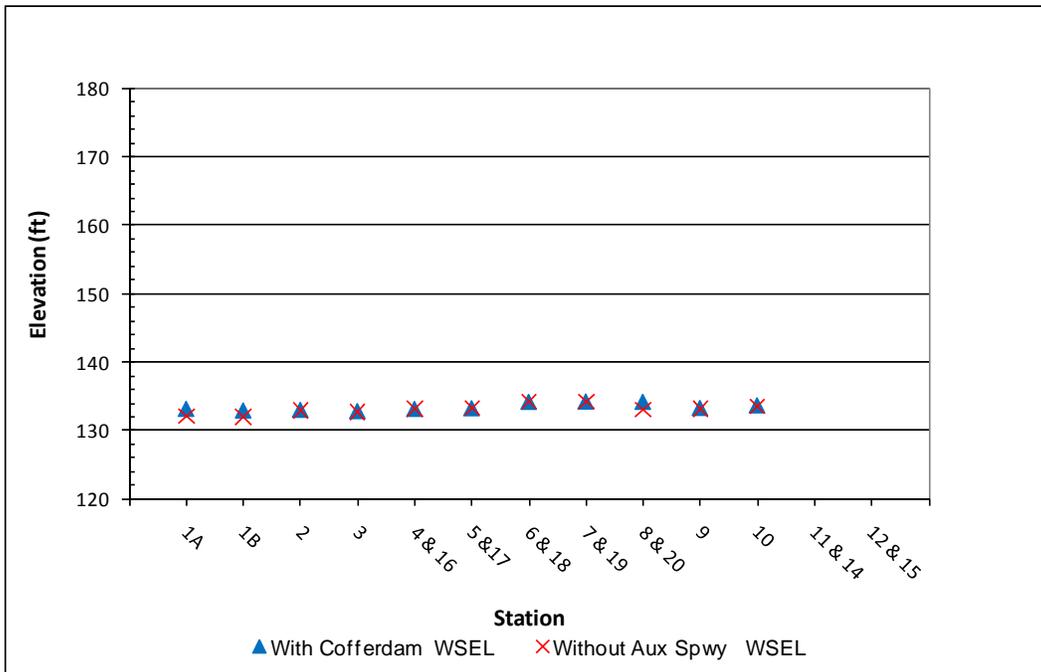


Figure 33. Main dam 15,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 133.14 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 34. Main dam 15,000 ft³/s and auxiliary spillway 0 ft³/s with the cofferdam. The cofferdam deflects all water into the main channel.



Figure 35. Main dam 15,000 ft³/s and auxiliary spillway 0 ft³/s without the cofferdam. Water pools on the access road and in the auxiliary stilling basin exit channel.



Figure 36. Main dam $15,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the auxiliary spillway.

Main Dam flow rate 0 ft³/s and auxiliary spillway 15,000 ft³/s for a total of 15,000 ft³/s with a tailwater elevation of 133.14 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

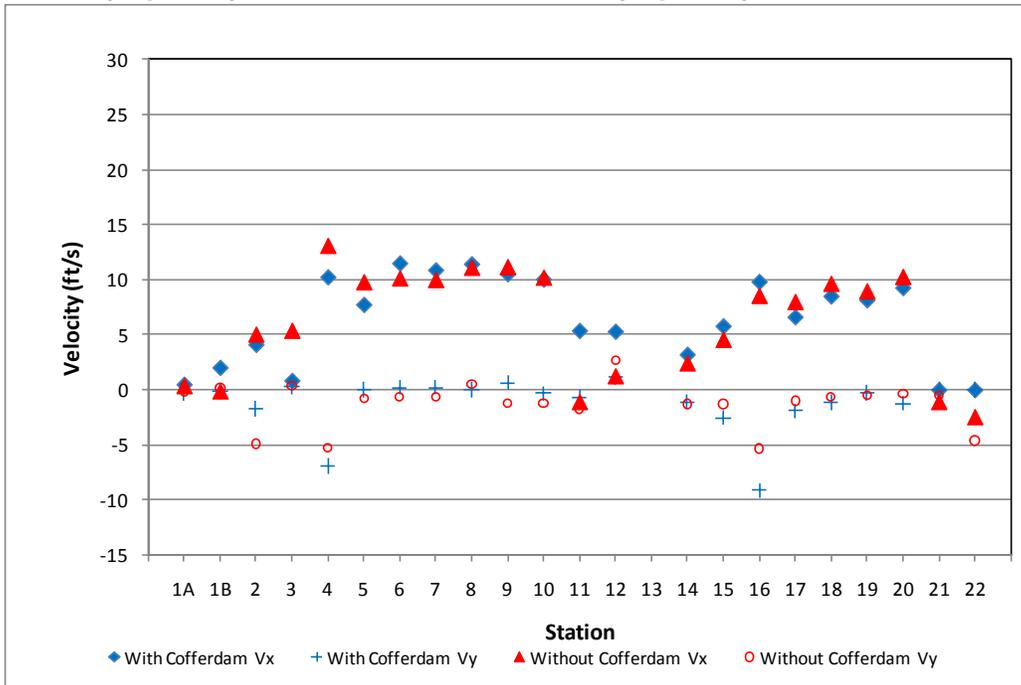


Figure 37. Main dam 0 ft³/s and auxiliary spillway 15,000 ft³/s with tailwater 133.14 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

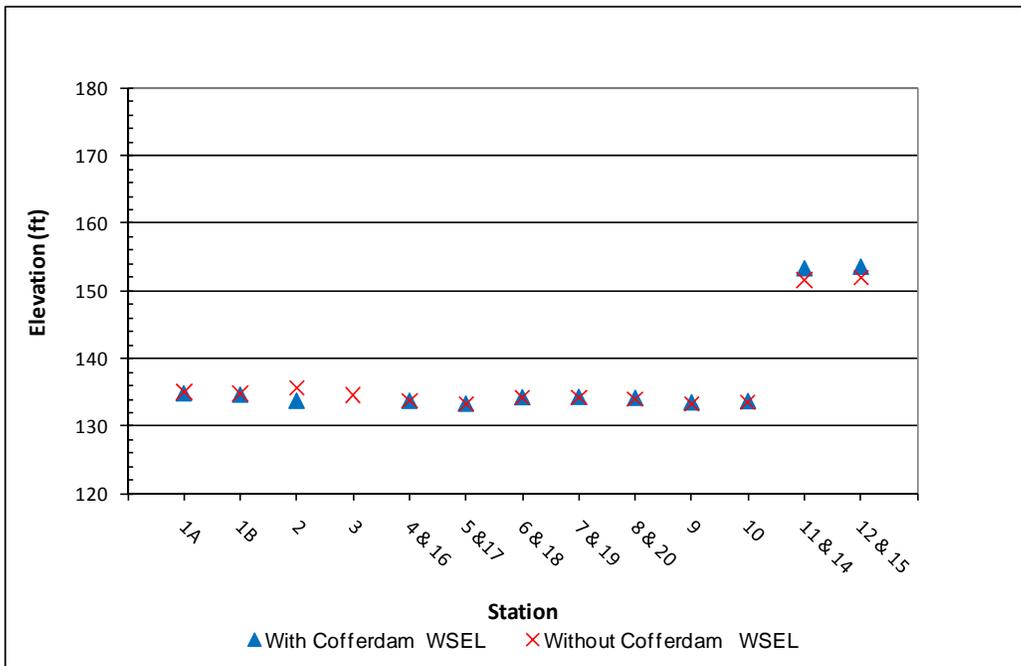


Figure 38. Main dam 0 ft³/s and auxiliary spillway 15,000 ft³/s with tailwater 133.14 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam. The data point at station 3 with the cofferdam was removed because it was in error.



Figure 39. Main dam 0 ft³/s and auxiliary spillway 15,000 ft³/s with the cofferdam. Water is backwatered on the access road.



Figure 40. Main dam 0 ft³/s and auxiliary spillway 15,000 ft³/s without the cofferdam.

Main Dam flow rate 25,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 25,000 ft³/s with a tailwater elevation of 140.0 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

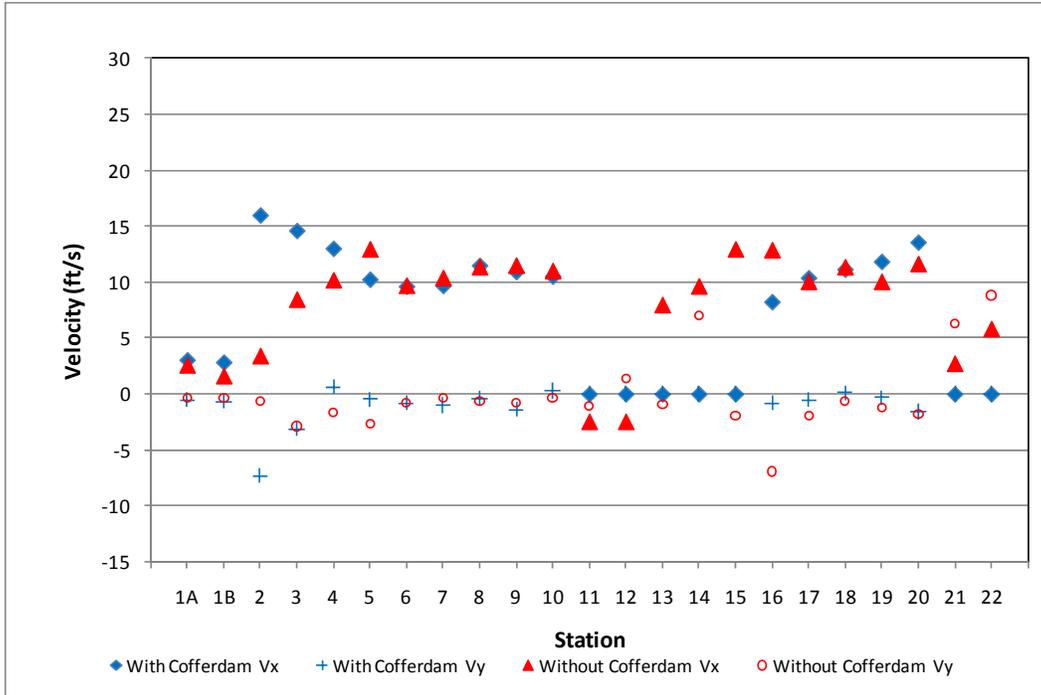


Figure 41. Main dam 25,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 140.0 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

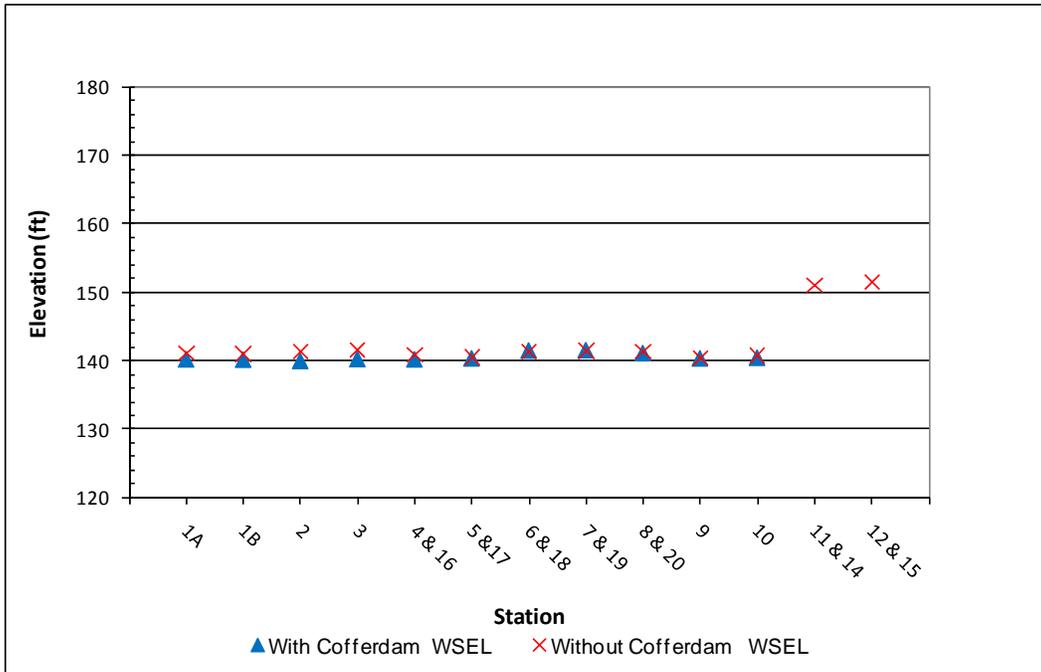


Figure 42. Main dam 25,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 140.0 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

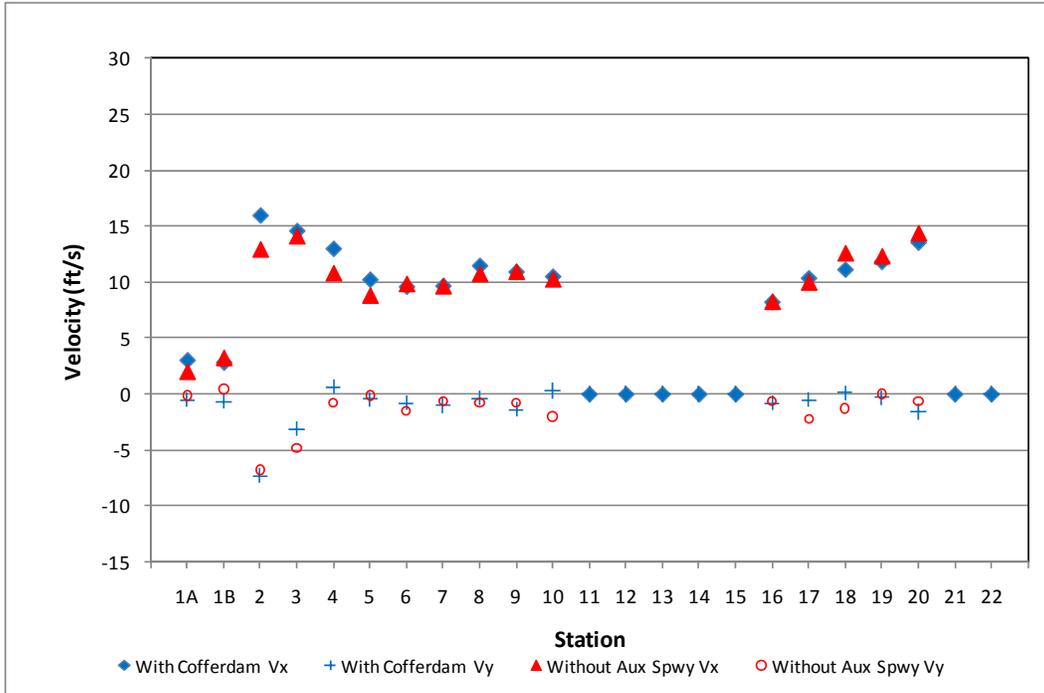


Figure 43. Main dam 25,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 140.0 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

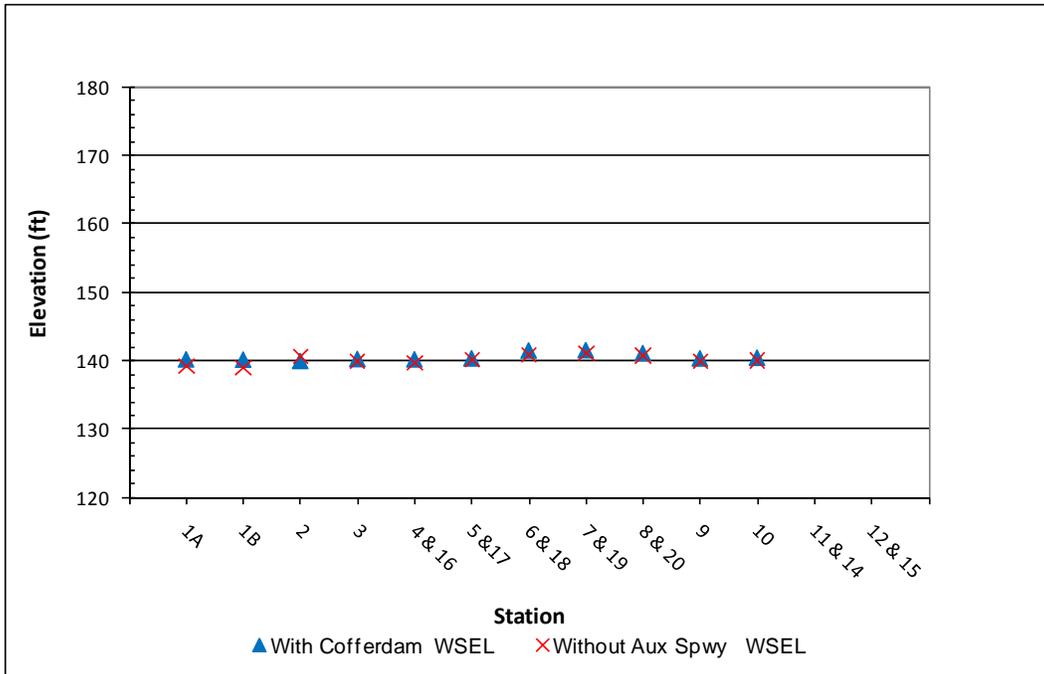


Figure 44. Main dam 25,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 140.0 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 45. Main dam $25,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ with the cofferdam. Small surges of water splash over the top of the knob.



Figure 46. Main dam $25,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the cofferdam. Surges of water splash over the top of the knob. A hydraulic jump forms on the access road.



Figure 47. Main dam 25,000 ft³/s and auxiliary spillway 0 ft³/s without the auxiliary spillway.

Main Dam flow rate 0 ft³/s and auxiliary spillway 25,000 ft³/s for a total of 25,000 ft³/s with a tailwater elevation of 140.0 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

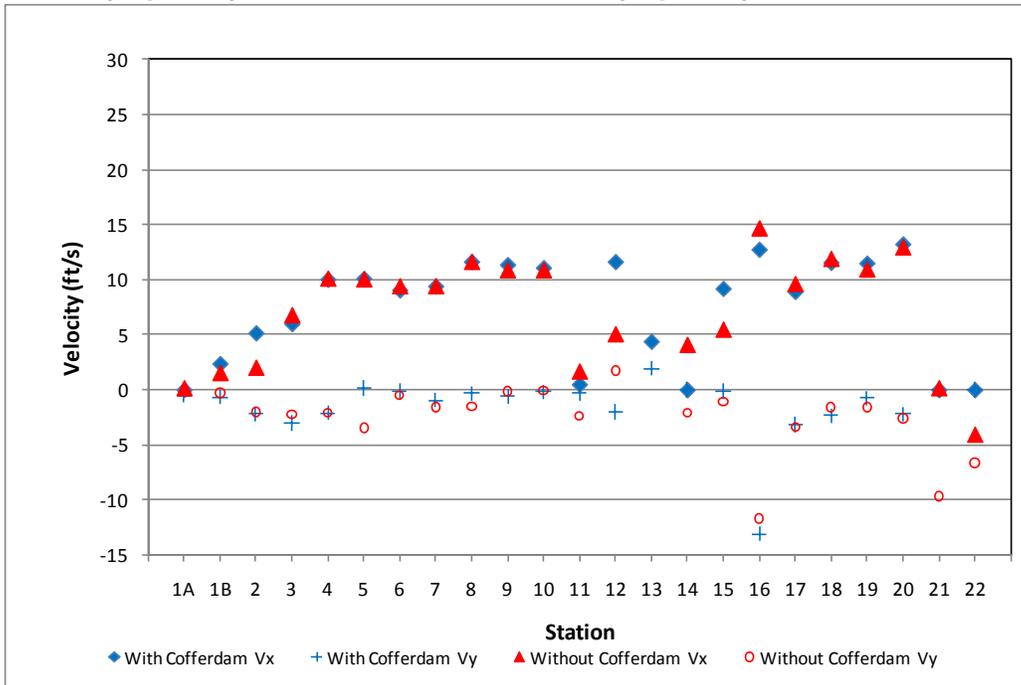


Figure 48. Main dam 0 ft³/s and auxiliary spillway 25,000 ft³/s with tailwater 140.0 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

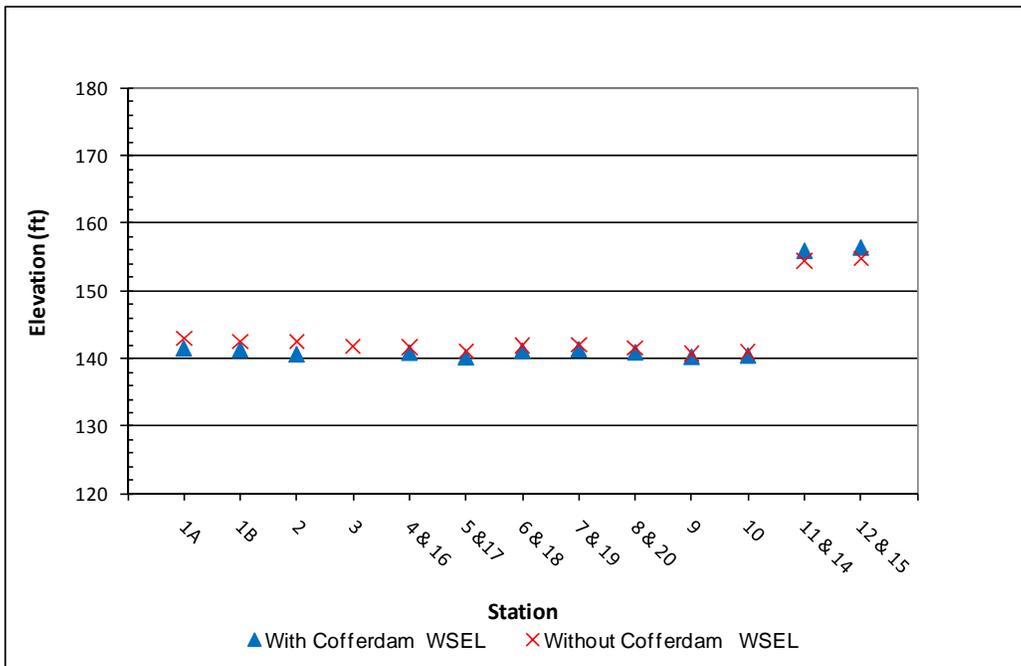


Figure 49. Main dam 0 ft³/s and auxiliary spillway 25,000 ft³/s with tailwater 140.0 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam. The data point at station 3 with the cofferdam was removed because it was in error.



Figure 50. Main dam 0 ft³/s and auxiliary spillway 25,000 ft³/s with the cofferdam. Water is backwatered on the access road.



Figure 51. Main dam 0 ft³/s and auxiliary spillway 25,000 ft³/s without the cofferdam. Water flows around the backside of the knob.

Main Dam flow rate 30,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 30,000 ft³/s with a tailwater elevation of 143.0 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

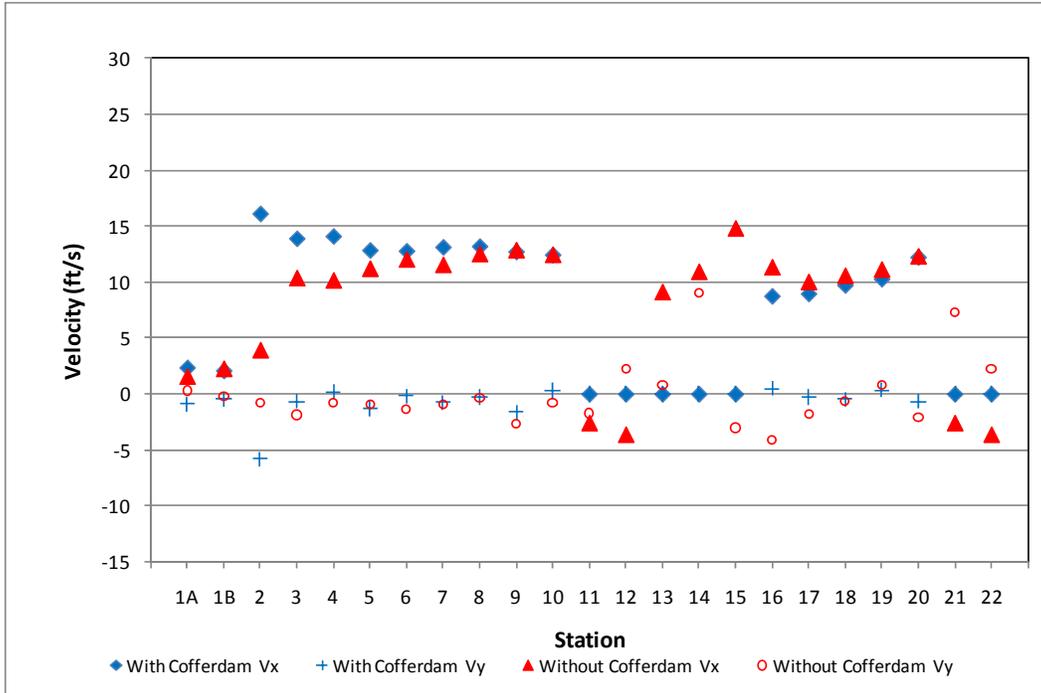


Figure 52. Main dam 30,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 143.0 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

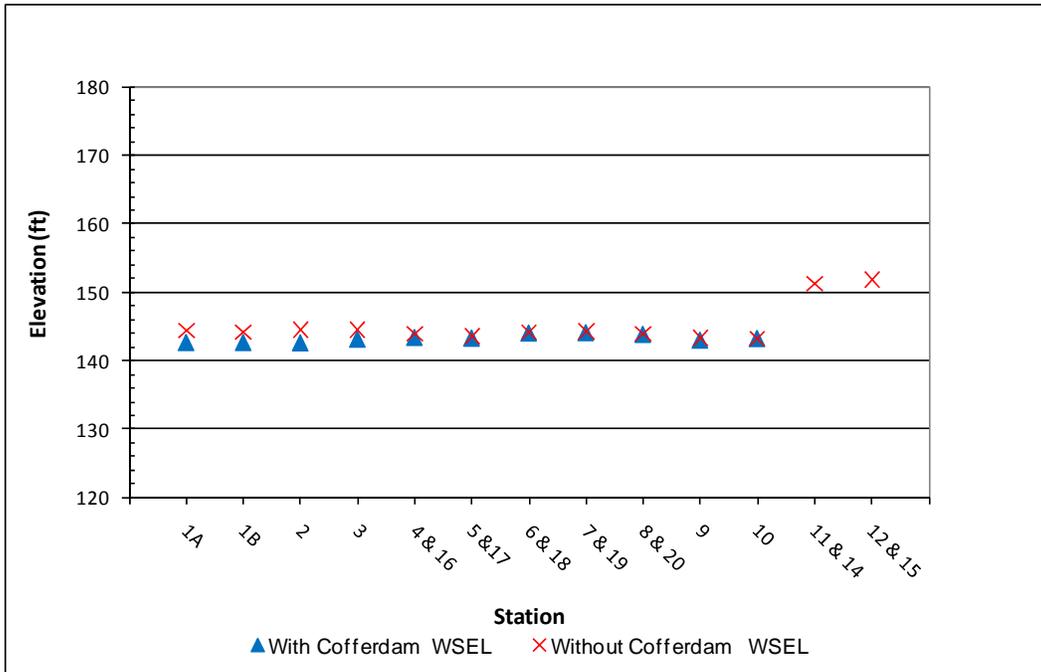


Figure 53. Main dam 30,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 143.0 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

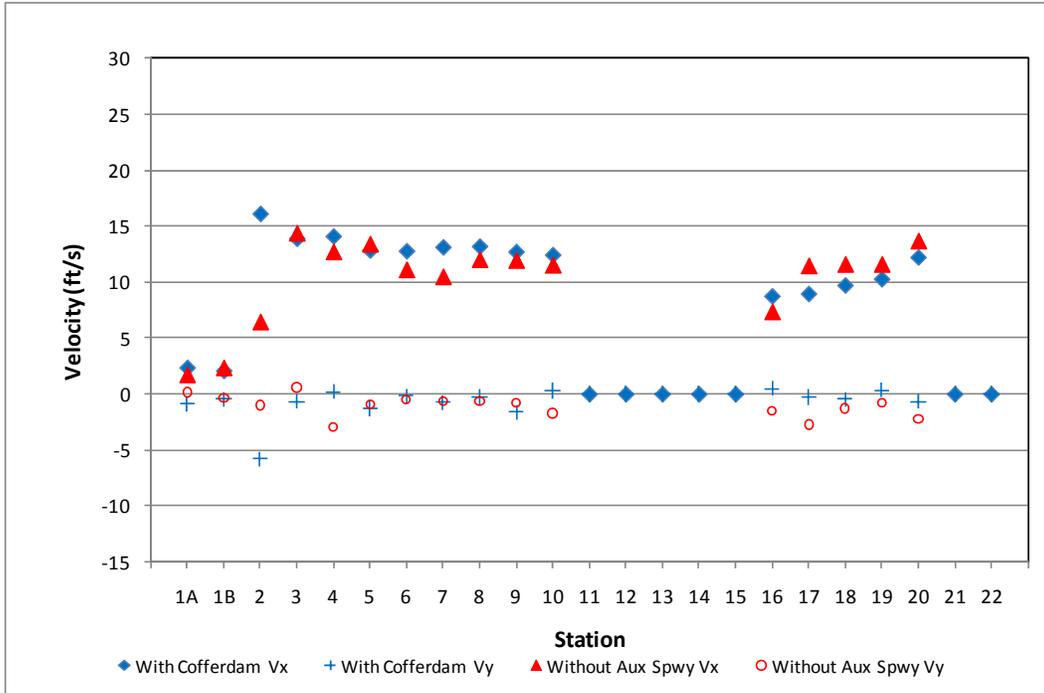


Figure 54. Main dam 30,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 143.0 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

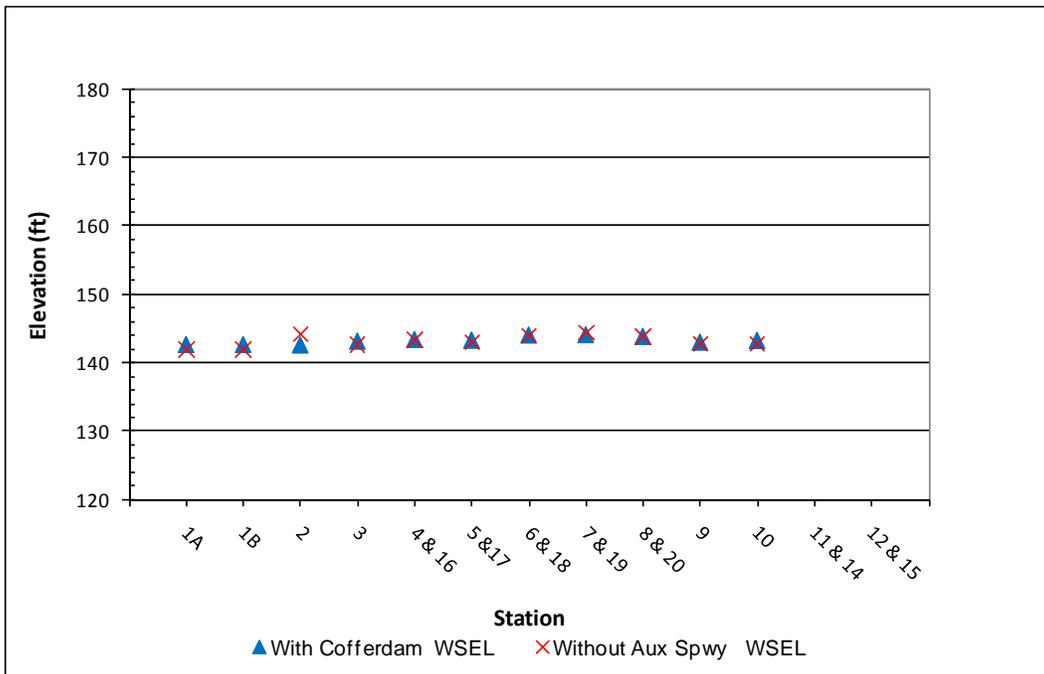


Figure 55. Main dam 30,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 143.0 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 56. Main dam 30,000 ft³/s and auxiliary spillway 0 ft³/s with the cofferdam. Surges of water flow over the top of the knob.



Figure 57. Main dam 30,000 ft³/s and auxiliary spillway 0 ft³/s without the cofferdam. Water flows around the backside of the knob.



Figure 58. Main dam $30,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the auxiliary spillway.

Main Dam flow rate 45,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 45,000 ft³/s with a tailwater elevation of 150.0 ft.

No Auxiliary spillway

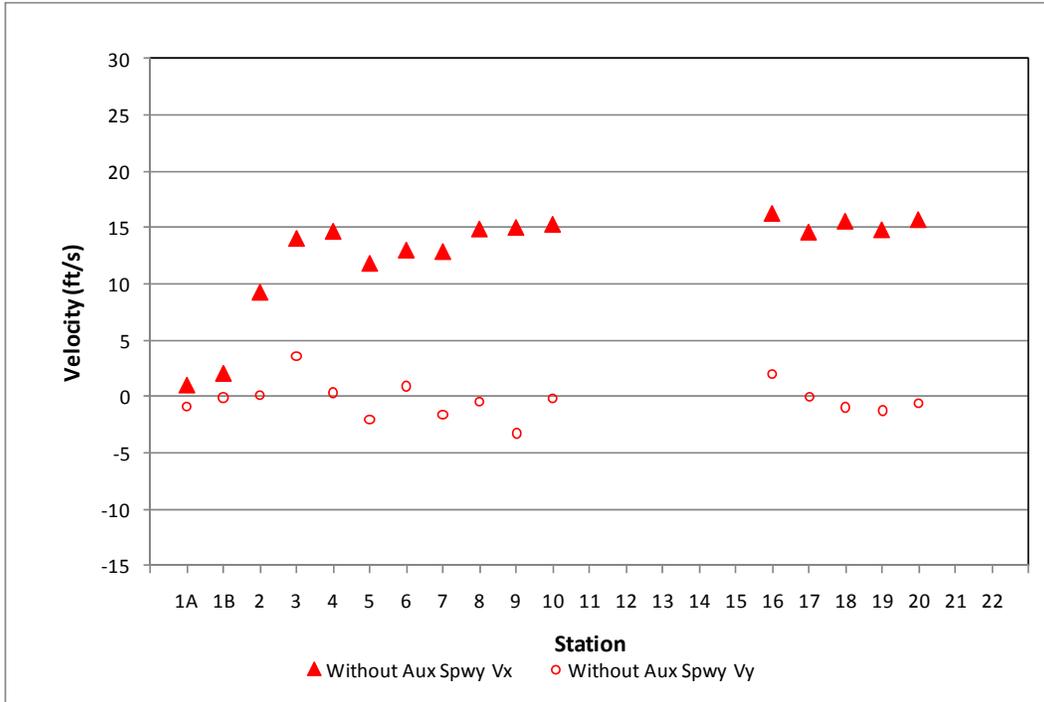


Figure 59. Main dam 45,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 150.0 ft.

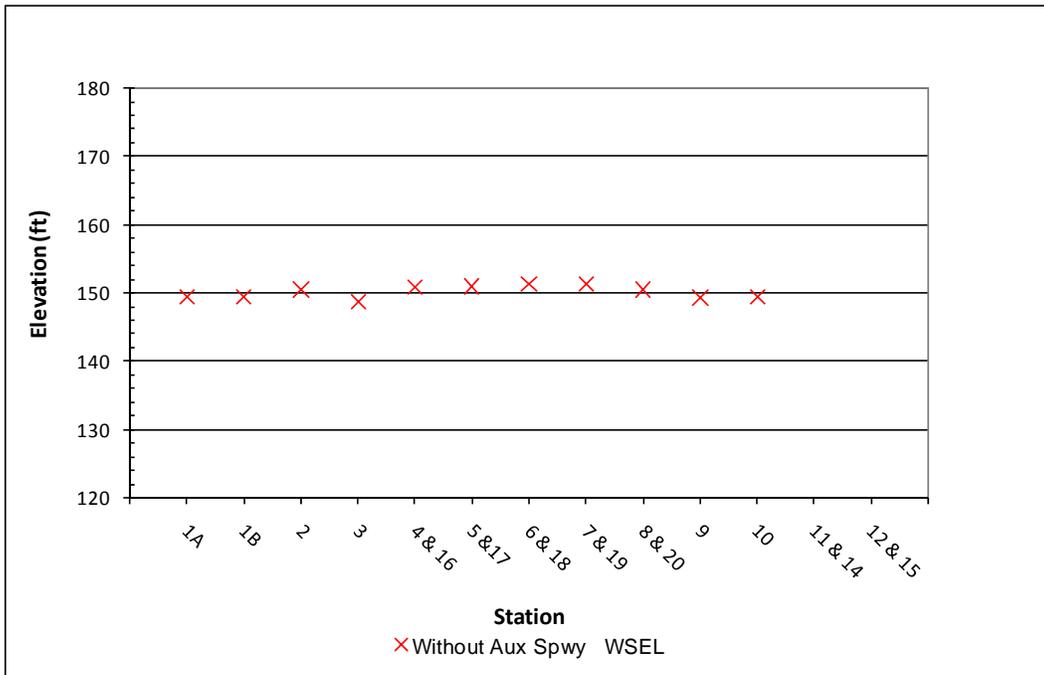


Figure 60. Main dam 45,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 150.0 ft.



Figure 61. Main dam $45,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the auxiliary spillway.

Main Dam flow rate 29,000 ft³/s and auxiliary spillway 22,000 ft³/s for a total of 51,000 ft³/s with a tailwater elevation of 152.5 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

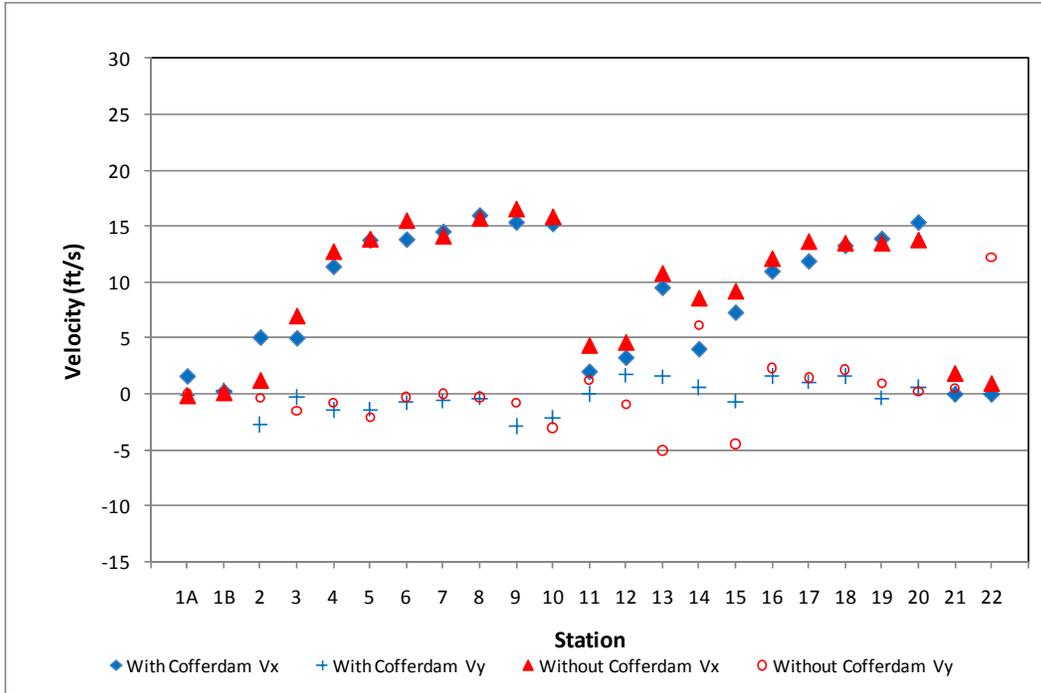


Figure 62. Main dam 29,000 ft³/s and auxiliary spillway 22,000 ft³/s with tailwater 152.5 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

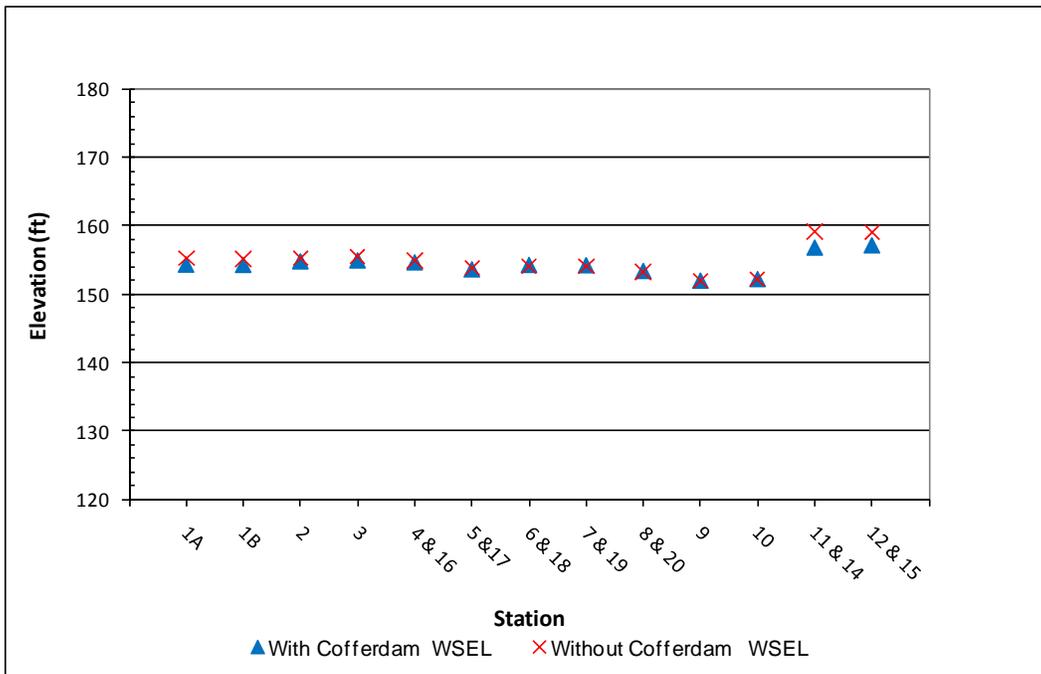


Figure 63. Main dam 29,000 ft³/s and aux spwy 22,000 ft³/s with tailwater 152.5 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 64. Main dam 29,000 ft³/s and auxiliary spillway 22,000 ft³/s with the cofferdam. Small surges flow over the knob. The cofferdam is not overtopped. There is a hydraulic jump on the upstream side of the knob.



Figure 65. Main dam 29,000 ft³/s and auxiliary spillway 22,000 ft³/s without the cofferdam. Small surges flow over the knob. Water flows to the right and left of the knob.

