PREPARED BY

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Updated Study Report

Hydrologic and Hydraulic Modeling: Upstream Hydraulic Model

Pensacola Hydroelectric Project
Project No. 1494

September 30, 2022

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Executive Summary

Mead & Hunt is assisting Grand River Dam Authority (GRDA) with its intent to relicense the Pensacola Hydroelectric Project (Project), which is regulated by the Federal Energy Regulatory Commission (FERC). Pursuant to federal law, including the Flood Control Act of 1944 and section 7612 of the National Defense Authorization Act for 2020, flood control operations at the Project are regulated exclusively by the United States Army Corps of Engineers (USACE). This Updated Study Report (USR) documents the findings of Hydrologic and Hydraulic (H&H) modeling upstream of the Project.

The Proposed Study Plan (PSP) and Revised Study Plan (RSP) recommended the development of a Comprehensive Hydraulic Model (CHM). The model upstream of the Project is referred to as the Upstream Hydraulic Model (UHM). Mead & Hunt used a Hydrologic Engineering Center River Analysis System (HEC-RAS) model, previously developed by Tetra Tech, as the base for UHM development. Mead & Hunt conducted a detailed review of Tetra Tech's model and identified ways in which the model should be improved (Mead & Hunt, 2016). As part of this study, Mead & Hunt transformed the Tetra Tech model by updating the version of HEC-RAS from a beta version to a full release version, modifying the geometry to contain larger flood events and to improve model stability and accuracy, updating bridge geometry, adding the Spring River and the Elk River, replacing the reservoir bathymetry to reflect newly surveyed conditions, and by using computational parameters recommended by the HEC-RAS development team. This resulted in an improved hydraulic model of Grand Lake and the river system upstream of Pensacola Dam.

Mead & Hunt calibrated the UHM using measured data, including United States Geological Survey (USGS) gage elevations, high water marks, and recorded data from loggers installed by the project team. Six historical events were used to calibrate the model. Manning's n-values were adjusted until simulated water surface elevations reasonably matched measured data. Flow roughness factors were used to fine-tune the model.

A flood frequency analysis was performed for the study area using data from USACE. Data from 1940 (dam construction date) to 2019 (latest available data at time of data delivery from USACE) were used and a graphical frequency analysis of peak inflows was performed. The analysis estimated a 100-year event flow at Pensacola Dam of approximately 300,000 cubic feet per second (cfs). The largest events of recent record did not meet or exceed the 100-year event threshold at Pensacola Dam. The July 2007 event was scaled so the peak flow at Pensacola Dam approximately matched the estimated 100-year event, with a daily inflow volume to Pensacola Dam that approximately matched the results of a statistical analysis of historical inflow volumes.

The calibrated UHM was used to analyze five historical inflow events and one synthetic event with a range of starting pool elevations at Pensacola Dam. Maximum water surface elevation (WSEL) values and inundation extents were extracted from HEC-RAS and analyzed.

The results of the UHM demonstrate that starting pool elevations at Pensacola Dam within GRDA's anticipated operational range have an immaterial impact on upstream WSELs, inundation, and duration for a range of inflow events. Compared to starting elevations within GRDA's anticipated operational range, only a different natural inflow event caused an appreciable difference in maximum WSEL, maximum inundation extent, or duration. The differences in WSEL, inundation extent, and duration due to the size of the natural inflow event were orders of magnitude greater than the differences in WSEL, inundation extent, and duration due to the initial stage at Pensacola Dam. The maximum impact of nature typically ranged from over 10 times to over 100 or even over 1,000 times the maximum simulated impact of GRDA's anticipated operational range.

Even if extreme, hypothetical starting pool elevations outside GRDA's anticipated operational range are used, the maximum impact of nature is much greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet. The impact of nature typically ranged from 2 times to 10 or even 100 times the impact of the extreme, hypothetical starting stage range.

Comparing anticipated operations to baseline operations for a suite of simulations that spanned the FERC-requested range of starting pool elevations and inflow event magnitudes, the results of the UHM demonstrate that anticipated operations have an immaterial impact on upstream WSELs, inundation, and duration as compared to baseline operations.

All conclusions on potential lentic or lotic conversion areas are discussed in each of the individual biological assessment reports.

List of Abbreviations and Terms

1D .... One-Dimensional
2D .... Two-Dimensional
2DFA .... Two-Dimensional Flow Area
CFS .... Cubic Feet Per Second
CHM .... Comprehensive Hydraulic Model
DEM .... Digital Elevation Model
FEMA .... Federal Emergency Management Agency
FERC .... Federal Energy Regulatory Commission
GEV .... Generalized Extreme Value
GRDA .... Grand River Dam Authority
H&H .... Hydrologic and Hydraulic
ISR .... Initial Study Report
HEC .... Hydrologic Engineering Center
LiDAR .... Light Detection and Ranging
MISR .... Model Input Status Report
NAVD88 .... North American Vertical Datum of 1988
NGVD29 .... National Geodetic Vertical Datum of 1929
NED .... National Elevation Dataset
NWIS .... National Water Information System
OM .... Operations Model
PD .... Pensacola Datum
Project .... Pensacola Hydroelectric Project
PSP .... Proposed Study Plan
RAS .... River Analysis System
RM .... River Mile
RSP .... Revised Study Plan
SPD .... Study Plan Determination
SSP .... Statistical Software Package
UHM .... Upstream Hydraulic Model
USACE .... United States Army Corps of Engineers
USGS .... United States Geological Survey
USR .... Updated Study Report
WSEL .... Water Surface Elevation

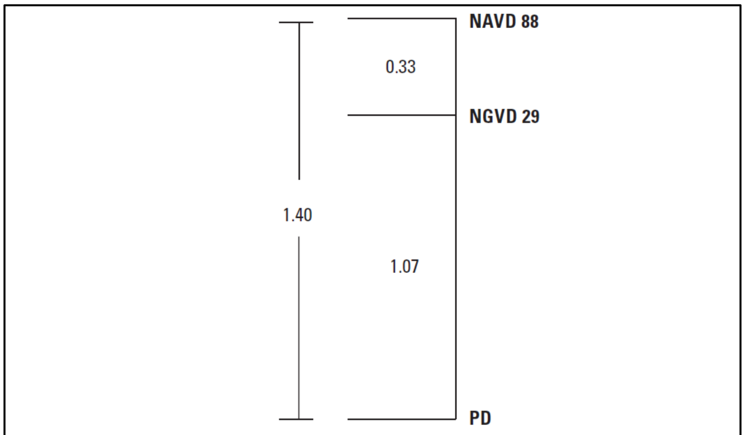
1. Introduction and Background

1.1 Project Description

The Pensacola Hydroelectric Project is owned and operated by GRDA and regulated by the FERC. The Pensacola Dam is in Mayes County, Oklahoma on the Grand-Neosho River. Pensacola Dam impounds Grand Lake. Construction of Pensacola Dam was completed in 1940. **Figure 2** displays the study area. Downstream of Pensacola Dam, GRDA also owns and operates the Robert S. Kerr Dam as the Markham Ferry Hydroelectric Project. Kerr Dam is also in Mayes County and impounds Lake Hudson, also known as Markham Ferry Reservoir. Flood control operations at both Pensacola Dam and Kerr Dam are regulated exclusively by USACE.

1.2 Vertical Datums

Data sources for this study use a variety of vertical datums. Unless otherwise noted, data are presented in the Pensacola Datum (PD). To convert from PD to the National Geodetic Vertical Datum of 1929 (NGVD29), add 1.07 feet. To convert from NGVD29 to the North American Vertical Datum of 1988 (NAVD88), add 0.33 feet. **Figure 1** displays datum transformations and conversions (Hunter, Trevisan, Villa, & Smith, 2020). The HEC-RAS model discussed in this report was developed in NGVD29.



	Elevations, in feet		
	NAVD 88	NGVD 29	PD
Conservation pool	743.40	743.07	742.00
Top of the dam	758.40	758.07	757.00

Figure 1. Datum transformations and conversions.
Source: (Hunter, Trevisan, Villa, & Smith, 2020).

1.3 Study Plan Proposals and Determination

GRDA is currently relicensing the Project. The timeline of study plan proposals and determination is as follows:

1. On April 27, 2018, GRDA filed its PSP to address hydrologic and hydraulic modeling in support of its intent to relicense the Project.
2. On September 24, 2018, GRDA filed its RSP.
3. On November 8, 2018, the FERC issued its Study Plan Determination (SPD) for the Project.

4. On January 23, 2020, the FERC issued an Order on the Request for Clarification and Rehearing, which clarified the timeline for certain milestones applicable to the relicensing study plan.
5. On September 30, 2021, GRDA filed its Initial Study Report (ISR).
6. On February 24, 2022, the FERC issued its Determination on Requests for Study Modifications and New Studies for the Project.
7. On September 30, 2022, GRDA filed this report, the Updated Study Report (USR).

The PSP and RSP recommended the development of a CHM. This report discusses the UHM. As stated in the RSP, the objectives of the H&H modeling study are to:

1. Determine the duration and extent of inundation under the current license operations of the Project during several measured inflow events.
2. Determine the duration and extent of inundation under any proposed change in these operations that occurs during several measured or synthetic inflow events.
3. Provide the model results in a format that can inform other analyses (to be completed separately) of Project effects, if any, in several resource areas.
4. Determine the feasibility of implementing alternative operations scenarios, if applicable, that may be proposed by GRDA as part of the relicensing effort.

The FERC's SPD and Order on Request for Clarification and Rehearing included direction to provide a model input status report by March 30, 2021, and hold a conference call on model inputs and calibration within 30 days of the input status report. The Upstream Hydraulic Model Input Status Report was filed with FERC and shared with stakeholders on March 30, 2021 (Mead & Hunt, 2021). A Technical Conference was held on April 21, 2021, to allow relicensing participants to ask questions regarding the Model Input Status Report (MISR).

GRDA's ISR was a continuation of the MISR and incorporated comments provided on the MISR as addressed in **Appendix A**. The ISR documented the development of the UHM and findings from the analyses of historical and synthetic flow events with different initial stages at Pensacola Dam. GRDA's ISR concluded only natural inflows—and not Project operation—have an appreciable impact on maximum water surface elevation (WSEL) and maximum inundation extent.

FERC's February 2022 Determination found GRDA's conclusion in the ISR premature and recommended the following modifications to the UHM portion of the H&H modeling study:

1. Run inflow event scenarios at starting reservoir elevations from 734 feet PD up to and including 757 feet PD.
2. Report the frequency, timing, amplitude (*i.e.,* elevation), and duration for each of the simulated inflow events with starting elevations between 734 feet PD and 757 feet PD.
3. Provide the means necessary to complete any additional return frequency analysis that may be deemed necessary following review of the USR.

As documented in this USR, GRDA has completed FERC's requested modifications as follows:

1. GRDA simulated inflow event scenarios with starting reservoir elevations ranging from 734 feet PD up to and including 757 feet PD.
2. GRDA reported the frequency, timing, amplitude, and duration of inflow events as follows:
    a. Frequency of the inflow events (*i.e.*, estimated return period) is reported in this document

and its appendices.

b. The term “timing” originates in the RSP and refers to seasonality of inflow and inundation. Timing (or seasonality) is discussed in Section 11. GRDA analyzed the seasonality of normal (median) operational levels and inflows as it impacts the Aquatic Species Study, the Terrestrial Species Study, and the Wetlands and Riparian Habitat Study.
c. Amplitude (*i.e.*, elevation) is reported as WSEL in this document and its appendices.
d. Duration of inundation is reported in this document and its appendices.

3. GRDA has included the return frequency analysis (*i.e.*, flood frequency analysis) as an electronic attachment to the USR.
4. As required by the approved study plan, GRDA has developed maps showing areas of potential lentic or lotic conversion (see Section 11.2).

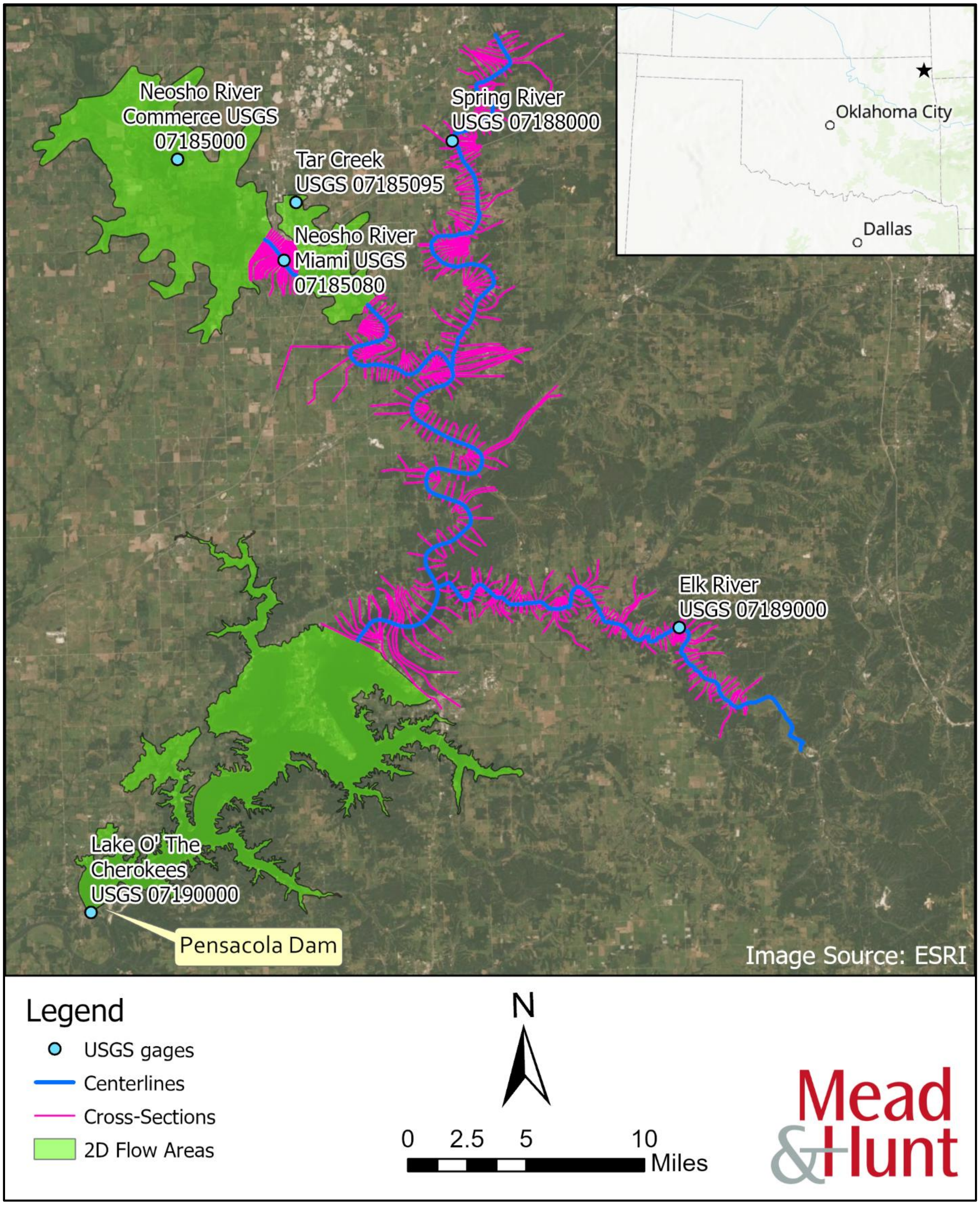


Figure 2. UHM study area.

2. Model Development

Tetra Tech previously developed a HEC-RAS model of the study area (Tetra Tech, 2015, 2016). Mead & Hunt used Tetra Tech's model as the base for UHM development. After a detailed review, the Tetra Tech model was transformed in the following ways, resulting in an improved comprehensive hydraulic model of Grand Lake and the river system upstream of Pensacola Dam.

1. Model was converted from a beta version of HEC-RAS to version 5.0.7.
2. Two-dimensional (2D) flow area (2DFA) was added for Grand Lake, replacing cross-sections.
3. 2DFAs in the vicinity of Miami, Oklahoma were expanded to fully contain inundation from larger flow events.
4. Mesh cell centers within 2DFAs were reviewed and adjusted in accordance with USACE guidance (USACE, 2016a).
5. Cross-sections were extended to fully contain the inundation from larger flow events.
6. 1D/2D flow boundaries were reviewed and adjusted in accordance with USACE guidance (USACE 2016a, USACE 2016b).
7. Bridge geometries were updated to reflect current conditions.
8. Bank stations and ineffective flow areas were reviewed and adjusted in accordance with USACE guidance (USACE, 2016b).
9. Elk River was added to the model.
10. Spring River was added to the model.
11. Recently published USGS Grand Lake bathymetry data were incorporated into model geometry (Hunter, Trevisan, Villa, & Smith, 2020).
12. Computational parameters were reviewed and adjusted in accordance with USACE guidance (USACE, 2016a).

UHM improvements are discussed in detail below.

2.1 HEC-RAS Version

Tetra Tech performed hydraulic modeling with the August 2016 5.0 beta version of HEC-RAS (Tetra Tech, 2015; Tetra Tech, 2016). At the time of Mead & Hunt's RSP and the FERC's SPD, the current version of HEC-RAS was 5.0.7. Therefore, Mead & Hunt used HEC-RAS 5.0.7 for analysis.

2.2 Grand Lake 2DFA

Tetra Tech used cross-sections to represent Grand Lake. Mead & Hunt replaced the cross-sections downstream of River Mile (RM) 100 with a 2DFA. The 2DFA better accounts for the volume in Grand Lake. **Figure 3** displays a comparison of Tetra Tech's model geometry to Mead & Hunt's geometry.

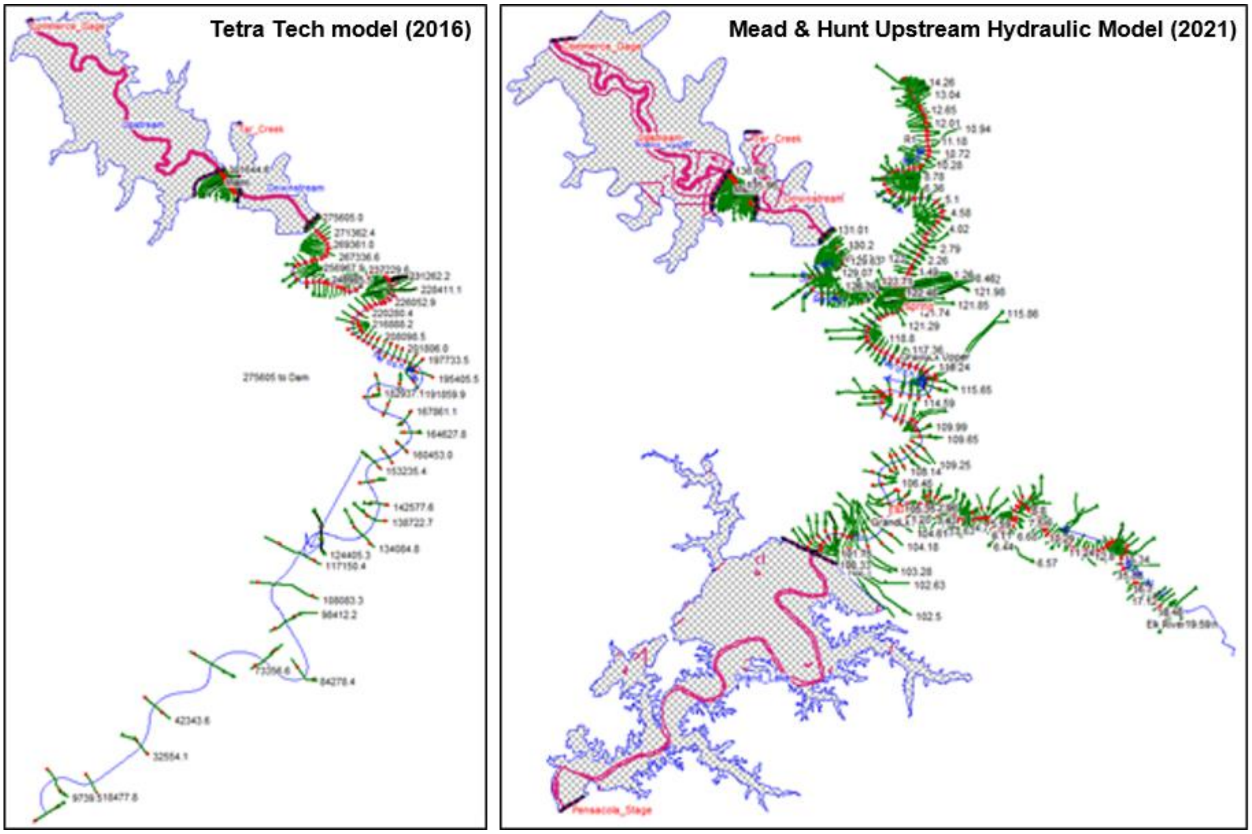


Figure 3. Comparison of model geometries.

2.3 Upstream 2DFAs

Tetra Tech included two 2DFAs in their HEC-RAS model: one just downstream of the City of Miami and one upstream of the City of Miami. Preliminary simulations showed that large flow events (e.g., the 100-year event) were not contained within the 2DFAs. Mead & Hunt expanded the 2DFAs so large flow events could be contained within the model boundaries. The expanded 2DFAs are displayed in **Figure 3**. In Mead & Hunt's model, the most upstream 2DFA is named "Miami_Upper" and the next 2DFA downstream is named "Miami_Lower".

The upstream boundary of the model along the Neosho River was not modified. Tetra Tech determined that it takes 4 hours for a flood wave to travel from the upstream end of the model (RM 152.2) to the Commerce gage (Tetra Tech, 2015). Mead & Hunt's preliminary simulations confirmed the 4-hour travel time. Therefore, Mead & Hunt applied a negative 4.0 hour offset to the USGS flow hydrographs, which were used as inflows at the upstream end of the Neosho River 2DFA. Flow data are further discussed in **Section 3.1**.

2.4 2DFA Cell Refinement

Tetra Tech included some refinement of 2DFA cells. However, cell faces were not aligned to the top of the river channel. Mead & Hunt refined cell alignments to follow the banks of the Neosho River in accordance with USACE guidance (USACE, 2016a). **Figure 4** displays an example comparison of Tetra Tech's 2DFA cell alignment to Mead & Hunt's cell alignment.

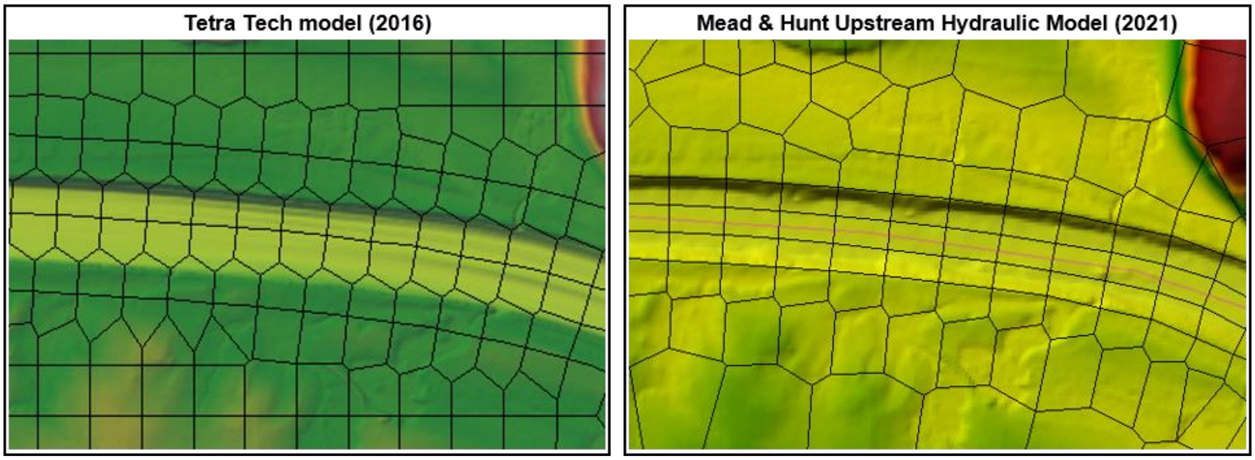


Figure 4. Comparison of 2DFA cells.

2.5 Cross-Section Adjustments

Like the 2DFAs, preliminary simulations showed large flow events (e.g., 100-year event) were not contained within the cross-sections. Mead & Hunt extended the cross-sections laterally so large flow events were contained within the cross-sections. An example of extended cross-sections is displayed in **Figure 5**.

2.6 1D/2D Boundaries

Mead & Hunt reviewed the 1D/2D boundaries in the Tetra Tech model and moved the boundaries to determine if model stability could be improved. Moving the most upstream 1D/2D boundary further upstream resulted in a more stable, accurate model. The adjusted boundary was placed in accordance with USACE guidance (USACE, 2016a; USACE, 2016b). The revised location of the 1D/2D model boundary is displayed in **Figure 5**.

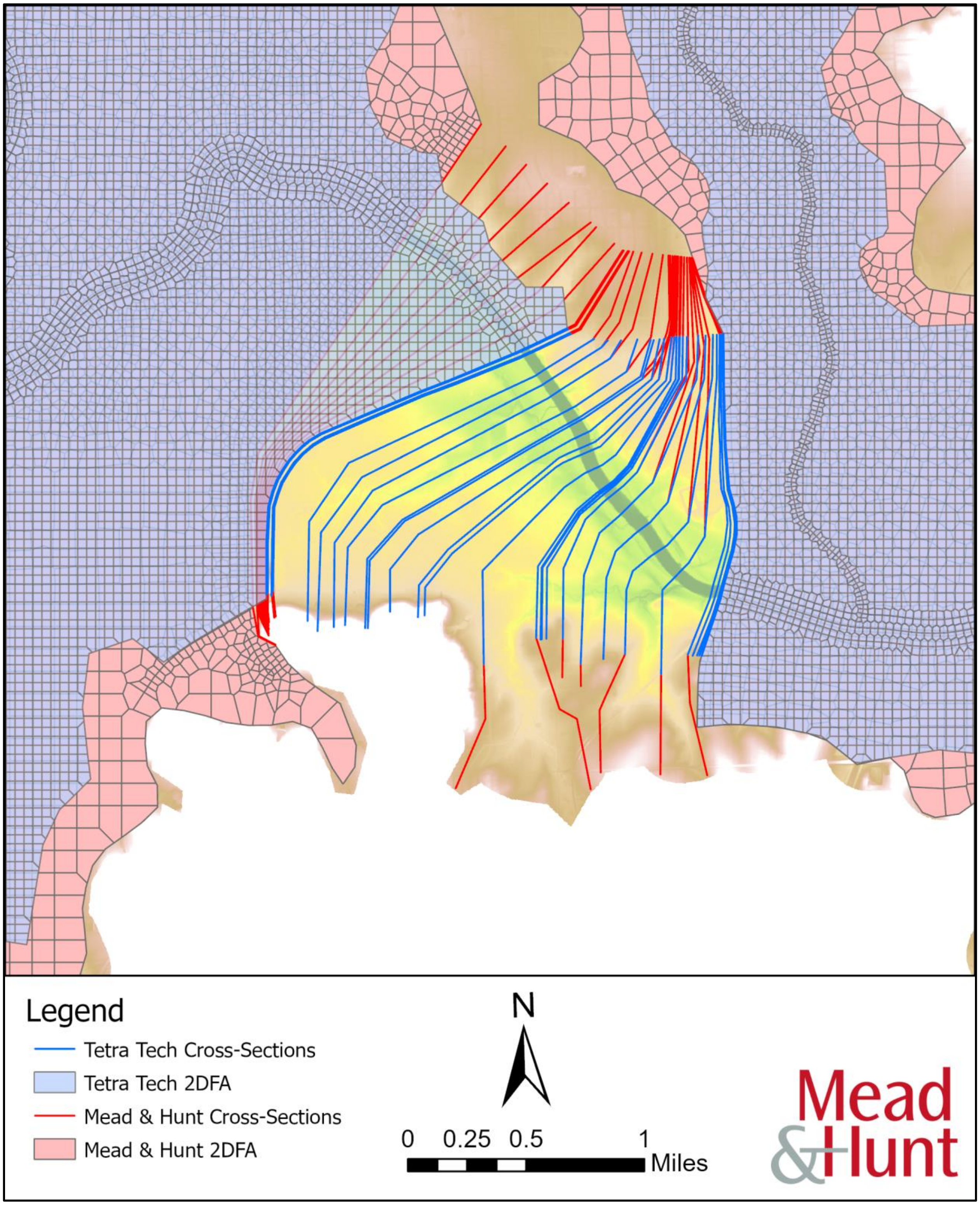


Figure 5. Comparison of cross-sections and most upstream 1D/2D boundary.

2.7 Bridge Geometries

Tetra Tech (2016) stated bridge geometry in their HEC-RAS model was primarily obtained from a Simons & Associates HEC-2 model (Simons & Associates, Inc., 1996). Mead & Hunt updated roadway bridge geometry using as-built drawings obtained from the Oklahoma Department of Transportation, Missouri Department of Transportation, and local/county road commissions. Railroad bridge geometries were updated using measurements provided by GRDA. An example of the updated bridge geometry at the Old Highway 69 Bridge in Miami, OK (RM 135.941) is displayed in **Figure 6**.

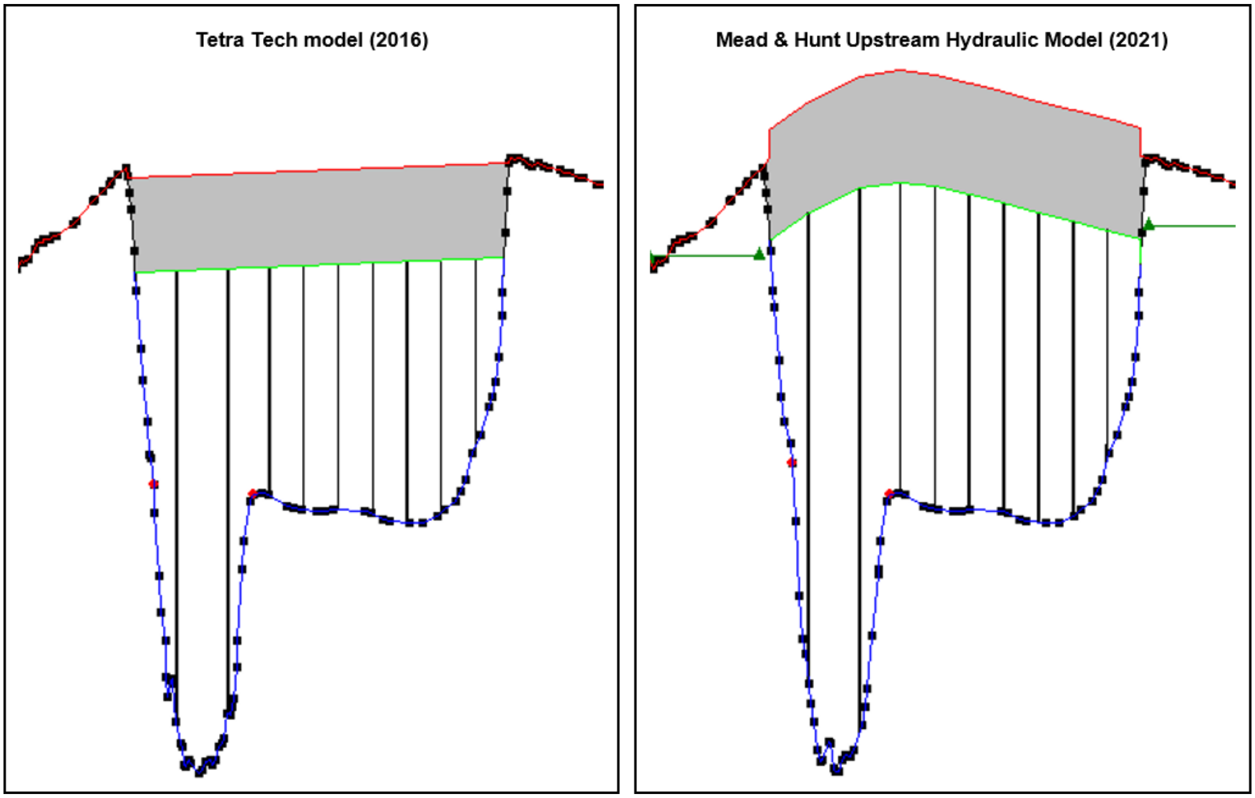


Figure 6. Example comparison of bridge geometry.

2.8 Bank Stations and Ineffective Flow Areas

Mead & Hunt reviewed and adjusted the bank stations and ineffective flow areas in the UHM according to best practices and the HEC-RAS Reference Manual (USACE, 2016b). Most adjustments to ineffective flow areas were upstream and downstream of bridges and were due to the updated bridge geometry. An example comparison of ineffective flow areas is displayed in **Figure 7**.

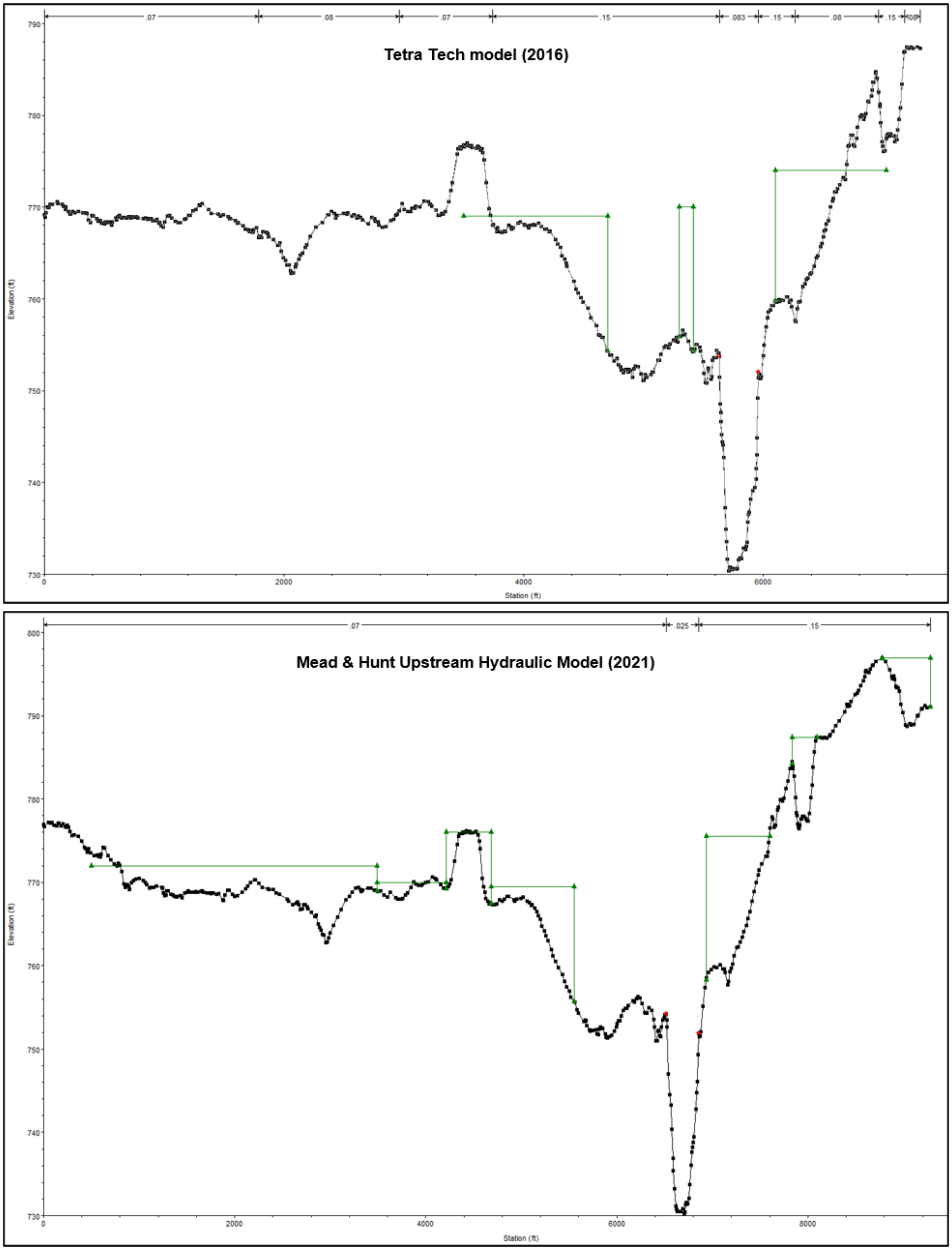


Figure 7. Example comparison of modified ineffective flow areas.

2.9 Spring River

Mead & Hunt added the Spring River to the UHM. The portion of the Spring River modeled by Mead & Hunt extended from the confluence with the Neosho River at the downstream end to RM 21.0 at the upstream end. The river centerline was digitized, and cross-sections were drawn perpendicular to the flow. Cross-sections were extended laterally far enough to contain large flow events (e.g., 100-year event). Bank stations were digitized and then adjusted in HEC-RAS. Ineffective flow areas were defined using guidance from the HEC-RAS Reference Manual (USACE, 2016b). **Figure 8** displays the riverbed profile of the Spring River. There are four bridges within the modeled reach:

1. E 57 Road (RM 14.16),
2. Interstate 44 Will Rogers Turnpike (RM 13.50),
3. OK 100 / E 10 Road (RM 8.01), and
4. US Highway 60 (RM 0.57).

There is one stream gage within the reach: Spring River near Quapaw, OK (USGS Gage No. 07188000). The gage is at E 57 Road (RM 14.16). Preliminary simulations indicated it takes 2.5 hours for a flood wave to travel from RM 21.0 (upstream end of the Spring River reach) to the USGS gage. Therefore, a negative 2.5-hour offset was applied to the USGS flow hydrographs, which were used as inflows at the upstream end of the Spring River.

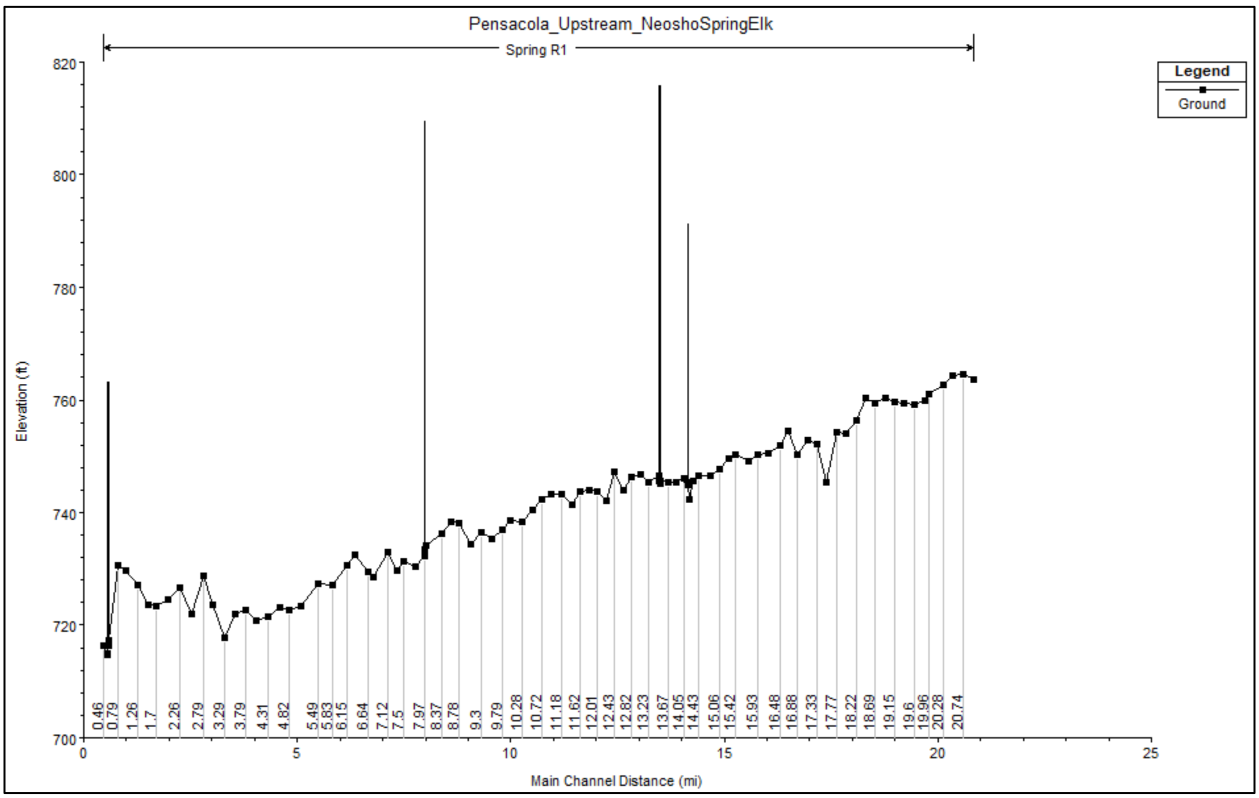


Figure 8. Riverbed profile of the Spring River.

2.10 Elk River

Mead & Hunt added the Elk River to the UHM. The portion of the Elk River modeled by Mead & Hunt extended from the confluence with Grand Lake at the downstream end to RM 19.59 at the upstream end. The river centerline, cross-sections, bank stations, and ineffective flow areas were defined with the same methodology used for the Spring River. **Figure 9** displays the riverbed profile of the Elk River. There are two bridges within the modeled reach:

1. Highway 10 (RM 4.67) and
2. Highway 43 (RM 14.22).

There is one stream gage within the reach: Elk River near Tiff City, MO (USGS Gage No. 07189000). The gage is at Highway 43 (RM 14.22). Preliminary simulations indicated that it takes 2 hours for a flood wave to travel from RM 19.59 (upstream end of the Elk River reach) to the USGS gage. Therefore, a negative 2.0-hour offset was applied to the USGS flow hydrographs, which were used as inflows at the upstream end of the Elk River.

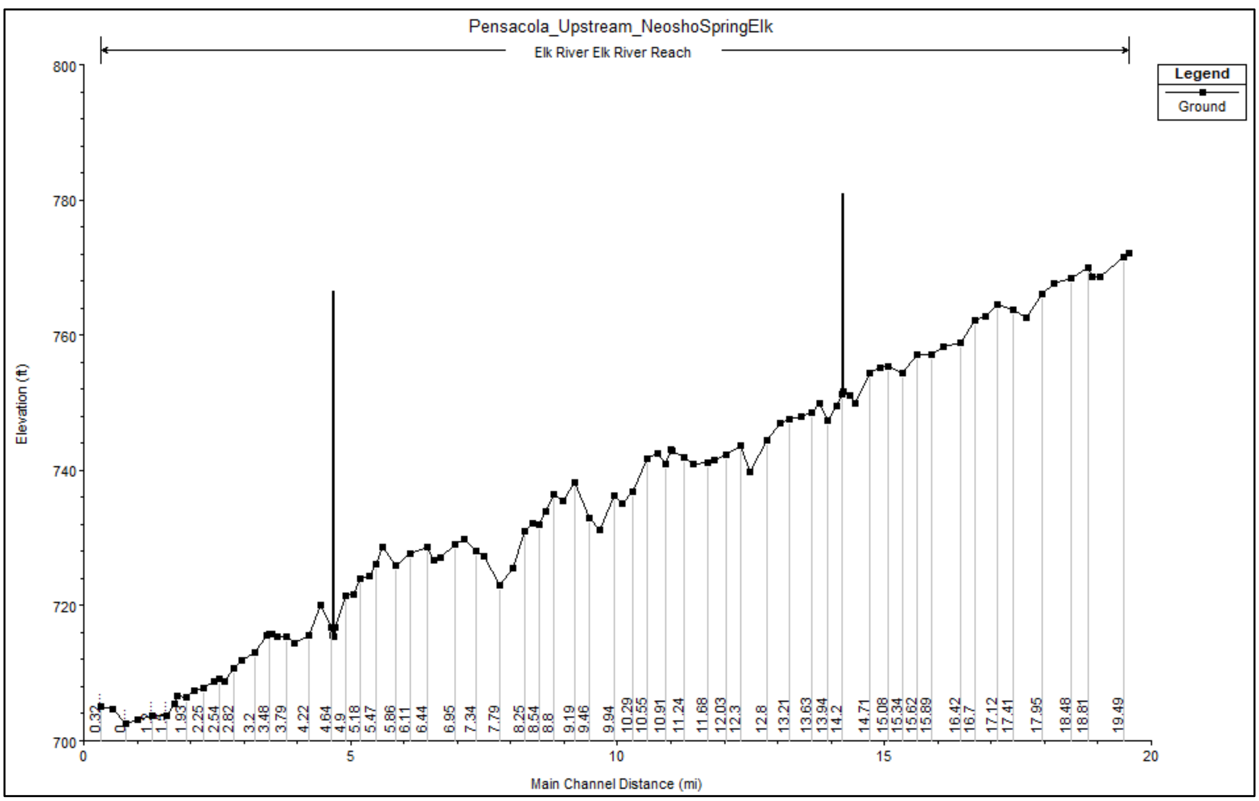


Figure 9. Riverbed profile of the Elk River.

2.11 Updated Bathymetry

In response to the FERC's SPD, GRDA enlisted USGS to perform a bathymetric survey of Grand Lake (Hunter, Trevisan, Villa, & Smith, 2020). Mead & Hunt integrated the Grand Lake bathymetry with a combined Digital Elevation Model (DEM) of the study area. The DEM was created with the following data, in descending order of priority:

1. USGS 2020 bathymetry, representing Grand Lake (Hunter, Trevisan, Villa, & Smith, 2020).
2. USGS 2017 bathymetry, representing the Neosho River, Spring River, and Elk River (Smith, Hunter, & Ashworth, 2017).
3. Federal Emergency Management Agency (FEMA) 2016 bathymetry from cross-section data, representing Tar Creek (FEMA, 2019).
4. Dewberry 2011 Light Detection and Ranging (LiDAR) overbank area (Dewberry, 2011).
5. USGS National Elevation Dataset (NED) 1/3 arc-second elevation layer, representing the overbank area in areas where no LiDAR data were available (USGS, 2017).

Figure 10 displays bathymetric and topographic data sources. USGS's 2020 report compared the capacity of Grand Lake, based on 2020 bathymetry, to previous capacity curves. **Figure 11** displays the capacity curves presented in USGS's report (Hunter, Trevisan, Villa, & Smith, 2020).

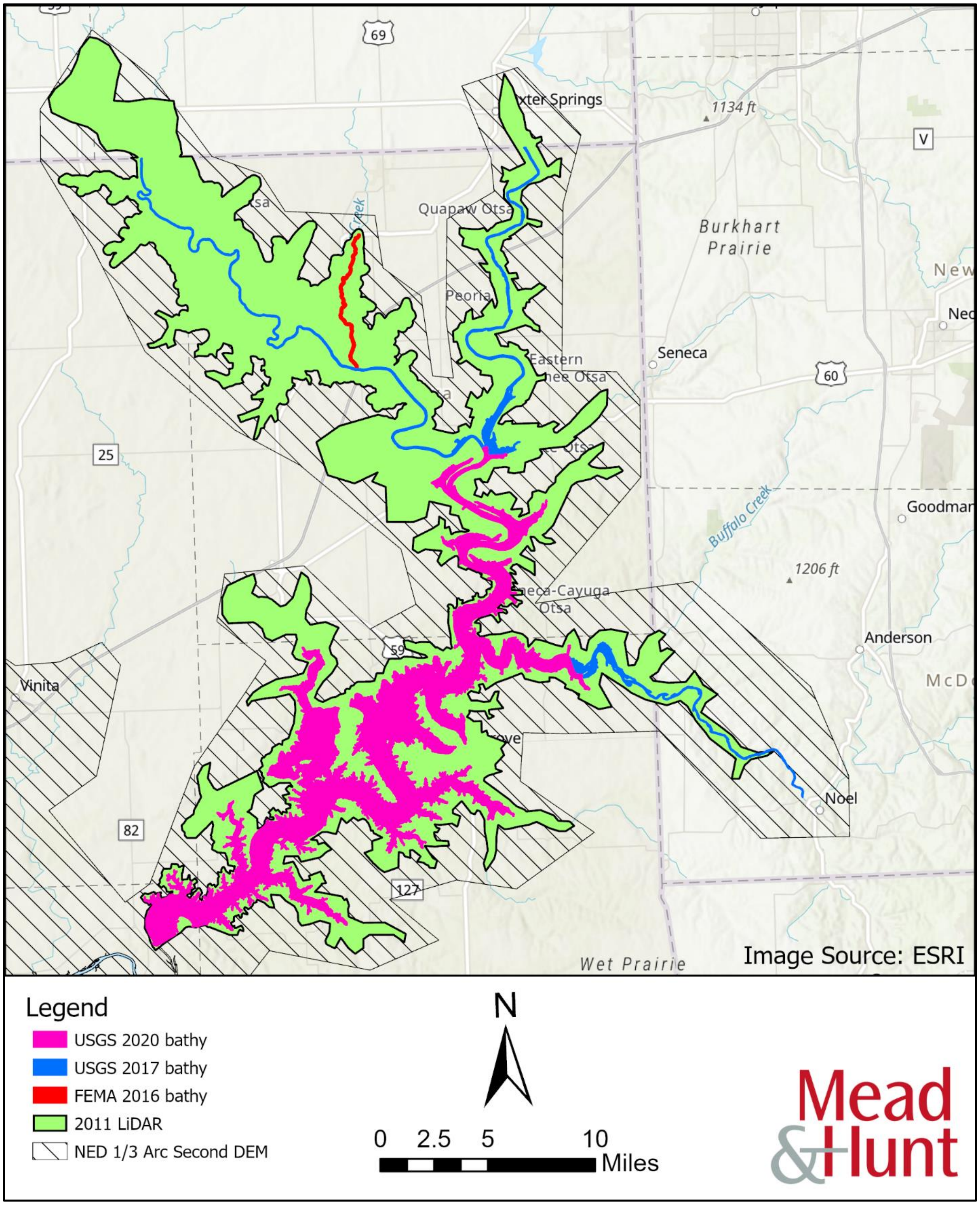


Figure 10. Bathymetric and topographic data sources.

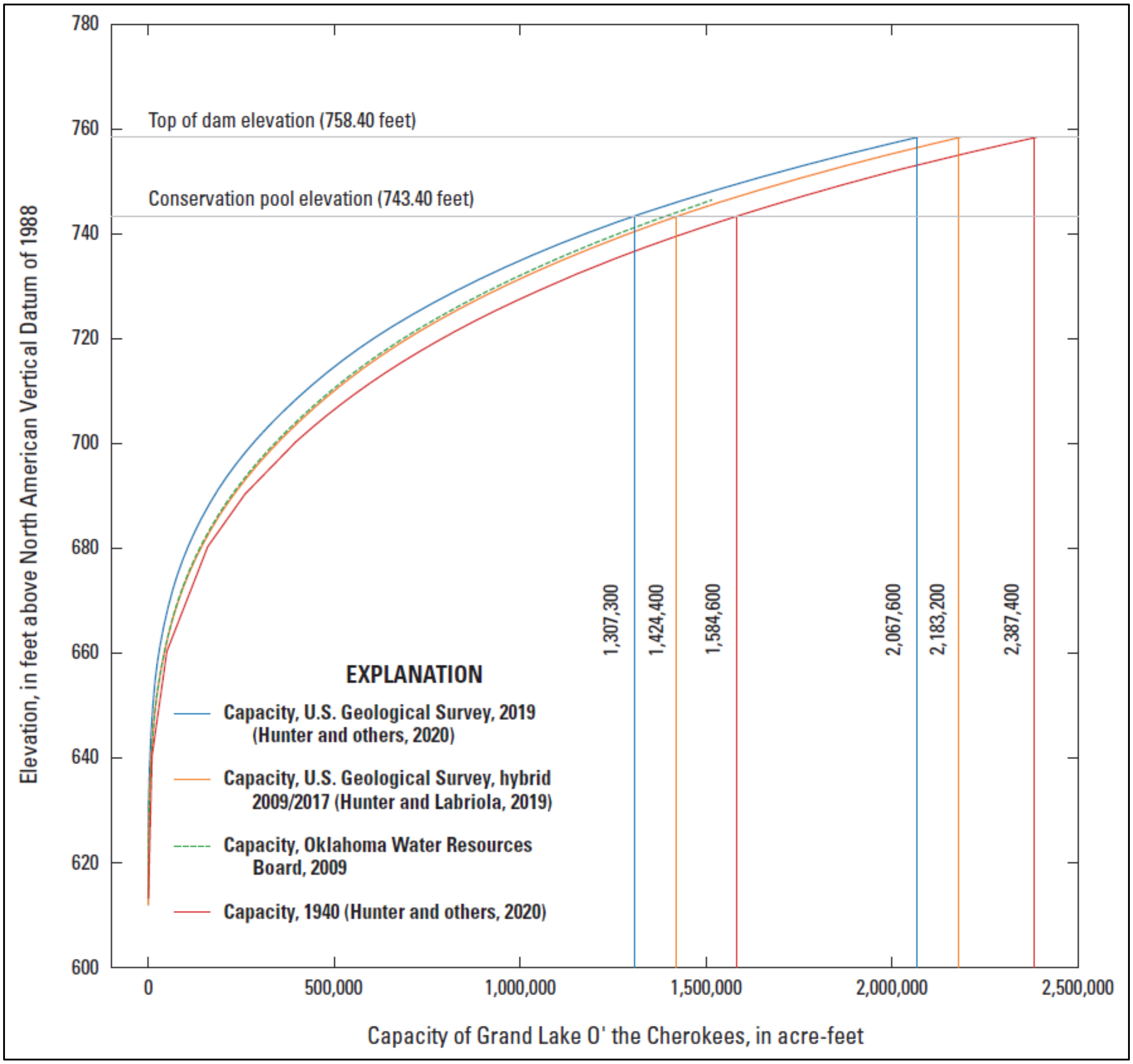


Figure 11. Grand Lake capacity curves.
Source: (Hunter, Trevisan, Villa, & Smith, 2020).

2.12 Computational Parameters

Tetra Tech's simulations all used the Diffusion Wave equation set. The HEC-RAS 2D Modeling User's Manual states the Diffusion Wave equations can be used while developing the model, but the Full Momentum equations should always be tested:

> *Once the model is in good working order, then make a second HEC-RAS Plan and switch the computational method to the Full Momentum equation option… Run the second plan and compare the two answers throughout the system. If there are significant differences between the two runs, the user should assume the Full Momentum (Saint Venant equations) answer is more accurate, and proceed with that equation set for model calibration and other event simulations* (USACE, 2016a)*.*

Mead & Hunt ran preliminary simulations of the UHM with both Diffusion Wave and Full Momentum equation sets. Results from one simulation are displayed in **Figure 12**. The displayed reach (RM 131 to RM 151) approximately covers the two upstream 2DFAs and the 1D reach between the two upstream 2DFAs. Based on the WSEL differences in the test results, Mead & Hunt used Full Momentum for the two most upstream 2DFAs: Miami Upper and Miami Lower (see again **Figure 12**).

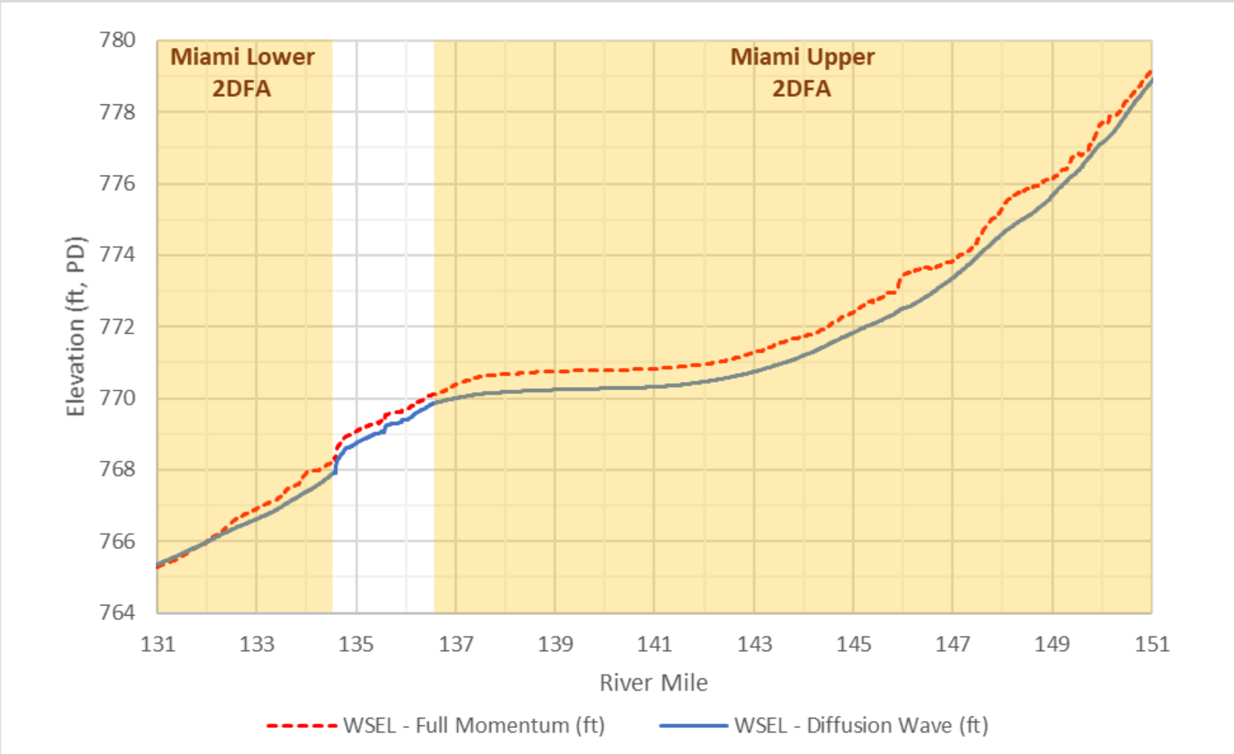


Figure 12. Simulation results from preliminary comparison of Diffusion Wave to Full Momentum equation sets.

Test results showed very little difference in WSEL in the Grand Lake 2DFA. Therefore, Mead & Hunt used the Diffusion Wave equation set for the Grand Lake 2DFA.

3. Model Calibration

The UHM was calibrated using several historical inflow events that represented a range of flows. Stream gage data were used for model boundary conditions and to compare measured WSEL to simulated values. High water marks and loggers installed by the project team were also used to compare measured and simulated WSEL.

3.1 Stream Gage Data

Data from the following stream gages were used for calibration:

1. Neosho River near Commerce, OK (USGS Gage No. 07185000)
2. Neosho River at Miami, OK (USGS Gage No. 07185080)
3. Tar Creek at 22nd Street Bridge at Miami, OK (USGS Gage No. 07185095)
4. Spring River near Quapaw, OK (USGS Gage No. 07188000)
5. Elk River near Tiff City, MO (USGS Gage No. 07189000)
6. Lake O' the Cherokees at Langley, OK (USGS Gage No. 07190000)

Details regarding the individual stream gages are discussed below. Stream gage data were obtained from the USGS National Water Information System (NWIS).

3.1.1 Neosho River near Commerce, OK

The Neosho River near Commerce, OK (USGS Gage No. 07185000) stream gage is at the Stepps Ford Bridge, approximately 6.7 miles downstream of the upper boundary of the model. Discharge data were available in hourly increments from April 1990 onward and stage data were available in hourly increments from October 2007 onward. The gage datum is 748.97 feet above NGVD29 (USGS, 2021a). Stage data at the gage were used in calibration.

Flow data were used as an upstream boundary condition for the Neosho River. Tetra Tech determined that it takes 4 hours for a flood wave to travel from the upstream end of the model (RM 152.2) to the Commerce gage (Tetra Tech, 2015). Mead & Hunt's preliminary simulations confirmed the 4-hour travel time. Therefore, Mead & Hunt applied a negative 4.0 hour offset to the USGS flow hydrographs, which were used as inflows at the upstream end of the Neosho River 2DFA.

3.1.2 Neosho River at Miami, OK

The Neosho River at Miami, OK (USGS Gage No. 07185080) stream gage is at the Highway 125 Bridge (RM 135.46) in the City of Miami. Stage data were available in hourly increments from October 2007 onward. Daily minimum, maximum, and mean stage data were available from October 1994 onward (USGS, 2021b). Stage data at the gage were used in calibration. Regarding the gage datum, Tetra Tech concluded that:

> *Although the NWIS website indicates that the datum for the Miami gage is referenced to NGVD29, field surveys to support this and previous Tetra Tech studies indicate that the datum is actually reported in the GRDA Pensacola Datum (PD). The reported values were, therefore, converted to NGVD29 for use in this analysis by adding 1.07 feet so that they are consistent with the Commerce data and the mapping and other data used for the modeling.*

Mead & Hunt analyzed the gage data and came to the same conclusion. Mead & Hunt contacted Scott Strong from the USGS Tulsa Field Office; Scott confirmed that the datum of the Miami gage is indeed in the Pensacola Datum.

3.1.3 Tar Creek at 22nd Street Bridge at Miami, OK

The Tar Creek at 22nd Street Bridge at Miami, OK (USGS Gage No. 07185095) stream gage had stage data available in hourly increments from October 2007 onward and had discharge data available in hourly increments from October 1989 onward. The gage datum is 762.23 feet above NGVD29 (USGS, 2021c).

Flow data were used as an upstream boundary condition for Tar Creek. No time offset was necessary because the gage is located at the upstream end of the model.

3.1.4 Spring River near Quapaw, OK

The Spring River near Quapaw, OK (USGS Gage No. 07188000) stream gage is at E 57 Road (RM 14.16). Stage data were available in hourly increments from October 2007 onward and discharge data were available in hourly increments from October 1989 onward. The gage datum is 746.25 feet above NGVD29 (USGS, 2021d).

Stage data at the gage were used in calibration. Flow data were used as an upstream boundary condition for the Spring River. As discussed in **Section 2.9**, a negative 2.5-hour offset was applied to flow hydrographs to account for flood wave travel time.

3.1.5 Elk River near Tiff City, MO

The Elk River near Tiff City, MO (USGS Gage No. 07189000) stream gage is at Highway 43 (RM 14.22). Stage data were available in hourly increments from October 2007 onward and discharge data were available in hourly increments from May 1990 onward. The gage datum is 750.61 feet above NGVD29 (USGS, 2021e).

Stage data at the gage were used in calibration. Flow data were used as an upstream boundary condition for the Elk River. As discussed in **Section 2.10**, a negative 2.0-hour offset was applied to flow hydrographs to account for flood wave travel time.

3.1.6 Lake O’ the Cherokees at Langley, OK

The Lake O’ the Cherokees at Langley, OK (USGS Gage No. 07190000) gage measures Grand Lake stage levels. Hourly stage data were available from October 2010 onward (USGS, 2021f). Stage data prior to October 2010 were provided by GRDA. Stage data were used as the downstream boundary condition for the model.

3.2 Historical Events

The following historical inflow events were used for calibration of the UHM.

1. July 2007
2. October 2009
3. December 2015
4. January 2017
5. April 2017
6. May 2019

Details regarding the individual inflow events are discussed below. For all historical events used in calibration of the UHM, USGS gage data were used for the upstream inflow boundaries and WSELs at Pensacola Dam were used for the downstream stage boundary. **Table 1** lists a summary of the historical event boundary conditions.

Table 1. Summary of historical event boundary conditions used in UHM calibration.

Historical Event	Peak Inflow (cfs)				Pensacola Peak Stage (feet, PD)
	Neosho River	Tar Creek	Spring River	Elk River	
July 2007	141,000	726	33,300	1,190	754.53
October 2009	46,100	4,630	66,200	39,300	749.59
December 2015	45,400	4,710	151,000	107,000	754.93
January 2017	10,200	678	15,900	1,140	742.82
April 2017	58,100	3,550	114,000	107,000	754.59
May 2019	91,400	6,410	109,000	66,500	755.08

3.2.1 July 2007

For the July 2007 event, hourly flow data were available for the Neosho River at Commerce gage, Tar Creek at Miami gage, Spring River at Quapaw gage, and Elk River near Tiff City gage. Daily minimum, mean, and maximum WSELs were available for the Neosho River at Miami gage. Grand Lake stage data were provided by GRDA. High water marks, compiled by Tetra Tech (2016), were available for this inflow event. Of the selected calibration events, the July 2007 event had the highest recorded flow on the Neosho River at the Commerce gage.

3.2.2 October 2009

For the October 2009 event, hourly flow and stage data were available for the Neosho River at Commerce gage, Tar Creek at Miami gage, Spring River at Quapaw gage, and Elk River near Tiff City gage. Hourly stage data were available for the Neosho River at Miami gage and Lake O' the Cherokees at Langley gage. High water marks, compiled by Tetra Tech (2016), were available for this inflow event.

3.2.3 December 2015

For the December 2015 event, hourly flow and stage data were available for the Neosho River at Commerce gage, Tar Creek at Miami gage, Spring River at Quapaw gage, and Elk River near Tiff City gage. Hourly stage data were available for the Neosho River at Miami gage and Lake O' the Cherokees at Langley gage. High water marks, compiled by Tetra Tech (2016), were available for this inflow event. Of the selected calibration events, the December 2015 event had the highest recorded flow on the Spring River at Quapaw gage. The peak flow at the Elk River near Tiff City gage was 107,000 cfs, which is equal to the peak flow that occurred at this gage during the April 2017 event. This flow is the highest recorded flow on the Elk River for the selected calibration events.

3.2.4 January 2017

For the January 2017 event, hourly flow and stage data were available for the Neosho River at Commerce gage, Tar Creek at Miami gage, Spring River at Quapaw gage, and Elk River near Tiff City gage. Hourly stage data were available for the Neosho River at Miami gage and Lake O' the Cherokees at Langley gage. Hourly WSEL logger data throughout the study area were collected by the project team for this event. Of the selected calibration events, the January 2017 event had the lowest recorded flow on all gages.

3.2.5 April 2017

For the April 2017 event, hourly flow and stage data were available for the Neosho River at Commerce gage, Tar Creek at Miami gage, Spring River at Quapaw gage, and Elk River near Tiff City gage. Hourly stage data were available for the Neosho River at Miami gage and Lake O' the Cherokees at Langley gage. Hourly WSEL logger data throughout the study area were collected by the project team for this event. The peak flow at the Elk River near Tiff City gage was 107,000 cfs, which is equal to the peak flow that occurred at this gage during the December 2015 event. This flow is the highest recorded flow on the Elk River for the selected calibration events.

3.2.6 May 2019

For the May 2019 event, hourly flow and stage data were available for the Neosho River at Commerce gage, Tar Creek at Miami gage, Spring River at Quapaw gage, and Elk River near Tiff City gage. Hourly stage data were available for the Neosho River at Miami gage and Lake O' the Cherokees at Langley gage. Hourly WSEL logger data throughout the study area were collected by the project team for this event. Of the selected calibration events, the May 2019 event had the highest recorded flow at the Tar Creek at Miami gage.

3.3 Methodology

The goal of model calibration was to create a single geometry file that could be used for a variety of synthetic/hypothetical simulations. Simulated WSEL values were compared to stream gage elevations within the study area, high water marks, and WSEL logger data collected by the project team.

Tetra Tech previously digitized land cover along the Neosho River from the confluence with the Spring River to the upstream end of the model (Tetra Tech, 2015). Mead & Hunt expanded the coverage, digitizing land cover in the following areas:

1. Neosho River, downstream of the confluence with the Spring River
2. Grand Lake
3. Elk River
4. Spring River

Tetra Tech assigned Manning's n-values to land cover categories (Tetra Tech, 2015). Tetra Tech's work relied on commonly used guidance (Arcement & Schneider, 1989) and area-specific investigation (Mussetter, 1998). Mead & Hunt continued to use the same Manning's n-values in overbank areas. Mead & Hunt digitized two new categories of land cover: field crops and dense urban areas. Manning's n-values were assigned to these categories based on other n-values and engineering judgment. Horizontal variation in n-values was applied to the cross-sections and spatially varied n-values were applied to the 2DFAs. **Table 2** lists the overbank Manning's n-values.

Table 2. Overbank Manning's n-values.

Land Cover	n-Value
Field crops	0.040
Pasture	0.080
Urban	0.070
Urban, dense	0.090
Water	0.040
Woody vegetation	0.100
Woody vegetation, dense	0.150

Manning's n-values in the main channel were iteratively adjusted until simulated WSELs reasonably agreed with measured data. **Table 3** lists the in-channel Manning's n-values that resulted from model calibration.

Table 3. Channel Manning's n-values.

Reach	n-Value
Grand Lake (reservoir, up to RM 121.29)	0.020
Neosho River (RM 121.51 up to RM 128.81)	0.035
Neosho River (RM 129.07 up to RM 135.44)	0.037
Neosho River (RM 135.47 up to RM 152.2)	0.025
Elk River (full reach)	0.042
Spring River (full reach)	0.038

After the base n-values were determined, flow roughness factors were iteratively applied to further decrease the differences between simulated and measured WSELs. **Table 4** lists the flow roughness factors that resulted from model calibration.

Table 4. Flow roughness factors.

Neosho River		Spring River		Elk River	
Flow (cfs)	Roughness Factor	Flow (cfs)	Roughness Factor	Flow (cfs)	Roughness Factor
0	0.60	0	0.79	0	1.15
20,000	0.60	20,000	0.79	40,000	1.15
40,000	0.70	40,000	0.94	60,000	0.80
45,000	0.70	60,000	0.94	80,000	0.80
50,000	1.00	80,000	0.94	100,000	1.00
55,000	1.25	100,000	1.00	120,000	1.00
60,000	1.25	120,000	1.00	140,000	1.00
80,000	1.25	140,000	1.10	160,000	1.00
90,000	1.30	160,000	1.10	350,000	1.00
110,000	1.30	180,000	1.00		
140,000	1.30	350,000	1.00		
150,000	1.30				
160,000	1.00				
350,000	1.00				

3.4 Results

The results from the model calibration are discussed in the following paragraphs. **Figure 13** displays the over/underprediction of peak simulated WSEL at USGS gages. The average difference between simulated WSELs and measured USGS gage WSELs is -0.1 feet; the model is slightly underpredicting the WSEL at USGS gages.

UHM results were also compared to the high water marks compiled by Tetra Tech (2016). **Figure 14** compares model results to the July 2007 high water marks, **Figure 15** compares results to the October 2009 marks, and **Figure 16** compares results to the December 2015 marks. The average underprediction of simulated WSEL is 0.5 feet for the July 2007 event, the average overprediction is 0.4 feet for the October 2009 event, and the average underprediction is 0.1 feet for the December 2015 event.

The project team installed WSEL loggers throughout the study area. Loggers were in place during three calibration events: January 2017, April 2017, and May 2019. **Figure 17** displays the logger locations. Not all logger locations have data for a given event; some loggers were missing when the project team visited to perform maintenance and download data. Loggers 3, 4, 11, and 12 were missing for the May 2019 event. Logger 9 was missing for all three events. Data from loggers 7, 8, 13, 14, and 15 were not included in calibration because the logger WSEL was influenced by incoming, un-gaged streams not modeled in the UHM. The loggers were placed in support of the Sedimentation Study, early in the pre-study period before model parameters were fully defined. **Figure 18** displays the over/underprediction of peak simulated WSEL at the loggers used for model calibration for the three events. The average difference between simulated WSELs and measured WSELs is -0.6 feet; the model is underpredicting the WSEL at the loggers.

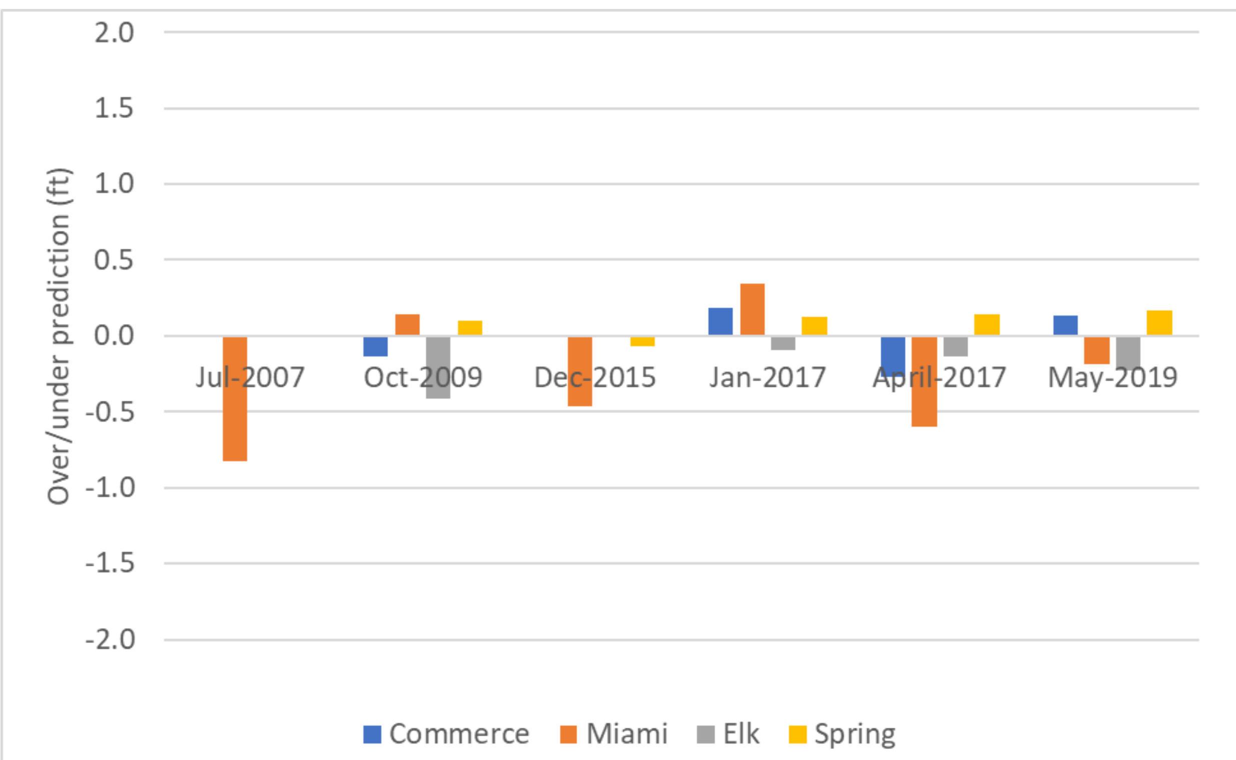


Figure 13. Over/underprediction of simulated WSEL at USGS gages.

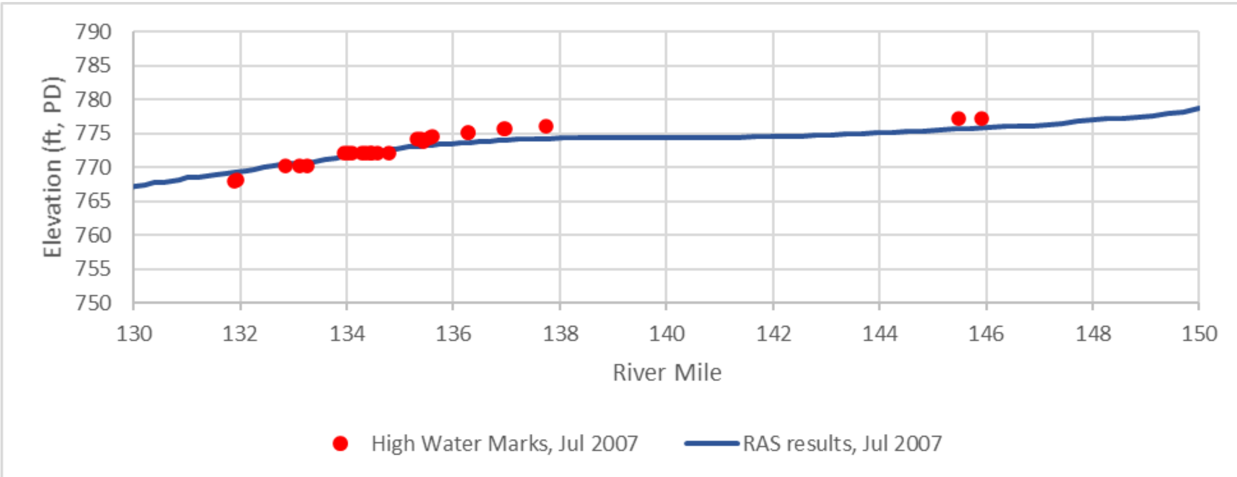


Figure 14. Comparison of UHM results to July 2007 high water marks.

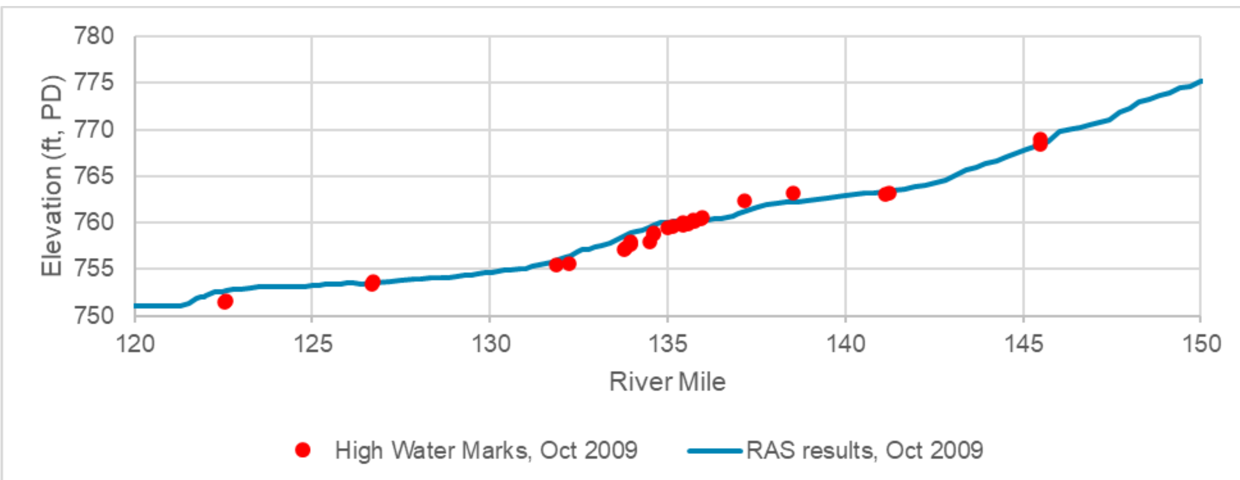


Figure 15. Comparison of UHM results to October 2009 high water marks.

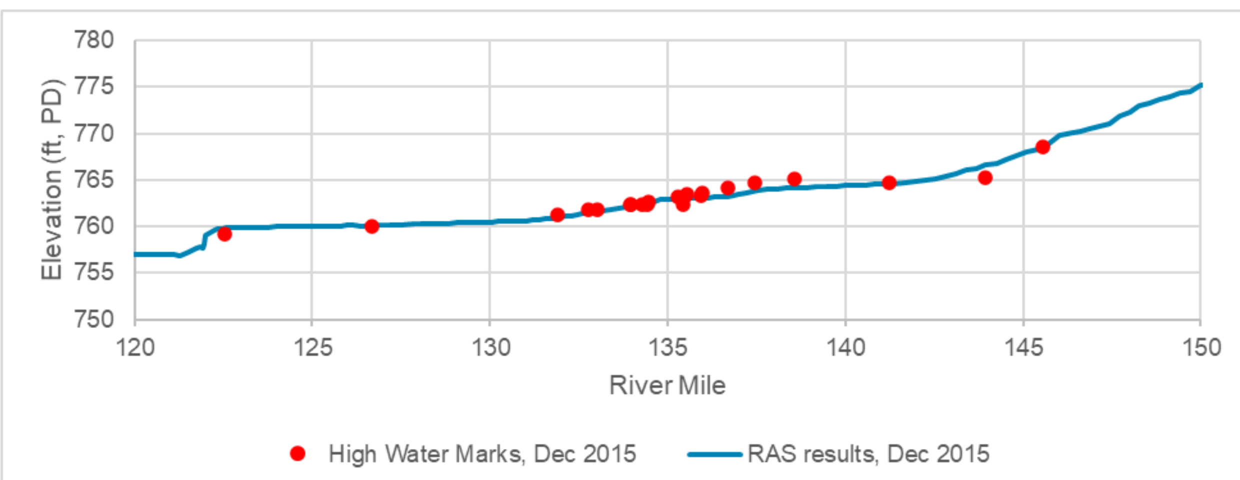


Figure 16. Comparison of UHM results to December 2015 high water marks.

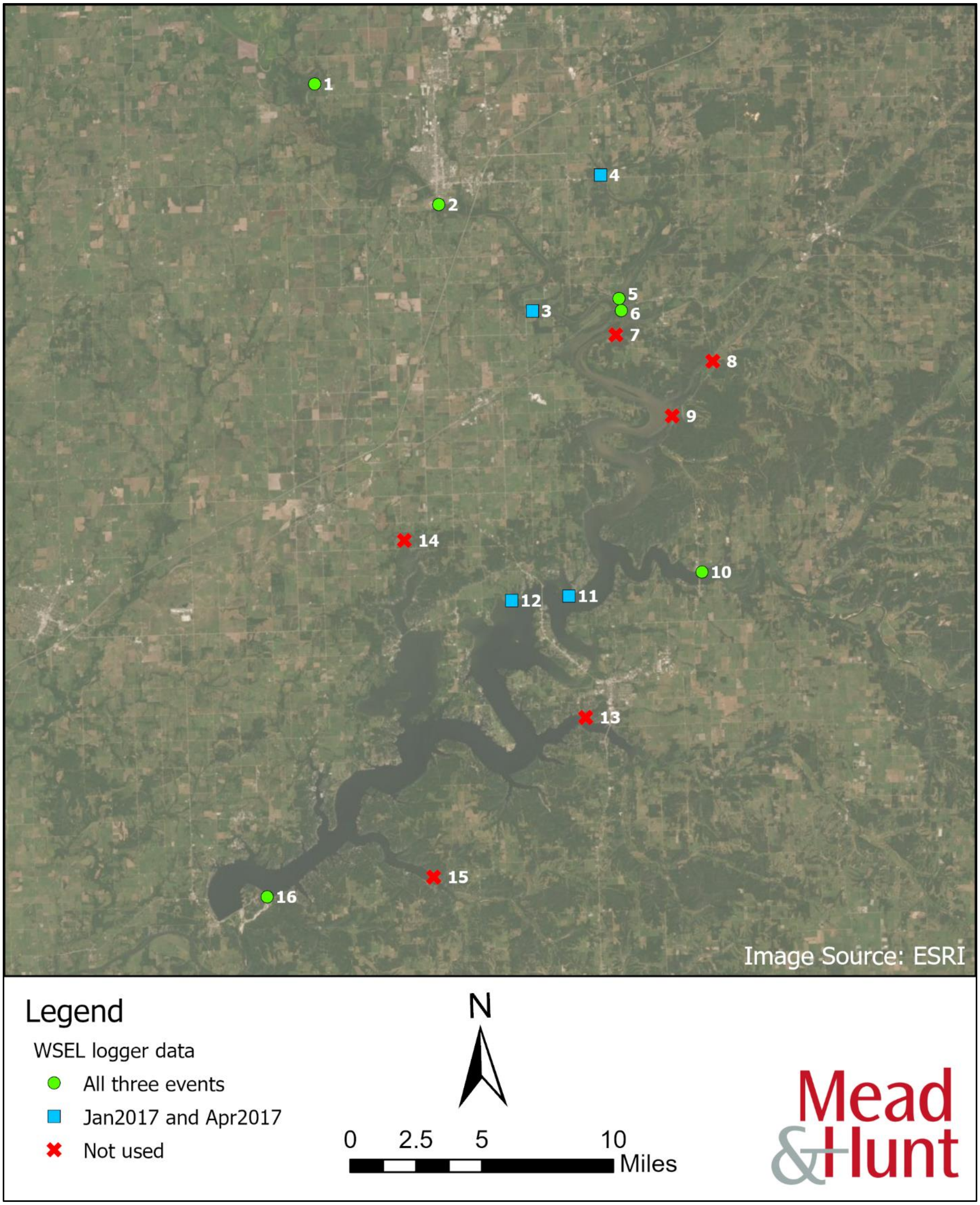


Figure 17. Locations of WSEL loggers installed by project team.

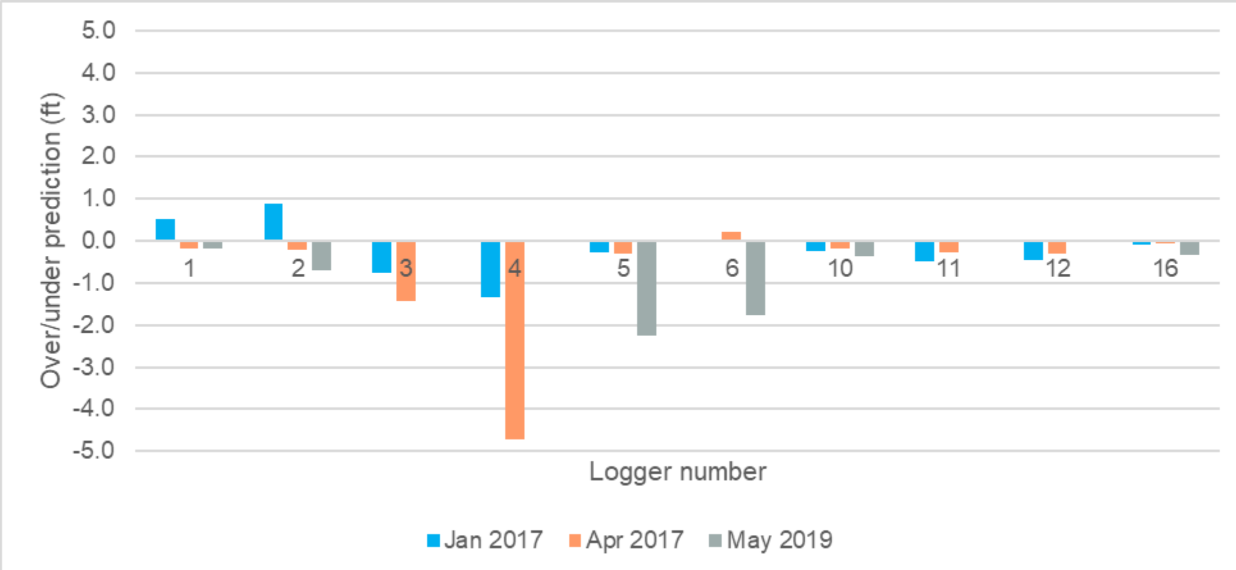


Figure 18. Over/underprediction of simulated WSEL at loggers installed by project team.

3.5 July 2007 Additional Data

As noted in **Section 3.1**, for gages where inflow hydrographs were defined, stage data were available in hourly increments from October 2007 onward. After the Technical Conference on April 21, 2021, the City of Miami, Oklahoma, provided comments regarding the Upstream MISR (City of Miami, 2021). The City of Miami noted that stage data for the Commerce gage from circa 1990 to October 2007 were not published online but were available upon request from USGS. The City of Miami recommended obtaining the data from USGS and using it in the calibration process.

Mead & Hunt contacted USGS and requested the pre-October 2007 hourly stage data for the Commerce gage on the Neosho River, the Miami gage on the Neosho River, the Tiff City gage on the Elk River, and the Quapaw gage on the Spring River. Scott Strong, from the USGS Tulsa Field Office, provided the pre-October 2007 hourly stage data for the gages to Mead & Hunt with the following disclaimer (USGS disclaimer):

> *Please note that prior to October 2007, instantaneous stage values were not considered a reportable data product. A small possibility exists that some of the data provided in this email was not processed in accordance with current USGS standards and could contain errors.*

Because of this disclaimer, Mead & Hunt compared the pre-October 2007 USGS data to other publicly available USGS data:

1. Peak streamflow is the maximum flow that occurred during the USGS water year. Stage associated with the peak streamflow is reported by USGS and was converted to WSEL (feet, PD datum) by Mead & Hunt for analysis. For the Miami gage, USGS reports maximum stage that occurred during the USGS water year because streamflow is not reported at the gage.
2. Streamflow measurements are USGS field measurements and are independent of gage-recorded values. USGS reports flow and gage height for streamflow measurements. Stage was converted to WSEL (feet, PD datum) by Mead & Hunt for analysis.

USGS data for the July 2007 event are discussed below.

3.5.1 Neosho River near Commerce, OK

For the Commerce gage, Mead & Hunt also reviewed USGS data available from the gage Peak Streamflow webpage (USGS, 2021g) and the gage Streamflow Measurements webpage (USGS, 2021h). These data, along with the pre-October 2007 USGS data and results from the HEC-RAS model, are presented in **Table 5**.

Mead & Hunt analyzed the difference between the USGS measurements and the HEC-RAS model results. The WSEL for the peak streamflow value is 0.15 feet lower than the maximum WSEL caculated by the HEC-RAS model. The WSELs from the streamflow measurements range from 0.58 feet to 1.29 feet higher than the HEC-RAS maximum WSEL. The maximum WSEL of the pre-October 2007 hourly time series data provided by USGS is 1.45 feet higher than the HEC-RAS maximum WSEL.

USGS measurements were also compared against each other. The highest USGS streamflow measurement is 0.16 feet lower than the maximum WSEL of the pre-October 2007 hourly time series data provided by USGS. The peak streamflow WSEL is 1.60 feet lower than the maximum WSEL of USGS hourly time series. The peak streamflow WSEL is reported on July 3, 2007. Compared to the two streamflow measurements collected on July 3, 2007, the peak streamflow WSEL ranges from 0.73 feet to 1.13 feet lower than the streamflow measurements.

While there are differences between the HEC-RAS results and the USGS measurements, there are also differences between the various USGS measurements. The magnitude of the differences between HEC-RAS results and USGS measurements is similar to the magnitude of differences between the various USGS measurements.

Table 5. Comparison of additional data for the Neosho River near Commerce, OK

Source	Date and Time	Water Surface Elevation (ft, PD)
USGS Peak Streamflow	7/3/2007 (no time listed)	775.55
USGS Streamflow Measurements	7/3/2007 1615 hours	776.28
	7/3/2007 1930 hours	776.68
	7/4/2007 1222 hours	776.99
Pre-October 2007 USGS Data Maximum WSEL	7/3/2007 2300 hours	777.15
HEC-RAS Maximum WSEL	7/4/2007 1200 hours	775.70

3.5.2 Neosho River at Miami, OK

For the Miami gage, Mead & Hunt also reviewed the USGS data available from the gage Peak Streamflow webpage (USGS, 2021i). No data were available for the July 2007 event on the gage Streamflow Measurements webpage (USGS, 2021j). The gage peak streamflow value, along with the pre-October 2007 USGS data, USGS daily maximum (see **Section 3.1.2**) and results from the HEC-RAS model, are presented in **Table 6**.

The WSELs for the peak streamflow, the pre-October 2007 USGS data, and the USGS daily maximum are all 774.05 ft. Because the values are exact matches, the peak streamflow value and daily maximum were potentially based on the pre-October 2007 data that USGS delivered to Mead & Hunt. The USGS WSELs are 0.83 feet higher than the maximum WSEL in the HEC-RAS model.

Table 6. Comparison of additional data for the Neosho River at Miami, OK

Source	Date and Time	Water Surface Elevation (ft, PD)
USGS Peak Streamflow	7/4/2007 (no time listed)	774.05
USGS Streamflow Measurements	*No data*	
Pre-October 2007 USGS Data Maximum WSEL	7/4/2007 0300 hours	774.05
USGS Daily Maximum WSEL	7/4/2007 (no time listed)	774.05
HEC-RAS Maximum WSEL	7/4/2007 1800 hours	773.22

3.5.3 Elk River near Tiff City, OK

For the Tiff City gage on the Elk River, Mead & Hunt also reviewed USGS data available from the gage Peak Streamflow webpage (USGS, 2021k) and the gage Streamflow Measurements webpage (USGS, 2021l). These data, along with the pre-October 2007 USGS data and results from the HEC-RAS model, are presented in **Table 7**.

The WSEL for the peak streamflow matches the WSEL for the pre-October 2007 USGS data. Because the values are exact matches, the peak streamflow value was potentially based on the pre-October 2007 data that USGS delivered to Mead & Hunt. The streamflow measurement occurred six days after the peak had passed and thus is not a good point for comparison. The WSEL for the peak streamflow is 0.58 feet lower than the maximum WSEL in the HEC-RAS model.

Table 7. Comparison of additional data for the Elk River near Tiff City, OK

Source	Date and Time	Water Surface Elevation (ft, PD)
USGS Peak Streamflow	6/13/2007 (no time listed)	758.32
USGS Streamflow Measurements	6/19/2007 1107 hours	754.20
Pre-October 2007 USGS Data Maximum WSEL	6/13/2007 0100 hours	758.32
HEC-RAS Maximum WSEL	6/13/2007 0300 hours	758.90

3.5.4 Spring River near Quapaw, OK

For the gage near Quapaw on the Spring River, Mead & Hunt also reviewed USGS data available from the gage Peak Streamflow webpage (USGS, 2021m) and the gage Streamflow Measurements webpage (USGS, 2021n). These data, along with the pre-October 2007 USGS data and results from the HEC-RAS model, are presented in **Table 8**.

The WSEL for the peak streamflow matches the WSEL for the pre-October 2007 USGS data. Because the values are exact matches, the peak streamflow value was potentially based on the pre-October 2007 data that USGS delivered to Mead & Hunt. Comparing USGS measurements to HEC-RAS, the WSEL for the peak streamflow is 0.63 feet higher than the maximum WSEL in the HEC-RAS model. The streamflow measurement is 0.97 feet lower than the maximum WSEL in the HEC-RAS model.

Comparing USGS measurements against each other, the peak streamflow WSEL is 1.60 feet higher than the streamflow measurement. The difference between the USGS measurements exceeds the difference between the HEC-RAS results and either of the USGS measurements.

Table 8. Comparison of additional data for the Spring River near Quapaw, OK

Source	Date and Time	Water Surface Elevation (ft, PD)
USGS Peak Streamflow	6/13/2007 (no time listed)	779.21
USGS Streamflow Measurements	6/13/2007 1218 hours	777.61
Pre-October 2007 USGS Data Maximum WSEL	6/13/2007 0400 hours	779.21
HEC-RAS Maximum WSEL	6/13/2007 0700 hours	778.58

3.5.5 Summary of Findings and Conclusions Regarding Additional Data

Mead & Hunt considered the following factors when determining if the model should be recalibrated to match the pre-October 2007 USGS data for the July 2007 event:

1. USGS included a disclaimer for the pre-October 2007 data, noting that the data may not have been processed in accordance with current USGS standards and could contain errors.
2. Differences between various USGS measurements are similar to or greater than differences between HEC-RAS results and USGS measurements.
    a. For the Neosho River near Commerce gage, the magnitude of the differences between HEC-RAS results and USGS measurements is similar to the magnitude of differences between the various USGS measurements.
    b. For the Spring River near Quapaw gage, the difference between the USGS measurements exceeds the difference between the HEC-RAS results and either of the USGS measurements.
3. In the HEC-RAS User's Manual, USACE states that a ± 5% flow measurement, which may be "optimistic," translates into a stage error of ±1.0 feet (USACE, 2016c). Considering the differences between the various USGS measurements at the gage locations, there may be errors for the July 2007 event flow measurement that result in stage errors of 1.0 feet or more.
4. In their comments on the Upstream MISR, the City of Miami recommended reducing the Commerce gage peak flow for the July 2007 event hydrograph. The City of Miami's lack of comfort using publicly available USGS flow data for the July 2007 event further reinforces the recommendation against recalibrating the model to match the pre-October 2007 USGS data (which was delivered by USGS with a data accuracy disclaimer).

The goal of UHM development and calibration is to create a single geometry file that could be used for a variety of synthetic/hypothetical simulations. Adjusting model calibration to match a dataset suspected to have accuracy issues contradicts that goal. Considering the factors listed above, it is inadvisable to recalibrate the model to match the pre-October 2007 USGS data for the July 2007 event.

4. Flood Frequency Analysis

Mead & Hunt performed a flood frequency analysis for the study area. USACE has developed a period of record RiverWare model that includes Pensacola Dam. Mead & Hunt extracted the total inflow at Pensacola Dam from 1940 (dam construction date) to 2019 (latest available data at time of data delivery from USACE) from the RiverWare model.

Annual peak inflows at Pensacola Dam were extracted using HEC's Statistical Software Package (SSP) version 2.2. The full inflow time series was imported into HEC-SSP and the annual peaks were automatically filtered. Water years were set to start at October 1st to align with USGS water years (USGS, 2016). One manual adjustment was necessary for an event that occurred in September and October 1986. HEC-SSP automatically selected September 30, 1986 for the peak of water year 1986 and October 2, 1986 for the peak of water year 1987, as displayed in **Figure 19**. The September 30th peak is not hydrologically independent of the October 2nd peak. Mead & Hunt manually selected the next highest peak for water year 1986: November 19, 1985. Manually correct flood peaks were re-imported and a Graphical Frequency Analysis of Peak Inflows was performed in HEC-SSP. Weibull plotting positions were used and a best-fit was digitized through the peak flows. Annual recurrence interval flows were rounded to the nearest thousand cubic feet per second (cfs).

Tabular results of flood frequency analysis are presented in **Table 9** and graphical results are presented in **Figure 20**. **Figure 20** also displays the exceedance curve from the Real Estate Adequacy Study (USACE, 1998), which was developed using similar methodology as Mead & Hunt's analysis. At lower recurrence intervals (2-year through 10-year), the new analysis resulted in higher flows. At higher recurrence intervals (20-year through 500-year), the new analysis resulted in lower flows. Differences between the Mead & Hunt analysis and the Real Estate Adequacy Study Analysis are primarily due to the additional two decades of data used in the new analysis.

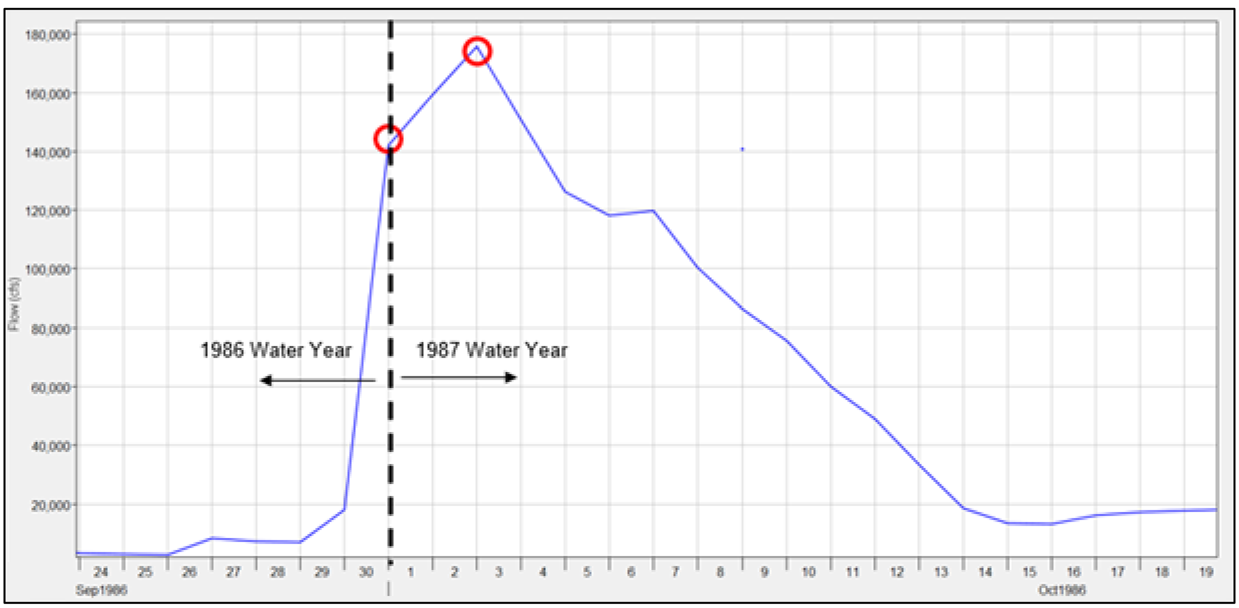


Figure 19. 1986 and 1987 water years in HEC-SSP.

Table 9. Flood frequency analysis tabular results.

Annual Recurrence Interval	Flow (cfs)
2	90,000
5	152,000
10	192,000
20	225,000
50	266,000
100	299,000
200	330,000
500	375,000

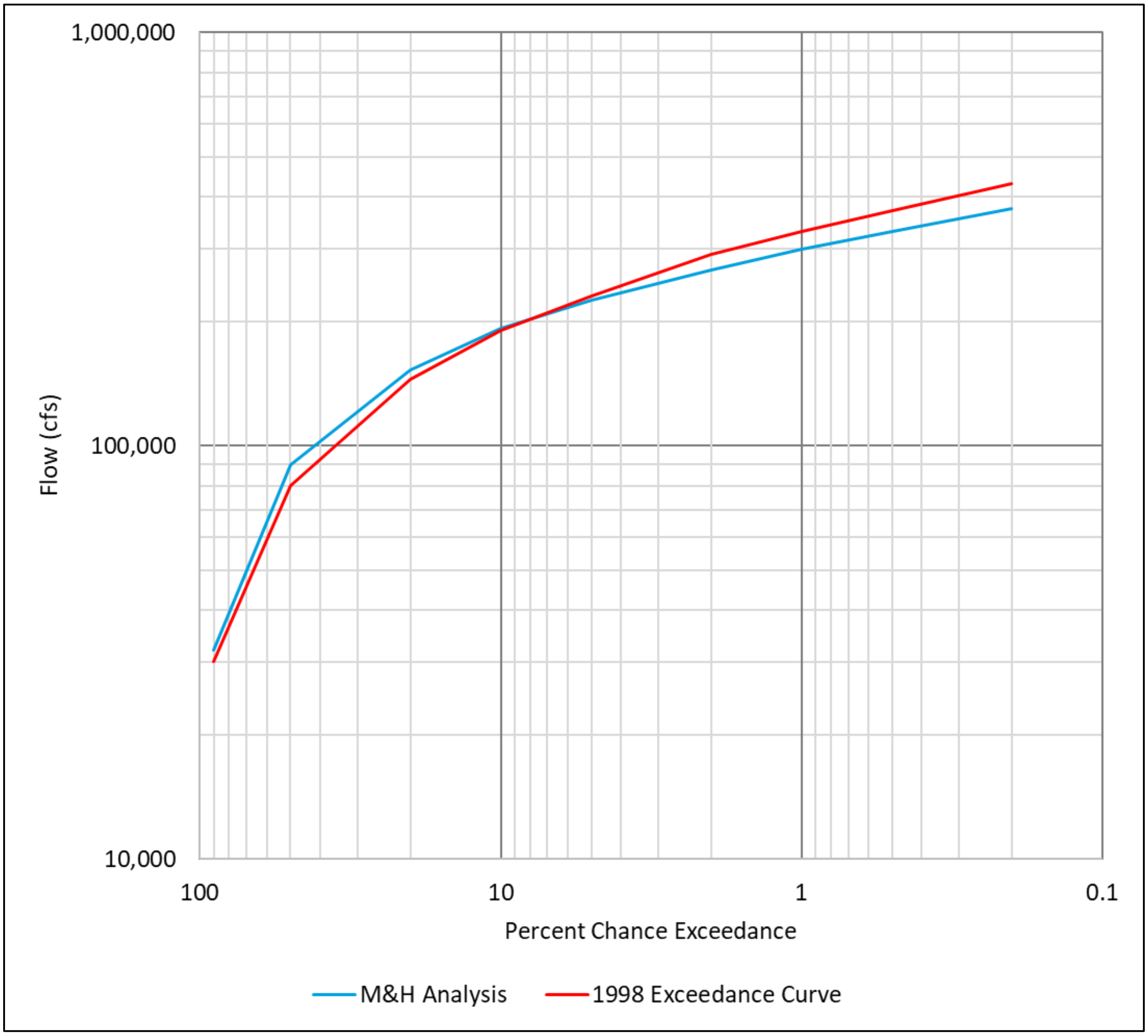


Figure 20. Flood frequency analysis graphical results.

5. Inflow Event Analysis

The flood frequency analysis estimated that the 100-year event flow at Pensacola Dam is approximately 300,000 cfs. The July 2007 event is the largest event of recent record on the Neosho River, with a peak flow of 141,000 cfs at the Commerce gage. Simulation results estimated a total peak inflow of approximately 130,000 at Pensacola Dam, which includes inflow from Tar Creek, the Elk River, and the Spring River. It also includes attenuation of the flood peaks as they travel to Pensacola Dam. When flood frequency at Pensacola Dam is considered, the July 2007 event is a 4-year return period event.

Three other recent events resulted in a large inflow at Pensacola Dam: September 1993, December 2015, and May 2019. Simulation results estimated a total peak inflow at Pensacola Dam of 226,000 cfs for the September 1993 event; 210,000 cfs for the December 2015 event; and 190,000 cfs for the May 2019 event. The peak inflow for the September 1993, July 2007, December 2015, and May 2019 events are listed in **Table 10**, along with the estimated return period.

The FERC's SPD stated that "If the flood frequency analysis shows that the selected historical inflow events do not exceed a 100-year recurrence interval, inflow events up to and including the 100-year recurrence interval would be evaluated." Therefore, Mead & Hunt iteratively scaled the events listed in **Table 10** until the total peak inflow at Pensacola Dam was approximately 300,000 cfs. The scaling factors are listed in **Table 10**. The scaled events were simulated in the UHM.

Table 10. Peak inflows at Pensacola Dam for four recent events.

Event	Peak Inflow[1] at Pensacola Dam (cfs)	Estimated Return Period	Scaling Factor to Estimate 100-year Return Period
September 1993	226,000	21 years	1.17
July 2007	130,000	4 years	2.26
December 2015	210,000	15 years	1.50
May 2019	190,000	9 years	1.70

[1] Peak inflow rounded to the nearest 10,000 cfs

Mead & Hunt selected the scaled July 2007 event to represent the 100-year inflow to Pensacola Dam. Mead & Hunt used a statistical analysis of historical inflow volumes and peak flows to adjust the inflow hydrograph volume for the scaled July 2007 event. For each 24-hour period of the hydrograph, the total volume to Pensacola Dam was estimated using a modeled volume vs. peak flow relationship. The statistical model was developed based on a coefficient of determination (R^2) best-fit calculation assuming the Generalized Extreme Value (GEV) distribution (Bolívar, Díaz-Francés, Ortega, & Vilchis, 2010.; Takara, 2009). The GEV distribution is a family of distributions (Gumbel, Frechét, and Weibull) commonly used to model infrequent (extreme) random variables, including wind speed, precipitation, and stream flow.

Pensacola Dam inflow for 24-hour periods was extracted from the USACE RiverWare model. Inflow by 24-hour duration was converted to volume. Volumes were placed into bins with D+0 representing the day when the peak inflow occurred, D-1 representing the day before the peak, D+1 representing the day after the peak, and so on. The outermost bins included the average over three days: D-8 to D-10, and D+7 to D+9. Thus, the full set of bins is as follows: D-8 to D-10, D-7, D-6, D-5, D-4, D-3, D-2, D-1, D+0, D+1, D+2, D+3, D+4, D+5, D+6, and D+7 to D+9.

Sets of bins were calculated for the day within each USGS water year for which the annual maximum inflow to Pensacola Dam occurred (one set of bins per USGS water year). Bins were then ordered according to maximum inflow to Pensacola Dam and used to calculate the GEV distribution parameters.

First, the 100-year inflow to Pensacola Dam was predicted using the GEV distribution parameters and the annual peak inflow values from RiverWare. The reduced variate was calculated for each ordered peak inflow value, and the shape parameter was adjusted to maximize the R^2 correlation of the GEV-linearized discharges (peak inflow vs. reduced variate of peak inflow). This resulted in a 100-year inflow to Pensacola Dam of 306,317 cfs, which is within 3 percent of the value calculated in Mead & Hunt's flood frequency analysis using the Graphical Frequency Analysis of Peak Inflows method, which validates the flood frequency analysis results. The shape parameter was then adjusted so the 100-year inflow would match the value of 299,000 cfs from the flood frequency analysis, for consistency. **Table 11** presents the GEV distribution parameters and flow results for both cases. Note that the R^2 value was very high for both the original and adjusted cases.

Table 11. GEV distribution parameters and results.

Parameter	Prediction of 100-year Inflow	Adjusted to Match Flood Frequency Analysis 100-year Inflow
shape parameter, k (approximate)	0.01	-0.02
scale parameter, σ (linear slope, m)	49703	51076
location parameter, μ (linear intercept, b)	73193	73586
coefficient of determination, R^2	0.991	0.990
reduced variate for 100-year event, y	4.69	4.41
100-year inflow (cfs)	306,317	299,000

For each volume bin (D-8 to D-10, D-7… D+0… D+6, and D+7 to D+9), the binned daily volumes were plotted as a function of the reduced variates for the corresponding peak inflow values, using the same adjusted shape parameter (k) used to predict the 100-year inflow. A linear trend line for each volume bin (e.g., D+0) was calculated to obtain the scale parameter σ (linear slope, m) and a location parameter μ (linear intercept, b) for each volume bin. The reduced variate for the 100-year peak inflow (4.41), along with the scale and location parameters were then used to calculate the daily inflow volumes for each bin that are predicted to correspond to a 100-year peak inflow event. **Table 12** displays the results of the statistical analysis. Additional information including correlation plots can be found in **Appendix B**.

Table 12. Results of historical inflow volume statistical analysis.

Volume Bin	Scale Parameter, σ (m)	Location Parameter, μ (b)	100-Year Inflow Volume (acre-feet)
D-8 to D-10 avg.	13701	15500	75,966
D-7	13651	15589	75,835
D-6	10187	18852	63,810
D-5	7285	23100	55,249
D-4	6811	28286	58,344
D-3	16733	34613	108,461
D-2	38161	50607	219,023
D-1	77487	93430	435,403
D+0	101308	145956	593,058
D+1	88088	115917	504,675
D+2	61232	85512	355,747
D+3	40672	57248	236,745
D+4	27591	39800	161,567
D+5	20812	33485	125,334
D+6	15887	30527	100,641
D+7 to D+9 avg.	11578	30060	81,157

The resulting volume curve at Pensacola Dam was used as a goal for the volume at Pensacola Dam in HEC-RAS. In HEC-RAS, variable factors were applied at different times along the inflow hydrographs iteratively until the resulting daily inflow volume at Pensacola Dam closely matched the results of the statistical analysis. The peak flow at Pensacola Dam is still scaled to approximately match the predicted 100-year peak flow at the dam, calculated in the flood frequency analysis. **Figure 21** presents the results graphically and **Table 13** presents the results in tabular format.

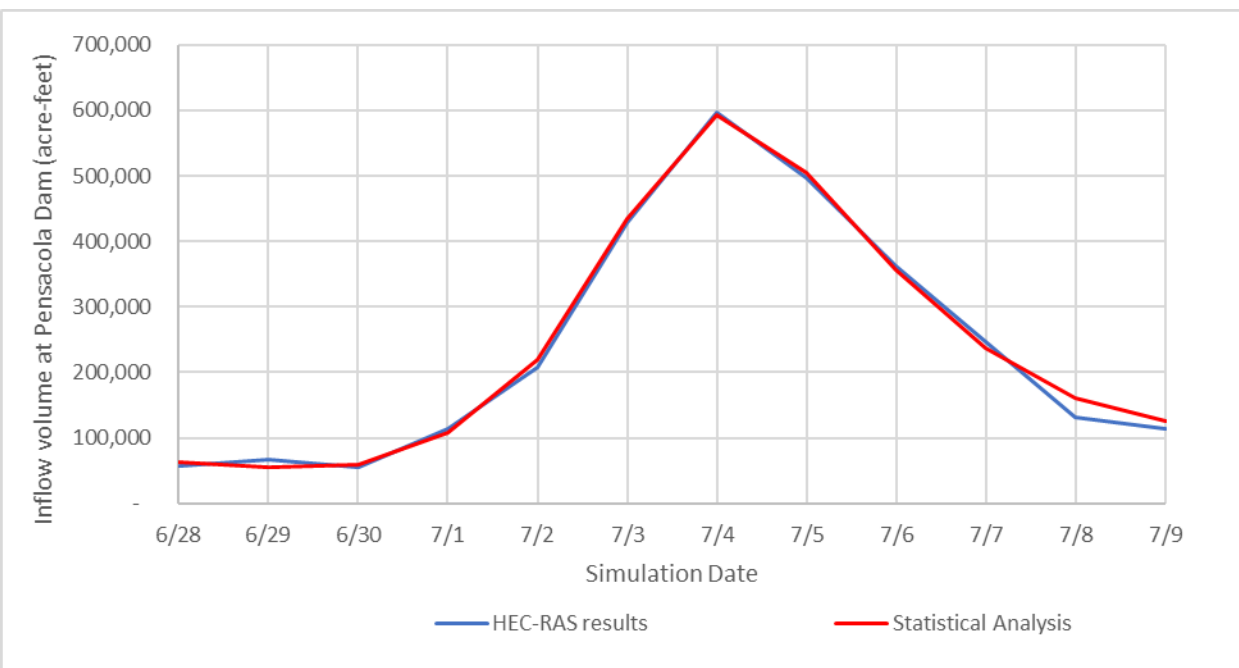


Figure 21. Graphical comparison of HEC-RAS results to statistical analysis for the 100-year flood event.

Table 13. Tabular comparison of HEC-RAS results to statistical analysis for the 100-year flood event.

Simulation Date	Volume (acre-feet)	
	Statistical Analysis	HEC-RAS Results
6/28/2007	63,810	57,073
6/29/2007	55,246	67,085
6/30/2007	58,345	55,453
7/1/2007	108,461	114,053
7/2/2007	219,027	207,606
7/3/2007	435,403	429,269
7/4/2007	593,058	596,025
7/5/2007	504,674	496,290
7/6/2007	355,747	361,363
7/7/2007	236,745	246,033
7/8/2007	161,566	130,901
7/9/2007	125,335	113,355

6. Definition of "Material Difference"

The RSP states that:

> *The H&H study area will encompass the channel and overbank areas of the Grand/Neosho River watershed that have a material difference in water surface elevation due to Project operation during the measured inflow events of the H&H Study. A material difference in water surface elevation due to Project operations will be based on professional judgment.*

In the SPD, the FERC recommended GRDA propose a definition of "material difference." On GRDA's behalf, Mead & Hunt reviewed how various government entities quantify difference in WSEL, and the findings are as follows:

1. FEMA requires base flood elevations, which is commonly the 100-year event WSEL, to "match within one-half foot" at the transition between a revised study and the study it is replacing (Office of the Federal Register, 2021).
2. USACE published an engineering manual for the Hydrologic Engineering Requirements for Reservoirs (USACE, 2018). The manual dictates the point of intersection between pre-project and post-project WSEL profiles is established where the profiles are within one foot of each other.
3. USGS defines field measurements of discharge as "excellent" if the flow measurement is within 2% of the actual value and as "good" if the measurement is within 5% of the actual value. Mead & Hunt ran all the calibration simulations with the gage inflows increased and decreased by 2%. WSELs between the two sets of simulations were compared at the USGS gages within the study area. There was a difference in WSEL of approximately one-half foot between the simulation results.

In an effort to follow generally accepted scientific practice, Mead & Hunt completed a review of how government agencies approach differences in WSEL. Material difference represents expected precision when comparing model results for the sole purpose of determining areas to be included in the model. Mead & Hunt is defining material difference as 0.5 feet of WSEL for out of bank events or 0.5 feet of WSEL within the banks where inundation impacts infrastructure or other sensitive resources. The study results (**Section 8**) confirmed that WSEL differences at the upstream ends of the model did not exceed 0.5 feet for either in bank or out of bank events.

7. Simulated Scenarios

The calibrated HEC-RAS model was used to analyze a range of operating conditions at Pensacola Dam. Five historical inflow events and one synthetic inflow event were analyzed. The inflow events and historical pool elevations at the start of the inflow events are listed in **Table 14**. In addition to the historical pool elevation, eleven other starting pool elevations were simulated. Starting pool elevations were divided into two categories:

1. Starting pool elevations within GRDA's anticipated operational range of 742 feet PD to 745 feet PD.
2. Extreme, hypothetical values of starting pool elevations outside GRDA's anticipated operational range. Values below and above GRDA's anticipated operational range were included in the study based on FERC's February 2022 Determination.

Table 15 lists the non-historical starting pool elevations analyzed. The Operations Model (OM), which was updated according to FERC's February 2022 Determination, was used to calculate stage hydrographs at Pensacola Dam for the various starting pool elevations. The starting pool elevations ranged from 734 feet PD up to 757 feet PD, which is the elevation of the crest of the dam.

Table 14. List of inflow events simulated and historical pool elevations at simulation start.

Inflow Event	Type	Estimated Return Period[1]	Pensacola Dam Historical Pool Elevation at Simulation Start (ft, PD)	Simulation Start/End Date
Sept. 1993	Historical	21 years	743.85	9/24/1993 – 10/16/1993
June 2004	Historical	1 year	743.42	6/13/2004 – 6/30/2004
July 2007	Historical	4 years	745.69	6/28/2007 – 7/25/2007
Oct. 2009	Historical	3 years	740.98	10/8/2009 – 10/21/2009
Dec. 2015	Historical	15 years	742.86	12/26/2015 – 1/16/2016
100-year	Synthetic	100 years	N/A[2]	

[1] Return period for peak inflow at Pensacola Dam.

[2] Because the 100-year event is synthetic, there is no historical pool elevation, or event start/end dates. The duration of simulation is 12.5 days.

Table 15. List of additional initial pool elevations simulated.

Inflow Event	Pensacola Dam Pool Elevation at Simulation Start (ft, PD)	
	Anticipated Operational Range	Extreme, Hypothetical Range
Sept. 1993 (21 year)	742.0, 742.5, 743.0, 743.5, 744.0, 744.5, 745.0	734.0, 749.0, 753.0, 757.0
June 2004 (1 year)	742.0, 742.5, 743.0, 743.5, 744.0, 744.5, 745.0	734.0, 749.0, 753.0, 757.0
July 2007 (4 year)	742.0, 742.5, 743.0, 743.5, 744.0, 744.5, 745.0	734.0, 749.0, 753.0, 757.0
Oct. 2009 (3 year)	742.0, 742.5, 743.0, 743.5, 744.0, 744.5, 745.0	734.0, 749.0, 753.0, 757.0
Dec. 2015 (15 year)	742.0, 742.5, 743.0, 743.5, 744.0, 744.5, 745.0	734.0, 749.0, 753.0, 757.0
100-year	742.0, 742.5, 743.0, 743.5, 744.0, 744.5, 745.0	734.0, 749.0, 753.0, 757.0

USGS flow data were used to define inflow hydrographs at the upstream ends of the model for the historical inflow events. The development of the inflow hydrographs for the synthetic 100-year event is discussed in **Section 5**. Peak inflows for the various inflow locations and inflow events are listed in **Table 16**. The flow hydrographs for the inflow events are included in **Appendix C**. Of the inflow events:

1. The September 1993 event had the highest recorded flow on the Spring River gage near Quapaw.

2. The June 2004 event had the lowest recorded flow on the Neosho River at the Commerce gage, the Spring River at the Quapaw gage, and the Elk River at the Tiff City gage.
3. The July 2007 event had the highest recorded flow on the Neosho River at the Commerce gage.
4. The October 2009 event had the second highest recorded flow on Tar Creek at the 22nd Street gage.
5. The December 2015 event had the highest recorded flow on the Elk River at the Tiff City gage.

Table 16. Summary of peak inflows.

Inflow Event	Peak Inflow (cfs)			
	Neosho River	Tar Creek	Spring River	Elk River
Sept. 1993 (21 year)	75,600	8,200	230,000	18,100
June 2004 (1 year)	24,800	749	10,500	577
July 2007 (4 year)	141,000	726	33,300	1,190
Oct. 2009 (3 year)	46,100	4,630	66,200	39,300
Dec. 2015 (15 year)	45,400	4,710	151,000	107,000
100-year	308,264	1,641	74,975	2,689

The inflow hydrographs and the Pensacola Dam starting pool elevations were input into the OM, which calculated the stage hydrographs at Pensacola Dam for the various scenarios. The OM USR, filed simultaneously with this report, discusses the development and results of the OM. **Table 17** summarizes, by inflow event, the lowest and highest peak elevation of the Pensacola Dam pool for the simulations with various Pensacola Dam starting pool elevations. The stage hydrographs at Pensacola Dam for the various starting pool elevations are included in **Appendix C**.

The highest peak elevation of the Pensacola Dam pool (757 feet PD for all inflow events) listed in **Table 17** is unrelated to the magnitude of the inflow event or GRDA operations during the inflow event. Rather, it is simply the maximum starting pool elevation simulated in accordance with FERC's February 2022 Determination. Because an elevation of 757 feet PD is equal to the crest of the dam, the OM immediately begins reducing the pool elevation after the start of the simulation. The highest peak pool elevation is thus only a function of the initial Pensacola Dam pool condition. When the highest peak is set at the top of the dam, there is no correlation to the magnitude of the inflow event or GRDA operations during the inflow event. The difference between the highest peak pool elevation when set at the top of the dam, and the lowest peak pool elevation likewise has little to do with the inflow event magnitude or GRDA operations.

Table 17. Summary of peak pool elevations at Pensacola Dam (USGS Gage No. 07190000) for all starting elevations, including extreme, hypothetical values outside GRDA's anticipated operational range.

Event	Pensacola Dam Pool Elevation (ft, PD)		Difference (ft)
	Lowest Peak	Highest Peak	
Sept. 1993 (21 year)	754.1	757.0	2.9
June 2004 (1 year)	744.2	757.0	12.8
July 2007 (4 year)	754.0	757.0	3.0
Oct. 2009 (3 year)	747.5	757.0	9.5
Dec. 2015 (15 year)	754.5	757.0	2.5
100-year	754.9	757.0	2.1

The limited usability of **Table 17** shows the need for presentation of results within GRDA's anticipated operational range, rather than the extreme, hypothetical range of starting WSELs. **Table 18** summarizes the lowest and highest peak elevation at Pensacola Dam for starting elevations within GRDA's anticipated operational range (742 to 745 ft PD). The maximum difference is 0.8 feet and occurs for the October 2009 (3-year) inflow event. Note that for the larger inflow events (15-year, 21-year, 100-year), there was no difference in peak pool elevation for the different starting elevations within GRDA's anticipated operational range.

Table 18. Summary of peak pool elevations at Pensacola Dam (USGS Gage No. 07190000) for starting elevations within GRDA's anticipated operational range.

Event	Pensacola Dam Pool Elevation (ft, PD)		Difference (ft)
	Lowest Peak	Highest Peak	
Sept. 1993 (21 year)	754.8	754.8	0.0
June 2004 (1 year)	744.6	745.0	0.4
July 2007 (4 year)	754.3	754.8	0.5
Oct. 2009 (3 year)	750.1	750.9	0.8
Dec. 2015 (15 year)	754.8	754.8	0.0
100-year	754.9	754.9	0.0

8. Study Results

Maximum WSELs and maximum inundation extents were extracted from HEC-RAS for each simulation. Maximum WSELs are presented in **Appendix D** (tabular format) and **Appendix E** (graphical format). Maximum inundation extents are presented in **Appendix F**. Durations of inundation are presented in **Appendix G**.

Tabulated results of maximum WSEL and maximum WSEL differences are presented in **Appendix D**. Within a set of tables, there is one table per modeled inflow source: the Neosho River, the Spring River, the Elk River, and Tar Creek. In **Appendix D.1** through **Appendix D.6**, tables are organized by inflow event. For example, the set of tables in **Appendix D.1** report maximum WSEL for the September 1993 inflow event. Each table in **Appendix D.1** through **Appendix D.6** includes two calculations of maximum difference in peak WSEL:

1. Maximum difference for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD).
2. Maximum difference for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

Appendix D.7 presents a set of tables for simulations that used historical starting pool elevations. Maximum WSELs are compared for the various inflow events. Each table in **Appendix D.7** includes the maximum difference in peak WSEL between the various inflow scenarios.

Plots of maximum WSEL profiles are presented in **Appendix E**. Like the tabulated results, **Appendix E.1** through **Appendix E.6** present profiles organized by inflow event, with simulation results from various starting pool elevations compared against each other. Each plot in **Appendix E.1** through **Appendix E.6** includes two profiles of calculated maximum difference in peak WSEL:

1. Maximum difference for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD).
2. Maximum difference for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

Appendix E.7 presents maximum WSEL profiles for simulations that used historical starting pool elevations. Maximum WSEL profiles are compared for the various inflow events. Each plot in **Appendix E.7** includes a profile of the maximum difference in peak WSEL between the various inflow events.

Appendix E.8 presents comparisons of maximum WSEL differences. Each plot in **Appendix E.8** includes the following plotted profiles:

1. Maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD).
2. Maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.
3. Maximum difference in WSEL for the historical inflow events (not including the synthetic 100-year inflow event).
4. Maximum difference in WSEL for all inflow events (including the synthetic 100-year inflow event).

The first profile listed above is the only profile that characterizes the impact of GRDA's anticipated operational range on differences in WSEL upstream of the dam. The second profile listed characterizes the potential impact of extreme, hypothetical starting elevations. The third profile listed characterizes the impact of nature, but only for the historical inflow events simulated. The fourth profile listed characterizes the impact of nature for all inflow events studied, including the synthetic 100-year inflow event[1].

Maps of maximum inundation extent are presented in **Appendix F**. **Appendix F.1** through **Appendix F.6** present mapped inundation extent organized by inflow event, with mapped results from various starting pool elevations compared against each other. **Appendix F.7** presents mapped inundation extent for simulations that used historical starting pool elevations, with mapped results from various inflow events compared against each other.

Tabulated results of inundation duration are presented in **Appendix G**. For areas within the boundary of the flowage easement for the Project, inundation duration was defined as the time of inundation above the flowage easement elevation. For areas outside the boundary of the flowage easement, inundation duration was defined as the time of inundation above the channel bank elevation. In **Appendix G.1** through **Appendix G.6**, tables are organized by inflow event. For example, the set of tables in **Appendix G.1** report inundation duration for the September 1993 inflow event. Each table in **Appendix G.1** through **Appendix G.6** includes two calculations of inundation duration:

1. Inundation duration for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD).
2. Inundation duration for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

Appendix G.7 presents a set of inundation duration tables for simulations that used historical starting pool elevations. Inundation durations are compared for the various inflow events. Each table in **Appendix G.7** includes the maximum difference in inundation duration between the various inflow scenarios.

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[1] Because the 100-year inflow event is synthetic, there is no historical starting pool elevation. To be conservative, a starting pool elevation of 734 feet PD was used for the 100-year inflow event when calculating the maximum difference in WSEL due to all inflow events.

9. Discussion of Results

Maximum WSELs, maximum inundation extents, and inundation durations were analyzed to determine the upstream impacts, if any, of various initial stages at Pensacola Dam. **Table 19** presents a summary of maximum WSEL differences along the modeled inflow reaches for simulated starting elevations within GRDA's anticipated operational range. The first six rows in the table present maximum WSEL differences for the various starting pool elevations for a given inflow event. The last two rows in the table present maximum WSEL differences for the various natural inflow events, first for the historical inflow events simulated, then for all inflow events simulated (including the 100-year event). Stated another way, the first six rows in the table characterize the impact of starting pool elevations within GRDA's anticipated operational range and the last two rows characterize the impact of nature. The maximum simulated WSEL differences due to a change in starting pool elevation within GRDA's anticipated operational range are orders of magnitude smaller than the maximum WSEL differences that can be caused by nature. More specifically:

1. Along the Neosho River, the maximum impact of nature ranges from 16 to 797 times greater than the maximum simulated impact of GRDA's anticipated operational range.
2. Along the Spring River, the maximum impact of nature ranges from 34 to 525 times greater than the maximum simulated impact of GRDA's anticipated operational range.
3. Along the Elk River, the maximum impact of nature ranges from 31 to 669 times greater than the maximum simulated impact of GRDA's anticipated operational range.
4. Along Tar Creek, the maximum impact of nature ranges from 59 to 2,922 times greater than the maximum simulated impact of GRDA's anticipated operational range.

Table 19. Summary of maximum WSEL differences for starting elevations within GRDA's anticipated operational range.

Event(s)	Maximum WSEL Differences (ft) for Starting Elevations Within GRDA's Anticipated Operational Range			
	Neosho River[1]	Spring River	Elk River	Tar Creek
Sept. 1993 (21 year)	0.40	0.12	0.06	0.16
June 2004 (1 year)	0.80	0.95	0.44	0.35
July 2007 (4 year)	1.29	1.07	0.53	0.12
Oct. 2009 (3 year)	0.99	0.50	0.87	0.10
Dec. 2015 (15 year)	0.06	0.14	0.06	0.04
100-year	0.04	0.07	0.04	0.01
Impact of inflow events (historical events only)	21.03	36.78	26.75	20.58
Impact of all inflow events (inc. 100-year event)	31.88	36.78	26.75	32.15

[1] Along the Neosho River, the maximum WSEL differences for the anticipated operations simulations occur at various locations between RM 112.6 and RM 128.8, which is downstream of Miami, OK. For the impact of inflow (impact of nature) simulations, the maximum WSEL difference occurs at RM 135.9, which is located in Miami, OK.

