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Nick Hollister  
Senior Operations Manager, North

June 23, 2021

*Via Electronic Filing*

Ms. Kimberly D. Bose, Secretary  
Federal Energy Regulatory Commission  
888 First Street, N.E.  
Washington, DC 20426

Re: FirstLight MA Hydro LLC, Turners Falls Hydroelectric Project (FERC No. 1889)  
Northfield Mountain LLC, Northfield Mountain Pumped Storage Project (FERC No. 2485).  
Response #3 to FERC January 14, 2021 Letter Regarding Additional Information Requests

Dear Secretary Bose:

On December 4, 2020, FirstLight MA Hydro LLC, owners of the Turners Falls Hydroelectric Project (Turners Falls Project, FERC No. 1889) and Northfield Mountain LLC, owners of the Northfield Mountain Pumped Storage Project (Northfield Mountain Project, FERC No. 2485) filed with the Federal Energy Regulatory Commission (FERC) Amended Final License Applications (AFLA) for the two projects.

### Background

On January 14, 2021, FERC issued separate letters to FirstLight MA Hydro LLC and Northfield Mountain LLC requesting the Licensees (collectively FirstLight) address deficiencies and additional information requests (AIRs) for each Project. On March 15, 2021, FirstLight filed its response to the deficiencies and most AIRs. In its March 15, 2021 letter, FirstLight noted that responses to the AIRs listed below required information on energy impacts, water levels, flows and Northfield Mountain pumping/generation volumes under FirstLight's AFLA operating proposal.

- TF AIR#4 and NFM AIR#3: FERC requested FirstLight quantify the annual energy impact due to various operating conditions (bypass flows, ramping rates, etc.) included in its AFLAs under proposed operations.
- TF AIR#5: FERC requested FirstLight provide simulated hourly water surface elevations in the Turners Falls Impoundment, flows in the bypass reach, and flow and water surface elevations below Cabot Station under baseline and proposed operations.
- TF AIR#13: FERC requested FirstLight provide water level duration curves at sensitive plant locations under proposed operations.
- TF AIR#14: FERC requested FirstLight to explain how proposed operations would affect special status plants.

- NFM AIR#4: FERC requested FirstLight provide estimated weekly and monthly pumping volume under proposed operations.

As explained in the March 15 letter, in FirstLight's analyses within the AFLA it had to make assumptions relative to Great River Hydro's (GRH)<sup>1</sup> proposed operation of its Wilder, Bellows Falls and Vernon Projects. Upon reviewing GRH's AFLA licensing proposal, our assumptions were different than that proposed by GRH. In general, GRH proposes to operate its three projects where inflow equals outflow using +/-0.5 feet of storage and flexible operations. To provide meaningful responses to the bullet list of AIRs above, both FirstLight's and GRH's proposed operations would need to be evaluated collectively in one operations model.

On February 12, 2021, FERC requested GRH to file year-round hourly water surface elevations and flow releases at each project for current operations and simulated run-of-river operations (i.e., IEO) for the years 2009, 2015, 2016 and 2017 by March 15, 2021. On March 15, 2021, GRH filed the requested information.

On March 25, 2021, FirstLight filed a letter with FERC summarizing its concerns with using the four years of Vernon discharge data. Instead FirstLight proposed using its existing 1962-2003 operations model to simulate the Wilder, Bellows Falls and Vernon Projects as proposed by GRH. The proposed approach had the benefit of evaluating conditions over a 42-year period of record, versus four years, reflecting a wider range of hydrologic conditions.

FirstLight simulated GRH operations at its three projects two ways within its model- run of river (ROR)<sup>2</sup> and as peaking facilities with +/-0.5 feet of storage. Where applicable, the attached AIR responses provide two sets of results reflecting the two modes of GRH operations- referred to throughout this response as GRH ROR and GRH Peaking.

If you have any questions regarding the enclosed, please do not hesitate to contact me at the telephone number on the cover sheet.

Respectfully,



Nick Hollister  
Senior Operations Manager, North

Attachments: Additional Information Request Responses for TF-AIR#4, TF-AIR#5, TF-AIR#13, TF-AIR#14, NFM-AIR#3, and NFM-AIR#4 (Note: FL responses to TF-AIR#13 and 14 were filed as privileged information due to sensitive plant information)

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<sup>1</sup> Great River Hydro has three hydroelectric projects located above the Turners Falls Project. In upstream to downstream order, they include Wilder, Bellows Falls and Vernon. The Vernon Project discharges into the Turners Falls Impoundment.

<sup>2</sup> Great River Hydro's flexible operations were not simulated in the FirstLight operations model.

## Turners Falls Project- Response to Additional Information Requests

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### TF-AIR#4

In section 9 of Exhibit D, FirstLight provides a list of proposed operational changes and their combined effects on annual generation (Table 9.0-1). For each proposed operational change (e.g., operate in accordance with operational flow regime; maintain continuous minimum flow), please note the associated effect on annual generation. This will allow staff to isolate effects of individual measures if resource agencies, stakeholders, or staff identify alternatives to the proposed measures that have different effects on annual generation.

### Response to TF#4

In its March 15, 2021 response to AIRs, FirstLight indicated the following: *“FirstLight’s operations proposal includes several operational changes including bypass flows, whitewater flows, base flows below Cabot Station, expanded use of the Upper Reservoir, rate of rise limitation in the Turners Falls Impoundment water level, peaking flow restrictions at Cabot Station, and up- and down-ramping restrictions at Cabot Station. Relative to breaking out the annual impact of generation due to the proposed changes FirstLight proposes to conduct the following to address TF-AIR#4:*

- *Quantify the annual impact on generation from whitewater and bypass flows releases.*
- *Quantify the shift in peak to off-peak annual generation due to base flows below Cabot, expanded use of the Upper Reservoir, rate of rise limitation in the Turners Falls Impoundment water level, and peaking flows restrictions at Cabot Station.*
- *The up- and down-ramping restrictions at Cabot Station may directly impact economics and does not change annual generation or peak/off peak generation. “*

As previously discussed, Great River Hydro (GRH) proposes to operate its three projects where inflow equals outflow using +/-0.5 feet of storage and flexible operations. The GRH Amended Final License Application (AFLA) states that *“Specifics regarding how to distinguish between flow adjustments for IEO<sup>3</sup> Operation and Flexible Operation for compliance purposes will be addressed in the operation compliance and monitoring plans (OCMPs) anticipated to be filed with the Commission.”* Since the OCMP was not available for review, it is currently unclear if GRH will implement a true run-of-river operation, or if these facilities will implement peaking operations within the +/-0.5 feet of storage. Due to this uncertainty in exactly how GRH will operate its facilities, and to capture the range of potential impact, FirstLight has evaluated both GRH operational scenarios (i.e., Run of River (ROR) and Peaking) for this AIR response.

The generation impacts were broken down into five categories, as described in [Table TF-AIR#4-1](#). FirstLight performed a series of operations model analyses which added operational conditions for each of these categories one at a time, thus building from the Baseline scenario (i.e., current operations) to FirstLight’s AFLA scenario. These scenarios were analyzed to determine the incremental impact at Northfield Mountain and Turners Falls (Cabot + Station No. 1) on total generation and the percent of the total generation occurring during peak hours. For purposes of this analysis peak hours were considered to be the 16-hour period from 7 AM to 11 PM. [Table TF-AIR#4-2](#) and [Table TF-AIR#4-3](#) identify these impacts assuming GRH operates in a ROR mode (GRH ROR) for Northfield Mountain and Turners Falls, respectively. [Table TF-AIR#4-4](#) and [Table TF-AIR#4-5](#) identify these impacts assuming GRH operates in

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<sup>3</sup> Inflow Equals Outflow.

a peaking mode within a +/- 0.5 feet band (GRH Peaking) for Northfield Mountain and Turners Falls, respectively.

**Table TF-AIR#4-1: Categorization of AFLA Proposed Operational Changes**

Impact Category	Description
GRH Operations	This category considers changes in operations at GRH’s Wilder, Bellows Falls, and Vernon Hydroelectric Projects from current peaking practices to either ROR (GRH ROR) or peaking within a +/- 0.5 feet band (GRH Peaking).
Northfield Mountain (NFM) Operations	<p>This category considers changes in operations at Northfield Mountain from its current operational water level range (i.e., 938 feet to 1,000.5 feet) to an expanded operational water level range (i.e., 920 feet to 1,004.5 feet). It is not possible to predict, with any certainty, whether increasing the Upper Reservoir storage capacity will result in more or less operation of Northfield Mountain. Northfield Mountain’s operation is a function of the cost of the energy to pump and the value of the energy when generating. These values vary hour to hour, day to day, and week to week.</p> <p>While on many days, the additional storage capability would likely not change the extent of pumped storage generation which is limited by system energy economics, on some other days, the system relies very heavily on pumped storage capability. Because it is not possible to predict whether increasing the Upper Reservoir storage will result in increased generation, the incremental change in generation relative to baseline was assumed to be 0 MWh.</p>
Bypass Flows	This category considers changes in flows not available for generation from current practices to AFLA proposed practices. The flows not available for generation include bypass reach requirements for environmental and recreational resources.
Cabot Operations	This category considers changes in operations at Cabot Station related to its minimum and maximum discharges. These changes include requirements for base loading a unit and restricting peaking for environmental resources.
Ramping	This category considers changes in operations at Northfield Mountain and Cabot related to the water level rate of change in the Turners Falls Impoundment as well as the flow rate of change downstream of Cabot.

**Table TF-AIR#4-2: Summary of Generation Impacts at Northfield Mountain Assuming GRH ROR**

Scenario <sup>1</sup>	Average Annual Total Generation (MWH)	Average Annual Peak Hours Generation (MWH)	Incremental Difference <sup>2</sup>			
			Average Annual Total Generation		Average Annual Peak Hours Generation	
			(MWH)	(%)	(MWH)	(%)
Baseline	938,197	925,588	-	-	-	-
GRH Operations	939,906	925,934	+1,709	+0.2%	+346	+0.0%
NFM Operations	939,906	981,166	0	0.0%	0	0.0%
Bypass Flows	939,906	981,175	0	0.0%	0	0.0%
Cabot Operations	939,906	981,179	0	0.0%	0	0.0%
Ramping	939,906	981,179	0	0.0%	0	0.0%

**Notes:**

1. The operating conditions for a given scenario build upon the conditions for all previously listed scenarios. For example, the Bypass Flows scenario includes conditions from the GRH Operations and Northfield Mountain Operations scenarios.
2. The incremental difference is the difference between that scenario and the previous scenario. For example, the incremental difference in Total Generation (MWH) for the Bypass Flows scenario is the difference between the Total Generation (MWH) in the Bypass Flows and Northfield Mountain Operations scenarios.

**Table TF-AIR#4-3: Summary of Generation Impacts at Turners Falls Assuming GRH ROR**

Scenario <sup>1</sup>	Average Annual Total Generation (MWH)	Average Annual Peak Hours Generation (MWH)	Incremental Difference <sup>2</sup>			
			Average Annual Total Generation		Average Annual Peak Hours Generation	
			(MWH)	(%)	(MWH)	(%)
Baseline	296,754	213,317	-	-	-	-
GRH Operations	296,564	214,530	-190	-0.1%	1,213	+0.6%
NFM Operations	296,564	214,530	0	0.0%	0	0.0%
Bypass Flows	265,501	193,100	-31,063	-10.5%	-21,430	-10.0%
Cabot Operations	265,448	192,589	-53	-0.0%	-511	-0.2%
Ramping	265,509	192,631	61	+0.0%	42	+0.0%

**Notes:**

3. The operating conditions for a given scenario build upon the conditions for all previously listed scenarios. For example, the Bypass Flows scenario includes conditions from the GRH Operations and Northfield Mountain Operations scenarios.
4. The incremental difference is the difference between that scenario and the previous scenario. For example, the incremental difference in Total Generation (MWH) for the Bypass Flows scenario is the difference between the Total Generation (MWH) in the Bypass Flows and Northfield Mountain Operations scenarios.

**Table TF-AIR#4-4: Summary of Generation Impacts at Northfield Mountain Assuming GRH Peaking using +/-0.5 feet of Storage**

Scenario <sup>1</sup>	Average Annual Total Generation (MWH)	Average Annual Peak Hours Generation (MWH)	Incremental Difference <sup>2</sup>			
			Average Annual Total Generation		Average Annual Peak Hours Generation	
			(MWH)	(%)	(MWH)	(%)
Baseline	938,197	925,588	-	-	-	-
GRH Operations	939,864	925,931	+1,667	+0.2%	+343	+0.0%
NFM Operations	939,864	925,931	0	0.0%	0	0.0%
Bypass Flows	939,864	925,931	0	0.0%	0	0.0%
Cabot Operations	939,864	925,931	0	0.0%	0	0.0%
Ramping	939,864	925,931	0	0.0%	0	0.0%

**Notes:**

1. The operating conditions for a given scenario build upon the conditions for all previously listed scenarios. For example, the Bypass Flows scenario includes conditions from the GRH Operations and Northfield Mountain Operations scenarios.
2. The incremental difference is the difference between that scenario and the previous scenario. For example, the incremental difference in Total Generation (MWH) for the Bypass Flows scenario is the difference between the Total Generation (MWH) in the Bypass Flows and Northfield Mountain Operations scenarios.

**Table TF-AIR#4-5: Summary of Generation Impacts at Turners Falls Assuming GRH Peaking using +/-0.5 feet of Storage**

Scenario <sup>1</sup>	Average Annual Total Generation (MWH)	Average Annual Peak Hours Generation (MWH)	Incremental Difference <sup>2</sup>			
			Average Annual Total Generation		Average Annual Peak Hours Generation	
			(MWH)	(%)	(MWH)	(%)
Baseline	938,197	925,588	-	-	-	-
GRH Operations	296,270	214,607	-484	-0.2%	1,290	0.6%
NFM Operations	296,270	214,607	0	0.0%	0	0.0%
Bypass Flows	265,265	193,108	-31,005	-10.4%	-21,499	-10.1%
Cabot Operations	265,383	192,540	+118	+0.0%	-568	-0.3%
Ramping	265,400	192,311	+17	+0.0%	-229	-0.1%

**Notes:**

1. The operating conditions for a given scenario build upon the conditions for all previously listed scenarios. For example, the Bypass Flows scenario includes conditions from the GRH Operations and Northfield Mountain Operations scenarios.
2. The incremental difference is the difference between that scenario and the previous scenario. For example, the incremental difference in Total Generation (MWH) for the Bypass Flows scenario is the difference between the Total Generation (MWH) in the Bypass Flows and Northfield Mountain Operations scenarios.

TF-AIR#5

*In section 3.3.2.2.1 of Exhibit E, FirstLight evaluates the effects of proposed changes to the operation of the project by comparing summaries for simulated water surface elevations (WSEL) and flows under the baseline and proposed project. These evaluations address changes in the Turners Falls impoundment WSEL, the Turners Falls bypassed reach flow, and the flow and WSEL downstream of Cabot Station. The time period for these summaries varies between location and parameter. The analysis for the reach downstream of Cabot Station excludes days with average flow at Montague of 18,000 cubic feet per second or more. To enable staff's evaluation of effects of the proposed project on Turners Falls impoundment WSEL, flow in the bypassed reach, and flow and WSEL downstream of Cabot Station, please provide the following for both current and proposed operations:*

- *Simulated hourly WSELs for the Turners Falls impoundment near Vernon dam, Pauchaug boat launch, Riverview boat launch, and at Turners Falls dam.*
- *Simulated hourly flows immediately downstream of Turners Falls dam, Station No. 1 discharge, total bypassed reach flow, Cabot Station discharge, and the Montague U.S. Geological Survey gage.*
- *Simulated hourly WSELs for river mile (RM) 118.508 (near Montague), RM 115.07, RM 112.36, RM 109.52, and RM 94.298 (Rainbow Beach).*

Response to TF-AIR#5

As noted in the cover letter, FirstLight is providing two sets of results to reflect GRH ROR and GRH Peaking operations. Three operations modeling runs were made as follows:

- Baseline Conditions (Baseline), where the FirstLight and GRH Projects (Wilder, Bellow Falls, and Vernon) were modeled as currently licensed;
- FirstLight Proposed Conditions as described in the AFLA with GRH Projects operated as ROR (FL AFLA with GRH ROR) as described in the response to TF-AIR#4; and
- FirstLight Proposed Conditions as described in the AFLA with GRH Projects operated with limited peaking (FL AFLA with GRH Peaking) utilizing +/- 0.5 foot of storage as described in the response to TF-AIR#4.

Attached as separate Excel files, are the following:

- Modeled hourly WSELs from the hydraulic models for the period 1962-2003 at the four locations in the Turners Falls Impoundment (TFI) (*Bullet 1*), and the five locations downstream of Cabot Station under low and high Holyoke downstream boundary conditions (*Bullet 3*). The filenames are below:

<b>Filename</b>	<b>Contents</b>
Near Vernon WSEL Raw Hourly.xlsx	Hourly WSEL data below Vernon
Pauchaug WSEL Raw Hourly.xlsx	Hourly WSEL data at Pauchaug
Riverview WSEL Raw Hourly.xlsx	Hourly WSEL data at Riverview
TFD WSEL Raw Hourly.xlsx	Hourly WSEL data at Turners Falls Dam
118.508 Raw Hourly WSELs.xlsx	Hourly WSEL at Transect 118.508 under high and low Holyoke

Filename	Contents
115.07 Raw Hourly WSELs.xlsx	Hourly WSEL at Transect 115.07 under high and low Holyoke
112.36 Raw Hourly WSELs.xlsx	Hourly WSEL at Transect 112.36 under high and low Holyoke
109.52 Raw Hourly WSELs.xlsx	Hourly WSEL at Transect 109.52 under high and low Holyoke
94.298 Raw Hourly WSELs.xlsx	Hourly WSEL at Transect 94.298 under high and low Holyoke (Rainbow Beach)

- Modeled hourly flow data from the operations model for the five requested locations (*Bullet 2*). See filenames are below:

Filename	Contents
TFD Discharge.xlsx	Hourly Turners Falls Dam Discharge
Station No. 1 Discharge.xlsx	Hourly Station No. 1 Discharge
Total Bypass Flow.xlsx	Hourly Total Bypass Flow (all bypass flow upstream of Cabot Discharge)
Cabot Discharge.xlsx	Hourly Cabot Discharge
Montague Flow.xlsx	Hourly flow at the Montague Gage

*Bullet 1- Simulated hourly WSELs for the Turners Falls impoundment near Vernon dam, Pauchaug boat launch, Riverview boat launch, and at Turners Falls dam.*

In addition to the raw data files requested by FERC, FirstLight created monthly WSEL duration curves based on hourly data comparing Baseline, FL AFLA with GRH ROR, and FLA with GRH Peaking at the four locations in the TFI. The plots are included as [Appendix TF-AIR#5 TFI WSEL Duration Curves](#) for the following locations:

- WSEL Duration Curve Downstream of Vernon;
- WSEL Duration Curve near Pauchaug;
- WSEL Duration Curve near Riverview; and
- WSEL Duration Curve at Turners Falls Dam.

In addition, annual and monthly histograms showing the maximum daily change in WSEL under Baseline, FL AFLA with GRH ROR and FLA with GRH Peaking were developed for the same four locations. The plots are included as [Appendix TF-AIR#5 TFI Histograms](#).

*Bullet 3- Simulated hourly WSELs for river mile (RM) 118.508 (near Montague), RM 115.07, RM 112.36, RM 109.52, and RM 94.298 (Rainbow Beach).*

The hydraulic model below Cabot was run under Low and High Holyoke WSEL downstream boundary conditions (99.47 ft NGVD for low and 100.67 NGVD for high at the Holyoke Dam). FirstLight created annual and monthly WSEL duration curves based on hourly data comparing Baseline, FL AFLA with GRH ROR and AFLA with GRH Peaking at the five locations below Cabot Station on days when the average daily flows at Montague are 18,000 cfs or less. The plots are included as [Appendix TF-AIR#5-DS WSEL Duration Curves](#) for the following locations.

- \*River Mile 118.508 WSEL Duration Curve (Reach 4 near Montague);
- \*River Mile 115.07 WSEL Duration Curve (Reach 4);



- \*River Mile 112.36 WSEL Duration Curve (Reach 4);
- \*River Mile 109.52 WSEL Duration Curve (Reach 4); and
- \*\*River Mile 94.298 Rainbow Beach WSEL Duration Curve (Reach 5)- Low Holyoke.
- \*\*River Mile 94.298 Rainbow Beach WSEL Duration Curve (Reach 5)- High Holyoke.

\* The downstream boundary in the model has minimal impact on Reach 4 WSELs. Thus, for these locations the WSEL duration curves are based on Low Holyoke to indicate the maximum amount of WSEL changes under the different flow conditions.

\*\*The downstream boundary in the model does have an impact on Reach 5 WSELs, especially during lower flows. Thus, for the Rainbow Beach location two sets of WSEL duration curves were developed for both Low and High Holyoke.

In addition, annual and monthly histograms showing the maximum daily change in WSEL under Baseline, FL AFLA with GRH ROR and FLA with GRH Peaking were developed for the same five locations. The plots are included as [Appendix TF-AIR#5- DS Histograms](#).

*Bullet 2- Simulated hourly flows immediately downstream of Turners Falls dam, Station No. 1 discharge, total bypassed reach flow, Cabot Station discharge, and the Montague U.S. Geological Survey gage.*

Hourly output from the Operations Model for the Baseline, FL AFLA with GRH ROR, and FL AFLA with GRH Peaking were used to develop seasonal flow duration curves similar to those provided in Exhibit E of AFLA. The plots are included as [Appendix TF-AIR#5-Flow Duration Curves](#) for the following locations:

- Turners Falls Dam Spill Flow Duration Curve;
- Station No. 1 Discharge Duration Curve;
- Total Bypass Reach Flow Duration Curve (reflects bypass flow upstream of Cabot);
- Cabot Station Discharge Duration Curve; and
- Montague USGS gage Flow Duration Curve (includes total bypass flow, Cabot Station Discharge, and Deerfield River flow).

Response to TF-AIR#13:

Filed with FERC as privileged.

Response to TF-AIR#14:

Filed with FERC as privileged.

## **Northfield Mountain Project- Response to Additional Information Requests**

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### NFM-AIR#3

*In section 9 of Exhibit D, Northfield Mountain provides a list of proposed operational changes and their combined effects on annual generation (table 9.0-1). For each proposed operational change (e.g., operate in accordance with operational flow regime; maintain continuous minimum flow), please note the associated effect on annual generation. This will allow staff to isolate effects of individual measures if resource agencies, stakeholders, or staff identify alternatives to the proposed measures that may have different effects on annual generation.*

### Response to NFM-AIR#3

See Response to TF-AIR#4.

### NFM-AIR#4

*In section 3.3.2.2.1 of Exhibit E, Northfield Mountain proposes to operate the Northfield Mountain Project Upper Reservoir between elevation 1004.5 and 920 feet National Geodetic Vertical Datum of 1929 (NGVD29). Northfield Mountain evaluates the effects of the proposed changes relative to baseline conditions by using hourly data from the Operations Model to develop flow and elevation duration curves for the Turner Falls Impoundment. In section 3.3.1.8, Northfield Mountain provides approximate hydraulic capacities for the Northfield Mountain Project when operating in pumping mode and generation mode. To enable staff's evaluation of effects of the proposed project on fish entrainment at the Northfield Mountain Project, please provide estimated weekly and/or monthly pumping flow volumes for both current and proposed operations in a typical year.*

### Response to NFM-AIR#4

As previously discussed, FirstLight has evaluated both GRH ROR and GRH Peaking scenarios in the operations model. Therefore, anticipated monthly volumes for each scenario have been prepared for this AIR response. [Table NFM-AIR#4-1](#) provides the average monthly volumetric flow rate of water pumped by Northfield Mountain over the 42-year period of record analyzed (i.e. 1962 – 2003).

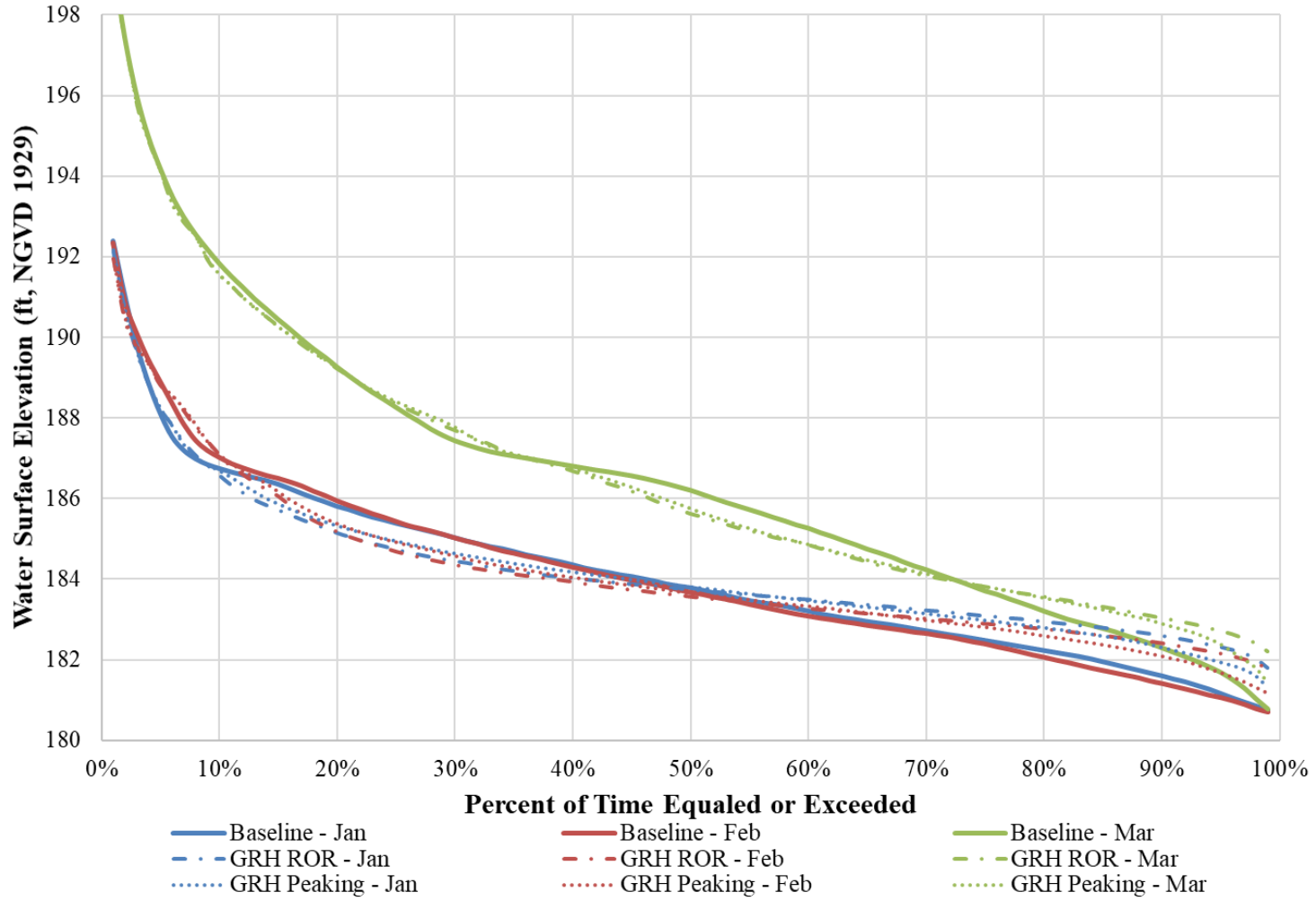
**Table NFM-AIR#4-1: Monthly Average Volumetric Rate of Water Pumped by Northfield Mountain**

Month	Baseline	FL AFLA (GRH ROR)		FL AFLA (Assumed GRH Peaking)	
	Average Pumping (cfs)	Average Pumping (cfs)	Difference from Baseline (cfs)	Average Pumping (cfs)	Difference from Baseline (cfs)
1	1,481	1,923	+442	1,923	+442
2	1,475	1,313	-162	1,313	-162
3	1,220	1,368	+148	1,367	+147
4	1,689	1,834	+145	1,834	+145
5	1,469	1,457	-12	1,458	-11
6	1,898	2,192	+294	2,187	+289
7	2,341	2,342	+1	2,346	+5
8	3,068	3,105	+37	3,103	+35
9	2,352	2,392	+40	2,392	+40
10	2,114	2,382	+268	2,383	+269
11	1,871	1,973	+102	1,973	+102
12	2,244	2,382	+138	2,382	+138

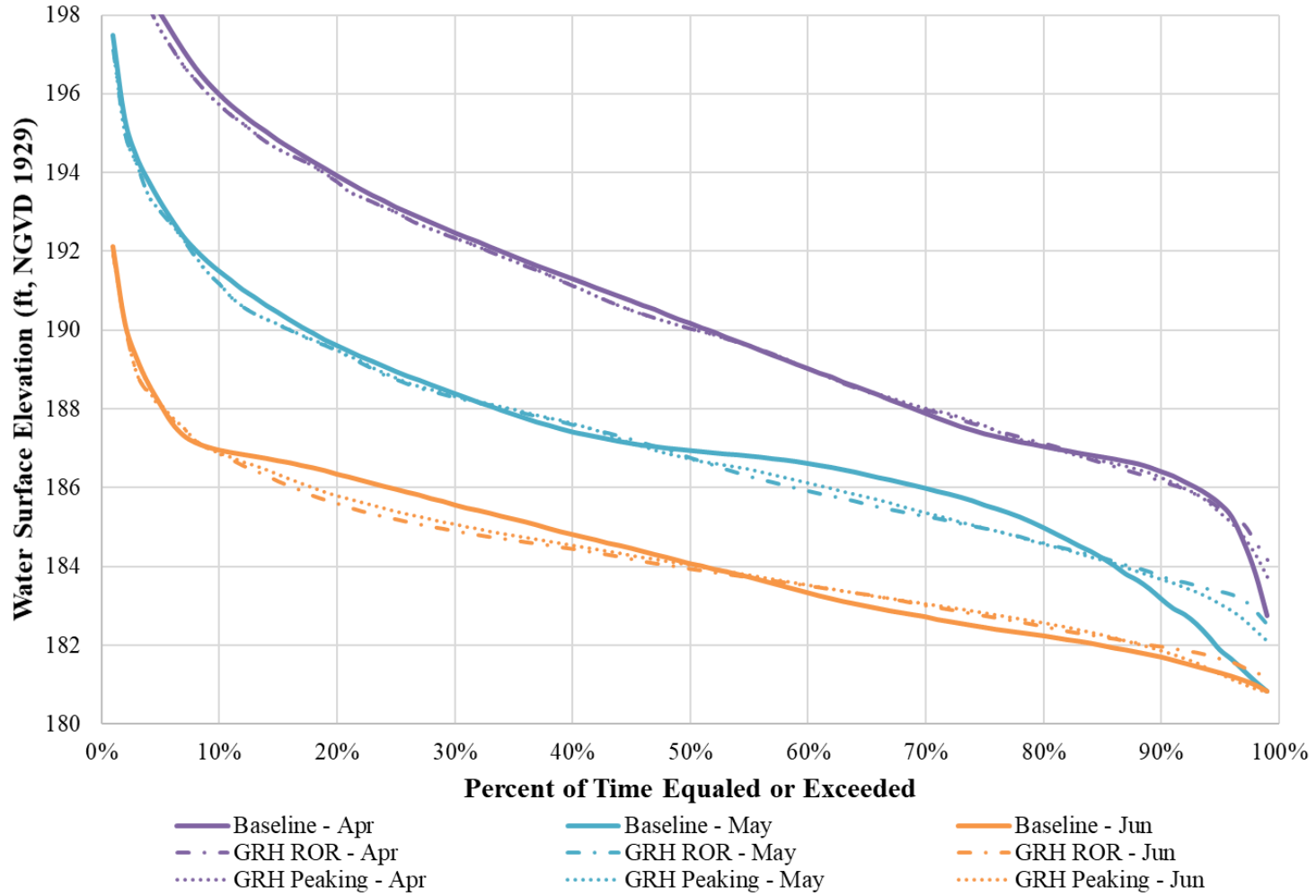
## **Appendix TF-AIR#5 TFI WSEL Duration Curves**

- WSEL Duration Curve Downstream of Vernon;
- WSEL Duration Curve near Pauchaug;
- WSEL Duration Curve near Riverview; and
- WSEL Duration Curve at Turners Falls Dam.