Main Dam flow rate 60,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 60,000 ft³/s with a tailwater elevation of 156.5 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

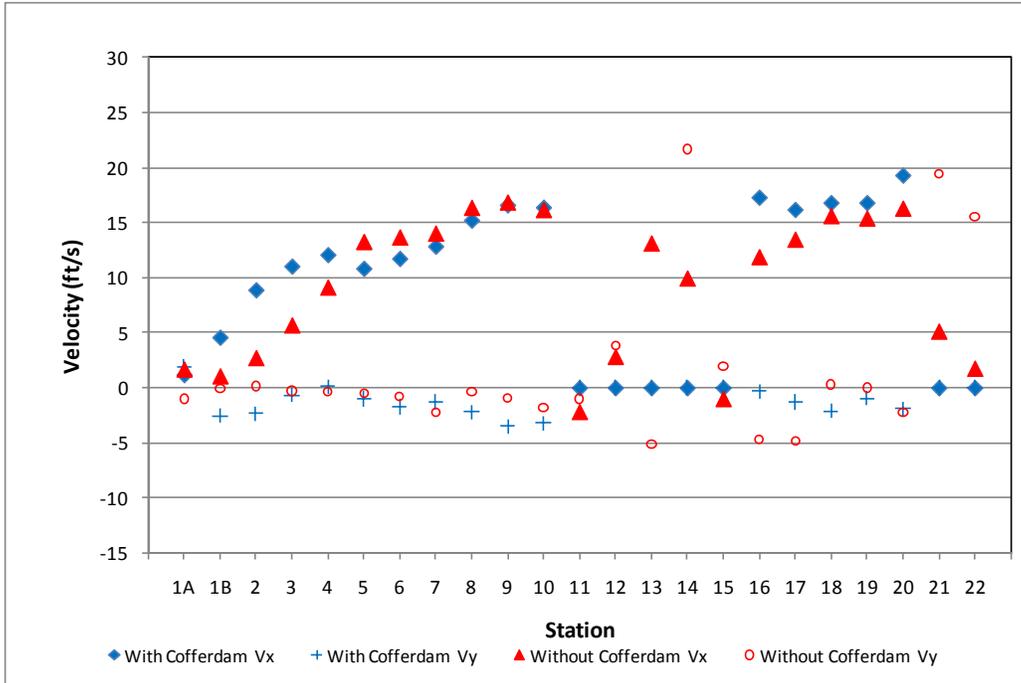


Figure 66. Main dam 60,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 156.5 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam. Note 21.7 ft/s velocity at station 14 without the cofferdam.

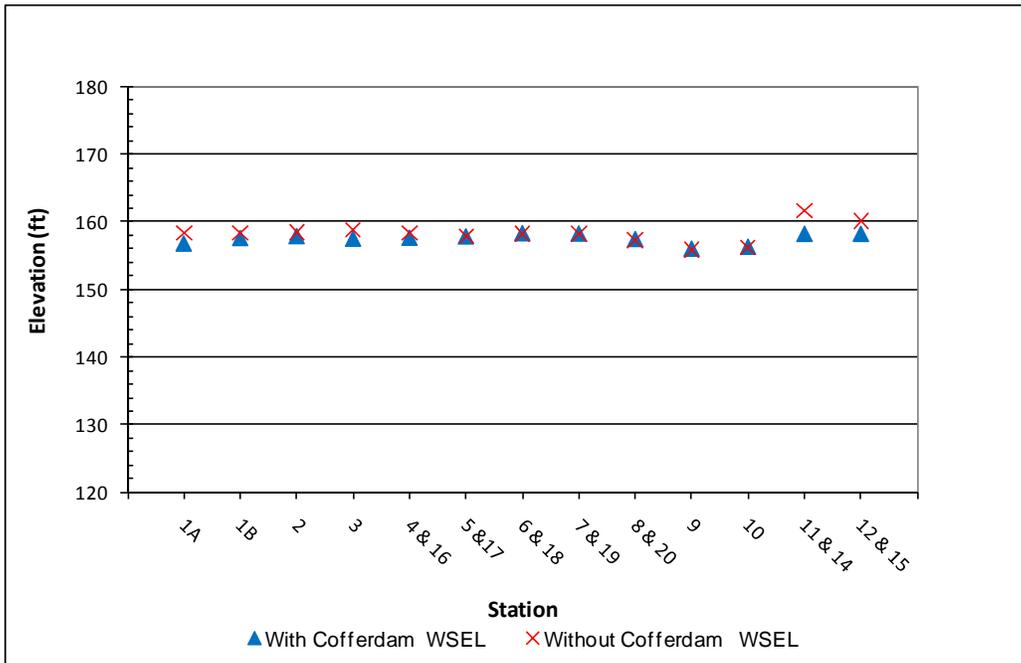


Figure 67. Main dam 60,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 156.5 ft. Water surface elevations: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

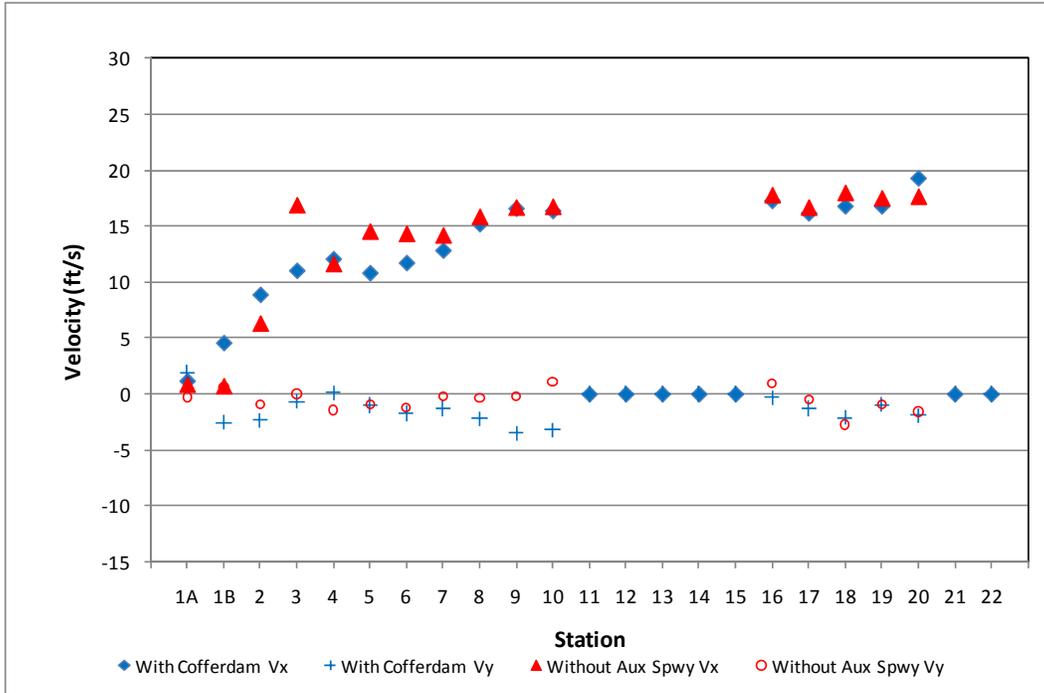


Figure 68. Main dam 60,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 156.5 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

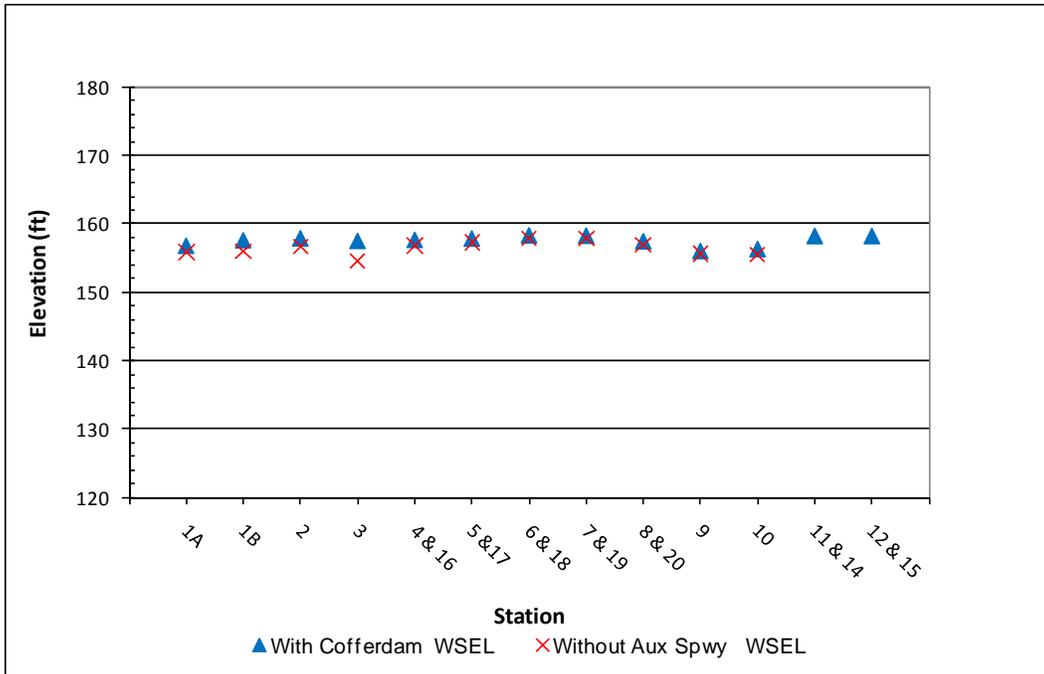


Figure 69. Main dam 60,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 156.5 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 70. Main dam $60,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ with the cofferdam. Water flows over the knob and occasional waves splash over the cofferdam. Auxiliary stilling basin is backwatered.



Figure 71. Main dam $60,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the cofferdam. There is a hydraulic jump to the right of the road and on the road. Water flows over the knob and to the left of the knob.



Figure 72. Main dam 60,000 ft³/s and auxiliary spillway 0 ft³/s without the auxiliary spillway.

Main Dam flow rate 0 ft³/s and auxiliary spillway 60,000 ft³/s for a total of 60,000 ft³/s with a tailwater elevation of 156.5 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

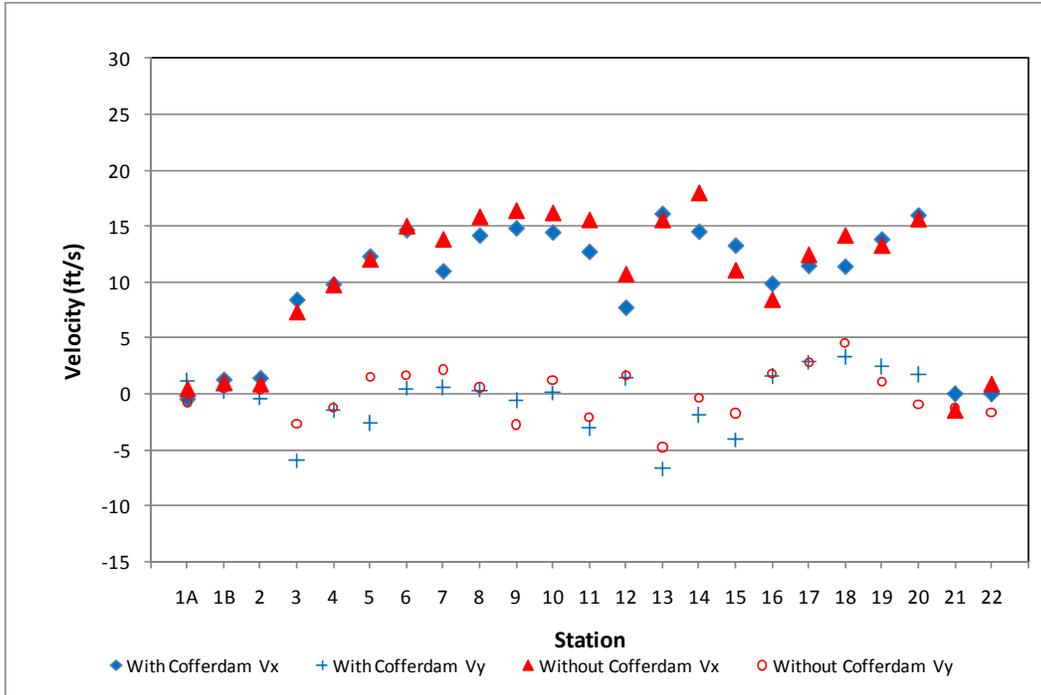


Figure 73. Main dam 0 ft³/s and auxiliary spillway 60,000 ft³/s with tailwater 156.5 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

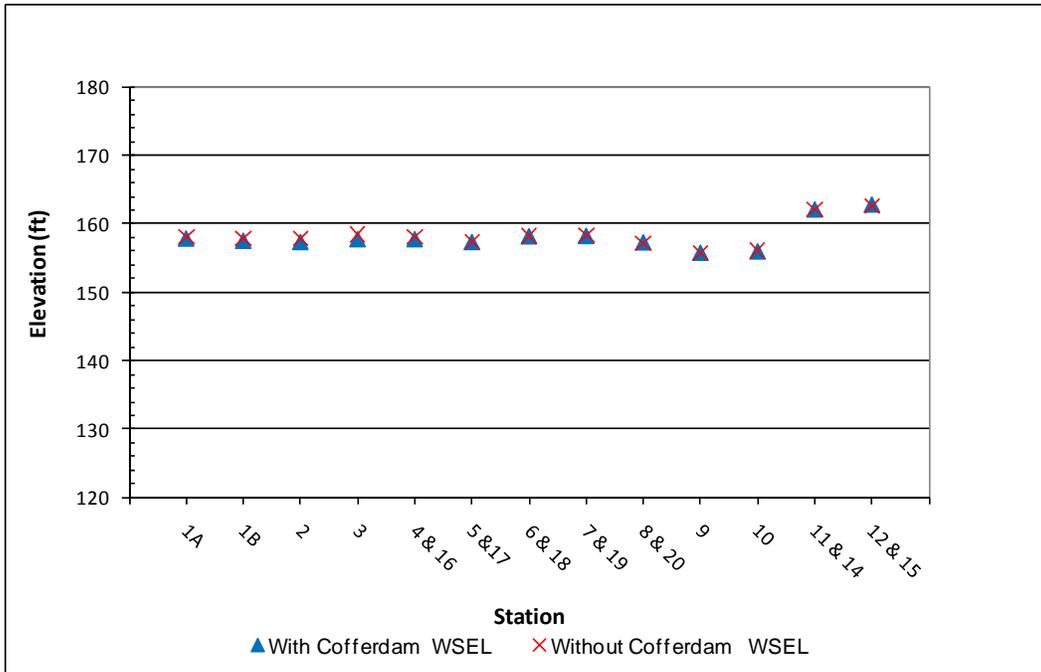


Figure 74. Main dam 0 ft³/s and auxiliary spillway 60,000 ft³/s with tailwater 156.5 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 75. Main dam 0 ft³/s and auxiliary spillway 60,000 ft³/s with the cofferdam.



Figure 76. Main dam 0 ft³/s and auxiliary spillway 60,000 ft³/s without the cofferdam.

Main Dam flow rate 75,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 75,000 ft³/s with a tailwater elevation of 161.5 ft.

No auxiliary spillway

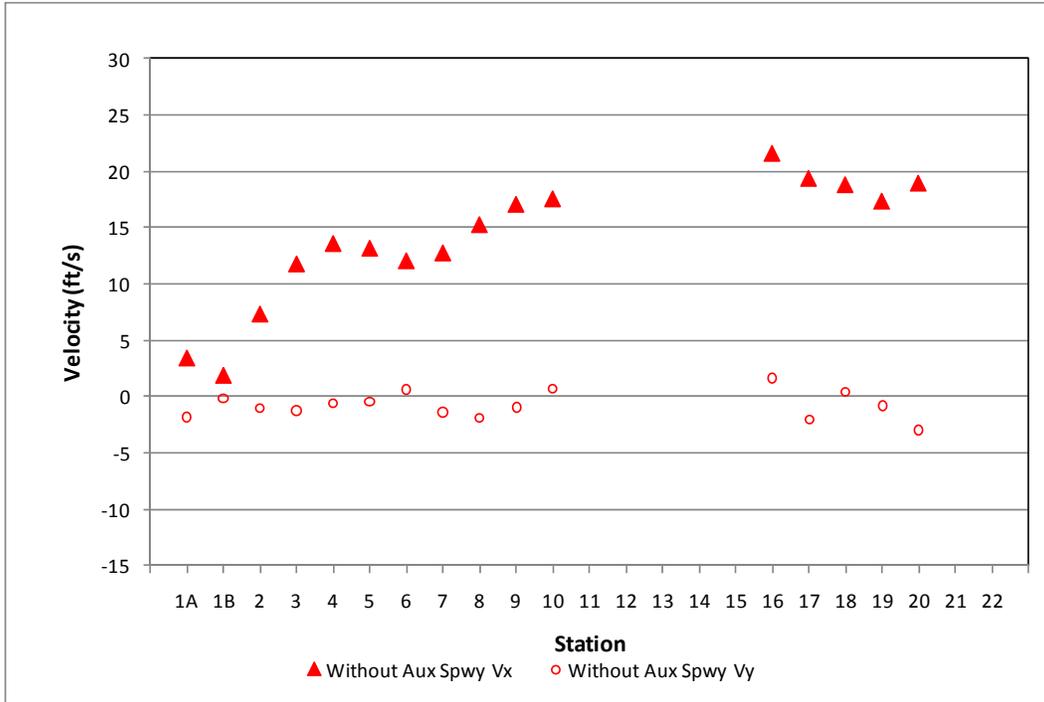


Figure 77. Main dam 75,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 161.5 ft.

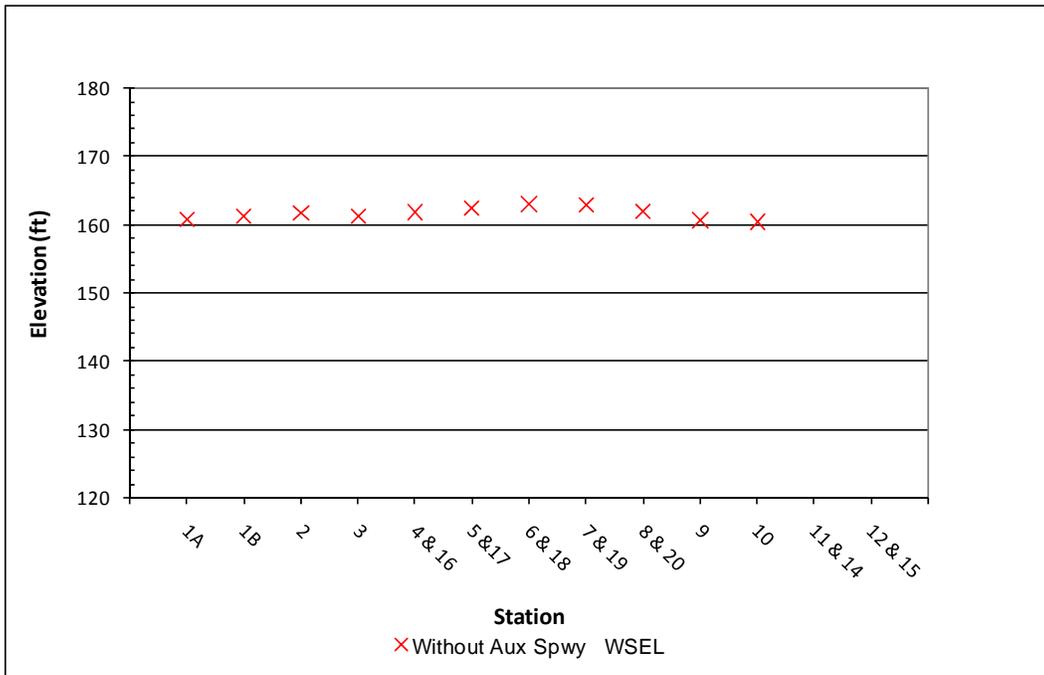


Figure 78. Main dam 75,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 161.5 ft.



Figure 79. Main dam $75,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the auxiliary spillway.

Main Dam flow rate 29,000 ft³/s and auxiliary spillway 47,000 ft³/s for a total of 76,000 ft³/s with a tailwater elevation of 161.8 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

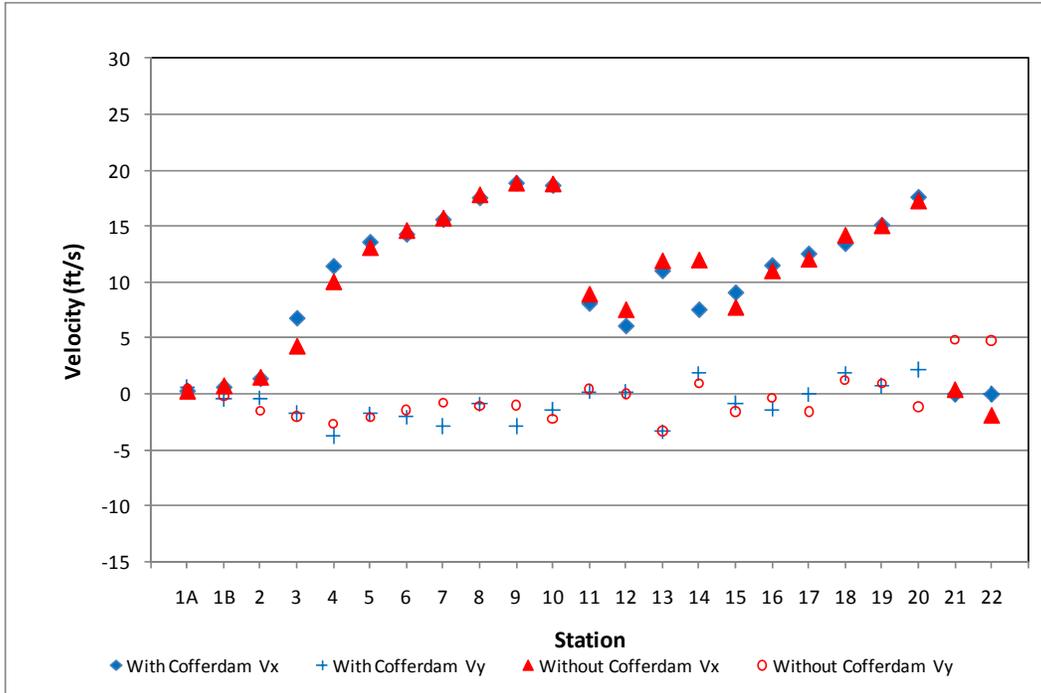


Figure 80. Main dam 29,000 ft³/s and auxiliary spillway 47,000 ft³/s with tailwater 161.8 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

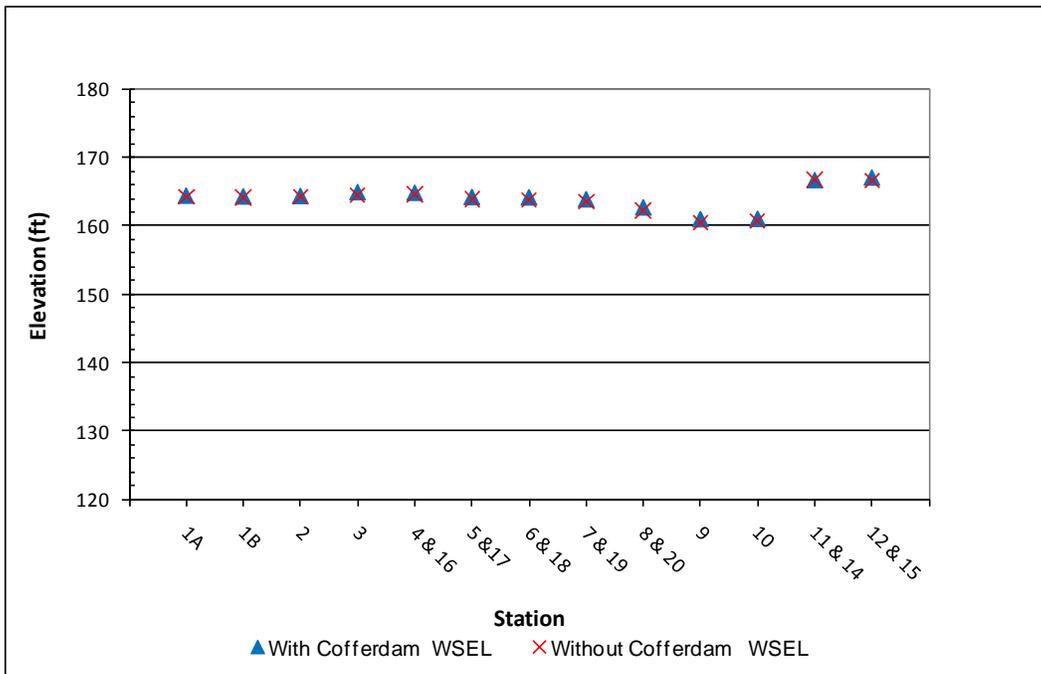


Figure 81. Main dam 29,000 ft³/s and auxiliary spillway 47,000 ft³/s with tailwater 161.8 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 82. Main dam 29,000 ft³/s and auxiliary spillway 47,000 ft³/s with the cofferdam.



Figure 83. Main dam 29,000 ft³/s and auxiliary spillway 47,000 ft³/s without the cofferdam.

Main Dam flow rate 90,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 90,000 ft³/s with a tailwater elevation of 166.58 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

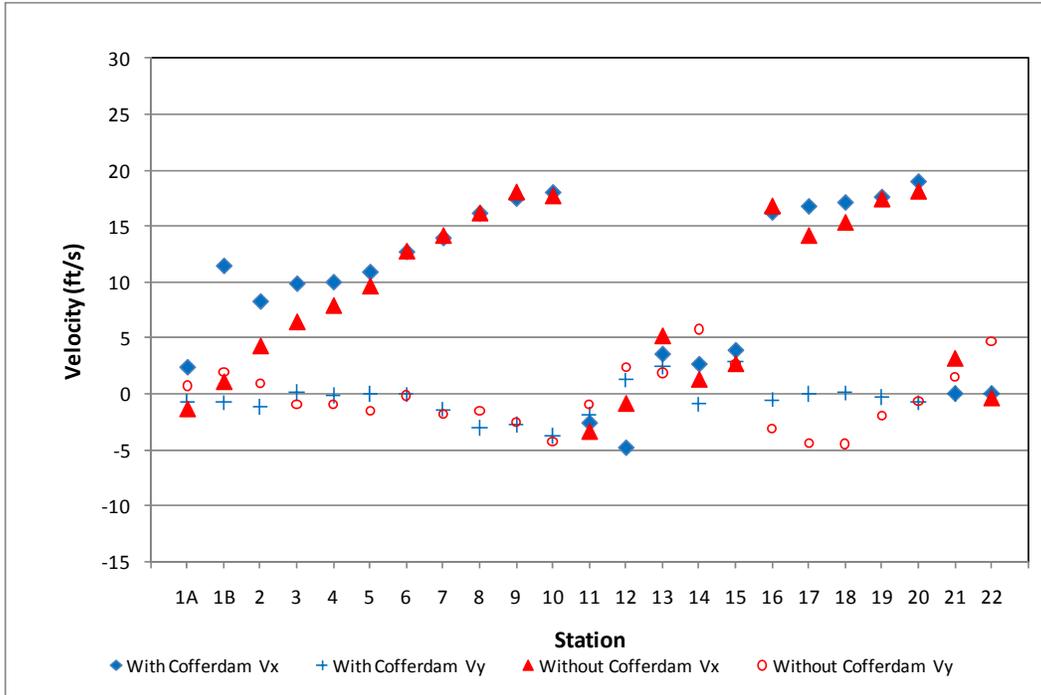


Figure 84. Main dam 90,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 166.58 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

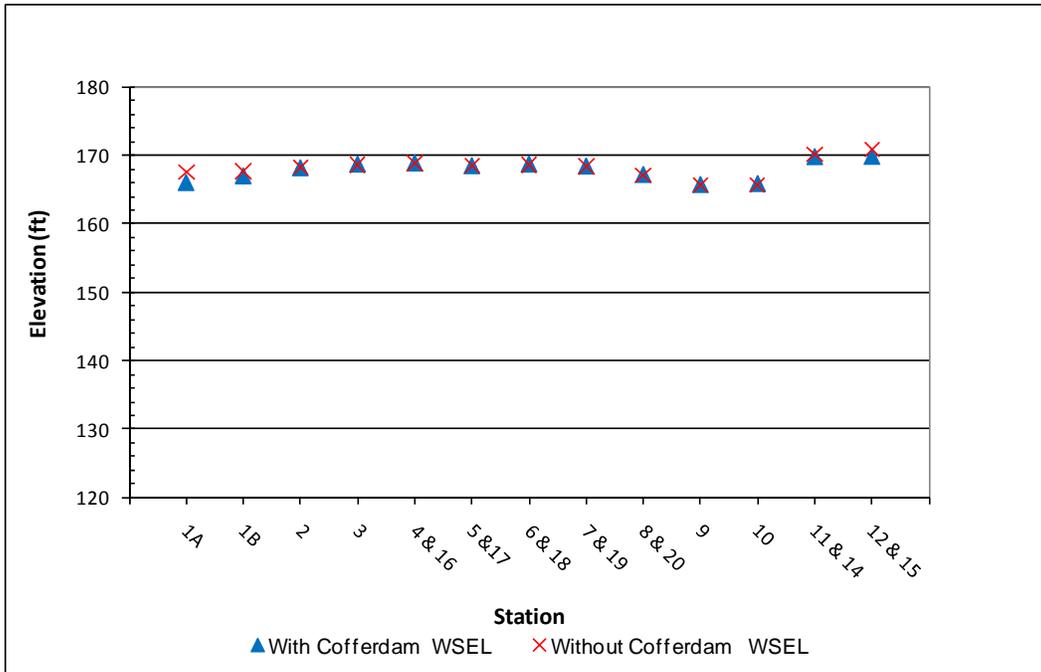


Figure 85. Main dam 90,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 166.58 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

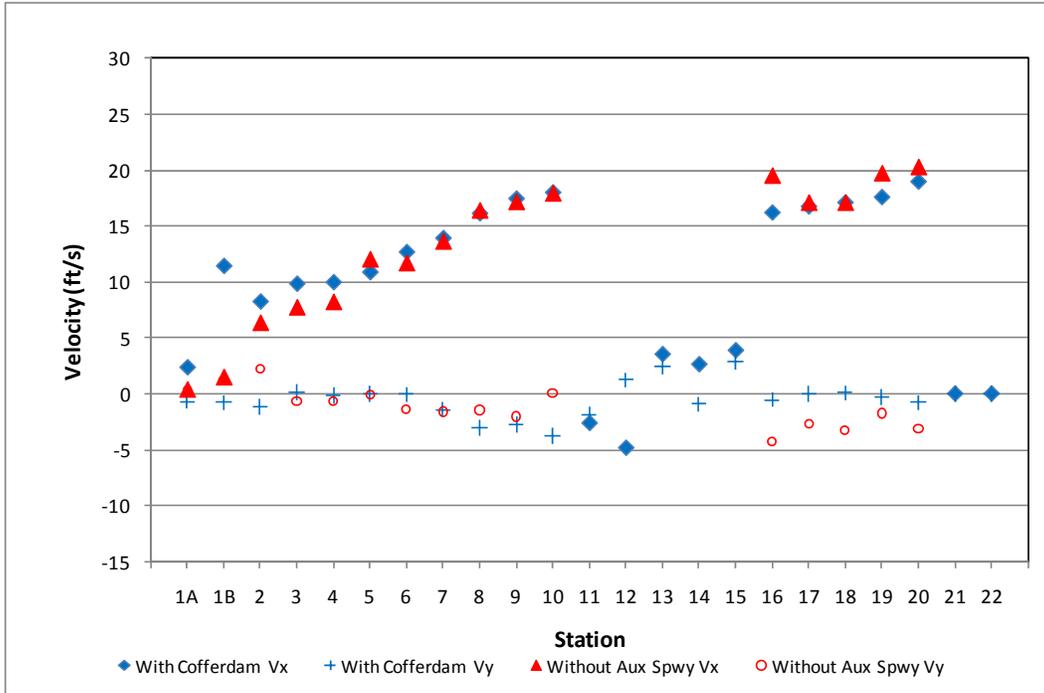


Figure 86. Main dam 90,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 166.58 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

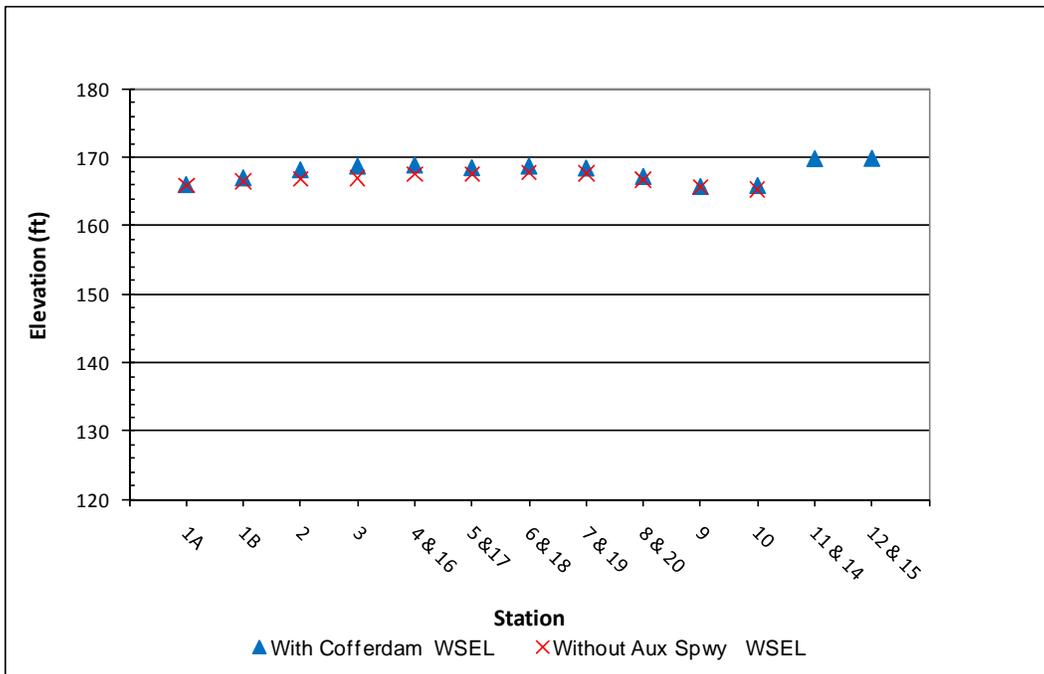


Figure 87. Main dam 90,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 166.58 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 88. Main dam $90,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ with the cofferdam. Flow consistently splashes and surges over the upstream end of the cofferdam wall. The downstream section of the cofferdam is submerged.



Figure 89. Main dam $90,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the cofferdam. Water flows over knob. Some recirculation downstream of the auxiliary stilling basin.



Figure 90. Main dam 90,000 ft³/s and auxiliary spillway 0 ft³/s without the auxiliary spillway.

Main Dam flow rate 0 ft³/s and auxiliary spillway 90,000 ft³/s for a total of 90,000 ft³/s with a tailwater elevation of 166.58 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

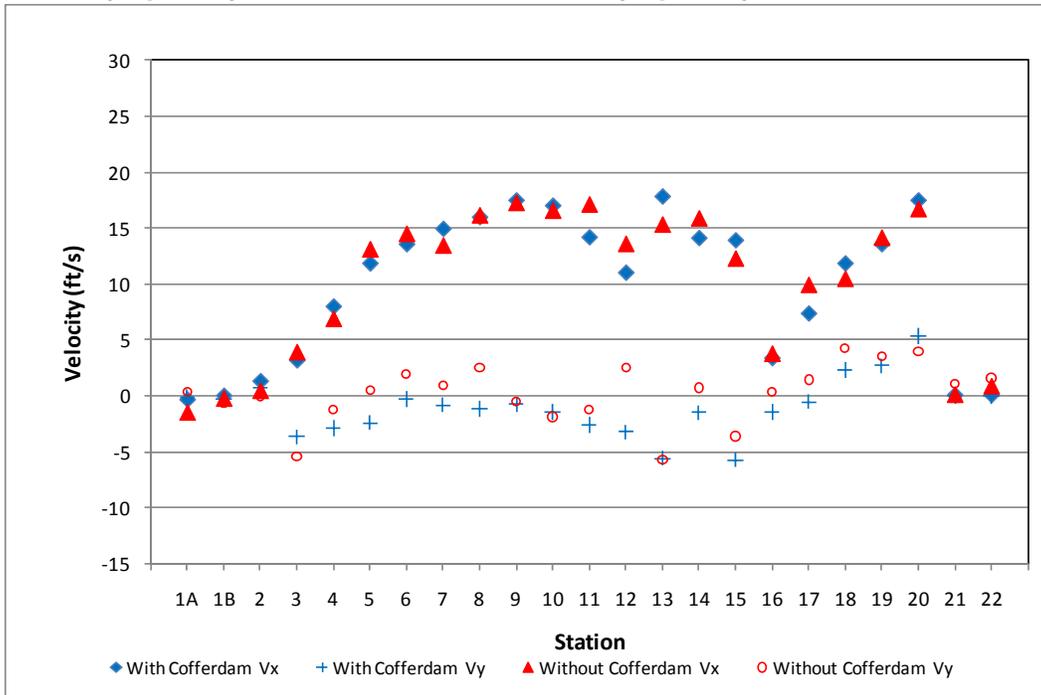


Figure 91. Main dam 0 ft³/s and auxiliary spillway 90,000 ft³/s with tailwater 166.58 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

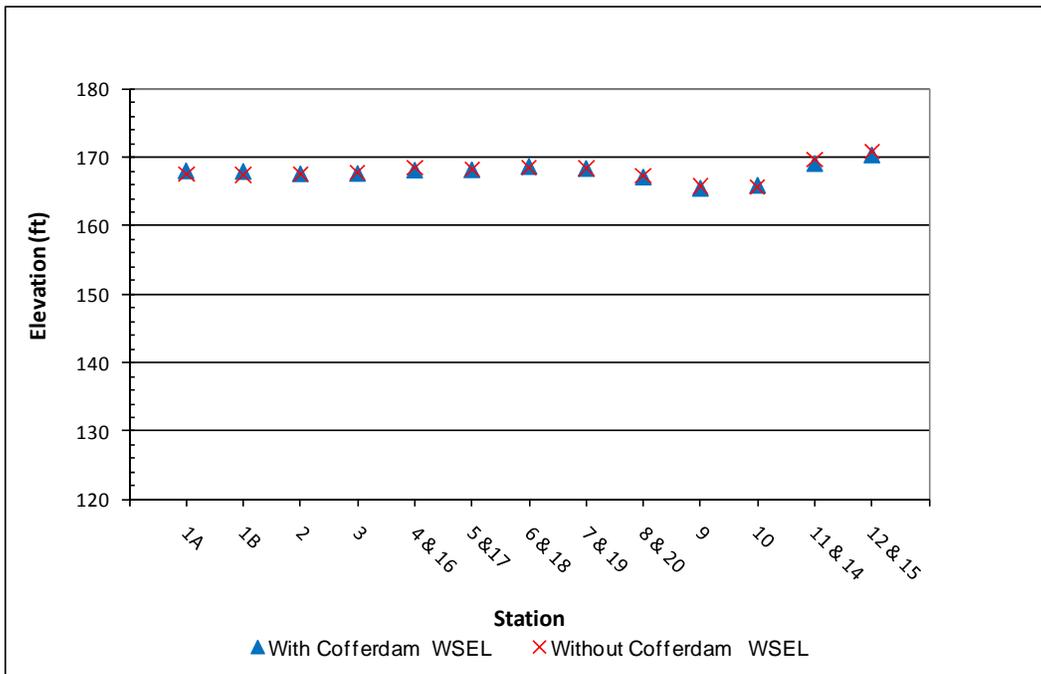


Figure 92. Main dam 0 ft³/s and auxiliary spillway 90,000 ft³/s with tailwater 166.58 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 93. Main dam 0 ft³/s and auxiliary spillway 90,000 ft³/s with the cofferdam. The downstream section of the cofferdam wall is submerged.



Figure 94. Main dam 0 ft³/s and auxiliary spillway 90,000 ft³/s without the cofferdam.