In accordance with FERC's February 2022 Determination, **Table 20** presents a summary of maximum WSEL differences along the modeled inflow reaches for simulated starting pool elevations outside GRDA's anticipated operational range. Even using these extreme, hypothetical starting stages, which range from 734 to 757 feet PD, the impact of nature is much greater than that of a 23-foot change in starting pool elevation. More specifically:

1. Along the Neosho River, the maximum impact of nature ranges from 1.6 to 16 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.

2. Along the Spring River, the maximum impact of nature ranges from 2.9 to 111 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.
3. Along the Elk River, the maximum impact of nature ranges from 2.1 to 14 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.
4. Along Tar Creek, the maximum impact of nature ranges from 3.0 to 564 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.

Along the Neosho River, the maximum WSEL differences for the extreme, hypothetical simulations occur at various locations between RM 77 (Pensacola Dam) and RM 122.0, which is downstream of Miami, OK.

Table 20. Summary of maximum WSEL differences for all starting elevations, including extreme, hypothetical values outside GRDA's anticipated operational range.

Event(s)	Maximum WSEL Differences (ft) for All Starting Elevations, Including Extreme, Hypothetical Values Outside GRDA's Anticipated Operational Range			
	Neosho River[1]	Spring River	Elk River	Tar Creek
Sept. 1993 (21 year)	2.92	0.98	2.97	0.71
June 2004 (1 year)	12.82	12.56	12.81	6.77
July 2007 (4 year)	3.02	2.13	3.00	0.29
Oct. 2009 (3 year)	9.69	6.32	9.65	2.03
Dec. 2015 (15 year)	3.15	3.10	2.59	1.84
100-year	2.05	0.33	1.88	0.06
Impact of inflow events (historical events only)	21.03	36.78	26.75	20.58
Impact of all inflow events (inc. 100-year event)	31.88	36.78	26.75	32.15

[1] Along the Neosho River, the maximum WSEL differences for the extreme, hypothetical simulations occur at various locations between RM 77 (Pensacola Dam) and RM 122.0, which is downstream of Miami, OK. For the impact of inflow (impact of nature) simulations, the maximum WSEL difference occurs at RM 135.9, which is located in Miami, OK .

Table 21 presents results of maximum WSEL differences through the City of Miami, OK in more detail for simulated starting pool elevations within GRDA's anticipated operational range. **Table 22** presents the same information for extreme, hypothetical starting elevations outside GRDA's anticipated operational range. In both tables, the columns on the right present maximum simulated differences in WSEL for four individual river mile segments that cover the City of Miami. The results show that any simulated impact of starting stage – whether within GRDA's anticipated operational range or for extreme, hypothetical stages – has little impact on WSELs when compared to nature's impact. More specifically:

1. The maximum impact of nature ranges from 46 to 3,188 times greater than the maximum simulated impact of GRDA's anticipated operational range.
2. The maximum impact of nature ranges from 2.3 to 531 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.

Table 21. Summary of maximum WSEL differences through Miami, OK for starting elevations within GRDA's anticipated operational range.

Event(s)	Maximum WSEL Differences Through Miami, OK (ft) for Starting Elevations Within GRDA's Anticipated Operational Range			
	RM 133-134	RM 134-135	RM 135-136	RM 136-137
Sept. 1993 (21 year)	0.20	0.16	0.14	0.12
June 2004 (1 year)	0.45	0.35	0.31	0.26
July 2007 (4 year)	0.16	0.12	0.08	0.07
Oct. 2009 (3 year)	0.13	0.10	0.09	0.08
Dec. 2015 (15 year)	0.04	0.04	0.05	0.05
100-year	0.01	0.01	0.01	0.02
Impact of inflow events (historical events only)	20.81	20.51	20.89	20.89
Impact of all inflow events (inc. 100-year event)	31.65	31.67	31.88	31.82

Table 22. Summary of maximum WSEL differences through Miami, OK for all starting elevations, including extreme, hypothetical values outside GRDA's anticipated operational range.

Event(s)	Maximum WSEL Differences Through Miami, OK (ft) for All Starting Elevations, Including Extreme, Hypothetical Values Outside GRDA's Anticipated Operational Range			
	RM 133-134	RM 134-135	RM 135-136	RM 136-137
Sept. 1993 (21 year)	0.83	0.70	0.61	0.58
June 2004 (1 year)	8.88	6.68	5.65	4.97
July 2007 (4 year)	0.33	0.28	0.23	0.21
Oct. 2009 (3 year)	2.61	2.00	1.71	1.60
Dec. 2015 (15 year)	2.12	1.82	1.65	1.60
100-year	0.06	0.06	0.06	0.06
Impact of inflow events (historical events only)	20.81	20.51	20.89	20.89
Impact of all inflow events (inc. 100-year event)	31.65	31.67	31.88	31.82

Table 23 presents a summary of smallest and largest inundation areas for simulated starting elevations within GRDA's anticipated operational range. The first six rows in the table present smallest and largest inundation areas for simulations with various starting pool elevations for a given inflow event. The last two rows in the table present smallest and largest inundation areas for the natural various inflow events, first for the historical inflow events simulated, then for all inflow events simulated (including the 100-year event). Stated another way, the first six rows in the table characterize the impact of GRDA's anticipated operations and the last two rows characterize the impact of nature. The simulated inundation area differences due to a change in starting pool elevation within GRDA's anticipated operational range are orders of magnitude smaller than the inundation differences that can be caused by nature. More specifically, regarding the difference in inundation area:

1. If only historical inflow events are considered, the maximum impact of nature ranges from 35 to 4,444 times greater than the maximum simulated impact of GRDA's anticipated operational range.
2. If all inflow events are considered, the maximum impact of nature ranges from 43 to 5,479 times greater than the maximum simulated impact of GRDA's anticipated operational range.

Table 23. Summary of smallest and largest inundation areas for starting elevations within GRDA's anticipated operational range.

Event(s)	Area of Inundation (acres) for Starting Elevations Within GRDA's Anticipated Operational Range		Difference (%)
	Smallest	Largest	
Sept. 1993 (21 year)	81,954	82,039	0.1%
June 2004 (1 year)	49,778	50,466	1.4%
July 2007 (4 year)	80,328	81,018	0.9%
Oct. 2009 (3 year)	70,506	71,085	0.8%
Dec. 2015 (15 year)	78,499	78,508	0.0%
100-year	92,637	92,649	0.0%
Impact of inflow events (historical events only)	50,102	82,033	48.3%
Impact of all inflow events (inc. 100-year event)	50,102	92,631	59.6%

In accordance with FERC's February 2022 Determination, **Table 24** presents a summary of smallest and largest inundation areas for simulated starting pool elevations outside GRDA's anticipated operational range. Even using these extreme, hypothetical stages, which range from 734 to 757 feet PD, the impact of nature is much greater than that of a 23-foot change in starting pool elevation. More specifically:

1. If only historical inflow events are considered, the maximum impact of nature ranges from 1.7 to 29 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.
2. If all inflow events are considered, the maximum impact of nature ranges from 2.1 to 36 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.

Table 24. Summary of smallest and largest maximum inundation areas for all starting elevations, including extreme, hypothetical values outside GRDA's anticipated operational range.

Event(s)	Area of Inundation (acres) for All Starting Elevations, Including Extreme, Hypothetical Values Outside GRDA's Anticipated Operational Range		Difference (%)
	Smallest	Largest	
Sept. 1993 (21 year)	81,277	84,085	3.4%
June 2004 (1 year)	48,943	65,075	28.3%
July 2007 (4 year)	79,989	82,910	3.6%
Oct. 2009 (3 year)	68,613	76,971	11.5%
Dec. 2015 (15 year)	77,482	80,606	4.0%
100-year	92,631	94,192	1.7%
Impact of inflow events (historical events only)	50,102	82,033	48.3%
Impact of all inflow events (inc. 100-year event)	50,102	92,631	59.6%

Table 25 presents results of maximum inundation area differences through the City of Miami, OK in more detail for simulated starting pool elevations within GRDA's anticipated operational range. **Table 26** presents the same information for extreme, hypothetical starting elevations outside GRDA's anticipated

operational range. The results show that any simulated impact of starting stage – whether within GRDA's anticipated operational range or for extreme, hypothetical stages – has little impact on inundation area within the City of Miami when compared to nature's impact. More specifically:

1. The maximum impact of nature ranges from 13 to 8,917 times greater than the maximum simulated impact of GRDA's anticipated operational range.
2. The maximum impact of nature ranges from 1.2 to 1,633 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.

Table 25. Summary of maximum inundation area differences through Miami, OK for starting elevations within GRDA's anticipated operational range.

Event(s)	Maximum Inundation Area Differences Through Miami, OK for Starting Elevations Within GRDA's Anticipated Operational Range			
	RM 133-134	RM 134-135	RM 135-136	RM 136-137
Sept. 1993 (21 year)	1.1%	0.8%	1.1%	0.9%
June 2004 (1 year)	11.3%	5.3%	6.2%	9.6%
July 2007 (4 year)	0.7%	0.8%	0.4%	0.2%
Oct. 2009 (3 year)	0.7%	0.4%	0.7%	0.7%
Dec. 2015 (15 year)	4.3%	0.2%	0.4%	0.5%
100-year	0.0%	0.1%	0.0%	0.0%
Impact of inflow events (historical events only)	143%	142%	134%	142%
Impact of all inflow events (inc. 100-year event)	162%	164%	147%	151%

Table 26. Summary of maximum inundation area differences through Miami, OK for all starting elevations, including extreme, hypothetical values outside GRDA's anticipated operational range.

Event(s)	Maximum Inundation Area Differences Through Miami, OK for All Starting Elevations, Including Extreme, Hypothetical Values Outside GRDA's Anticipated Operational Range			
	RM 133-134	RM 134-135	RM 135-136	RM 136-137
Sept. 1993 (21 year)	4%	3%	4%	5%
June 2004 (1 year)	116%	83%	70%	88%
July 2007 (4 year)	1%	2%	1%	0%
Oct. 2009 (3 year)	16%	8%	16%	15%
Dec. 2015 (15 year)	14%	9%	14%	19%
100-year	0%	0%	0%	0%
Impact of inflow events (historical events only)	143%	142%	134%	142%
Impact of all inflow events (inc. 100-year event)	162%	164%	147%	151%

Table 27 presents a summary of inundation duration differences for simulated starting elevations within GRDA's anticipated operational range. The first six rows in the table present the maximum differences in duration for simulations with various starting pool elevations for a given inflow event. The last two rows in the table present the maximum difference in duration for the various natural inflow events, first for the historical inflow events simulated, then for all inflow events simulated (including the 100-year event). Stated another way, the first six rows in the table characterize the impact of starting pool elevations within GRDA's anticipated operational range and the last two rows characterize the impact of nature. The

simulated duration differences due to a change in starting pool elevation within GRDA's anticipated operational range are orders of magnitude smaller than the duration differences that can be caused by nature. More specifically:

1. Along the Neosho River, the maximum impact of nature ranges from 6 to 261 times greater than the maximum simulated impact of GRDA's anticipated operational range.
2. Along the Spring River, the maximum impact of nature ranges from 14 to 115 times greater than the maximum simulated impact of GRDA's anticipated operational range.
3. Along the Elk River, the maximum impact of nature is 118 times greater than the maximum simulated impact of GRDA's anticipated operational range.
4. Along Tar Creek, the maximum impact of nature ranges from 79 to 210 times greater than the maximum simulated impact of GRDA's anticipated operational range.

As **Table 27** presents, some of the maximum duration differences for a given inflow event on a given reach were zero. In such instances, a value of one hour was used instead of zero to calculate the ratios listed above, which would otherwise be undefined.

Table 27. Summary of inundation duration differences for starting elevations within GRDA's anticipated operational range.

Event(s)	Maximum Duration Difference (hours) for Starting Elevations Within GRDA's Anticipated Operational Range			
	Neosho River	Spring River	Elk River	Tar Creek
Sept. 1993 (21 year)	20	6	0	2
June 2004 (1 year)	1	0	0	0
July 2007 (4 year)	43	8	0	2
Oct. 2009 (3 year)	4	1	0	1
Dec. 2015 (15 year)	3	2	0	1
100-year	2	2	0	1
Impact of inflow events (historical events only)	239	112	118	158
Impact of all inflow events (inc. 100-year event)	261	115	118	210

The largest differences in duration for simulated starting elevations within GRDA's anticipated operational range occur in rural, sparsely populated areas. For the September 1993 (21 year) inflow event, the 20-hour maximum simulated difference in duration listed in **Table 27** is isolated to RM 124 to 125 on the Neosho River. This location is between the Highway 60 Bridge at Twin Bridges State Park (RM 122.57) and the S 590 Road Bridge (RM 126.70). The simulated difference in duration is isolated to this location and does not extend either upstream or downstream. For the September 1993 (21 year) inflow event, there are no other locations along the Neosho River with differences in duration greater than 8 hours. For the July 2007 (4 year) inflow event, the 43-hour simulated difference listed in **Table 27** is also isolated to RM 124 to 125 on the Neosho River. The simulated difference in duration does not extend either upstream or downstream. For the July 2007 (4 year) inflow event, there are no other locations along the Neosho River with differences in duration greater than 8 hours.

In accordance with FERC's February 2022 Determination, **Table 28** presents a summary of duration differences for simulated starting pool elevations outside GRDA's anticipated operational range. Even using these extreme, hypothetical stages, which range from 734 to 757 feet PD, the impact of nature is much greater than that of a 23-foot change in starting pool elevation. More specifically:

1. Along the Neosho River, the maximum impact of nature ranges from 4 to 10 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.
2. Along the Spring River, the maximum impact of nature ranges from 3 to 115 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.
3. Along the Elk River, the maximum impact of nature ranges from 39 to 118 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.
4. Along Tar Creek, the maximum impact of nature ranges from 2 to 210 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.

As **Table 28** presents, some of the maximum duration differences for a given inflow event on a given reach were zero. In such instances, a value of one hour was used instead of zero to calculate the ratios listed above, which would otherwise be undefined.

Table 28. Summary of inundation duration differences for all starting elevations, including extreme, hypothetical values outside GRDA's anticipated operational range.

Event(s)	Maximum Duration Difference (hours) for All Starting Elevations, Including Extreme, Hypothetical Values Outside GRDA's Anticipated Operational Range			
	Neosho River	Spring River	Elk River	Tar Creek
Sept. 1993 (21 year)	42	25	1	15
June 2004 (1 year)	41	0	0	0
July 2007 (4 year)	51	41	0	13
Oct. 2009 (3 year)	59	23	1	91
Dec. 2015 (15 year)	52	41	3	59
100-year	25	15	0	7
Impact of inflow events (historical events only)	239	112	118	158
Impact of all inflow events (inc. 100-year event)	261	115	118	210

Table 29 presents results of maximum duration differences through the City of Miami, OK in more detail for simulated starting pool elevations within GRDA's anticipated operational range. **Table 30** presents the same information for extreme, hypothetical starting elevations outside GRDA's anticipated operational range. The results show that any simulated impact of starting stage – whether within GRDA's anticipated operational range or for extreme, hypothetical stages – has little impact on duration when compared to nature's impact. More specifically:

1. The maximum impact of nature ranges from 42 to 223 times greater than the maximum simulated impact of GRDA's anticipated operational range.
2. The maximum impact of nature ranges from 3 to 223 times greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet.

Table 29. Summary of maximum duration differences through Miami, OK for starting elevations within GRDA's anticipated operational range.

Event(s)	Maximum Duration Differences Through Miami, OK (hours) for Starting Elevations Within GRDA's Anticipated Operational Range			
	RM 133-134	RM 134-135	RM 135-136	RM 136-137
Sept. 1993 (21 year)	1	1	2	1
June 2004 (1 year)	0	0	0	0
July 2007 (4 year)	2	3	3	2
Oct. 2009 (3 year)	0	4	3	2
Dec. 2015 (15 year)	1	1	1	0
100-year	1	1	1	0
Impact of inflow events (historical events only)	154	166	168	175
Impact of all inflow events (inc. 100-year event)	210	219	220	223

Table 30. Summary of maximum duration differences through Miami, OK for all starting elevations, including extreme, hypothetical values outside GRDA's anticipated operational range.

Event(s)	Maximum Duration Differences Through Miami, OK (hours) for All Starting Elevations, Including Extreme, Hypothetical Values Outside GRDA's Anticipated Operational Range			
	RM 133-134	RM 134-135	RM 135-136	RM 136-137
Sept. 1993 (21 year)	9	10	10	10
June 2004 (1 year)	0	0	0	0
July 2007 (4 year)	13	14	15	16
Oct. 2009 (3 year)	59	59	35	31
Dec. 2015 (15 year)	32	22	18	16
100-year	7	7	7	7
Impact of inflow events (historical events only)	154	166	168	175
Impact of all inflow events (inc. 100-year event)	210	219	220	223

Figure 22 through **Figure 33** display examples of maximum WSEL profiles and maximum inundation extent organized by inflow event, as presented in **Appendix E.1** through **Appendix E.6** (WSEL profiles) and **Appendix F.1** through **Appendix F.6** (maximum inundation extent). **Figure 34** and **Figure 35** display examples of maximum WSEL profiles and maximum inundation extents, respectively, for simulations that used historical starting pool elevations for various inflow events, as presented in **Appendix E.7** and **Appendix F.7**.

Figure 22 through **Figure 35** are representative of the data presented in **Table 19** through **Table 26**. The magnitude of the incoming flow event is the primary determining factor of maximum WSEL and maximum inundation extent upstream of Pensacola Dam. For the various inflow events, modifying the starting pool elevation within GRDA's anticipated operational range (742 to 745 feet PD, a range of 3 feet) resulted in little difference in maximum WSEL and little difference in maximum inundation extent. The maximum WSEL differences due to a change in starting pool elevation within GRDA's anticipated operational range (**Figure 22** through **Figure 33**) are orders of magnitude smaller than the maximum WSEL differences that can be caused by nature (**Figure 34** and **Figure 35**). Even if the operational range were expanded to the extreme, hypothetical stages analyzed in accordance with FERC's February 2022 Determination, nature is the controlling factor. For an extreme 23-foot starting pool range (734 to 757 feet PD, with a maximum starting pool elevation equal to the top of the dam), the differences are still far less than the differences caused by nature. The differences in maximum WSEL and maximum inundation extent caused by nature are twice or more than simulated differences for a 23-foot change in starting pool elevation.

To show this more explicitly, **Figure 36** through **Figure 43** display examples of maximum WSEL profiles and maximum inundation extents for simulations that used various natural inflow events and a single starting pool elevation. The figures display results for the following starting pool elevations:

1. 734 feet PD, the lowest extreme, hypothetical starting stage FERC recommended simulating,
2. 742 feet PD, the lowest elevation of GRDA's anticipated operational range,
3. 745 feet PD, the highest elevation of GRDA's anticipated operational range, and
4. 757 feet PD, the highest extreme, hypothetical starting stage FERC recommended simulating and the elevation of the top of the dam.

These figures show that for the same starting pool elevation, there are large differences in maximum WSEL and maximum inundation extent due to the magnitude of the incoming natural inflow event. The magnitude of the natural inflow event is the primary determining factor of maximum WSEL and maximum inundation extent.

A final comparison is presented to show how the magnitude of the natural inflow event is the primary determining factor of maximum WSEL, as opposed to the starting pool elevation. **Figure 44** displays an example comparison of maximum WSEL differences, as presented in **Appendix E.8**. The figure includes four plots of maximum difference in peak WSEL:

1. Maximum difference due to changes in starting pool elevation within GRDA's anticipated operational range (742 to 745 feet PD).
2. Maximum difference due to changes in starting pool elevation at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.
3. Maximum difference in WSEL due to the magnitude of the historical inflow events (does not include synthetic, 100-year event).
4. Maximum difference in WSEL due to the magnitude of the inflow event (1-year to 100-year).

Figure 44 shows the following:

1. The magnitude of the natural inflow event is the primary determining factor of maximum WSEL.
2. Starting pool elevations within GRDA's anticipated operational range have an immaterial impact on upstream WSELs.
3. Even if extreme, hypothetical values of starting pool elevations outside GRDA's anticipated operational range are used, the impact of nature is much greater than that of a 23-foot change in starting pool elevation.

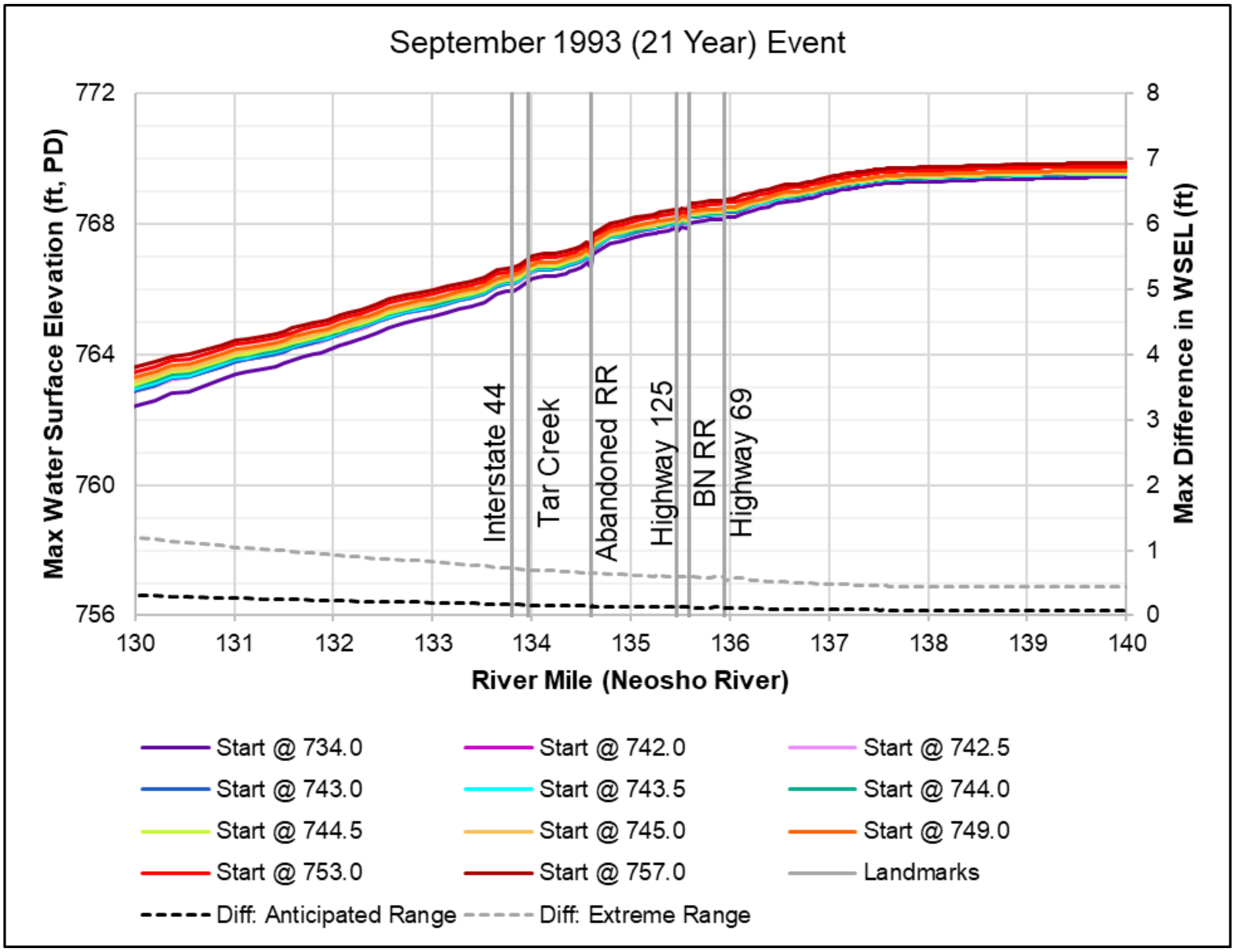

Figure 22. Maximum WSELs near Miami, OK for the September 1993 (21 year) event.

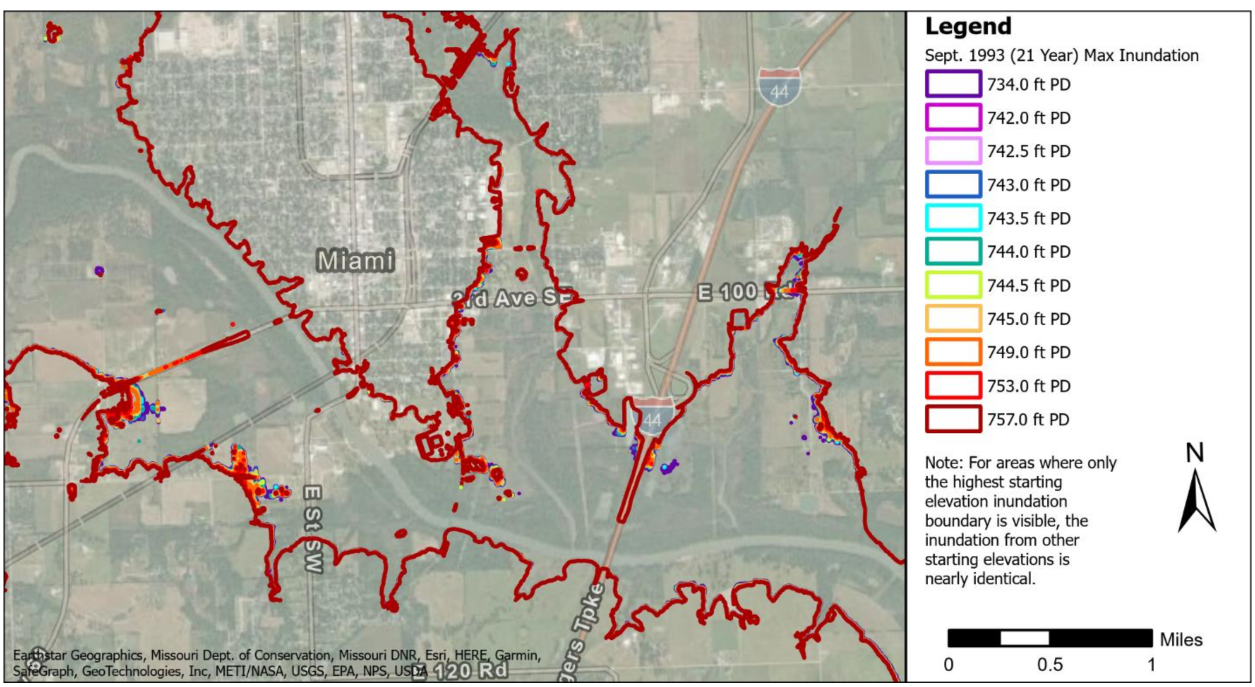

Figure 23. Maximum inundation extents near Miami, OK for the September 1993 (21 year) event.

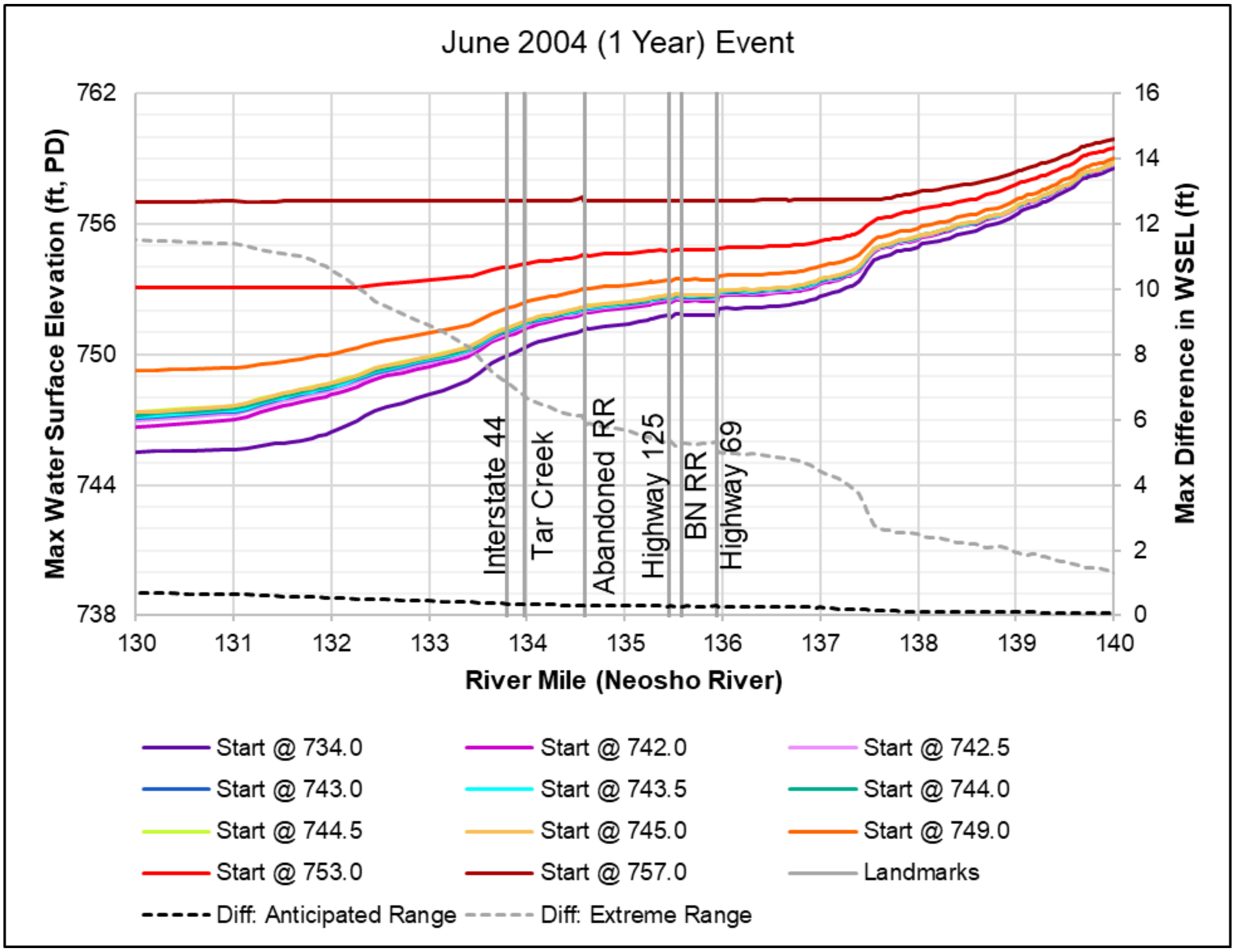

Figure 24. Maximum WSELs near Miami, OK for the June 2004 (1 year) event.

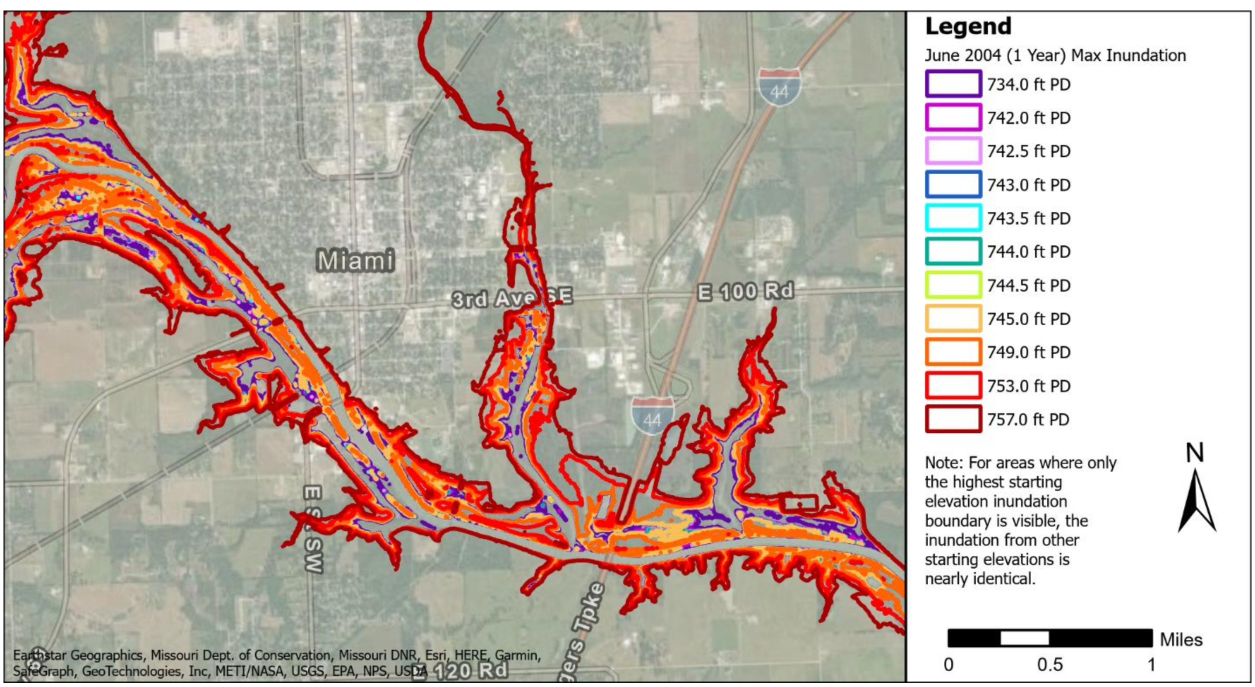

Figure 25. Maximum inundation extents near Miami, OK for the June 2004 (1 year) event.

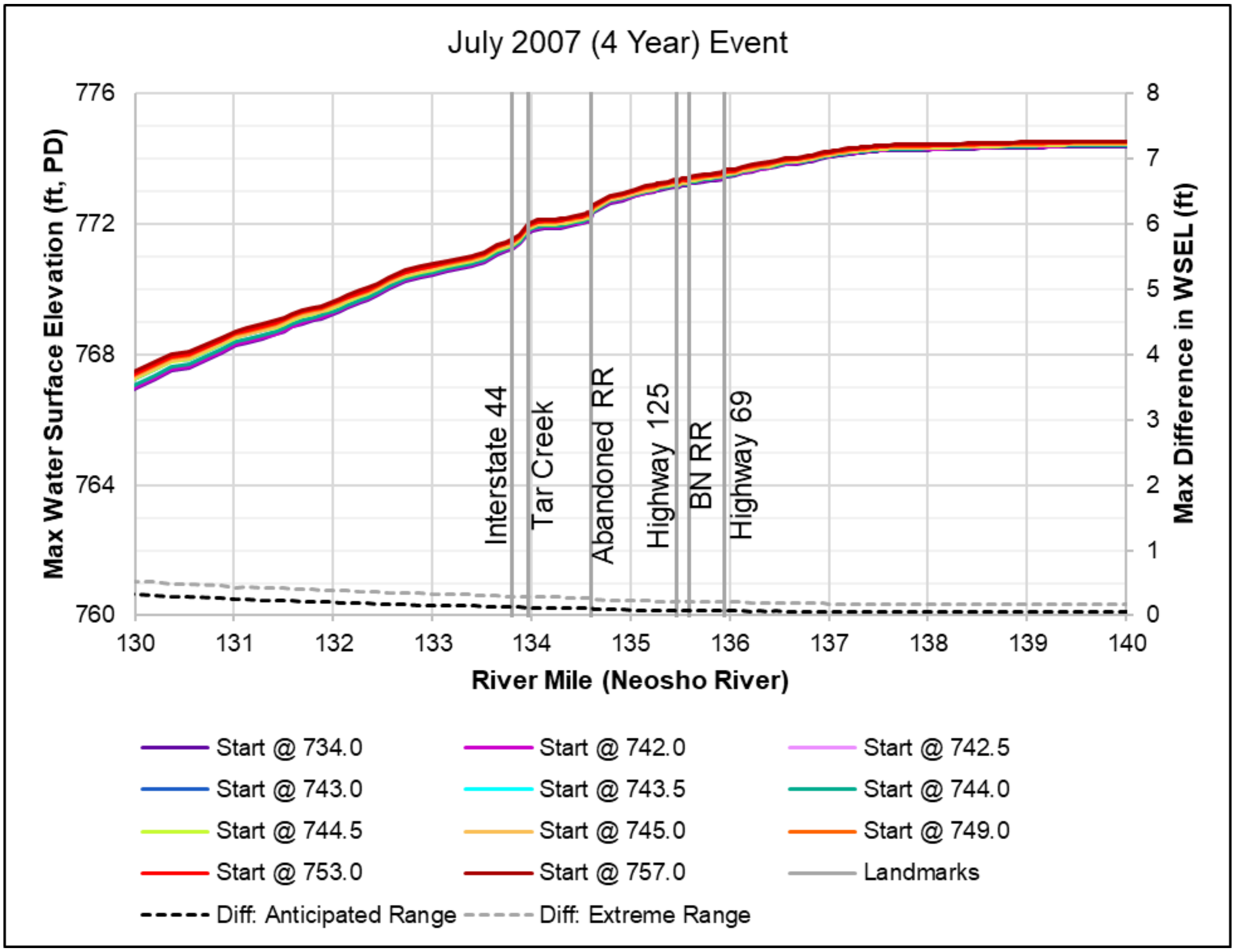

Figure 26. Maximum WSELs near Miami, OK for the July 2007 (4 year) event.

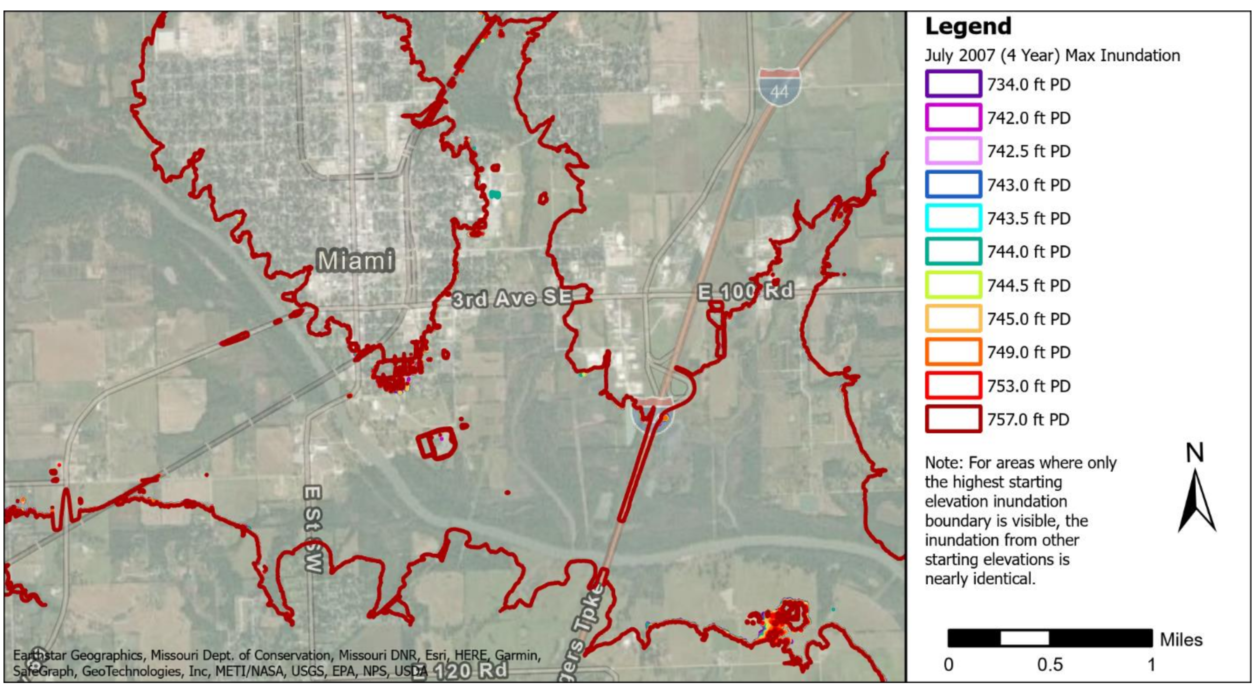

Figure 27. Maximum inundation extents near Miami, OK for the July 2007 (4 year) event.

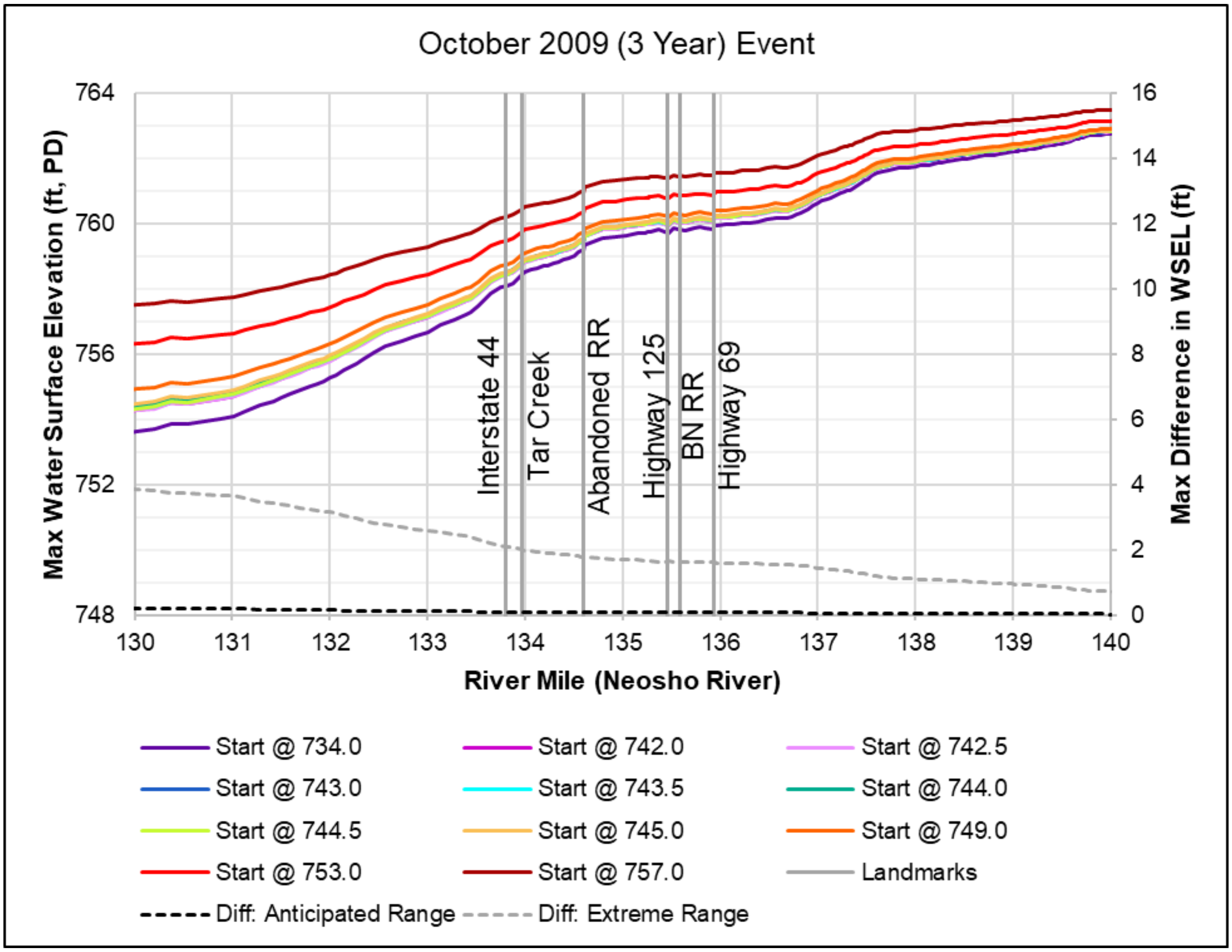

Figure 28. Maximum WSELs near Miami, OK for the October 2009 (3 year) event.

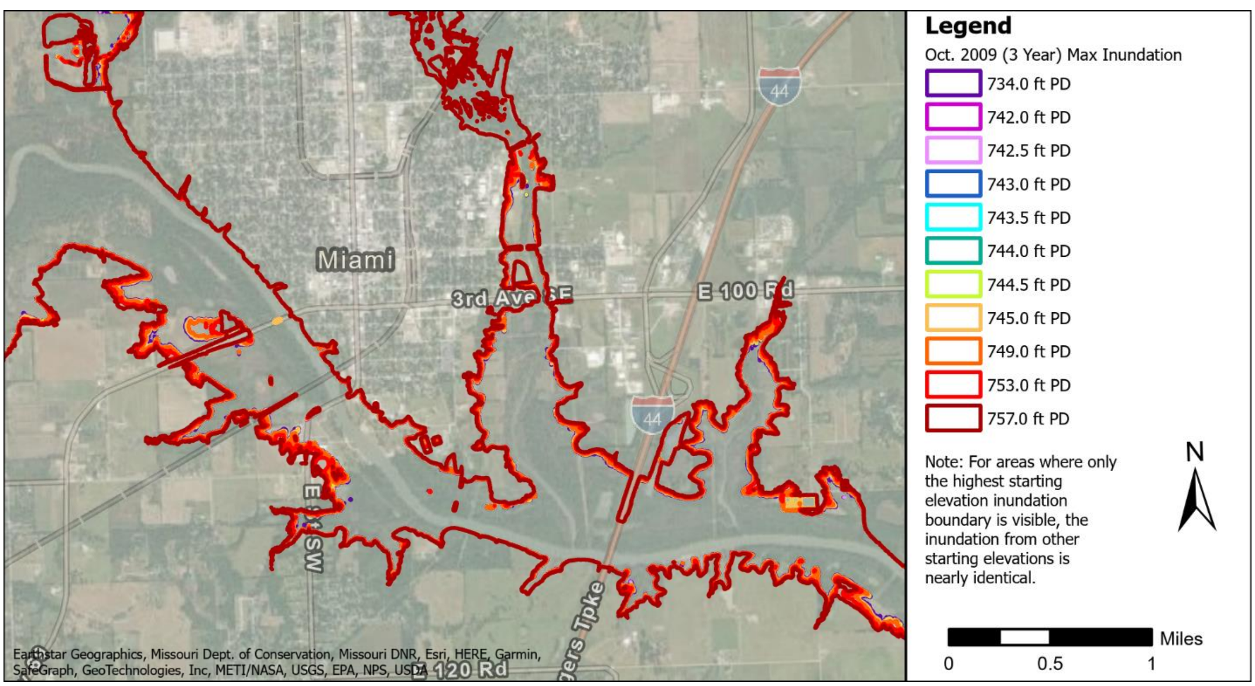

Figure 29. Maximum inundation extents near Miami, OK for the October 2009 (3 year) event.

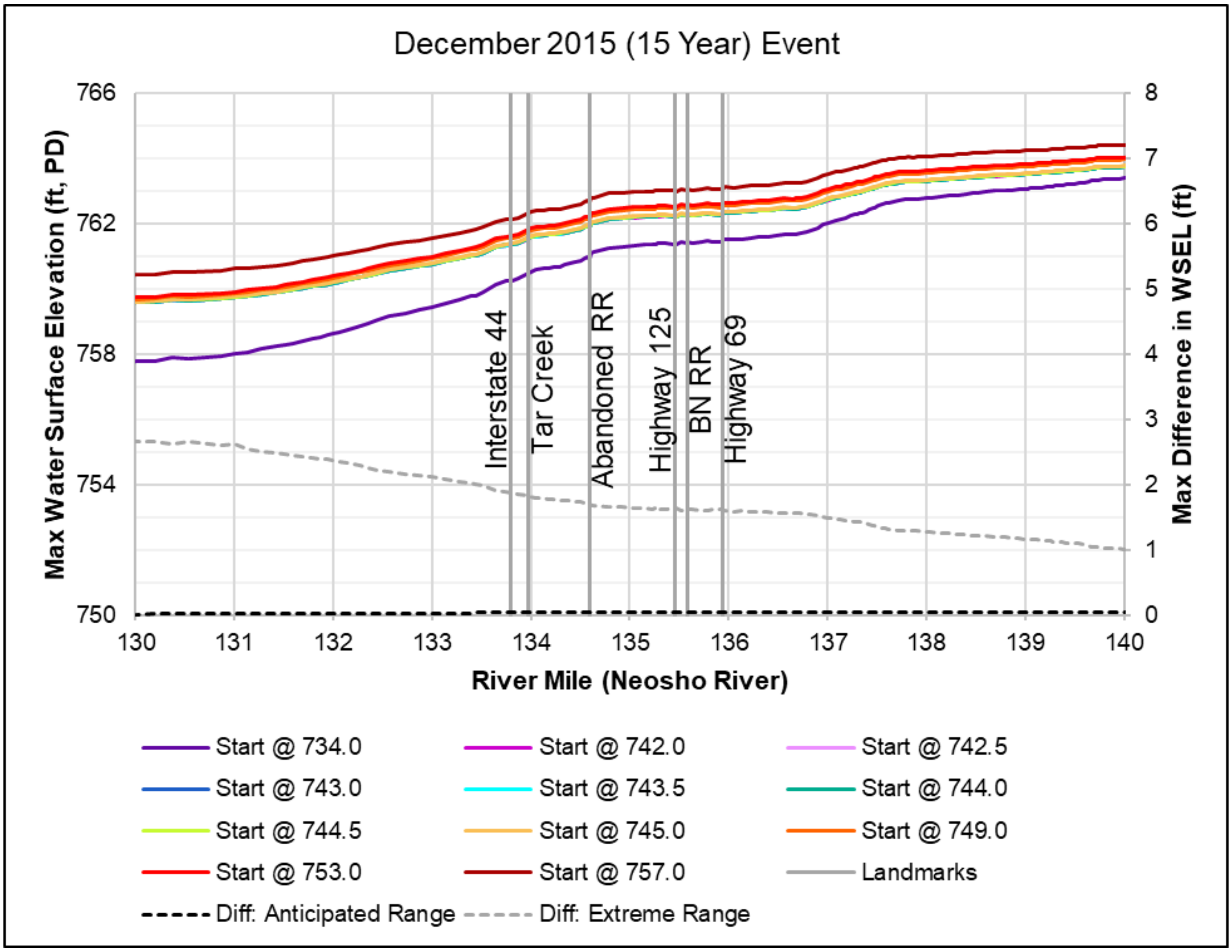

Figure 30. Maximum WSELs near Miami, OK for the December 2015 (15 year) event.

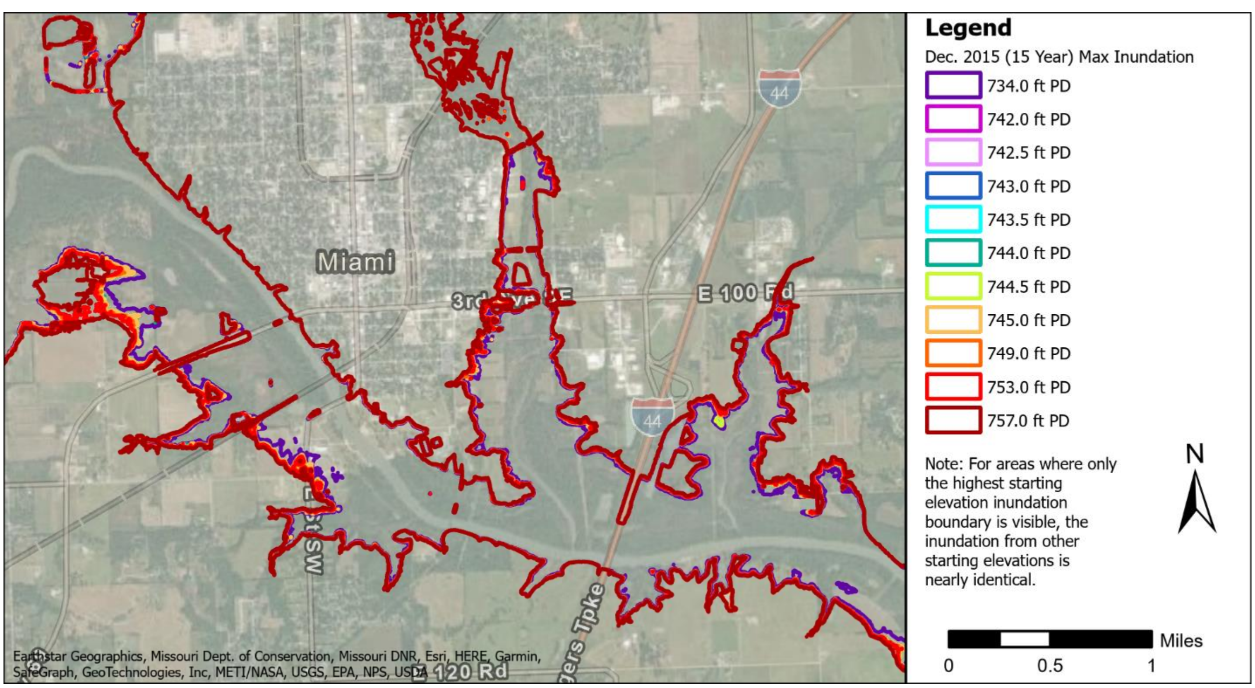

Figure 31. Maximum inundation extents near Miami, OK for the December 2015 (15 year) event.

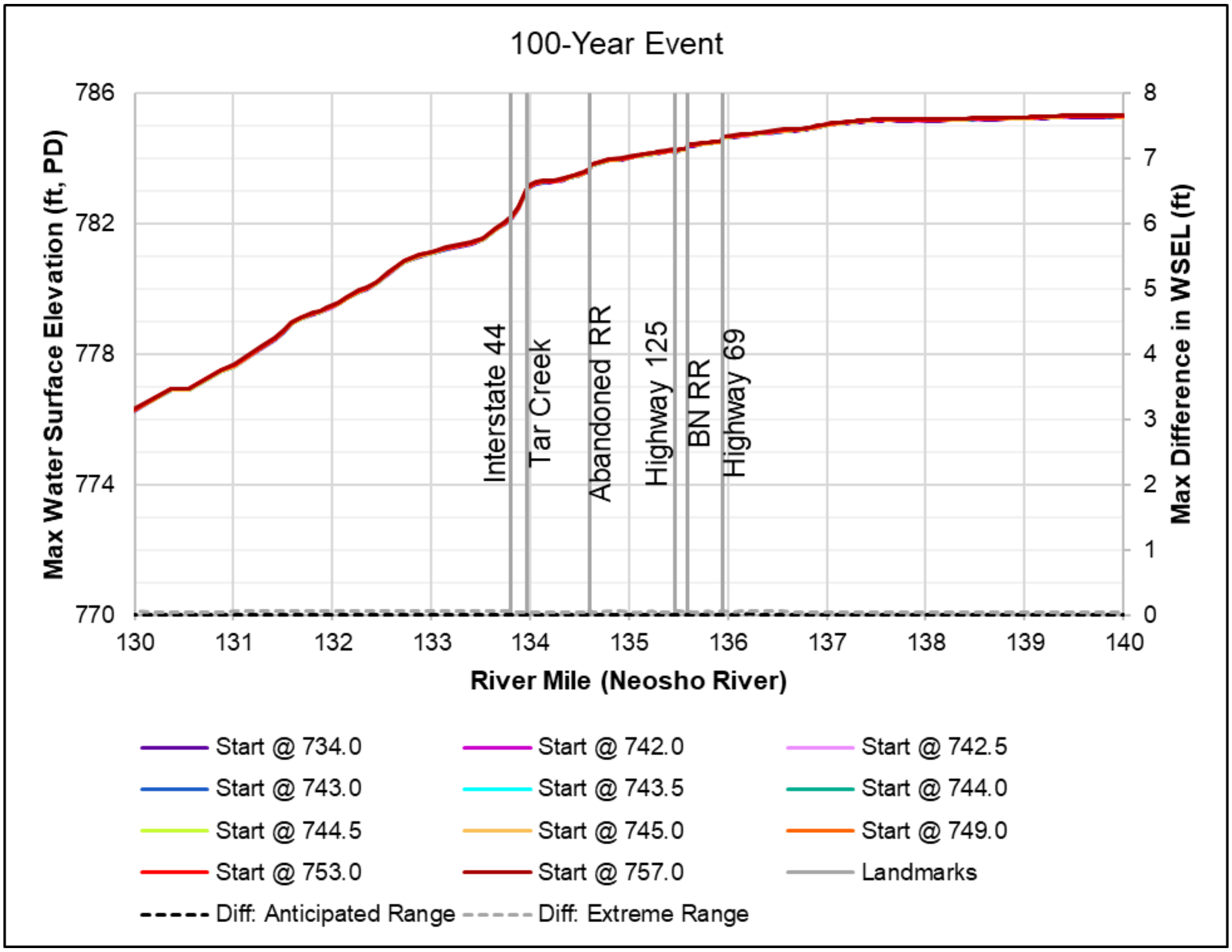

Figure 32. Maximum WSELs near Miami, OK for the 100-year event.

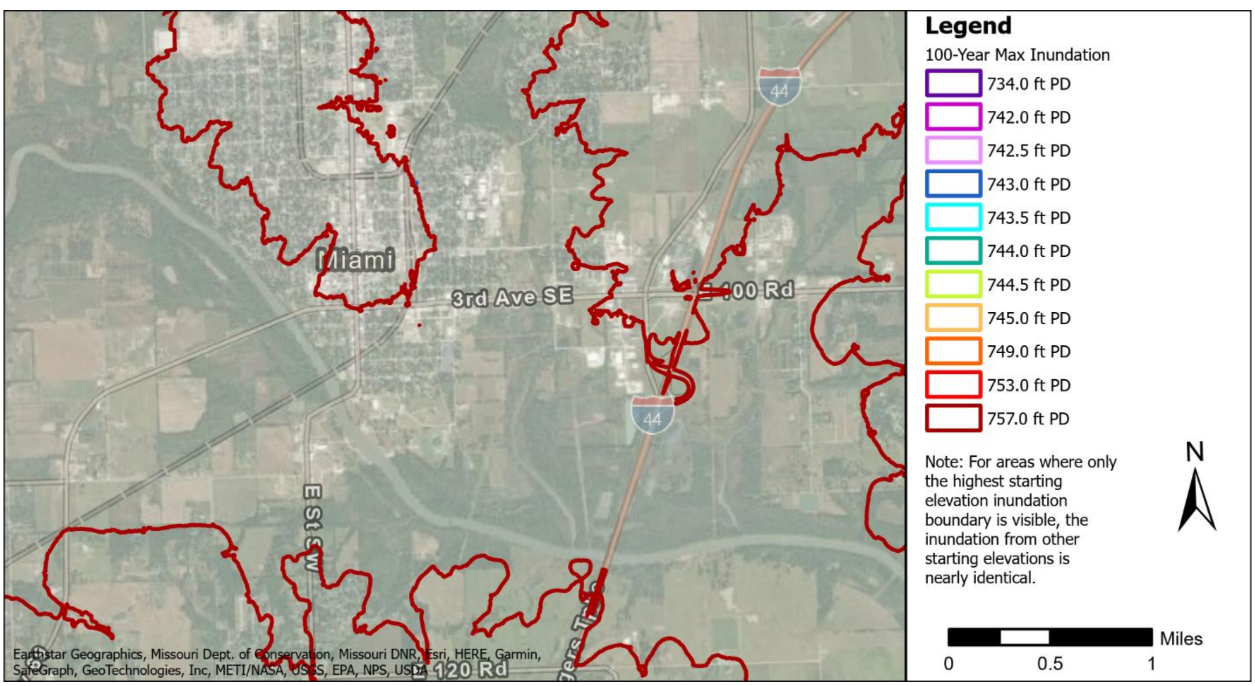

Figure 33. Maximum inundation extents near Miami, OK for the 100-year event.

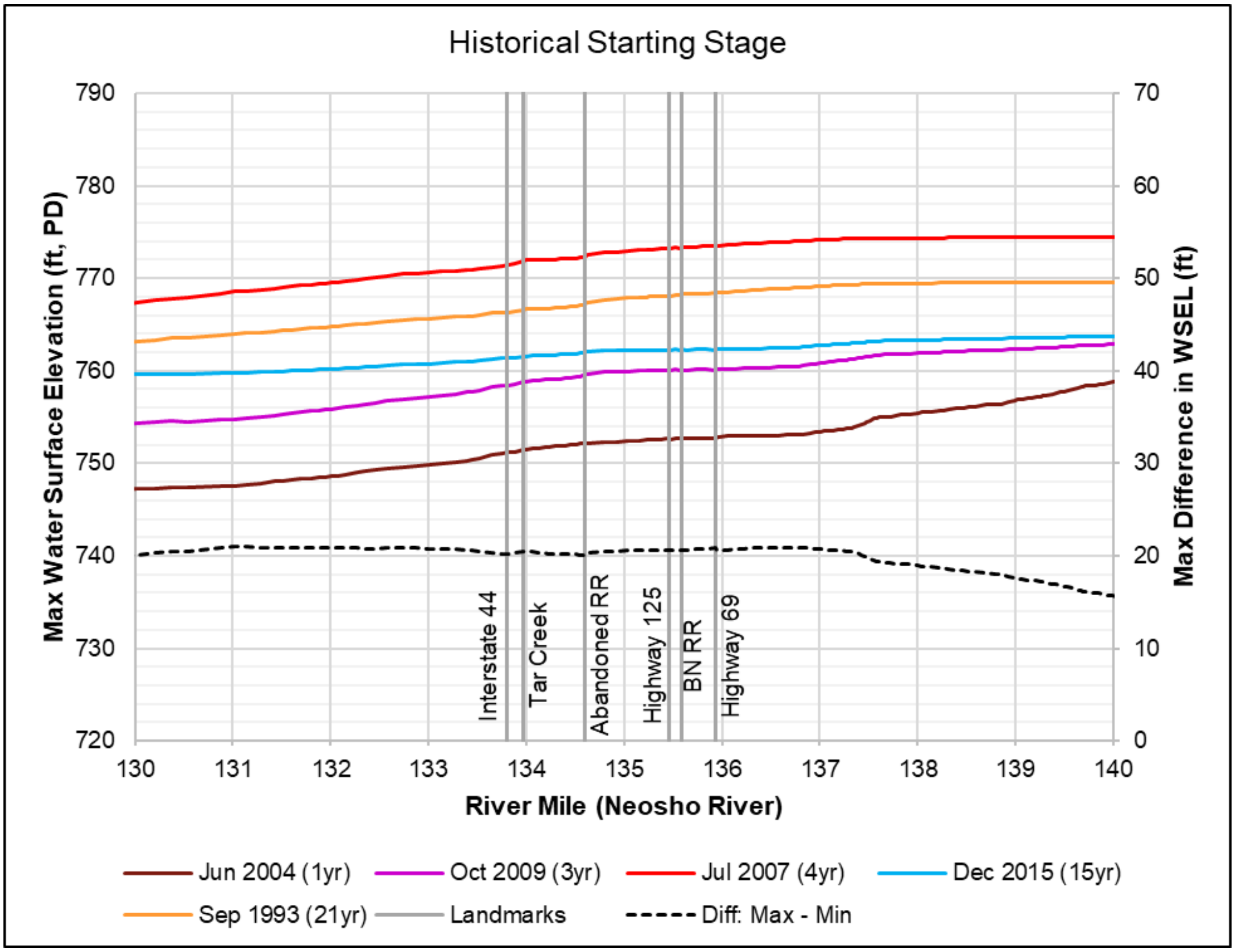

Figure 34. Maximum WSELs near Miami, OK for simulations with historical starting stages.

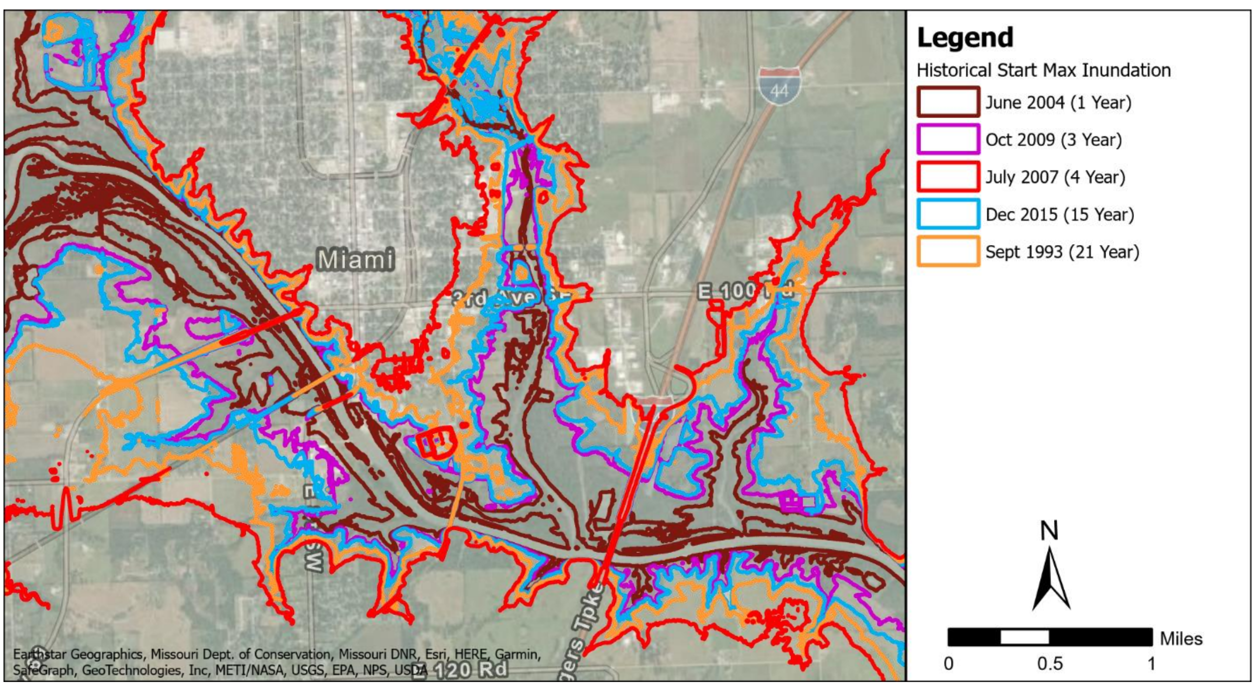

Figure 35. Maximum inundation extents near Miami, OK for simulations with historical starting stages.

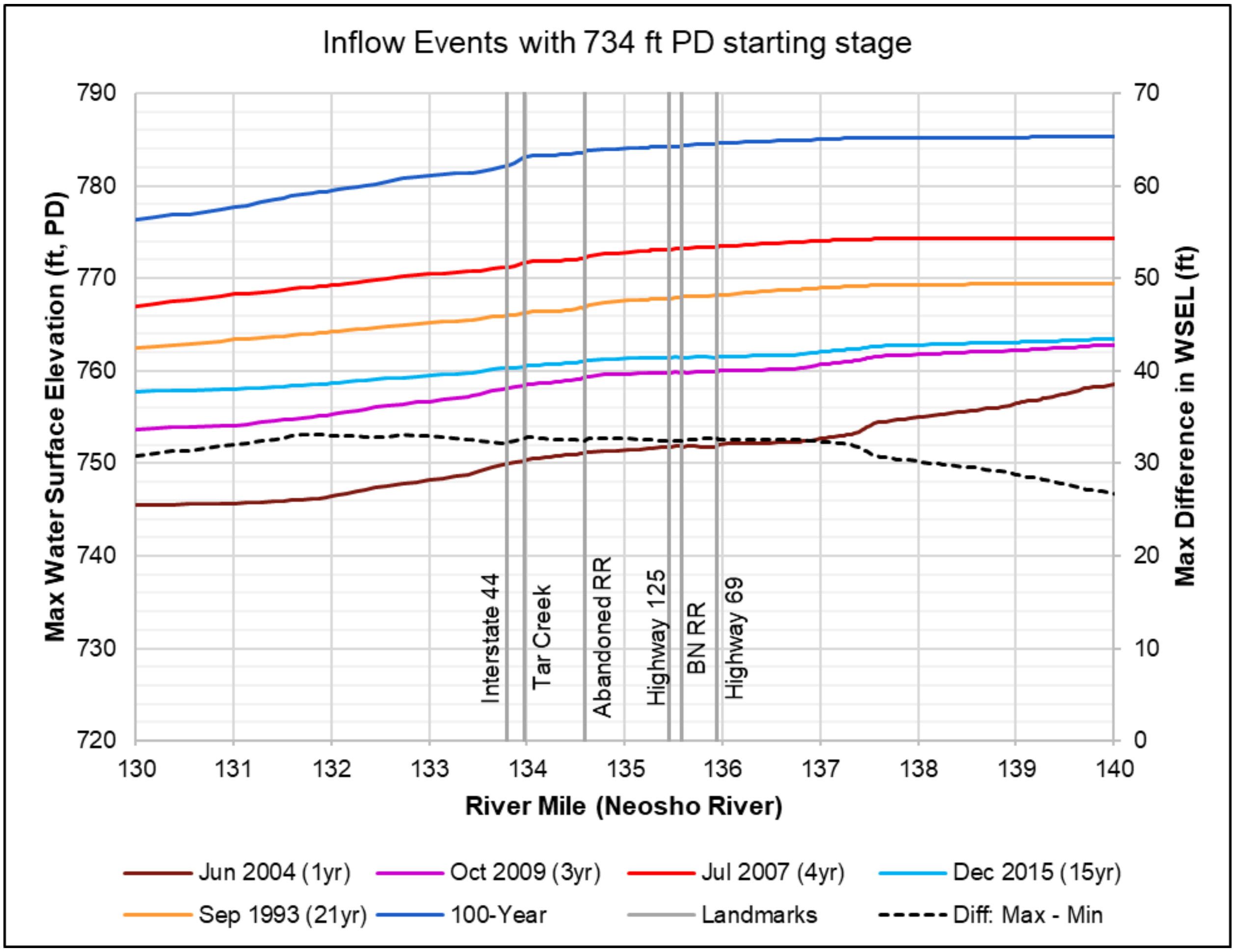

Figure 36. Maximum WSELs near Miami, OK for various natural inflow events, using a starting pool elevation of 734 feet.

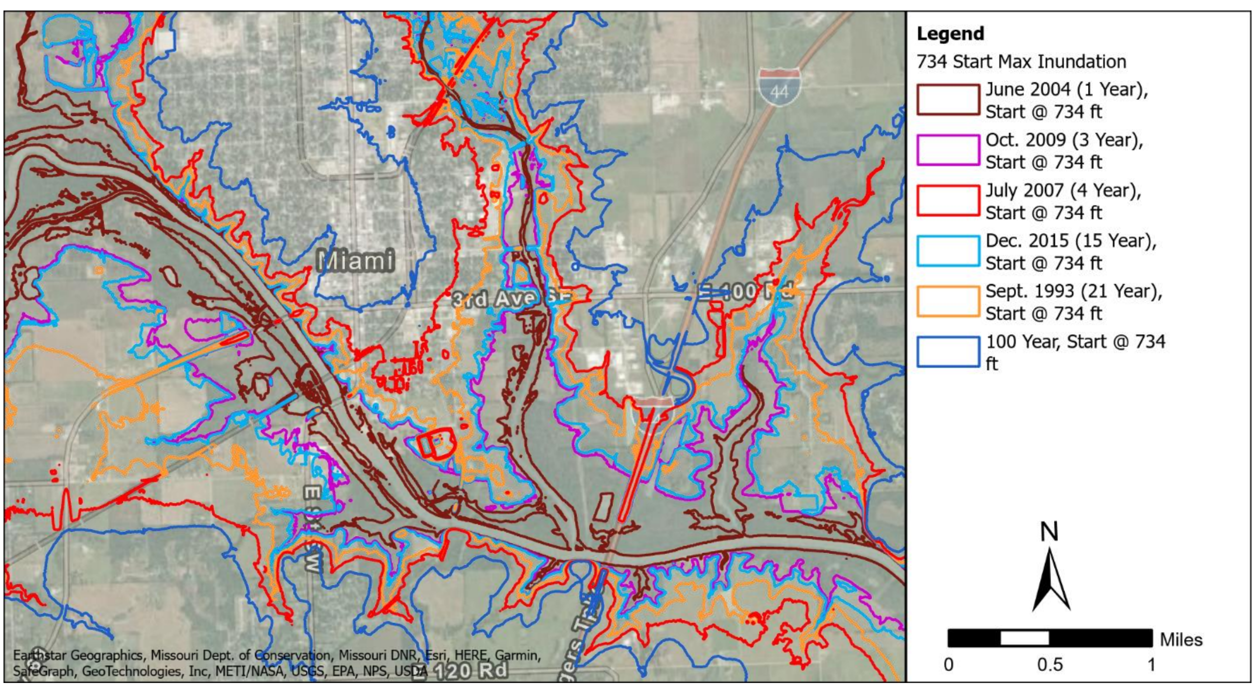

Figure 37. Maximum inundation extents near Miami, OK for various natural inflow events, using a starting pool elevation of 734 feet.

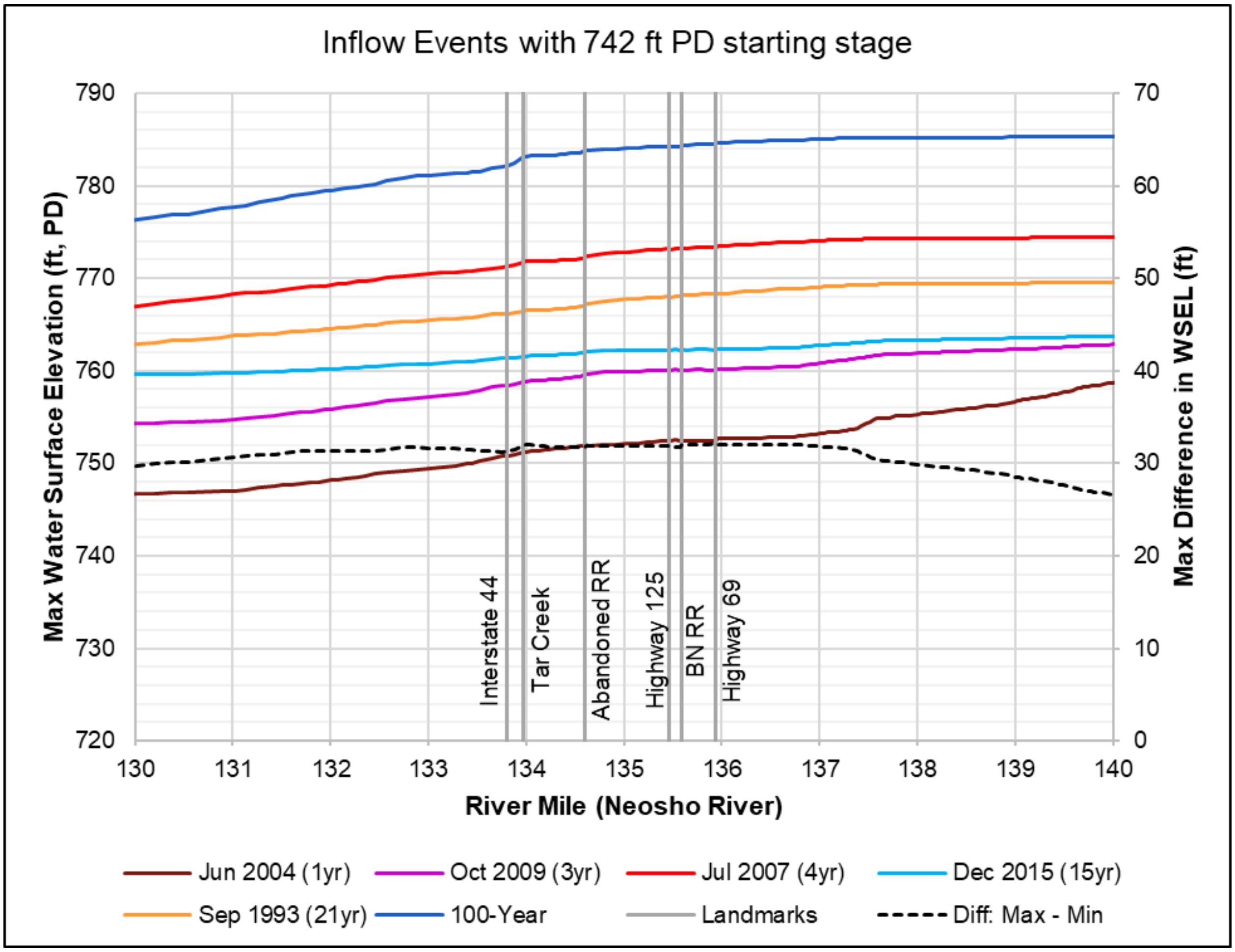

Figure 38. Maximum WSELs near Miami, OK for various natural inflow events, using a starting pool elevation of 742 feet.

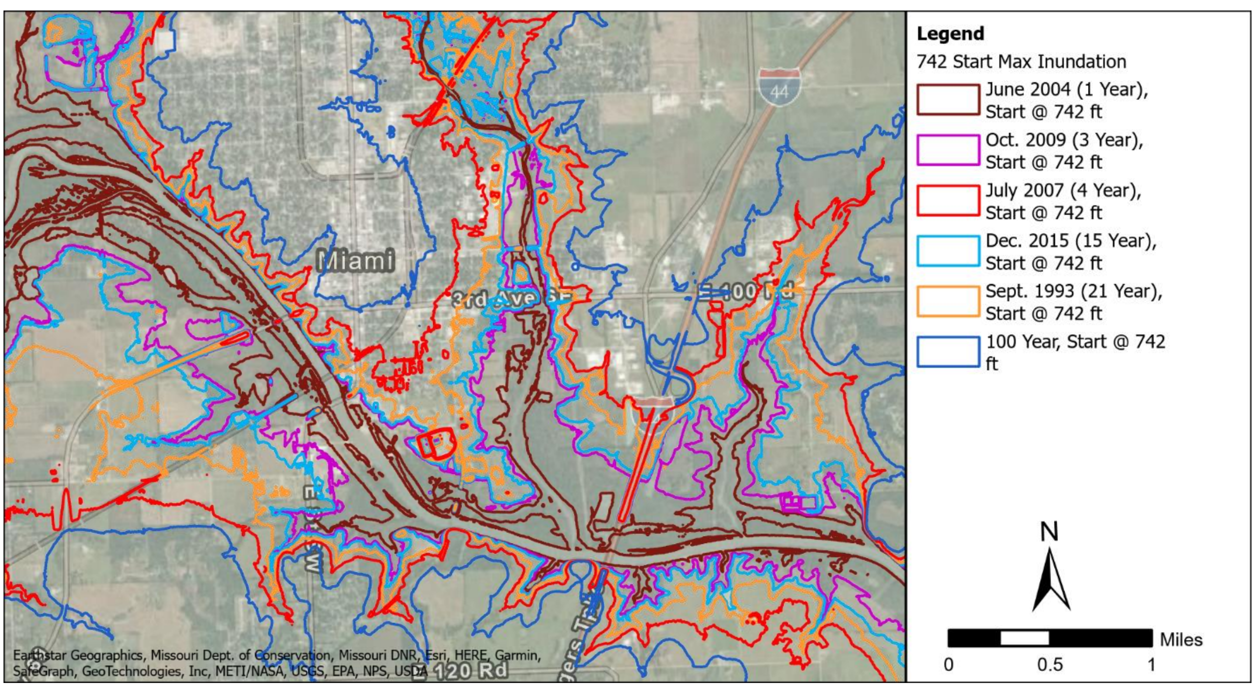

Figure 39. Maximum inundation extents near Miami, OK for various natural inflow events, using a starting pool elevation of 742 feet.

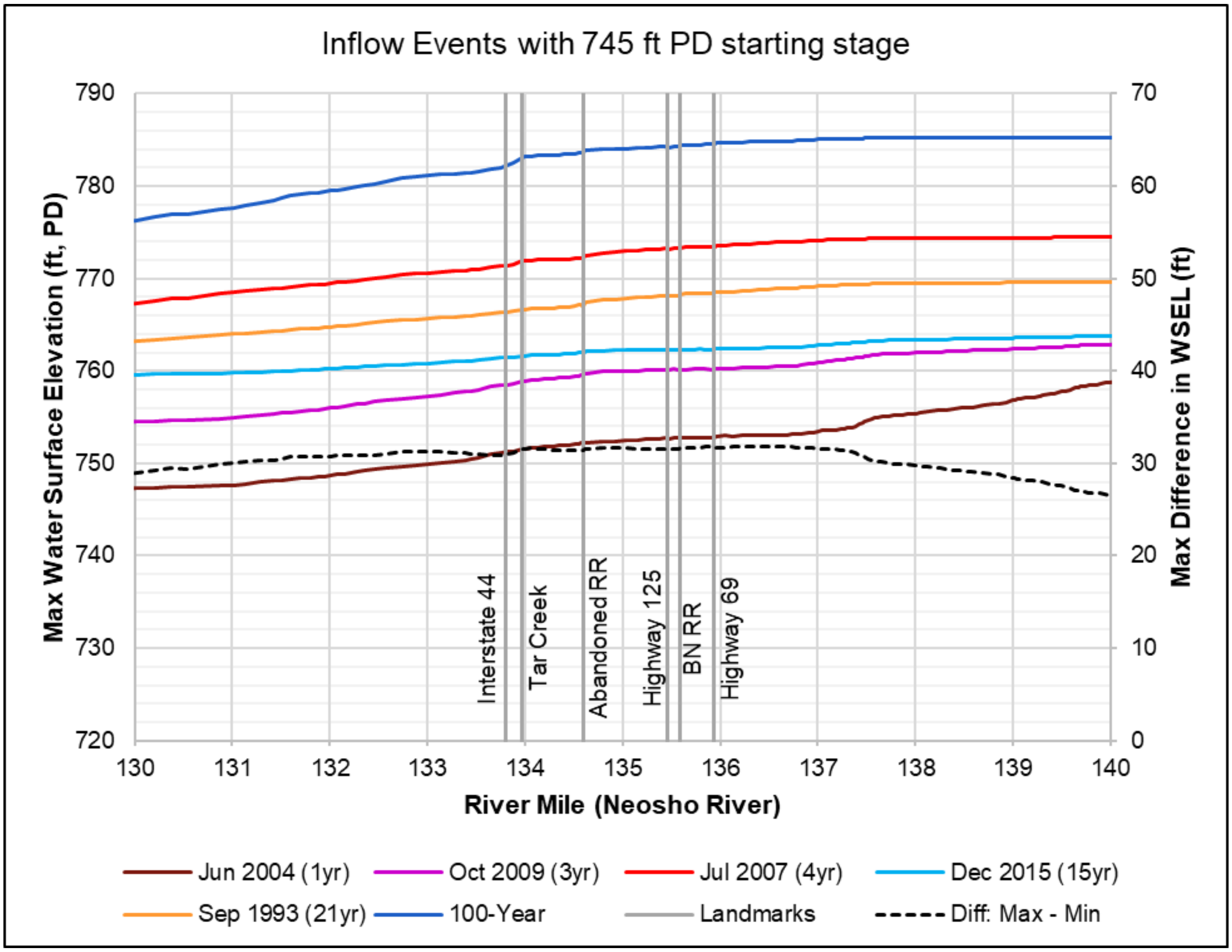

Figure 40. Maximum WSELs near Miami, OK for various natural inflow events, using a starting pool elevation of 745 feet.

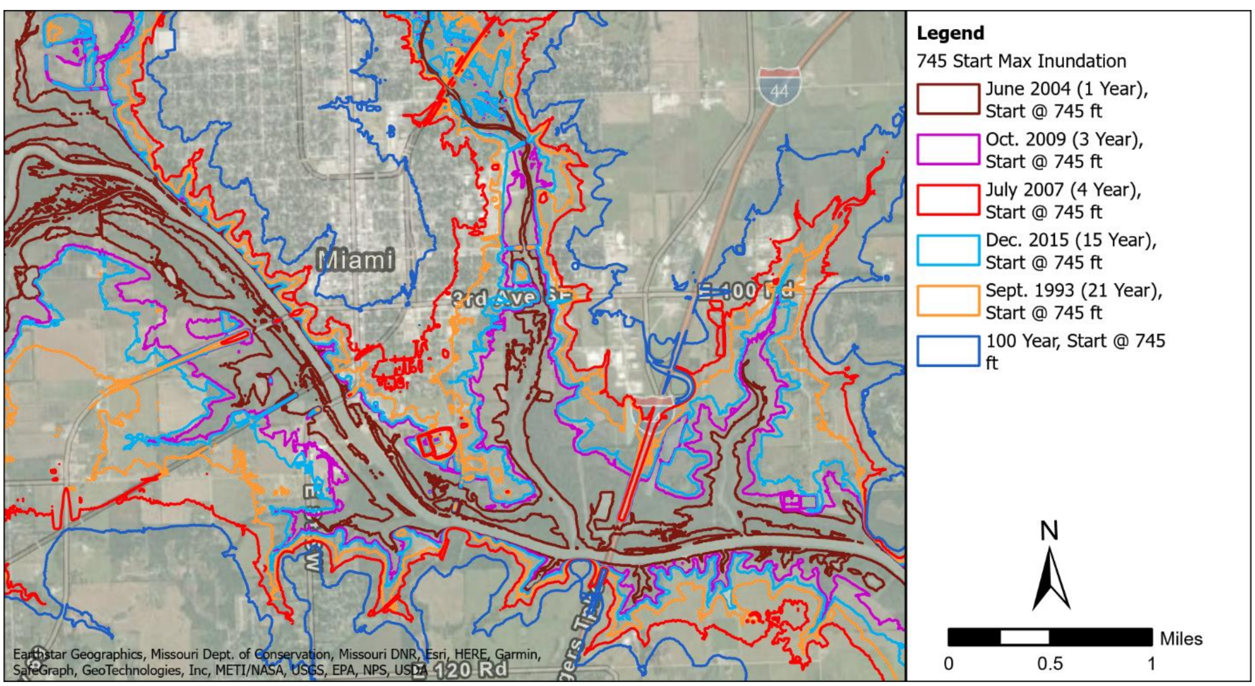

Figure 41. Maximum inundation extents near Miami, OK for various natural inflow events, using a starting pool elevation of 745 feet.

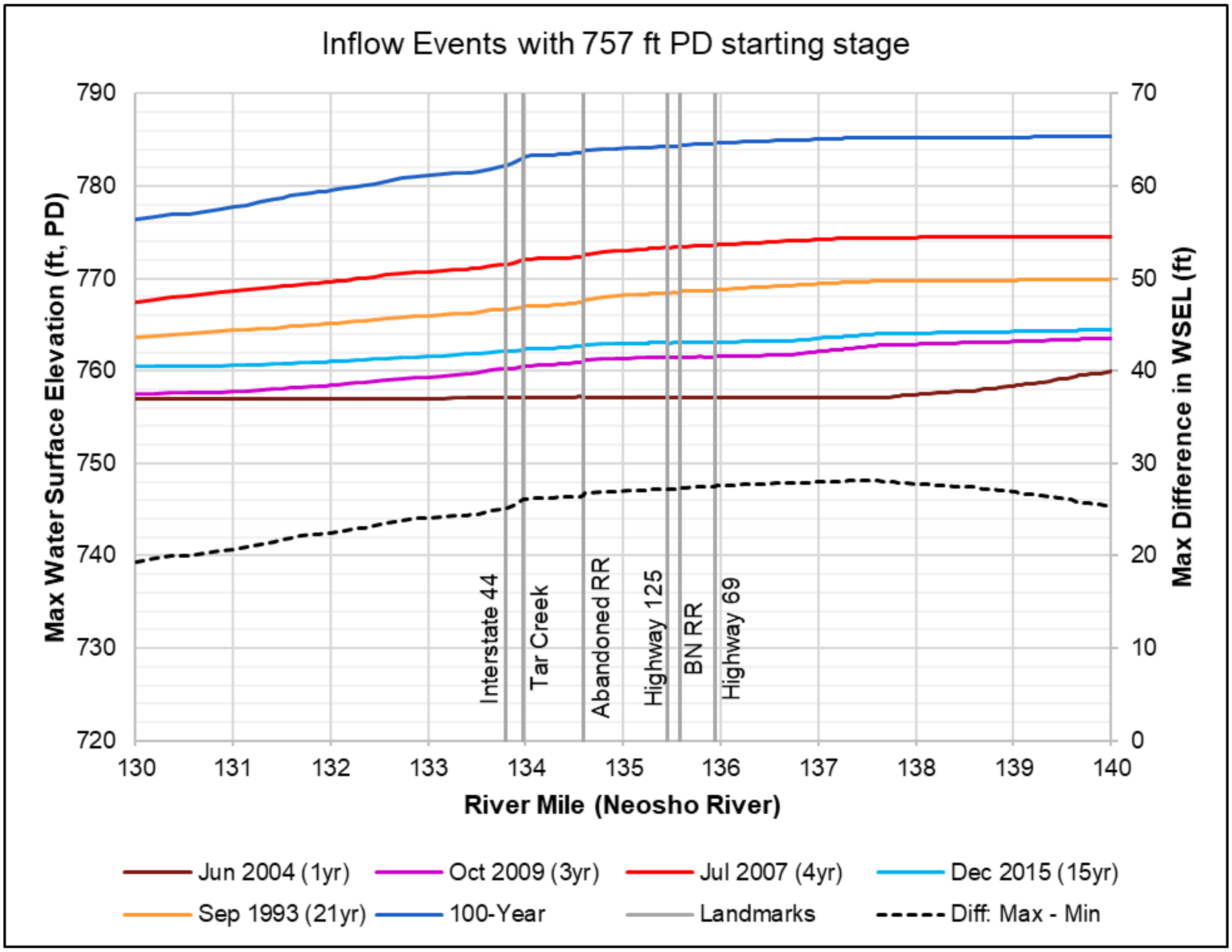

Figure 42. Maximum WSELs near Miami, OK for various natural inflow events, using a starting pool elevation of 757 feet.

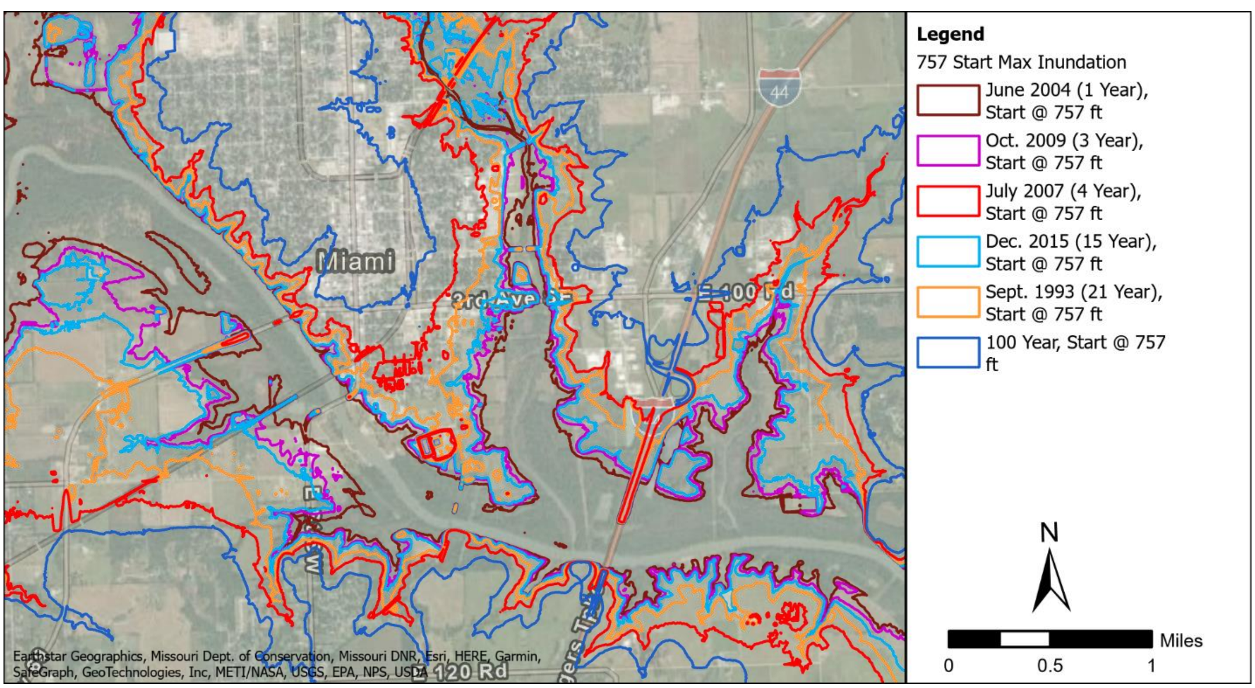

Figure 43. Maximum inundation extents near Miami, OK for natural various inflow events, using a starting pool elevation of 757 feet.

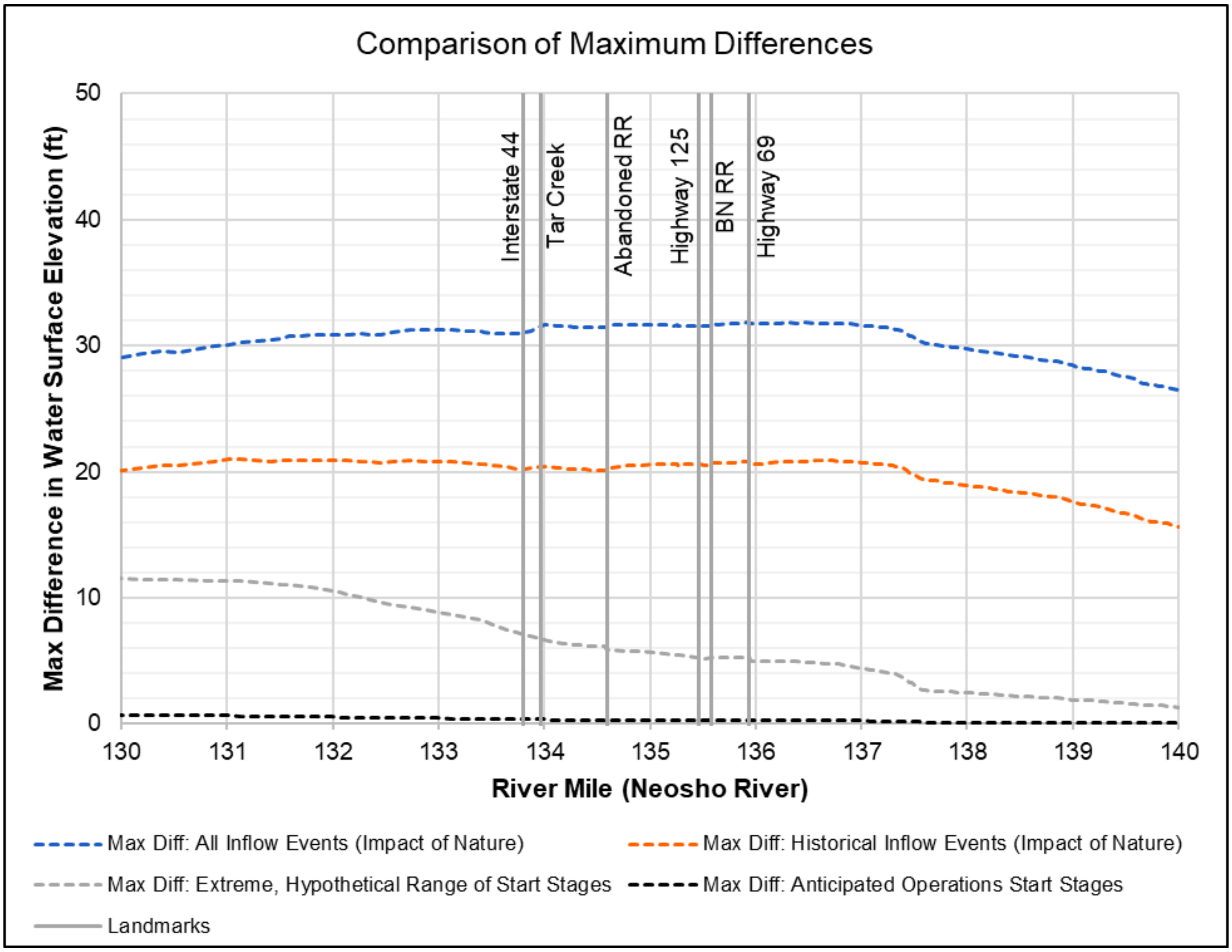

Figure 44. Comparison of maximum WSEL differences near Miami, OK.

10. Anticipated Operations Analysis

As proposed in Section 2.6.5 of the H&H Study RSP, "an additional suite of model runs following the same parameters" was run for the operational scenario anticipated by GRDA. As discussed in Section 1.6.2 of GRDA's December 29, 2021 filing with FERC, GRDA anticipates the following operational parameters will apply during the new license term:

1. GRDA will no longer utilize a rule curve with seasonal target elevations.
2. GRDA will maintain the reservoir between elevations 742 and 745 feet PD for purposes of normal hydropower operations. While hydropower operations may occur when water surface elevations are outside this range (e.g., maintenance drawdowns and high-flow events), GRDA expects to generally maintain water surface elevations between 742 and 745 feet PD during normal Project operations.
3. Instead of managing the Project to target a specified seasonal elevation, GRDA's anticipated operations may fluctuate reservoir levels within the elevational range of 742 and 745 feet PD, for purposes of responding to grid demands, market conditions, and the public interest, such as environmental and recreational considerations.
4. GRDA will continue to adhere to USACE's direction on flood control operations in accordance with the Water Control Manual.

This operational scenario is henceforth referred to as "anticipated operations". To characterize the impact of anticipated operations on the range of inflow events and starting pool elevations studied, the following scenarios were simulated:

1. June 2004 (1 year) inflow event, starting pool elevation of 734.0 feet PD,
2. June 2004 (1 year) inflow event, starting pool elevation of 757.0 feet PD,
3. July 2007 (4 year) inflow event, using the OM period of record starting pool elevation,
4. 100-year inflow event, starting pool elevation of 734.0 feet PD, and
5. 100-year inflow event, starting pool elevation of 757.0 feet PD.

These 5 scenarios were simulated with (1) baseline operations and (2) anticipated operations for a total of 10 simulations. The suite of simulations represents:

1. The minimum and maximum starting pool elevations requested by FERC,
2. The smallest and largest inflow events requested by FERC, and
3. An event of historical importance to upstream communities that is within the studied range of starting pool elevations and within the studied range of inflow magnitudes. The starting pool elevation for this event was not arbitrary, but came out of the operational simulations, making it the most integrous comparison of the effects of anticipated operations versus baseline operations on maximum WSEL in this study.

Results from the analysis are presented in **Appendix H**. The baseline operations stage hydrographs and anticipated operations stage hydrographs[2] are included in **Appendix H.1**. Tabulated results of maximum WSEL are included in **Appendix H.2**. Plots of maximum WSEL profiles are included in **Appendix H.3**. Tabulated results of inundation duration are presented in **Appendix H.4**.

[2] Inflow hydrographs are included in **Appendix C.2**.

Table 31 presents a summary of maximum increases in peak WSEL for anticipated operations as compared to baseline operations. For each simulation, the maximum increase in peak WSEL along all reaches (Neosho River, Spring River, Elk River, Tar Creek) is presented.

1. For the June 2004 (1 year) inflow event, there are no increases in peak WSEL along any modeled reach for a starting elevation of 734 feet PD.
2. For the June 2004 (1 year) inflow event, there are no increases in peak WSEL along any modeled reach for a starting elevation of 757 feet PD.
3. For the July 2007 (4 year) inflow event, the maximum increase in peak WSEL is 0.02 feet, which occurs along the Elk River. Maximum increases of 0.01 feet also occur along the Neosho River and Tar Creek. There are no increases along the Spring River.
4. For the 100-year inflow event with a starting pool elevation of 734 feet, the maximum increase is 0.05 feet, which occurs along the Spring River. A maximum increase of 0.03 feet also occurs along the Neosho River and an increase of 0.01 occurs along Tar Creek. There are no increases along the Elk River.
5. For the 100-year inflow event, there are no increases in peak WSEL for a starting elevation of 757 feet PD.

The results show that anticipated operations have an immaterial impact on upstream WSELs as compared to baseline operations.

Table 31. Summary of increases in WSEL due to anticipated operations, as compared to baseline operations.

Simulation	Maximum Increase in WSEL Due to Anticipated Operations (ft)
June 2004 (1 year) event, starting pool elevation of 734.0 feet PD	0.00
June 2004 (1 year) event, starting pool elevation of 757.0 feet PD	0.00
July 2007 (4 year) event, period of record starting pool elevation	0.02
100-year event, starting pool elevation of 734.0 feet PD	0.05
100-year event, starting pool elevation of 757.0 feet PD	0.00

Figure 45 displays maximum WSEL profiles for the June 2004 (1 year) inflow event, the smallest inflow event studied, near Miami, OK. Baseline and anticipated operational results are displayed for starting elevations of 734 and 757 feet, the minimum and maximum starting pool elevations requested by FERC. The dotted lines plot the increase in WSEL due to anticipated operations as compared to baseline operations and are plotted on the secondary y-axis. The dotted lines are not visible because the increase in WSEL is zero. Similarly, **Figure 46** displays maximum WSEL profiles for the July 2007 (4 year) inflow event, and **Figure 47** displays profiles for the 100-year inflow event. The dotted lines, which plot the increase in WSEL due to anticipated operations as compared to baseline operations, are difficult to see because the increase in WSEL is nearly zero.

The plots show how anticipated operations have an immaterial impact on upstream WSELs as compared to baseline operations for a suite of simulations that spans the FERC-requested range of starting pool elevations and inflow event magnitudes.

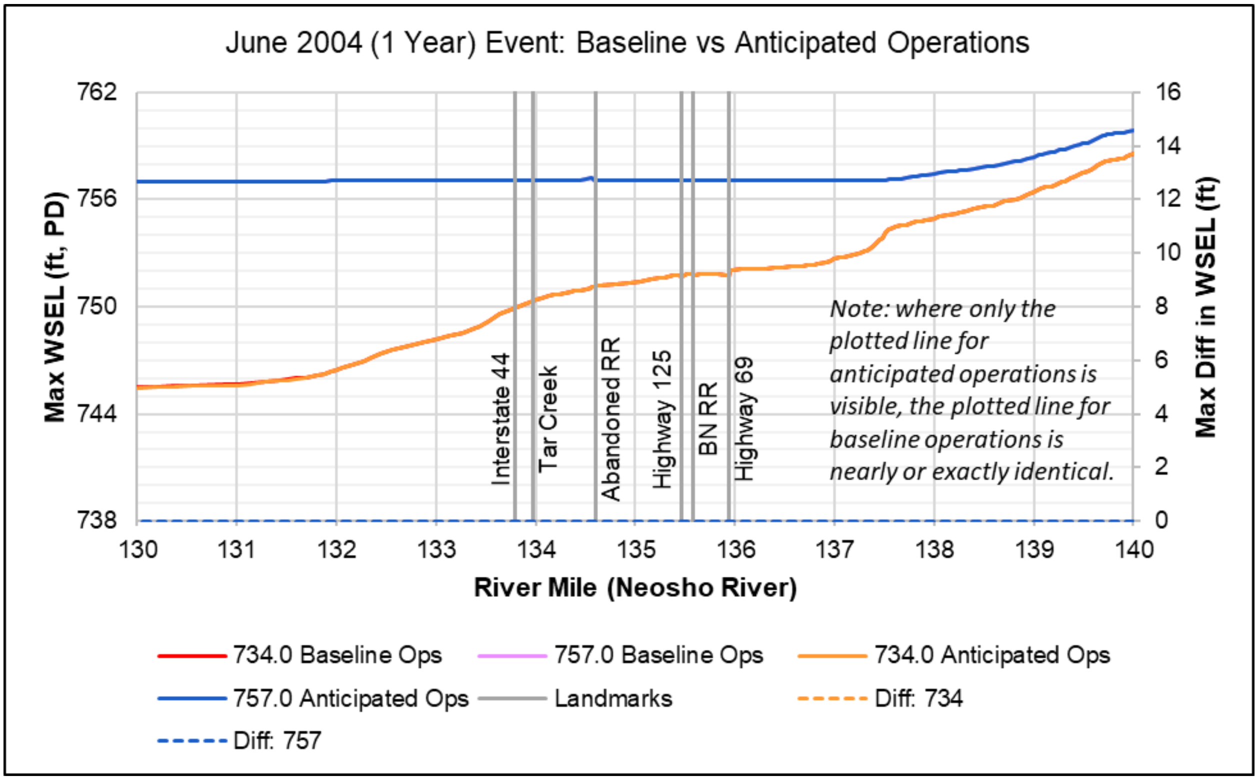

Figure 45. Maximum WSELs near Miami, OK for baseline and anticipated operations during the June 2004 inflow event.

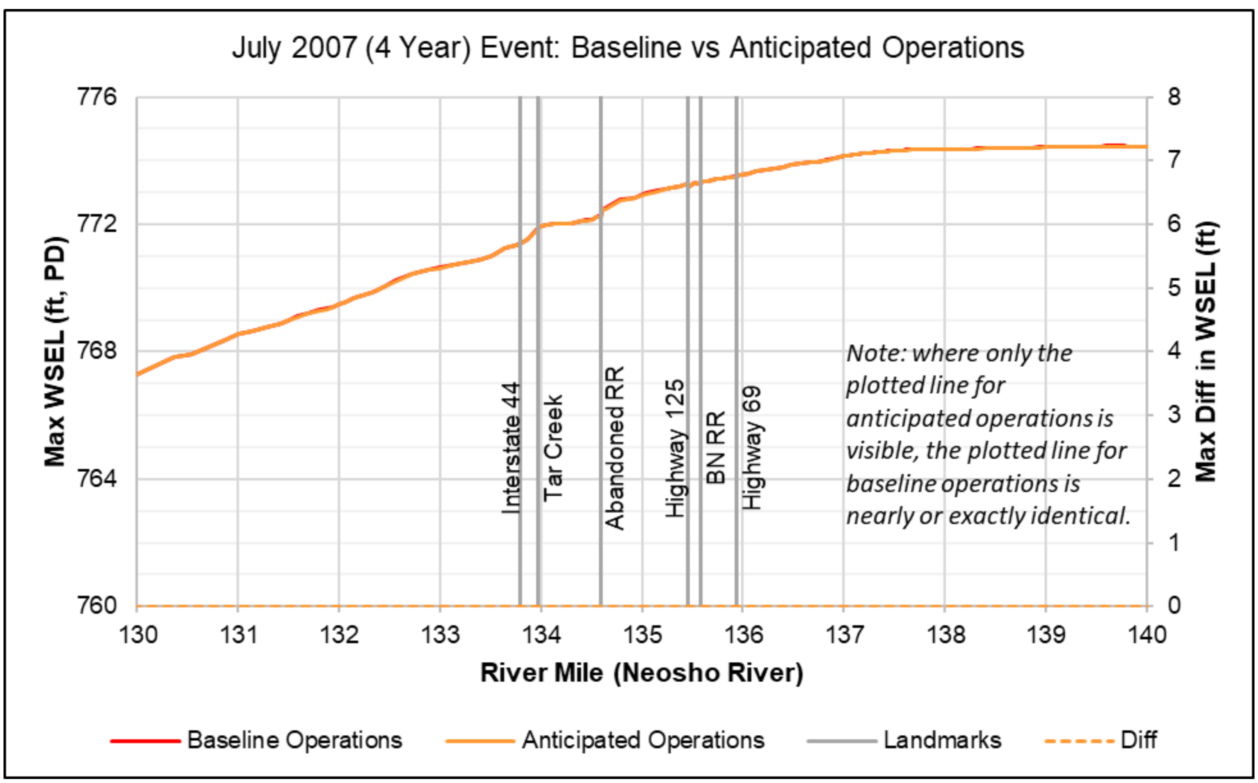

Figure 46. Maximum WSELs near Miami, OK for baseline and anticipated operations during the July 2007 inflow event.

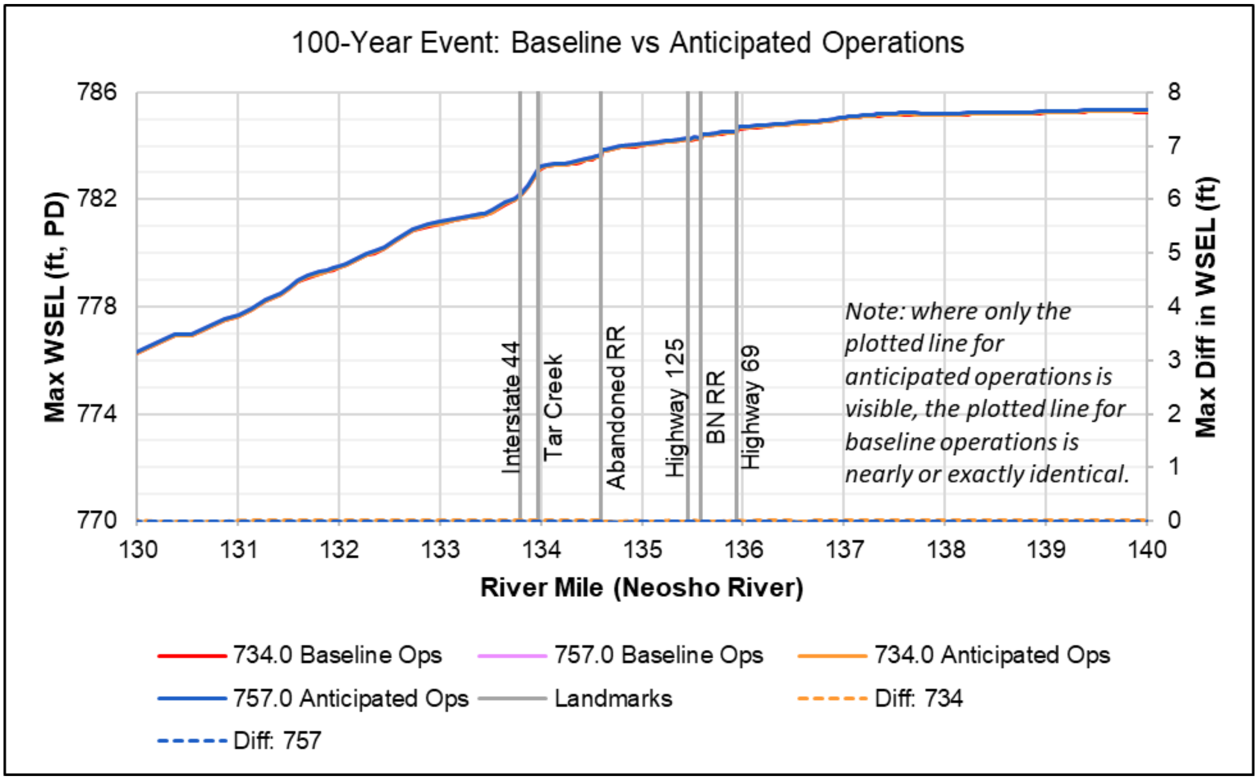

Figure 47. Maximum WSELs near Miami, OK for baseline and anticipated operations during the 100-year inflow event.

Inundation maps are presented in **Appendix F**. Based on the maximum WSEL results, no additional inundation maps were created. A difference in inundation extent for differences in WSEL of 0.05 feet or less at a few discrete locations cannot be effectively displayed on an inundation map. The extent of inundation for anticipated operations is virtually identical to the extent of inundation for baseline operations.

Table 32 presents a summary of maximum increases in duration for anticipated operations as compared to baseline operations. Only the 100-year event simulations resulted in an increase in duration along any modeled reach. For both simulations of the 100-year event, the increases in duration occurred at RM 129.0, just upstream of the S 590 Road or Connor Bridge (RM 126.7). This area is rural, sparsely populated, and the 2-hour increase in duration is isolated to this location.

Table 32. Summary of increases in duration due to anticipated operations, as compared to baseline operations.

Simulation	Maximum Increase in Inundation Duration Due to Anticipated Operations (hours)
June 2004 (1 year) event, starting pool elevation of 734.0 feet PD	0
June 2004 (1 year) event, starting pool elevation of 757.0 feet PD	0
July 2007 (4 year) event, period of record starting pool elevation	0
100-year event, starting pool elevation of 734.0 feet PD	2
100-year event, starting pool elevation of 757.0 feet PD	2

11. Supporting Analysis for Other Studies

Mead & Hunt performed analysis in support of four studies: the Aquatic Species Study, the Terrestrial Species Study, the Wetlands and Riparian Habitat Study, and the Sedimentation Study. Mead & Hunt's supporting analysis is discussed below.

11.1 Aquatic Species Study

In support of the Aquatic Species Study, Mead & Hunt performed additional simulations that were used to assess operational impact to specific aquatic species. One product of the simulations was the development of maps showing changes to potential lake spawning species. The Aquatic Species Study team requested a comparison between anticipated operations and baseline operations during normal operations and inflows. The focus on normal operations and inflows and not flood events is necessary in biological assessments. This is because flood events do not occur at a frequency that causes long term changes to the physical and biological environment such that the biological entities need to adapt to survive. Whereas normal events and operations represent conditions that occur at a frequency and persist for long periods of time such that biological habits may need to change to survive.

To represent normal operations and inflows, Mead & Hunt simulated inflows and operations for the 2004 to 2019 period of record in the OM under both anticipated operations and baseline operations. Based on the period of record, normal (median) operational level and inflows were extracted for the annual seasonal period of May 15 to July 8, a time period identified by the Aquatic Species Study team as a critical time period sensitive to water level fluctuations. The critical time period is surrogate for all lake spawning fish and was based upon the nursery period for largemouth bass (Zale, 1991). For both anticipated operations and baseline operations, the seasonal median operational level and inflows were simulated in the UHM. Results were provided to the Aquatic Species Study team. In accordance with Section 2.6 of the Aquatic Species RSP, maximum inundation was also identified on all maps showing changes to potential lake spawning species. To develop a boundary of maximum inundation during the period of record, the maximum inundations for all major inflow events during the period of record (July 2007, December 2015, April 2017, and May 2019) were merged into a single inundation boundary. This procedure was performed for both anticipated and baseline operations. The maximum inundation was virtually identical for anticipated and baseline operations. Therefore, a single boundary of maximum inundation was mapped. Maps showing changes to potential lake spawning species habitat are presented in **Appendix I.1**.

11.2 Terrestrial Species Study

In support of the Terrestrial Species Study, Mead & Hunt performed additional simulations that were used to assess operational impact to specific terrestrial species. One product of the simulations was the development of maps showing areas of potential lentic or lotic conversion which could impact the habits of specific terrestrial species. Mead & Hunt followed the same process as the Aquatic Species Study. The seasonal period identified by the Terrestrial Species Study team was the entire calendar year, January 1 to December 31 because several critical terrestrial species could be most impacted during both their active and inactive or hibernation periods each year. For both anticipated operations and baseline operations, the seasonal median operational level and inflows were simulated in the UHM. Results were mapped and provided to the Terrestrial Species Study team. Maximum inundation, discussed in **Section 11.1**, was included on the maps. Maps showing areas of potential lentic or lotic conversion are presented in **Appendix I.2**.

11.3 Wetlands and Riparian Habitat Study

In support of the Wetlands and Riparian Habitat Study, Mead & Hunt performed additional simulations and developed maps of potential wetland and riparian inundation changes that could cause the areas to change from seasonally flooded to permanently flooded. Mead & Hunt followed the same process used to develop maps for the Terrestrial Species Study. The annual seasonal period identified by the Wetland and Riparian Habitat Study team was March 30 to November 2, which is the growing season based on Tulsa, OK climatological records. For both anticipated operations and baseline operations, the seasonal median operational level and inflows were simulated in the UHM. Results were mapped and provided to the Wetlands and Riparian Habitat Study team. Maximum inundation, discussed in **Section 11.1**, was included on the maps. Maps of potential wetland and riparian inundation changes are presented in **Appendix I.3**.

11.4 Sedimentation Study

In accordance with FERC's May 27, 2022 Determination regarding the Sedimentation Study, Mead & Hunt used a 1D version of the UHM to simulate the July 2007 (4 year) historical inflow event and the 100-year inflow event with starting reservoir elevations of 740-, 745-, and 750-feet PD. These scenarios were simulated to understand the effects of project operation and predicted channel geometry on upstream WSELs. The OM was used to calculate downstream stage hydrographs at Pensacola Dam and geometry files were provided by the Sedimentation Study team. Sedimentation scenario results are discussed in the Sedimentation USR.

12. Conclusions

The results of the UHM demonstrate that starting pool elevations at Pensacola Dam within GRDA's anticipated operational range have an immaterial impact on upstream WSELs, inundation, and duration for a range of inflow events. Compared to starting elevations within GRDA's anticipated operational range, only natural inflows—and not Project operation—caused an appreciable difference in maximum WSEL, maximum inundation extent, or duration. The differences in WSEL, inundation extent, and duration due to the size of the natural inflow event were orders of magnitude greater than the differences in WSEL, inundation extent, and duration due to the initial stage at Pensacola Dam. The maximum impact of nature typically ranged from over 10 times to over 100 or even over 1,000 times the maximum simulated impact of GRDA's anticipated operations.

Even if extreme, hypothetical starting pool elevations outside GRDA's anticipated operational range are used, the maximum impact of nature is much greater than the maximum simulated impact of an extreme, hypothetical starting stage range of 23 feet. The impact of nature typically ranged from 2 times to 10 or even 100 times the impact of the extreme, hypothetical starting stage range.

Comparing anticipated operations to baseline operations for a suite of simulations that spanned the FERC-requested range of starting pool elevations and inflow event magnitudes, the results of the UHM demonstrate that anticipated operations have an immaterial impact on upstream WSELs, inundation, and duration as compared to baseline operations.

All conclusions on potential lentic or lotic conversion areas are discussed in each of the individual biological assessment reports.

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APPENDIX A:
RESPONSE TO CITY OF MIAMI COMMENTS

This document compiles comments received on *H&H Modeling: Upstream Hydraulic Model – Model Input Status Report*, filed with FERC on March 30, 2021. The City of Miami was the only entity to file comments; their comments were filed with FERC on June 23, 2021. After each comment, Mead & Hunt has provided a response. Page numbers listed below reference the *Model Input Status Report*.

Comment No. 1, Section 2.1, page 4
City of Miami Comment

The USACE's Hydrologic Engineering Center (HEC) has recently released HEC-RAS Version 6.0. This model has several improvements over Version 5.0.7, including the ability to represent bridges within a 2-D area. Tetra Tech recommends developing and calibrating a fully 2-D hydraulic model using HEC-RAS Version 6.0.

Mead & Hunt Response to Comment No. 1

The FERC-approved Revised Study Plan states that HEC-RAS version 5.0.3 or later will be used. Consistent with this requirement, the model was developed in HEC-RAS version 5.0.7. Version 6.0 includes an expanded set of features. The ability to represent bridges within a 2D Flow Area is new to version 6.0. The engineering community has not yet extensively tested this, or other new features. It is inadvisable to move the model to this new version at this time.

Comment No. 2, Section 2.2, page 4
City of Miami Comment

Because the 2DFA better accounts for the volume in Grand Lake, it should be applied to the entire area of the lake.

Mead & Hunt Response to Comment No. 2

The cross-sections upstream of River Mile 100 extend across the reservoir and thus properly account for the volume.

Comment No. 3, Section 2.2, page 4
City of Miami Comment

The River Miles along Grand Lake and the Neosho River are different by approximately 8 miles compared to previous studies (Holly, 2001; Tetra Tech, 2015). For comparative purposes with previous studies, Tetra Tech recommends using the original river mile stationing.

Mead & Hunt Response to Comment No. 3

Mead & Hunt used USGS river miles because it is a publicly available dataset.

Comment No. 4, Section 2.4, page 6

City of Miami Comment

The Mead & Hunt hydraulic model has many areas where the cell alignments do not follow the top of banks, as shown in Figure A. Mead & Hunt should therefore review the cell alignments in its model and refine them to ensure that they meet Mead & Hunt's stated goal of matching cell alignments to waterway banks.

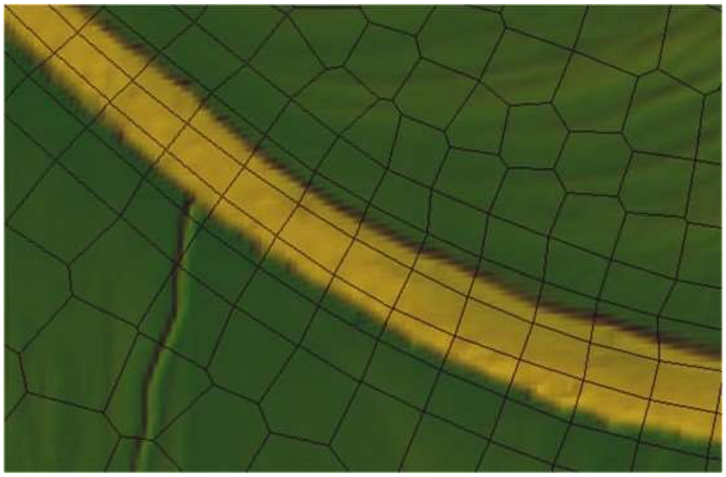


Figure A. Example of 2DFA mesh of the Mead & Hunt model where the cell alignments do not follow the top of banks. This section of mesh is located on the Neosho River upstream from the City of Miami.

Mead & Hunt Response to Comment No. 4

Mead & Hunt followed USACE guidance in the 2D Modeling User's Manual when aligning cell faces near the Neosho River banks (USACE, February 2016). USACE provides the following guidance in the 2D Modeling User's Manual:

> "*Break lines can… be placed along the main channel banks in order to keep flow in the channel until it gets high enough to overtop any high ground berm along the main channel*" (page 3-3).

Mead & Hunt followed this guidance and aligned the cell faces so that faces did not go into the channel.

Secondly, Mead & Hunt followed the guidance in the 2D Modeling User's Manual by not placing the break lines too close to each other. The 2D Modeling User's Manual states:

> *"[Cells with collinear faces are] generally caused by placing two or more break lines parallel to each other, and* ***close together****, such that the creation of cells along one break line can create problems with cells along the other break line*" (page 3-18, emphasis added).

The 2D Modeling User's Manual warns:

> "*If cells end up [with collinear faces],* ***the software will run, but the computation across cell faces that are like this will not be correct***" (page 3-17, emphasis added).

Tetra Tech's recommendation would not improve model performance and may result in a degraded computational mesh, which could result in incorrect computations. It is more important for the cell face to represent a consistent overbank elevation than be as close to the bank as possible. Mead & Hunt's cell face alignment follows USACE guidance.

Comment No. 5, Section 2.11, page 12
City of Miami Comment

In reviewing the Mead & Hunt model input status report, Tetra Tech developed bed elevation profiles along the centerline of the historic Grand and Neosho Rivers using the 2008 OWRB, 2015 Tetra Tech, 2017 USGS, and 2019 USGS hydrographic data; the following observations were made about the profiles (**Figure B**):

- Bed elevations from the 2015 Tetra Tech and 2017 USGS surveys along the centerline of the channel between Twin Bridges and Miami are in good agreement.
- Upstream of Twin Bridges, there is significant variability in the 2017 USGS profile. The model input status report indicates that Mead & Hunt used the 2017 USGS survey of the Neosho River to represent the channel from Twin Bridges to approximately the Kansas border. From Twin Bridges to about 3 miles upstream of the City of Miami, the USGS surveyed cross-sections approximately perpendicular to the flow. From 3 miles upstream of the City to the Kansas border, the USGS surveyed the channel in a zig-zag pattern (**Figure C**). The resulting interpolation of the survey points provides a poor representation of the channel topography, as indicated by the variability in the bed profile and bed elevations shown in Figure C. The interpolation method applied by the USGS is not known. Tetra Tech recommends re-evaluating the USGS survey data to develop representative channel conditions. Tetra Tech recommends using the Tetra Tech survey data, where available, to supplement the USGS data.
- The 2008 OWRB and 2019 USGS surveys show similar amounts of aggradation between about the Elk River and Twin Bridges; however, elevations from the 2019 USGS surveys are typically higher. From Pensacola Dam to about 30 miles upstream, the 2019 USGS survey is 5 to 8 feet higher than 2008 OWRB survey. The nearby upstream tributaries are relatively small and likely do not contribute enough sediment to cause this amount of aggradation. Tetra Tech would expect minor aggradation in this area between construction of the dam and the present, therefore, the differences are likely due to differences in surveying equipment and method, an error in one (or both) of the surveys, or a combination of both.

For this review, Tetra Tech also developed a comparison of the 2008 OWRB and 2019 USGS digital elevation models (surfaces) of Grand Lake, shows that:

- The differences are larger at the downstream end (near Pensacola Dam) compared to upstream (Figure D); this is consistent with the centerline profiles in Figure B but is an unexpected result. Typically, it would be expected that there would be relatively little difference between the surveys near Pensacola Dam and larger differences near Twin Bridges due to sedimentation at the head of Grand Lake.
- The USGS (2019) report presents an elevation-volume rating curve (Figure 11) that indicates a reduction in volume at the dam crest elevation (755 feet) of about 10 percent between 2008 and 2019 and about 17 percent between 1940 and 2019 (USGS Figure 5). The USGS (2019) attributes the difference to survey methods and equipment but does not provide either profile or planform comparisons of the two surveys to allow independent evaluation of this conclusion.

Tetra Tech recommends that Mead and Hunt perform an analysis of the differences between the OWRB and USGS surveys and substantiate why the USGS survey is being used for the study. Tetra Tech would support Mead & Hunt collecting spot elevations of the lake bed in the vicinity of the dam to confirm that the USGS survey is correct.

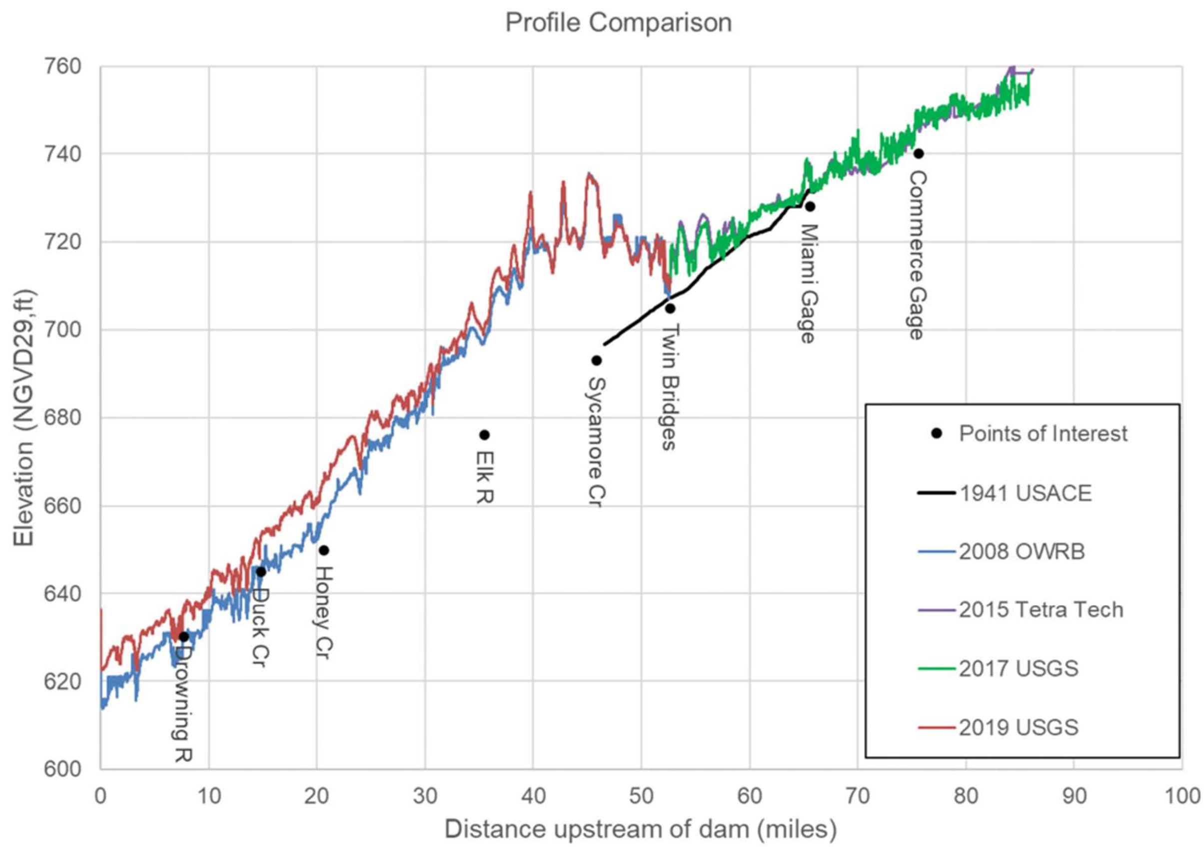


Figure B. Comparison of the 1941 USACE, 2008 OWRB, 2015 Tetra Tech, 2017 USGS and 2019 USGS profiles along the centerline of the historic Grand River and Neosho River.