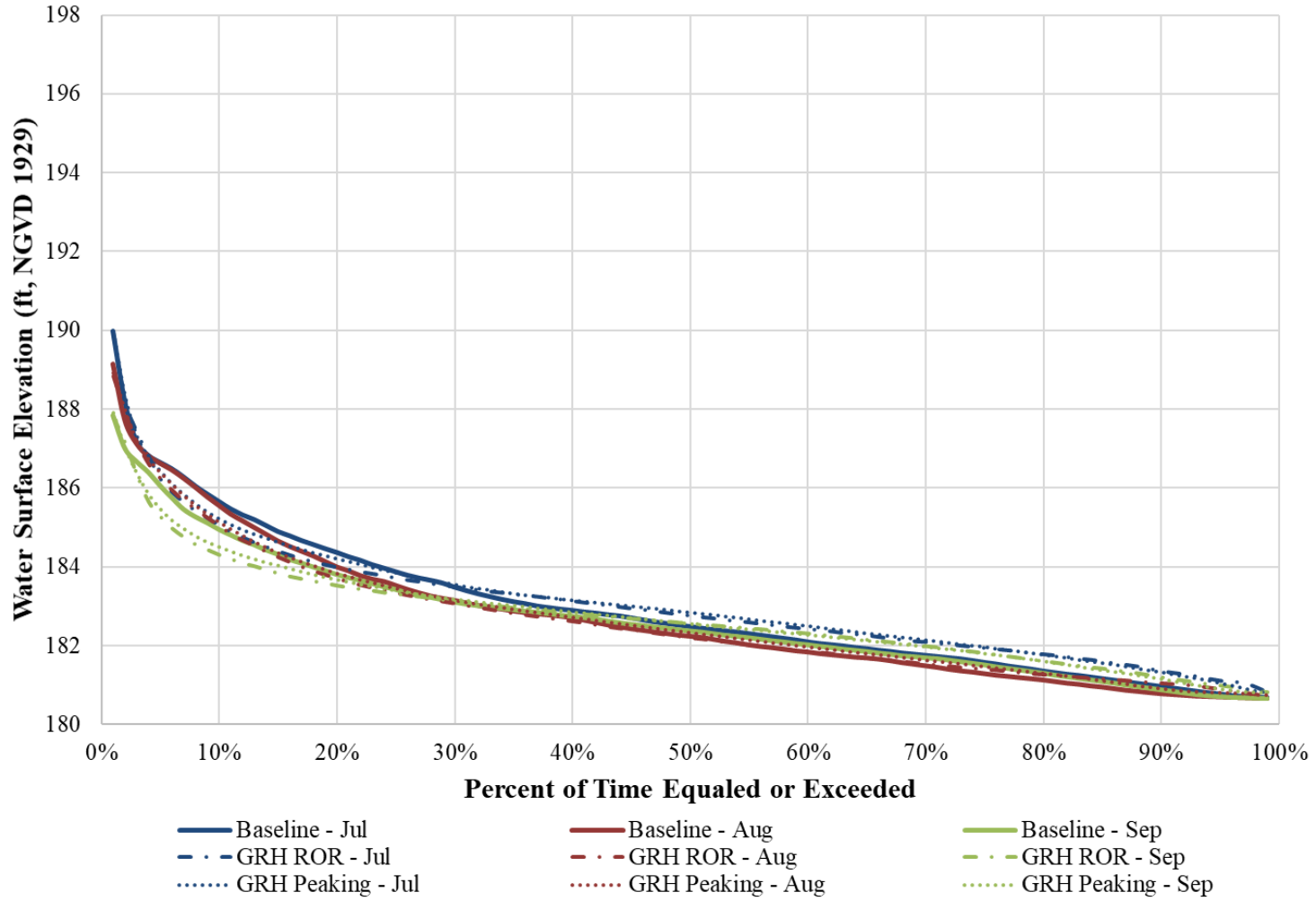
**Water Surface Elevations at HEC-RAS Station 104757 (Near Vernon)  
Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking**



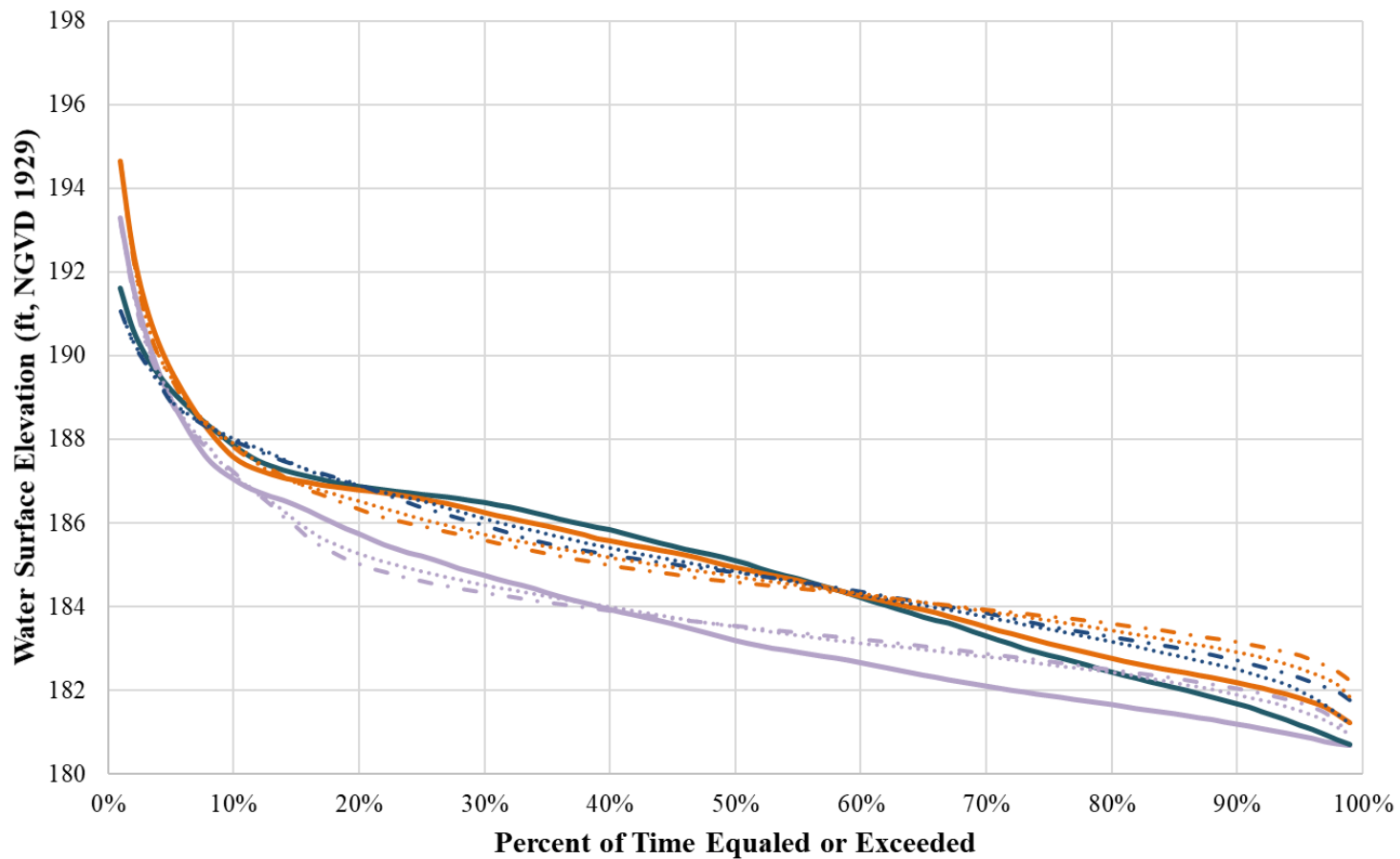
### Water Surface Elevations at HEC-RAS Station 104757 (Near Vernon) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking



### Water Surface Elevations at HEC-RAS Station 104757 (Near Vernon) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking



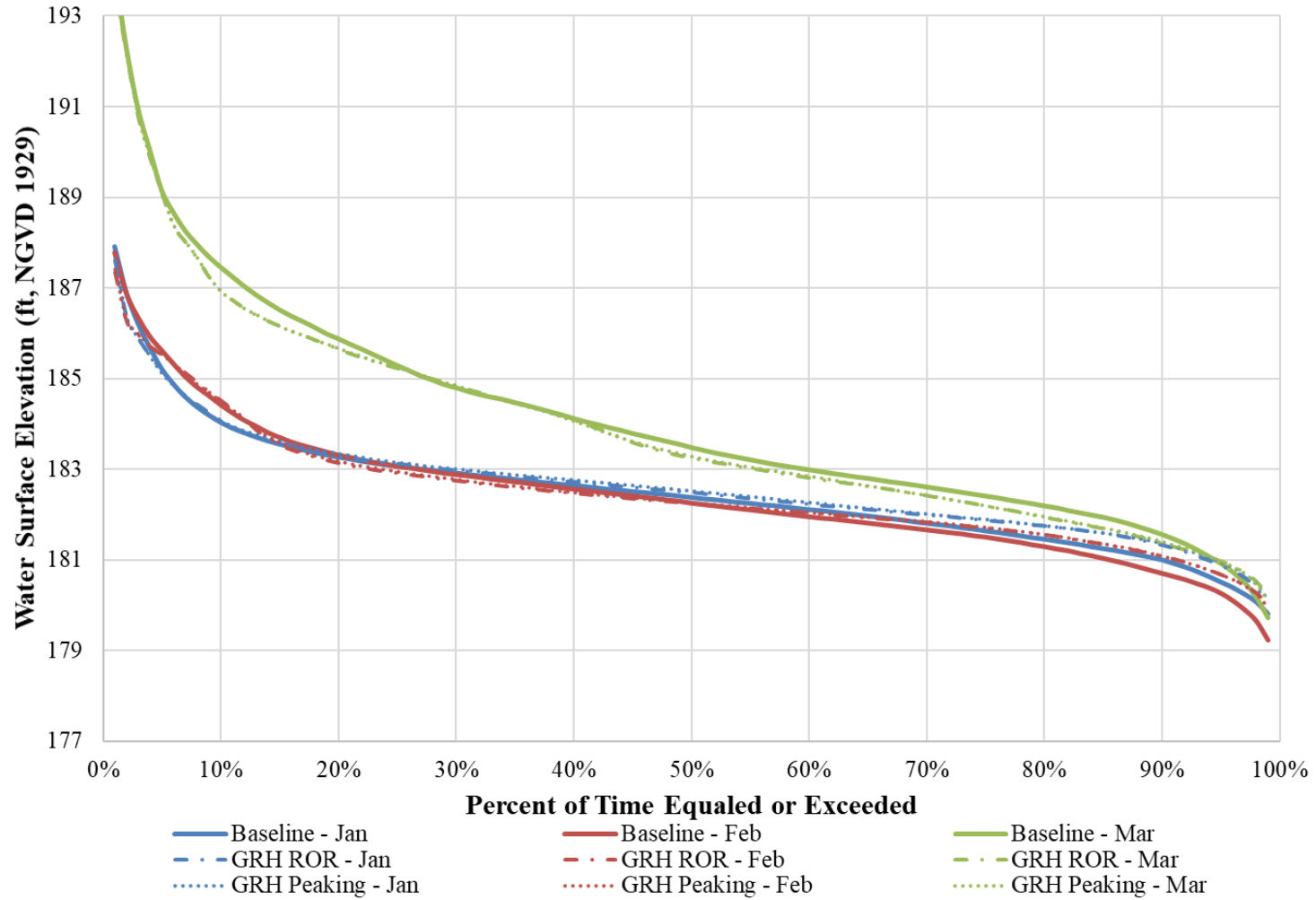
### Water Surface Elevations at HEC-RAS Station 104757 (Near Vernon) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking



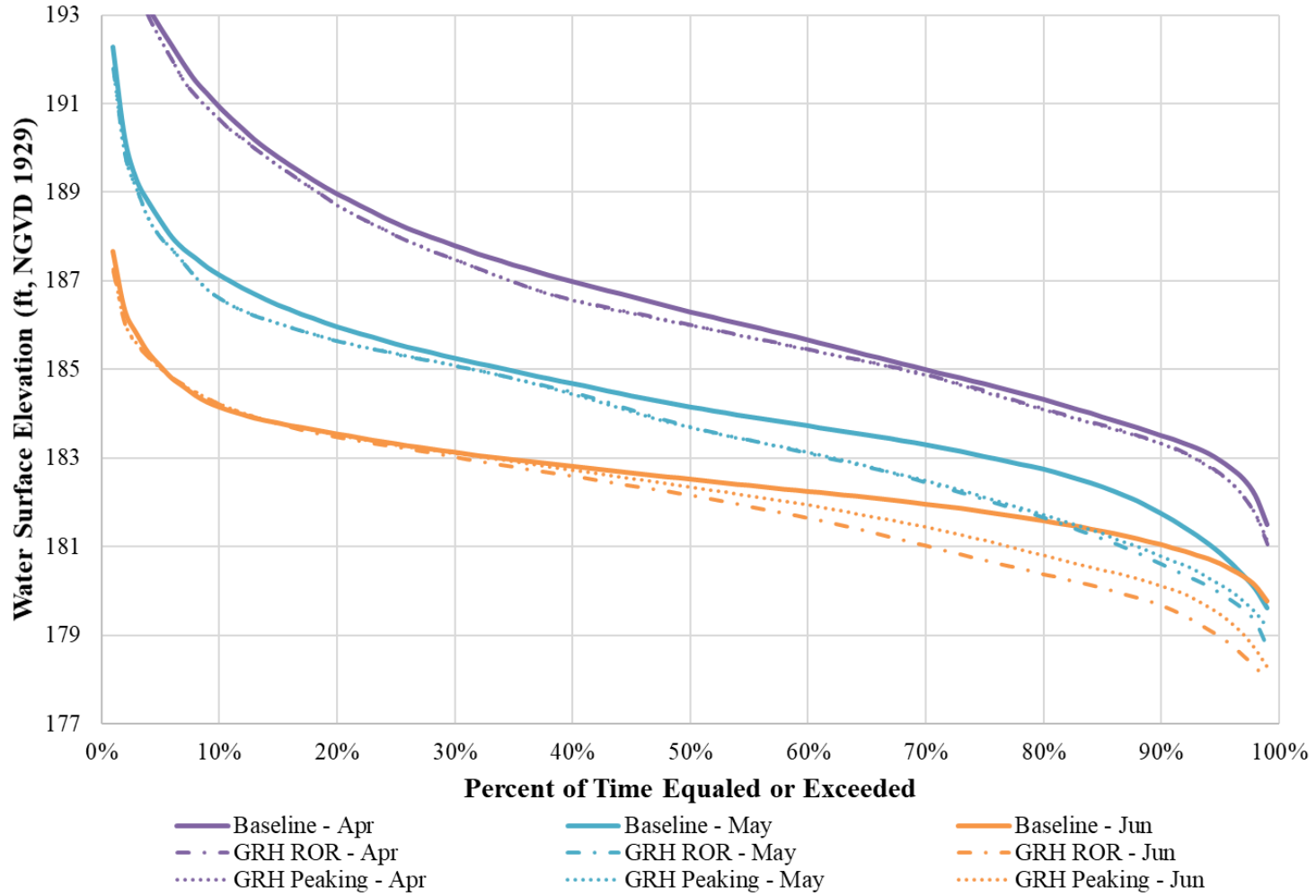
- Baseline - Oct
- Baseline - Nov
- Baseline - Dec
- - GRH ROR - Oct
- - GRH ROR - Nov
- - GRH ROR - Dec
- ... GRH Peaking - Oct
- ... GRH Peaking - Nov
- ... GRH Peaking - Dec



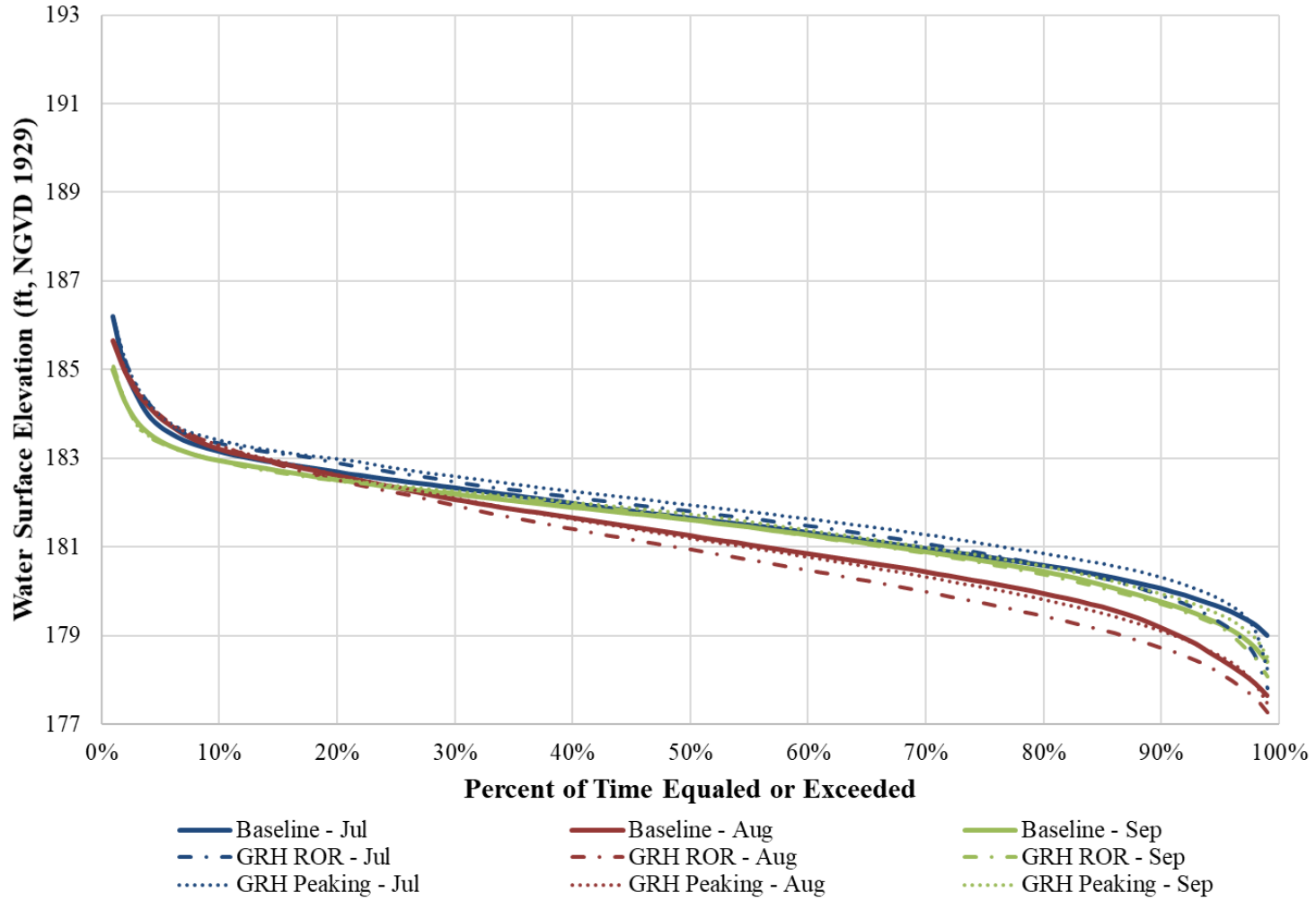
**Water Surface Elevations at HEC-RAS Station 70732 (Near Pauchaug)  
Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking**



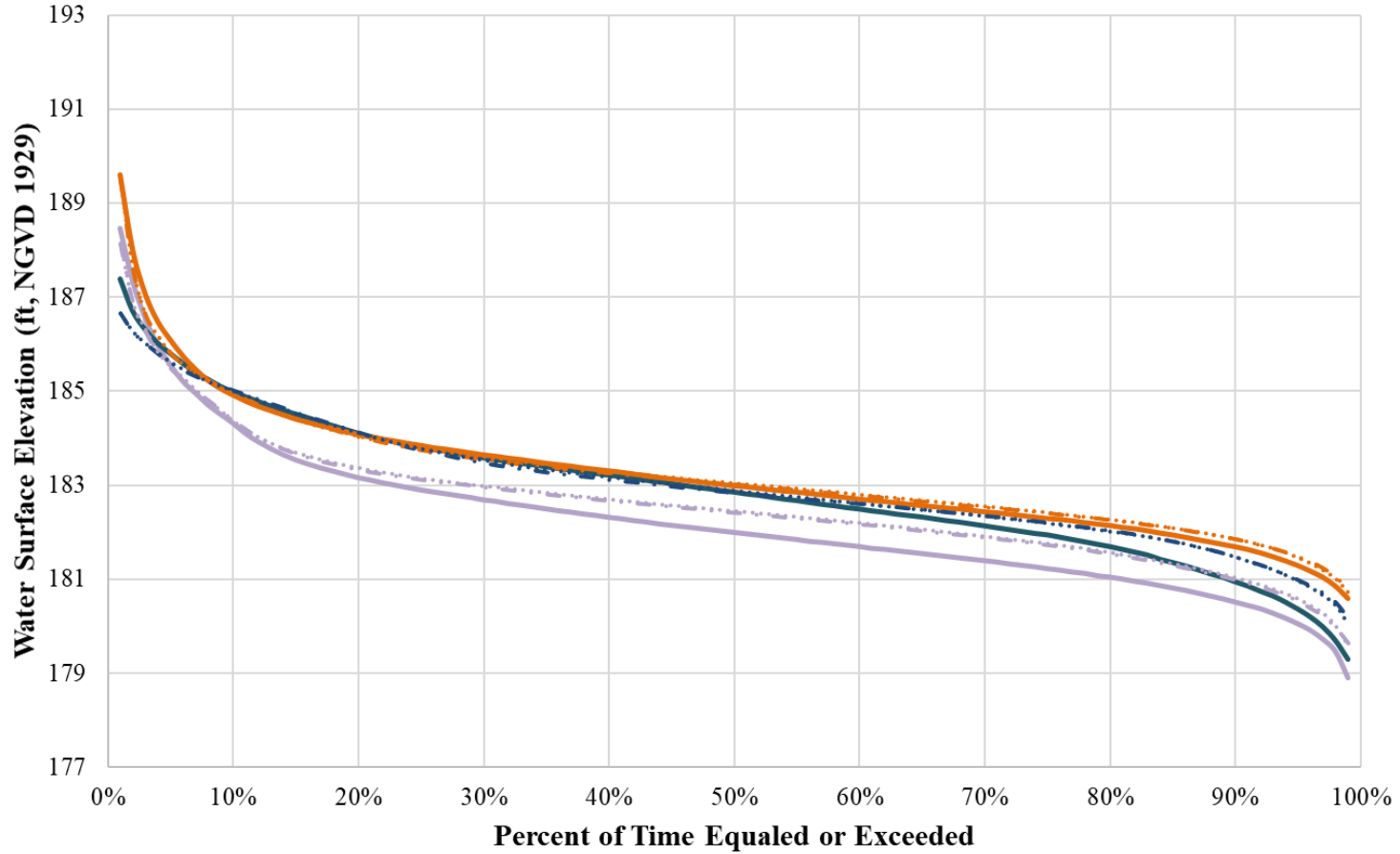
### Water Surface Elevations at HEC-RAS Station 70732 (Near Pauchaug) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking



### Water Surface Elevations at HEC-RAS Station 70732 (Near Pauchaug) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking

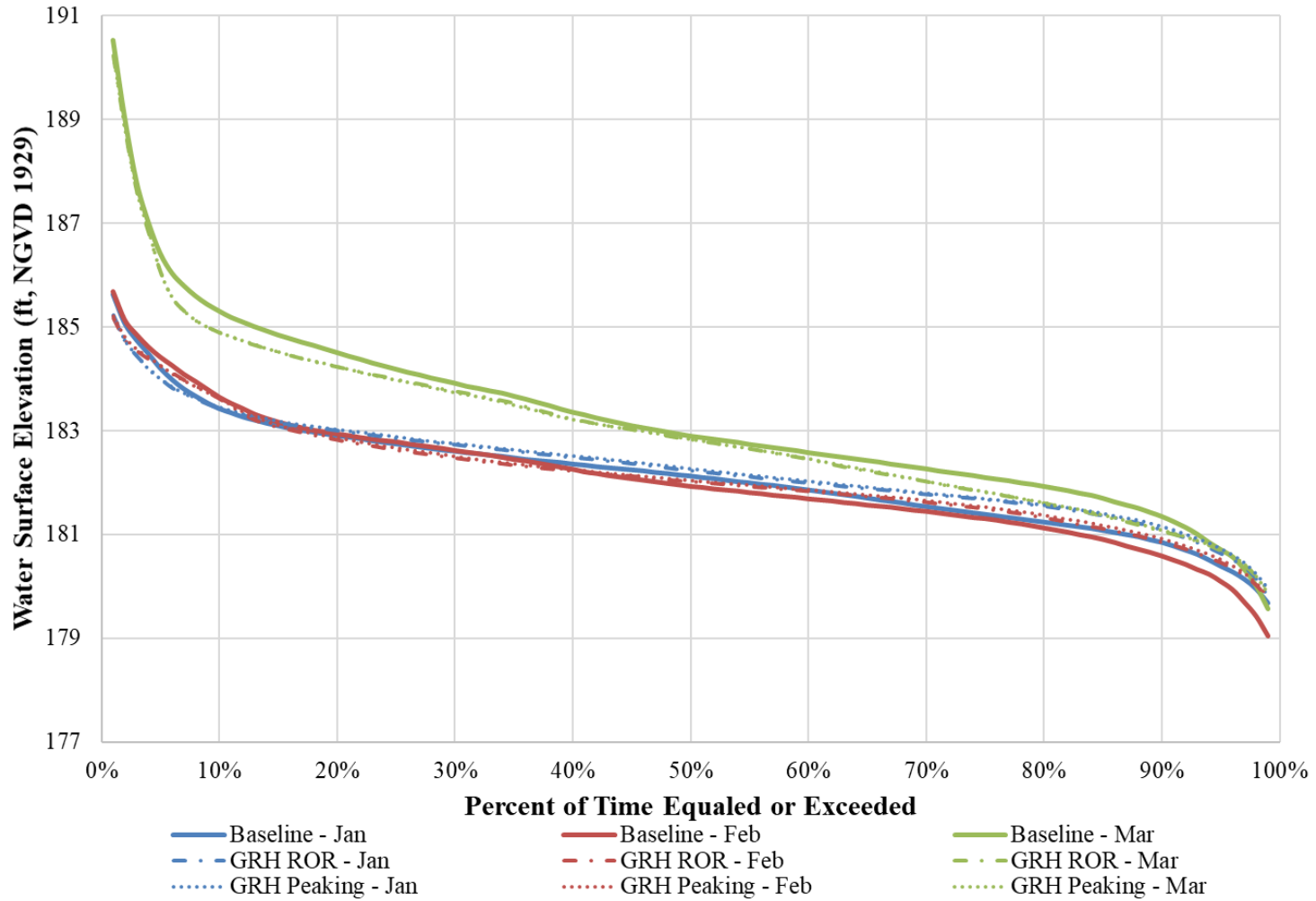


### Water Surface Elevations at HEC-RAS Station 70732 (Near Pauchaug) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking

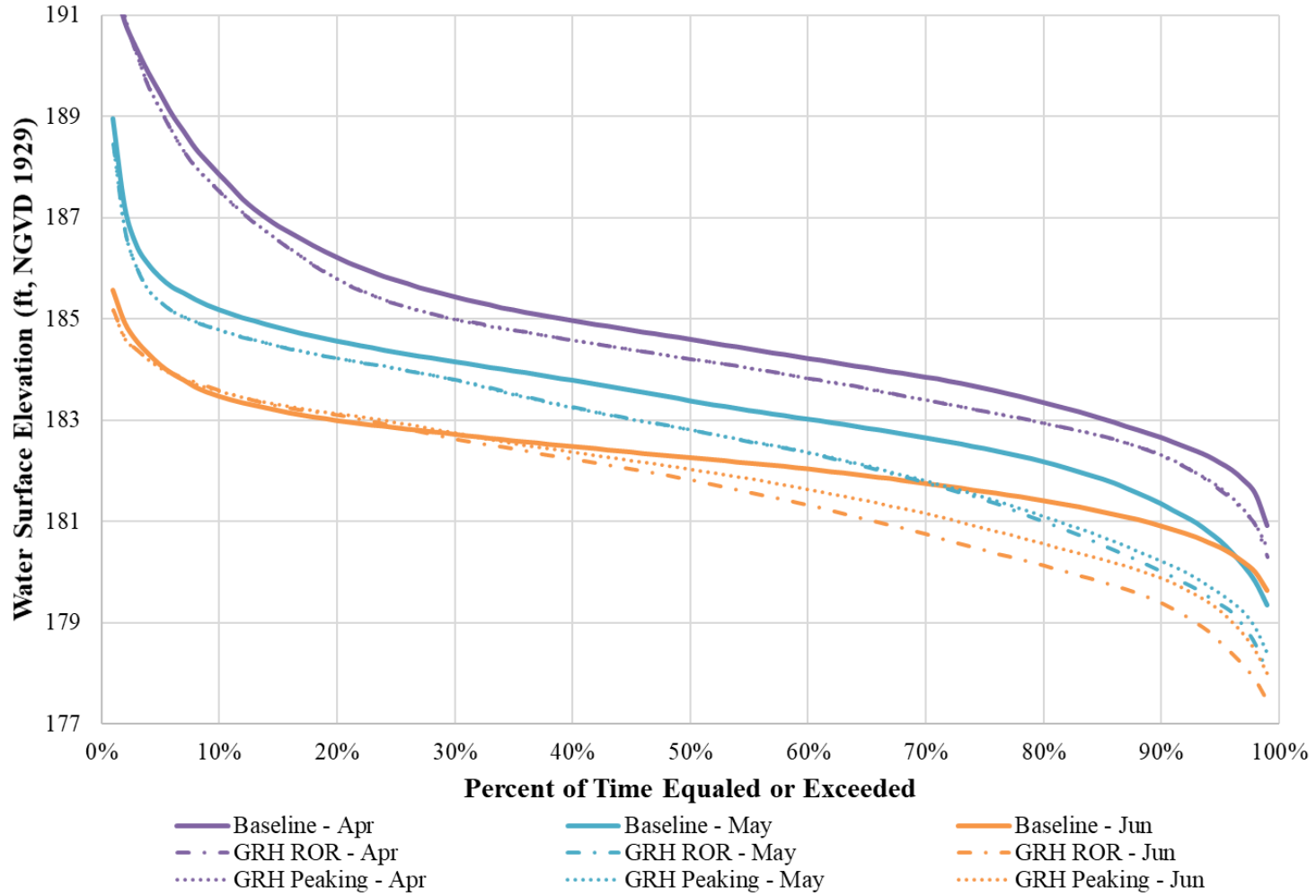


- Baseline - Oct
- GRH ROR - Oct
- GRH Peaking - Oct
- Baseline - Nov
- GRH ROR - Nov
- GRH Peaking - Nov
- Baseline - Dec
- GRH ROR - Dec
- GRH Peaking - Dec