Main Dam flow rate 115,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

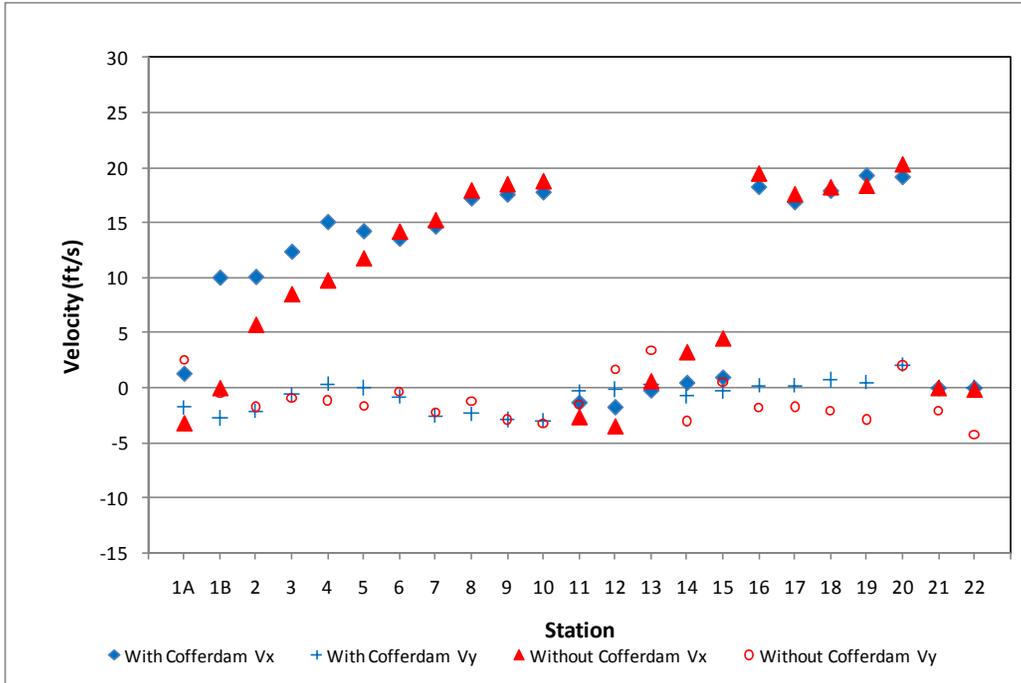


Figure 95. Main dam 115,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 174.29 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

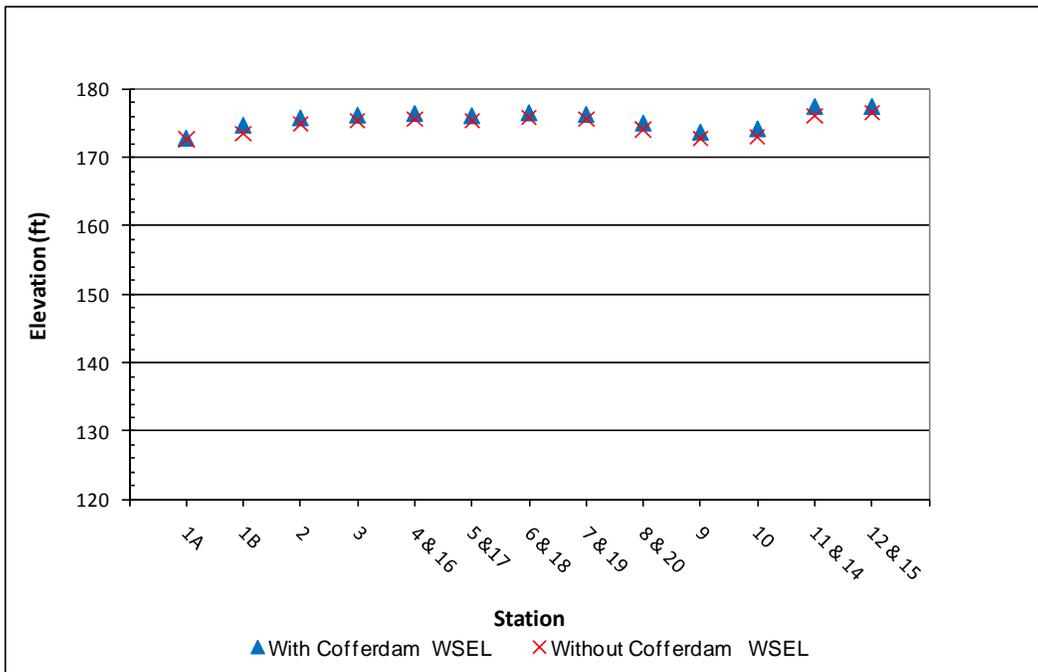


Figure 96. Main dam 115,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 174.29 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

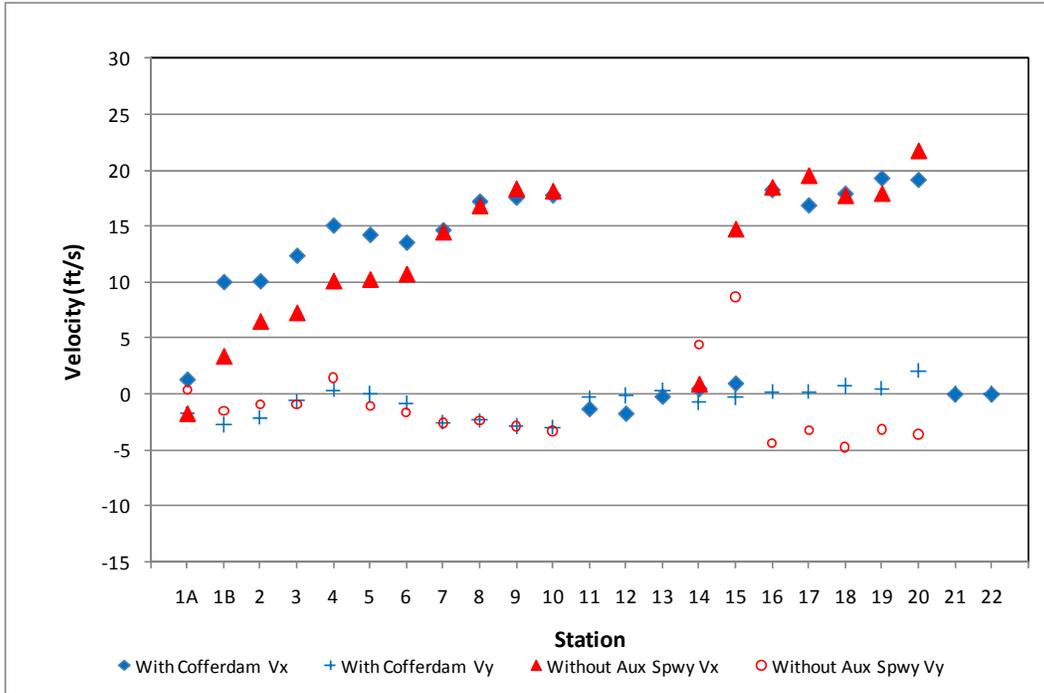


Figure 97. Main dam 115,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 174.29 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

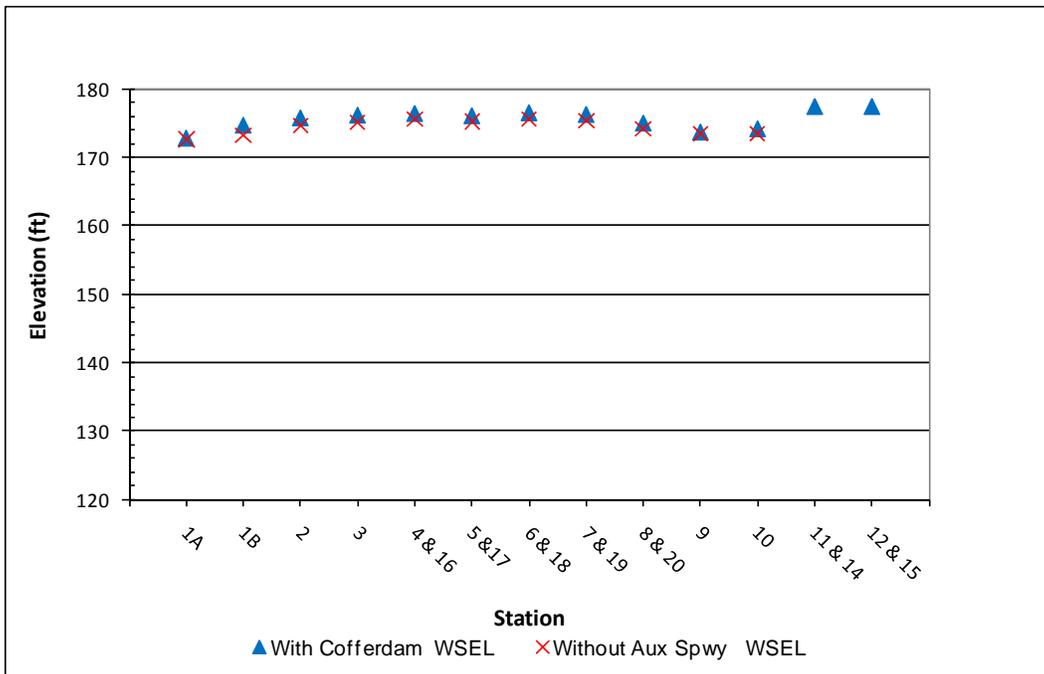


Figure 98. Main dam 115,000 ft³/s and auxiliary spillway 0 ft³/s with tailwater 174.29 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 99. Main dam 115,000 ft³/s and auxiliary spillway 0 ft³/s with the cofferdam. Flow overtops up stream end of cofferdam.



Figure 100. Main dam 115,000 ft³/s and auxiliary spillway 0 ft³/s without the cofferdam. Flow recirculates in the auxiliary spillway exit channel.



Figure 101. Main dam 115,000 ft³/s and auxiliary spillway 0 ft³/s without the auxiliary spillway.

Main Dam flow rate 30,000 ft³/s and auxiliary spillway 85,000 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

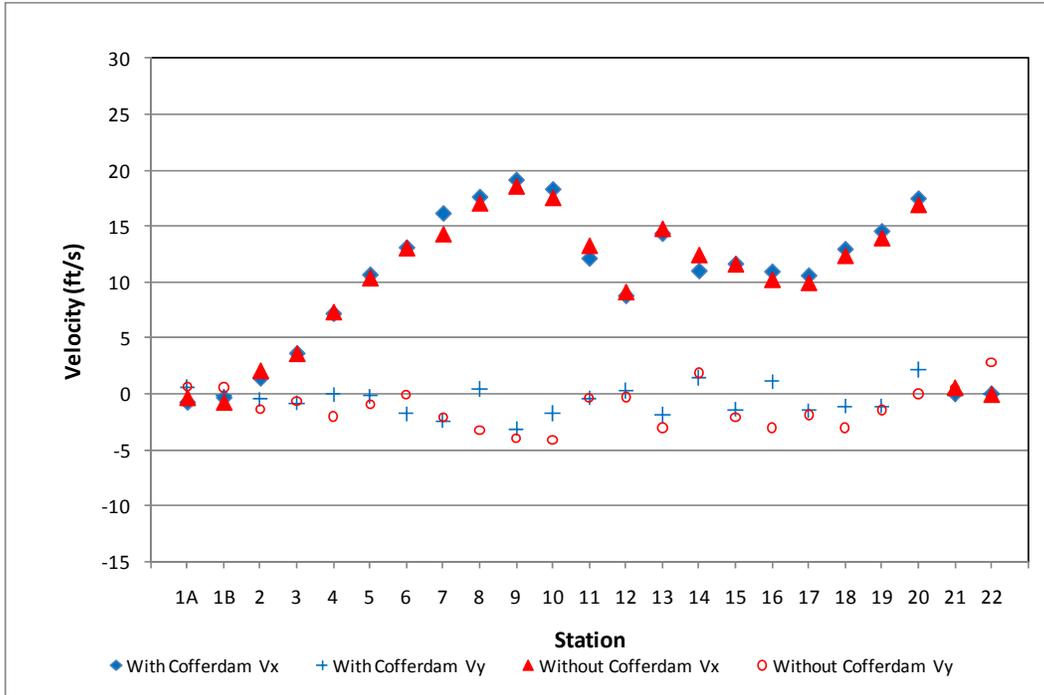


Figure 102. Main dam 30,000 ft³/s and aux spwy 85,000 ft³/s with tailwater 174.29 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

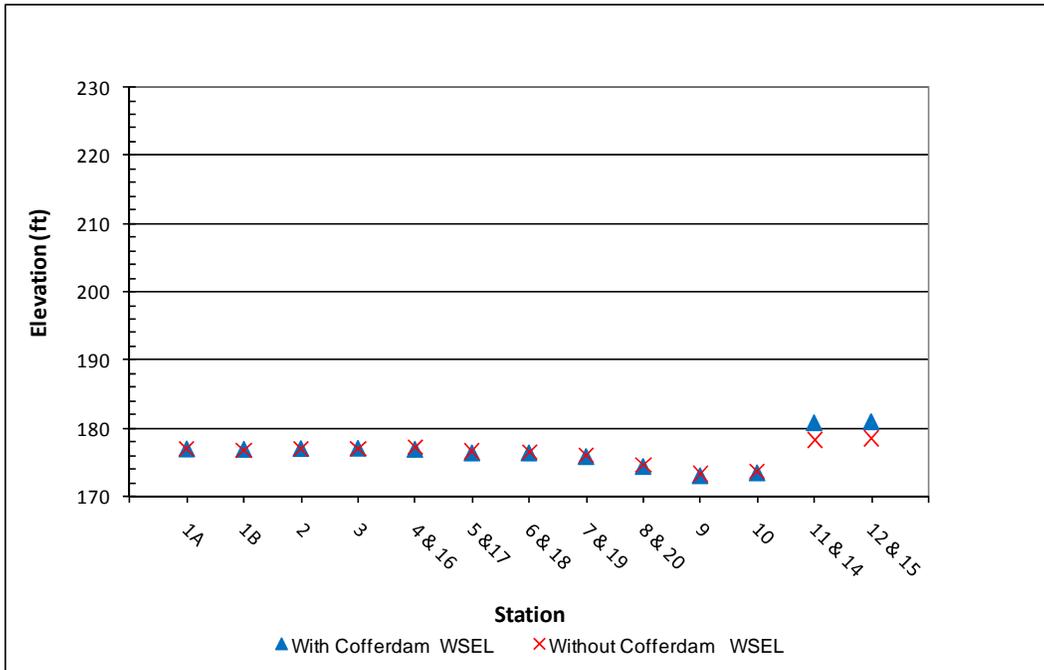


Figure 103. Main dam 30,000 ft³/s and aux spwy 85,000 ft³/s with tailwater 174.29 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 104. Main dam 30,000 ft³/s and auxiliary spillway 85,000 ft³/s with the cofferdam. Water overtops the cofferdam. The flow on the access road is not measurable.



Figure 105. Main dam 30,000 ft³/s and auxiliary spillway 85,000 ft³/s without the cofferdam.

Main Dam flow rate 0 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

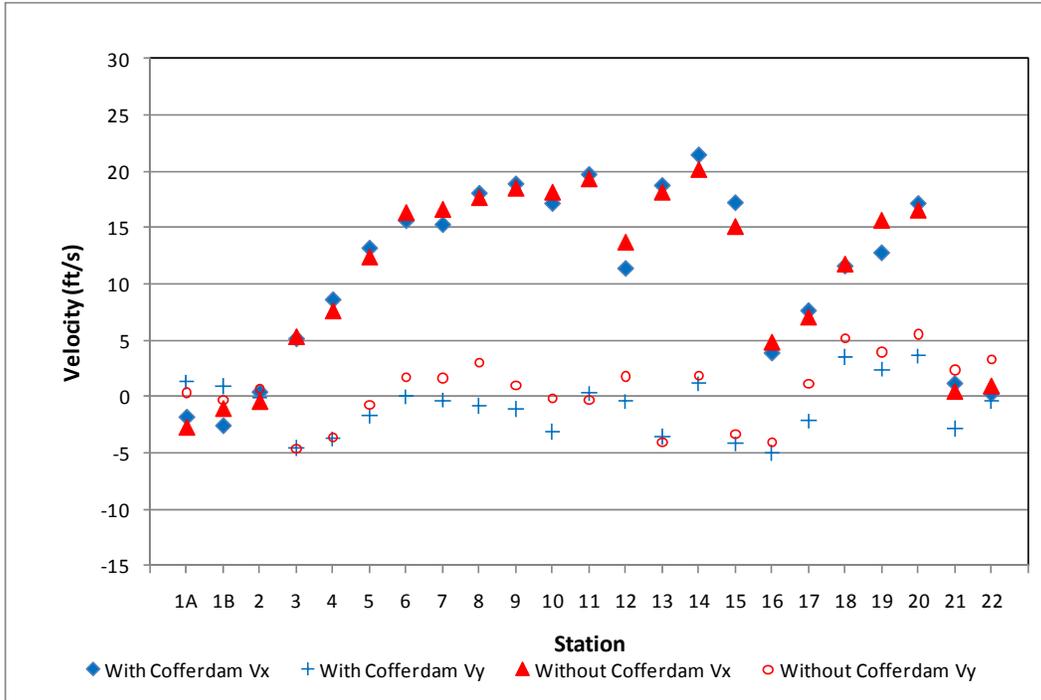


Figure 106. Main dam 0 ft³/s and auxiliary spillway 115,000 ft³/s with tailwater 174.29 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

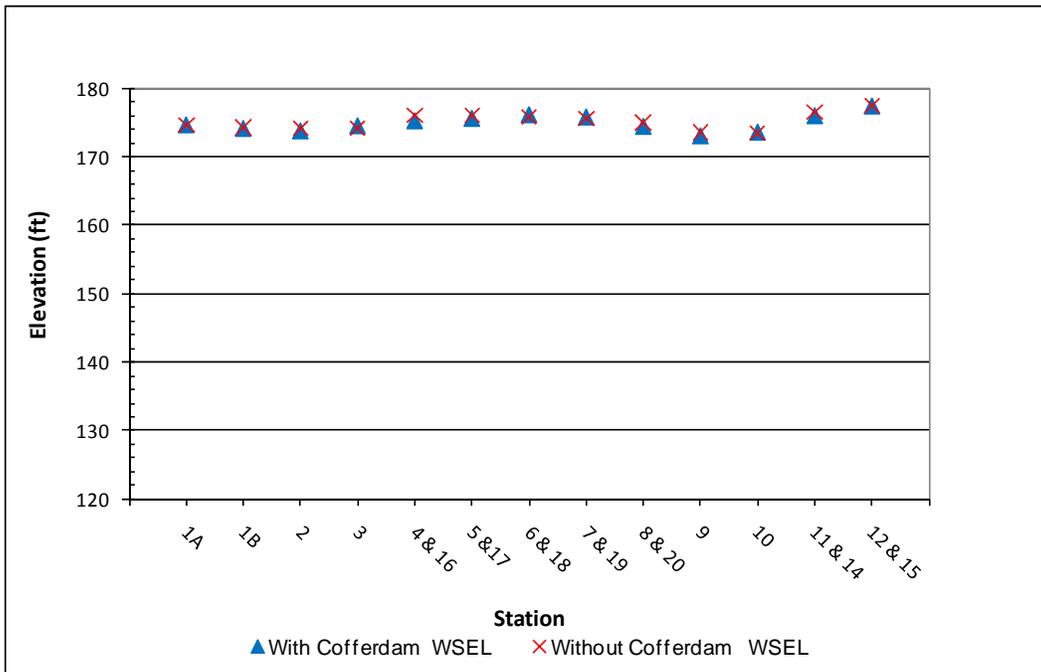


Figure 107. Main dam 0 ft³/s and auxiliary spillway 115,000 ft³/s with tailwater 174.29 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 108. Main dam 0 ft³/s and auxiliary spillway 115,000 ft³/s with the cofferdam.



Figure 109. Main dam 0 ft³/s and auxiliary spillway 115,000 ft³/s without the cofferdam.

Main Dam flow rate 0 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 135,000 ft³/s with a tailwater elevation of 180.0 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

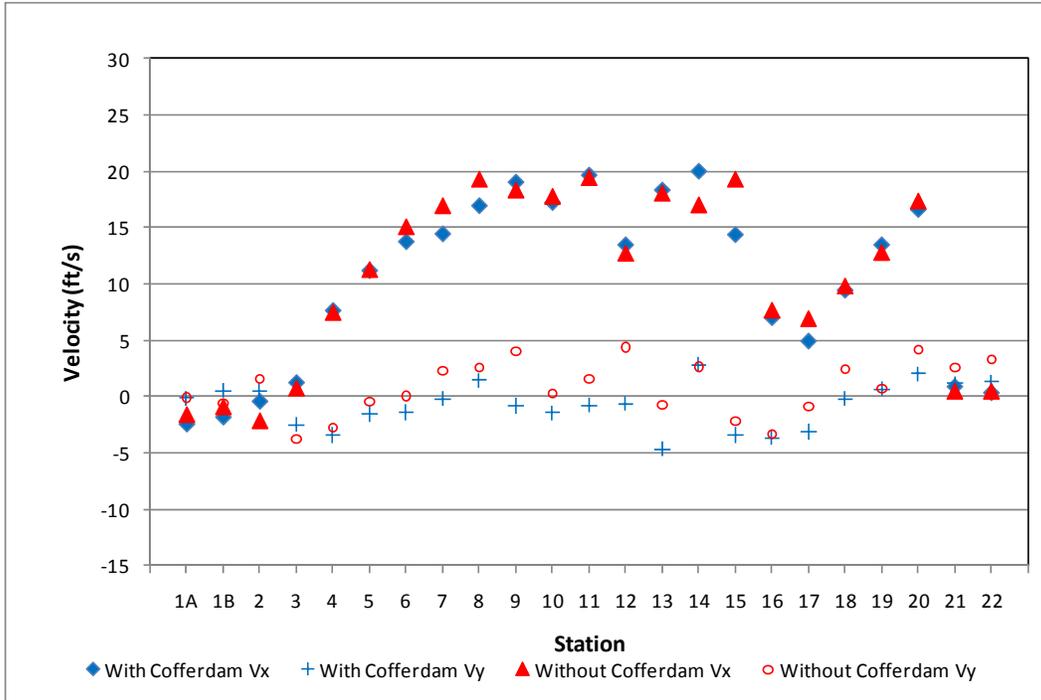


Figure 110. Main dam 0 ft³/s and auxiliary spillway 135,000 ft³/s with tailwater 180.0 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

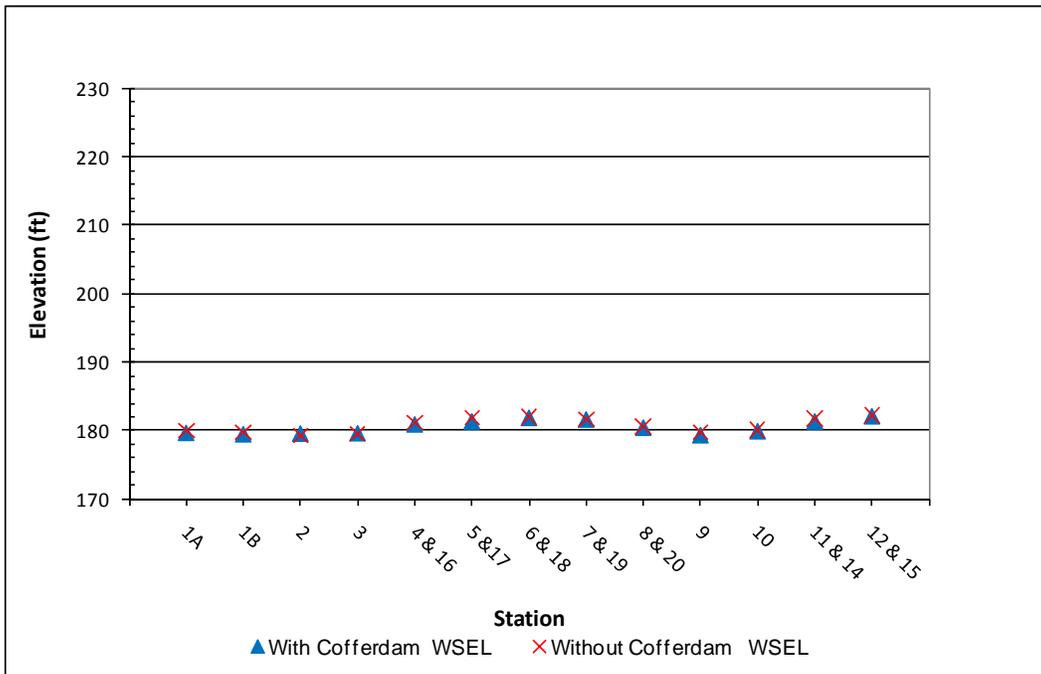


Figure 111. Main dam 0 ft³/s and auxiliary spillway 135,000 ft³/s, with tailwater 180.0 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 112. Main dam 0 ft³/s and auxiliary spillway 135,000 ft³/s with the cofferdam.

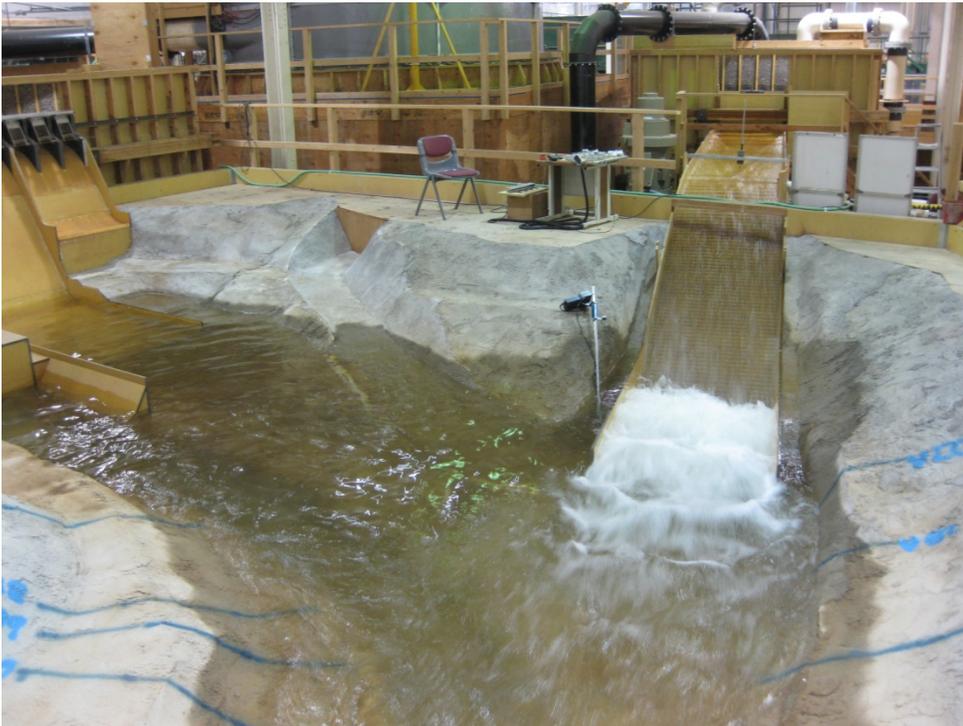


Figure 113. Main dam 0 ft³/s and auxiliary spillway 135,000 ft³/s without the cofferdam.

Main Dam flow rate 30,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

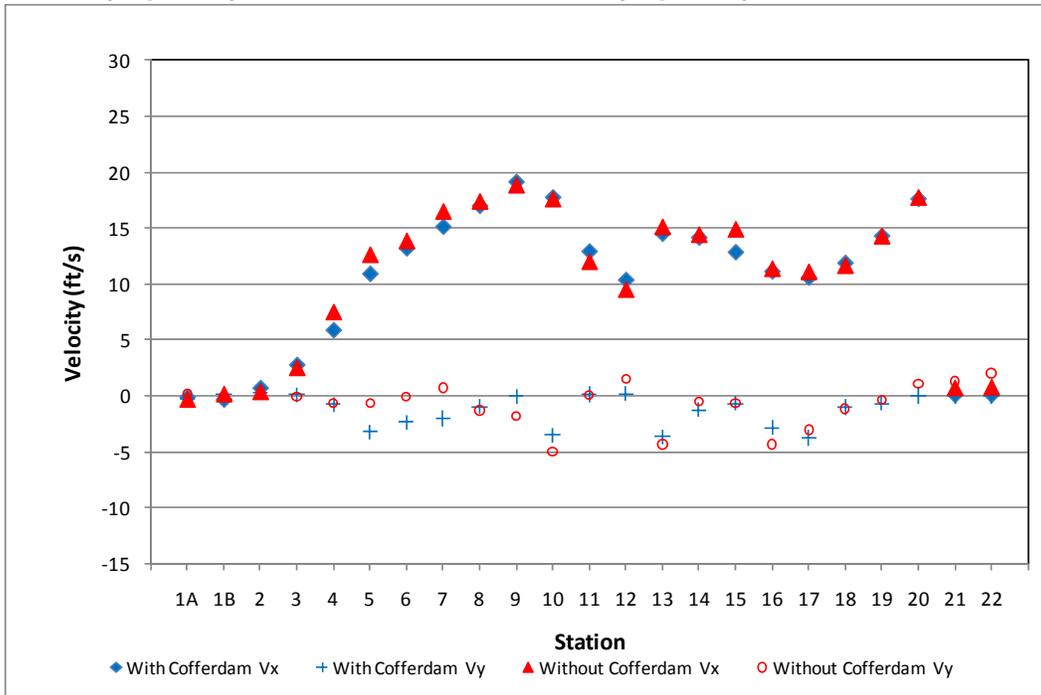


Figure 114. Main dam 30,000 ft³/s and auxiliary spillway 115,000 ft³/s with tailwater 181.6 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

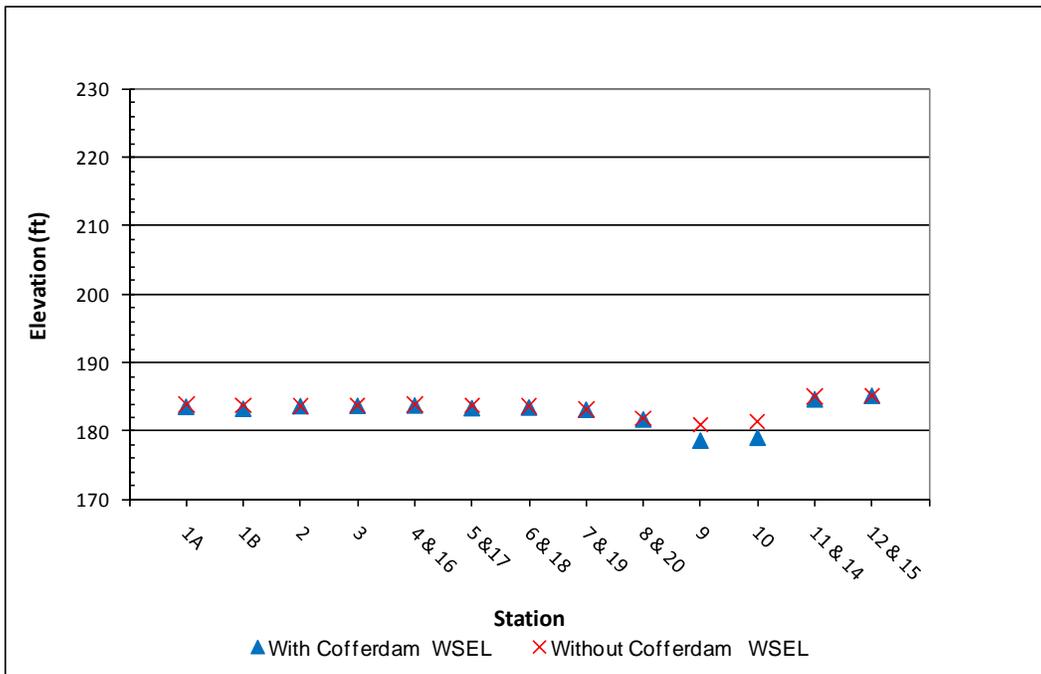


Figure 115. Main dam 30,000 ft³/s and aux spwy 115,000 ft³/s with tailwater 181.6 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 116. Main dam 30,000 ft³/s and auxiliary spillway 115,000 ft³/s with the cofferdam.



Figure 117. Main dam 30,000 ft³/s and auxiliary spillway 115,000 ft³/s without the cofferdam.

Main Dam flow rate 10,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

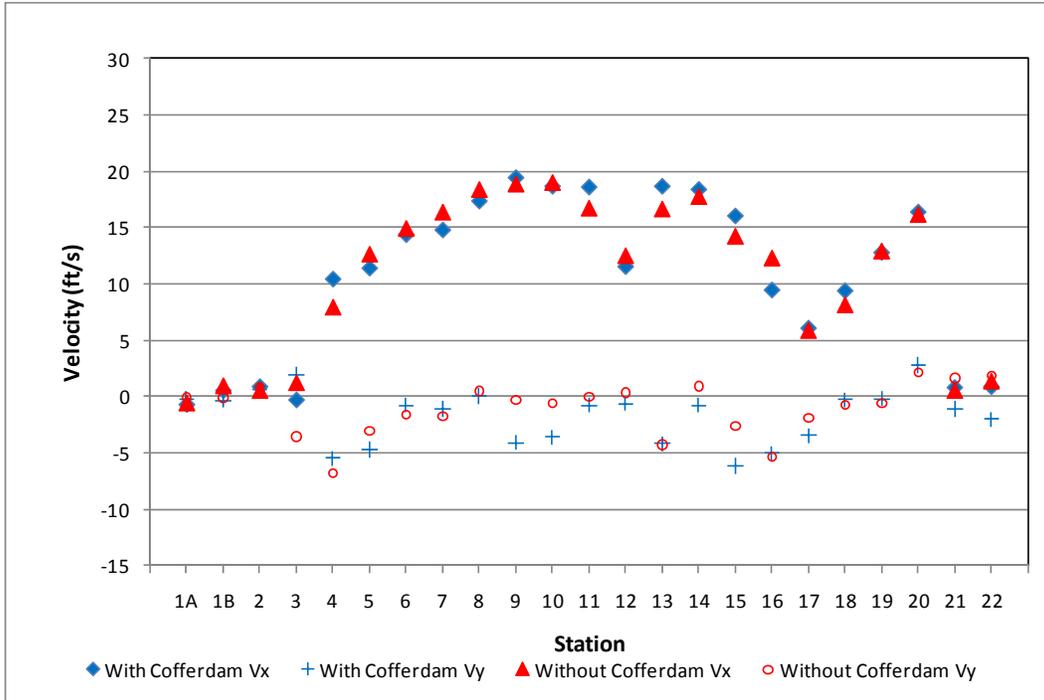


Figure 118. Main dam 10,000 ft³/s and auxiliary spillway 135,000 ft³/s with tailwater 181.6 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

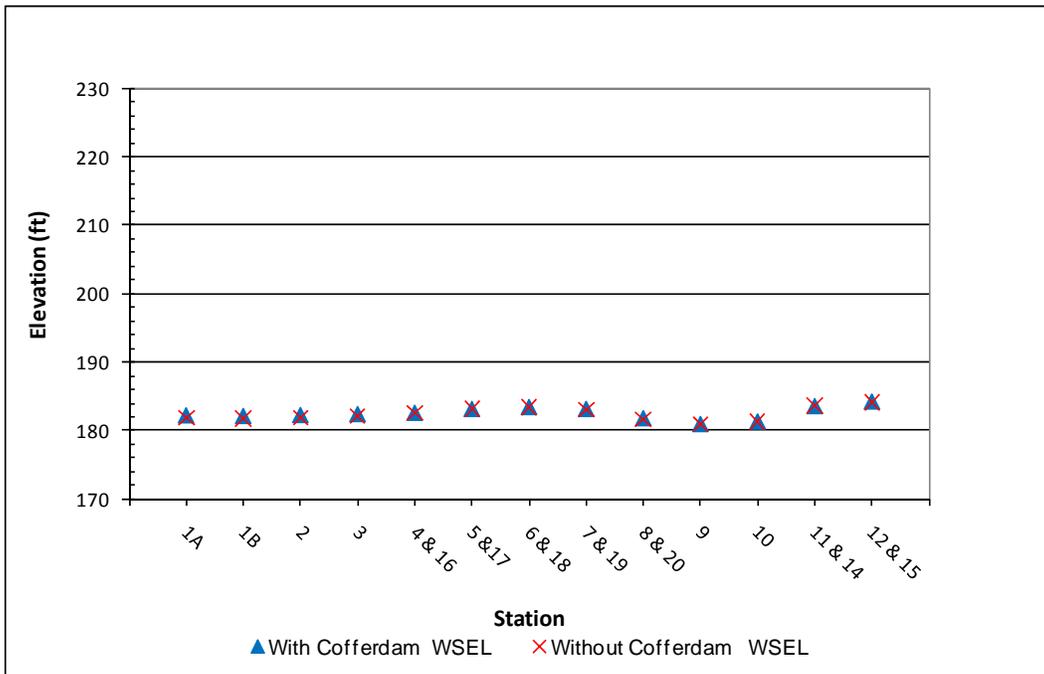


Figure 119. Main dam 10,000 ft³/s and aux spwy 135,000 ft³/s with tailwater 181.6 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 120. Main dam 10,000 ft³/s and auxiliary spillway 135,000 ft³/s with the cofferdam.



Figure 121. Main dam 10,000 ft³/s and auxiliary spillway 135,000 ft³/s without the cofferdam.

Main Dam flow rate 0 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

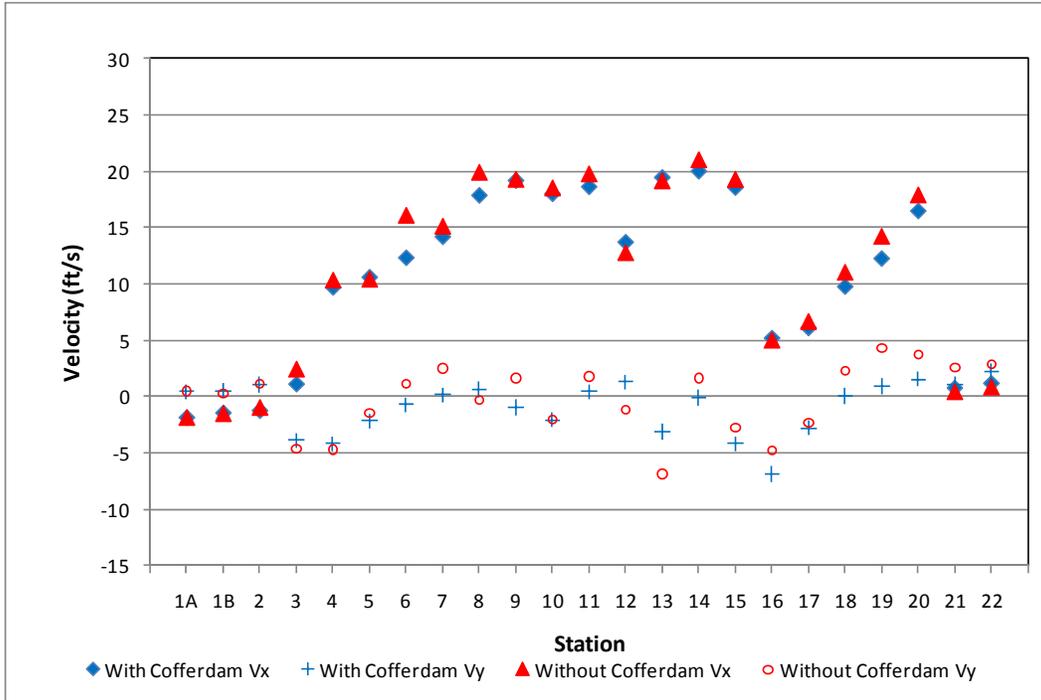


Figure 122. Main dam 0 ft³/s and auxiliary spillway 145,000 ft³/s with tailwater 181.6 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

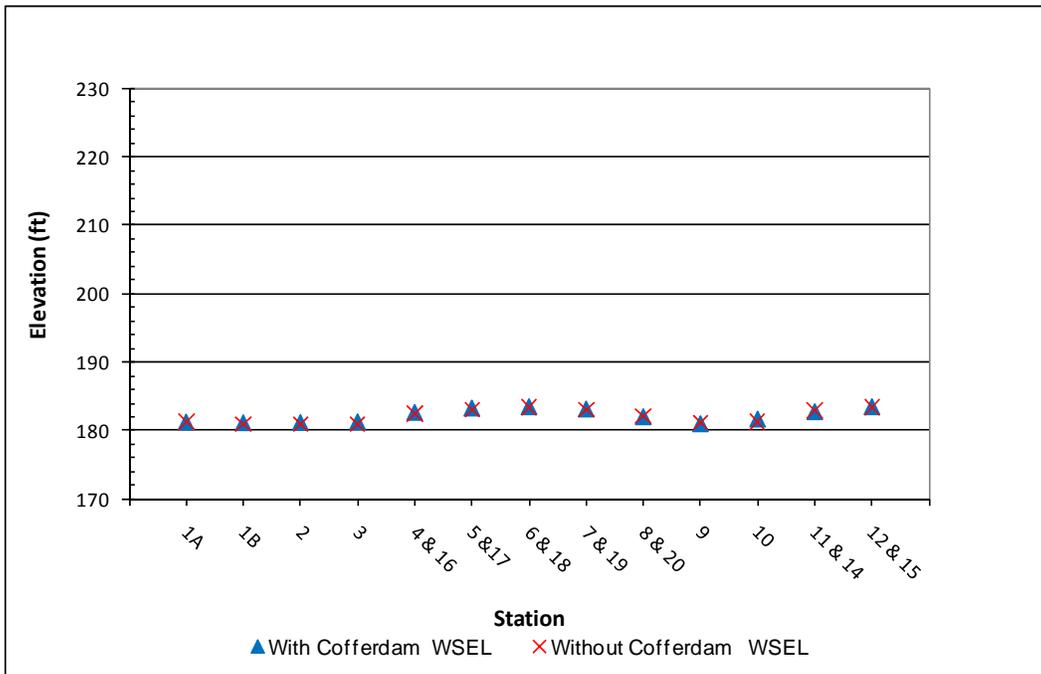


Figure 123. Main dam 0 ft³/s and auxiliary spillway 145,000 ft³/s with tailwater 181.6 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 124. Main dam 0 ft³/s and auxiliary spillway 145,000 ft³/s with the cofferdam.



Figure 125. Main dam 0 ft³/s and auxiliary spillway 145,000 ft³/s without the cofferdam.

Main Dam flow rate 115,000 ft³/s and auxiliary spillway 45,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

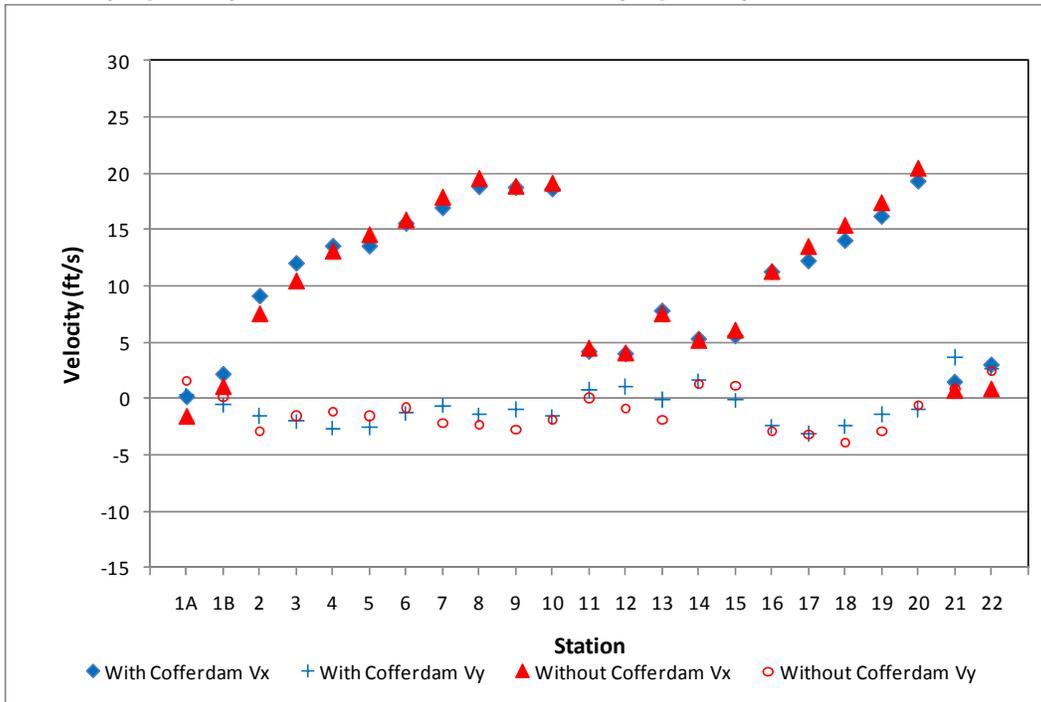


Figure 126. Main dam 115,000 ft³/s and aux spwy 45,000 ft³/s with tailwater 184.26 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

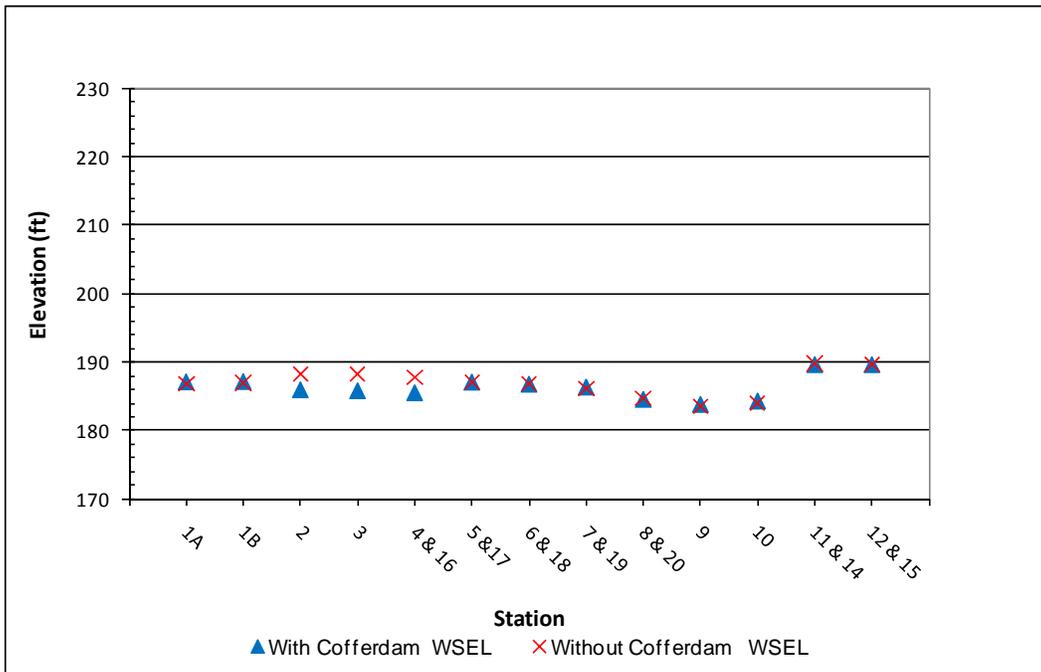


Figure 127. Main dam 115,000 ft³/s and aux spwy 45,000 ft³/s with a tailwater 184.26 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 128. Main dam 115,000 ft³/s and auxiliary spillway 45,000 ft³/s with the cofferdam.