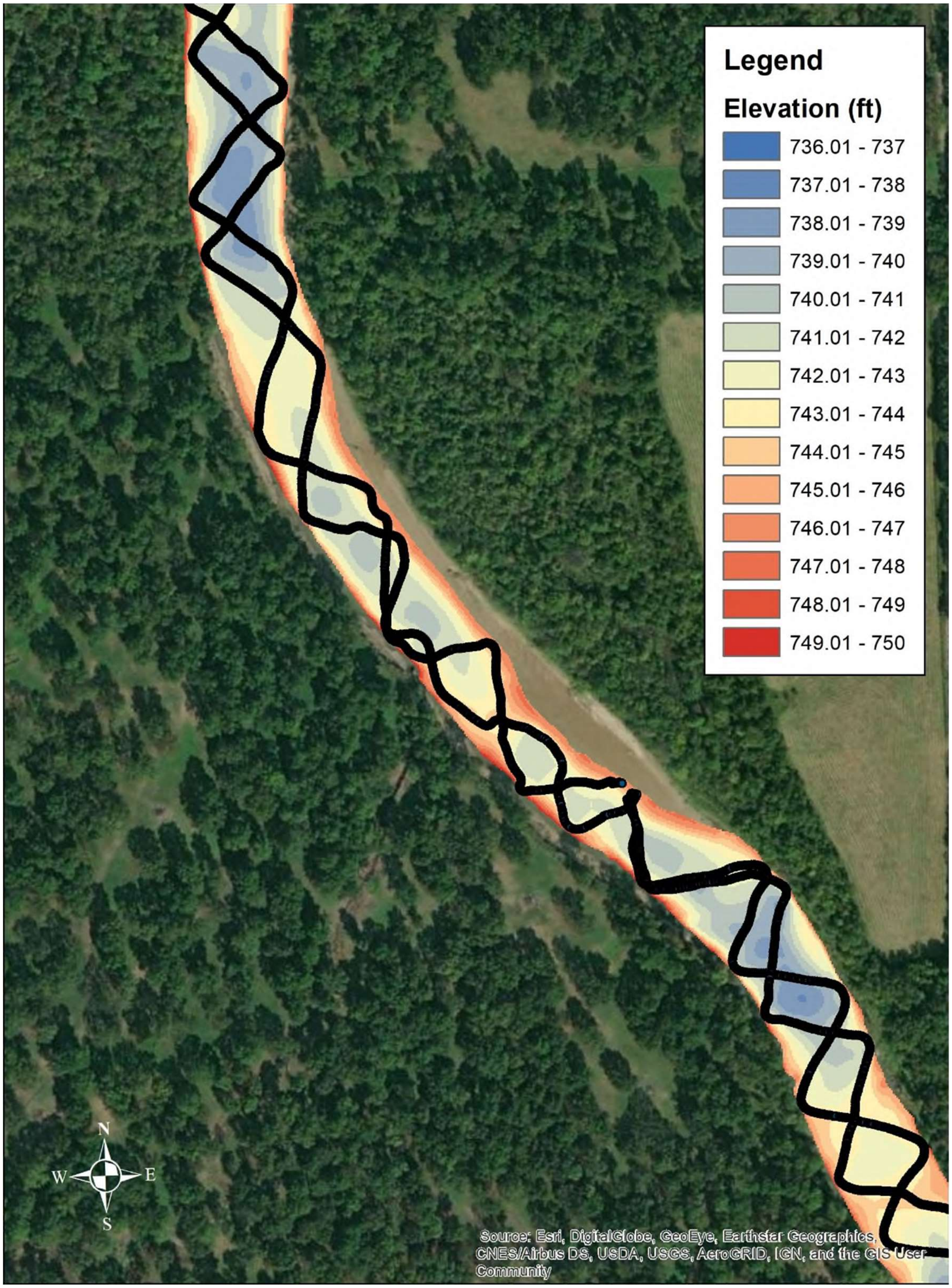


Figure C. Example of survey points collected by the USGS (2017) and overlaying the Digital Elevation Model developed by the USGS. The irregular bed elevations are due to the surface development method and are not representative of actual conditions.

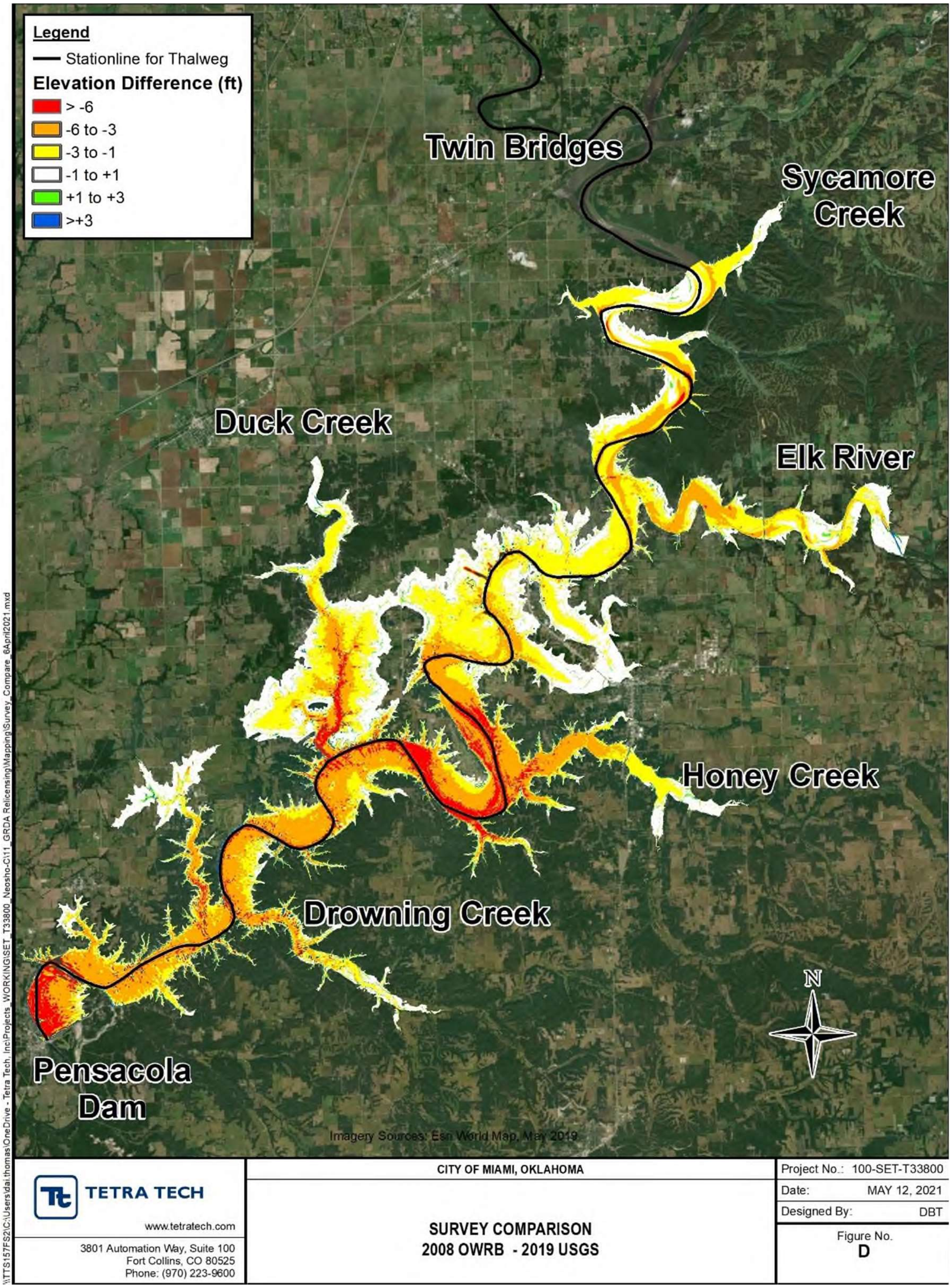


Figure D. Difference in elevation between the 2008 OWRB and 2019 USGS surveys.

Mead & Hunt Response to Comment No. 5

There is no basis to question the accuracy of the 2017 or 2019 bathymetry data collected by USGS for the following reasons:

1. The 2019 bathymetry was completed at the City of Miami's request and at FERC's direction in the Study Plan Determination. USGS is a nationally recognized agency for their expertise in data collection. USGS was selected as a non-biased, objective entity for bathymetric data collection. USGS performed the data collection in accordance with the Study Plan Determination.
2. USGS's 2019 report documents the use of industry standard practices for multi-beam bathymetric data collection quality assurance, namely beam-angle checks and patch tests. USGS also documented the use of industry standards when estimating uncertainty in the collected data.
3. USGS's 2017 report documents the use of industry standard practices for single-beam bathymetric data collection quality assurance, namely independent speed of sound measurements and bar checks at depths that spanned the range of measured depth. USGS also documented the use of industry standards when estimating uncertainty in the collected data.
4. USGS's 2017 bathymetry data was officially released in September 2017. The Proposed Study Plan (April 2018) and the Revised Study Plan (September 2018) both discussed the proposed use of USGS's 2017 bathymetry data. Tetra Tech had ample time to review USGS's data prior to and during the study planning process and did not object to the use of the USGS 2017 bathymetry during the study planning process. Raising issues with the 2017 data at this point in the relicensing process is not appropriate.

GRDA and Mead & Hunt have followed City of Miami and Tetra Tech recommendations regarding bathymetric data collection. Further inquiries regarding USGS data should be directed to USGS.

Comment No. 6, Section 2.12, page 15

City of Miami Comment

Figure 12 indicates up to 5 feet of difference in water-surface elevation between the full momentum and diffusion wave methods. Tetra Tech ran Mead & Hunt's model applying the diffusion wave method. Comparison of the water-surface elevations between the two methods showed differences of up to 0.8 feet (Figure E), significantly less than the 5-feet reported by Mead and Hunt.

Tetra Tech also ran its own 2015 model for the 2007 flood and found differences in the water-surface elevation of less than 0.5 feet. Therefore, it appears to Tetra Tech that the Mead & Hunt model results presented in this section and Figure 12 are wrong. Tetra Tech has encountered this issue before and recommends deleting the output files (including the dss file) and re-running the model. Tetra Tech would be pleased to discuss these results with Mead & Hunt to identify and eliminate the discrepancy.

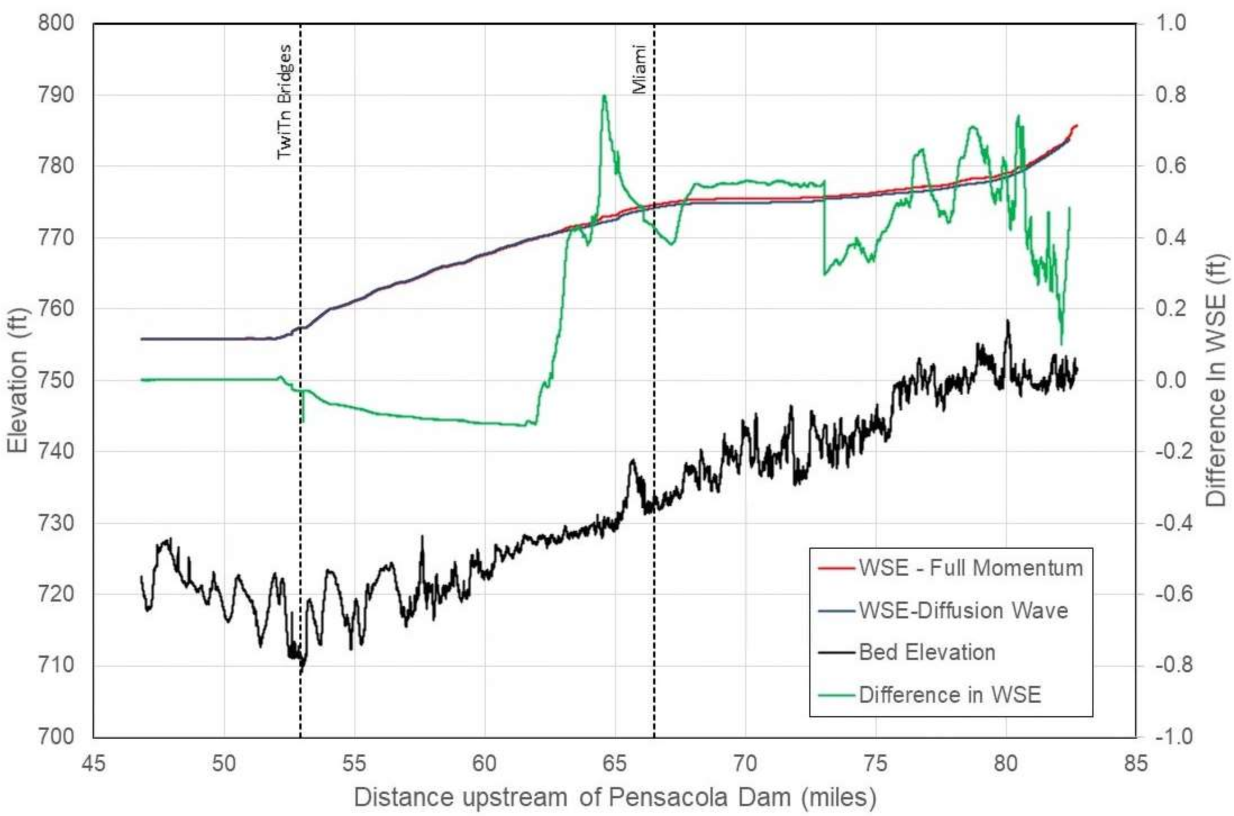


Figure E. Comparison of the predicted water-surface elevation profiles by the Mead & Hunt model applying the full momentum and diffusion wave equations for the June 2007 flood.

Mead & Hunt Response to Comment No. 6

The results displayed in Figure 12 are from a preliminary simulation, as stated in the report. Part of the process that FERC recommended in the Study Plan Determination is the presentation of preliminary results in the Model Input Status Report.

The Manning's n-values used in the calibrated model were not yet applied when this simulation was performed, so differences between the figure and Tetra Tech's re-run of the model are to be expected. Updated results are presented in the Initial Study Report.

Comment No. 7, Section 3.1.1, page 16

City of Miami Comment

Stage data for the period from c1990 to October 2007 are not published online but are available upon request from the USGS. Tetra Tech received the data from:
Scott Strong sstrong@usgs.gov
Jason Lewis jmlewis@usgs.gov
U.S. Geological Survey
Oklahoma City, OK 73116
(405) 810-4404
Tetra Tech recommends obtaining that data from USGS and using it in the calibration process.

Mead & Hunt Response to Comment No. 7

Discussion of data availability for the July 2007 event has been updated in Mead & Hunt’s report.

Comment No. 8, Section 3.1.2, page 16

City of Miami Comment

The Neosho River at Miami, OK (USGS Gage No. 07185080) started operating in 1994. Hourly gage data are available from the USGS upon request. Tetra Tech recommends obtaining these data and using them in calibration.

Mead & Hunt Response to Comment No. 8

In general, Mead & Hunt looked at hourly time series data when calibrating. For the 2007 event, Mead & Hunt used the daily maximum values at the Miami gage because hourly data was not publicly available. Because the flood event occurred over multiple days, the publicly available daily maximum values were sufficient.

Comment No. 9, Section 3.2.1, page 18

City of Miami Comment

The spike in flow near the peak of the 2007 flood is likely an anomaly, as it does not occur in the stage data (Figure F). The USGS measured the flow near the peak of the 2007 flood and applied a shift to the rating-curve for the data collected after the measurement. As a result, the USGS applied two rating curves to the 2007 flood, which has led to the downward shift in the flow hydrograph. Tetra Tech recommends that Mead and Hunt re-calculate the flows prior to the peak using the stage-versus-discharge rating-curve reported near the peak.

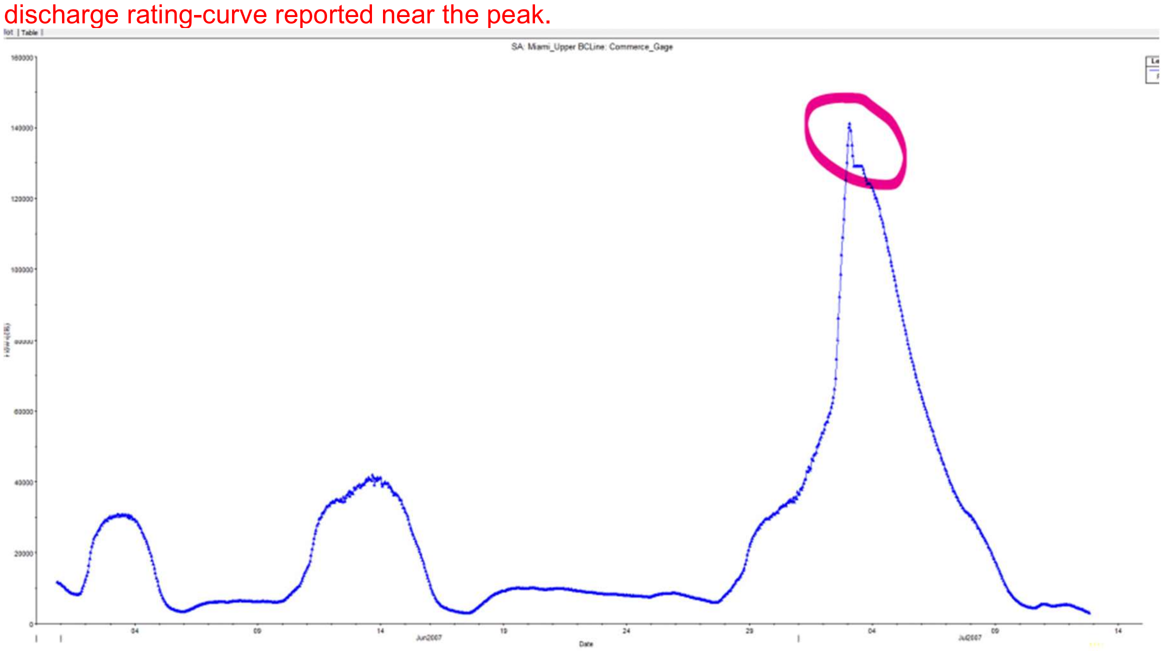
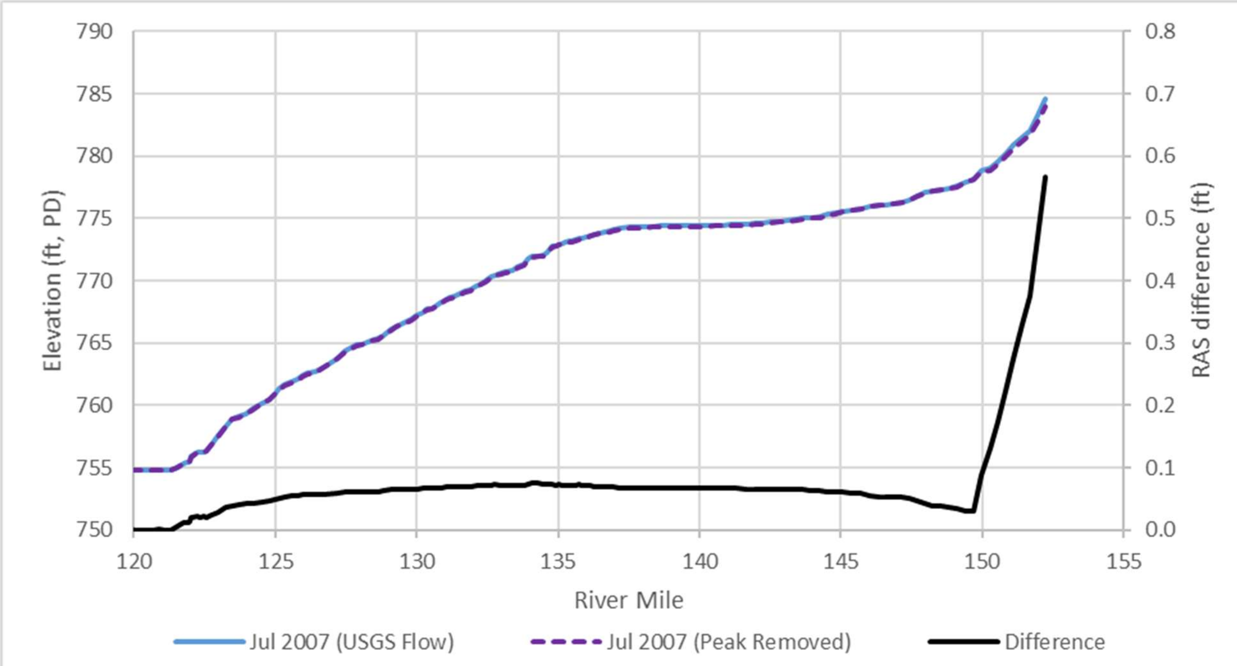


Figure F. The highlighted section represents a spike in the hydrograph that is not representative of the actual flows.

Mead & Hunt Response to Comment No. 9

Mead & Hunt simulated the July 2007 event with the spike at the peak of the hydrograph removed. The results from the simulation with the peak removed were compared to results from the simulation using the publicly available USGS flow hydrograph. See the figure below. The difference in water surface elevation is less than 0.6 feet at the very upstream end of the model, and quickly drops to less than 0.1 feet. Given the choice between (1) using USGS flow data directly and (2) manipulating the flow data using the second rating curve, it is best to use the USGS data directly.



790
785
780
775
770
765
760
755
750
Elevation (ft, PD)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
RAS difference (ft)
120
125
130
135
140
145
150
155
River Mile
Jul 2007 (USGS Flow)
Jul 2007 (Peak Removed)
Difference

Comment No. 10, Section 3.3, page 21

City of Miami Comment

HEC-RAS has the ability to simulate vertically varied Manning's n-values for 1-D areas but not for 2-D areas. In general, the Manning's n-values increase at higher flows due to the increased roughness of the tree canopy. The application of the roughness factors only to 1-D areas does not make physical sense. There could be a difference in Manning's n value by a factor of 0.6 or 1.3 on either side of the 1D/2D boundary. For example, the Manning's n roughness value in the 2-D area is 0.037, while the n-value in the 1-D area varies from 0.022 to 0.047. Also, it does not make physical sense to increase the Manning's n values in the lake. Since the lake is deep, the model is likely to be relatively insensitive to the Manning's n (within a reasonable range of n-values). Tetra Tech recommends performing a sensitivity analysis of the effects of changing Manning n-values in the lake as well as along the Neosho, Spring and Elk Rivers.

For the Neosho River, the roughness factor in the Mead & Hunt model decreases from 1.3 at 150,000 cfs to 1.0 at flows greater than 160,000 cfs. This does not make physical sense as there is no obvious reason why the roughness would decrease at greater discharges. If Mead & Hunt continue using this method, Tetra Tech recommends keeping the roughness factor the same at the larger flow events.

Mead & Hunt Response to Comment No. 10

USACE recommends the use of flow roughness factors in model calibration (HEC-RAS User's Manual, page 8-65). By using flow roughness factors, Mead & Hunt is following USACE guidance.

Tetra Tech raises a concern with the discontinuity in n-values at the 1D/2D boundary. Tetra Tech notes that the Mead & Hunt model has a difference in n-value at the 1D/2D boundary of 0.037 (2D) and a range from 0.022 to 0.047 (1D). In the same area, Tetra Tech's 2016 analysis used n-values of 0.037, then 0.083, then 0.035, then 0.043, with abrupt transitions between these values (Tetra Tech, 2016). Mead & Hunt's approach results in less abrupt changes in n-values.

Regarding increasing n-values in the lake, there were no flow roughness factors applied to Grand Lake. Flow roughness factors were not applied below River Mile 121.51.

Regarding the suggestion of a sensitivity analysis, Mead & Hunt tested the sensitivity to Manning's n-values early in our modeling and found that the Neosho River, the Spring River, and the Elk River were relatively sensitive to changes in n-values. Grand Lake was relatively insensitive to n-values.

Regarding the flow roughness factor of 1.0 for flows higher than those used in calibration, there is no available, comprehensive set of observed data collected at higher flows to justify the application of flow roughness factors at higher flows.

Comment No. 11, Section 3.4, page 21
City of Miami Comment

Based on the Mead & Hunt model output for the October 2009 flood, the average of the absolute differences between the predicted maximum water-surface elevations and measured high-water marks is 0.57 feet.

For the 2007 flood, the average of the absolute differences between the predicted maximum water-surface elevations and measured high-water marks is 1.19 feet. As shown in Figure 13, the greatest calibration differences occur at the Miami Gage, which is a key area of interest to the City of Miami.

In general, the Mead & Hunt model is underpredicting the measured water-surface elevations for the larger flood events. Because much of the flood plain upstream of Grand Lake is relatively flat, small underpredictions of water surface elevation translate into much greater underpredictions in the lateral extent of flooding in many areas. Therefore, Tetra Tech supports calibrating the individual high-water marks to an absolute difference of less than 0.5 feet, and not the average of all the differences to less than 0.5 feet, which can under-represent the differences.

Mead & Hunt Response to Comment No. 11

Mead & Hunt followed USACE guidance in the HEC-RAS User's Manual when calibrating (USACE, February 2016).

1. USACE states that a ± 5% flow measurement, which may be "*optimistic*", "*translates into a stage error of ±1.0 feet*" (page 8-54). It is inadvisable to further modify the model to force the water surface elevation profiles to match each high-water mark within 0.5 feet.
2. USACE states that "*high water marks in the overbank area are often higher than in the channel*" (page 8-55). Because many of the high-water marks were collected in the overbank area, a slight model underprediction is expected when compared to measured water surface elevations.
3. USACE recommends the user to "*not force a calibration to fit with unrealistic Manning's n-values*" (page 8-65). Rather than force the water surface elevation to match each high-water mark within 0.5 feet by aggressively modifying n-values, Mead & Hunt followed USACE guidance and accomplished the goal of a water surface elevation profile that passes through or near the high-water marks.

Mead & Hunt's report has been updated with a comparison of measured water surface elevations for the July 2007 event.

Comment No. 12, Section 3.4, page 21
City of Miami Comment

Tetra Tech's review of the predicted flow hydrograph neat the mouth of the Elk River indicated probable model instability for the 2007 flood (Figure G). Tetra Tech recommends reviewing the model output and adjusting the model to prevent model instability.

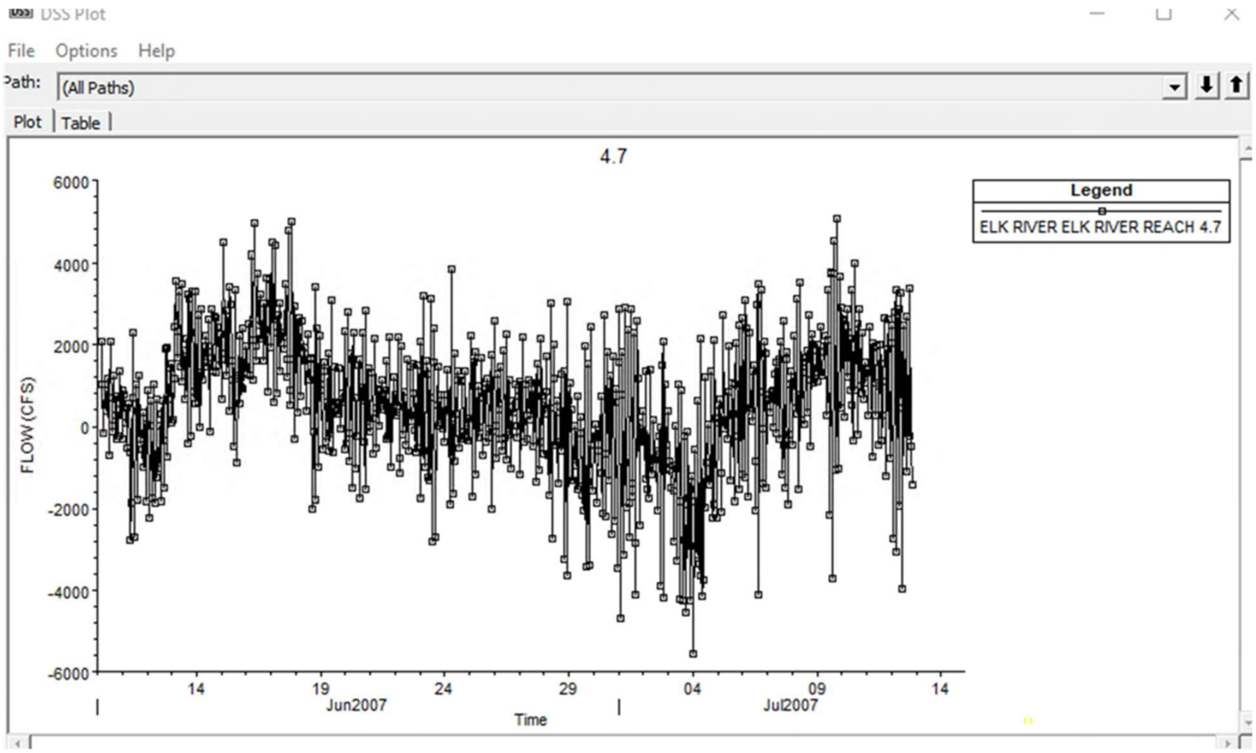


Figure G. Screen capture from HEC-RAS showing the predicted flow for the 2007 flood at cross- section 4.7 on the Elk River. The variability in the predicted flow indicates numerical instability in the model.

Mead & Hunt Response to Comment No. 12

The fluctuating flow, which is different than model instability, is due to the use of recorded historical stage hydrograph as the downstream boundary. The recorded stage hydrograph includes fluctuations which create fluctuating flow toward the downstream end of the model. Synthetic or smoothed stage boundary conditions, which are used for the operational scenario simulations, result in less flow fluctuation.

Comment No. 13, Section 3.4, page 22
City of Miami Comment

Figure 13 does not show the calibration of the 2007 flood at Commerce gage. Tetra Tech recommends obtaining the hourly stage data from the USGS and calibrating the Mead & Hunt Model to the Commerce gage.

Mead & Hunt Response to Comment No. 13

Peak stage at the Commerce gage for the July 2007 event is discussed in Mead & Hunt's Initial Study Report.

Comment No. 14, Section 3.4, page 23

City of Miami Comment

Figure 16 shows a significant drop in water-surface elevation near RM 123. Mead & Hunt should explain the reason for the drop, and why it does not call into question Mead & Hunt's modeling results.

Mead & Hunt Response to Comment No. 14

The decrease in water surface elevation occurs at the downstream face of the Burlington Northern Railroad Bridge and is a function of bridge hydraulics.

Comment No. 15, Section 4, page 26

City of Miami Comment

Tetra Tech recommends a comparison between the peak flows reported by the RiverWare and gage records to ensure the data sets match by a reasonable amount. Tetra Tech recommends a flood-frequency and/or partial duration flood-frequency analysis for all the gages contributing to Grand Lake, including the Neosho, Spring, and Elk Rivers and Tar Creek.

Mead & Hunt Response to Comment No. 15

By using RiverWare for the flood frequency analysis, Mead & Hunt is following the City's recommendation.

Comment No. 16, Section 4, page 26

City of Miami Comment

Tetra Tech understands that the Real Estate Adequacy Study (U.S. Army Corps of Engineers, 1998) may have significant problems in terms of both the methods and results. The report was admitted into evidence in the 1998 state civil trial, Dalrymple et al v. Grand River Dam Authority, CJ 94-444, regarding the question of "'to what extent' Pensacola Dam causes backwater effects in the subject reach." Dr. Forrest Holly, the Referee agreed to by all parties, placed little weight in the study, making no reference to it in coming to his conclusions (Referee Report, February 15, 1999). Further, Holly (2001) concluded that there was substantially more backwater effect in the Miami reach than the Corps concluded in its September 1998 Real Estate Adequacy Study. Tetra Tech recommends independently verifying any methods or results presented in the study.

Mead & Hunt Response to Comment No. 16

Mead & Hunt's objective is not to verify previous studies, including the 1998 REAS. The flood frequency curve from the 1998 REAS is only presented in the report for comparative purposes. Mead & Hunt's methodology for the flood frequency analysis follows best practices (USGS Bulletin 17C, USACE EM 1110-2-1415).

Comment No. 17, Section 5, page 28
City of Miami Comment

In addition to the peak flow, the hydrograph volume has an important impact on the lake elevation and outflow operations during flood events. The Mead & Hunt (2021) report does not provide any analysis of the inflow flood volume.

During flood events, the USACE attempts to limit the outflow to 100,000 cfs to prevent downstream flooding. During large floods, such as the 2019 flood, the lake reached its highest level in history at 755.1 feet Pensacola Datum and the outflow peaked at approximately 180,000 cfs.

A large inflow volume can result in a significant increase in Grand Lake's water-surface elevation and an associated increase in flooding along the Neosho, Spring, and Elk Rivers.

The application of the scaling number to determine the 100-year inflow to Grand Lake is not appropriate, as it may result in unrealistic peak flows and flow volumes. For example, FEMA developed the 100-year peak flow hydrograph for the Neosho River by performing a flood-frequency analysis (using the HEC-SSP software) to estimate the peak flow, then performing hydrologic (rainfall/runoff) modeling (using the HEC-HMS software) to estimate the flood volume. The resulting hydrograph had a peak flow of about 165,000 cfs and volume of about 1,424,000 ac-ft (Figure H). In comparison, multiplying the 2007 flood hydrograph by scaling factor of 2.15 produces a peak flow of about 319,000 cfs and volume of 2,884,300 cfs; both the peak flow and volume are far in excess of FEMA's 100-year peak flow and volume, and physically unrealistic for the 100-year event (Figure H).

The flood-frequency curve for the Neosho River at Commerce Gage is shown in Figure I. The 100-year peak flow is approximately 165,000 cfs. The 100-year peak flow applied by Mead & Hunt plots well outside the 95th percentile confidence limit.

Tetra Tech recommends that Mead & Hunt perform a basin-wide hydrologic analysis to develop flood hydrographs at each of the inflow locations that have physically based rationale for predicting the peak flow and volume.

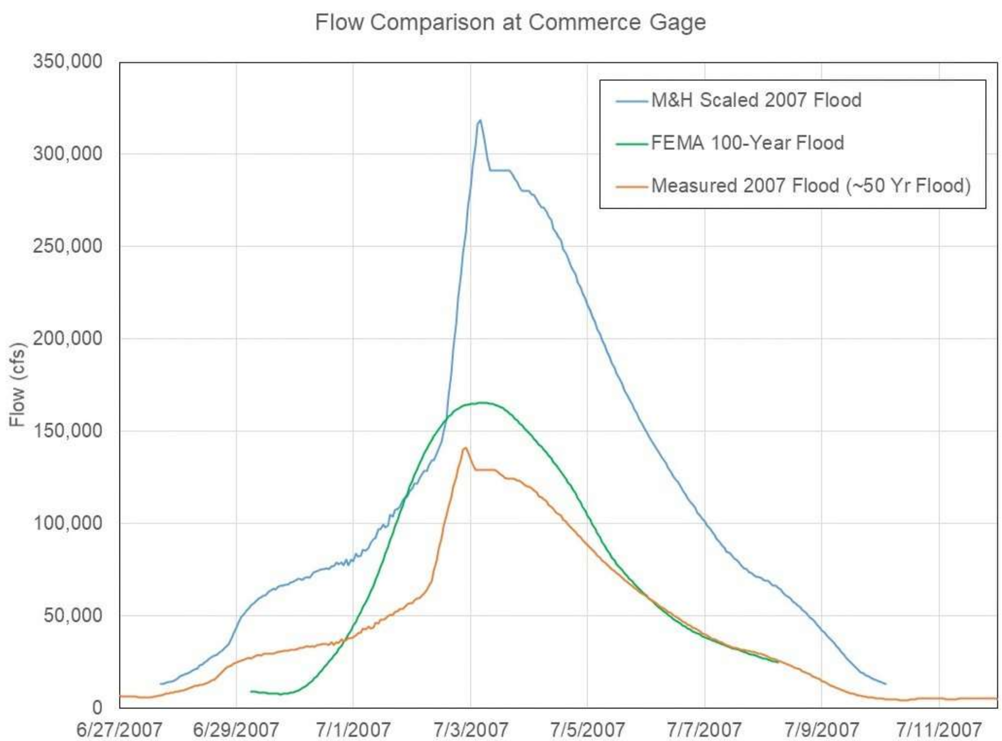


Figure H. Comparison of the measured 2007 flood at Commerce Gage, FEMA 100-year flood hydrograph, and scaled 2007 flood in the Mead & Hunt model used to represent the 100-year inflow to Grand Lake.

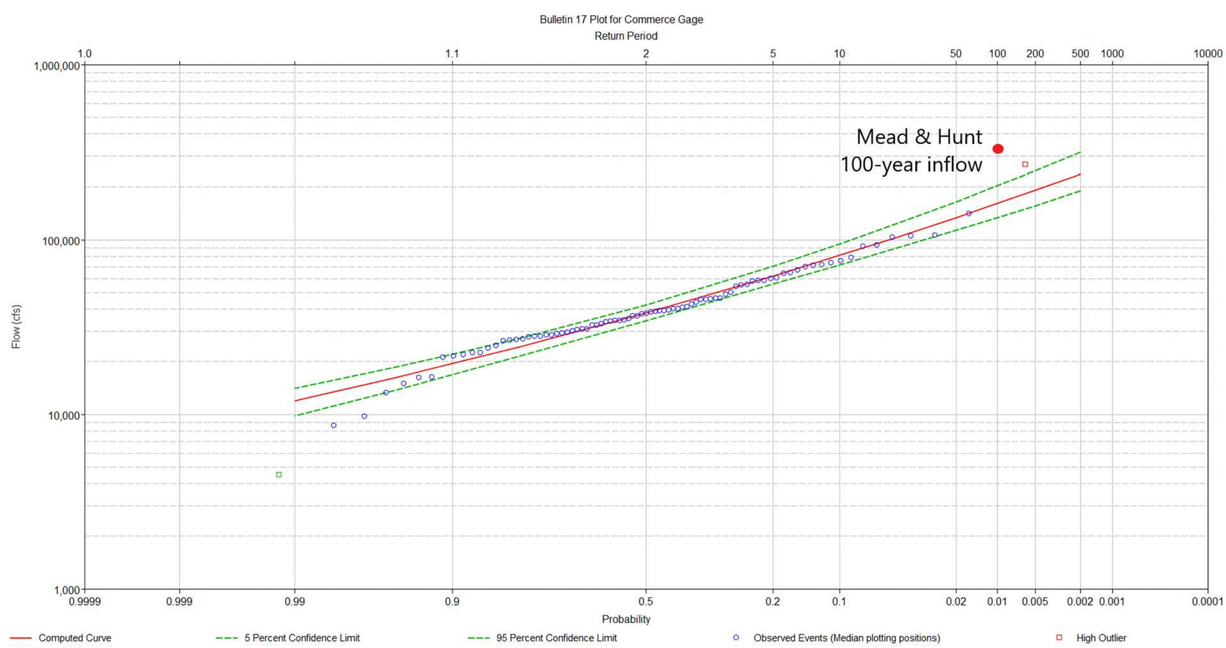


Figure I. Flood-frequency curve for the Neosho River at Commerce gage. Note that the scaled 100-year peak flow predicted by the Mead & Hunt model falls well outside the confidence limits of the flood-frequency curve.

Mead & Hunt Response to Comment No. 17

A basin-wide hydrologic analysis was not recommended in the Revised Study Plan, nor required in FERC's Study Plan Determination.

The FEMA flood-frequency analysis referenced by Tetra Tech was performed using a HEC-HMS model. A single sub-basin was used to represent the 5,927 square miles that drain to the Commerce gage and the model did not include John Redmond Reservoir. Model calibration was performed using the 2007 event and model validation was performed using a flood frequency curve computed using statistical methods in USGS's PeakFQ software. FEMA's approach includes the following deficiencies:

1. Not including John Redmond Reservoir (thus treating a regulated system like an unregulated system) and then calibrating to historic data from the regulated system will result in inaccurate model parameters, which will decrease the predictive capability of the model.
2. Statistical methods should not be used to estimate flood frequency for regulated basins. Using statistical methods within PeakFQ to validate the HEC-HMS model does not follow best practices (USGS Bulletin 17C).

Regarding the inflow volume, Mead & Hunt used a statistical analysis of historic inflow volume to better estimate the hydrograph volume.

Comment No. 18, Section 6, page 29

City of Miami Comment

This method is for determining the Guide Take Line for real estate takings. It should not be used to define the "material difference" for calibration purposes.

Adjusting the flows by ±2% and comparing the difference in water-surface elevations is essentially a sensitivity analysis. The results are valid only for the selected site and for the modeled flood event. This method should not be evaluated for determining the "material difference".

Mead & Hunt Response to Comment No. 18

Mead & Hunt reviewed how various government entities quantify difference in water surface elevation. We understand that the scenarios for which these quantifications are applied are not exactly like the scenario at hand. However, they are still instructive for the purpose of defining material difference.

Comment No. 19, Section 6, page 29

City of Miami Comment

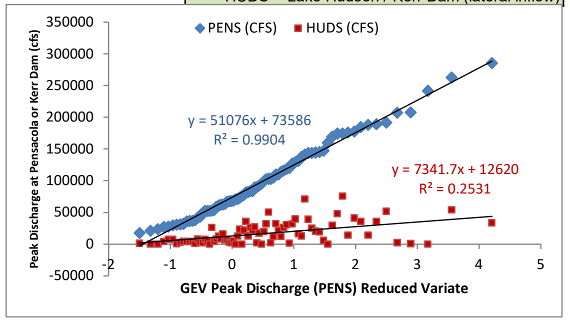
In addition to the "out of bank events", the "material difference" criterion of 0.5 feet should be applied to the calibration for the within bank flows.

Mead & Hunt Response to Comment No. 19

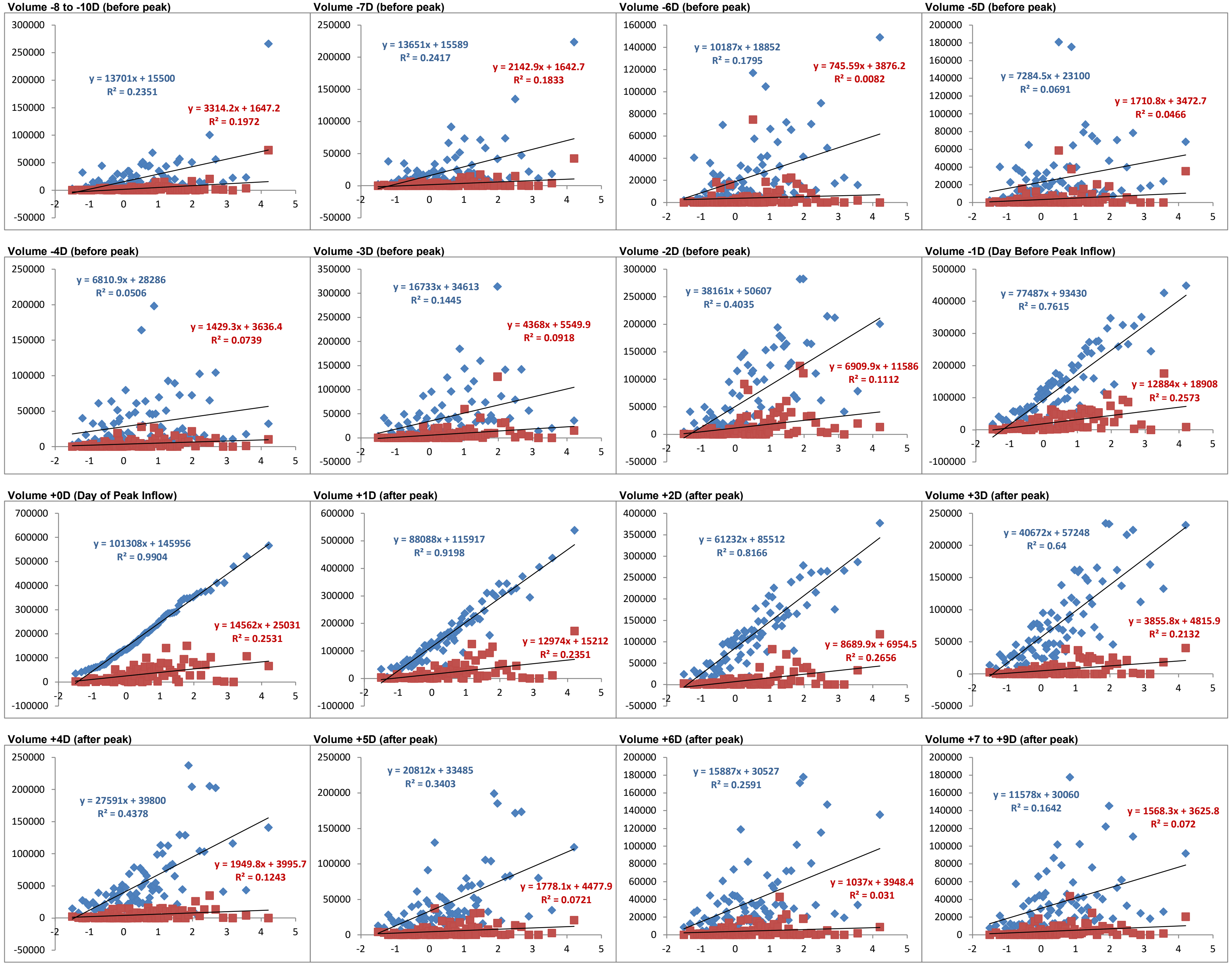
Mead & Hunt is considering 0.5 feet of difference in water surface elevation within banks where it is required to meet the objectives of the study. Specifically, we are considering 0.5 feet of water surface elevation difference within the banks where the inundation impacts infrastructure or other sensitive resources.

APPENDIX B:
HISTORICAL INFLOW VOLUME STATISTICAL ANALYSIS

PENS = Pensacola Dam / Grand Lake (total inflow)
HUDS = Lake Hudson / Kerr Dam (lateral inflow)

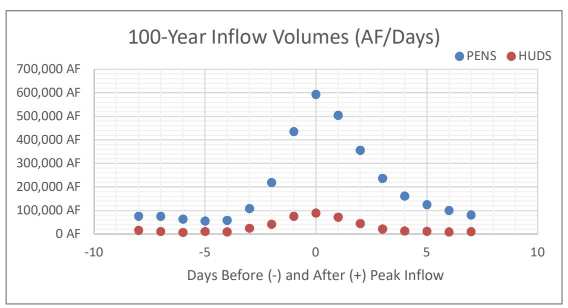


Average Daily Volume (AF) vs GEV Peak Discharge (PENS) Reduced Variate Correlation Plots



reduced variate for 100-year event, y = 4.41

	scale, σ (m)	location, μ (b)	100-year
PENS (CFS)	51076	73586	299,000 cfs
HUDS (CFS)	7342	12620	45,021 cfs
PENS D–8 to –10 (AF)	13701	15500	75,966 AF
PENS D–7 (AF)	13651	15589	75,835 AF
PENS D–6 (AF)	10187	18852	63,810 AF
PENS D–5 (AF)	7285	23100	55,249 AF
PENS D–4 (AF)	6811	28286	58,344 AF
PENS D–3 (AF)	16733	34613	108,461 AF
PENS D–2 (AF)	38161	50607	219,023 AF
PENS D–1 (AF)	77487	93430	435,403 AF
PENS D+0 (AF)	101308	145956	593,058 AF
PENS D+1 (AF)	88088	115917	504,675 AF
PENS D+2 (AF)	61232	85512	355,747 AF
PENS D+3 (AF)	40672	57248	236,745 AF
PENS D+4 (AF)	27591	39800	161,567 AF
PENS D+5 (AF)	20812	33485	125,334 AF
PENS D+6 (AF)	15887	30527	100,641 AF
PENS D+7 to +9 (AF)	11578	30060	81,157 AF
HUDS D–8 to –10 (AF)	3314	1647	16,274 AF
HUDS D–7 (AF)	2143	1643	11,100 AF
HUDS D–6 (AF)	746	3876	7,167 AF
HUDS D–5 (AF)	1711	3473	11,023 AF
HUDS D–4 (AF)	1429	3636	9,944 AF
HUDS D–3 (AF)	4368	5550	24,827 AF
HUDS D–2 (AF)	6910	11586	42,081 AF
HUDS D–1 (AF)	12884	18908	75,769 AF
HUDS D+0 (AF)	14562	25031	89,297 AF
HUDS D+1 (AF)	12974	15212	72,470 AF
HUDS D+2 (AF)	8690	6955	45,306 AF
HUDS D+3 (AF)	3856	4816	21,833 AF
HUDS D+4 (AF)	1950	3996	12,601 AF
HUDS D+5 (AF)	1778	4478	12,325 AF
HUDS D+6 (AF)	1037	3948	8,525 AF
HUDS D+7 to +9 (AF)	1568	3626	10,547 AF



APPENDIX C:
HYDROGRAPHS

APPENDIX C.1:
INFLOW HYDROGRAPHS

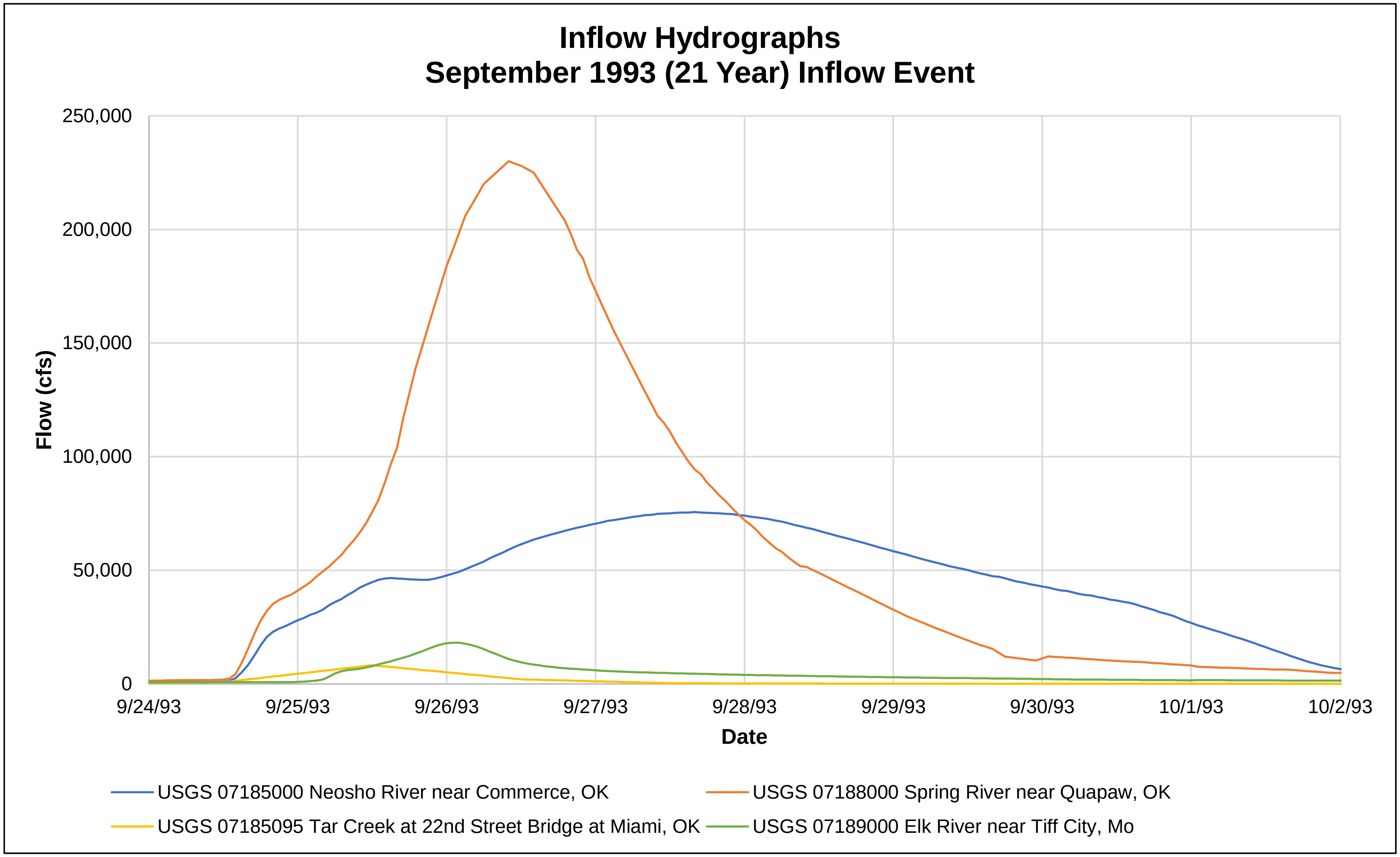


Figure C.1. Inflow hydrographs for the September 1993 (21 year) inflow event upstream of Pensacola Dam.

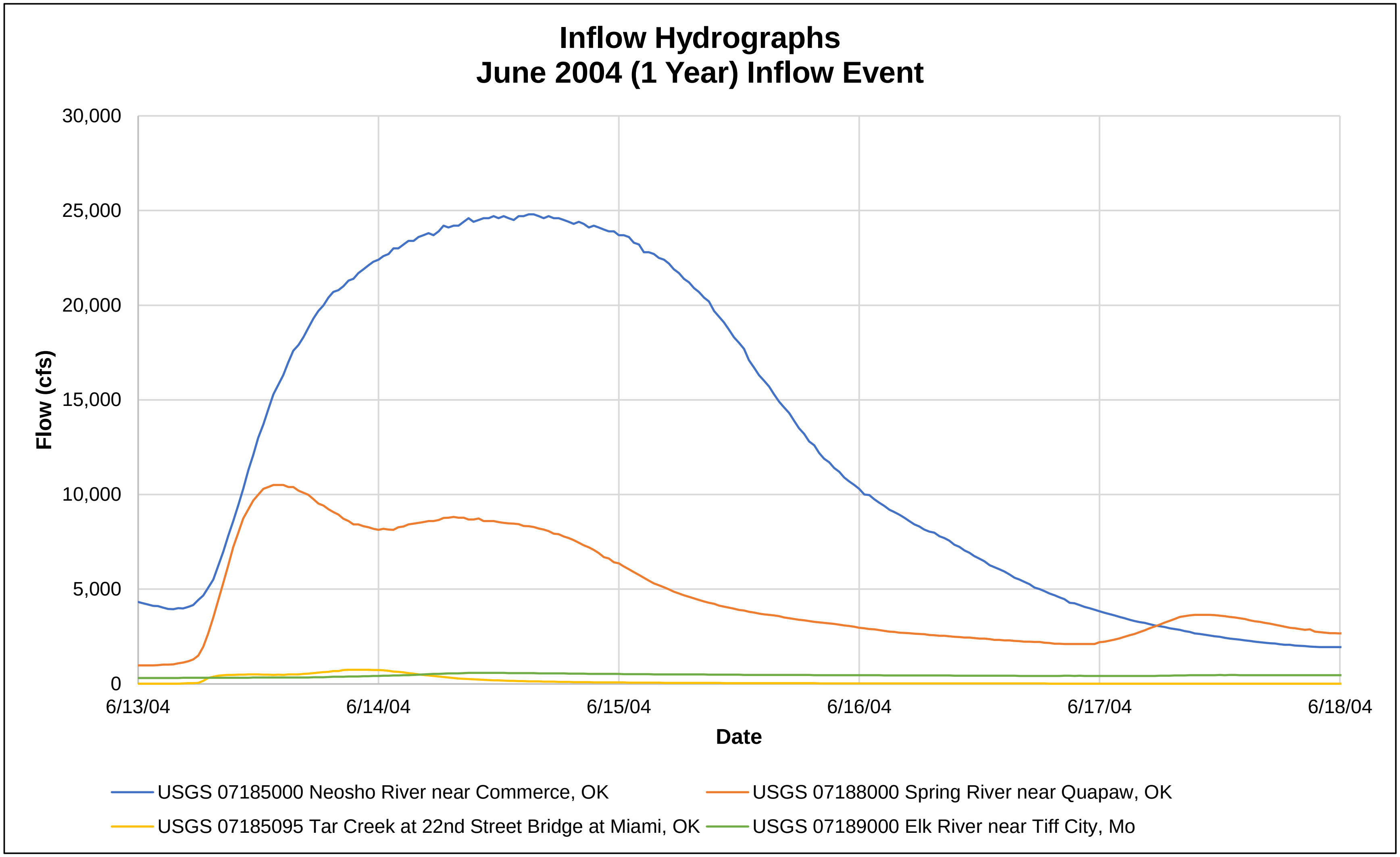


Figure C.2. Inflow hydrographs for the June 2004 (1 year) inflow event upstream of Pensacola Dam.

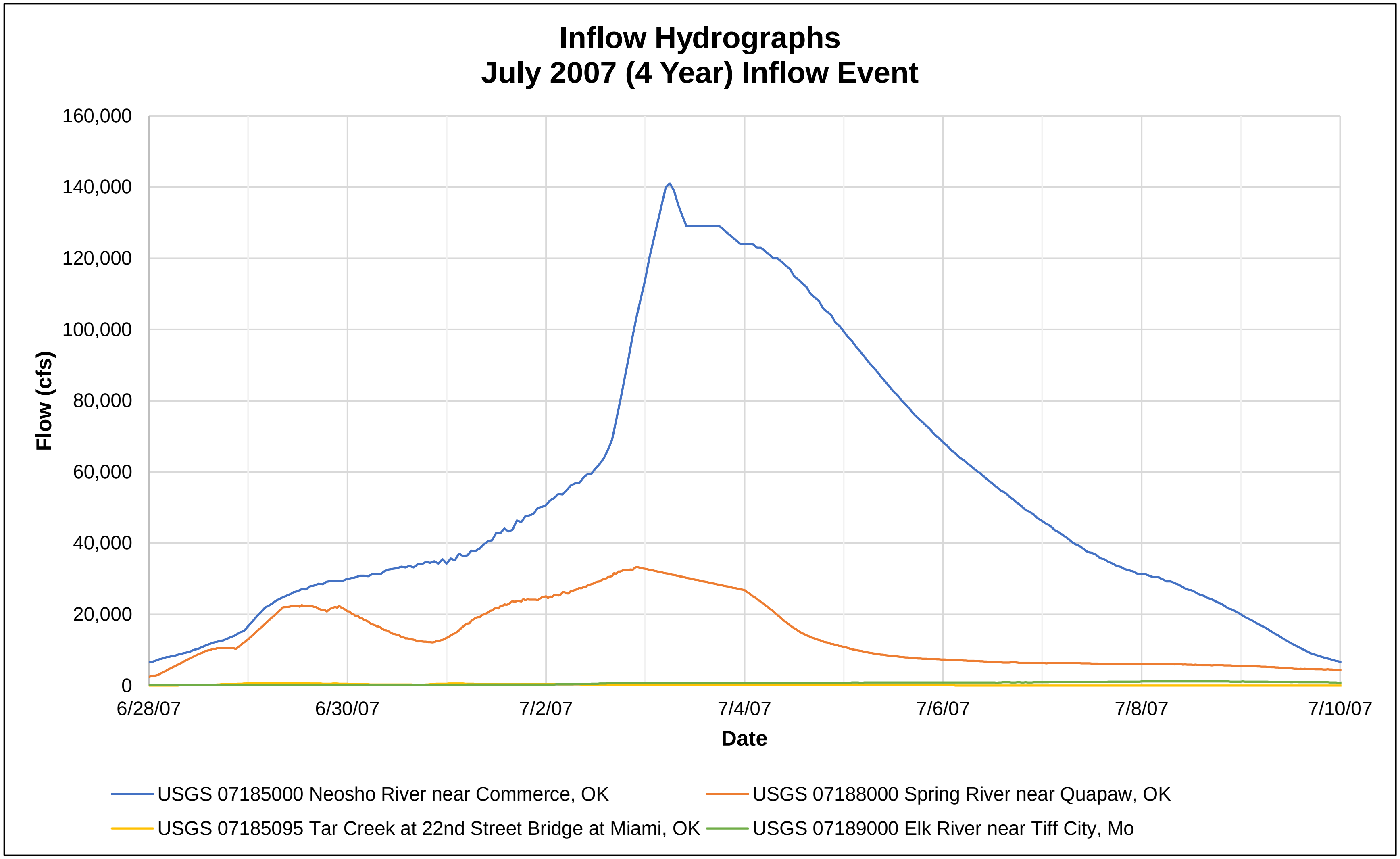


Figure C.3. Inflow hydrographs for the July 2007 (4 year) inflow event upstream of Pensacola Dam.

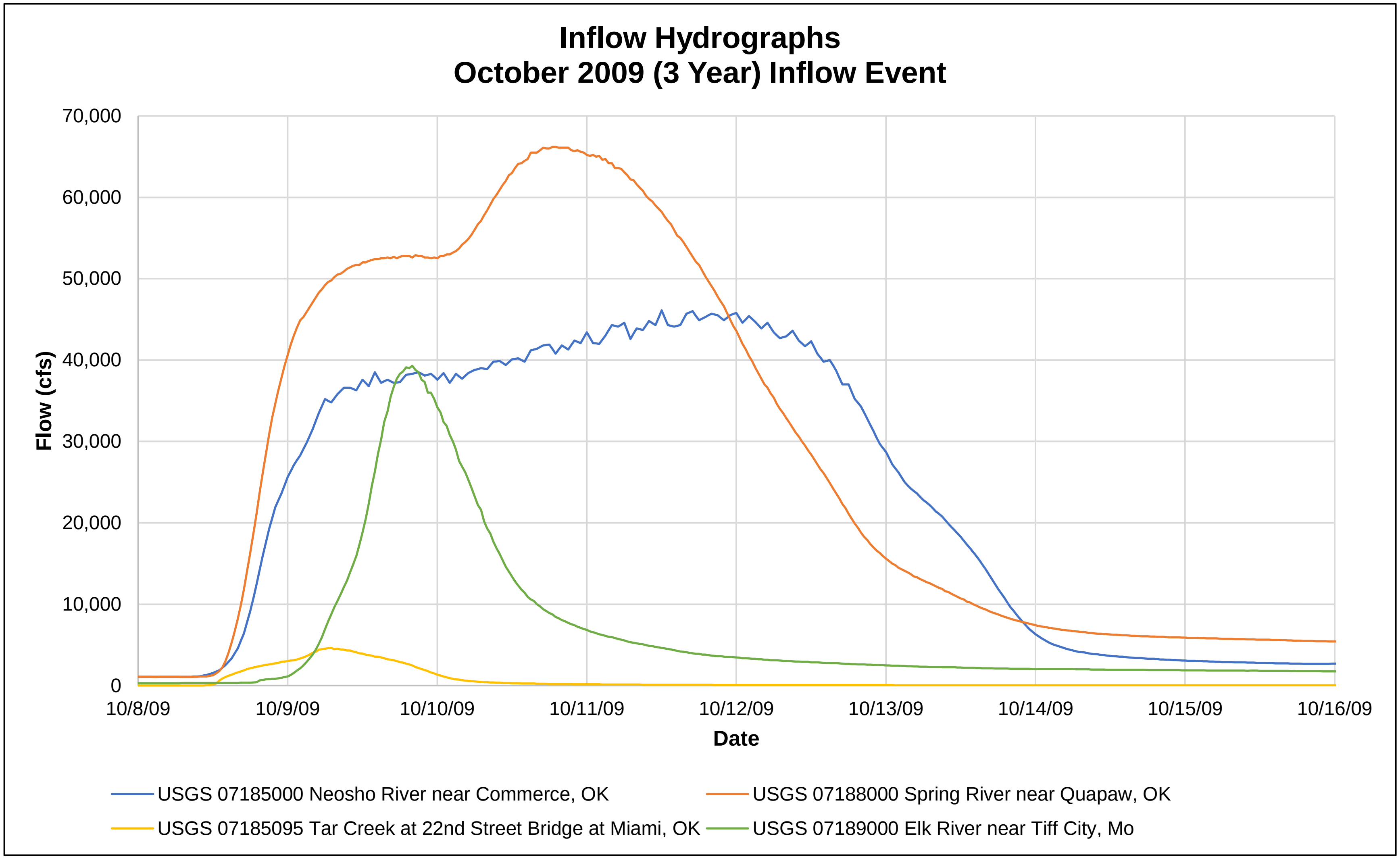


Figure C.4. Inflow hydrographs for the October 2009 (3 year) inflow event upstream of Pensacola Dam.

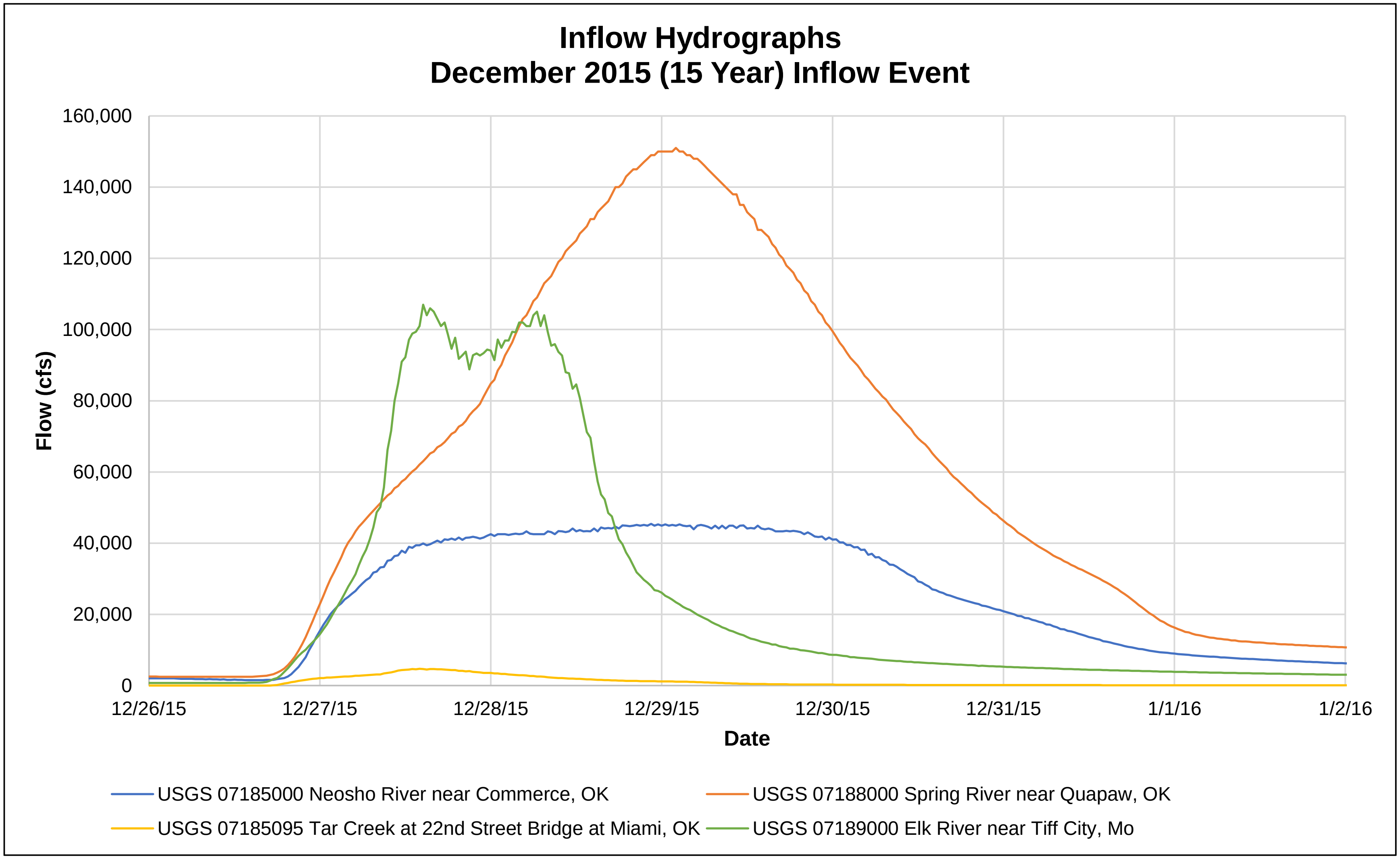


Figure C.5. Inflow hydrographs for the December 2015 (15 year) inflow event upstream of Pensacola Dam.

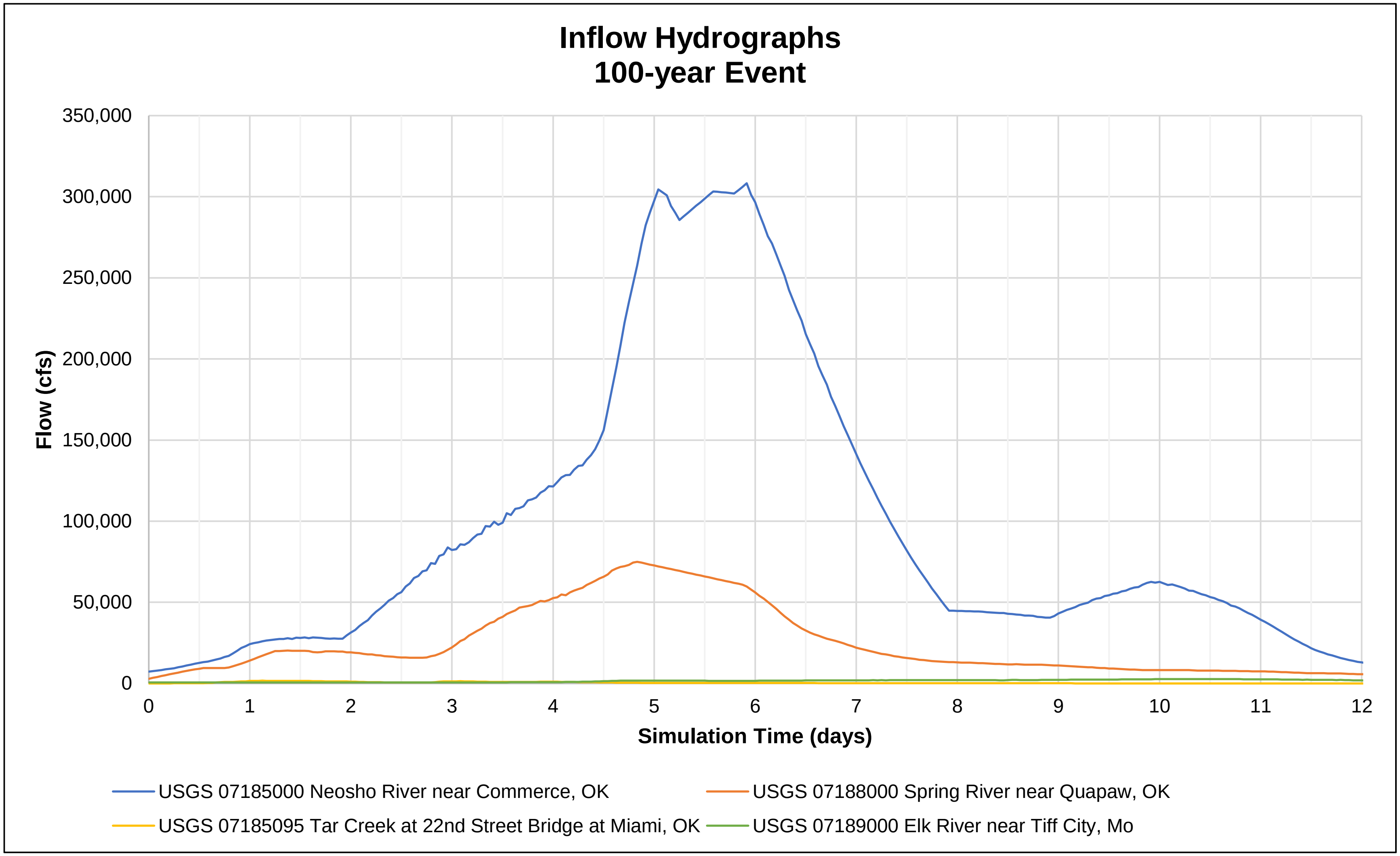


Figure C.6. Inflow hydrographs for the 100-year event upstream of Pensacola Dam.

Note: *Because the 100-year event is synthetic, there is no historical start or end date, so stage hydrographs for the 100-year event are presented as a function of simulation time rather than date.*

APPENDIX C.2:
STAGE HYDROGRAPHS

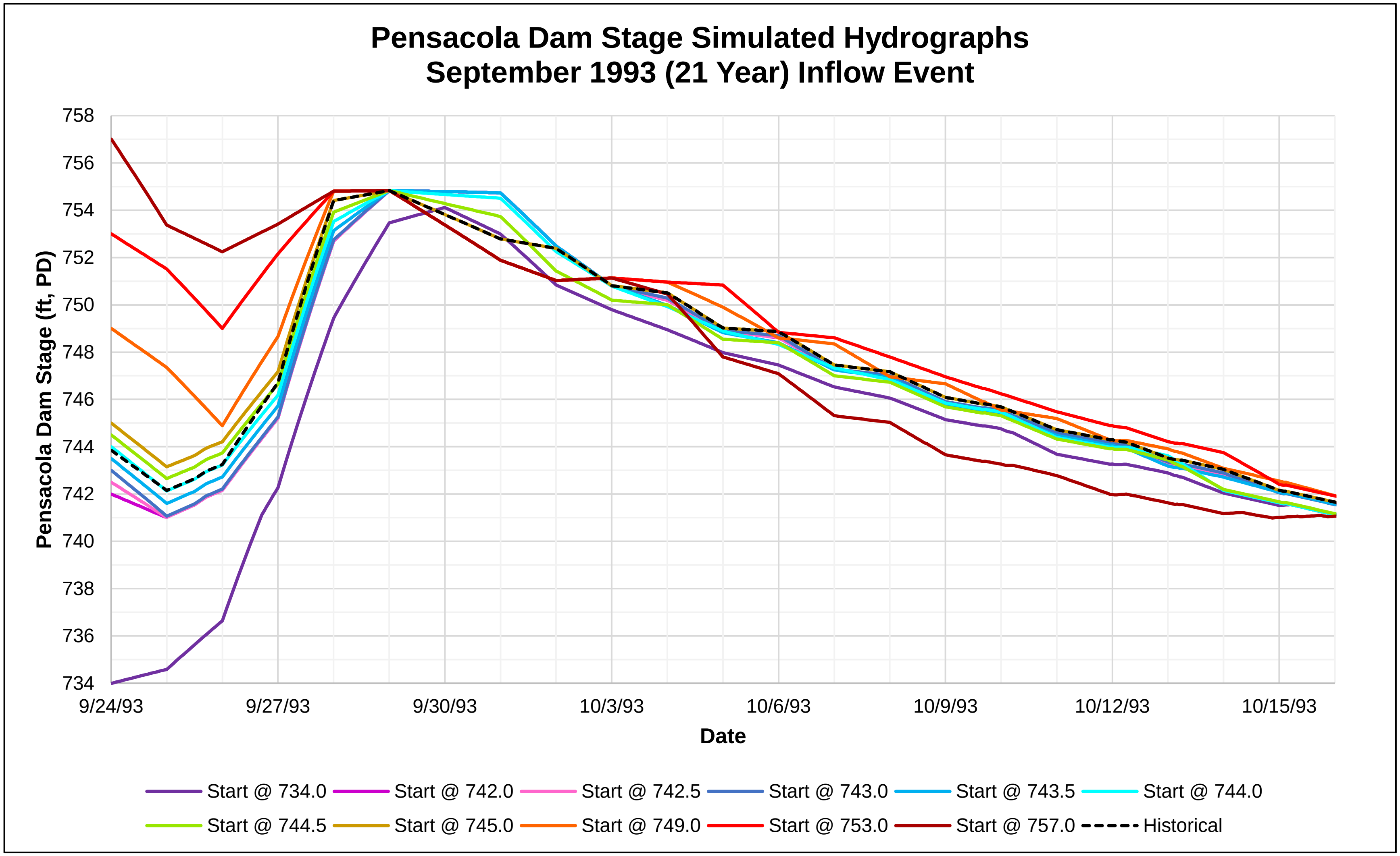


Figure C.7. Simulated stage hydrographs for the September 1993 (21 year) inflow event upstream of Pensacola Dam.

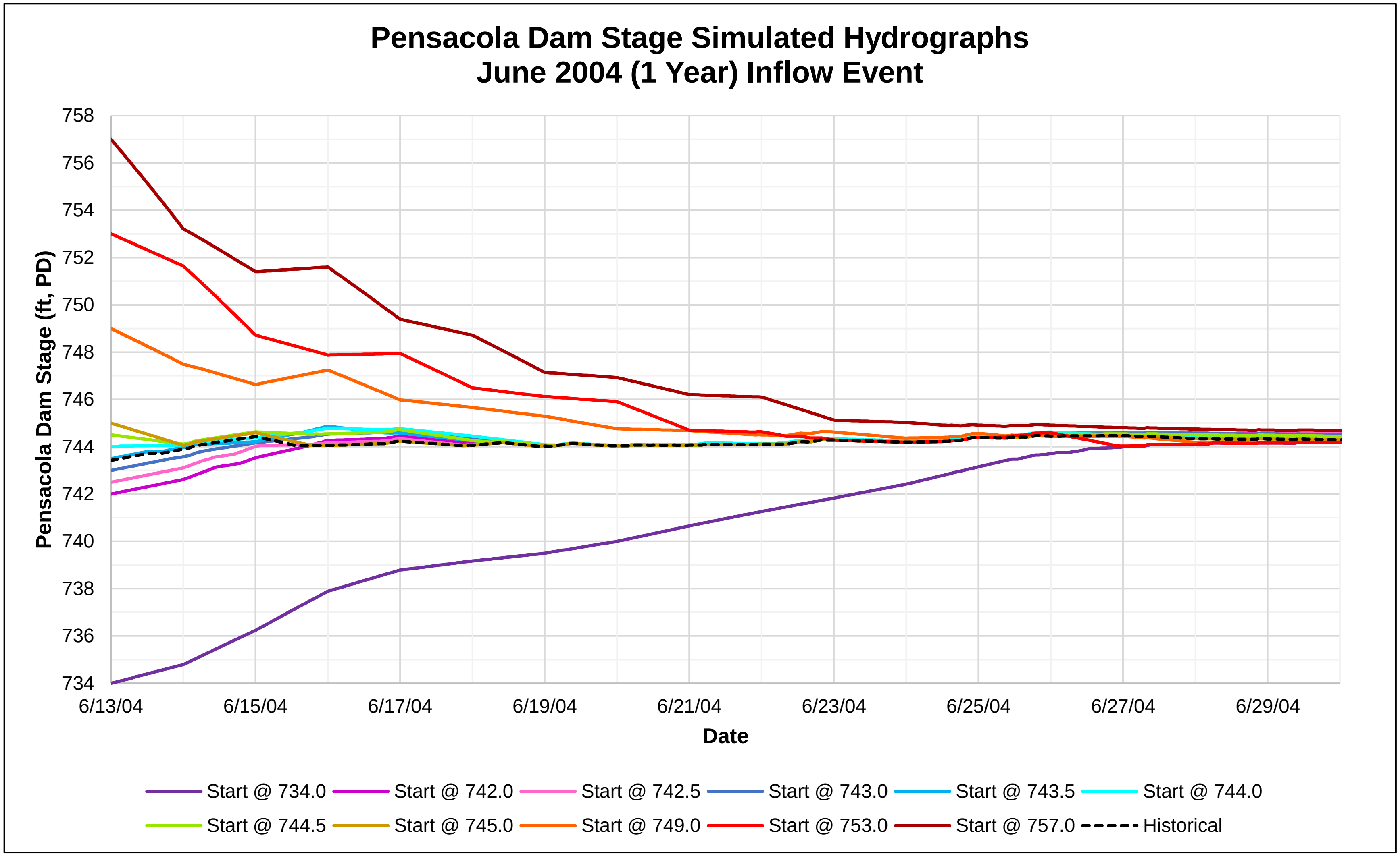


Figure C.8. Simulated stage hydrographs for the June 2004 (1 year) inflow event upstream of Pensacola Dam.

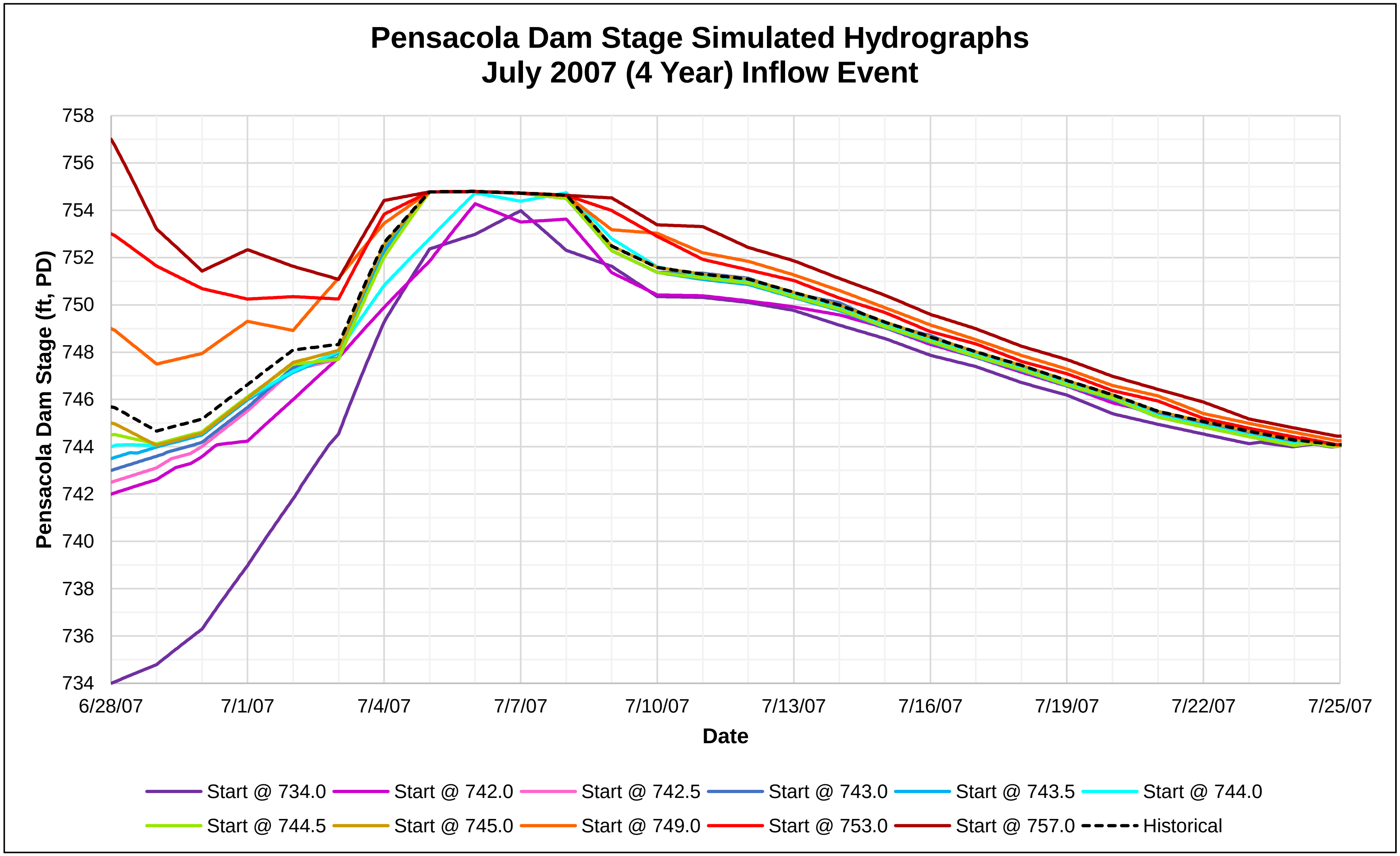


Figure C.9. Simulated stage hydrographs for the July 2007 (4 year) inflow event upstream of Pensacola Dam.

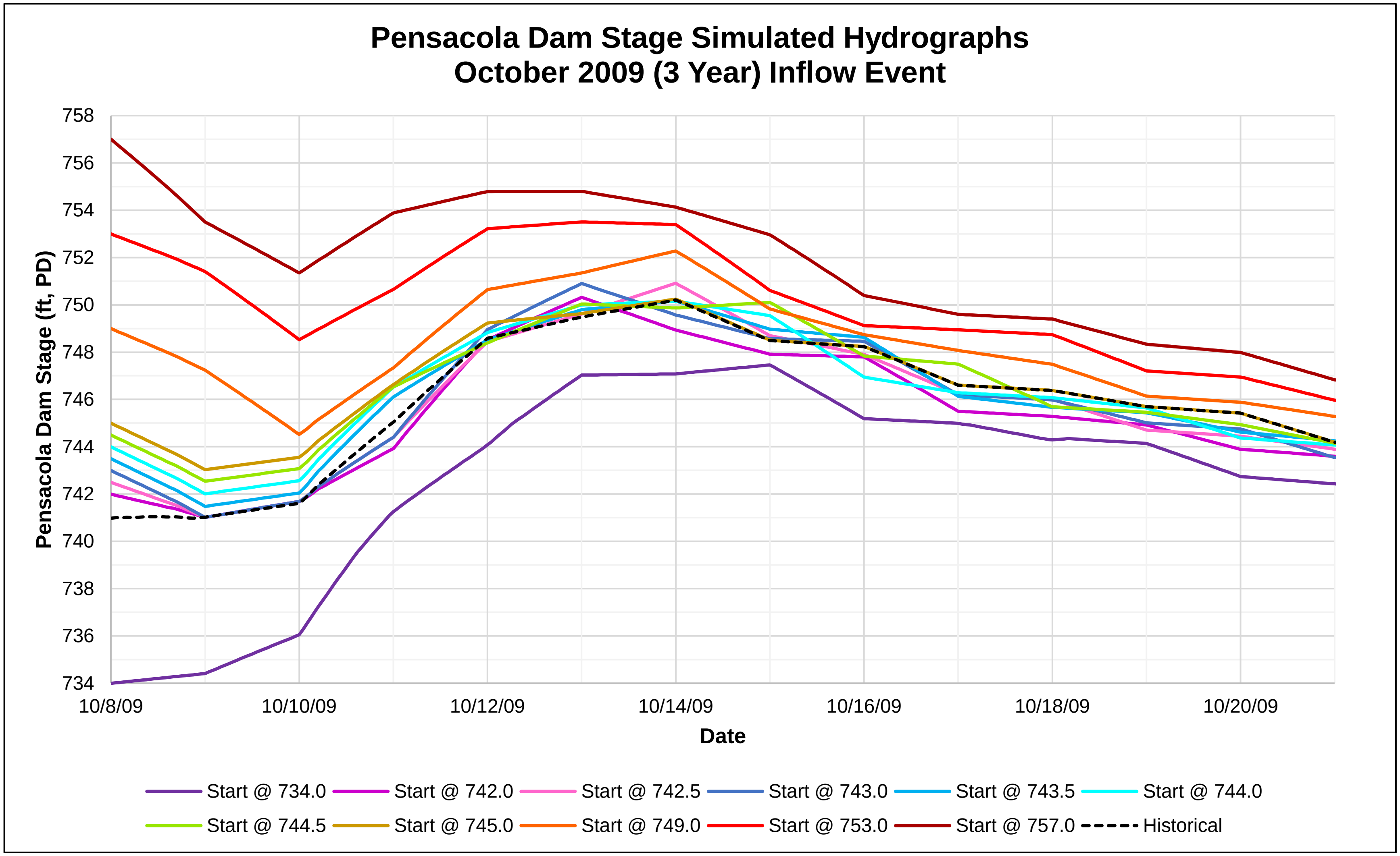


Figure C.10. Simulated stage hydrographs for the October 2009 (3 year) inflow event upstream of Pensacola Dam.

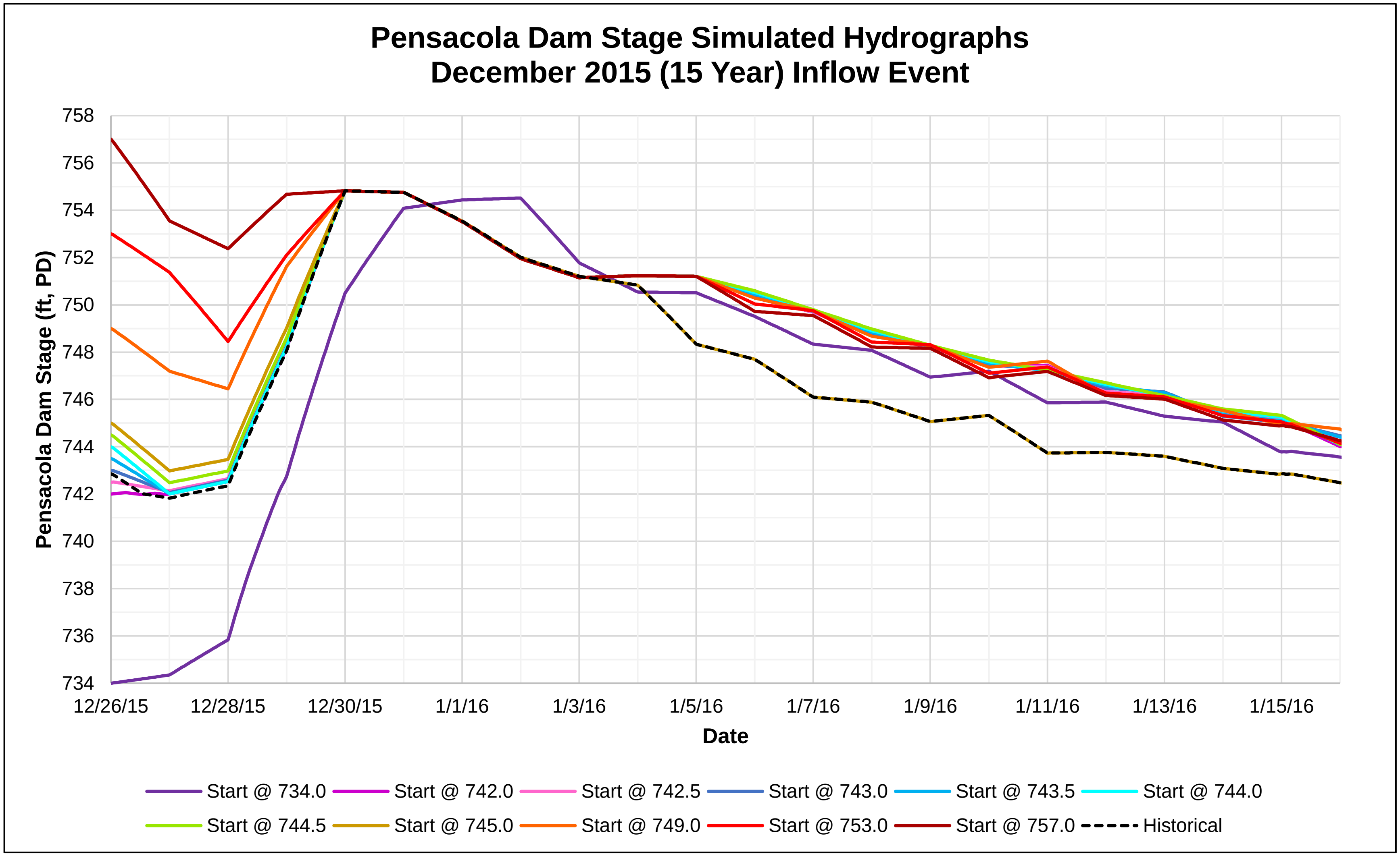


Figure C.11. Simulated stage hydrographs for the December 2015 (15 year) inflow event upstream of Pensacola Dam.

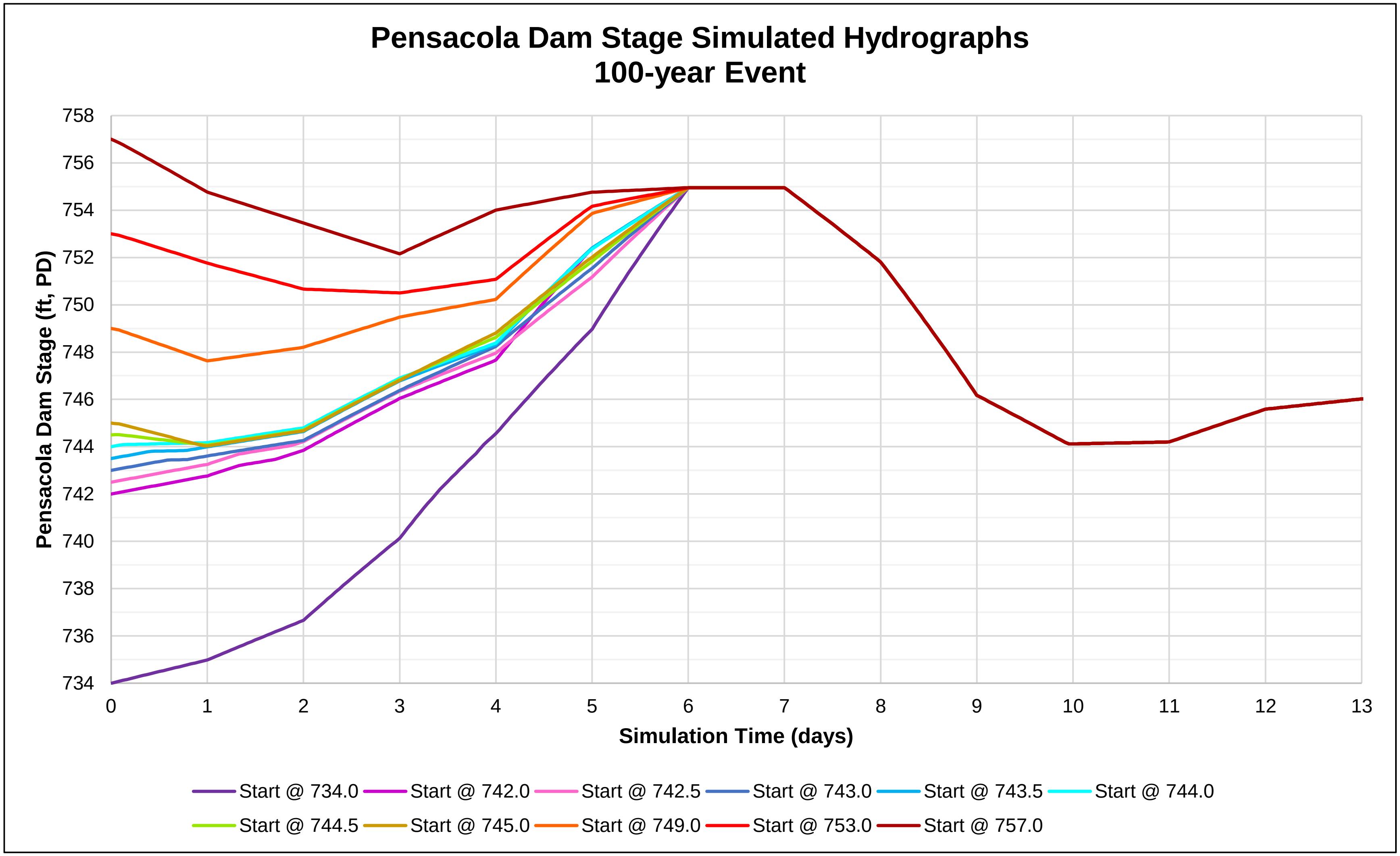


Figure C.12. Simulated stage hydrographs for the 100-year event upstream of Pensacola Dam.

Note: *Because the 100-year event is synthetic, there is no historical start or end date, so stage hydrographs for the 100-year event are presented as a function of simulation time rather than date.*

APPENDIX D:
MAXIMUM WATER SURFACE ELEVATIONS

APPENDIX D.1:

SEPTEMBER 1993 (21 YEAR) INFLOW EVENT

MAXIMUM WATER SURFACE ELEVATIONS

PENSACOLA DAM **TABLE D.1**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - SEP 1993 (21 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
152.175	Upstream end of model													
152.175	752.29	780.71	780.71	780.71	780.71	780.71	780.71	780.71	780.71	780.71	780.71	780.71	0.00	0.00
151.000	748.53	777.94	777.94	777.94	777.94	777.94	777.94	777.94	777.94	777.94	777.94	777.95	0.00	0.00
150.000	748.47	776.66	776.66	776.66	776.66	776.66	776.66	776.66	776.66	776.66	776.66	776.67	0.00	0.01
149.000	750.14	775.12	775.12	775.12	775.12	775.12	775.12	775.12	775.12	775.13	775.14	775.14	0.00	0.02
148.000	749.29	774.25	774.25	774.25	774.25	774.25	774.25	774.25	774.25	774.26	774.28	774.30	0.00	0.05
147.000	747.76	772.70	772.71	772.71	772.71	772.71	772.72	772.72	772.72	772.74	772.78	772.82	0.01	0.12
145.500	745.12	771.59	771.61	771.61	771.62	771.62	771.63	771.63	771.64	771.67	771.74	771.81	0.03	0.22
145.480	E 60 Road Bridge													
145.400	748.01	771.52	771.55	771.55	771.55	771.55	771.56	771.57	771.58	771.60	771.68	771.74	0.03	0.22
144.000	743.43	770.48	770.53	770.53	770.53	770.55	770.56	770.57	770.59	770.62	770.72	770.80	0.05	0.32
143.000	737.95	769.99	770.06	770.06	770.06	770.08	770.09	770.11	770.13	770.17	770.28	770.37	0.07	0.37
142.000	742.91	769.62	769.70	769.70	769.70	769.72	769.73	769.75	769.78	769.82	769.94	770.03	0.08	0.41
141.000	741.01	769.47	769.56	769.56	769.56	769.58	769.59	769.61	769.64	769.68	769.80	769.90	0.08	0.43
140.000	736.33	769.42	769.51	769.51	769.52	769.53	769.55	769.57	769.59	769.64	769.76	769.86	0.08	0.43
139.000	743.99	769.38	769.47	769.47	769.47	769.49	769.50	769.52	769.55	769.60	769.72	769.81	0.08	0.44
138.000	736.48	769.29	769.38	769.38	769.39	769.40	769.42	769.44	769.47	769.52	769.64	769.74	0.08	0.45
137.000	733.33	768.95	769.06	769.06	769.07	769.09	769.11	769.13	769.16	769.21	769.34	769.44	0.09	0.48
135.950	731.18	768.21	768.35	768.35	768.35	768.37	768.40	768.43	768.46	768.52	768.65	768.76	0.11	0.55
135.941	Highway 69 Bridge													
135.940	731.21	768.20	768.34	768.34	768.34	768.37	768.39	768.42	768.46	768.52	768.65	768.76	0.12	0.56
135.590	731.77	768.03	768.19	768.19	768.19	768.21	768.24	768.27	768.31	768.37	768.51	768.62	0.12	0.59
135.586	BN RR Bridge													
135.580	731.07	767.85	768.00	768.00	768.01	768.03	768.06	768.09	768.13	768.19	768.33	768.44	0.13	0.59
135.470	732.63	767.79	767.95	767.95	767.95	767.98	768.01	768.04	768.08	768.14	768.28	768.39	0.13	0.60
135.460	Highway 125 Bridge													
135.440	731.60	767.84	767.99	767.99	767.99	768.02	768.05	768.08	768.12	768.18	768.32	768.43	0.13	0.59
135.000	732.64	767.54	767.70	767.70	767.71	767.73	767.76	767.80	767.84	767.91	768.05	768.16	0.14	0.62

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.1**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - SEP 1993 (21 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
134.610	728.75	767.01	767.20	767.20	767.20	767.23	767.27	767.30	767.35	767.41	767.55	767.67	0.15	0.66
134.599	Abandonded RR Bridge													
134.595	728.58	766.71	766.91	766.91	766.91	766.94	766.97	767.01	767.05	767.12	767.25	767.35	0.14	0.64
134.000	727.23	766.31	766.53	766.53	766.53	766.56	766.60	766.64	766.69	766.76	766.90	767.01	0.16	0.70
133.973	Tar Creek													
133.900	727.72	766.08	766.31	766.31	766.32	766.35	766.39	766.43	766.48	766.55	766.69	766.80	0.17	0.71
133.800	Interstate 44 Bridge													
133.700	728.57	765.88	766.12	766.12	766.12	766.16	766.19	766.23	766.29	766.36	766.50	766.61	0.17	0.73
133.000	727.70	765.15	765.43	765.43	765.44	765.48	765.52	765.57	765.63	765.72	765.86	765.98	0.20	0.83
132.000	727.96	764.19	764.54	764.54	764.54	764.59	764.64	764.69	764.77	764.86	765.01	765.12	0.23	0.93
131.000	726.82	763.37	763.77	763.77	763.78	763.83	763.89	763.95	764.03	764.14	764.29	764.41	0.26	1.04
130.000	723.18	762.41	762.88	762.88	762.88	762.95	763.02	763.09	763.19	763.31	763.47	763.61	0.31	1.20
129.000	719.79	761.76	762.00	762.00	762.01	762.09	762.18	762.27	762.38	762.52	762.71	762.96	0.38	1.19
128.000	719.69	761.62	761.70	761.70	761.71	761.73	761.75	761.78	761.81	761.93	762.32	762.62	0.11	1.00
126.710	715.94	761.46	761.55	761.55	761.55	761.57	761.59	761.62	761.66	761.77	762.16	762.45	0.11	0.99
126.700	S 590 Road Bridge													
126.670	715.61	761.44	761.52	761.52	761.53	761.55	761.57	761.60	761.64	761.74	762.14	762.43	0.12	0.99
126.000	720.35	761.41	761.50	761.50	761.50	761.52	761.55	761.57	761.61	761.72	762.12	762.41	0.12	1.00
125.000	717.08	761.32	761.40	761.40	761.40	761.43	761.45	761.48	761.51	761.62	762.03	762.33	0.11	1.01
124.000	715.62	761.27	761.36	761.36	761.36	761.38	761.41	761.44	761.47	761.58	761.99	762.29	0.11	1.02
123.000	713.34	761.19	761.28	761.28	761.28	761.30	761.33	761.36	761.39	761.50	761.91	762.21	0.11	1.02
122.580	711.08	761.14	761.23	761.23	761.23	761.25	761.28	761.31	761.34	761.45	761.87	762.17	0.11	1.03
122.570	Highway 60 Bridge													
122.550	709.97	761.14	761.22	761.22	761.23	761.25	761.27	761.30	761.33	761.44	761.85	762.15	0.11	1.01
122.350	Spring River													
122.000	710.64	760.03	760.12	760.12	760.12	760.15	760.18	760.21	760.25	760.37	760.79	761.05	0.13	1.02
121.980	709.90	759.56	759.66	759.66	759.66	759.68	759.71	759.75	759.79	759.91	760.28	760.52	0.13	0.96
121.970	BN RR Bridge													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.1**

GRAND RIVER DAM AUTHORITY

NEOSHO RIVER MAX WSELs - SEP 1993 (21 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
121.960	710.89	756.82	756.92	756.92	756.93	756.95	756.98	757.02	757.06	757.21	758.06	758.75	0.14	1.93
120.000	717.63	755.14	755.59	755.59	755.58	755.59	755.59	755.60	755.95	756.26	756.85	757.68	0.37	2.54
118.000	720.29	754.40	755.36	755.36	755.36	755.36	755.36	755.36	755.51	755.84	755.86	757.10	0.15	2.70
116.000	725.99	754.34	755.25	755.25	755.25	755.25	755.25	755.26	755.30	755.63	755.63	757.09	0.05	2.75
114.000	718.27	754.24	755.07	755.07	755.07	755.07	755.07	755.06	755.06	755.29	755.26	757.08	0.01	2.85
112.000	714.31	754.19	754.98	754.98	754.98	754.98	754.97	754.97	754.97	755.12	755.08	757.07	0.01	2.88
110.000	719.24	754.16	754.94	754.94	754.94	754.94	754.93	754.93	754.93	755.03	754.99	757.06	0.01	2.90
108.000	710.68	754.13	754.88	754.88	754.88	754.88	754.87	754.87	754.86	754.92	754.87	757.05	0.02	2.92
106.000	700.35	754.13	754.88	754.88	754.87	754.87	754.87	754.86	754.86	754.89	754.86	757.04	0.02	2.91
105.350	Elk River													
105.000	701.60	754.13	754.88	754.88	754.87	754.87	754.87	754.86	754.86	754.89	754.86	757.04	0.02	2.91
104.000	696.61	754.13	754.87	754.87	754.87	754.87	754.86	754.86	754.86	754.88	754.86	757.03	0.01	2.90
102.000	688.58	754.12	754.86	754.86	754.86	754.86	754.85	754.85	754.85	754.85	754.85	757.02	0.01	2.90
101.750	685.91	754.12	754.85	754.85	754.85	754.85	754.85	754.85	754.85	754.85	754.85	757.02	0.00	2.90
101.730	Highway 59 (Sailboat Bridge)													
101.710	682.31	754.11	754.84	754.84	754.84	754.84	754.84	754.84	754.84	754.84	754.84	757.01	0.00	2.90
100.000	702.62	754.11	754.84	754.84	754.84	754.84	754.84	754.84	754.84	754.84	754.84	757.01	0.00	2.89
90.000	681.52	754.11	754.83	754.83	754.83	754.83	754.83	754.83	754.83	754.83	754.83	757.00	0.00	2.89
80.000	657.03	754.11	754.83	754.83	754.83	754.83	754.83	754.83	754.83	754.83	754.83	757.00	0.00	2.89
78.000	653.11	754.11	754.83	754.83	754.83	754.83	754.83	754.83	754.83	754.83	754.83	757.00	0.00	2.89
77.000	Pensacola Dam													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM | **TABLE D.2**

GRAND RIVER DAM AUTHORITY

SPRING RIVER MAX WSELs - SEP 1993 (21 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
21.000	Upstream end of model													
21.000	762.67	805.10	805.10	805.10	805.10	805.10	805.10	805.10	805.10	805.10	805.10	805.10	0.00	0.00
20.000	760.13	804.41	804.41	804.41	804.41	804.41	804.41	804.41	804.41	804.41	804.41	804.41	0.00	0.00
19.000	759.04	803.09	803.09	803.09	803.09	803.09	803.09	803.09	803.09	803.09	803.09	803.09	0.00	0.00
18.000	753.18	800.93	800.93	800.93	800.93	800.93	800.93	800.93	800.93	800.93	800.93	800.93	0.00	0.00
17.000	750.54	799.10	799.10	799.10	799.10	799.10	799.10	799.10	799.10	799.10	799.10	799.10	0.00	0.00
16.000	749.28	796.17	796.17	796.17	796.17	796.17	796.17	796.17	796.17	796.17	796.17	796.17	0.00	0.00
15.000	746.37	794.15	794.15	794.15	794.15	794.15	794.15	794.15	794.15	794.15	794.15	794.15	0.00	0.00
14.170	741.32	791.71	791.71	791.71	791.71	791.71	791.71	791.71	791.71	791.71	791.71	791.71	0.00	0.00
14.160	E 57 Road													
14.120	744.21	789.81	789.81	789.81	789.81	789.81	789.81	789.81	789.81	789.81	789.81	789.81	0.00	0.00
13.510	744.59	786.79	786.79	786.79	786.79	786.79	786.79	786.79	786.79	786.79	786.79	786.79	0.00	0.00
13.500	Interstate 44 Bridge													
13.450	745.52	784.91	784.91	784.91	784.91	784.91	784.91	784.91	784.91	784.91	784.91	784.91	0.00	0.00
12.000	742.72	780.13	780.13	780.13	780.13	780.13	780.13	780.13	780.13	780.13	780.13	780.13	0.00	0.00
11.000	742.23	778.45	778.45	778.45	778.45	778.45	778.45	778.45	778.45	778.45	778.45	778.45	0.00	0.00
10.000	737.62	776.97	776.97	776.97	776.97	776.97	776.97	776.97	776.97	776.97	776.97	776.97	0.00	0.00
9.000	733.92	774.02	774.02	774.02	774.02	774.02	774.02	774.02	774.02	774.02	774.02	774.03	0.00	0.00
8.020	733.14	772.73	772.73	772.73	772.73	772.73	772.73	772.73	772.73	772.73	772.72	772.74	0.00	0.02
8.010	OK Highway 10 Bridge													
7.970	731.28	771.27	771.29	771.29	771.29	771.29	771.30	771.30	771.31	771.33	771.64	771.70	0.02	0.43
7.000	730.33	769.20	769.23	769.23	769.23	769.23	769.24	769.25	769.26	769.29	769.48	769.69	0.03	0.49
6.000	727.95	767.84	767.88	767.88	767.88	767.88	767.89	767.90	767.92	767.96	768.19	768.43	0.04	0.59
5.000	722.10	766.48	766.52	766.52	766.52	766.53	766.54	766.56	766.57	766.62	766.90	767.17	0.05	0.70
4.000	720.00	765.58	765.62	765.62	765.63	765.64	765.65	765.66	765.68	765.74	766.06	766.34	0.06	0.76
3.000	723.22	764.30	764.36	764.36	764.36	764.37	764.39	764.41	764.43	764.50	764.85	765.16	0.07	0.86
2.000	723.73	763.43	763.50	763.50	763.50	763.51	763.53	763.55	763.58	763.66	764.04	764.36	0.08	0.93
1.000	728.44	762.56	762.63	762.63	762.63	762.65	762.67	762.70	762.72	762.81	763.21	763.53	0.09	0.97
0.580	716.17	760.58	760.66	760.66	760.66	760.68	760.71	760.74	760.77	760.88	761.26	761.54	0.11	0.96
0.570	Highway 60 Bridge													
0.560	713.76	760.09	760.18	760.18	760.18	760.20	760.23	760.26	760.30	760.41	760.80	761.07	0.12	0.98
0.460	715.35	760.74	760.83	760.83	760.83	760.85	760.87	760.90	760.94	761.05	761.44	761.72	0.11	0.98
0.000	Downstream end of Spring River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.3**

GRAND RIVER DAM AUTHORITY ELK RIVER MAX WSELs - SEP 1993 (21 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
19.590	Upstream end of model													
19.590	771.15	787.52	787.52	787.52	787.52	787.52	787.52	787.52	787.52	787.52	787.52	787.52	0.00	0.00
19.000	767.51	785.42	785.42	785.42	785.42	785.42	785.42	785.42	785.42	785.42	785.42	785.42	0.00	0.00
18.000	765.41	781.77	781.77	781.77	781.77	781.77	781.77	781.77	781.77	781.77	781.77	781.77	0.00	0.00
17.000	762.53	777.78	777.78	777.78	777.78	777.78	777.78	777.78	777.78	777.78	777.78	777.78	0.00	0.00
16.000	756.63	773.42	773.42	773.42	773.42	773.42	773.42	773.42	773.42	773.42	773.42	773.42	0.00	0.00
15.000	754.26	769.55	769.55	769.55	769.55	769.55	769.55	769.55	769.55	769.55	769.55	769.55	0.00	0.00
14.240	750.52	766.33	766.33	766.33	766.33	766.33	766.33	766.33	766.33	766.33	766.33	766.33	0.00	0.00
14.220	Highway 43 Bridge													
14.200	750.12	766.08	766.08	766.08	766.08	766.08	766.08	766.08	766.08	766.08	766.08	766.08	0.00	0.00
14.000	747.07	764.91	764.91	764.91	764.91	764.91	764.91	764.91	764.91	764.91	764.92	764.92	0.00	0.01
13.000	745.41	760.77	760.77	760.77	760.77	760.77	760.77	760.77	760.77	760.77	760.78	760.82	0.00	0.05
12.000	741.15	757.41	757.41	757.41	757.41	757.41	757.41	757.41	757.41	757.41	757.45	757.66	0.00	0.25
11.910	OK/MO State Line													
11.000	741.93	754.15	754.94	754.94	754.94	754.93	754.93	754.90	754.89	755.06	754.94	757.11	0.05	2.96
10.000	734.62	754.14	754.93	754.93	754.92	754.91	754.91	754.89	754.87	755.03	754.91	757.10	0.06	2.96
9.000	734.66	754.14	754.92	754.92	754.91	754.90	754.90	754.88	754.87	755.01	754.90	757.09	0.05	2.95
8.000	724.21	754.14	754.91	754.91	754.91	754.90	754.90	754.88	754.87	754.99	754.89	757.09	0.04	2.95
7.000	728.21	754.14	754.91	754.91	754.90	754.89	754.89	754.88	754.87	754.96	754.89	757.08	0.04	2.94
6.000	727.13	754.13	754.90	754.90	754.90	754.89	754.89	754.87	754.87	754.96	754.88	757.07	0.03	2.94
5.000	721.05	754.13	754.90	754.90	754.89	754.89	754.88	754.87	754.86	754.94	754.88	757.07	0.04	2.94
4.700	716.13	754.13	754.90	754.90	754.89	754.89	754.88	754.87	754.86	754.93	754.88	757.07	0.04	2.94
4.670	OK Highway 10 Bridge													
4.640	715.21	754.13	754.90	754.90	754.89	754.88	754.88	754.87	754.86	754.94	754.88	757.06	0.04	2.93
4.000	716.61	754.13	754.89	754.89	754.89	754.88	754.88	754.87	754.86	754.93	754.87	757.06	0.03	2.93
3.000	714.74	754.13	754.89	754.89	754.88	754.88	754.87	754.87	754.86	754.92	754.87	757.05	0.03	2.92
2.000	709.09	754.13	754.88	754.88	754.88	754.88	754.87	754.87	754.86	754.91	754.86	757.05	0.02	2.92
1.000	705.82	754.13	754.88	754.88	754.87	754.87	754.87	754.86	754.86	754.90	754.86	757.04	0.02	2.91
0.320	706.36	754.13	754.88	754.88	754.87	754.87	754.87	754.86	754.86	754.89	754.86	757.04	0.02	2.91
0.000	Downstream end of Elk River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.4**

GRAND RIVER DAM AUTHORITY TAR CREEK MAX WSELs - SEP 1993 (21 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
4.152	Upstream end of model													
4.152	762.17	776.77	776.77	776.77	776.77	776.77	776.77	776.77	776.77	776.77	776.77	776.77	0.00	0.00
3.900	760.10	775.76	775.76	775.76	775.76	775.76	775.76	775.76	775.76	775.76	775.76	775.76	0.00	0.00
3.840	22nd Ave Bridge													
3.800	762.30	774.50	774.50	774.50	774.50	774.50	774.50	774.50	774.50	774.50	774.50	774.50	0.00	0.00
3.300	759.46	772.27	772.27	772.27	772.27	772.27	772.27	772.27	772.27	772.27	772.27	772.27	0.00	0.00
2.800	756.73	768.46	768.46	768.46	768.46	768.46	768.46	768.46	768.46	768.46	768.46	768.47	0.00	0.00
2.710	BN RR Bridge													
2.700	755.72	767.11	767.11	767.11	767.11	767.11	767.11	767.11	767.11	767.12	767.14	767.19	0.00	0.08
2.500	754.95	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
2.300	754.15	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
2.200	Rockdale Blvd Bridge													
2.100	751.51	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
1.900	750.02	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
1.700	749.58	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
1.660	Central Ave Bridge													
1.600	746.47	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
1.500	744.29	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
1.400	OK Highway 10 Bridge													
1.300	742.00	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
1.000	739.34	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
0.700	737.06	766.21	766.43	766.43	766.44	766.47	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
0.300	736.42	766.22	766.44	766.44	766.44	766.48	766.51	766.55	766.60	766.67	766.81	766.92	0.16	0.71
0.041	735.85	766.20	766.42	766.42	766.43	766.46	766.50	766.53	766.59	766.66	766.80	766.91	0.16	0.71
0.000	Downstream end of Tar Creek													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX D.2:
JUNE 2004 (1 YEAR) INFLOW EVENT
MAXIMUM WATER SURFACE ELEVATIONS

PENSACOLA DAM **TABLE D.5**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - JUN 2004 (1 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
152.175	Upstream end of model													
152.175	752.29	773.78	773.78	773.79	773.79	773.79	773.79	773.79	773.79	773.80	773.83	773.85	0.00	0.07
151.000	748.53	772.51	772.52	772.52	772.52	772.52	772.52	772.52	772.52	772.54	772.56	772.59	0.01	0.08
150.000	748.47	771.80	771.81	771.81	771.82	771.82	771.82	771.82	771.82	771.83	771.87	771.90	0.01	0.09
149.000	750.14	770.43	770.44	770.44	770.44	770.44	770.44	770.44	770.44	770.46	770.50	770.54	0.00	0.11
148.000	749.29	768.73	768.75	768.76	768.76	768.76	768.76	768.76	768.76	768.80	768.85	768.89	0.01	0.17
147.000	747.76	766.90	766.93	766.93	766.93	766.94	766.94	766.94	766.94	766.99	767.07	767.12	0.01	0.23
145.500	745.12	764.66	764.70	764.70	764.71	764.71	764.72	764.72	764.72	764.79	764.92	765.00	0.02	0.34
145.480	E 60 Road Bridge													
145.400	748.01	764.55	764.60	764.60	764.61	764.61	764.61	764.62	764.62	764.69	764.82	764.90	0.02	0.35
144.000	743.43	763.27	763.33	763.33	763.34	763.34	763.35	763.35	763.35	763.44	763.60	763.69	0.02	0.42
143.000	737.95	762.10	762.16	762.17	762.18	762.18	762.19	762.19	762.19	762.30	762.48	762.62	0.03	0.52
142.000	742.91	761.17	761.24	761.25	761.26	761.27	761.27	761.27	761.27	761.39	761.61	761.77	0.03	0.60
141.000	741.01	759.97	760.07	760.09	760.10	760.11	760.11	760.12	760.12	760.27	760.58	760.81	0.05	0.84
140.000	736.33	758.57	758.73	758.75	758.77	758.78	758.79	758.79	758.79	759.03	759.50	759.90	0.07	1.33
139.000	743.99	756.44	756.70	756.73	756.76	756.78	756.79	756.80	756.80	757.09	757.80	758.38	0.10	1.94
138.000	736.48	754.95	755.28	755.33	755.37	755.39	755.41	755.41	755.41	755.80	756.63	757.44	0.13	2.50
137.000	733.33	752.67	753.22	753.31	753.37	753.40	753.43	753.47	753.47	754.08	755.23	757.09	0.25	4.42
135.950	731.18	752.01	752.62	752.72	752.78	752.81	752.84	752.89	752.88	753.56	754.86	757.08	0.27	5.07
135.941	Highway 69 Bridge													
135.940	731.21	751.71	752.38	752.48	752.55	752.59	752.62	752.67	752.66	753.40	754.79	757.08	0.29	5.37
135.590	731.77	751.79	752.45	752.55	752.61	752.65	752.68	752.73	752.72	753.44	754.79	757.08	0.28	5.29
135.586	BN RR Bridge													
135.580	731.07	751.84	752.48	752.58	752.64	752.68	752.71	752.76	752.75	753.46	754.80	757.07	0.28	5.23
135.470	732.63	751.71	752.37	752.47	752.54	752.57	752.61	752.66	752.65	753.37	754.75	757.07	0.29	5.36
135.460	Highway 125 Bridge													
135.440	731.60	751.78	752.43	752.53	752.59	752.63	752.66	752.71	752.70	753.41	754.77	757.07	0.28	5.29
135.000	732.64	751.39	752.12	752.23	752.30	752.33	752.37	752.42	752.42	753.18	754.65	757.07	0.31	5.68

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.5**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - JUN 2004 (1 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
134.610	728.75	751.21	751.95	752.06	752.13	752.17	752.21	752.26	752.25	753.03	754.55	757.07	0.31	5.86
134.599	Abandonded RR Bridge													
134.595	728.58	751.10	751.86	751.97	752.04	752.08	752.12	752.17	752.16	752.95	754.50	757.07	0.31	5.97
134.000	727.23	750.38	751.23	751.36	751.44	751.47	751.52	751.58	751.57	752.44	754.20	757.06	0.35	6.68
133.973	Tar Creek													
133.900	727.72	750.13	751.02	751.15	751.22	751.26	751.31	751.37	751.36	752.25	754.08	757.06	0.36	6.92
133.800	Interstate 44 Bridge													
133.700	728.57	749.72	750.68	750.82	750.90	750.94	750.98	751.05	751.04	751.98	753.93	757.05	0.38	7.33
133.000	727.70	748.16	749.45	749.63	749.71	749.76	749.82	749.90	749.89	750.99	753.40	757.04	0.45	8.88
132.000	727.96	746.45	748.15	748.37	748.47	748.52	748.59	748.70	748.68	750.03	753.07	757.03	0.55	10.58
131.000	726.82	745.65	746.99	747.26	747.37	747.42	747.51	747.65	747.62	749.39	753.05	757.03	0.66	11.38
130.000	723.18	745.51	746.66	746.94	747.05	747.11	747.20	747.35	747.32	749.26	753.05	757.02	0.69	11.51
129.000	719.79	745.29	746.12	746.43	746.54	746.60	746.70	746.86	746.83	749.14	753.04	757.02	0.74	11.73
128.000	719.69	745.25	746.00	746.31	746.43	746.49	746.59	746.75	746.72	749.14	753.04	757.02	0.75	11.77
126.710	715.94	745.13	745.70	746.02	746.14	746.20	746.31	746.47	746.44	749.13	753.04	757.02	0.77	11.89
126.700	S 590 Road Bridge													
126.670	715.61	745.12	745.68	746.00	746.12	746.18	746.29	746.45	746.42	749.13	753.04	757.02	0.77	11.90
126.000	720.35	745.08	745.57	745.89	746.01	746.08	746.18	746.35	746.32	749.13	753.04	757.02	0.78	11.94
125.000	717.08	745.01	745.36	745.69	745.81	745.88	745.99	746.16	746.13	749.13	753.04	757.02	0.80	12.01
124.000	715.62	744.95	745.31	745.55	745.67	745.74	745.85	746.02	745.99	749.12	753.03	757.02	0.71	12.07
123.000	713.34	744.90	745.26	745.42	745.54	745.62	745.73	745.90	745.87	749.12	753.03	757.02	0.63	12.12
122.580	711.08	744.89	745.25	745.38	745.50	745.59	745.69	745.86	745.83	749.12	753.03	757.02	0.61	12.13
122.570	Highway 60 Bridge													
122.550	709.97	744.44	744.80	744.93	745.06	745.15	745.25	745.43	745.40	749.01	753.01	757.01	0.63	12.57
122.350	Spring River													
122.000	710.64	744.44	744.80	744.92	745.05	745.14	745.23	745.41	745.38	749.01	753.01	757.01	0.61	12.57
121.980	709.90	744.43	744.80	744.91	745.04	745.13	745.22	745.40	745.37	749.01	753.01	757.01	0.60	12.58
121.970	BN RR Bridge													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.5**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - JUN 2004 (1 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
121.960	710.89	744.42	744.79	744.89	745.02	745.12	745.21	745.39	745.36	749.01	753.00	757.00	0.60	12.58
120.000	717.63	744.37	744.74	744.73	744.83	745.04	745.02	745.20	745.17	749.01	753.00	757.00	0.48	12.63
118.000	720.29	744.32	744.70	744.69	744.75	745.00	744.92	745.07	745.04	749.00	753.00	757.00	0.38	12.68
116.000	725.99	744.29	744.68	744.67	744.75	744.98	744.89	744.98	745.01	749.00	753.00	757.00	0.34	12.71
114.000	718.27	744.23	744.64	744.63	744.74	744.93	744.84	744.79	744.99	749.00	753.00	757.00	0.36	12.77
112.000	714.31	744.21	744.62	744.61	744.73	744.91	744.82	744.74	744.99	749.00	753.00	757.00	0.38	12.79
110.000	719.24	744.20	744.62	744.60	744.73	744.90	744.81	744.74	745.00	749.00	753.00	757.00	0.40	12.80
108.000	710.68	744.19	744.61	744.59	744.72	744.89	744.80	744.73	745.00	749.00	753.00	757.00	0.41	12.81
106.000	700.35	744.19	744.61	744.59	744.72	744.89	744.79	744.73	745.01	749.00	753.00	757.00	0.42	12.81
105.350	Elk River													
105.000	701.60	744.19	744.61	744.59	744.72	744.89	744.79	744.73	745.01	749.00	753.00	757.00	0.42	12.81
104.000	696.61	744.19	744.60	744.59	744.72	744.88	744.79	744.73	745.01	749.00	753.00	757.00	0.42	12.81
102.000	688.58	744.18	744.60	744.58	744.71	744.88	744.79	744.72	745.02	749.00	753.00	757.00	0.44	12.82
101.750	685.91	744.18	744.60	744.58	744.71	744.88	744.79	744.72	745.03	749.00	753.00	757.00	0.45	12.82
101.730	Highway 59 (Sailboat Bridge)													
101.710	682.31	744.18	744.60	744.58	744.71	744.87	744.78	744.72	745.02	749.00	753.00	757.00	0.44	12.82
100.000	702.62	744.18	744.60	744.58	744.71	744.87	744.78	744.72	745.01	749.00	753.00	757.00	0.43	12.82
90.000	681.52	744.18	744.60	744.58	744.71	744.87	744.78	744.72	745.00	749.00	753.00	757.00	0.42	12.82
80.000	657.03	744.18	744.60	744.58	744.71	744.87	744.78	744.72	745.00	749.00	753.00	757.00	0.42	12.82
78.000	653.11	744.18	744.60	744.58	744.71	744.87	744.78	744.72	745.00	749.00	753.00	757.00	0.42	12.82
77.000	Pensacola Dam													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.6**

GRAND RIVER DAM AUTHORITY SPRING RIVER MAX WSELs - JUN 2004 (1 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
21.000	Upstream end of model													
21.000	762.67	773.88	773.88	773.88	773.88	773.88	773.88	773.88	773.88	773.88	773.88	773.88	0.00	0.00
20.000	760.13	771.04	771.04	771.04	771.04	771.04	771.04	771.04	771.04	771.04	771.04	771.04	0.00	0.00
19.000	759.04	768.52	768.52	768.52	768.52	768.52	768.52	768.52	768.52	768.52	768.53	768.54	0.00	0.02
18.000	753.18	764.57	764.57	764.57	764.57	764.57	764.57	764.57	764.57	764.58	764.62	764.71	0.00	0.14
17.000	750.54	762.75	762.75	762.75	762.75	762.75	762.75	762.75	762.75	762.77	762.87	763.03	0.00	0.28
16.000	749.28	760.33	760.33	760.34	760.34	760.34	760.34	760.34	760.34	760.39	760.66	761.04	0.01	0.71
15.000	746.37	758.32	758.33	758.33	758.33	758.34	758.34	758.34	758.34	758.44	758.97	759.60	0.02	1.27
14.170	741.32	757.45	757.45	757.45	757.46	757.46	757.47	757.47	757.47	757.61	758.27	759.03	0.02	1.58
14.160	E 57 Road													
14.120	744.21	757.47	757.48	757.48	757.48	757.49	757.49	757.50	757.50	757.63	758.30	759.05	0.02	1.58
13.510	744.59	756.82	756.83	756.83	756.84	756.84	756.85	756.85	756.86	757.03	757.83	758.70	0.03	1.88
13.500	Interstate 44 Bridge													
13.450	745.52	756.56	756.57	756.57	756.57	756.58	756.59	756.59	756.60	756.78	757.65	758.57	0.03	2.01
12.000	742.72	753.20	753.26	753.28	753.31	753.34	753.36	753.39	753.41	754.19	756.21	757.70	0.15	4.50
11.000	742.23	751.43	751.58	751.63	751.69	751.77	751.81	751.85	751.90	753.19	755.72	757.46	0.32	6.03
10.000	737.62	749.79	750.11	750.20	750.31	750.43	750.51	750.59	750.66	752.47	755.39	757.44	0.55	7.65
9.000	733.92	748.61	749.11	749.24	749.39	749.56	749.65	749.75	749.84	752.00	755.18	757.44	0.73	8.83
8.020	733.14	747.09	747.98	748.19	748.38	748.56	748.68	748.81	748.93	751.51	754.96	757.44	0.95	10.35
8.010	OK Highway 10 Bridge													
7.970	731.28	744.73	745.75	745.97	746.16	746.31	746.42	746.55	746.67	749.27	753.01	757.01	0.92	12.28
7.000	730.33	744.48	745.27	745.52	745.73	745.88	745.95	746.03	746.11	749.02	753.01	757.01	0.84	12.53
6.000	727.95	744.47	744.87	745.17	745.39	745.54	745.62	745.73	745.70	749.02	753.01	757.01	0.86	12.54
5.000	722.10	744.46	744.83	745.10	745.28	745.41	745.51	745.63	745.60	749.02	753.01	757.01	0.80	12.55
4.000	720.00	744.46	744.82	745.05	745.20	745.32	745.41	745.55	745.52	749.01	753.01	757.01	0.73	12.55
3.000	723.22	744.46	744.82	745.03	745.17	745.28	745.38	745.52	745.50	749.01	753.01	757.01	0.70	12.55
2.000	723.73	744.46	744.82	745.01	745.14	745.23	745.34	745.50	745.47	749.01	753.01	757.01	0.68	12.55
1.000	728.44	744.45	744.82	744.99	745.12	745.20	745.31	745.48	745.45	749.01	753.01	757.01	0.66	12.56
0.580	716.17	744.45	744.82	744.98	745.11	745.19	745.30	745.48	745.45	749.01	753.01	757.01	0.66	12.56
0.570	Highway 60 Bridge													
0.560	713.76	744.45	744.82	744.98	745.11	745.19	745.30	745.47	745.44	749.01	753.01	757.01	0.65	12.56
0.460	715.35	744.45	744.82	744.98	745.11	745.19	745.30	745.47	745.44	749.01	753.01	757.01	0.65	12.56
0.000	Downstream end of Spring River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.7**