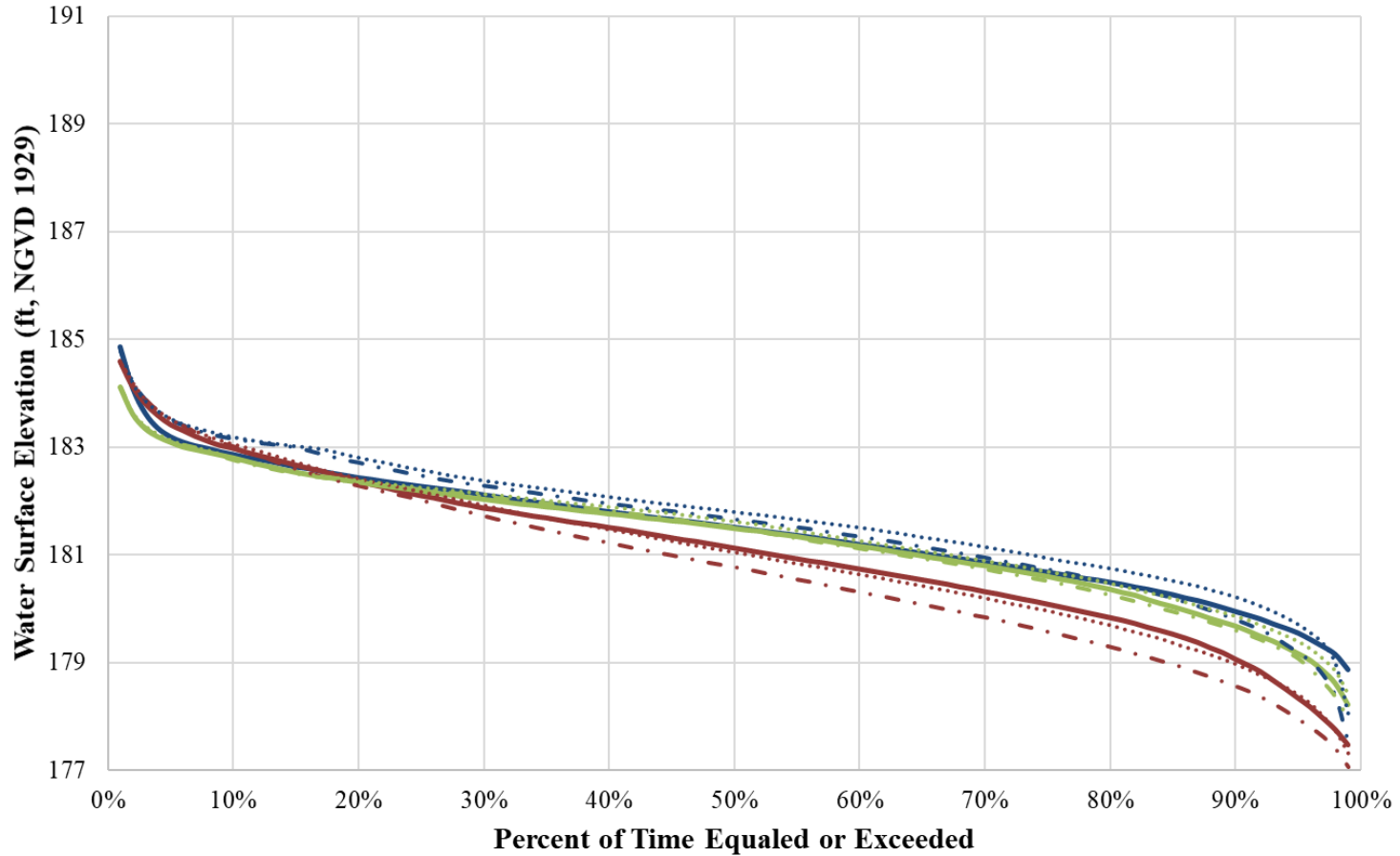
**Water Surface Elevations at HEC-RAS Station 27123 (near Riverview)  
Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking**



### Water Surface Elevations at HEC-RAS Station 27123 (near Riverview) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking

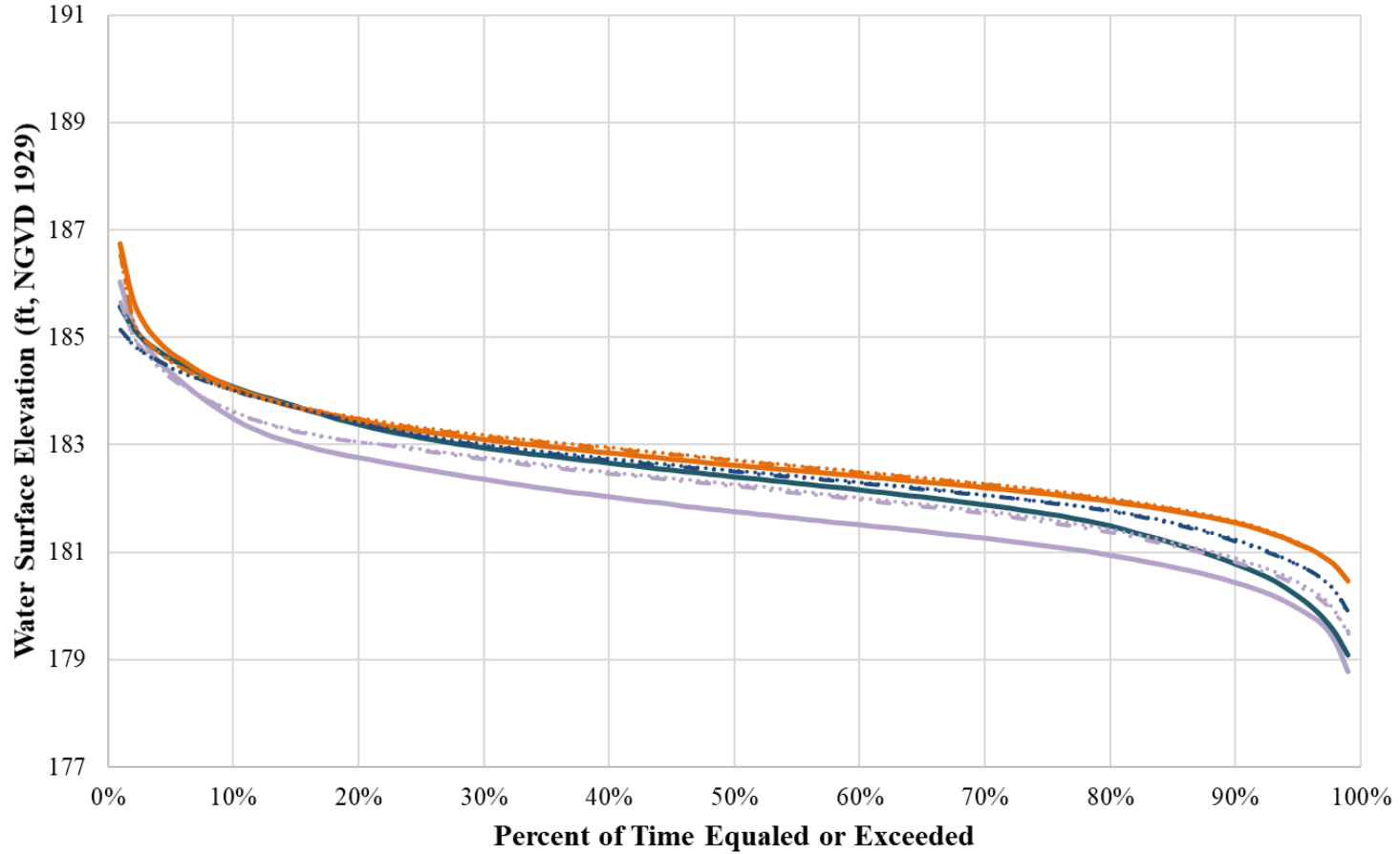


### Water Surface Elevations at HEC-RAS Station 27123 (near Riverview) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking



- Baseline - Jul
- - GRH ROR - Jul
- ..... GRH Peaking - Jul
- Baseline - Aug
- - GRH ROR - Aug
- ..... GRH Peaking - Aug
- Baseline - Sep
- - GRH ROR - Sep
- ..... GRH Peaking - Sep

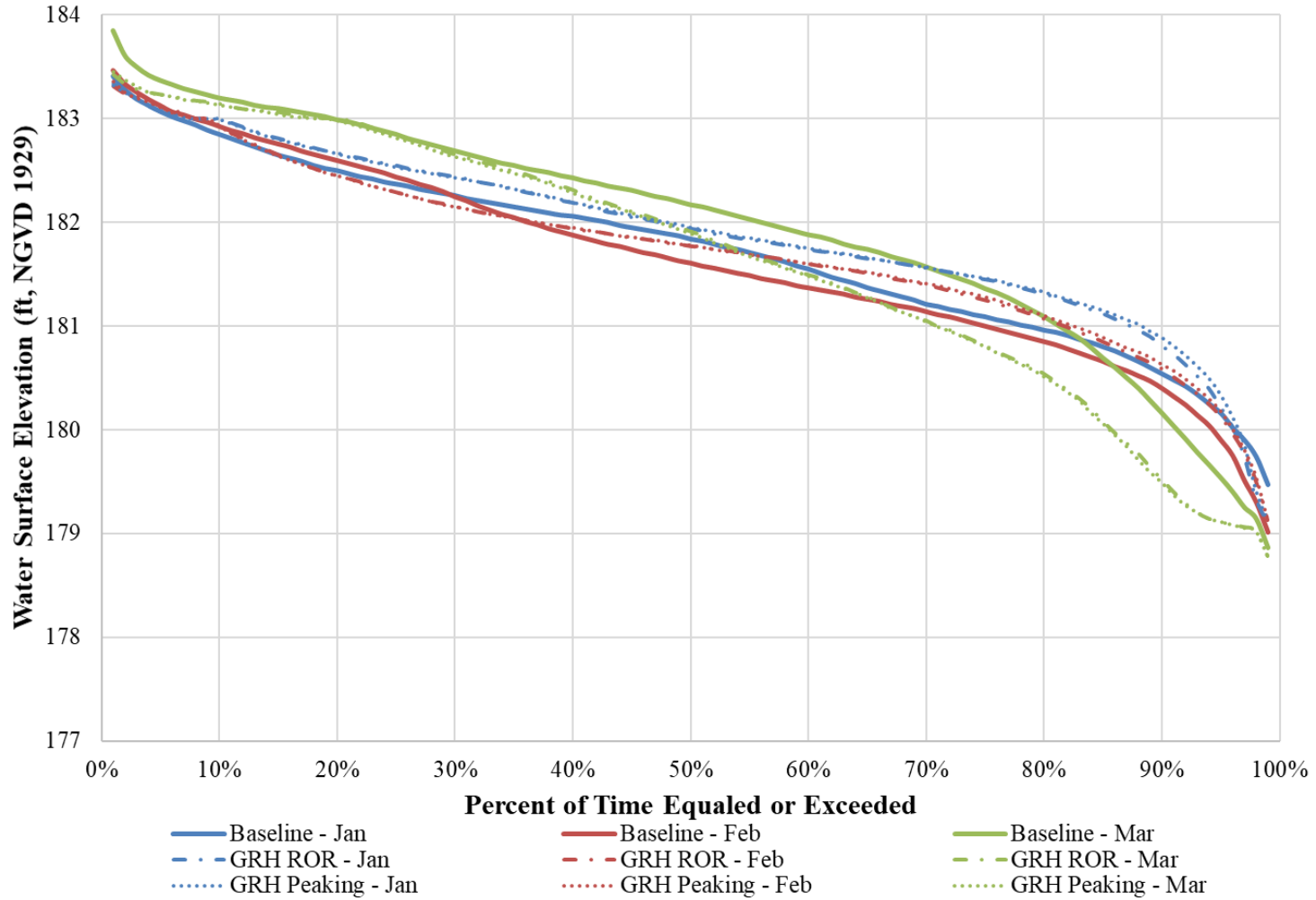
### Water Surface Elevations at HEC-RAS Station 27123 (near Riverview) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking



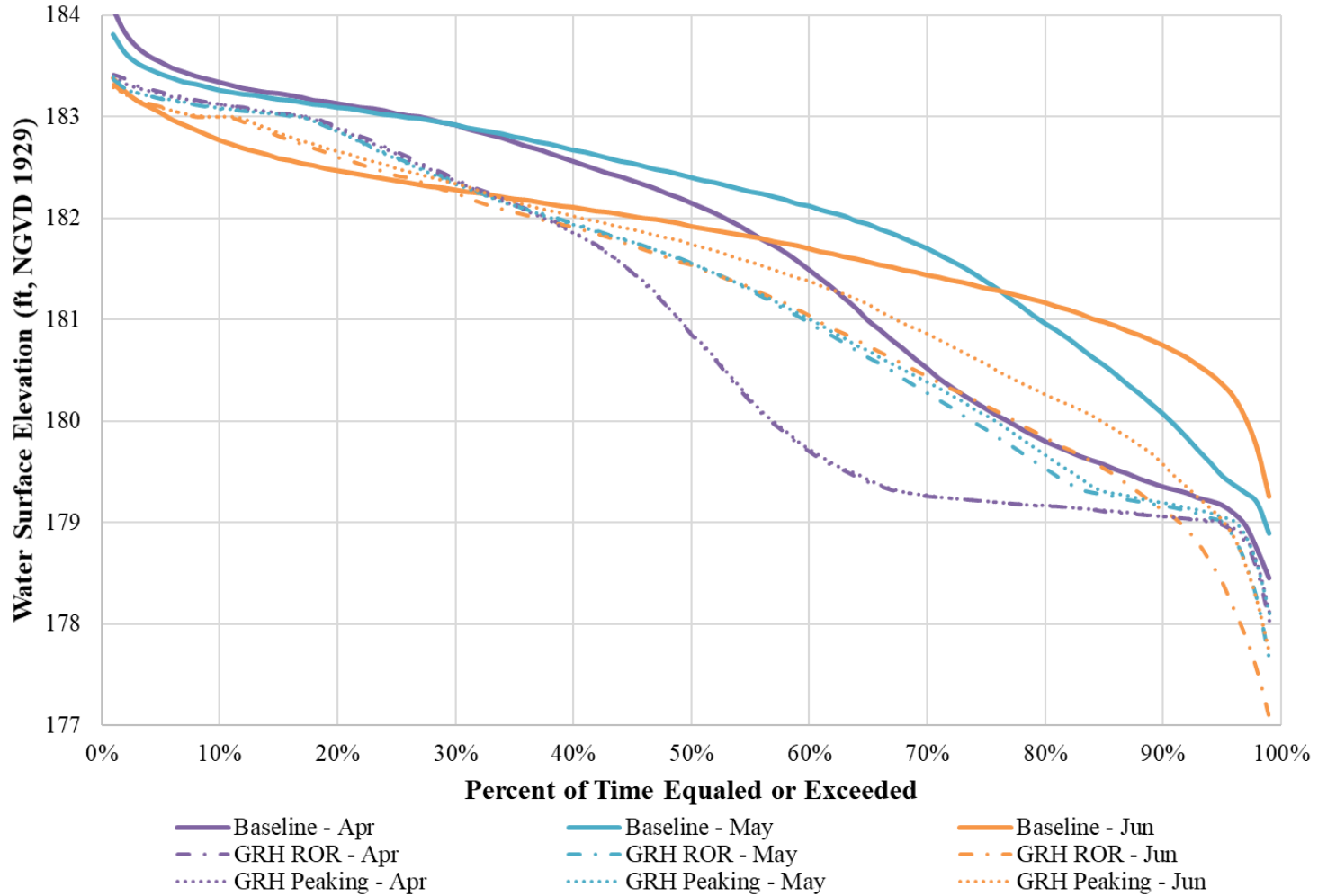
- Baseline - Oct
- GRH ROR - Oct
- GRH Peaking - Oct
- Baseline - Nov
- GRH ROR - Nov
- GRH Peaking - Nov
- Baseline - Dec
- GRH ROR - Dec
- GRH Peaking - Dec



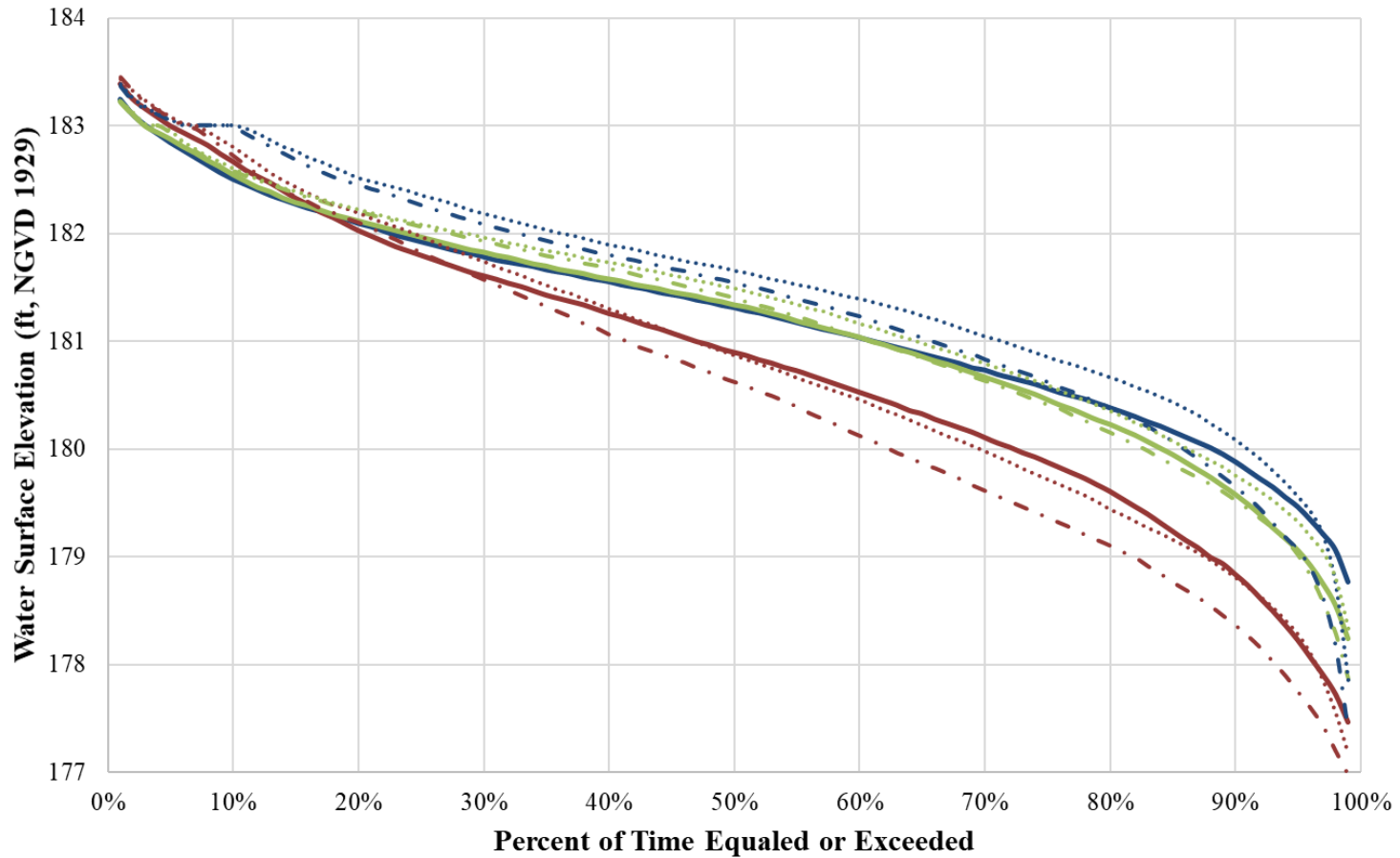
### Water Surface Elevations at Turners Falls Dam Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking



### Water Surface Elevations at Turners Falls Dam Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking

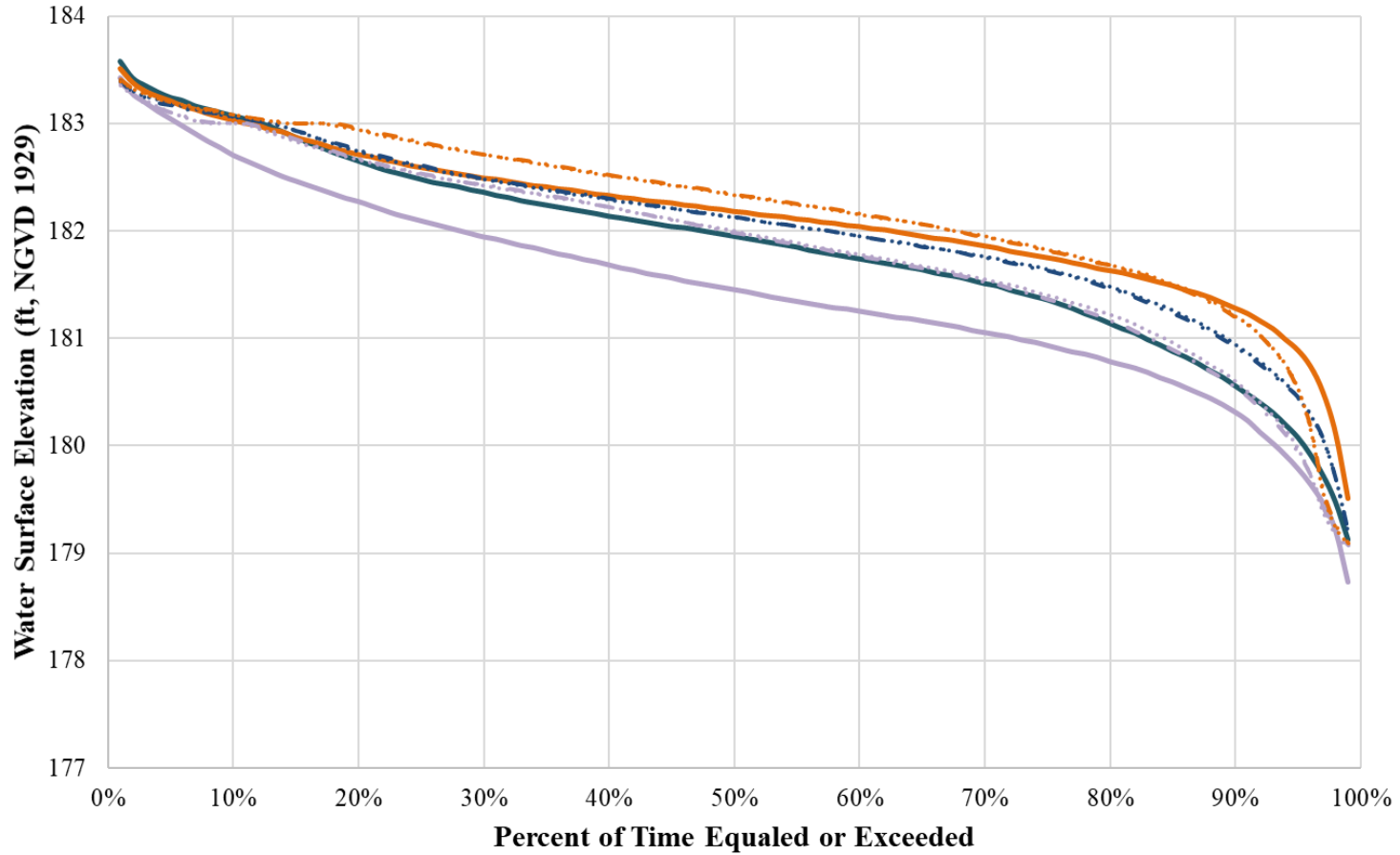


## Water Surface Elevations at Turners Falls Dam Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking



- |  |  |  |
|--|--|--|
| <ul style="list-style-type: none"> <li>— Baseline - Jul</li> <li>- - GRH ROR - Jul</li> <li>..... GRH Peaking - Jul</li> </ul> | <ul style="list-style-type: none"> <li>— Baseline - Aug</li> <li>- - GRH ROR - Aug</li> <li>..... GRH Peaking - Aug</li> </ul> | <ul style="list-style-type: none"> <li>— Baseline - Sep</li> <li>- - GRH ROR - Sep</li> <li>..... GRH Peaking - Sep</li> </ul> |
|--|--|--|

### Water Surface Elevations at Turners Falls Dam Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking

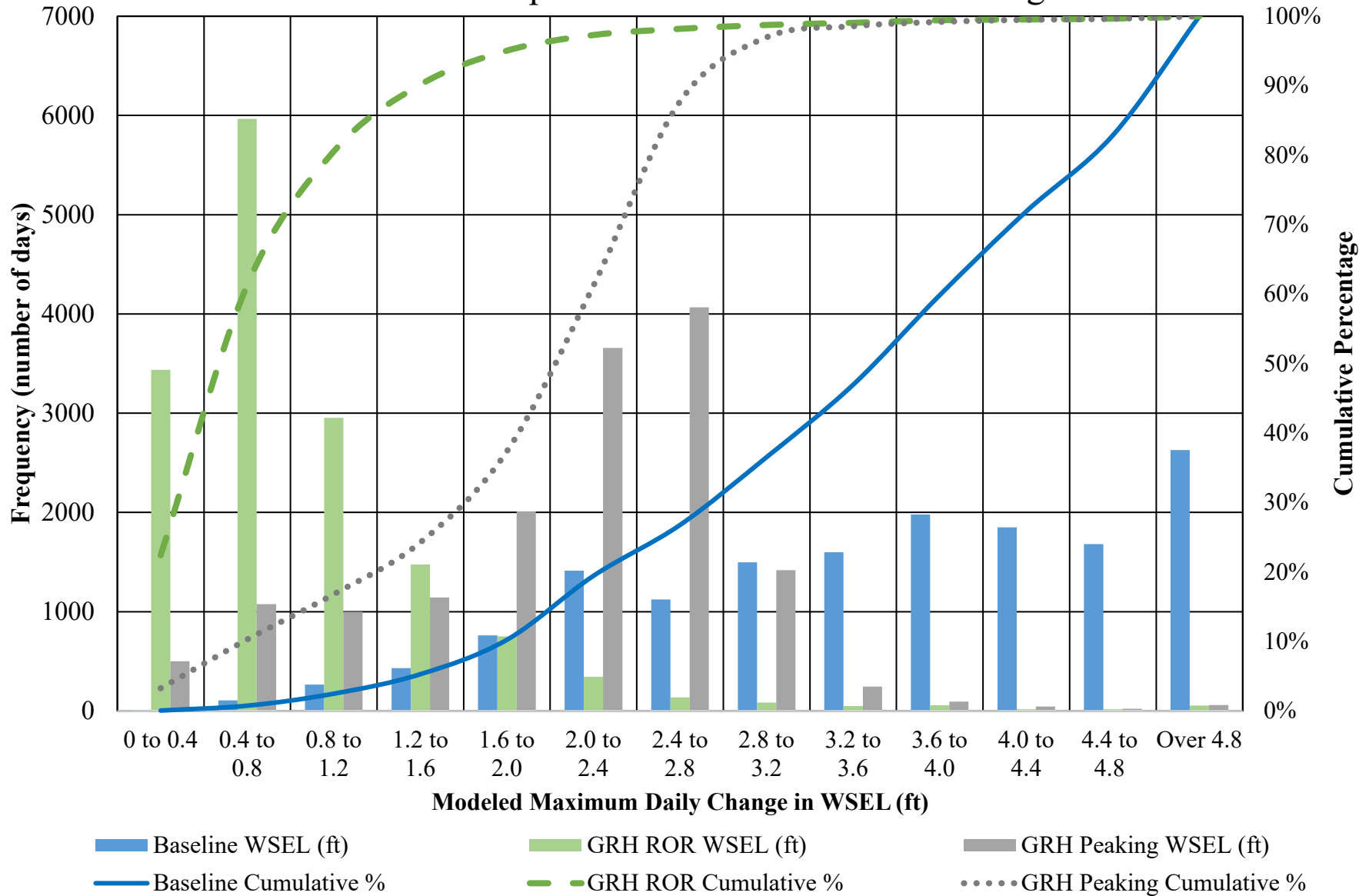


- |                         |                         |                         |
|-------------------------|-------------------------|-------------------------|
| — Baseline - Oct        | — Baseline - Nov        | — Baseline - Dec        |
| - - GRH ROR - Oct       | - - GRH ROR - Nov       | - - GRH ROR - Dec       |
| ..... GRH Peaking - Oct | ..... GRH Peaking - Nov | ..... GRH Peaking - Dec |

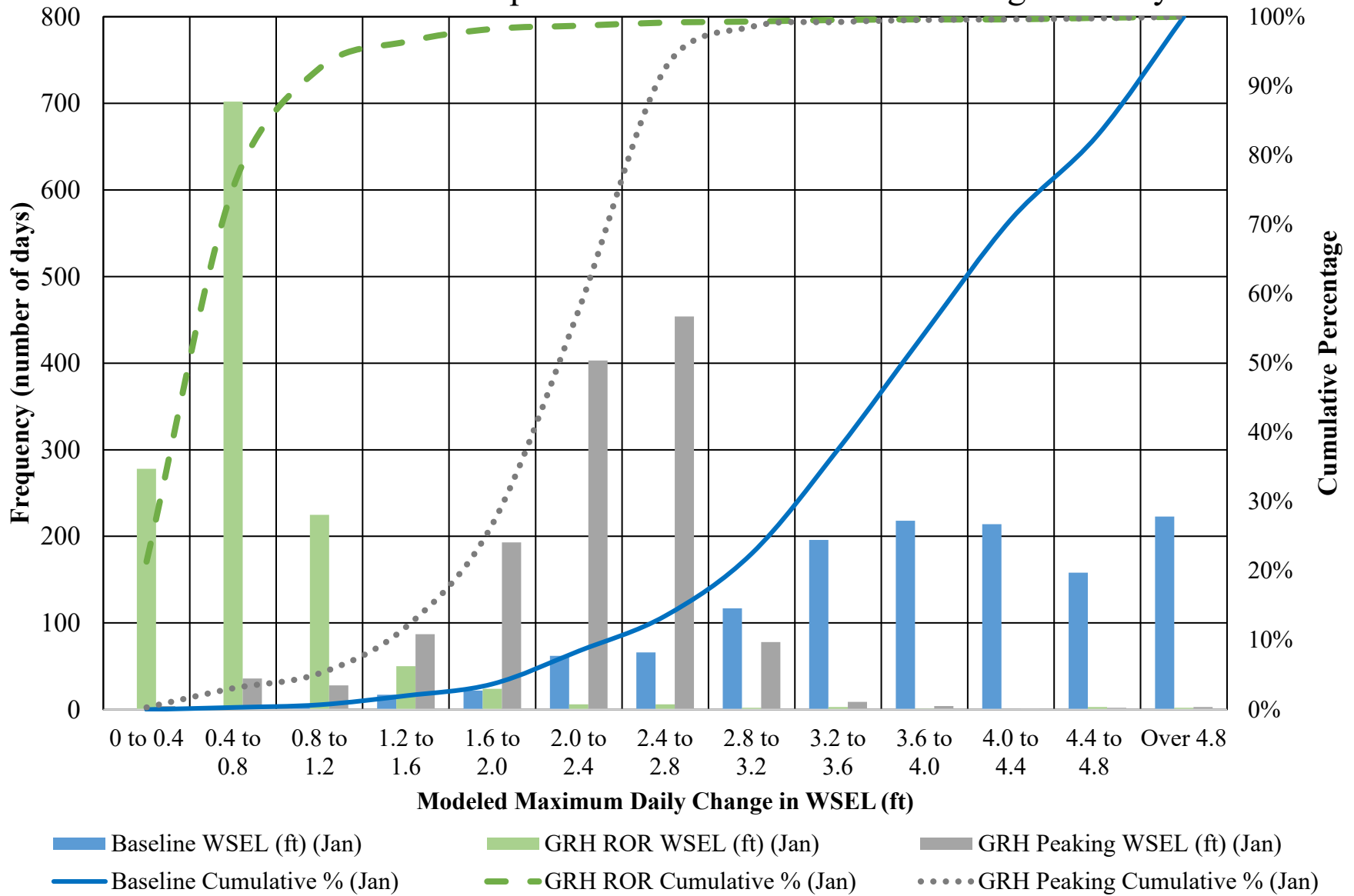
**Appendix TF-AIR#5 TFI Histograms.**

- WSEL Histogram Downstream of Vernon;
- WSEL Histogram near Pauchaug;
- WSEL Histogram near Riverview; and
- WSEL Histogram at Turners Falls Dam.