Figure 129. Main dam 115,000 ft³/s and auxiliary spillway 45,000 ft³/s without the cofferdam.

Main Dam flow rate 45,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

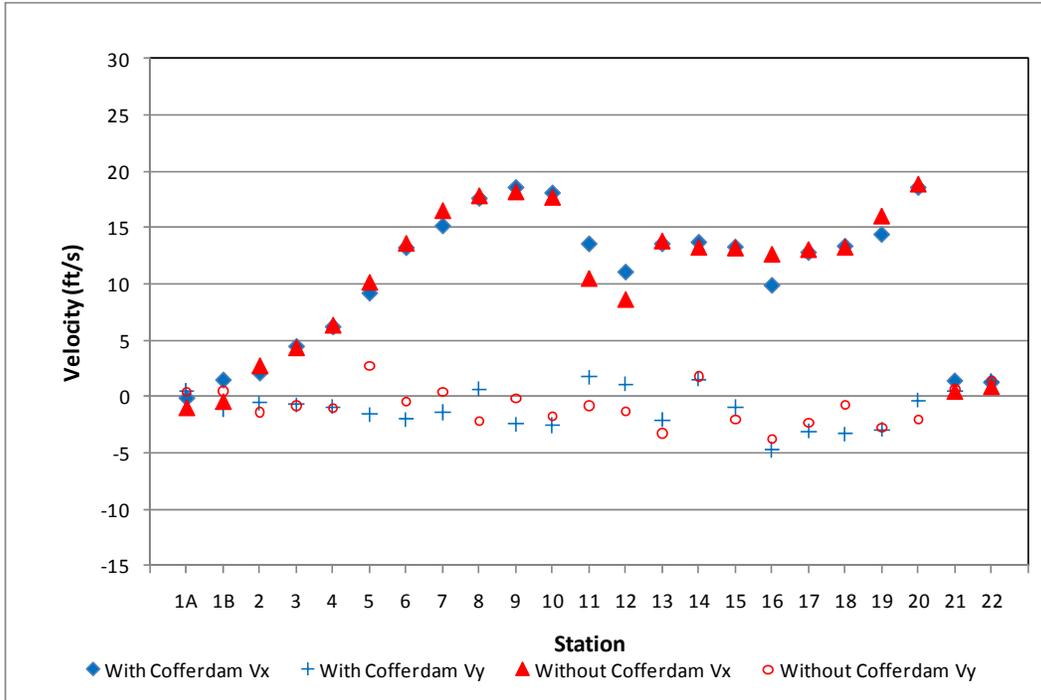


Figure 130. Main dam 45,000 ft³/s and aux spwy 115,000 ft³/s with tailwater 184.26 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

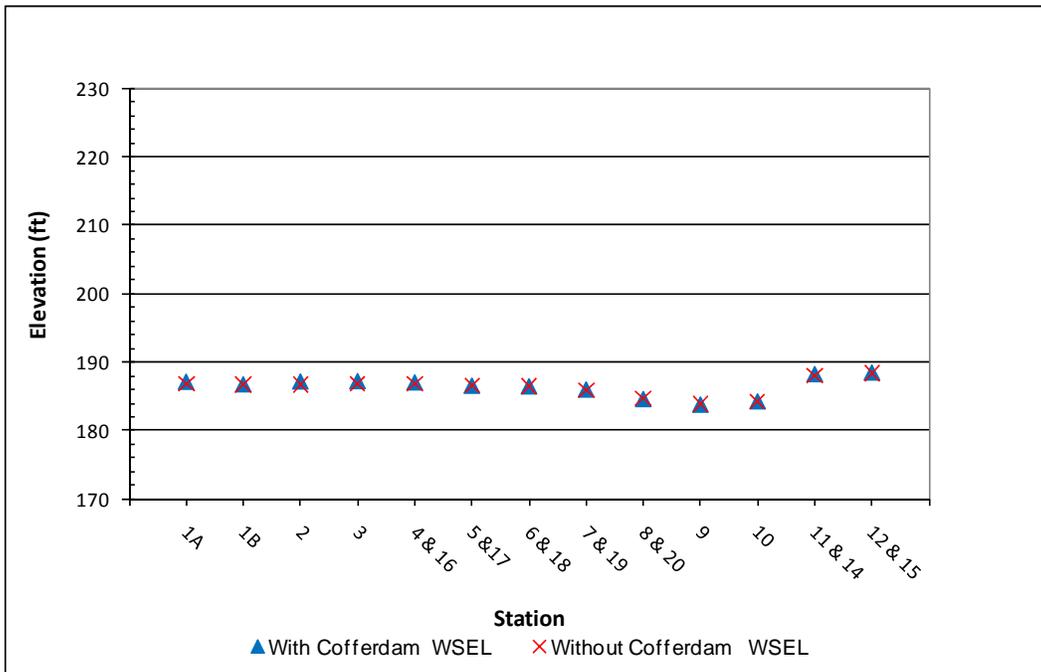


Figure 131. Main dam 45,000 ft³/s and aux spwy 115,000 ft³/s with tailwater 184.26 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 132. Main dam 45,000 ft³/s and auxiliary spillway 115,000 ft³/s with the cofferdam.



Figure 133. Main dam 45,000 ft³/s and auxiliary spillway 115,000 ft³/s without the cofferdam.

Main Dam flow rate 31,000 ft³/s and auxiliary spillway 129,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

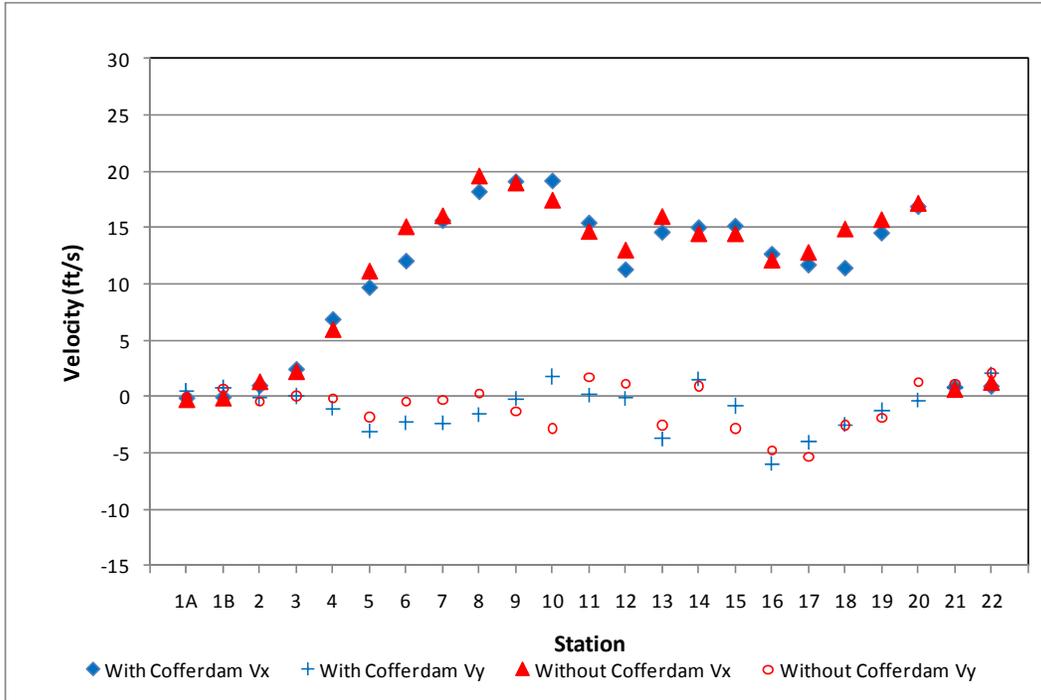


Figure 134. Main dam 31,000 ft³/s and aux spwy 129,000 ft³/s with tailwater 184.26 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

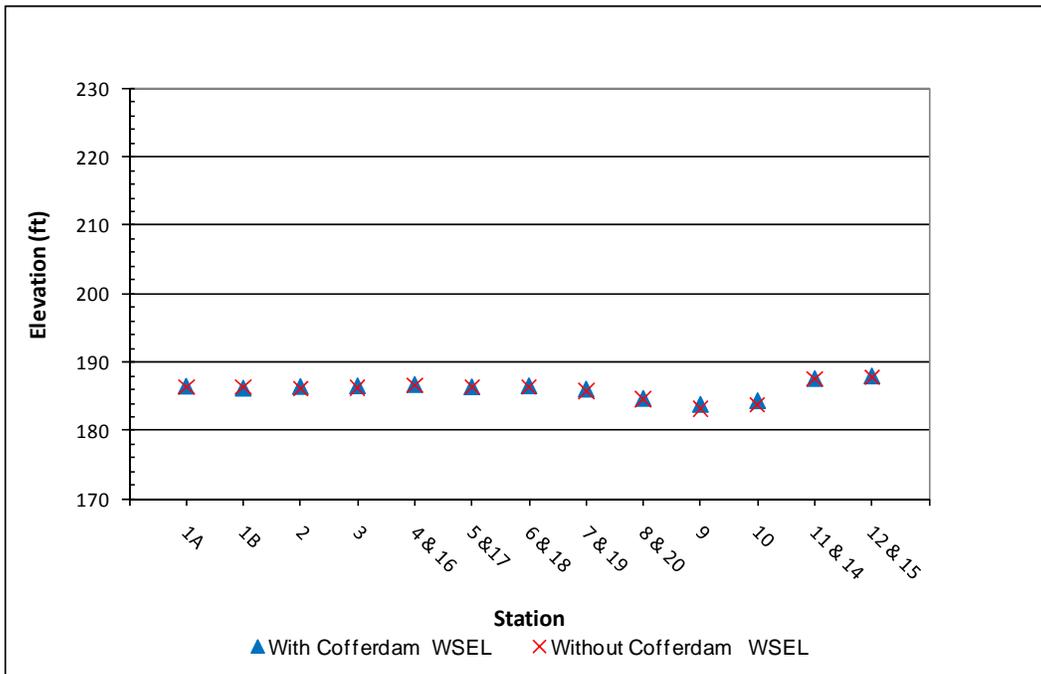


Figure 135. Main dam 31,000 ft³/s and aux spwy 129,000 ft³/s with tailwater 184.26 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 136. Main dam 31,000 ft³/s and auxiliary spillway 129,000 ft³/s with the cofferdam.



Figure 137. Main dam 31,000 ft³/s and auxiliary spillway 129,000 ft³/s without the cofferdam.

Main Dam flow rate 25,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

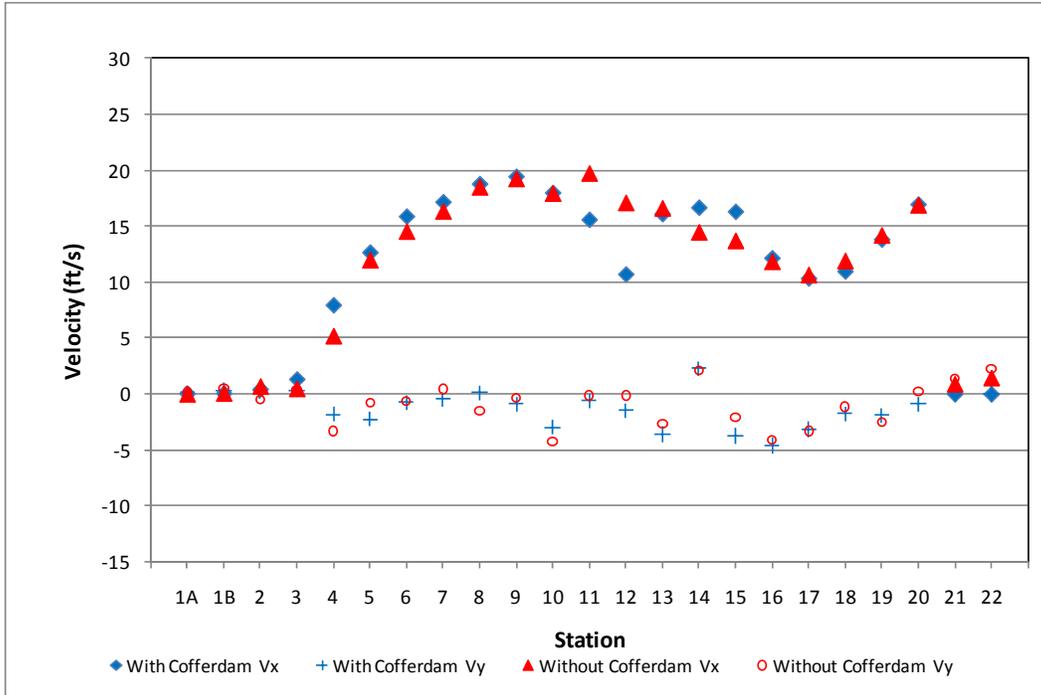


Figure 138. Main dam 25,000 ft³/s and aux spwy 135,000 ft³/s with tailwater 184.26 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

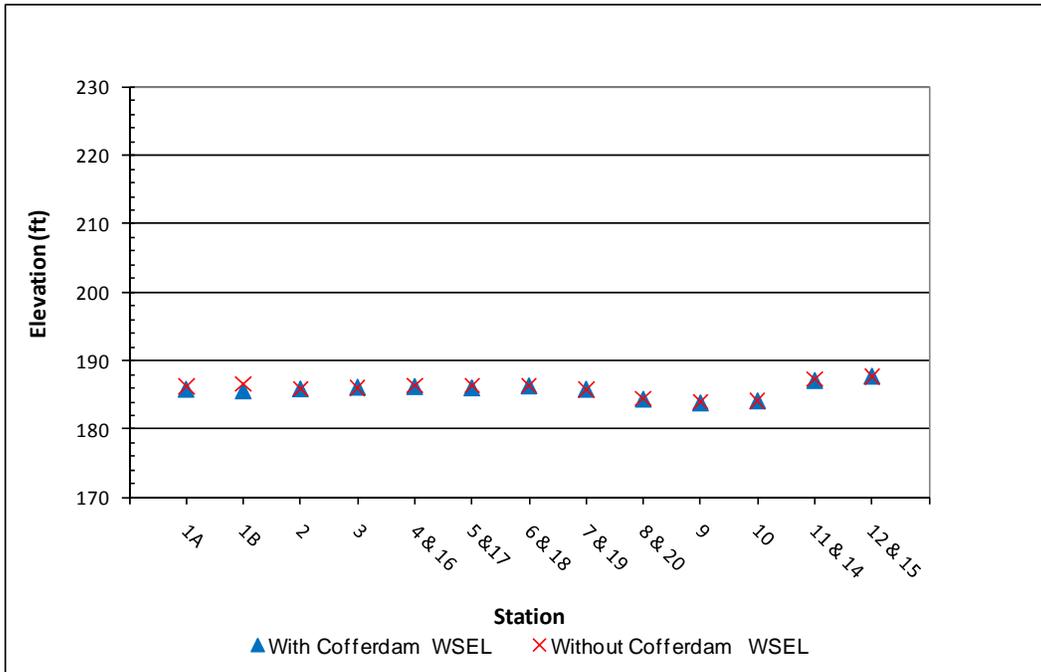


Figure 139. Main dam 25,000 ft³/s and aux spwy 135,000 ft³/s with tailwater 184.26 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 140. Main dam 25,000 ft³/s and auxiliary spillway 135,000 ft³/s with the cofferdam.



Figure 141. Main dam 25,000 ft³/s and auxiliary spillway 135,000 ft³/s without the cofferdam.

Main Dam flow rate 15,000 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

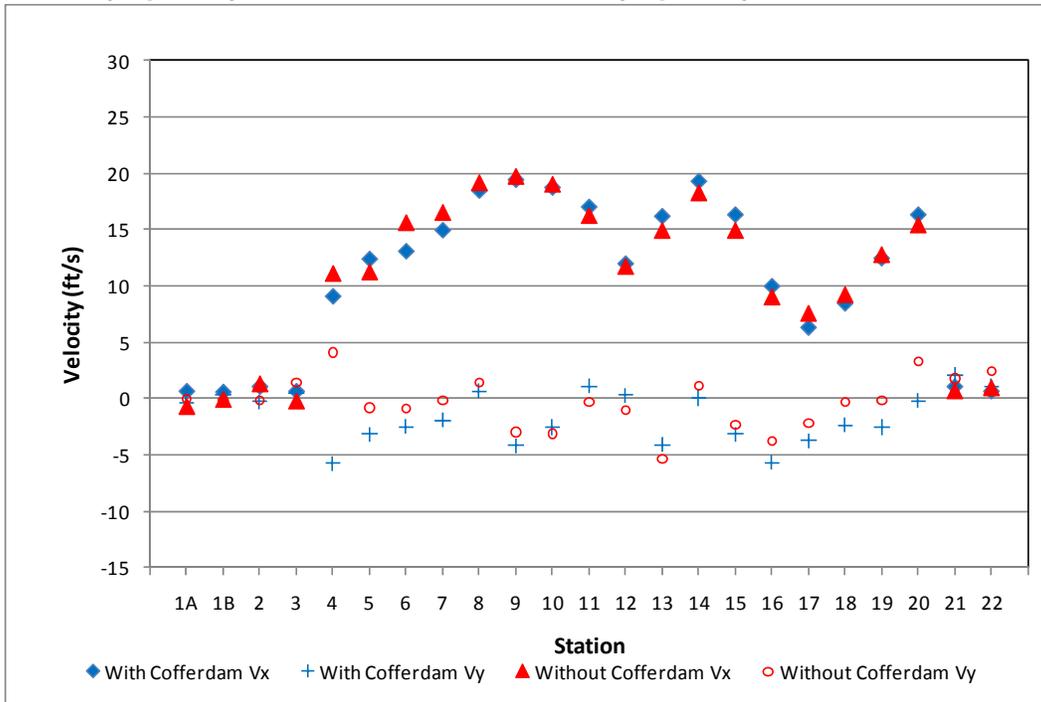


Figure 142. Main dam 15,000 ft³/s and aux spwy 145,000 ft³/s with tailwater 184.26 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

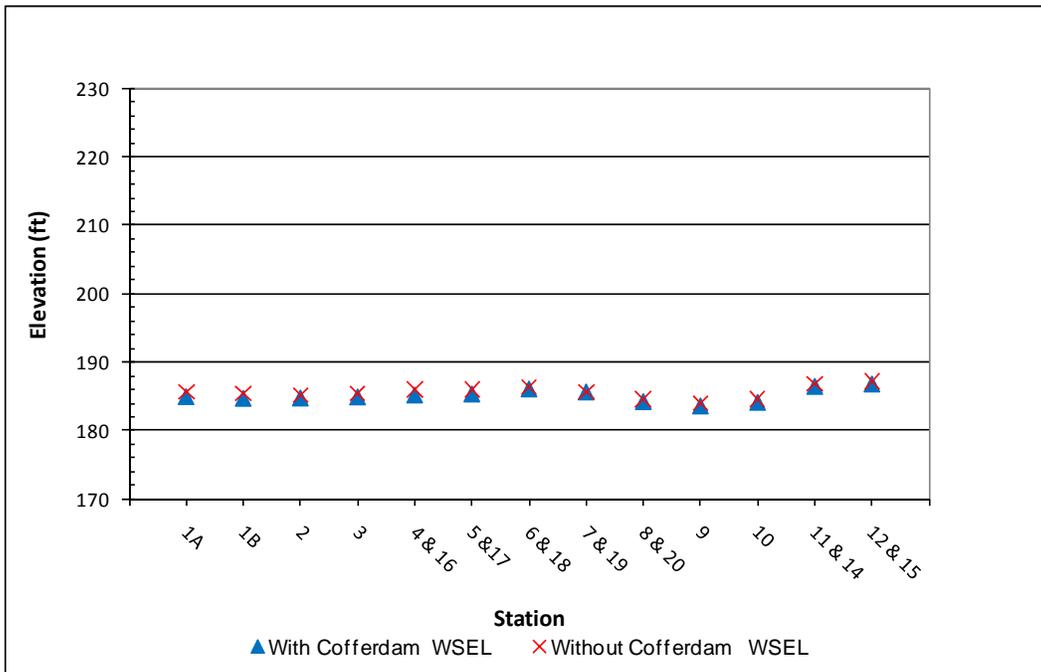


Figure 143. Main dam 15,000 ft³/s and aux spwy 145,000 ft³/s with tailwater of 184.26 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 144. Main dam $15,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $145,000 \text{ ft}^3/\text{s}$ with the cofferdam.



Figure 145. Main dam $15,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $145,000 \text{ ft}^3/\text{s}$ without the cofferdam.

Main Dam flow rate 0 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

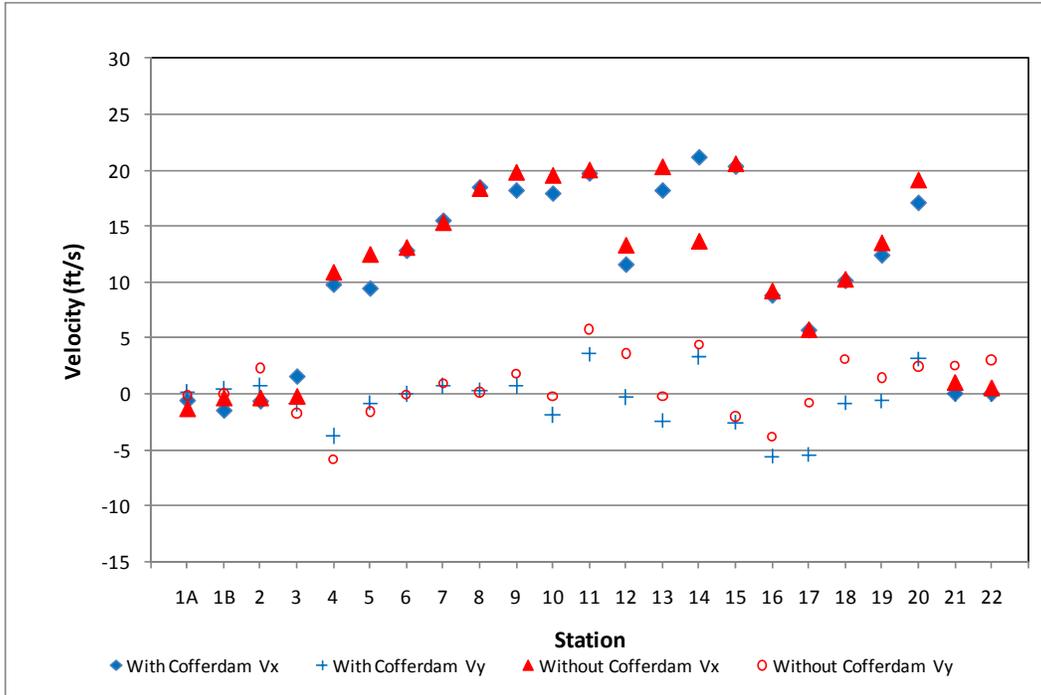


Figure 146. Main dam 0 ft³/s and aux spwy 160,000 ft³/s with tailwater 184.26 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

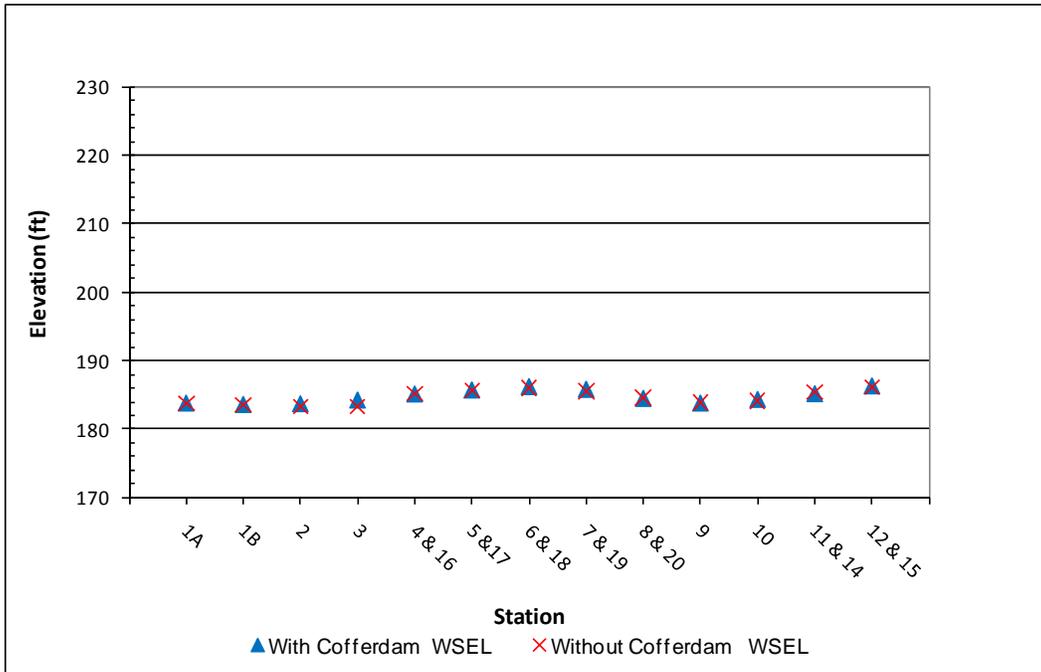


Figure 147. Main dam 0 ft³/s and aux spwy 160,000 ft³/s with tailwater 184.26 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 148. Main dam 0 ft³/s and auxiliary spillway 160,000 ft³/s with the cofferdam.



Figure 149. Main dam 0 ft³/s and auxiliary spillway 160,000 ft³/s without the cofferdam.

Main Dam flow rate 45,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 180,000 ft³/s with a tailwater elevation of 187.8 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

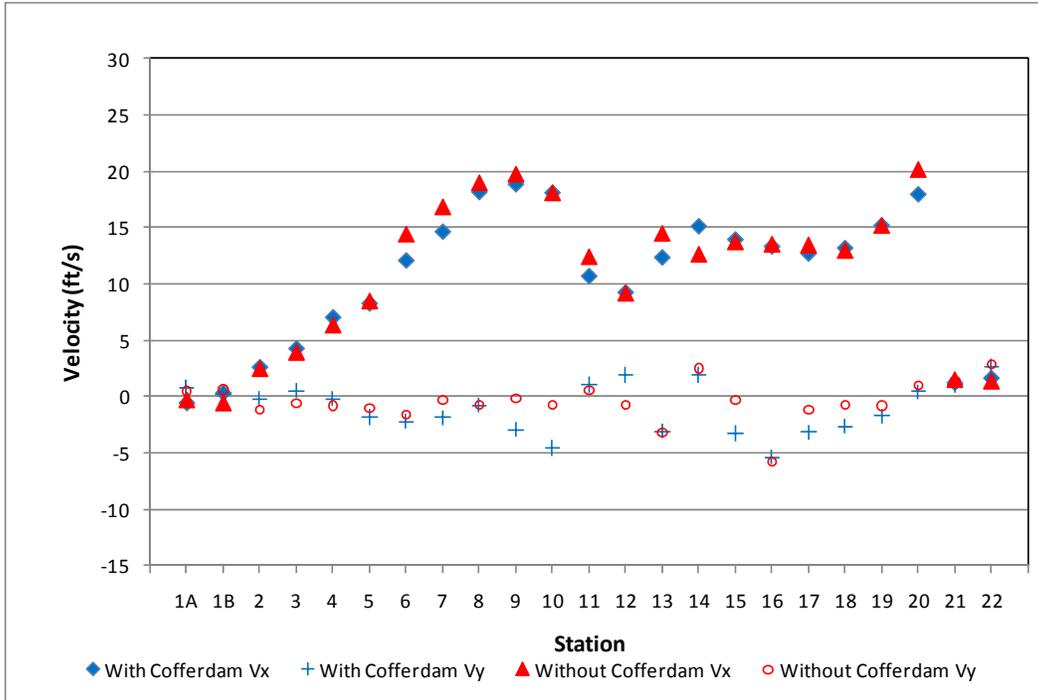


Figure 150. Main dam 45,000 ft³/s and aux spwy 135,000 ft³/s with tailwater 187.8 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

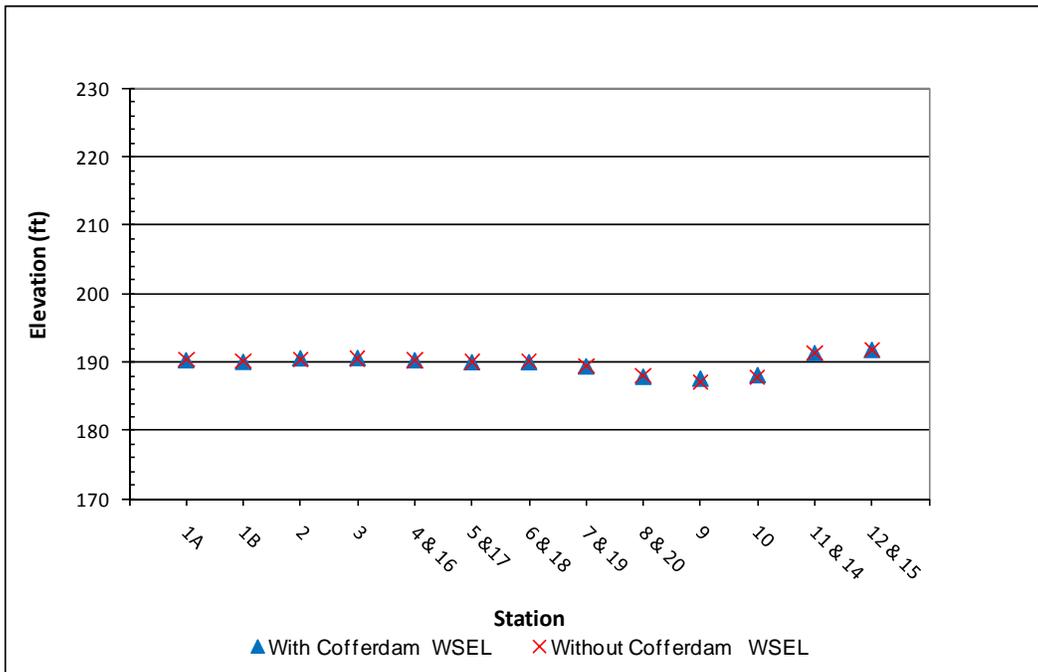


Figure 151. Main dam 45,000 ft³/s and aux spwy 135,000 ft³/s with tailwater 187.8 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 152. Main dam 45,000 ft³/s and auxiliary spillway 135,000 ft³/s with the cofferdam.



Figure 153. Main dam 45,000 ft³/s and auxiliary spillway 135,000 ft³/s without the cofferdam.

Main Dam flow rate 75,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

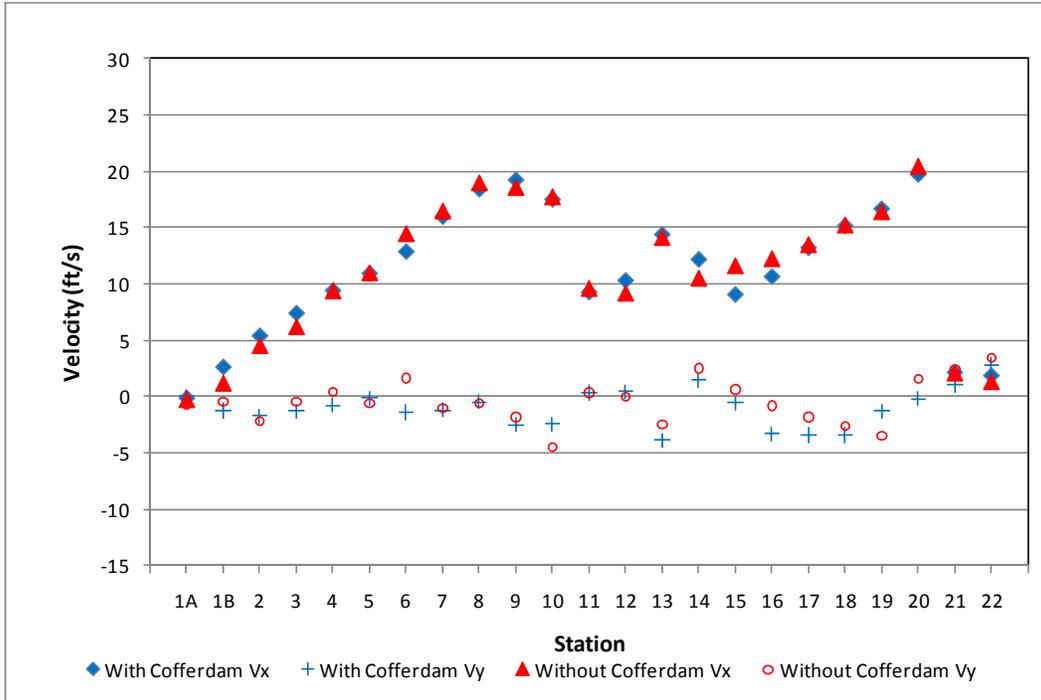


Figure 154. Main dam 75,000 ft³/s and aux spwy 115,000 ft³/s with tailwater 189.3 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

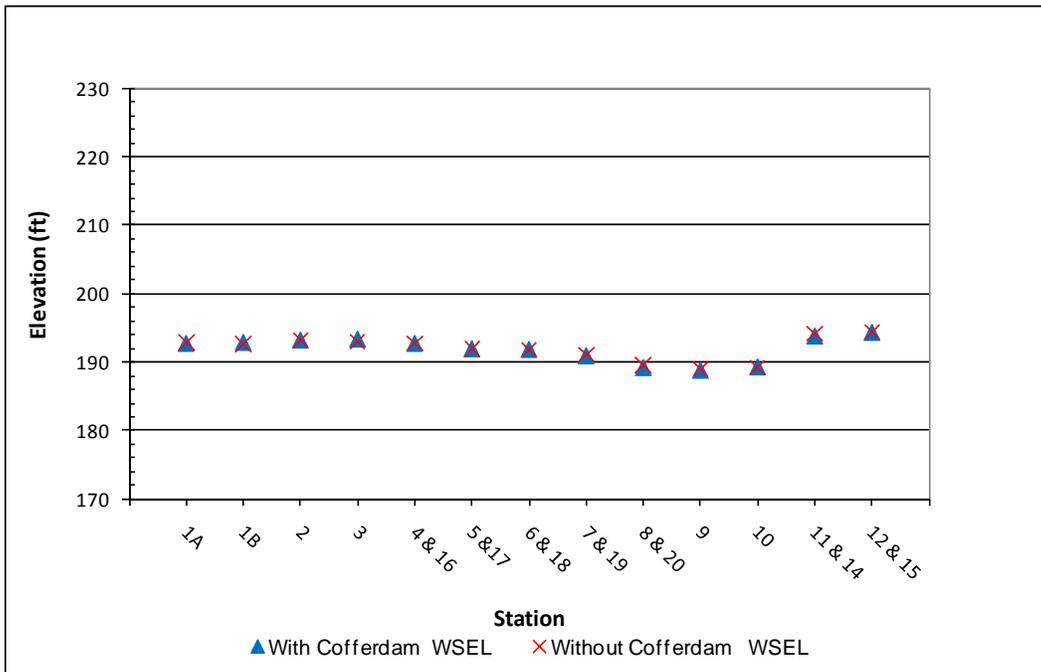


Figure 155. Main dam 75,000 ft³/s and aux spwy 115,000 ft³/s, with tailwater 189.3 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 156. Main dam $75,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $115,000 \text{ ft}^3/\text{s}$ with the cofferdam.



Figure 157. Main dam $75,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $115,000 \text{ ft}^3/\text{s}$ without the cofferdam.

Main Dam flow rate 45,000 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

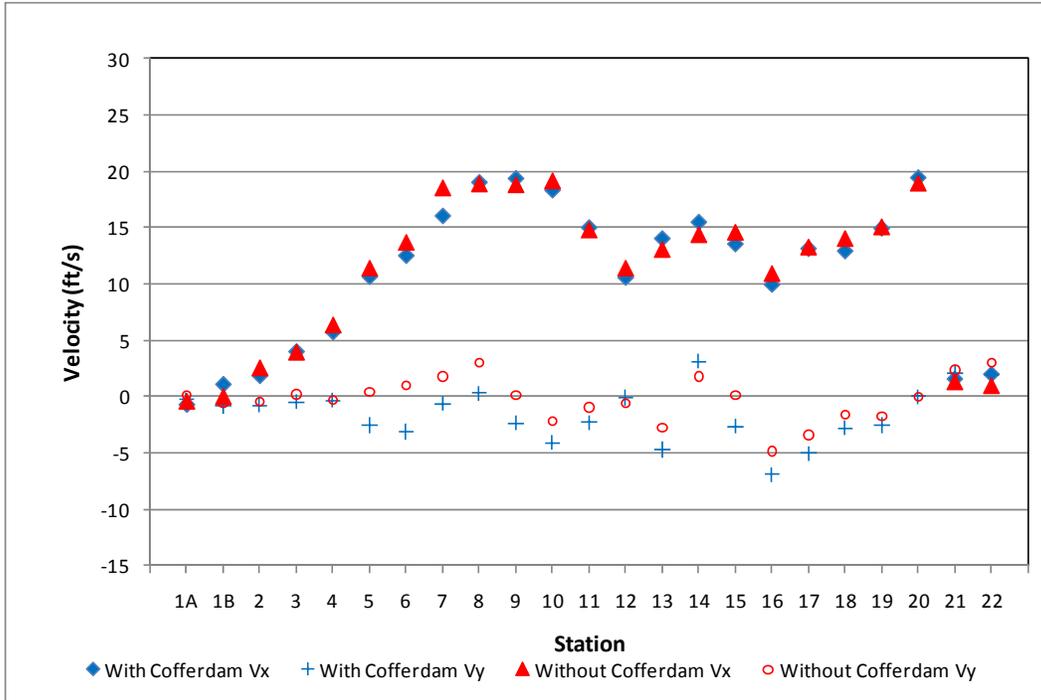


Figure 158. Main dam 45,000 ft³/s and aux spwy 145,000 ft³/s with tailwater 189.3 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

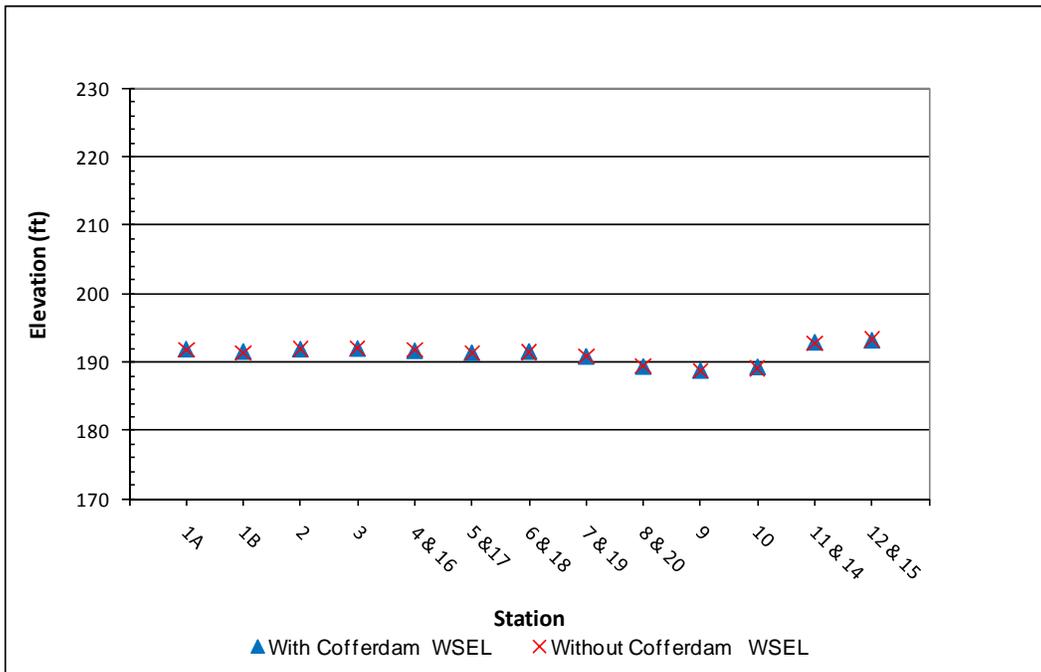


Figure 159. Main dam 45,000 ft³/s and aux spwy 145,000 ft³/s, with tailwater 189.3 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 160. Main dam 45,000 ft³/s and auxiliary spillway 145,000 ft³/s with the cofferdam.



Figure 161. Main dam 45,000 ft³/s and auxiliary spillway 145,000 ft³/s without the cofferdam.