GRAND RIVER DAM AUTHORITY ELK RIVER MAX WSELs - JUN 2004 (1 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
19.590	Upstream end of model													
19.590	771.15	774.17	774.17	774.17	774.17	774.17	774.17	774.17	774.17	774.17	774.17	774.17	0.00	0.00
19.000	767.51	772.64	772.64	772.64	772.64	772.64	772.64	772.64	772.64	772.64	772.64	772.64	0.00	0.00
18.000	765.41	769.18	769.18	769.18	769.18	769.18	769.18	769.18	769.18	769.18	769.18	769.18	0.00	0.00
17.000	762.53	766.13	766.13	766.13	766.13	766.13	766.13	766.13	766.13	766.13	766.13	766.13	0.00	0.00
16.000	756.63	761.16	761.16	761.16	761.16	761.16	761.16	761.16	761.16	761.16	761.16	761.16	0.00	0.00
15.000	754.26	757.92	757.92	757.92	757.92	757.92	757.92	757.92	757.92	757.92	757.92	757.92	0.00	0.00
14.240	750.52	753.18	753.18	753.18	753.18	753.18	753.18	753.18	753.18	753.18	753.31	757.03	0.00	3.85
14.220	Highway 43 Bridge													
14.200	750.12	753.10	753.10	753.10	753.10	753.10	753.10	753.10	753.10	753.10	753.28	757.02	0.00	3.92
14.000	747.07	752.78	752.78	752.78	752.78	752.78	752.78	752.78	752.78	752.78	753.22	757.02	0.00	4.24
13.000	745.41	749.01	749.01	749.01	749.01	749.01	749.01	749.01	749.01	749.40	753.02	757.00	0.00	8.00
12.000	741.15	746.01	746.06	746.06	746.03	746.01	746.01	746.01	746.01	749.03	753.01	757.00	0.05	10.99
11.910	OK/MO State Line													
11.000	741.93	744.92	744.79	744.79	744.96	745.12	745.06	745.02	745.14	749.00	753.00	757.00	0.35	12.21
10.000	734.62	744.21	744.64	744.61	744.74	744.92	744.83	744.75	745.05	749.00	753.00	757.00	0.44	12.79
9.000	734.66	744.21	744.64	744.61	744.74	744.92	744.83	744.75	745.03	749.00	753.00	757.00	0.42	12.79
8.000	724.21	744.21	744.63	744.61	744.74	744.91	744.82	744.75	745.02	749.00	753.00	757.00	0.41	12.79
7.000	728.21	744.20	744.63	744.60	744.74	744.91	744.81	744.75	745.00	749.00	753.00	757.00	0.40	12.80
6.000	727.13	744.20	744.62	744.60	744.73	744.90	744.81	744.74	745.00	749.00	753.00	757.00	0.40	12.80
5.000	721.05	744.20	744.62	744.60	744.73	744.90	744.81	744.74	745.00	749.00	753.00	757.00	0.40	12.80
4.700	716.13	744.20	744.61	744.60	744.73	744.90	744.81	744.74	745.00	749.00	753.00	757.00	0.40	12.80
4.670	OK Highway 10 Bridge													
4.640	715.21	744.20	744.61	744.60	744.73	744.90	744.80	744.74	745.00	749.00	753.00	757.00	0.40	12.80
4.000	716.61	744.19	744.61	744.59	744.73	744.89	744.80	744.74	745.00	749.00	753.00	757.00	0.41	12.81
3.000	714.74	744.19	744.61	744.59	744.73	744.89	744.80	744.74	745.00	749.00	753.00	757.00	0.41	12.81
2.000	709.09	744.19	744.61	744.59	744.72	744.89	744.80	744.74	745.00	749.00	753.00	757.00	0.41	12.81
1.000	705.82	744.19	744.61	744.59	744.72	744.89	744.80	744.73	745.01	749.00	753.00	757.00	0.42	12.81
0.320	706.36	744.19	744.61	744.59	744.72	744.89	744.79	744.73	745.01	749.00	753.00	757.00	0.42	12.81
0.000	Downstream end of Elk River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.8**

GRAND RIVER DAM AUTHORITY TAR CREEK MAX WSELs - JUN 2004 (1 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
4.152	Upstream end of model													
4.152	762.17	768.17	768.17	768.17	768.17	768.17	768.17	768.17	768.17	768.17	768.17	768.17	0.00	0.00
3.900	760.10	767.29	767.29	767.29	767.29	767.29	767.29	767.29	767.29	767.29	767.29	767.29	0.00	0.00
3.840	22nd Ave Bridge													
3.800	762.30	766.05	766.05	766.05	766.05	766.05	766.05	766.05	766.05	766.05	766.05	766.05	0.00	0.00
3.300	759.46	764.09	764.09	764.09	764.09	764.09	764.09	764.09	764.09	764.09	764.09	764.09	0.00	0.00
2.800	756.73	760.95	760.95	760.95	760.95	760.95	760.95	760.95	760.95	760.95	760.96	760.96	0.00	0.01
2.710	BN RR Bridge													
2.700	755.72	760.45	760.45	760.45	760.45	760.45	760.45	760.45	760.45	760.45	760.46	760.46	0.00	0.01
2.500	754.95	759.30	759.30	759.30	759.30	759.30	759.30	759.30	759.30	759.30	759.30	759.33	0.00	0.03
2.300	754.15	757.47	757.47	757.47	757.47	757.47	757.47	757.47	757.47	757.47	757.49	757.63	0.00	0.16
2.200	Rockdale Blvd Bridge													
2.100	751.51	754.83	754.83	754.84	754.84	754.84	754.84	754.84	754.84	754.87	755.19	757.06	0.00	2.23
1.900	750.02	753.18	753.21	753.21	753.22	753.22	753.23	753.23	753.23	753.40	754.46	757.06	0.02	3.87
1.700	749.58	750.72	751.23	751.33	751.39	751.43	751.47	751.52	751.51	752.38	754.21	757.06	0.29	6.34
1.660	Central Ave Bridge													
1.600	746.47	750.30	751.16	751.29	751.36	751.40	751.44	751.51	751.50	752.38	754.19	757.06	0.35	6.76
1.500	744.29	750.29	751.16	751.29	751.36	751.40	751.44	751.51	751.50	752.38	754.18	757.06	0.35	6.76
1.400	OK Highway 10 Bridge													
1.300	742.00	750.29	751.16	751.29	751.36	751.40	751.44	751.51	751.50	752.38	754.18	757.06	0.35	6.76
1.000	739.34	750.29	751.16	751.29	751.36	751.40	751.44	751.51	751.50	752.38	754.17	757.06	0.35	6.77
0.700	737.06	750.29	751.16	751.29	751.36	751.40	751.44	751.51	751.50	752.38	754.17	757.06	0.35	6.77
0.300	736.42	750.29	751.16	751.29	751.36	751.40	751.44	751.51	751.50	752.38	754.16	757.06	0.35	6.77
0.041	735.85	750.29	751.15	751.28	751.36	751.40	751.44	751.50	751.49	752.37	754.16	757.06	0.35	6.77
0.000	Downstream end of Tar Creek													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX D.3:

JULY 2007 (4 YEAR) INFLOW EVENT

MAXIMUM WATER SURFACE ELEVATIONS

PENSACOLA DAM **TABLE D.9**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - JUL 2007 (4 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
152.175	Upstream end of model													
152.175	752.29	784.43	784.43	784.43	784.43	784.43	784.43	784.43	784.43	784.43	784.43	784.43	0.00	0.00
151.000	748.53	780.33	780.33	780.33	780.33	780.33	780.33	780.33	780.33	780.33	780.33	780.33	0.00	0.00
150.000	748.47	778.90	778.90	778.90	778.90	778.90	778.90	778.90	778.90	778.90	778.90	778.90	0.00	0.00
149.000	750.14	777.44	777.45	777.46	777.46	777.46	777.45	777.45	777.46	777.47	777.48	777.49	0.01	0.05
148.000	749.29	777.07	777.08	777.09	777.09	777.09	777.09	777.08	777.09	777.10	777.11	777.13	0.01	0.06
147.000	747.76	776.19	776.21	776.22	776.22	776.22	776.22	776.22	776.23	776.25	776.26	776.28	0.02	0.09
145.500	745.12	775.69	775.71	775.73	775.73	775.73	775.72	775.73	775.74	775.77	775.78	775.81	0.03	0.11
145.480	E 60 Road Bridge													
145.400	748.01	775.65	775.67	775.69	775.69	775.69	775.68	775.69	775.70	775.72	775.74	775.76	0.02	0.11
144.000	743.43	775.05	775.07	775.10	775.10	775.10	775.09	775.10	775.11	775.14	775.16	775.19	0.04	0.14
143.000	737.95	774.77	774.79	774.83	774.83	774.83	774.81	774.82	774.83	774.87	774.89	774.92	0.04	0.15
142.000	742.91	774.53	774.56	774.60	774.60	774.60	774.57	774.59	774.60	774.64	774.66	774.69	0.05	0.16
141.000	741.01	774.40	774.43	774.47	774.47	774.47	774.45	774.46	774.48	774.52	774.54	774.57	0.05	0.17
140.000	736.33	774.36	774.39	774.43	774.43	774.43	774.41	774.42	774.44	774.48	774.50	774.53	0.05	0.17
139.000	743.99	774.33	774.36	774.40	774.40	774.40	774.37	774.39	774.41	774.45	774.47	774.50	0.05	0.17
138.000	736.48	774.26	774.29	774.33	774.33	774.33	774.31	774.32	774.34	774.38	774.40	774.43	0.05	0.17
137.000	733.33	774.04	774.07	774.12	774.12	774.12	774.09	774.11	774.12	774.17	774.19	774.22	0.06	0.18
135.950	731.18	773.38	773.41	773.47	773.47	773.48	773.43	773.46	773.48	773.53	773.55	773.59	0.07	0.21
135.941	Highway 69 Bridge													
135.940	731.21	773.41	773.44	773.50	773.50	773.50	773.46	773.49	773.51	773.56	773.58	773.62	0.07	0.21
135.590	731.77	773.23	773.26	773.32	773.32	773.32	773.28	773.31	773.33	773.38	773.40	773.44	0.07	0.21
135.586	BN RR Bridge													
135.580	731.07	773.16	773.19	773.25	773.25	773.26	773.21	773.24	773.26	773.31	773.34	773.38	0.07	0.22
135.470	732.63	773.08	773.11	773.18	773.18	773.18	773.14	773.17	773.19	773.24	773.26	773.30	0.08	0.22
135.460	Highway 125 Bridge													
135.440	731.60	773.13	773.16	773.23	773.23	773.23	773.19	773.22	773.24	773.29	773.31	773.35	0.08	0.22
135.000	732.64	772.80	772.83	772.90	772.90	772.90	772.86	772.89	772.91	772.96	772.99	773.03	0.08	0.23

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.9**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - JUL 2007 (4 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
134.610	728.75	772.32	772.35	772.44	772.44	772.44	772.39	772.43	772.46	772.51	772.54	772.58	0.11	0.26
134.599	Abandonded RR Bridge													
134.595	728.58	772.06	772.09	772.19	772.19	772.19	772.12	772.17	772.20	772.25	772.28	772.32	0.11	0.26
134.000	727.23	771.78	771.81	771.92	771.92	771.92	771.85	771.91	771.93	771.99	772.02	772.06	0.12	0.28
133.973	Tar Creek													
133.900	727.72	771.46	771.49	771.61	771.61	771.61	771.53	771.59	771.62	771.68	771.71	771.75	0.13	0.29
133.800	Interstate 44 Bridge													
133.700	728.57	771.12	771.15	771.27	771.27	771.27	771.19	771.25	771.28	771.34	771.37	771.41	0.13	0.30
133.000	727.70	770.43	770.46	770.61	770.61	770.61	770.51	770.59	770.62	770.68	770.72	770.76	0.16	0.33
132.000	727.96	769.24	769.27	769.46	769.46	769.46	769.33	769.44	769.47	769.54	769.57	769.63	0.20	0.39
131.000	726.82	768.26	768.28	768.52	768.52	768.53	768.36	768.51	768.54	768.61	768.65	768.70	0.25	0.43
130.000	723.18	766.95	766.97	767.27	767.27	767.27	767.07	767.25	767.29	767.37	767.41	767.47	0.32	0.52
129.000	719.79	765.69	765.71	766.10	766.10	766.10	765.83	766.08	766.12	766.20	766.24	766.31	0.41	0.62
128.000	719.69	764.58	764.59	765.06	765.06	765.07	764.73	765.05	765.08	765.16	765.21	765.28	0.49	0.70
126.710	715.94	762.70	762.67	763.36	763.36	763.36	762.88	763.34	763.38	763.45	763.50	763.57	0.71	0.90
126.700	S 590 Road Bridge													
126.670	715.61	762.65	762.61	763.31	763.31	763.32	762.83	763.30	763.33	763.41	763.45	763.53	0.72	0.92
126.000	720.35	762.00	761.95	762.74	762.74	762.74	762.19	762.72	762.75	762.83	762.87	762.95	0.80	0.99
125.000	717.08	760.46	760.36	761.36	761.36	761.37	760.69	761.35	761.38	761.44	761.48	761.56	1.02	1.20
124.000	715.62	758.81	758.71	759.97	759.98	759.98	759.13	759.96	759.99	760.04	760.08	760.15	1.28	1.44
123.000	713.34	756.90	757.22	758.37	758.37	758.37	757.55	758.36	758.38	758.43	758.46	758.51	1.16	1.61
122.580	711.08	755.56	756.26	757.22	757.22	757.22	756.62	757.21	757.22	757.26	757.28	757.32	0.96	1.76
122.570	Highway 60 Bridge													
122.550	709.97	755.51	756.21	757.22	757.22	757.22	756.59	757.21	757.23	757.26	757.29	757.33	1.02	1.82
122.350	Spring River													
122.000	710.64	755.13	755.96	756.93	756.93	756.94	756.36	756.93	756.94	756.97	756.99	757.04	0.98	1.91
121.980	709.90	755.04	755.84	756.78	756.78	756.79	756.24	756.78	756.79	756.82	756.84	757.02	0.95	1.98
121.970	BN RR Bridge													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.9**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - JUL 2007 (4 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
121.960	710.89	754.84	755.51	756.29	756.29	756.29	755.89	756.28	756.29	756.31	756.32	757.01	0.78	2.17
120.000	717.63	754.52	755.04	755.72	755.72	755.72	755.46	755.72	755.72	755.73	755.74	757.01	0.68	2.49
118.000	720.29	754.35	754.81	755.43	755.43	755.43	755.24	755.43	755.43	755.44	755.44	757.01	0.62	2.66
116.000	725.99	754.27	754.70	755.30	755.30	755.30	755.13	755.29	755.30	755.30	755.31	757.00	0.60	2.73
114.000	718.27	754.14	754.52	755.07	755.07	755.07	754.96	755.07	755.07	755.07	755.07	757.00	0.55	2.86
112.000	714.31	754.08	754.43	754.96	754.96	754.96	754.87	754.96	754.96	754.95	754.95	757.00	0.54	2.92
110.000	719.24	754.05	754.38	754.91	754.91	754.90	754.83	754.91	754.90	754.89	754.90	757.00	0.53	2.95
108.000	710.68	754.01	754.32	754.83	754.83	754.83	754.78	754.84	754.83	754.82	754.82	757.00	0.52	2.99
106.000	700.35	754.00	754.31	754.82	754.82	754.82	754.77	754.82	754.82	754.82	754.82	757.00	0.51	3.00
105.350	Elk River													
105.000	701.60	754.00	754.31	754.82	754.82	754.82	754.77	754.82	754.82	754.82	754.82	757.00	0.51	3.00
104.000	696.61	754.00	754.31	754.82	754.82	754.82	754.76	754.82	754.82	754.82	754.82	757.00	0.51	3.00
102.000	688.58	754.00	754.29	754.81	754.81	754.81	754.75	754.81	754.81	754.81	754.81	757.00	0.52	3.00
101.750	685.91	753.99	754.29	754.81	754.81	754.81	754.75	754.81	754.81	754.81	754.81	757.00	0.52	3.01
101.730	Highway 59 (Sailboat Bridge)													
101.710	682.31	753.98	754.28	754.80	754.80	754.80	754.74	754.80	754.80	754.80	754.80	757.00	0.52	3.02
100.000	702.62	753.98	754.28	754.80	754.80	754.80	754.74	754.80	754.80	754.80	754.80	757.00	0.52	3.01
90.000	681.52	753.98	754.27	754.79	754.79	754.79	754.74	754.79	754.79	754.79	754.79	757.00	0.52	3.02
80.000	657.03	753.98	754.27	754.79	754.79	754.79	754.74	754.79	754.79	754.79	754.79	757.00	0.52	3.02
78.000	653.11	753.98	754.27	754.79	754.79	754.79	754.74	754.79	754.79	754.79	754.79	757.00	0.52	3.02
77.000	Pensacola Dam													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.10**

GRAND RIVER DAM AUTHORITY — SPRING RIVER MAX WSELs - JUL 2007 (4 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
21.000	Upstream end of model													
21.000	762.67	783.49	783.49	783.49	783.49	783.49	783.49	783.49	783.49	783.49	783.49	783.50	0.00	0.01
20.000	760.13	780.70	780.70	780.70	780.70	780.70	780.70	780.70	780.70	780.70	780.70	780.70	0.00	0.00
19.000	759.04	777.52	777.52	777.52	777.52	777.52	777.52	777.52	777.52	777.52	777.52	777.52	0.00	0.00
18.000	753.18	774.19	774.20	774.20	774.20	774.20	774.20	774.20	774.20	774.20	774.20	774.20	0.00	0.01
17.000	750.54	772.20	772.20	772.20	772.20	772.20	772.20	772.20	772.20	772.21	772.21	772.21	0.00	0.01
16.000	749.28	770.00	770.00	770.00	770.00	770.00	770.00	770.00	770.00	770.00	770.00	770.02	0.00	0.02
15.000	746.37	767.51	767.51	767.51	767.51	767.51	767.51	767.51	767.51	767.52	767.52	767.54	0.01	0.03
14.170	741.32	765.96	765.96	765.96	765.96	765.96	765.96	765.96	765.96	765.97	765.97	766.01	0.00	0.05
14.160	E 57 Road													
14.120	744.21	766.18	766.18	766.18	766.18	766.18	766.18	766.18	766.18	766.19	766.19	766.22	0.00	0.04
13.510	744.59	765.30	765.30	765.30	765.30	765.30	765.30	765.30	765.30	765.31	765.31	765.35	0.00	0.05
13.500	Interstate 44 Bridge													
13.450	745.52	764.98	764.98	764.98	764.98	764.98	764.98	764.98	764.98	764.99	764.99	765.03	0.00	0.05
12.000	742.72	762.16	762.16	762.16	762.16	762.16	762.16	762.16	762.16	762.20	762.19	762.29	0.00	0.13
11.000	742.23	760.39	760.39	760.39	760.39	760.39	760.39	760.39	760.40	760.47	760.44	760.62	0.01	0.23
10.000	737.62	758.86	758.86	758.87	758.87	758.87	758.87	758.87	758.87	759.21	759.27	759.55	0.01	0.69
9.000	733.92	757.29	757.55	758.52	758.52	758.53	757.89	758.52	758.53	758.58	758.72	759.03	0.98	1.74
8.020	733.14	756.72	757.52	758.47	758.47	758.48	757.85	758.47	758.48	758.52	758.55	758.78	0.96	2.06
8.010	OK Highway 10 Bridge													
7.970	731.28	755.66	756.33	757.38	757.38	757.39	756.71	757.38	757.39	757.44	757.47	757.66	1.06	2.00
7.000	730.33	755.62	756.30	757.35	757.35	757.35	756.68	757.34	757.36	757.40	757.43	757.50	1.06	1.88
6.000	727.95	755.59	756.29	757.33	757.34	757.34	756.67	757.33	757.34	757.39	757.41	757.47	1.05	1.88
5.000	722.10	755.58	756.28	757.32	757.32	757.33	756.66	757.32	757.33	757.37	757.40	757.45	1.05	1.87
4.000	720.00	755.57	756.27	757.32	757.32	757.32	756.66	757.31	757.33	757.37	757.39	757.45	1.06	1.88
3.000	723.22	755.57	756.27	757.31	757.31	757.32	756.65	757.31	757.32	757.36	757.39	757.44	1.05	1.87
2.000	723.73	755.56	756.26	757.31	757.31	757.31	756.65	757.30	757.32	757.36	757.38	757.44	1.06	1.88
1.000	728.44	755.56	756.26	757.31	757.31	757.31	756.65	757.30	757.32	757.36	757.38	757.43	1.06	1.87
0.580	716.17	755.56	756.26	757.30	757.30	757.31	756.64	757.30	757.31	757.35	757.38	757.43	1.05	1.87
0.570	Highway 60 Bridge													
0.560	713.76	755.55	756.25	757.30	757.30	757.30	756.64	757.29	757.31	757.35	757.37	757.42	1.06	1.87
0.460	715.35	755.55	756.25	757.30	757.30	757.30	756.64	757.29	757.31	757.35	757.37	757.42	1.06	1.87
0.000	Downstream end of Spring River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.11**

GRAND RIVER DAM AUTHORITY ELK RIVER MAX WSELs - JUL 2007 (4 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
19.590	Upstream end of model													
19.590	771.15	775.57	775.57	775.57	775.57	775.57	775.57	775.57	775.57	775.57	775.57	775.57	0.00	0.00
19.000	767.51	774.03	774.03	774.03	774.03	774.03	774.03	774.03	774.03	774.03	774.03	774.03	0.00	0.00
18.000	765.41	770.46	770.46	770.46	770.46	770.46	770.46	770.46	770.46	770.46	770.46	770.46	0.00	0.00
17.000	762.53	767.01	767.01	767.01	767.01	767.01	767.01	767.01	767.01	767.01	767.01	767.01	0.00	0.00
16.000	756.63	762.78	762.78	762.78	762.78	762.78	762.78	762.78	762.78	762.78	762.78	762.78	0.00	0.00
15.000	754.26	759.23	759.23	759.23	759.23	759.23	759.23	759.23	759.23	759.23	759.24	759.24	0.00	0.00
14.240	750.52	754.93	755.05	755.42	755.42	755.42	755.57	755.42	755.51	755.50	755.50	757.02	0.52	2.09
14.220	Highway 43 Bridge													
14.200	750.12	754.89	755.02	755.39	755.39	755.39	755.55	755.39	755.48	755.47	755.47	757.01	0.53	2.12
14.000	747.07	754.74	754.90	755.25	755.25	755.25	755.40	755.25	755.33	755.32	755.32	757.01	0.50	2.27
13.000	745.41	754.13	754.45	754.95	754.94	754.93	754.89	754.95	754.94	754.90	754.90	757.00	0.50	2.87
12.000	741.15	754.05	754.39	754.90	754.90	754.89	754.84	754.91	754.89	754.85	754.85	757.00	0.52	2.95
11.910	OK/MO State Line													
11.000	741.93	754.03	754.37	754.89	754.88	754.87	754.82	754.89	754.88	754.84	754.83	757.00	0.52	2.97
10.000	734.62	754.03	754.36	754.88	754.87	754.86	754.81	754.88	754.87	754.83	754.83	757.00	0.52	2.97
9.000	734.66	754.02	754.35	754.87	754.87	754.86	754.81	754.87	754.86	754.83	754.83	757.00	0.52	2.98
8.000	724.21	754.02	754.35	754.86	754.86	754.85	754.80	754.86	754.85	754.83	754.83	757.00	0.51	2.98
7.000	728.21	754.02	754.34	754.86	754.85	754.85	754.80	754.86	754.85	754.83	754.83	757.00	0.52	2.98
6.000	727.13	754.02	754.34	754.85	754.85	754.85	754.79	754.85	754.85	754.82	754.82	757.00	0.51	2.98
5.000	721.05	754.01	754.33	754.85	754.84	754.84	754.79	754.85	754.84	754.82	754.82	757.00	0.52	2.99
4.700	716.13	754.01	754.33	754.84	754.84	754.84	754.79	754.84	754.84	754.82	754.82	757.00	0.51	2.99
4.670	OK Highway 10 Bridge													
4.640	715.21	754.01	754.33	754.84	754.84	754.84	754.79	754.84	754.84	754.82	754.82	757.00	0.51	2.99
4.000	716.61	754.01	754.33	754.84	754.84	754.84	754.78	754.84	754.83	754.82	754.82	757.00	0.51	2.99
3.000	714.74	754.01	754.32	754.84	754.84	754.83	754.78	754.84	754.83	754.82	754.82	757.00	0.52	2.99
2.000	709.09	754.01	754.32	754.83	754.83	754.83	754.78	754.83	754.83	754.82	754.82	757.00	0.51	2.99
1.000	705.82	754.00	754.32	754.83	754.83	754.82	754.77	754.83	754.82	754.82	754.82	757.00	0.51	3.00
0.320	706.36	754.00	754.31	754.82	754.82	754.82	754.77	754.82	754.82	754.82	754.82	757.00	0.51	3.00
0.000	Downstream end of Elk River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.12**

GRAND RIVER DAM AUTHORITY TAR CREEK MAX WSELs - JUL 2007 (4 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
4.152	Upstream end of model													
4.152	762.17	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
3.900	760.10	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
3.840	22nd Ave Bridge													
3.800	762.30	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
3.300	759.46	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
2.800	756.73	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
2.710	BN RR Bridge													
2.700	755.72	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
2.500	754.95	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
2.300	754.15	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
2.200	Rockdale Blvd Bridge													
2.100	751.51	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
1.900	750.02	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
1.700	749.58	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
1.660	Central Ave Bridge													
1.600	746.47	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
1.500	744.29	771.86	771.89	772.00	772.00	772.00	771.93	771.99	772.01	772.07	772.10	772.15	0.12	0.29
1.400	OK Highway 10 Bridge													
1.300	742.00	771.86	771.89	772.00	772.00	772.00	771.93	771.98	772.01	772.07	772.10	772.14	0.12	0.29
1.000	739.34	771.85	771.88	771.99	771.99	771.99	771.92	771.98	772.00	772.06	772.09	772.14	0.12	0.29
0.700	737.06	771.84	771.88	771.98	771.98	771.98	771.91	771.97	772.00	772.05	772.08	772.13	0.12	0.29
0.300	736.42	771.78	771.81	771.92	771.92	771.92	771.85	771.90	771.93	771.99	772.02	772.06	0.12	0.29
0.041	735.85	771.69	771.73	771.83	771.83	771.84	771.76	771.82	771.85	771.90	771.93	771.98	0.12	0.29
0.000	Downstream end of Tar Creek													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX D.4:
OCTOBER 2009 (3 YEAR) INFLOW EVENT
MAXIMUM WATER SURFACE ELEVATIONS

PENSACOLA DAM **TABLE D.13**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - OCT 2009 (3 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
152.175	Upstream end of model													
152.175	752.29	778.47	778.47	778.47	778.47	778.47	778.47	778.47	778.47	778.47	778.47	778.47	0.00	0.00
151.000	748.53	776.35	776.35	776.35	776.35	776.35	776.35	776.35	776.35	776.35	776.35	776.35	0.00	0.00
150.000	748.47	775.17	775.17	775.17	775.17	775.17	775.17	775.17	775.17	775.17	775.17	775.18	0.00	0.00
149.000	750.14	773.78	773.78	773.78	773.78	773.78	773.78	773.78	773.78	773.78	773.78	773.78	0.00	0.00
148.000	749.29	772.40	772.40	772.40	772.40	772.40	772.40	772.40	772.40	772.40	772.40	772.40	0.00	0.01
147.000	747.76	770.52	770.52	770.52	770.52	770.52	770.52	770.52	770.52	770.52	770.52	770.53	0.00	0.02
145.500	745.12	768.34	768.34	768.34	768.34	768.35	768.35	768.35	768.35	768.35	768.36	768.39	0.00	0.05
145.480	E 60 Road Bridge													
145.400	748.01	768.23	768.23	768.23	768.23	768.24	768.24	768.24	768.24	768.24	768.25	768.28	0.00	0.05
144.000	743.43	766.45	766.46	766.46	766.46	766.46	766.46	766.46	766.46	766.47	766.50	766.56	0.01	0.11
143.000	737.95	764.99	765.00	765.01	765.01	765.01	765.01	765.01	765.02	765.03	765.10	765.23	0.01	0.24
142.000	742.91	763.80	763.83	763.83	763.83	763.84	763.85	763.84	763.85	763.87	764.00	764.21	0.02	0.41
141.000	741.01	763.13	763.18	763.18	763.19	763.19	763.20	763.19	763.21	763.25	763.44	763.72	0.03	0.59
140.000	736.33	762.76	762.83	762.83	762.84	762.85	762.86	762.85	762.87	762.92	763.17	763.49	0.04	0.73
139.000	743.99	762.21	762.31	762.31	762.33	762.34	762.35	762.34	762.36	762.44	762.77	763.17	0.05	0.96
138.000	736.48	761.75	761.88	761.88	761.91	761.91	761.93	761.91	761.94	762.04	762.42	762.88	0.06	1.13
137.000	733.33	760.65	760.85	760.84	760.88	760.88	760.90	760.88	760.92	761.05	761.56	762.11	0.07	1.45
135.950	731.18	759.95	760.18	760.18	760.22	760.21	760.24	760.21	760.26	760.41	760.97	761.57	0.08	1.62
135.941	Highway 69 Bridge													
135.940	731.21	759.91	760.14	760.14	760.18	760.17	760.20	760.17	760.22	760.37	760.94	761.54	0.08	1.63
135.590	731.77	759.84	760.08	760.07	760.12	760.11	760.13	760.11	760.15	760.31	760.89	761.49	0.08	1.65
135.586	BN RR Bridge													
135.580	731.07	759.82	760.05	760.05	760.09	760.08	760.11	760.08	760.13	760.29	760.86	761.46	0.08	1.64
135.470	732.63	759.73	759.97	759.96	760.01	760.00	760.03	760.00	760.05	760.21	760.79	761.40	0.09	1.67
135.460	Highway 125 Bridge													
135.440	731.60	759.78	760.01	760.01	760.05	760.04	760.07	760.04	760.09	760.25	760.82	761.43	0.08	1.65
135.000	732.64	759.64	759.89	759.89	759.93	759.92	759.95	759.92	759.97	760.14	760.73	761.36	0.08	1.72

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.13**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - OCT 2009 (3 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
134.610	728.75	759.36	759.63	759.62	759.67	759.65	759.68	759.65	759.71	759.88	760.50	761.14	0.09	1.78
134.599	Abandonded RR Bridge													
134.595	728.58	759.17	759.44	759.43	759.49	759.47	759.50	759.47	759.52	759.70	760.33	760.97	0.09	1.80
134.000	727.23	758.52	758.83	758.82	758.88	758.86	758.90	758.86	758.92	759.12	759.82	760.52	0.10	2.00
133.973	Tar Creek													
133.900	727.72	758.26	758.59	758.58	758.65	758.62	758.65	758.62	758.68	758.89	759.62	760.33	0.10	2.07
133.800	Interstate 44 Bridge													
133.700	728.57	757.97	758.32	758.31	758.38	758.35	758.39	758.35	758.41	758.64	759.41	760.14	0.11	2.17
133.000	727.70	756.70	757.15	757.13	757.22	757.17	757.22	757.17	757.25	757.54	758.46	759.31	0.13	2.61
132.000	727.96	755.29	755.84	755.81	755.94	755.87	755.93	755.86	755.97	756.33	757.46	758.45	0.16	3.16
131.000	726.82	754.10	754.73	754.71	754.85	754.78	754.84	754.77	754.91	755.33	756.65	757.77	0.20	3.66
130.000	723.18	753.64	754.29	754.27	754.41	754.35	754.40	754.34	754.48	754.93	756.34	757.52	0.21	3.87
129.000	719.79	752.93	753.60	753.59	753.76	753.68	753.79	753.68	753.92	754.51	756.04	757.26	0.33	4.33
128.000	719.69	752.65	753.32	753.31	753.48	753.40	753.52	753.42	753.66	754.27	755.85	757.20	0.35	4.54
126.710	715.94	752.11	752.77	752.76	752.94	752.88	753.00	752.91	753.14	753.79	755.48	757.20	0.38	5.09
126.700	S 590 Road Bridge													
126.670	715.61	752.09	752.75	752.74	752.92	752.86	752.98	752.89	753.12	753.77	755.46	757.20	0.38	5.11
126.000	720.35	752.05	752.71	752.70	752.89	752.82	752.95	752.85	753.09	753.75	755.44	757.21	0.39	5.16
125.000	717.08	751.74	752.40	752.39	752.58	752.53	752.66	752.57	752.80	753.49	755.24	757.20	0.41	5.46
124.000	715.62	751.56	752.22	752.21	752.40	752.36	752.49	752.41	752.62	753.34	755.13	757.20	0.41	5.64
123.000	713.34	751.32	751.97	751.95	752.16	752.13	752.26	752.19	752.39	753.13	754.98	757.20	0.44	5.88
122.580	711.08	751.23	751.88	751.86	752.07	752.05	752.17	752.11	752.30	753.05	754.91	757.19	0.44	5.96
122.570	Highway 60 Bridge													
122.550	709.97	750.96	751.63	751.61	751.83	751.81	751.94	751.87	752.07	752.85	754.77	757.24	0.46	6.28
122.350	Spring River													
122.000	710.64	750.51	751.37	751.35	751.75	751.47	751.62	751.51	751.81	752.63	754.62	757.24	0.46	6.73
121.980	709.90	750.30	751.23	751.21	751.70	751.31	751.47	751.34	751.67	752.52	754.52	757.23	0.49	6.93
121.970	BN RR Bridge													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.13**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - OCT 2009 (3 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
121.960	710.89	750.20	751.19	751.13	751.67	751.23	751.39	751.24	751.60	752.44	754.36	757.25	0.54	7.05
120.000	717.63	748.31	750.87	751.00	751.39	750.43	750.59	750.63	750.74	752.34	753.94	757.24	0.96	8.93
118.000	720.29	747.87	750.71	750.98	751.25	750.26	750.42	750.46	750.34	752.32	753.74	757.22	0.99	9.35
116.000	725.99	747.69	750.63	750.97	751.18	750.22	750.33	750.37	750.30	752.32	753.67	757.19	0.96	9.50
114.000	718.27	747.48	750.50	750.95	751.06	750.19	750.20	750.23	750.27	752.30	753.60	757.17	0.87	9.69
112.000	714.31	747.47	750.43	750.94	751.00	750.18	750.17	750.15	750.26	752.29	753.55	757.14	0.85	9.67
110.000	719.24	747.47	750.40	750.94	750.97	750.17	750.17	750.12	750.26	752.29	753.54	757.11	0.85	9.64
108.000	710.68	747.47	750.36	750.93	750.94	750.17	750.16	750.10	750.25	752.28	753.52	757.09	0.84	9.62
106.000	700.35	747.46	750.35	750.93	750.93	750.17	750.16	750.10	750.25	752.28	753.51	757.06	0.83	9.60
105.350	Elk River													
105.000	701.60	747.46	750.35	750.93	750.93	750.17	750.16	750.10	750.25	752.28	753.51	757.06	0.83	9.60
104.000	696.61	747.46	750.34	750.92	750.92	750.17	750.16	750.10	750.25	752.28	753.51	757.05	0.82	9.59
102.000	688.58	747.46	750.33	750.92	750.91	750.16	750.16	750.10	750.25	752.28	753.51	757.02	0.82	9.56
101.750	685.91	747.46	750.33	750.92	750.91	750.16	750.16	750.10	750.24	752.27	753.51	757.02	0.82	9.56
101.730	Highway 59 (Sailboat Bridge)													
101.710	682.31	747.46	750.33	750.91	750.91	750.16	750.15	750.10	750.24	752.27	753.50	757.02	0.81	9.56
100.000	702.62	747.46	750.32	750.91	750.90	750.16	750.15	750.10	750.24	752.27	753.50	757.00	0.81	9.54
90.000	681.52	747.46	750.32	750.91	750.90	750.16	750.15	750.10	750.24	752.27	753.50	757.00	0.81	9.54
80.000	657.03	747.46	750.32	750.91	750.90	750.16	750.15	750.10	750.24	752.27	753.50	757.00	0.81	9.54
78.000	653.11	747.46	750.32	750.91	750.90	750.16	750.15	750.10	750.24	752.27	753.50	757.00	0.81	9.54
77.000	Pensacola Dam													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.14**

GRAND RIVER DAM AUTHORITY SPRING RIVER MAX WSELs - OCT 2009 (3 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD) El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0	Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
21.000	Upstream end of model													
21.000	762.67	790.77	790.77	790.77	790.77	790.77	790.77	790.77	790.77	790.77	790.77	790.77	0.00	0.00
20.000	760.13	788.92	788.92	788.92	788.92	788.92	788.92	788.92	788.92	788.92	788.92	788.92	0.00	0.00
19.000	759.04	785.68	785.68	785.68	785.68	785.68	785.68	785.68	785.68	785.68	785.68	785.68	0.00	0.00
18.000	753.18	782.60	782.60	782.60	782.60	782.60	782.60	782.60	782.60	782.60	782.60	782.60	0.00	0.00
17.000	750.54	780.53	780.53	780.53	780.53	780.53	780.53	780.53	780.53	780.53	780.53	780.54	0.00	0.01
16.000	749.28	778.12	778.12	778.12	778.12	778.12	778.12	778.12	778.12	778.12	778.12	778.13	0.00	0.01
15.000	746.37	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.16	775.18	0.00	0.02
14.170	741.32	772.80	772.81	772.81	772.81	772.81	772.81	772.81	772.81	772.81	772.82	772.84	0.00	0.04
14.160	E 57 Road													
14.120	744.21	773.22	773.22	773.22	773.22	773.22	773.22	773.22	773.22	773.22	773.23	773.25	0.00	0.03
13.510	744.59	772.08	772.08	772.08	772.08	772.08	772.08	772.08	772.08	772.08	772.09	772.12	0.00	0.04
13.500	Interstate 44 Bridge													
13.450	745.52	771.61	771.61	771.61	771.61	771.61	771.61	771.61	771.61	771.61	771.63	771.66	0.00	0.05
12.000	742.72	767.89	767.89	767.89	767.89	767.89	767.89	767.89	767.89	767.90	767.93	767.99	0.00	0.10
11.000	742.23	765.97	765.98	765.98	765.98	765.98	765.98	765.99	765.99	765.99	766.04	766.16	0.01	0.19
10.000	737.62	764.45	764.46	764.46	764.46	764.46	764.47	764.47	764.47	764.48	764.56	764.75	0.01	0.30
9.000	733.92	762.26	762.28	762.28	762.28	762.29	762.30	762.30	762.31	762.32	762.46	762.79	0.03	0.54
8.020	733.14	760.73	760.75	760.76	760.76	760.78	760.78	760.79	760.80	760.82	761.04	761.55	0.05	0.82
8.010	OK Highway 10 Bridge													
7.970	731.28	759.41	759.44	759.45	759.45	759.47	759.49	759.49	759.50	759.53	759.80	760.43	0.06	1.02
7.000	730.33	756.98	757.04	757.06	757.06	757.12	757.15	757.16	757.17	757.23	757.74	758.81	0.12	1.83
6.000	727.95	755.40	755.50	755.52	755.52	755.63	755.68	755.69	755.70	755.80	756.60	758.01	0.20	2.61
5.000	722.10	754.09	754.24	754.27	754.28	754.45	754.51	754.51	754.54	754.69	755.78	757.42	0.29	3.34
4.000	720.00	753.26	753.46	753.50	753.51	753.71	753.79	753.79	753.83	754.03	755.44	757.25	0.37	3.99
3.000	723.22	752.50	752.76	752.81	752.82	753.05	753.14	753.13	753.19	753.51	755.23	757.25	0.43	4.76
2.000	723.73	751.87	752.22	752.28	752.32	752.54	752.64	752.62	752.71	753.26	755.08	757.25	0.49	5.38
1.000	728.44	751.40	751.91	751.91	752.10	752.17	752.29	752.24	752.39	753.09	754.96	757.25	0.48	5.85
0.580	716.17	750.97	751.70	751.68	751.90	751.84	751.97	751.89	752.13	752.91	754.83	757.24	0.45	6.27
0.570	Highway 60 Bridge													
0.560	713.76	750.92	751.66	751.65	751.88	751.80	751.93	751.84	752.10	752.88	754.80	757.24	0.45	6.32
0.460	715.35	750.95	751.69	751.67	751.89	751.83	751.96	751.88	752.12	752.90	754.82	757.24	0.45	6.29
0.000	Downstream end of Spring River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.

2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.15**

GRAND RIVER DAM AUTHORITY — ELK RIVER MAX WSELs - OCT 2009 (3 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
19.590	Upstream end of model													
19.590	771.15	793.77	793.77	793.77	793.77	793.77	793.77	793.77	793.77	793.77	793.77	793.77	0.00	0.00
19.000	767.51	791.13	791.13	791.13	791.13	791.13	791.13	791.13	791.13	791.13	791.13	791.13	0.00	0.00
18.000	765.41	787.17	787.17	787.17	787.17	787.17	787.17	787.17	787.17	787.17	787.17	787.17	0.00	0.00
17.000	762.53	783.91	783.91	783.91	783.91	783.91	783.91	783.91	783.91	783.91	783.91	783.91	0.00	0.00
16.000	756.63	779.22	779.22	779.22	779.22	779.22	779.22	779.22	779.22	779.22	779.22	779.22	0.00	0.00
15.000	754.26	775.00	775.00	775.00	775.00	775.00	775.00	775.00	775.00	775.00	775.00	775.00	0.00	0.00
14.240	750.52	771.70	771.70	771.70	771.70	771.70	771.70	771.70	771.70	771.70	771.70	771.70	0.00	0.00
14.220	Highway 43 Bridge													
14.200	750.12	771.20	771.20	771.20	771.20	771.20	771.20	771.20	771.20	771.20	771.20	771.20	0.00	0.00
14.000	747.07	770.02	770.02	770.02	770.02	770.02	770.02	770.02	770.02	770.02	770.02	770.02	0.00	0.00
13.000	745.41	764.84	764.84	764.84	764.84	764.84	764.84	764.84	764.84	764.84	764.84	764.85	0.00	0.01
12.000	741.15	761.15	761.15	761.15	761.15	761.15	761.15	761.15	761.15	761.15	761.17	761.22	0.00	0.07
11.910	OK/MO State Line													
11.000	741.93	755.16	755.17	755.17	755.17	755.17	755.17	755.18	755.18	755.21	755.44	757.14	0.01	1.98
10.000	734.62	750.86	750.88	751.07	751.09	750.89	750.91	750.93	750.96	752.30	753.53	757.13	0.21	6.27
9.000	734.66	747.82	750.40	750.95	750.97	750.18	750.17	750.11	750.26	752.30	753.52	757.13	0.86	9.31
8.000	724.21	747.47	750.39	750.95	750.97	750.17	750.17	750.11	750.26	752.29	753.52	757.12	0.86	9.65
7.000	728.21	747.47	750.38	750.94	750.96	750.17	750.17	750.11	750.26	752.29	753.52	757.11	0.85	9.64
6.000	727.13	747.47	750.38	750.94	750.96	750.17	750.17	750.11	750.26	752.29	753.52	757.11	0.85	9.64
5.000	721.05	747.47	750.37	750.94	750.95	750.17	750.16	750.11	750.26	752.29	753.52	757.10	0.84	9.63
4.700	716.13	747.47	750.37	750.94	750.95	750.17	750.16	750.11	750.26	752.29	753.52	757.10	0.84	9.63
4.670	OK Highway 10 Bridge													
4.640	715.21	747.47	750.37	750.94	750.95	750.17	750.16	750.11	750.25	752.29	753.52	757.10	0.84	9.63
4.000	716.61	747.47	750.37	750.94	750.94	750.17	750.16	750.11	750.25	752.29	753.52	757.09	0.83	9.62
3.000	714.74	747.46	750.36	750.93	750.94	750.17	750.16	750.10	750.25	752.28	753.52	757.08	0.84	9.62
2.000	709.09	747.46	750.36	750.93	750.94	750.17	750.16	750.10	750.25	752.28	753.52	757.08	0.84	9.62
1.000	705.82	747.46	750.35	750.93	750.93	750.17	750.16	750.10	750.25	752.28	753.51	757.07	0.83	9.61
0.320	706.36	747.46	750.35	750.93	750.93	750.17	750.16	750.10	750.25	752.28	753.51	757.06	0.83	9.60
0.000	Downstream end of Elk River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.16**

GRAND RIVER DAM AUTHORITY TAR CREEK MAX WSELs - OCT 2009 (3 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
4.152	Upstream end of model													
4.152	762.17	775.04	775.04	775.04	775.04	775.04	775.04	775.04	775.04	775.04	775.04	775.04	0.00	0.00
3.900	760.10	774.11	774.11	774.11	774.11	774.11	774.11	774.11	774.11	774.11	774.11	774.11	0.00	0.00
3.840	22nd Ave Bridge													
3.800	762.30	772.86	772.86	772.86	772.86	772.86	772.86	772.86	772.86	772.86	772.86	772.86	0.00	0.00
3.300	759.46	770.57	770.57	770.57	770.57	770.57	770.57	770.57	770.57	770.57	770.57	770.57	0.00	0.00
2.800	756.73	766.52	766.52	766.52	766.52	766.52	766.52	766.52	766.52	766.52	766.53	766.53	0.00	0.00
2.710	BN RR Bridge													
2.700	755.72	765.50	765.50	765.50	765.50	765.50	765.50	765.50	765.50	765.50	765.50	765.50	0.00	0.01
2.500	754.95	764.13	764.13	764.13	764.13	764.13	764.13	764.13	764.13	764.13	764.13	764.14	0.00	0.01
2.300	754.15	762.23	762.23	762.23	762.23	762.23	762.23	762.23	762.23	762.23	762.24	762.29	0.00	0.07
2.200	Rockdale Blvd Bridge													
2.100	751.51	759.49	759.50	759.50	759.50	759.50	759.50	759.51	759.51	759.54	759.74	760.43	0.01	0.94
1.900	750.02	758.40	758.72	758.71	758.77	758.75	758.78	758.75	758.81	759.01	759.73	760.43	0.10	2.03
1.700	749.58	758.40	758.72	758.71	758.77	758.75	758.78	758.75	758.81	759.01	759.73	760.43	0.10	2.03
1.660	Central Ave Bridge													
1.600	746.47	758.40	758.72	758.71	758.77	758.75	758.78	758.75	758.81	759.01	759.73	760.43	0.10	2.03
1.500	744.29	758.40	758.72	758.71	758.77	758.75	758.78	758.75	758.81	759.01	759.73	760.43	0.10	2.03
1.400	OK Highway 10 Bridge													
1.300	742.00	758.40	758.72	758.71	758.77	758.75	758.78	758.75	758.81	759.01	759.73	760.43	0.10	2.03
1.000	739.34	758.40	758.72	758.71	758.77	758.75	758.78	758.75	758.81	759.01	759.73	760.43	0.10	2.03
0.700	737.06	758.40	758.72	758.71	758.77	758.75	758.78	758.75	758.81	759.01	759.73	760.43	0.10	2.03
0.300	736.42	758.41	758.73	758.72	758.78	758.75	758.79	758.75	758.81	759.02	759.74	760.44	0.10	2.03
0.041	735.85	758.39	758.71	758.70	758.77	758.74	758.78	758.74	758.80	759.01	759.72	760.42	0.10	2.03
0.000	Downstream end of Tar Creek													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX D.5:
DECEMBER 2015 (15 YEAR) INFLOW EVENT
MAXIMUM WATER SURFACE ELEVATIONS

PENSACOLA DAM — **TABLE D.17**

GRAND RIVER DAM AUTHORITY — NEOSHO RIVER MAX WSELs - DEC 2015 (15 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0 Max WSE (ft, PD)	El. 742.0 Max WSE (ft, PD)	El. 742.5 Max WSE (ft, PD)	El. 743.0 Max WSE (ft, PD)	El. 743.5 Max WSE (ft, PD)	El. 744.0 Max WSE (ft, PD)	El. 744.5 Max WSE (ft, PD)	El. 745.0 Max WSE (ft, PD)	El. 749.0 Max WSE (ft, PD)	El. 753.0 Max WSE (ft, PD)	El. 757.0 Max WSE (ft, PD)		
152.175	Upstream end of model													
152.175	752.29	778.38	778.38	778.38	778.38	778.38	778.38	778.38	778.38	778.38	778.38	778.38	0.00	0.00
151.000	748.53	776.27	776.27	776.27	776.27	776.27	776.27	776.27	776.27	776.27	776.27	776.27	0.00	0.00
150.000	748.47	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	0.00	0.00
149.000	750.14	773.76	773.76	773.76	773.76	773.76	773.76	773.76	773.76	773.76	773.76	773.76	0.00	0.00
148.000	749.29	772.37	772.37	772.37	772.37	772.37	772.37	772.37	772.37	772.37	772.37	772.38	0.00	0.01
147.000	747.76	770.49	770.50	770.50	770.50	770.50	770.50	770.50	770.50	770.50	770.51	770.53	0.00	0.03
145.500	745.12	768.33	768.34	768.34	768.34	768.34	768.34	768.34	768.34	768.36	768.37	768.43	0.00	0.10
145.480	E 60 Road Bridge													
145.400	748.01	768.22	768.23	768.23	768.23	768.23	768.23	768.23	768.23	768.25	768.26	768.32	0.00	0.10
144.000	743.43	766.48	766.51	766.51	766.51	766.51	766.51	766.51	766.52	766.57	766.60	766.73	0.01	0.25
143.000	737.95	765.14	765.23	765.23	765.23	765.23	765.23	765.24	765.25	765.37	765.41	765.64	0.03	0.50
142.000	742.91	764.13	764.31	764.31	764.31	764.31	764.31	764.33	764.34	764.51	764.56	764.87	0.04	0.74
141.000	741.01	763.63	763.91	763.92	763.92	763.91	763.91	763.93	763.95	764.13	764.20	764.54	0.04	0.91
140.000	736.33	763.40	763.75	763.75	763.75	763.75	763.75	763.77	763.79	763.98	764.05	764.42	0.04	1.02
139.000	743.99	763.08	763.52	763.53	763.52	763.52	763.52	763.54	763.56	763.77	763.84	764.25	0.04	1.17
138.000	736.48	762.79	763.31	763.32	763.31	763.31	763.31	763.33	763.35	763.56	763.64	764.07	0.04	1.28
137.000	733.33	762.04	762.74	762.75	762.75	762.75	762.75	762.76	762.79	762.99	763.07	763.53	0.04	1.50
135.950	731.18	761.52	762.34	762.35	762.35	762.34	762.34	762.36	762.38	762.58	762.66	763.12	0.04	1.60
135.941	Highway 69 Bridge													
135.940	731.21	761.49	762.32	762.33	762.32	762.32	762.32	762.34	762.36	762.56	762.63	763.10	0.04	1.61
135.590	731.77	761.44	762.28	762.29	762.28	762.28	762.28	762.30	762.32	762.52	762.59	763.06	0.04	1.62
135.586	BN RR Bridge													
135.580	731.07	761.42	762.26	762.26	762.26	762.26	762.26	762.28	762.30	762.49	762.57	763.04	0.04	1.62
135.470	732.63	761.36	762.21	762.22	762.22	762.22	762.22	762.23	762.26	762.45	762.52	763.00	0.05	1.64
135.460	Highway 125 Bridge													
135.440	731.60	761.39	762.24	762.25	762.25	762.24	762.24	762.26	762.28	762.48	762.55	763.03	0.04	1.64
135.000	732.64	761.32	762.19	762.20	762.20	762.20	762.20	762.21	762.24	762.43	762.51	762.98	0.05	1.66

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.17**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - DEC 2015 (15 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
134.610	728.75	761.12	762.03	762.03	762.03	762.03	762.03	762.05	762.07	762.26	762.33	762.81	0.04	1.69
134.599		Abandonded RR Bridge												
134.595	728.58	760.96	761.91	761.91	761.91	761.91	761.91	761.93	761.95	762.13	762.20	762.68	0.04	1.72
134.000	727.23	760.55	761.59	761.60	761.59	761.59	761.59	761.61	761.63	761.80	761.87	762.37	0.04	1.82
133.973		Tar Creek												
133.900	727.72	760.37	761.45	761.46	761.46	761.45	761.45	761.48	761.49	761.66	761.73	762.23	0.04	1.86
133.800		Interstate 44 Bridge												
133.700	728.57	760.20	761.32	761.33	761.33	761.33	761.33	761.35	761.36	761.52	761.59	762.10	0.04	1.90
133.000	727.70	759.44	760.77	760.77	760.77	760.77	760.77	760.79	760.80	760.94	761.01	761.56	0.03	2.12
132.000	727.96	758.64	760.20	760.20	760.20	760.20	760.20	760.21	760.23	760.34	760.40	761.01	0.03	2.37
131.000	726.82	758.01	759.76	759.76	759.76	759.76	759.76	759.77	759.78	759.87	759.93	760.63	0.02	2.62
130.000	723.18	757.78	759.61	759.61	759.61	759.61	759.61	759.61	759.62	759.70	759.76	760.45	0.01	2.67
129.000	719.79	757.54	759.46	759.46	759.46	759.46	759.46	759.46	759.48	759.54	759.60	760.30	0.02	2.77
128.000	719.69	757.40	759.38	759.38	759.38	759.38	759.38	759.38	759.39	759.44	759.49	760.23	0.02	2.82
126.710	715.94	757.13	759.22	759.22	759.22	759.22	759.22	759.22	759.23	759.25	759.31	760.07	0.01	2.94
126.700		S 590 Road Bridge												
126.670	715.61	757.12	759.20	759.20	759.20	759.20	759.20	759.20	759.21	759.23	759.28	760.06	0.01	2.94
126.000	720.35	757.10	759.18	759.17	759.17	759.17	759.17	759.17	759.18	759.21	759.27	760.03	0.01	2.94
125.000	717.08	756.94	759.09	759.08	759.08	759.08	759.08	759.08	759.09	759.09	759.16	759.94	0.01	3.00
124.000	715.62	756.86	759.04	759.04	759.04	759.04	759.04	759.04	759.05	759.04	759.11	759.90	0.01	3.04
123.000	713.34	756.76	758.97	758.97	758.97	758.97	758.97	758.97	758.98	758.95	759.00	759.82	0.01	3.07
122.580	711.08	756.69	758.93	758.93	758.93	758.93	758.93	758.93	758.94	758.90	758.95	759.78	0.01	3.09
122.570		Highway 60 Bridge												
122.550	709.97	756.62	758.92	758.92	758.92	758.92	758.92	758.92	758.93	758.89	758.94	759.77	0.01	3.15
122.350		Spring River												
122.000	710.64	756.04	758.41	758.41	758.41	758.41	758.41	758.41	758.42	758.41	758.44	759.17	0.01	3.13
121.980	709.90	755.77	758.18	758.18	758.18	758.18	758.18	758.18	758.19	758.19	758.23	758.92	0.01	3.15
121.970		BN RR Bridge												

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.17**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - DEC 2015 (15 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
121.960	710.89	755.07	757.25	757.26	757.25	757.25	757.25	757.26	757.26	757.26	757.25	757.53	0.01	2.46
120.000	717.63	754.72	756.52	756.52	756.52	756.52	756.52	756.53	756.53	756.57	756.59	757.23	0.01	2.51
118.000	720.29	754.54	756.01	756.01	756.01	756.01	756.01	756.01	756.02	756.06	756.07	757.21	0.01	2.67
116.000	725.99	754.53	755.76	755.77	755.76	755.76	755.76	755.77	755.76	755.80	755.81	757.19	0.01	2.66
114.000	718.27	754.52	755.34	755.35	755.35	755.35	755.34	755.36	755.39	755.38	755.39	757.17	0.05	2.64
112.000	714.31	754.52	755.15	755.16	755.16	755.16	755.16	755.19	755.20	755.17	755.17	757.14	0.05	2.62
110.000	719.24	754.52	755.06	755.08	755.08	755.07	755.07	755.10	755.09	755.06	755.06	757.11	0.04	2.59
108.000	710.68	754.52	754.97	754.98	754.98	754.98	754.98	754.97	754.95	754.92	754.92	757.09	0.03	2.57
106.000	700.35	754.52	754.95	754.94	754.95	754.95	754.95	754.94	754.93	754.90	754.90	757.06	0.02	2.54
105.350	Elk River													
105.000	701.60	754.52	754.94	754.94	754.94	754.94	754.94	754.94	754.93	754.90	754.90	757.06	0.02	2.54
104.000	696.61	754.52	754.93	754.92	754.92	754.92	754.92	754.92	754.92	754.89	754.89	757.05	0.01	2.53
102.000	688.58	754.51	754.88	754.88	754.88	754.88	754.88	754.88	754.88	754.87	754.87	757.02	0.00	2.51
101.750	685.91	754.51	754.87	754.87	754.87	754.87	754.87	754.87	754.87	754.86	754.86	757.02	0.00	2.51
101.730	Highway 59 (Sailboat Bridge)													
101.710	682.31	754.51	754.86	754.86	754.86	754.86	754.86	754.86	754.86	754.84	754.84	757.02	0.00	2.51
100.000	702.62	754.51	754.84	754.84	754.84	754.84	754.84	754.84	754.84	754.84	754.84	757.00	0.00	2.49
90.000	681.52	754.51	754.83	754.83	754.83	754.83	754.83	754.83	754.83	754.83	754.83	757.00	0.00	2.49
80.000	657.03	754.51	754.82	754.82	754.82	754.82	754.82	754.82	754.82	754.82	754.82	757.00	0.00	2.49
78.000	653.11	754.51	754.82	754.82	754.82	754.82	754.82	754.82	754.82	754.82	754.82	757.00	0.00	2.49
77.000	Pensacola Dam													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.18**

GRAND RIVER DAM AUTHORITY — SPRING RIVER MAX WSELs - DEC 2015 (15 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
21.000	Upstream end of model													
21.000	762.67	800.70	800.69	800.69	800.69	800.69	800.69	800.69	800.69	800.69	800.68	800.66	0.00	0.04
20.000	760.13	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.50	799.51	0.00	0.01
19.000	759.04	797.69	797.69	797.69	797.69	797.69	797.69	797.69	797.69	797.69	797.69	797.69	0.00	0.00
18.000	753.18	795.45	795.45	795.45	795.45	795.45	795.45	795.45	795.45	795.45	795.45	795.45	0.00	0.00
17.000	750.54	793.52	793.52	793.52	793.52	793.52	793.52	793.52	793.52	793.51	793.51	793.51	0.00	0.01
16.000	749.28	790.74	790.74	790.74	790.74	790.74	790.74	790.74	790.74	790.74	790.74	790.74	0.00	0.00
15.000	746.37	788.26	788.26	788.26	788.26	788.26	788.26	788.26	788.26	788.26	788.26	788.26	0.00	0.00
14.170	741.32	785.82	785.82	785.82	785.82	785.82	785.82	785.82	785.82	785.82	785.82	785.82	0.00	0.00
14.160	E 57 Road													
14.120	744.21	784.98	784.97	784.97	784.97	784.97	784.97	784.97	784.97	784.96	784.95	784.95	0.00	0.03
13.510	744.59	783.35	783.33	783.32	783.32	783.32	783.32	783.32	783.32	783.29	783.27	783.19	0.01	0.16
13.500	Interstate 44 Bridge													
13.450	745.52	782.65	782.64	782.64	782.63	782.64	782.64	782.64	782.63	782.57	782.56	782.46	0.01	0.19
12.000	742.72	777.95	777.94	777.94	777.94	777.94	777.94	777.94	777.93	777.91	777.90	777.84	0.01	0.11
11.000	742.23	776.26	776.26	776.26	776.26	776.26	776.26	776.26	776.26	776.25	776.25	776.24	0.00	0.02
10.000	737.62	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.15	775.14	0.00	0.00
9.000	733.92	773.56	773.56	773.56	773.56	773.56	773.56	773.56	773.56	773.55	773.54	773.53	0.00	0.02
8.020	733.14	772.72	772.72	772.72	772.72	772.72	772.72	772.72	772.72	772.87	772.87	772.87	0.00	0.15
8.010	OK Highway 10 Bridge													
7.970	731.28	767.78	767.85	767.86	767.86	767.85	767.85	767.87	767.89	768.05	768.09	768.36	0.04	0.58
7.000	730.33	765.08	765.23	765.24	765.24	765.23	765.23	765.26	765.30	765.58	765.66	766.09	0.07	1.02
6.000	727.95	763.48	763.70	763.72	763.71	763.71	763.71	763.75	763.81	764.18	764.27	764.83	0.10	1.36
5.000	722.10	761.95	762.29	762.31	762.30	762.30	762.30	762.35	762.41	762.88	763.00	763.68	0.12	1.73
4.000	720.00	760.88	761.34	761.37	761.36	761.35	761.35	761.41	761.48	762.01	762.15	762.92	0.13	2.03
3.000	723.22	759.52	760.33	760.34	760.33	760.33	760.33	760.34	760.35	760.92	761.06	761.93	0.02	2.42
2.000	723.73	758.53	759.86	759.87	759.86	759.86	759.86	759.87	759.88	760.19	760.35	761.27	0.02	2.74
1.000	728.44	757.63	759.45	759.45	759.45	759.45	759.45	759.45	759.46	759.61	759.76	760.64	0.01	3.01
0.580	716.17	756.47	758.73	758.72	758.72	758.72	758.72	758.72	758.73	758.73	758.74	759.55	0.01	3.08
0.570	Highway 60 Bridge													
0.560	713.76	756.34	758.58	758.58	758.58	758.58	758.58	758.59	758.59	758.61	758.60	759.33	0.01	2.99
0.460	715.35	756.51	758.79	758.78	758.78	758.78	758.78	758.78	758.79	758.79	758.81	759.61	0.01	3.10
0.000	Downstream end of Spring River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
19.590	Upstream end of model													
19.590	771.15	800.12	800.12	800.12	800.12	800.12	800.12	800.12	800.12	800.12	800.12	800.12	0.00	0.00
19.000	767.51	797.92	797.92	797.92	797.92	797.92	797.92	797.92	797.92	797.92	797.92	797.92	0.00	0.00
18.000	765.41	794.01	794.01	794.01	794.01	794.01	794.01	794.01	794.01	794.01	794.01	794.01	0.00	0.00
17.000	762.53	790.87	790.87	790.87	790.87	790.87	790.87	790.87	790.87	790.87	790.87	790.87	0.00	0.00
16.000	756.63	786.22	786.22	786.22	786.22	786.22	786.22	786.22	786.22	786.22	786.22	786.22	0.00	0.00
15.000	754.26	782.38	782.38	782.38	782.38	782.38	782.38	782.38	782.38	782.38	782.38	782.38	0.00	0.00
14.240	750.52	779.28	779.28	779.28	779.28	779.28	779.28	779.28	779.28	779.28	779.28	779.28	0.00	0.00
14.220	Highway 43 Bridge													
14.200	750.12	776.85	776.85	776.85	776.85	776.85	776.85	776.85	776.85	776.85	776.85	776.85	0.00	0.00
14.000	747.07	775.82	775.82	775.82	775.82	775.82	775.82	775.82	775.82	775.82	775.82	775.82	0.00	0.00
13.000	745.41	769.73	769.73	769.73	769.73	769.73	769.73	769.73	769.73	769.73	769.73	769.74	0.00	0.01
12.000	741.15	765.85	765.86	765.86	765.86	765.86	765.86	765.86	765.86	765.86	765.86	765.89	0.00	0.04
11.910	OK/MO State Line													
11.000	741.93	760.17	760.18	760.18	760.18	760.18	760.18	760.18	760.18	760.23	760.30	760.62	0.00	0.45
10.000	734.62	756.33	756.38	756.38	756.38	756.38	756.38	756.39	756.41	756.61	756.84	757.78	0.03	1.45
9.000	734.66	754.53	755.08	755.06	755.07	755.06	755.06	755.02	755.07	754.98	754.97	757.12	0.06	2.59
8.000	724.21	754.53	755.05	755.04	755.05	755.04	755.04	755.00	755.04	754.96	754.95	757.11	0.05	2.58
7.000	728.21	754.53	755.04	755.03	755.03	755.03	755.03	755.00	755.02	754.95	754.94	757.11	0.04	2.58
6.000	727.13	754.53	755.04	755.02	755.03	755.03	755.03	754.99	755.01	754.95	754.94	757.10	0.05	2.57
5.000	721.05	754.53	755.02	755.01	755.02	755.01	755.01	754.99	754.99	754.94	754.93	757.10	0.03	2.57
4.700	716.13	754.52	755.01	755.00	755.01	755.01	755.01	754.98	754.98	754.93	754.93	757.09	0.03	2.57
4.670	OK Highway 10 Bridge													
4.640	715.21	754.52	755.01	755.00	755.01	755.01	755.01	754.98	754.98	754.93	754.92	757.09	0.03	2.57
4.000	716.61	754.52	755.00	754.99	755.00	755.00	755.00	754.98	754.97	754.93	754.92	757.09	0.03	2.57
3.000	714.74	754.52	754.99	754.98	754.99	754.98	754.98	754.97	754.96	754.92	754.91	757.08	0.03	2.56
2.000	709.09	754.52	754.98	754.97	754.97	754.97	754.97	754.96	754.95	754.91	754.91	757.07	0.03	2.55
1.000	705.82	754.52	754.96	754.95	754.96	754.96	754.96	754.95	754.94	754.91	754.90	757.07	0.02	2.55
0.320	706.36	754.52	754.95	754.94	754.95	754.95	754.95	754.94	754.93	754.90	754.90	757.06	0.02	2.54
0.000	Downstream end of Elk River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.20**

GRAND RIVER DAM AUTHORITY TAR CREEK MAX WSELs - DEC 2015 (15 YEAR) EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD) El. 734.0 Max WSE (ft, PD)	El. 742.0 Max WSE (ft, PD)	El. 742.5 Max WSE (ft, PD)	El. 743.0 Max WSE (ft, PD)	El. 743.5 Max WSE (ft, PD)	El. 744.0 Max WSE (ft, PD)	El. 744.5 Max WSE (ft, PD)	El. 745.0 Max WSE (ft, PD)	El. 749.0 Max WSE (ft, PD)	El. 753.0 Max WSE (ft, PD)	El. 757.0 Max WSE (ft, PD)	Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
4.152	Upstream end of model													
4.152	762.17	775.09	775.09	775.09	775.09	775.09	775.09	775.09	775.09	775.09	775.09	775.09	0.00	0.00
3.900	760.10	774.16	774.16	774.16	774.16	774.16	774.16	774.16	774.16	774.16	774.16	774.16	0.00	0.00
3.840	22nd Ave Bridge													
3.800	762.30	772.90	772.90	772.90	772.90	772.90	772.90	772.90	772.90	772.90	772.90	772.90	0.00	0.00
3.300	759.46	770.62	770.62	770.62	770.62	770.62	770.62	770.62	770.62	770.62	770.62	770.62	0.00	0.00
2.800	756.73	766.58	766.58	766.58	766.58	766.58	766.58	766.58	766.58	766.58	766.59	766.59	0.00	0.00
2.710	BN RR Bridge													
2.700	755.72	765.54	765.54	765.54	765.54	765.54	765.54	765.54	765.54	765.54	765.54	765.54	0.00	0.01
2.500	754.95	764.16	764.16	764.16	764.16	764.16	764.16	764.16	764.16	764.16	764.17	764.18	0.00	0.02
2.300	754.15	762.23	762.24	762.24	762.24	762.24	762.24	762.24	762.24	762.25	762.33	762.45	0.00	0.22
2.200	Rockdale Blvd Bridge													
2.100	751.51	760.47	761.53	761.54	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
1.900	750.02	760.47	761.53	761.54	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
1.700	749.58	760.47	761.53	761.53	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
1.660	Central Ave Bridge													
1.600	746.47	760.47	761.53	761.53	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
1.500	744.29	760.47	761.53	761.53	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
1.400	OK Highway 10 Bridge													
1.300	742.00	760.47	761.53	761.53	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
1.000	739.34	760.47	761.53	761.53	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
0.700	737.06	760.47	761.53	761.53	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
0.300	736.42	760.47	761.53	761.54	761.53	761.53	761.53	761.55	761.57	761.74	761.81	762.31	0.04	1.84
0.041	735.85	760.46	761.52	761.53	761.53	761.52	761.52	761.54	761.56	761.73	761.80	762.30	0.04	1.84
0.000	Downstream end of Tar Creek													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX D.6:
100-YEAR EVENT
MAXIMUM WATER SURFACE ELEVATIONS

PENSACOLA DAM **TABLE D.21**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - 100-YEAR EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
152.175	Upstream end of model													
152.175	752.29	791.90	791.91	791.91	791.91	791.91	791.91	791.91	791.91	791.92	791.92	791.93	0.00	0.02
151.000	748.53	788.12	788.13	788.13	788.13	788.13	788.13	788.13	788.13	788.14	788.15	788.16	0.01	0.05
150.000	748.47	787.42	787.44	787.43	787.43	787.44	787.44	787.44	787.44	787.45	787.46	787.47	0.01	0.05
149.000	750.14	786.89	786.91	786.90	786.91	786.91	786.91	786.91	786.91	786.93	786.93	786.95	0.01	0.06
148.000	749.29	786.82	786.84	786.83	786.83	786.84	786.84	786.84	786.84	786.85	786.86	786.88	0.01	0.06
147.000	747.76	786.45	786.47	786.46	786.47	786.47	786.47	786.47	786.47	786.49	786.49	786.51	0.01	0.05
145.500	745.12	786.21	786.23	786.22	786.22	786.23	786.23	786.23	786.23	786.24	786.25	786.27	0.01	0.06
145.480	E 60 Road Bridge													
145.400	748.01	786.19	786.21	786.20	786.20	786.20	786.20	786.21	786.20	786.22	786.22	786.24	0.01	0.06
144.000	743.43	785.80	785.82	785.81	785.81	785.82	785.82	785.82	785.81	785.83	785.84	785.85	0.01	0.06
143.000	737.95	785.60	785.62	785.61	785.62	785.62	785.62	785.62	785.62	785.64	785.64	785.66	0.01	0.06
142.000	742.91	785.44	785.46	785.45	785.45	785.46	785.46	785.46	785.45	785.47	785.48	785.50	0.01	0.06
141.000	741.01	785.31	785.33	785.32	785.32	785.33	785.33	785.33	785.32	785.34	785.35	785.37	0.01	0.06
140.000	736.33	785.27	785.29	785.28	785.28	785.28	785.28	785.29	785.28	785.30	785.31	785.32	0.01	0.06
139.000	743.99	785.23	785.25	785.24	785.24	785.24	785.24	785.25	785.24	785.26	785.26	785.28	0.01	0.06
138.000	736.48	785.16	785.18	785.17	785.17	785.18	785.18	785.18	785.18	785.19	785.20	785.22	0.01	0.06
137.000	733.33	785.02	785.04	785.03	785.03	785.04	785.04	785.04	785.03	785.05	785.06	785.08	0.01	0.06
135.950	731.18	784.61	784.63	784.62	784.62	784.63	784.63	784.63	784.62	784.64	784.65	784.67	0.01	0.06
135.941	Highway 69 Bridge													
135.940	731.21	784.50	784.52	784.51	784.51	784.52	784.52	784.52	784.51	784.53	784.54	784.56	0.01	0.06
135.590	731.77	784.39	784.41	784.40	784.41	784.41	784.41	784.41	784.41	784.43	784.43	784.45	0.01	0.06
135.586	BN RR Bridge													
135.580	731.07	784.26	784.28	784.27	784.27	784.27	784.27	784.28	784.27	784.29	784.30	784.31	0.01	0.05
135.470	732.63	784.19	784.21	784.20	784.20	784.21	784.21	784.21	784.21	784.22	784.23	784.25	0.01	0.06
135.460	Highway 125 Bridge													
135.440	731.60	784.24	784.26	784.25	784.25	784.25	784.25	784.26	784.25	784.27	784.27	784.29	0.01	0.05
135.000	732.64	784.03	784.05	784.04	784.04	784.04	784.04	784.05	784.04	784.06	784.06	784.08	0.01	0.05

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.21**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - 100-YEAR EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
134.610	728.75	783.79	783.81	783.80	783.81	783.81	783.81	783.81	783.81	783.83	783.83	783.85	0.01	0.06
134.599	Abandonded RR Bridge													
134.595	728.58	783.59	783.61	783.60	783.61	783.61	783.61	783.61	783.61	783.63	783.63	783.65	0.01	0.06
134.000	727.23	783.17	783.19	783.18	783.18	783.18	783.18	783.19	783.18	783.20	783.20	783.22	0.01	0.06
133.973	Tar Creek													
133.900	727.72	782.61	782.63	782.62	782.63	782.63	782.63	782.63	782.63	782.65	782.65	782.67	0.01	0.06
133.800	Interstate 44 Bridge													
133.700	728.57	781.92	781.94	781.93	781.94	781.94	781.94	781.94	781.94	781.96	781.96	781.98	0.01	0.06
133.000	727.70	781.10	781.12	781.11	781.12	781.12	781.12	781.12	781.12	781.14	781.14	781.16	0.01	0.06
132.000	727.96	779.46	779.48	779.47	779.47	779.48	779.48	779.48	779.48	779.50	779.50	779.52	0.01	0.06
131.000	726.82	777.63	777.65	777.64	777.64	777.65	777.65	777.65	777.65	777.66	777.67	777.69	0.01	0.06
130.000	723.18	776.29	776.31	776.30	776.30	776.31	776.31	776.31	776.30	776.32	776.33	776.35	0.01	0.06
129.000	719.79	775.16	775.18	775.17	775.17	775.18	775.18	775.18	775.18	775.19	775.20	775.22	0.01	0.06
128.000	719.69	774.10	774.12	774.11	774.12	774.12	774.12	774.12	774.12	774.14	774.14	774.16	0.01	0.06
126.710	715.94	772.60	772.62	772.61	772.61	772.62	772.62	772.62	772.62	772.64	772.64	772.66	0.01	0.06
126.700	S 590 Road Bridge													
126.670	715.61	772.24	772.26	772.25	772.25	772.26	772.26	772.26	772.26	772.27	772.28	772.30	0.01	0.06
126.000	720.35	771.56	771.58	771.57	771.58	771.58	771.58	771.58	771.58	771.60	771.60	771.62	0.01	0.06
125.000	717.08	769.64	769.66	769.65	769.65	769.66	769.66	769.66	769.66	769.67	769.68	769.70	0.01	0.05
124.000	715.62	767.95	767.97	767.96	767.96	767.97	767.97	767.97	767.96	767.98	767.99	768.01	0.01	0.06
123.000	713.34	765.51	765.52	765.51	765.51	765.52	765.52	765.52	765.51	765.53	765.54	765.56	0.01	0.05
122.580	711.08	762.55	762.55	762.55	762.55	762.55	762.55	762.55	762.55	762.55	762.55	762.55	0.00	0.00
122.570	Highway 60 Bridge													
122.550	709.97	762.32	762.37	762.35	762.35	762.37	762.37	762.37	762.36	762.40	762.41	762.45	0.02	0.13
122.350	Spring River													
122.000	710.64	762.40	762.47	762.44	762.44	762.46	762.46	762.46	762.45	762.51	762.52	762.58	0.03	0.18
121.980	709.90	761.87	761.95	761.91	761.92	761.94	761.94	761.94	761.93	762.00	762.02	762.08	0.04	0.21
121.970	BN RR Bridge													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.21**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - 100-YEAR EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
121.960	710.89	761.16	761.17	761.17	761.17	761.17	761.17	761.17	761.17	761.18	761.19	761.20	0.00	0.04
120.000	717.63	759.87	759.88	759.87	759.87	759.87	759.87	759.88	759.87	759.88	759.88	759.89	0.00	0.03
118.000	720.29	758.57	758.58	758.57	758.57	758.57	758.57	758.57	758.57	758.58	758.58	758.59	0.00	0.02
116.000	725.99	757.93	757.93	757.93	757.93	757.93	757.93	757.93	757.93	757.94	757.94	757.94	0.00	0.01
114.000	718.27	756.68	756.68	756.68	756.68	756.68	756.68	756.68	756.68	756.68	756.68	757.00	0.00	0.33
112.000	714.31	756.01	756.01	756.01	756.01	756.01	756.01	756.01	756.01	756.01	756.01	757.00	0.00	0.99
110.000	719.24	755.66	755.66	755.66	755.66	755.66	755.66	755.66	755.66	755.66	755.66	757.00	0.00	1.34
108.000	710.68	755.19	755.17	755.18	755.17	755.17	755.17	755.17	755.17	755.16	755.16	757.00	0.01	1.84
106.000	700.35	755.13	755.11	755.12	755.12	755.11	755.11	755.11	755.12	755.11	755.10	757.00	0.01	1.90
105.350	Elk River													
105.000	701.60	755.14	755.13	755.13	755.13	755.13	755.13	755.13	755.13	755.13	755.12	757.00	0.01	1.88
104.000	696.61	755.12	755.11	755.11	755.11	755.11	755.11	755.11	755.11	755.11	755.11	757.00	0.00	1.89
102.000	688.58	755.07	755.06	755.06	755.06	755.06	755.06	755.06	755.06	755.06	755.06	757.00	0.00	1.94
101.750	685.91	755.03	755.02	755.02	755.02	755.02	755.02	755.02	755.02	755.02	755.02	757.00	0.00	1.98
101.730	Highway 59 (Sailboat Bridge)													
101.710	682.31	755.00	754.99	755.00	754.99	754.99	754.99	754.99	754.99	754.99	754.99	757.00	0.01	2.01
100.000	702.62	755.02	755.02	755.02	755.02	755.02	755.02	755.02	755.02	755.02	755.02	757.00	0.00	1.98
90.000	681.52	754.98	754.98	754.98	754.98	754.98	754.98	754.98	754.98	754.98	754.98	757.00	0.00	2.02
80.000	657.03	754.95	754.95	754.95	754.95	754.95	754.95	754.95	754.95	754.95	754.95	757.00	0.00	2.05
78.000	653.11	754.95	754.95	754.95	754.95	754.95	754.95	754.95	754.95	754.95	754.95	757.00	0.00	2.05
77.000	Pensacola Dam													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.22**

GRAND RIVER DAM AUTHORITY SPRING RIVER MAX WSELs - 100-YEAR EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
21.000	Upstream end of model													
21.000	762.67	791.80	791.80	791.80	791.80	791.80	791.80	791.80	791.80	791.80	791.80	791.80	0.00	0.00
20.000	760.13	790.14	790.14	790.14	790.14	790.14	790.14	790.14	790.14	790.15	790.15	790.15	0.00	0.01
19.000	759.04	786.91	786.91	786.91	786.91	786.91	786.91	786.91	786.91	786.91	786.91	786.91	0.01	0.01
18.000	753.18	783.88	783.88	783.88	783.88	783.88	783.88	783.88	783.88	783.88	783.89	783.89	0.00	0.01
17.000	750.54	781.90	781.91	781.91	781.91	781.91	781.91	781.91	781.91	781.92	781.92	781.93	0.00	0.03
16.000	749.28	779.42	779.43	779.43	779.43	779.43	779.43	779.43	779.43	779.44	779.44	779.46	0.00	0.04
15.000	746.37	776.44	776.46	776.45	776.45	776.46	776.46	776.46	776.46	776.47	776.48	776.50	0.01	0.06
14.170	741.32	773.95	773.98	773.97	773.97	773.98	773.98	773.98	773.98	774.01	774.02	774.05	0.01	0.10
14.160	E 57 Road													
14.120	744.21	774.41	774.44	774.43	774.43	774.44	774.44	774.44	774.44	774.46	774.47	774.50	0.01	0.09
13.510	744.59	773.23	773.26	773.25	773.26	773.26	773.26	773.26	773.26	773.29	773.30	773.34	0.01	0.11
13.500	Interstate 44 Bridge													
13.450	745.52	772.71	772.74	772.73	772.74	772.75	772.75	772.74	772.75	772.78	772.79	772.83	0.02	0.12
12.000	742.72	768.85	768.96	768.91	768.92	768.96	768.96	768.93	768.94	769.06	769.09	769.15	0.05	0.30
11.000	742.23	767.46	767.59	767.53	767.55	767.59	767.59	767.57	767.57	767.68	767.70	767.76	0.06	0.29
10.000	737.62	766.63	766.68	766.66	766.67	766.68	766.68	766.67	766.67	766.73	766.75	766.80	0.02	0.17
9.000	733.92	765.63	765.67	765.65	765.66	765.67	765.67	765.67	765.67	765.70	765.71	765.73	0.02	0.10
8.020	733.14	765.18	765.22	765.20	765.21	765.22	765.22	765.22	765.21	765.25	765.26	765.29	0.02	0.11
8.010	OK Highway 10 Bridge													
7.970	731.28	764.51	764.56	764.54	764.54	764.55	764.55	764.55	764.55	764.58	764.59	764.63	0.02	0.12
7.000	730.33	764.20	764.25	764.23	764.23	764.24	764.24	764.24	764.24	764.27	764.28	764.32	0.02	0.12
6.000	727.95	764.08	764.12	764.10	764.11	764.12	764.12	764.12	764.11	764.15	764.16	764.19	0.02	0.12
5.000	722.10	763.99	764.03	764.01	764.02	764.03	764.03	764.03	764.02	764.06	764.07	764.10	0.02	0.12
4.000	720.00	763.94	763.98	763.96	763.97	763.98	763.98	763.98	763.97	764.01	764.02	764.05	0.02	0.11
3.000	723.22	763.88	763.92	763.90	763.91	763.92	763.92	763.92	763.91	763.95	763.96	764.00	0.02	0.12
2.000	723.73	763.84	763.89	763.87	763.87	763.88	763.88	763.88	763.88	763.91	763.92	763.96	0.02	0.12
1.000	728.44	763.81	763.86	763.83	763.84	763.85	763.85	763.85	763.84	763.88	763.89	763.93	0.03	0.12
0.580	716.17	763.74	763.78	763.76	763.77	763.78	763.78	763.78	763.77	763.81	763.82	763.86	0.02	0.12
0.570	Highway 60 Bridge													
0.560	713.76	763.71	763.76	763.74	763.74	763.75	763.75	763.75	763.75	763.79	763.80	763.83	0.02	0.12
0.460	715.35	763.73	763.77	763.75	763.76	763.77	763.77	763.77	763.76	763.80	763.81	763.85	0.02	0.12
0.000	Downstream end of Spring River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.23**

GRAND RIVER DAM AUTHORITY ELK RIVER MAX WSELs - 100-YEAR EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
19.590	Upstream end of model													
19.590	771.15	777.77	777.77	777.77	777.77	777.77	777.77	777.77	777.77	777.77	777.77	777.77	0.00	0.00
19.000	767.51	776.22	776.22	776.22	776.22	776.22	776.22	776.22	776.22	776.22	776.22	776.22	0.00	0.00
18.000	765.41	772.64	772.64	772.64	772.64	772.64	772.64	772.64	772.64	772.64	772.64	772.64	0.00	0.00
17.000	762.53	768.77	768.77	768.77	768.77	768.77	768.77	768.77	768.77	768.77	768.77	768.77	0.00	0.00
16.000	756.63	764.95	764.95	764.95	764.95	764.95	764.95	764.95	764.95	764.95	764.95	764.95	0.00	0.00
15.000	754.26	761.27	761.27	761.27	761.27	761.27	761.27	761.27	761.27	761.27	761.27	761.27	0.00	0.00
14.240	750.52	756.89	756.89	756.89	756.89	756.89	756.89	756.89	756.89	756.89	756.89	757.07	0.00	0.18
14.220	Highway 43 Bridge													
14.200	750.12	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	756.83	757.07	0.00	0.24
14.000	747.07	756.37	756.37	756.37	756.37	756.37	756.37	756.37	756.37	756.37	756.37	757.05	0.00	0.68
13.000	745.41	755.43	755.35	755.38	755.38	755.35	755.36	755.37	755.37	755.34	755.34	757.01	0.03	1.67
12.000	741.15	755.32	755.23	755.26	755.26	755.23	755.24	755.25	755.25	755.21	755.19	757.00	0.03	1.81
11.910	OK/MO State Line													
11.000	741.93	755.28	755.19	755.22	755.22	755.19	755.20	755.21	755.21	755.16	755.15	757.00	0.03	1.85
10.000	734.62	755.26	755.18	755.21	755.21	755.18	755.19	755.20	755.20	755.16	755.14	757.00	0.03	1.86
9.000	734.66	755.24	755.17	755.20	755.20	755.17	755.18	755.19	755.19	755.15	755.14	757.00	0.03	1.86
8.000	724.21	755.23	755.17	755.19	755.19	755.17	755.18	755.18	755.18	755.15	755.14	757.00	0.02	1.86
7.000	728.21	755.21	755.16	755.18	755.18	755.16	755.17	755.17	755.17	755.14	755.14	757.00	0.02	1.86
6.000	727.13	755.21	755.16	755.18	755.17	755.16	755.16	755.17	755.17	755.14	755.13	757.00	0.02	1.87
5.000	721.05	755.19	755.15	755.17	755.16	755.15	755.16	755.16	755.16	755.14	755.13	757.00	0.02	1.87
4.700	716.13	755.19	755.15	755.17	755.16	755.15	755.15	755.16	755.16	755.14	755.13	757.00	0.02	1.87
4.670	OK Highway 10 Bridge													
4.640	715.21	755.19	755.15	755.17	755.16	755.15	755.15	755.16	755.16	755.14	755.13	757.00	0.02	1.87
4.000	716.61	755.18	755.15	755.16	755.16	755.15	755.15	755.15	755.15	755.13	755.13	757.00	0.01	1.87
3.000	714.74	755.17	755.14	755.15	755.15	755.15	755.14	755.15	755.15	755.13	755.13	757.00	0.01	1.87
2.000	709.09	755.16	755.14	755.15	755.14	755.14	755.14	755.14	755.14	755.13	755.13	757.00	0.01	1.87
1.000	705.82	755.15	755.14	755.14	755.14	755.14	755.14	755.14	755.14	755.13	755.13	757.00	0.00	1.87
0.320	706.36	755.15	755.13	755.14	755.14	755.13	755.13	755.13	755.13	755.13	755.12	757.00	0.01	1.88
0.000	Downstream end of Elk River													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE D.24**

GRAND RIVER DAM AUTHORITY TAR CREEK MAX WSELs - 100-YEAR EVENT

River Mile	Bed El. (ft, PD)	Pensacola Dam Starting Stage (ft, PD)											Anticipated Operation Range WSE Difference[1] (ft)	Extreme, Hypothetical Range WSE Difference[2] (ft)
		El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)		
4.152	Upstream end of model													
4.152	762.17	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
3.900	760.10	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.65	0.01	0.06
3.840	22nd Ave Bridge													
3.800	762.30	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
3.300	759.46	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
2.800	756.73	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
2.710	BN RR Bridge													
2.700	755.72	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
2.500	754.95	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
2.300	754.15	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
2.200	Rockdale Blvd Bridge													
2.100	751.51	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
1.900	750.02	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
1.700	749.58	783.59	783.61	783.60	783.60	783.61	783.61	783.61	783.60	783.62	783.63	783.64	0.01	0.06
1.660	Central Ave Bridge													
1.600	746.47	783.59	783.61	783.60	783.60	783.60	783.60	783.61	783.60	783.62	783.62	783.64	0.01	0.06
1.500	744.29	783.58	783.60	783.59	783.60	783.60	783.60	783.60	783.60	783.62	783.62	783.64	0.01	0.06
1.400	OK Highway 10 Bridge													
1.300	742.00	783.56	783.58	783.57	783.58	783.58	783.58	783.58	783.58	783.60	783.60	783.62	0.01	0.06
1.000	739.34	783.52	783.54	783.53	783.53	783.54	783.54	783.54	783.53	783.55	783.56	783.58	0.01	0.06
0.700	737.06	783.48	783.50	783.49	783.49	783.49	783.49	783.50	783.49	783.51	783.51	783.53	0.01	0.06
0.300	736.42	783.25	783.27	783.26	783.26	783.27	783.27	783.27	783.26	783.28	783.29	783.30	0.01	0.06
0.041	735.85	783.04	783.07	783.06	783.06	783.06	783.06	783.06	783.06	783.08	783.08	783.10	0.01	0.06
0.000	Downstream end of Tar Creek													

1 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in Max WSEL from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX D.7:
HISTORICAL STARTING STAGE
MAXIMUM WATER SURFACE ELEVATIONS

PENSACOLA DAM **TABLE D.25**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - HISTORICAL STARTING STAGES

River Mile	Bed El. (ft, PD)	Historical Inflow Event					Max WSEL Difference* (ft)
		Sept 1993 (21 Year)	June 2004 (1 Year)	July 2007 (4 Year)	Oct 2009 (3 Year)	Dec 2015 (15 Year)	
		Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	
152.175	Upstream end of model						
152.175	752.29	780.71	773.79	784.43	778.47	778.38	10.65
151.000	748.53	777.94	772.52	780.33	776.35	776.27	7.81
150.000	748.47	776.66	771.82	778.90	775.17	775.15	7.09
149.000	750.14	775.12	770.44	777.46	773.78	773.76	7.01
148.000	749.29	774.25	768.76	777.09	772.40	772.37	8.33
147.000	747.76	772.72	766.94	776.23	770.52	770.50	9.29
145.500	745.12	771.64	764.71	775.74	768.34	768.33	11.03
145.480	E 60 Road Bridge						
145.400	748.01	771.57	764.61	775.70	768.23	768.23	11.09
144.000	743.43	770.58	763.34	775.11	766.46	766.51	11.77
143.000	737.95	770.12	762.18	774.84	765.01	765.23	12.65
142.000	742.91	769.77	761.27	774.61	763.83	764.31	13.34
141.000	741.01	769.63	760.11	774.48	763.18	763.91	14.37
140.000	736.33	769.58	758.78	774.44	762.84	763.74	15.66
139.000	743.99	769.54	756.78	774.41	762.33	763.52	17.63
138.000	736.48	769.46	755.40	774.34	761.90	763.31	18.94
137.000	733.33	769.15	753.43	774.13	760.86	762.74	20.70
135.950	731.18	768.45	752.84	773.49	760.19	762.34	20.65
135.941	Highway 69 Bridge						
135.940	731.21	768.45	752.62	773.51	760.15	762.32	20.89
135.590	731.77	768.30	752.67	773.34	760.09	762.28	20.67
135.586	BN RR Bridge						
135.580	731.07	768.12	752.71	773.27	760.07	762.25	20.56
135.470	732.63	768.07	752.60	773.20	759.98	762.21	20.60
135.460	Highway 125 Bridge						
135.440	731.60	768.10	752.65	773.24	760.02	762.24	20.59
135.000	732.64	767.83	752.37	772.92	759.90	762.19	20.55
134.610	728.75	767.33	752.21	772.46	759.64	762.03	20.25
134.599	Abandonded RR Bridge						
134.595	728.58	767.04	752.12	772.20	759.45	761.90	20.08
134.000	727.23	766.68	751.51	771.94	758.84	761.59	20.42
133.973	Tar Creek						
133.900	727.72	766.47	751.31	771.63	758.60	761.45	20.32

*Difference between the highest and lowest Max WSELs from the simulations with historical starting stages.

PENSACOLA DAM **TABLE D.25**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - HISTORICAL STARTING STAGES

River Mile	Bed El. (ft, PD)	Historical Inflow Event: Sept 1993 (21 Year) Max WSEL (ft, PD)	June 2004 (1 Year) Max WSEL (ft, PD)	July 2007 (4 Year) Max WSEL (ft, PD)	Oct 2009 (3 Year) Max WSEL (ft, PD)	Dec 2015 (15 Year) Max WSEL (ft, PD)	Max WSEL Difference* (ft)
133.800	Interstate 44 Bridge						
133.700	728.57	766.28	750.98	771.29	758.33	761.32	20.31
133.000	727.70	765.62	749.82	770.63	757.15	760.77	20.81
132.000	727.96	764.75	748.60	769.48	755.85	760.20	20.88
131.000	726.82	764.02	747.53	768.55	754.76	759.76	21.02
130.000	723.18	763.18	747.22	767.30	754.32	759.61	20.08
129.000	719.79	762.37	746.72	766.13	753.65	759.46	19.41
128.000	719.69	761.77	746.61	765.09	753.37	759.38	18.47
126.710	715.94	761.61	746.33	763.38	752.83	759.22	17.05
126.700	S 590 Road Bridge						
126.670	715.61	761.59	746.31	763.34	752.81	759.20	17.03
126.000	720.35	761.56	746.21	762.76	752.77	759.18	16.55
125.000	717.08	761.47	746.01	761.38	752.47	759.09	15.46
124.000	715.62	761.42	745.88	759.99	752.28	759.04	15.54
123.000	713.34	761.34	745.75	758.39	752.03	758.97	15.60
122.580	711.08	761.29	745.71	757.23	751.94	758.93	15.58
122.570	Highway 60 Bridge						
122.550	709.97	761.29	745.27	757.23	751.70	758.92	16.02
122.350	Spring River						
122.000	710.64	760.20	745.26	756.94	751.43	758.42	14.94
121.980	709.90	759.73	745.25	756.79	751.29	758.18	14.48
121.970	BN RR Bridge						
121.960	710.89	757.01	745.23	756.29	751.22	757.26	12.03
120.000	717.63	755.95	745.05	755.72	750.30	756.52	11.47
118.000	720.29	755.51	744.91	755.43	750.27	756.01	11.10
116.000	725.99	755.30	744.81	755.30	750.26	755.76	10.96
114.000	718.27	755.06	744.61	755.07	750.24	755.35	10.74
112.000	714.31	754.97	744.53	754.96	750.22	755.16	10.63
110.000	719.24	754.93	744.49	754.90	750.22	755.06	10.57
108.000	710.68	754.86	744.48	754.83	750.21	754.95	10.47
106.000	700.35	754.86	744.48	754.82	750.21	754.95	10.47
105.350	Elk River						
105.000	701.60	754.86	744.48	754.82	750.21	754.95	10.47
104.000	696.61	754.86	744.47	754.82	750.21	754.93	10.46

*Difference between the highest and lowest Max WSELs from the simulations with historical starting stages.

PENSACOLA DAM **TABLE D.25**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - HISTORICAL STARTING STAGES

River Mile	Bed El. (ft, PD)	Historical Inflow Event					Max WSEL Difference* (ft)
		Sept 1993 (21 Year)	June 2004 (1 Year)	July 2007 (4 Year)	Oct 2009 (3 Year)	Dec 2015 (15 Year)	
		Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	
102.000	688.58	754.85	744.47	754.81	750.21	754.89	10.42
101.750	685.91	754.85	744.47	754.81	750.20	754.88	10.41
101.730	Highway 59 (Sailboat Bridge)						
101.710	682.31	754.84	744.47	754.80	750.20	754.86	10.39
100.000	702.62	754.84	744.47	754.80	750.20	754.84	10.37
90.000	681.52	754.83	744.47	754.79	750.20	754.83	10.36
80.000	657.03	754.83	744.47	754.79	750.20	754.82	10.36
78.000	653.11	754.83	744.47	754.79	750.20	754.82	10.36
77.000	Pensacola Dam						

*Difference between the highest and lowest Max WSELs from the simulations with historical starting stages.

PENSACOLA DAM **TABLE D.26**

GRAND RIVER DAM AUTHORITY SPRING RIVER MAX WSELs - HISTORICAL STARTING STAGES

River Mile	Bed El. (ft, PD)	Historical Inflow Event					Max WSEL Difference* (ft)
		Sept 1993 (21 Year)	June 2004 (1 Year)	July 2007 (4 Year)	Oct 2009 (3 Year)	Dec 2015 (15 Year)	
		Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	
21.000	Upstream end of model						
21.000	762.67	805.10	773.88	783.49	790.77	800.69	31.22
20.000	760.13	804.41	771.04	780.70	788.92	799.50	33.37
19.000	759.04	803.09	768.52	777.52	785.68	797.69	34.58
18.000	753.18	800.93	764.57	774.20	782.60	795.45	36.37
17.000	750.54	799.10	762.75	772.20	780.53	793.52	36.34
16.000	749.28	796.17	760.34	770.00	778.12	790.74	35.83
15.000	746.37	794.15	758.33	767.51	775.15	788.26	35.81
14.170	741.32	791.71	757.46	765.96	772.81	785.82	34.25
14.160	E 57 Road						
14.120	744.21	789.81	757.49	766.18	773.22	784.97	32.32
13.510	744.59	786.79	756.84	765.30	772.08	783.33	29.95
13.500	Interstate 44 Bridge						
13.450	745.52	784.91	756.58	764.98	771.61	782.64	28.33
12.000	742.72	780.13	753.34	762.17	767.89	777.94	26.80
11.000	742.23	778.45	751.75	760.40	765.98	776.26	26.70
10.000	737.62	776.97	750.41	758.87	764.46	775.15	26.56
9.000	733.92	774.02	749.53	758.54	762.29	773.56	24.50
8.020	733.14	772.73	748.52	758.49	760.76	772.72	24.21
8.010	OK Highway 10 Bridge						
7.970	731.28	771.30	746.31	757.40	759.45	767.85	24.99
7.000	730.33	769.24	745.90	757.36	757.08	765.22	23.34
6.000	727.95	767.90	745.58	757.35	755.55	763.69	22.32
5.000	722.10	766.55	745.48	757.34	754.32	762.28	21.07
4.000	720.00	765.65	745.40	757.33	753.57	761.33	20.25
3.000	723.22	764.40	745.37	757.33	752.89	760.33	19.03
2.000	723.73	763.54	745.35	757.32	752.37	759.86	18.19
1.000	728.44	762.68	745.33	757.32	752.01	759.45	17.35
0.580	716.17	760.72	745.32	757.32	751.77	758.73	15.40
0.570	Highway 60 Bridge						
0.560	713.76	760.25	745.32	757.31	751.73	758.59	14.93
0.460	715.35	760.89	745.32	757.31	751.75	758.79	15.57
0.000	Downstream end of Spring River						

*Difference between the highest and lowest Max WSELs from the simulations with historical starting stages.

PENSACOLA DAM **TABLE D.27**

GRAND RIVER DAM AUTHORITY ELK RIVER MAX WSELs - HISTORICAL STARTING STAGES

River Mile	Bed El. (ft, PD)	Historical Inflow Event					Max WSEL Difference* (ft)
		Sept 1993 (21 Year)	June 2004 (1 Year)	July 2007 (4 Year)	Oct 2009 (3 Year)	Dec 2015 (15 Year)	
		Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	
19.590	Upstream end of model						
19.590	771.15	787.52	774.17	775.57	793.77	800.12	25.95
19.000	767.51	785.42	772.64	774.03	791.13	797.92	25.28
18.000	765.41	781.77	769.18	770.46	787.17	794.01	24.83
17.000	762.53	777.78	766.13	767.01	783.91	790.87	24.74
16.000	756.63	773.42	761.16	762.78	779.22	786.22	25.06
15.000	754.26	769.55	757.92	759.23	775.00	782.38	24.46
14.240	750.52	766.33	753.18	755.51	771.70	779.28	26.10
14.220	Highway 43 Bridge						
14.200	750.12	766.08	753.10	755.48	771.20	776.85	23.75
14.000	747.07	764.91	752.78	755.33	770.02	775.82	23.04
13.000	745.41	760.77	749.01	754.92	764.84	769.73	20.72
12.000	741.15	757.41	746.01	754.87	761.15	765.86	19.85
11.910	OK/MO State Line						
11.000	741.93	754.89	744.91	754.86	755.17	760.18	15.27
10.000	734.62	754.87	744.49	754.85	750.88	756.37	11.88
9.000	734.66	754.87	744.49	754.85	750.23	755.09	10.60
8.000	724.21	754.87	744.48	754.84	750.22	755.06	10.58
7.000	728.21	754.87	744.48	754.84	750.22	755.04	10.56
6.000	727.13	754.86	744.48	754.84	750.22	755.04	10.56
5.000	721.05	754.86	744.48	754.83	750.22	755.02	10.54
4.700	716.13	754.86	744.48	754.83	750.22	755.01	10.53
4.670	OK Highway 10 Bridge						
4.640	715.21	754.86	744.48	754.83	750.22	755.01	10.53
4.000	716.61	754.86	744.48	754.83	750.21	755.00	10.52
3.000	714.74	754.86	744.48	754.83	750.21	754.99	10.51
2.000	709.09	754.86	744.48	754.83	750.21	754.97	10.49
1.000	705.82	754.86	744.48	754.82	750.21	754.96	10.48
0.320	706.36	754.86	744.48	754.82	750.21	754.95	10.47
0.000	Downstream end of Elk River						

*Difference between the highest and lowest Max WSELs from the simulations with historical starting stages.

River Mile	Bed El. (ft, PD)	Historical Inflow Event					Max WSEL Difference* (ft)
		Sept 1993 (21 Year)	June 2004 (1 Year)	July 2007 (4 Year)	Oct 2009 (3 Year)	Dec 2015 (15 Year)	
		Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	Max WSEL (ft, PD)	
4.152	Upstream end of model						
4.152	762.17	776.77	768.17	772.02	775.04	775.09	8.60
3.900	760.10	775.76	767.29	772.02	774.11	774.16	8.47
3.840	22nd Ave Bridge						
3.800	762.30	774.50	766.05	772.02	772.86	772.90	8.45
3.300	759.46	772.27	764.09	772.02	770.57	770.62	8.17
2.800	756.73	768.46	760.95	772.02	766.52	766.58	11.06
2.710	BN RR Bridge						
2.700	755.72	767.11	760.45	772.02	765.50	765.54	11.56
2.500	754.95	766.59	759.30	772.02	764.13	764.16	12.72
2.300	754.15	766.59	757.47	772.02	762.23	762.24	14.55
2.200	Rockdale Blvd Bridge						
2.100	751.51	766.59	754.84	772.02	759.50	761.53	17.18
1.900	750.02	766.59	753.22	772.02	758.73	761.53	18.80
1.700	749.58	766.59	751.46	772.02	758.73	761.53	20.56
1.660	Central Ave Bridge						
1.600	746.47	766.59	751.44	772.02	758.73	761.53	20.58
1.500	744.29	766.59	751.44	772.02	758.73	761.53	20.58
1.400	OK Highway 10 Bridge						
1.300	742.00	766.59	751.44	772.02	758.73	761.53	20.58
1.000	739.34	766.59	751.44	772.01	758.73	761.53	20.57
0.700	737.06	766.59	751.44	772.00	758.73	761.53	20.56
0.300	736.42	766.59	751.44	771.94	758.74	761.53	20.50
0.041	735.85	766.58	751.44	771.85	758.72	761.52	20.42
0.000	Downstream end of Tar Creek						

*Difference between the highest and lowest Max WSELs from the simulations with historical starting stages.

APPENDIX E:
WATER SURFACE ELEVATION PROFILES

APPENDIX E.1:
SEPTEMBER 1993 (21 YEAR) INFLOW EVENT
WATER SURFACE ELEVATION PROFILES

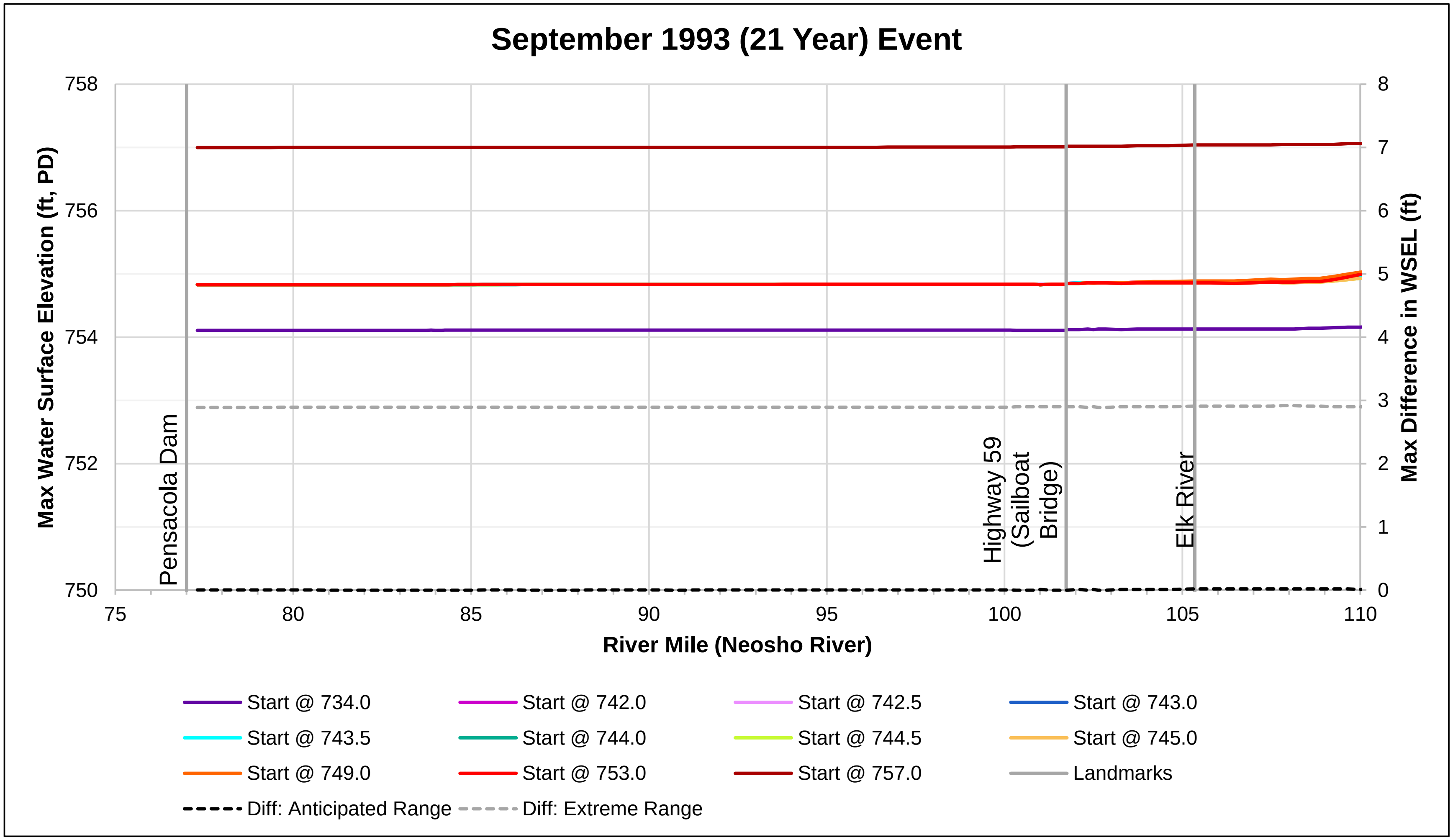


Figure E.1. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

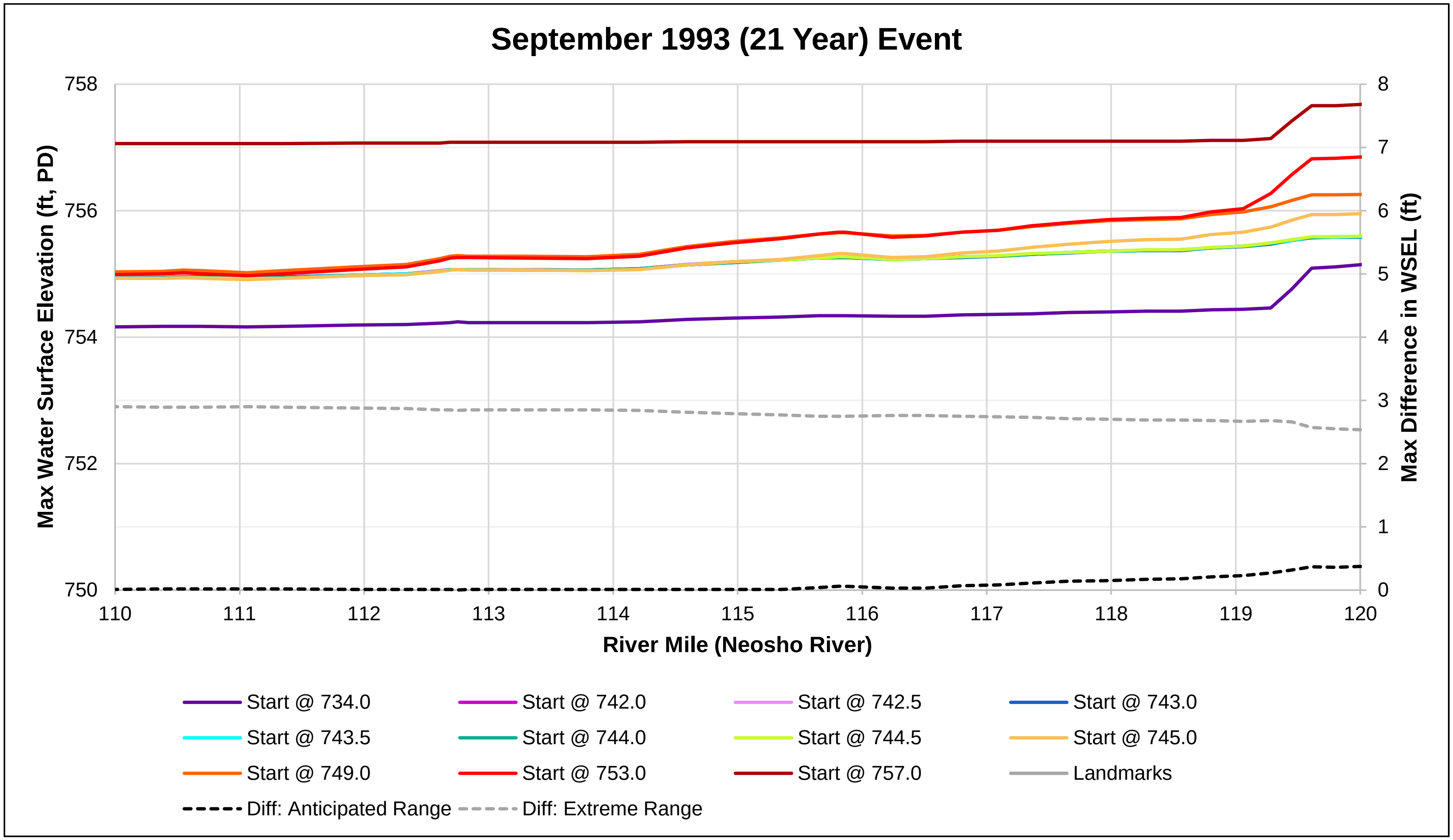


Figure E.2. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

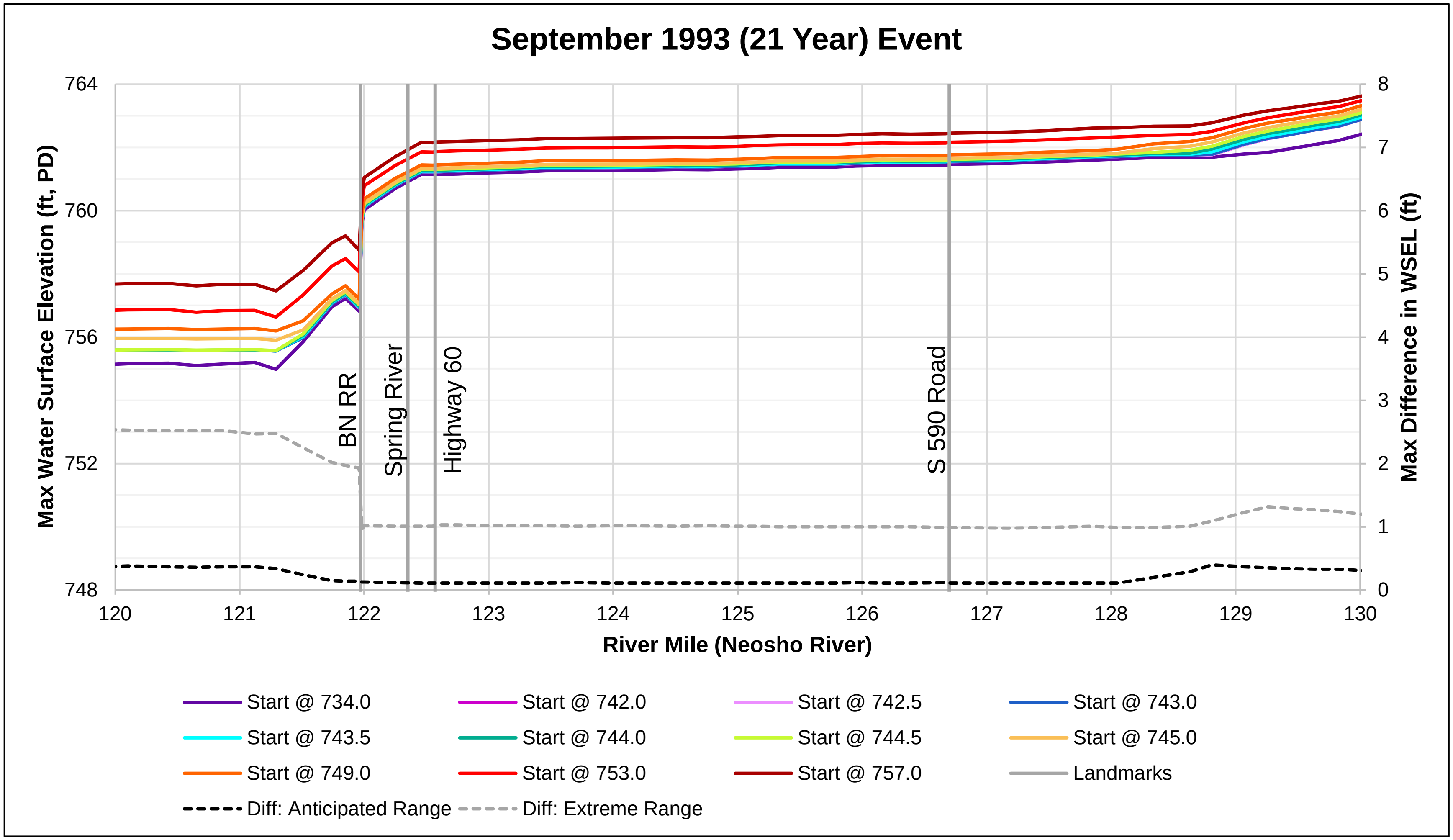


Figure E.3. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

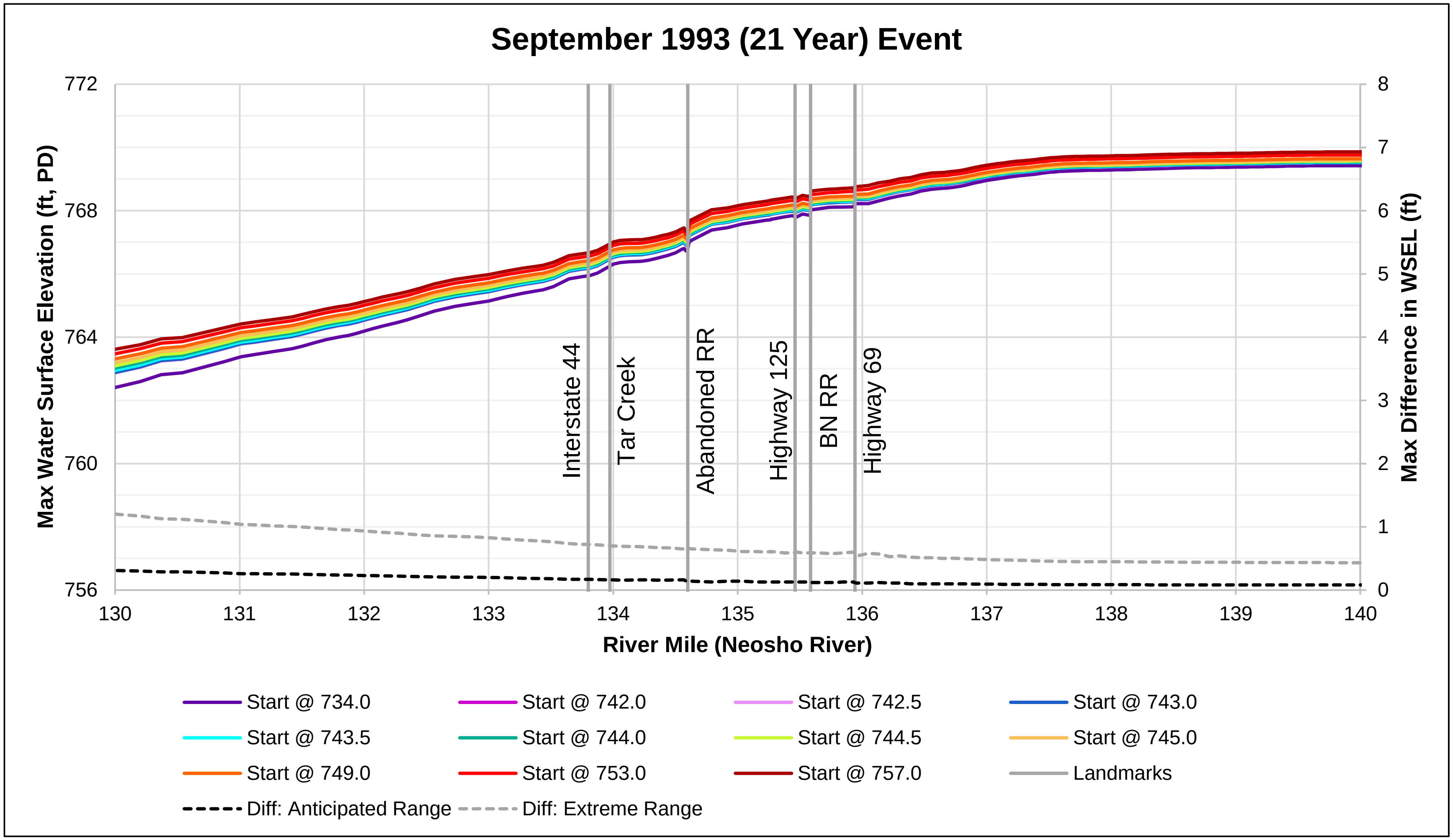


Figure E.4. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

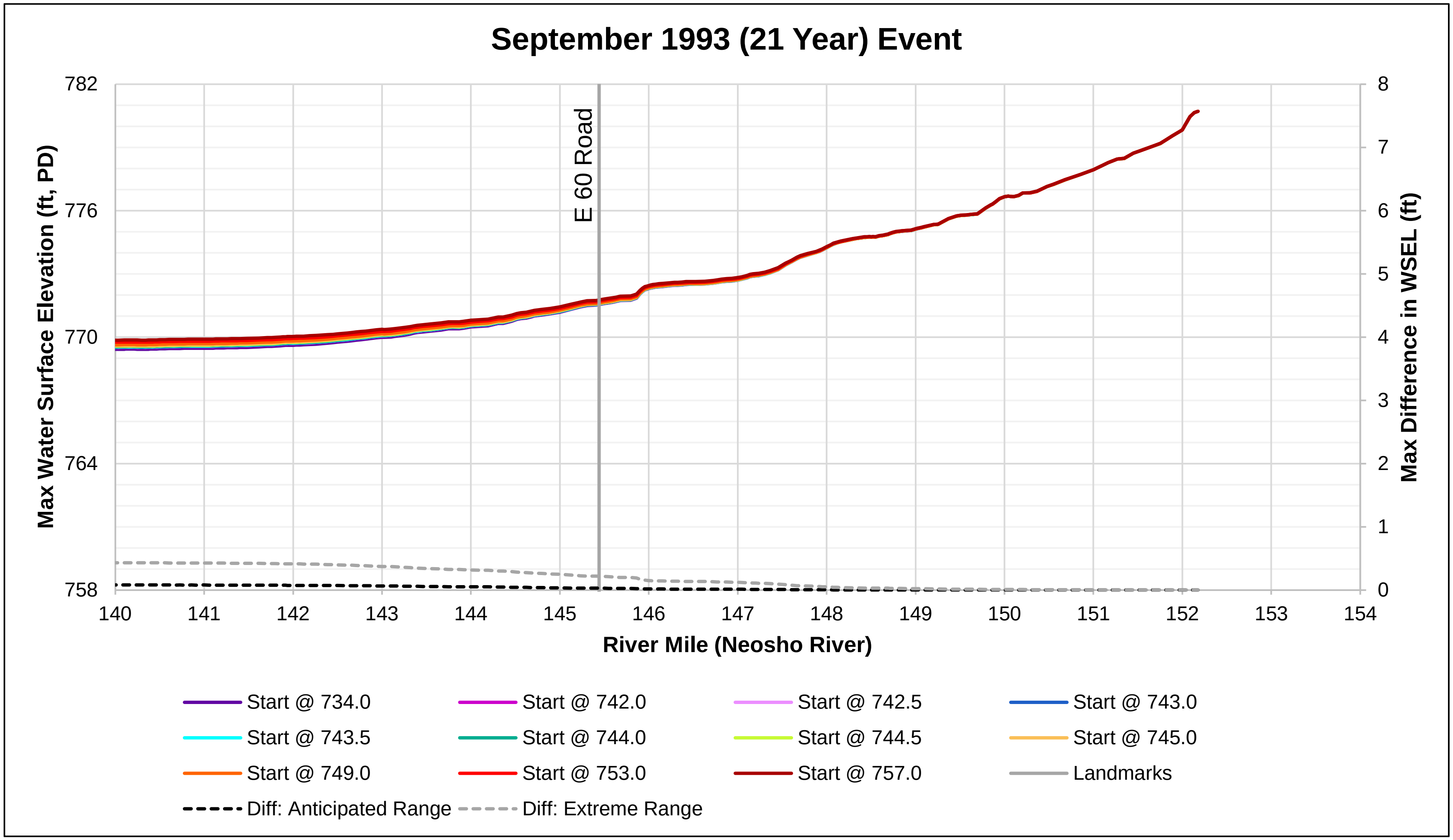


Figure E.5. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

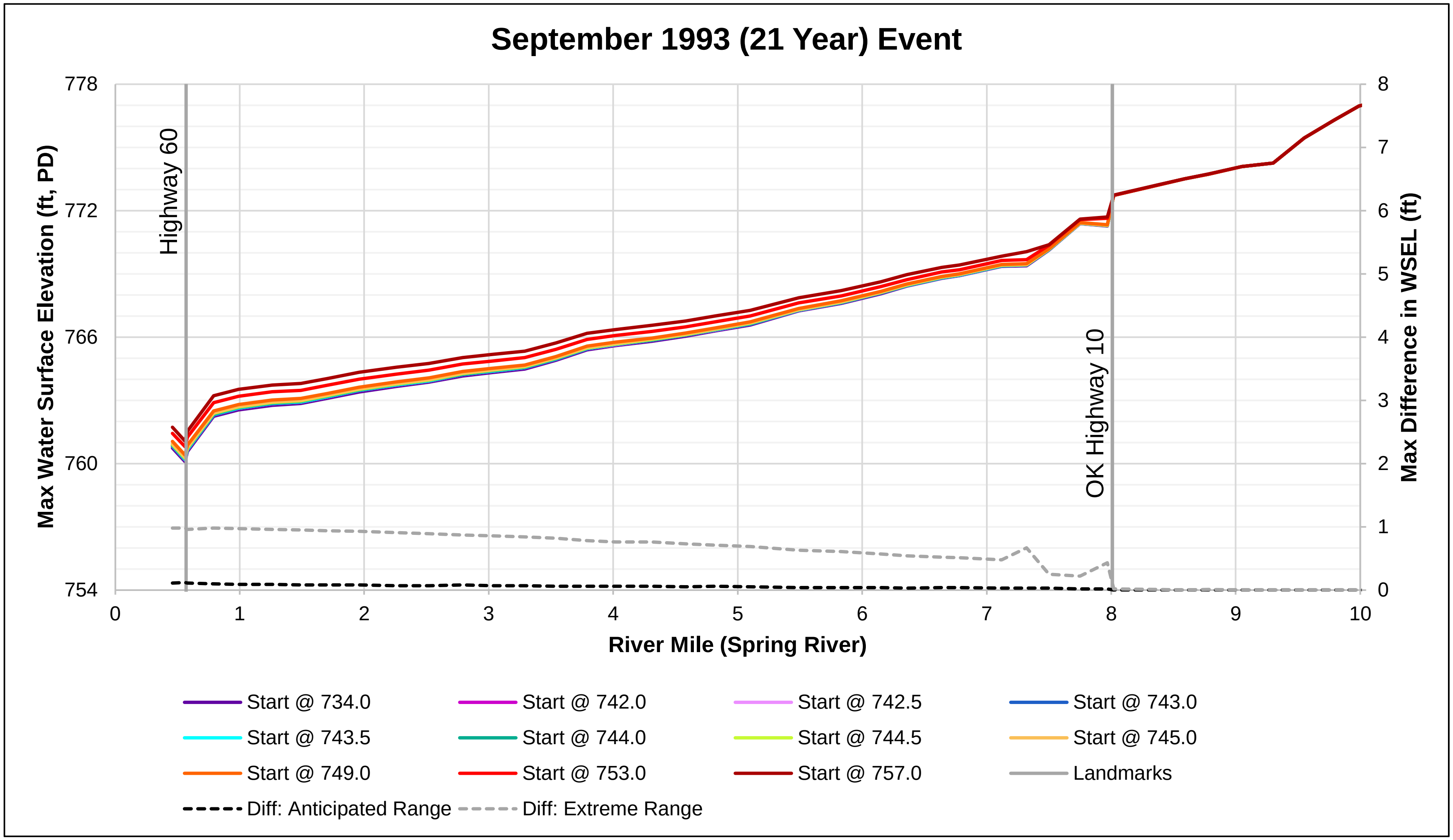


Figure E.6. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

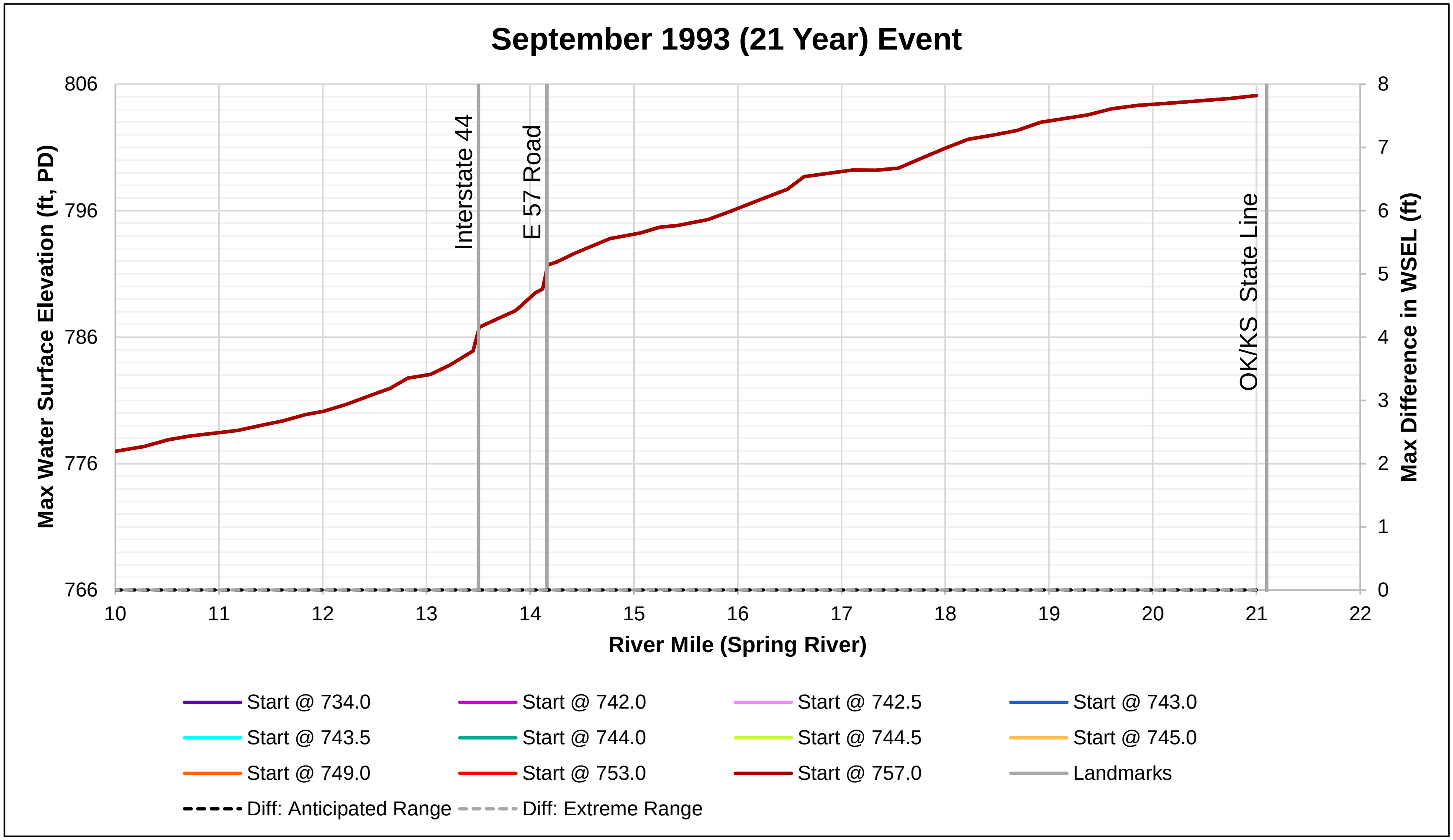


Figure E.7. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

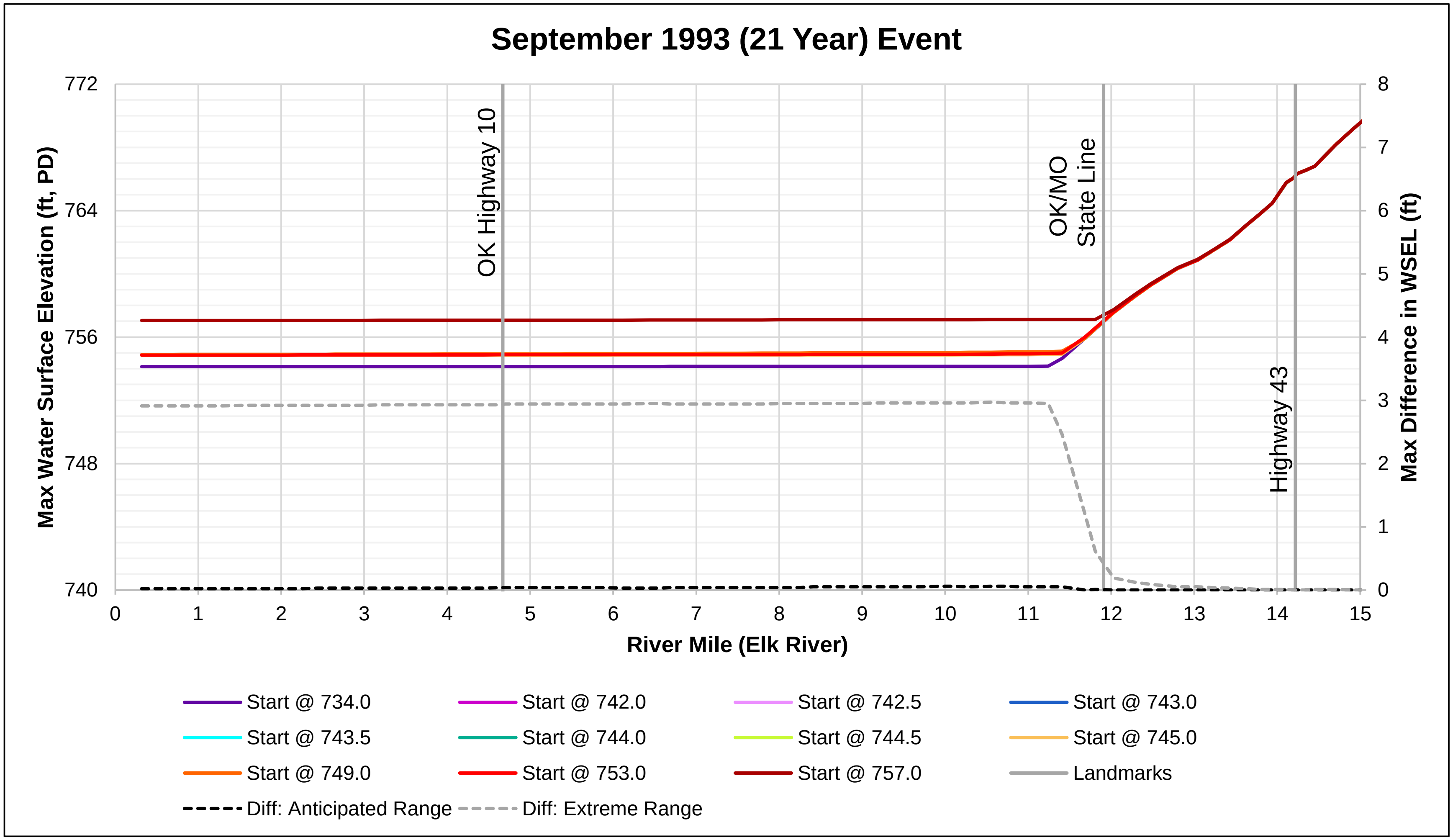


Figure E.8. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

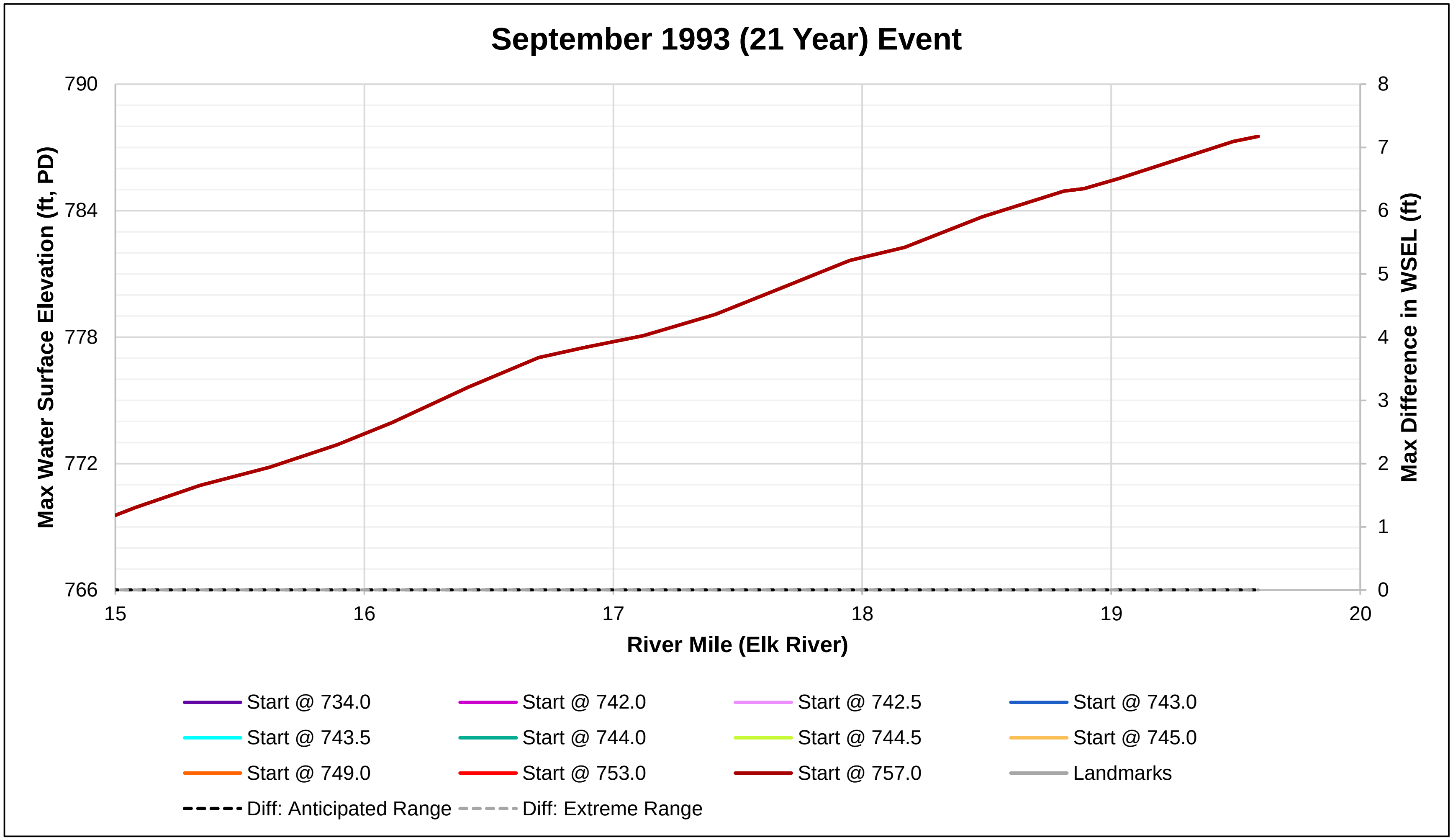


Figure E.9. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

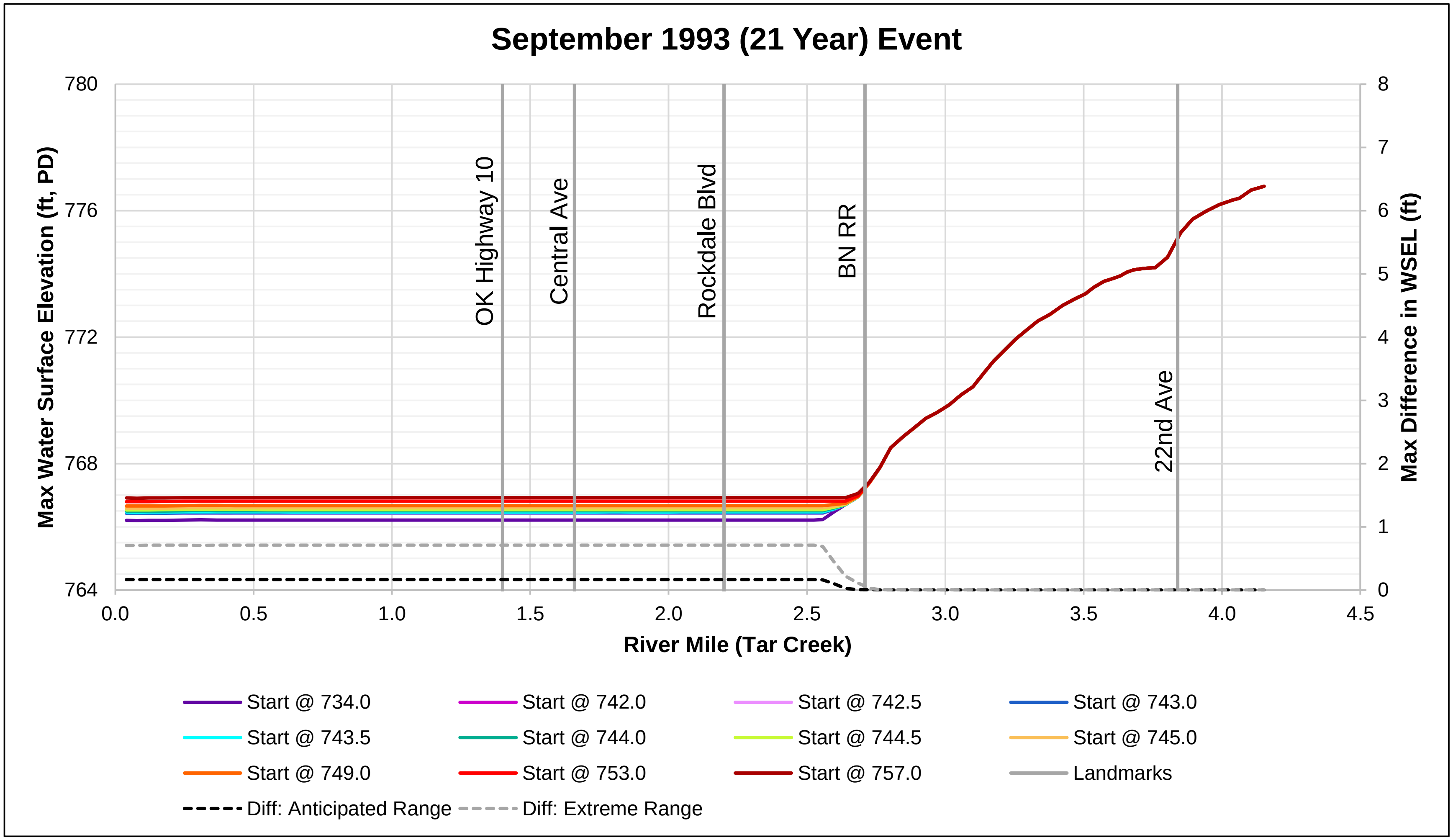


Figure E.10. Water surface elevations for the September 1993 (21 year) inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