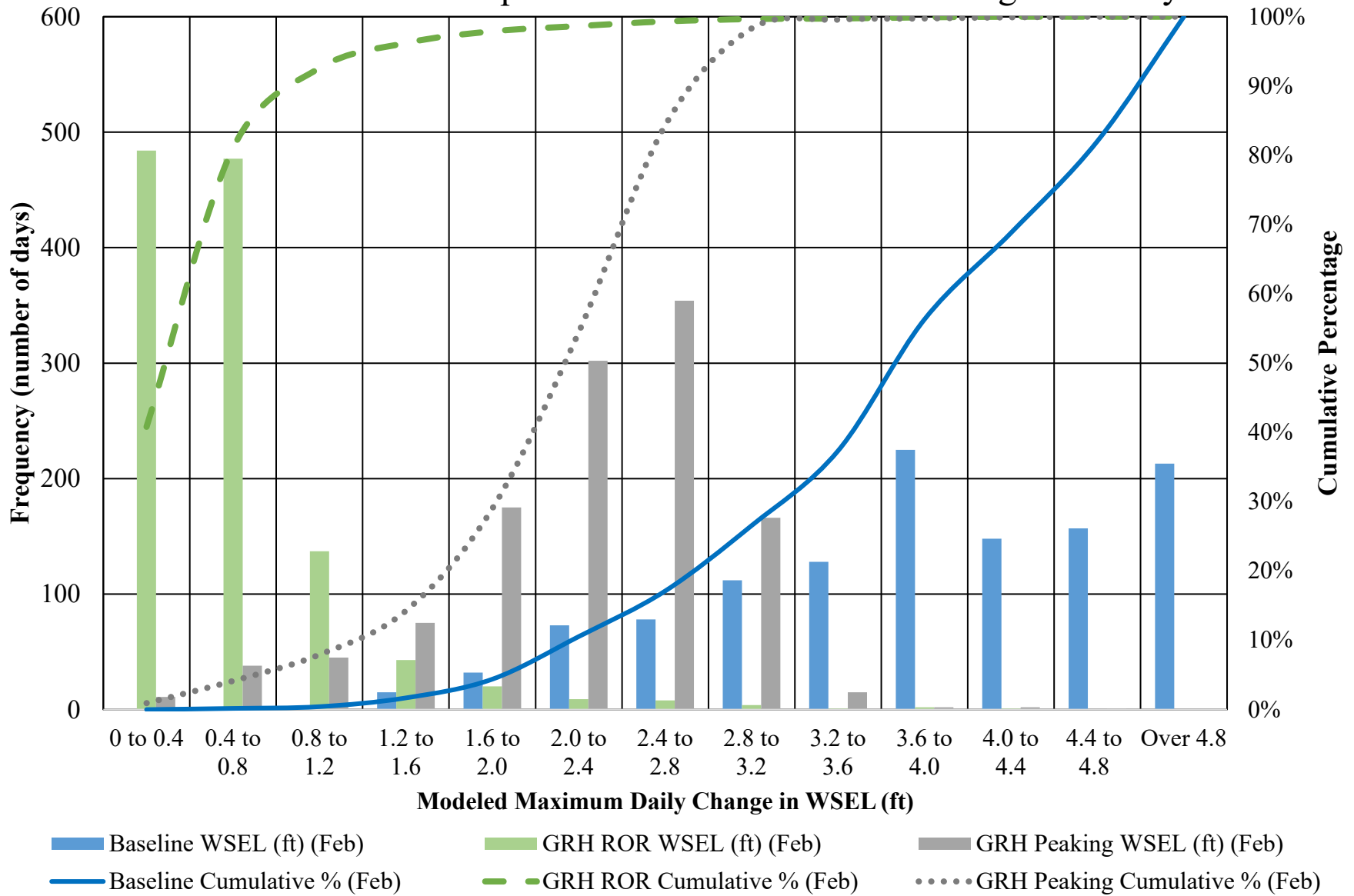
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - Annual



## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - January

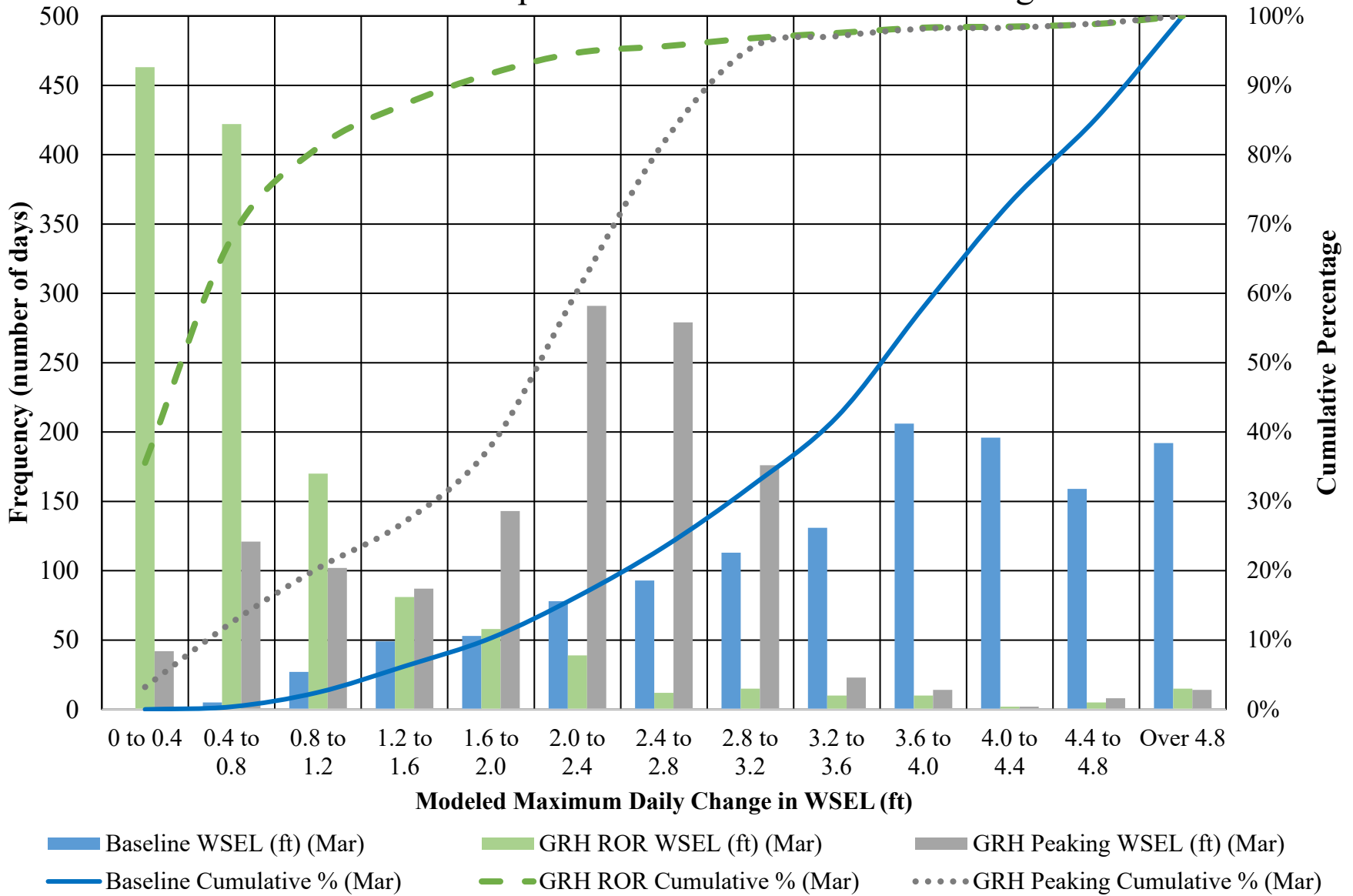


## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - February

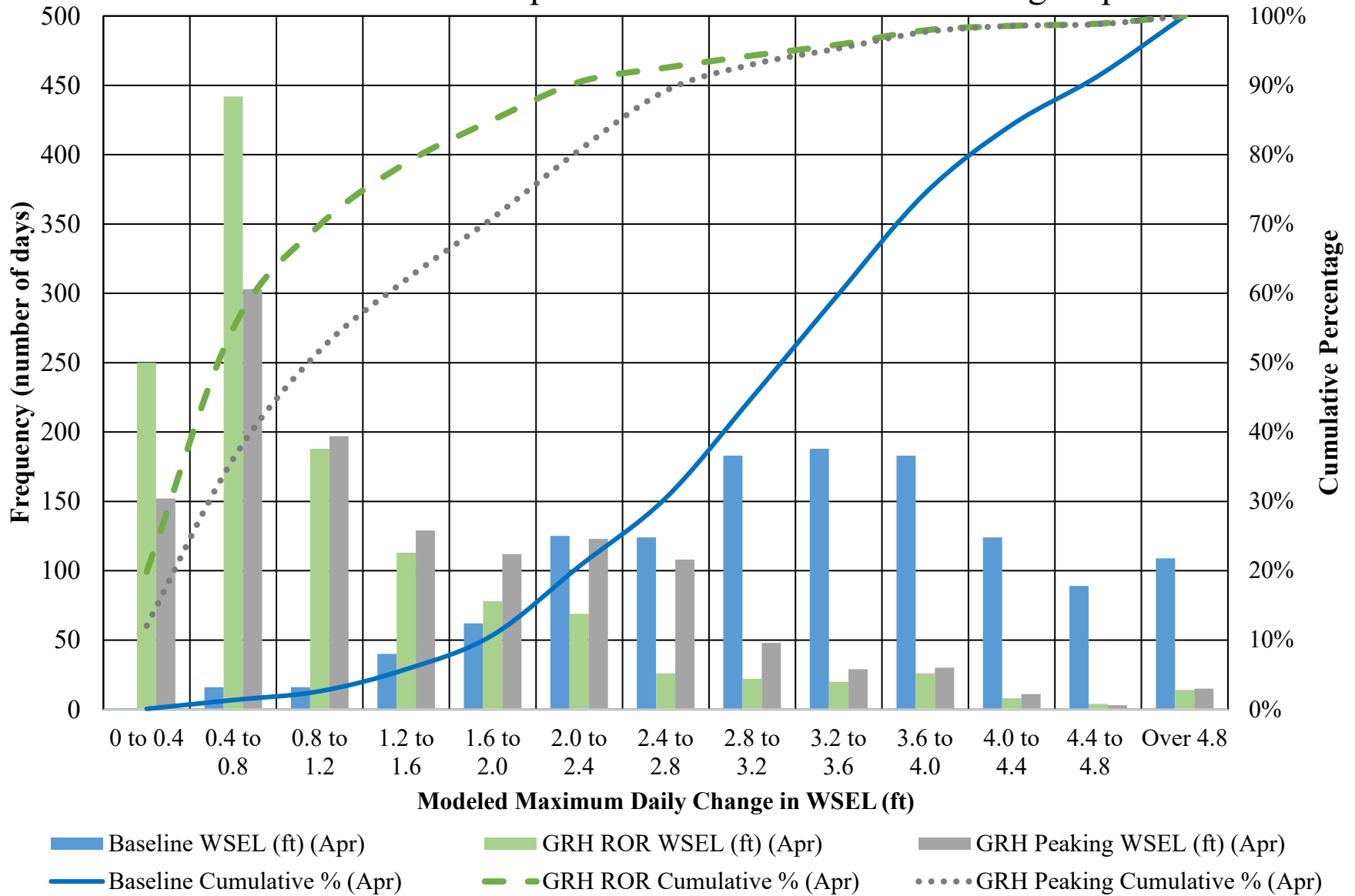




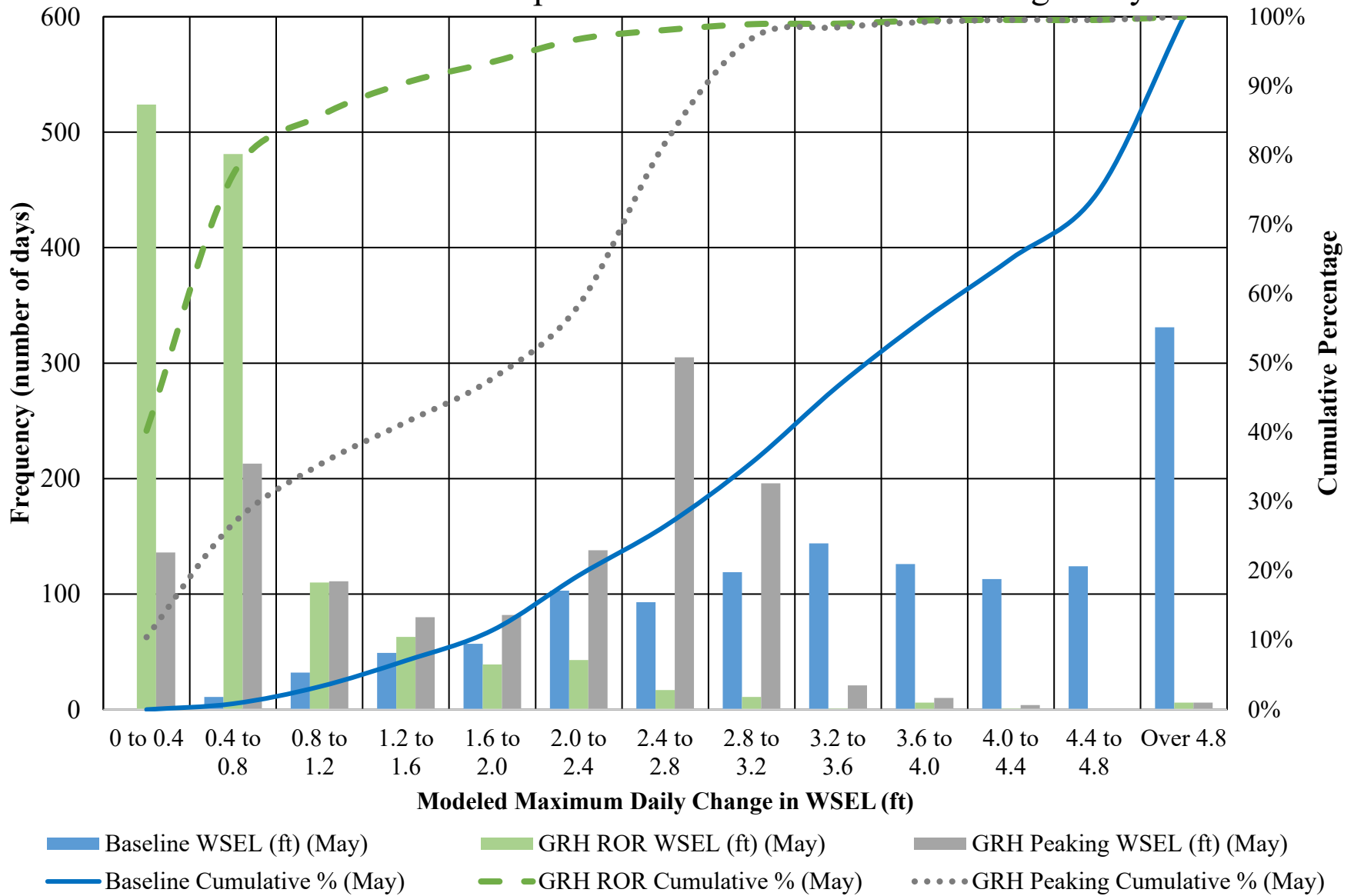
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - March



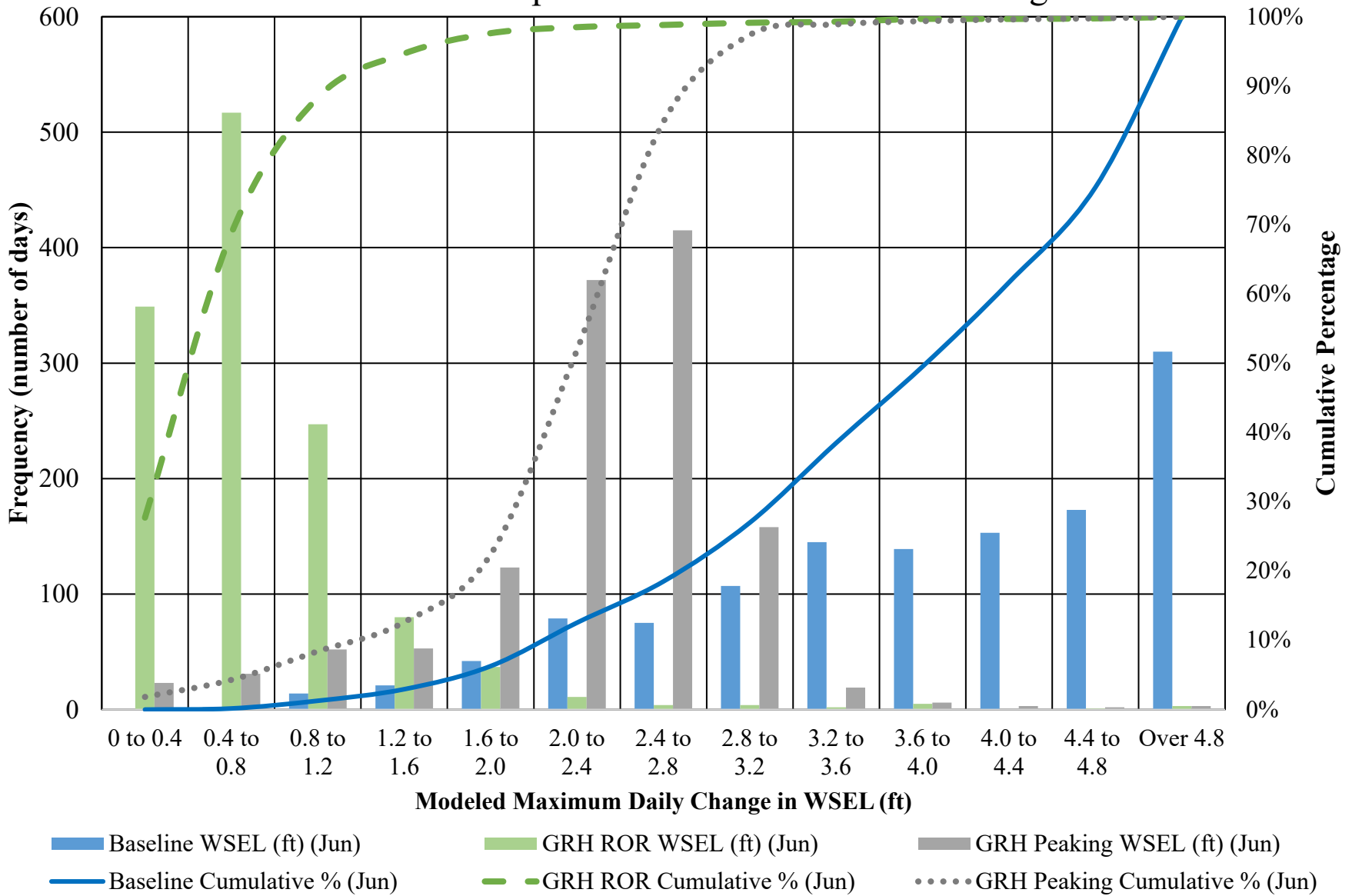
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - April



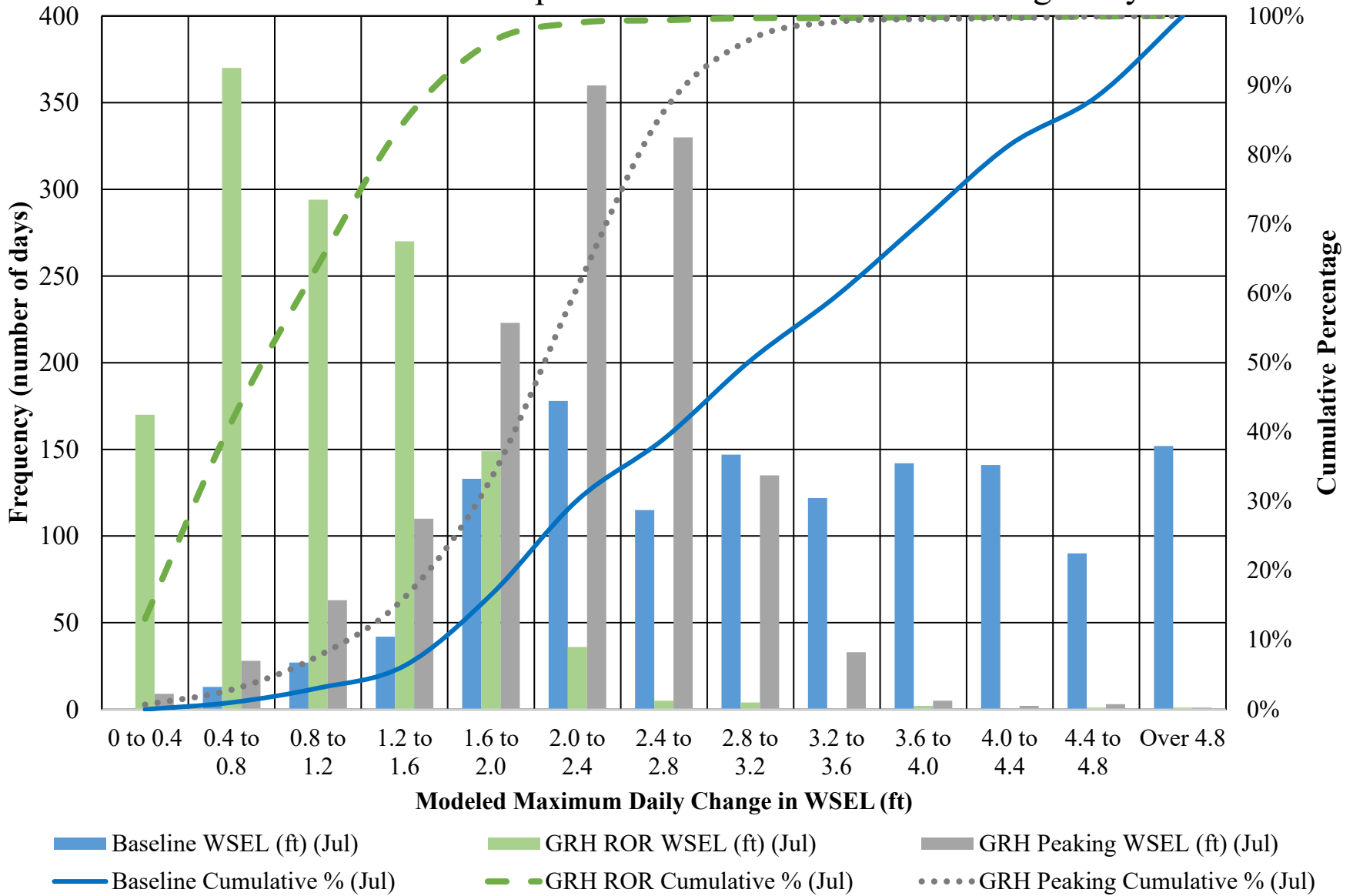
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - May



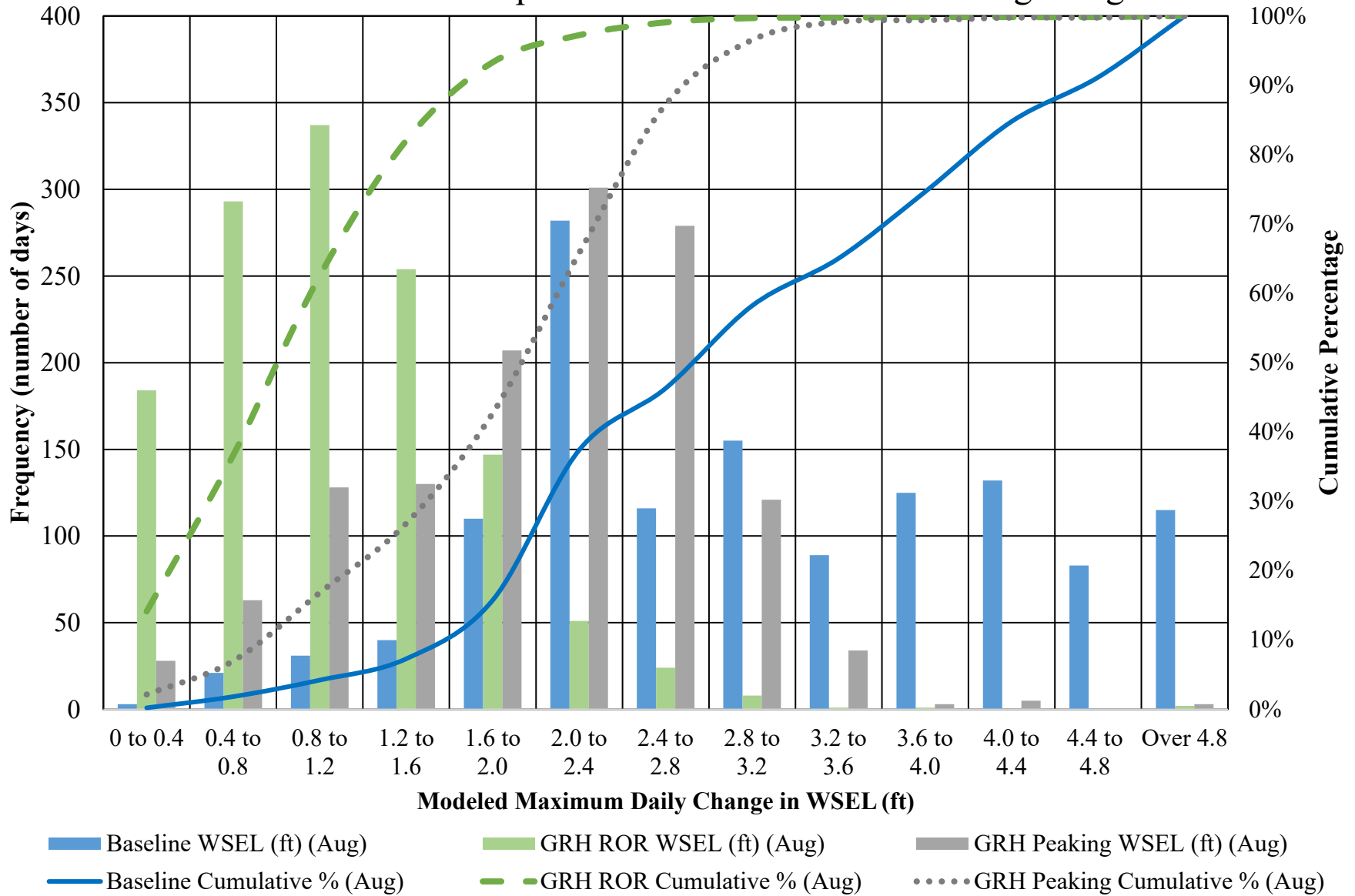
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - June



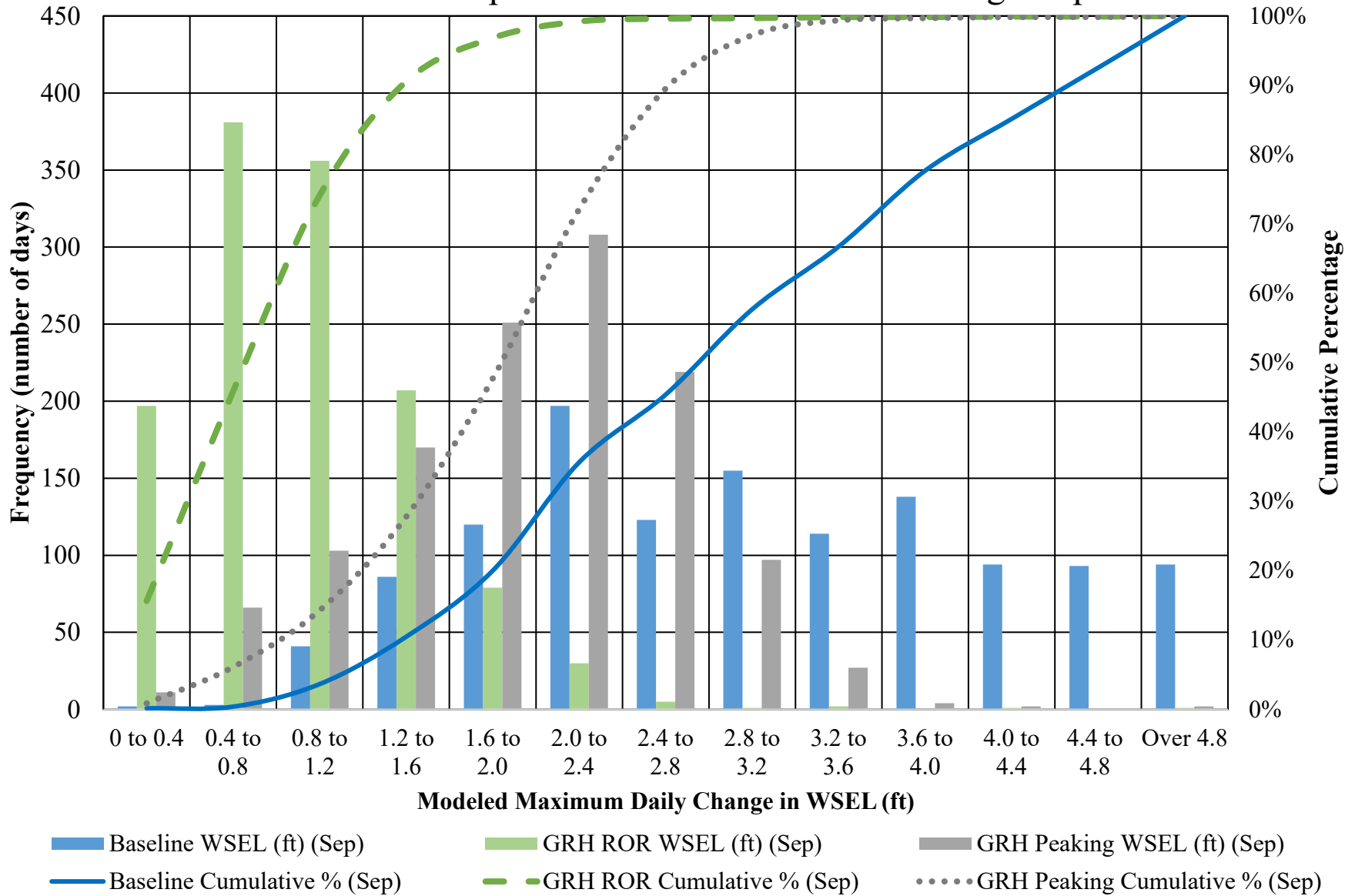
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - July



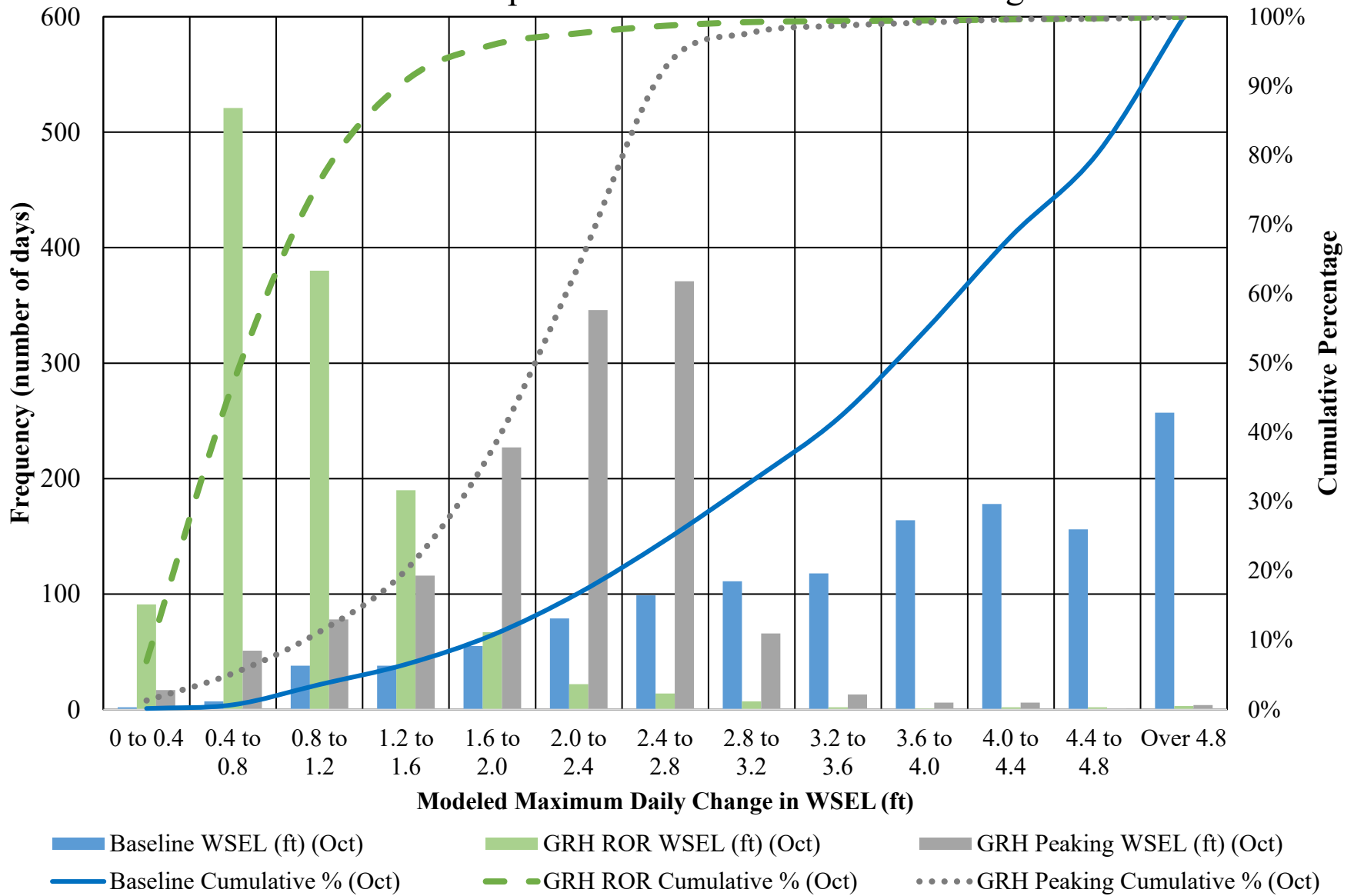
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - August



## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - September

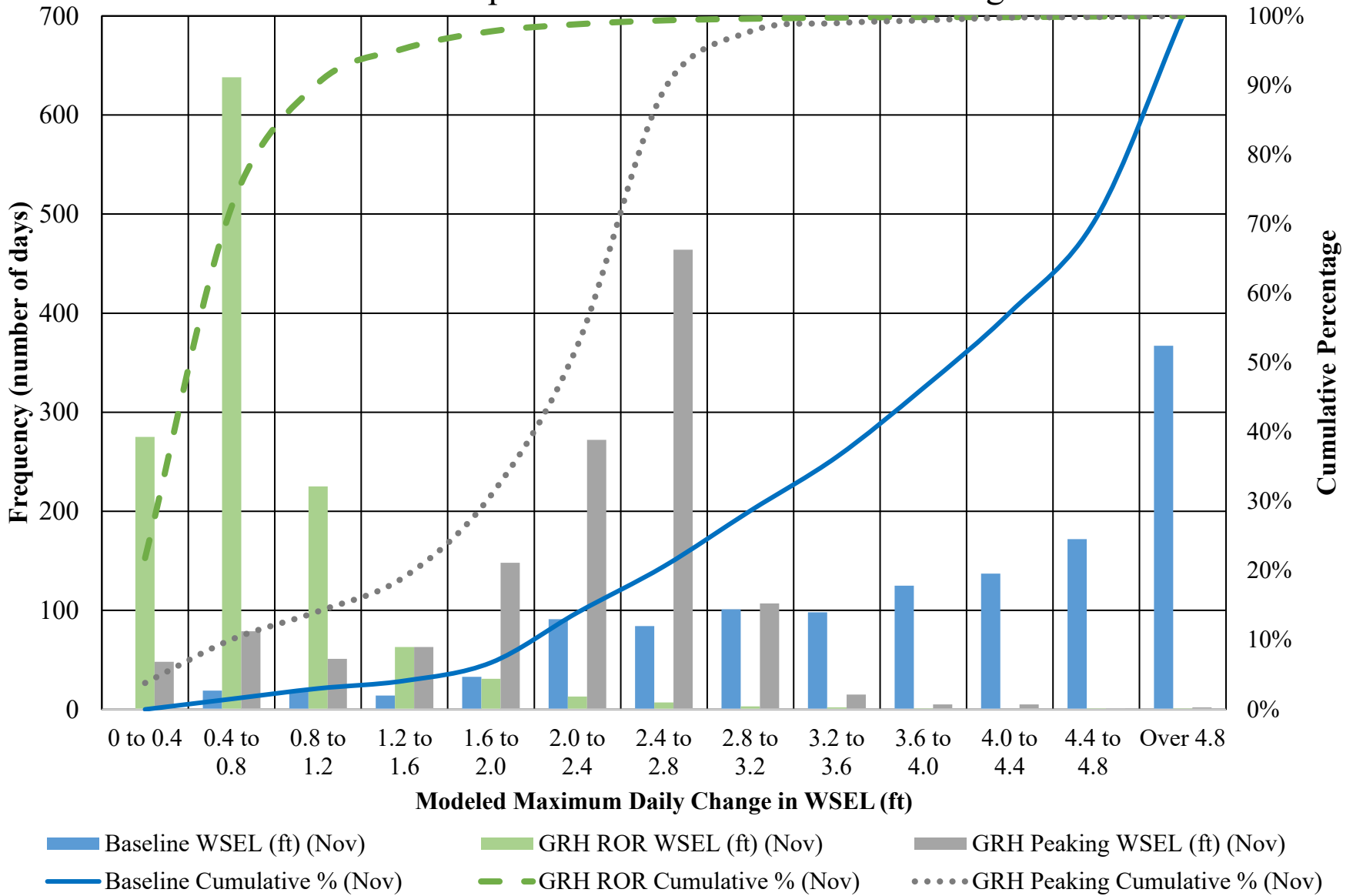


## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - October

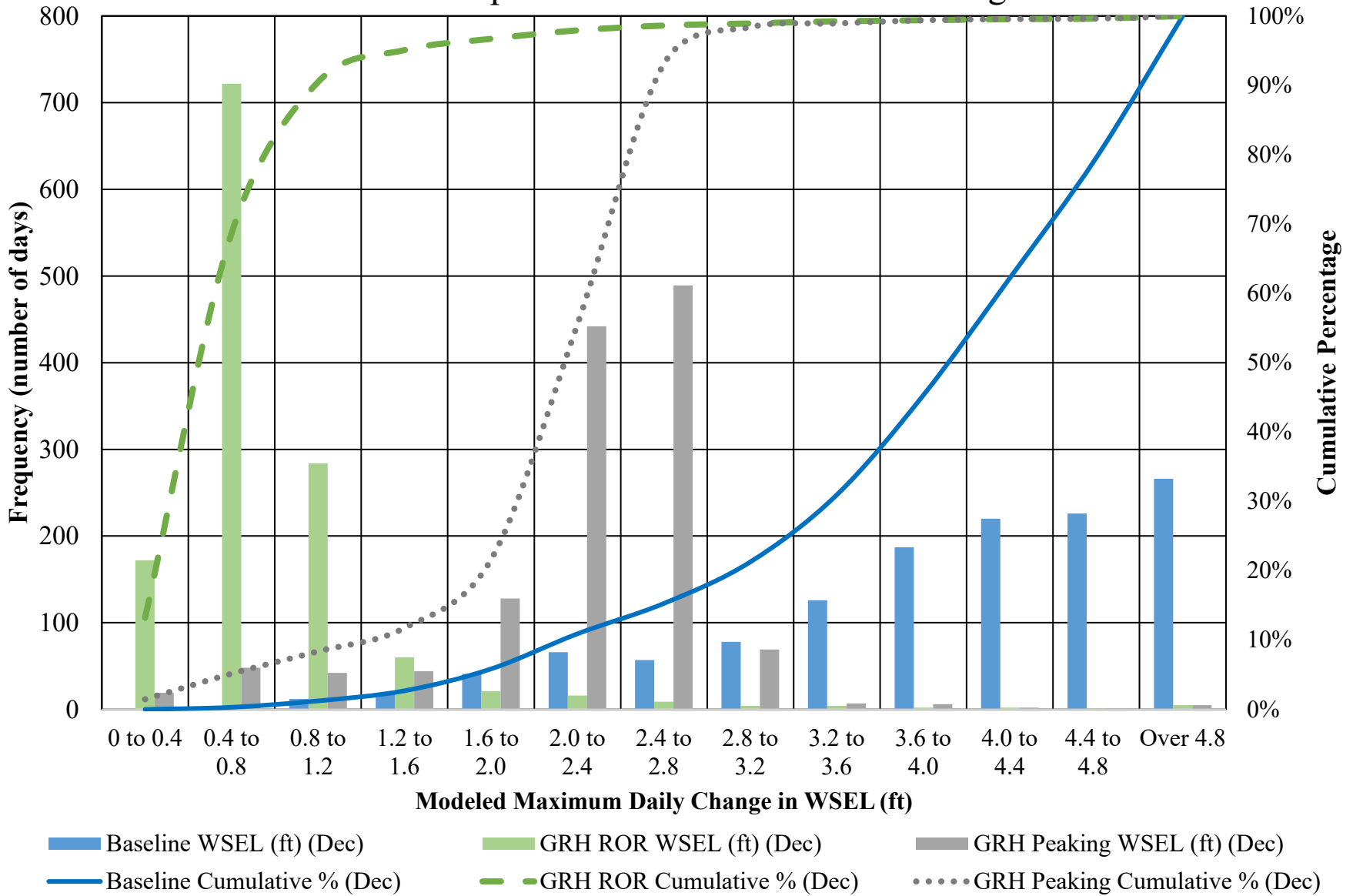




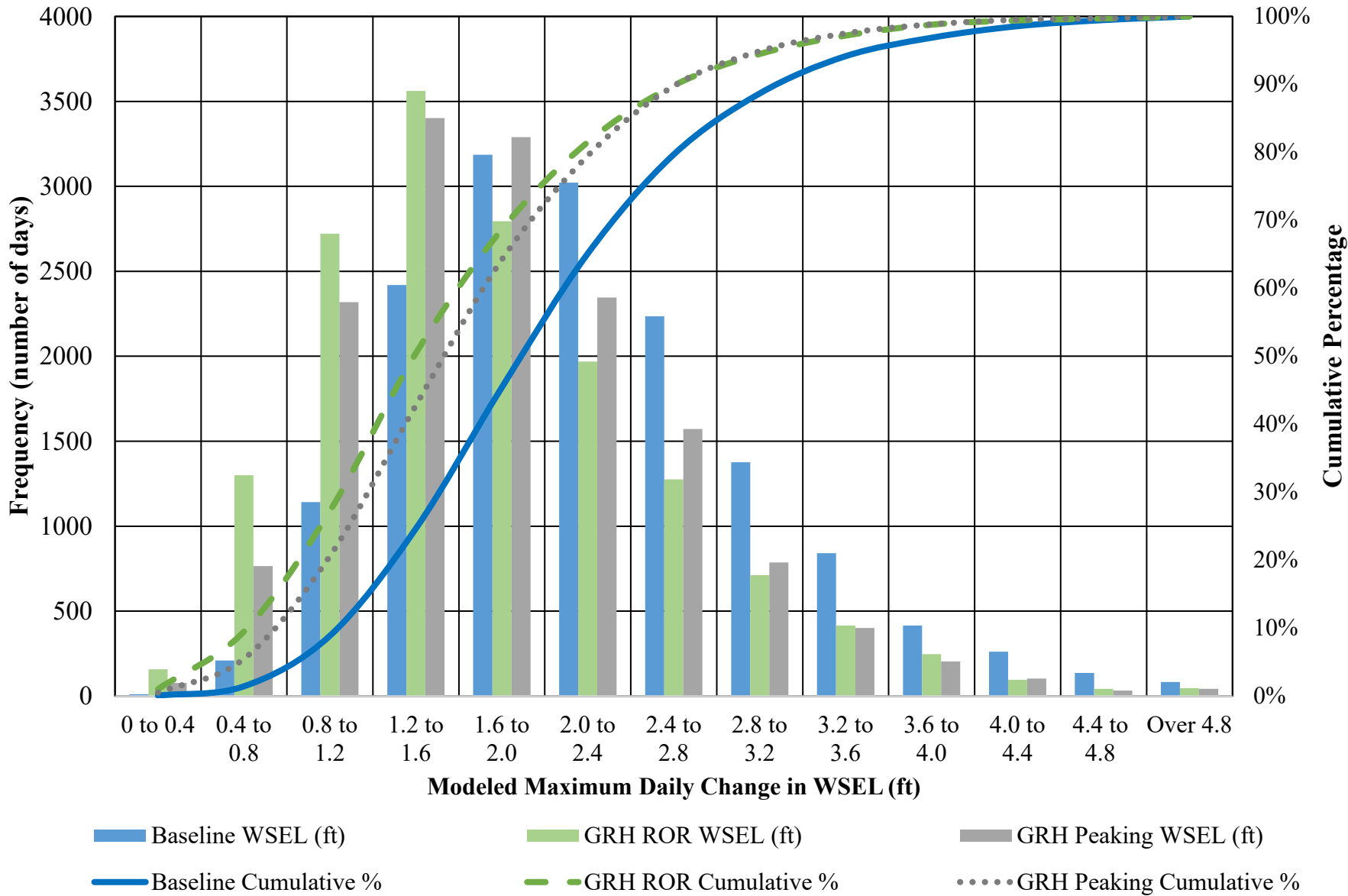
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - November



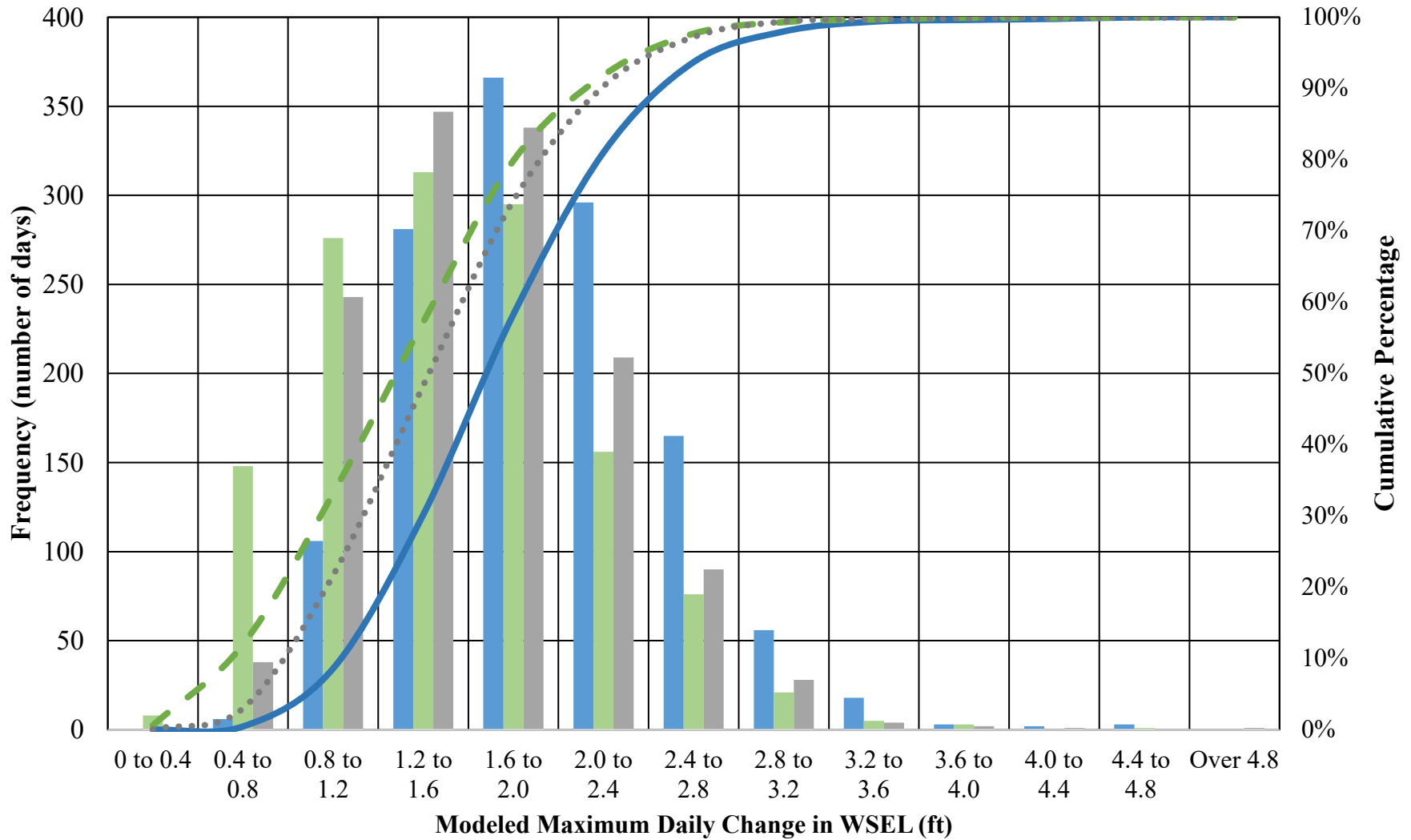
## HEC-RAS Station 104757 (Near Vernon) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - December



## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - Annual

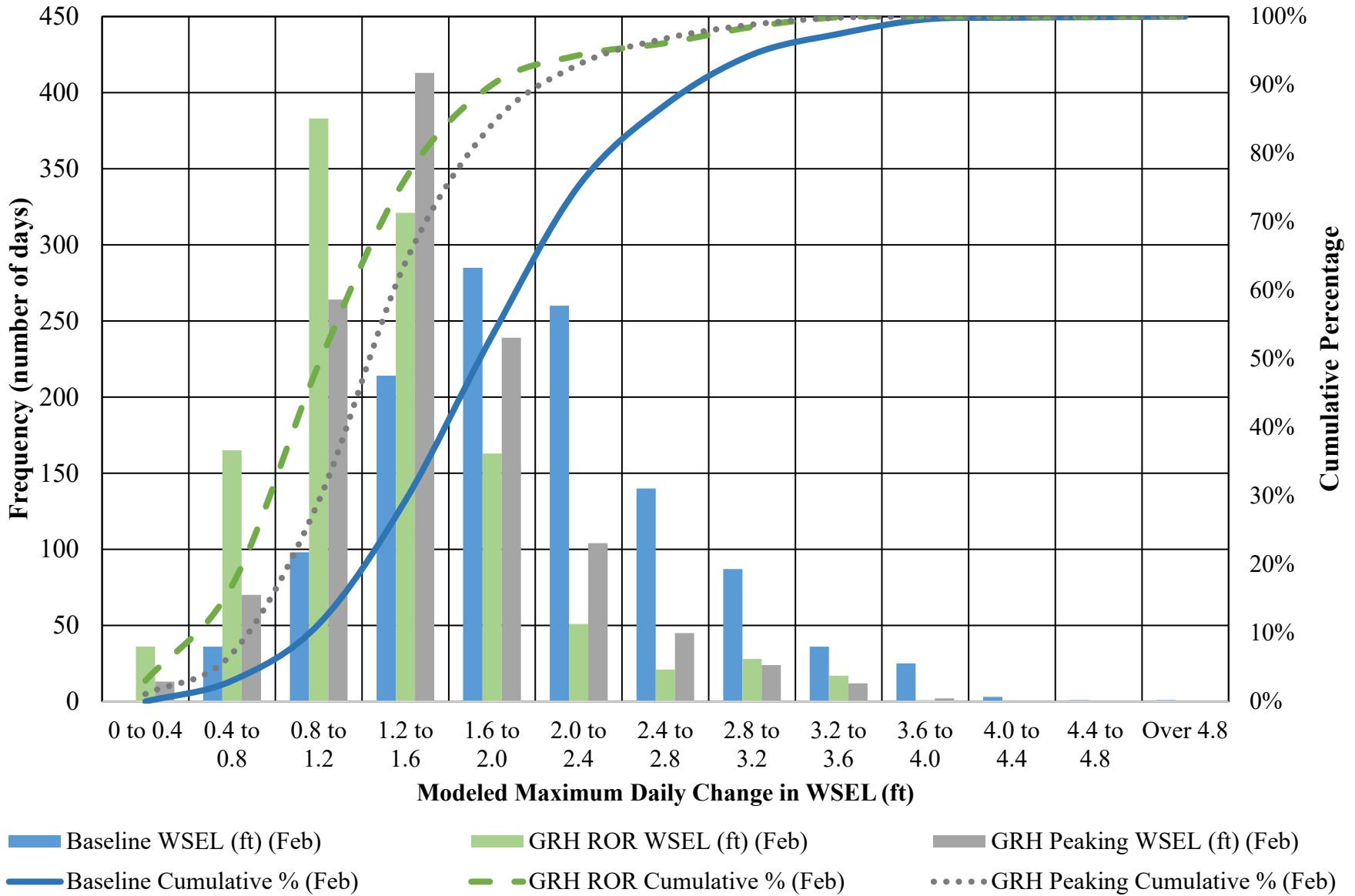


## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - January

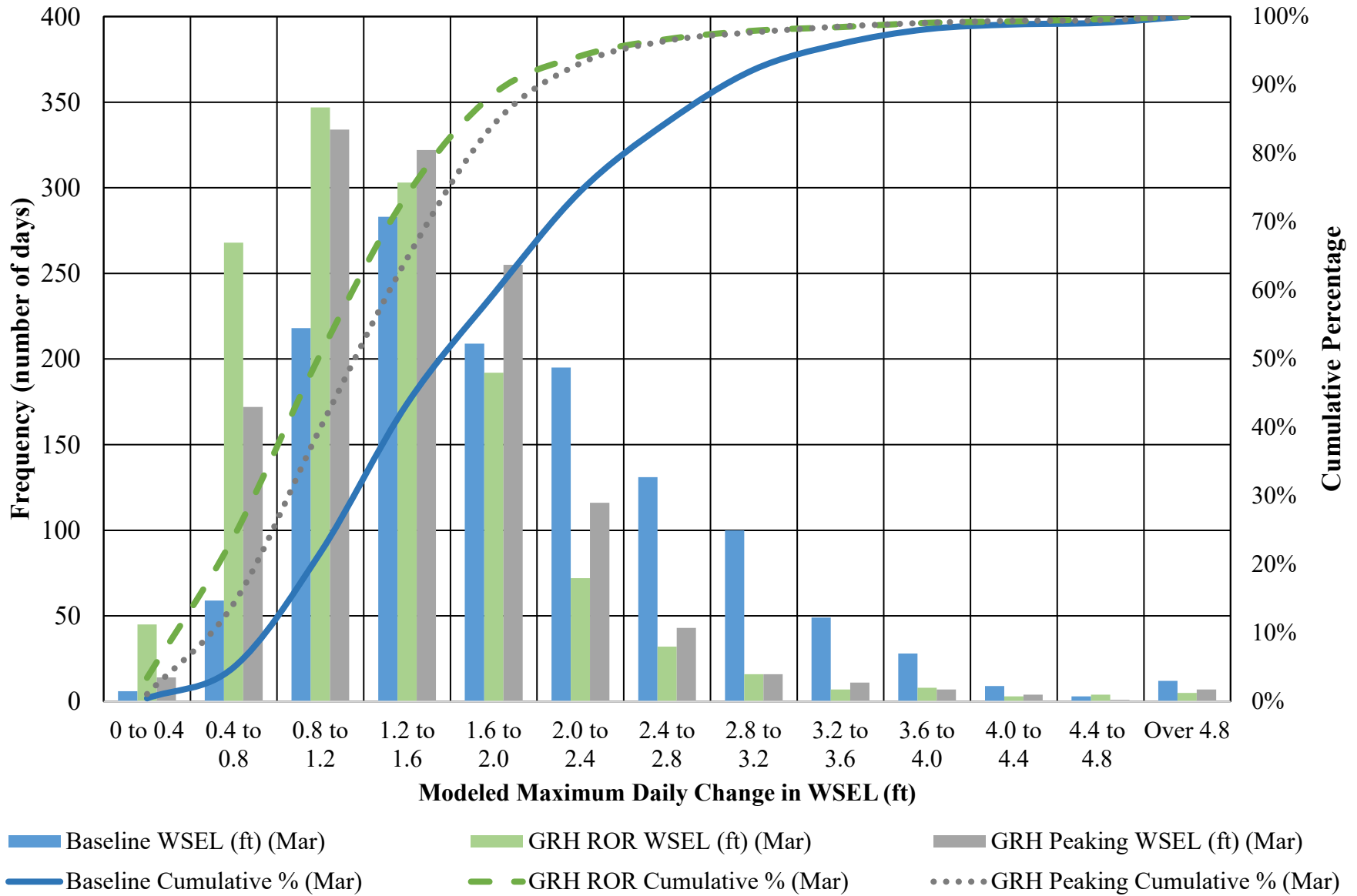


- Baseline WSEL (ft) (Jan)
- GRH ROR WSEL (ft) (Jan)
- GRH Peaking WSEL (ft) (Jan)
- Baseline Cumulative % (Jan)
- - - GRH ROR Cumulative % (Jan)
- · · · · GRH Peaking Cumulative % (Jan)

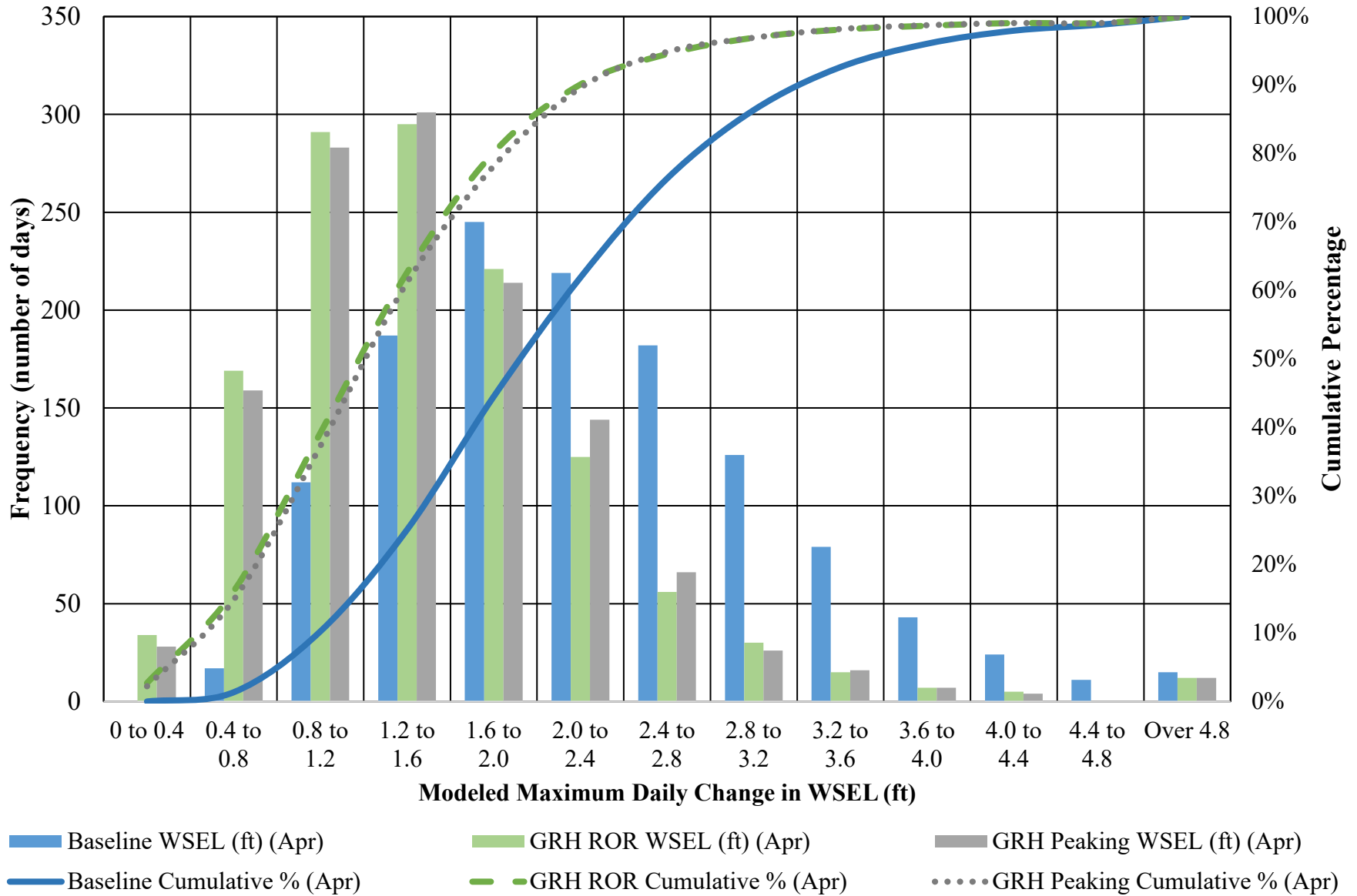
## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - February



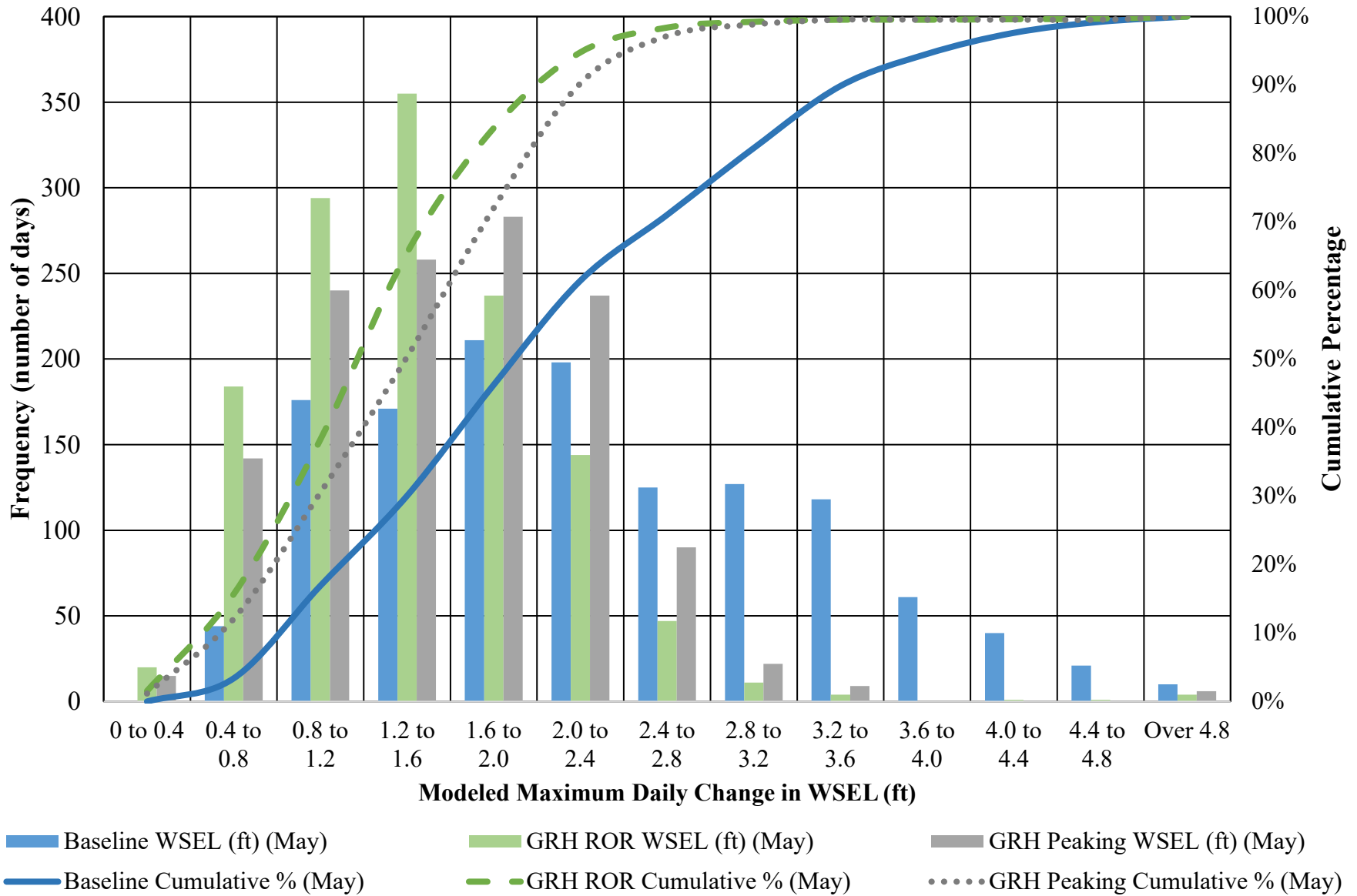
## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - March



## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - April

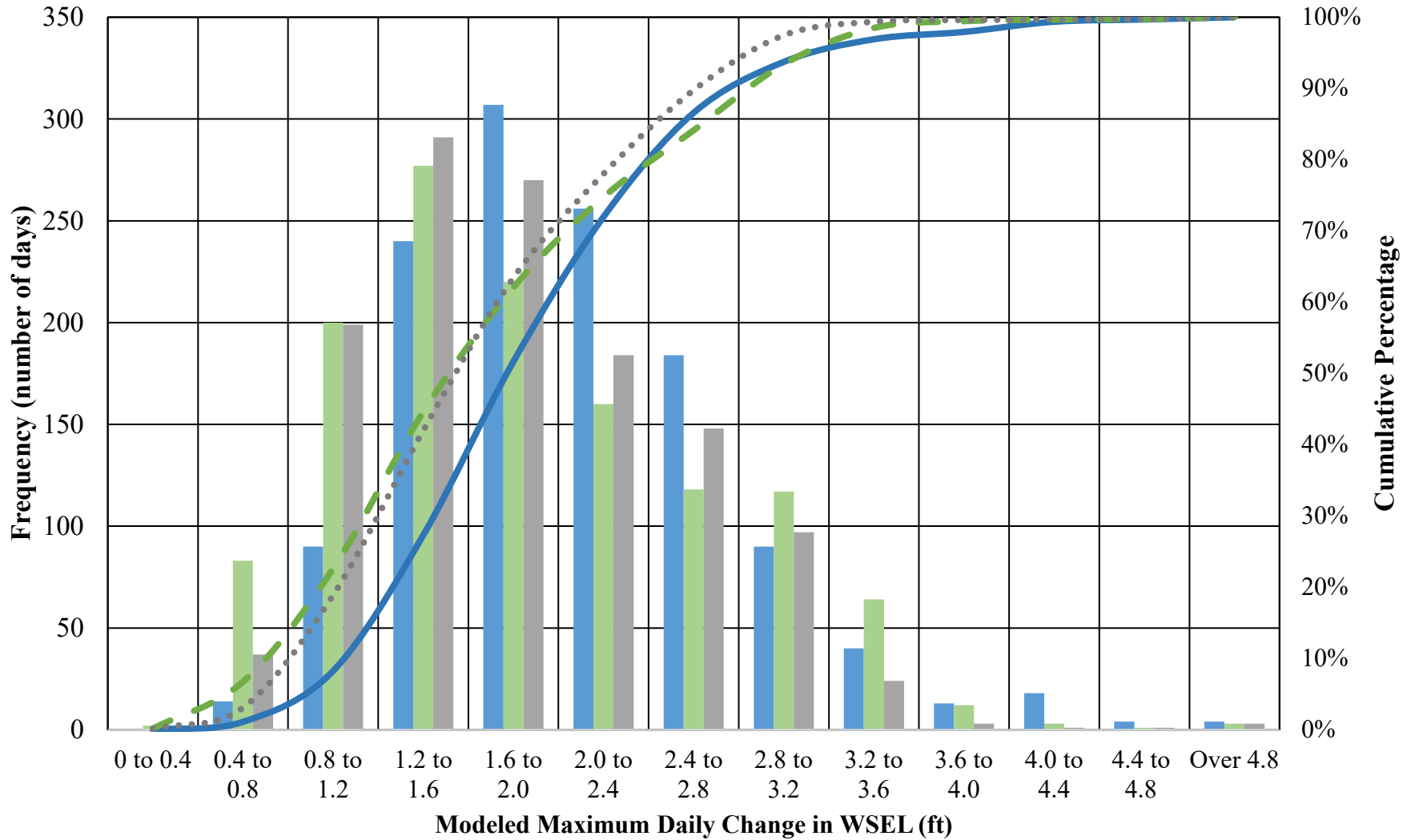


## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - May



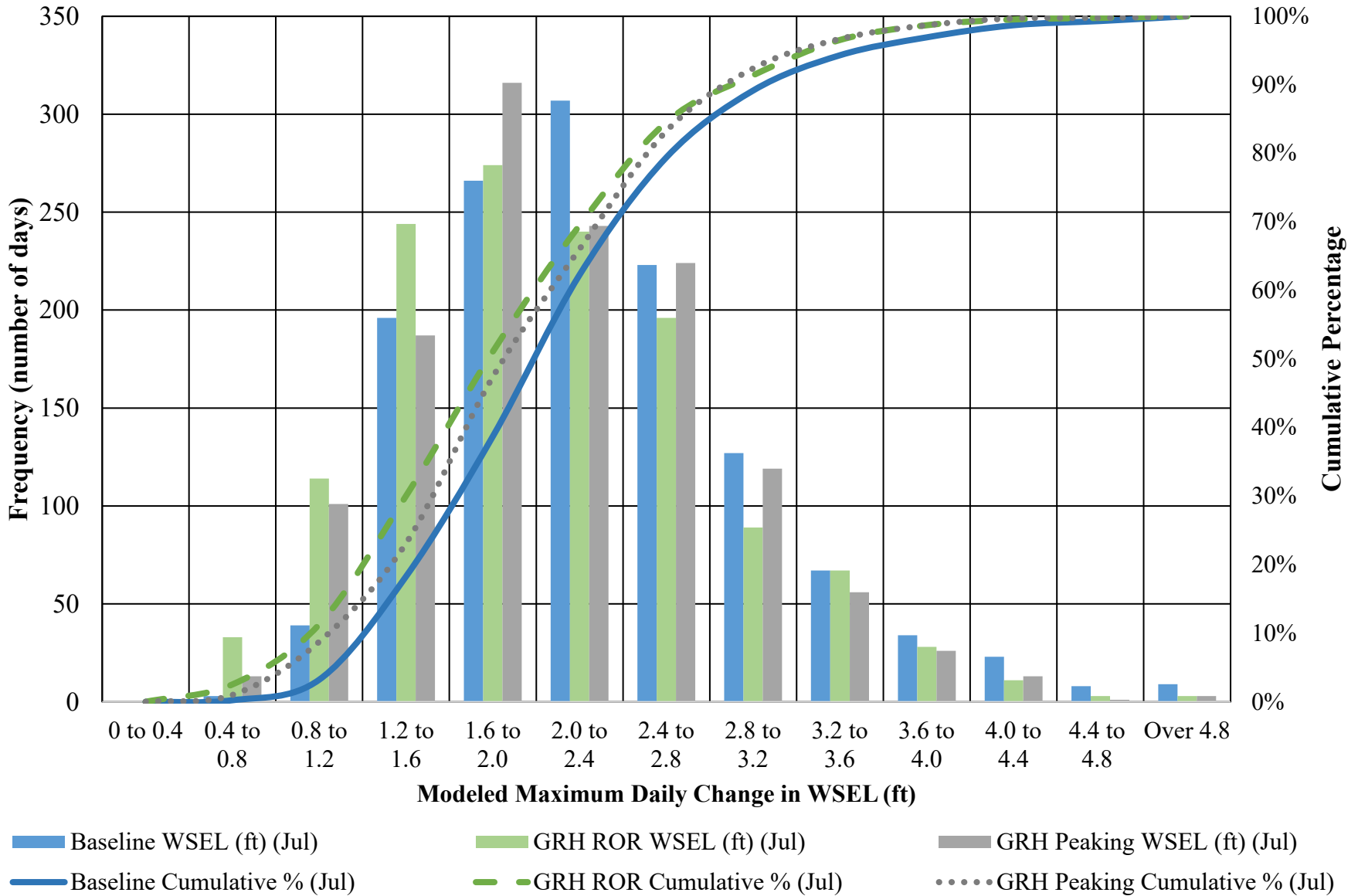


## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - June

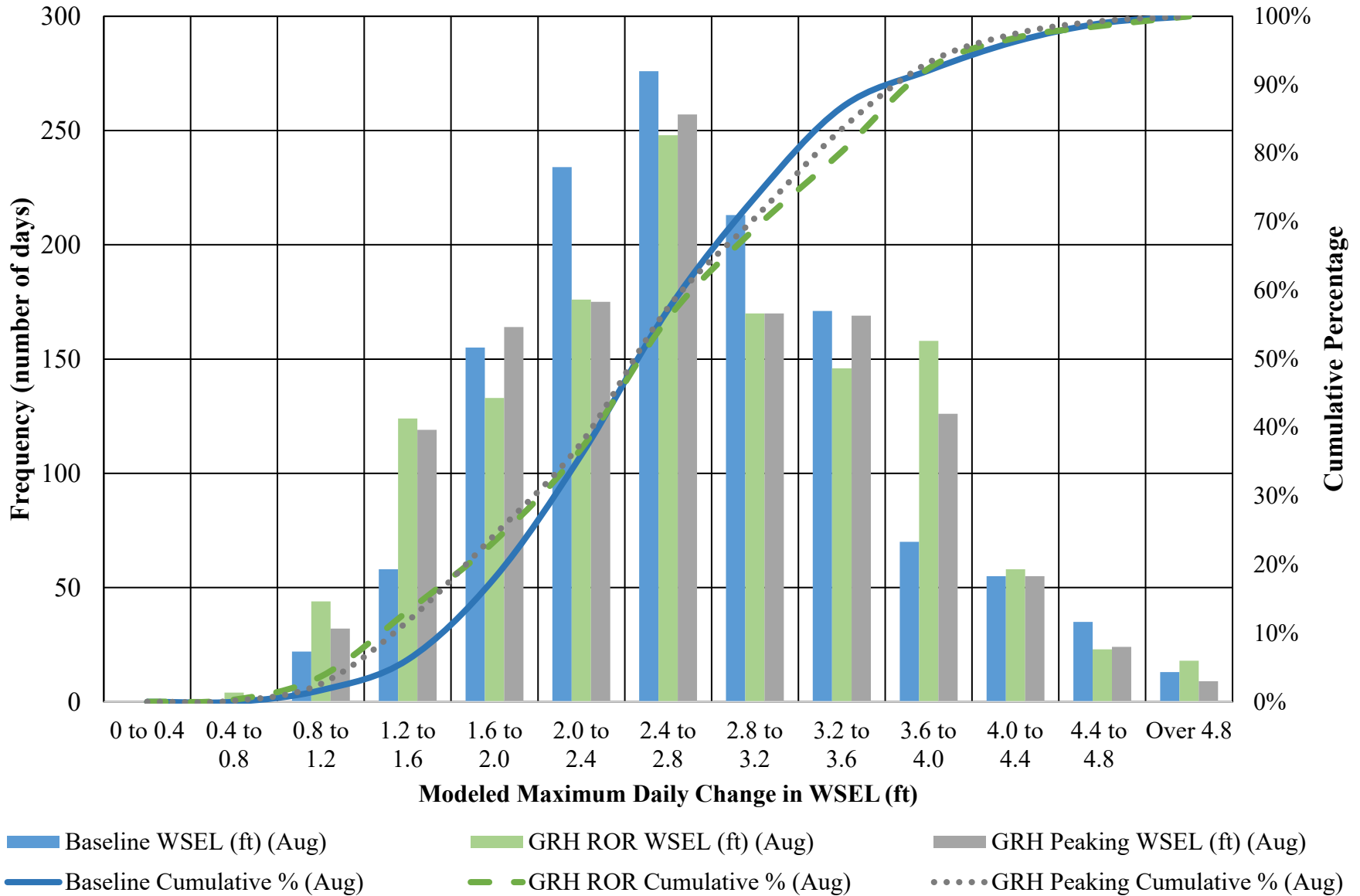


- Baseline WSEL (ft) (Jun)
- GRH ROR WSEL (ft) (Jun)
- GRH Peaking WSEL (ft) (Jun)
- Baseline Cumulative % (Jun)
- GRH ROR Cumulative % (Jun)
- GRH Peaking Cumulative % (Jun)

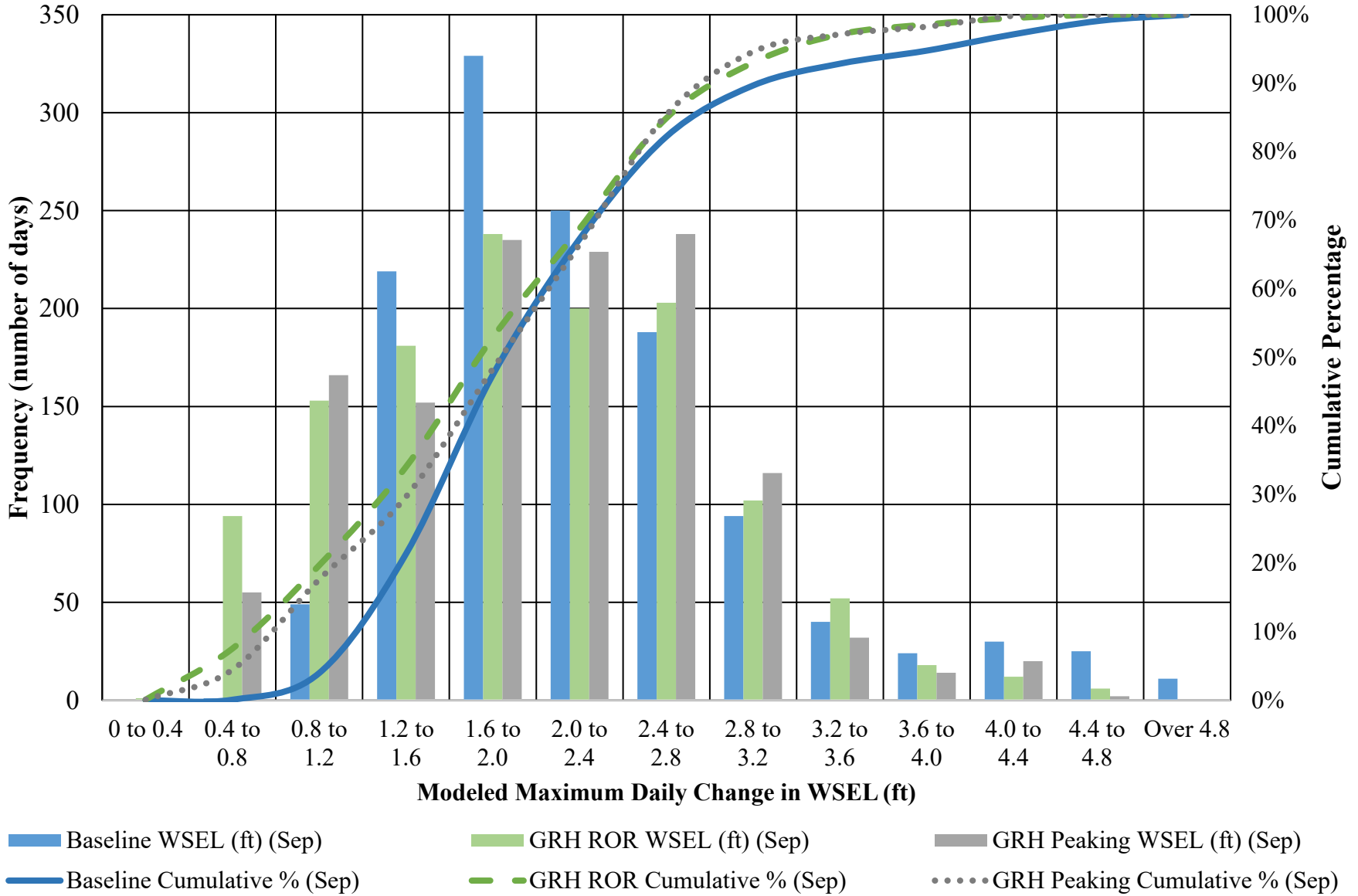
## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - July



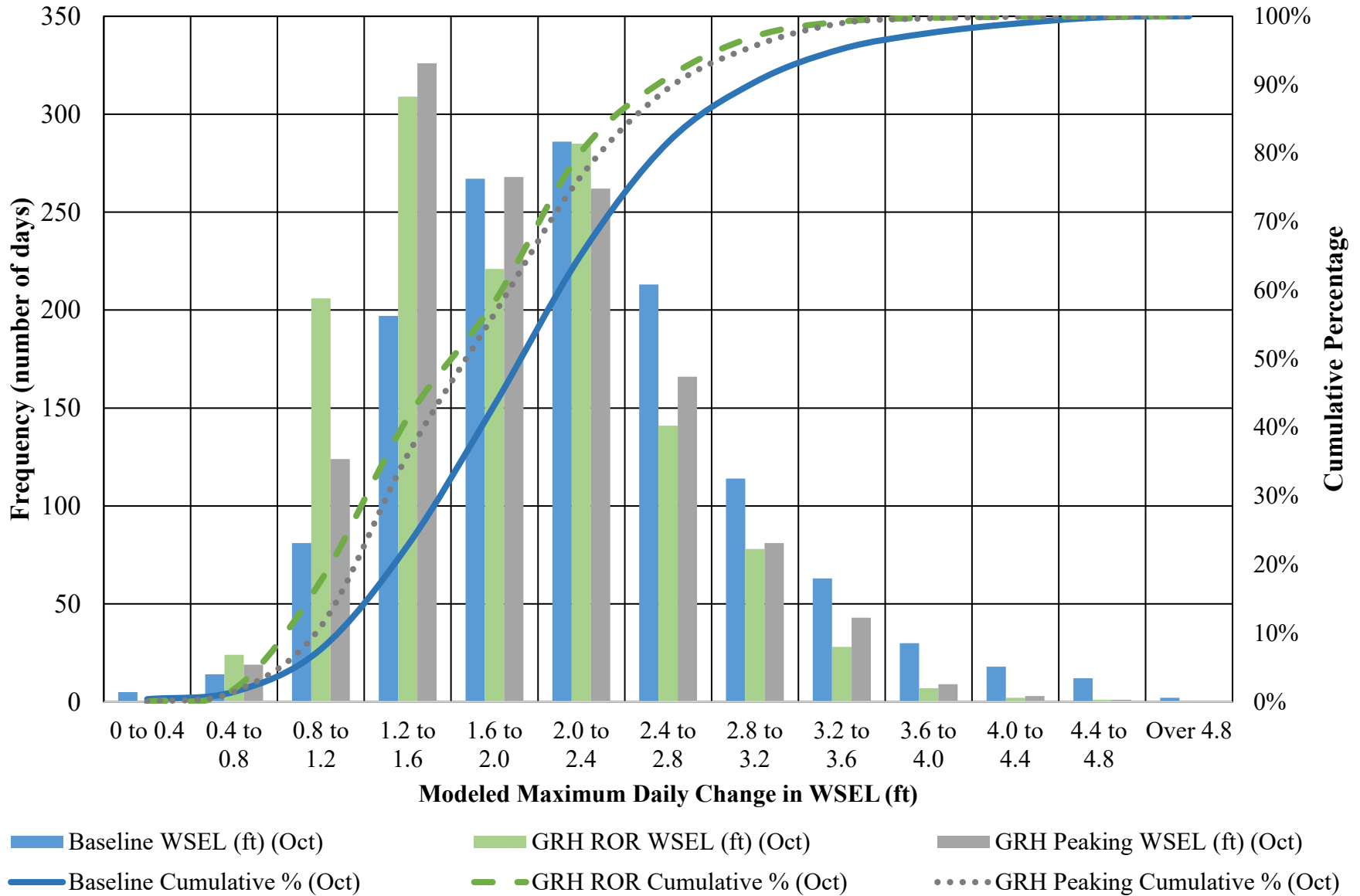
## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - August



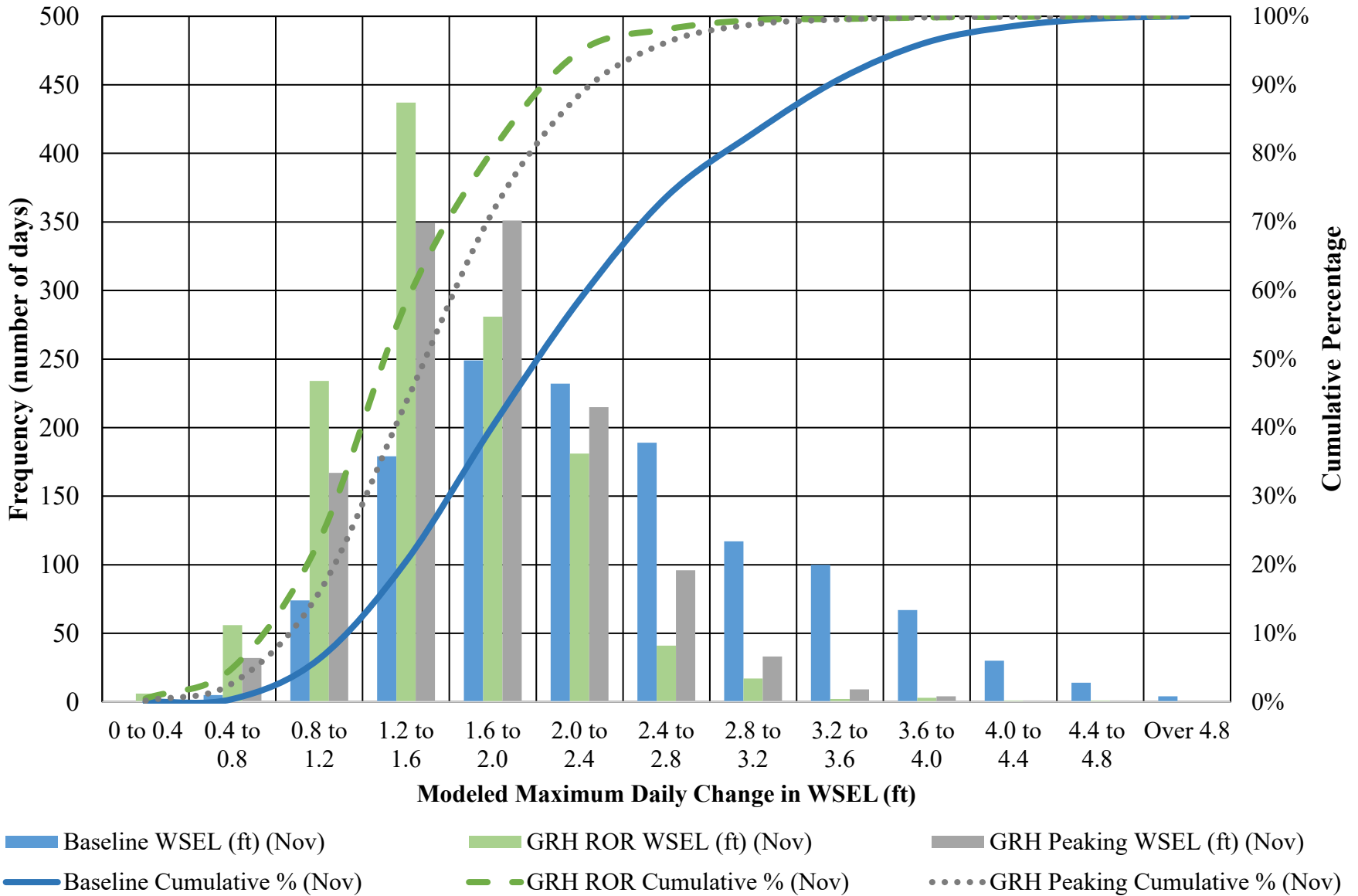
## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - September



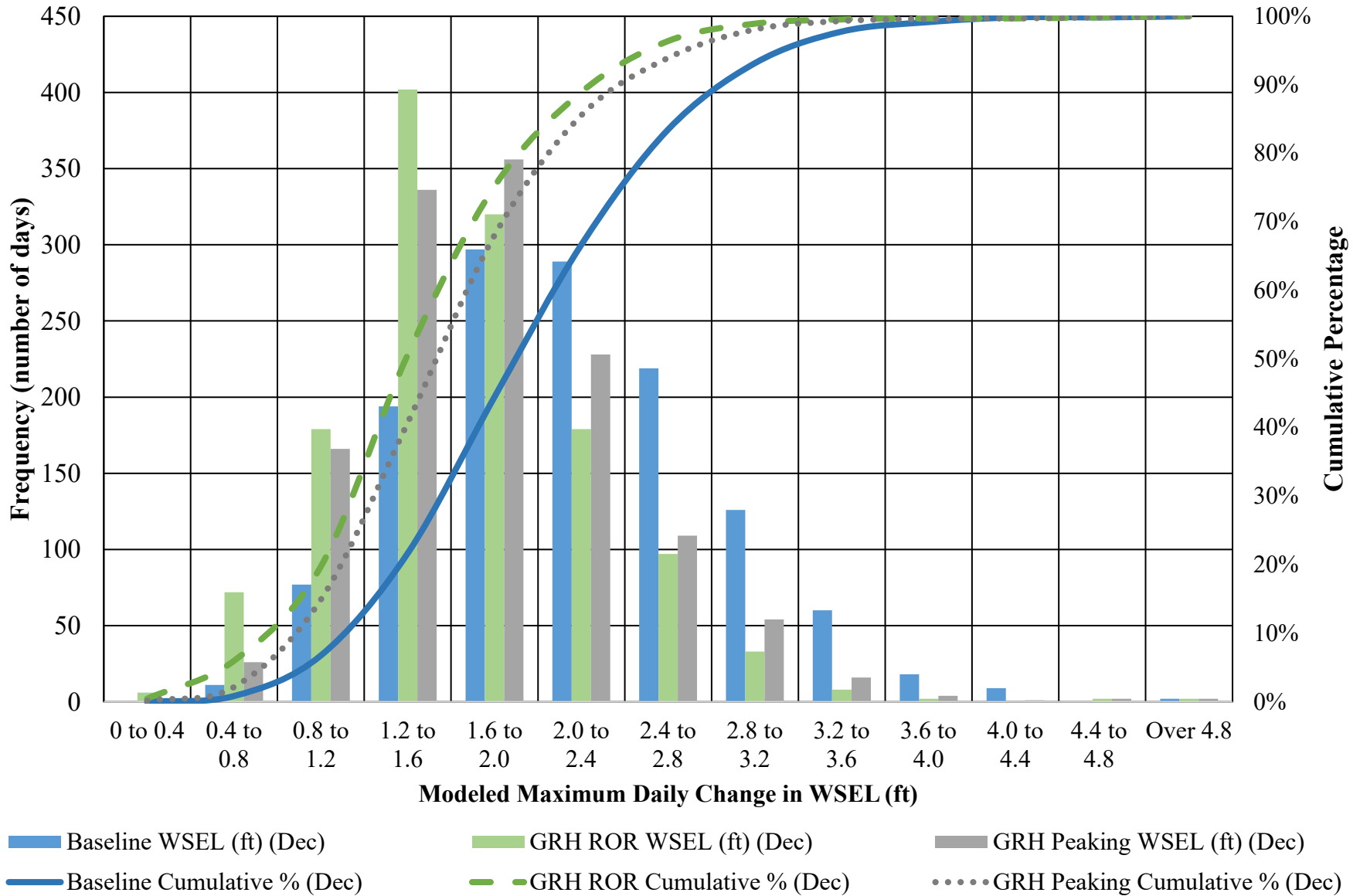
## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - October



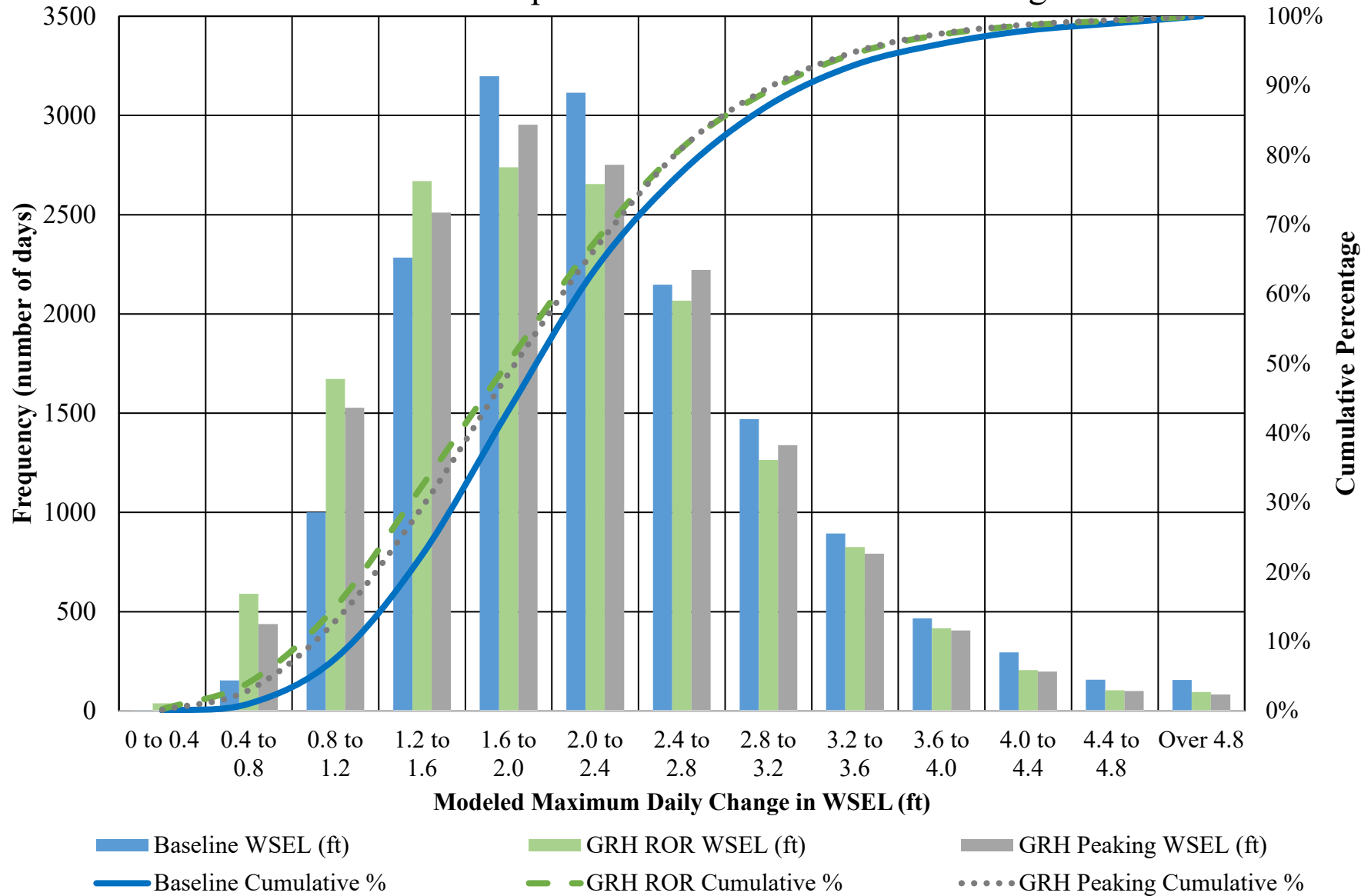
## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - November