Main Dam flow rate 30,000 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

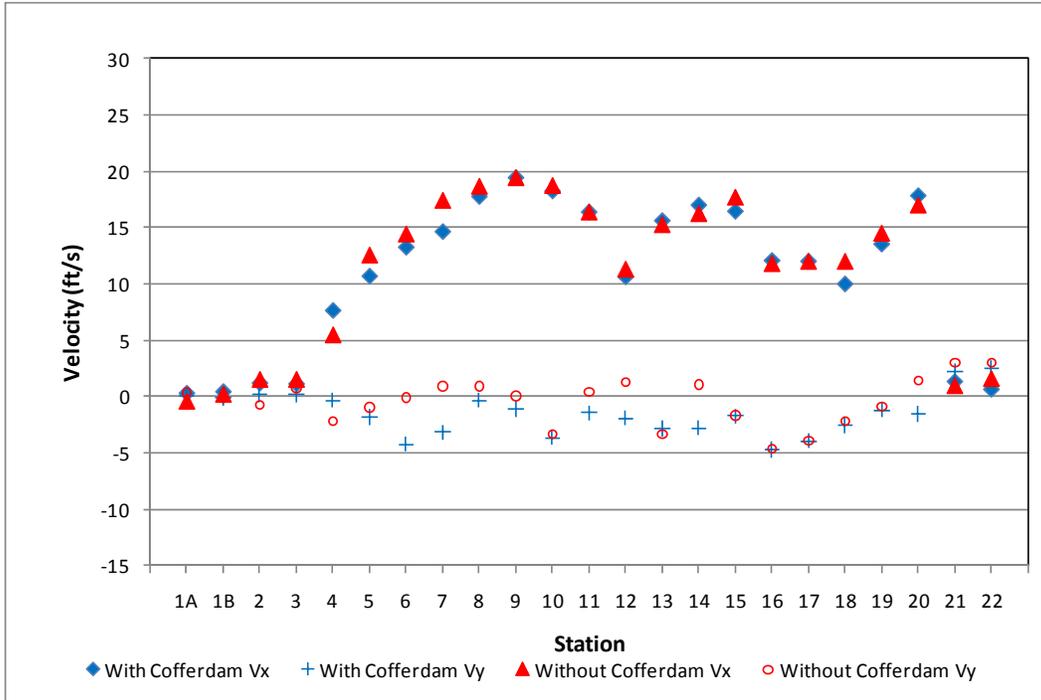


Figure 162. Main dam 30,000 ft³/s and aux spwy 160,000 ft³/s with tailwater 189.3 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

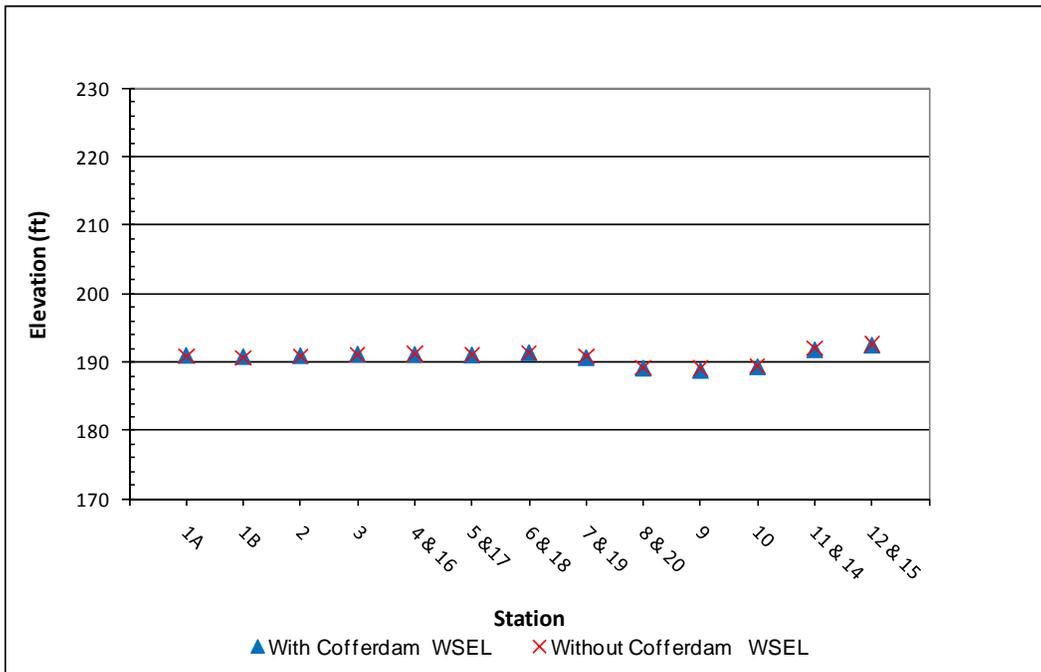


Figure 163. Main dam 30,000 ft³/s and aux spwy 160,000 ft³/s with tailwater 189.3 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 164. Main dam 30,000 ft³/s and auxiliary spillway 160,000 ft³/s with the cofferdam.



Figure 165. Main dam 30,000 ft³/s and auxiliary spillway 160,000 ft³/s without the cofferdam.

Main Dam flow rate 60,000 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 220,000 ft³/s with a tailwater elevation of 193.7 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

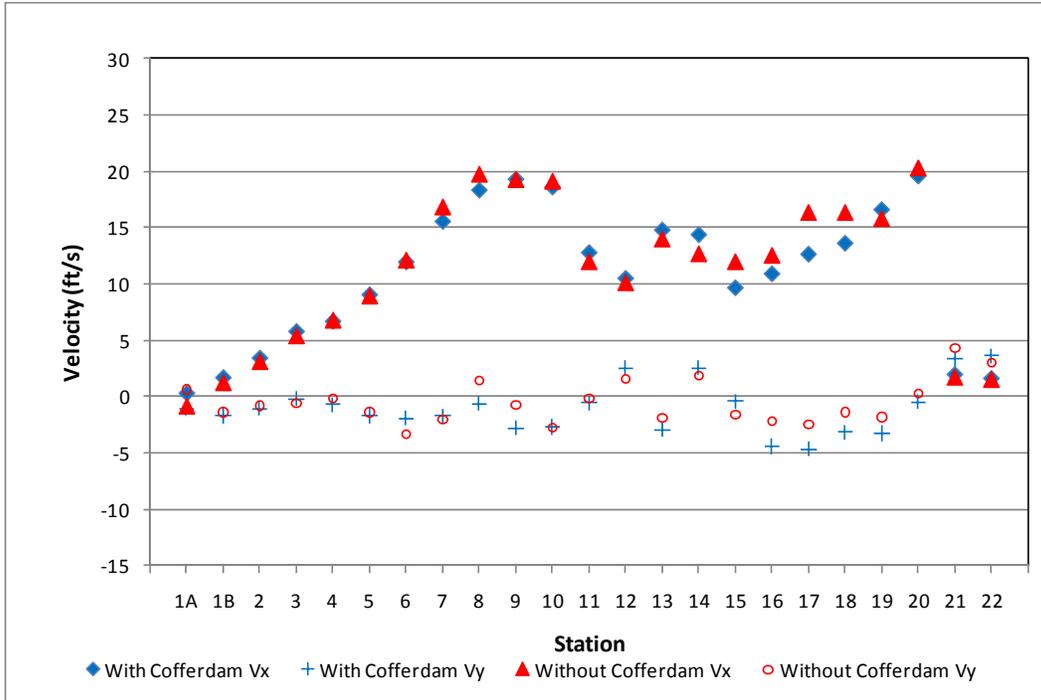


Figure 166. Main dam 60,000 ft³/s and aux spwy 160,000 ft³/s with tailwater 193.7 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

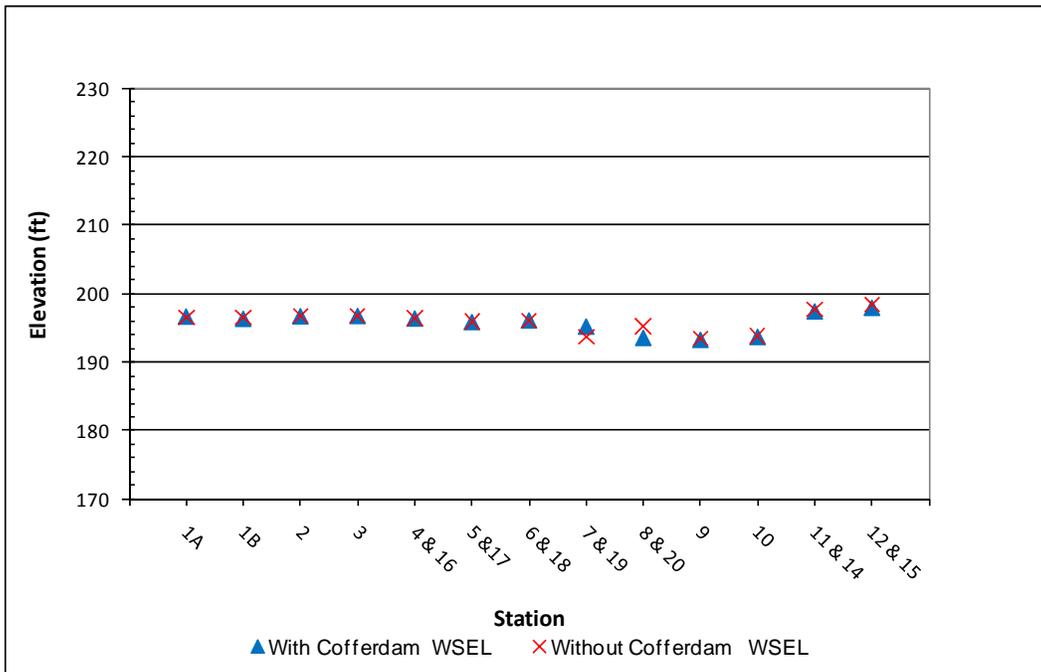


Figure 167. Main dam 60,000 ft³/s and aux spwy 160,000 ft³/s with tailwater 193.7 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 168. Main dam 60,000 ft³/s and auxiliary spillway 160,000 ft³/s with the cofferdam.



Figure 169. Main dam 60,000 ft³/s and auxiliary spillway 160,000 ft³/s without the cofferdam.

Main Dam flow rate 238,266 ft³/s and auxiliary spillway 0 ft³/s for a total of 238,266 ft³/s with a tailwater elevation of 196.44 ft.

No auxiliary spillway

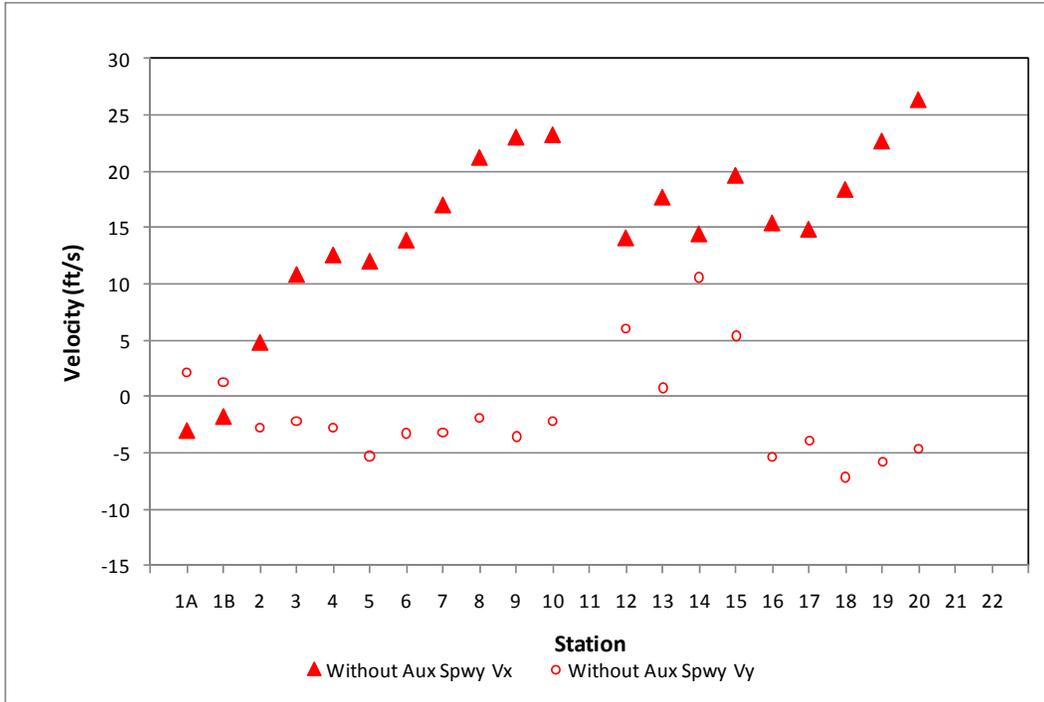


Figure 170. Main dam 238,266 ft³/s and auxiliary spillway 0 ft³/s with tailwater 196.44 ft.

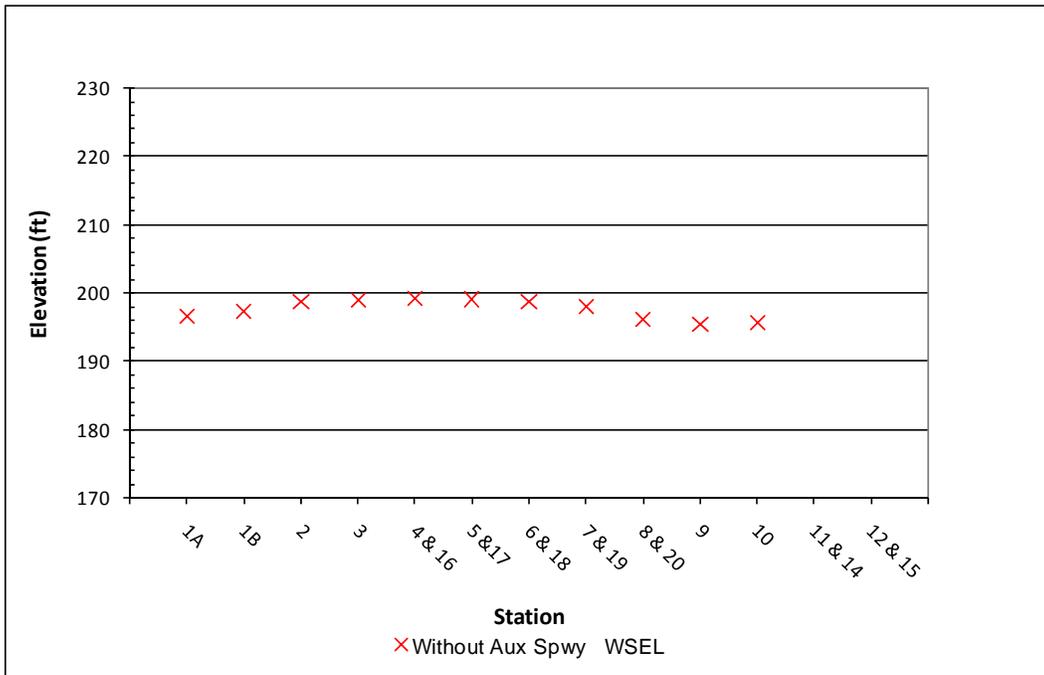


Figure 171. Main dam 238,266 ft³/s and auxiliary spillway 0 ft³/s with tailwater 196.44 ft.



Figure 172. Main dam $238,266 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the auxiliary spillway.

Main Dam flow rate 115,000 ft³/s and auxiliary spillway 141,000 ft³/s for a total of 256,000 ft³/s with a tailwater elevation of 199.1 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

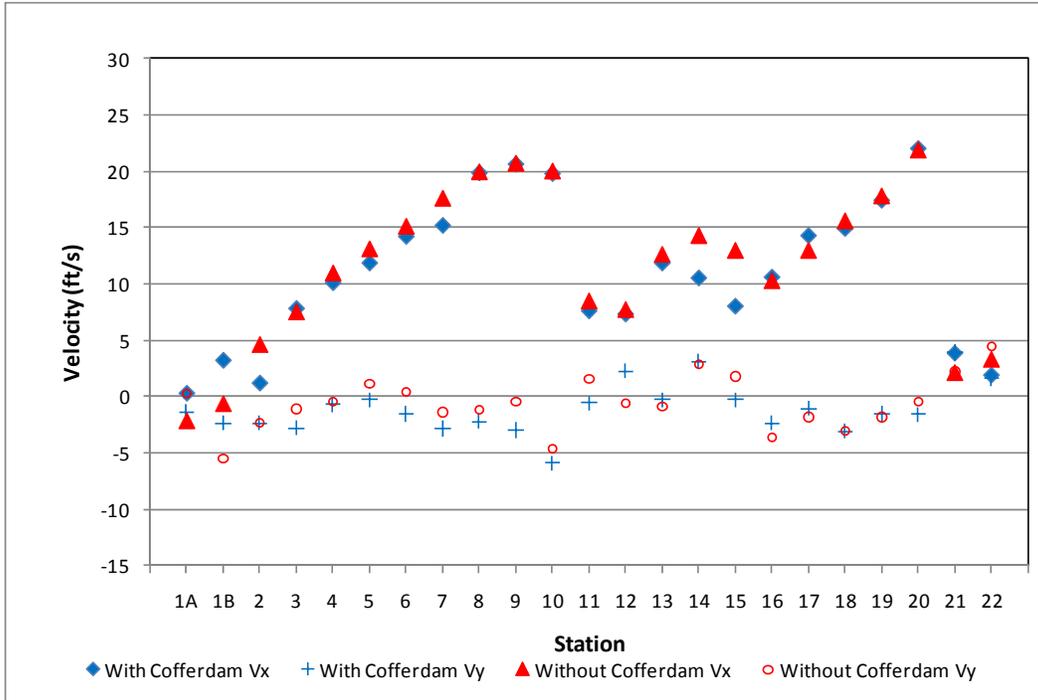


Figure 173. Main dam 115,000 ft³/s and aux spwy 141,000 ft³/s with tailwater 199.1 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

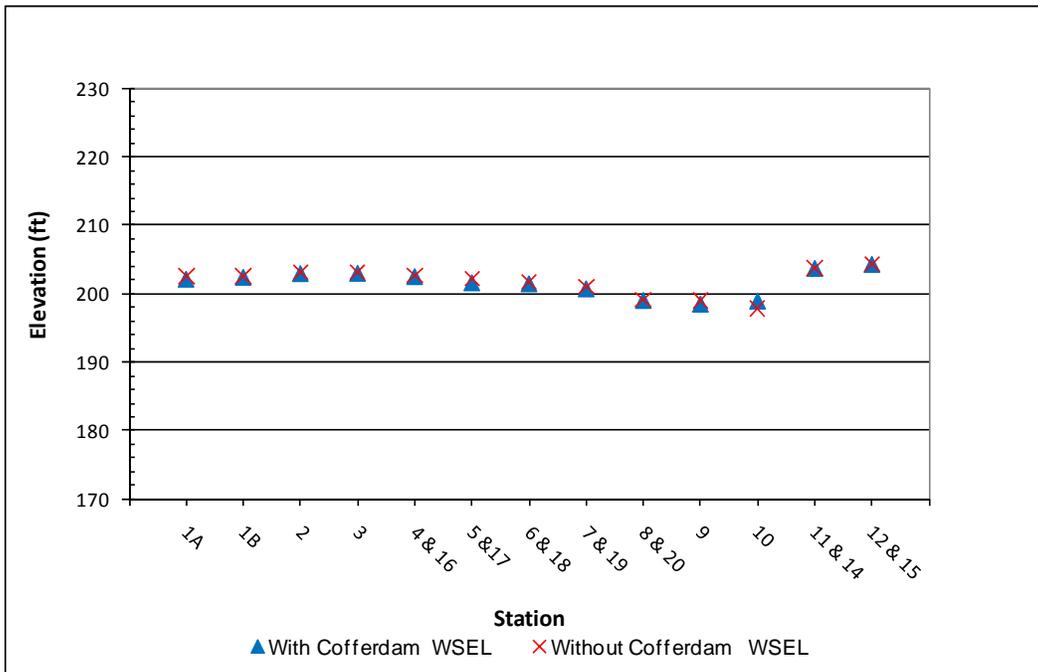


Figure 174. Main dam 115,000 ft³/s and aux spwy 141,000 ft³/s with tailwater 199.1 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 175. Main dam 115,000 ft³/s and auxiliary spillway 141,000 ft³/s with the cofferdam.



Figure 176. Main dam 115,000 ft³/s and auxiliary spillway 141,000 ft³/s without the cofferdam.

Main Dam flow rate 300,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 300,000 ft³/s with a tailwater elevation of 205.75 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

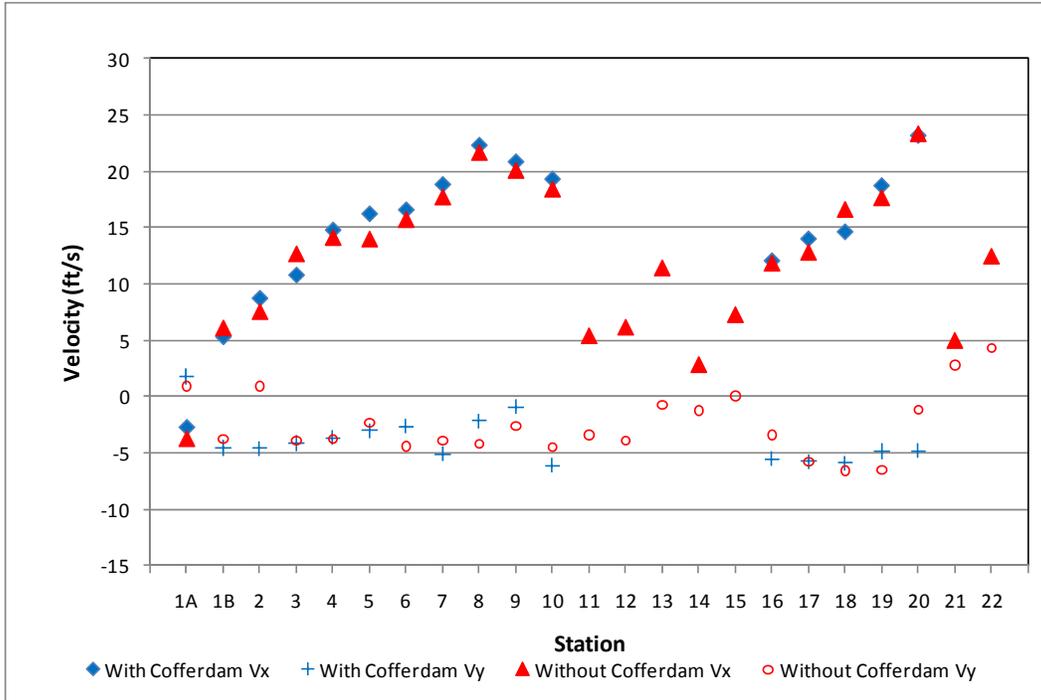


Figure 177. Main dam 300,000 ft³/s and aux spwy 0 ft³/s with tailwater 205.75 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

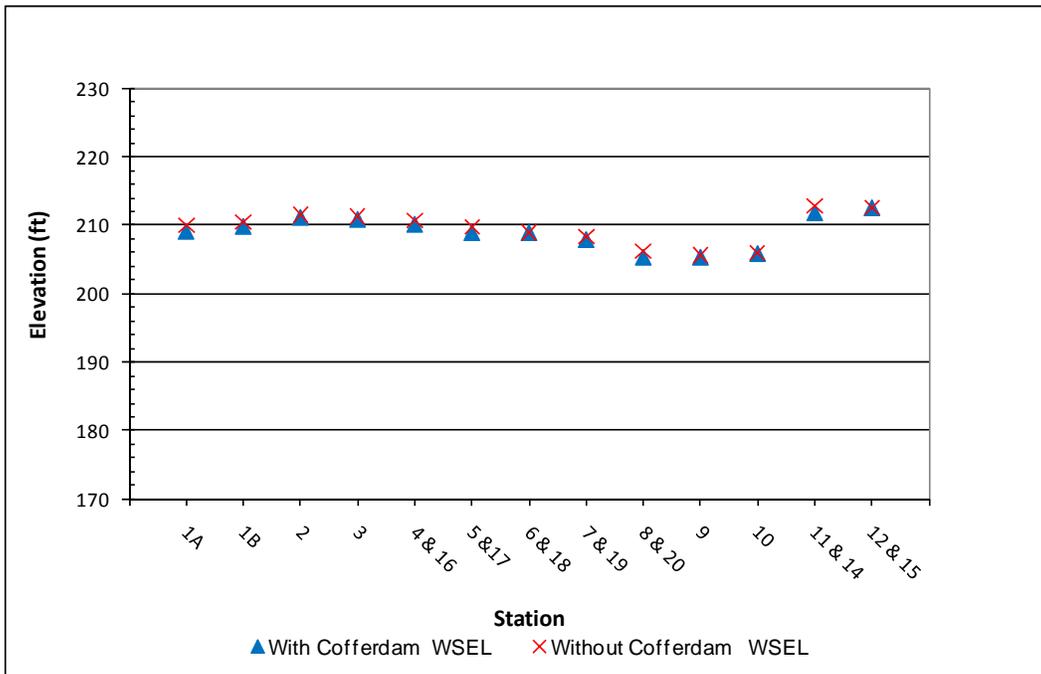


Figure 178. Main dam 300,000 ft³/s and aux spwy 0 ft³/s with tailwater 205.75 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

Auxiliary spillway with cofferdam vs. no auxiliary spillway

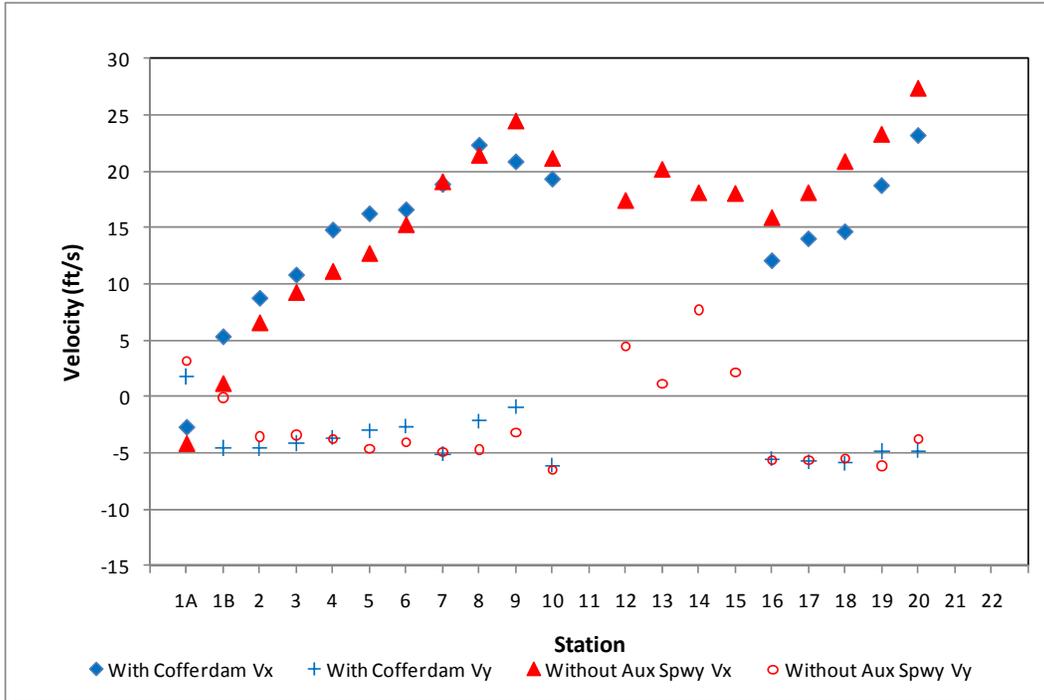


Figure 179. Main dam 300,000 ft³/s and aux spwy 0 ft³/s with tailwater 205.75 ft. Velocity comparison: aux spwy with cofferdam vs. no aux spwy.

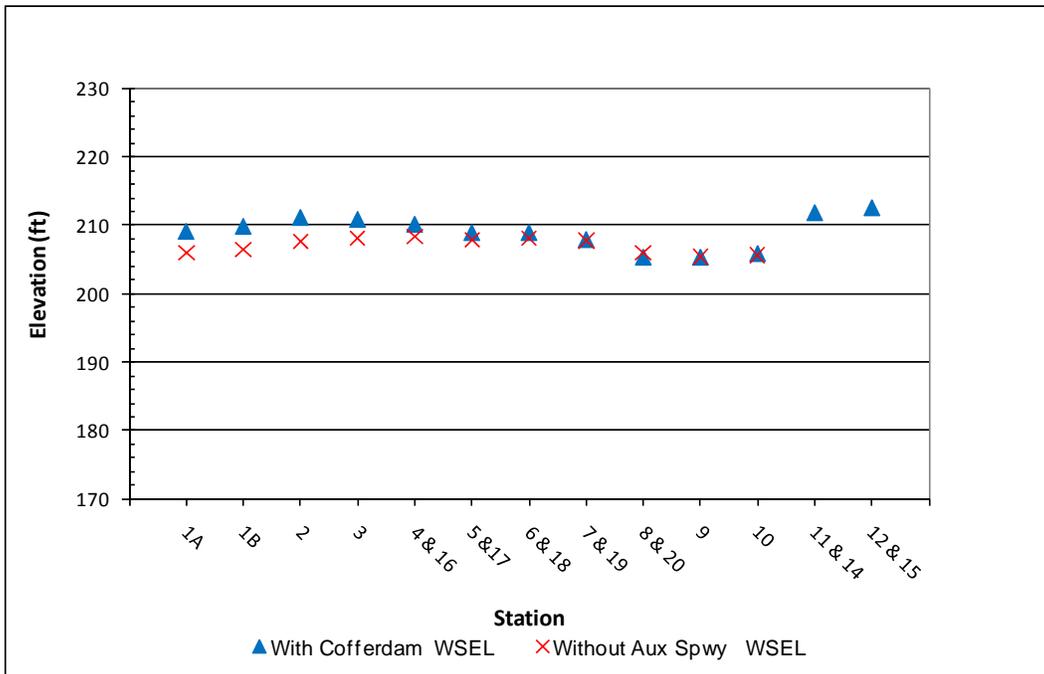


Figure 180. Main dam 300,000 ft³/s and aux spwy 0 ft³/s with tailwater 205.75 ft. Water surface comparison: aux spwy with cofferdam vs. no aux spwy.



Figure 181. Main dam $300,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ with the cofferdam.



Figure 182. Main dam $300,000 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the cofferdam.



Figure 183. Main dam 300,000 ft³/s and auxiliary spillway 0 ft³/s without the auxiliary spillway.

Main Dam flow rate 115,000 ft³/s and auxiliary spillway 237,000 ft³/s for a total of 352,000 ft³/s with a tailwater elevation of 212.95 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

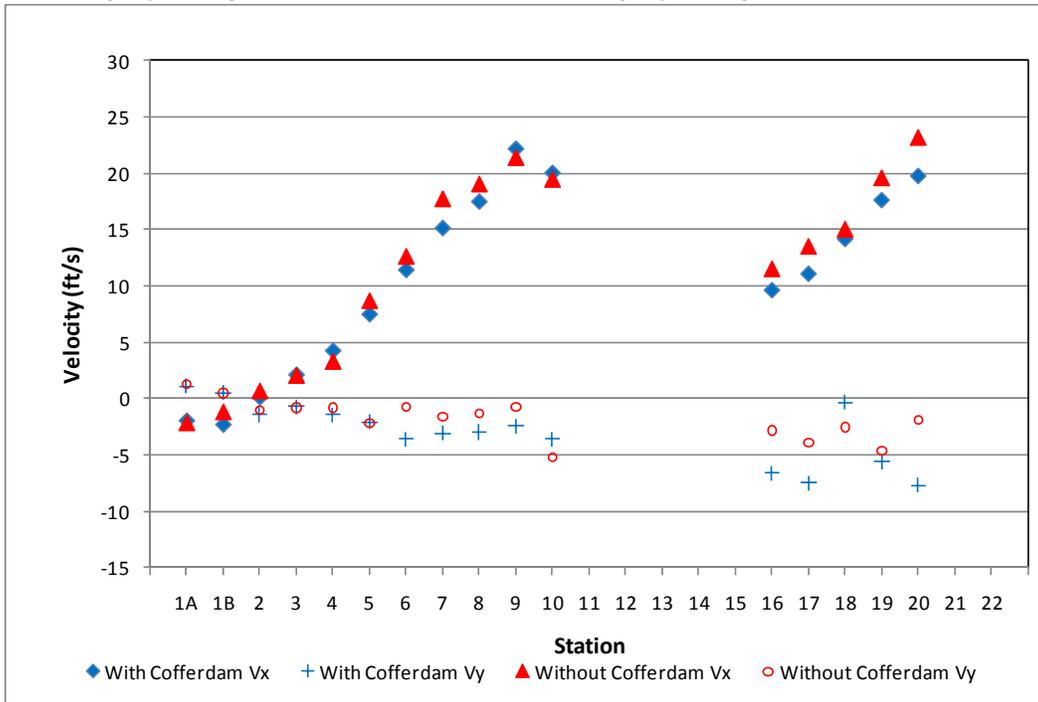


Figure 184. Main dam 115,000 ft³/s and aux spwy 237,000 ft³/s with tailwater 212.95 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

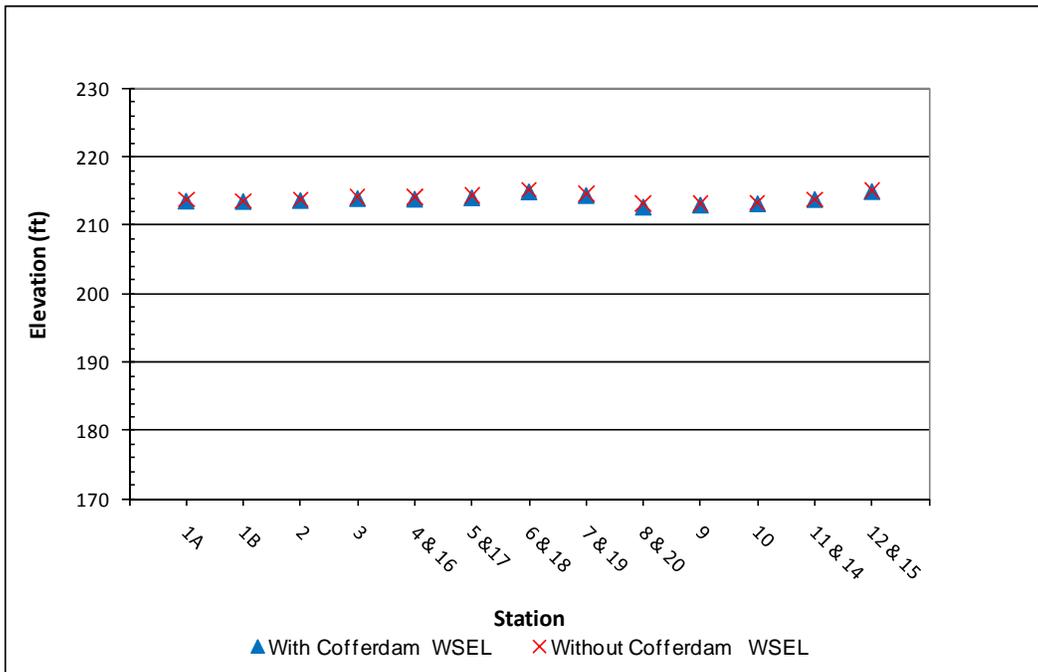


Figure 185. Main dam 115,000 ft³/s and aux spwy 237,000 ft³/s with tailwater 212.95 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 186. Main dam 115,000 ft³/s and auxiliary spillway 237,000 ft³/s with the cofferdam.



Figure 187. Main dam 115,000 ft³/s and auxiliary spillway 237,000 ft³/s without the cofferdam.

Main Dam flow rate 528,090 ft³/s and auxiliary spillway 0 ft³/s for a total of 528,090 ft³/s with a tailwater elevation of 230.48 ft.

No auxiliary spillway

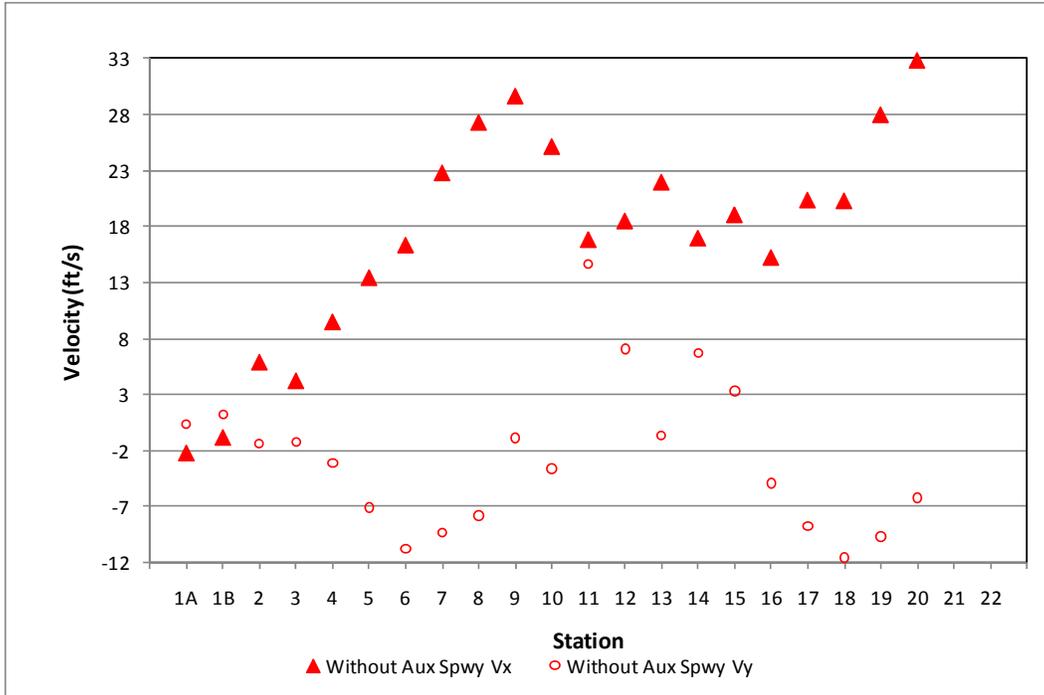


Figure 188. Main dam 528,090 ft³/s and auxiliary spillway 0 ft³/s with tailwater 230.48 ft.

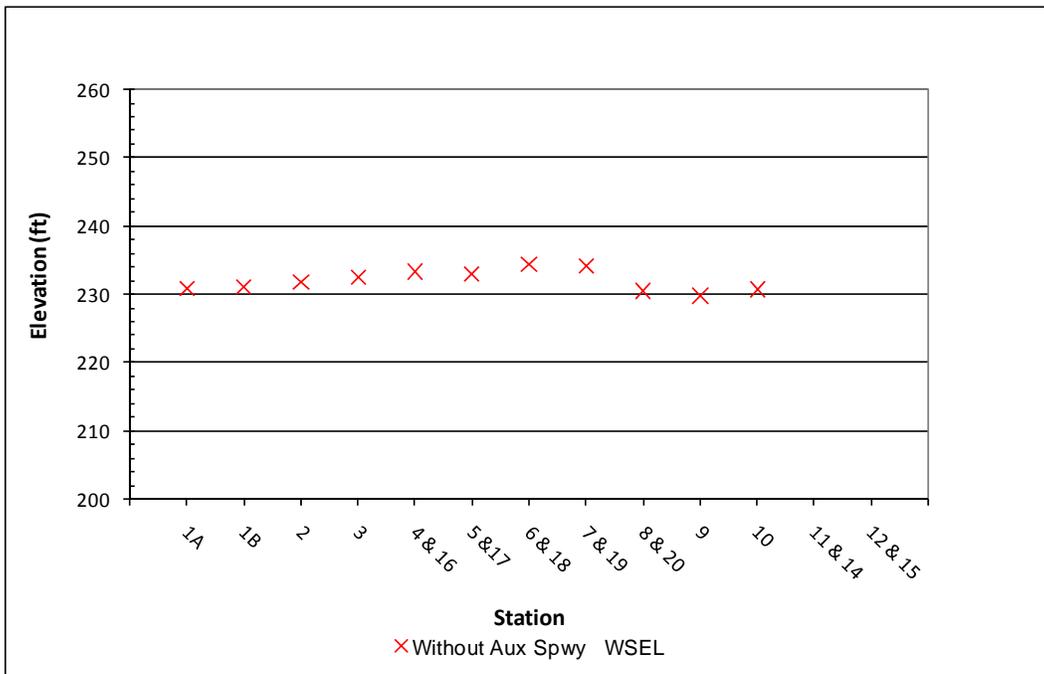


Figure 189. Main dam 528,090 ft³/s and auxiliary spillway 0 ft³/s with tailwater 230.48 ft.



Figure 190. Main dam $528,090 \text{ ft}^3/\text{s}$ and auxiliary spillway $0 \text{ ft}^3/\text{s}$ without the auxiliary spillway.