APPENDIX E.2:
JUNE 2004 (1 YEAR) INFLOW EVENT
WATER SURFACE ELEVATION PROFILES

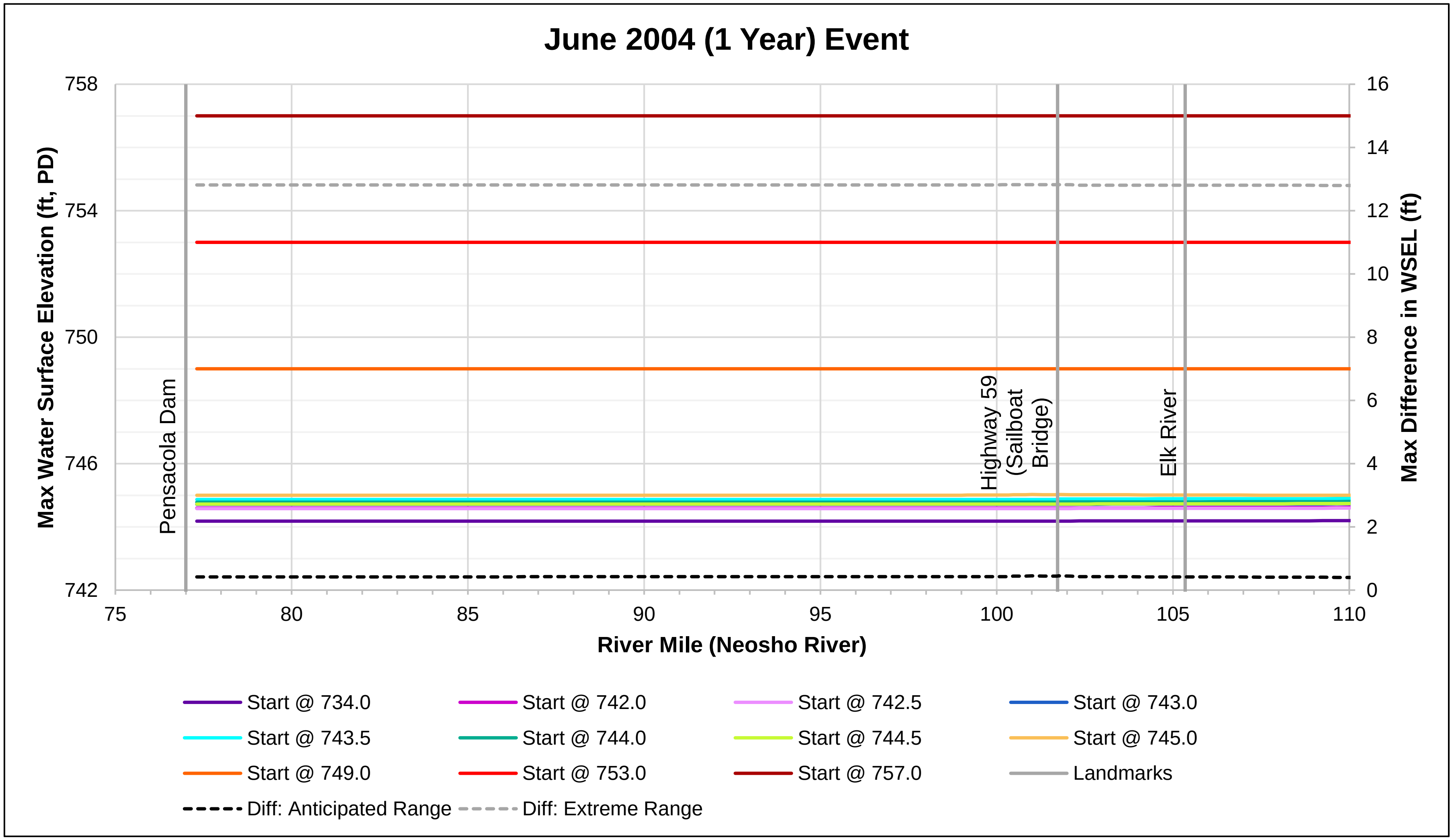


Figure E.11. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

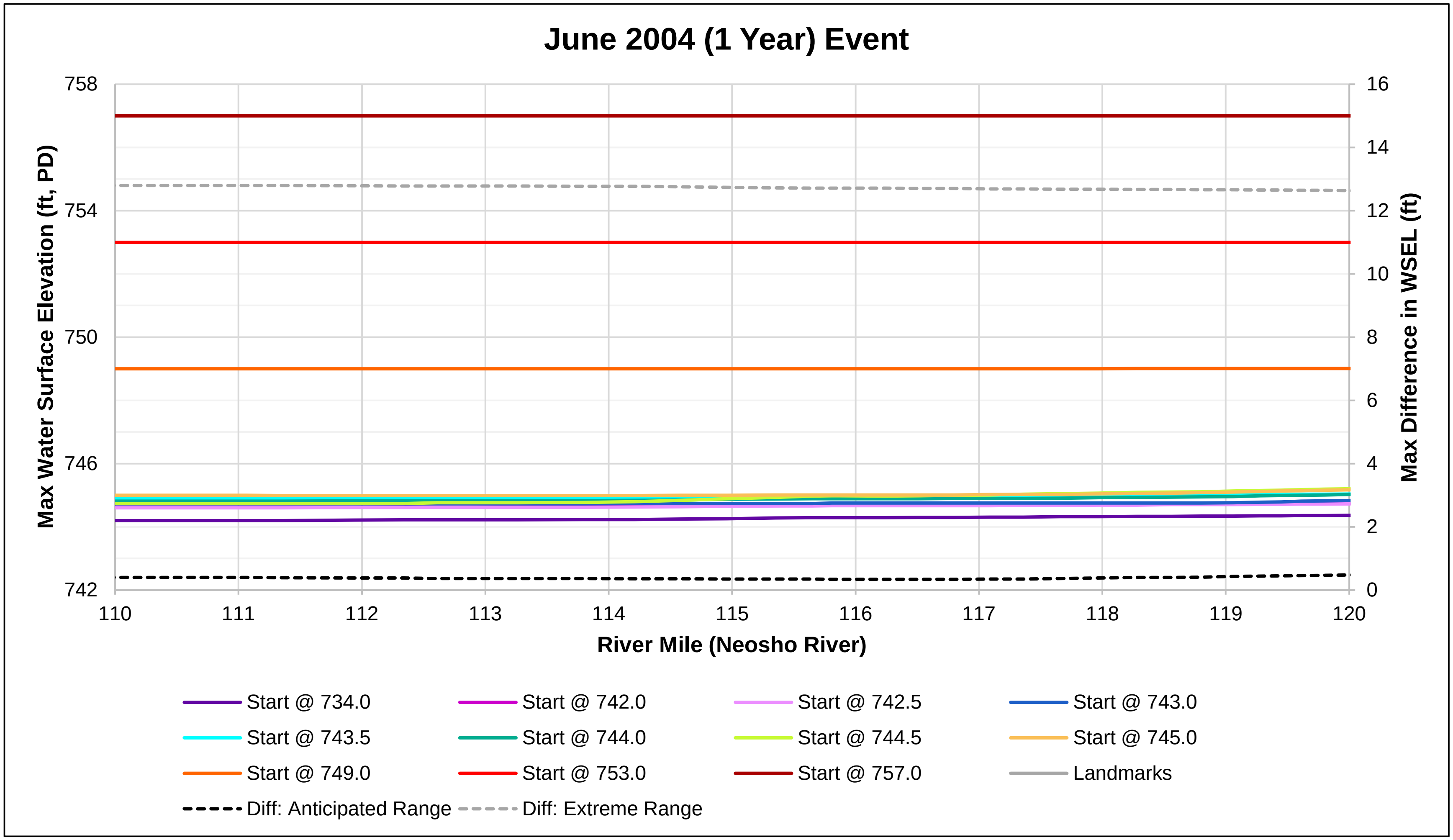


Figure E.12. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

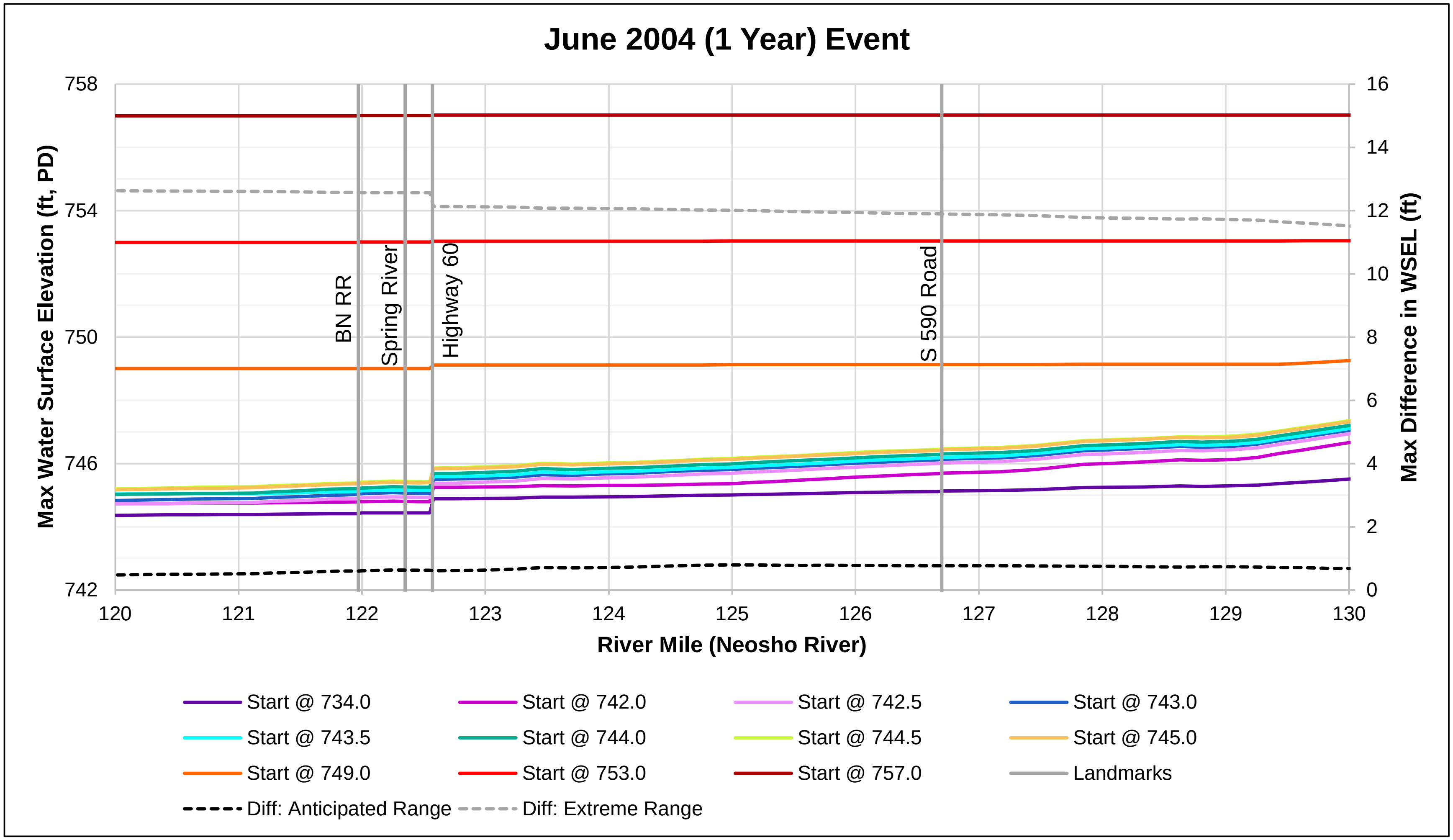


Figure E.13. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

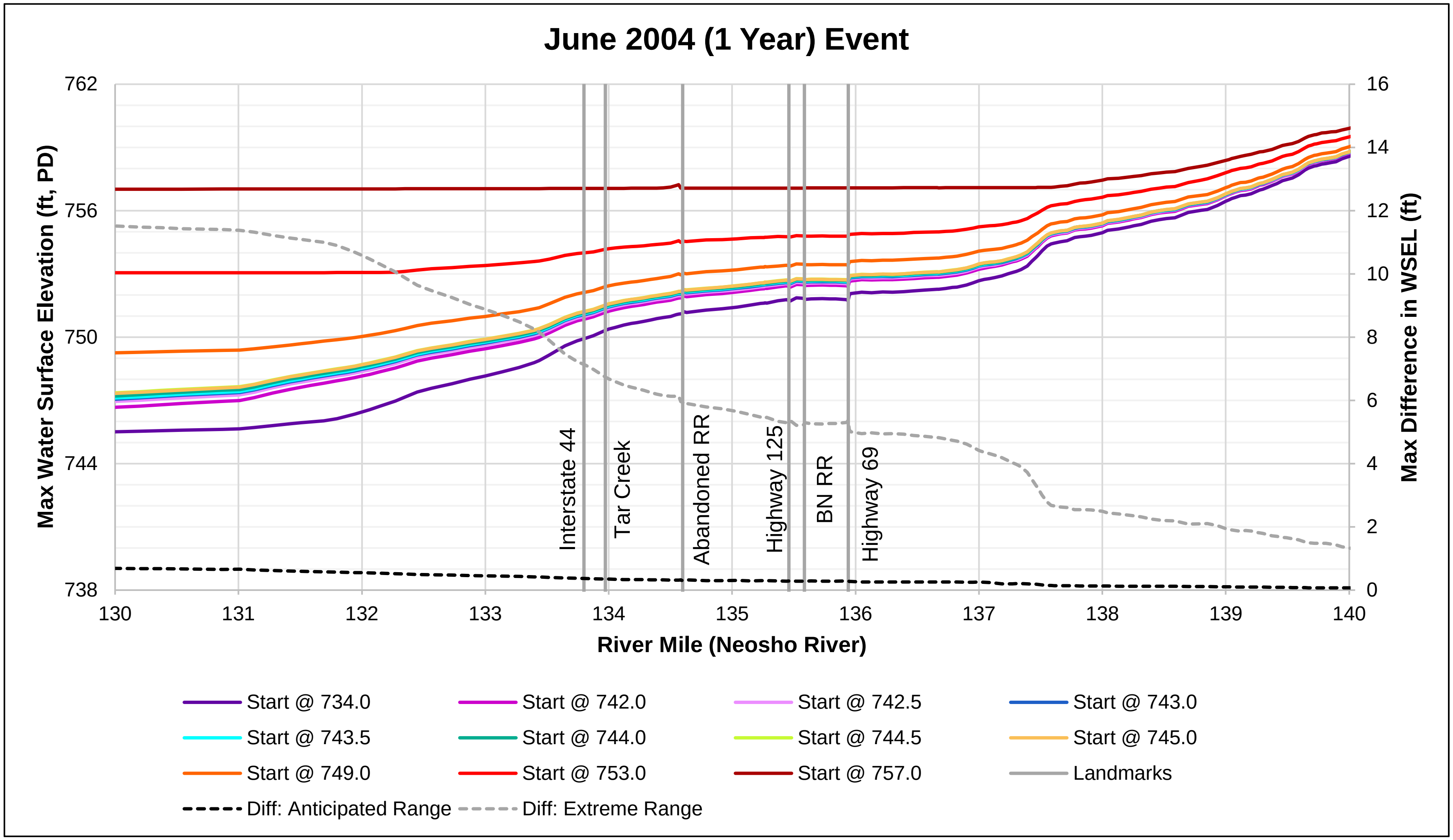


Figure E.14. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

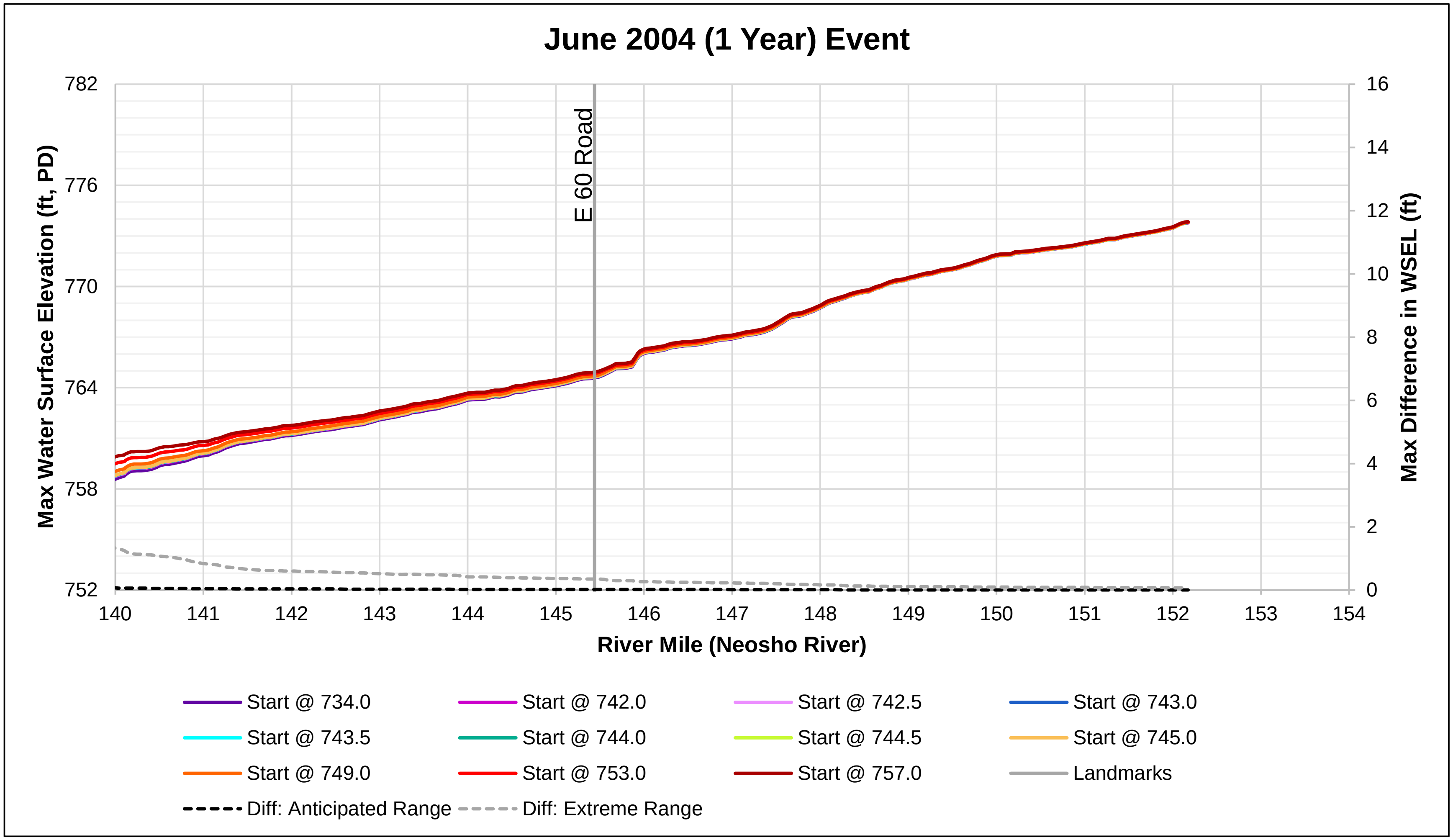


Figure E.15. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

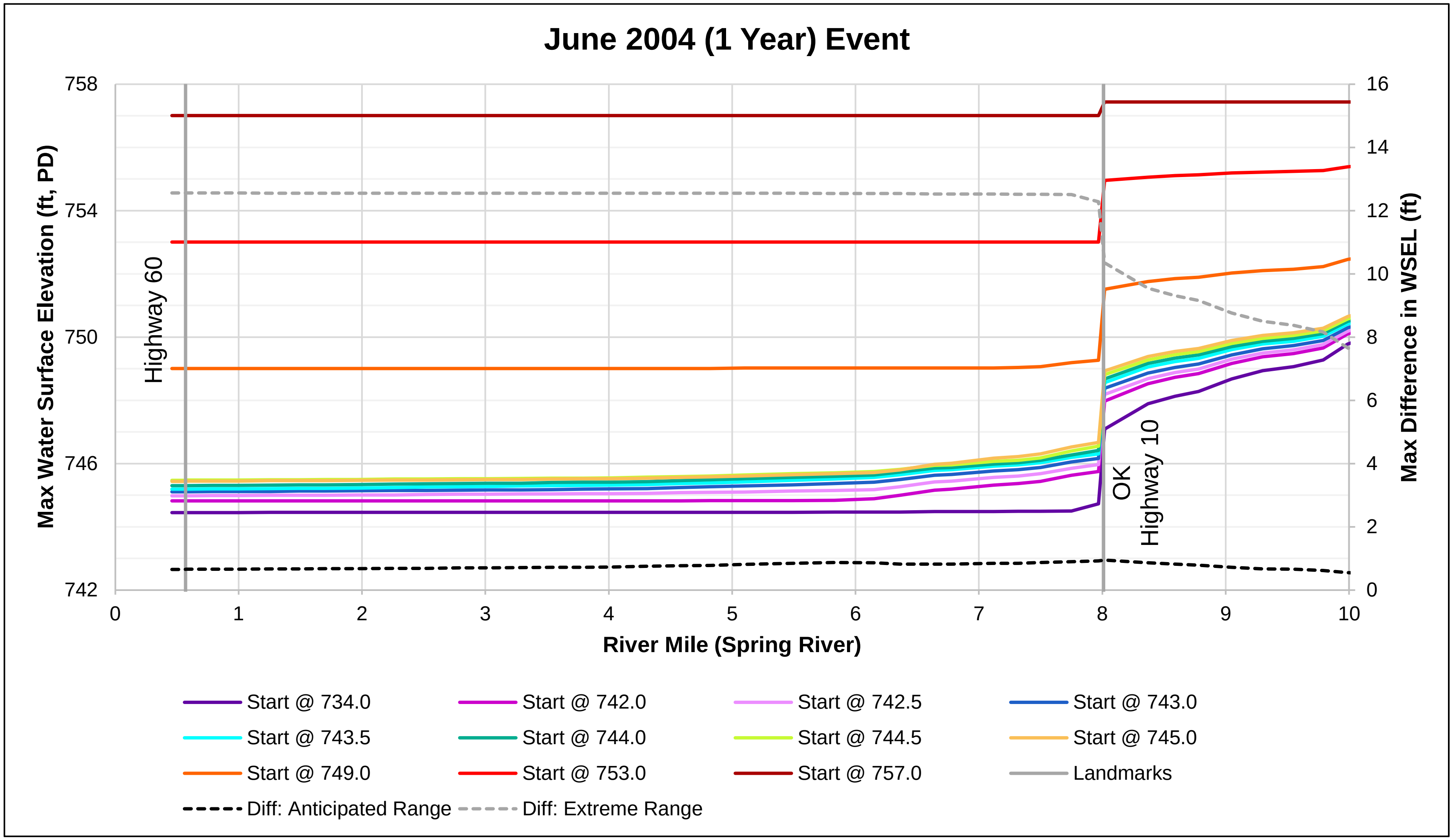


Figure E.16. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

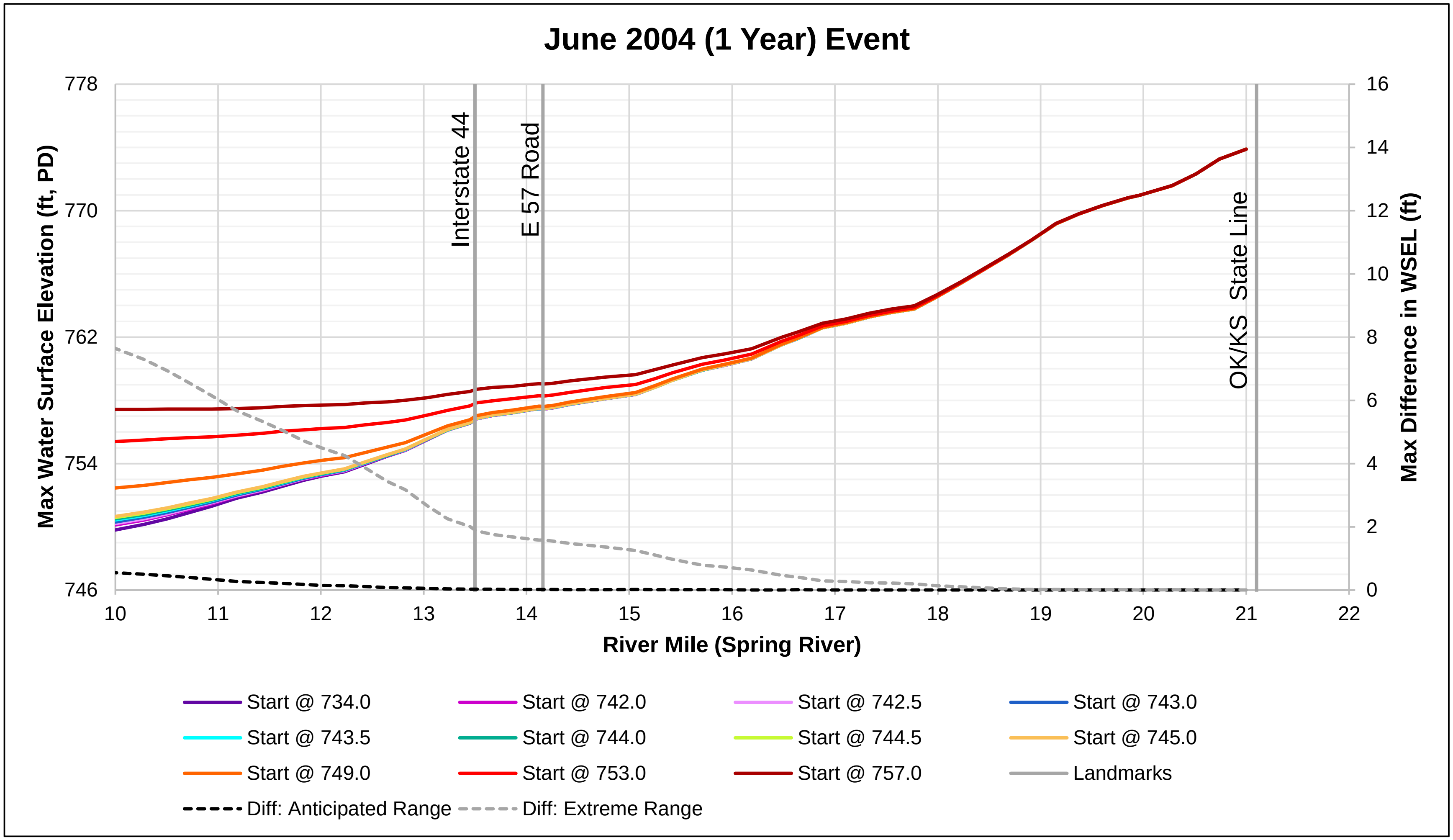


Figure E.17. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

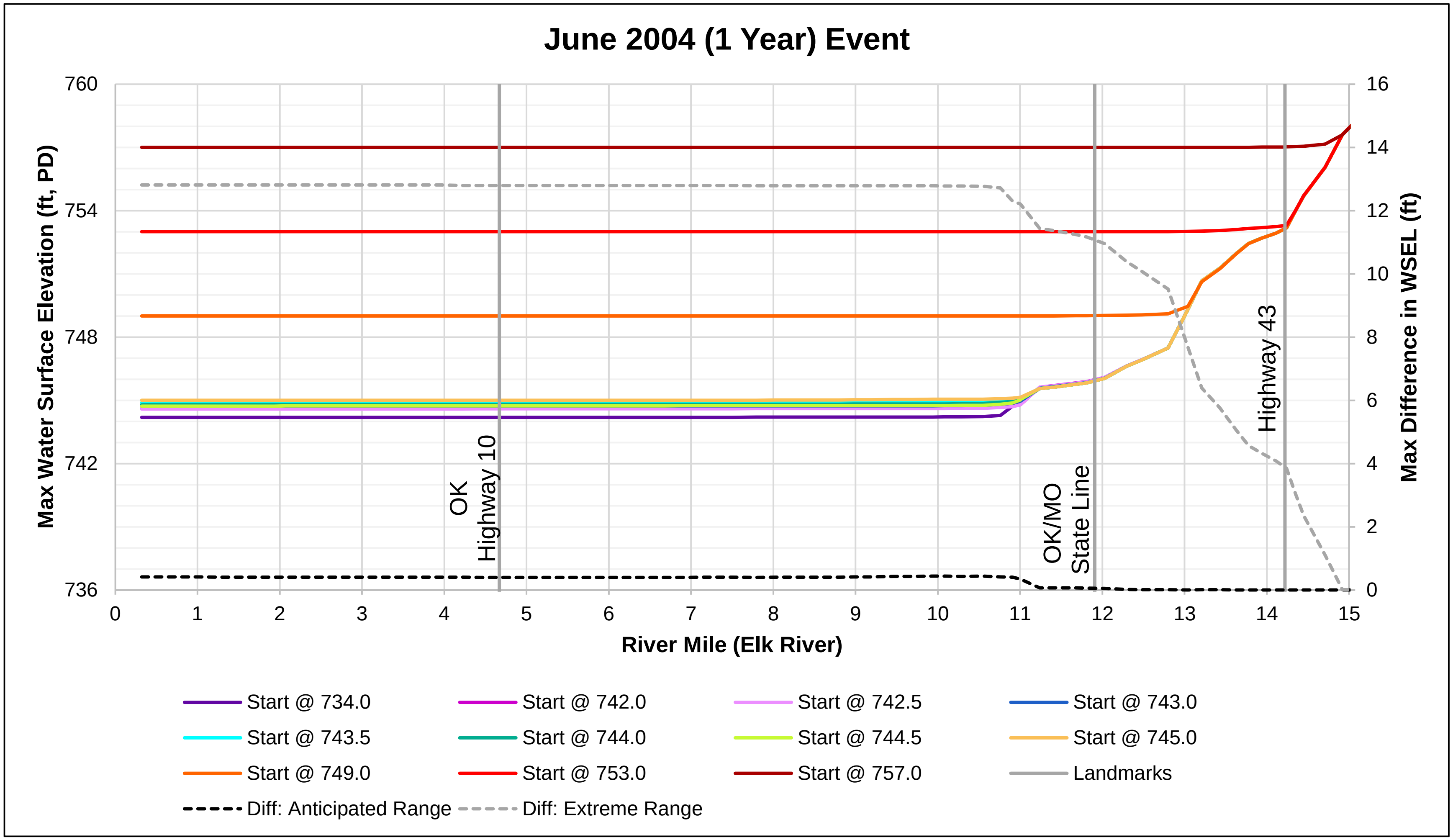


Figure E.18. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

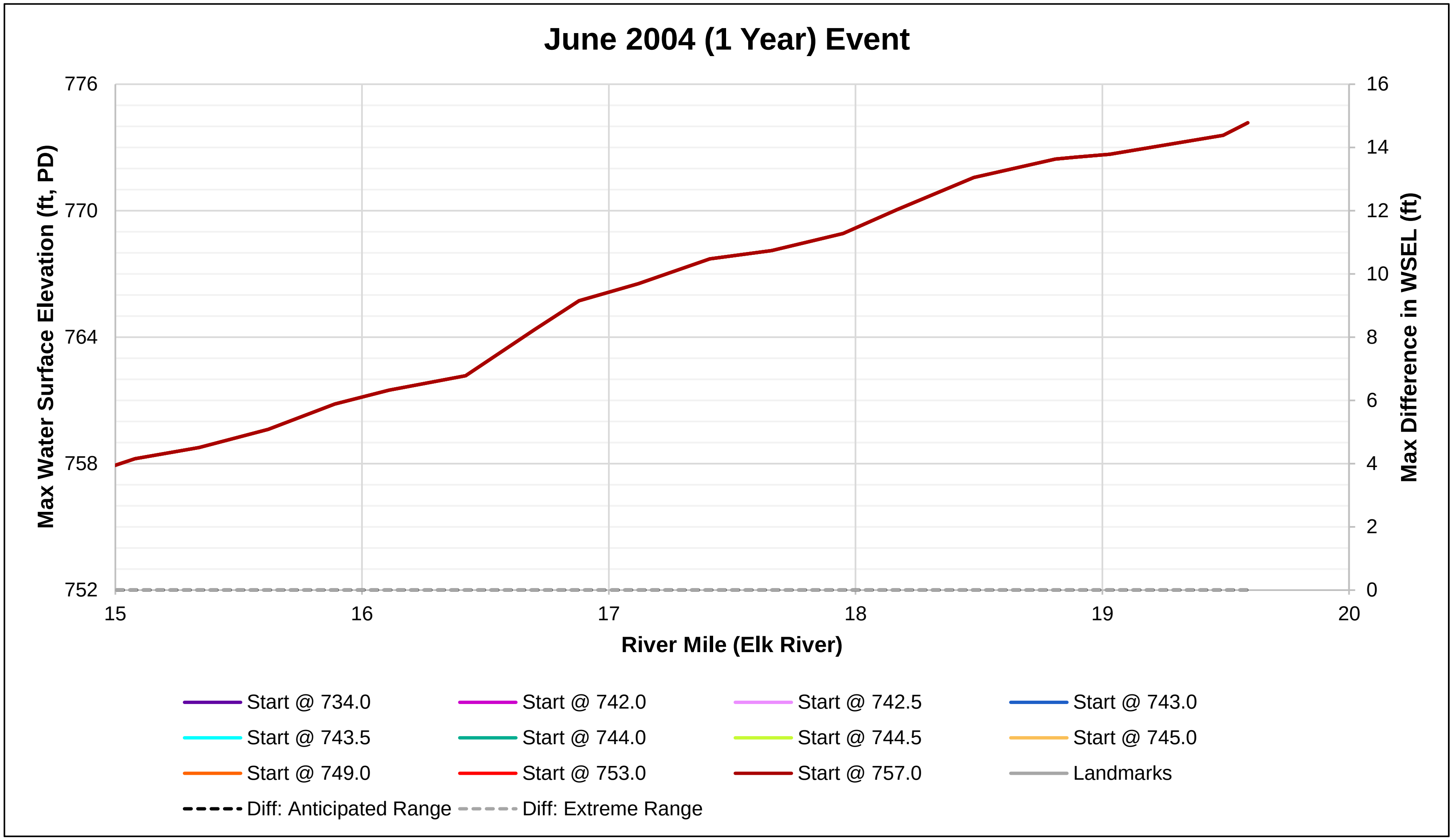


Figure E.19. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

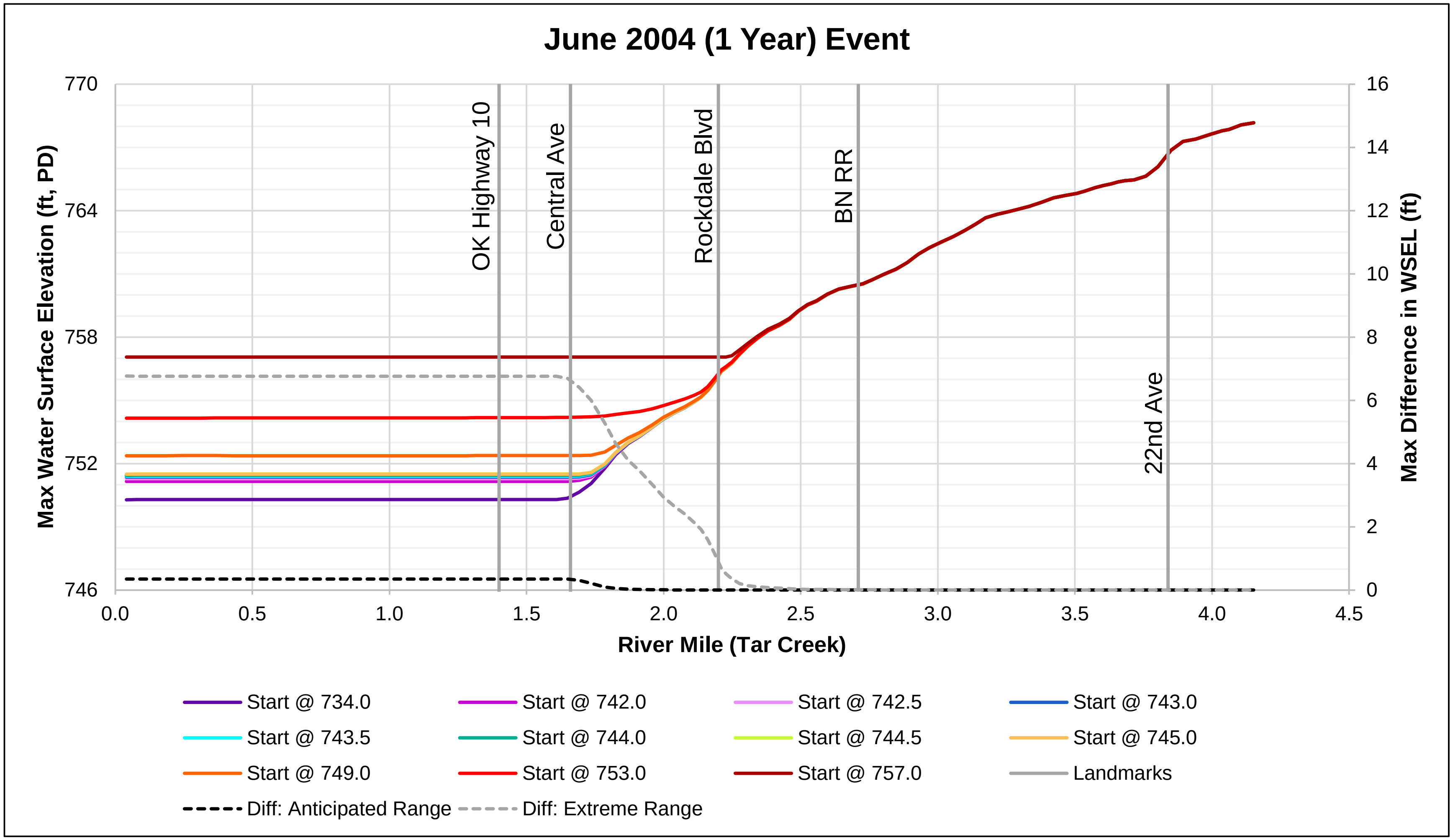


Figure E.20. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes: 1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*

2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*

3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*

4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

APPENDIX E.3:
JULY 2007 (4 YEAR) INFLOW EVENT
WATER SURFACE ELEVATION PROFILES

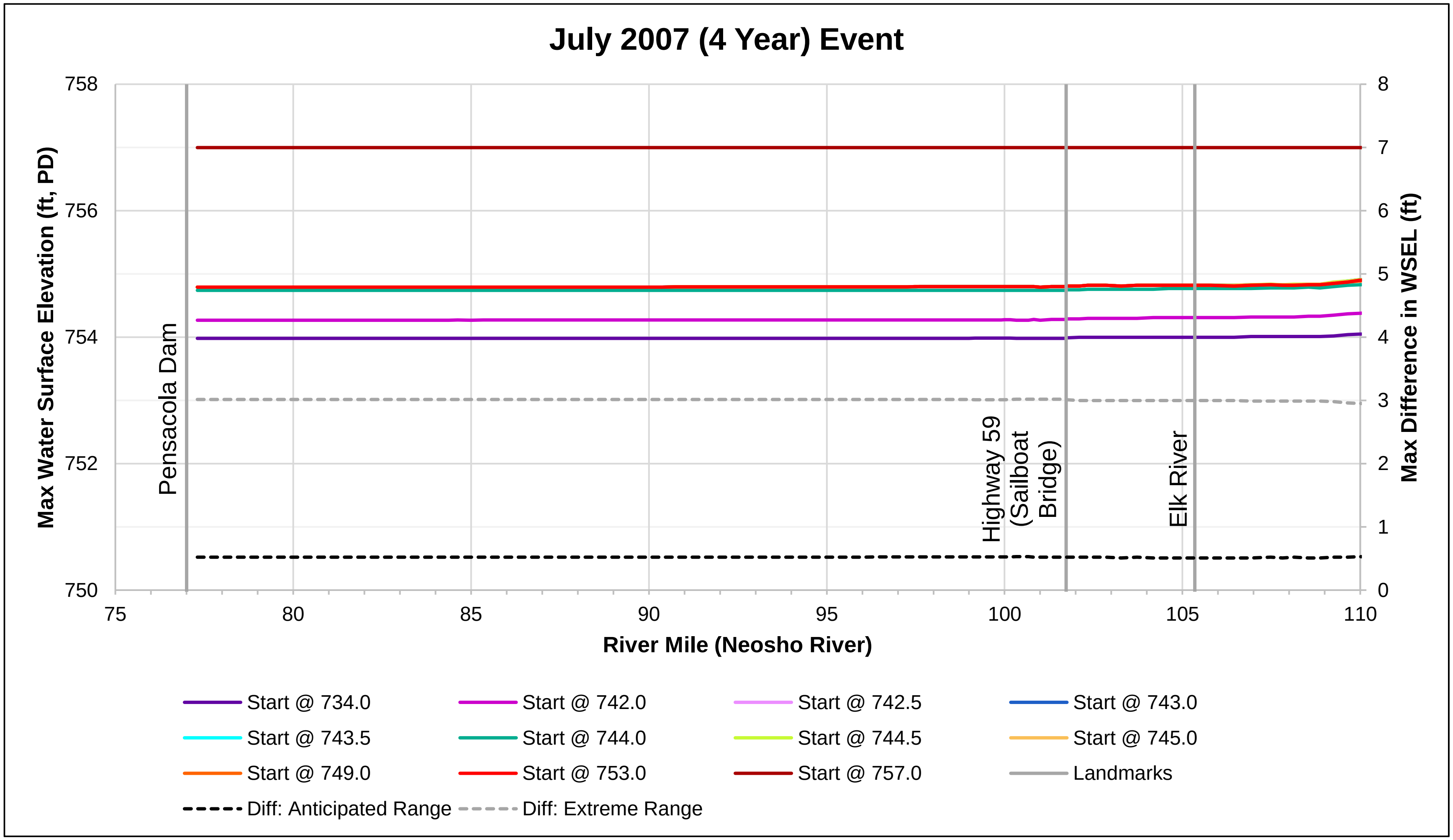


Figure E.21. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

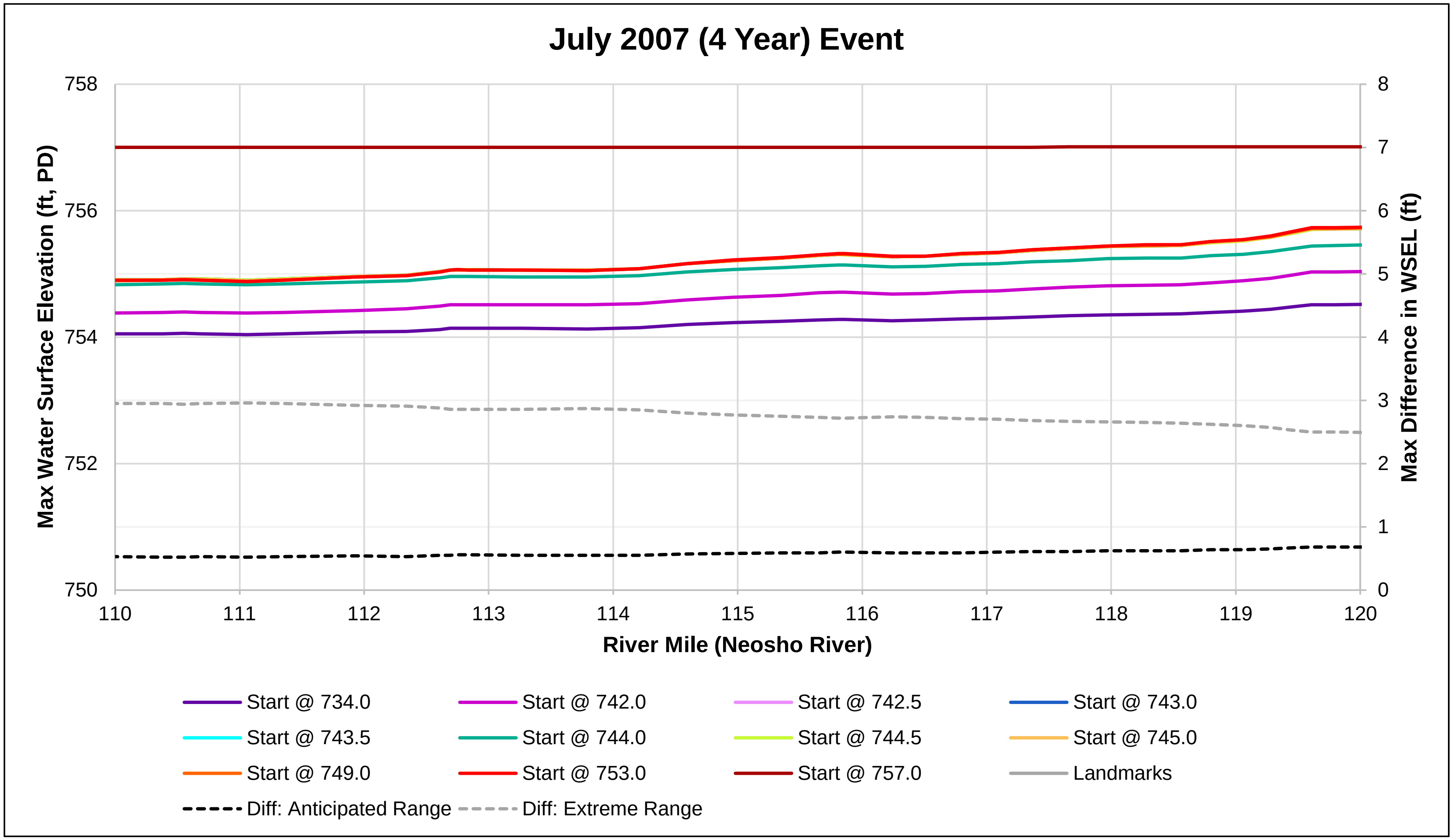


Figure E.22. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

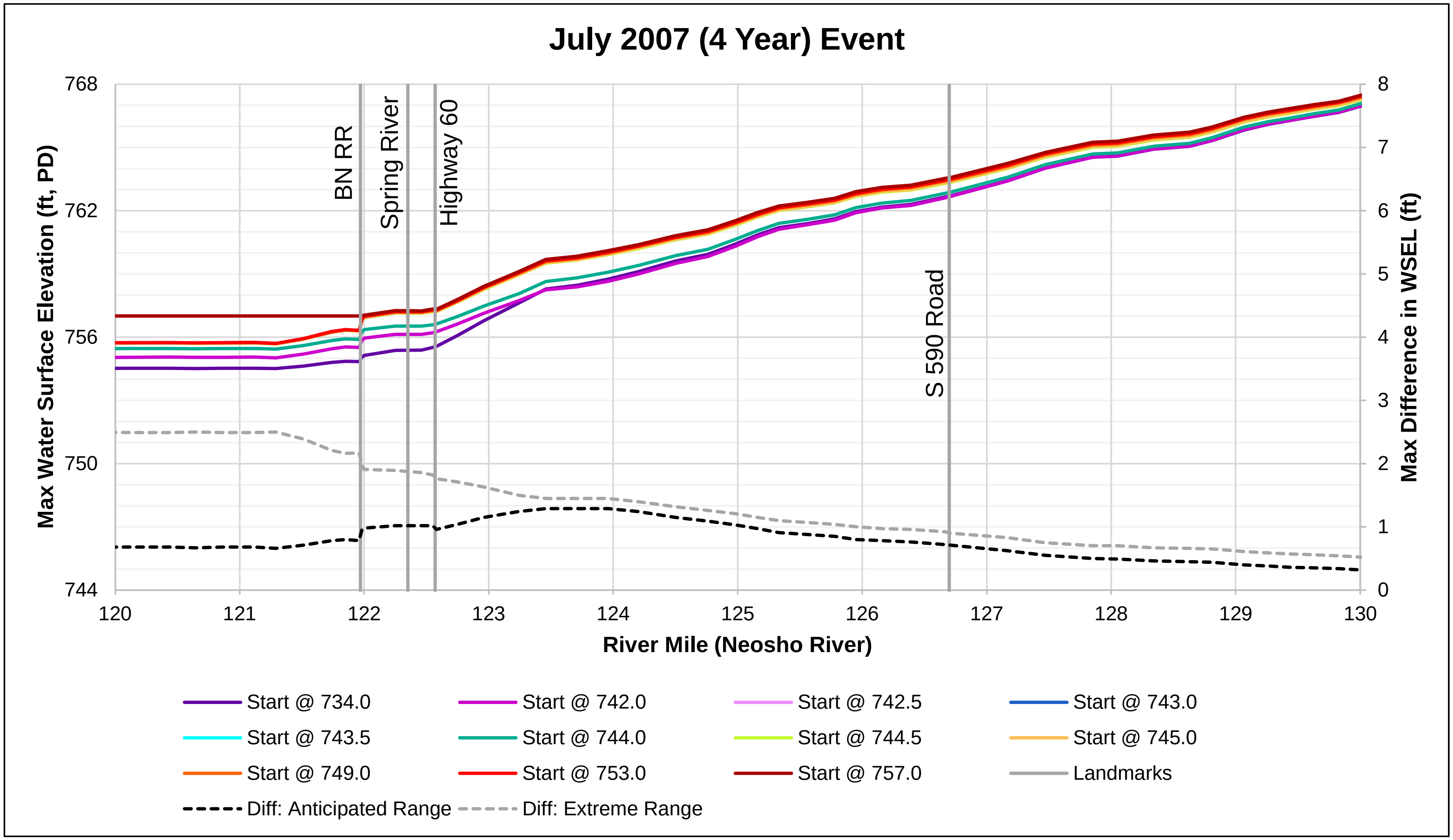


Figure E.23. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

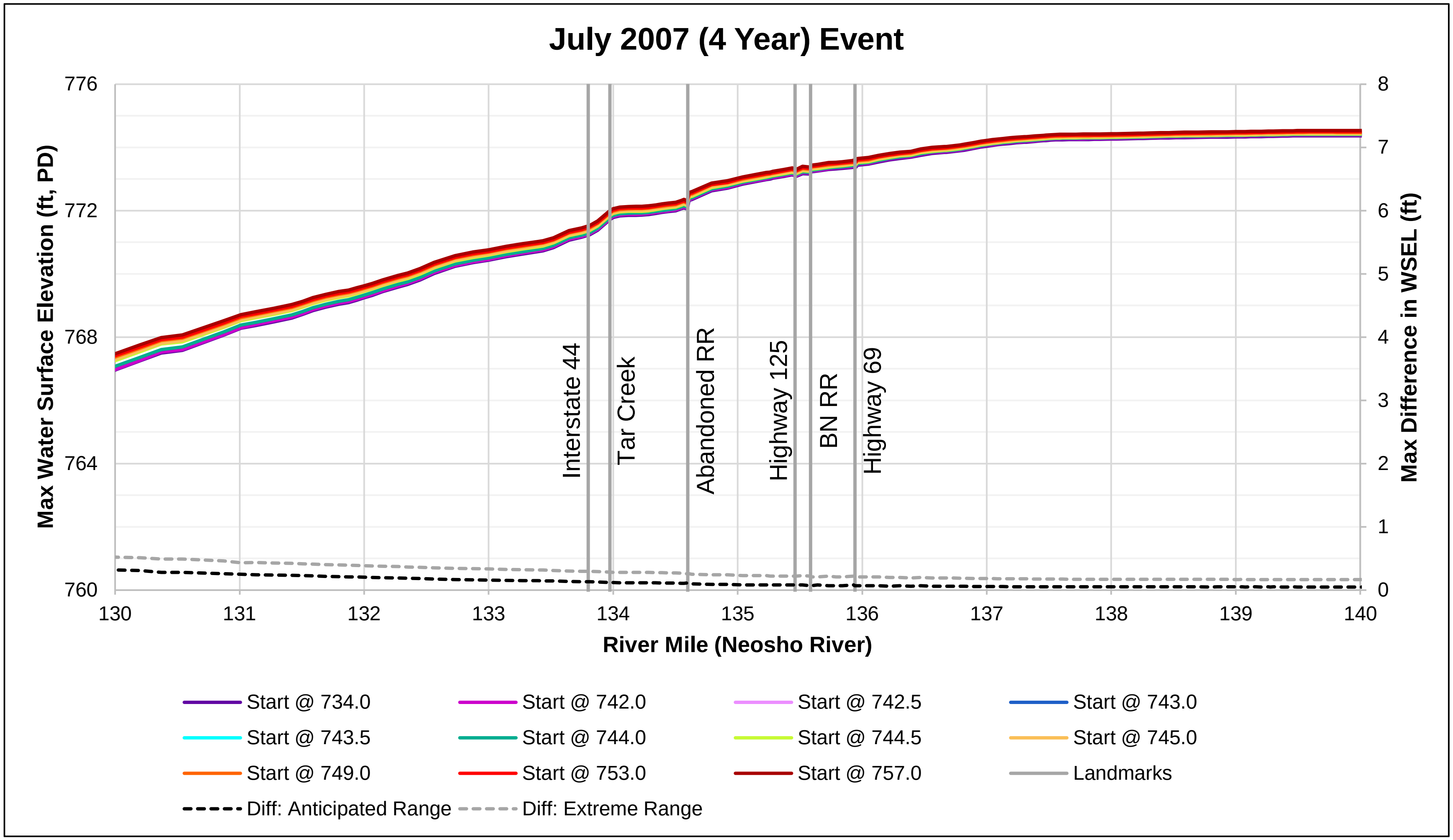


Figure E.24. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

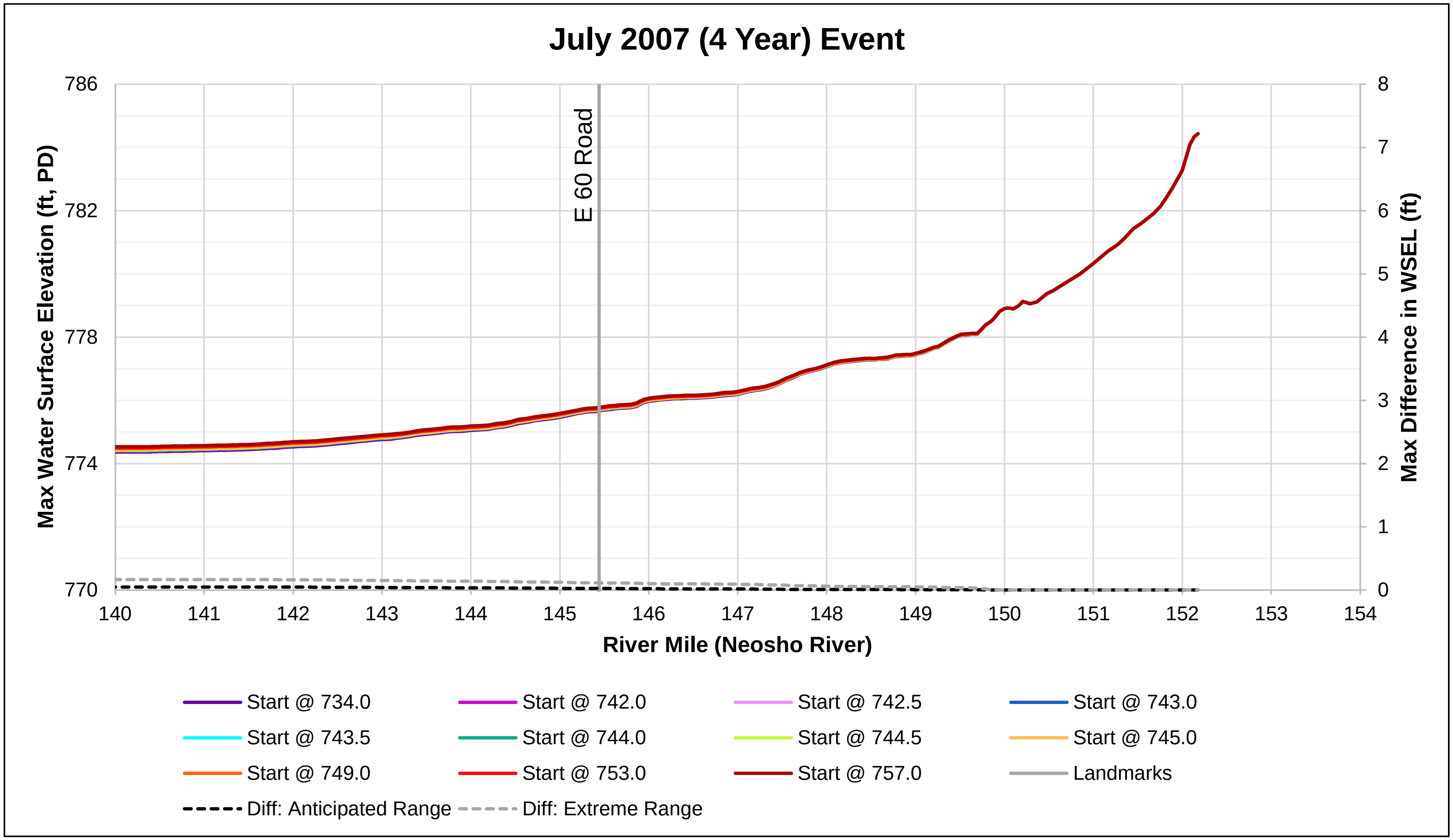


Figure E.25. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

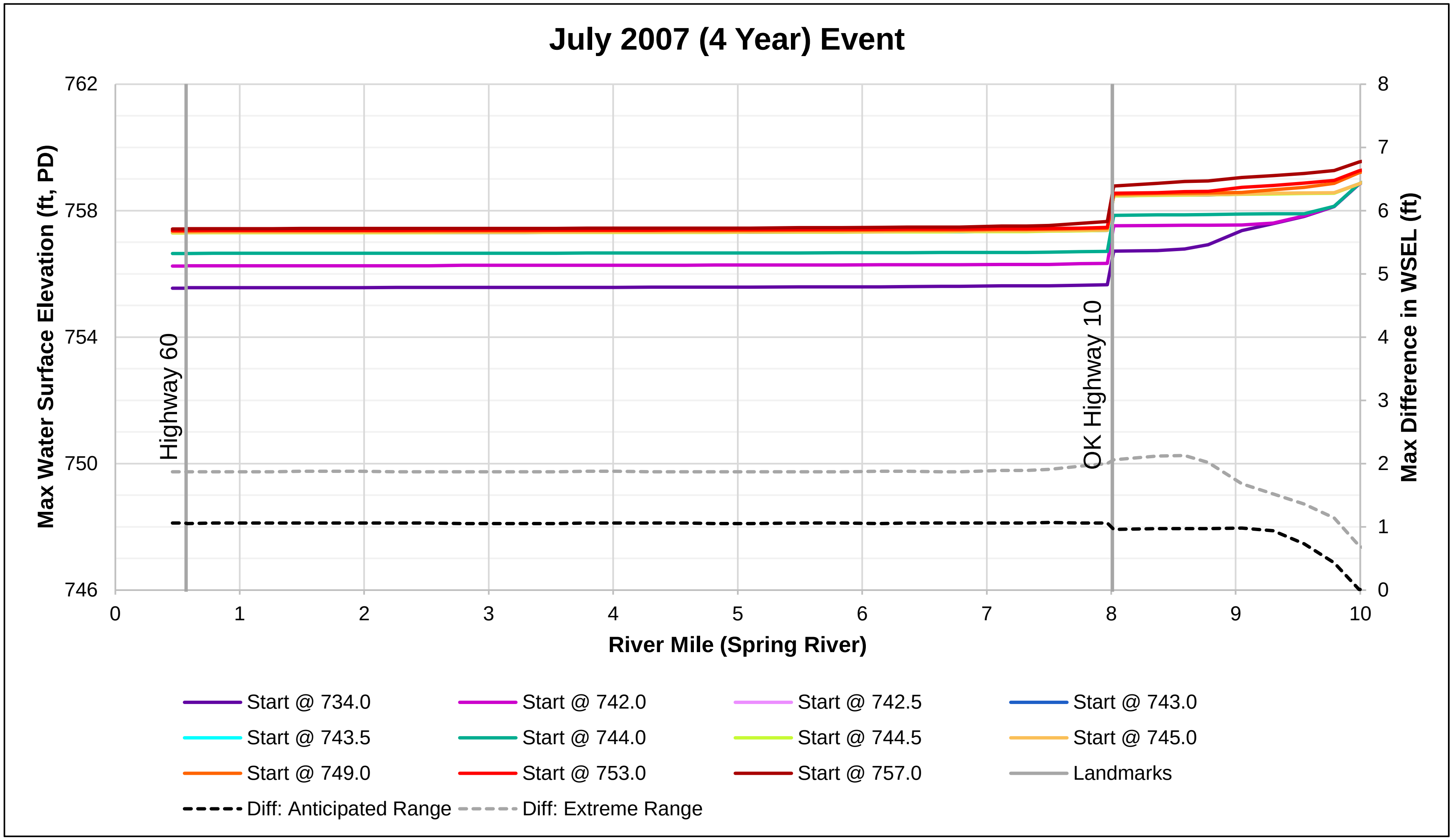


Figure E.26. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

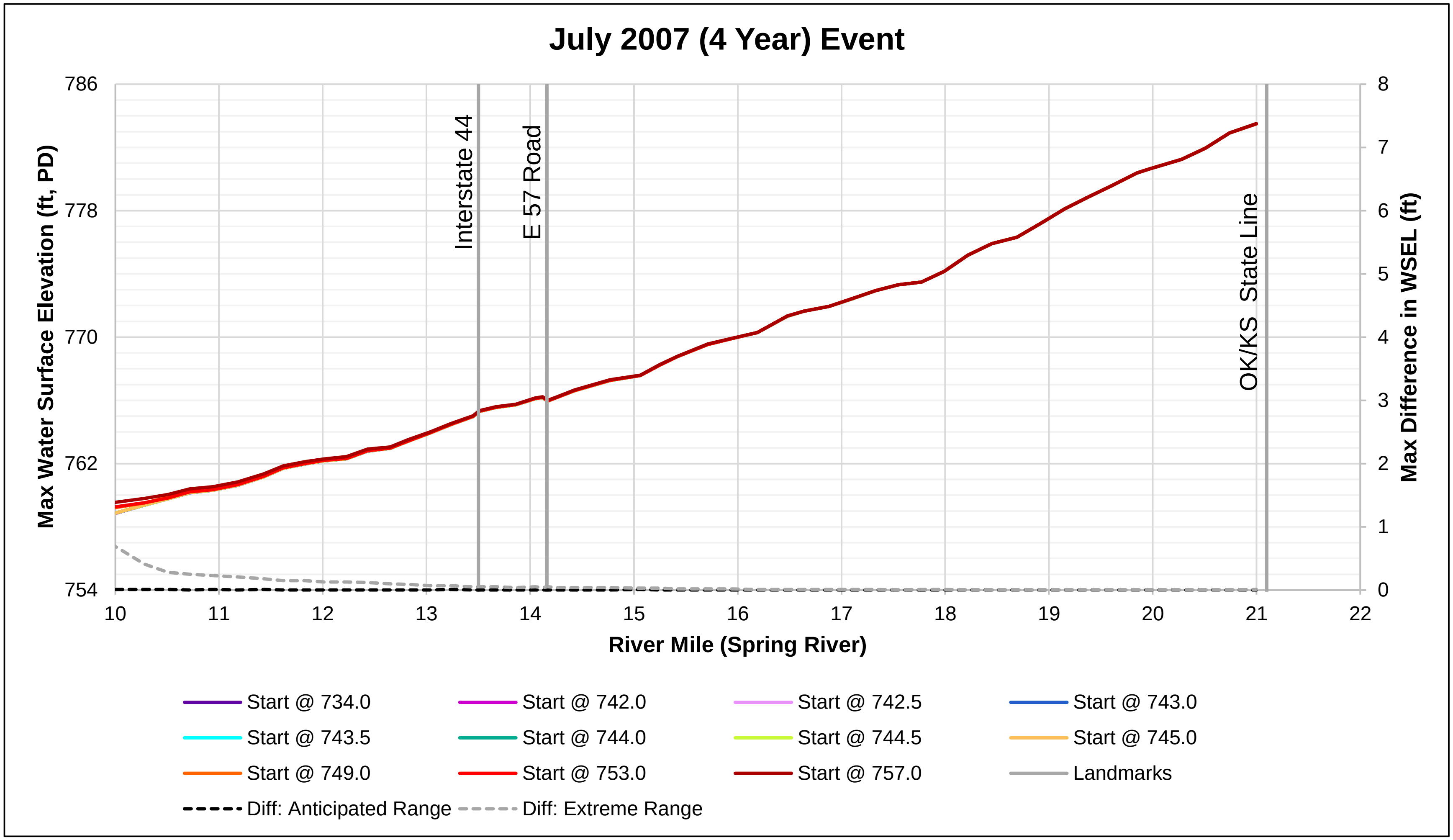


Figure E.27. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

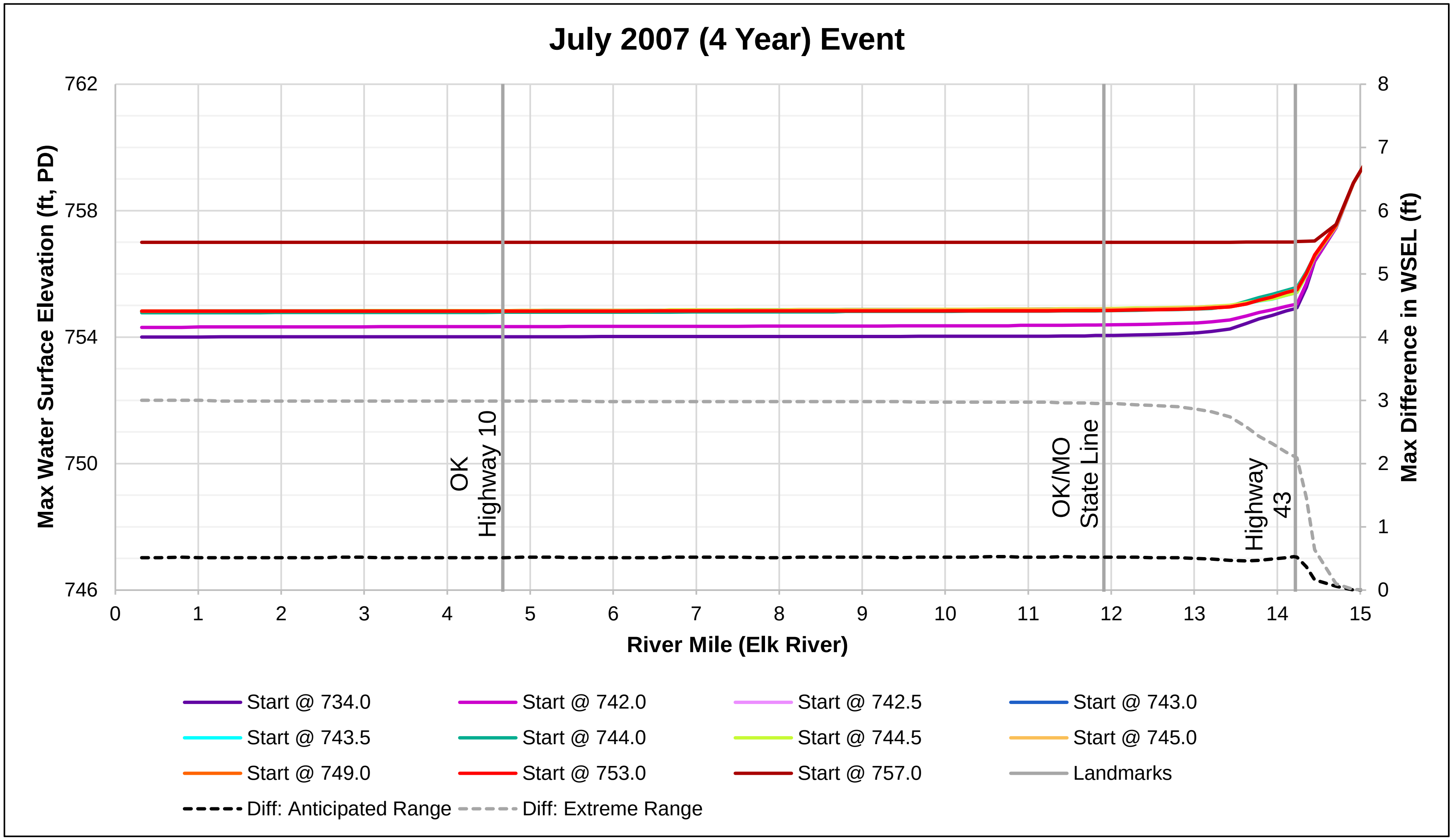


Figure E.28. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

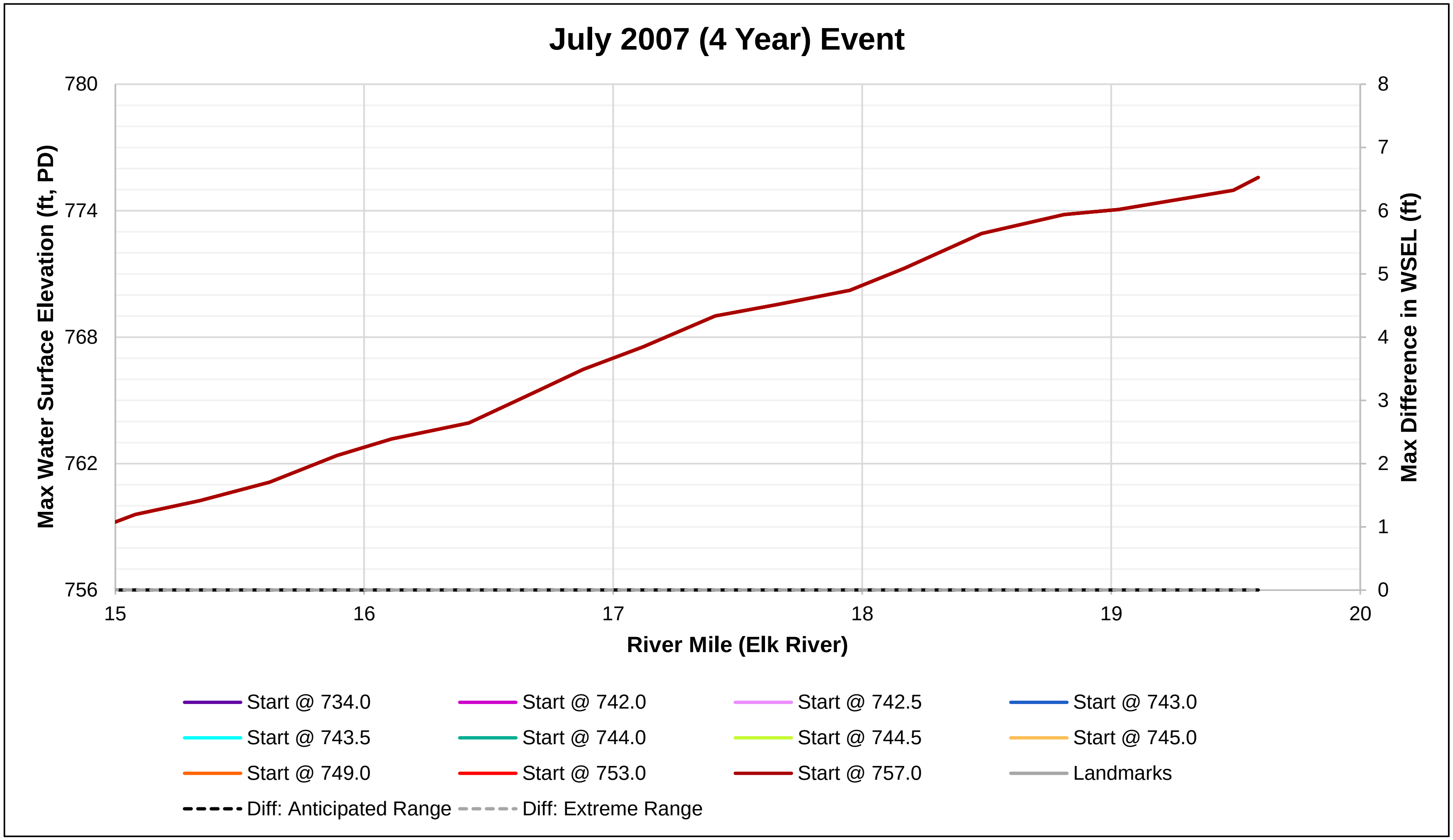


Figure E.29. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

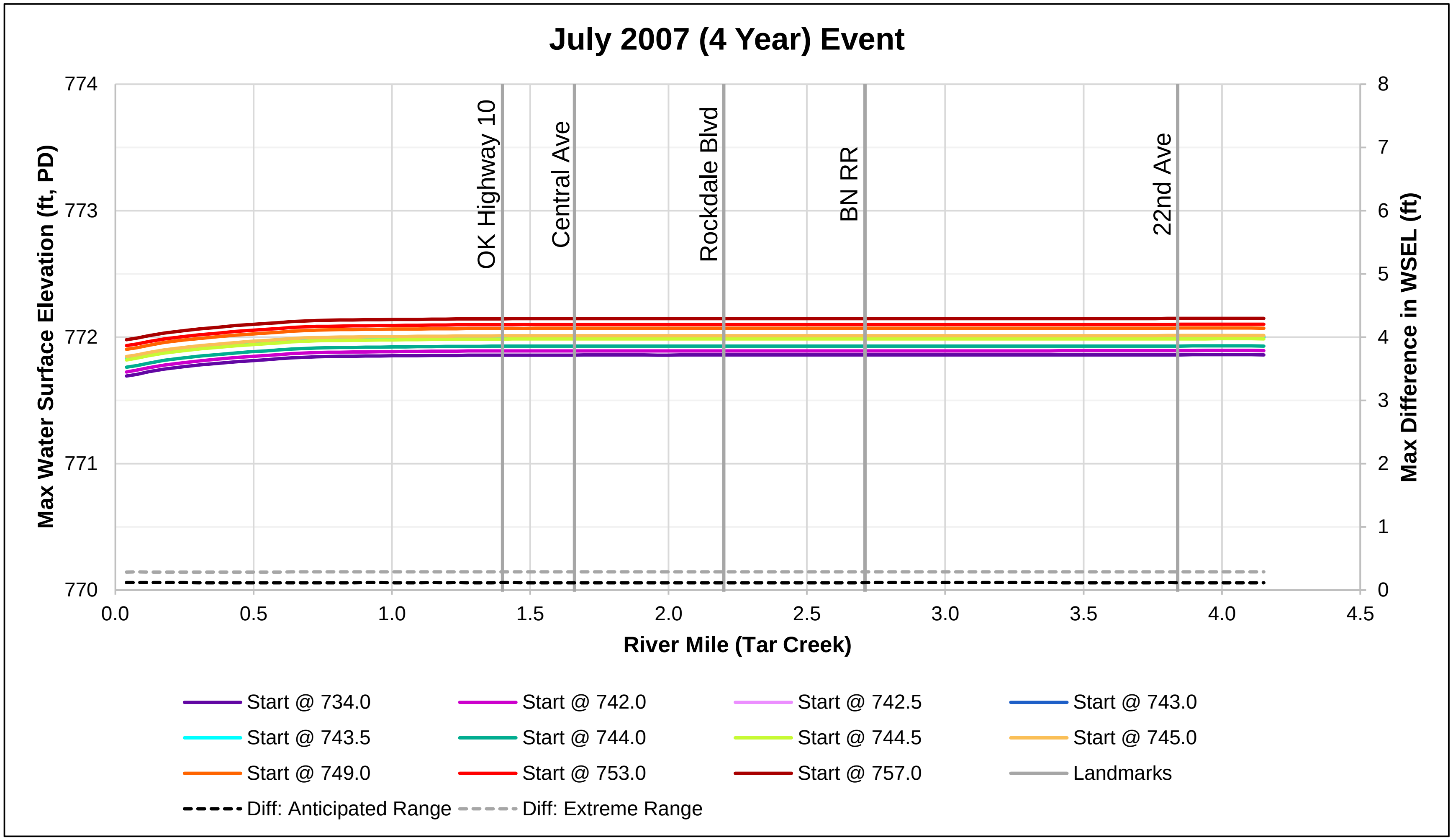


Figure E.30. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

APPENDIX E.4:
OCTOBER 2009 (3 YEAR) INFLOW EVENT
WATER SURFACE ELEVATION PROFILES

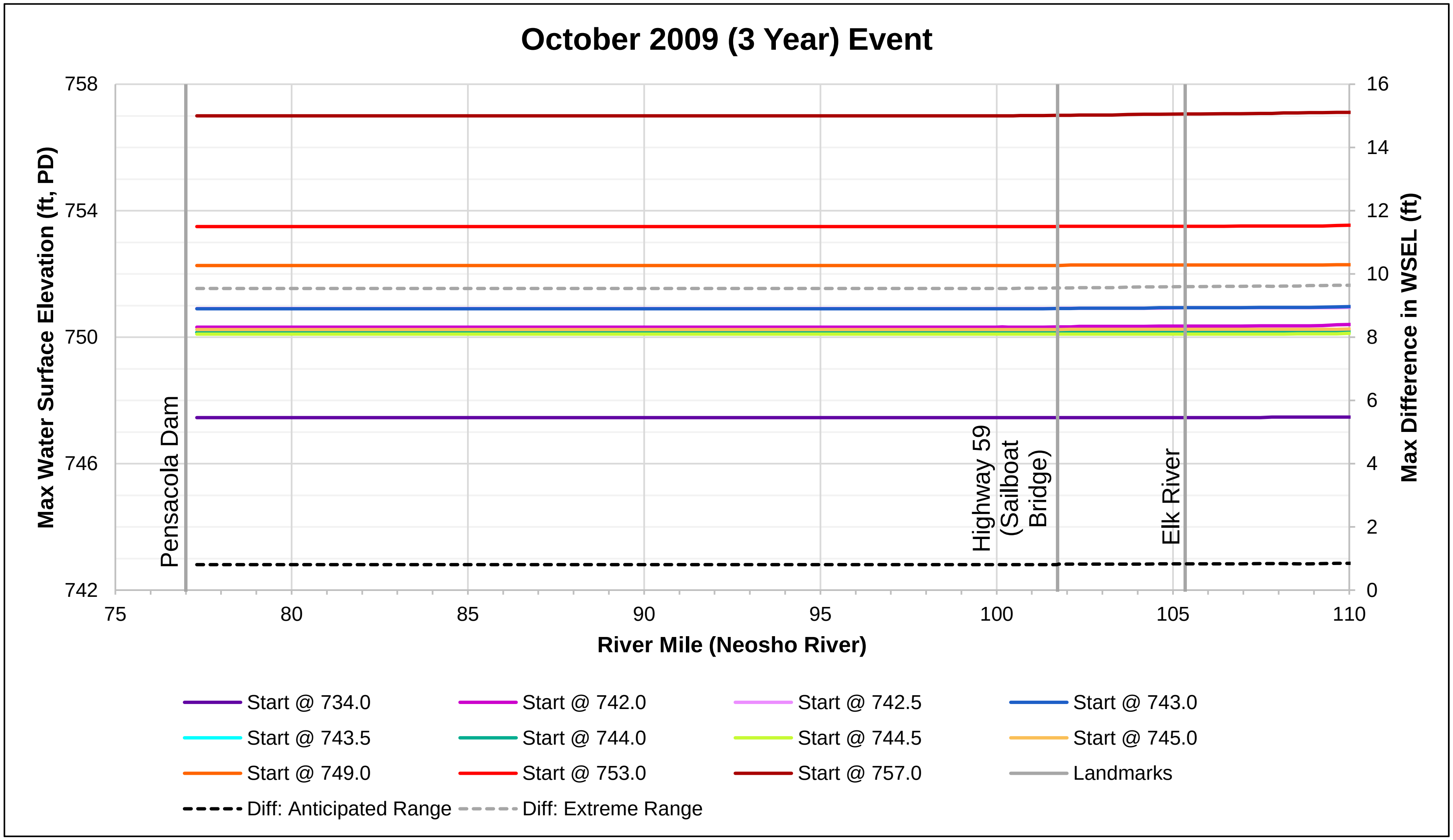


Figure E.31. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

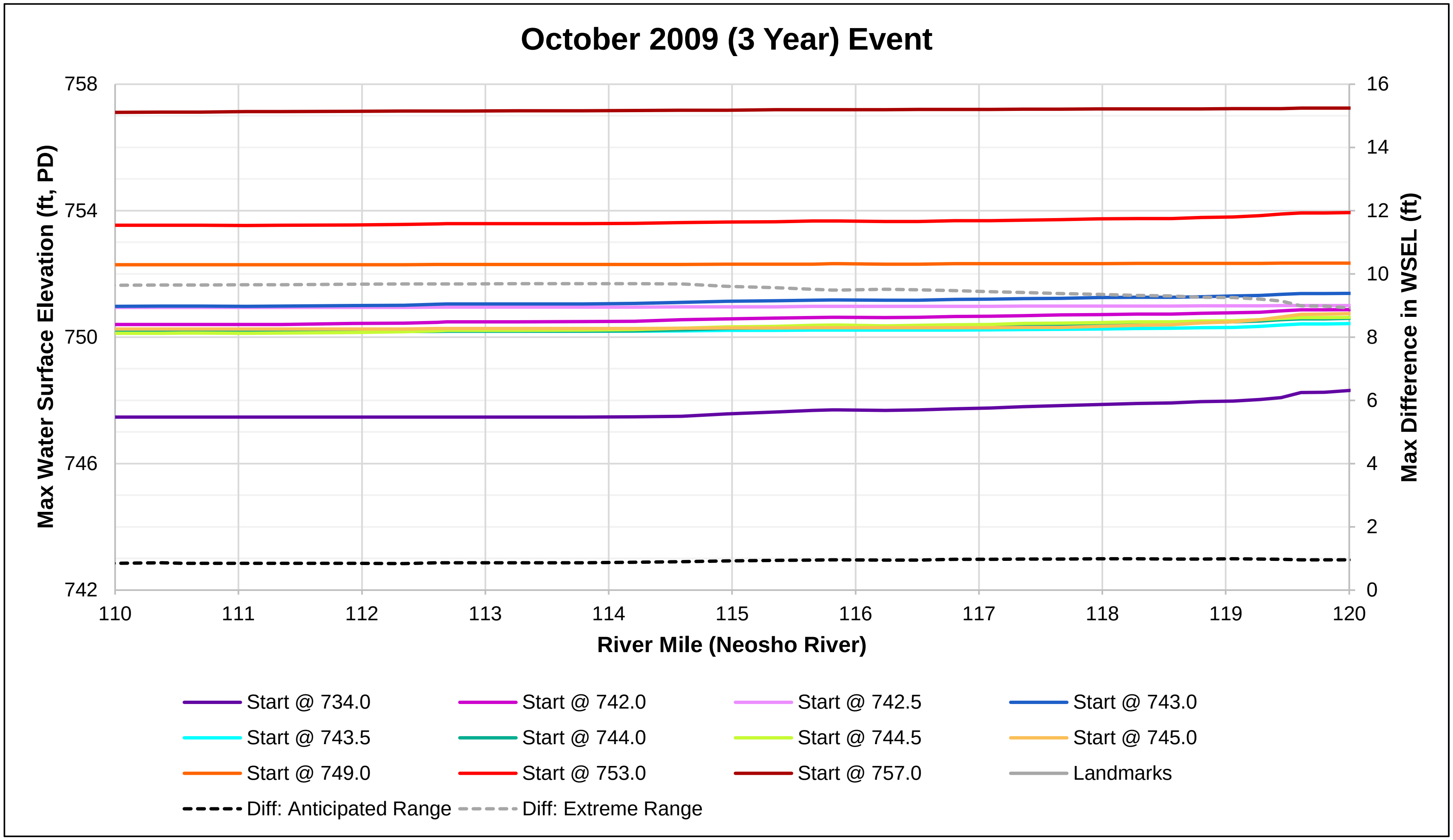


Figure E.32. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

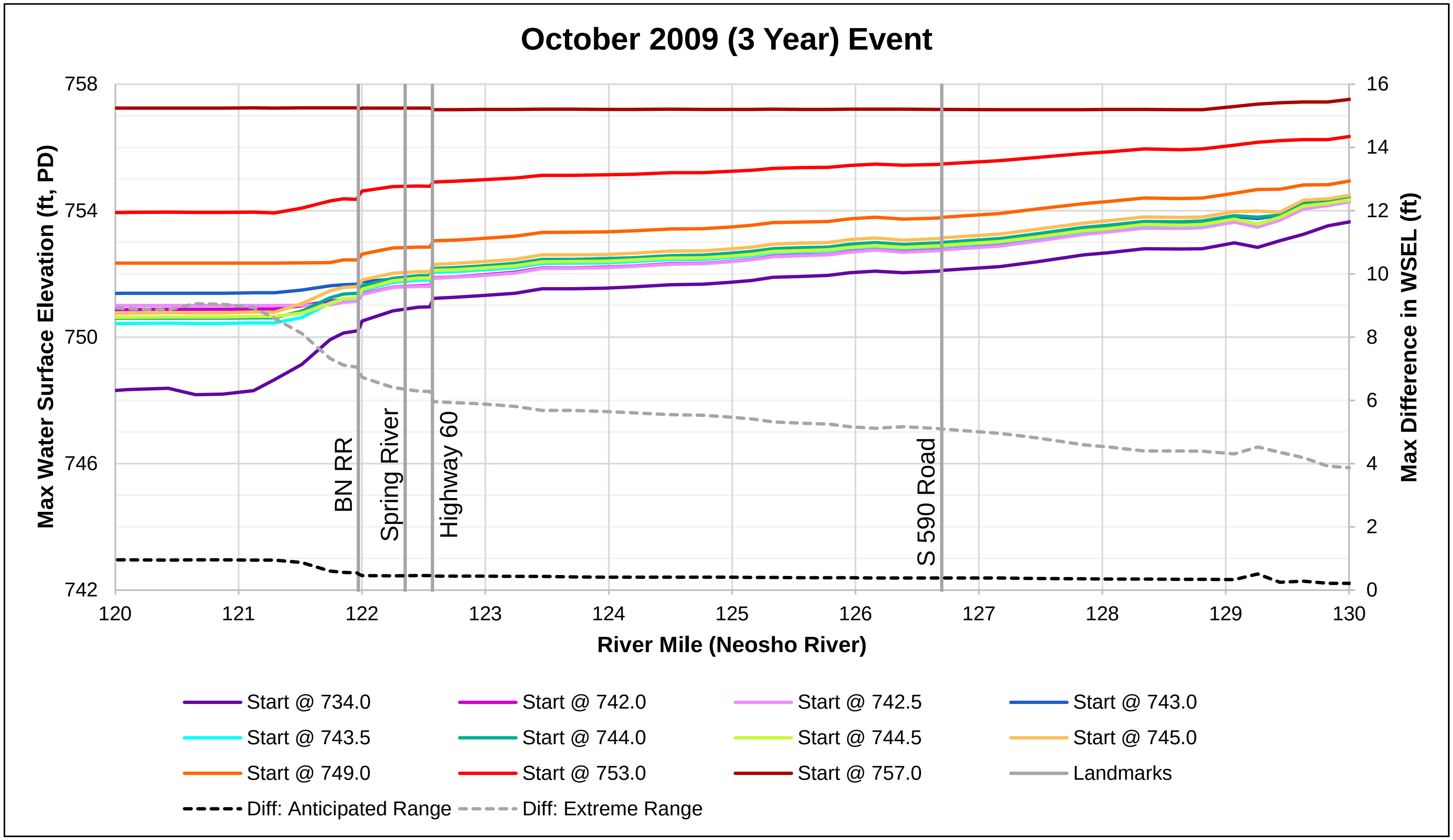


Figure E.33. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:
1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

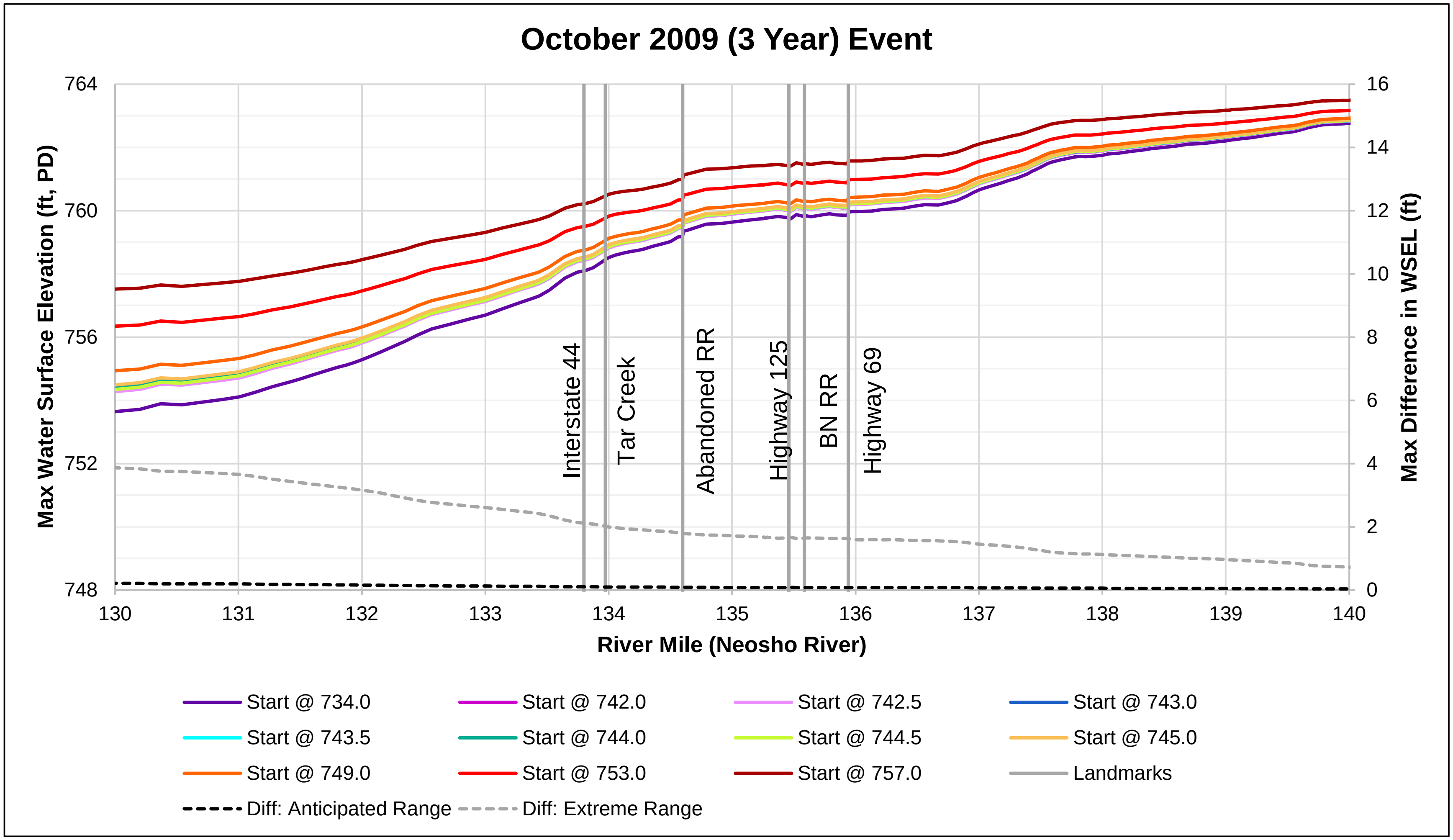


Figure E.34. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes: 1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*

2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*

3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*

4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

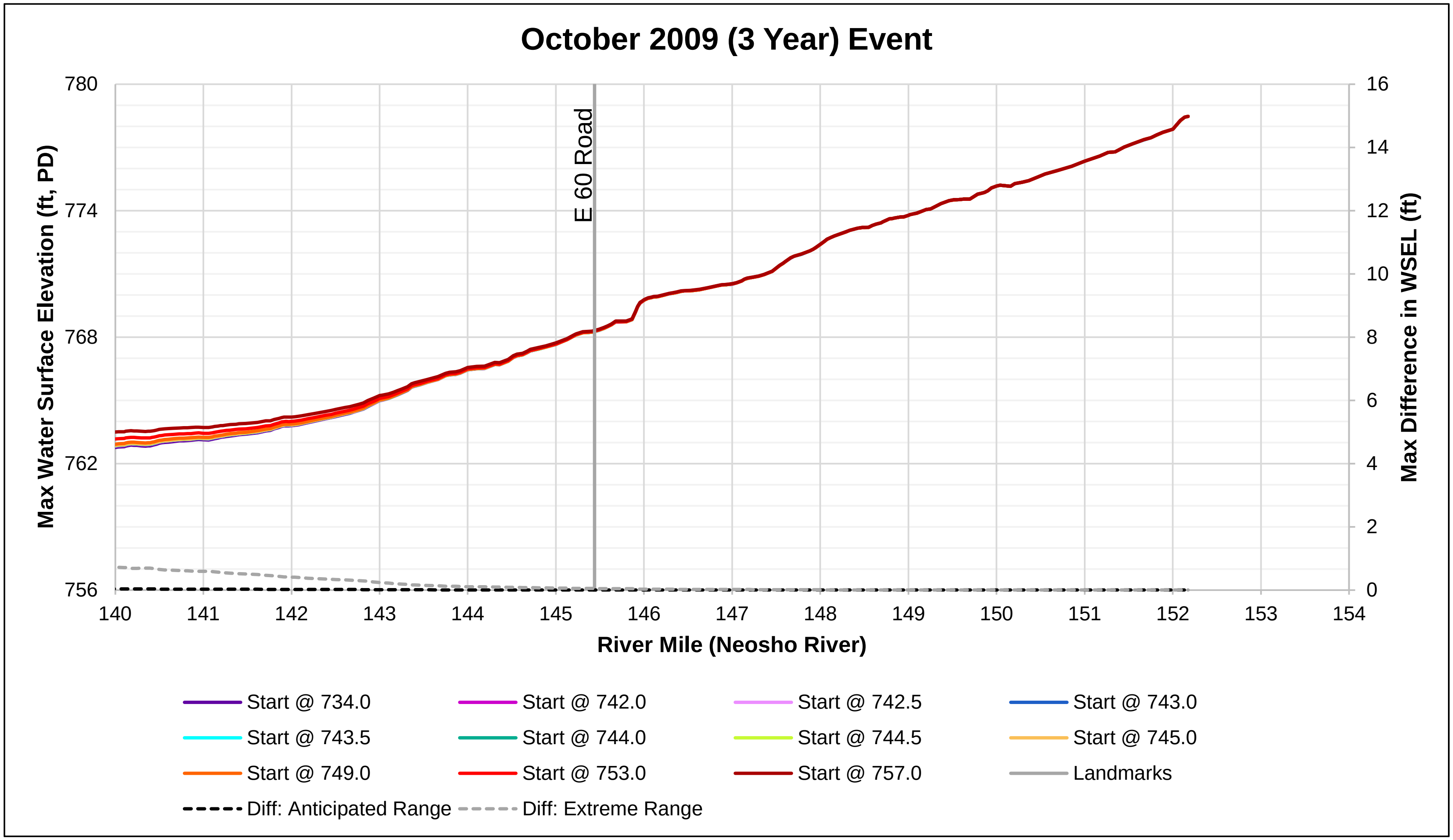


Figure E.35. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

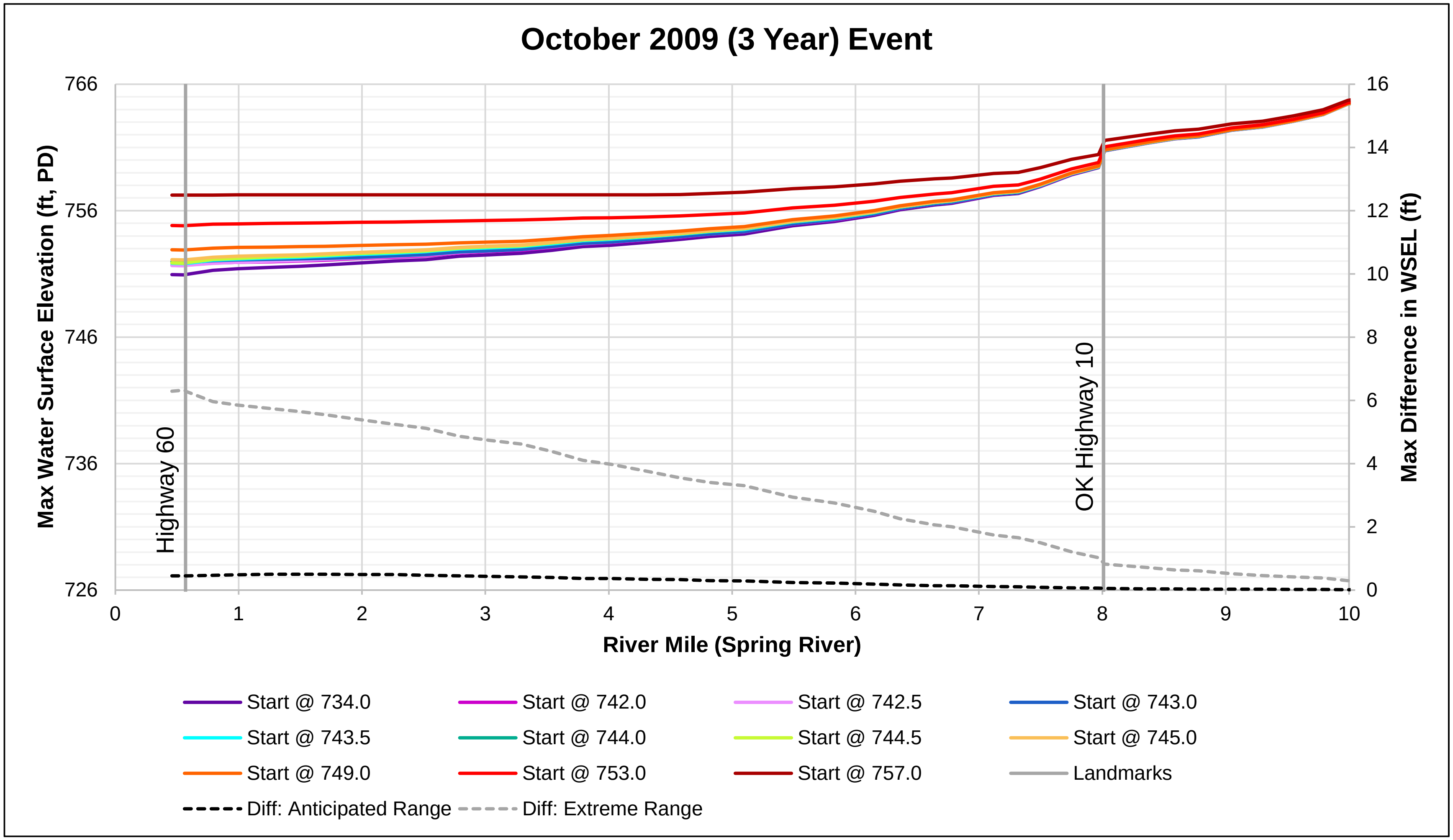


Figure E.36. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

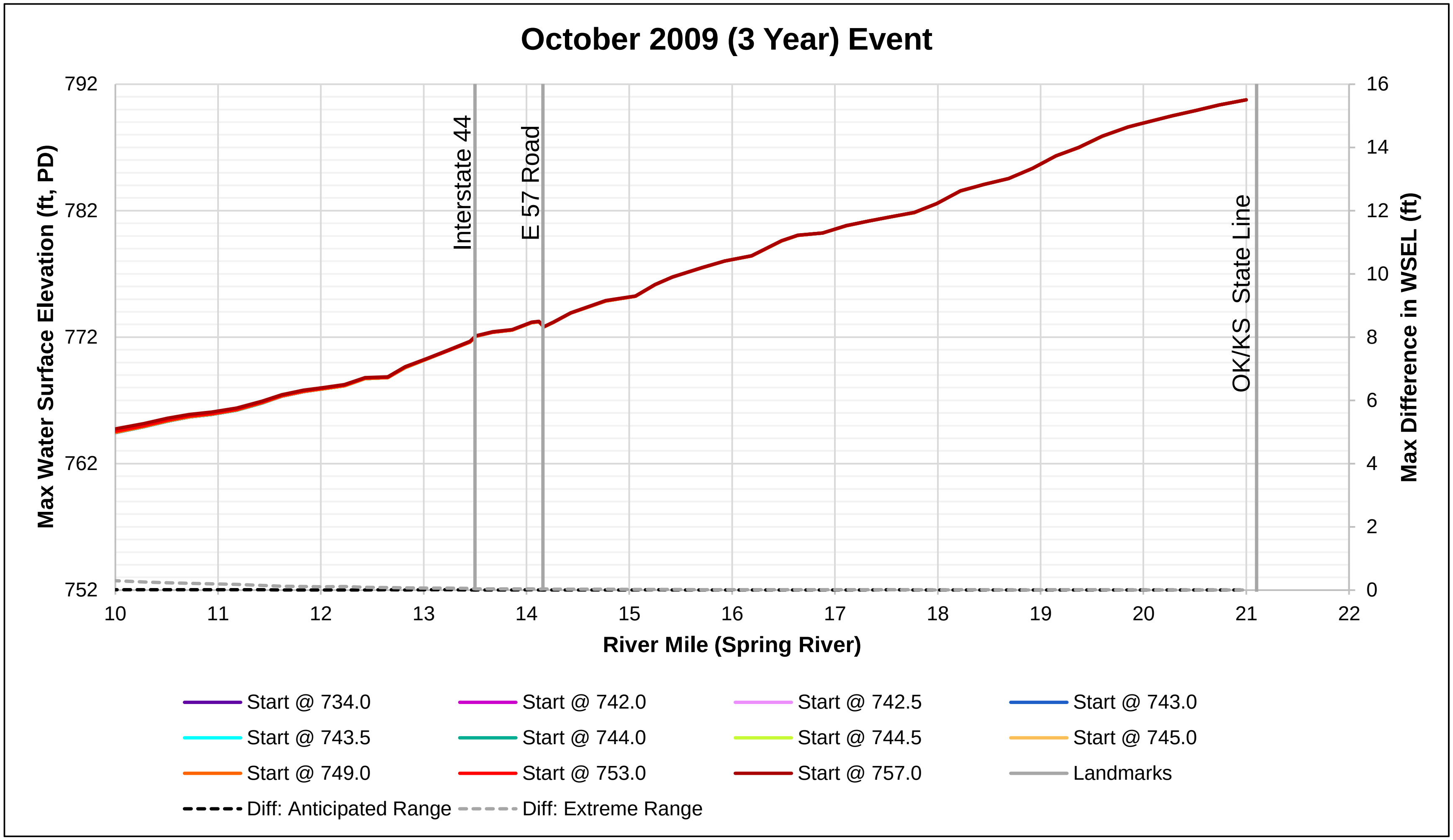


Figure E.37. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

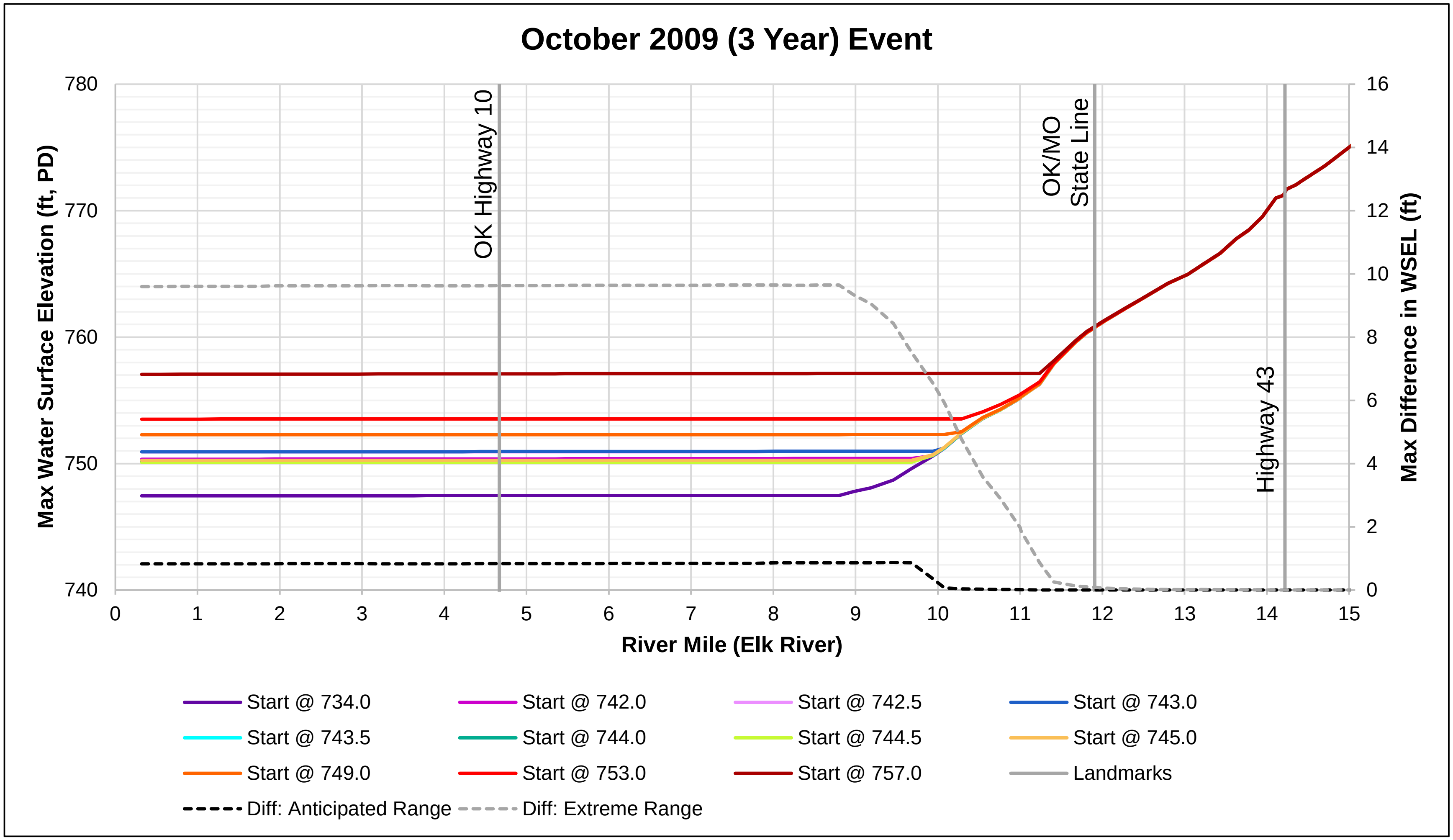


Figure E.38. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

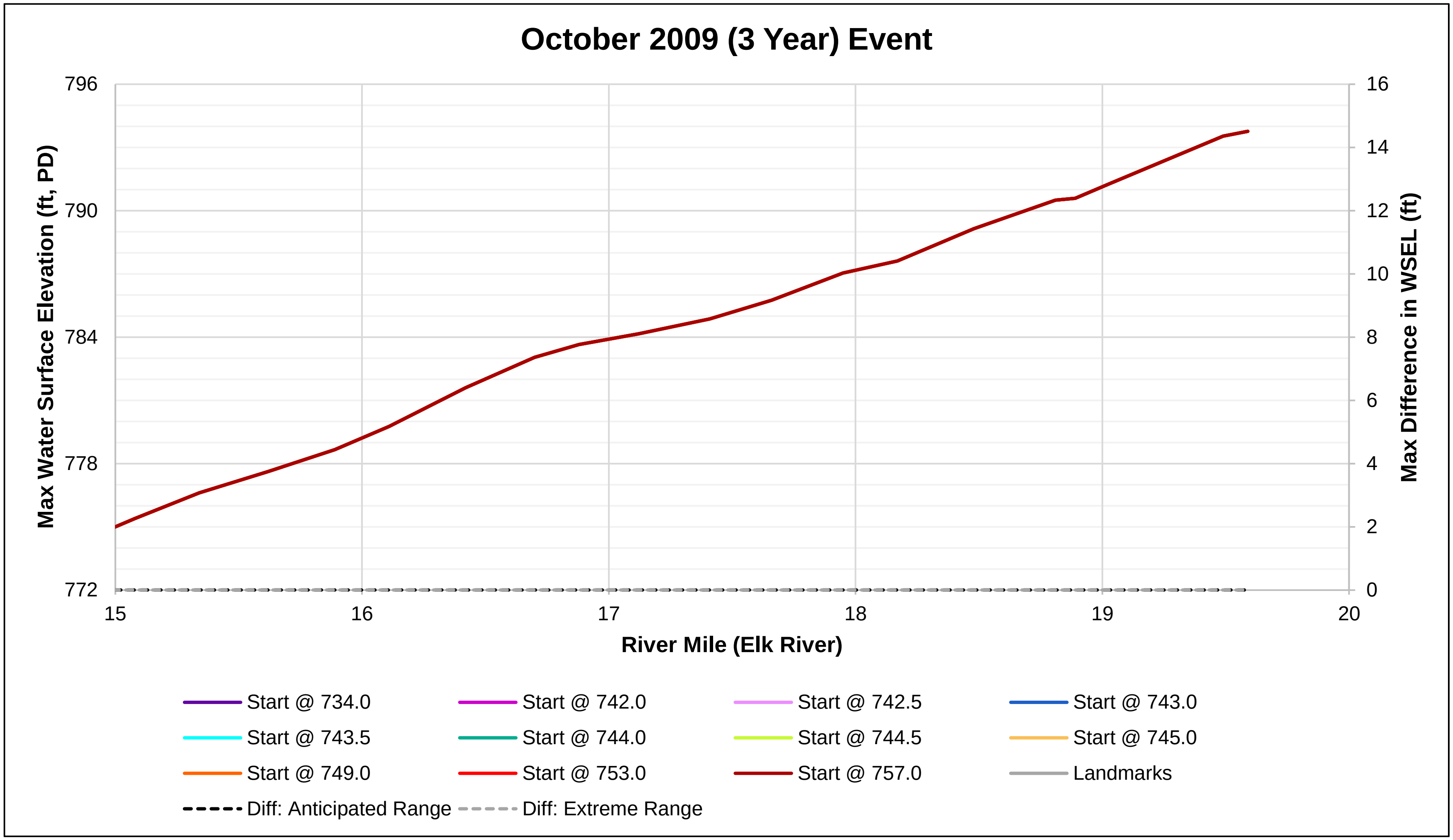


Figure E.39. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

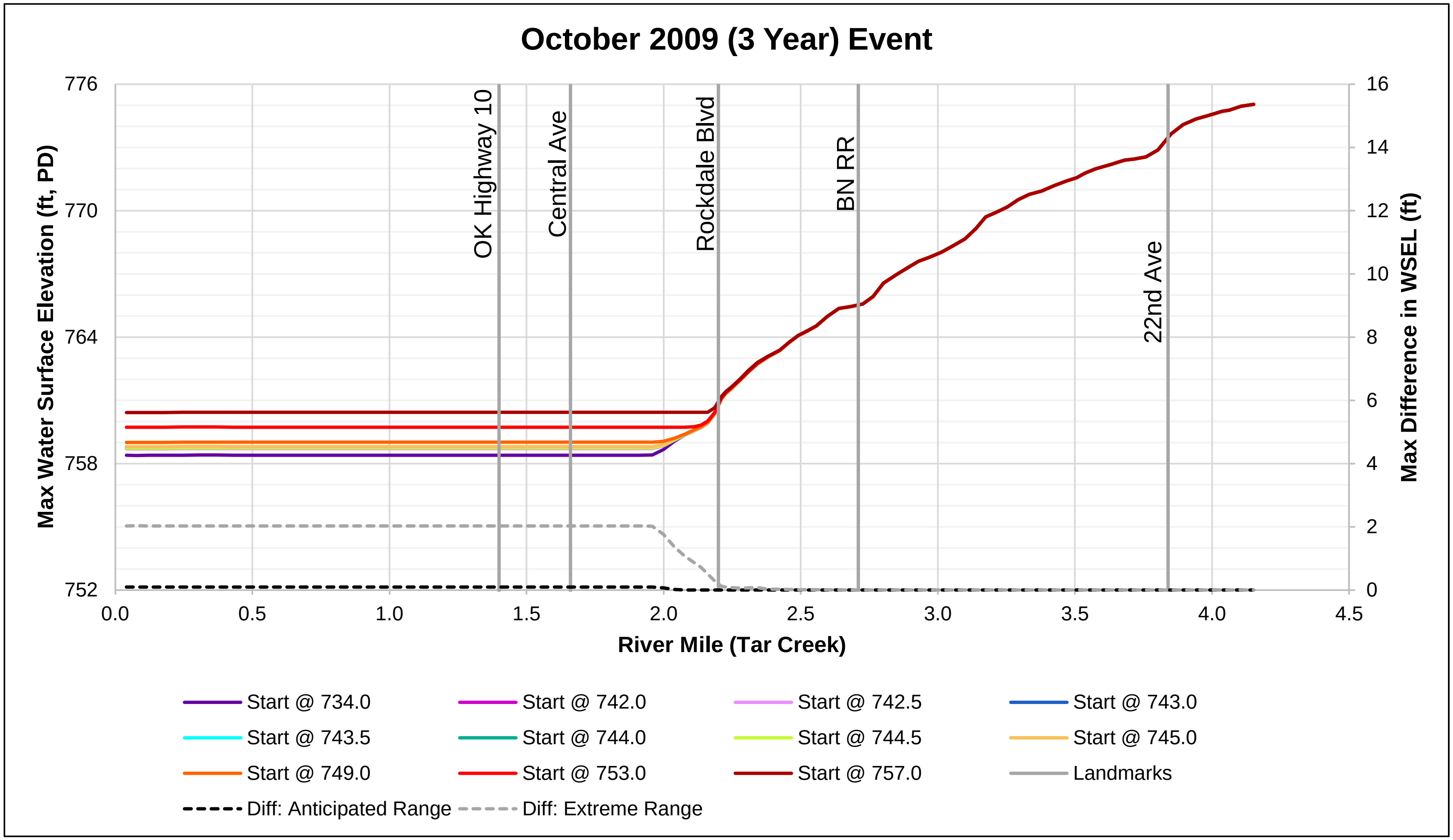


Figure E.40. Water surface elevations for the October 2009 (3 year) inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

APPENDIX E.5:
DECEMBER 2015 (15 YEAR) INFLOW EVENT
WATER SURFACE ELEVATION PROFILES

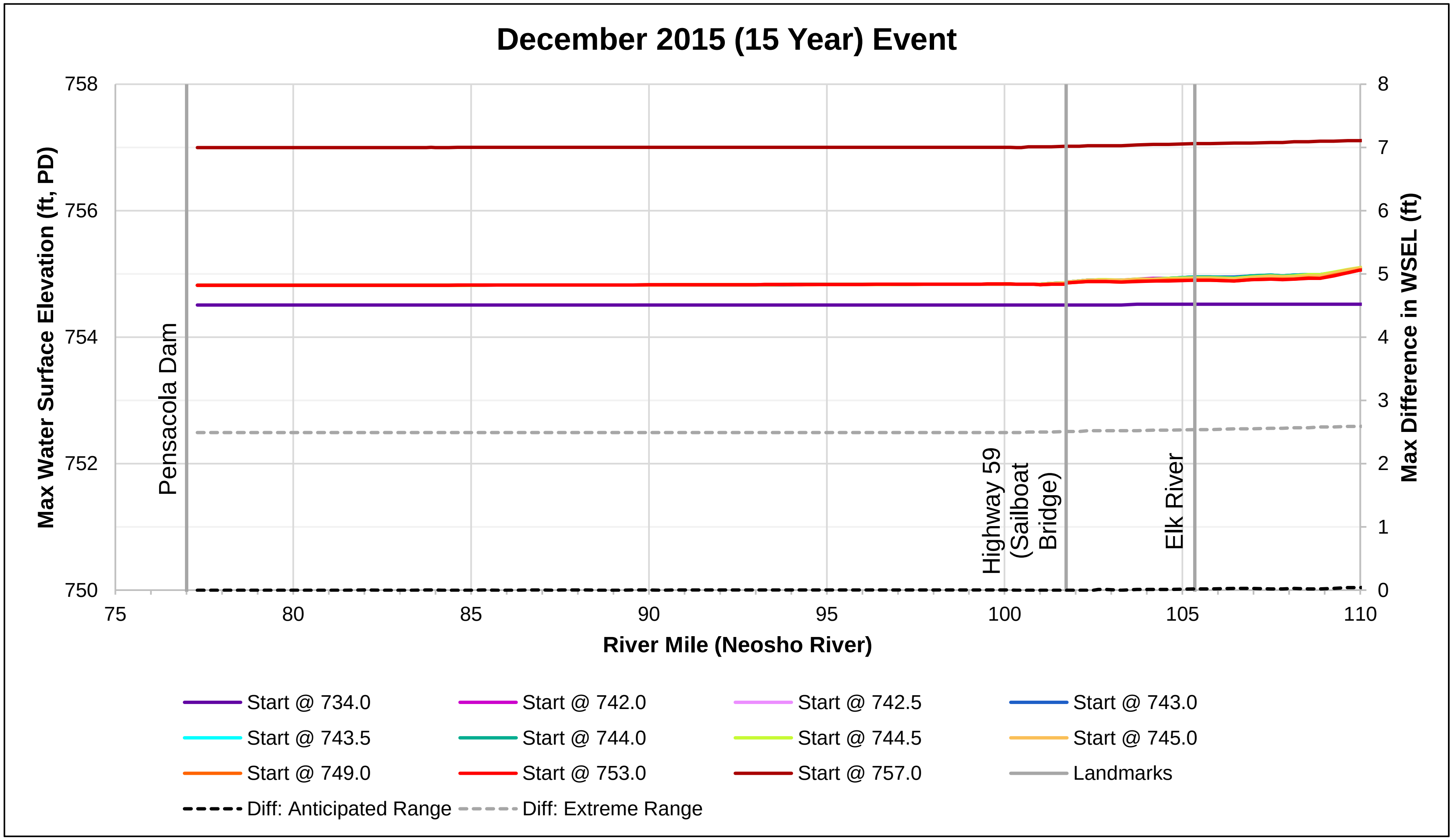


Figure E.41. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes: 1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*