Main Dam flow rate 238,266 ft³/s and auxiliary spillway 297,851 ft³/s for a total of 536,117 ft³/s with a tailwater elevation of 231.15 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

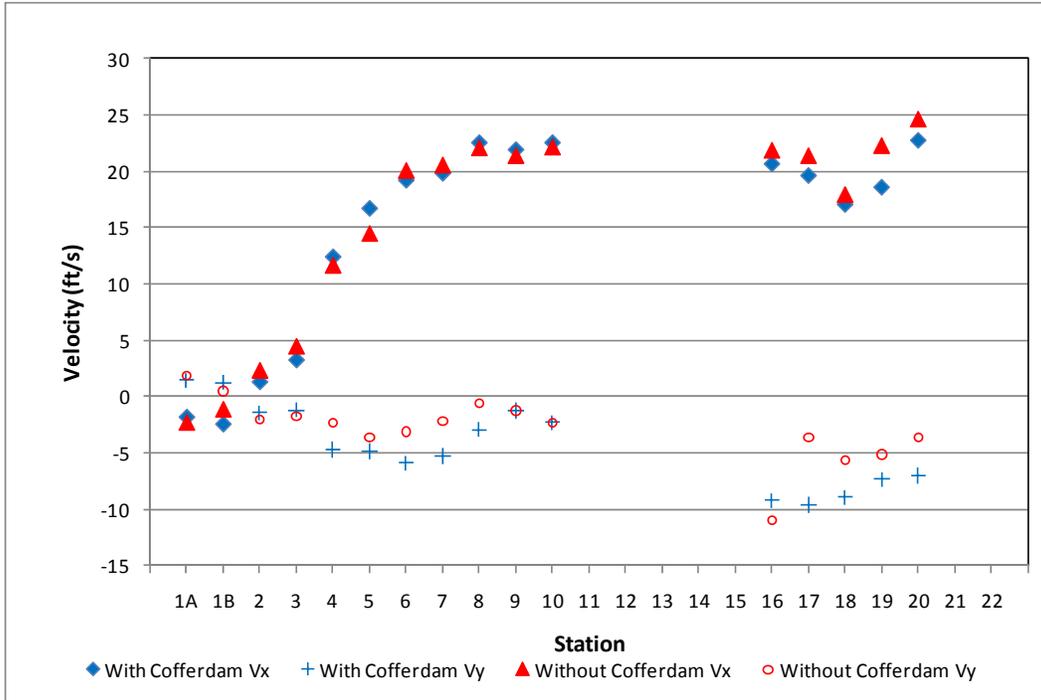


Figure 191. Main dam 238,266 ft³/s and aux spwy 297,851 ft³/s with tailwater 231.15 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

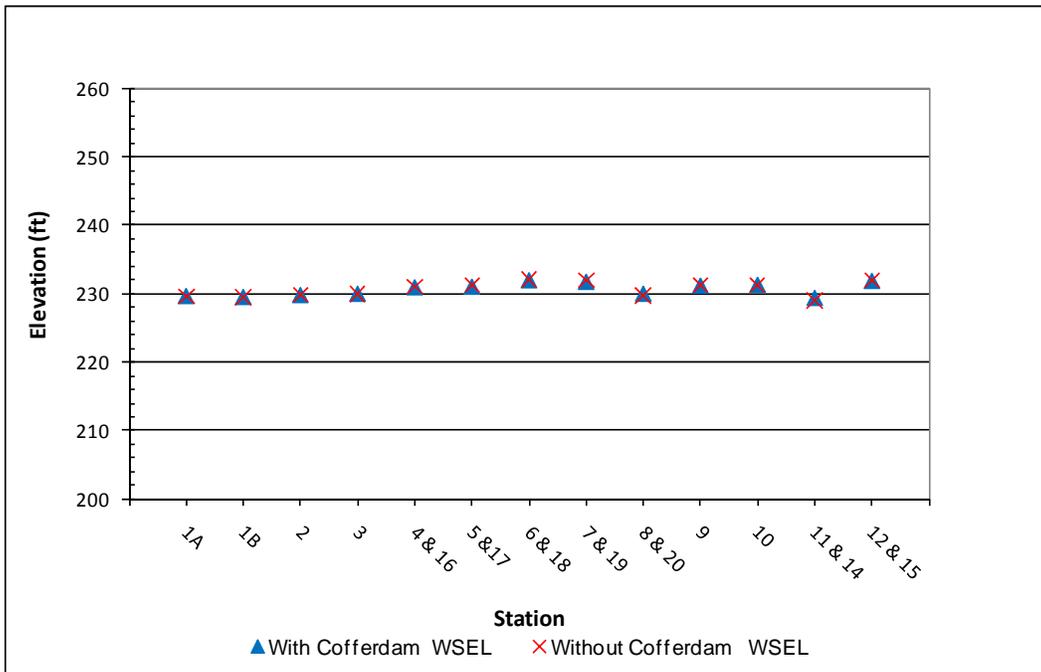


Figure 192. Main dam 238,266 ft³/s and aux spwy 297,851 ft³/s with tailwater 231.15 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 193. Main dam 238,266 ft³/s and auxiliary spillway 297,851 ft³/s with the cofferdam.



Figure 194. Main dam 238,266 ft³/s and auxiliary spillway 297,851 ft³/s without the cofferdam.

Main Dam flow rate 528,090 ft³/s and auxiliary spillway 313,640 ft³/s for a total of 841,730 ft³/s with a tailwater elevation of 253.78 ft.

Auxiliary spillway with cofferdam vs. auxiliary spillway without cofferdam

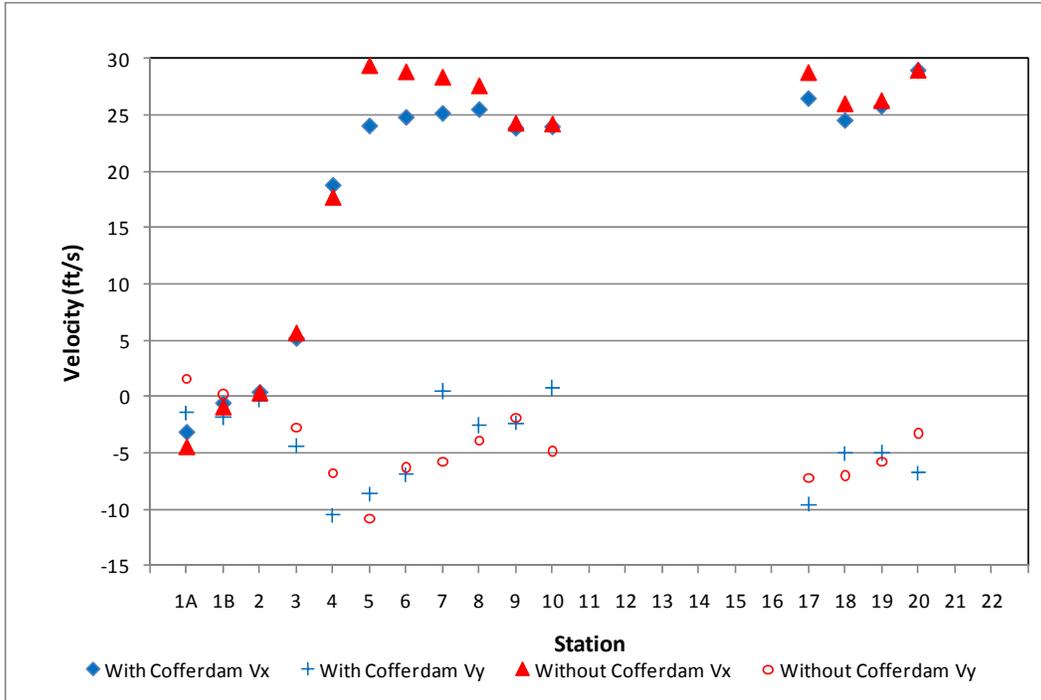


Figure 195. Main dam 528,090 ft³/s and aux spwy 313,640 ft³/s with tailwater 253.78 ft. Velocity comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.

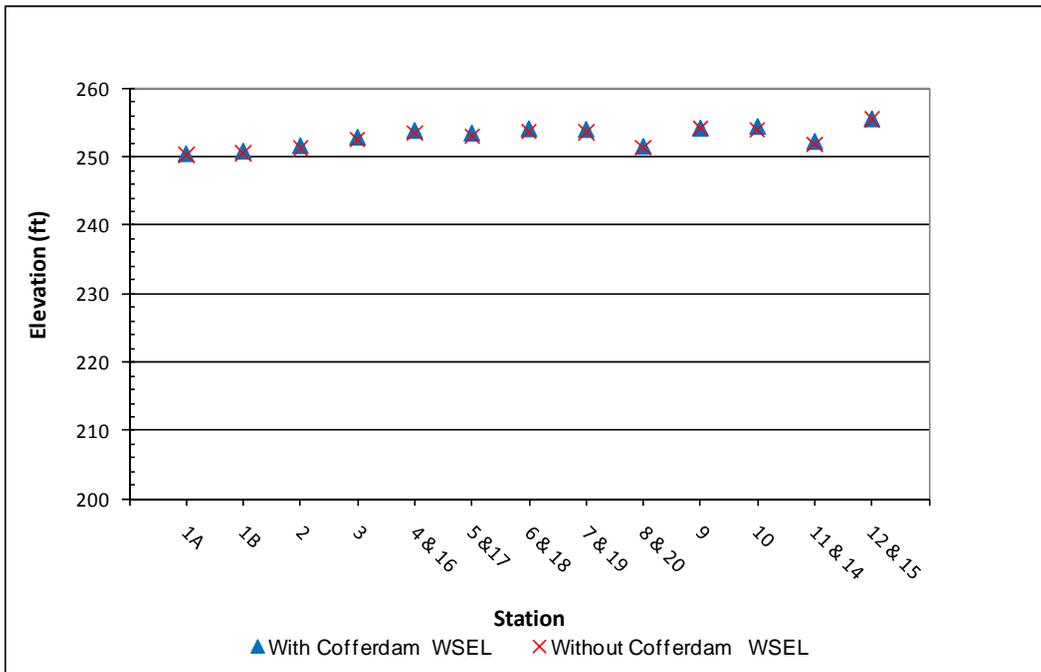


Figure 196. Main dam 528,090 ft³/s and aux spwy 313,640 ft³/s with tailwater 253.78 ft. Water surface comparison: aux spwy with cofferdam vs. aux spwy without cofferdam.



Figure 197. Main dam 528,090 ft³/s and auxiliary spillway 313,640 ft³/s with the cofferdam.



Figure 198. Main dam 528,090 ft³/s and auxiliary spillway 313,640 ft³/s without the cofferdam.

Conclusions

The cofferdam wall constructed along the haul road influences flow patterns of low main dam discharges by redirecting water in front of the knob and into the river channel. At 25,000 ft³/s small surges of water push over the top of the knob. The knob is overtopped by a main dam release of 60,000 ft³/s and submerged at 90,000 ft³/s. When the cofferdam is not installed, some of the main dam discharge flows down the haul road to the left of the knob and into the auxiliary spillway exit channel.

When only the auxiliary spillway is operating and the cofferdam wall is in place, water fills in behind the cofferdam wall on the excavated haul road, but water cannot flow around the knob. When the cofferdam is removed, water from the auxiliary spillway is able to flow onto the excavated haul road and around to the right of the knob into the American River channel.

In general, model data show that the cofferdam influences measured velocities and observed flow patterns when the total flow rate is 115,000 ft³/s and lower. When total flows are greater than 115,000 ft³/s, measured velocities and flow patterns are similar due to the submergence of the cofferdam and knob feature. The highest velocities in the notch through the knob occur when 60,000 ft³/s is released from the main dam with no flow from the auxiliary spillway, without the cofferdam in place. In this situation, flow sweeps past the knob without full submergence of the knob. Water surface elevations with and without the cofferdam are similar for all compared flow rates.

Flow patterns without the auxiliary spillway were compared to flow conditions with the auxiliary spillway and cofferdam in place. When total flow rates were less than 115,000 ft³/s, the most notable difference between the two configurations was the location of the entry point of flow into the river channel and the velocity magnitudes at that point. At 115,000 ft³/s and above, the change in model topography between the configuration with and without the auxiliary spillway produces different overall flow patterns in the confluence area. However, water surface elevations were similar for compared flow rates.

With the exception of discharges greater than 500,000 ft³/s, the highest velocities perpendicular to a bankline for both pre- and post-auxiliary spillway construction were measured at the condition of 7,000 ft³/s from the main dam spillway only, at station 2. Pre-auxiliary spillway conditions noted a velocity of 15.2 ft/s perpendicular to the right bank, while post-aux spillway construction readings were 8.4 ft/s perpendicular to the right bank of the American River channel in the confluence area (cofferdam wall in place). However, this condition is not likely to occur under normal operating conditions because this discharge is typically released with some or all of the flow coming from the powerhouse. The physical

model does not have the capability to release flow through the powerhouse or outlet works. Erosion potential and bank stability in the confluence area during different operational scenarios should be analyzed by project geotechnical engineers.

References

Svoboda, C.D., Robert F. Einhellig, and K. Warren Frizell. (2010). "Hydraulic Model Study of Folsom Dam Joint Federal Project Auxiliary Spillway Confluence Area." Bureau of Reclamation, Hydraulic Laboratory, Report HL-2009-05, Denver, Colorado.

Appendix A. Velocity Data

Appendix Key:

No Water = No water at the velocity measurement location.

Too Shallow = Water was not deep enough to obtain a velocity reading.

Too Turbulent = Water was too turbulent to accurately measure velocity.

N/A = Velocity was not available (the location does not exist in the No Auxiliary Spillway configuration).

Table 1. Main dam flow rate 4,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 4,000 ft³/s with a tailwater elevation of 125.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 1 - Auxiliary Spillway Without Cofferdam			Test 1 - Auxiliary Spillway With Cofferdam			Test 1 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location									
4,000	0									
1A	36	0.83	0.00	0.83	0.21	0.00	0.21	0.14	0.00	0.14
1B	37	0.21	0.00	0.21	1.04	-0.28	1.08	1.04	-0.14	1.05
2	38	6.72	-1.52	6.89	4.50	-0.55	4.54	4.43	-1.87	4.81
3	39	6.44	0.83	6.50	5.82	-0.28	5.83	6.65	0.00	6.65
4	40	5.27	0.35	5.28	4.30	-0.62	4.34	5.40	0.76	5.46
5	41	4.78	0.21	4.78	3.95	-0.07	3.95	4.23	-0.21	4.23
6	42	4.50	-0.07	4.50	3.46	-0.14	3.47	3.60	-0.21	3.61
7	43	4.99	0.07	4.99	3.53	0.14	3.54	4.36	0.14	4.37
8	44	4.50	0.21	4.51	3.46	0.21	3.47	4.30	0.00	4.30
9	48	3.60	0.48	3.64	3.88	0.28	3.89	4.02	-0.14	4.02
10	49	3.81	-0.14	3.81	4.16	0.14	4.16	3.81	-0.21	3.82
11	27A	0	0	0	No water	No water	No water	No water	No water	No water
12	28A	0	0	0	No water	No water	No water	No water	No water	No water
13	Left Bank	Too shallow	Too shallow	Too shallow	No water	No water	No water	No water	No water	No water
14	27B	0	0	0	No water	No water	No water	No water	No water	No water
15	28B	0	0	0	No water	No water	No water	No water	No water	No water
16	40B	2.15	-0.21	2.16	2.98	-0.55	3.03	5.13	-0.14	5.13
17	41B	4.30	-0.48	4.32	4.64	-0.69	4.69	3.81	-0.42	3.83
18	42B	4.64	-0.21	4.65	4.57	-0.35	4.59	4.57	-0.14	4.57
19	43B	5.06	0.14	5.06	3.88	0.00	3.88	4.92	-0.21	4.92
20	44B	4.64	-0.28	4.65	4.64	0.14	4.64	4.36	0.00	4.36
21	Knob Upstream	0	0	0	No water	No water	No water	N/A	N/A	N/A
22	Knob Downstream	0	0	0	No water	No water	No water	N/A	N/A	N/A

Table 2. Main dam flow rate 0 ft³/s and auxiliary spillway 4,000 ft³/s for a total of 4,000 ft³/s with a tailwater elevation of 125.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 2 - Auxiliary Spillway Without Cofferdam			Test 2 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	4,000						
Station	Location						
1A	36	0.07	-0.27	0.28	-1.39	-0.28	1.41
1B	37	-1.91	2.30	2.99	0.48	0.14	0.50
2	38	0.43	-1.63	1.68	-2.22	-5.96	6.36
3	39	3.43	0.75	3.51	-0.42	1.39	1.45
4	40	3.95	-0.75	4.02	6.58	-6.10	8.97
5	41	5.56	0.53	5.59	5.20	0.35	5.21
6	42	4.93	0.07	4.93	5.47	0.07	5.47
7	43	4.93	0.54	4.96	5.06	0.28	5.07
8	44	4.55	0.39	4.56	4.43	0.00	4.43
9	48	3.95	0.45	3.98	4.30	0.07	4.30
10	49	3.83	-0.09	3.83	4.02	-0.07	4.02
11	27A	2.07	-0.31	2.09	3.33	0.62	3.38
12	28A	0.55	-0.11	0.57	1.59	-0.42	1.65
13	Left Bank	Too shallow	Too shallow	Too shallow	Too shallow	Too shallow	Too shallow
14	27B	-1.69	-0.94	1.93	1.32	-0.35	1.36
15	28B	0.94	-0.31	0.99	2.15	-0.90	2.33
16	40B	5.33	-0.70	5.38	1.11	-0.76	1.35
17	41B	3.47	-0.54	3.51	2.08	-0.42	2.12
18	42B	3.73	-0.30	3.74	2.22	-0.07	2.22
19	43B	4.17	0.16	4.17	2.42	0.00	2.42
20	44B	4.12	0.00	4.12	2.70	-0.07	2.70
21	Knob Upstream	-3.01	-1.67	3.44	0	0	0
22	Knob Downstream	-0.69	-2.93	3.01	0	0	0

Table 3. Main dam flow rate 7,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 7,000 ft³/s with a tailwater elevation of 127.14 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 3 - Auxiliary Spillway Without Cofferdam			Test 3 - Auxiliary Spillway With Cofferdam			Test 2 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location									
7,000	0									
1A	36	0.35	-0.07	0.35	0.55	0.00	0.55	0.55	-0.07	0.56
1B	37	0.35	0.07	0.35	1.52	0.07	1.53	0.97	0.62	1.15
2	38	7.27	-6.79	9.95	10.18	-8.38	13.19	8.04	-15.17	17.17
3	39	5.89	0.76	5.94	7.69	0.21	7.69	11.50	-1.45	11.59
4	40	7.55	1.04	7.62	6.30	0.48	6.32	8.59	0.48	8.60
5	41	8.11	0.28	8.11	5.68	-0.28	5.69	6.86	-0.14	6.86
6	42	9.15	1.18	9.22	6.37	-0.90	6.44	6.58	-0.42	6.59
7	43	8.04	0.42	8.05	6.65	0.28	6.66	6.79	0.55	6.81
8	44	7.55	0.14	7.55	6.24	-0.14	6.24	7.00	0.62	7.03
9	48	6.79	0.35	6.80	5.89	-0.69	5.93	6.51	0.21	6.52
10	49	6.17	0.28	6.17	5.96	0.07	5.96	6.24	0.35	6.24
11	27A	-0.83	-0.62	1.04	No water	No water	No water	No water	No water	No water
12	28A	-1.04	1.04	1.47	No water	No water	No water	No water	No water	No water
13	Left Bank	Too shallow	Too shallow	Too shallow	No water	No water	No water	No water	No water	No water
14	27B	0.76	-0.55	0.94	No water	No water	No water	No water	No water	No water
15	28B	1.11	-0.62	1.27	No water	No water	No water	No water	No water	No water
16	40B	3.46	-0.55	3.51	6.24	-0.07	6.24	3.95	-0.62	4.00
17	41B	4.09	-0.69	4.15	6.30	-0.97	6.38	6.03	-1.11	6.13
18	42B	4.78	-0.97	4.88	6.72	-0.48	6.74	7.27	-0.14	7.28
19	43B	5.82	-0.69	5.86	6.79	-0.48	6.81	8.24	0.55	8.26
20	44B	7.14	-0.90	7.19	7.00	-0.28	7.00	7.69	-0.48	7.71
21	Knob Upstream	0.14	0.21	0.25	No water	No water	No water	N/A	N/A	N/A
22	Knob Downstream	0.76	1.04	1.29	No water	No water	No water	N/A	N/A	N/A

Table 4. Main dam flow rate 0 ft³/s and auxiliary spillway 7,000 ft³/s for a total of 7,000 ft³/s with a tailwater elevation of 127.14 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 4 - Auxiliary Spillway Without Cofferdam			Test 4 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	7,000						
Station	Location						
1A	36	0.14	-0.35	0.37	-0.21	0.35	0.40
1B	37	1.66	-0.48	1.73	0.42	0.00	0.42
2	38	-0.62	-1.73	1.84	-2.08	-6.37	6.70
3	39	5.13	0.07	5.13	-0.21	2.29	2.30
4	40	7.97	-3.19	8.58	9.91	-6.58	11.89
5	41	8.18	-0.14	8.18	6.93	0.21	6.93
6	42	7.83	-0.42	7.84	7.34	0.07	7.34
7	43	7.83	0.28	7.83	7.69	0.28	7.70
8	44	7.69	-0.62	7.72	7.14	-0.28	7.14
9	48	7.90	-0.97	7.96	6.86	-0.21	6.86
10	49	6.79	-0.42	6.80	6.65	0.00	6.65
11	27A	0.42	-1.59	1.65	4.23	0.00	4.23
12	28A	0.76	1.18	1.40	2.98	0.14	2.98
13	Left Bank	Too shallow	Too shallow	Too shallow	Too shallow	Too shallow	Too shallow
14	27B	2.08	-2.63	3.35	1.11	0.42	1.18
15	28B	2.08	-0.55	2.15	3.19	-1.32	3.45
16	40B	6.79	-0.28	6.80	4.92	-0.90	5.00
17	41B	5.54	-0.83	5.60	5.06	-0.76	5.11
18	42B	5.75	0.07	5.75	5.27	-0.76	5.32
19	43B	6.24	-0.69	6.27	5.68	-0.42	5.70
20	44B	6.65	-0.28	6.66	6.24	-0.76	6.28
21	Knob Upstream	-0.55	-4.36	4.40	0	0	0
22	Knob Downstream	-2.70	-3.12	4.13	0	0	0

Table 5. Main dam flow rate 15,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 15,000 ft³/s with a tailwater elevation of 133.14 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 5 - Auxiliary Spillway Without Cofferdam			Test 5 - Auxiliary Spillway With Cofferdam			Test 3 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location									
15,000	0									
1A	36	0.62	0.07	0.63	1.59	-1.25	2.02	0.69	0.83	1.08
1B	37	0.76	0.00	0.76	2.36	2.70	3.58	2.08	-0.62	2.17
2	38	6.03	-1.45	6.20	14.06	-6.72	15.59	12.96	-11.22	17.14
3	39	5.61	-4.16	6.98	7.48	-0.35	7.49	12.82	-1.66	12.92
4	40	8.31	-2.98	8.83	6.58	0.35	6.59	7.62	-2.01	7.88
5	41	10.32	-0.42	10.33	7.55	-0.55	7.57	8.11	0.48	8.12
6	42	10.60	0.62	10.62	8.73	-0.62	8.75	8.94	-0.48	8.95
7	43	10.74	-0.97	10.78	8.94	-0.55	8.95	8.66	-0.69	8.69
8	44	10.46	-0.28	10.47	9.63	-0.07	9.63	10.05	-0.48	10.06
9	48	10.05	0.00	10.05	8.52	-0.62	8.54	9.15	0.55	9.16
10	49	10.12	0.14	10.12	8.80	-1.04	8.86	8.66	0.90	8.71
11	27A	-1.73	-0.48	1.80	No water	No water	No water	No water	No water	No water
12	28A	-1.39	1.73	2.22	No water	No water	No water	No water	No water	No water
13	Left Bank	Too shallow	Too shallow	Too shallow	No water	No water	No water	No water	No water	No water
14	27B	4.30	3.19	5.35	No water	No water	No water	No water	No water	No water
15	28B	10.67	2.49	10.96	No water	No water	No water	No water	No water	No water
16	40B	8.52	-2.77	8.96	9.49	-0.21	9.49	6.93	-2.42	7.34
17	41B	9.08	-0.83	9.11	9.84	-1.45	9.95	8.87	-0.69	8.90
18	42B	8.73	-0.97	8.78	9.84	-0.35	9.84	11.71	0.28	11.71
19	43B	9.42	0.28	9.43	10.39	0.00	10.39	9.98	-0.21	9.98
20	44B	11.09	-0.28	11.09	11.02	0.00	11.02	10.88	-1.39	10.97
21	Knob Upstream	1.11	0.42	1.18	No water	No water	No water	N/A	N/A	N/A
22	Knob Downstream	3.67	6.30	7.30	No water	No water	No water	N/A	N/A	N/A

Table 6. Main dam flow rate 0 ft³/s and auxiliary spillway 15,000 ft³/s for a total of 15,000 ft³/s with a tailwater elevation of 133.14 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 6 - Auxiliary Spillway Without Cofferdam			Test 6 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	15,000						
Station	Location						
1A	36	0.28	-0.14	0.31	0.48	-0.35	0.60
1B	37	-0.21	0.14	0.25	2.01	-0.14	2.01
2	38	4.99	-4.92	7.01	4.09	-1.73	4.44
3	39	5.33	0.35	5.35	0.83	0.28	0.88
4	40	13.09	-5.27	14.11	10.18	-6.93	12.32
5	41	9.77	-0.76	9.80	7.69	0.00	7.69
6	42	10.12	-0.62	10.13	11.43	0.21	11.43
7	43	9.98	-0.69	10.00	10.81	0.21	10.81
8	44	11.09	0.48	11.10	11.36	0.00	11.36
9	48	11.15	-1.25	11.22	10.46	0.62	10.48
10	49	10.18	-1.25	10.26	9.98	-0.35	9.98
11	27A	-1.18	-1.73	2.09	5.33	-0.69	5.38
12	28A	1.18	2.70	2.95	5.27	1.11	5.38
13	Left Bank	Too shallow	Too shallow	Too shallow	Too shallow	Too shallow	Too shallow
14	27B	2.36	-1.32	2.70	3.19	-1.11	3.37
15	28B	4.50	-1.32	4.69	5.75	-2.56	6.30
16	40B	8.52	-5.33	10.05	9.77	-9.15	13.38
17	41B	7.97	-1.04	8.03	6.58	-1.94	6.86
18	42B	9.63	-0.69	9.66	8.45	-1.18	8.53
19	43B	8.94	-0.55	8.95	8.11	-0.28	8.11
20	44B	10.25	-0.35	10.26	9.21	-1.25	9.30
21	Knob Upstream	-1.18	-0.48	1.27	0	0	0
22	Knob Downstream	-2.56	-4.64	5.30	0	0	0

Table 7. Main dam flow rate 25,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 25,000 ft³/s with a tailwater elevation of 140.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 7 - Auxiliary Spillway Without Cofferdam			Test 7 - Auxiliary Spillway With Cofferdam			Test 4 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location									
25,000	0									
1A	36	2.56	-0.42	2.60	3.05	-0.55	3.10	1.94	-0.14	1.94
1B	37	1.59	-0.35	1.63	2.84	-0.69	2.92	3.19	0.42	3.21
2	38	3.39	-0.69	3.46	16.00	-7.34	17.61	12.96	-6.79	14.63
3	39	8.45	-2.91	8.94	14.62	-3.12	14.95	14.13	-4.85	14.94
4	40	10.18	-1.66	10.32	13.03	0.62	13.04	10.81	-0.83	10.84
5	41	12.96	-2.70	13.23	10.25	-0.48	10.27	8.80	-0.14	8.80
6	42	9.70	-0.76	9.73	9.63	-0.83	9.67	9.84	-1.52	9.96
7	43	10.39	-0.42	10.40	9.70	-1.04	9.75	9.63	-0.62	9.65
8	44	11.36	-0.62	11.38	11.50	-0.42	11.51	10.74	-0.76	10.77
9	48	11.50	-0.76	11.53	10.95	-1.39	11.03	10.95	-0.83	10.98
10	49	11.02	-0.42	11.02	10.53	0.28	10.53	10.25	-2.01	10.45
11	27A	-2.49	-1.11	2.73	0	0	0	No water	No water	No water
12	28A	-2.49	1.39	2.85	0	0	0	No water	No water	No water
13	Left Bank	7.97	-0.97	8.03	0	0	0	No water	No water	No water
14	27B	9.63	7.00	11.90	0	0	0	No water	No water	No water
15	28B	12.96	-1.94	13.10	0	0	0	No water	No water	No water
16	40B	12.89	-6.93	14.63	8.24	-0.83	8.29	8.24	-0.62	8.27
17	41B	10.05	-1.94	10.23	10.39	-0.55	10.41	9.98	-2.29	10.24
18	42B	11.36	-0.62	11.38	11.15	0.07	11.15	12.61	-1.32	12.68
19	43B	10.05	-1.25	10.12	11.85	-0.35	11.85	12.33	0.00	12.33
20	44B	11.64	-1.80	11.78	13.58	-1.59	13.67	14.41	-0.69	14.43
21	Knob Upstream	2.70	6.24	6.80	0	0	0	N/A	N/A	N/A
22	Knob Downstream	5.82	8.80	10.55	0	0	0	N/A	N/A	N/A

Table 8. Main dam flow rate 0 ft³/s and auxiliary spillway 25,000 ft³/s for a total of 25,000 ft³/s with a tailwater elevation of 140.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 8 - Auxiliary Spillway Without Cofferdam			Test 8 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	25,000						
Station	Location						
1A	36	0.07	-0.21	0.22	0.00	-0.55	0.55
1B	37	1.45	-0.28	1.48	2.36	-0.69	2.46
2	38	1.94	-2.01	2.79	5.13	-2.22	5.59
3	39	6.72	-2.29	7.10	5.96	-3.05	6.69
4	40	10.05	-2.15	10.27	9.98	-2.15	10.21
5	41	9.98	-3.46	10.56	10.05	0.14	10.05
6	42	9.35	-0.48	9.37	9.01	-0.14	9.01
7	43	9.35	-1.59	9.49	9.35	-0.97	9.40
8	44	11.57	-1.52	11.67	11.57	-0.35	11.58
9	48	10.81	-0.14	10.81	11.29	-0.62	11.31
10	49	10.81	-0.07	10.81	11.02	-0.21	11.02
11	27A	1.59	-2.36	2.84	0.48	-0.28	0.56
12	28A	4.99	1.73	5.28	11.57	-2.01	11.74
13	Left Bank	Too shallow	Too shallow	Too shallow	4.36	1.94	4.78
14	27B	4.02	-2.08	4.52	0.00	0.00	0.00
15	28B	5.40	-1.11	5.52	9.15	-0.14	9.15
16	40B	14.62	-11.71	18.73	12.68	-13.09	18.23
17	41B	9.56	-3.39	10.15	8.87	-3.19	9.42
18	42B	11.85	-1.59	11.95	11.50	-2.36	11.74
19	43B	10.88	-1.59	10.99	11.43	-0.76	11.46
20	44B	12.89	-2.63	13.15	13.16	-2.22	13.35
21	Knob Upstream	0.07	-9.70	9.70	0	0	0
22	Knob Downstream	-4.16	-6.65	7.84	0	0	0

Table 9. Main dam flow rate 30,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 30,000 ft³/s with a tailwater elevation of 143.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 9 - Auxiliary Spillway Without Cofferdam			Test 9 - Auxiliary Spillway With Cofferdam			Test 5 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location									
30,000	0									
1A	36	1.59	0.28	1.62	2.36	-0.90	2.52	1.73	0.14	1.74
1B	37	2.29	-0.21	2.30	2.08	-0.48	2.13	2.36	-0.35	2.38
2	38	3.95	-0.83	4.04	16.07	-5.82	17.09	6.44	-1.04	6.53
3	39	10.39	-1.87	10.56	13.86	-0.69	13.87	14.34	0.55	14.35
4	40	10.18	-0.83	10.22	14.06	0.21	14.07	12.68	-2.98	13.02
5	41	11.22	-0.97	11.27	12.82	-1.32	12.88	13.37	-0.90	13.40
6	42	12.06	-1.39	12.13	12.75	-0.21	12.75	11.09	-0.55	11.10
7	43	11.57	-0.90	11.61	13.09	-0.76	13.12	10.46	-0.62	10.48
8	44	12.54	-0.42	12.55	13.16	-0.28	13.17	11.99	-0.69	12.01
9	48	12.89	-2.70	13.17	12.68	-1.66	12.79	11.92	-0.83	11.95
10	49	12.47	-0.76	12.49	12.40	0.28	12.40	11.50	-1.73	11.63
11	27A	-2.56	-1.73	3.09	0	0	0	No water	No water	No water
12	28A	-3.60	2.22	4.23	0	0	0	No water	No water	No water
13	Left Bank	9.15	0.76	9.18	0	0	0	No water	No water	No water
14	27B	10.95	9.01	14.18	0	0	0	No water	No water	No water
15	28B	14.83	-3.05	15.14	0	0	0	No water	No water	No water
16	40B	11.36	-4.09	12.08	8.73	0.48	8.74	7.34	-1.52	7.50
17	41B	10.05	-1.80	10.21	8.94	-0.28	8.94	11.43	-2.77	11.76
18	42B	10.60	-0.69	10.62	9.70	-0.48	9.71	11.57	-1.32	11.64
19	43B	11.15	0.76	11.18	10.25	0.35	10.26	11.57	-0.76	11.60
20	44B	12.33	-2.08	12.51	12.19	-0.69	12.21	13.65	-2.22	13.83
21	Knob Upstream	-2.56	7.27	7.71	0	0	0	N/A	N/A	N/A
22	Knob Downstream	-3.60	2.22	4.23	0	0	0	N/A	N/A	N/A

Table 10. Main dam flow rate 45,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 45,000 ft³/s with a tailwater elevation of 150.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 6 - No Auxiliary Spillway		
		Prototype Velocity		
45,000	0	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location			
1A	36	1.04	-0.90	1.38
1B	37	2.08	-0.07	2.08
2	38	9.28	0.14	9.28
3	39	14.06	3.60	14.52
4	40	14.69	0.35	14.69
5	41	11.85	-2.08	12.03
6	42	13.03	0.90	13.06
7	43	12.89	-1.59	12.98
8	44	14.90	-0.42	14.90
9	48	15.03	-3.26	15.38
10	49	15.31	-0.21	15.31
11	27A	No water	No water	No water
12	28A	No water	No water	No water
13	Left Bank	No water	No water	No water
14	27B	No water	No water	No water
15	28B	No water	No water	No water
16	40B	16.28	2.01	16.40
17	41B	14.62	0.00	14.62
18	42B	15.59	-0.97	15.62
19	43B	14.83	-1.25	14.88
20	44B	15.73	-0.55	15.74
21	Knob Upstream	N/A	N/A	N/A
22	Knob Downstream	N/A	N/A	N/A

Table 11. Main dam flow rate 29,000 ft³/s and auxiliary spillway 22,000 ft³/s for a total of 51,000 ft³/s with a tailwater elevation of 152.5 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 1 0- Auxiliary Spillway Without Cofferdam			Test 10 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
29,000	22,000						
1A	36	-0.14	0.00	0.14	1.59	-0.14	1.60
1B	37	0.14	0.07	0.15	0.21	0.35	0.40
2	38	1.25	-0.35	1.29	5.06	-2.77	5.77
3	39	7.00	-1.52	7.16	4.99	-0.28	5.00
4	40	12.75	-0.76	12.77	11.36	-1.45	11.46
5	41	13.86	-2.15	14.02	13.72	-1.39	13.79
6	42	15.52	-0.28	15.52	13.79	-0.76	13.81
7	43	14.13	0.00	14.13	14.48	-0.62	14.49
8	44	15.73	-0.28	15.73	15.93	-0.42	15.94
9	48	16.56	-0.83	16.58	15.31	-2.91	15.59
10	49	15.87	-3.05	16.16	15.17	-2.15	15.32
11	27A	4.36	1.18	4.52	2.01	0.00	2.01
12	28A	4.64	-0.90	4.73	3.26	1.66	3.66
13	Left Bank	10.81	-5.06	11.93	9.49	1.52	9.61
14	27B	8.59	6.10	10.53	4.02	0.55	4.06
15	28B	9.21	-4.50	10.26	7.27	-0.69	7.31
16	40B	12.12	2.29	12.34	10.95	1.59	11.06
17	41B	13.65	1.45	13.73	11.85	1.04	11.89
18	42B	13.51	2.15	13.68	13.23	1.59	13.33
19	43B	13.51	0.90	13.54	13.86	-0.42	13.86
20	44B	13.79	0.21	13.79	15.31	0.55	15.32
21	Knob Upstream	1.87	0.48	1.93	0	0	0
22	Knob Downstream	0.97	12.19	12.23	0	0	0

Table 12. Main dam flow rate 60,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 60,000 ft³/s with a tailwater elevation of 156.5 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 11 - Auxiliary Spillway Without Cofferdam			Test 11 - Auxiliary Spillway With Cofferdam			Test 7 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
60,000	0									
Station	Location									
1A	36	1.59	-1.04	1.90	1.18	1.94	2.27	0.76	-0.28	0.81
1B	37	0.97	-0.07	0.97	4.57	-2.56	5.24	0.62	0.55	0.83
2	38	2.63	0.14	2.64	8.87	-2.36	9.18	6.24	-0.97	6.31
3	39	5.61	-0.28	5.62	11.02	-0.69	11.04	16.84	0.00	16.84
4	40	9.08	-0.42	9.09	12.06	0.07	12.06	11.57	-1.45	11.66
5	41	13.23	-0.48	13.24	10.81	-1.04	10.86	14.48	-0.90	14.51
6	42	13.65	-0.76	13.67	11.71	-1.73	11.84	14.27	-1.25	14.33
7	43	13.99	-2.22	14.17	12.82	-1.32	12.88	14.13	-0.21	14.14
8	44	16.35	-0.35	16.35	15.17	-2.22	15.33	15.80	-0.35	15.80
9	48	16.84	-0.97	16.86	16.56	-3.53	16.93	16.63	-0.21	16.63
10	49	16.14	-1.80	16.24	16.35	-3.26	16.67	16.70	1.04	16.73
11	27A	-2.29	-1.04	2.51	0	0	0	No water	No water	No water
12	28A	2.74	3.81	4.70	0	0	0	No water	No water	No water
13	Left Bank	13.09	-5.13	14.06	0	0	0	No water	No water	No water
14	27B	9.91	21.69	23.84	0	0	0	No water	No water	No water
15	28B	-1.11	1.94	2.23	0	0	0	No water	No water	No water
16	40B	11.85	-4.71	12.75	17.25	-0.35	17.25	17.74	0.97	17.76
17	41B	13.44	-4.85	14.29	16.14	-1.32	16.20	16.63	-0.48	16.63
18	42B	15.59	0.28	15.59	16.77	-2.15	16.90	17.94	-2.77	18.16
19	43B	15.38	0.00	15.38	16.77	-0.97	16.79	17.46	-0.90	17.48
20	44B	16.28	-2.22	16.43	19.26	-1.94	19.36	17.60	-1.59	17.67
21	Knob Upstream	5.06	19.40	20.05	0	0	0	N/A	N/A	N/A
22	Knob Downstream	1.66	15.52	15.61	0	0	0	N/A	N/A	N/A

Table 13. Main dam flow rate 0 ft³/s and auxiliary spillway 60,000 ft³/s for a total of 60,000 ft³/s with a tailwater elevation of 156.5 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 12 - Auxiliary Spillway Without Cofferdam			Test 12 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	60,000						
Station	Location						
1A	36	0.42	-0.83	0.93	-0.48	1.18	1.27
1B	37	0.97	0.48	1.08	1.25	0.28	1.28
2	38	0.83	0.42	0.93	1.39	-0.42	1.45
3	39	7.27	-2.70	7.76	8.38	-5.96	10.28
4	40	9.70	-1.25	9.78	9.77	-1.45	9.88
5	41	11.99	1.52	12.08	12.26	-2.63	12.54
6	42	14.96	1.66	15.06	14.62	0.48	14.63
7	43	13.79	2.15	13.95	10.95	0.55	10.96
8	44	15.80	0.55	15.81	14.13	0.35	14.14
9	48	16.35	-2.77	16.58	14.78	-0.58	14.80
10	49	16.14	1.18	16.19	14.41	0.07	14.41
11	27A	15.52	-2.15	15.67	12.68	-3.05	13.04
12	28A	10.67	1.66	10.80	7.69	1.45	7.83
13	Left Bank	15.52	-4.78	16.24	16.07	-6.72	17.42
14	27B	17.94	-0.35	17.95	14.48	-1.87	14.60
15	28B	11.02	-1.73	11.15	13.23	-4.09	13.85
16	40B	8.38	1.80	8.57	9.84	1.59	9.97
17	41B	12.40	2.77	12.71	11.43	2.84	11.78
18	42B	14.13	4.57	14.85	11.36	3.33	11.84
19	43B	13.23	1.11	13.28	13.79	2.42	14.00
20	44B	15.59	-0.90	15.61	15.93	1.73	16.03
21	Knob Upstream	-1.52	-1.25	1.97	0	0	0
22	Knob Downstream	0.83	-1.66	1.86	0	0	0

Table 14. Main dam flow rate 75,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 75,000 ft³/s with a tailwater elevation of 161.5 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 8 - No Auxiliary Spillway		
		Prototype Velocity		
75,000	0	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location			
1A	36	3.46	-1.80	3.90
1B	37	1.94	-0.14	1.94
2	38	7.34	-1.04	7.42
3	39	11.78	-1.25	11.84
4	40	13.58	-0.55	13.59
5	41	13.16	-0.42	13.17
6	42	12.06	0.62	12.07
7	43	12.75	-1.39	12.82
8	44	15.24	-1.94	15.36
9	48	17.04	-0.97	17.07
10	49	17.53	0.69	17.54
11	27A	No water	No water	No water
12	28A	No water	No water	No water
13	Left Bank	No water	No water	No water
14	27B	No water	No water	No water
15	28B	No water	No water	No water
16	40B	21.55	1.66	21.61
17	41B	19.33	-2.08	19.44
18	42B	18.78	0.42	18.78
19	43B	17.32	-0.83	17.34
20	44B	18.91	-2.98	19.15
21	Knob Upstream	N/A	N/A	N/A
22	Knob Downstream	N/A	N/A	N/A

Table 15. Main dam flow rate 29,000 ft³/s and auxiliary spillway 47,000 ft³/s for a total of 76,000 ft³/s with a tailwater elevation of 161.8 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 13 - Auxiliary Spillway Without Cofferdam			Test 13 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
29,000	47,000						
1A	36	0.28	0.42	0.50	0.28	0.62	0.68
1B	37	0.76	-0.21	0.79	0.62	-0.48	0.79
2	38	1.52	-1.52	2.16	1.39	-0.42	1.45
3	39	4.30	-2.01	4.74	6.79	-1.73	7.01
4	40	10.05	-2.70	10.40	11.43	-3.74	12.03
5	41	13.09	-2.15	13.27	13.58	-1.80	13.70
6	42	14.62	-1.45	14.69	14.27	-2.08	14.42
7	43	15.73	-0.76	15.75	15.59	-2.91	15.86
8	44	17.81	-1.11	17.84	17.53	-0.90	17.55
9	48	18.84	-1.04	18.87	18.84	-2.91	19.07
10	49	18.78	-2.29	18.91	18.64	-1.39	18.69
11	27A	8.94	0.42	8.95	8.11	0.21	8.11
12	28A	7.55	0.00	7.55	6.10	0.21	6.10
13	Left Bank	11.92	-3.33	12.37	11.02	-3.39	11.53
14	27B	11.99	0.90	12.02	7.55	1.80	7.76
15	28B	7.76	-1.59	7.92	9.08	-0.83	9.11
16	40B	11.02	-0.35	11.02	11.50	-1.39	11.58
17	41B	12.06	-1.59	12.16	12.54	-0.07	12.54
18	42B	14.20	1.25	14.26	13.44	1.80	13.56
19	43B	15.03	0.90	15.06	15.10	0.69	15.12
20	44B	17.25	-1.18	17.29	17.60	2.15	17.73
21	Knob Upstream	0.42	4.85	4.87	0	0	0
22	Knob Downstream	-1.87	4.78	5.13	0	0	0