2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*

3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*

4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

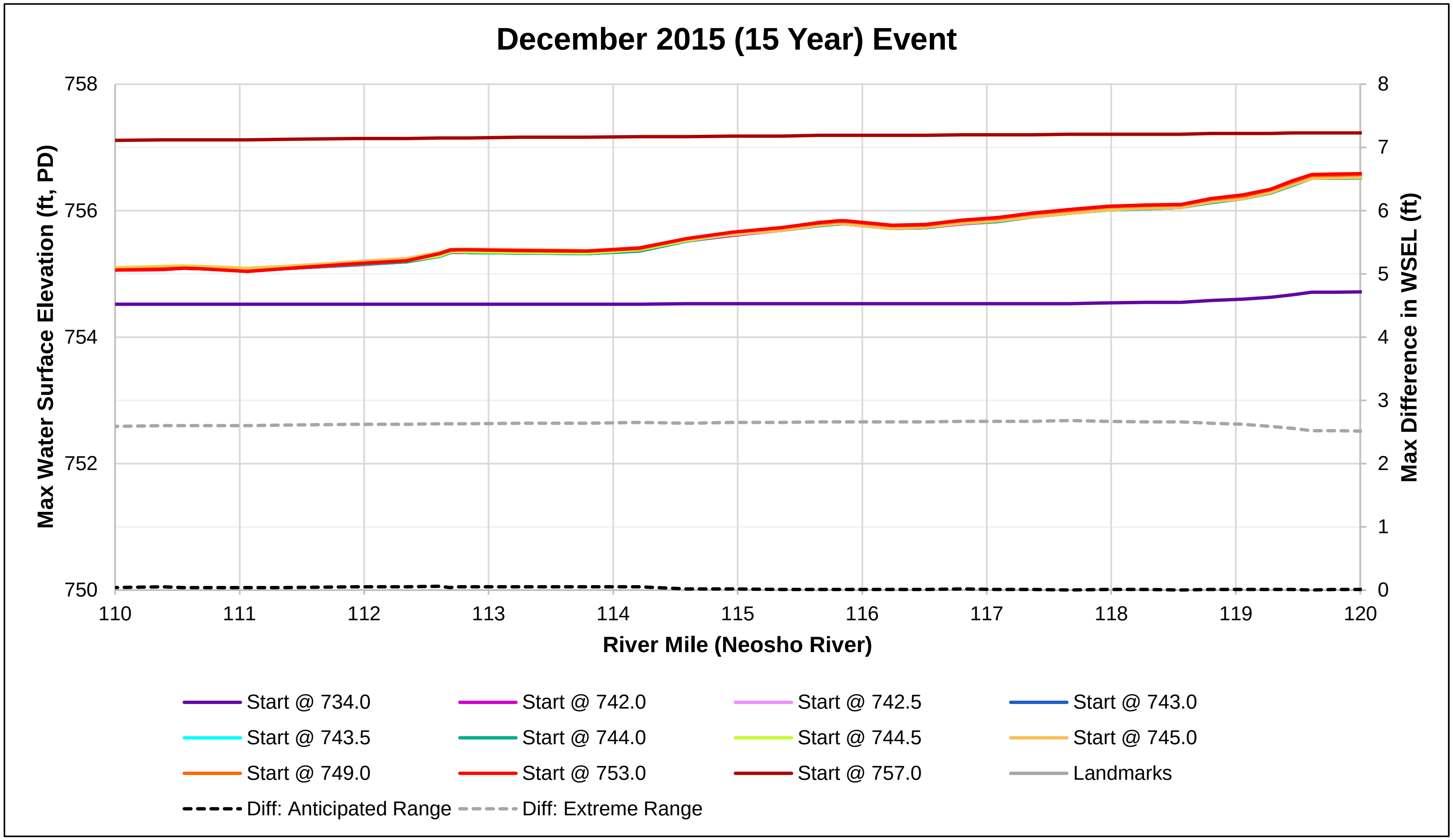


Figure E.42. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

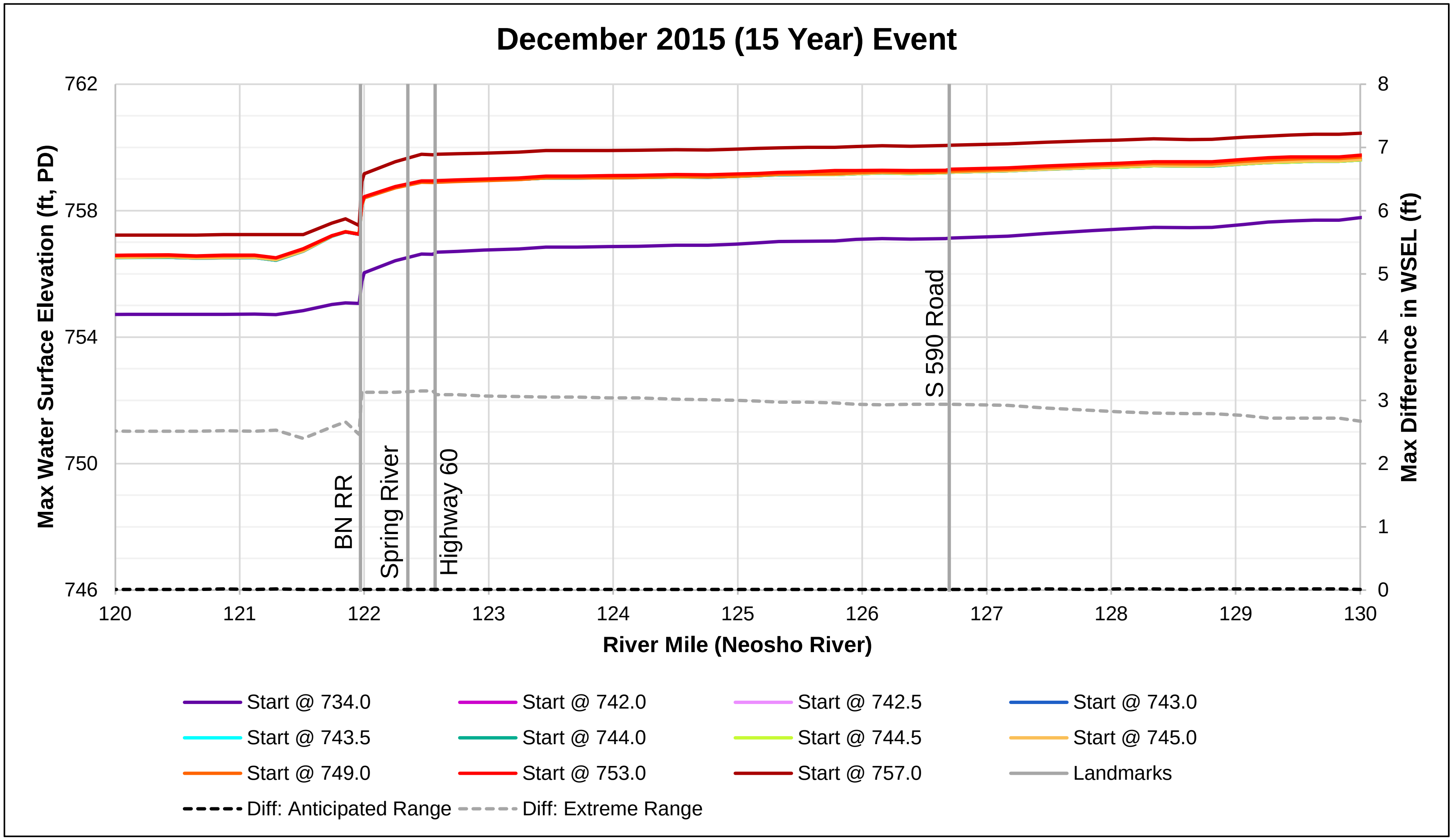


Figure E.43. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes: *1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

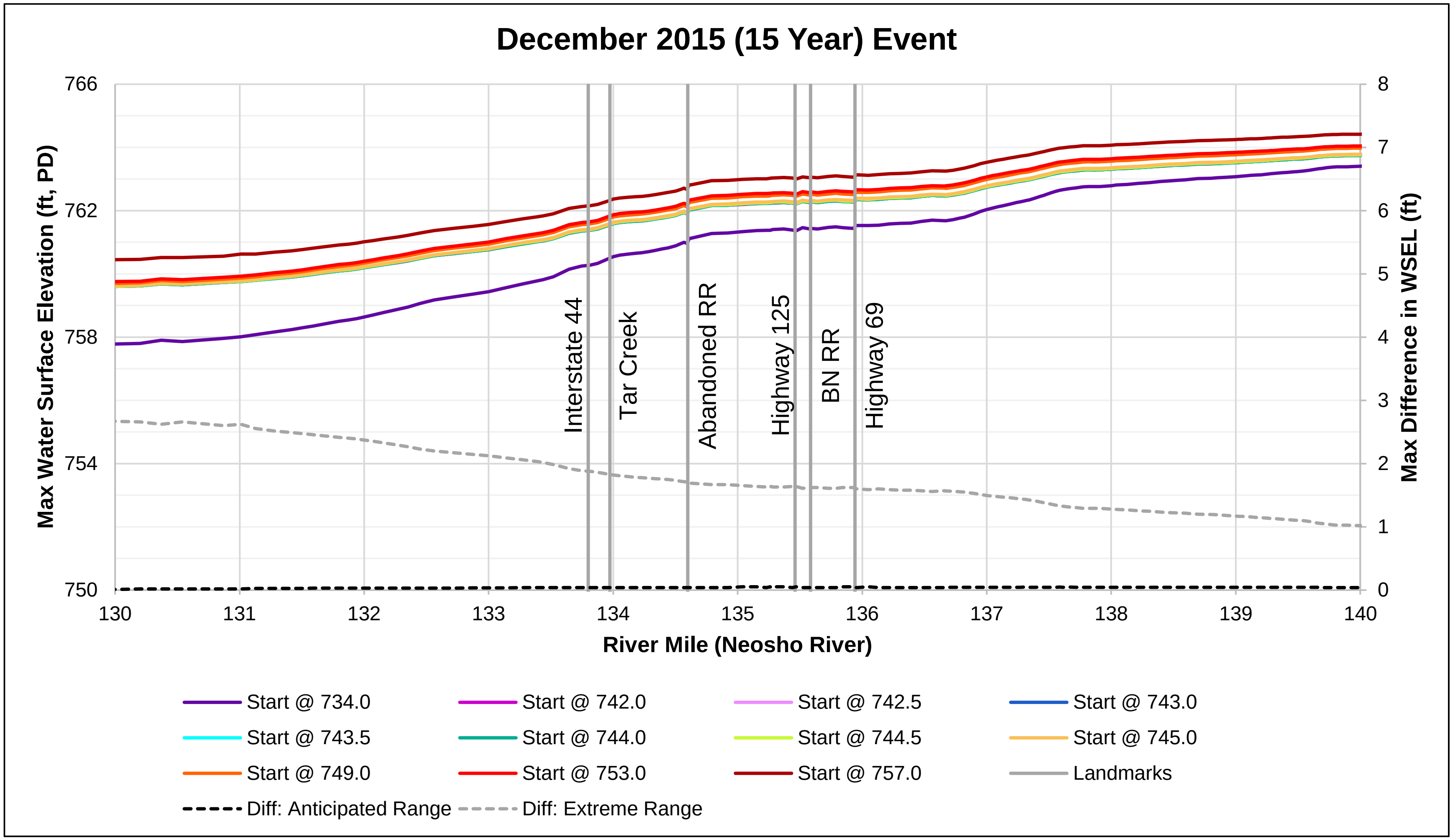


Figure E.44. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

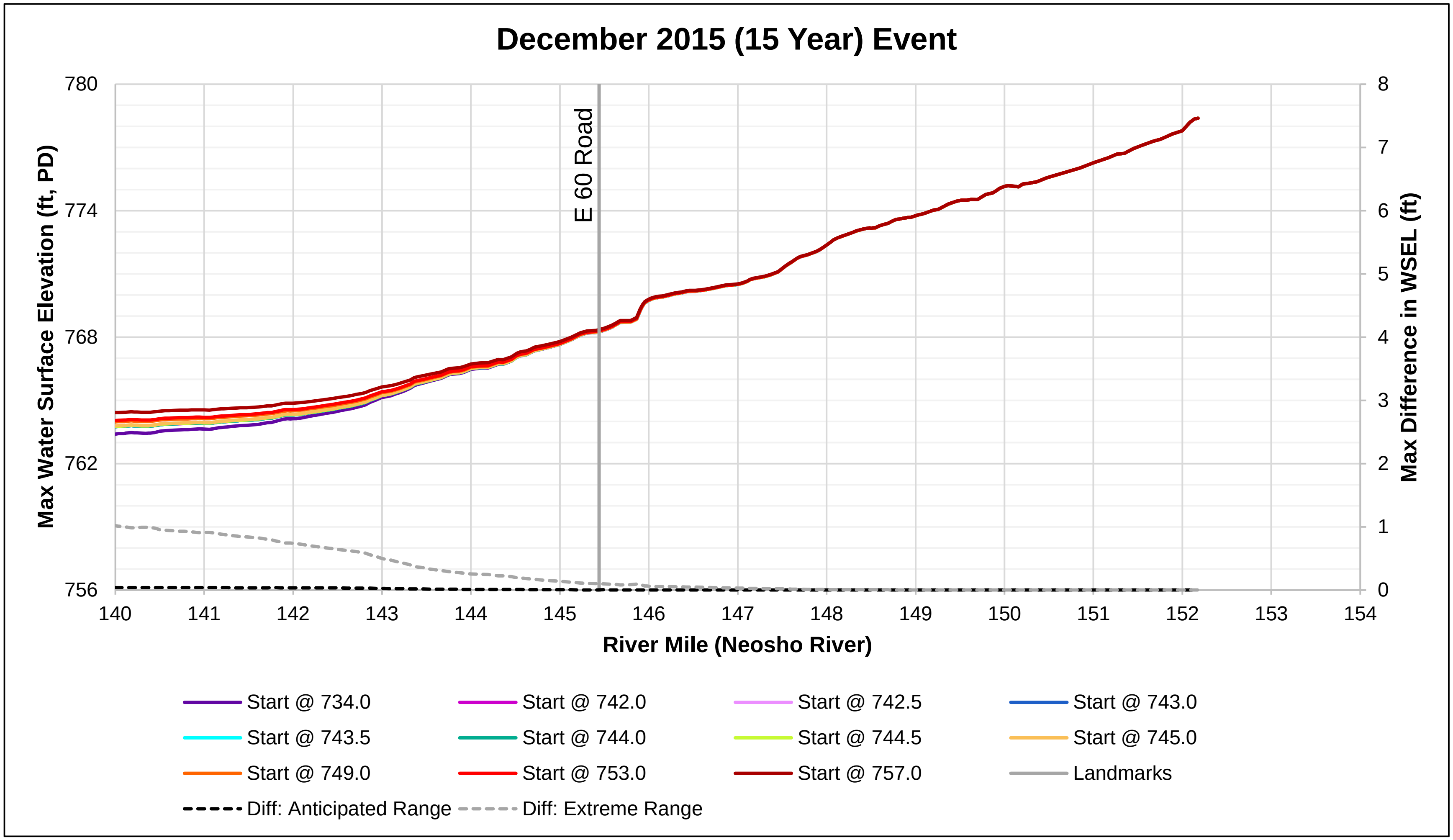


Figure E.45. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

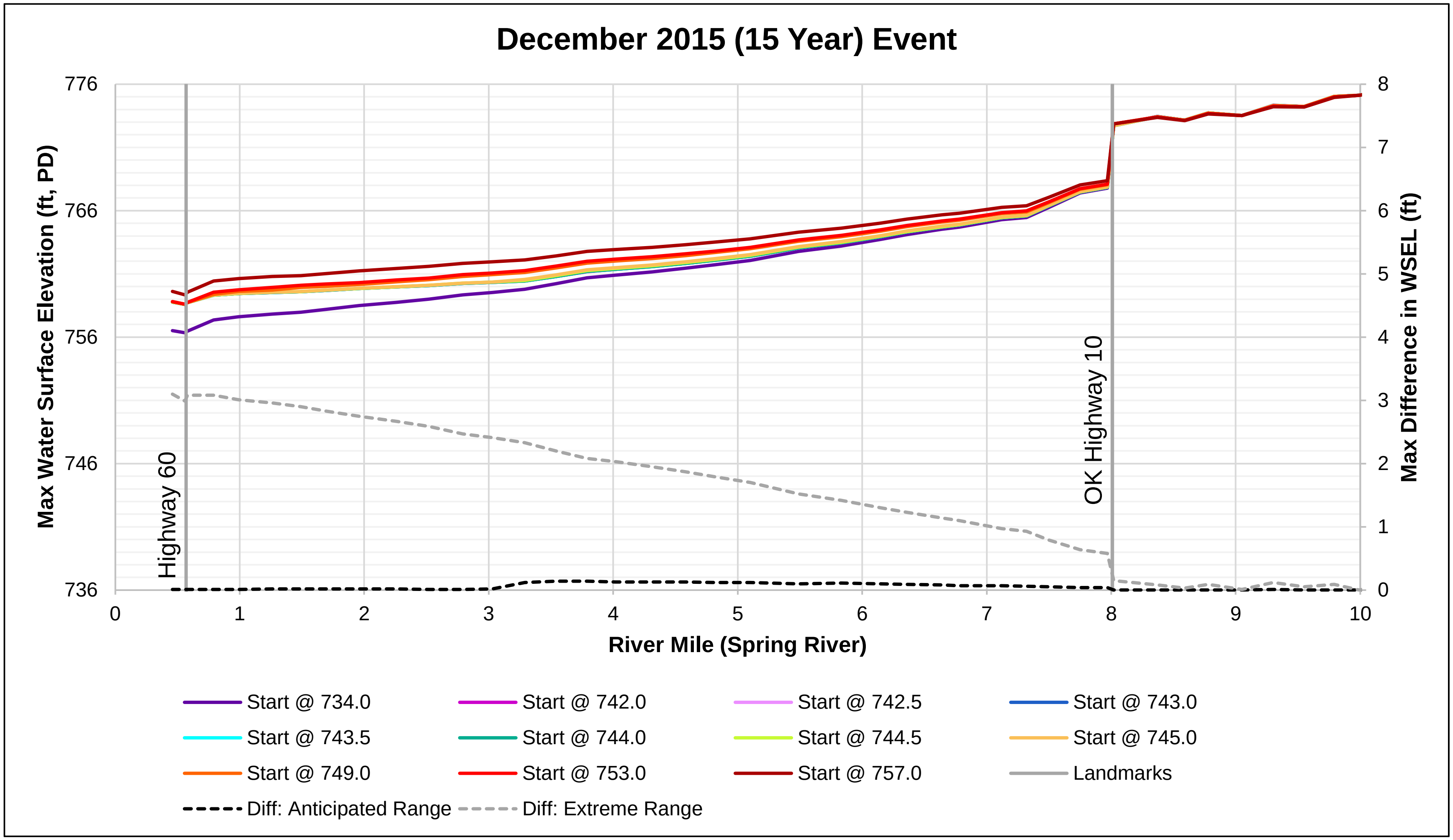


Figure E.46. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

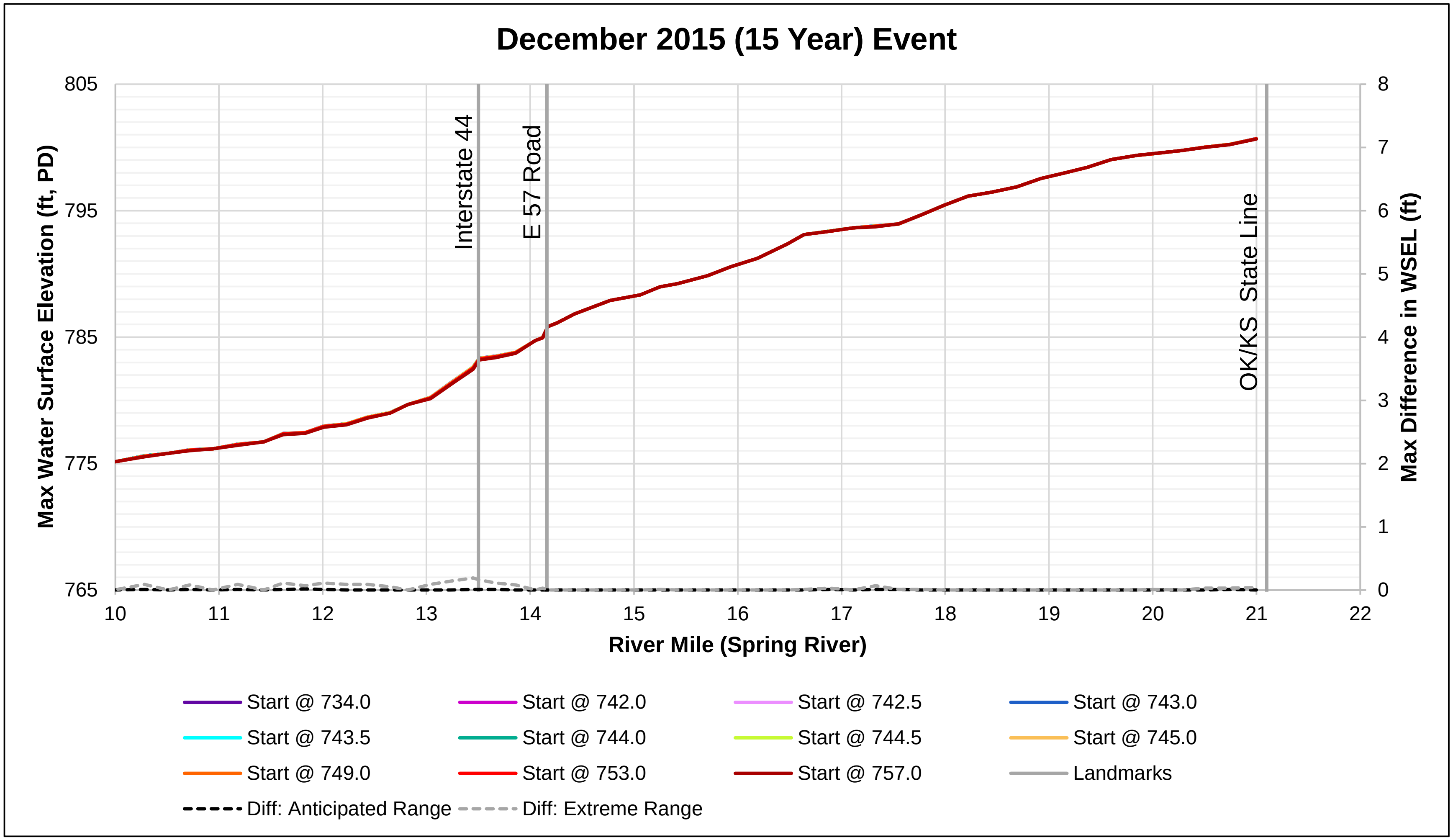


Figure E.47. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

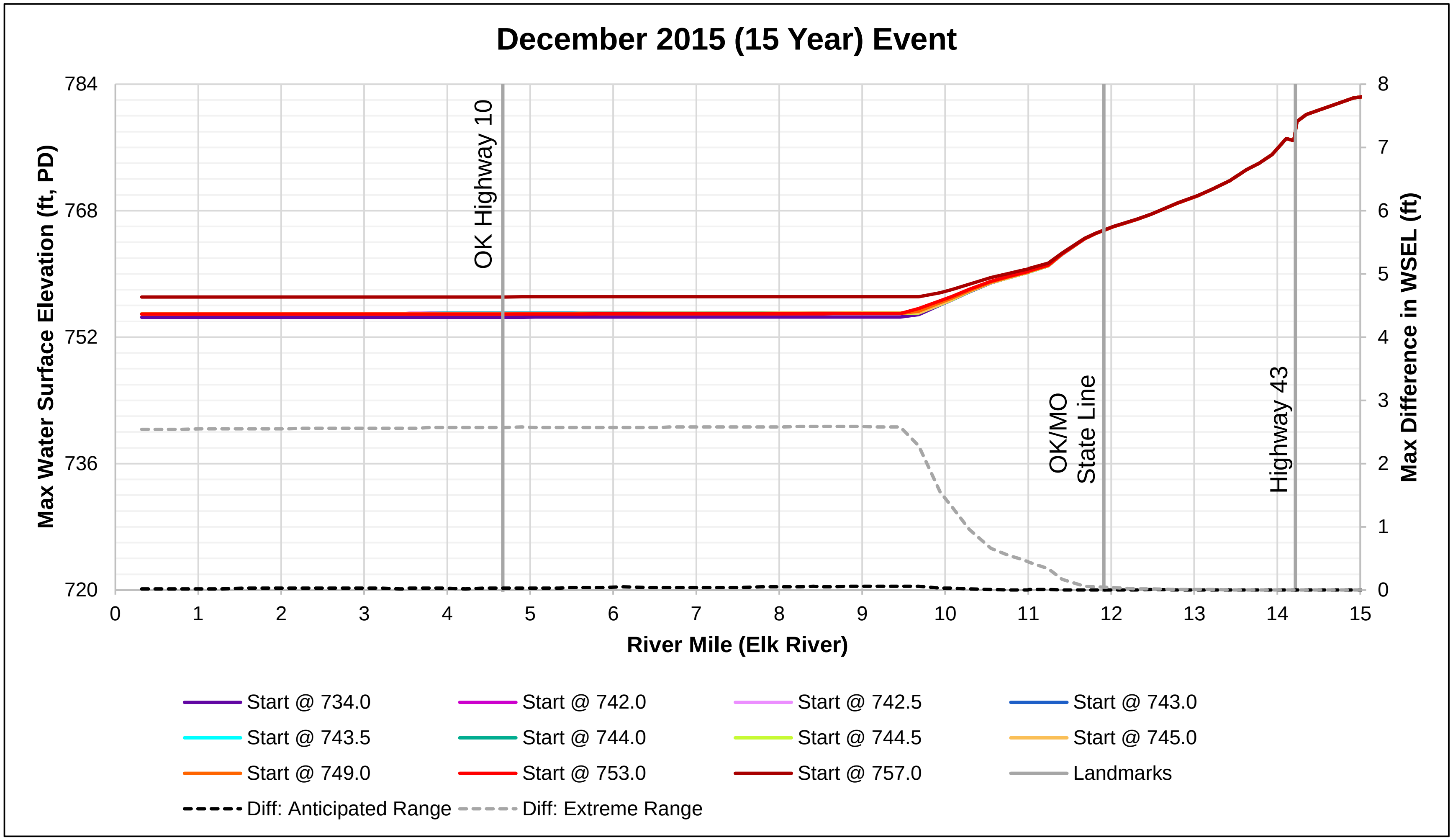


Figure E.48. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

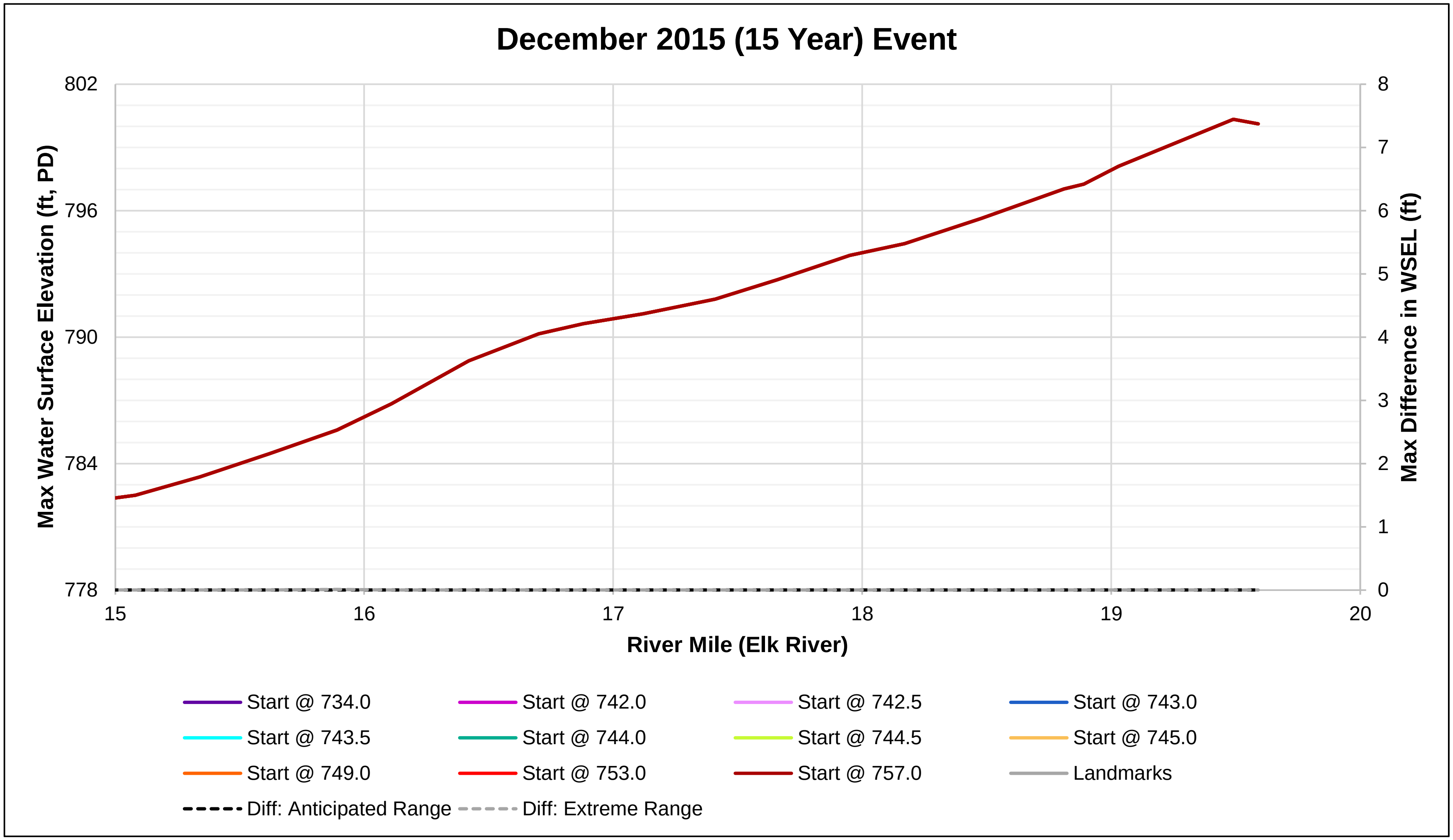


Figure E.49. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

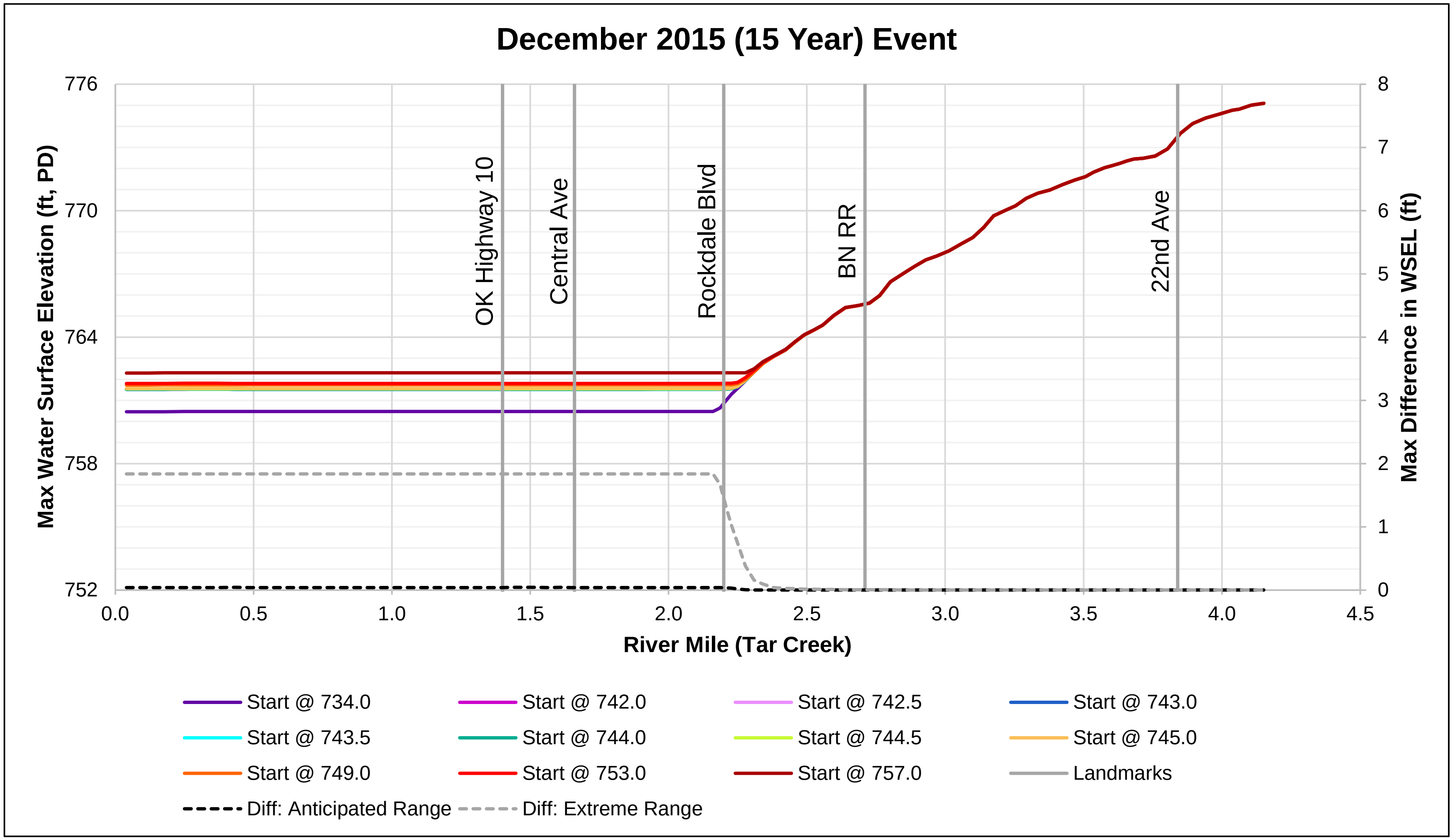


Figure E.50. Water surface elevations for the December 2015 (15 year) inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

APPENDIX E.6:
100-YEAR INFLOW EVENT
WATER SURFACE ELEVATION PROFILES

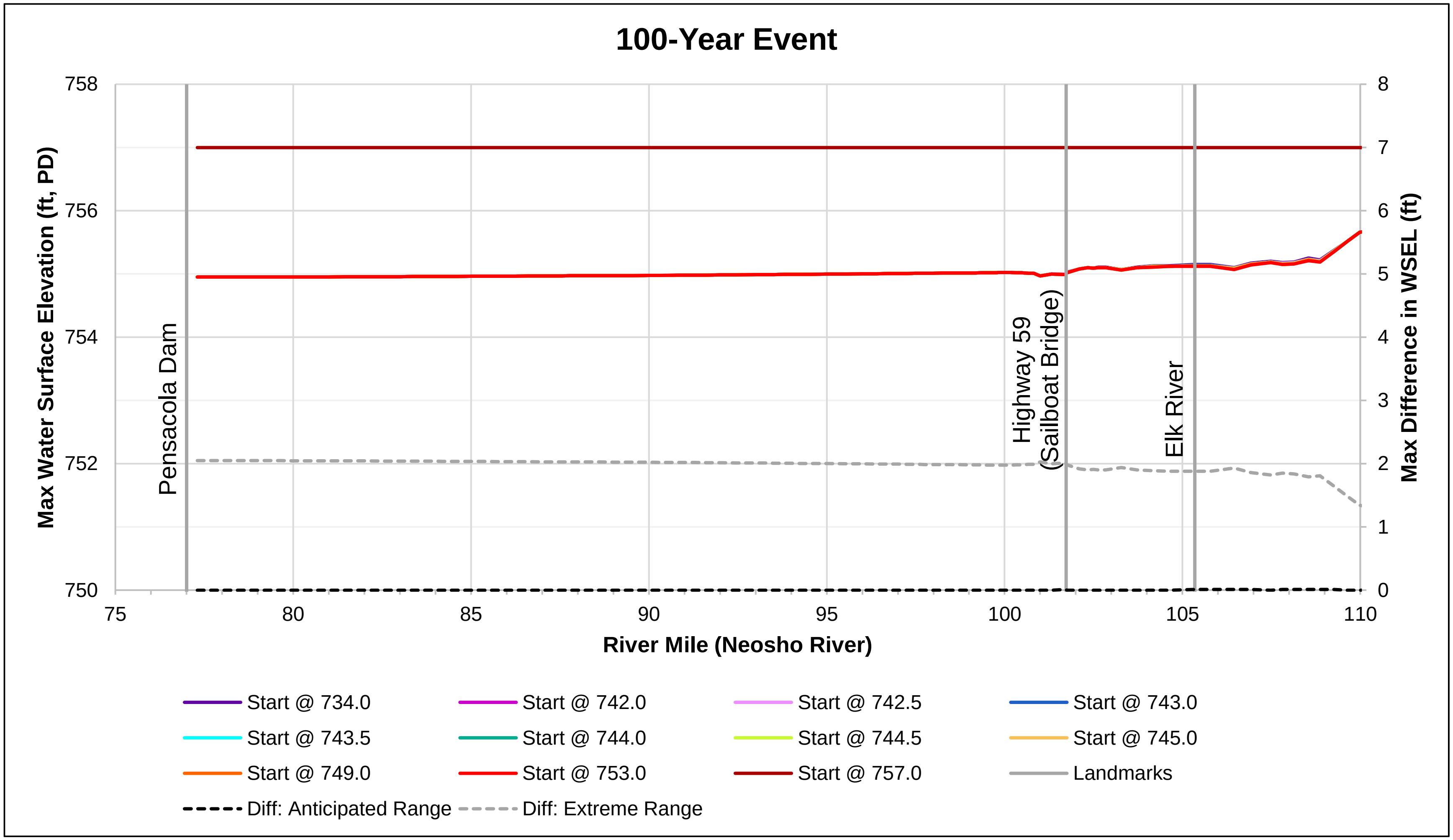


Figure E.51. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

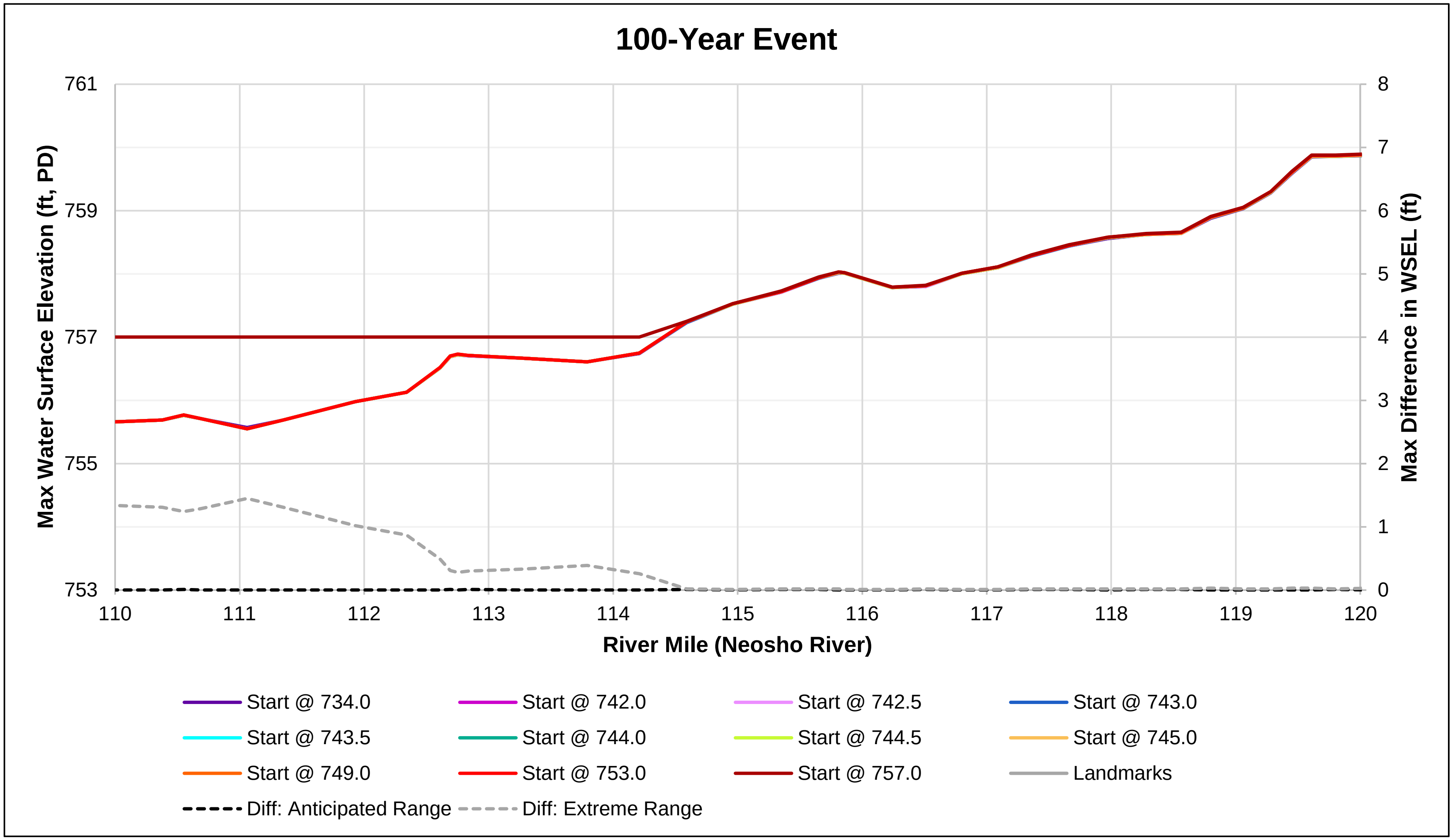


Figure E.52. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

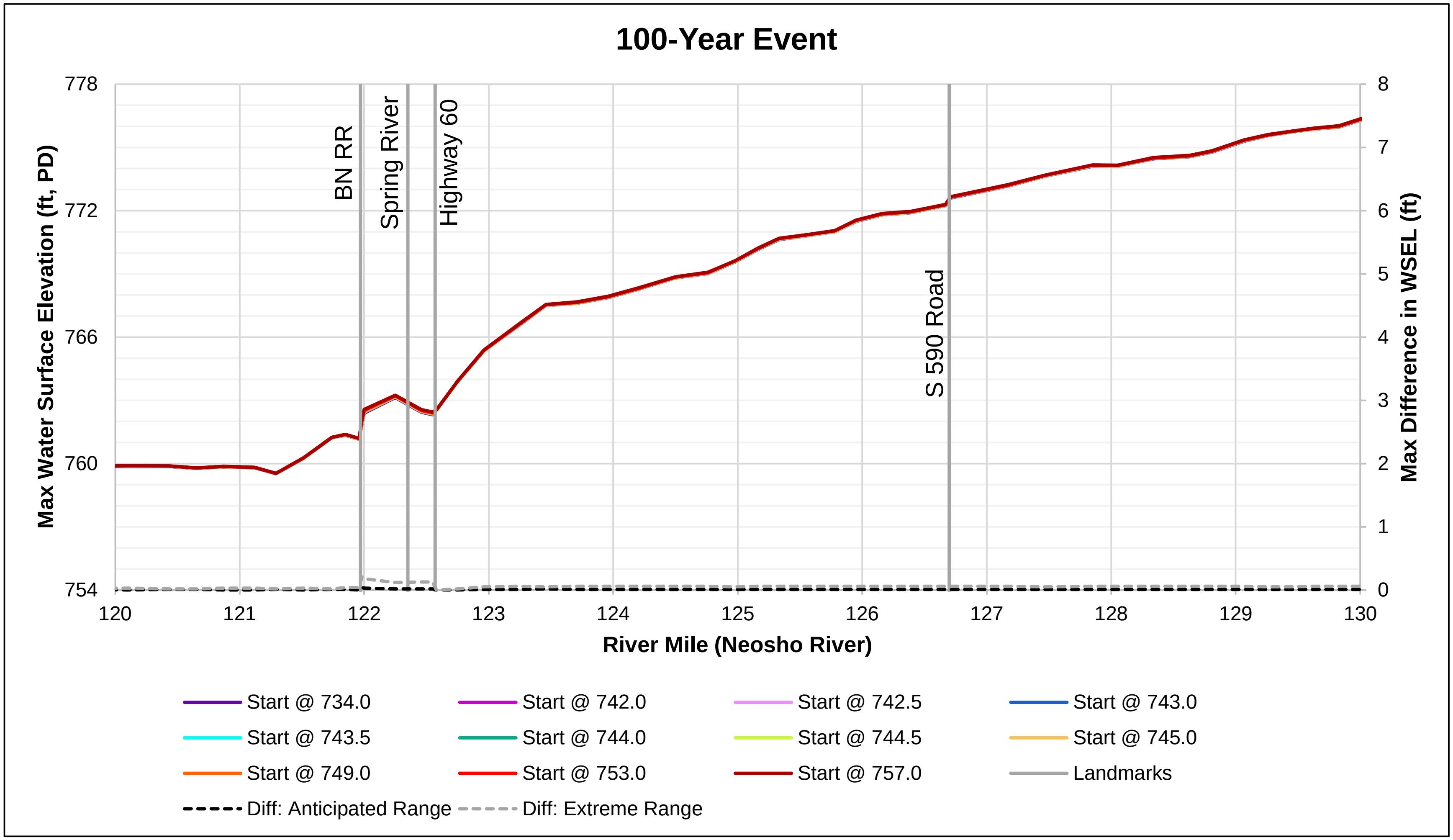


Figure E.53. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

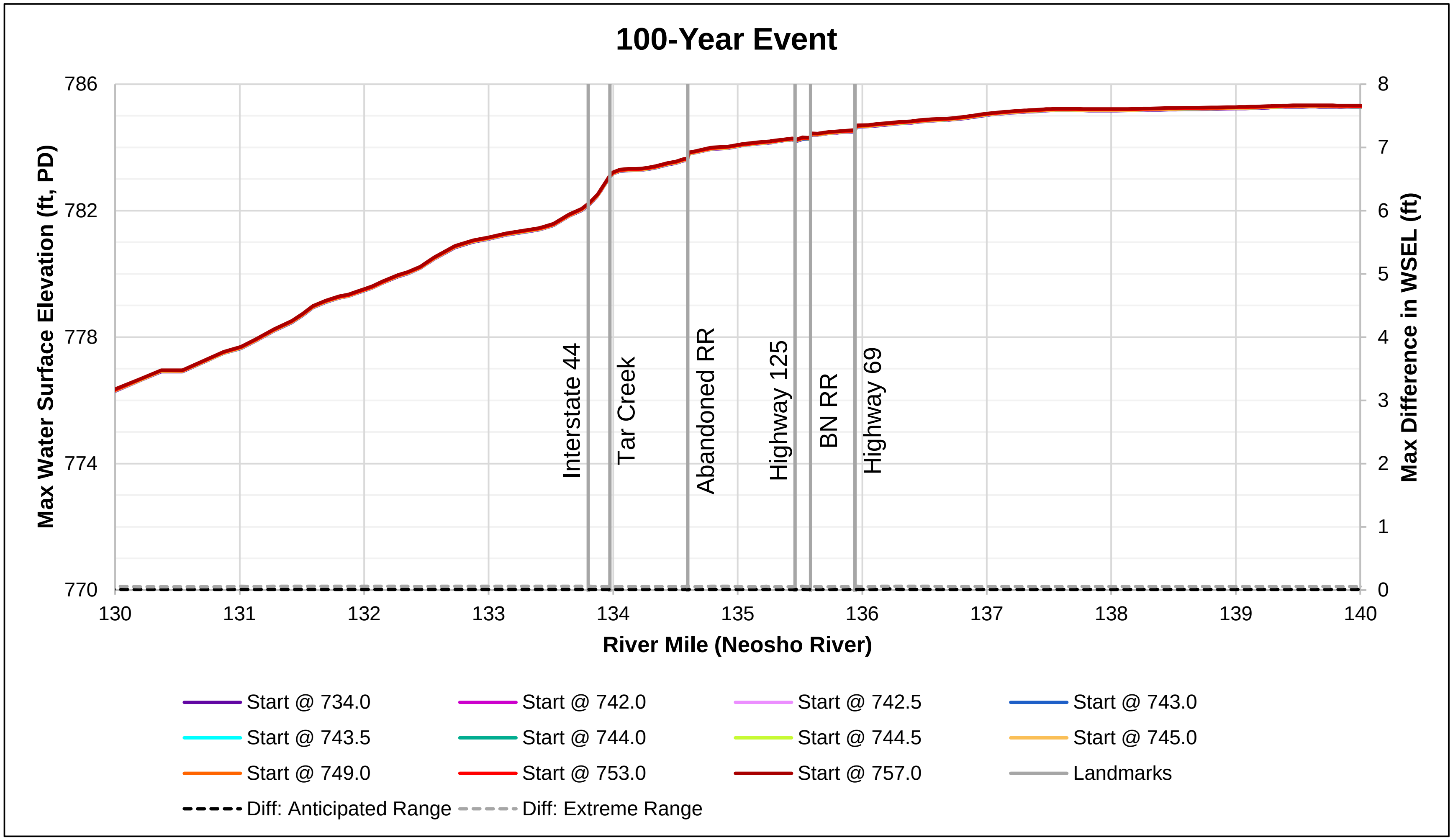


Figure E.54. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

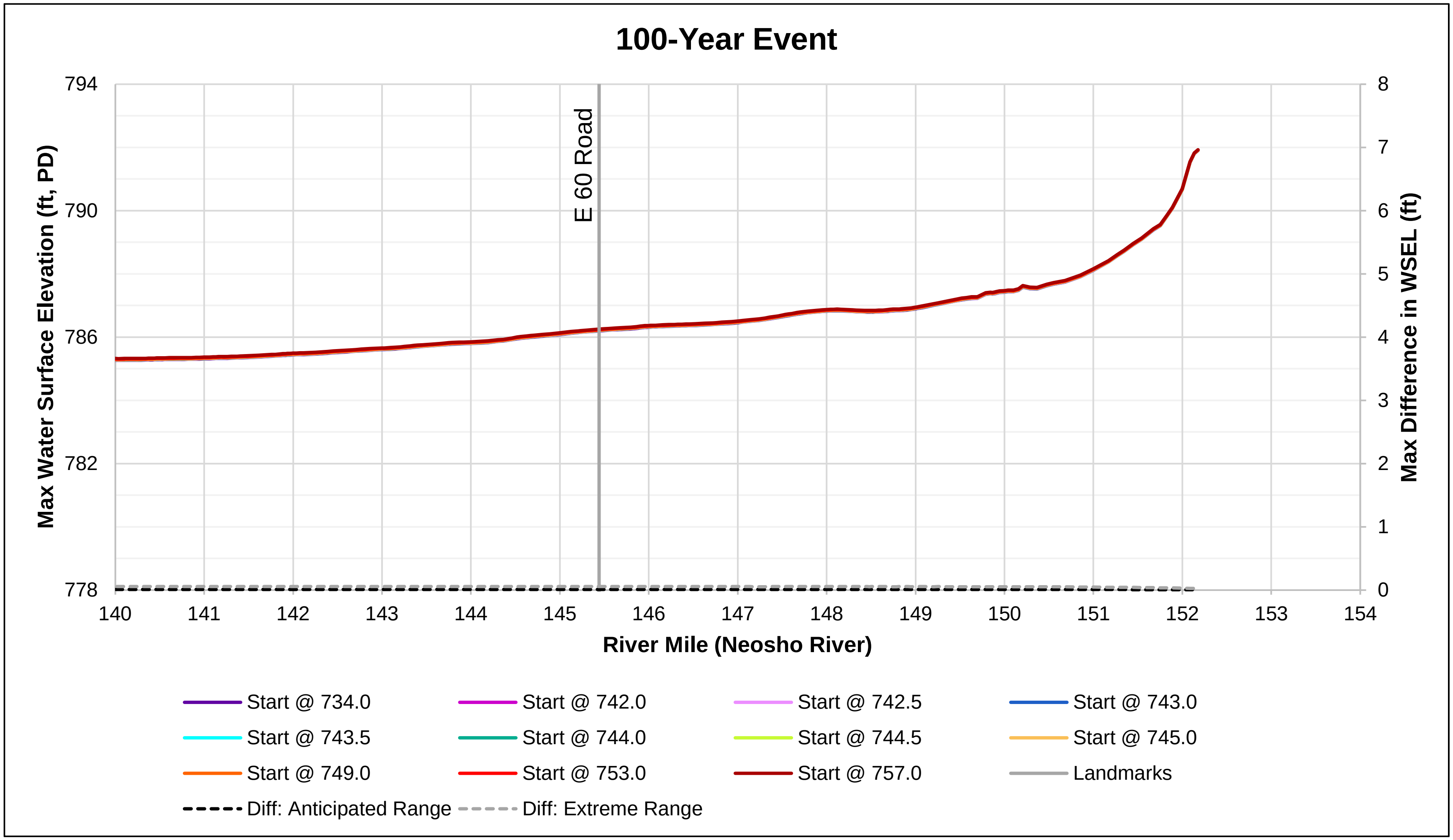


Figure E.55. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

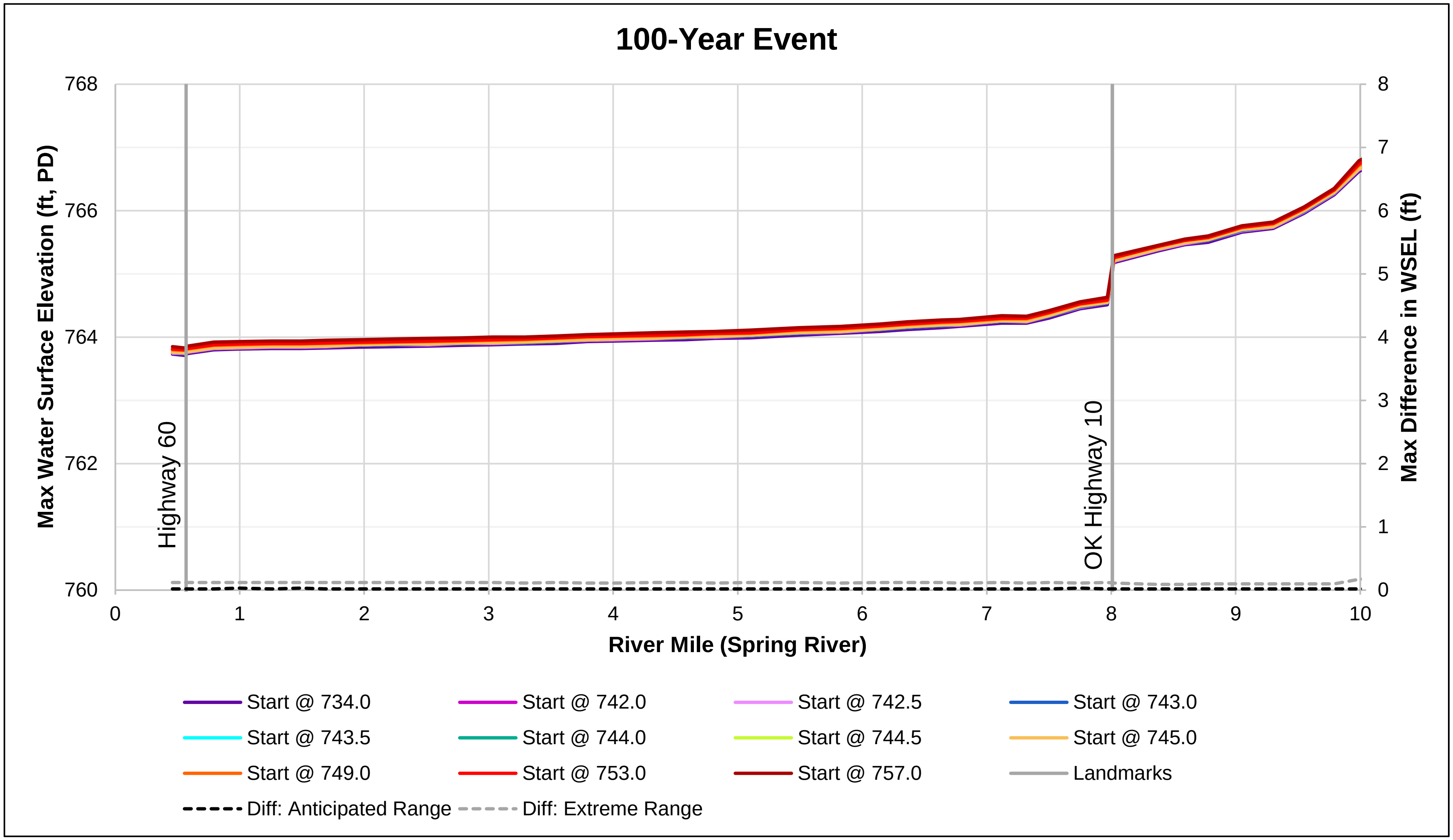


Figure E.56. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

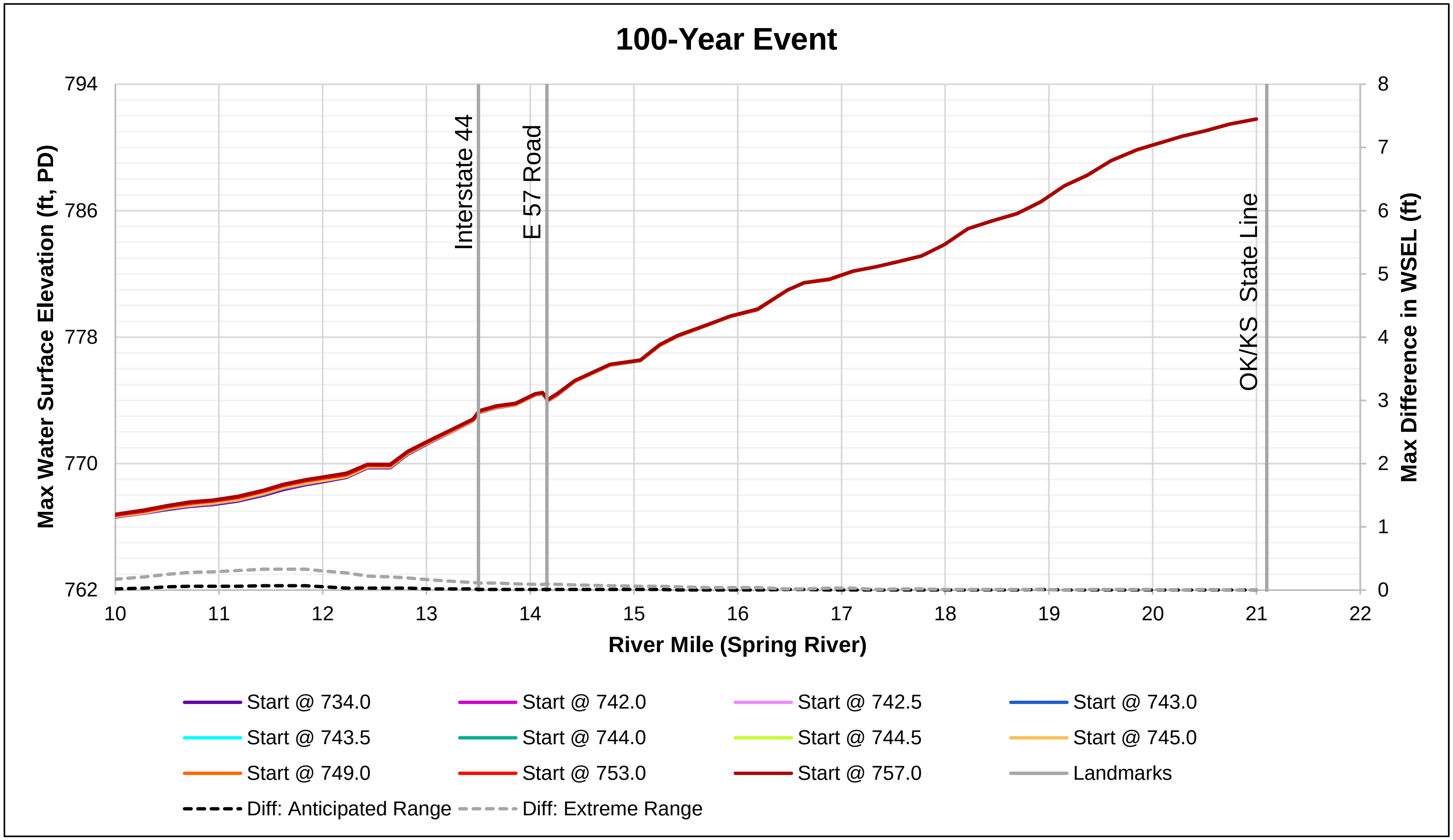


Figure E.57. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

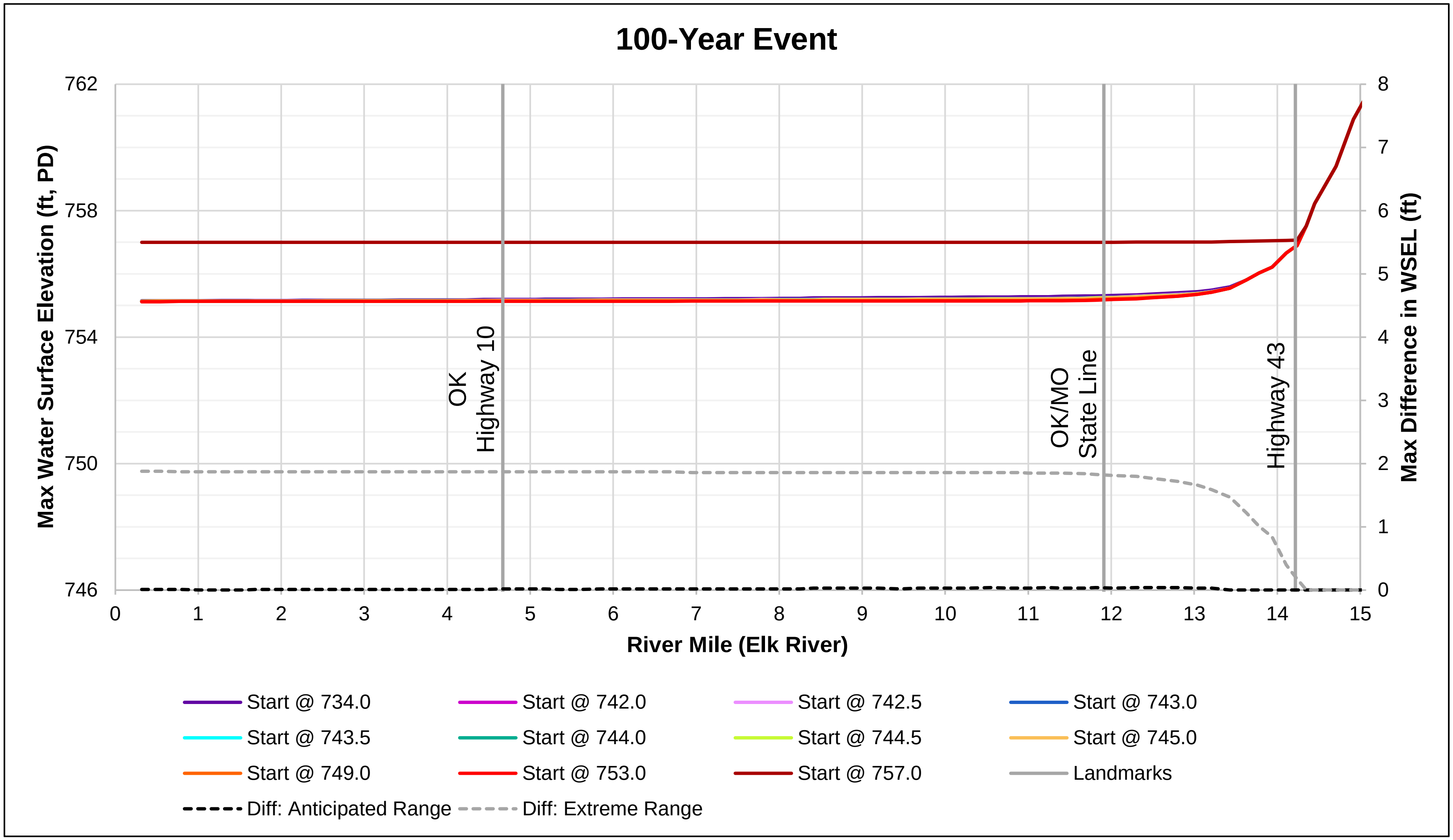


Figure E.58. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

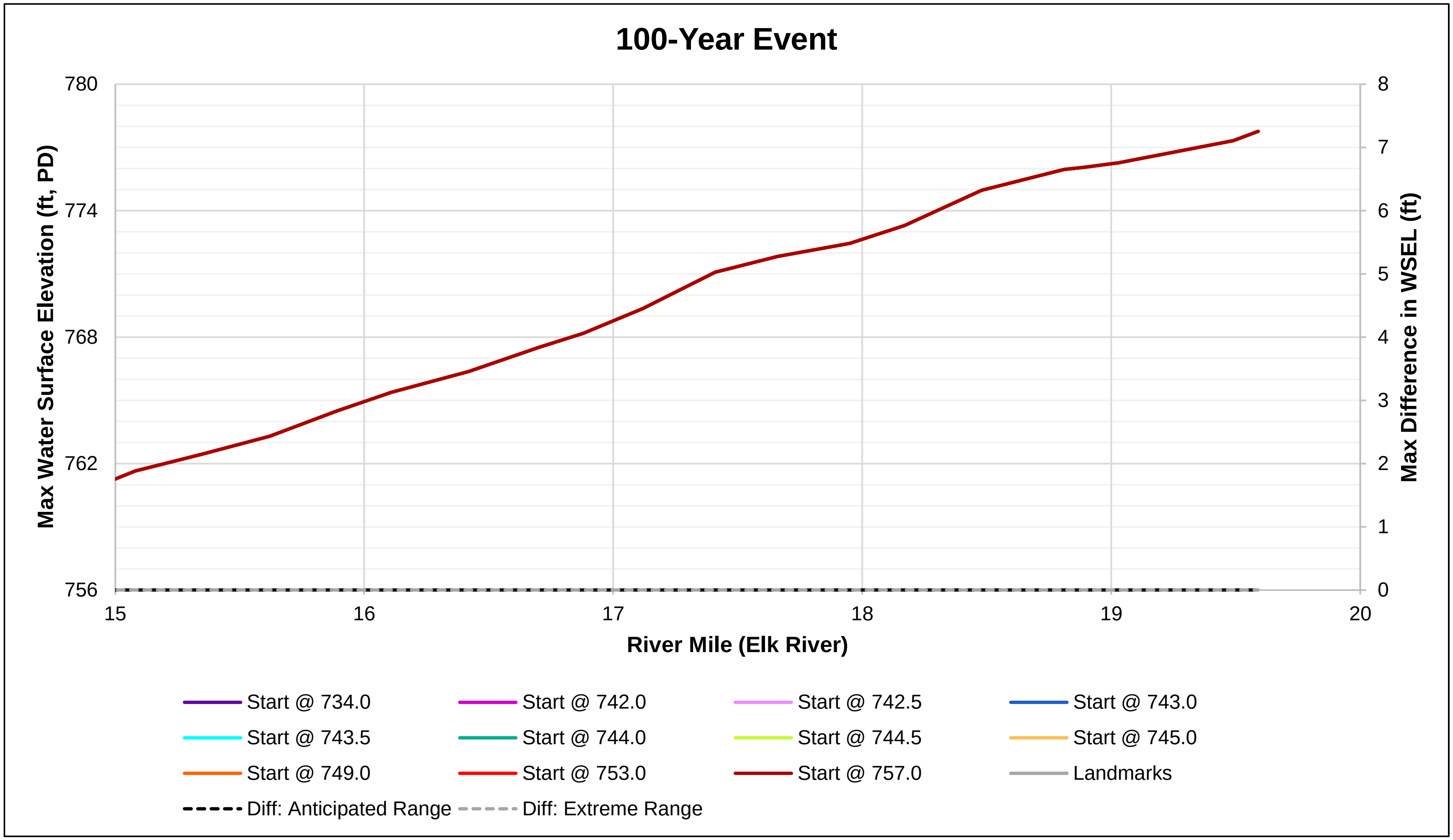


Figure E.59. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. *The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.*
2. *The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.*

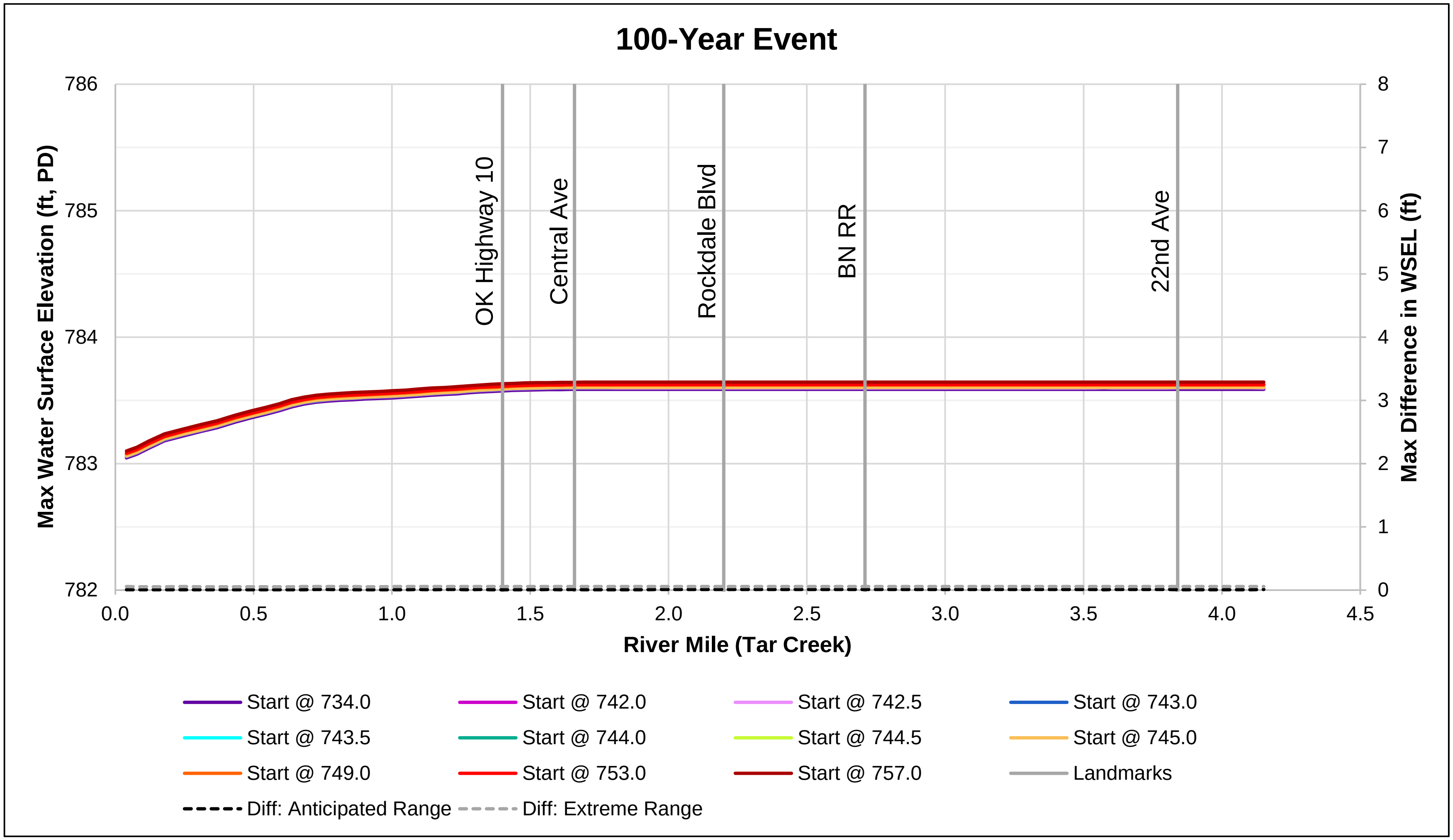


Figure E.60. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. The first set of series' names refers to starting pool elevation at Pensacola Dam. For example, "Start @ 742" means a starting pool elevation of 742 ft PD.

2. The black dashed line plotted against the right y-axis represents the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range (742 to 745 feet PD). The gray dashed line represents the maximum difference in WSEL for simulations with starting stages at extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the highest starting elevation WSEL profile is visible, the WSEL profiles for the other starting elevations are nearly identical.

APPENDIX E.7:
HISTORICAL STARTING STAGE
WATER SURFACE ELEVATION PROFILES

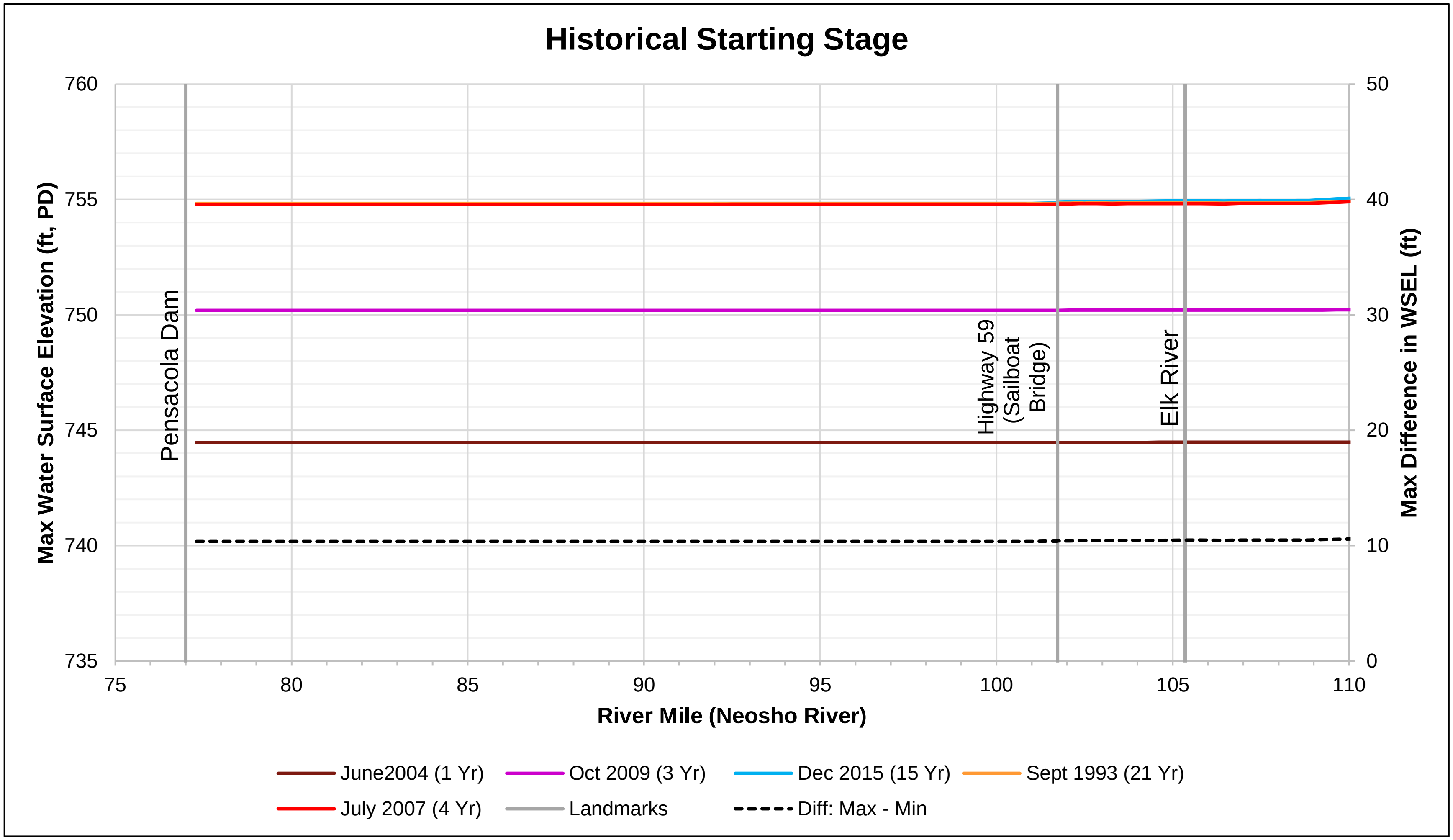


Figure E.61. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

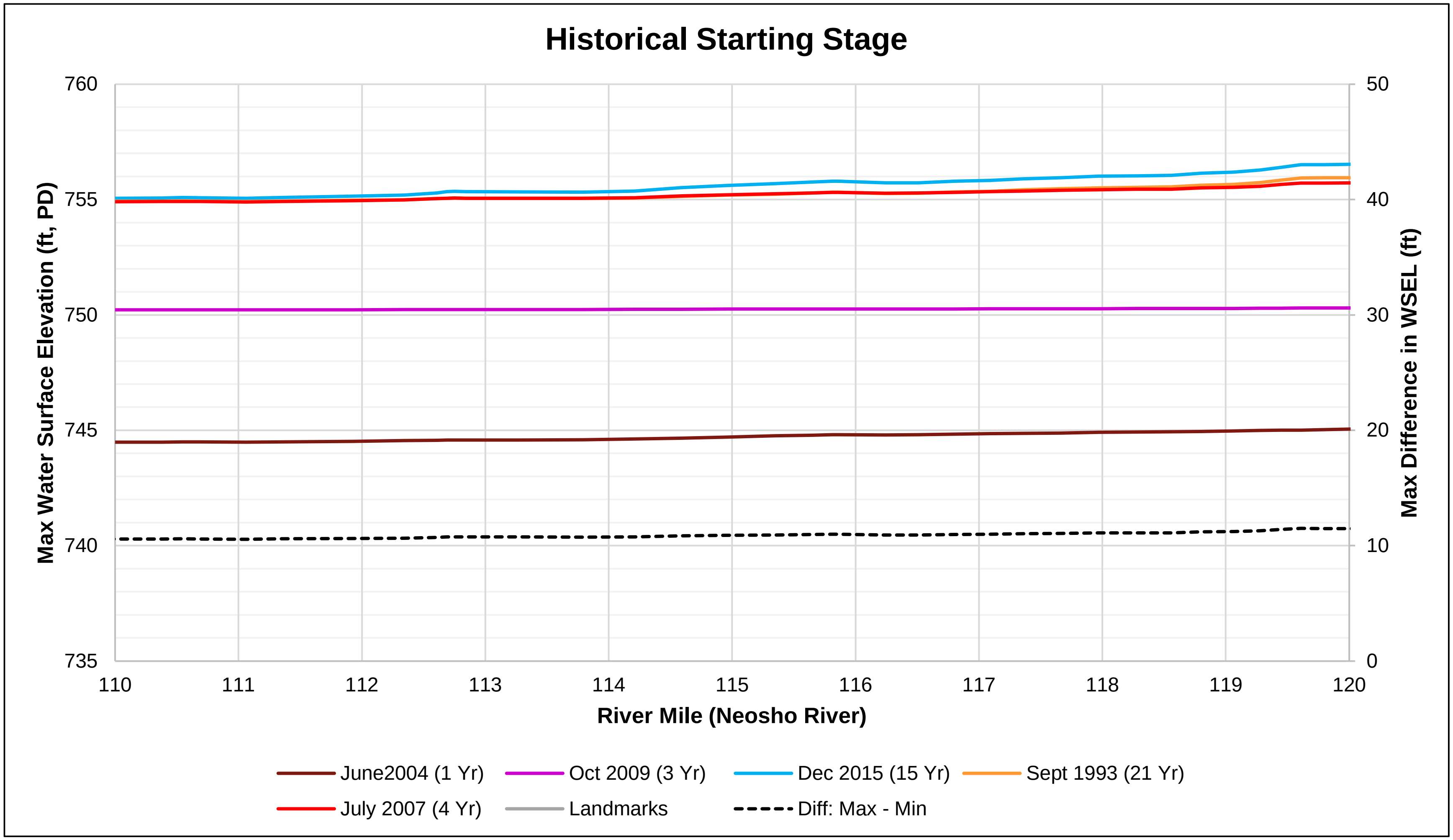


Figure E.62. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

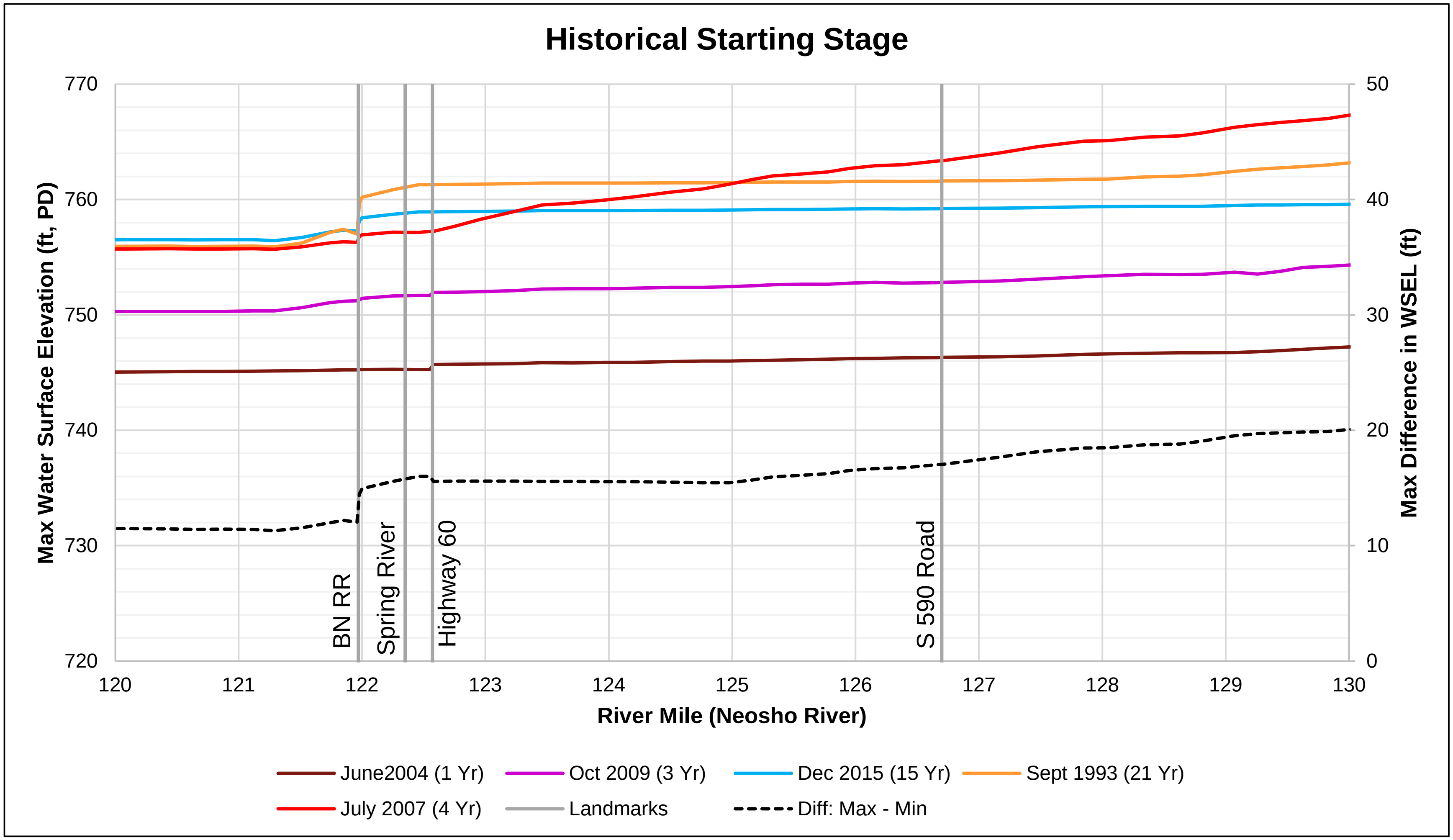


Figure E.63. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

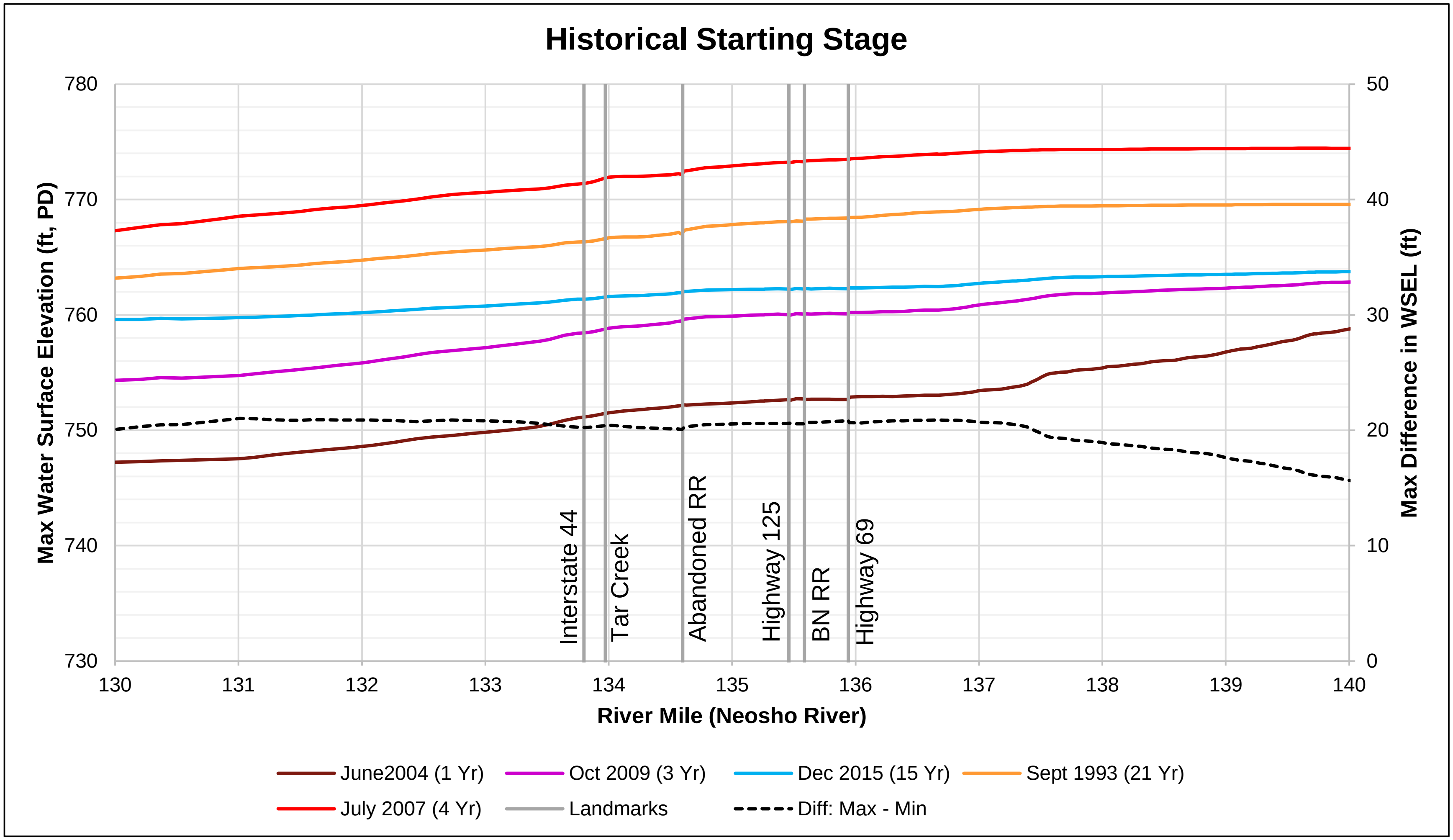


Figure E.64. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

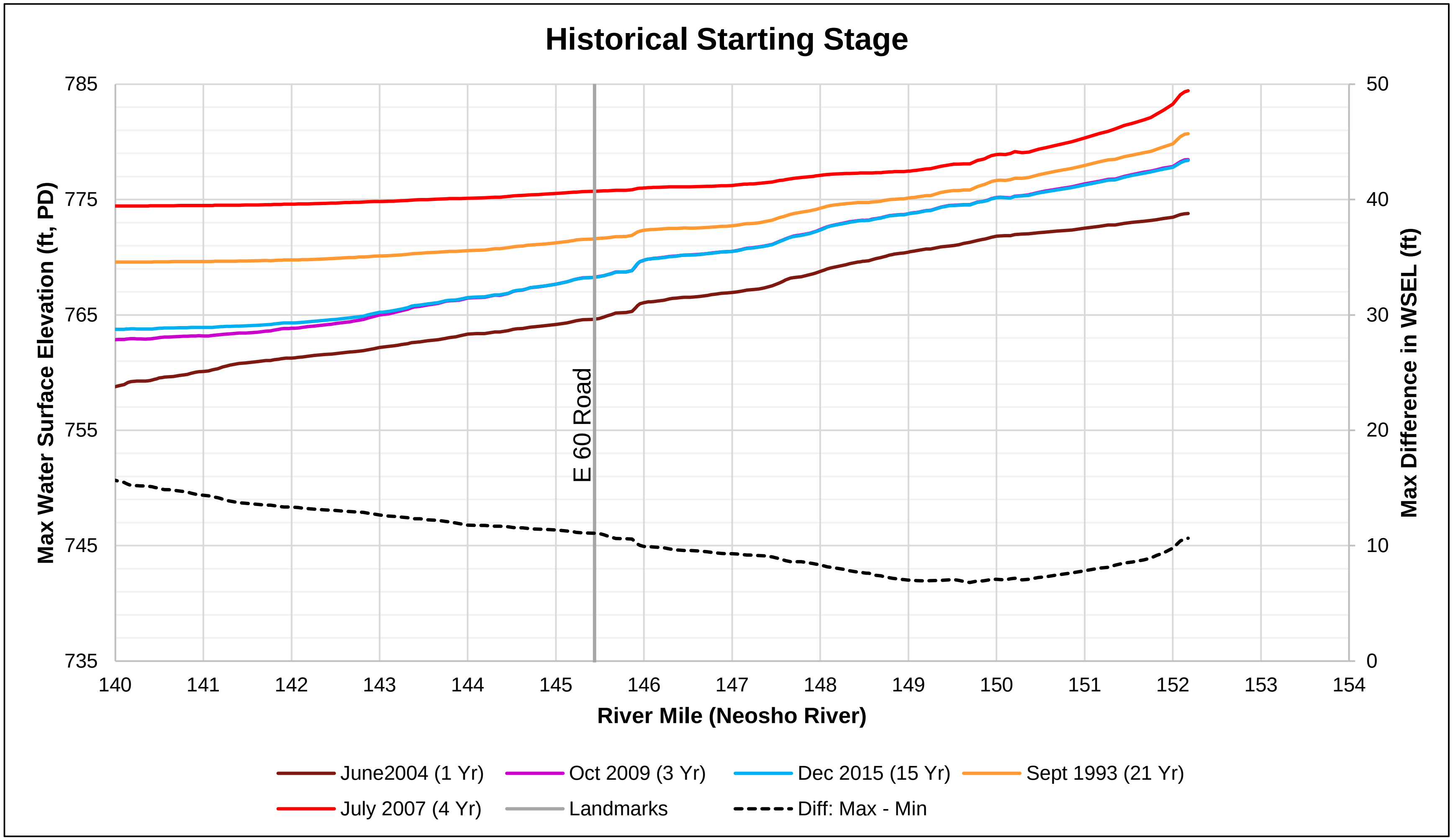


Figure E.65. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

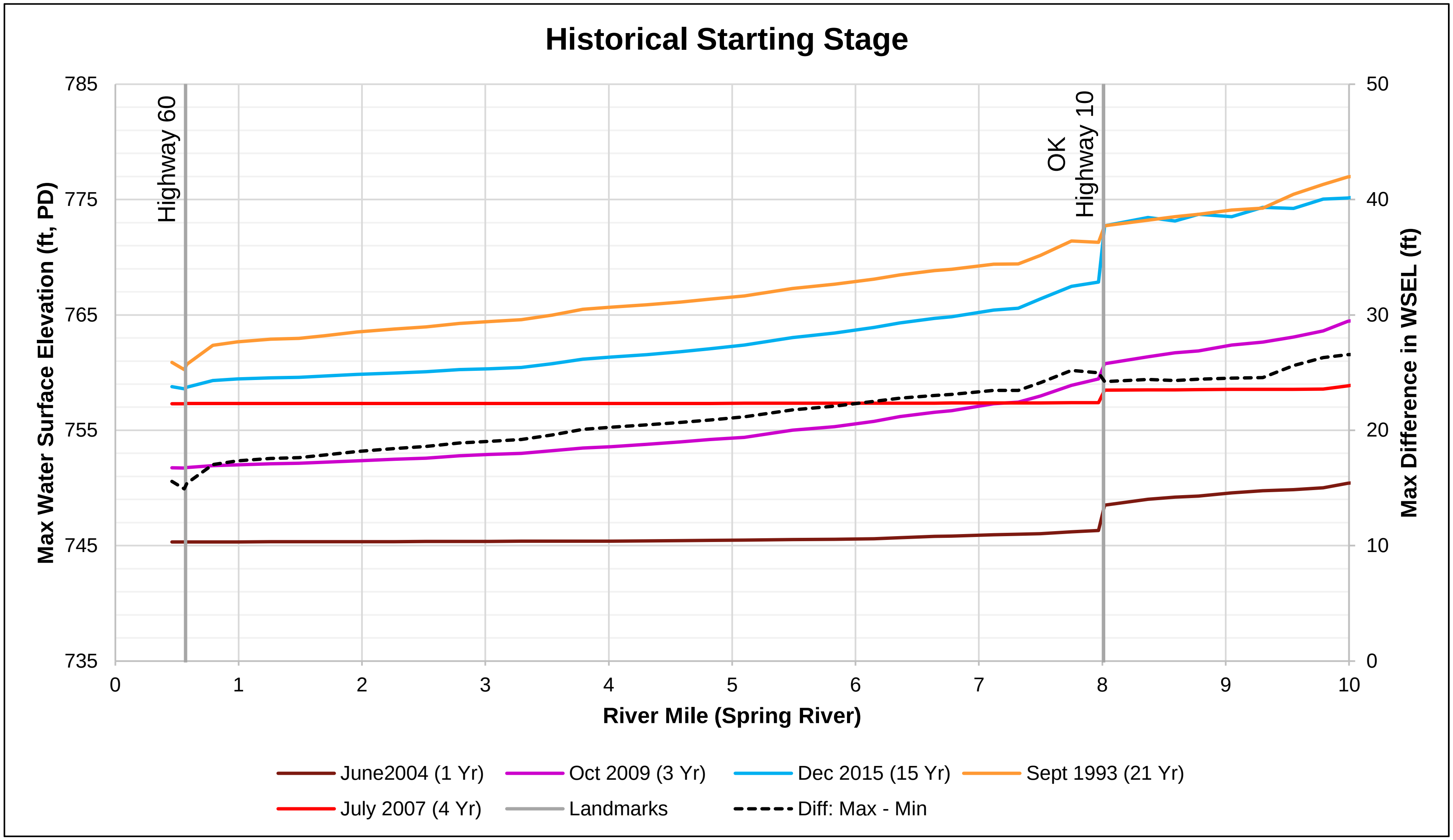


Figure E.66. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

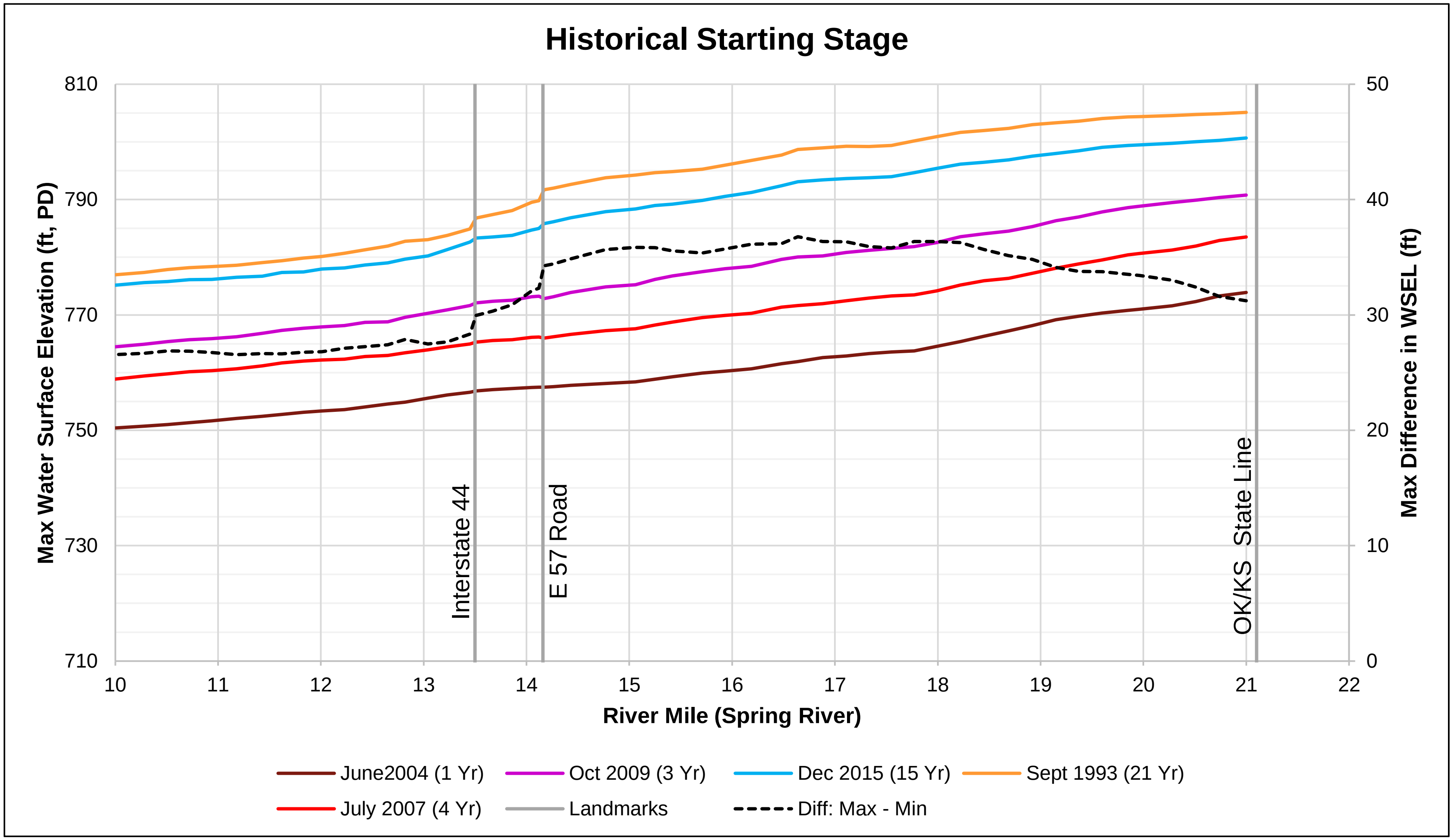


Figure E.67. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes: 1. *The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.*

2. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.*

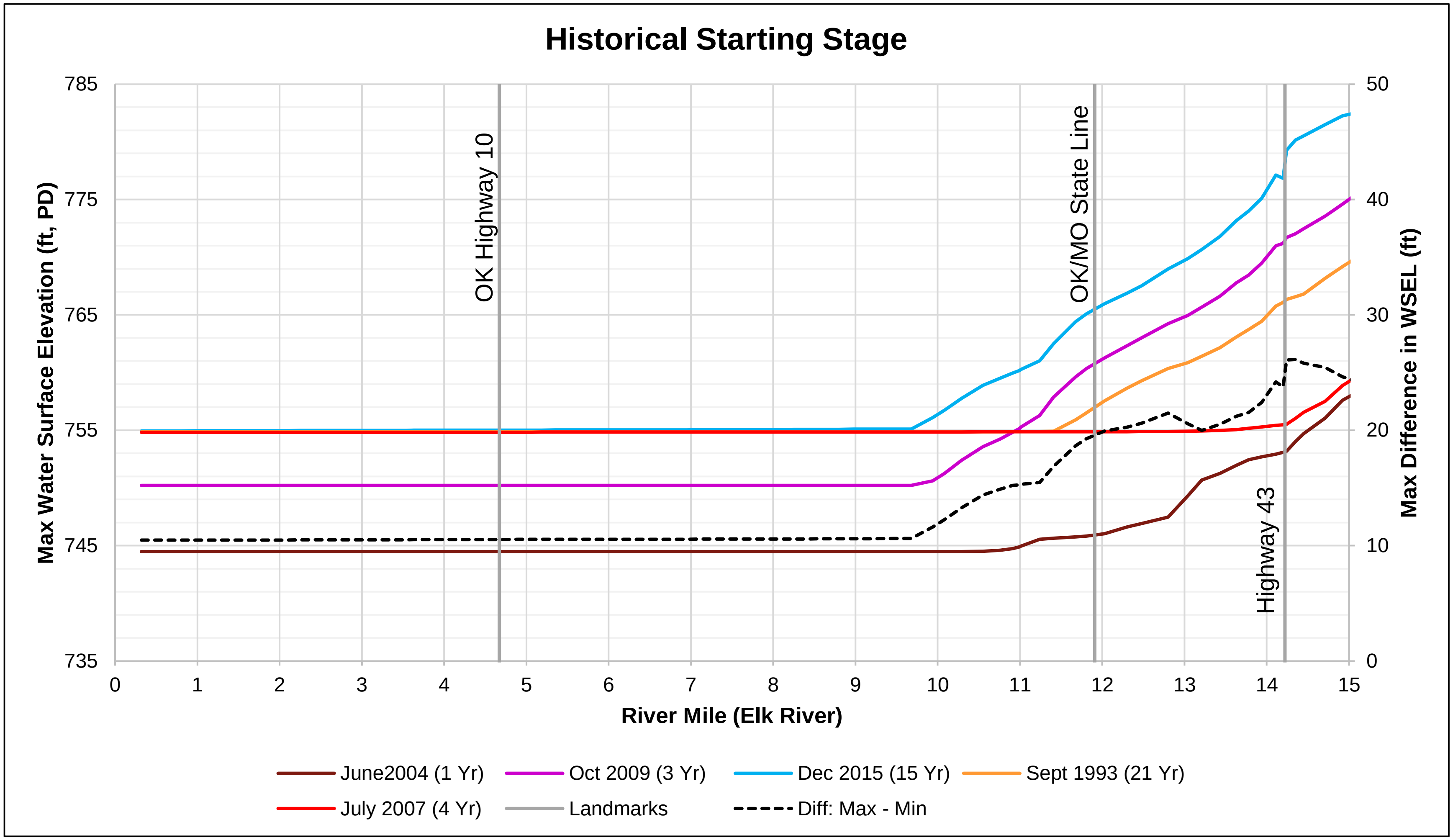


Figure E.68. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

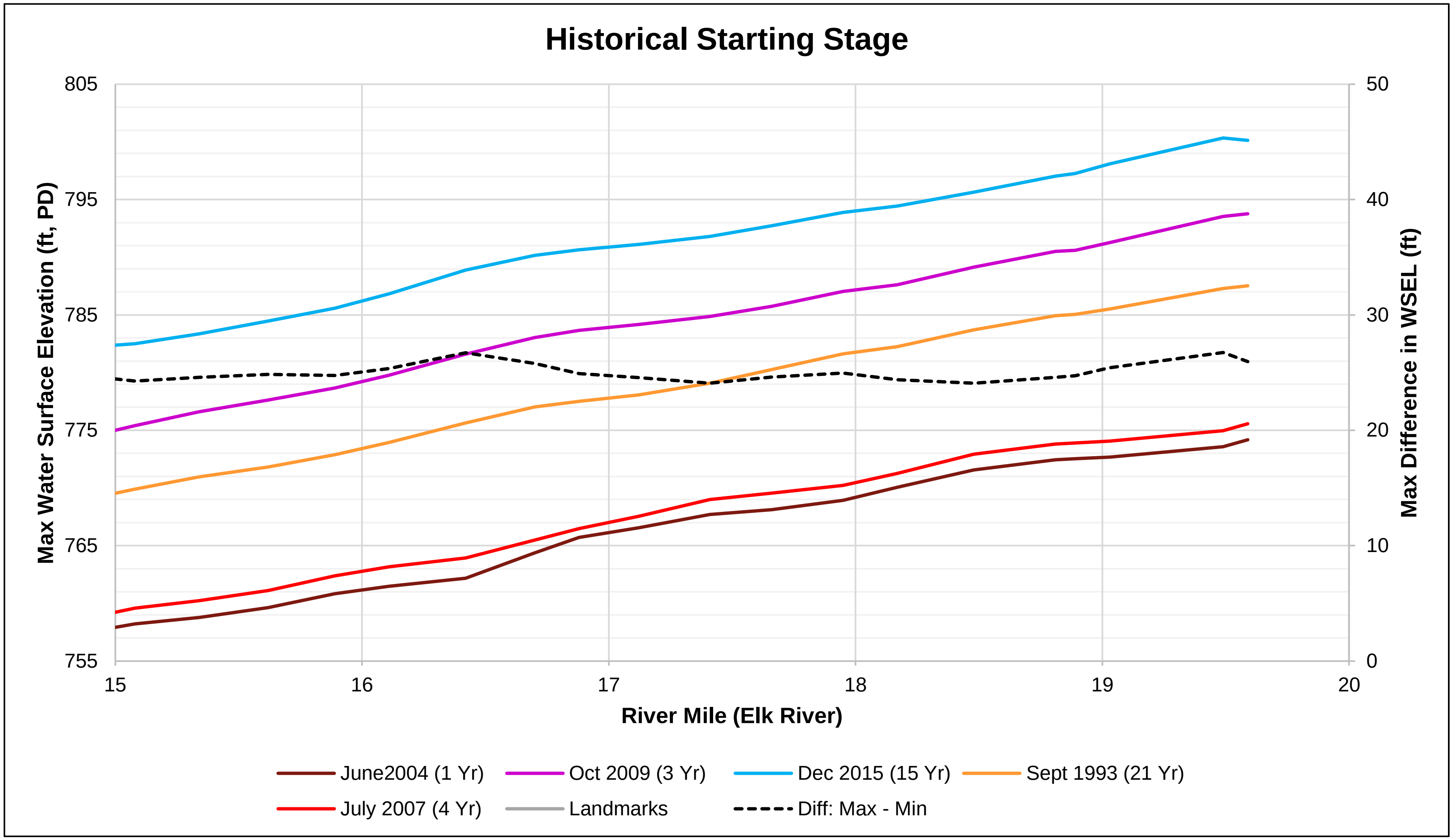


Figure E.69. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

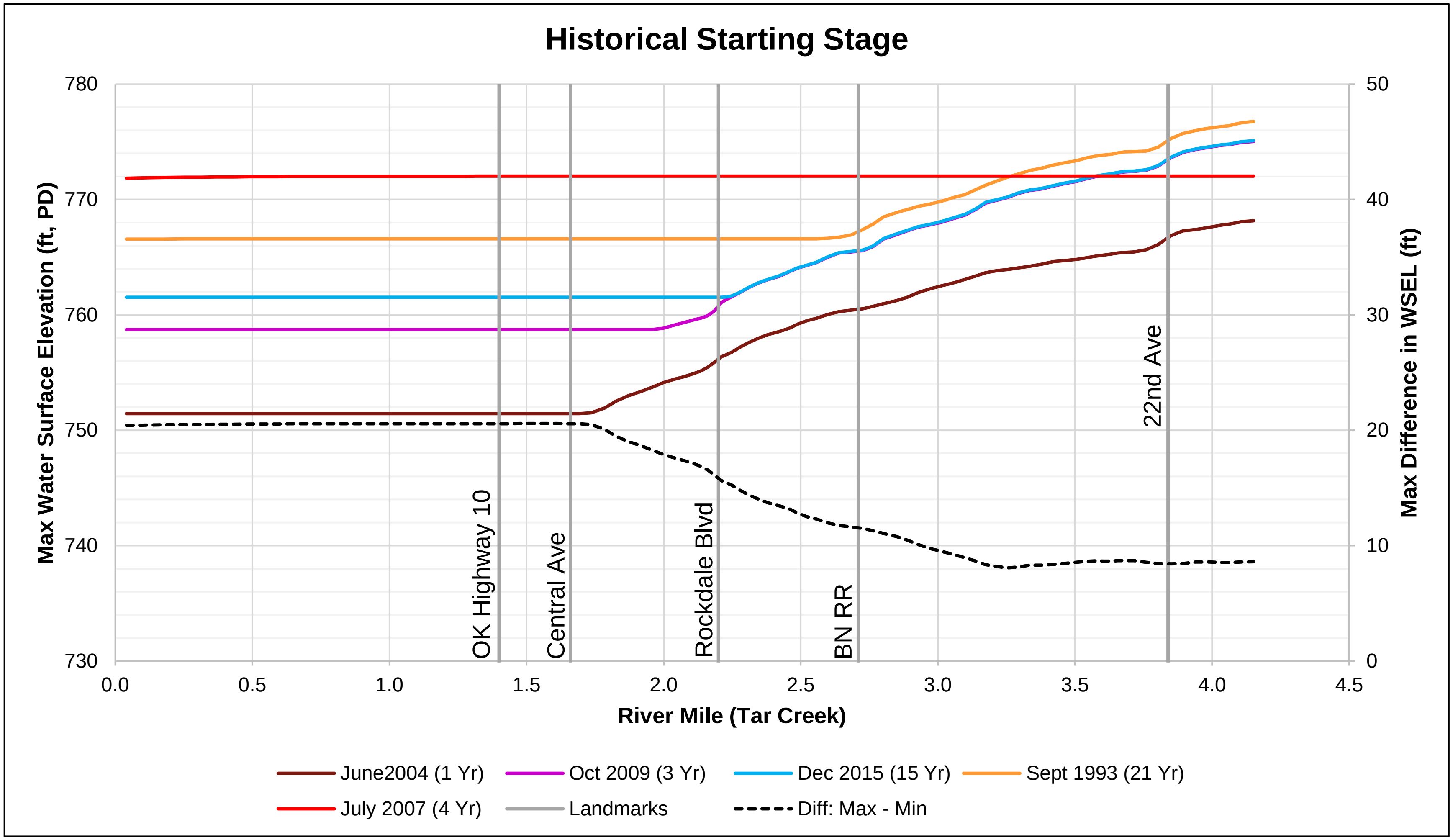


Figure E.70. Water surface elevations for events with historical starting stages upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes: 1. The dashed line is plotted against the right y-axis and represents the difference between the highest and lowest max WSEL displayed on the figure.

2. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles displayed.

APPENDIX E.8:
COMPARISON OF MAXIMUM DIFFERENCES

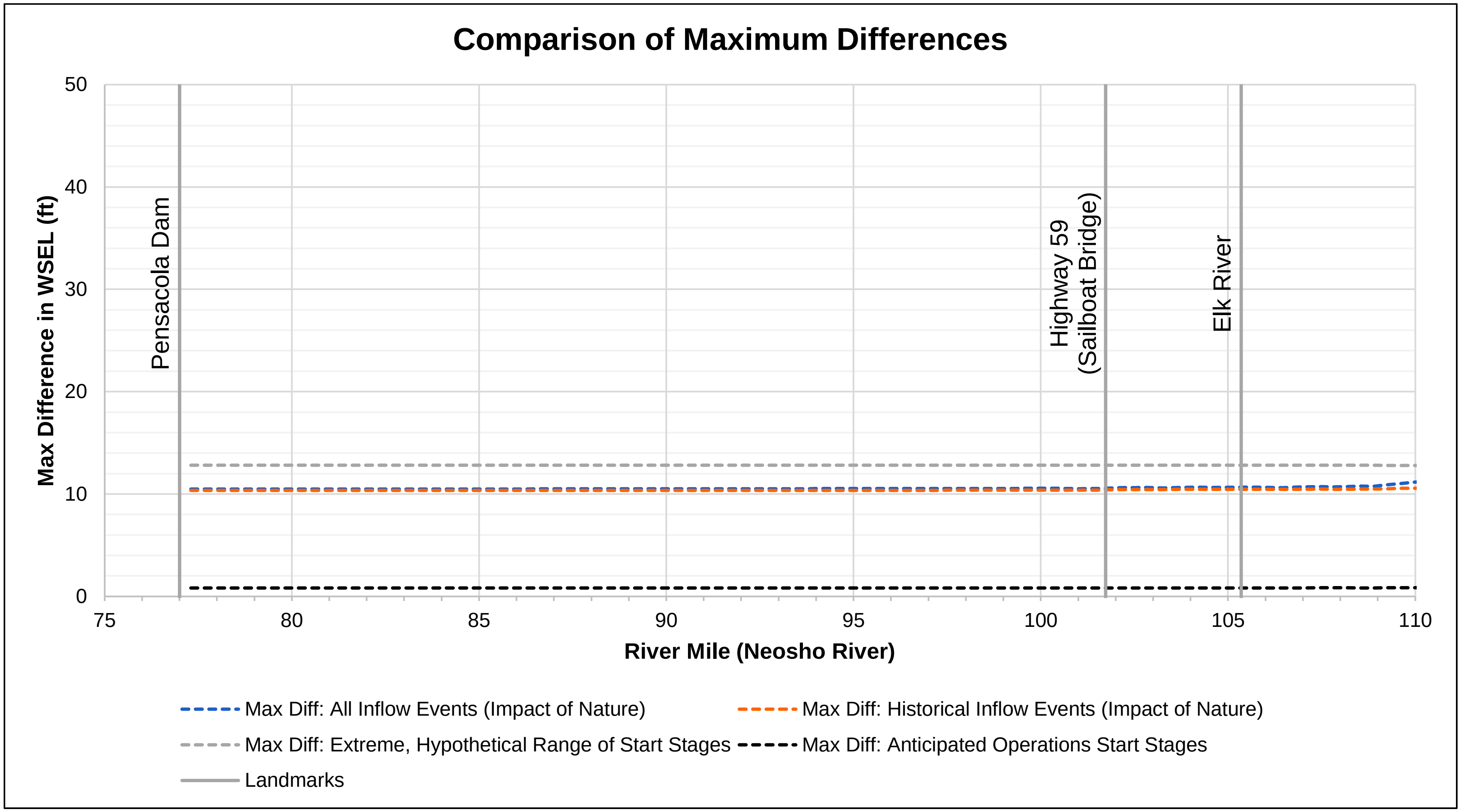


Figure E.71. Comparison of maximum water surface elevation differences along the Neosho River profile (1 of 5).

Notes:

1. *The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).*
2. *The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.*
3. *The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
4. *The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.*

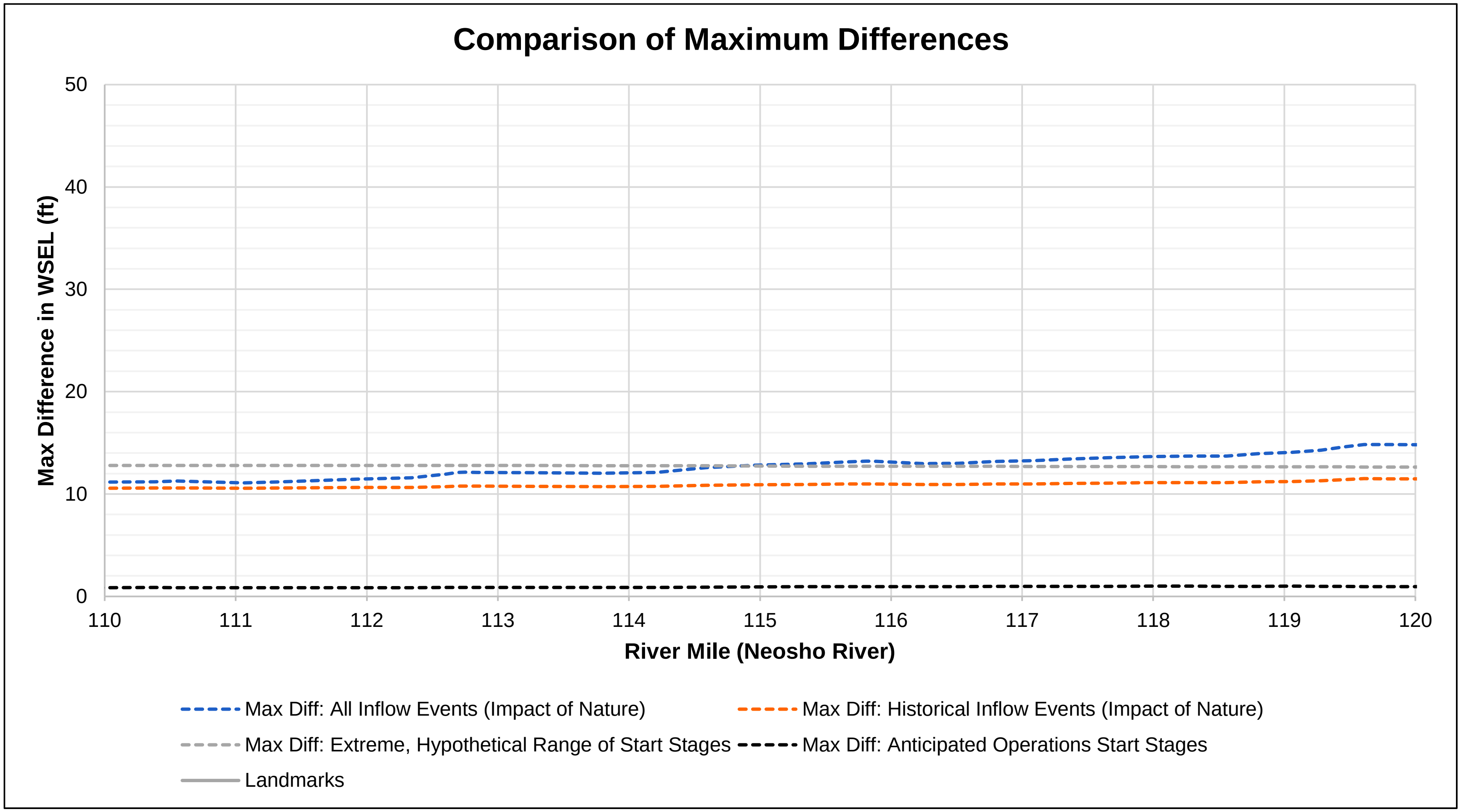


Figure E.72. Comparison of maximum water surface elevation differences along the Neosho River profile (2 of 5).

Notes:

1. The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).

2. The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.

3. The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

4. The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.

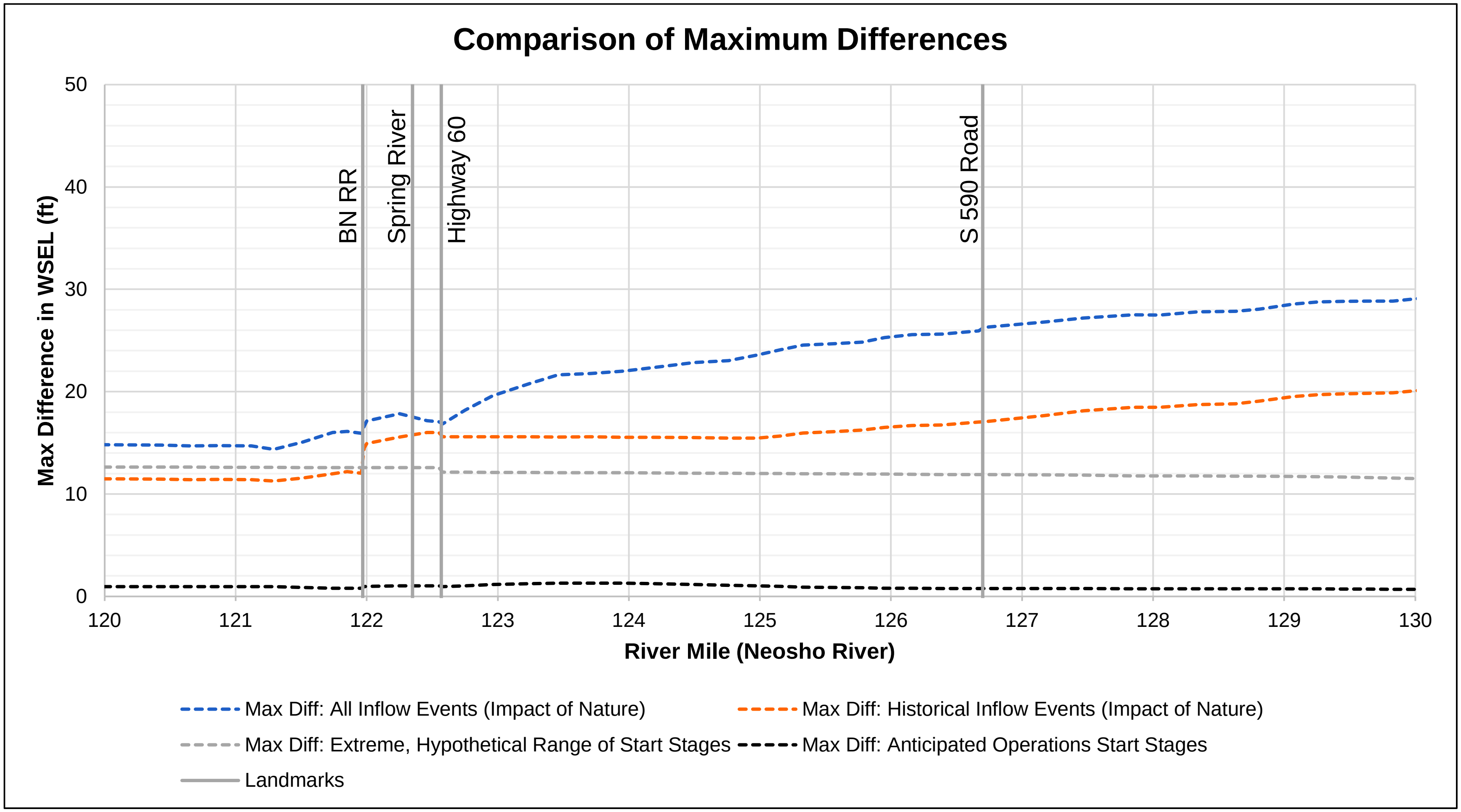


Figure E.73. Comparison of maximum water surface elevation differences along the Neosho River profile (3 of 5).

Notes:

1. *The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).*
2. *The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.*
3. *The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
4. *The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.*

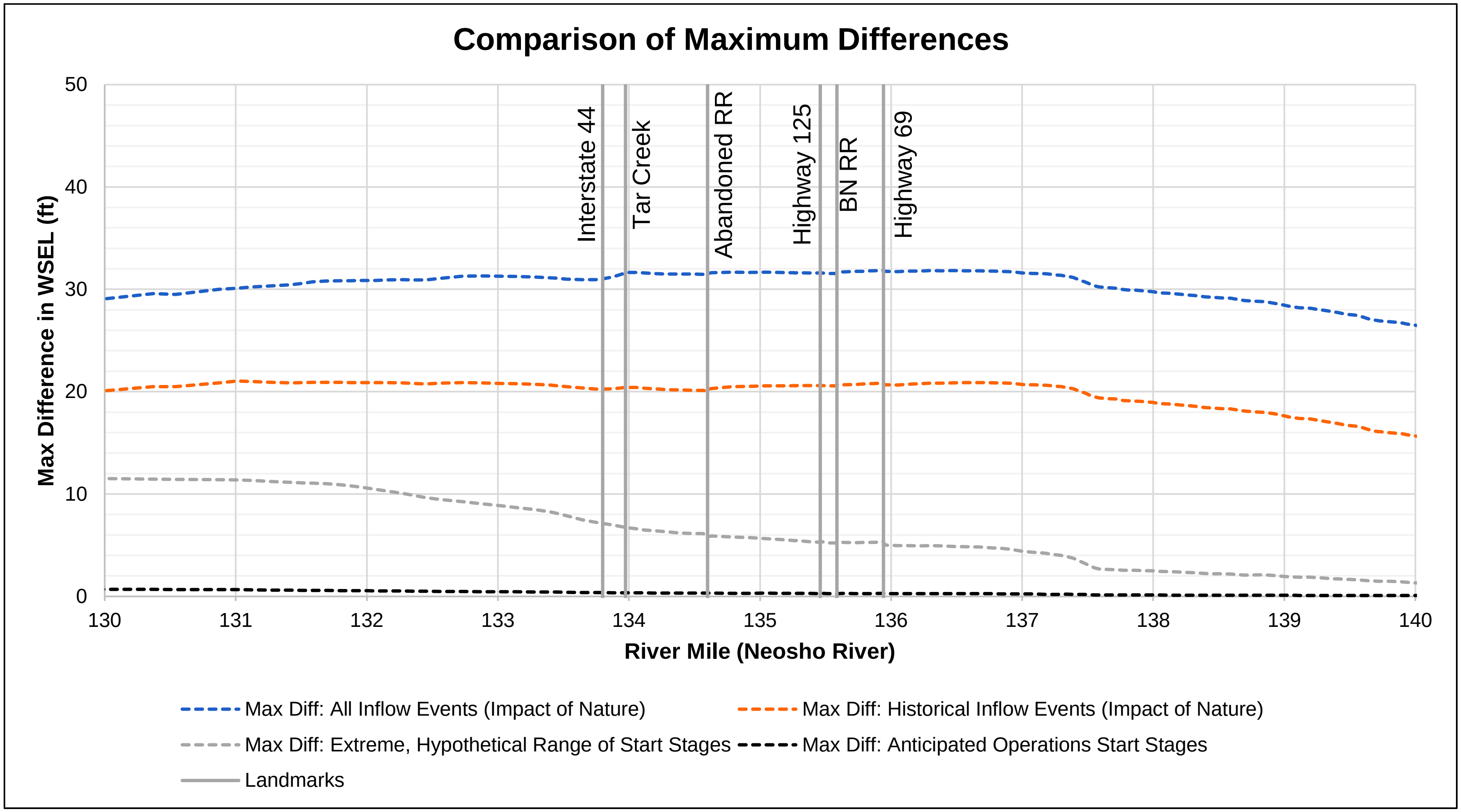


Figure E.74. Comparison of maximum water surface elevation differences along the Neosho River profile (4 of 5).

Notes:

1. *The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).*
2. *The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.*
3. *The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
4. *The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.*

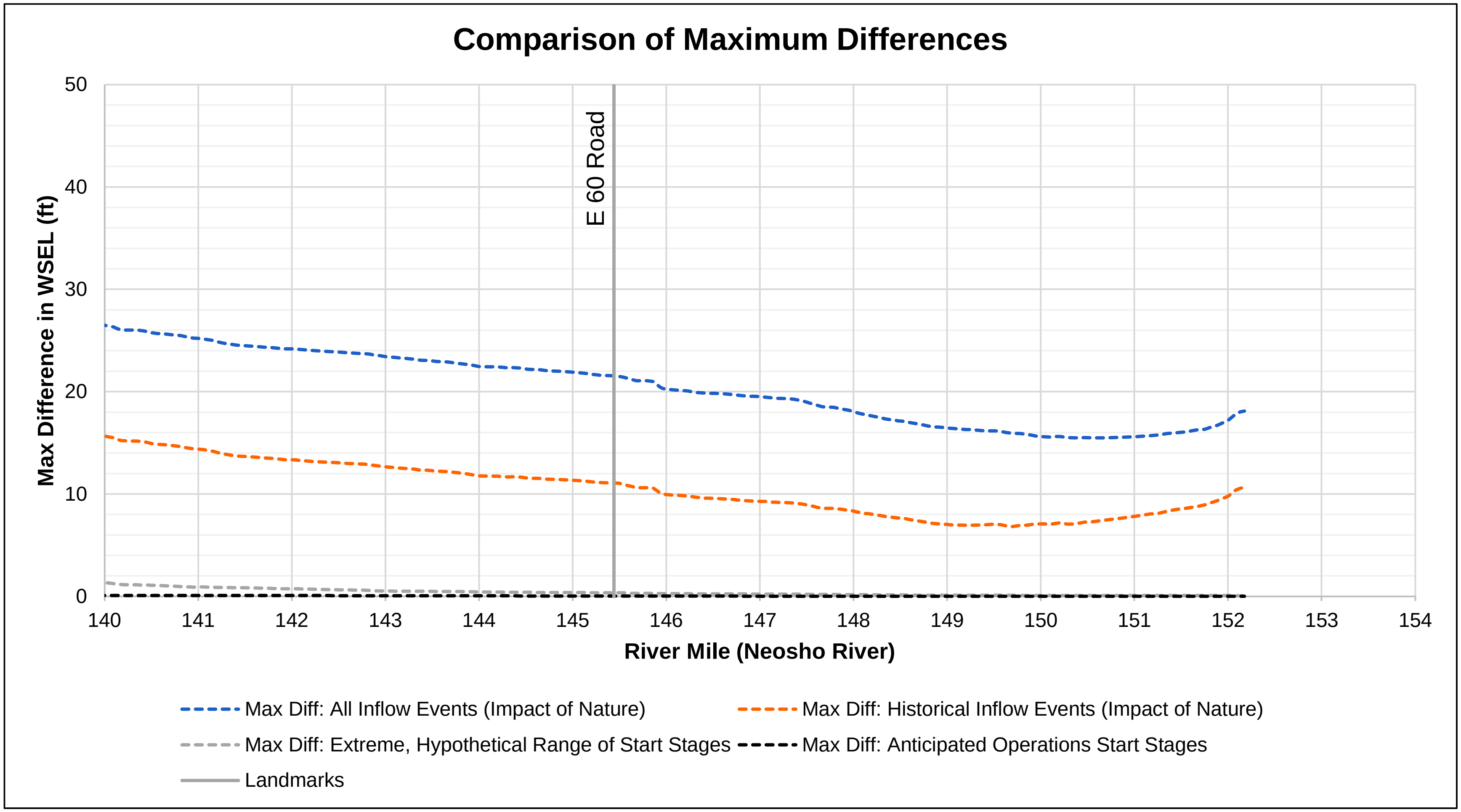


Figure E.75. Comparison of maximum water surface elevation differences along the Neosho River profile (5 of 5).