Table 16. Main dam flow rate 90,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 90,000 ft³/s with a tailwater elevation of 166.58 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 15 - Auxiliary Spillway Without Cofferdam			Test 15 - Auxiliary Spillway With Cofferdam			Test 9 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
90,000	0									
Station	Location									
1A	36	-1.32	0.69	1.49	2.36	-0.69	2.46	0.35	0.28	0.44
1B	37	1.11	1.94	2.23	11.43	-0.76	11.46	1.45	1.25	1.92
2	38	4.30	0.97	4.40	8.24	-1.18	8.33	6.30	2.22	6.68
3	39	6.44	-0.90	6.51	9.84	0.14	9.84	7.69	-0.69	7.72
4	40	7.90	-0.97	7.96	9.98	-0.14	9.98	8.18	-0.69	8.20
5	41	9.63	-1.52	9.75	10.88	0.00	10.88	11.99	-0.07	11.99
6	42	12.75	-0.14	12.75	12.68	-0.07	12.68	11.64	-1.39	11.72
7	43	14.13	-1.80	14.25	13.93	-1.39	13.99	13.58	-1.59	13.67
8	44	16.14	-1.52	16.21	16.14	-3.05	16.43	16.35	-1.45	16.42
9	48	18.01	-2.49	18.19	17.46	-2.77	17.68	17.11	-2.01	17.23
10	49	17.67	-4.30	18.18	18.01	-3.74	18.40	17.87	0.07	17.87
11	27A	-3.33	-0.97	3.46	-2.63	-1.87	3.23	No water	No water	No water
12	28A	-0.83	2.36	2.50	-4.85	1.25	5.01	No water	No water	No water
13	Left Bank	5.20	1.87	5.52	3.53	2.42	4.29	No water	No water	No water
14	27B	1.32	5.75	5.90	2.63	-0.90	2.78	Too shallow	Too shallow	Too shallow
15	28B	2.70	2.70	3.82	3.88	2.84	4.81	Too shallow	Too shallow	Too shallow
16	40B	16.77	-3.12	17.05	16.21	-0.55	16.22	19.47	-4.23	19.92
17	41B	14.13	-4.43	14.81	16.77	0.00	16.77	17.04	-2.70	17.26
18	42B	15.31	-4.50	15.96	17.11	0.07	17.11	17.04	-3.26	17.35
19	43B	17.39	-1.94	17.50	17.60	-0.28	17.60	19.68	-1.73	19.75
20	44B	18.08	-0.69	18.10	18.98	-0.76	19.00	20.23	-3.12	20.47
21	Knob Upstream	3.19	1.52	3.53	0	0	0	N/A	N/A	N/A
22	Knob Downstream	-0.35	4.64	4.65	0	0	0	N/A	N/A	N/A

Table 17. Main dam flow rate 0 ft³/s and auxiliary spillway 90,000 ft³/s for a total of 90,000 ft³/s with a tailwater elevation of 166.58 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 14 - Auxiliary Spillway Without Cofferdam			Test 14 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	90,000						
Station	Location						
1A	36	-1.52	0.35	1.56	-0.42	-0.14	0.44
1B	37	-0.28	-0.62	0.68	-0.07	-0.35	0.35
2	38	0.42	0.00	0.42	1.25	0.69	1.43
3	39	3.88	-5.40	6.65	3.12	-3.67	4.82
4	40	6.86	-1.25	6.97	7.97	-2.91	8.48
5	41	13.09	0.48	13.10	11.85	-2.42	12.09
6	42	14.48	1.94	14.61	13.58	-0.28	13.58
7	43	13.44	0.97	13.48	14.96	-0.83	14.99
8	44	16.14	2.49	16.33	16.00	-1.18	16.05
9	48	17.25	-0.48	17.26	17.53	-0.76	17.54
10	49	16.56	-1.87	16.66	17.04	-1.45	17.11
11	27A	17.11	-1.25	17.16	14.20	-2.63	14.44
12	28A	13.58	2.49	13.81	11.02	-3.26	11.49
13	Left Bank	15.31	-5.68	16.33	17.87	-5.61	18.73
14	27B	15.87	0.69	15.88	14.13	-1.52	14.22
15	28B	12.26	-3.60	12.78	13.93	-5.75	15.07
16	40B	3.74	0.35	3.76	3.33	-1.45	3.63
17	41B	9.91	1.45	10.01	7.34	-0.55	7.36
18	42B	10.46	4.30	11.31	11.85	2.29	12.07
19	43B	14.13	3.53	14.57	13.58	2.70	13.85
20	44B	16.70	3.95	17.16	17.53	5.33	18.32
21	Knob Upstream	0.07	1.04	1.04	0	0	0
22	Knob Downstream	0.83	1.59	1.80	0	0	0

Table 18. Main dam flow rate 115,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 16 - Auxiliary Spillway Without Cofferdam			Test 16 - Auxiliary Spillway With Cofferdam			Test 10 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location									
115,000	0									
1A	36	-3.26	2.49	4.10	1.32	-1.80	2.23	-1.80	0.35	1.83
1B	37	-0.07	-0.55	0.56	10.05	-2.77	10.42	3.33	-1.52	3.66
2	38	5.68	-1.73	5.94	10.12	-2.15	10.34	6.44	-0.97	6.52
3	39	8.45	-0.97	8.51	12.40	-0.62	12.42	7.21	-0.90	7.26
4	40	9.70	-1.18	9.77	15.10	0.35	15.11	10.05	1.45	10.15
5	41	11.71	-1.66	11.83	14.27	0.00	14.27	10.18	-1.11	10.24
6	42	14.13	-0.35	14.14	13.58	-0.83	13.60	10.67	-1.66	10.80
7	43	15.17	-2.22	15.33	14.69	-2.56	14.91	14.41	-2.63	14.65
8	44	17.87	-1.25	17.92	17.25	-2.36	17.41	16.77	-2.42	16.94
9	48	18.43	-2.91	18.66	17.60	-2.91	17.84	18.29	-2.91	18.52
10	49	18.71	-3.26	18.99	17.81	-2.98	18.05	18.08	-3.33	18.39
11	27A	-2.70	-1.52	3.10	-1.32	-0.35	1.36	No water	No water	No water
12	28A	-3.53	1.66	3.91	-1.73	-0.14	1.74	No water	No water	No water
13	Left Bank	0.55	3.39	3.44	-0.21	0.35	0.40	Too shallow	Too shallow	Too shallow
14	27B	3.19	-3.05	4.41	0.48	-0.76	0.90	0.83	4.36	4.44
15	28B	4.43	0.48	4.46	0.97	-0.35	1.03	14.69	8.66	17.05
16	40B	19.40	-1.80	19.48	18.29	0.21	18.29	18.43	-4.43	18.95
17	41B	17.53	-1.73	17.61	16.90	0.21	16.91	19.47	-3.26	19.74
18	42B	18.15	-2.15	18.28	17.94	0.69	17.96	17.67	-4.78	18.30
19	43B	18.29	-2.91	18.52	19.33	0.48	19.34	17.87	-3.19	18.16
20	44B	20.23	2.01	20.33	19.19	2.08	19.30	21.69	-3.60	21.98
21	Knob Upstream	-0.07	-2.15	2.15	0	0	0	N/A	N/A	N/A
22	Knob Downstream	-0.21	-4.30	4.30	0	0	0	N/A	N/A	N/A

Table 19. Main dam flow rate 30,000 ft³/s and auxiliary spillway 85,000 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 17 - Auxiliary Spillway Without Cofferdam			Test 17 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
30,000	85,000						
1A	36	-0.42	0.62	0.75	-0.76	0.55	0.94
1B	37	-0.83	0.55	1.00	-0.35	-0.21	0.40
2	38	2.01	-1.39	2.44	1.39	-0.48	1.47
3	39	3.53	-0.69	3.60	3.60	-0.83	3.70
4	40	7.27	-2.01	7.55	7.14	-0.07	7.14
5	41	10.32	-0.97	10.37	10.60	-0.21	10.60
6	42	13.03	-0.07	13.03	13.03	-1.80	13.15
7	43	14.27	-2.15	14.43	16.07	-2.42	16.26
8	44	17.04	-3.26	17.35	17.53	0.42	17.53
9	48	18.57	-3.95	18.98	19.05	-3.12	19.31
10	49	17.53	-4.16	18.01	18.22	-1.73	18.30
11	27A	13.23	-0.35	13.24	12.06	-0.42	12.06
12	28A	9.08	-0.28	9.08	8.73	0.28	8.73
13	Left Bank	14.76	-3.05	15.07	14.27	-1.87	14.39
14	27B	12.40	1.87	12.54	10.95	1.45	11.04
15	28B	11.57	-2.08	11.76	11.57	-1.39	11.65
16	40B	10.18	-3.05	10.63	10.88	1.11	10.93
17	41B	9.91	-1.87	10.08	10.53	-1.52	10.64
18	42B	12.33	-3.05	12.70	12.89	-1.11	12.93
19	43B	13.93	-1.45	14.00	14.48	-1.11	14.52
20	44B	16.90	0.00	16.90	17.39	2.15	17.52
21	Knob Upstream	0.48	0.48	0.69	0	0	0
22	Knob Downstream	-0.14	2.77	2.77	0	0	0

Table 20. Main dam flow rate 0 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 18 - Auxiliary Spillway Without Cofferdam			Test 18 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	115,000						
Station	Location						
1A	36	-2.77	0.35	2.79	-1.80	1.32	2.23
1B	37	-1.11	-0.35	1.16	-2.56	0.90	2.72
2	38	-0.48	0.69	0.85	0.42	-0.14	0.44
3	39	5.27	-4.64	7.02	5.13	-4.57	6.87
4	40	7.55	-3.60	8.37	8.59	-3.74	9.37
5	41	12.33	-0.69	12.35	13.16	-1.73	13.28
6	42	16.28	1.73	16.37	15.59	0.00	15.59
7	43	16.56	1.66	16.64	15.24	-0.35	15.25
8	44	17.60	2.98	17.85	18.01	-0.83	18.03
9	48	18.43	0.97	18.45	18.84	-1.11	18.88
10	49	18.08	-0.21	18.08	17.11	-3.12	17.39
11	27A	19.26	-0.28	19.26	19.68	0.28	19.68
12	28A	13.65	1.80	13.77	11.36	-0.42	11.37
13	Left Bank	18.08	-4.09	18.54	18.71	-3.53	19.04
14	27B	20.09	1.87	20.18	21.41	1.18	21.44
15	28B	15.03	-3.33	15.40	17.18	-4.16	17.68
16	40B	4.78	-4.09	6.29	3.88	-4.99	6.32
17	41B	7.00	1.18	7.10	7.62	-2.15	7.92
18	42B	11.71	5.13	12.78	11.57	3.53	12.10
19	43B	15.59	3.95	16.08	12.75	2.42	12.98
20	44B	16.49	5.54	17.40	17.11	3.60	17.49
21	Knob Upstream	0.42	2.36	2.39	1.18	-2.84	3.08
22	Knob Downstream	0.90	3.26	3.38	0.28	-0.42	0.50

Table 21. Main dam flow rate 0 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 135,000 ft³/s with a tailwater elevation of 180.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 19 - Auxiliary Spillway Without Cofferdam			Test 19 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	135,000						
Station	Location						
1A	36	-1.59	-0.07	1.59	-2.42	-0.14	2.43
1B	37	-0.90	-0.62	1.10	-1.80	0.55	1.88
2	38	-2.15	1.59	2.67	-0.42	0.55	0.69
3	39	0.76	-3.74	3.82	1.25	-2.49	2.79
4	40	7.48	-2.77	7.98	7.62	-3.39	8.34
5	41	11.29	-0.42	11.30	11.15	-1.52	11.26
6	42	15.10	0.07	15.10	13.72	-1.39	13.79
7	43	16.97	2.29	17.13	14.41	-0.21	14.41
8	44	19.33	2.56	19.50	16.90	1.45	16.97
9	48	18.36	4.02	18.79	18.98	-0.83	19.00
10	49	17.81	0.28	17.81	17.18	-1.45	17.24
11	27A	19.47	1.59	19.53	19.61	-0.76	19.62
12	28A	12.75	4.36	13.47	13.44	-0.62	13.46
13	Left Bank	18.08	-0.69	18.10	18.29	-4.64	18.87
14	27B	17.04	2.63	17.25	19.95	2.84	20.15
15	28B	19.33	-2.15	19.45	14.34	-3.39	14.74
16	40B	7.69	-3.33	8.38	7.00	-3.67	7.90
17	41B	6.93	-0.90	6.99	4.92	-3.12	5.82
18	42B	9.84	2.42	10.13	9.42	-0.21	9.42
19	43B	12.82	0.69	12.84	13.44	0.69	13.46
20	44B	17.39	4.16	17.88	16.56	2.01	16.68
21	Knob Upstream	0.48	2.56	2.61	0.90	1.18	1.48
22	Knob Downstream	0.48	3.26	3.29	0.35	1.32	1.36

Table 22. Main dam flow rate 30,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 20 - Auxiliary Spillway Without Cofferdam			Test 20 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
30,000	115,000						
1A	36	-0.35	0.21	0.40	-0.21	-0.35	0.40
1B	37	0.14	-0.07	0.15	-0.42	0.07	0.42
2	38	0.35	0.28	0.44	0.62	0.35	0.71
3	39	2.49	-0.07	2.50	2.70	0.07	2.70
4	40	7.48	-0.62	7.51	5.82	-0.76	5.87
5	41	12.61	-0.69	12.63	10.88	-3.26	11.35
6	42	13.86	-0.07	13.86	13.16	-2.36	13.37
7	43	16.49	0.69	16.50	15.10	-2.01	15.24
8	44	17.39	-1.32	17.44	16.97	-0.97	17.00
9	48	18.84	-1.80	18.93	19.12	-0.07	19.12
10	49	17.60	-4.99	18.29	17.74	-3.53	18.08
11	27A	11.99	0.07	11.99	12.89	0.14	12.89
12	28A	9.49	1.52	9.61	10.32	0.21	10.33
13	Left Bank	15.10	-4.36	15.72	14.48	-3.67	14.94
14	27B	14.41	-0.55	14.42	14.13	-1.25	14.19
15	28B	14.90	-0.69	14.91	12.82	-0.69	12.84
16	40B	11.36	-4.36	12.17	11.09	-2.84	11.44
17	41B	11.09	-3.05	11.50	10.53	-3.74	11.18
18	42B	11.64	-1.18	11.70	11.85	-1.04	11.89
19	43B	14.27	-0.42	14.28	14.27	-0.69	14.29
20	44B	17.74	1.11	17.77	17.60	0.00	17.60
21	Knob Upstream	0.69	1.32	1.49	0	0	0
22	Knob Downstream	0.76	2.01	2.15	0	0	0

Table 23. Main dam flow rate 10,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 21 - Auxiliary Spillway Without Cofferdam			Test 21 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
10,000	135,000						
1A	36	-0.55	-0.07	0.56	-0.76	-0.21	0.79
1B	37	0.97	-0.07	0.97	0.48	-0.35	0.60
2	38	0.55	0.83	1.00	0.83	0.62	1.04
3	39	1.25	-3.53	3.75	-0.35	1.94	1.97
4	40	7.97	-6.79	10.47	10.39	-5.47	11.75
5	41	12.68	-3.05	13.04	11.36	-4.71	12.30
6	42	14.96	-1.59	15.05	14.34	-0.76	14.36
7	43	16.42	-1.73	16.51	14.76	-1.11	14.80
8	44	18.43	0.48	18.44	17.32	0.07	17.32
9	48	18.91	-0.28	18.92	19.40	-4.09	19.82
10	49	19.05	-0.62	19.06	18.64	-3.60	18.98
11	27A	16.77	0.00	16.77	18.57	-0.76	18.58
12	28A	12.54	0.35	12.54	11.50	-0.62	11.52
13	Left Bank	16.70	-4.30	17.24	18.64	-4.16	19.09
14	27B	17.81	0.90	17.83	18.36	-0.76	18.38
15	28B	14.27	-2.63	14.51	16.00	-6.17	17.15
16	40B	12.33	-5.33	13.44	9.42	-5.06	10.69
17	41B	5.89	-1.87	6.18	6.03	-3.46	6.95
18	42B	8.18	-0.76	8.21	9.35	-0.28	9.36
19	43B	12.96	-0.55	12.97	12.75	-0.21	12.75
20	44B	16.21	2.15	16.35	16.35	2.77	16.58
21	Knob Upstream	0.55	1.66	1.75	0.76	-1.11	1.35
22	Knob Downstream	1.39	1.87	2.33	0.83	-2.01	2.17

Table 24. Main dam flow rate 0 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 22 - Auxiliary Spillway Without Cofferdam			Test 22 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	145,000						
Station	Location						
1A	36	-1.80	0.48	1.87	-1.87	0.42	1.92
1B	37	-1.45	0.28	1.48	-1.45	0.55	1.56
2	38	-0.90	1.18	1.48	-1.25	1.04	1.62
3	39	2.49	-4.64	5.27	1.11	-3.88	4.04
4	40	10.39	-4.71	11.41	9.70	-4.16	10.55
5	41	10.46	-1.45	10.56	10.60	-2.15	10.82
6	42	16.14	1.11	16.18	12.33	-0.69	12.35
7	43	15.17	2.49	15.38	14.20	0.14	14.20
8	44	19.95	-0.28	19.96	17.87	0.62	17.89
9	48	19.33	1.66	19.40	19.19	-0.97	19.22
10	49	18.57	-2.08	18.68	18.01	-2.08	18.13
11	27A	19.81	1.80	19.90	18.64	0.42	18.64
12	28A	12.82	-1.18	12.87	13.72	1.32	13.78
13	Left Bank	19.19	-6.86	20.38	19.47	-3.12	19.72
14	27B	21.06	1.66	21.13	20.02	-0.07	20.02
15	28B	19.33	-2.77	19.53	18.57	-4.16	19.03
16	40B	5.06	-4.78	6.96	5.20	-6.86	8.60
17	41B	6.72	-2.36	7.12	6.10	-2.77	6.70
18	42B	11.09	2.29	11.32	9.77	0.07	9.77
19	43B	14.27	4.30	14.90	12.26	0.90	12.30
20	44B	17.94	3.74	18.33	16.49	1.52	16.56
21	Knob Upstream	0.48	2.56	2.61	0.76	1.04	1.29
22	Knob Downstream	0.90	2.84	2.98	1.18	2.29	2.57

Table 25. Main dam flow rate 115,000 ft³/s and auxiliary spillway 45,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 23 - Auxiliary Spillway Without Cofferdam			Test 23 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
115,000	45,000						
1A	36	-1.59	1.59	2.25	0.14	0.28	0.31
1B	37	1.04	0.14	1.05	2.15	-0.55	2.22
2	38	7.48	-2.91	8.03	9.08	-1.52	9.20
3	39	10.39	-1.52	10.50	11.99	-2.01	12.15
4	40	13.03	-1.18	13.08	13.51	-2.63	13.76
5	41	14.48	-1.52	14.56	13.51	-2.56	13.75
6	42	15.80	-0.83	15.82	15.52	-1.32	15.57
7	43	17.81	-2.15	17.93	16.90	-0.62	16.92
8	44	19.47	-2.29	19.60	18.78	-1.45	18.83
9	48	18.78	-2.77	18.98	18.71	-0.97	18.73
10	49	19.05	-1.87	19.14	18.57	-1.59	18.64
11	27A	4.43	0.07	4.43	4.16	0.76	4.23
12	28A	4.02	-0.90	4.12	3.95	1.04	4.08
13	Left Bank	7.48	-1.87	7.71	7.76	-0.07	7.76
14	27B	5.13	1.32	5.29	5.27	1.59	5.50
15	28B	6.03	1.18	6.14	5.54	-0.14	5.54
16	40B	11.22	-2.91	11.59	11.22	-2.42	11.48
17	41B	13.44	-3.19	13.81	12.19	-3.12	12.59
18	42B	15.31	-3.95	15.81	13.99	-2.42	14.20
19	43B	17.32	-2.91	17.56	16.14	-1.39	16.20
20	44B	20.37	-0.62	20.38	19.26	-0.97	19.28
21	Knob Upstream	0.69	0.83	1.08	1.45	3.67	3.95
22	Knob Downstream	0.83	2.42	2.56	2.98	2.70	4.02

Table 26. Main dam flow rate 45,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 24 - Auxiliary Spillway Without Cofferdam			Test 24 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
45,000	115,000						
1A	36	-0.97	0.42	1.06	-0.07	0.55	0.56
1B	37	-0.42	0.48	0.64	1.52	-1.11	1.88
2	38	2.77	-1.39	3.10	2.15	-0.55	2.22
3	39	4.36	-0.83	4.44	4.50	-0.69	4.56
4	40	6.37	-1.04	6.46	6.24	-0.90	6.30
5	41	10.18	2.70	10.54	9.21	-1.59	9.35
6	42	13.65	-0.42	13.65	13.23	-2.01	13.38
7	43	16.56	0.42	16.56	15.17	-1.39	15.24
8	44	17.87	-2.22	18.01	17.60	0.69	17.61
9	48	18.22	-0.14	18.22	18.57	-2.42	18.73
10	49	17.74	-1.73	17.82	18.08	-2.56	18.26
11	27A	10.53	-0.83	10.56	13.58	1.73	13.69
12	28A	8.66	-1.32	8.76	11.09	1.11	11.14
13	Left Bank	13.86	-3.26	14.23	13.58	-2.08	13.74
14	27B	13.30	1.80	13.42	13.72	1.52	13.80
15	28B	13.23	-2.08	13.40	13.30	-0.97	13.34
16	40B	12.68	-3.74	13.22	9.91	-4.71	10.97
17	41B	13.09	-2.36	13.30	12.82	-3.05	13.17
18	42B	13.30	-0.69	13.32	13.37	-3.33	13.78
19	43B	16.07	-2.77	16.31	14.41	-2.91	14.70
20	44B	18.91	-2.01	19.02	18.57	-0.35	18.57
21	Knob Upstream	0.48	0.62	0.79	1.45	0.48	1.53
22	Knob Downstream	0.90	1.39	1.65	1.32	1.39	1.91

Table 27. Main dam flow rate 31,000 ft³/s and auxiliary spillway 129,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 25 - Auxiliary Spillway Without Cofferdam			Test 25 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
1A	36	-0.28	-0.07	0.29	-0.14	0.48	0.50
1B	37	-0.14	0.69	0.71	-0.07	0.83	0.83
2	38	1.32	-0.42	1.38	0.97	-0.14	0.98
3	39	2.22	0.07	2.22	2.42	0.07	2.43
4	40	5.96	-0.21	5.96	6.86	-1.04	6.94
5	41	11.15	-1.80	11.30	9.70	-3.05	10.17
6	42	15.10	-0.48	15.11	12.06	-2.29	12.27
7	43	16.07	-0.28	16.08	15.66	-2.36	15.83
8	44	19.61	0.28	19.61	18.22	-1.59	18.29
9	48	18.98	-1.32	19.03	19.12	-0.21	19.12
10	49	17.46	-2.84	17.69	19.19	1.80	19.28
11	27A	14.69	1.73	14.79	15.45	0.14	15.45
12	28A	13.03	1.18	13.08	11.29	-0.14	11.29
13	Left Bank	16.00	-2.56	16.21	14.62	-3.74	15.09
14	27B	14.48	0.90	14.51	15.03	1.52	15.11
15	28B	14.48	-2.84	14.76	15.17	-0.83	15.20
16	40B	12.12	-4.78	13.03	12.68	-5.96	14.01
17	41B	12.82	-5.40	13.91	11.71	-4.02	12.38
18	42B	14.90	-2.56	15.11	11.43	-2.49	11.70
19	43B	15.73	-1.87	15.84	14.55	-1.25	14.60
20	44B	17.18	1.32	17.23	16.90	-0.35	16.91
21	Knob Upstream	0.62	1.18	1.33	0.83	0.76	1.13
22	Knob Downstream	1.25	2.08	2.42	0.90	2.01	2.20

Table 28. Main dam flow rate 25,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 26 - Auxiliary Spillway Without Cofferdam			Test 26 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
25,000	135,000						
1A	36	0.00	0.14	0.14	0.04	0.07	0.08
1B	37	0.07	0.48	0.49	0.07	0.28	0.29
2	38	0.69	-0.48	0.85	0.44	0.29	0.53
3	39	0.48	0.35	0.60	1.33	0.31	1.36
4	40	5.20	-3.33	6.17	7.93	-1.85	8.15
5	41	11.99	-0.83	12.01	12.63	-2.29	12.83
6	42	14.55	-0.62	14.56	15.84	-0.80	15.86
7	43	16.35	0.42	16.36	17.12	-0.51	17.13
8	44	18.50	-1.52	18.56	18.73	0.11	18.73
9	48	19.26	-0.35	19.26	19.39	-0.94	19.41
10	49	17.94	-4.30	18.45	17.94	-3.01	18.19
11	27A	19.75	-0.14	19.75	15.55	-0.63	15.56
12	28A	17.11	-0.14	17.11	10.68	-1.51	10.79
13	Left Bank	16.63	-2.70	16.85	16.06	-3.63	16.47
14	27B	14.48	2.08	14.63	16.63	2.28	16.79
15	28B	13.72	-2.08	13.87	16.27	-3.75	16.69
16	40B	11.85	-4.09	12.53	12.12	-4.64	12.98
17	41B	10.67	-3.33	11.18	10.32	-3.19	10.80
18	42B	11.92	-1.18	11.97	10.95	-1.80	11.09
19	43B	14.20	-2.56	14.43	13.79	-1.94	13.92
20	44B	16.90	0.21	16.91	16.90	-0.90	16.93
21	Knob Upstream	0.90	1.39	1.65	0	0	0
22	Knob Downstream	1.45	2.22	2.65	0	0	0

Table 29. Main dam flow rate 15,000 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 27 - Auxiliary Spillway Without Cofferdam			Test 27 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
15,000	145,000						
1A	36	-0.69	0.00	0.69	0.62	-0.35	0.71
1B	37	-0.07	-0.14	0.15	0.55	0.28	0.62
2	38	1.32	-0.14	1.32	1.04	-0.28	1.08
3	39	-0.21	1.45	1.47	0.62	0.55	0.83
4	40	11.09	4.09	11.81	9.08	-5.75	10.74
5	41	11.22	-0.83	11.25	12.40	-3.19	12.80
6	42	15.59	-0.90	15.61	13.09	-2.49	13.33
7	43	16.49	-0.14	16.49	14.96	-1.94	15.09
8	44	19.12	1.39	19.17	18.50	0.69	18.51
9	48	19.68	-2.98	19.90	19.47	-4.16	19.91
10	49	18.98	-3.12	19.24	18.78	-2.56	18.95
11	27A	16.21	-0.28	16.21	17.04	1.11	17.08
12	28A	11.71	-1.04	11.75	11.99	0.28	11.99
13	Left Bank	14.90	-5.33	15.82	16.21	-4.09	16.72
14	27B	18.22	1.18	18.26	19.33	0.07	19.33
15	28B	14.90	-2.29	15.07	16.35	-3.19	16.66
16	40B	9.01	-3.74	9.75	9.98	-5.68	11.48
17	41B	7.55	-2.15	7.85	6.30	-3.74	7.33
18	42B	9.21	-0.28	9.22	8.45	-2.36	8.77
19	43B	12.75	-0.14	12.75	12.47	-2.56	12.73
20	44B	15.38	3.26	15.72	16.35	-0.21	16.35
21	Knob Upstream	0.69	1.80	1.93	1.04	2.08	2.32
22	Knob Downstream	0.97	2.42	2.61	0.62	1.11	1.27

Table 30. Main dam flow rate 0 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 28 - Auxiliary Spillway Without Cofferdam			Test 28 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
0	160,000						
Station	Location						
1A	36	-1.39	-0.14	1.39	-0.62	0.21	0.66
1B	37	-0.42	0.00	0.42	-1.52	0.42	1.58
2	38	-0.42	2.29	2.32	-0.69	0.69	0.98
3	39	-0.28	-1.73	1.75	1.52	-0.90	1.77
4	40	10.81	-5.89	12.31	9.77	-3.74	10.46
5	41	12.40	-1.59	12.50	9.42	-0.83	9.46
6	42	13.03	-0.07	13.03	12.82	0.00	12.82
7	43	15.24	0.90	15.27	15.52	0.69	15.53
8	44	18.29	0.14	18.29	18.50	0.35	18.50
9	48	19.75	1.80	19.83	18.22	0.69	18.23
10	49	19.47	-0.21	19.47	17.94	-1.87	18.04
11	27A	19.95	5.75	20.77	19.75	3.53	20.06
12	28A	13.23	3.60	13.71	11.57	-0.28	11.57
13	Left Bank	20.23	-0.21	20.23	18.22	-2.42	18.38
14	27B	13.58	4.36	14.26	21.20	3.33	21.46
15	28B	20.51	-2.01	20.61	20.37	-2.56	20.53
16	40B	9.15	-3.88	9.93	8.80	-5.61	10.44
17	41B	5.68	-0.76	5.73	5.68	-5.47	7.89
18	42B	10.18	3.12	10.65	10.12	-0.83	10.15
19	43B	13.44	1.45	13.52	12.40	-0.62	12.42
20	44B	19.05	2.42	19.21	17.11	3.12	17.39
21	Knob Upstream	0.97	2.49	2.68	0	0	0
22	Knob Downstream	0.48	3.05	3.09	0	0	0

Table 31. Main dam flow rate 45,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 180,000 ft³/s with a tailwater elevation of 187.8 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 29 - Auxiliary Spillway Without Cofferdam			Test 29 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
45,000	135,000						
1A	36	-0.35	0.48	0.60	-0.55	0.76	0.94
1B	37	-0.62	0.62	0.88	0.35	0.21	0.40
2	38	2.42	-1.18	2.70	2.63	-0.21	2.64
3	39	3.88	-0.55	3.92	4.30	0.55	4.33
4	40	6.30	-0.83	6.36	7.07	-0.21	7.07
5	41	8.45	-1.04	8.52	8.31	-1.80	8.51
6	42	14.41	-1.59	14.50	12.12	-2.22	12.33
7	43	16.84	-0.28	16.84	14.69	-1.87	14.81
8	44	18.98	-0.69	19.00	18.22	-0.76	18.24
9	48	19.75	-0.21	19.75	18.91	-2.91	19.14
10	49	18.08	-0.69	18.10	18.15	-4.57	18.72
11	27A	12.40	0.55	12.41	10.74	1.04	10.79
12	28A	9.15	-0.69	9.17	9.28	1.94	9.48
13	Left Bank	14.48	-3.19	14.83	12.40	-3.05	12.77
14	27B	12.61	2.49	12.85	15.17	1.94	15.30
15	28B	13.72	-0.28	13.72	13.99	-3.26	14.37
16	40B	13.51	-5.82	14.71	13.37	-5.40	14.42
17	41B	13.44	-1.18	13.49	12.75	-3.19	13.14
18	42B	12.96	-0.76	12.98	13.23	-2.63	13.49
19	43B	15.17	-0.83	15.20	15.24	-1.73	15.34
20	44B	20.16	0.97	20.18	18.01	0.42	18.02
21	Knob Upstream	1.45	1.39	2.01	1.25	1.04	1.62
22	Knob Downstream	1.32	2.84	3.13	1.66	2.63	3.11

Table 32. Main dam flow rate 75,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 30 - Auxiliary Spillway Without Cofferdam			Test 30 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
75,000	115,000						
1A	36	-0.28	-0.69	0.75	-0.21	0.00	0.21
1B	37	1.18	-0.42	1.25	2.56	-1.25	2.85
2	38	4.50	-2.22	5.02	5.33	-1.73	5.61
3	39	6.17	-0.48	6.19	7.34	-1.32	7.46
4	40	9.35	0.42	9.36	9.35	-0.76	9.38
5	41	10.95	-0.55	10.96	10.88	-0.14	10.88
6	42	14.41	1.66	14.51	12.82	-1.39	12.89
7	43	16.42	-1.04	16.45	15.93	-1.18	15.98
8	44	18.91	-0.55	18.92	18.36	-0.48	18.37
9	48	18.50	-1.80	18.59	19.19	-2.49	19.35
10	49	17.67	-4.50	18.23	17.46	-2.42	17.63
11	27A	9.56	0.35	9.57	9.21	0.35	9.22
12	28A	9.15	0.00	9.15	10.25	0.42	10.26
13	Left Bank	14.06	-2.49	14.28	14.34	-3.88	14.86
14	27B	10.46	2.49	10.75	12.12	1.45	12.21
15	28B	11.57	0.62	11.59	9.01	-0.55	9.02
16	40B	12.19	-0.83	12.22	10.60	-3.33	11.11
17	41B	13.44	-1.80	13.56	13.16	-3.39	13.59
18	42B	15.17	-2.63	15.40	15.10	-3.39	15.48
19	43B	16.35	-3.46	16.71	16.63	-1.32	16.68
20	44B	20.37	1.52	20.43	19.68	-0.21	19.68
21	Knob Upstream	2.08	2.42	3.19	2.08	1.04	2.32
22	Knob Downstream	1.32	3.46	3.71	1.80	2.77	3.31

Table 33. Main dam flow rate 45,000 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 31 - Auxiliary Spillway Without Cofferdam			Test 31 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
45,000	145,000						
1A	36	-0.48	0.14	0.50	-0.76	-0.28	0.81
1B	37	-0.07	-0.62	0.63	1.04	-0.83	1.33
2	38	2.49	-0.48	2.54	1.80	-0.76	1.96
3	39	3.88	0.21	3.89	3.95	-0.48	3.98
4	40	6.30	-0.35	6.31	5.68	-0.35	5.69
5	41	11.36	0.42	11.37	10.60	-2.56	10.91
6	42	13.65	0.97	13.68	12.47	-3.12	12.85
7	43	18.50	1.80	18.59	16.00	-0.62	16.02
8	44	18.84	2.98	19.08	18.98	0.28	18.99
9	48	18.78	0.14	18.78	19.33	-2.36	19.47
10	49	19.12	-2.22	19.25	18.29	-4.09	18.74
11	27A	14.76	-0.97	14.79	14.96	-2.29	15.14
12	28A	11.36	-0.62	11.38	10.53	-0.07	10.53
13	Left Bank	13.03	-2.77	13.32	13.99	-4.71	14.77
14	27B	14.34	1.80	14.45	15.45	3.12	15.76
15	28B	14.55	0.14	14.55	13.51	-2.63	13.76
16	40B	10.88	-4.85	11.91	9.91	-6.93	12.09
17	41B	13.23	-3.39	13.66	13.09	-5.06	14.04
18	42B	13.99	-1.59	14.09	12.89	-2.77	13.18
19	43B	15.03	-1.73	15.13	14.90	-2.56	15.11
20	44B	18.91	0.00	18.91	19.40	0.00	19.40
21	Knob Upstream	1.25	2.36	2.67	1.52	2.08	2.58
22	Knob Downstream	0.90	3.05	3.18	1.94	1.87	2.69

Table 34. Main dam flow rate 30,000 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 32 - Auxiliary Spillway Without Cofferdam			Test 32 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
1A	36	-0.42	0.35	0.54	0.28	0.07	0.29
1B	37	0.21	-0.21	0.29	0.42	-0.14	0.44
2	38	1.52	-0.69	1.67	1.18	0.21	1.20
3	39	1.52	0.76	1.70	1.11	0.21	1.13
4	40	5.47	-2.15	5.88	7.62	-0.35	7.63
5	41	12.54	-0.97	12.58	10.67	-1.80	10.82
6	42	14.41	-0.07	14.41	13.23	-4.23	13.89
7	43	17.39	0.90	17.41	14.62	-3.19	14.96
8	44	18.64	0.90	18.66	17.74	-0.35	17.74
9	48	19.40	0.07	19.40	19.40	-1.11	19.43
10	49	18.71	-3.33	19.00	18.22	-3.67	18.59
11	27A	16.35	0.42	16.36	16.35	-1.45	16.42
12	28A	11.29	1.25	11.36	10.60	-1.94	10.78
13	Left Bank	15.24	-3.33	15.60	15.59	-2.84	15.85
14	27B	16.21	1.04	16.25	16.97	-2.77	17.20
15	28B	17.67	-1.66	17.74	16.42	-1.73	16.51
16	40B	11.78	-4.64	12.66	12.06	-4.71	12.94
17	41B	11.99	-3.95	12.62	11.99	-3.95	12.62
18	42B	11.99	-2.22	12.19	9.98	-2.56	10.30
19	43B	14.48	-0.90	14.51	13.51	-1.18	13.56
20	44B	16.97	1.39	17.03	17.81	-1.52	17.87
21	Knob Upstream	0.97	2.98	3.13	1.32	2.29	2.64
22	Knob Downstream	1.59	3.05	3.44	0.62	2.49	2.57

Table 35. Main dam flow rate 60,000 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 220,000 ft³/s with a tailwater elevation of 193.7 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 33 - Auxiliary Spillway Without Cofferdam			Test 33 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
1A	36	-0.83	0.62	1.04	0.28	-1.04	1.08
1B	37	1.25	-1.39	1.86	1.66	-1.66	2.35
2	38	3.12	-0.83	3.23	3.39	-1.04	3.55
3	39	5.40	-0.55	5.43	5.75	-0.21	5.75
4	40	6.79	-0.21	6.79	6.65	-0.69	6.69
5	41	8.94	-1.39	9.04	9.01	-1.66	9.16
6	42	12.12	-3.33	12.57	11.92	-1.94	12.07
7	43	16.84	-2.08	16.96	15.52	-1.73	15.62
8	44	19.75	1.39	19.79	18.29	-0.62	18.30
9	48	19.26	-0.69	19.27	19.26	-2.77	19.46
10	49	19.12	-2.77	19.32	18.57	-2.70	18.76
11	27A	11.99	-0.21	11.99	12.75	-0.55	12.76
12	28A	10.12	1.52	10.23	10.46	2.56	10.77
13	Left Bank	13.99	-1.94	14.13	14.76	-2.91	15.04
14	27B	12.68	1.87	12.82	14.34	2.56	14.57
15	28B	11.99	-1.59	12.09	9.63	-0.42	9.64
16	40B	12.54	-2.22	12.73	10.88	-4.43	11.75
17	41B	16.35	-2.42	16.53	12.61	-4.64	13.44
18	42B	16.35	-1.39	16.41	13.58	-3.19	13.95
19	43B	15.80	-1.80	15.90	16.56	-3.26	16.88
20	44B	20.30	0.28	20.30	19.54	-0.48	19.54
21	Knob Upstream	1.73	4.30	4.63	1.94	3.33	3.85
22	Knob Downstream	1.52	3.05	3.41	1.59	3.60	3.94

Table 36. Main dam flow rate 238,266 ft³/s and auxiliary spillway 0 ft³/s for a total of 238,266 ft³/s with a tailwater elevation of 196.44 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 11 - No Auxiliary Spillway		
		Prototype Velocity		
238,266	0	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location			
1A	36	-3.05	2.15	3.73
1B	37	-1.80	1.25	2.19
2	38	4.78	-2.77	5.53
3	39	10.81	-2.22	11.03
4	40	12.54	-2.77	12.84
5	41	11.99	-5.27	13.09
6	42	13.86	-3.26	14.23
7	43	16.97	-3.19	17.27
8	44	21.20	-1.87	21.28
9	48	23.00	-3.53	23.27
10	49	23.21	-2.22	23.32
11	27A	Too shallow	Too shallow	Too shallow
12	28A	14.06	6.03	15.30
13	Left Bank	17.67	0.76	17.68
14	27B	14.41	10.60	17.89
15	28B	19.61	5.40	20.34
16	40B	15.38	-5.40	16.30
17	41B	14.83	-3.95	15.34
18	42B	18.36	-7.14	19.70
19	43B	22.66	-5.75	23.37
20	44B	26.33	-4.64	26.73
21	Knob Upstream	N/A	N/A	N/A
22	Knob Downstream	N/A	N/A	N/A

Table 37. Main dam flow rate 115,000 ft³/s and auxiliary spillway 141,000 ft³/s for a total of 256,000 ft³/s with a tailwater elevation of 199.1 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 34 - Auxiliary Spillway Without Cofferdam			Test 34 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
115,000	141,000						
1A	36	-2.22	0.28	2.23	0.35	-1.39	1.43
1B	37	-0.69	-5.54	5.59	3.26	-2.36	4.02
2	38	4.57	-2.36	5.14	1.25	-2.36	2.67
3	39	7.48	-1.11	7.56	7.83	-2.77	8.30
4	40	10.95	-0.48	10.96	10.12	-0.69	10.14
5	41	13.09	1.18	13.15	11.85	-0.28	11.85
6	42	15.10	0.42	15.11	14.20	-1.52	14.28
7	43	17.60	-1.39	17.65	15.17	-2.84	15.44
8	44	19.95	-1.18	19.99	19.81	-2.22	19.94
9	48	20.72	-0.42	20.72	20.58	-2.98	20.79
10	49	20.02	-4.64	20.55	19.75	-5.89	20.60
11	27A	8.45	1.59	8.60	7.62	-0.55	7.64
12	28A	7.69	-0.55	7.71	7.34	2.29	7.69
13	Left Bank	12.61	-0.90	12.64	11.85	-0.28	11.85
14	27B	14.27	2.91	14.57	10.53	3.12	10.98
15	28B	12.96	1.80	13.08	8.04	-0.28	8.04
16	40B	10.25	-3.67	10.89	10.60	-2.36	10.86
17	41B	12.96	-1.80	13.08	14.27	-1.04	14.31
18	42B	15.59	-3.05	15.88	14.90	-3.05	15.20
19	43B	17.81	-1.80	17.90	17.39	-1.52	17.46
20	44B	21.89	-0.42	21.90	21.96	-1.59	22.02
21	Knob Upstream	2.08	2.22	3.04	3.88	3.95	5.54
22	Knob Downstream	3.26	4.43	5.50	1.94	1.59	2.51