Notes:

1. The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).

2. The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.

3. The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

4. The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.

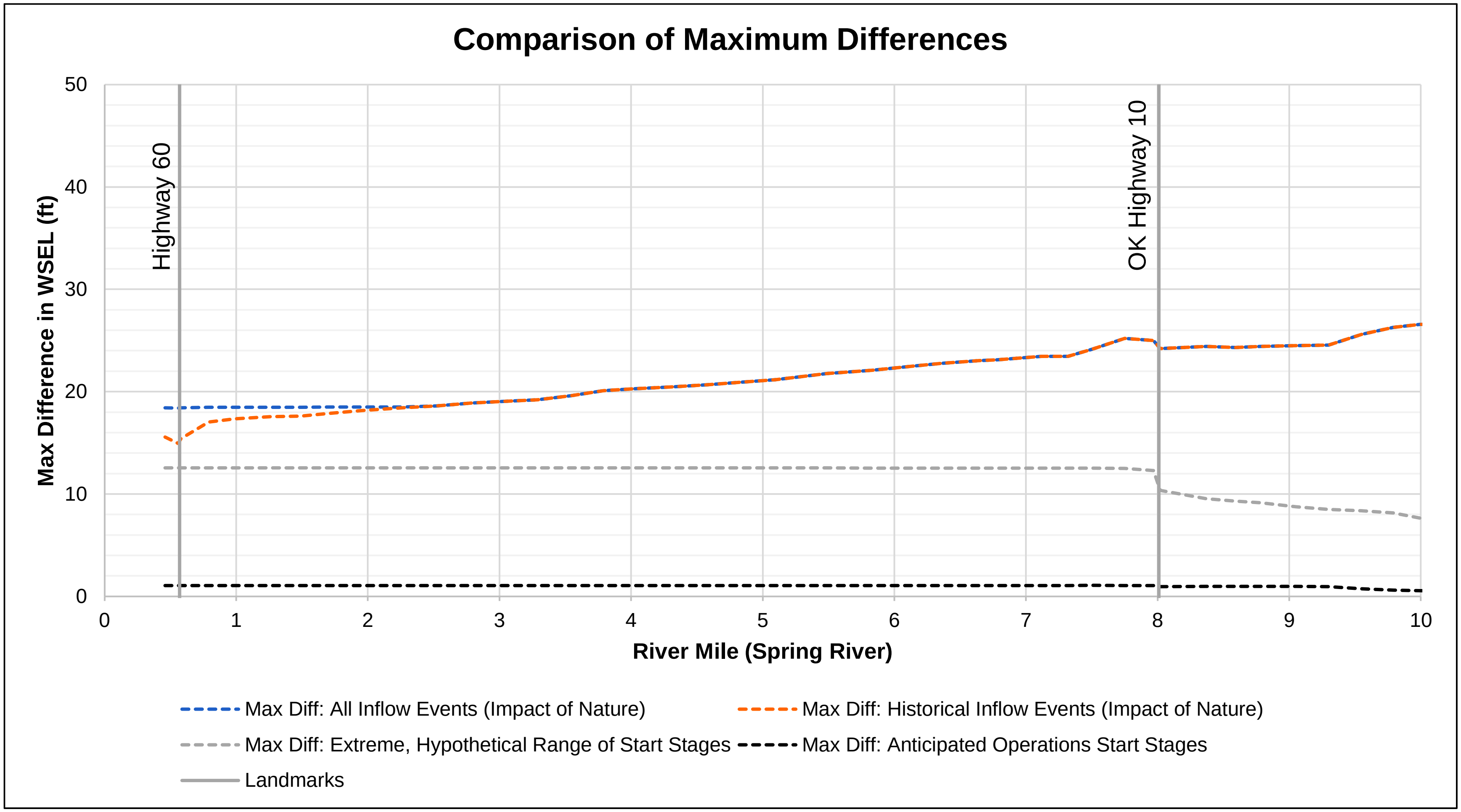


Figure E.76. Comparison of maximum water surface elevation differences along the Spring River profile (1 of 2).

Notes:

1. *The blue dotted line “Max Diff: All Inflow Events (Impact of Nature)” plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).*
2. *The orange dashed line “Max Diff: Historical Inflow Events (Impact of Nature)” plots the maximum difference in WSEL for all historical inflow events.*
3. *The grey dashed line “Max Diff: Extreme, Hypothetical Range of Start Stages” plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA’s anticipated operational range.*
4. *The black dashed line “Max Diff: Anticipated Operations Start Stages” plots the maximum difference in WSEL for simulations with starting stages within GRDA’s anticipated operational range.*

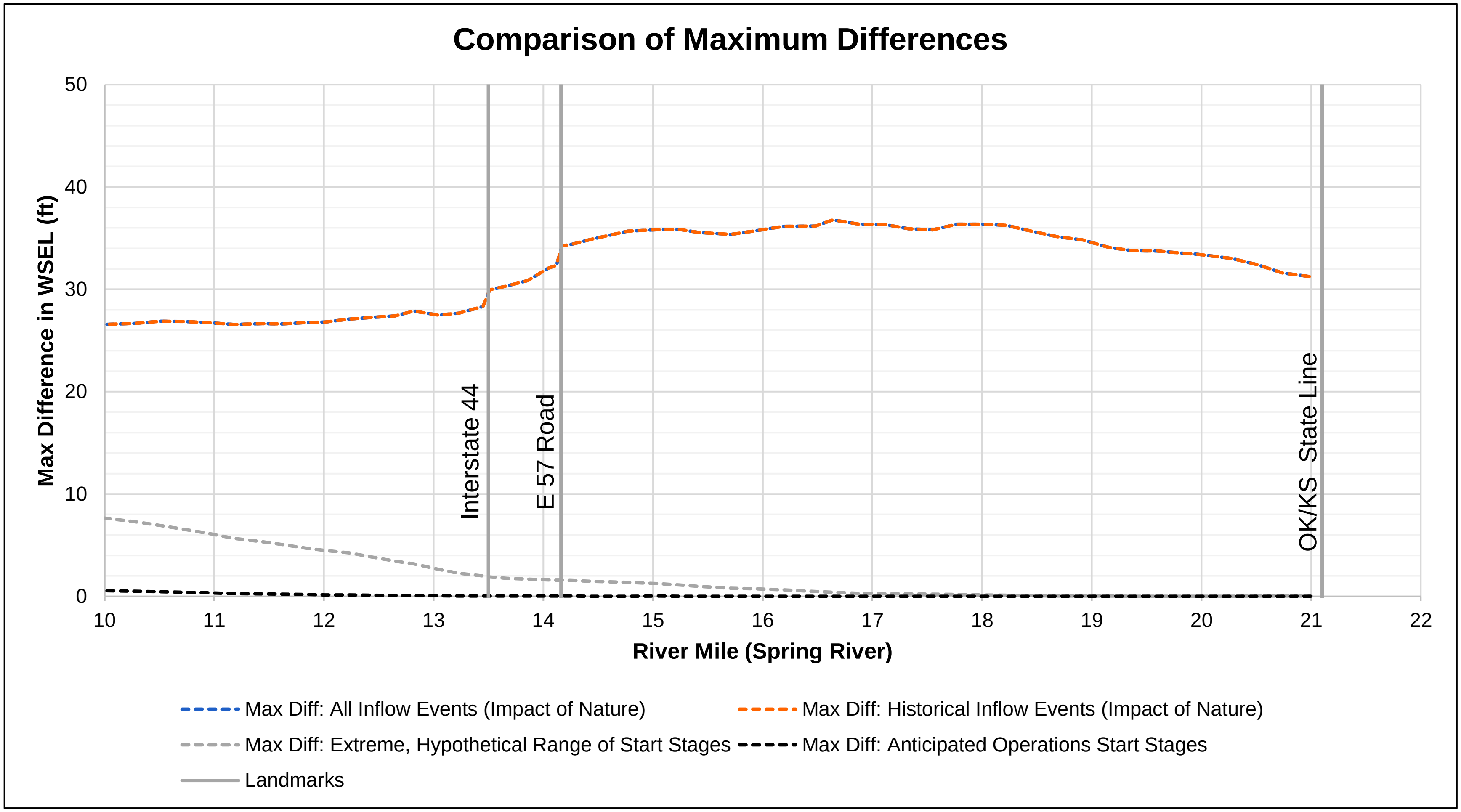


Figure E.77. Comparison of maximum water surface elevation differences along the Spring River profile (2 of 2).

Notes:

1. *The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).*
2. *The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.*
3. *The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
4. *The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.*

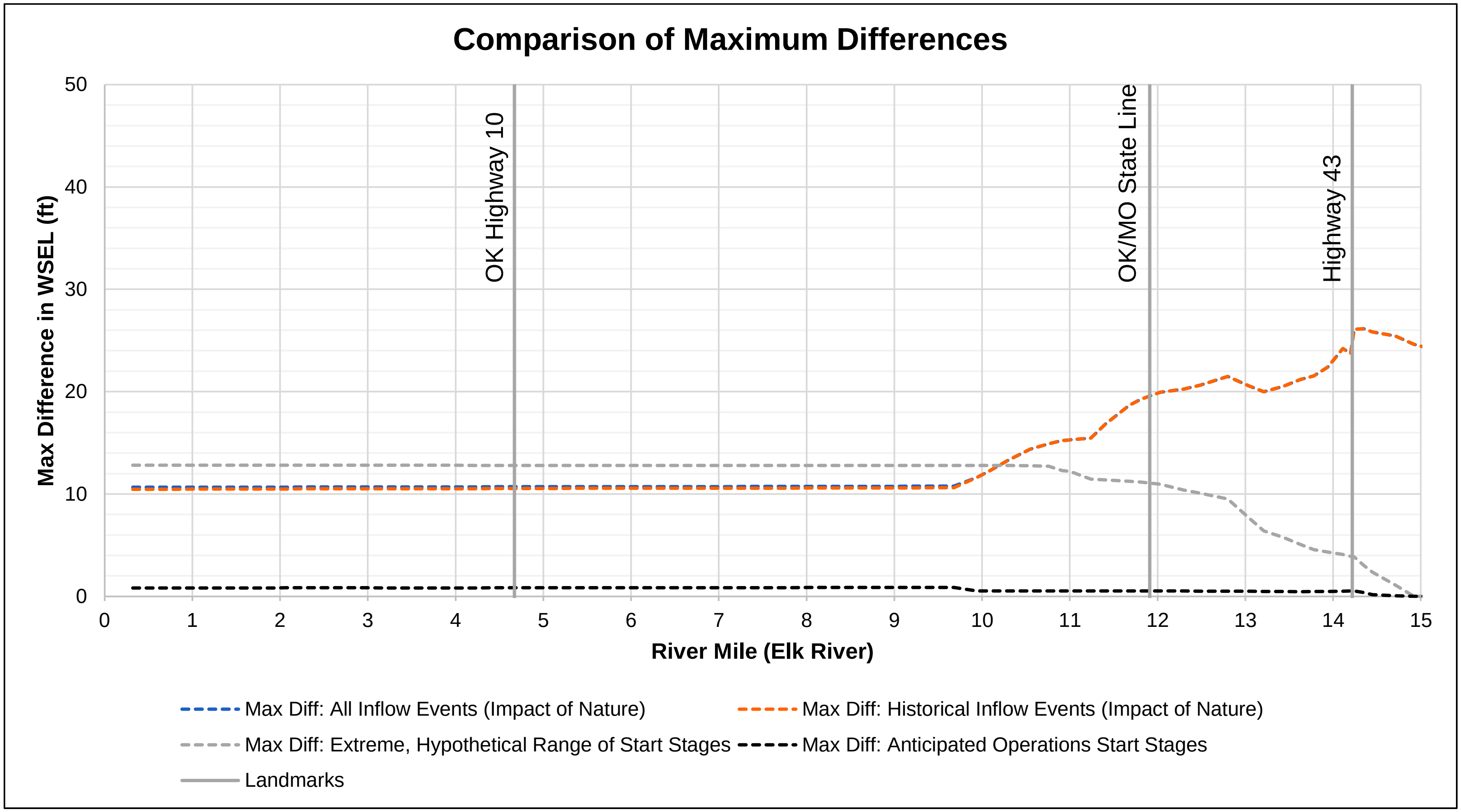


Figure E.78. Comparison of maximum water surface elevation differences along the Elk River profile (1 of 2).

Notes:

1. The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).

2. The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.

3. The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.

4. The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.

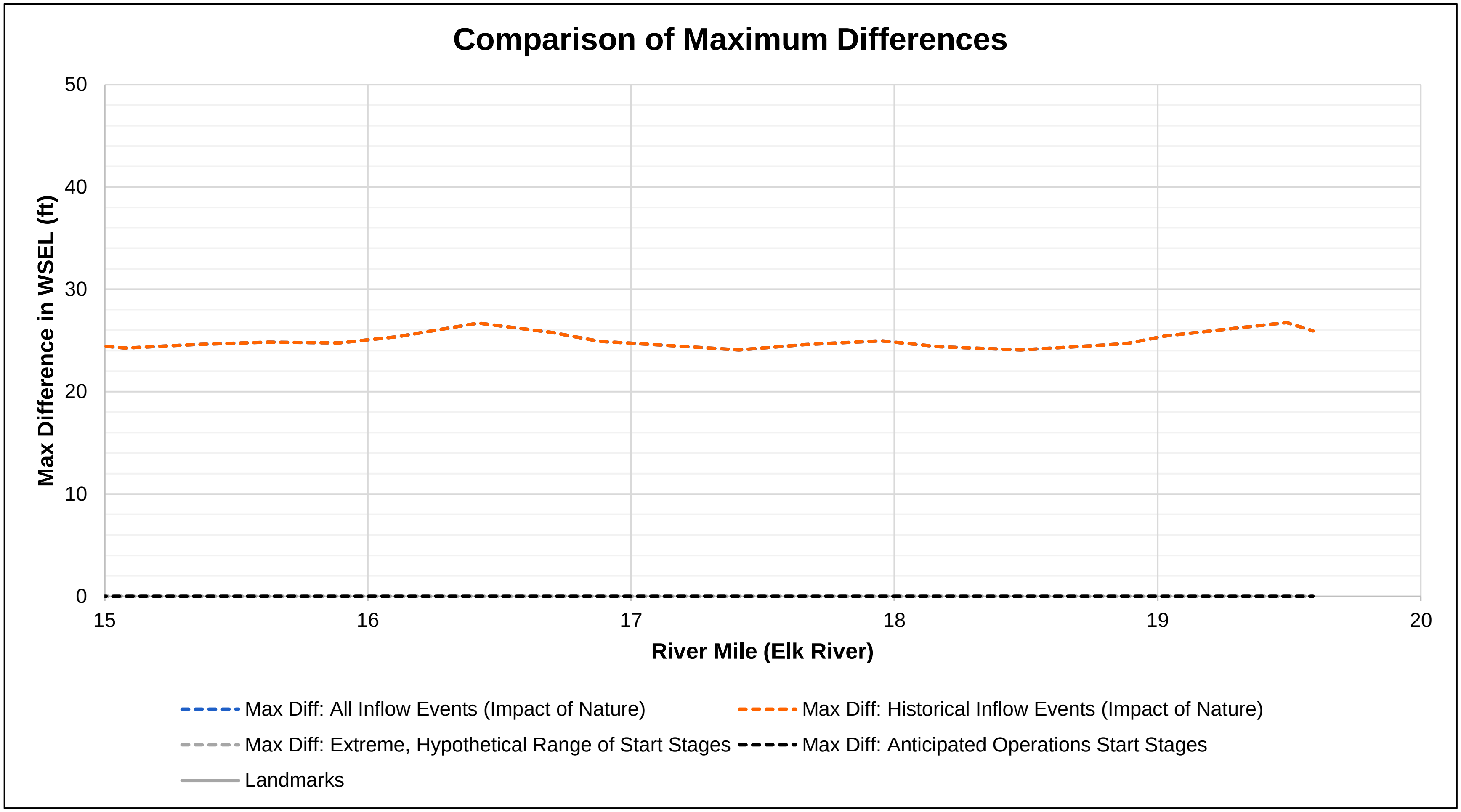


Figure E.79. Comparison of maximum water surface elevation differences along the Elk River profile (2 of 2).

Notes:

1. *The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).*
2. *The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.*
3. *The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
4. *The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.*

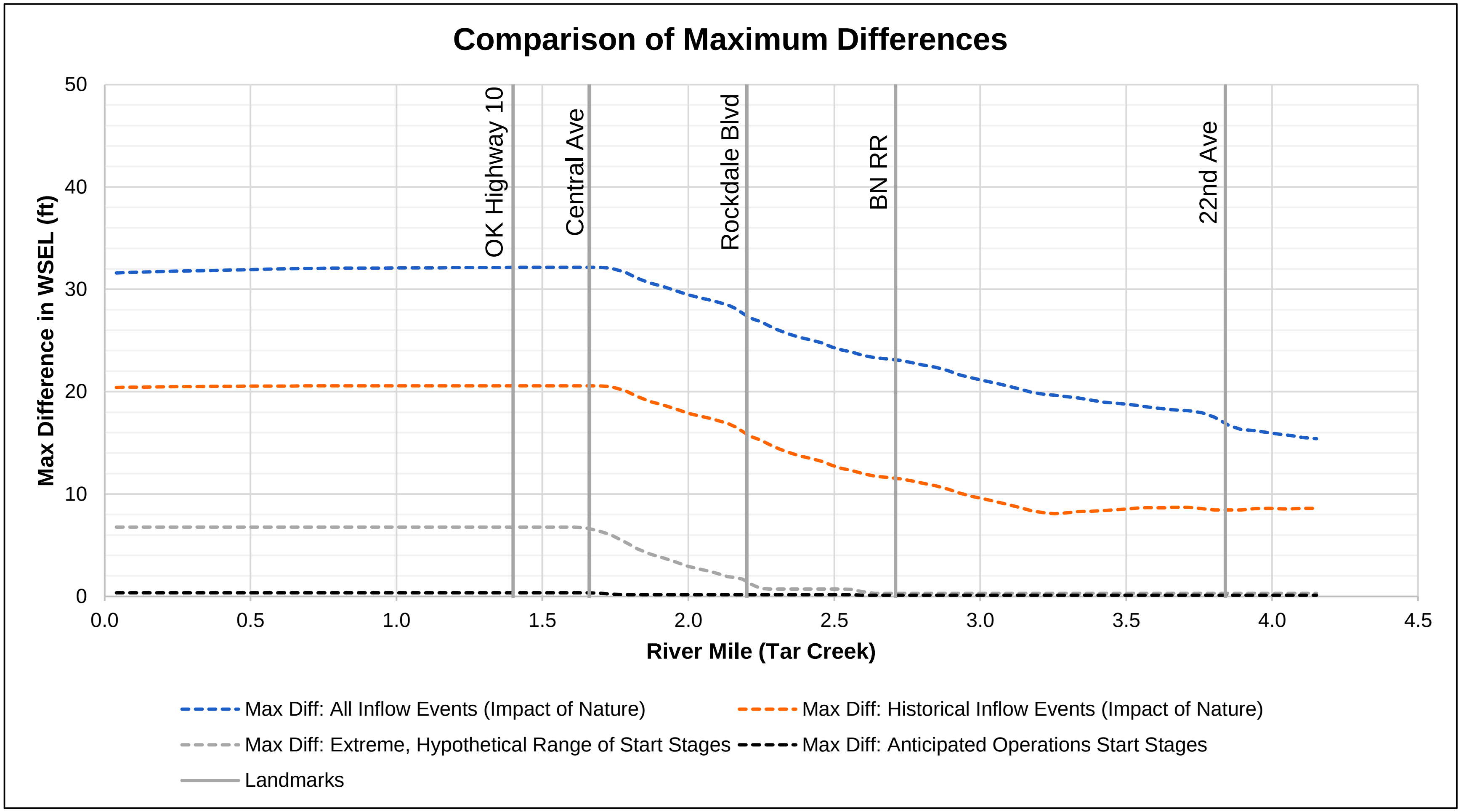


Figure E.80. Comparison of maximum water surface elevation differences along the Tar Creek profile (1 of 1).

Notes:

1. *The blue dotted line "Max Diff: All Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all inflow events (including the 100-year inflow event).*
2. *The orange dashed line "Max Diff: Historical Inflow Events (Impact of Nature)" plots the maximum difference in WSEL for all historical inflow events.*
3. *The grey dashed line "Max Diff: Extreme, Hypothetical Range of Start Stages" plots the maximum difference in WSEL for simulations with all FERC-required starting elevations, including extreme, hypothetical values (734 to 757 feet PD) outside GRDA's anticipated operational range.*
4. *The black dashed line "Max Diff: Anticipated Operations Start Stages" plots the maximum difference in WSEL for simulations with starting stages within GRDA's anticipated operational range.*

APPENDIX F:
INUNDATION MAPS

Due to the size of inundation map files, maps are included as a set of separate PDFs.

The following maps serve a dual purpose for both (A) the ***Hydrologic and Hydraulic Modeling: Upstream Hydraulic Model*** *report and (B) the* ***Infrastructure*** *report:*

1. *September 1993 (21 Year) Inundation Scenario*
2. *June 2004 (1 Year) Inundation Scenario*
3. *July 2007 (4 Year) Inundation Scenario*
4. *October 2009 (3 Year) Inundation Scenario*
5. *December 2015 (15 Year) Inundation Scenario*

And the remaining maps are only for the ***Hydrologic and Hydraulic Model: Upstream Hydraulic Model*** *report:*

6. *100-Year Inundation Scenario*
7. *Historical Inundation Scenarios*

APPENDIX G:
DURATION OF INUNDATION

APPENDIX G.1:

SEPTEMBER 1993 (21 YEAR) INFLOW EVENT

DURATION OF INUNDATION

PENSACOLA DAM **TABLE G.1**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - SEP 1993 (21 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
152.175	Upstream end of model												
152.175	137	137	137	137	137	137	137	137	137	137	137	0	0
151.000	117	117	117	117	117	117	117	117	117	117	117	0	0
150.000	144	145	145	145	145	145	145	145	145	145	145	0	1
149.000	142	142	142	142	142	142	142	142	142	142	142	0	0
148.000	143	144	144	144	144	144	144	144	144	144	144	0	1
147.000	138	138	138	138	138	138	138	138	138	138	138	0	0
145.500	154	155	155	155	155	155	155	155	154	154	155	0	1
145.480	E 60 Road Bridge												
145.400	153	154	154	154	154	154	153	153	154	154	154	1	1
144.000	159	160	160	160	160	160	160	160	160	161	162	0	3
143.000	153	153	153	153	153	153	153	153	153	154	155	0	2
142.000	171	172	172	172	172	172	172	171	171	172	173	1	2
141.000	169	169	169	169	169	169	169	169	169	171	172	0	3
140.000	163	164	164	164	164	164	163	163	164	166	169	1	6
139.000	149	150	150	150	150	150	150	150	151	154	158	0	9
138.000	143	145	145	145	145	145	145	145	145	148	153	0	10
137.000	136	138	138	138	139	138	138	138	138	142	146	1	10
135.950	134	136	136	136	136	135	135	136	136	139	144	1	10
135.941	Highway 69 Bridge												
135.940	134	136	136	136	136	135	135	134	135	139	143	2	9
135.590	133	135	135	135	135	135	135	134	135	139	143	1	10
135.586	BN RR Bridge												
135.580	133	135	135	135	135	135	135	134	135	139	143	1	10
135.470	133	135	135	135	135	135	135	134	135	138	143	1	10
135.460	Highway 125 Bridge												
135.440	133	135	135	135	135	135	135	134	135	139	143	1	10
135.000	133	134	134	134	135	135	134	134	135	138	143	1	10

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.1**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - SEP 1993 (21 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
134.610	131	134	134	134	134	134	133	133	133	136	141	1	10
134.599	Abandonded RR Bridge												
134.595	131	132	132	132	132	132	132	132	133	136	141	0	10
134.000	129	130	130	130	130	130	129	129	129	132	138	1	9
133.973	Tar Creek												
133.900	127	129	129	129	129	128	128	128	128	131	135	1	8
133.800	Interstate 44 Bridge												
133.700	127	128	128	128	128	128	127	127	127	130	135	1	8
133.000	122	124	124	124	124	124	123	123	122	124	128	1	6
132.000	117	120	120	120	120	120	119	118	118	120	123	2	6
131.000	114	116	116	116	116	116	115	114	113	115	119	2	6
130.000	109	114	114	114	114	114	112	111	109	112	115	3	6
129.000	104	110	110	110	110	110	108	106	103	106	109	4	7
128.000	97	104	104	104	105	105	101	97	95	97	100	8	10
126.710	72	83	83	83	83	82	82	81	80	82	86	2	14
126.700	S 590 Road Bridge												
126.670	71	82	82	82	82	81	81	80	79	82	85	2	14
126.000	39	76	76	76	76	76	75	75	75	77	81	1	42
125.000	29	45	45	45	50	56	59	63	64	67	70	18	41
124.000	24	26	26	26	26	27	33	46	50	53	56	20	32
123.000	21	22	22	22	22	23	23	24	33	44	47	2	26
122.580	20	21	21	21	21	21	22	22	25	38	42	1	22
122.570	Highway 60 Bridge												
122.550	20	21	21	21	21	21	22	22	25	38	42	1	22
122.350	Spring River												
122.000	13	13	13	13	13	14	14	15	16	26	37	2	24
121.980	10	10	10	10	11	11	11	12	12	21	31	2	21
121.970	BN RR Bridge												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.1**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - SEP 1993 (21 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
121.960	0	0	0	0	0	0	0	0	0	0	0	0	0
120.000	0	0	0	0	0	0	0	0	0	0	0	0	0
118.000	0	0	0	0	0	0	0	0	0	0	0	0	0
116.000	0	0	0	0	0	0	0	0	0	0	0	0	0
114.000	0	0	0	0	0	0	0	0	0	0	0	0	0
112.000	0	0	0	0	0	0	0	0	0	0	0	0	0
110.000	0	0	0	0	0	0	0	0	0	0	0	0	0
108.000	0	0	0	0	0	0	0	0	0	0	0	0	0
106.000	0	0	0	0	0	0	0	0	0	0	0	0	0
105.350	Elk River												
105.000	0	0	0	0	0	0	0	0	0	0	0	0	0
104.000	0	0	0	0	0	0	0	0	0	0	0	0	0
102.000	0	0	0	0	0	0	0	0	0	0	0	0	0
101.750	0	0	0	0	0	0	0	0	0	0	0	0	0
101.730	Highway 59 (Sailboat Bridge)												
101.710	0	0	0	0	0	0	0	0	0	0	0	0	0
100.000	0	0	0	0	0	0	0	0	0	0	0	0	0
90.000	0	0	0	0	0	0	0	0	0	0	0	0	0
80.000	0	0	0	0	0	0	0	0	0	0	0	0	0
78.000	0	0	0	0	0	0	0	0	0	0	0	0	0
77.000	Pensacola Dam												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.2**

GRAND RIVER DAM AUTHORITY SPRING RIVER DURATIONS - SEP 1993 (21 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
21.000	Upstream end of model												
21.000	54	54	54	54	54	54	54	54	54	54	54	0	0
20.000	52	52	52	52	52	52	52	52	52	52	52	0	0
19.000	70	70	70	70	70	70	70	70	70	70	70	0	0
18.000	70	70	70	70	70	70	70	70	70	70	70	0	0
17.000	72	72	72	72	72	72	72	72	72	72	72	0	0
16.000	79	79	79	79	79	79	79	79	79	79	79	0	0
15.000	74	75	75	75	75	75	75	75	75	75	75	0	1
14.170	92	92	92	92	92	92	92	92	92	92	92	0	0
14.160	E 57 Road												
14.120	93	93	93	93	93	93	93	93	93	93	94	0	1
13.510	93	93	93	93	93	93	93	93	93	93	94	0	1
13.500	Interstate 44 Bridge												
13.450	92	93	93	93	93	93	93	93	93	93	93	0	1
12.000	92	93	93	93	93	93	93	93	93	93	94	0	2
11.000	110	112	112	112	112	112	112	112	112	113	114	0	4
10.000	104	107	107	107	107	108	108	108	107	108	109	1	5
9.000	95	99	99	99	99	99	99	99	100	102	105	0	10
8.020	85	91	91	91	91	91	91	91	92	95	97	0	12
8.010	OK Highway 10 Bridge												
7.970	72	78	78	78	78	79	80	80	82	83	85	2	13
7.000	60	64	64	64	65	66	67	69	70	71	73	5	13
6.000	53	57	57	57	58	59	60	62	64	64	67	5	14
5.000	46	49	49	49	50	51	53	54	57	59	61	5	15
4.000	43	46	46	46	47	48	50	52	54	55	58	6	15
3.000	40	41	41	41	42	42	43	47	51	52	53	6	13
2.000	33	37	37	37	38	39	40	41	46	49	50	4	17
1.000	29	30	30	30	31	31	32	36	38	45	49	6	20
0.580	16	18	18	18	18	19	19	19	21	35	40	1	24
0.570	Highway 60 Bridge												
0.560	13	15	15	15	15	15	15	16	18	33	38	1	25
0.460	18	19	19	19	19	19	19	20	22	36	41	1	23
0.000	Downstream end of Spring River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.3**

GRAND RIVER DAM AUTHORITY ELK RIVER DURATIONS - SEP 1993 (21 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
19.590	Upstream end of model												
19.590	10	10	10	10	10	10	10	10	10	10	10	0	0
19.000	0	0	0	0	0	0	0	0	0	0	0	0	0
18.000	7	7	7	7	7	7	7	7	7	7	7	0	0
17.000	56	56	56	56	56	56	56	56	56	56	56	0	0
16.000	61	62	62	62	62	62	62	62	62	62	62	0	1
15.000	48	48	48	48	48	48	48	48	48	48	49	0	1
14.240	18	18	18	18	18	18	18	18	19	19	19	0	1
14.220	Highway 43 Bridge												
14.200	18	18	18	18	18	18	18	18	18	18	18	0	0
14.000	12	12	12	12	12	12	12	12	12	12	12	0	0
13.000	14	14	14	14	14	14	14	14	14	14	15	0	1
12.000	0	0	0	0	0	0	0	0	0	0	0	0	0
11.910	OK/MO State Line												
11.000	0	0	0	0	0	0	0	0	0	0	0	0	0
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0
8.000	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.700	0	0	0	0	0	0	0	0	0	0	0	0	0
4.670	OK Highway 10 Bridge												
4.640	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.320	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Elk River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.4**

GRAND RIVER DAM AUTHORITY TAR CREEK DURATIONS - SEP 1993 (21 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
4.152	Upstream end of model												
4.152	25	25	25	25	25	25	25	25	25	25	25	0	0
3.900	32	32	32	32	32	32	32	32	32	32	32	0	0
3.840	22nd Ave Bridge												
3.800	36	36	36	36	36	36	36	36	36	36	36	0	0
3.300	28	28	28	28	28	28	28	28	29	29	29	0	1
2.800	20	20	20	20	20	20	20	20	20	20	21	0	1
2.710	BN RR Bridge												
2.700	130	133	133	133	133	133	132	131	131	131	131	2	3
2.500	140	142	142	142	142	142	141	140	140	140	140	2	2
2.300	143	145	145	145	145	145	144	144	143	143	143	1	2
2.200	Rockdale Blvd Bridge												
2.100	157	159	159	159	159	159	158	158	157	157	158	1	2
1.900	143	146	146	146	146	146	145	145	144	146	148	1	5
1.700	129	131	131	131	132	132	131	131	132	138	144	1	15
1.660	Central Ave Bridge												
1.600	128	131	131	131	131	131	130	130	130	135	143	1	15
1.500	128	131	131	131	131	131	130	130	130	135	143	1	15
1.400	OK Highway 10 Bridge												
1.300	128	130	130	130	130	130	129	129	129	133	139	1	11
1.000	128	130	130	130	130	130	129	129	129	133	138	1	10
0.700	128	130	130	130	130	130	129	129	129	132	138	1	10
0.300	128	130	130	130	130	130	129	129	129	132	137	1	9
0.041	127	130	130	130	130	130	129	129	129	132	137	1	10
0.000	Downstream end of Tar Creek												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX G.2:
JUNE 2004 (1 YEAR) INFLOW EVENT
DURATION OF INUNDATION

PENSACOLA DAM **TABLE G.5**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - JUN 2004 (1 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
152.175	Upstream end of model												
152.175	0	0	0	0	0	0	0	0	0	0	0	0	0
151.000	0	0	0	0	0	0	0	0	0	0	0	0	0
150.000	0	0	0	0	0	0	0	0	0	0	0	0	0
149.000	0	0	0	0	0	0	0	0	0	0	0	0	0
148.000	0	0	0	0	0	0	0	0	0	0	0	0	0
147.000	0	0	0	0	0	0	0	0	0	0	0	0	0
145.500	0	0	0	0	0	0	0	0	0	0	7	0	7
145.480	E 60 Road Bridge												
145.400	0	0	0	0	0	0	0	0	0	0	0	0	0
144.000	17	18	18	18	18	19	19	19	21	26	31	1	14
143.000	0	0	0	0	0	0	0	0	0	0	0	0	0
142.000	42	42	42	43	43	43	43	43	44	47	53	1	11
141.000	31	33	33	33	33	34	34	34	37	42	49	1	18
140.000	0	0	0	0	0	0	0	0	9	27	41	0	41
139.000	0	0	0	0	0	0	0	0	0	0	0	0	0
138.000	0	0	0	0	0	0	0	0	0	0	0	0	0
137.000	0	0	0	0	0	0	0	0	0	0	0	0	0
135.950	0	0	0	0	0	0	0	0	0	0	0	0	0
135.941	Highway 69 Bridge												
135.940	0	0	0	0	0	0	0	0	0	0	0	0	0
135.590	0	0	0	0	0	0	0	0	0	0	0	0	0
135.586	BN RR Bridge												
135.580	0	0	0	0	0	0	0	0	0	0	0	0	0
135.470	0	0	0	0	0	0	0	0	0	0	0	0	0
135.460	Highway 125 Bridge												
135.440	0	0	0	0	0	0	0	0	0	0	0	0	0
135.000	0	0	0	0	0	0	0	0	0	0	0	0	0

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.5**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - JUN 2004 (1 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
134.610	0	0	0	0	0	0	0	0	0	0	0	0	0
134.599	Abandonded RR Bridge												
134.595	0	0	0	0	0	0	0	0	0	0	0	0	0
134.000	0	0	0	0	0	0	0	0	0	0	0	0	0
133.973	Tar Creek												
133.900	0	0	0	0	0	0	0	0	0	0	0	0	0
133.800	Interstate 44 Bridge												
133.700	0	0	0	0	0	0	0	0	0	0	0	0	0
133.000	0	0	0	0	0	0	0	0	0	0	0	0	0
132.000	0	0	0	0	0	0	0	0	0	0	0	0	0
131.000	0	0	0	0	0	0	0	0	0	0	0	0	0
130.000	0	0	0	0	0	0	0	0	0	0	0	0	0
129.000	0	0	0	0	0	0	0	0	0	0	0	0	0
128.000	0	0	0	0	0	0	0	0	0	0	0	0	0
126.710	0	0	0	0	0	0	0	0	0	0	0	0	0
126.700	S 590 Road Bridge												
126.670	0	0	0	0	0	0	0	0	0	0	0	0	0
126.000	0	0	0	0	0	0	0	0	0	0	0	0	0
125.000	0	0	0	0	0	0	0	0	0	0	0	0	0
124.000	0	0	0	0	0	0	0	0	0	0	0	0	0
123.000	0	0	0	0	0	0	0	0	0	0	0	0	0
122.580	0	0	0	0	0	0	0	0	0	0	0	0	0
122.570	Highway 60 Bridge												
122.550	0	0	0	0	0	0	0	0	0	0	0	0	0
122.350	Spring River												
122.000	0	0	0	0	0	0	0	0	0	0	0	0	0
121.980	0	0	0	0	0	0	0	0	0	0	0	0	0
121.970	BN RR Bridge												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.5**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - JUN 2004 (1 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
121.960	0	0	0	0	0	0	0	0	0	0	0	0	0
120.000	0	0	0	0	0	0	0	0	0	0	0	0	0
118.000	0	0	0	0	0	0	0	0	0	0	0	0	0
116.000	0	0	0	0	0	0	0	0	0	0	0	0	0
114.000	0	0	0	0	0	0	0	0	0	0	0	0	0
112.000	0	0	0	0	0	0	0	0	0	0	0	0	0
110.000	0	0	0	0	0	0	0	0	0	0	0	0	0
108.000	0	0	0	0	0	0	0	0	0	0	0	0	0
106.000	0	0	0	0	0	0	0	0	0	0	0	0	0
105.350	Elk River												
105.000	0	0	0	0	0	0	0	0	0	0	0	0	0
104.000	0	0	0	0	0	0	0	0	0	0	0	0	0
102.000	0	0	0	0	0	0	0	0	0	0	0	0	0
101.750	0	0	0	0	0	0	0	0	0	0	0	0	0
101.730	Highway 59 (Sailboat Bridge)												
101.710	0	0	0	0	0	0	0	0	0	0	0	0	0
100.000	0	0	0	0	0	0	0	0	0	0	0	0	0
90.000	0	0	0	0	0	0	0	0	0	0	0	0	0
80.000	0	0	0	0	0	0	0	0	0	0	0	0	0
78.000	0	0	0	0	0	0	0	0	0	0	0	0	0
77.000	Pensacola Dam												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.6**

GRAND RIVER DAM AUTHORITY — SPRING RIVER DURATIONS - JUN 2004 (1 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
21.000	Upstream end of model												
21.000	0	0	0	0	0	0	0	0	0	0	0	0	0
20.000	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	0	0	0	0	0	0	0	0	0	0	0	0	0
18.000	0	0	0	0	0	0	0	0	0	0	0	0	0
17.000	0	0	0	0	0	0	0	0	0	0	0	0	0
16.000	0	0	0	0	0	0	0	0	0	0	0	0	0
15.000	0	0	0	0	0	0	0	0	0	0	0	0	0
14.170	0	0	0	0	0	0	0	0	0	0	0	0	0
14.160	E 57 Road												
14.120	0	0	0	0	0	0	0	0	0	0	0	0	0
13.510	0	0	0	0	0	0	0	0	0	0	0	0	0
13.500	Interstate 44 Bridge												
13.450	0	0	0	0	0	0	0	0	0	0	0	0	0
12.000	0	0	0	0	0	0	0	0	0	0	0	0	0
11.000	0	0	0	0	0	0	0	0	0	0	0	0	0
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0
8.020	0	0	0	0	0	0	0	0	0	0	0	0	0
8.010	OK Highway 10 Bridge												
7.970	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.580	0	0	0	0	0	0	0	0	0	0	0	0	0
0.570	Highway 60 Bridge												
0.560	0	0	0	0	0	0	0	0	0	0	0	0	0
0.460	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Spring River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.7**

GRAND RIVER DAM AUTHORITY ELK RIVER DURATIONS - JUN 2004 (1 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
19.590	Upstream end of model												
19.590	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	0	0	0	0	0	0	0	0	0	0	0	0	0
18.000	0	0	0	0	0	0	0	0	0	0	0	0	0
17.000	0	0	0	0	0	0	0	0	0	0	0	0	0
16.000	0	0	0	0	0	0	0	0	0	0	0	0	0
15.000	0	0	0	0	0	0	0	0	0	0	0	0	0
14.240	0	0	0	0	0	0	0	0	0	0	0	0	0
14.220	Highway 43 Bridge												
14.200	0	0	0	0	0	0	0	0	0	0	0	0	0
14.000	0	0	0	0	0	0	0	0	0	0	0	0	0
13.000	0	0	0	0	0	0	0	0	0	0	0	0	0
12.000	0	0	0	0	0	0	0	0	0	0	0	0	0
11.910	OK/MO State Line												
11.000	0	0	0	0	0	0	0	0	0	0	0	0	0
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0
8.000	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.700	0	0	0	0	0	0	0	0	0	0	0	0	0
4.670	OK Highway 10 Bridge												
4.640	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.320	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Elk River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.8**

GRAND RIVER DAM AUTHORITY TAR CREEK DURATIONS - JUN 2004 (1 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
4.152	Upstream end of model												
4.152	0	0	0	0	0	0	0	0	0	0	0	0	0
3.900	0	0	0	0	0	0	0	0	0	0	0	0	0
3.840	22nd Ave Bridge												
3.800	0	0	0	0	0	0	0	0	0	0	0	0	0
3.300	0	0	0	0	0	0	0	0	0	0	0	0	0
2.800	0	0	0	0	0	0	0	0	0	0	0	0	0
2.710	BN RR Bridge												
2.700	0	0	0	0	0	0	0	0	0	0	0	0	0
2.500	0	0	0	0	0	0	0	0	0	0	0	0	0
2.300	0	0	0	0	0	0	0	0	0	0	0	0	0
2.200	Rockdale Blvd Bridge												
2.100	0	0	0	0	0	0	0	0	0	0	0	0	0
1.900	0	0	0	0	0	0	0	0	0	0	0	0	0
1.700	0	0	0	0	0	0	0	0	0	0	0	0	0
1.660	Central Ave Bridge												
1.600	0	0	0	0	0	0	0	0	0	0	0	0	0
1.500	0	0	0	0	0	0	0	0	0	0	0	0	0
1.400	OK Highway 10 Bridge												
1.300	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.700	0	0	0	0	0	0	0	0	0	0	0	0	0
0.300	0	0	0	0	0	0	0	0	0	0	0	0	0
0.041	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Tar Creek												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX G.3:

JULY 2007 (4 YEAR) INFLOW EVENT

DURATION OF INUNDATION

PENSACOLA DAM | **TABLE G.9**

GRAND RIVER DAM AUTHORITY | NEOSHO RIVER DURATIONS - JUL 2007 (4 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
152.175	Upstream end of model												
152.175	193	193	193	193	193	193	193	193	193	193	193	0	0
151.000	143	143	144	144	144	143	144	144	143	143	143	1	1
150.000	213	213	213	213	213	213	213	213	213	213	214	0	1
149.000	208	208	208	208	208	208	208	208	208	209	209	0	1
148.000	209	209	209	209	209	209	209	209	210	210	211	0	2
147.000	193	193	193	193	193	193	193	193	193	193	193	0	0
145.500	228	228	228	228	228	228	228	228	229	229	230	0	2
145.480	E 60 Road Bridge												
145.400	226	227	228	228	228	228	228	228	228	229	230	1	4
144.000	236	236	236	237	237	237	237	237	237	238	239	1	3
143.000	221	223	223	223	223	223	223	223	223	225	226	0	5
142.000	252	252	253	253	253	253	253	253	254	256	260	1	8
141.000	248	248	249	249	249	249	249	249	250	253	255	1	7
140.000	237	238	239	239	239	239	239	239	241	245	249	1	12
139.000	204	206	208	208	208	208	208	208	213	220	225	2	21
138.000	186	189	190	190	191	192	191	192	197	202	208	3	22
137.000	170	172	174	174	174	174	174	174	177	180	186	2	16
135.950	164	166	168	168	168	169	168	168	171	173	178	3	14
135.941	Highway 69 Bridge												
135.940	164	165	167	167	167	167	167	167	171	173	178	2	14
135.590	163	165	167	167	167	167	167	167	170	172	177	2	14
135.586	BN RR Bridge												
135.580	163	165	167	167	167	167	167	167	170	172	177	2	14
135.470	162	164	166	166	166	166	166	166	168	171	175	2	13
135.460	Highway 125 Bridge												
135.440	162	165	166	166	166	166	167	167	169	172	177	2	15
135.000	161	164	165	166	165	166	166	166	168	171	175	2	14

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.9**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - JUL 2007 (4 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
134.610	158	161	162	163	162	163	163	163	166	168	172	2	14
134.599	Abandonded RR Bridge												
134.595	156	158	161	161	161	161	161	161	163	166	169	3	13
134.000	149	152	153	153	153	153	154	154	156	159	162	2	13
133.973	Tar Creek												
133.900	146	148	150	150	150	150	150	150	154	155	159	2	13
133.800	Interstate 44 Bridge												
133.700	145	148	149	150	150	150	150	150	152	154	157	2	12
133.000	137	139	140	140	140	141	140	141	142	143	144	2	7
132.000	132	132	134	134	134	134	134	135	135	136	137	3	5
131.000	126	128	130	130	130	130	130	130	131	132	132	2	6
130.000	120	122	126	126	126	126	125	126	127	127	127	4	7
129.000	112	116	119	119	119	120	119	120	122	121	122	4	10
128.000	103	107	113	113	113	114	113	114	116	115	116	7	13
126.710	84	85	92	92	93	90	92	93	95	95	96	8	12
126.700	S 590 Road Bridge												
126.670	83	83	91	91	91	90	91	91	94	93	95	8	12
126.000	75	76	84	84	84	81	84	84	87	86	88	8	13
125.000	53	59	67	67	67	64	66	67	70	70	72	8	19
124.000	0	0	41	41	41	23	40	43	47	49	51	43	51
123.000	0	0	0	0	0	0	0	0	0	0	0	0	0
122.580	0	0	0	0	0	0	0	0	0	0	0	0	0
122.570	Highway 60 Bridge												
122.550	0	0	0	0	0	0	0	0	0	0	0	0	0
122.350	Spring River												
122.000	0	0	0	0	0	0	0	0	0	0	0	0	0
121.980	0	0	0	0	0	0	0	0	0	0	0	0	0
121.970	BN RR Bridge												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.9**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - JUL 2007 (4 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
121.960	0	0	0	0	0	0	0	0	0	0	0	0	0
120.000	0	0	0	0	0	0	0	0	0	0	0	0	0
118.000	0	0	0	0	0	0	0	0	0	0	0	0	0
116.000	0	0	0	0	0	0	0	0	0	0	0	0	0
114.000	0	0	0	0	0	0	0	0	0	0	0	0	0
112.000	0	0	0	0	0	0	0	0	0	0	0	0	0
110.000	0	0	0	0	0	0	0	0	0	0	0	0	0
108.000	0	0	0	0	0	0	0	0	0	0	0	0	0
106.000	0	0	0	0	0	0	0	0	0	0	0	0	0
105.350	Elk River												
105.000	0	0	0	0	0	0	0	0	0	0	0	0	0
104.000	0	0	0	0	0	0	0	0	0	0	0	0	0
102.000	0	0	0	0	0	0	0	0	0	0	0	0	0
101.750	0	0	0	0	0	0	0	0	0	0	0	0	0
101.730	Highway 59 (Sailboat Bridge)												
101.710	0	0	0	0	0	0	0	0	0	0	0	0	0
100.000	0	0	0	0	0	0	0	0	0	0	0	0	0
90.000	0	0	0	0	0	0	0	0	0	0	0	0	0
80.000	0	0	0	0	0	0	0	0	0	0	0	0	0
78.000	0	0	0	0	0	0	0	0	0	0	0	0	0
77.000	Pensacola Dam												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.10**

GRAND RIVER DAM AUTHORITY SPRING RIVER DURATIONS - JUL 2007 (4 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
21.000	Upstream end of model												
21.000	0	0	0	0	0	0	0	0	0	0	0	0	0
20.000	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	0	0	0	0	0	0	0	0	0	0	0	0	0
18.000	0	0	0	0	0	0	0	0	0	0	0	0	0
17.000	0	0	0	0	0	0	0	0	0	0	0	0	0
16.000	0	0	0	0	0	0	0	0	0	0	0	0	0
15.000	0	0	0	0	0	0	0	0	0	0	0	0	0
14.170	0	0	0	0	0	0	0	0	0	0	0	0	0
14.160	E 57 Road												
14.120	0	0	0	0	0	0	0	0	0	0	0	0	0
13.510	0	0	0	0	0	0	0	0	0	0	0	0	0
13.500	Interstate 44 Bridge												
13.450	0	0	0	0	0	0	0	0	0	0	0	0	0
12.000	0	0	0	0	0	0	0	0	0	0	0	0	0
11.000	38	39	45	45	45	40	44	47	53	56	63	8	25
10.000	0	0	0	0	0	0	0	0	31	15	41	0	41
9.000	0	0	0	0	0	0	0	0	0	0	8	0	8
8.020	0	0	0	0	0	0	0	0	0	0	0	0	0
8.010	OK Highway 10 Bridge												
7.970	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.580	0	0	0	0	0	0	0	0	0	0	0	0	0
0.570	Highway 60 Bridge												
0.560	0	0	0	0	0	0	0	0	0	0	0	0	0
0.460	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Spring River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.11**

GRAND RIVER DAM AUTHORITY ELK RIVER DURATIONS - JUL 2007 (4 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
19.590	Upstream end of model												
19.590	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	0	0	0	0	0	0	0	0	0	0	0	0	0
18.000	0	0	0	0	0	0	0	0	0	0	0	0	0
17.000	0	0	0	0	0	0	0	0	0	0	0	0	0
16.000	0	0	0	0	0	0	0	0	0	0	0	0	0
15.000	0	0	0	0	0	0	0	0	0	0	0	0	0
14.240	0	0	0	0	0	0	0	0	0	0	0	0	0
14.220	Highway 43 Bridge												
14.200	0	0	0	0	0	0	0	0	0	0	0	0	0
14.000	0	0	0	0	0	0	0	0	0	0	0	0	0
13.000	0	0	0	0	0	0	0	0	0	0	0	0	0
12.000	0	0	0	0	0	0	0	0	0	0	0	0	0
11.910	OK/MO State Line												
11.000	0	0	0	0	0	0	0	0	0	0	0	0	0
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0
8.000	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.700	0	0	0	0	0	0	0	0	0	0	0	0	0
4.670	OK Highway 10 Bridge												
4.640	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.320	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Elk River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.12**

GRAND RIVER DAM AUTHORITY TAR CREEK DURATIONS - JUL 2007 (4 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
4.152	Upstream end of model												
4.152	0	0	0	0	0	0	0	0	0	0	0	0	0
3.900	0	0	0	0	0	0	0	0	0	0	0	0	0
3.840	22nd Ave Bridge												
3.800	32	33	35	35	35	33	35	35	36	36	37	2	5
3.300	46	46	48	48	48	47	48	48	49	49	50	2	4
2.800	80	82	83	83	83	82	83	83	83	83	84	1	4
2.710	BN RR Bridge												
2.700	110	110	112	112	112	112	112	112	112	113	113	2	3
2.500	118	120	122	122	122	122	122	122	122	122	123	2	5
2.300	127	128	129	129	129	129	129	129	130	130	131	1	4
2.200	Rockdale Blvd Bridge												
2.100	148	151	153	153	153	153	153	153	156	159	161	2	13
1.900	148	151	153	153	153	153	153	153	156	158	161	2	13
1.700	148	151	153	153	153	153	153	153	156	158	161	2	13
1.660	Central Ave Bridge												
1.600	148	151	153	153	153	153	153	153	156	158	161	2	13
1.500	148	151	153	153	153	153	153	153	156	158	161	2	13
1.400	OK Highway 10 Bridge												
1.300	148	151	153	153	153	153	153	153	156	158	161	2	13
1.000	148	151	153	153	153	153	153	153	156	158	161	2	13
0.700	148	151	153	153	153	153	153	153	156	158	161	2	13
0.300	148	151	153	153	153	153	153	153	156	158	161	2	13
0.041	148	151	153	153	153	153	153	153	156	158	161	2	13
0.000	Downstream end of Tar Creek												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX G.4:

OCTOBER 2009 (3 YEAR) INFLOW EVENT

DURATION OF INUNDATION

PENSACOLA DAM **TABLE G.13**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - OCT 2009 (3 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
152.175	Upstream end of model												
152.175	90	90	90	90	90	90	90	90	90	90	90	0	0
151.000	42	42	42	42	42	42	42	42	42	42	42	0	0
150.000	95	95	95	95	95	95	95	95	95	95	95	0	0
149.000	92	93	93	93	93	93	93	93	93	94	94	0	2
148.000	95	95	95	95	95	95	95	95	95	95	95	0	0
147.000	87	87	87	87	87	87	87	87	87	87	89	0	2
145.500	104	104	104	104	104	104	104	104	104	104	105	0	1
145.480	E 60 Road Bridge												
145.400	102	102	102	102	102	102	102	102	103	104	105	0	3
144.000	107	107	107	107	107	108	108	108	108	110	110	1	3
143.000	100	100	100	100	100	100	100	100	100	102	103	0	3
142.000	117	117	117	117	117	117	117	117	119	121	123	0	6
141.000	114	115	114	115	114	115	115	114	116	118	121	1	7
140.000	108	108	109	110	109	110	109	109	111	114	117	2	9
139.000	91	93	93	93	93	93	93	93	95	101	108	0	17
138.000	80	81	81	82	82	82	82	82	85	92	100	1	20
137.000	57	60	59	60	60	60	61	61	63	74	88	2	31
135.950	44	48	48	49	49	49	49	50	53	63	77	2	33
135.941	Highway 69 Bridge												
135.940	43	47	46	47	48	49	49	49	51	62	76	3	33
135.590	42	46	45	46	46	47	47	47	50	62	75	2	33
135.586	BN RR Bridge												
135.580	42	45	45	46	46	46	47	47	50	61	75	2	33
135.470	39	44	43	45	45	45	45	46	49	59	74	3	35
135.460	Highway 125 Bridge												
135.440	40	44	45	46	45	46	46	46	50	61	75	2	35
135.000	37	41	42	43	43	43	43	44	47	58	72	3	35

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.

2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.13**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - OCT 2009 (3 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
134.610	28	34	35	36	36	37	37	37	42	54	69	3	41
134.599	Abandonded RR Bridge												
134.595	22	30	29	32	32	33	33	33	37	50	66	4	44
134.000	0	0	0	0	0	0	0	0	16	38	59	0	59
133.973	Tar Creek												
133.900	0	0	0	0	0	0	0	0	0	32	54	0	54
133.800	Interstate 44 Bridge												
133.700	0	0	0	0	0	0	0	0	0	30	54	0	54
133.000	0	0	0	0	0	0	0	0	0	0	30	0	30
132.000	0	0	0	0	0	0	0	0	0	0	0	0	0
131.000	0	0	0	0	0	0	0	0	0	0	0	0	0
130.000	0	0	0	0	0	0	0	0	0	0	0	0	0
129.000	0	0	0	0	0	0	0	0	0	0	0	0	0
128.000	0	0	0	0	0	0	0	0	0	0	0	0	0
126.710	0	0	0	0	0	0	0	0	0	0	0	0	0
126.700	S 590 Road Bridge												
126.670	0	0	0	0	0	0	0	0	0	0	0	0	0
126.000	0	0	0	0	0	0	0	0	0	0	0	0	0
125.000	0	0	0	0	0	0	0	0	0	0	0	0	0
124.000	0	0	0	0	0	0	0	0	0	0	0	0	0
123.000	0	0	0	0	0	0	0	0	0	0	0	0	0
122.580	0	0	0	0	0	0	0	0	0	0	0	0	0
122.570	Highway 60 Bridge												
122.550	0	0	0	0	0	0	0	0	0	0	0	0	0
122.350	Spring River												
122.000	0	0	0	0	0	0	0	0	0	0	0	0	0
121.980	0	0	0	0	0	0	0	0	0	0	0	0	0
121.970	BN RR Bridge												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.13**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - OCT 2009 (3 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
121.960	0	0	0	0	0	0	0	0	0	0	0	0	0
120.000	0	0	0	0	0	0	0	0	0	0	0	0	0
118.000	0	0	0	0	0	0	0	0	0	0	0	0	0
116.000	0	0	0	0	0	0	0	0	0	0	0	0	0
114.000	0	0	0	0	0	0	0	0	0	0	0	0	0
112.000	0	0	0	0	0	0	0	0	0	0	0	0	0
110.000	0	0	0	0	0	0	0	0	0	0	0	0	0
108.000	0	0	0	0	0	0	0	0	0	0	0	0	0
106.000	0	0	0	0	0	0	0	0	0	0	0	0	0
105.350	Elk River												
105.000	0	0	0	0	0	0	0	0	0	0	0	0	0
104.000	0	0	0	0	0	0	0	0	0	0	0	0	0
102.000	0	0	0	0	0	0	0	0	0	0	0	0	0
101.750	0	0	0	0	0	0	0	0	0	0	0	0	0
101.730	Highway 59 (Sailboat Bridge)												
101.710	0	0	0	0	0	0	0	0	0	0	0	0	0
100.000	0	0	0	0	0	0	0	0	0	0	0	0	0
90.000	0	0	0	0	0	0	0	0	0	0	0	0	0
80.000	0	0	0	0	0	0	0	0	0	0	0	0	0
78.000	0	0	0	0	0	0	0	0	0	0	0	0	0
77.000	Pensacola Dam												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.14**

GRAND RIVER DAM AUTHORITY SPRING RIVER DURATIONS - OCT 2009 (3 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
21.000	Upstream end of model												
21.000	0	0	0	0	0	0	0	0	0	0	0	0	0
20.000	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	28	28	28	28	28	28	28	28	28	28	28	0	0
18.000	29	29	29	29	29	29	29	29	29	29	29	0	0
17.000	32	32	32	32	32	32	32	32	32	32	32	0	0
16.000	59	59	59	59	59	59	59	59	59	59	59	0	0
15.000	39	39	39	39	39	39	39	39	39	39	39	0	0
14.170	75	75	75	75	75	75	75	75	75	75	76	0	1
14.160	E 57 Road												
14.120	76	76	76	76	76	76	76	76	76	76	76	0	0
13.510	76	76	76	76	76	76	76	76	76	76	77	0	1
13.500	Interstate 44 Bridge												
13.450	74	74	74	74	74	74	74	74	74	76	76	0	2
12.000	75	75	75	75	75	75	75	75	75	76	76	0	1
11.000	87	87	87	87	87	87	87	87	89	91	94	0	7
10.000	81	82	82	82	82	82	82	82	84	86	89	0	8
9.000	73	74	74	74	74	74	74	74	75	79	84	0	11
8.020	53	55	55	55	55	56	56	56	59	68	76	1	23
8.010	OK Highway 10 Bridge												
7.970	20	21	22	22	22	22	22	22	23	30	39	1	19
7.000	0	0	0	0	0	0	0	0	0	0	3	0	3
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.580	0	0	0	0	0	0	0	0	0	0	0	0	0
0.570	Highway 60 Bridge												
0.560	0	0	0	0	0	0	0	0	0	0	0	0	0
0.460	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Spring River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM | **TABLE G.15**

GRAND RIVER DAM AUTHORITY | ELK RIVER DURATIONS - OCT 2009 (3 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
19.590	Upstream end of model												
19.590	24	24	24	24	24	24	24	24	24	24	24	0	0
19.000	19	19	19	19	19	19	19	19	19	19	19	0	0
18.000	22	22	22	22	22	22	22	22	22	22	22	0	0
17.000	56	56	56	56	56	56	56	56	56	56	56	0	0
16.000	58	58	58	58	58	58	58	58	58	58	58	0	0
15.000	51	51	51	51	51	51	51	51	51	51	51	0	0
14.240	31	31	31	31	31	31	31	31	31	31	31	0	0
14.220	Highway 43 Bridge												
14.200	30	30	30	30	30	30	30	30	30	30	30	0	0
14.000	25	25	25	25	25	25	25	25	25	25	25	0	0
13.000	27	27	27	27	27	27	27	27	27	27	28	0	1
12.000	15	15	15	15	15	15	15	15	15	15	15	0	0
11.910	OK/MO State Line												
11.000	0	0	0	0	0	0	0	0	0	0	0	0	0
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0
8.000	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.700	0	0	0	0	0	0	0	0	0	0	0	0	0
4.670	OK Highway 10 Bridge												
4.640	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.320	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Elk River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.16**

GRAND RIVER DAM AUTHORITY TAR CREEK DURATIONS - OCT 2009 (3 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
4.152	Upstream end of model												
4.152	1	1	1	1	1	1	1	1	1	1	1	0	0
3.900	12	12	12	12	12	12	12	12	12	12	12	0	0
3.840	22nd Ave Bridge												
3.800	18	18	18	18	18	18	18	18	18	18	18	0	0
3.300	7	7	7	7	7	7	7	7	7	7	7	0	0
2.800	0	0	0	0	0	0	0	0	0	0	0	0	0
2.710	BN RR Bridge												
2.700	20	20	20	20	20	20	20	20	20	20	20	0	0
2.500	14	14	14	14	14	14	14	14	14	14	14	0	0
2.300	6	6	6	6	6	6	6	6	6	7	7	0	1
2.200	Rockdale Blvd Bridge												
2.100	10	10	10	10	10	10	11	11	84	95	101	1	91
1.900	0	0	0	0	0	0	0	0	12	36	57	0	57
1.700	0	0	0	0	0	0	0	0	12	36	57	0	57
1.660	Central Ave Bridge												
1.600	0	0	0	0	0	0	0	0	12	36	57	0	57
1.500	0	0	0	0	0	0	0	0	12	36	57	0	57
1.400	OK Highway 10 Bridge												
1.300	0	0	0	0	0	0	0	0	12	36	57	0	57
1.000	0	0	0	0	0	0	0	0	12	36	57	0	57
0.700	0	0	0	0	0	0	0	0	12	36	57	0	57
0.300	0	0	0	0	0	0	0	0	12	36	57	0	57
0.041	0	0	0	0	0	0	0	0	12	36	57	0	57
0.000	Downstream end of Tar Creek												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX G.5:
DECEMBER 2015 (15 YEAR) INFLOW EVENT
DURATION OF INUNDATION

PENSACOLA DAM **TABLE G.17**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - DEC 2015 (15 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
152.175	Upstream end of model												
152.175	74	74	74	74	74	74	74	74	74	74	74	0	0
151.000	47	47	47	47	47	47	47	47	47	47	48	0	1
150.000	80	80	80	80	80	80	80	80	80	80	81	0	1
149.000	79	79	79	79	79	79	79	79	79	79	79	0	0
148.000	80	80	80	80	80	80	80	80	81	81	81	0	1
147.000	73	74	74	74	74	74	74	74	74	75	75	0	2
145.500	91	92	92	92	92	92	92	92	92	92	94	0	3
145.480	E 60 Road Bridge												
145.400	90	91	91	91	91	91	91	91	92	92	92	0	2
144.000	96	98	98	98	98	98	98	98	99	99	100	0	4
143.000	88	90	90	90	90	90	90	90	90	91	93	0	5
142.000	113	114	114	114	114	114	114	114	114	115	116	0	3
141.000	109	110	110	110	110	110	110	110	111	112	114	0	5
140.000	102	105	105	105	105	105	105	105	106	107	109	0	7
139.000	87	89	89	89	89	89	90	90	91	94	98	1	11
138.000	78	82	82	82	82	82	82	82	83	86	92	0	14
137.000	68	72	72	72	72	72	72	72	73	76	84	0	16
135.950	62	67	67	67	67	67	67	67	69	72	80	0	18
135.941	Highway 69 Bridge												
135.940	62	67	67	67	67	67	67	67	69	72	80	0	18
135.590	62	67	67	67	67	67	67	67	69	72	80	0	18
135.586	BN RR Bridge												
135.580	62	66	67	66	66	66	67	67	69	71	80	1	18
135.470	61	65	65	65	65	65	65	65	68	71	78	0	17
135.460	Highway 125 Bridge												
135.440	61	66	66	66	66	66	66	67	68	71	79	1	18
135.000	60	65	65	65	65	65	65	65	68	71	78	0	18

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.

2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.17**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - DEC 2015 (15 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
134.610	57	63	63	63	63	63	63	63	65	68	77	0	20
134.599	Abandonded RR Bridge												
134.595	56	61	61	61	61	61	61	62	65	67	75	1	19
134.000	49	57	57	57	57	57	57	57	60	62	71	0	22
133.973	Tar Creek												
133.900	44	53	53	53	53	53	54	54	57	60	69	1	25
133.800	Interstate 44 Bridge												
133.700	42	51	52	52	51	51	52	52	57	59	68	1	26
133.000	28	40	40	40	40	40	41	41	48	50	60	1	32
132.000	0	30	30	30	30	30	31	32	38	40	52	2	52
131.000	0	20	20	20	20	20	21	23	32	33	45	3	45
130.000	0	15	16	15	15	15	16	18	28	30	43	3	43
129.000	0	11	12	11	11	11	13	14	25	28	41	3	41
128.000	0	9	10	10	9	9	10	10	23	26	38	1	38
126.710	0	5	6	5	5	5	7	6	17	22	35	2	35
126.700	S 590 Road Bridge												
126.670	0	5	5	5	5	5	5	5	17	20	33	0	33
126.000	0	5	5	5	5	5	5	5	15	20	33	0	33
125.000	0	3	3	3	3	3	3	3	9	16	30	0	30
124.000	0	2	2	2	2	2	2	3	4	14	29	1	29
123.000	0	0	0	0	0	0	0	0	0	2	27	0	27
122.580	0	0	0	0	0	0	0	0	0	1	26	0	26
122.570	Highway 60 Bridge												
122.550	0	0	0	0	0	0	0	0	0	0	25	0	25
122.350	Spring River												
122.000	0	0	0	0	0	0	0	0	0	0	14	0	14
121.980	0	0	0	0	0	0	0	0	0	0	0	0	0
121.970	BN RR Bridge												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.17**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - DEC 2015 (15 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
121.960	0	0	0	0	0	0	0	0	0	0	0	0	0
120.000	0	0	0	0	0	0	0	0	0	0	0	0	0
118.000	0	0	0	0	0	0	0	0	0	0	0	0	0
116.000	0	0	0	0	0	0	0	0	0	0	0	0	0
114.000	0	0	0	0	0	0	0	0	0	0	0	0	0
112.000	0	0	0	0	0	0	0	0	0	0	0	0	0
110.000	0	0	0	0	0	0	0	0	0	0	0	0	0
108.000	0	0	0	0	0	0	0	0	0	0	0	0	0
106.000	0	0	0	0	0	0	0	0	0	0	0	0	0
105.350	Elk River												
105.000	0	0	0	0	0	0	0	0	0	0	0	0	0
104.000	0	0	0	0	0	0	0	0	0	0	0	0	0
102.000	0	0	0	0	0	0	0	0	0	0	0	0	0
101.750	0	0	0	0	0	0	0	0	0	0	0	0	0
101.730	Highway 59 (Sailboat Bridge)												
101.710	0	0	0	0	0	0	0	0	0	0	0	0	0
100.000	0	0	0	0	0	0	0	0	0	0	0	0	0
90.000	0	0	0	0	0	0	0	0	0	0	0	0	0
80.000	0	0	0	0	0	0	0	0	0	0	0	0	0
78.000	0	0	0	0	0	0	0	0	0	0	0	0	0
77.000	Pensacola Dam												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.18**

GRAND RIVER DAM AUTHORITY SPRING RIVER DURATIONS - DEC 2015 (15 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
21.000	Upstream end of model												
21.000	54	54	54	54	54	54	54	54	54	54	54	0	0
20.000	52	52	52	52	52	52	52	52	52	52	52	0	0
19.000	76	76	76	76	76	76	76	76	76	76	76	0	0
18.000	77	77	77	77	77	77	77	77	77	77	77	0	0
17.000	79	79	79	79	79	79	79	79	79	79	79	0	0
16.000	86	86	86	86	86	86	86	86	86	86	86	0	0
15.000	82	82	82	82	82	82	82	82	82	82	82	0	0
14.170	96	97	97	97	97	97	97	97	97	97	98	0	2
14.160	E 57 Road												
14.120	98	98	98	98	98	98	98	98	98	98	98	0	0
13.510	99	99	99	99	99	99	99	99	99	99	99	0	0
13.500	Interstate 44 Bridge												
13.450	97	97	97	97	97	97	97	97	97	97	97	0	0
12.000	97	97	97	97	97	97	97	98	98	98	98	1	1
11.000	112	111	111	111	111	111	112	112	112	113	113	1	2
10.000	108	108	108	108	108	108	108	108	108	108	109	0	1
9.000	100	101	101	101	101	101	101	101	102	103	104	0	4
8.020	92	93	93	93	93	93	93	93	93	95	97	0	5
8.010	OK Highway 10 Bridge												
7.970	78	81	81	81	81	81	81	81	82	83	85	0	7
7.000	61	65	65	65	65	65	65	65	66	67	71	0	10
6.000	51	57	57	57	57	57	57	57	58	58	61	0	10
5.000	41	49	49	49	49	49	49	49	50	51	54	0	13
4.000	28	38	38	38	38	38	38	38	43	45	50	0	22
3.000	15	32	32	32	32	32	33	33	35	37	45	1	30
2.000	0	25	25	25	25	25	26	27	31	32	41	2	41
1.000	0	8	8	8	8	8	8	10	25	27	35	2	35
0.580	0	0	0	0	0	0	0	0	0	0	23	0	23
0.570	Highway 60 Bridge												
0.560	0	0	0	0	0	0	0	0	0	0	19	0	19
0.460	0	0	0	0	0	0	0	0	0	0	24	0	24
0.000	Downstream end of Spring River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.19**

GRAND RIVER DAM AUTHORITY ELK RIVER DURATIONS - DEC 2015 (15 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
19.590	Upstream end of model												
19.590	58	58	58	58	58	58	58	58	58	58	58	0	0
19.000	51	51	51	51	51	51	51	51	51	51	51	0	0
18.000	55	55	55	55	55	55	55	55	55	55	55	0	0
17.000	111	111	111	111	111	111	111	111	111	111	111	0	0
16.000	118	118	118	118	118	118	118	118	118	118	118	0	0
15.000	103	104	104	104	104	104	104	104	104	104	104	0	1
14.240	68	68	68	68	68	68	68	68	68	68	68	0	0
14.220	Highway 43 Bridge												
14.200	67	67	67	67	67	67	67	67	67	67	67	0	0
14.000	59	59	59	59	59	59	59	59	59	59	59	0	0
13.000	62	62	62	62	62	62	62	62	63	64	65	0	3
12.000	46	46	46	46	46	46	46	46	46	46	48	0	2
11.910	OK/MO State Line												
11.000	21	21	21	21	21	21	21	21	21	21	23	0	2
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0
8.000	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.700	0	0	0	0	0	0	0	0	0	0	0	0	0
4.670	OK Highway 10 Bridge												
4.640	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.320	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Elk River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.20**

GRAND RIVER DAM AUTHORITY TAR CREEK DURATIONS - DEC 2015 (15 YEAR) EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
4.152	Upstream end of model												
4.152	4	4	4	4	4	4	4	4	4	4	4	0	0
3.900	15	15	15	15	15	15	15	15	15	15	15	0	0
3.840	22nd Ave Bridge												
3.800	21	21	21	21	21	21	21	21	21	21	21	0	0
3.300	9	9	9	9	9	9	9	9	9	9	9	0	0
2.800	0	0	0	0	0	0	0	0	0	0	0	0	0
2.710	BN RR Bridge												
2.700	24	24	24	24	24	24	24	24	24	24	24	0	0
2.500	17	17	17	17	17	17	17	17	17	17	17	0	0
2.300	8	8	8	8	8	8	8	8	8	9	67	0	59
2.200	Rockdale Blvd Bridge												
2.100	84	89	89	89	89	89	89	89	90	90	92	0	8
1.900	49	56	56	56	56	56	56	56	60	62	74	0	25
1.700	48	55	56	55	55	55	56	56	60	62	72	1	24
1.660	Central Ave Bridge												
1.600	48	55	55	55	55	55	56	56	60	62	72	1	24
1.500	48	55	55	55	55	55	56	56	60	62	72	1	24
1.400	OK Highway 10 Bridge												
1.300	48	55	55	55	55	55	56	56	59	62	71	1	23
1.000	48	55	55	55	55	55	55	56	59	62	70	1	22
0.700	48	55	55	55	55	55	55	56	59	62	70	1	22
0.300	48	55	55	55	55	55	55	56	59	62	70	1	22
0.041	48	55	55	55	55	55	55	56	59	62	70	1	22
0.000	Downstream end of Tar Creek												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX G.6:
100-YEAR INFLOW EVENT
DURATION OF INUNDATION

PENSACOLA DAM **TABLE G.21**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - 100-YEAR EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
152.175	Upstream end of model												
152.175	221	221	221	221	221	221	221	221	221	221	221	0	0
151.000	209	209	209	209	209	209	209	209	209	209	209	0	0
150.000	227	227	227	227	227	227	227	227	233	234	235	0	8
149.000	227	227	227	227	227	227	227	227	227	227	227	0	0
148.000	229	229	229	229	229	229	229	229	229	229	229	0	0
147.000	225	225	225	225	225	225	225	225	225	225	225	0	0
145.500	253	254	254	254	254	254	254	254	254	255	257	0	4
145.480	E 60 Road Bridge												
145.400	252	253	253	253	253	253	253	253	253	254	256	0	4
144.000	261	262	262	262	262	262	262	262	262	264	266	0	5
143.000	242	243	243	243	244	244	244	244	246	250	254	1	12
142.000	275	275	275	275	275	276	276	276	276	278	284	1	9
141.000	272	272	272	272	272	272	272	272	273	275	280	0	8
140.000	261	263	263	263	263	263	263	263	266	270	276	0	15
139.000	238	239	239	239	239	239	239	239	241	245	263	0	25
138.000	230	231	231	231	231	231	231	231	233	235	243	0	13
137.000	223	224	224	224	224	224	224	224	225	226	230	0	7
135.950	220	221	221	221	221	221	221	221	222	223	226	0	6
135.941	Highway 69 Bridge												
135.940	220	220	221	221	221	221	221	221	222	223	226	1	6
135.590	219	220	220	220	220	221	220	220	222	223	226	1	7
135.586	BN RR Bridge												
135.580	219	220	220	220	220	220	220	220	222	223	226	0	7
135.470	219	220	220	220	220	220	220	220	221	222	225	0	6
135.460	Highway 125 Bridge												
135.440	219	220	220	220	220	220	220	220	221	223	225	0	6
135.000	219	220	220	220	220	220	220	220	221	222	225	0	6

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.21**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - 100-YEAR EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0 Duration (hours)	El. 742.0 Duration (hours)	El. 742.5 Duration (hours)	El. 743.0 Duration (hours)	El. 743.5 Duration (hours)	El. 744.0 Duration (hours)	El. 744.5 Duration (hours)	El. 745.0 Duration (hours)	El. 749.0 Duration (hours)	El. 753.0 Duration (hours)	El. 757.0 Duration (hours)		
134.610	217	218	218	218	218	218	218	218	219	220	223	0	6
134.599	Abandonded RR Bridge												
134.595	216	217	217	217	217	217	217	217	219	220	222	0	6
134.000	210	211	212	212	212	212	212	212	213	215	217	1	7
133.973	Tar Creek												
133.900	209	210	210	210	211	211	211	211	212	213	216	1	7
133.800	Interstate 44 Bridge												
133.700	208	209	209	209	209	209	209	209	211	212	214	0	6
133.000	202	203	203	203	204	204	204	204	205	205	207	1	5
132.000	196	197	197	197	197	197	197	197	198	198	200	0	4
131.000	191	191	191	191	192	192	192	192	193	193	195	1	4
130.000	180	181	181	181	181	181	181	181	182	183	184	0	4
129.000	156	157	157	157	157	157	157	157	158	159	161	0	5
128.000	134	136	136	136	136	136	136	136	138	138	141	0	7
126.710	114	115	116	116	116	116	116	116	118	119	124	1	10
126.700	S 590 Road Bridge												
126.670	113	115	115	115	116	116	116	116	118	119	124	1	11
126.000	108	110	110	110	110	110	110	110	112	114	119	0	11
125.000	96	98	98	98	98	99	98	99	101	102	108	1	12
124.000	84	87	86	87	87	87	87	87	90	91	96	1	12
123.000	70	72	71	71	72	72	71	72	74	75	80	1	10
122.580	59	61	61	61	62	62	61	62	64	65	68	1	9
122.570	Highway 60 Bridge												
122.550	60	63	62	62	63	63	62	63	65	66	69	1	9
122.350	Spring River												
122.000	59	61	61	61	62	62	61	61	63	63	65	1	6
121.980	57	60	59	59	60	60	59	60	61	62	63	1	6
121.970	BN RR Bridge												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.21**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - 100-YEAR EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
121.960	37	41	39	39	41	40	40	40	43	44	46	2	9
120.000	25	27	26	27	27	27	27	27	29	30	32	1	7
118.000	0	0	0	0	0	0	0	0	0	0	0	0	0
116.000	0	0	0	0	0	0	0	0	0	0	0	0	0
114.000	0	0	0	0	0	0	0	0	0	0	0	0	0
112.000	0	0	0	0	0	0	0	0	0	0	0	0	0
110.000	0	0	0	0	0	0	0	0	0	0	0	0	0
108.000	0	0	0	0	0	0	0	0	0	0	0	0	0
106.000	0	0	0	0	0	0	0	0	0	0	0	0	0
105.350	Elk River												
105.000	0	0	0	0	0	0	0	0	0	0	0	0	0
104.000	0	0	0	0	0	0	0	0	0	0	0	0	0
102.000	0	0	0	0	0	0	0	0	0	0	0	0	0
101.750	0	0	0	0	0	0	0	0	0	0	0	0	0
101.730	Highway 59 (Sailboat Bridge)												
101.710	0	0	0	0	0	0	0	0	0	0	0	0	0
100.000	0	0	0	0	0	0	0	0	0	0	0	0	0
90.000	0	0	0	0	0	0	0	0	0	0	0	0	0
80.000	0	0	0	0	0	0	0	0	0	0	0	0	0
78.000	0	0	0	0	0	0	0	0	0	0	0	0	0
77.000	Pensacola Dam												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.22**

GRAND RIVER DAM AUTHORITY SPRING RIVER DURATIONS - 100-YEAR EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
21.000	Upstream end of model												
21.000	0	0	0	0	0	0	0	0	0	0	0	0	0
20.000	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	40	40	40	40	40	40	40	40	40	40	40	0	0
18.000	41	41	41	41	41	41	41	41	41	41	41	0	0
17.000	43	43	43	43	43	43	43	43	43	43	44	0	1
16.000	55	55	55	55	55	55	55	55	55	55	55	0	0
15.000	49	49	49	49	49	49	49	49	49	49	49	0	0
14.170	72	72	72	72	72	72	72	72	72	72	72	0	0
14.160	E 57 Road												
14.120	73	73	73	73	73	73	73	73	73	73	73	0	0
13.510	75	75	75	75	75	75	75	75	75	75	75	0	0
13.500	Interstate 44 Bridge												
13.450	73	73	73	73	73	73	73	73	73	73	73	0	0
12.000	84	84	84	84	84	84	84	84	84	84	85	0	1
11.000	115	115	115	115	115	115	115	115	116	116	117	0	2
10.000	110	110	111	111	111	111	111	111	111	111	112	1	2
9.000	103	103	103	103	103	104	104	104	105	105	107	1	4
8.020	94	96	96	96	96	96	96	96	98	99	103	0	9
8.010	OK Highway 10 Bridge												
7.970	81	82	82	82	82	82	82	83	84	85	92	1	11
7.000	70	74	73	74	74	74	74	74	77	78	84	1	14
6.000	65	70	69	69	71	71	70	70	74	75	80	2	15
5.000	63	67	66	66	67	67	67	67	71	72	77	1	14
4.000	63	66	65	65	66	66	66	66	69	71	76	1	13
3.000	62	64	63	63	64	64	64	64	67	68	75	1	13
2.000	62	64	63	63	64	64	64	64	67	68	73	1	11
1.000	62	64	63	63	64	64	64	64	66	67	71	1	9
0.580	62	64	63	63	64	64	64	64	65	66	69	1	7
0.570	Highway 60 Bridge												
0.560	62	63	63	63	64	64	64	64	65	66	69	1	7
0.460	62	64	63	63	64	64	64	64	66	66	70	1	8
0.000	Downstream end of Spring River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.23**

GRAND RIVER DAM AUTHORITY ELK RIVER DURATIONS - 100-YEAR EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
19.590	Upstream end of model												
19.590	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	0	0	0	0	0	0	0	0	0	0	0	0	0
18.000	0	0	0	0	0	0	0	0	0	0	0	0	0
17.000	0	0	0	0	0	0	0	0	0	0	0	0	0
16.000	0	0	0	0	0	0	0	0	0	0	0	0	0
15.000	0	0	0	0	0	0	0	0	0	0	0	0	0
14.240	0	0	0	0	0	0	0	0	0	0	0	0	0
14.220	Highway 43 Bridge												
14.200	0	0	0	0	0	0	0	0	0	0	0	0	0
14.000	0	0	0	0	0	0	0	0	0	0	0	0	0
13.000	0	0	0	0	0	0	0	0	0	0	0	0	0
12.000	0	0	0	0	0	0	0	0	0	0	0	0	0
11.910	OK/MO State Line												
11.000	0	0	0	0	0	0	0	0	0	0	0	0	0
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0
8.000	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.700	0	0	0	0	0	0	0	0	0	0	0	0	0
4.670	OK Highway 10 Bridge												
4.640	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.320	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Elk River												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

PENSACOLA DAM **TABLE G.24**

GRAND RIVER DAM AUTHORITY TAR CREEK DURATIONS - 100-YEAR EVENT

River Mile	Pensacola Dam Starting Stage (ft, PD)											Anticipated Op Range Duration Difference[1] (hours)	Extreme, Hypothetical Range Duration Difference[2] (hours)
	El. 734.0	El. 742.0	El. 742.5	El. 743.0	El. 743.5	El. 744.0	El. 744.5	El. 745.0	El. 749.0	El. 753.0	El. 757.0		
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)		
4.152	Upstream end of model												
4.152	70	70	70	70	70	70	70	70	70	70	70	0	0
3.900	79	80	80	80	80	80	80	80	80	80	80	0	1
3.840	22nd Ave Bridge												
3.800	91	92	92	92	92	92	92	92	92	92	93	0	2
3.300	97	97	97	97	97	97	97	97	98	98	99	0	2
2.800	120	120	120	120	120	120	121	121	121	121	123	1	3
2.710	BN RR Bridge												
2.700	171	171	171	171	171	171	171	171	172	172	173	0	2
2.500	184	184	185	185	185	185	185	185	185	186	187	1	3
2.300	193	194	194	194	194	194	194	194	195	195	196	0	3
2.200	Rockdale Blvd Bridge												
2.100	210	212	212	212	212	212	212	212	214	215	217	0	7
1.900	210	211	211	211	212	212	212	212	213	214	217	1	7
1.700	210	211	211	211	211	212	211	211	213	214	217	1	7
1.660	Central Ave Bridge												
1.600	210	211	211	211	211	211	211	211	213	214	217	0	7
1.500	210	211	211	211	211	211	211	211	213	214	217	0	7
1.400	OK Highway 10 Bridge												
1.300	210	211	211	211	211	211	211	211	213	214	217	0	7
1.000	210	211	211	211	211	211	211	211	213	214	217	0	7
0.700	210	211	211	211	211	211	211	211	213	214	217	0	7
0.300	210	211	211	211	211	211	211	211	213	214	217	0	7
0.041	210	211	211	211	211	211	211	211	213	214	217	0	7
0.000	Downstream end of Tar Creek												

1 Max difference in duration from simulations with Pensacola Dam starting stages of El. 742.0 to El. 745.0 ft.
2 Max difference in duration from simulations with Pensacola Dam starting stages of El. 734.0 to El. 757.0 ft.

APPENDIX G.7:
HISTORICAL STARTING STAGES
DURATION OF INUNDATION

PENSACOLA DAM **TABLE G.25**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - HISTORICAL STARTING STAGES

River Mile	Historical Inflow Event					Max Duration Difference* (hours)
	Sept 1993 (21 year)	June 2004 (1 year)	July 2007 (4 year)	Oct 2009 (3 year)	Dec 2015 (15 year)	
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	
152.175	Upstream end of model					
152.175	137	0	193	90	74	193
151.000	117	0	143	42	47	143
150.000	145	0	213	95	80	213
149.000	142	0	208	93	79	208
148.000	144	0	209	95	80	209
147.000	138	0	193	87	74	193
145.500	155	0	228	104	92	228
145.480	E 60 Road Bridge					
145.400	153	0	228	102	91	228
144.000	160	18	237	107	98	219
143.000	153	0	223	100	90	223
142.000	171	43	253	117	114	210
141.000	169	34	249	114	110	215
140.000	163	0	239	108	105	239
139.000	150	0	209	92	89	209
138.000	145	0	192	81	82	192
137.000	138	0	175	59	71	175
135.950	135	0	168	48	67	168
135.941	Highway 69 Bridge					
135.940	134	0	168	47	67	168
135.590	134	0	167	46	67	167
135.586	BN RR Bridge					
135.580	134	0	167	45	66	167
135.470	134	0	167	43	65	167
135.460	Highway 125 Bridge					
135.440	134	0	167	45	65	167
135.000	134	0	166	42	65	166
134.610	133	0	163	35	63	163

* Max difference in duration from simulations with historical starting stages.

PENSACOLA DAM **TABLE G.25**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - HISTORICAL STARTING STAGES

River Mile	Historical Inflow Event					Max Duration Difference* (hours)
	Sept 1993 (21 year)	June 2004 (1 year)	July 2007 (4 year)	Oct 2009 (3 year)	Dec 2015 (15 year)	
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	
134.599	Abandonded RR Bridge					
134.595	131	0	162	30	61	162
134.000	129	0	154	0	56	154
133.973	Tar Creek					
133.900	127	0	151	0	53	151
133.800	Interstate 44 Bridge					
133.700	127	0	150	0	51	150
133.000	123	0	141	0	40	141
132.000	118	0	135	0	30	135
131.000	114	0	130	0	20	130
130.000	111	0	126	0	15	126
129.000	106	0	121	0	11	121
128.000	97	0	114	0	9	114
126.710	80	0	93	0	5	93
126.700	S 590 Road Bridge					
126.670	79	0	92	0	5	92
126.000	74	0	84	0	5	84
125.000	62	0	67	0	3	67
124.000	45	0	44	0	2	45
123.000	23	0	0	0	0	23
122.580	22	0	0	0	0	22
122.570	Highway 60 Bridge					
122.550	22	0	0	0	0	22
122.350	Spring River					
122.000	14	0	0	0	0	14
121.980	11	0	0	0	0	11
121.970	BN RR Bridge					
121.960	0	0	0	0	0	0
120.000	0	0	0	0	0	0

* Max difference in duration from simulations with historical starting stages.

PENSACOLA DAM **TABLE G.25**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - HISTORICAL STARTING STAGES

River Mile	Historical Inflow Event					Max Duration Difference* (hours)
	Sept 1993 (21 year)	June 2004 (1 year)	July 2007 (4 year)	Oct 2009 (3 year)	Dec 2015 (15 year)	
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	
118.000	0	0	0	0	0	0
116.000	0	0	0	0	0	0
114.000	0	0	0	0	0	0
112.000	0	0	0	0	0	0
110.000	0	0	0	0	0	0
108.000	0	0	0	0	0	0
106.000	0	0	0	0	0	0
105.350	Elk River					
105.000	0	0	0	0	0	0
104.000	0	0	0	0	0	0
102.000	0	0	0	0	0	0
101.750	0	0	0	0	0	0
101.730	Highway 59 (Sailboat Bridge)					
101.710	0	0	0	0	0	0
100.000	0	0	0	0	0	0
90.000	0	0	0	0	0	0
80.000	0	0	0	0	0	0
78.000	0	0	0	0	0	0
77.000	Pensacola Dam					

* Max difference in duration from simulations with historical starting stages.

PENSACOLA DAM **TABLE G.26**

GRAND RIVER DAM AUTHORITY SPRING RIVER DURATIONS - HISTORICAL STARTING STAGES

River Mile	Historical Inflow Event					Max Duration Difference* (hours)
	Sept 1993 (21 year)	June 2004 (1 year)	July 2007 (4 year)	Oct 2009 (3 year)	Dec 2015 (15 year)	
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	
21.000	Upstream end of model					
21.000	54	0	0	0	54	54
20.000	52	0	0	0	52	52
19.000	70	0	0	28	76	76
18.000	70	0	0	29	77	77
17.000	72	0	0	32	79	79
16.000	79	0	0	59	86	86
15.000	75	0	0	39	82	82
14.170	92	0	0	75	97	97
14.160	E 57 Road					
14.120	93	0	0	76	98	98
13.510	93	0	0	76	99	99
13.500	Interstate 44 Bridge					
13.450	93	0	0	74	97	97
12.000	93	0	0	75	97	97
11.000	112	0	47	87	111	112
10.000	107	0	0	82	108	108
9.000	99	0	0	74	101	101
8.020	91	0	0	55	93	93
8.010	OK Highway 10 Bridge					
7.970	80	0	0	22	81	81
7.000	69	0	0	0	65	69
6.000	61	0	0	0	57	61
5.000	54	0	0	0	49	54
4.000	52	0	0	0	38	52
3.000	46	0	0	0	32	46
2.000	40	0	0	0	25	40
1.000	33	0	0	0	8	33
0.580	19	0	0	0	0	19
0.570	Highway 60 Bridge					
0.560	15	0	0	0	0	15
0.460	19	0	0	0	0	19
0.000	Downstream end of Spring River					

* Max difference in duration from simulations with historical starting stages.

PENSACOLA DAM **TABLE G.27**

GRAND RIVER DAM AUTHORITY

ELK RIVER DURATIONS - HISTORICAL STARTING STAGES

River Mile	Historical Inflow Event					Max Duration Difference* (hours)
	Sept 1993 (21 year)	June 2004 (1 year)	July 2007 (4 year)	Oct 2009 (3 year)	Dec 2015 (15 year)	
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	
19.590	Upstream end of model					
19.590	10	0	0	24	58	58
19.000	0	0	0	19	51	51
18.000	7	0	0	22	55	55
17.000	56	0	0	56	111	111
16.000	62	0	0	58	118	118
15.000	48	0	0	51	104	104
14.240	18	0	0	31	68	68
14.220	Highway 43 Bridge					
14.200	18	0	0	30	67	67
14.000	12	0	0	25	59	59
13.000	14	0	0	27	62	62
12.000	0	0	0	15	46	46
11.910	OK/MO State Line					
11.000	0	0	0	0	21	21
10.000	0	0	0	0	0	0
9.000	0	0	0	0	0	0
8.000	0	0	0	0	0	0
7.000	0	0	0	0	0	0
6.000	0	0	0	0	0	0
5.000	0	0	0	0	0	0
4.700	0	0	0	0	0	0
4.670	OK Highway 10 Bridge					
4.640	0	0	0	0	0	0
4.000	0	0	0	0	0	0
3.000	0	0	0	0	0	0
2.000	0	0	0	0	0	0
1.000	0	0	0	0	0	0
0.320	0	0	0	0	0	0
0.000	Downstream end of Elk River					

* Max difference in duration from simulations with historical starting stages.

PENSACOLA DAM **TABLE G.28**

GRAND RIVER DAM AUTHORITY

TAR CREEK DURATIONS - HISTORICAL STARTING STAGES

River Mile	Historical Inflow Event					Max Duration Difference* (hours)
	Sept 1993 (21 year)	June 2004 (1 year)	July 2007 (4 year)	Oct 2009 (3 year)	Dec 2015 (15 year)	
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	
4.152	Upstream end of model					
4.152	25	0	0	1	4	25
3.900	32	0	0	12	15	32
3.840	22nd Ave Bridge					
3.800	36	0	36	18	21	36
3.300	28	0	49	7	9	49
2.800	20	0	83	0	0	83
2.710	BN RR Bridge					
2.700	131	0	112	20	24	131
2.500	140	0	122	14	17	140
2.300	144	0	130	6	8	144
2.200	Rockdale Blvd Bridge					
2.100	158	0	154	10	89	158
1.900	145	0	154	0	56	154
1.700	131	0	154	0	55	154
1.660	Central Ave Bridge					
1.600	130	0	154	0	55	154
1.500	130	0	154	0	55	154
1.400	OK Highway 10 Bridge					
1.300	129	0	154	0	55	154
1.000	129	0	154	0	55	154
0.700	129	0	154	0	55	154
0.300	129	0	154	0	55	154
0.041	129	0	153	0	55	153
0.000	Downstream end of Tar Creek					

* Max difference in duration from simulations with historical starting stages.

APPENDIX H:
ANTICIPATED OPERATIONS ANALYSIS

APPENDIX H.1:
ANTICIPATED OPERATIONS ANALYSIS
STAGE HYDROGRAPHS

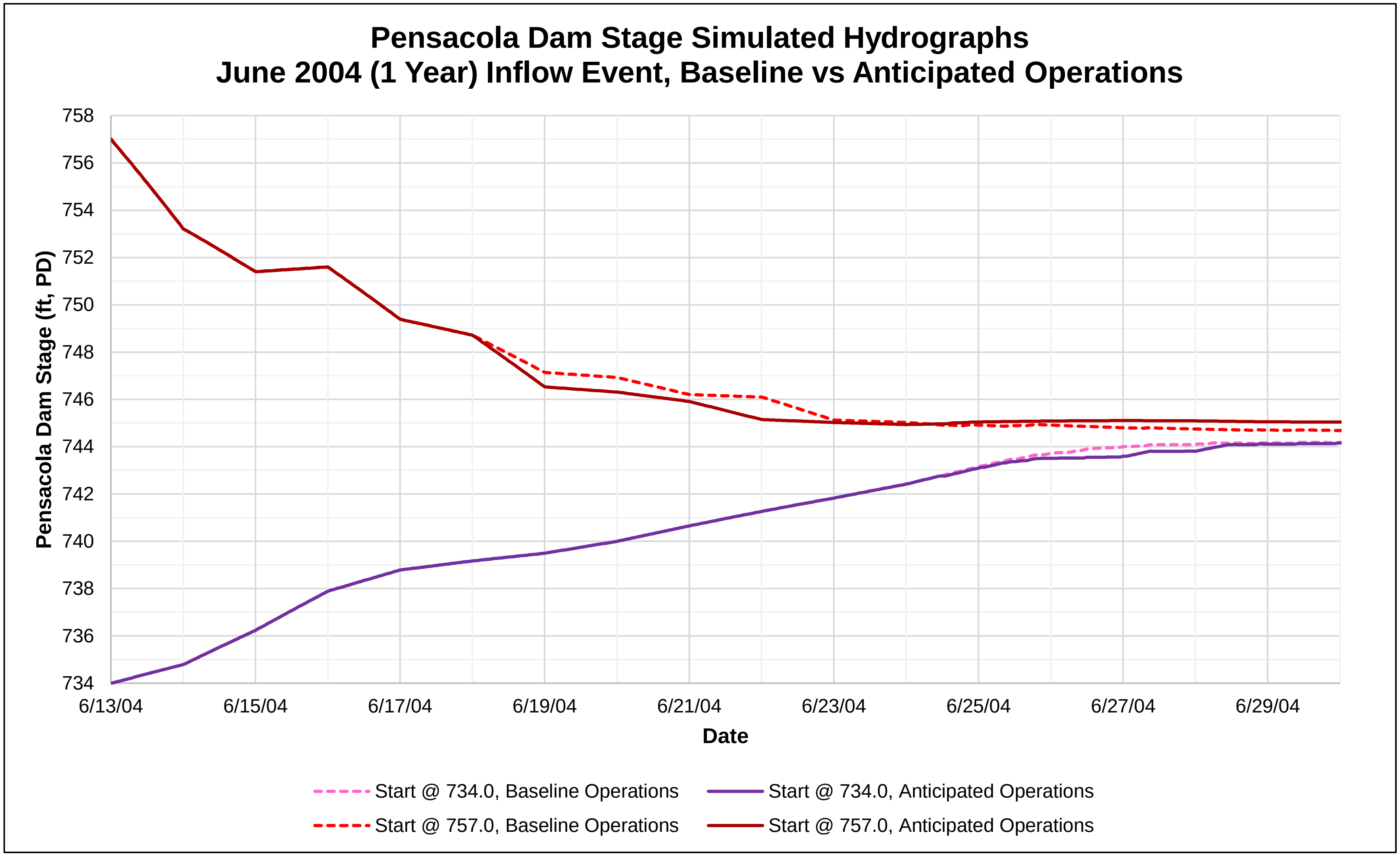


Figure H.1. Simulated stage hydrographs for the June 2004 (1 year) inflow event upstream of Pensacola Dam.

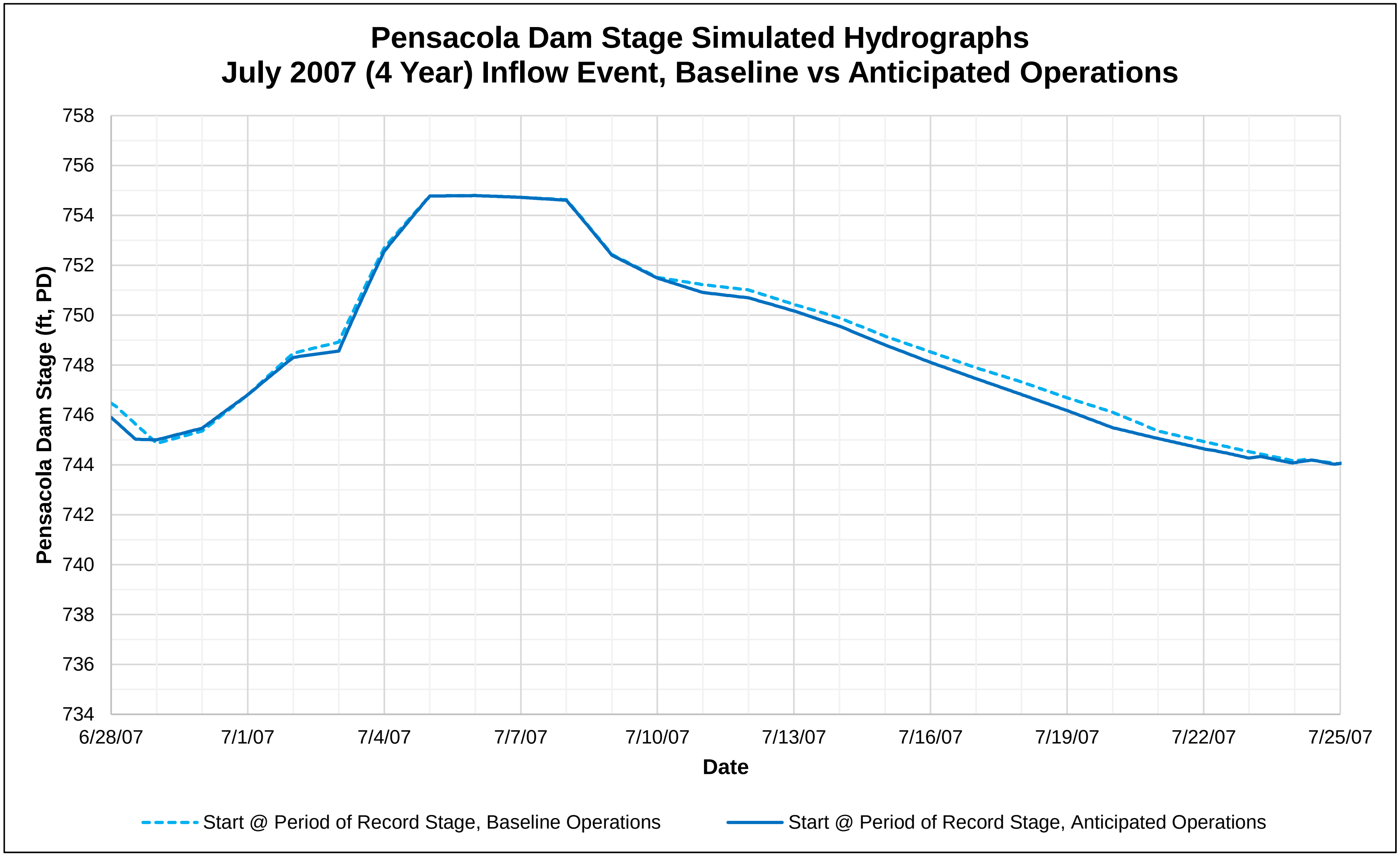


Figure H.2. Simulated stage hydrographs for the July 2007 (4 year) inflow event upstream of Pensacola Dam.

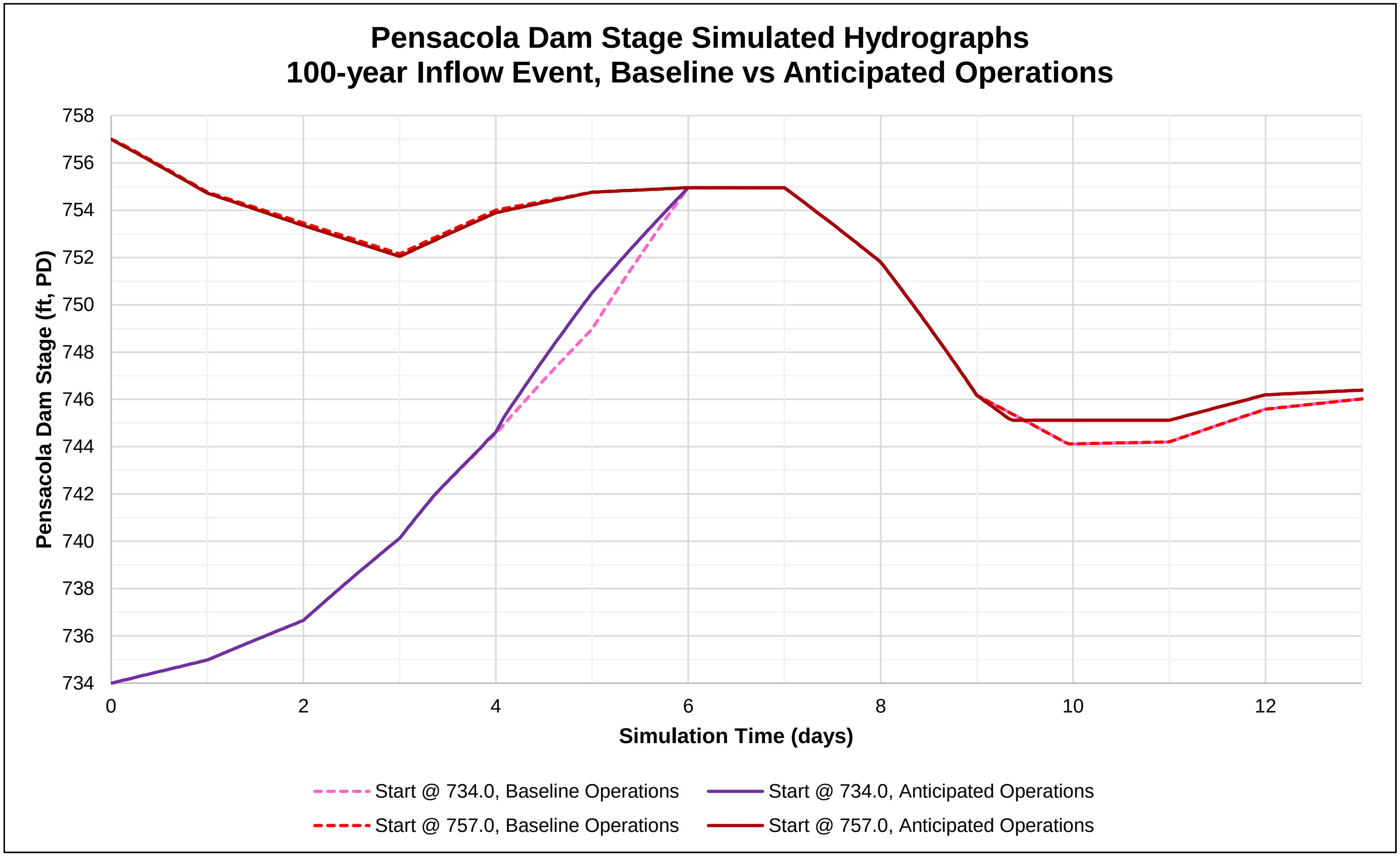


Figure H.3. Simulated stage hydrographs for the 100-year event upstream of Pensacola Dam.

Note: *Because the 100-year event is synthetic, there is no historical start or end date, so stage hydrographs for the 100-year event are presented as a function of simulation time rather than date.*

APPENDIX H.2:

ANTICIPATED OPERATIONS ANALYSIS

MAXIMUM WATER SURFACE ELEVATIONS

PENSACOLA DAM **TABLE H.1**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Bed El. (ft, PD)	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
		Jun 2004 (1 Year), Start @ 734 ft Max WSE (ft, PD)	Jun 2004 (1 Year), Start @ 757 ft Max WSE (ft, PD)	Jul 2007 (4 Year), Period of Record Max WSE (ft, PD)	100-Year, Start @ 734 ft Max WSE (ft, PD)	100-Year, Start @ 757 ft Max WSE (ft, PD)	Jun 2004 (1 Year), Start @ 734 ft Max WSE (ft, PD)	Jun 2004 (1 Year), Start @ 757 ft Max WSE (ft, PD)	Jul 2007 (4 Year), Period of Record Max WSE (ft, PD)	100-Year, Start @ 734 ft Max WSE (ft, PD)	100-Year, Start @ 757 ft Max WSE (ft, PD)	Jun 2004 (1 year) Difference (ft)	July 2007 (4 year) Difference (ft)	100-Year Difference (ft)
152.175	Upstream end of model													
152.175	752.29	773.78	773.85	784.43	791.90	791.93	773.78	773.85	784.43	791.91	791.93	0.00	0.00	0.00
151.000	748.53	772.51	772.59	780.33	788.12	788.16	772.51	772.59	780.33	788.12	788.16	0.00	0.00	0.00
150.000	748.47	771.80	771.90	778.90	787.42	787.47	771.80	771.90	778.90	787.43	787.47	0.00	0.00	0.00
149.000	750.14	770.43	770.54	777.46	786.89	786.95	770.43	770.54	777.46	786.90	786.95	0.00	0.00	0.01
148.000	749.29	768.73	768.89	777.10	786.82	786.88	768.73	768.89	777.09	786.83	786.88	0.00	0.00	0.00
147.000	747.76	766.90	767.12	776.23	786.45	786.51	766.90	767.12	776.23	786.46	786.51	0.00	0.00	0.01
145.500	745.12	764.66	765.00	775.75	786.21	786.27	764.66	765.00	775.74	786.22	786.27	0.00	0.00	0.01
145.480	E 60 Road Bridge													
145.400	748.01	764.55	764.90	775.71	786.19	786.24	764.55	764.90	775.70	786.19	786.24	0.00	0.00	0.01
144.000	743.43	763.27	763.69	775.12	785.80	785.85	763.27	763.69	775.12	785.80	785.85	0.00	0.00	0.00
143.000	737.95	762.10	762.62	774.84	785.60	785.66	762.10	762.62	774.84	785.61	785.66	0.00	0.00	0.00
142.000	742.91	761.17	761.77	774.61	785.44	785.50	761.17	761.77	774.61	785.44	785.49	0.00	0.00	0.00
141.000	741.01	759.97	760.81	774.49	785.31	785.37	759.97	760.81	774.49	785.32	785.37	0.00	0.00	0.01
140.000	736.33	758.57	759.90	774.45	785.27	785.32	758.57	759.90	774.45	785.27	785.32	0.00	0.00	0.00
139.000	743.99	756.44	758.38	774.42	785.23	785.28	756.44	758.38	774.41	785.23	785.28	0.00	0.00	0.00
138.000	736.48	754.95	757.44	774.35	785.16	785.22	754.95	757.44	774.35	785.17	785.22	0.00	0.00	0.00
137.000	733.33	752.67	757.09	774.14	785.02	785.08	752.67	757.09	774.13	785.02	785.07	0.00	0.00	0.00
135.950	731.18	752.01	757.08	773.50	784.61	784.67	752.01	757.08	773.49	784.61	784.67	0.00	-0.01	0.00
135.941	Highway 69 Bridge													
135.940	731.21	751.71	757.08	773.52	784.50	784.56	751.70	757.08	773.52	784.51	784.56	0.00	0.00	0.01
135.590	731.77	751.79	757.08	773.35	784.39	784.45	751.79	757.08	773.34	784.40	784.45	0.00	-0.01	0.01
135.586	BN RR Bridge													
135.580	731.07	751.84	757.07	773.28	784.26	784.31	751.84	757.07	773.27	784.26	784.31	0.00	-0.01	0.00
135.470	732.63	751.71	757.07	773.20	784.19	784.25	751.71	757.07	773.20	784.20	784.25	0.00	0.00	0.01
135.460	Highway 125 Bridge													
135.440	731.60	751.78	757.07	773.25	784.24	784.29	751.78	757.07	773.25	784.24	784.29	0.00	0.00	0.00

1 Max increase in max WSEL for the simulated inflow event listed. Baseline operations max WSEL is subtracted from anticipated operations max WSEL to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.1**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Bed El. (ft, PD)	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
		Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (ft)	July 2007 (4 year) Difference (ft)	100-Year Difference (ft)
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)			
135.000	732.64	751.39	757.07	772.93	784.03	784.08	751.39	757.07	772.92	784.03	784.08	0.00	-0.01	0.00
134.610	728.75	751.21	757.07	772.47	783.79	783.85	751.21	757.07	772.46	783.80	783.85	0.00	-0.01	0.01
134.599	Abandonded RR Bridge													
134.595	728.58	751.10	757.07	772.21	783.59	783.65	751.10	757.07	772.20	783.60	783.65	0.00	-0.01	0.01
134.000	727.23	750.38	757.06	771.95	783.17	783.22	750.38	757.06	771.94	783.17	783.22	0.00	-0.01	0.01
133.973	Tar Creek													
133.900	727.72	750.13	757.06	771.63	782.61	782.67	750.13	757.06	771.63	782.62	782.67	0.00	-0.01	0.01
133.800	Interstate 44 Bridge													
133.700	728.57	749.72	757.05	771.30	781.92	781.98	749.72	757.05	771.29	781.93	781.98	0.00	-0.01	0.01
133.000	727.70	748.16	757.04	770.64	781.10	781.16	748.16	757.04	770.63	781.11	781.16	0.00	-0.01	0.00
132.000	727.96	746.45	757.03	769.49	779.46	779.52	746.45	757.03	769.48	779.47	779.52	0.00	-0.01	0.01
131.000	726.82	745.65	757.03	768.56	777.63	777.69	745.61	757.03	768.55	777.64	777.69	0.00	-0.01	0.01
130.000	723.18	745.51	757.02	767.31	776.29	776.35	745.47	757.02	767.30	776.30	776.35	0.00	-0.01	0.01
129.000	719.79	745.29	757.02	766.14	775.16	775.22	745.25	757.02	766.13	775.17	775.22	0.00	-0.01	0.01
128.000	719.69	745.25	757.02	765.10	774.10	774.16	745.20	757.02	765.09	774.11	774.16	0.00	-0.01	0.01
126.710	715.94	745.13	757.02	763.39	772.60	772.66	745.09	757.02	763.38	772.61	772.66	0.00	-0.01	0.01
126.700	S 590 Road Bridge													
126.670	715.61	745.12	757.02	763.35	772.24	772.30	745.08	757.02	763.34	772.25	772.30	0.00	-0.01	0.01
126.000	720.35	745.08	757.02	762.77	771.56	771.62	745.03	757.02	762.76	771.57	771.62	0.00	-0.01	0.01
125.000	717.08	745.01	757.02	761.39	769.64	769.70	744.96	757.02	761.38	769.65	769.70	0.00	-0.01	0.00
124.000	715.62	744.95	757.02	760.00	767.95	768.01	744.91	757.02	759.99	767.95	768.01	0.00	-0.01	0.00
123.000	713.34	744.90	757.02	758.39	765.51	765.56	744.85	757.02	758.38	765.51	765.56	0.00	-0.01	0.00
122.580	711.08	744.89	757.02	757.23	762.55	762.55	744.84	757.02	757.22	762.55	762.55	0.00	-0.01	0.00
122.570	Highway 60 Bridge													
122.550	709.97	744.44	757.01	757.23	762.32	762.45	744.39	757.01	757.23	762.34	762.45	0.00	0.00	0.02
122.350	Spring River													
122.000	710.64	744.44	757.01	756.95	762.40	762.58	744.39	757.01	756.94	762.42	762.57	0.00	-0.01	0.02

1 Max increase in max WSEL for the simulated inflow event listed. Baseline operations max WSEL is subtracted from anticipated operations max WSEL to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.1**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER MAX WSELs - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Bed El. (ft, PD)	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
		Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (ft)	July 2007 (4 year) Difference (ft)	100-Year Difference (ft)
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)			
121.980	709.90	744.43	757.01	756.80	761.87	762.08	744.39	757.01	756.79	761.90	762.08	0.00	-0.01	0.03
121.970	BN RR Bridge													
121.960	710.89	744.42	757.00	756.29	761.16	761.20	744.38	757.00	756.29	761.16	761.20	0.00	0.00	0.00
120.000	717.63	744.37	757.00	755.72	759.87	759.89	744.33	757.00	755.72	759.87	759.89	0.00	0.00	0.01
118.000	720.29	744.32	757.00	755.43	758.57	758.59	744.29	757.00	755.43	758.57	758.59	0.00	0.00	0.01
116.000	725.99	744.29	757.00	755.30	757.93	757.94	744.27	757.00	755.30	757.93	757.94	0.00	0.00	0.00
114.000	718.27	744.23	757.00	755.07	756.68	757.00	744.22	757.00	755.07	756.68	757.00	0.00	0.00	0.00
112.000	714.31	744.21	757.00	754.96	756.01	757.00	744.19	757.00	754.96	756.01	757.00	0.00	0.01	0.00
110.000	719.24	744.20	757.00	754.90	755.66	757.00	744.18	757.00	754.91	755.66	757.00	0.00	0.01	0.00
108.000	710.68	744.19	757.00	754.83	755.19	757.00	744.17	757.00	754.83	755.18	757.00	0.00	0.00	0.00
106.000	700.35	744.19	757.00	754.82	755.13	757.00	744.17	757.00	754.82	755.12	757.00	0.00	0.00	0.00
105.350	Elk River													
105.000	701.60	744.19	757.00	754.82	755.14	757.00	744.17	757.00	754.82	755.14	757.00	0.00	0.00	0.00
104.000	696.61	744.19	757.00	754.82	755.12	757.00	744.17	757.00	754.82	755.11	757.00	0.00	0.00	0.00
102.000	688.58	744.18	757.00	754.81	755.07	757.00	744.17	757.00	754.81	755.07	757.00	0.00	0.00	0.00
101.750	685.91	744.18	757.00	754.81	755.03	757.00	744.16	757.00	754.81	755.03	757.00	0.00	0.00	0.00
101.730	Highway 59 (Sailboat Bridge)													
101.710	682.31	744.18	757.00	754.80	755.00	757.00	744.16	757.00	754.80	755.00	757.00	0.00	0.00	0.00
100.000	702.62	744.18	757.00	754.80	755.02	757.00	744.16	757.00	754.80	755.02	757.00	0.00	0.00	0.00
90.000	681.52	744.18	757.00	754.79	754.98	757.00	744.16	757.00	754.79	754.98	757.00	0.00	0.00	0.00
80.000	657.03	744.18	757.00	754.79	754.95	757.00	744.16	757.00	754.79	754.95	757.00	0.00	0.00	0.00
78.000	653.11	744.18	757.00	754.79	754.95	757.00	744.16	757.00	754.79	754.95	757.00	0.00	0.00	0.00
77.000	Pensacola Dam													

1 Max increase in max WSEL for the simulated inflow event listed. Baseline operations max WSEL is subtracted from anticipated operations max WSEL to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.2**

GRAND RIVER DAM AUTHORITY SPRING RIVER MAX WSELs - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Bed El. (ft, PD)	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
		Jun 2004 (1 Year), Start @ 734 ft Max WSE (ft, PD)	Jun 2004 (1 Year), Start @ 757 ft Max WSE (ft, PD)	Jul 2007 (4 Year), Period of Record Max WSE (ft, PD)	100-Year, Start @ 734 ft Max WSE (ft, PD)	100-Year, Start @ 757 ft Max WSE (ft, PD)	Jun 2004 (1 Year), Start @ 734 ft Max WSE (ft, PD)	Jun 2004 (1 Year), Start @ 757 ft Max WSE (ft, PD)	Jul 2007 (4 Year), Period of Record Max WSE (ft, PD)	100-Year, Start @ 734 ft Max WSE (ft, PD)	100-Year, Start @ 757 ft Max WSE (ft, PD)	Jun 2004 (1 year) Difference (ft)	July 2007 (4 year) Difference (ft)	100-Year Difference (ft)
21.000	Upstream end of model													
21.000	762.67	773.88	773.88	783.49	791.80	791.80	773.88	773.88	783.49	791.80	791.80	0.00	0.00	0.00
20.000	760.13	771.04	771.04	780.70	790.14	790.15	771.04	771.04	780.70	790.14	790.15	0.00	0.00	0.00
19.000	759.04	768.52	768.54	777.52	786.91	786.91	768.52	768.54	777.52	786.91	786.91	0.00	0.00	0.00
18.000	753.18	764.57	764.71	774.20	783.88	783.89	764.57	764.71	774.20	783.88	783.89	0.00	0.00	0.00
17.000	750.54	762.75	763.03	772.20	781.90	781.93	762.75	763.03	772.20	781.91	781.93	0.00	0.00	0.01
16.000	749.28	760.33	761.04	770.00	779.42	779.46	760.33	761.04	770.00	779.42	779.46	0.00	0.00	0.00
15.000	746.37	758.32	759.60	767.52	776.44	776.50	758.32	759.60	767.51	776.44	776.50	0.00	0.00	0.00
14.170	741.32	757.45	759.03	765.96	773.95	774.05	757.45	759.03	765.96	773.96	774.05	0.00	0.00	0.01
14.160	E 57 Road													
14.120	744.21	757.47	759.05	766.18	774.41	774.50	757.47	759.05	766.18	774.42	774.50	0.00	0.00	0.01
13.510	744.59	756.82	758.70	765.30	773.23	773.34	756.82	758.70	765.30	773.24	773.34	0.00	0.00	0.01
13.500	Interstate 44 Bridge													
13.450	745.52	756.56	758.57	764.98	772.71	772.83	756.56	758.57	764.98	772.72	772.83	0.00	0.00	0.01
12.000	742.72	753.20	757.70	762.17	768.85	769.15	753.20	757.70	762.17	768.87	769.15	0.00	0.00	0.02
11.000	742.23	751.43	757.46	760.40	767.46	767.76	751.43	757.46	760.40	767.51	767.76	0.00	0.00	0.04
10.000	737.62	749.79	757.44	758.88	766.63	766.80	749.79	757.44	758.88	766.65	766.80	0.00	0.00	0.02
9.000	733.92	748.61	757.44	758.54	765.63	765.73	748.61	757.44	758.54	765.64	765.73	0.00	0.00	0.01
8.020	733.14	747.09	757.44	758.49	765.18	765.29	747.09	757.44	758.49	765.20	765.29	0.00	0.00	0.02
8.010	OK Highway 10 Bridge													
7.970	731.28	744.73	757.01	757.40	764.51	764.63	744.73	757.01	757.40	764.53	764.62	0.00	0.00	0.02
7.000	730.33	744.48	757.01	757.37	764.20	764.32	744.43	757.01	757.36	764.21	764.31	0.00	-0.01	0.01
6.000	727.95	744.47	757.01	757.35	764.08	764.19	744.42	757.01	757.35	764.09	764.19	0.00	0.00	0.02
5.000	722.10	744.46	757.01	757.34	763.99	764.10	744.42	757.01	757.33	764.00	764.10	0.00	-0.01	0.02
4.000	720.00	744.46	757.01	757.33	763.94	764.05	744.41	757.01	757.33	763.95	764.05	0.00	0.00	0.01
3.000	723.22	744.46	757.01	757.33	763.88	764.00	744.41	757.01	757.32	763.89	763.99	0.00	-0.01	0.01
2.000	723.73	744.46	757.01	757.33	763.84	763.96	744.41	757.01	757.32	763.86	763.96	0.00	-0.01	0.02
1.000	728.44	744.45	757.01	757.33	763.81	763.93	744.41	757.01	757.32	763.82	763.93	0.00	-0.01	0.01
0.580	716.17	744.45	757.01	757.32	763.74	763.86	744.41	757.01	757.32	763.75	763.86	0.00	0.00	0.01
0.570	Highway 60 Bridge													
0.560	713.76	744.45	757.01	757.31	763.71	763.83	744.41	757.01	757.31	763.73	763.83	0.00	0.00	0.02
0.460	715.35	744.45	757.01	757.32	763.73	763.85	744.41	757.01	757.31	763.74	763.85	0.00	-0.01	0.01
0.000	Downstream end of Spring River													

1 Max increase in max WSEL for the simulated inflow event listed. Baseline operations max WSEL is subtracted from anticipated operations max WSEL to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.3**

GRAND RIVER DAM AUTHORITY ELK RIVER MAX WSELs - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Bed El. (ft, PD)	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
		Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (ft)	July 2007 (4 year) Difference (ft)	100-Year Difference (ft)
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)			
19.590	Upstream end of model													
19.590	771.15	774.17	774.17	775.57	777.77	777.77	774.17	774.17	775.57	777.77	777.77	0.00	0.00	0.00
19.000	767.51	772.64	772.64	774.03	776.22	776.22	772.64	772.64	774.03	776.22	776.22	0.00	0.00	0.00
18.000	765.41	769.18	769.18	770.46	772.64	772.64	769.18	769.18	770.46	772.64	772.64	0.00	0.00	0.00
17.000	762.53	766.13	766.13	767.01	768.77	768.77	766.13	766.13	767.01	768.77	768.77	0.00	0.00	0.00
16.000	756.63	761.16	761.16	762.78	764.95	764.95	761.16	761.16	762.78	764.95	764.95	0.00	0.00	0.00
15.000	754.26	757.92	757.92	759.23	761.27	761.27	757.92	757.92	759.23	761.27	761.27	0.00	0.00	0.00
14.240	750.52	753.18	757.03	755.50	756.89	757.07	753.18	757.03	755.48	756.89	757.07	0.00	-0.02	0.00
14.220	Highway 43 Bridge													
14.200	750.12	753.10	757.02	755.47	756.83	757.07	753.10	757.02	755.45	756.83	757.07	0.00	-0.02	0.00
14.000	747.07	752.78	757.02	755.32	756.37	757.05	752.78	757.02	755.30	756.37	757.05	0.00	-0.02	0.00
13.000	745.41	749.01	757.00	754.93	755.43	757.01	749.01	757.00	754.94	755.40	757.01	0.00	0.01	0.00
12.000	741.15	746.01	757.00	754.88	755.32	757.00	746.01	757.00	754.90	755.29	757.00	0.00	0.02	0.00
11.910	OK/MO State Line													
11.000	741.93	744.92	757.00	754.87	755.28	757.00	744.92	757.00	754.88	755.25	757.00	0.00	0.01	0.00
10.000	734.62	744.21	757.00	754.86	755.26	757.00	744.21	757.00	754.87	755.23	757.00	0.00	0.01	0.00
9.000	734.66	744.21	757.00	754.85	755.24	757.00	744.20	757.00	754.87	755.22	757.00	0.00	0.02	0.00
8.000	724.21	744.21	757.00	754.85	755.23	757.00	744.20	757.00	754.86	755.21	757.00	0.00	0.01	0.00
7.000	728.21	744.20	757.00	754.84	755.21	757.00	744.19	757.00	754.86	755.19	757.00	0.00	0.02	0.00
6.000	727.13	744.20	757.00	754.84	755.21	757.00	744.19	757.00	754.85	755.19	757.00	0.00	0.01	0.00
5.000	721.05	744.20	757.00	754.83	755.19	757.00	744.18	757.00	754.85	755.18	757.00	0.00	0.02	0.00
4.700	716.13	744.20	757.00	754.83	755.19	757.00	744.18	757.00	754.84	755.17	757.00	0.00	0.01	0.00
4.670	OK Highway 10 Bridge													
4.640	715.21	744.20	757.00	754.83	755.19	757.00	744.18	757.00	754.84	755.17	757.00	0.00	0.01	0.00
4.000	716.61	744.19	757.00	754.83	755.18	757.00	744.18	757.00	754.84	755.17	757.00	0.00	0.01	0.00
3.000	714.74	744.19	757.00	754.83	755.17	757.00	744.18	757.00	754.84	755.16	757.00	0.00	0.01	0.00
2.000	709.09	744.19	757.00	754.82	755.16	757.00	744.18	757.00	754.83	755.15	757.00	0.00	0.01	0.00
1.000	705.82	744.19	757.00	754.82	755.15	757.00	744.17	757.00	754.82	755.14	757.00	0.00	0.00	0.00
0.320	706.36	744.19	757.00	754.82	755.15	757.00	744.17	757.00	754.82	755.14	757.00	0.00	0.00	0.00
0.000	Downstream end of Elk River													

1 Max increase in max WSEL for the simulated inflow event listed. Baseline operations max WSEL is subtracted from anticipated operations max WSEL to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.4**

GRAND RIVER DAM AUTHORITY TAR CREEK MAX WSELs - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Bed El. (ft, PD)	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
		Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (ft)	July 2007 (4 year) Difference (ft)	100-Year Difference (ft)
		Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)	Max WSE (ft, PD)			
4.152	Upstream end of model													
4.152	762.17	768.17	768.17	772.03	783.59	783.64	768.17	768.17	772.02	783.59	783.64	0.00	-0.01	0.01
3.900	760.10	767.29	767.29	772.03	783.59	783.65	767.29	767.29	772.02	783.59	783.64	0.00	-0.01	0.01
3.840	22nd Ave Bridge													
3.800	762.30	766.05	766.05	772.03	783.59	783.64	766.05	766.05	772.02	783.59	783.64	0.00	-0.01	0.01
3.300	759.46	764.09	764.09	772.03	783.59	783.64	764.09	764.09	772.02	783.59	783.64	0.00	-0.01	0.01
2.800	756.73	760.95	760.96	772.03	783.59	783.64	760.95	760.96	772.02	783.59	783.64	0.00	-0.01	0.01
2.710	BN RR Bridge													
2.700	755.72	760.45	760.46	772.03	783.59	783.64	760.45	760.46	772.02	783.59	783.64	0.00	-0.01	0.00
2.500	754.95	759.30	759.33	772.03	783.59	783.64	759.30	759.33	772.02	783.59	783.64	0.00	-0.01	0.00
2.300	754.15	757.47	757.63	772.03	783.59	783.64	757.47	757.63	772.02	783.59	783.64	0.00	-0.01	0.01
2.200	Rockdale Blvd Bridge													
2.100	751.51	754.83	757.06	772.03	783.59	783.64	754.83	757.06	772.02	783.59	783.64	0.00	-0.01	0.00
1.900	750.02	753.18	757.06	772.03	783.59	783.64	753.18	757.06	772.02	783.59	783.64	0.00	-0.01	0.00
1.700	749.58	750.72	757.06	772.03	783.59	783.64	750.72	757.06	772.02	783.59	783.64	0.00	-0.01	0.01
1.660	Central Ave Bridge													
1.600	746.47	750.30	757.06	772.03	783.59	783.64	750.30	757.06	772.02	783.59	783.64	0.00	-0.01	0.01
1.500	744.29	750.29	757.06	772.03	783.58	783.64	750.29	757.06	772.02	783.59	783.64	0.00	-0.01	0.01
1.400	OK Highway 10 Bridge													
1.300	742.00	750.29	757.06	772.03	783.56	783.62	750.29	757.06	772.02	783.57	783.62	0.00	-0.01	0.01
1.000	739.34	750.29	757.06	772.02	783.52	783.58	750.29	757.06	772.01	783.53	783.57	0.00	-0.01	0.01
0.700	737.06	750.29	757.06	772.01	783.48	783.53	750.29	757.06	772.00	783.48	783.53	0.00	-0.01	0.01
0.300	736.42	750.29	757.06	771.95	783.25	783.30	750.29	757.06	771.94	783.25	783.30	0.00	-0.01	0.01
0.041	735.85	750.29	757.06	771.86	783.04	783.10	750.29	757.06	771.85	783.05	783.10	0.00	-0.01	0.01
0.000	Downstream end of Tar Creek													

1 Max increase in max WSEL for the simulated inflow event listed. Baseline operations max WSEL is subtracted from anticipated operations max WSEL to assess the impact of anticipated operations.

APPENDIX H.3:

ANTICIPATED OPERATIONS ANALYSIS

WATER SURFACE ELEVATION PROFILES

JUNE 2004 (1 YEAR) INFLOW EVENT

ANTICIPATED OPERATIONS ANALYSIS

WATER SURFACE ELEVATION PROFILES

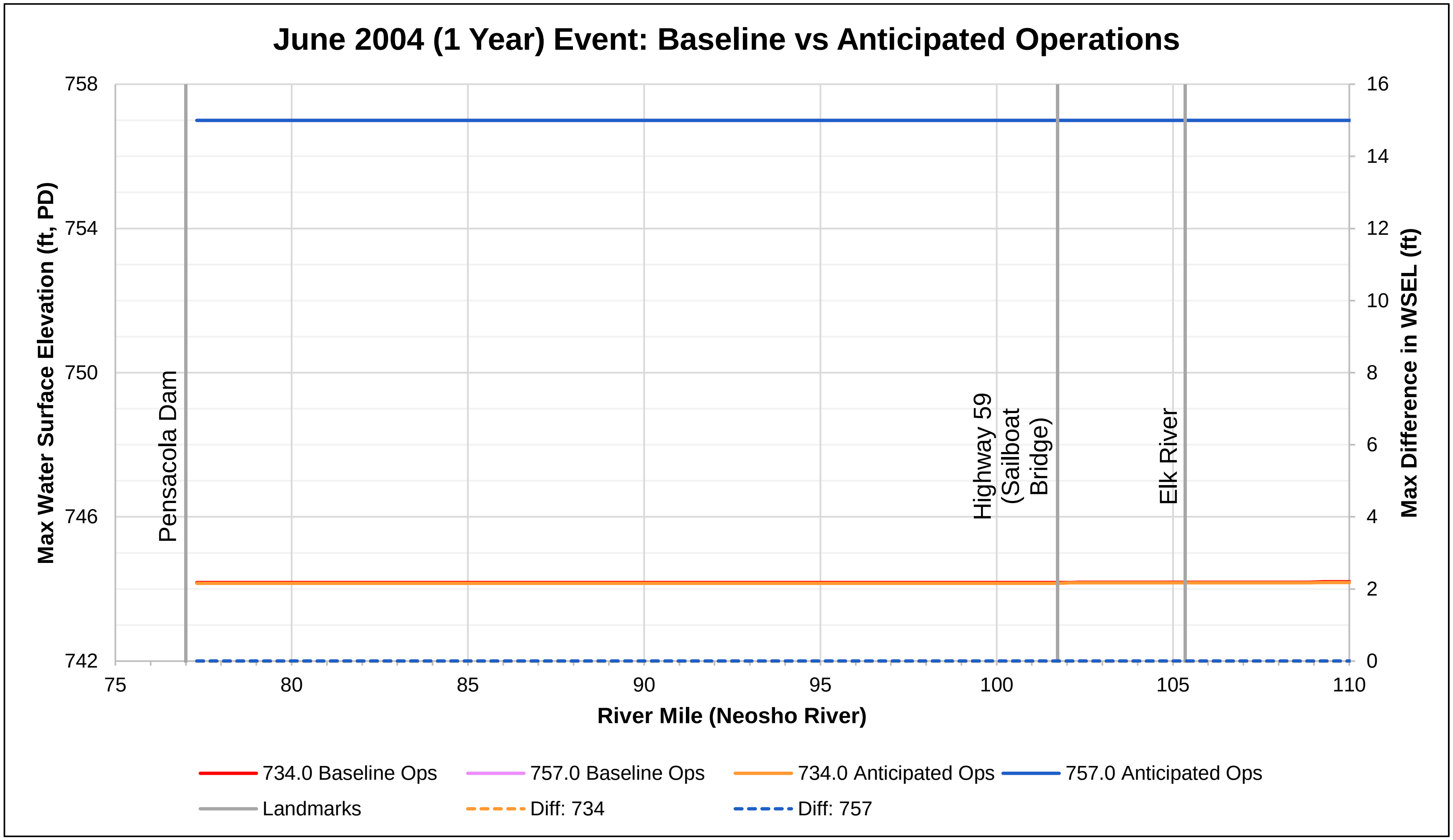


Figure H. 1. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

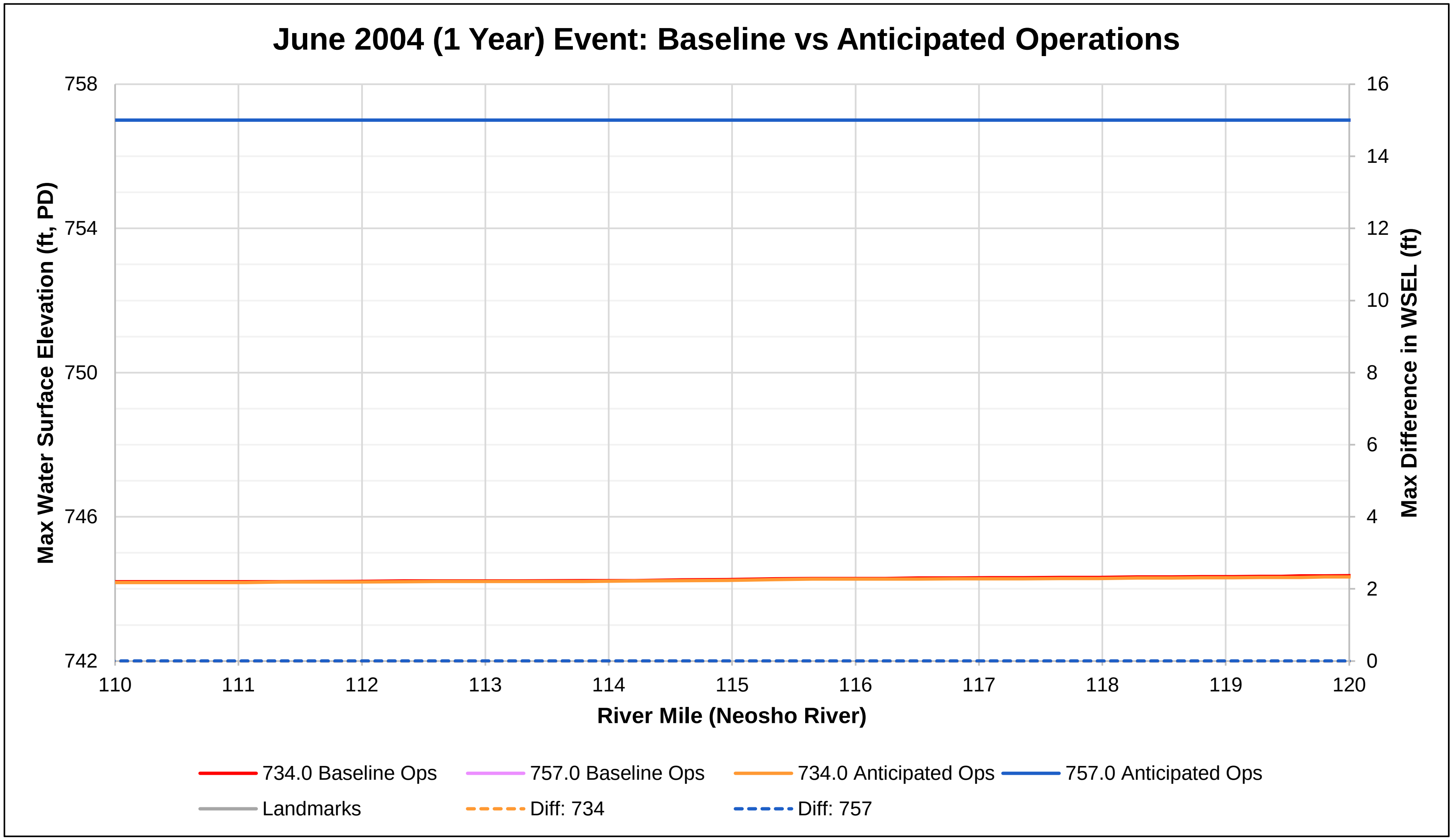


Figure H. 2. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

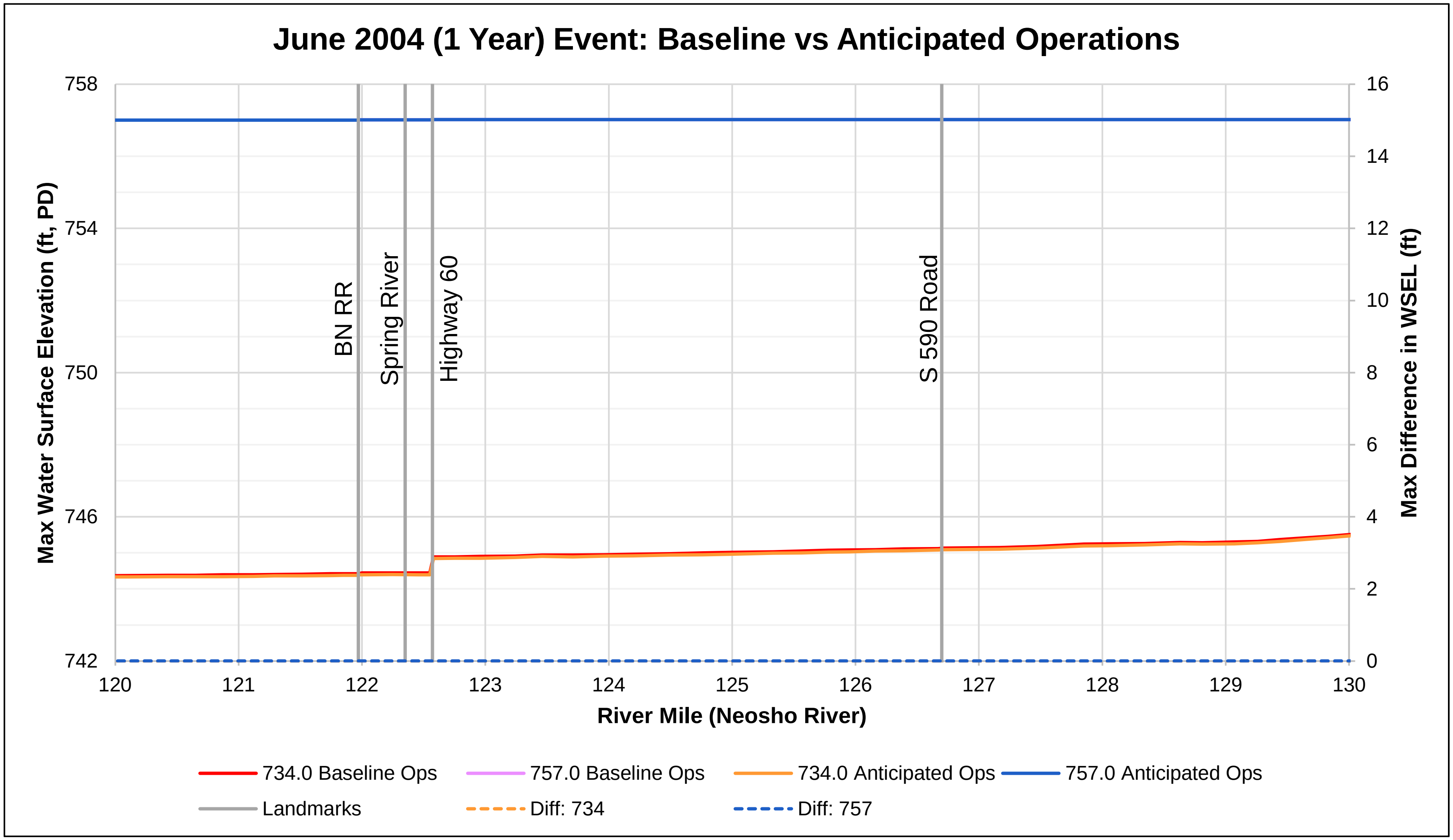


Figure H. 3. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:
1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

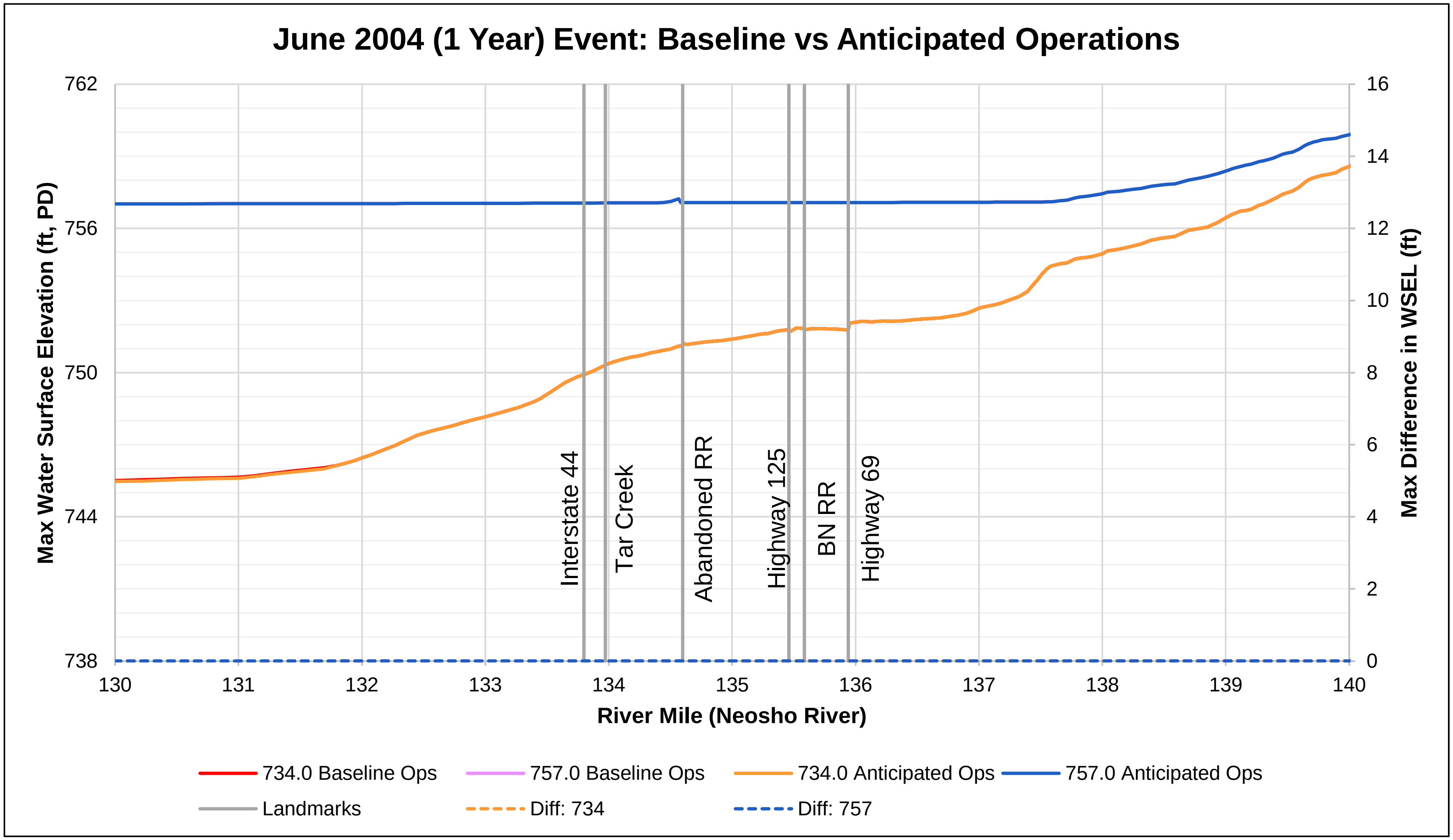


Figure H. 4. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

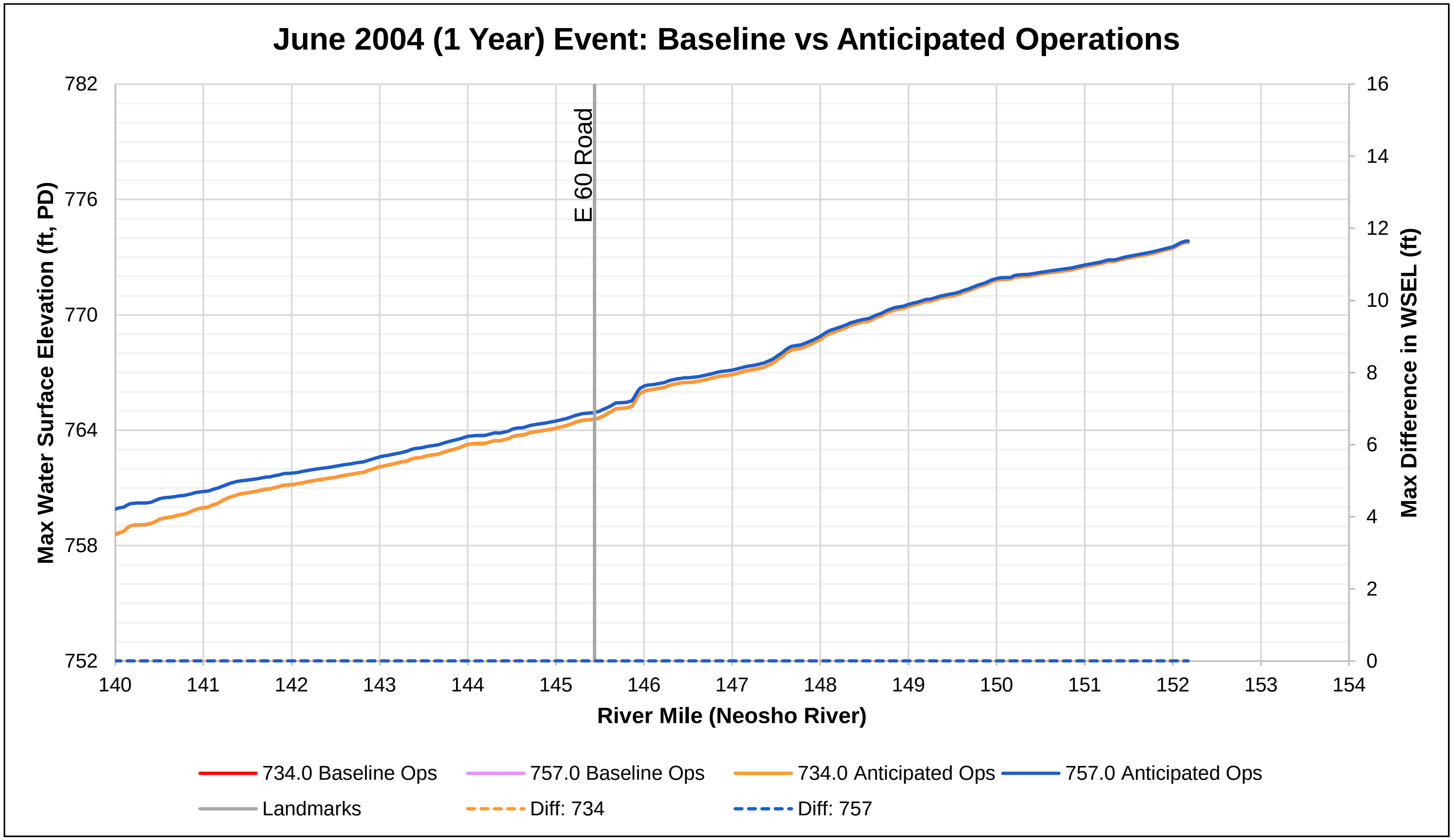


Figure H. 5. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

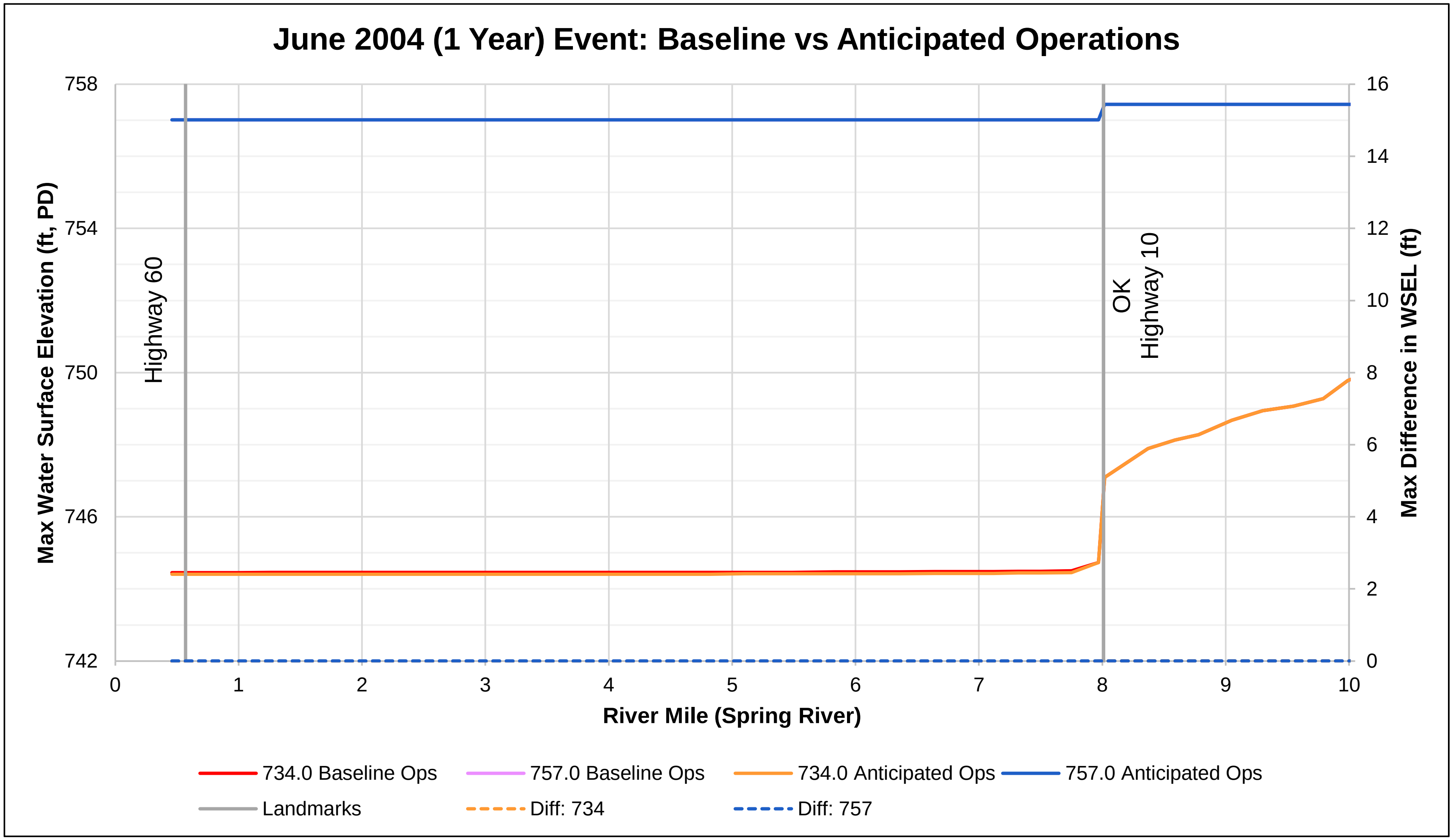


Figure H. 6. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:
1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

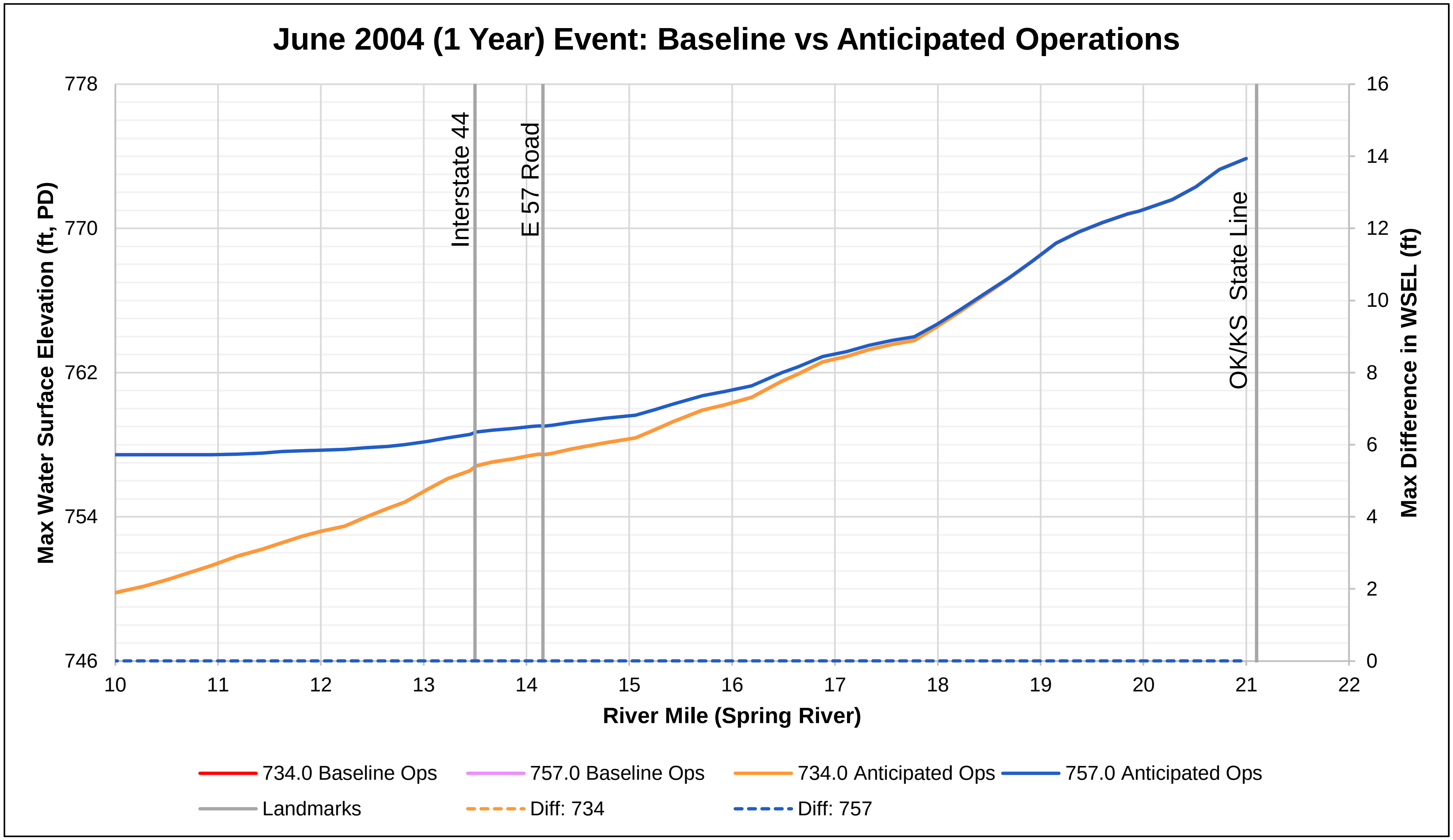


Figure H. 7. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

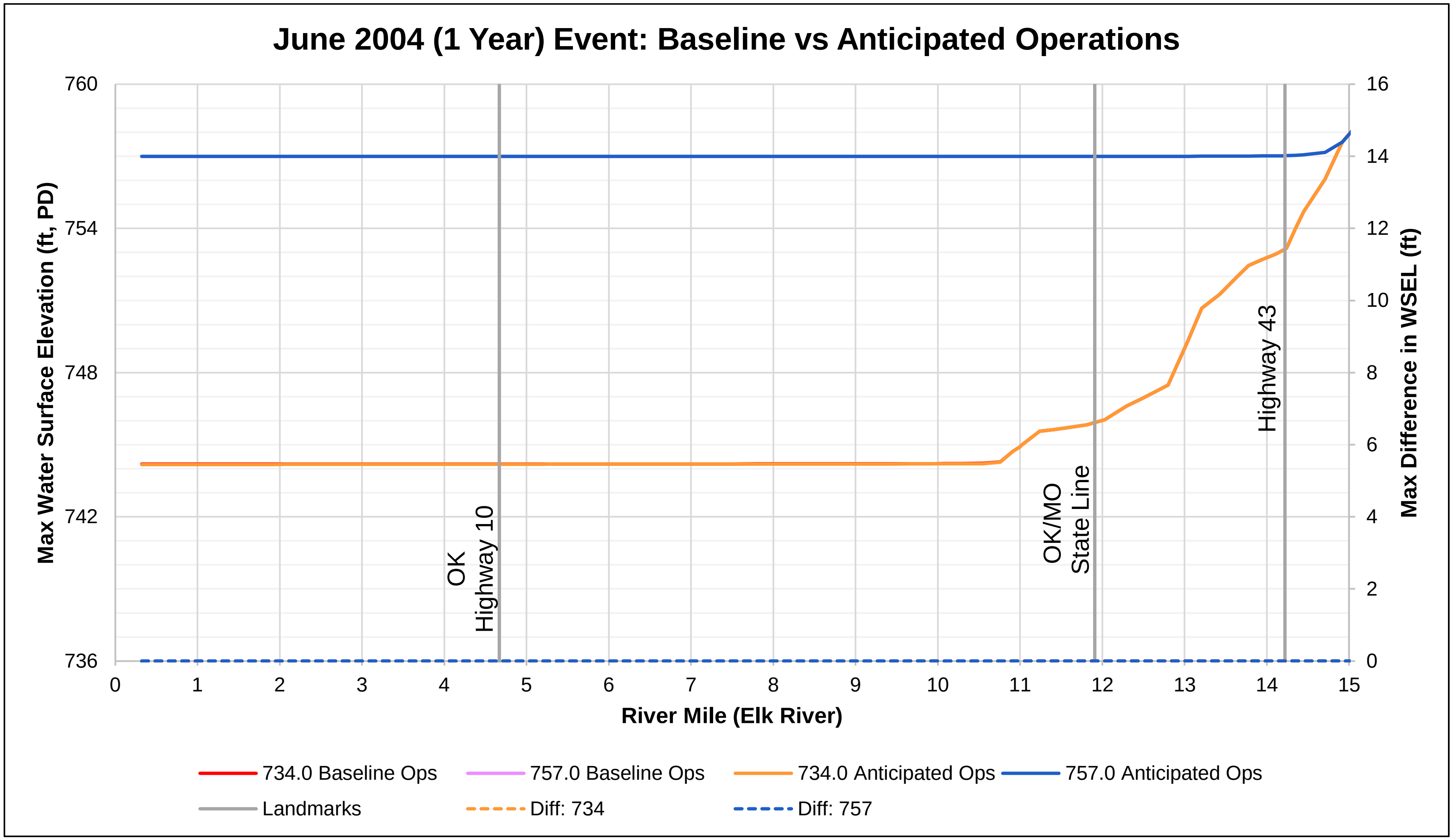


Figure H. 8. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

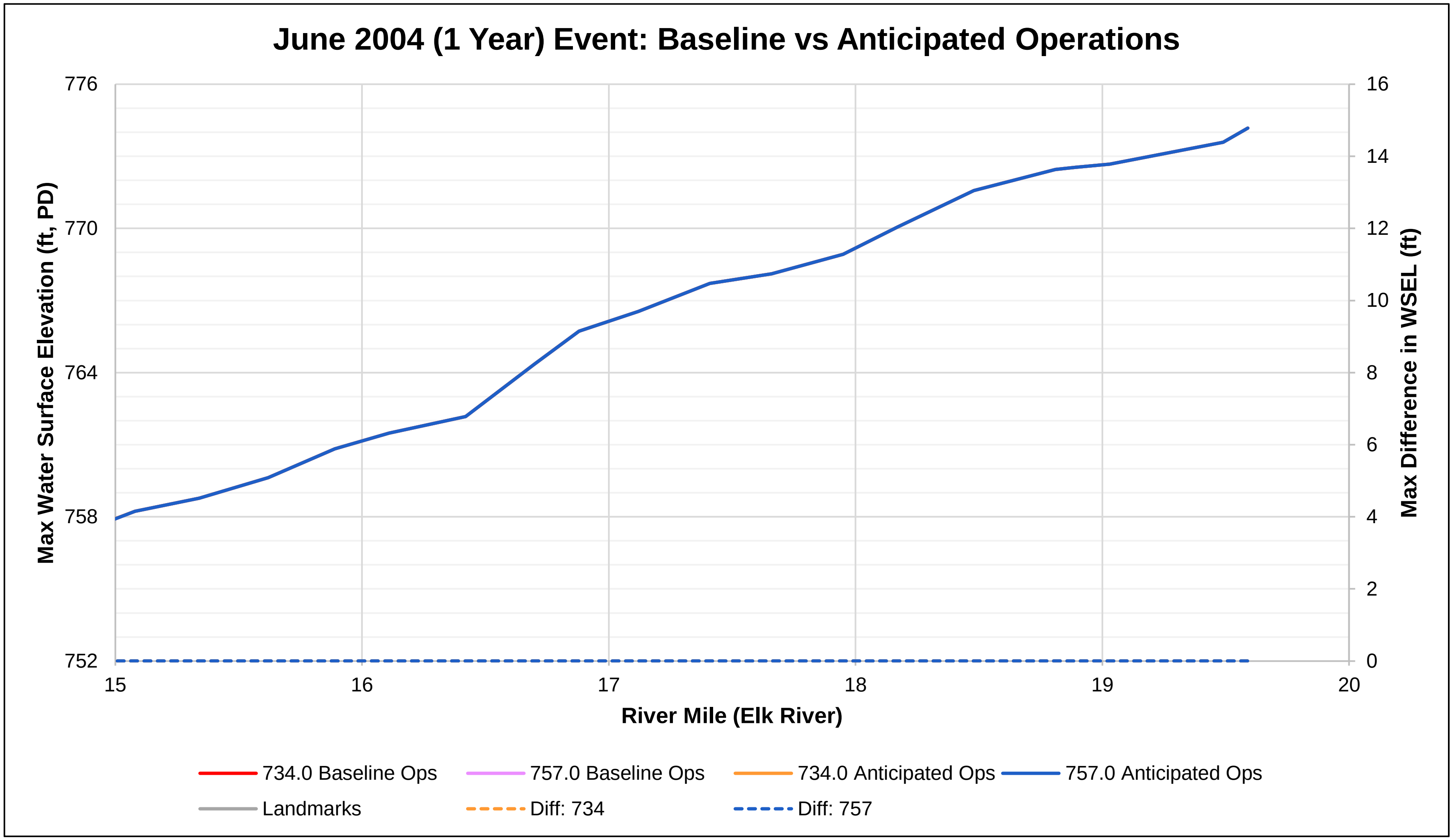


Figure H. 9. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

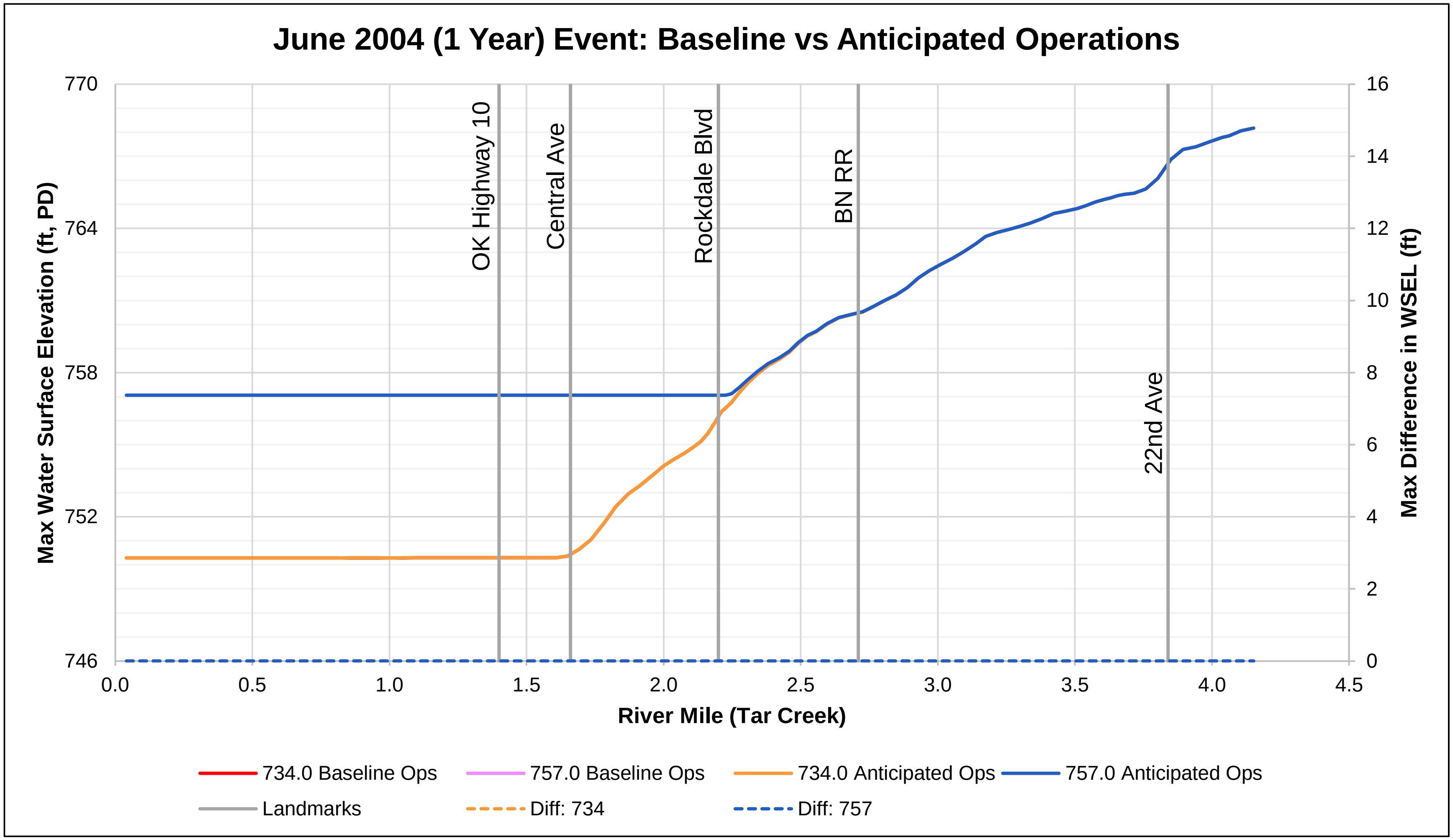


Figure H. 10. Water surface elevations for the June 2004 (1 year) inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

JULY 2007 (4 YEAR) INFLOW EVENT
ANTICIPATED OPERATIONS ANALYSIS
WATER SURFACE ELEVATION PROFILES

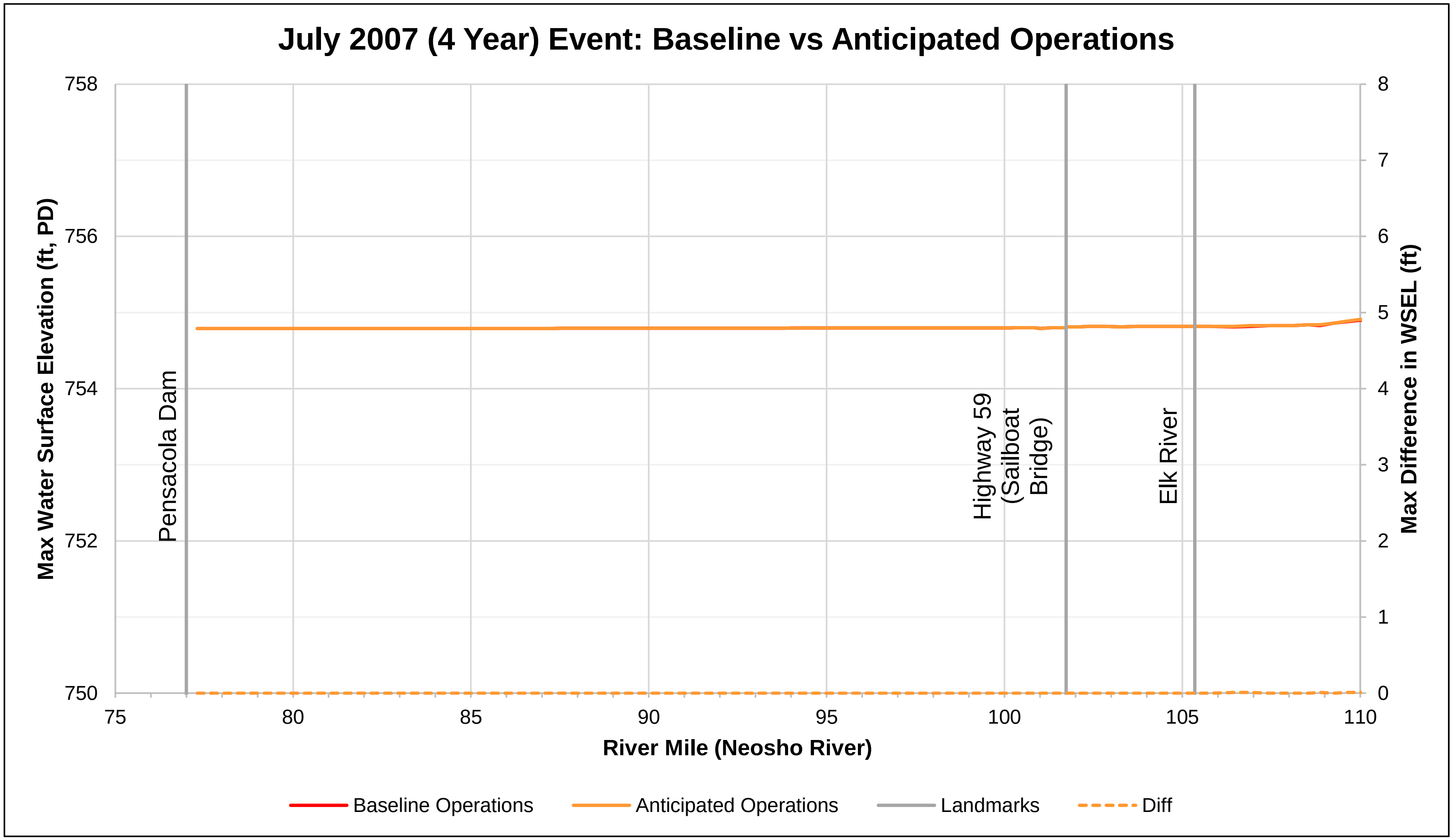


Figure H. 11. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:
1. *Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

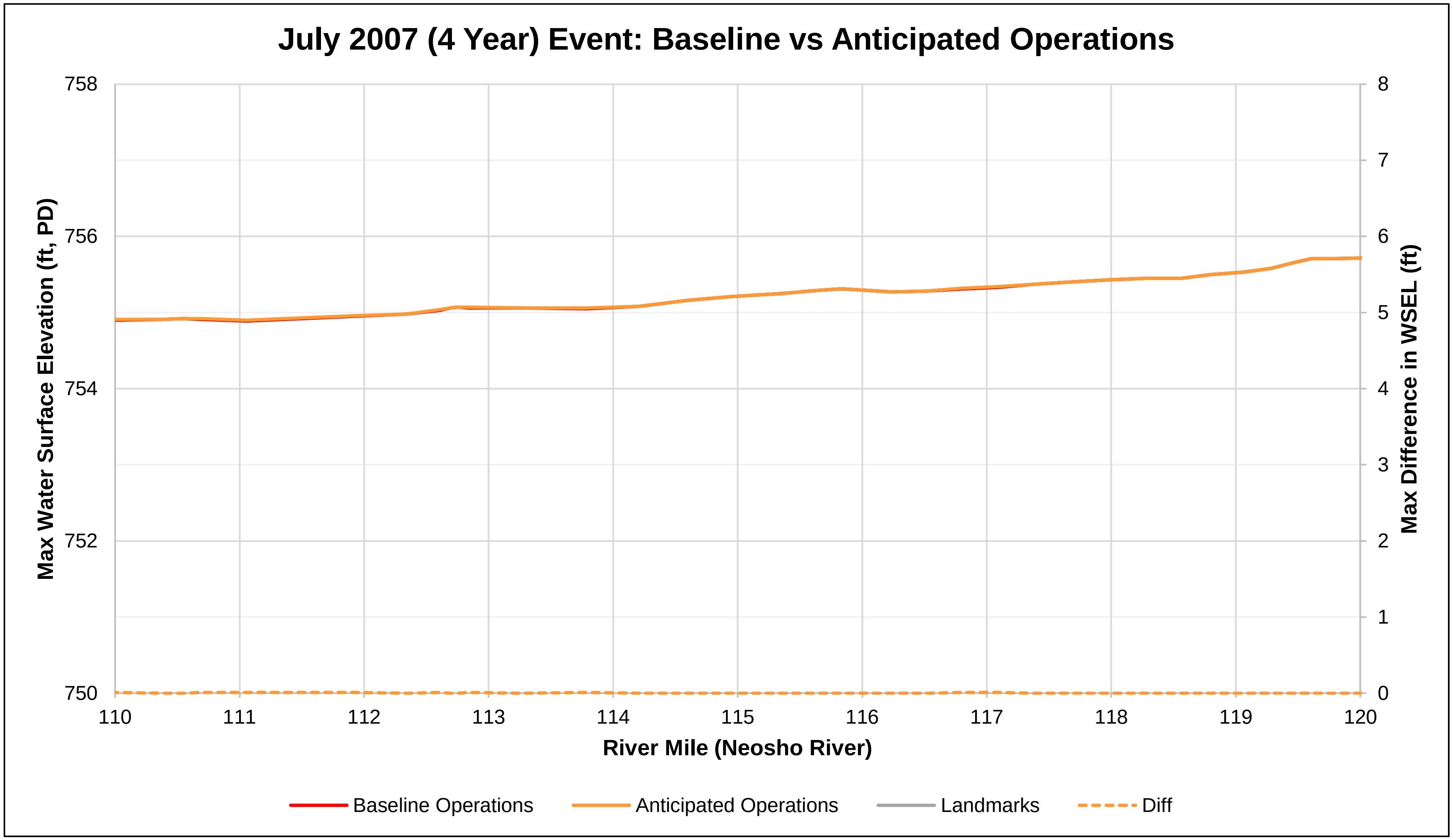


Figure H. 12. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. *Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

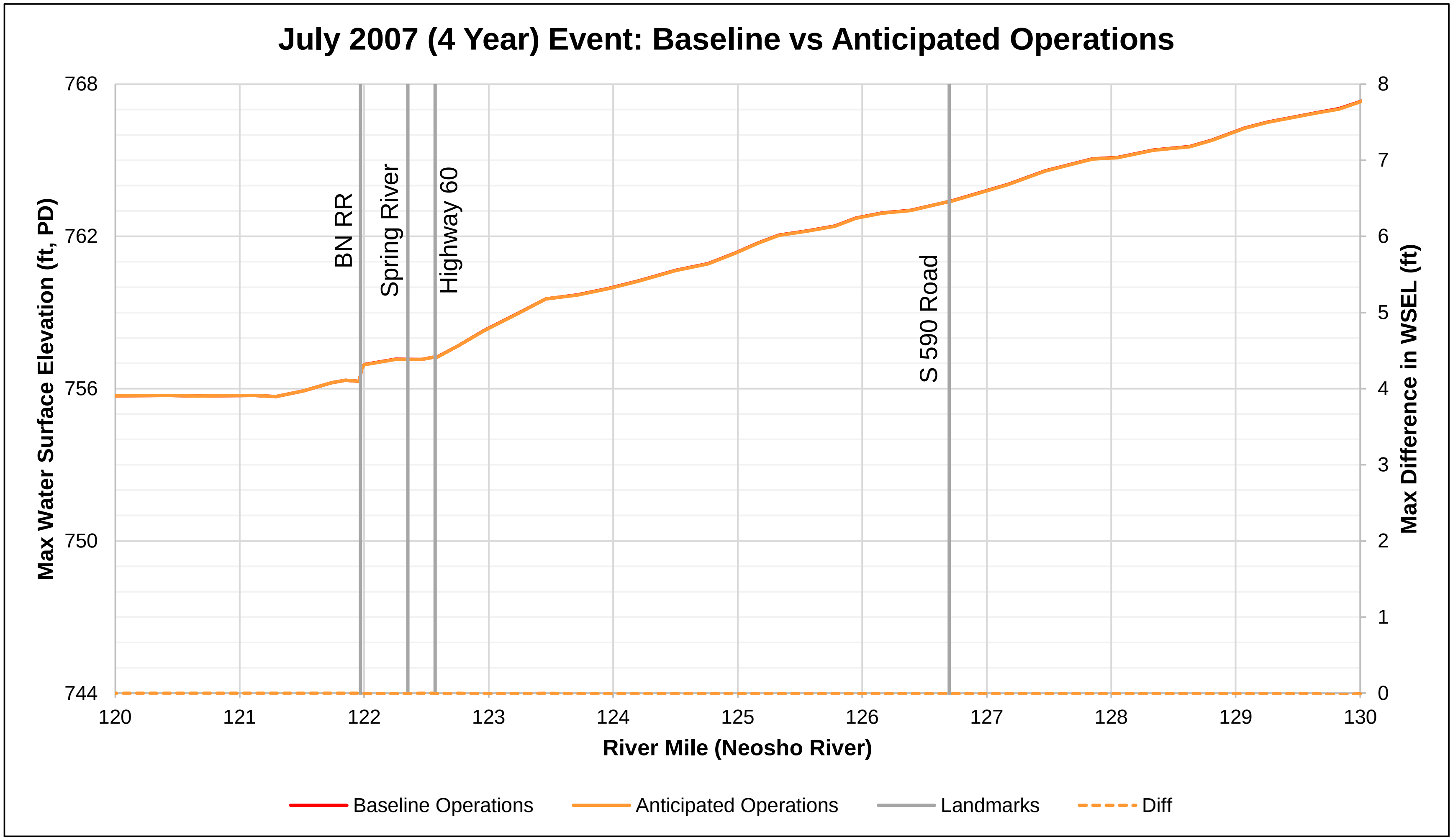


Figure H. 13. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:

1. *Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

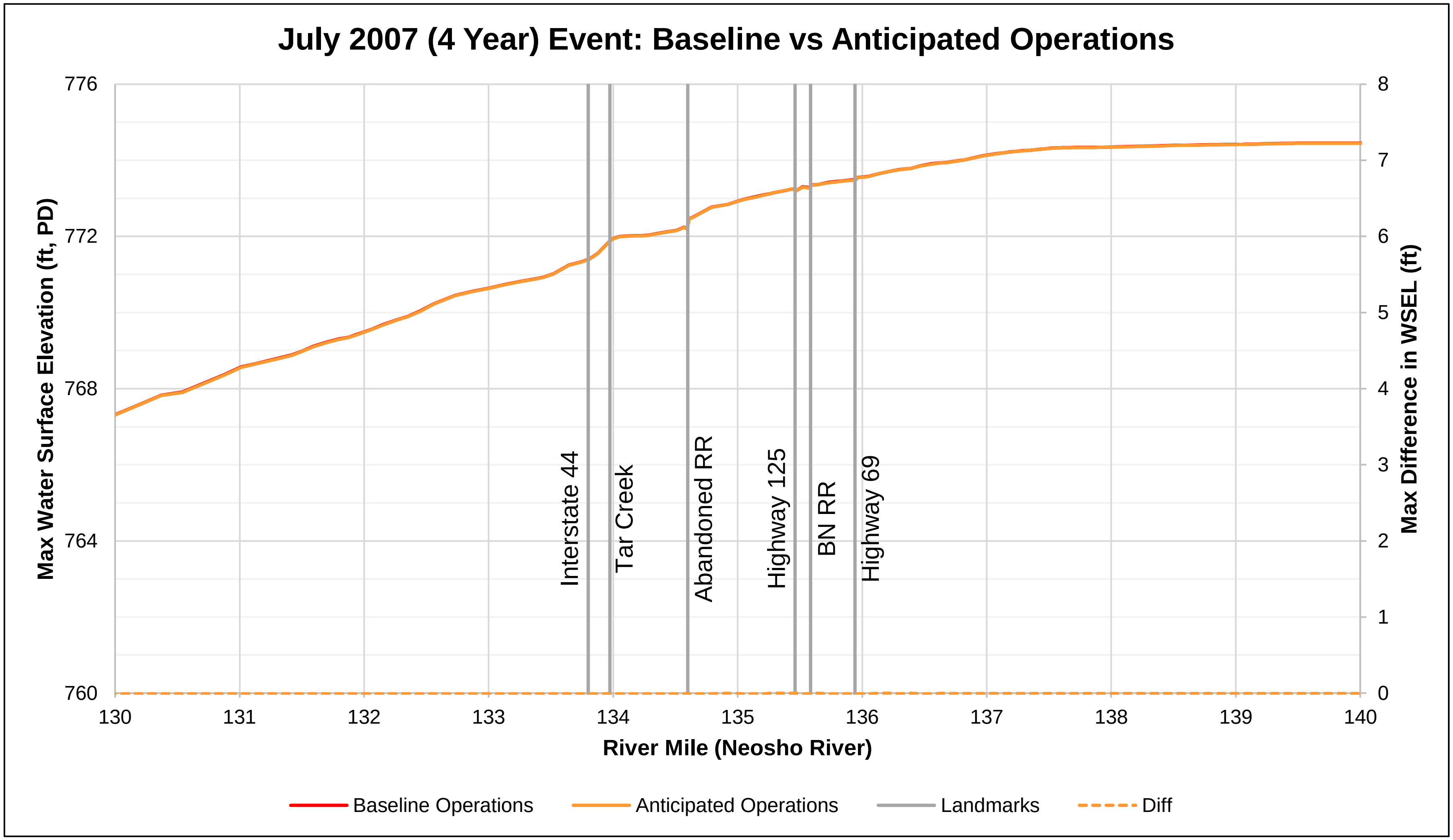


Figure H. 14. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. *Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

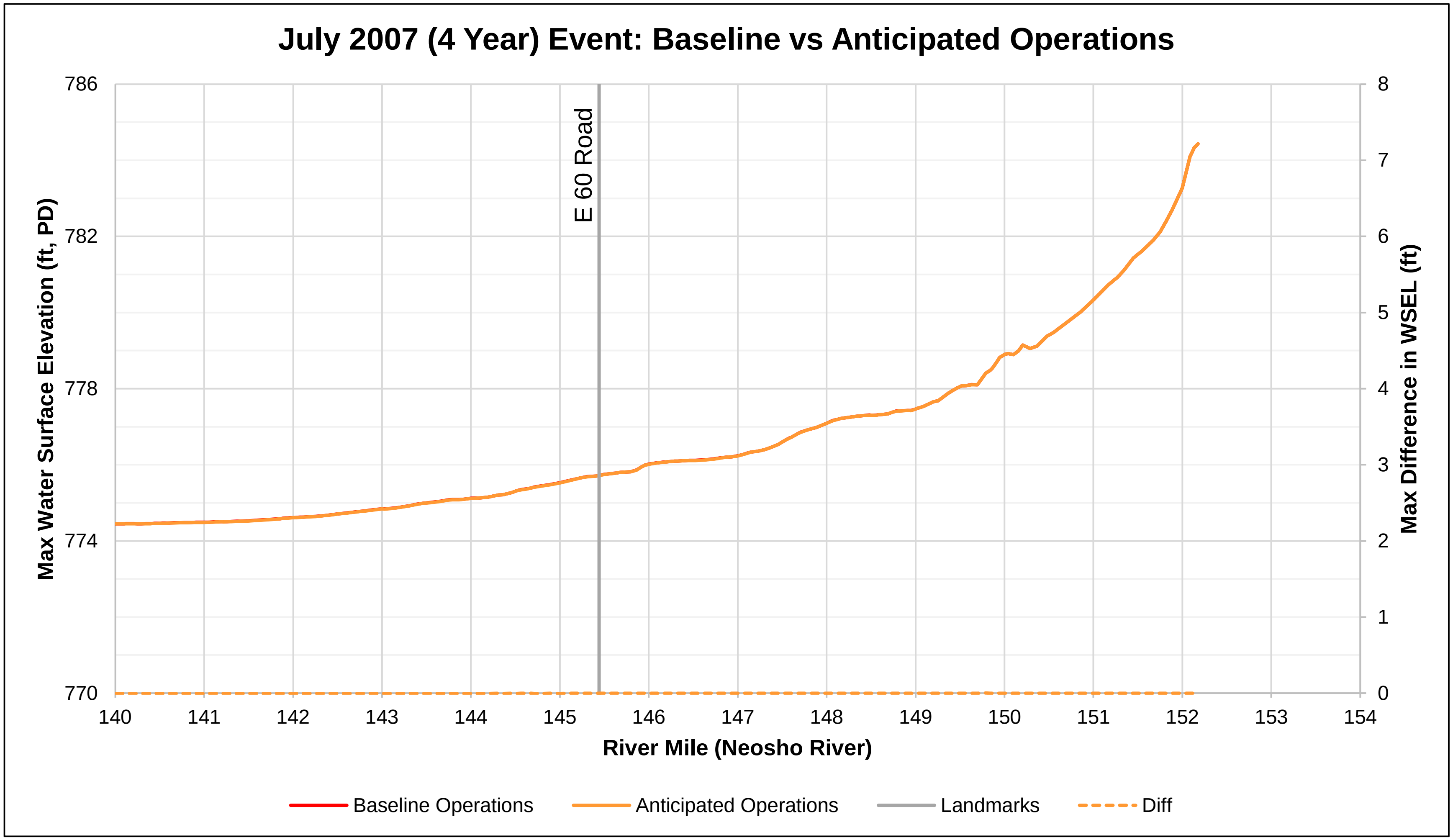


Figure H. 15. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:
1. *Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

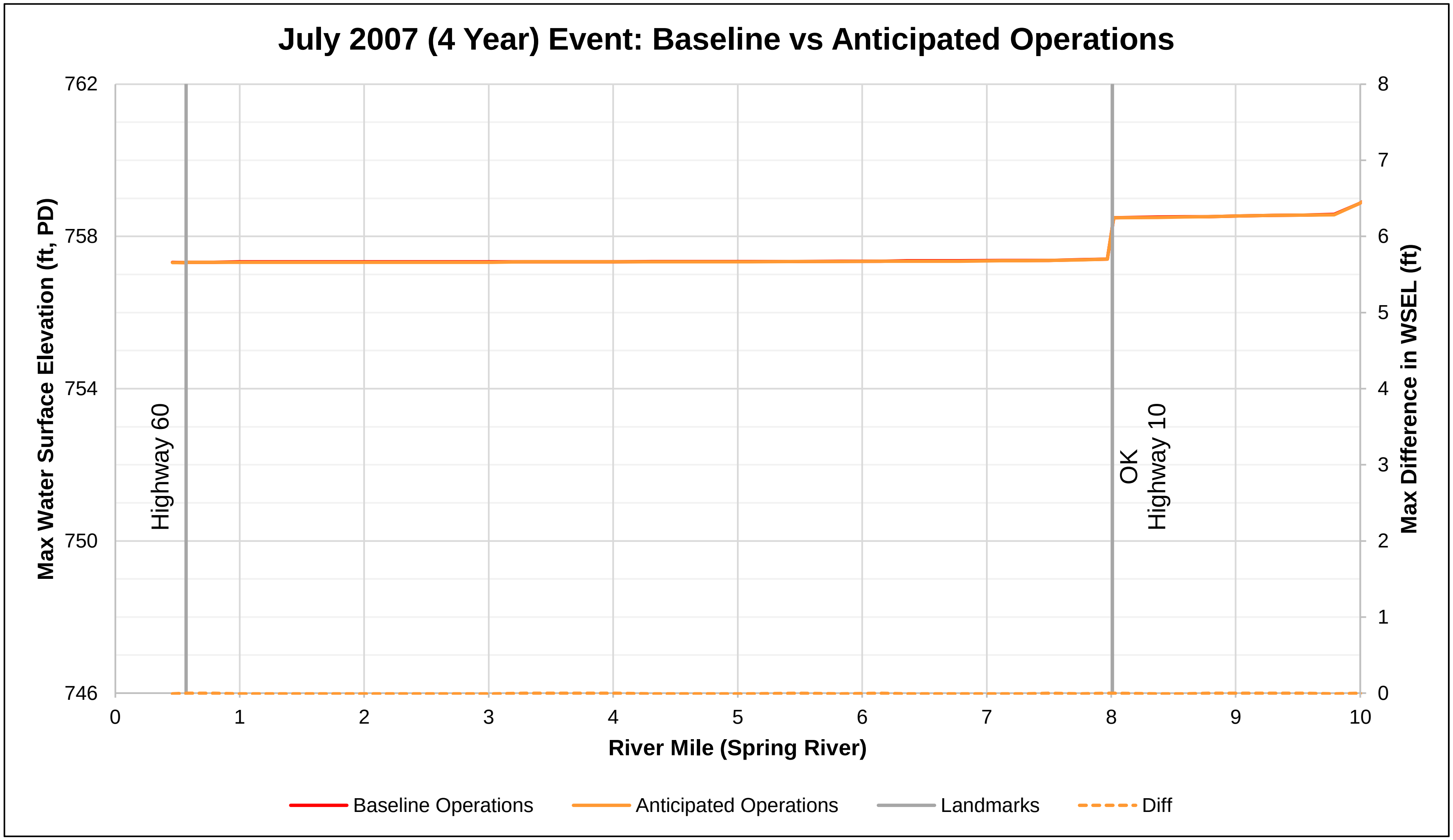


Figure H. 16. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.

2. The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.

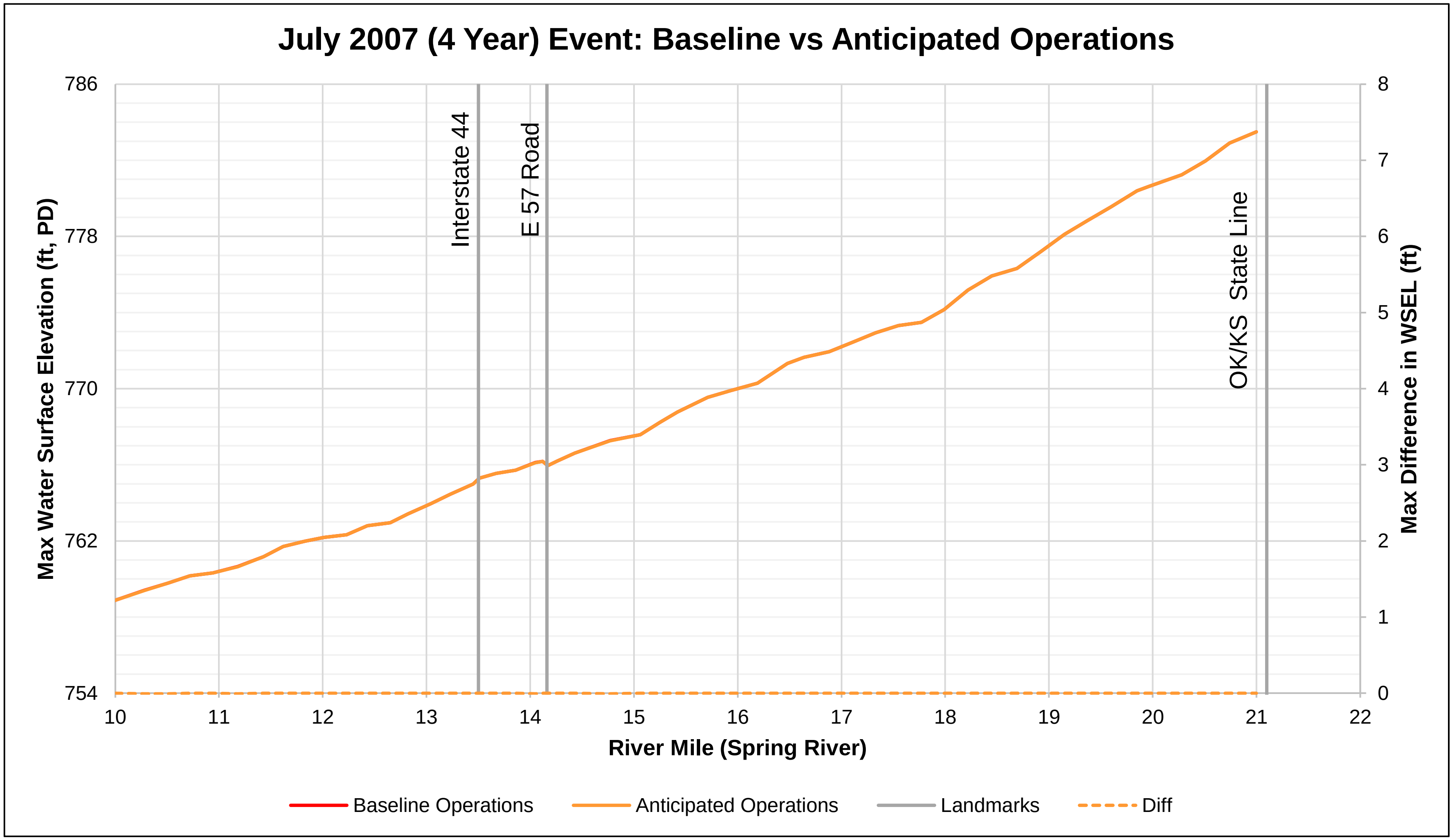


Figure H. 17. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. *Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

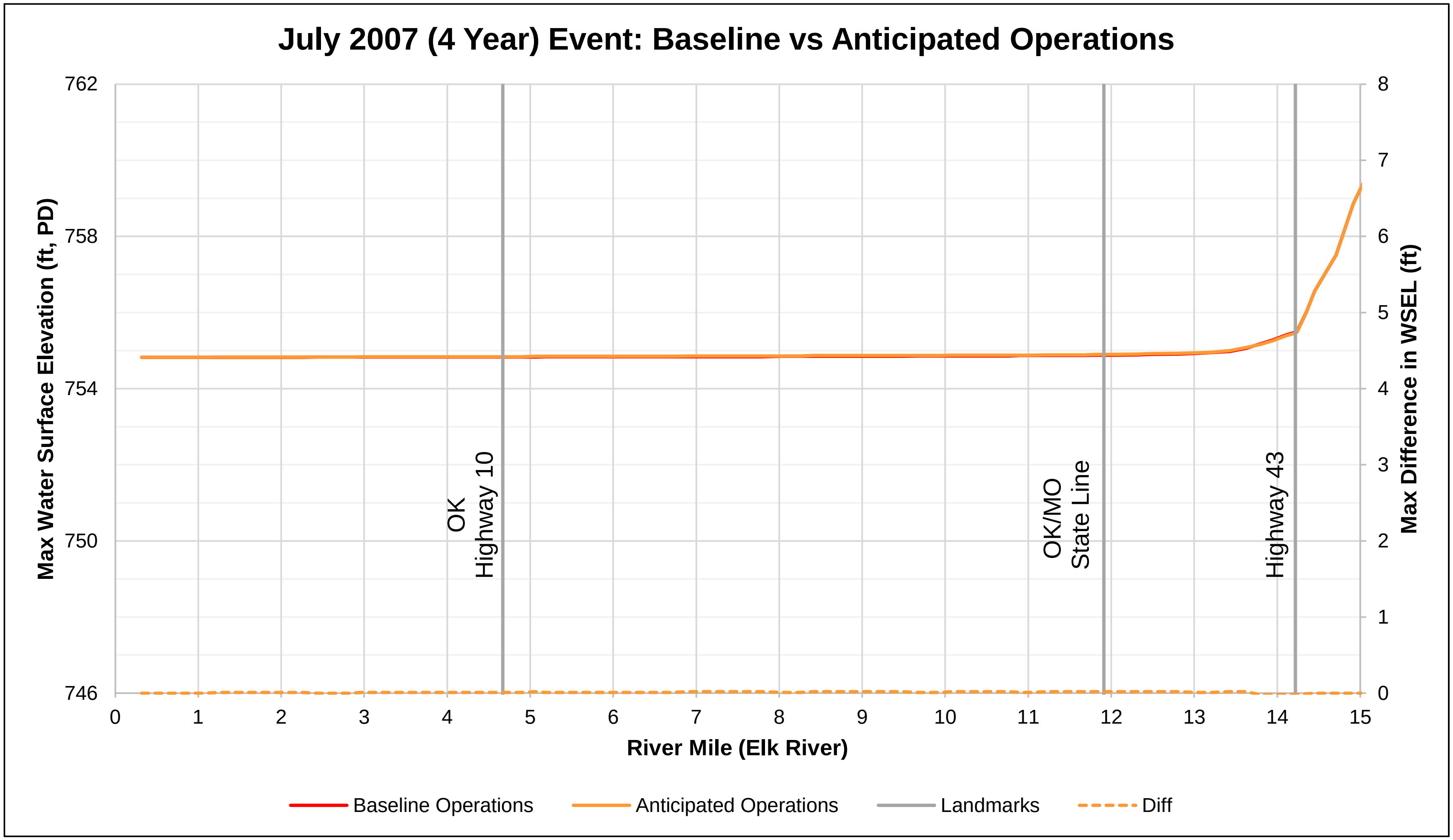


Figure H. 18. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. *Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

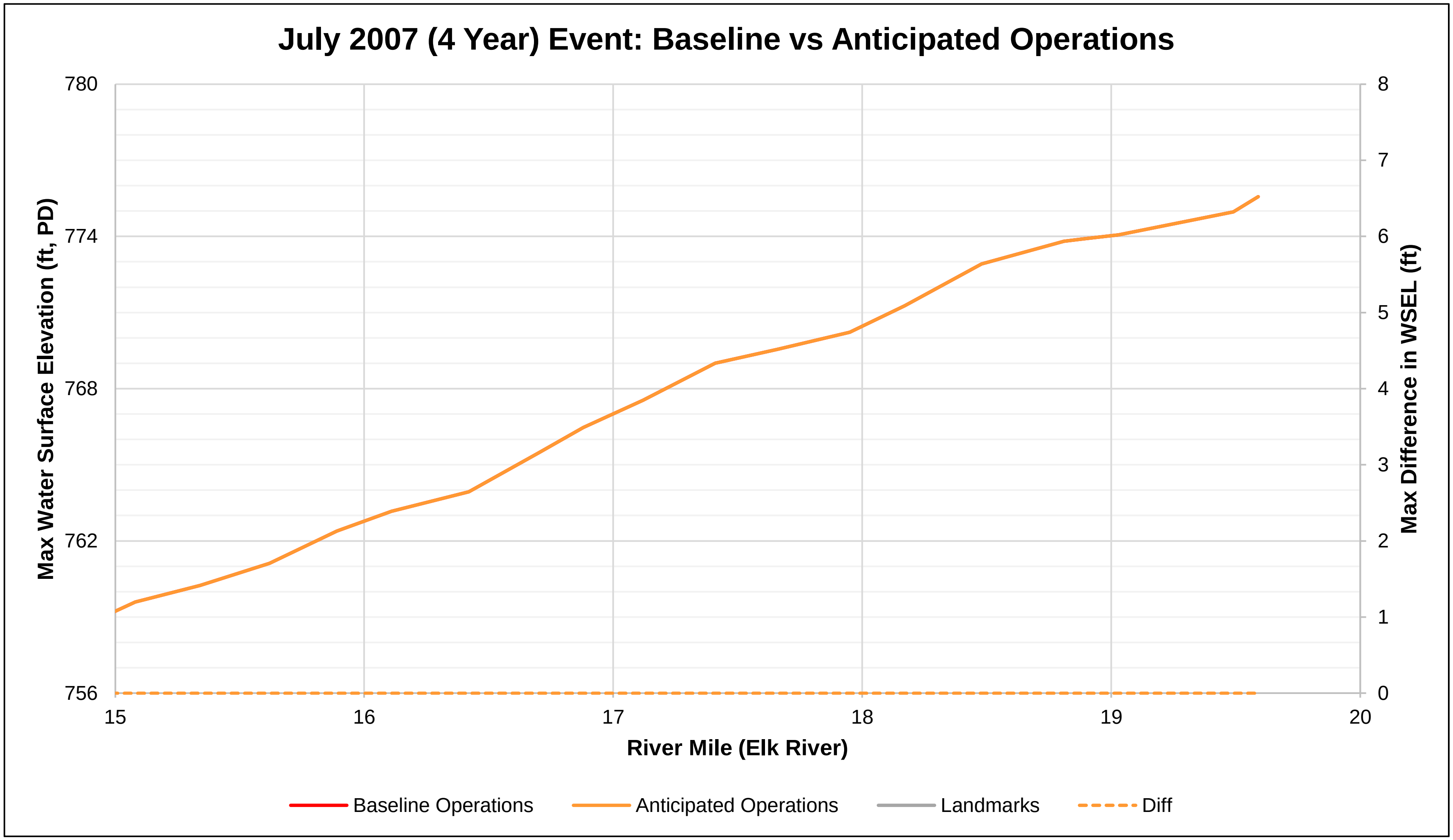


Figure H. 19. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.

2. The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.

3. Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.

4. For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.

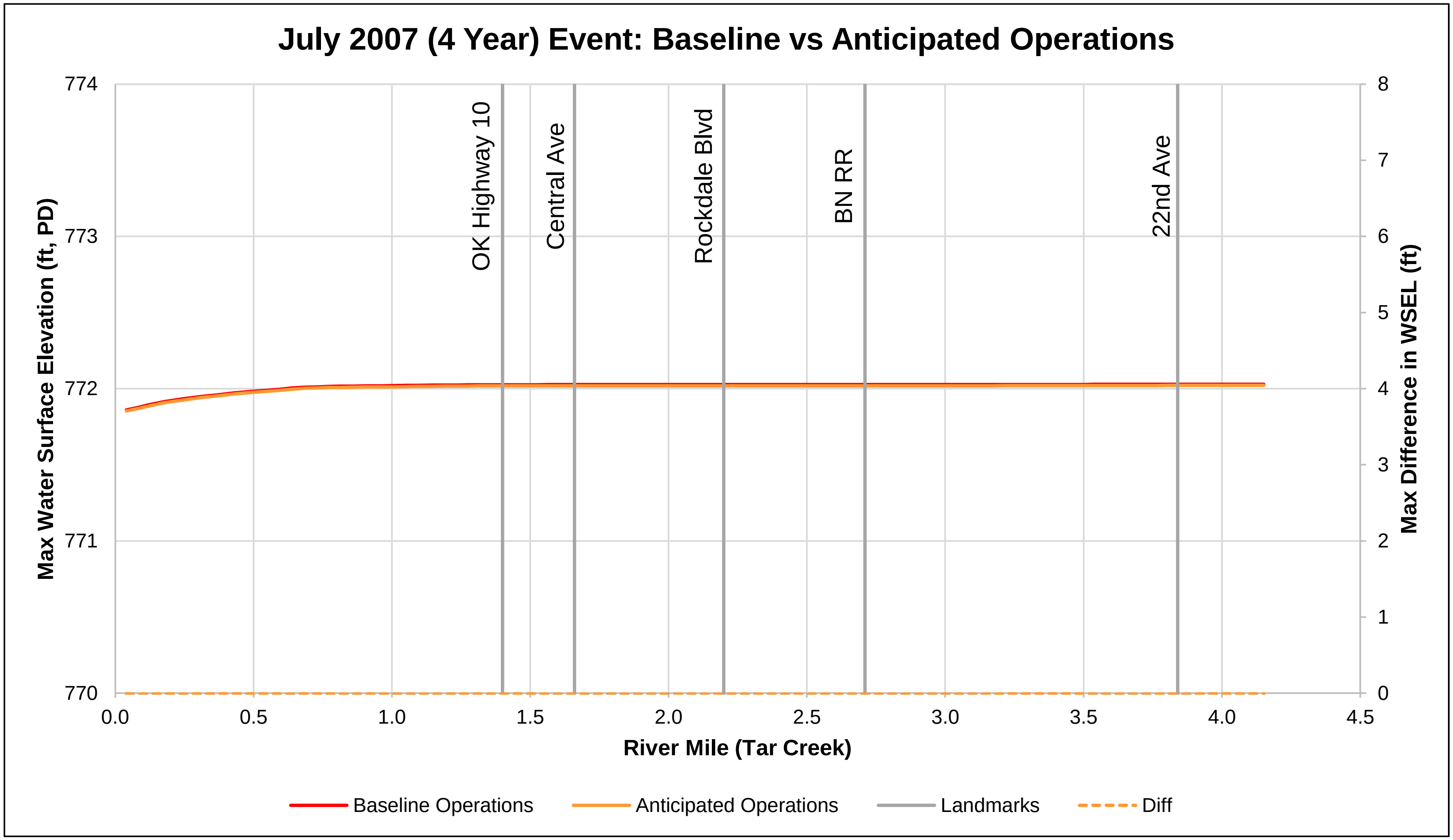


Figure H. 20. Water surface elevations for the July 2007 (4 year) inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. *Both the baseline operations and anticipated operations simulations used their respective period of record stage as the simulation starting stage.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

100-YEAR INFLOW EVENT
ANTICIPATED OPERATIONS ANALYSIS
WATER SURFACE ELEVATION PROFILES

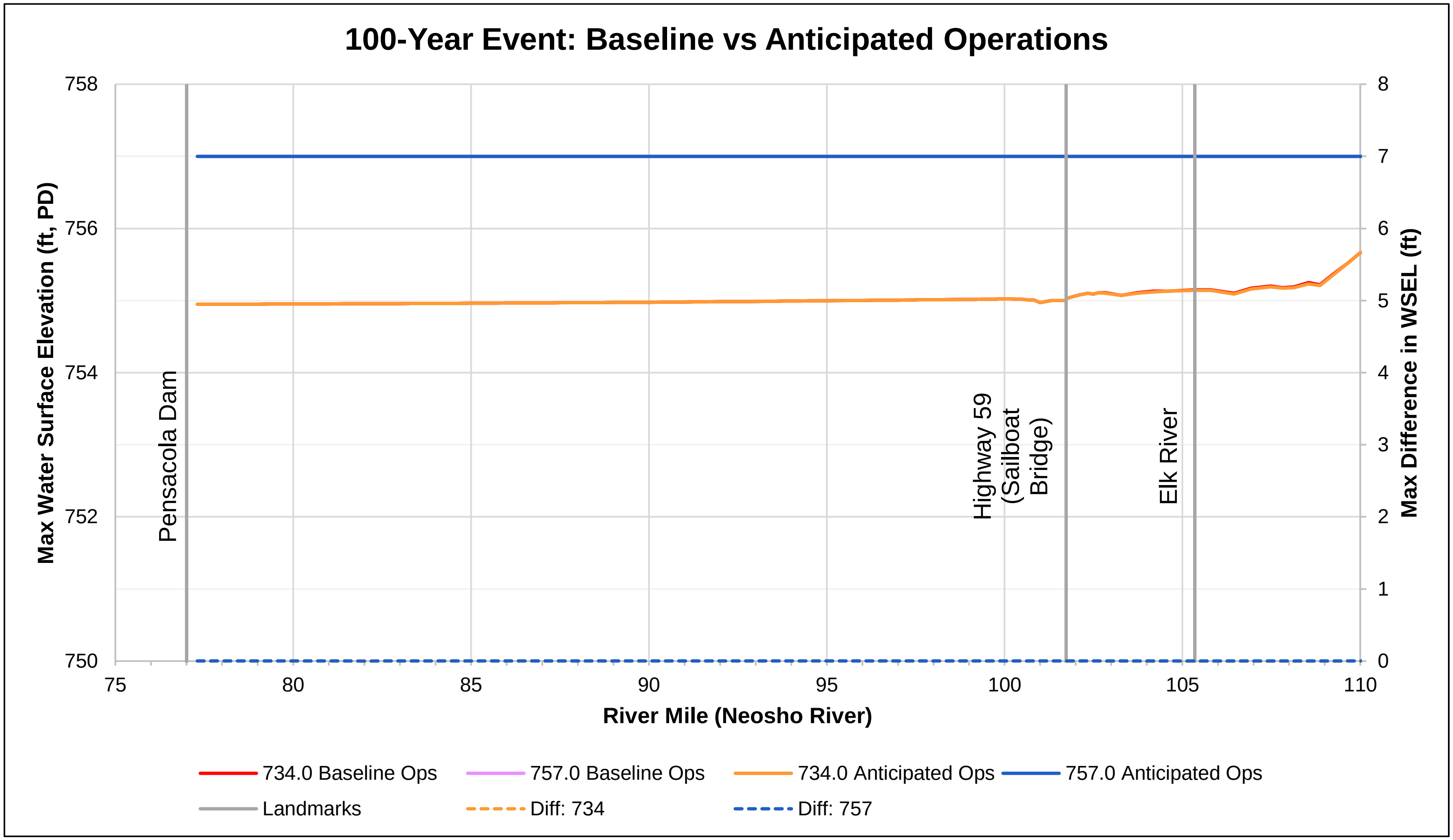


Figure H. 21. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (1 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

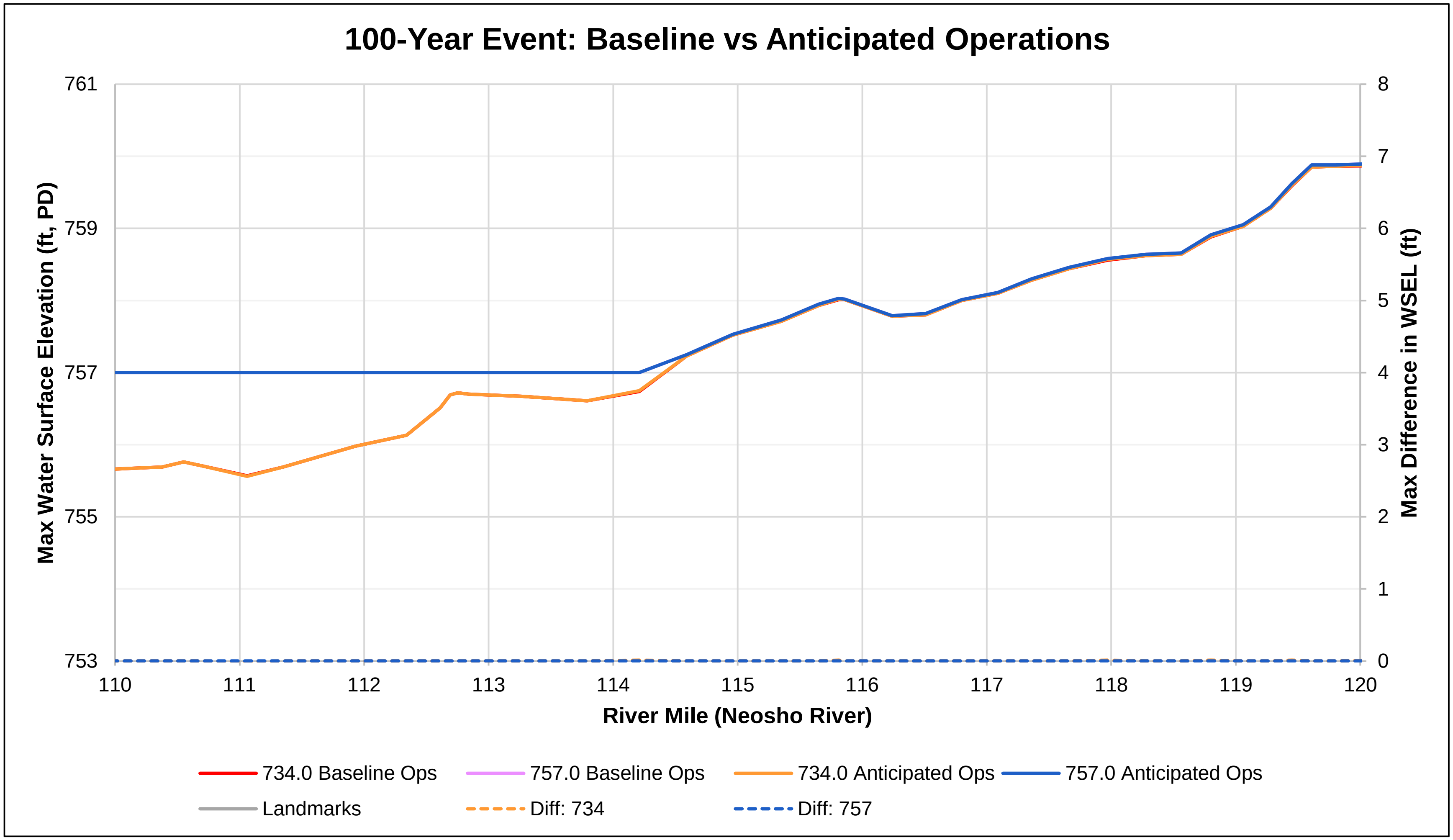


Figure H. 22. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (2 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

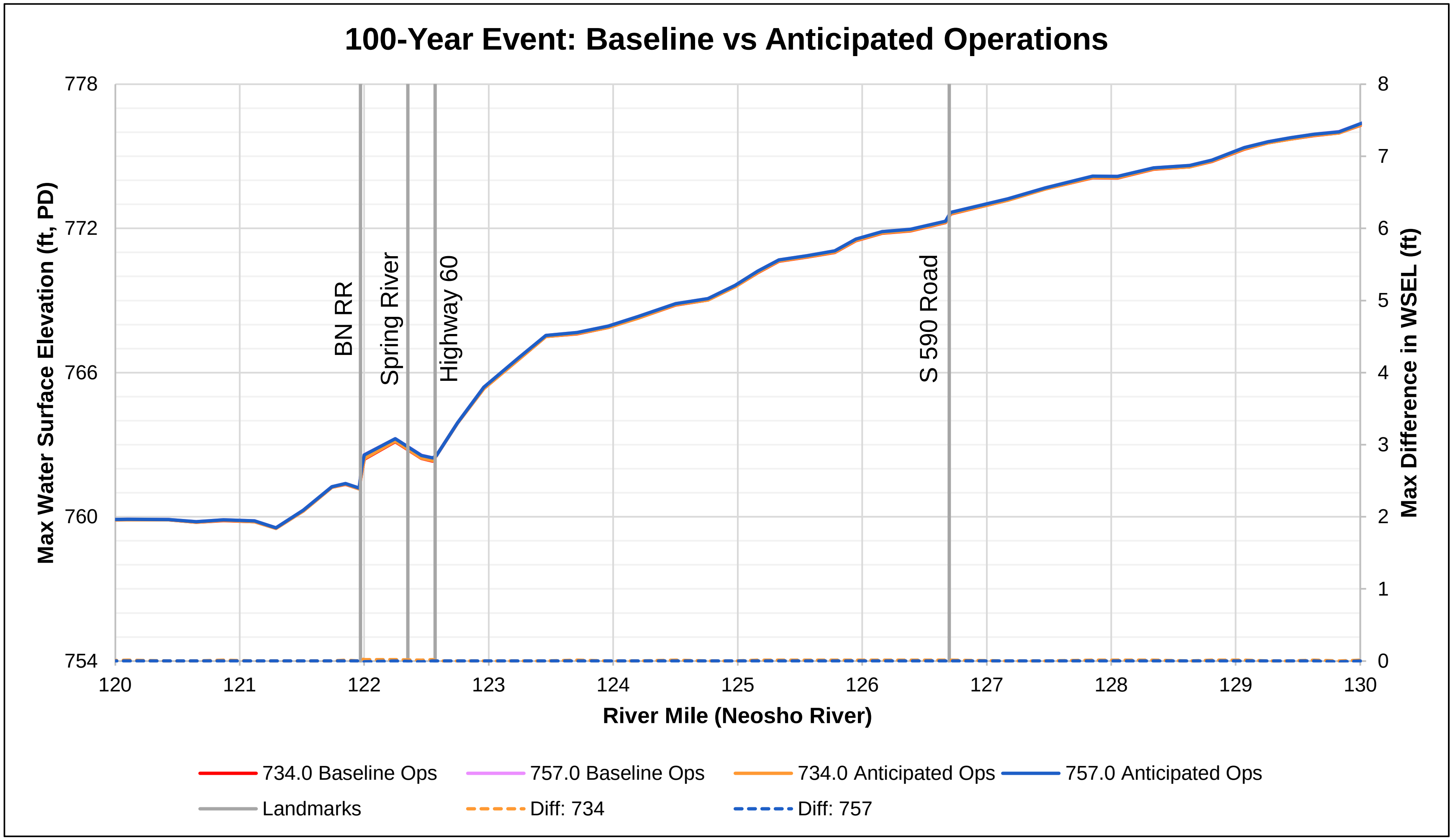


Figure H. 23. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (3 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

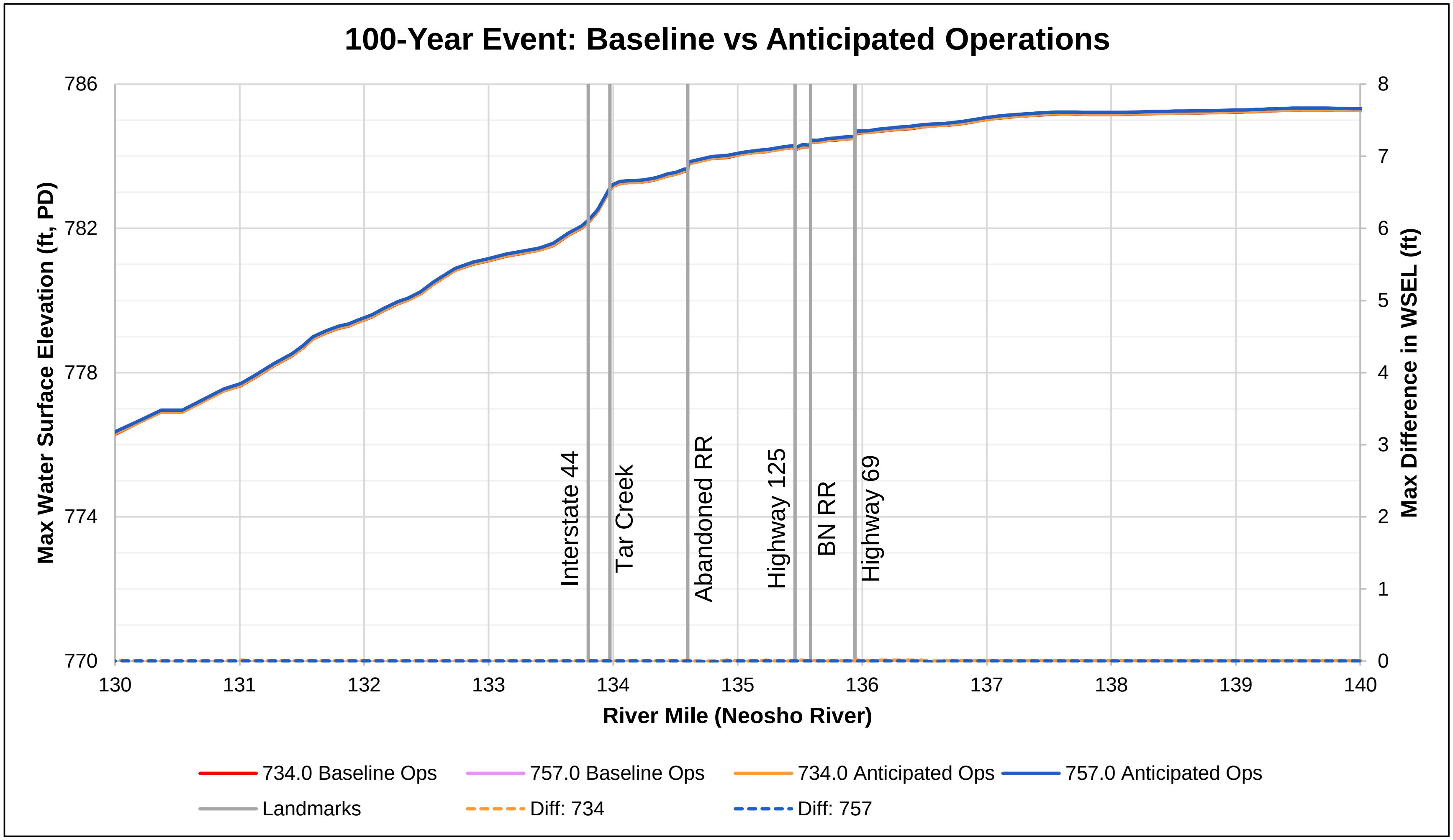


Figure H. 24. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (4 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

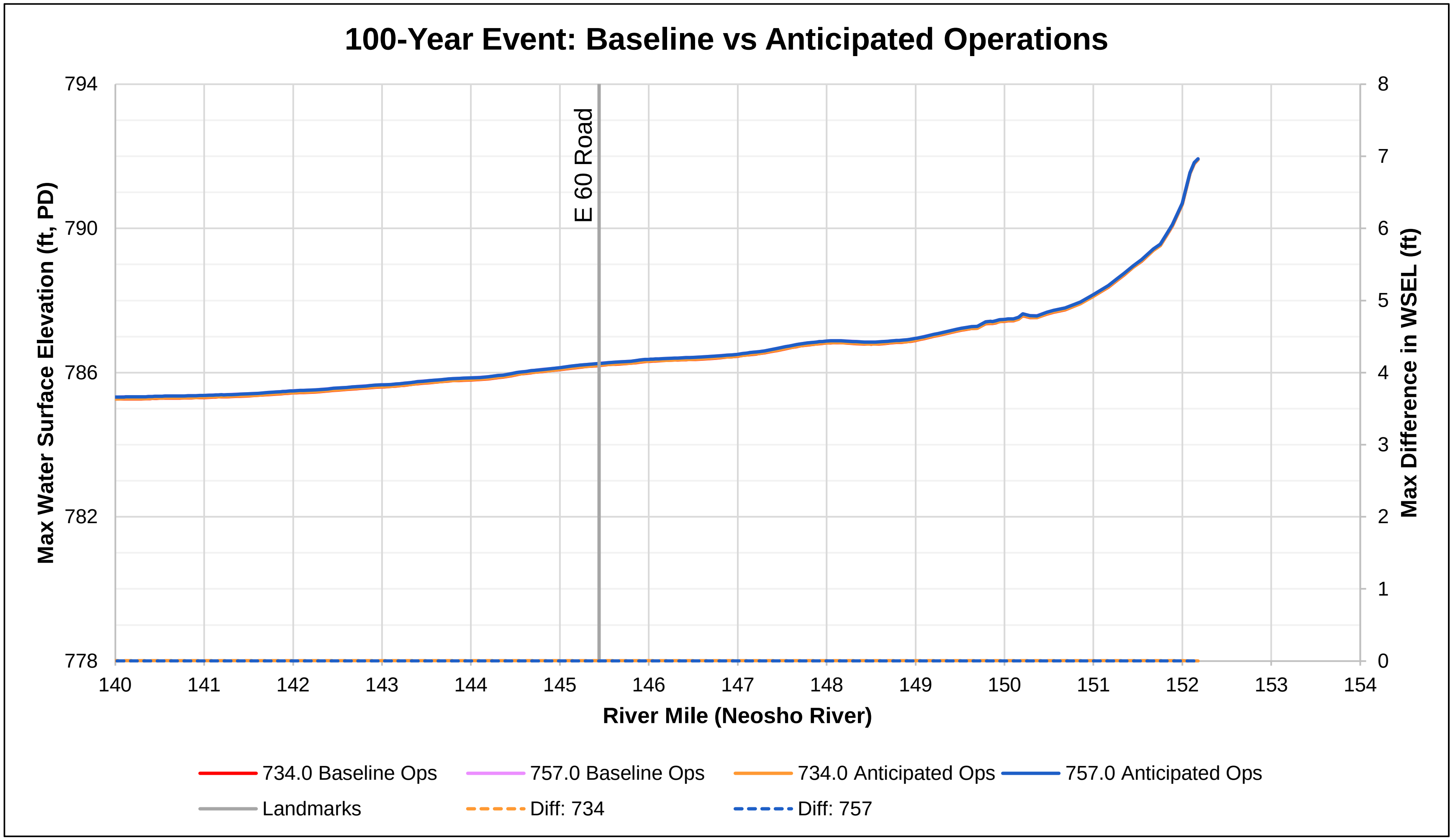


Figure H. 25. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Neosho River profile (5 of 5).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

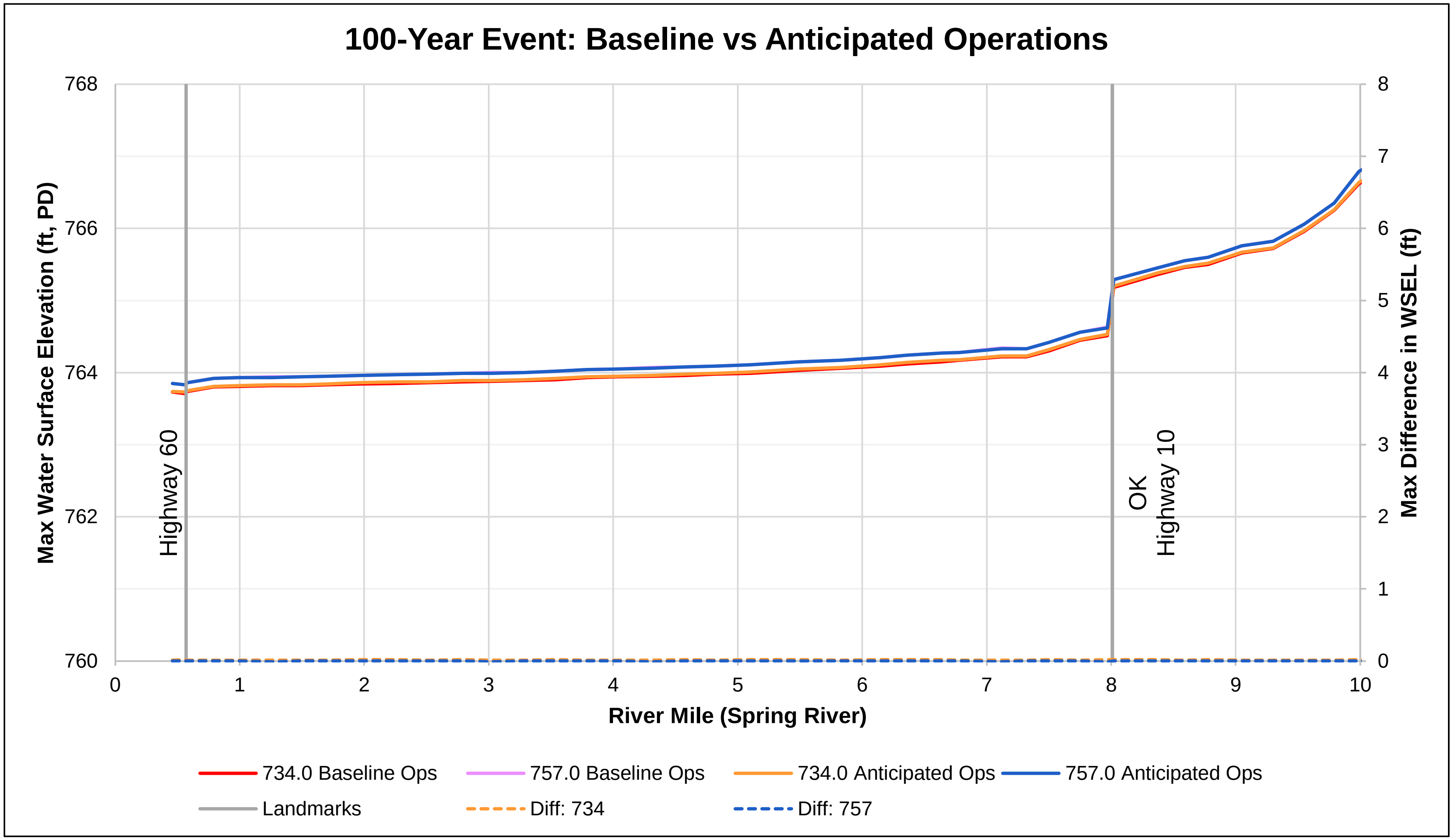


Figure H. 26. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Spring River profile (1 of 2).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

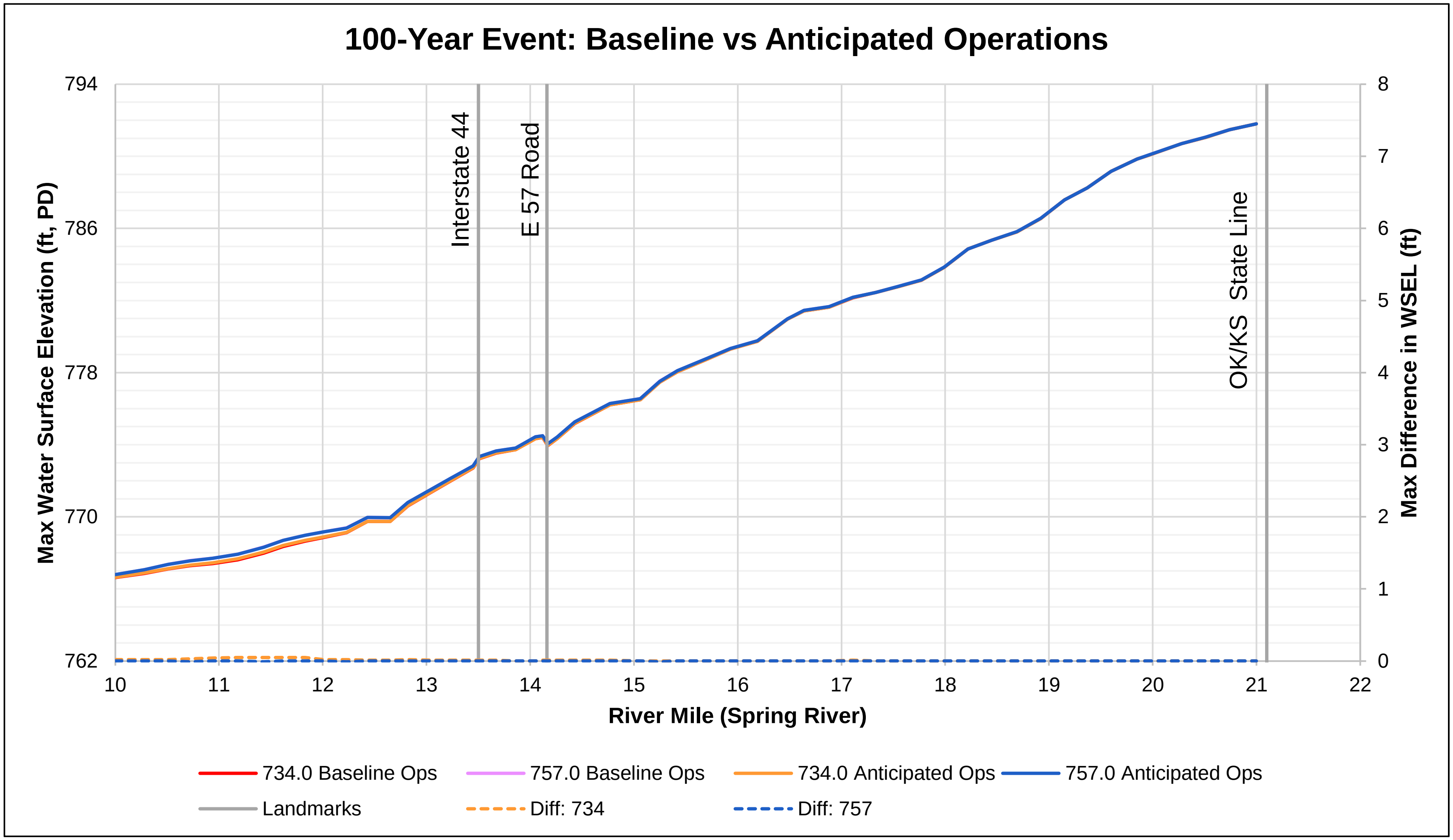


Figure H. 27. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Spring River profile (2 of 2).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

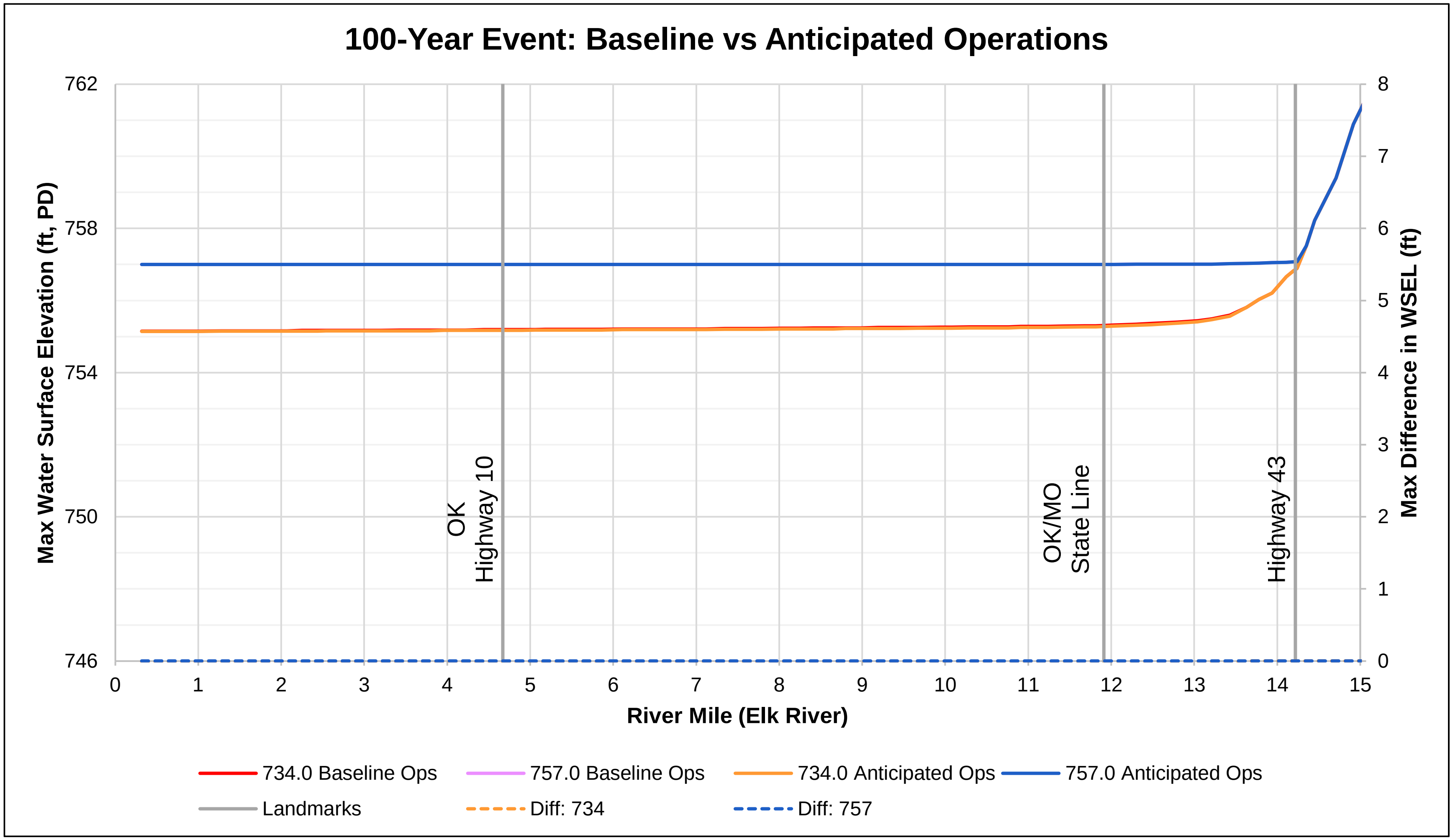


Figure H. 28. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Elk River profile (1 of 2).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

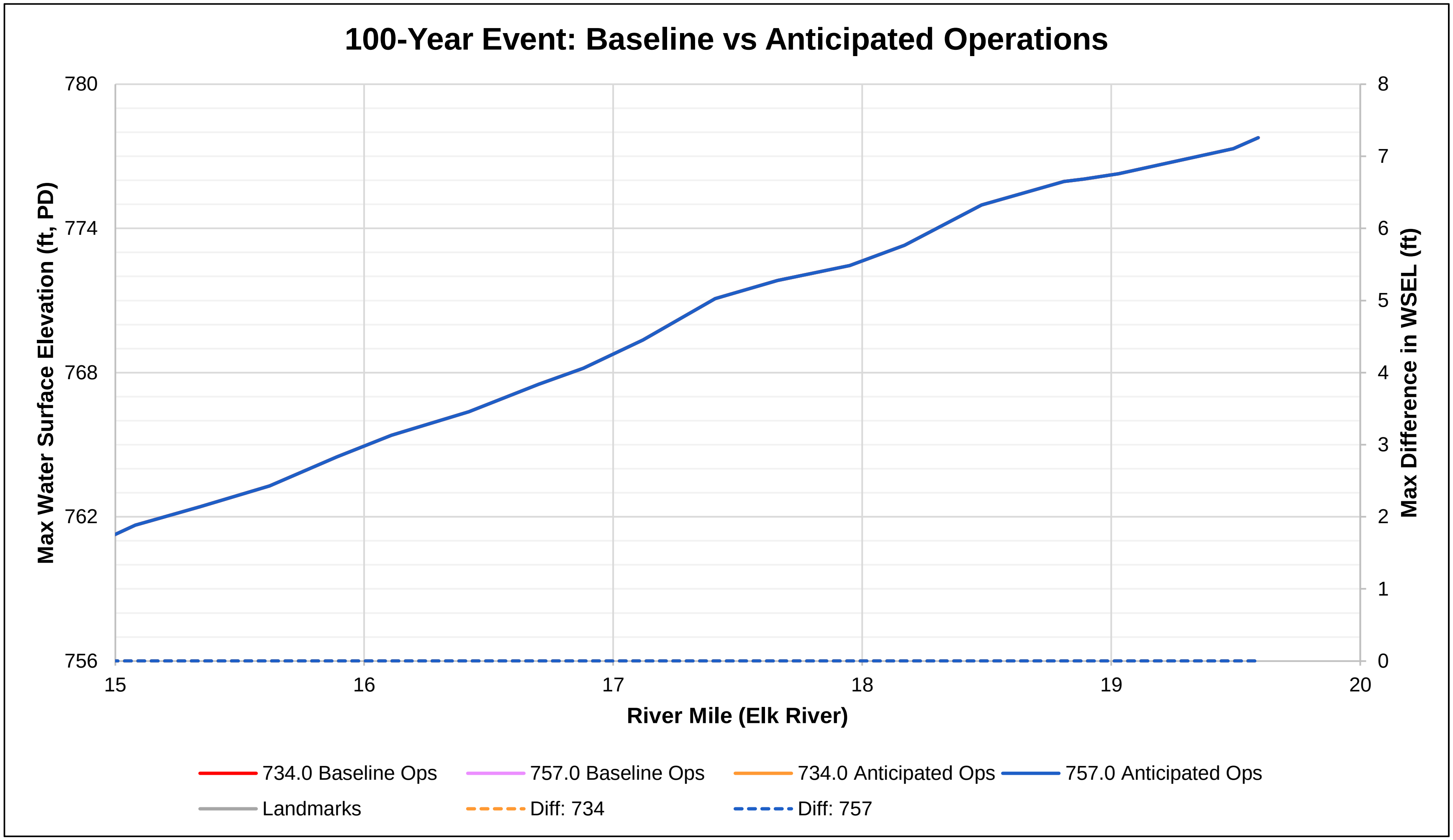


Figure H. 29. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Elk River profile (2 of 2).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

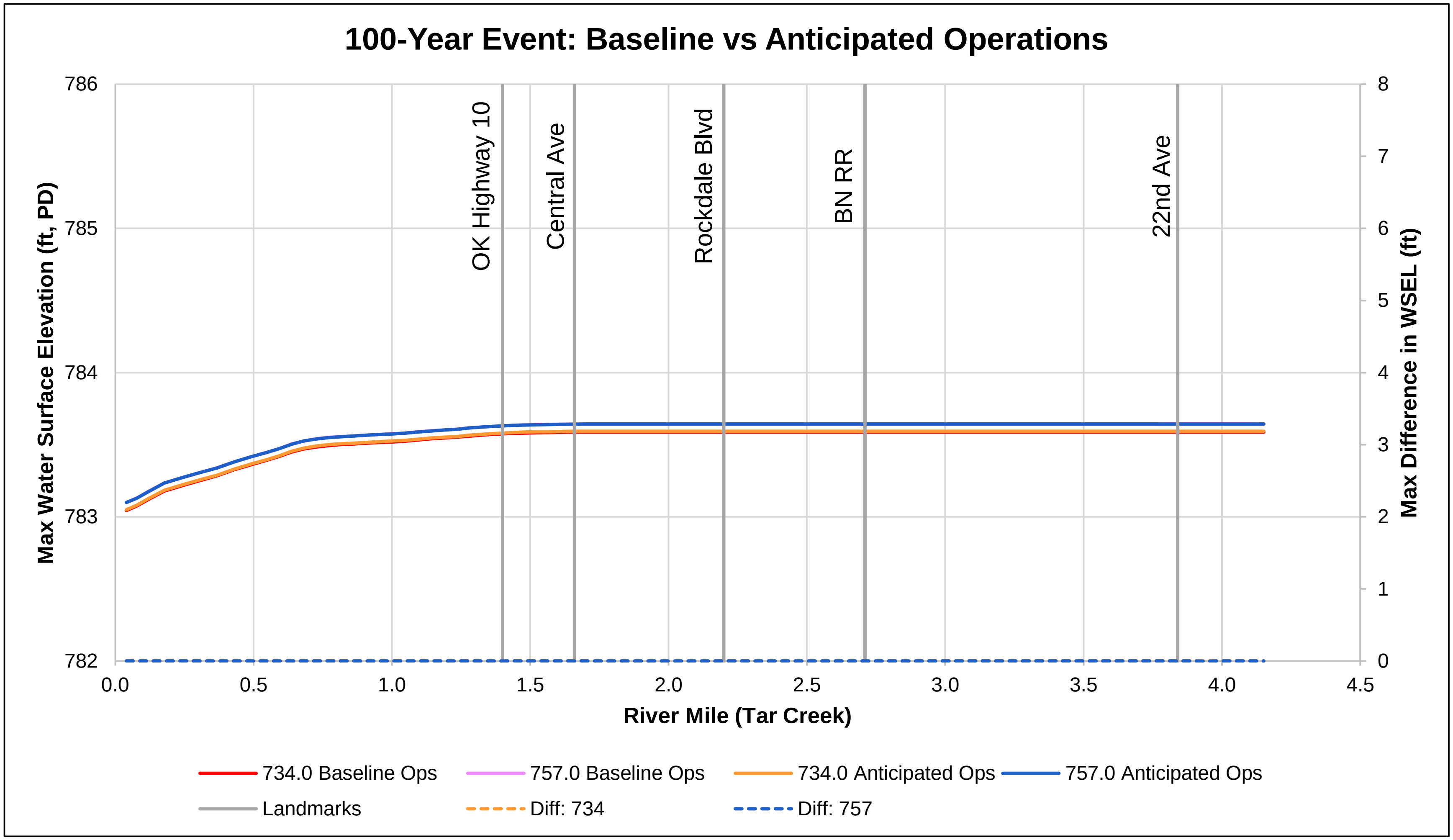


Figure H. 30. Water surface elevations for the 100-year inflow event upstream of Pensacola Dam along the Tar Creek profile (1 of 1).

Notes:

1. *The start of series' names refers to starting pool elevation at Pensacola Dam. For example, "734.0" means a starting pool elevation of 734 ft PD.*
2. *The orange dashed line plotted against the right y-axis represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 734 feet PD. The blue dashed line represents the maximum difference in WSEL between baseline and anticipated operations at a starting elevation of 757 feet PD.*
3. *Vertical and horizontal scales vary between plots based on the slope of the WSEL profiles and maximum differences displayed.*
4. *For portions of the reach where only the anticipated operations WSEL profile is visible, the WSEL profile for the baseline operations is nearly identical.*

APPENDIX H.4:
ANTICIPATED OPERATIONS ANALYSIS
DURATION OF INUNDATION

PENSACOLA DAM **TABLE H.5**

GRAND RIVER DAM AUTHORITY — NEOSHO RIVER DURATIONS - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (hours)	July 2007 (4 year) Difference (hours)	100-Year Difference (hours)
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)			
152.175	Upstream end of model												
152.175	0	0	193	221	221	0	0	193	221	221	0	0	0
151.000	0	0	143	209	209	0	0	143	209	209	0	0	0
150.000	0	0	213	227	235	0	0	213	227	235	0	0	0
149.000	0	0	208	227	227	0	0	208	227	227	0	0	0
148.000	0	0	209	229	229	0	0	209	229	229	0	0	0
147.000	0	0	193	225	225	0	0	193	225	225	0	0	0
145.500	0	7	228	253	257	0	7	228	253	257	0	0	0
145.480	E 60 Road Bridge												
145.400	0	0	228	252	256	0	0	228	252	256	0	0	0
144.000	17	31	237	261	266	17	31	237	261	266	0	0	0
143.000	0	0	223	242	254	0	0	223	242	254	0	0	0
142.000	42	53	253	275	284	42	53	253	275	284	0	0	0
141.000	31	49	249	272	280	31	49	249	272	280	0	0	0
140.000	0	41	240	261	276	0	41	240	261	276	0	0	0
139.000	0	0	209	238	263	0	0	209	238	262	0	0	0
138.000	0	0	192	230	243	0	0	192	230	242	0	0	0
137.000	0	0	175	223	230	0	0	175	223	230	0	0	0
135.950	0	0	169	220	226	0	0	168	220	226	0	-1	0
135.941	Highway 69 Bridge												
135.940	0	0	168	220	226	0	0	168	220	226	0	0	0
135.590	0	0	168	219	226	0	0	168	219	225	0	0	0
135.586	BN RR Bridge												
135.580	0	0	168	219	226	0	0	168	219	225	0	0	0
135.470	0	0	167	219	225	0	0	167	219	225	0	0	0
135.460	Highway 125 Bridge												
135.440	0	0	167	219	225	0	0	167	219	225	0	0	0
135.000	0	0	166	219	225	0	0	166	219	225	0	0	0

1 Max increase in duration for the simulated inflow event listed. Baseline operations duration is subtracted from anticipated operations duration to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.5**

GRAND RIVER DAM AUTHORITY NEOSHO RIVER DURATIONS - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (hours)	July 2007 (4 year) Difference (hours)	100-Year Difference (hours)
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)			
134.610	0	0	163	217	223	0	0	163	218	224	0	0	1
134.599	Abandonded RR Bridge												
134.595	0	0	162	216	222	0	0	162	216	222	0	0	0
134.000	0	0	155	210	217	0	0	155	210	217	0	0	0
133.973	Tar Creek												
133.900	0	0	151	209	216	0	0	151	209	216	0	0	0
133.800	Interstate 44 Bridge												
133.700	0	0	151	208	214	0	0	150	208	214	0	-1	0
133.000	0	0	142	202	207	0	0	141	202	207	0	-1	0
132.000	0	0	135	196	200	0	0	135	196	200	0	0	0
131.000	0	0	130	191	195	0	0	130	191	195	0	0	0
130.000	0	0	126	180	184	0	0	126	180	184	0	0	0
129.000	0	0	121	156	161	0	0	121	158	163	0	0	2
128.000	0	0	115	134	141	0	0	113	134	141	0	-2	0
126.710	0	0	93	114	124	0	0	93	114	124	0	0	0
126.700	S 590 Road Bridge												
126.670	0	0	92	113	124	0	0	92	113	124	0	0	0
126.000	0	0	85	108	119	0	0	84	108	119	0	-1	0
125.000	0	0	67	96	108	0	0	67	96	108	0	0	0
124.000	0	0	44	84	96	0	0	44	84	96	0	0	0
123.000	0	0	0	70	80	0	0	0	70	80	0	0	0
122.580	0	0	0	59	68	0	0	0	60	67	0	0	1
122.570	Highway 60 Bridge												
122.550	0	0	0	60	69	0	0	0	61	69	0	0	1
122.350	Spring River												
122.000	0	0	0	59	65	0	0	0	60	65	0	0	1
121.980	0	0	0	57	63	0	0	0	58	63	0	0	1
121.970	BN RR Bridge												

1 Max increase in duration for the simulated inflow event listed. Baseline operations duration is subtracted from anticipated operations duration to assess the impact of anticipated operations.

PENSACOLA DAM | **TABLE H.5**

GRAND RIVER DAM AUTHORITY | NEOSHO RIVER DURATIONS - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (hours)	July 2007 (4 year) Difference (hours)	100-Year Difference (hours)
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)			
121.960	0	0	0	37	46	0	0	0	38	46	0	0	1
120.000	0	0	0	25	32	0	0	0	26	32	0	0	1
118.000	0	0	0	0	0	0	0	0	0	0	0	0	0
116.000	0	0	0	0	0	0	0	0	0	0	0	0	0
114.000	0	0	0	0	0	0	0	0	0	0	0	0	0
112.000	0	0	0	0	0	0	0	0	0	0	0	0	0
110.000	0	0	0	0	0	0	0	0	0	0	0	0	0
108.000	0	0	0	0	0	0	0	0	0	0	0	0	0
106.000	0	0	0	0	0	0	0	0	0	0	0	0	0
105.350	Elk River												
105.000	0	0	0	0	0	0	0	0	0	0	0	0	0
104.000	0	0	0	0	0	0	0	0	0	0	0	0	0
102.000	0	0	0	0	0	0	0	0	0	0	0	0	0
101.750	0	0	0	0	0	0	0	0	0	0	0	0	0
101.730	Highway 59 (Sailboat Bridge)												
101.710	0	0	0	0	0	0	0	0	0	0	0	0	0
100.000	0	0	0	0	0	0	0	0	0	0	0	0	0
90.000	0	0	0	0	0	0	0	0	0	0	0	0	0
80.000	0	0	0	0	0	0	0	0	0	0	0	0	0
78.000	0	0	0	0	0	0	0	0	0	0	0	0	0
77.000	Pensacola Dam												

1 Max increase in duration for the simulated inflow event listed. Baseline operations duration is subtracted from anticipated operations duration to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.6**

GRAND RIVER DAM AUTHORITY

SPRING RIVER DURATIONS - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
	Jun 2004 (1 Year), Start @ 734 ft Duration (hours)	Jun 2004 (1 Year), Start @ 757 ft Duration (hours)	Jul 2007 (4 Year), Period of Record Duration (hours)	100-Year, Start @ 734 ft Duration (hours)	100-Year, Start @ 757 ft Duration (hours)	Jun 2004 (1 Year), Start @ 734 ft Duration (hours)	Jun 2004 (1 Year), Start @ 757 ft Duration (hours)	Jul 2007 (4 Year), Period of Record Duration (hours)	100-Year, Start @ 734 ft Duration (hours)	100-Year, Start @ 757 ft Duration (hours)	Jun 2004 (1 year) Difference (hours)	July 2007 (4 year) Difference (hours)	100-Year Difference (hours)
21.000	Upstream end of model												
21.000	0	0	0	0	0	0	0	0	0	0	0	0	0
20.000	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	0	0	0	40	40	0	0	0	40	40	0	0	0
18.000	0	0	0	41	41	0	0	0	41	41	0	0	0
17.000	0	0	0	43	44	0	0	0	43	44	0	0	0
16.000	0	0	0	55	55	0	0	0	55	55	0	0	0
15.000	0	0	0	49	49	0	0	0	49	49	0	0	0
14.170	0	0	0	72	72	0	0	0	72	72	0	0	0
14.160	E 57 Road												
14.120	0	0	0	73	73	0	0	0	73	73	0	0	0
13.510	0	0	0	75	75	0	0	0	75	75	0	0	0
13.500	Interstate 44 Bridge												
13.450	0	0	0	73	73	0	0	0	73	73	0	0	0
12.000	0	0	0	84	85	0	0	0	84	85	0	0	0
11.000	0	0	48	115	117	0	0	47	115	117	0	-1	0
10.000	0	0	0	110	112	0	0	0	110	112	0	0	0
9.000	0	0	0	103	107	0	0	0	103	107	0	0	0
8.020	0	0	0	94	103	0	0	0	94	103	0	0	0
8.010	OK Highway 10 Bridge												
7.970	0	0	0	81	92	0	0	0	81	91	0	0	0
7.000	0	0	0	70	84	0	0	0	72	84	0	0	2
6.000	0	0	0	65	80	0	0	0	67	80	0	0	2
5.000	0	0	0	63	77	0	0	0	64	77	0	0	1
4.000	0	0	0	63	76	0	0	0	64	76	0	0	1
3.000	0	0	0	62	75	0	0	0	62	74	0	0	0
2.000	0	0	0	62	73	0	0	0	62	73	0	0	0
1.000	0	0	0	62	71	0	0	0	62	71	0	0	0
0.580	0	0	0	62	69	0	0	0	62	69	0	0	0
0.570	Highway 60 Bridge												
0.560	0	0	0	62	69	0	0	0	62	69	0	0	0
0.460	0	0	0	62	70	0	0	0	62	70	0	0	0
0.000	Downstream end of Spring River												

1 Max increase in duration for the simulated inflow event listed. Baseline operations duration is subtracted from anticipated operations duration to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.7**

GRAND RIVER DAM AUTHORITY ELK RIVER DURATIONS - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (hours)	July 2007 (4 year) Difference (hours)	100-Year Difference (hours)
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)			
19.590	Upstream end of model												
19.590	0	0	0	0	0	0	0	0	0	0	0	0	0
19.000	0	0	0	0	0	0	0	0	0	0	0	0	0
18.000	0	0	0	0	0	0	0	0	0	0	0	0	0
17.000	0	0	0	0	0	0	0	0	0	0	0	0	0
16.000	0	0	0	0	0	0	0	0	0	0	0	0	0
15.000	0	0	0	0	0	0	0	0	0	0	0	0	0
14.240	0	0	0	0	0	0	0	0	0	0	0	0	0
14.220	Highway 43 Bridge												
14.200	0	0	0	0	0	0	0	0	0	0	0	0	0
14.000	0	0	0	0	0	0	0	0	0	0	0	0	0
13.000	0	0	0	0	0	0	0	0	0	0	0	0	0
12.000	0	0	0	0	0	0	0	0	0	0	0	0	0
11.910	OK/MO State Line												
11.000	0	0	0	0	0	0	0	0	0	0	0	0	0
10.000	0	0	0	0	0	0	0	0	0	0	0	0	0
9.000	0	0	0	0	0	0	0	0	0	0	0	0	0
8.000	0	0	0	0	0	0	0	0	0	0	0	0	0
7.000	0	0	0	0	0	0	0	0	0	0	0	0	0
6.000	0	0	0	0	0	0	0	0	0	0	0	0	0
5.000	0	0	0	0	0	0	0	0	0	0	0	0	0
4.700	0	0	0	0	0	0	0	0	0	0	0	0	0
4.670	OK Highway 10 Bridge												
4.640	0	0	0	0	0	0	0	0	0	0	0	0	0
4.000	0	0	0	0	0	0	0	0	0	0	0	0	0
3.000	0	0	0	0	0	0	0	0	0	0	0	0	0
2.000	0	0	0	0	0	0	0	0	0	0	0	0	0
1.000	0	0	0	0	0	0	0	0	0	0	0	0	0
0.320	0	0	0	0	0	0	0	0	0	0	0	0	0
0.000	Downstream end of Elk River												

1 Max increase in duration for the simulated inflow event listed. Baseline operations duration is subtracted from anticipated operations duration to assess the impact of anticipated operations.

PENSACOLA DAM **TABLE H.8**

GRAND RIVER DAM AUTHORITY TAR CREEK DURATIONS - BASELINE VS ANTICIPATED OPERATIONS

River Mile	Baseline Operations					Anticipated Operations					Anticipated vs. Baseline[1]		
	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 Year), Start @ 734 ft	Jun 2004 (1 Year), Start @ 757 ft	Jul 2007 (4 Year), Period of Record	100-Year, Start @ 734 ft	100-Year, Start @ 757 ft	Jun 2004 (1 year) Difference (hours)	July 2007 (4 year) Difference (hours)	100-Year Difference (hours)
	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)	Duration (hours)			
4.152	Upstream end of model												
4.152	0	0	0	70	70	0	0	0	70	70	0	0	0
3.900	0	0	0	79	80	0	0	0	79	80	0	0	0
3.840	22nd Ave Bridge												
3.800	0	0	36	91	93	0	0	36	91	93	0	0	0
3.300	0	0	49	97	99	0	0	49	97	99	0	0	0
2.800	0	0	83	120	123	0	0	83	120	123	0	0	0
2.710	BN RR Bridge												
2.700	0	0	112	171	173	0	0	112	171	173	0	0	0
2.500	0	0	122	184	187	0	0	122	184	187	0	0	0
2.300	0	0	130	193	196	0	0	130	193	196	0	0	0
2.200	Rockdale Blvd Bridge												
2.100	0	0	154	210	217	0	0	154	210	217	0	0	0
1.900	0	0	154	210	217	0	0	154	210	217	0	0	0
1.700	0	0	154	210	217	0	0	154	210	217	0	0	0
1.660	Central Ave Bridge												
1.600	0	0	154	210	217	0	0	154	210	217	0	0	0
1.500	0	0	154	210	217	0	0	154	210	217	0	0	0
1.400	OK Highway 10 Bridge												
1.300	0	0	154	210	217	0	0	154	210	217	0	0	0
1.000	0	0	154	210	217	0	0	154	210	217	0	0	0
0.700	0	0	154	210	217	0	0	154	210	217	0	0	0
0.300	0	0	154	210	217	0	0	154	210	216	0	0	0
0.041	0	0	154	210	217	0	0	154	210	216	0	0	0
0.000	Downstream end of Tar Creek												

1 Max increase in duration for the simulated inflow event listed. Baseline operations duration is subtracted from anticipated operations duration to assess the impact of anticipated operations.

APPENDIX I:
SUPPORTING MAPS FOR OTHER STUDIES

Due to the size of map files, maps are included as a set of separate PDFs.