Table 38. Main dam flow rate 300,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 300,000 ft³/s with a tailwater elevation of 205.75 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 35 - Auxiliary Spillway Without Cofferdam			Test 35 - Auxiliary Spillway With Cofferdam			Test 12 - No Auxiliary Spillway		
		Prototype Velocity			Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location									
300,000	0									
1A	36	-3.74	0.90	3.85	-2.68	1.80	3.23	-4.23	3.12	5.25
1B	37	6.10	-3.81	7.19	5.33	-4.57	7.03	1.11	-0.07	1.11
2	38	7.55	0.90	7.61	8.73	-4.62	9.88	6.51	-3.53	7.41
3	39	12.68	-3.95	13.28	10.79	-4.13	11.56	9.21	-3.39	9.82
4	40	14.13	-3.74	14.62	14.77	-3.63	15.21	11.09	-3.74	11.70
5	41	13.99	-2.29	14.18	16.21	-3.02	16.49	12.68	-4.64	13.50
6	42	15.73	-4.43	16.34	16.56	-2.66	16.78	15.24	-4.02	15.76
7	43	17.74	-3.88	18.16	18.81	-5.10	19.49	19.05	-4.92	19.68
8	44	21.69	-4.23	22.09	22.28	-2.15	22.38	21.41	-4.71	21.92
9	48	20.09	-2.63	20.26	20.81	-0.92	20.83	24.46	-3.19	24.66
10	49	18.43	-4.50	18.97	19.28	-6.11	20.23	21.13	-6.51	22.11
11	27A	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too shallow	Too shallow	Too shallow
12	28A	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	17.39	4.43	17.95
13	Left Bank	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	20.16	1.11	20.19
14	27B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	18.08	7.69	19.65
15	28B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	18.01	2.15	18.14
16	40B	11.85	-3.39	12.32	12.06	-5.54	13.27	15.87	-5.61	16.83
17	41B	12.82	-5.75	14.05	13.99	-5.75	15.13	18.08	-5.68	18.95
18	42B	16.63	-6.58	17.88	14.62	-5.89	15.76	20.85	-5.54	21.58
19	43B	17.67	-6.51	18.83	18.71	-4.85	19.32	23.28	-6.17	24.08
20	44B	23.35	-1.18	23.38	23.14	-4.78	23.63	27.37	-3.74	27.62
21	Knob Upstream	4.99	2.77	5.71	Too turbulent	Too turbulent	Too turbulent	N/A	N/A	N/A
22	Knob Downstream	12.47	4.30	13.19	Too turbulent	Too turbulent	Too turbulent	N/A	N/A	N/A

Table 39. Main dam flow rate 115,000 ft³/s and auxiliary spillway 237,000 ft³/s for a total of 352,000 ft³/s with a tailwater elevation of 212.95 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 36 - Auxiliary Spillway Without Cofferdam			Test 36 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
115,000	237,000						
1A	36	-2.22	1.32	2.58	-2.01	1.11	2.29
1B	37	-1.25	0.48	1.34	-2.36	0.55	2.42
2	38	0.62	-1.04	1.21	0.07	-1.39	1.39
3	39	2.01	-0.83	2.17	2.08	-0.69	2.19
4	40	3.26	-0.83	3.36	4.23	-1.45	4.47
5	41	8.66	-2.15	8.92	7.48	-2.08	7.77
6	42	12.61	-0.69	12.63	11.43	-3.60	11.99
7	43	17.74	-1.59	17.81	15.17	-3.05	15.48
8	44	19.05	-1.32	19.10	17.53	-2.98	17.78
9	48	21.41	-0.76	21.42	22.24	-2.42	22.37
10	49	19.47	-5.20	20.15	20.09	-3.60	20.41
11	27A	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
12	28A	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
13	Left Bank	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
14	27B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
15	28B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
16	40B	11.50	-2.84	11.85	9.63	-6.65	11.70
17	41B	13.51	-3.88	14.06	11.09	-7.48	13.37
18	42B	15.03	-2.56	15.25	14.20	-0.35	14.21
19	43B	19.61	-4.64	20.15	17.67	-5.61	18.54
20	44B	23.21	-1.94	23.29	19.81	-7.69	21.25
21	Knob Upstream	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
22	Knob Downstream	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent

Table 40. Main dam flow rate 528,090 ft³/s and auxiliary spillway 0 ft³/s for a total of 528,090 ft³/s with a tailwater elevation of 230.48 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 13 - No Auxiliary Spillway		
		Prototype Velocity		
528,090	0	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location			
1A	36	-2.29	0.35	2.31
1B	37	-0.90	1.25	1.54
2	38	5.82	-1.39	5.98
3	39	4.16	-1.25	4.34
4	40	9.42	-3.12	9.92
5	41	13.37	-7.07	15.12
6	42	16.28	-10.81	19.54
7	43	22.72	-9.35	24.57
8	44	27.23	-7.83	28.33
9	48	29.58	-0.90	29.60
10	49	25.08	-3.60	25.34
11	27A	16.77	14.62	22.24
12	28A	18.43	7.07	19.74
13	Left Bank	21.89	-0.69	21.90
14	27B	16.90	6.72	18.19
15	28B	18.98	3.33	19.27
16	40B	15.17	-4.92	15.95
17	41B	20.30	-8.73	22.10
18	42B	20.23	-11.57	23.31
19	43B	27.92	-9.70	29.56
20	44B	32.77	-6.24	33.36
21	Knob Upstream	N/A	N/A	N/A
22	Knob Downstream	N/A	N/A	N/A

Table 41. Main dam flow rate 238,266 ft³/s and auxiliary spillway 297,851 ft³/s for a total of 536,117 ft³/s with a tailwater elevation of 231.15 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 37 - Auxiliary Spillway Without Cofferdam			Test 37 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
238,266	297,851						
1A	36	-2.36	1.87	3.01	-1.80	1.45	2.32
1B	37	-1.18	0.48	1.27	-2.42	1.25	2.73
2	38	2.29	-2.01	3.04	1.32	-1.45	1.96
3	39	4.43	-1.73	4.76	3.26	-1.18	3.46
4	40	11.64	-2.36	11.88	12.40	-4.71	13.27
5	41	14.48	-3.60	14.92	16.70	-4.85	17.39
6	42	20.09	-3.12	20.33	19.19	-5.89	20.07
7	43	20.58	-2.22	20.70	19.81	-5.27	20.50
8	44	22.10	-0.55	22.11	22.52	-2.91	22.70
9	48	21.41	-1.25	21.44	21.89	-1.25	21.93
10	49	22.17	-2.29	22.29	22.52	-2.29	22.63
11	27A	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
12	28A	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
13	Left Bank	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
14	27B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
15	28B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
16	40B	21.89	-11.02	24.51	20.65	-9.21	22.61
17	41B	21.41	-3.67	21.72	19.61	-9.63	21.84
18	42B	17.94	-5.68	18.82	17.04	-8.94	19.24
19	43B	22.31	-5.13	22.89	18.57	-7.34	19.97
20	44B	24.66	-3.60	24.93	22.72	-7.00	23.78
21	Knob Upstream	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
22	Knob Downstream	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent

Table 42. Main dam flow rate 528,090 ft³/s and auxiliary spillway 313,640 ft³/s for a total of 841,730 ft³/s with a tailwater elevation of 253.78 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)	Test 38 - Auxiliary Spillway Without Cofferdam			Test 38 - Auxiliary Spillway With Cofferdam		
		Prototype Velocity			Prototype Velocity		
		Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)	Vx (ft/s)	Vy (ft/s)	Resultant (ft/s)
Station	Location						
528,090	313,640						
1A	36	-4.43	1.59	4.71	-3.12	-1.45	3.44
1B	37	-0.90	0.21	0.92	-0.55	-1.80	1.88
2	38	0.35	0.21	0.40	0.42	-0.35	0.54
3	39	5.68	-2.77	6.32	5.20	-4.36	6.79
4	40	17.74	-6.79	18.99	18.78	-10.53	21.53
5	41	29.44	-10.81	31.37	24.04	-8.66	25.55
6	42	28.89	-6.30	29.57	24.80	-6.93	25.75
7	43	28.41	-5.75	28.98	25.15	0.48	25.15
8	44	27.64	-3.88	27.91	25.50	-2.56	25.62
9	48	24.32	-1.87	24.39	23.83	-2.36	23.95
10	49	24.25	-4.85	24.73	23.97	0.76	23.98
11	27A	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
12	28A	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
13	Left Bank	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
14	27B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
15	28B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
16	40B	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
17	41B	28.82	-7.27	29.73	26.47	-9.56	28.14
18	42B	26.05	-7.00	26.97	24.53	-5.06	25.04
19	43B	26.33	-5.82	26.96	25.77	-4.99	26.25
20	44B	29.03	-3.26	29.21	28.96	-6.79	29.75
21	Knob Upstream	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent
22	Knob Downstream	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent	Too turbulent

Appendix B. Water Surface Elevation Data

Appendix Key:

No Water = No water at the piezometer tap location.

N/A = Water surface elevation was not available (i.e., the location does not exist in the No Auxiliary Spillway configuration or the recorded measurement was in error).

Table 1. Main dam flow rate 4,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 4,000 ft³/s with a tailwater elevation of 125.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 1 - Auxiliary Spillway Without Cofferdam	Test 1 - Auxiliary Spillway With Cofferdam	Test 1 - No Auxiliary Spillway
4,000	0		Elevation (ft)	Elevation (ft)	Elevation (ft)
Station	Location	Tap #			
1A	800	36	124.73	124.87	125.16
1B	900	37	124.68	124.78	125.11
2	1000	38	123.34	123.58	123.77
3	1100	39	123.58	124.10	124.20
4 & 16	1200	40	123.77	124.15	124.54
5 & 17	1300	41	123.77	123.96	124.58
6 & 18	1400	42	124.63	124.87	125.11
7 & 19	1500	43	124.63	124.78	125.02
8 & 20	1600	44	124.68	125.02	125.02
9	2000	48	124.44	124.63	124.78
10	2100	49	124.54	124.68	124.97
11 & 14	900	27	144.60	No water	N/A
12 & 15	1000	28	144.60	No water	N/A

Table 2. Main dam flow rate 0 ft³/s and auxiliary spillway 4,000 ft³/s for a total of 4,000 ft³/s with a tailwater elevation of 125.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 2 - Auxiliary Spillway Without Cofferdam Elevation (ft)	Test 2 - Auxiliary Spillway With Cofferdam Elevation (ft)
0	4,000			
Station	Location	Tap #		
1A	800	36	125.02	124.78
1B	900	37	124.06	124.44
2	1000	38	124.97	124.06
3	1100	39	124.87	N/A
4 & 16	1200	40	124.73	124.10
5 & 17	1300	41	124.58	124.06
6 & 18	1400	42	125.45	125.16
7 & 19	1500	43	125.40	125.16
8 & 20	1600	44	125.59	125.40
9	2000	48	125.16	124.92
10	2100	49	125.35	125.16
11 & 14	900	27	147.38	149.11
12 & 15	1000	28	147.48	149.21

Table 3. Main dam flow rate 7,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 7,000 ft³/s with a tailwater elevation of 127.14 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 3 - Auxiliary Spillway Without Cofferdam Elevation (ft)	Test 3 - Auxiliary Spillway With Cofferdam Elevation (ft)	Test 2 - No Auxiliary Spillway Elevation (ft)
7,000	0				
Station	Location	Tap #			
1A	800	36	128.52	127.90	127.18
1B	900	37	128.38	127.27	127.03
2	1000	38	127.56	126.36	125.26
3	1100	39	127.42	126.94	125.78
4 & 16	1200	40	127.18	127.22	126.60
5 & 17	1300	41	127.08	127.13	126.65
6 & 18	1400	42	127.66	127.56	127.13
7 & 19	1500	43	127.66	127.75	127.08
8 & 20	1600	44	127.56	127.85	127.08
9	2000	48	126.98	127.32	126.55
10	2100	49	127.08	127.56	126.70
11 & 14	900	27	147.19	No water	N/A
12 & 15	1000	28	147.19	No water	N/A

Table 4. Main dam flow rate 0 ft³/s and auxiliary spillway 7,000 ft³/s for a total of 7,000 ft³/s with a tailwater elevation of 127.14 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 4 - Auxiliary Spillway Without Cofferdam	Test 4 - Auxiliary Spillway With Cofferdam
0	7,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	128.47	128.23
1B	900	37	128.04	128.14
2	1000	38	128.14	127.18
3	1100	39	128.04	127.18
4 & 16	1200	40	127.46	127.13
5 & 17	1300	41	127.18	126.70
6 & 18	1400	42	127.99	127.66
7 & 19	1500	43	127.90	127.61
8 & 20	1600	44	127.99	127.61
9	2000	48	127.37	127.03
10	2100	49	127.61	127.37
11 & 14	900	27	148.73	150.50
12 & 15	1000	28	148.73	150.55

Table 5. Main dam flow rate 15,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 15,000 ft³/s with a tailwater elevation of 133.14 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 5 - Auxiliary Spillway Without Cofferdam	Test 5 - Auxiliary Spillway With Cofferdam	Test 3 - No Auxiliary Spillway
15,000	0		Elevation	Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)	(ft)
1A	800	36	134.23	133.18	132.12
1B	900	37	134.09	132.94	131.98
2	1000	38	134.18	133.03	132.94
3	1100	39	134.18	132.84	132.74
4 & 16	1200	40	133.99	133.18	133.18
5 & 17	1300	41	133.18	133.27	133.37
6 & 18	1400	42	134.23	134.23	134.18
7 & 19	1500	43	134.18	134.28	134.18
8 & 20	1600	44	133.94	134.23	133.03
9	2000	48	133.18	133.32	133.18
10	2100	49	133.46	133.70	133.46
11 & 14	900	27	149.98	No water	N/A
12 & 15	1000	28	150.12	No water	N/A

Table 6. Main dam flow rate 0 ft³/s and auxiliary spillway 15,000 ft³/s for a total of 15,000 ft³/s with a tailwater elevation of 133.14 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 6 - Auxiliary Spillway Without Cofferdam	Test 6 - Auxiliary Spillway With Cofferdam
0	15,000		Elevation (ft)	Elevation (ft)
Station	Location	Tap #		
1A	800	36	135.10	134.86
1B	900	37	134.86	134.66
2	1000	38	135.62	133.75
3	1100	39	134.57	N/A
4 & 16	1200	40	133.80	133.75
5 & 17	1300	41	133.32	133.32
6 & 18	1400	42	134.28	134.28
7 & 19	1500	43	134.23	134.33
8 & 20	1600	44	133.99	134.18
9	2000	48	133.32	133.51
10	2100	49	133.61	133.70
11 & 14	900	27	151.61	153.43
12 & 15	1000	28	151.90	153.67

Table 7. Main dam flow rate 25,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 25,000 ft³/s with a tailwater elevation of 140.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 7 - Auxiliary Spillway Without Cofferdam	Test 7 - Auxiliary Spillway With Cofferdam	Test 4 - No Auxiliary Spillway
25,000	0		Elevation (ft)	Elevation (ft)	Elevation (ft)
Station	Location	Tap #			
1A	800	36	141.14	140.14	139.13
1B	900	37	140.95	140.09	138.94
2	1000	38	141.38	139.90	140.62
3	1100	39	141.58	140.18	139.90
4 & 16	1200	40	140.86	140.14	139.75
5 & 17	1300	41	140.47	140.28	140.09
6 & 18	1400	42	141.34	141.43	140.86
7 & 19	1500	43	141.48	141.48	141.14
8 & 20	1600	44	141.29	141.05	140.71
9	2000	48	140.42	140.28	139.94
10	2100	49	140.71	140.38	140.04
11 & 14	900	27	151.03	No water	N/A
12 & 15	1000	28	151.51	No water	N/A

Table 8. Main dam flow rate 0 ft³/s and auxiliary spillway 25,000 ft³/s for a total of 25,000 ft³/s with a tailwater elevation of 140.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 8 - Auxiliary Spillway Without Cofferdam	Test 8 - Auxiliary Spillway With Cofferdam
0	25,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	142.92	141.58
1B	900	37	142.58	141.38
2	1000	38	142.54	140.71
3	1100	39	141.82	N/A
4 & 16	1200	40	141.67	140.95
5 & 17	1300	41	141.14	140.28
6 & 18	1400	42	141.96	141.24
7 & 19	1500	43	142.06	141.43
8 & 20	1600	44	141.53	141.00
9	2000	48	140.76	140.33
10	2100	49	140.95	140.52
11 & 14	900	27	154.44	155.88
12 & 15	1000	28	154.82	156.36

Table 9. Main dam flow rate 30,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 30,000 ft³/s with a tailwater elevation of 143.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 9 - Auxiliary Spillway Without Cofferdam	Test 9 - Auxiliary Spillway With Cofferdam	Test 5 - No Auxiliary Spillway
30,000	0		Elevation	Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)	(ft)
1A	800	36	144.41	142.63	141.96
1B	900	37	144.17	142.63	141.91
2	1000	38	144.55	142.58	144.22
3	1100	39	144.55	143.11	142.63
4 & 16	1200	40	143.98	143.35	143.30
5 & 17	1300	41	143.59	143.26	142.92
6 & 18	1400	42	144.22	143.98	143.88
7 & 19	1500	43	144.31	144.02	144.36
8 & 20	1600	44	143.93	143.78	143.83
9	2000	48	143.35	142.97	142.73
10	2100	49	143.16	143.21	142.82
11 & 14	900	27	151.27	No water	N/A
12 & 15	1000	28	151.85	No water	N/A

Table 10. Main dam flow rate 45,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 45,000 ft³/s with a tailwater elevation of 150.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 6 - No Auxiliary Spillway
45,000	0		Elevation (ft)
Station	Location	Tap #	
1A	800	36	149.35
1B	900	37	149.50
2	1000	38	150.50
3	1100	39	148.68
4 & 16	1200	40	150.84
5 & 17	1300	41	150.98
6 & 18	1400	42	151.37
7 & 19	1500	43	151.27
8 & 20	1600	44	150.50
9	2000	48	149.30
10	2100	49	149.50
11 & 14	900	27	N/A
12 & 15	1000	28	N/A

Table 11. Main dam flow rate 29,000 ft³/s and auxiliary spillway 22,000 ft³/s for a total of 51,000 ft³/s with a tailwater elevation of 152.5 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 10 - Auxiliary Spillway Without Cofferdam	Test 10 - Auxiliary Spillway With Cofferdam
29,000	22,000		Elevation (ft)	Elevation (ft)
Station	Location	Tap #		
1A	800	36	155.21	154.30
1B	900	37	155.16	154.25
2	1000	38	155.26	154.78
3	1100	39	155.45	154.92
4 & 16	1200	40	154.92	154.63
5 & 17	1300	41	153.91	153.58
6 & 18	1400	42	154.15	154.25
7 & 19	1500	43	154.15	154.20
8 & 20	1600	44	153.24	153.34
9	2000	48	151.90	151.90
10	2100	49	152.23	152.14
11 & 14	900	27	159.14	156.84
12 & 15	1000	28	159.10	157.18

Table 12. Main dam flow rate 60,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 60,000 ft³/s with a tailwater elevation of 156.5 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 11 - Auxiliary Spillway Without Cofferdam	Test 11 - Auxiliary Spillway With Cofferdam	Test 7 - No Auxiliary Spillway
60,000	0		Elevation	Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)	(ft)
1A	800	36	158.28	156.70	155.83
1B	900	37	158.33	157.51	155.98
2	1000	38	158.47	157.80	156.74
3	1100	39	158.86	157.42	154.54
4 & 16	1200	40	158.38	157.56	156.84
5 & 17	1300	41	157.80	157.75	157.27
6 & 18	1400	42	158.18	158.23	157.94
7 & 19	1500	43	158.23	158.18	157.90
8 & 20	1600	44	157.27	157.37	156.89
9	2000	48	155.83	155.93	155.59
10	2100	49	156.17	156.22	155.50
11 & 14	900	27	161.59	158.14	N/A
12 & 15	1000	28	160.15	158.14	N/A

Table 13. Main dam flow rate 0 ft³/s and auxiliary spillway 60,000 ft³/s for a total of 60,000 ft³/s with a tailwater elevation of 156.5 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 12 - Auxiliary Spillway Without Cofferdam	Test 12 - Auxiliary Spillway With Cofferdam
0	60,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	158.14	157.85
1B	900	37	157.85	157.51
2	1000	38	157.90	157.32
3	1100	39	158.47	157.75
4 & 16	1200	40	158.14	157.75
5 & 17	1300	41	157.32	157.32
6 & 18	1400	42	158.23	158.18
7 & 19	1500	43	158.33	158.23
8 & 20	1600	44	157.22	157.27
9	2000	48	155.74	155.74
10	2100	49	156.07	155.93
11 & 14	900	27	162.07	162.17
12 & 15	1000	28	162.65	162.89

Table 14. Main dam flow rate 75,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 75,000 ft³/s with a tailwater elevation of 161.5 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 8 - No Auxiliary Spillway
75,000	0		Elevation (ft)
Station	Location	Tap #	
1A	800	36	160.82
1B	900	37	161.21
2	1000	38	161.69
3	1100	39	161.16
4 & 16	1200	40	161.83
5 & 17	1300	41	162.36
6 & 18	1400	42	163.03
7 & 19	1500	43	162.94
8 & 20	1600	44	161.93
9	2000	48	160.68
10	2100	49	160.44
11 & 14	900	27	N/A
12 & 15	1000	28	N/A

Table 15. Main dam flow rate 29,000 ft³/s and auxiliary spillway 47,000 ft³/s for a total of 76,000 ft³/s with a tailwater elevation of 161.8 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 13 - Auxiliary Spillway Without Cofferdam	Test 13 - Auxiliary Spillway With Cofferdam
29,000	47,000		Elevation (ft)	Elevation (ft)
Station	Location	Tap #		
1A	800	36	164.18	164.33
1B	900	37	164.14	164.23
2	1000	38	164.23	164.28
3	1100	39	164.52	164.86
4 & 16	1200	40	164.57	164.76
5 & 17	1300	41	163.90	164.14
6 & 18	1400	42	163.75	164.09
7 & 19	1500	43	163.46	163.80
8 & 20	1600	44	162.22	162.60
9	2000	48	160.49	160.87
10	2100	49	160.63	160.92
11 & 14	900	27	166.73	166.63
12 & 15	1000	28	166.63	167.02

Table 16. Main dam flow rate 90,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 90,000 ft³/s with a tailwater elevation of 166.58 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 15 - Auxiliary Spillway Without Cofferdam	Test 15 - Auxiliary Spillway With Cofferdam	Test 9 - No Auxiliary Spillway
90,000	0		Elevation	Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)	(ft)
1A	800	36	167.50	166.06	165.96
1B	900	37	167.69	167.02	166.49
2	1000	38	168.31	168.17	166.78
3	1100	39	168.60	168.70	166.97
4 & 16	1200	40	168.89	168.84	167.50
5 & 17	1300	41	168.50	168.46	167.54
6 & 18	1400	42	168.65	168.70	167.83
7 & 19	1500	43	168.36	168.41	167.69
8 & 20	1600	44	167.06	167.21	166.73
9	2000	48	165.72	165.77	165.67
10	2100	49	165.67	165.91	165.34
11 & 14	900	27	170.23	169.75	N/A
12 & 15	1000	28	170.81	169.80	N/A

Table 17. Main dam flow rate 0 ft³/s and auxiliary spillway 90,000 ft³/s for a total of 90,000 ft³/s with a tailwater elevation of 166.58 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 14 - Auxiliary Spillway Without Cofferdam	Test 14 - Auxiliary Spillway With Cofferdam
0	90,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	167.59	167.98
1B	900	37	167.40	167.88
2	1000	38	167.50	167.54
3	1100	39	167.74	167.59
4 & 16	1200	40	168.46	168.07
5 & 17	1300	41	168.26	168.12
6 & 18	1400	42	168.55	168.60
7 & 19	1500	43	168.36	168.31
8 & 20	1600	44	167.26	167.06
9	2000	48	165.77	165.43
10	2100	49	165.67	165.86
11 & 14	900	27	169.66	169.03
12 & 15	1000	28	170.81	170.28

Table 18. Main dam flow rate 115,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 16 - Auxiliary Spillway Without Cofferdam	Test 16 - Auxiliary Spillway With Cofferdam	Test 10 - No Auxiliary Spillway
115,000	0		Elevation (ft)	Elevation (ft)	Elevation (ft)
Station	Location	Tap #			
1A	800	36	172.63	172.82	172.63
1B	900	37	173.50	174.70	173.16
2	1000	38	174.94	175.75	174.70
3	1100	39	175.42	176.14	175.18
4 & 16	1200	40	175.66	176.38	175.56
5 & 17	1300	41	175.42	176.04	175.27
6 & 18	1400	42	175.75	176.47	175.51
7 & 19	1500	43	175.51	176.23	175.37
8 & 20	1600	44	174.07	174.98	174.12
9	2000	48	172.73	173.69	173.45
10	2100	49	173.02	174.17	173.40
11 & 14	900	27	175.99	177.38	N/A
12 & 15	1000	28	176.47	177.38	N/A

Table 19. Main dam flow rate 30,000 ft³/s and auxiliary spillway 85,000 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 17 - Auxiliary Spillway Without Cofferdam	Test 17 - Auxiliary Spillway With Cofferdam
30,000	85,000		Elevation (ft)	Elevation (ft)
Station	Location	Tap #		
1A	800	36	177.00	176.90
1B	900	37	176.76	176.86
2	1000	38	176.90	176.95
3	1100	39	176.95	177.00
4 & 16	1200	40	177.19	176.86
5 & 17	1300	41	176.62	176.33
6 & 18	1400	42	176.47	176.33
7 & 19	1500	43	175.99	175.80
8 & 20	1600	44	174.60	174.36
9	2000	48	173.30	173.02
10	2100	49	173.64	173.45
11 & 14	900	27	178.30	180.70
12 & 15	1000	28	178.49	180.84

Table 20. Main dam flow rate 0 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 115,000 ft³/s with a tailwater elevation of 174.29 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 18 - Auxiliary Spillway Without Cofferdam	Test 18 - Auxiliary Spillway With Cofferdam
0	115,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	174.70	174.70
1B	900	37	174.31	174.17
2	1000	38	174.22	173.83
3	1100	39	174.17	174.55
4 & 16	1200	40	176.04	175.27
5 & 17	1300	41	176.14	175.61
6 & 18	1400	42	175.75	176.14
7 & 19	1500	43	175.51	175.80
8 & 20	1600	44	175.03	174.46
9	2000	48	173.59	173.11
10	2100	49	173.50	173.64
11 & 14	900	27	176.47	175.99
12 & 15	1000	28	177.43	177.38

Table 21. Main dam flow rate 0 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 135,000 ft³/s with a tailwater elevation of 180.0 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 19 - Auxiliary Spillway Without Cofferdam	Test 19 - Auxiliary Spillway With Cofferdam
0	135,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	179.98	179.59
1B	900	37	179.74	179.40
2	1000	38	179.30	179.50
3	1100	39	179.50	179.54
4 & 16	1200	40	181.18	180.84
5 & 17	1300	41	181.90	181.27
6 & 18	1400	42	181.99	181.80
7 & 19	1500	43	181.70	181.56
8 & 20	1600	44	180.55	180.36
9	2000	48	179.83	179.26
10	2100	49	180.07	179.83
11 & 14	900	27	181.75	181.27
12 & 15	1000	28	182.23	182.04

Table 22. Main dam flow rate 30,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 20 - Auxiliary Spillway Without Cofferdam	Test 20 - Auxiliary Spillway With Cofferdam
30,000	115,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	183.91	183.62
1B	900	37	183.77	183.34
2	1000	38	183.67	183.72
3	1100	39	183.72	183.77
4 & 16	1200	40	183.86	183.82
5 & 17	1300	41	183.77	183.43
6 & 18	1400	42	183.67	183.53
7 & 19	1500	43	183.19	183.19
8 & 20	1600	44	181.90	181.75
9	2000	48	180.94	178.63
10	2100	49	181.46	179.06
11 & 14	900	27	185.06	184.73
12 & 15	1000	28	185.16	185.26

Table 23. Main dam flow rate 10,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 21 - Auxiliary Spillway Without Cofferdam	Test 21 - Auxiliary Spillway With Cofferdam
10,000	135,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	181.90	182.18
1B	900	37	181.75	182.09
2	1000	38	181.94	182.23
3	1100	39	182.09	182.38
4 & 16	1200	40	182.62	182.57
5 & 17	1300	41	183.14	183.14
6 & 18	1400	42	183.43	183.43
7 & 19	1500	43	183.00	183.14
8 & 20	1600	44	181.61	181.75
9	2000	48	180.98	180.89
10	2100	49	181.27	181.27
11 & 14	900	27	183.67	183.58
12 & 15	1000	28	184.15	184.25

Table 24. Main dam flow rate 0 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 145,000 ft³/s with a tailwater elevation of 181.6 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 22 - Auxiliary Spillway Without Cofferdam	Test 22 - Auxiliary Spillway With Cofferdam
0	145,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	181.27	181.22
1B	900	37	180.94	181.13
2	1000	38	180.89	181.18
3	1100	39	180.94	181.27
4 & 16	1200	40	182.47	182.62
5 & 17	1300	41	183.10	183.24
6 & 18	1400	42	183.43	183.43
7 & 19	1500	43	183.05	183.10
8 & 20	1600	44	182.14	181.99
9	2000	48	181.22	180.98
10	2100	49	181.27	181.66
11 & 14	900	27	182.95	182.71
12 & 15	1000	28	183.43	183.43

Table 25. Main dam flow rate 115,000 ft³/s and auxiliary spillway 45,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 23 - Auxiliary Spillway Without Cofferdam	Test 23 - Auxiliary Spillway With Cofferdam
115,000	45,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	186.89	187.18
1B	900	37	186.98	187.22
2	1000	38	188.23	186.02
3	1100	39	188.28	185.88
4 & 16	1200	40	187.80	185.59
5 & 17	1300	41	187.13	187.13
6 & 18	1400	42	186.79	186.84
7 & 19	1500	43	186.07	186.41
8 & 20	1600	44	184.68	184.63
9	2000	48	183.53	183.91
10	2100	49	184.06	184.39
11 & 14	900	27	189.77	189.67
12 & 15	1000	28	189.67	189.67

Table 26. Main dam flow rate 45,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 24 - Auxiliary Spillway Without Cofferdam	Test 24 - Auxiliary Spillway With Cofferdam
45,000	115,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	186.89	187.13
1B	900	37	186.74	186.74
2	1000	38	186.70	187.18
3	1100	39	186.79	187.22
4 & 16	1200	40	186.79	187.03
5 & 17	1300	41	186.60	186.55
6 & 18	1400	42	186.50	186.46
7 & 19	1500	43	185.83	185.98
8 & 20	1600	44	184.73	184.54
9	2000	48	183.91	183.72
10	2100	49	184.30	184.20
11 & 14	900	27	188.09	188.28
12 & 15	1000	28	188.38	188.52

Table 27. Main dam flow rate 31,000 ft³/s and auxiliary spillway 129,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 25 - Auxiliary Spillway Without Cofferdam	Test 25 - Auxiliary Spillway With Cofferdam
31,000	129,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	186.41	186.41
1B	900	37	186.36	186.12
2	1000	38	186.07	186.36
3	1100	39	186.22	186.46
4 & 16	1200	40	186.55	186.65
5 & 17	1300	41	186.41	186.31
6 & 18	1400	42	186.36	186.46
7 & 19	1500	43	185.78	185.98
8 & 20	1600	44	184.63	184.63
9	2000	48	183.19	183.77
10	2100	49	183.72	184.30
11 & 14	900	27	187.61	187.51
12 & 15	1000	28	187.80	187.90

Table 28. Main dam flow rate 25,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 26 - Auxiliary Spillway Without Cofferdam	Test 26 - Auxiliary Spillway With Cofferdam
25,000	135,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	186.22	185.83
1B	900	37	186.60	185.59
2	1000	38	185.83	185.88
3	1100	39	186.02	186.12
4 & 16	1200	40	186.41	186.22
5 & 17	1300	41	186.41	186.02
6 & 18	1400	42	186.31	186.31
7 & 19	1500	43	185.78	185.83
8 & 20	1600	44	184.54	184.39
9	2000	48	184.01	183.86
10	2100	49	184.15	184.15
11 & 14	900	27	187.37	187.08
12 & 15	1000	28	187.66	187.70

Table 29. Main dam flow rate 15,000 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 27 - Auxiliary Spillway Without Cofferdam	Test 27 - Auxiliary Spillway With Cofferdam
15,000	145,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	185.59	185.02
1B	900	37	185.45	184.78
2	1000	38	185.21	184.82
3	1100	39	185.45	184.97
4 & 16	1200	40	185.98	185.26
5 & 17	1300	41	186.02	185.40
6 & 18	1400	42	186.31	186.12
7 & 19	1500	43	185.74	185.69
8 & 20	1600	44	184.58	184.30
9	2000	48	184.01	183.67
10	2100	49	184.58	184.20
11 & 14	900	27	186.79	186.50
12 & 15	1000	28	187.22	186.84

Table 30. Main dam flow rate 0 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 160,000 ft³/s with a tailwater elevation of 184.26 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 28 - Auxiliary Spillway Without Cofferdam	Test 28 - Auxiliary Spillway With Cofferdam
0	160,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	183.82	183.86
1B	900	37	183.58	183.67
2	1000	38	183.34	183.77
3	1100	39	183.34	184.30
4 & 16	1200	40	185.26	185.16
5 & 17	1300	41	185.74	185.74
6 & 18	1400	42	186.02	186.22
7 & 19	1500	43	185.54	185.83
8 & 20	1600	44	184.63	184.54
9	2000	48	183.91	183.86
10	2100	49	184.15	184.39
11 & 14	900	27	185.35	185.21
12 & 15	1000	28	186.07	186.31

Table 31. Main dam flow rate 45,000 ft³/s and auxiliary spillway 135,000 ft³/s for a total of 180,000 ft³/s with a tailwater elevation of 187.8 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 29 - Auxiliary Spillway Without Cofferdam	Test 29 - Auxiliary Spillway With Cofferdam
45,000	135,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	190.34	190.30
1B	900	37	190.10	190.06
2	1000	38	190.39	190.58
3	1100	39	190.54	190.63
4 & 16	1200	40	190.30	190.30
5 & 17	1300	41	190.06	190.01
6 & 18	1400	42	190.10	190.01
7 & 19	1500	43	189.38	189.38
8 & 20	1600	44	187.99	187.85
9	2000	48	187.13	187.56
10	2100	49	187.80	188.09
11 & 14	900	27	191.40	191.35
12 & 15	1000	28	191.88	191.83

Table 32. Main dam flow rate 75,000 ft³/s and auxiliary spillway 115,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 30 - Auxiliary Spillway Without Cofferdam	Test 30 - Auxiliary Spillway With Cofferdam
75,000	115,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	192.84	192.70
1B	900	37	192.60	192.84
2	1000	38	193.22	193.18
3	1100	39	193.03	193.32
4 & 16	1200	40	192.70	192.70
5 & 17	1300	41	191.93	191.93
6 & 18	1400	42	191.83	191.83
7 & 19	1500	43	191.11	190.92
8 & 20	1600	44	189.58	189.24
9	2000	48	188.90	188.86
10	2100	49	189.19	189.34
11 & 14	900	27	194.14	193.75
12 & 15	1000	28	194.47	194.28

Table 33. Main dam flow rate 45,000 ft³/s and auxiliary spillway 145,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 31 - Auxiliary Spillway Without Cofferdam	Test 31 - Auxiliary Spillway With Cofferdam
45,000	145,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	191.74	191.93
1B	900	37	191.40	191.59
2	1000	38	191.93	191.93
3	1100	39	192.02	192.02
4 & 16	1200	40	191.74	191.69
5 & 17	1300	41	191.26	191.40
6 & 18	1400	42	191.45	191.59
7 & 19	1500	43	190.82	190.87
8 & 20	1600	44	189.38	189.38
9	2000	48	188.76	188.81
10	2100	49	189.10	189.34
11 & 14	900	27	192.79	192.94
12 & 15	1000	28	193.37	193.22

Table 34. Main dam flow rate 30,000 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 190,000 ft³/s with a tailwater elevation of 189.3 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 32 - Auxiliary Spillway Without Cofferdam	Test 32 - Auxiliary Spillway With Cofferdam
30,000	160,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	190.92	191.02
1B	900	37	190.63	190.82
2	1000	38	190.92	190.97
3	1100	39	191.06	191.21
4 & 16	1200	40	191.21	191.16
5 & 17	1300	41	191.06	191.06
6 & 18	1400	42	191.40	191.40
7 & 19	1500	43	190.82	190.68
8 & 20	1600	44	189.19	189.14
9	2000	48	189.05	188.81
10	2100	49	189.38	189.34
11 & 14	900	27	192.07	191.83
12 & 15	1000	28	192.60	192.50

Table 35. Main dam flow rate 60,000 ft³/s and auxiliary spillway 160,000 ft³/s for a total of 220,000 ft³/s with a tailwater elevation of 193.7 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 33 - Auxiliary Spillway Without Cofferdam	Test 33 - Auxiliary Spillway With Cofferdam
60,000	160,000		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	196.49	196.68
1B	900	37	196.54	196.34
2	1000	38	196.78	196.73
3	1100	39	196.82	196.78
4 & 16	1200	40	196.44	196.39
5 & 17	1300	41	195.91	195.86
6 & 18	1400	42	196.10	196.10
7 & 19	1500	43	193.75	195.19
8 & 20	1600	44	195.19	193.51
9	2000	48	193.51	193.22
10	2100	49	193.85	193.66
11 & 14	900	27	197.69	197.45
12 & 15	1000	28	198.36	197.98

Table 36. Main dam flow rate 238,266 ft³/s and auxiliary spillway 0 ft³/s for a total of 238,266 ft³/s with a tailwater elevation of 196.44 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 11 - No Auxiliary Spillway
238,266	0		Elevation (ft)
Station	Location	Tap #	
1A	800	36	196.54
1B	900	37	197.30
2	1000	38	198.70
3	1100	39	198.94
4 & 16	1200	40	199.18
5 & 17	1300	41	199.08
6 & 18	1400	42	198.70
7 & 19	1500	43	198.02
8 & 20	1600	44	196.15
9	2000	48	195.43
10	2100	49	195.72
11 & 14	900	27	N/A
12 & 15	1000	28	N/A

Table 37. Main dam flow rate 115,000 ft³/s and auxiliary spillway 141,000 ft³/s for a total of 256,000 ft³/s with a tailwater elevation of 199.1 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 34 - Auxiliary Spillway Without Cofferdam	Test 34 - Auxiliary Spillway With Cofferdam
115,000	141,000		Elevation (ft)	Elevation (ft)
Station	Location	Tap #		
1A	800	36	202.58	202.15
1B	900	37	202.54	202.44
2	1000	38	203.16	202.97
3	1100	39	203.11	203.02
4 & 16	1200	40	202.73	202.54
5 & 17	1300	41	202.20	201.62
6 & 18	1400	42	201.77	201.48
7 & 19	1500	43	201.00	200.76
8 & 20	1600	44	199.08	199.08
9	2000	48	198.98	198.55
10	2100	49	197.83	198.98
11 & 14	900	27	203.74	203.74
12 & 15	1000	28	204.26	204.31

Table 38. Main dam flow rate 300,000 ft³/s and auxiliary spillway 0 ft³/s for a total of 300,000 ft³/s with a tailwater elevation of 205.75 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 35 - Auxiliary Spillway Without Cofferdam	Test 35 - Auxiliary Spillway With Cofferdam	Test 12 - No Auxiliary Spillway
300,000	0		Elevation (ft)	Elevation (ft)	Elevation (ft)
Station	Location	Tap #			
1A	800	36	209.98	209.06	205.99
1B	900	37	210.50	209.78	206.38
2	1000	38	211.56	211.08	207.58
3	1100	39	211.27	210.79	208.06
4 & 16	1200	40	210.70	210.07	208.30
5 & 17	1300	41	209.74	208.87	207.91
6 & 18	1400	42	208.92	208.87	208.15
7 & 19	1500	43	208.39	207.86	207.77
8 & 20	1600	44	206.18	205.32	205.99
9	2000	48	205.61	205.32	205.37
10	2100	49	205.99	205.85	205.61
11 & 14	900	27	212.81	211.75	N/A
12 & 15	1000	28	212.57	212.47	N/A

Table 39. Main dam flow rate 115,000 ft³/s and auxiliary spillway 237,000 ft³/s for a total of 352,000 ft³/s with a tailwater elevation of 212.95 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 36 - Auxiliary Spillway Without Cofferdam	Test 36 - Auxiliary Spillway With Cofferdam
115,000	237,000		Elevation (ft)	Elevation (ft)
Station	Location	Tap #		
1A	800	36	213.72	213.58
1B	900	37	213.58	213.53
2	1000	38	213.72	213.67
3	1100	39	214.10	213.96
4 & 16	1200	40	214.15	213.86
5 & 17	1300	41	214.34	214.06
6 & 18	1400	42	215.26	214.92
7 & 19	1500	43	214.63	214.39
8 & 20	1600	44	213.19	212.71
9	2000	48	213.19	213.00
10	2100	49	213.29	213.19
11 & 14	900	27	213.82	213.82
12 & 15	1000	28	215.11	214.97

Table 40. Main dam flow rate 528,090 ft³/s and auxiliary spillway 0 ft³/s for a total of 528,090 ft³/s with a tailwater elevation of 230.48 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 13 - No Auxiliary Spillway
528,090	0		Elevation (ft)
Station	Location	Tap #	
1A	800	36	230.86
1B	900	37	231.10
2	1000	38	231.82
3	1100	39	232.54
4 & 16	1200	40	233.30
5 & 17	1300	41	233.02
6 & 18	1400	42	234.31
7 & 19	1500	43	234.07
8 & 20	1600	44	230.47
9	2000	48	229.75
10	2100	49	230.71
11 & 14	900	27	N/A
12 & 15	1000	28	N/A

Table 41. Main dam flow rate 238,266 ft³/s and auxiliary spillway 297,851 ft³/s for a total of 536,117 ft³/s with a tailwater elevation of 231.15 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 37 - Auxiliary Spillway Without Cofferdam	Test 37 - Auxiliary Spillway With Cofferdam
238,266	297,851		Elevation (ft)	Elevation (ft)
Station	Location	Tap #		
1A	800	36	229.66	229.66
1B	900	37	229.51	229.51
2	1000	38	229.90	229.80
3	1100	39	229.94	229.99
4 & 16	1200	40	231.00	230.95
5 & 17	1300	41	231.19	231.05
6 & 18	1400	42	232.06	232.01
7 & 19	1500	43	231.96	231.77
8 & 20	1600	44	229.75	229.99
9	2000	48	231.19	231.19
10	2100	49	231.29	231.34
11 & 14	900	27	229.03	229.37
12 & 15	1000	28	231.91	231.91

Table 42. Main dam flow rate 528,090 ft³/s and auxiliary spillway 313,640 ft³/s for a total of 841,730 ft³/s with a tailwater elevation of 253.78 ft.

Main Dam Flow Rate (ft ³ /s)	Aux Spwy Flow Rate (ft ³ /s)		Test 38 - Auxiliary Spillway Without Cofferdam	Test 38 - Auxiliary Spillway With Cofferdam
528,090	313,640		Elevation	Elevation
Station	Location	Tap #	(ft)	(ft)
1A	800	36	250.30	250.54
1B	900	37	250.54	250.92
2	1000	38	251.21	251.69
3	1100	39	252.46	252.94
4 & 16	1200	40	253.42	253.90
5 & 17	1300	41	253.03	253.51
6 & 18	1400	42	253.66	254.14
7 & 19	1500	43	253.56	254.04
8 & 20	1600	44	251.30	251.59
9	2000	48	254.23	254.23
10	2100	49	253.99	254.47
11 & 14	900	27	251.83	252.31
12 & 15	1000	28	255.43	255.58