## HEC-RAS Station 70732 (near Pauchaug) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - December

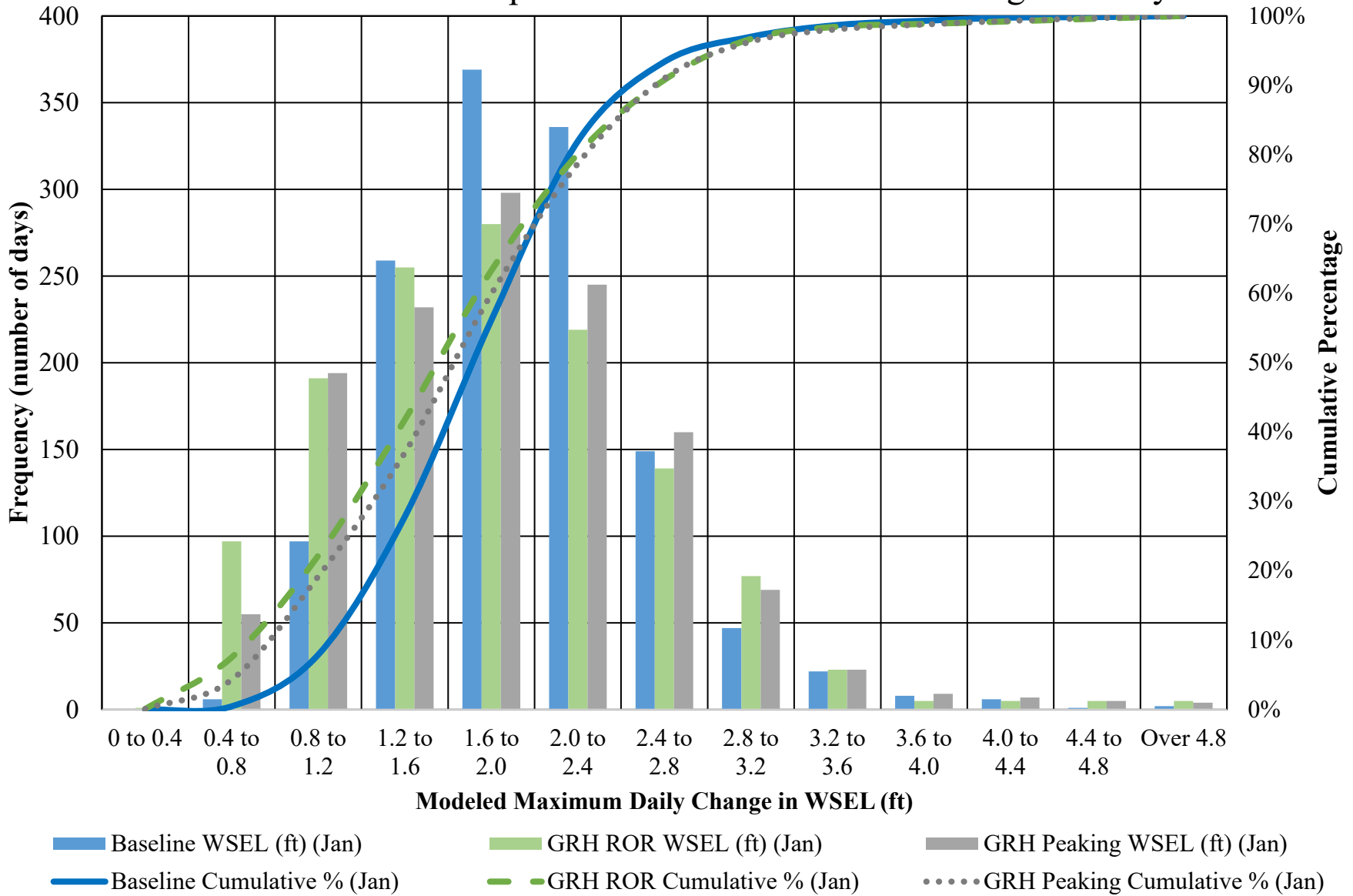


## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - Annual

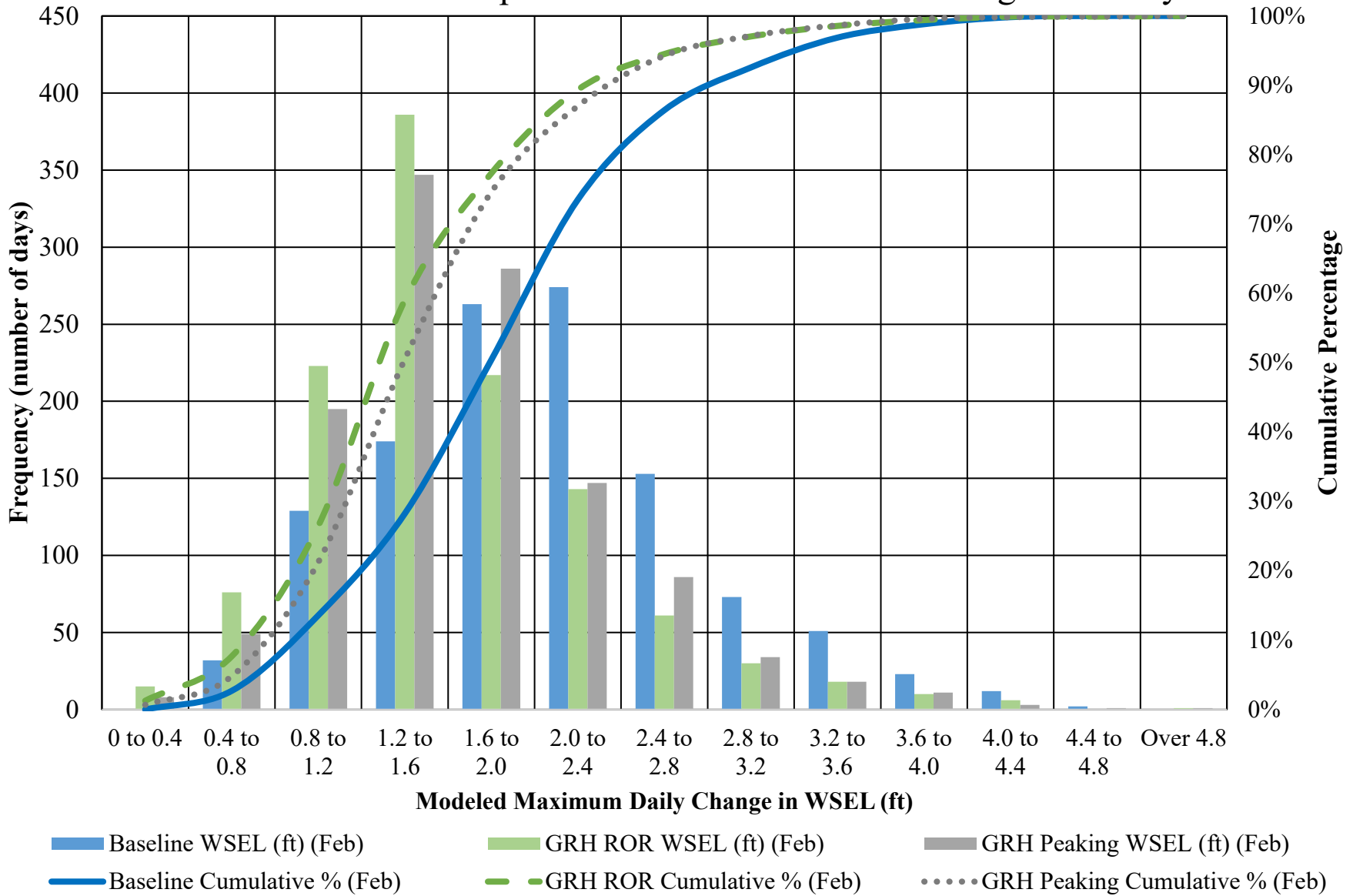




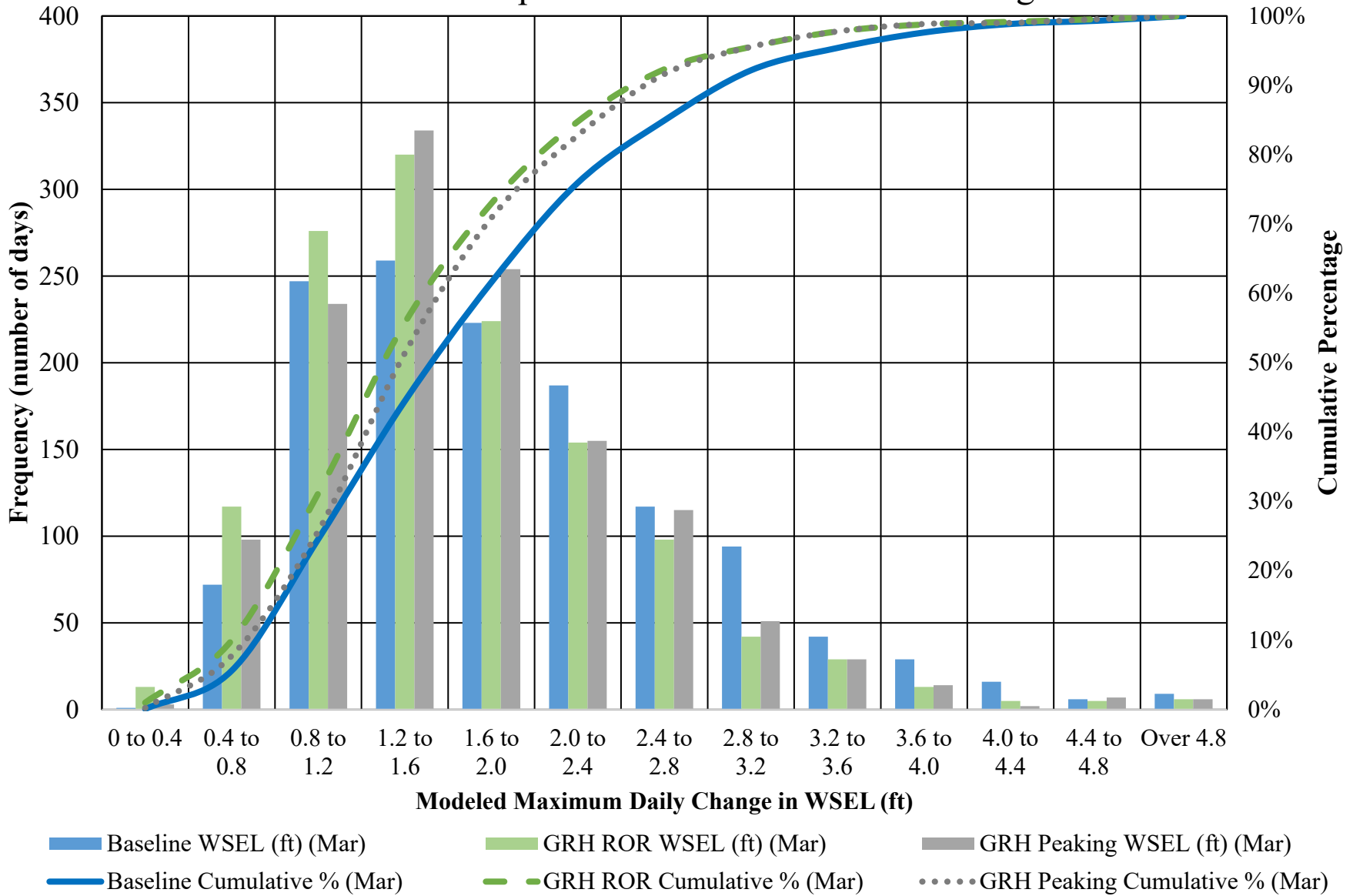
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - January



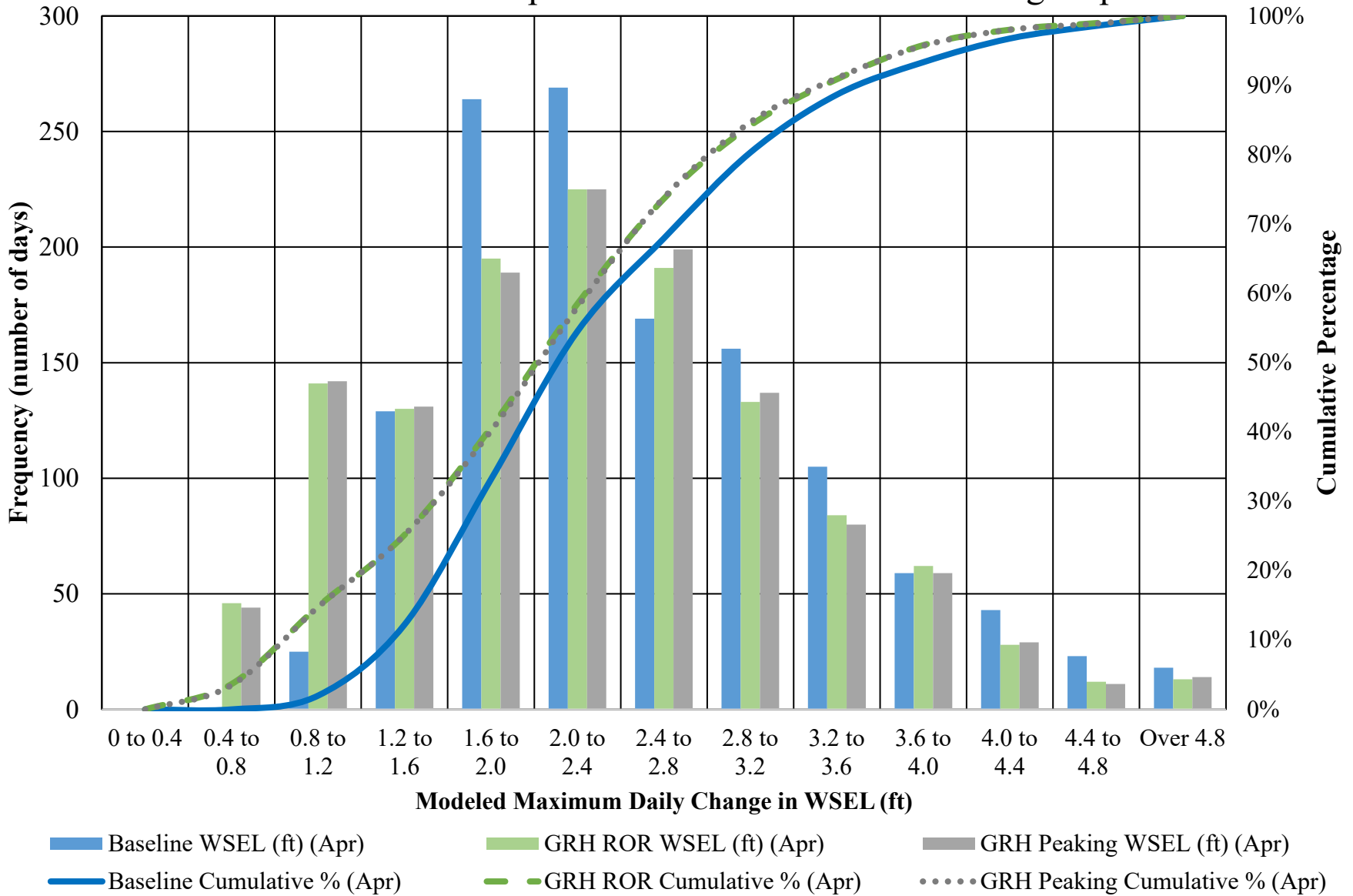
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - February



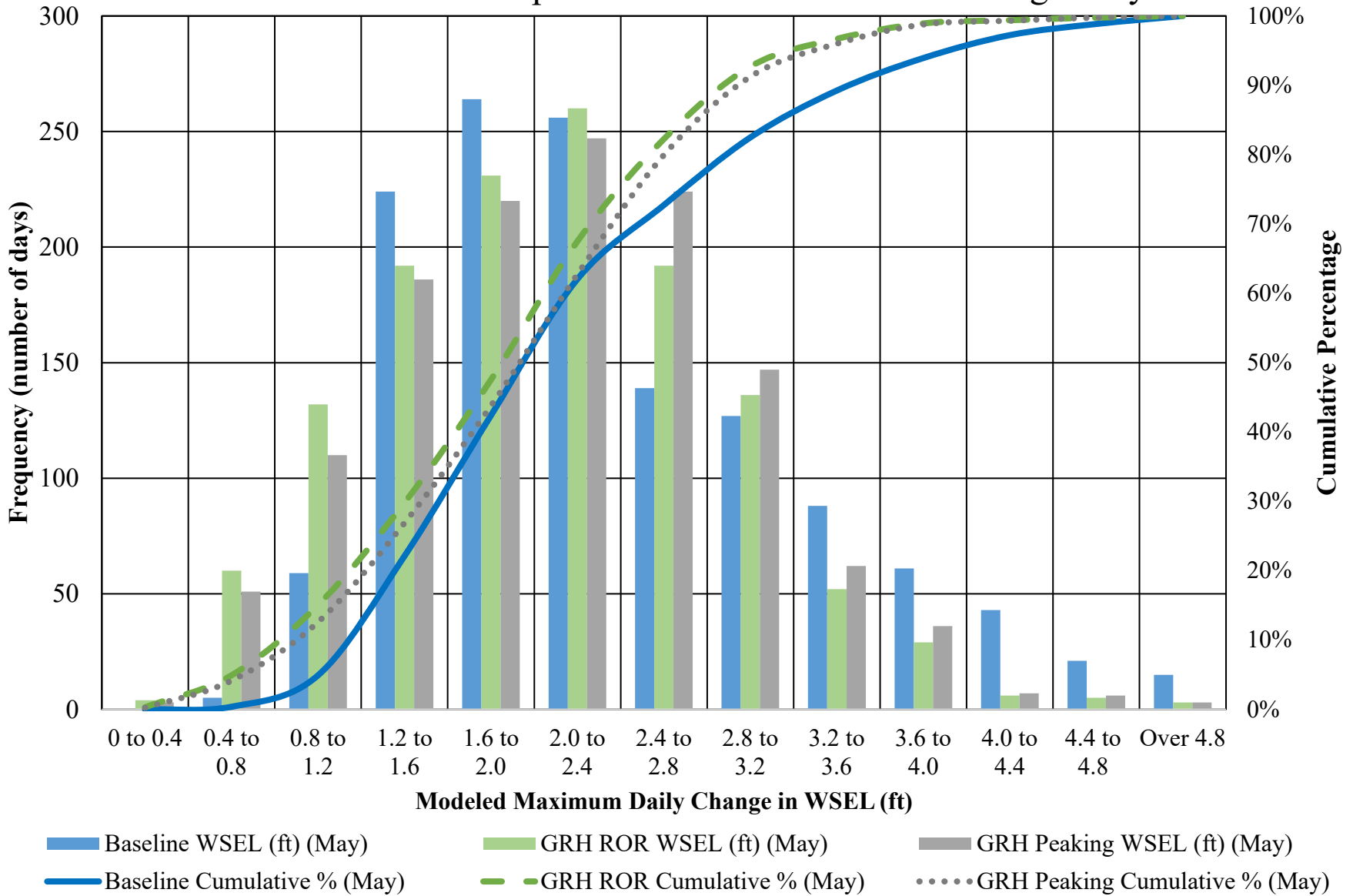
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - March



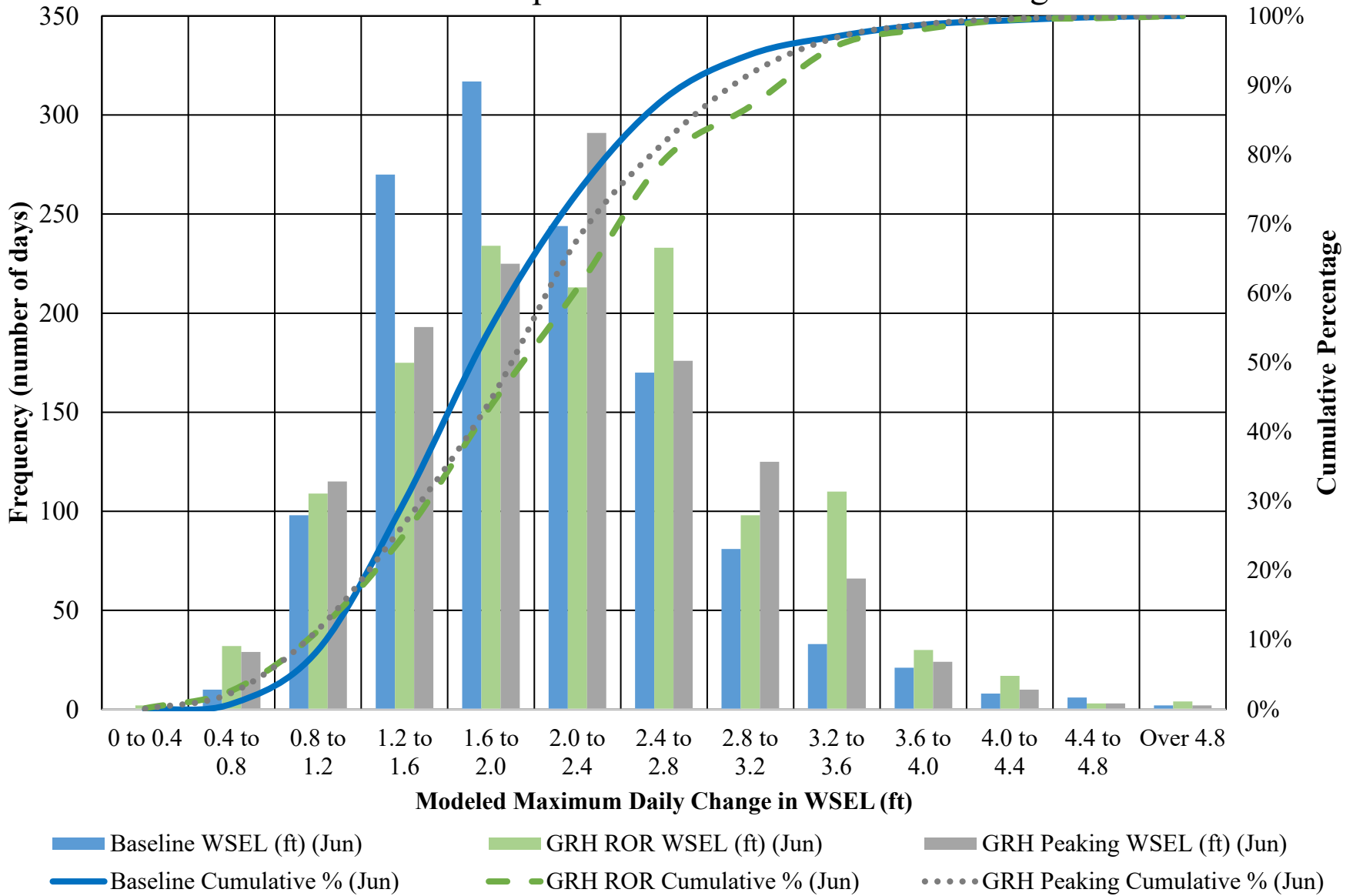
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - April



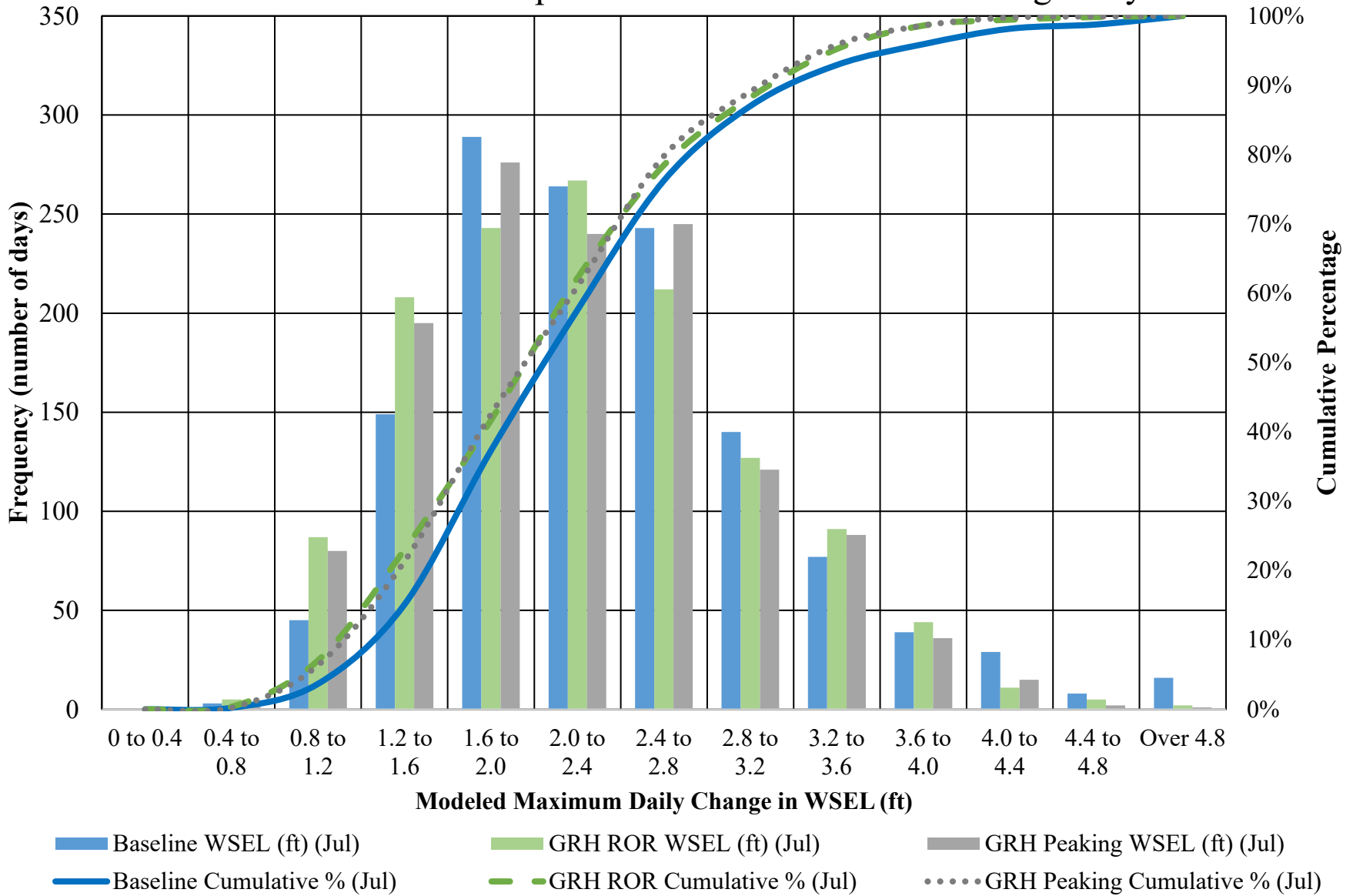
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - May



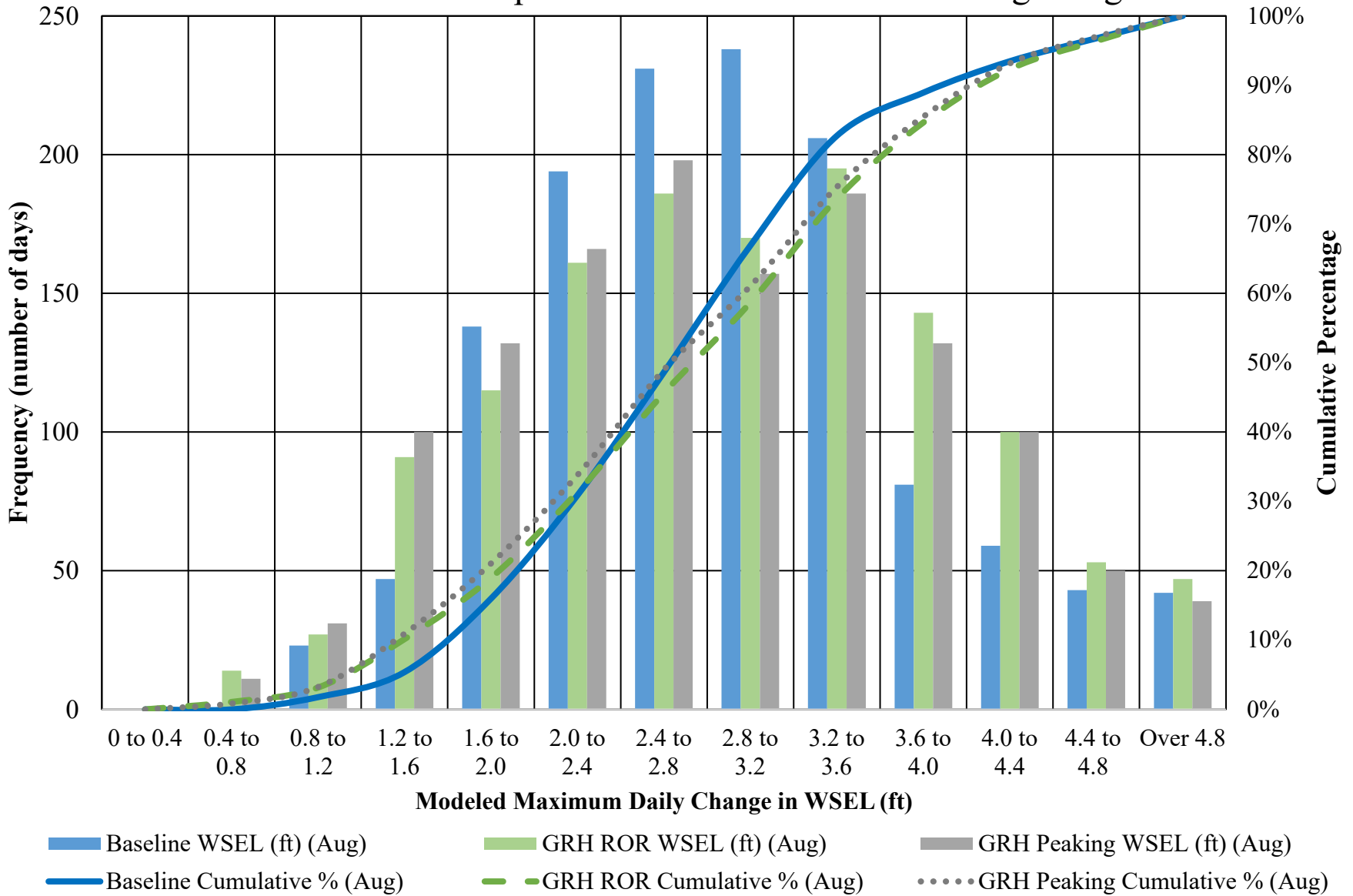
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - June



## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - July

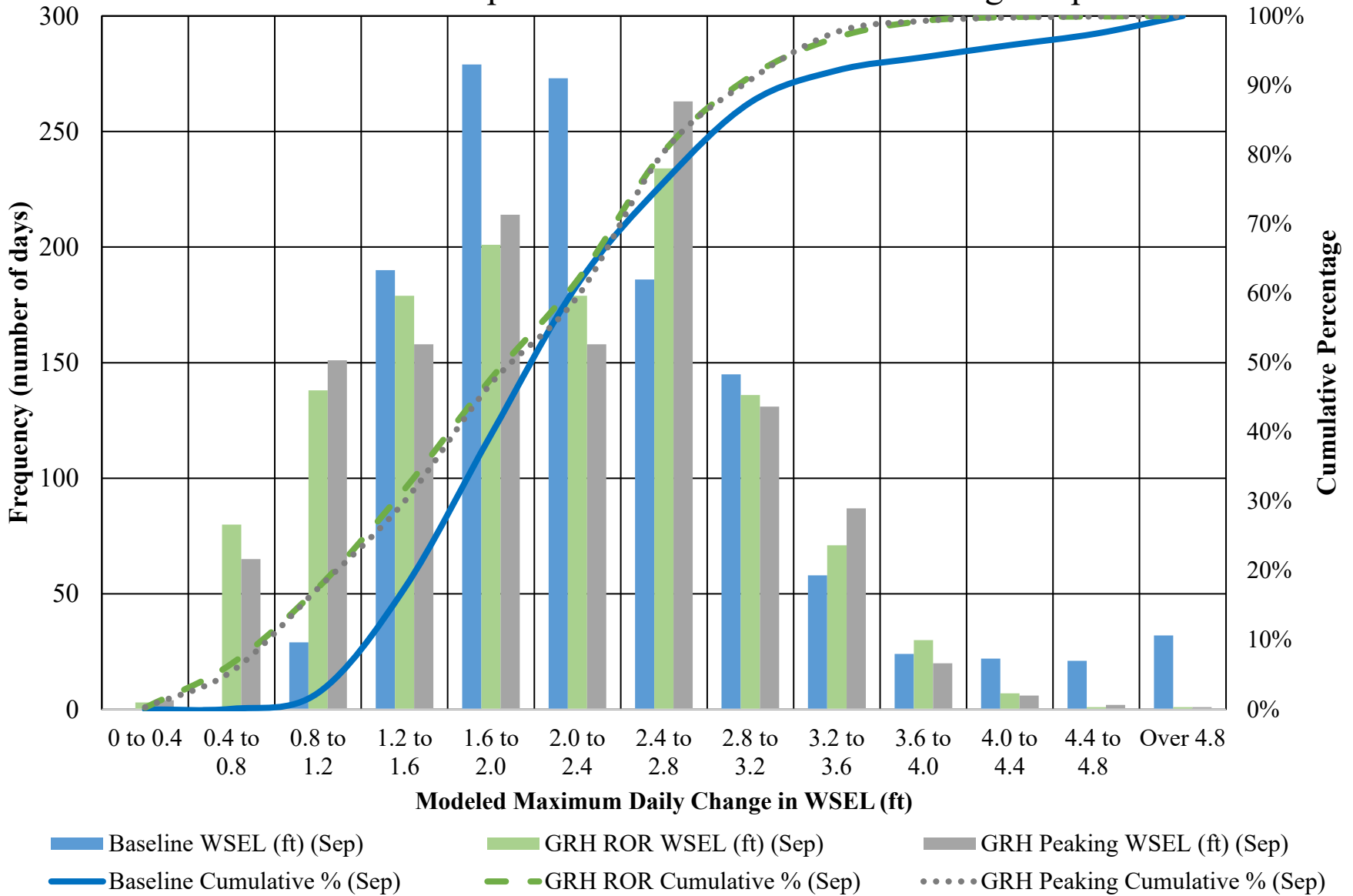


## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - August

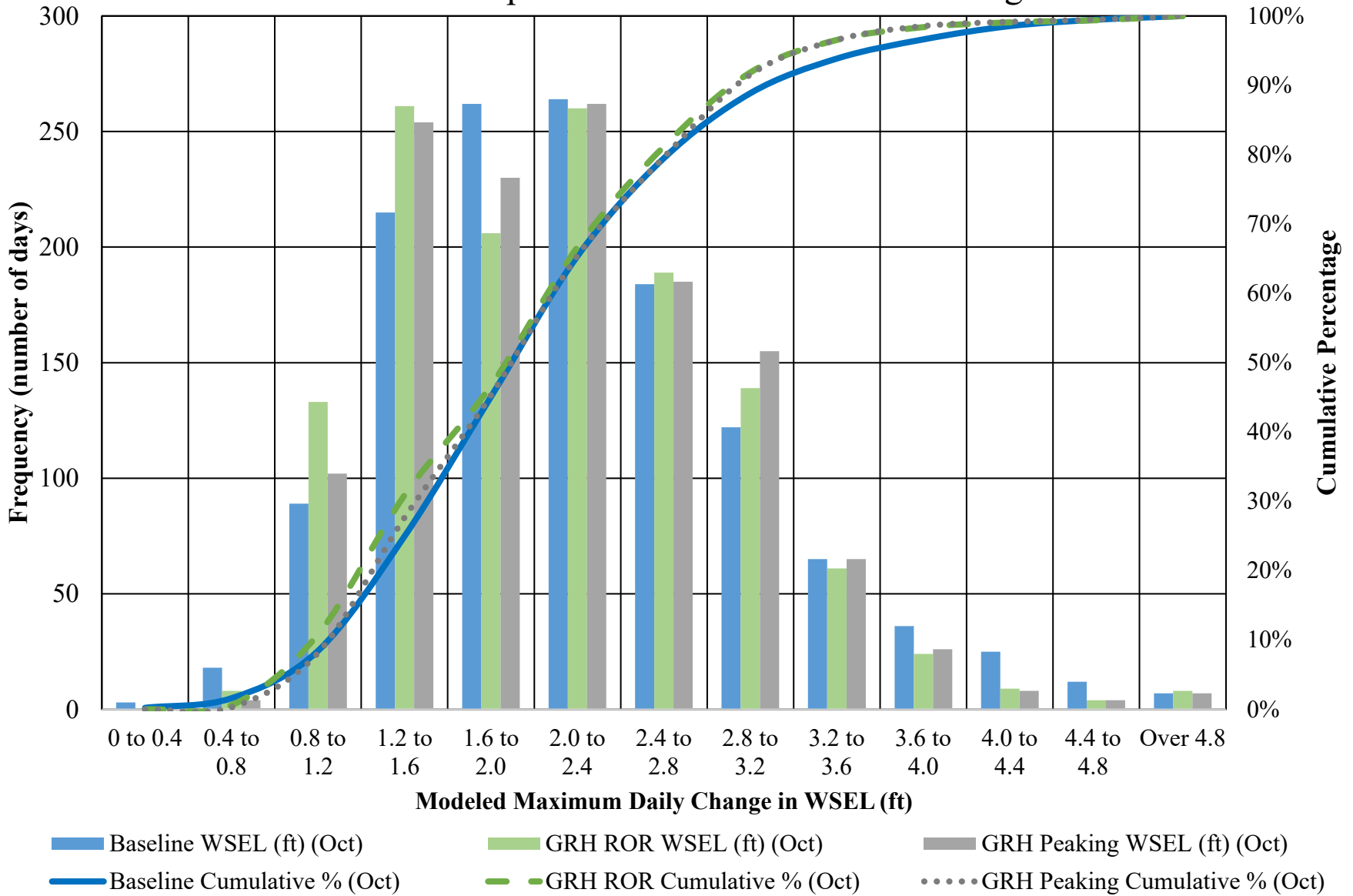




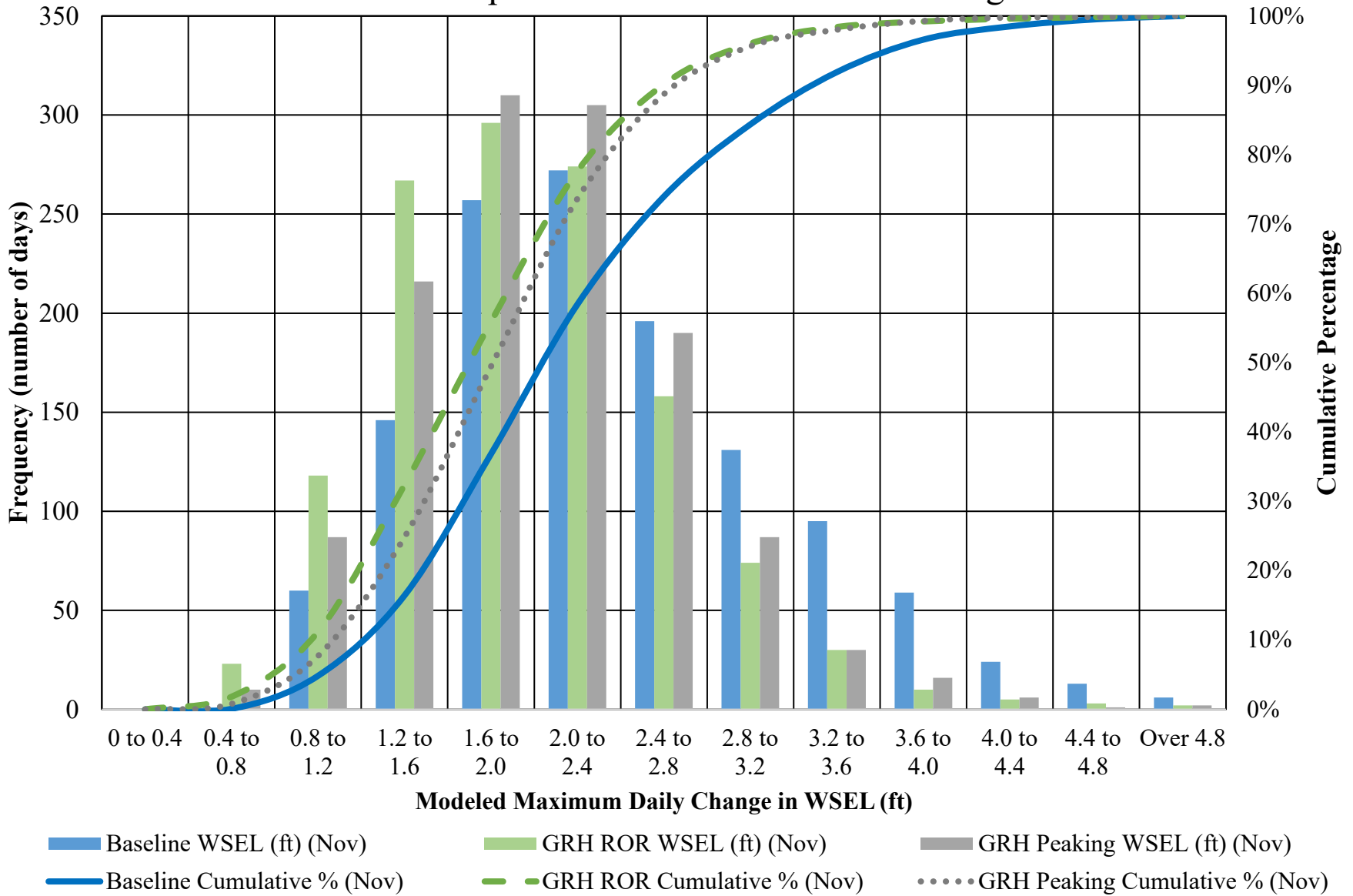
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - September



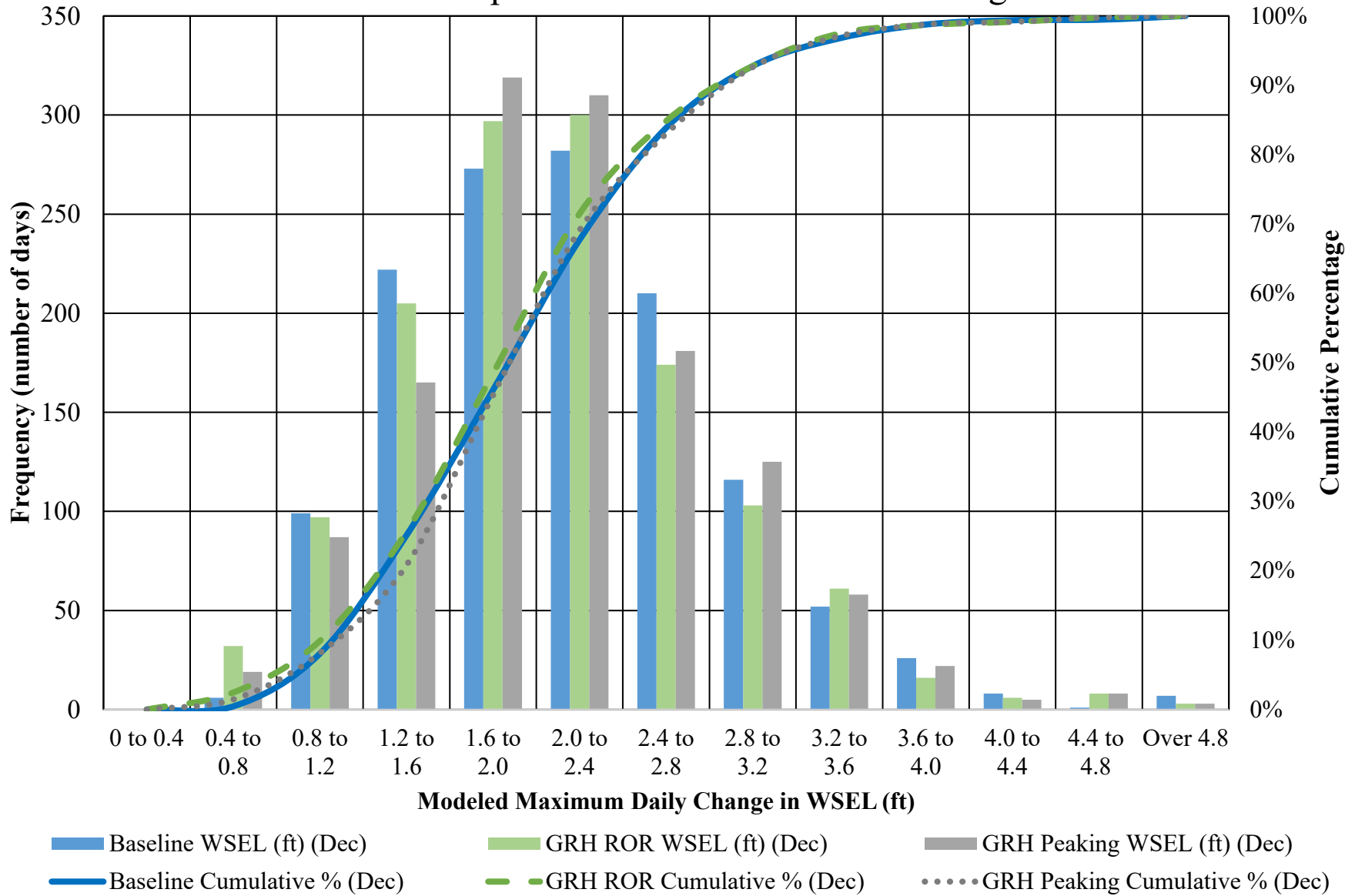
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - October



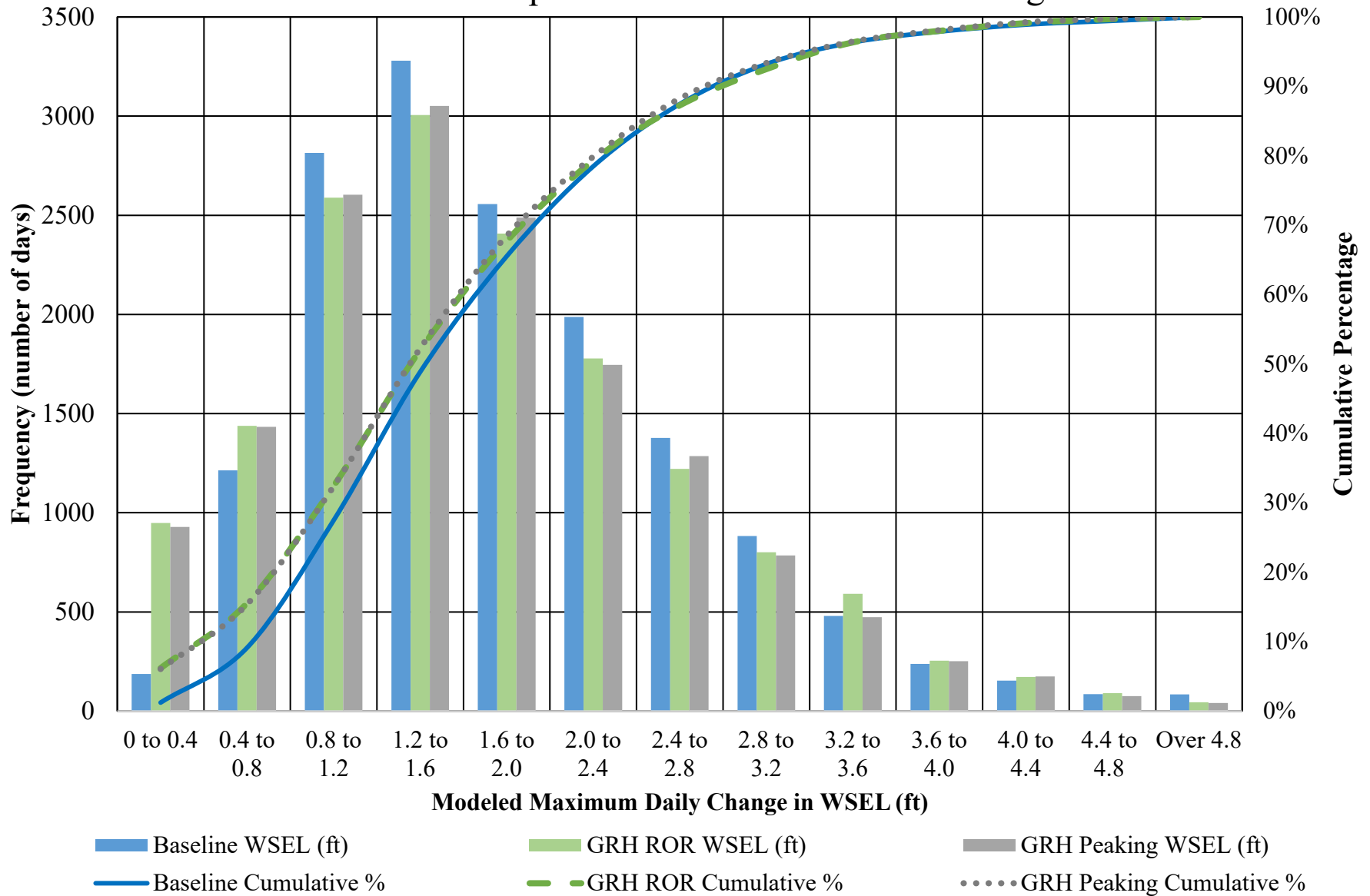
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - November



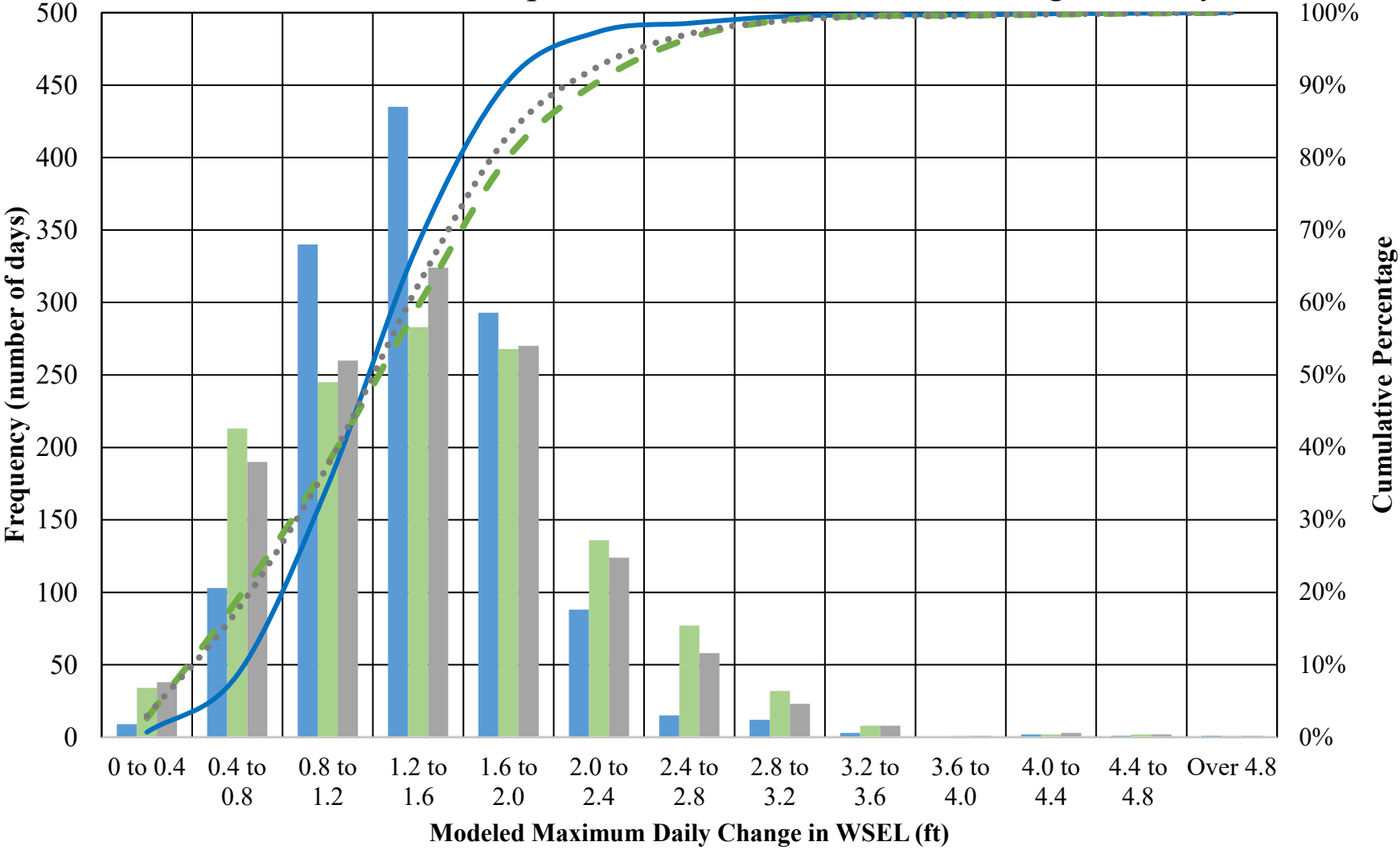
## HEC-RAS Station 27123 (near Riverview) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - November



## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - Annual

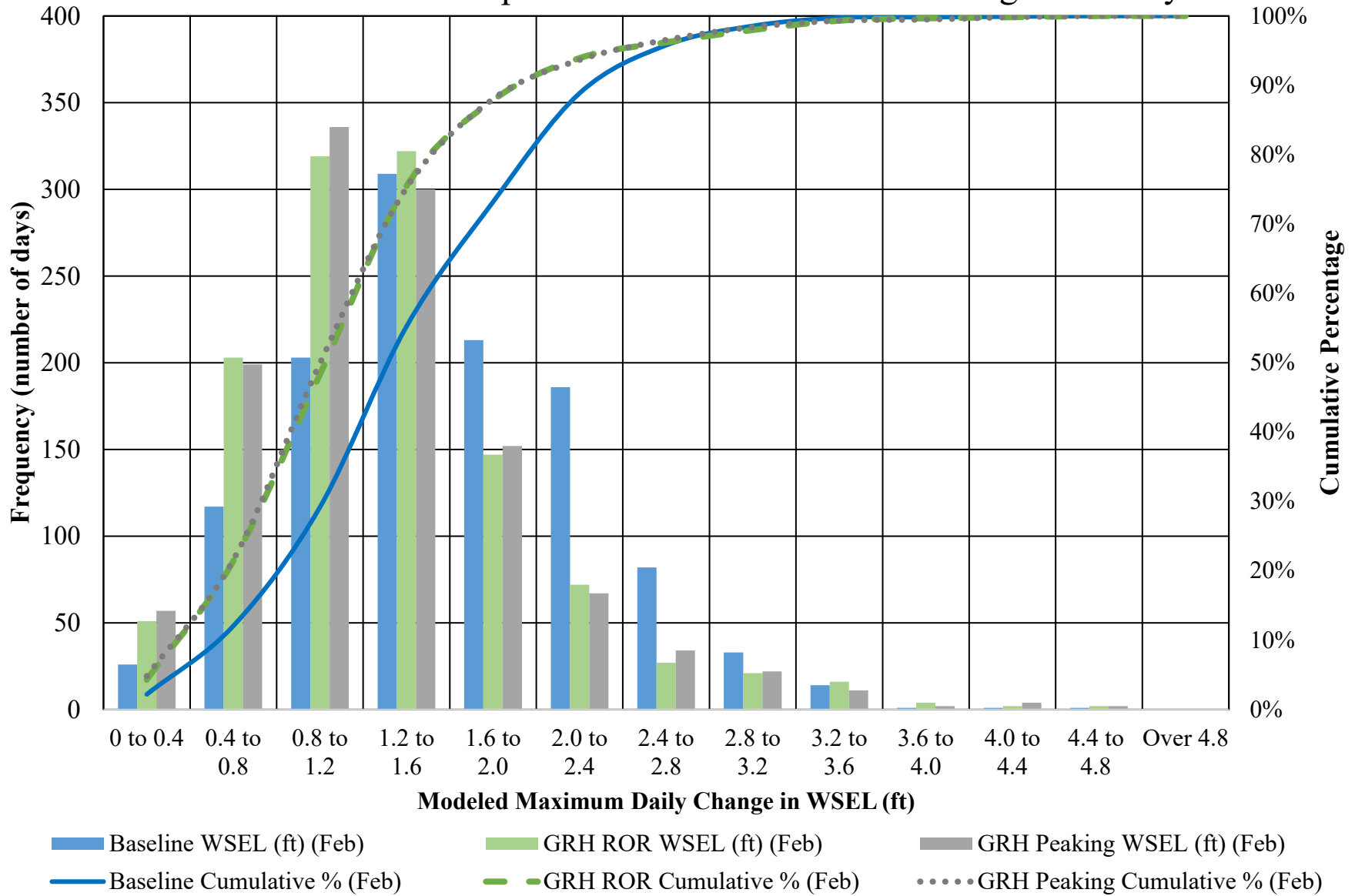


## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - January

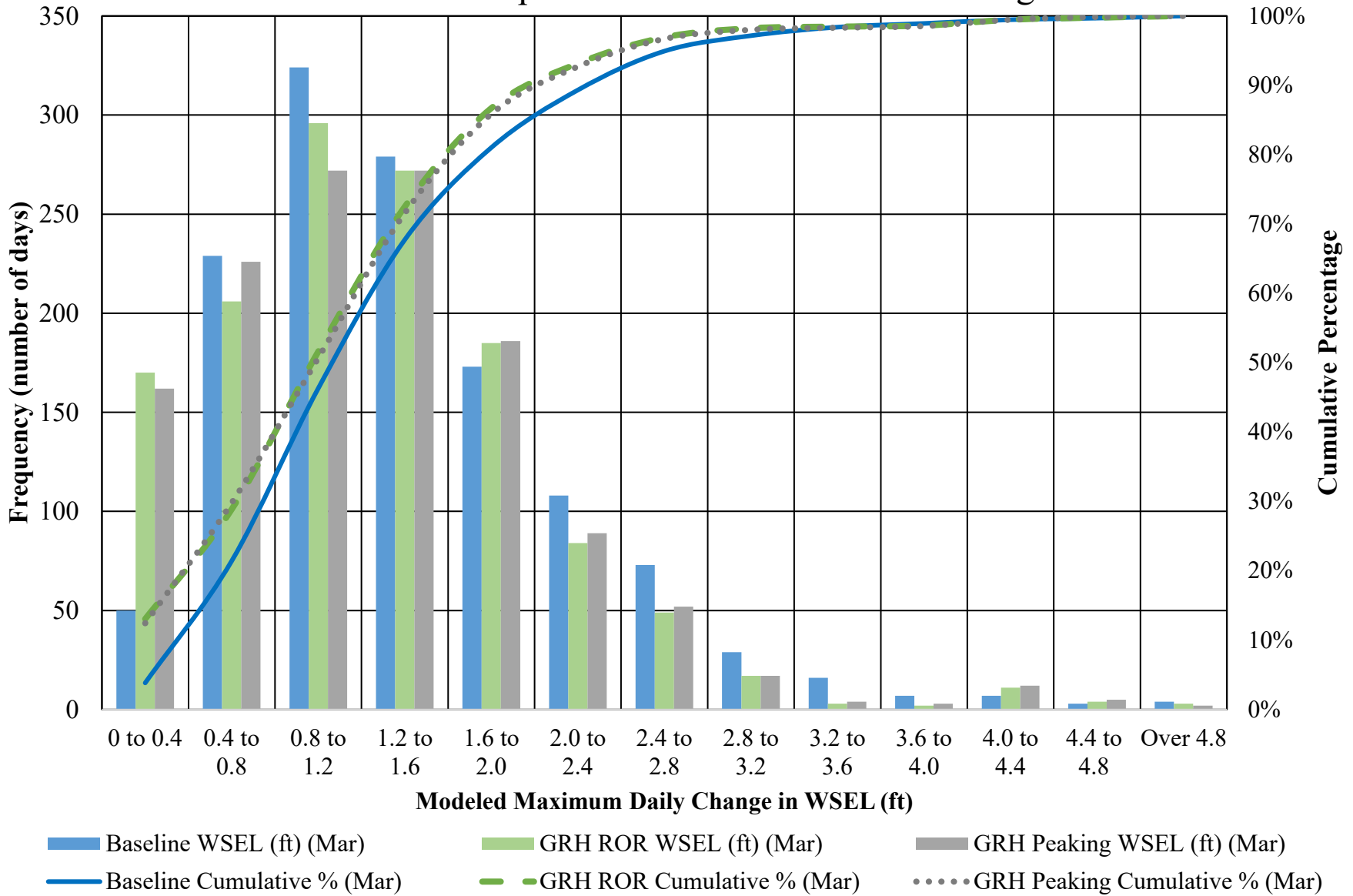


- █ Baseline WSEL (ft) (Jan)
- █ GRH ROR WSEL (ft) (Jan)
- █ GRH Peaking WSEL (ft) (Jan)
- Baseline Cumulative % (Jan)
- - - GRH ROR Cumulative % (Jan)
- ⋯ GRH Peaking Cumulative % (Jan)

## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - February

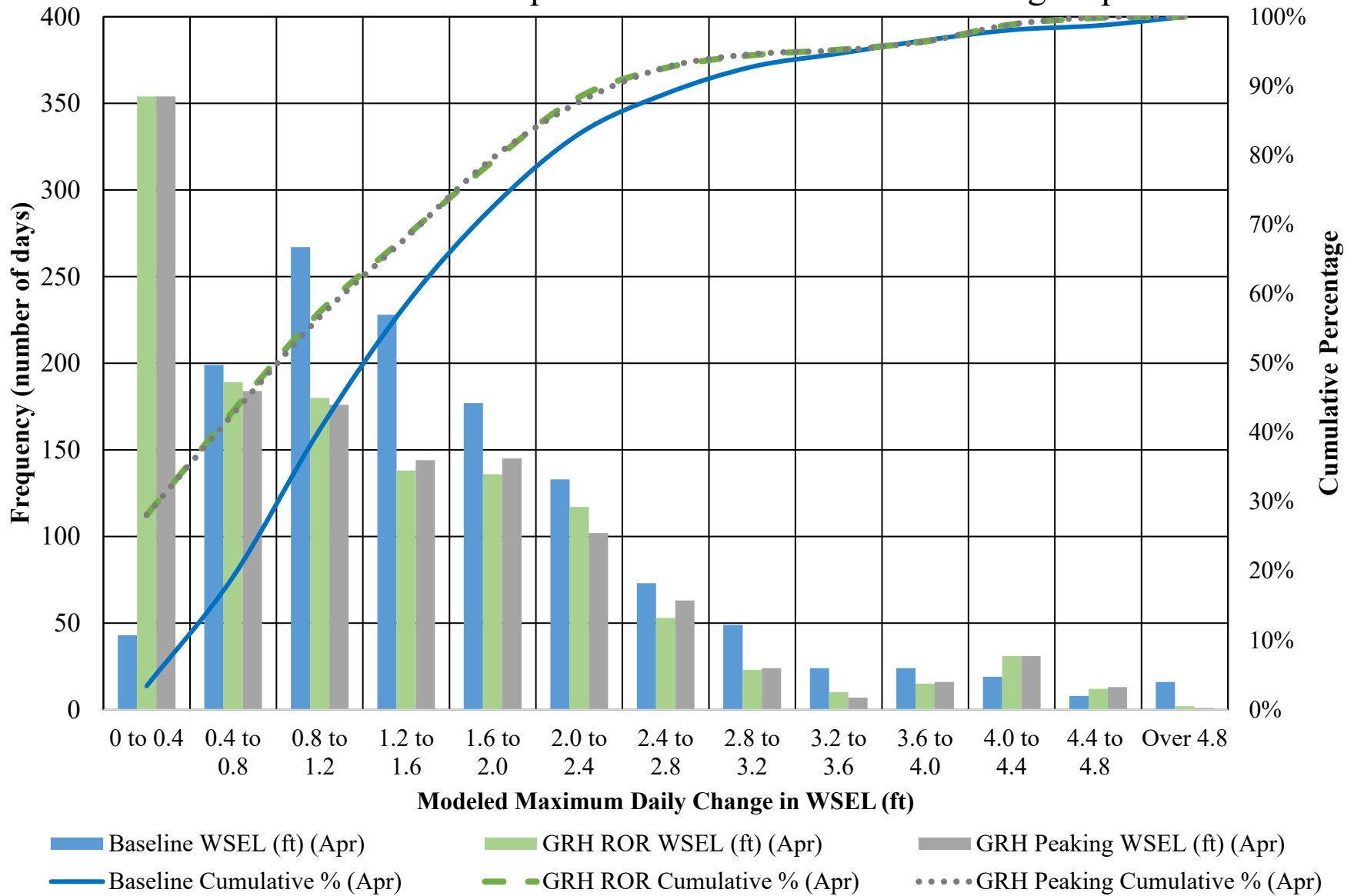


## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - March

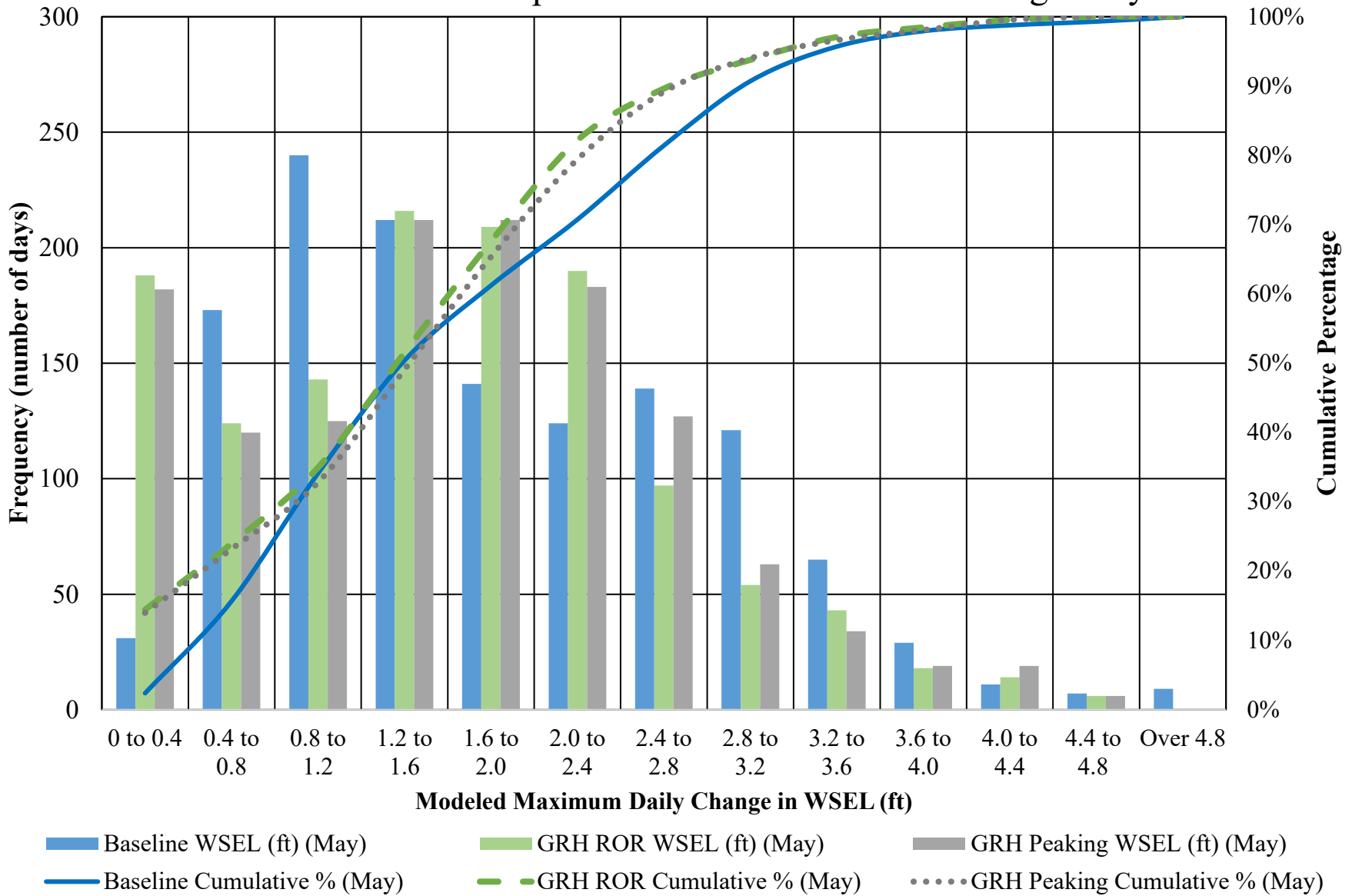




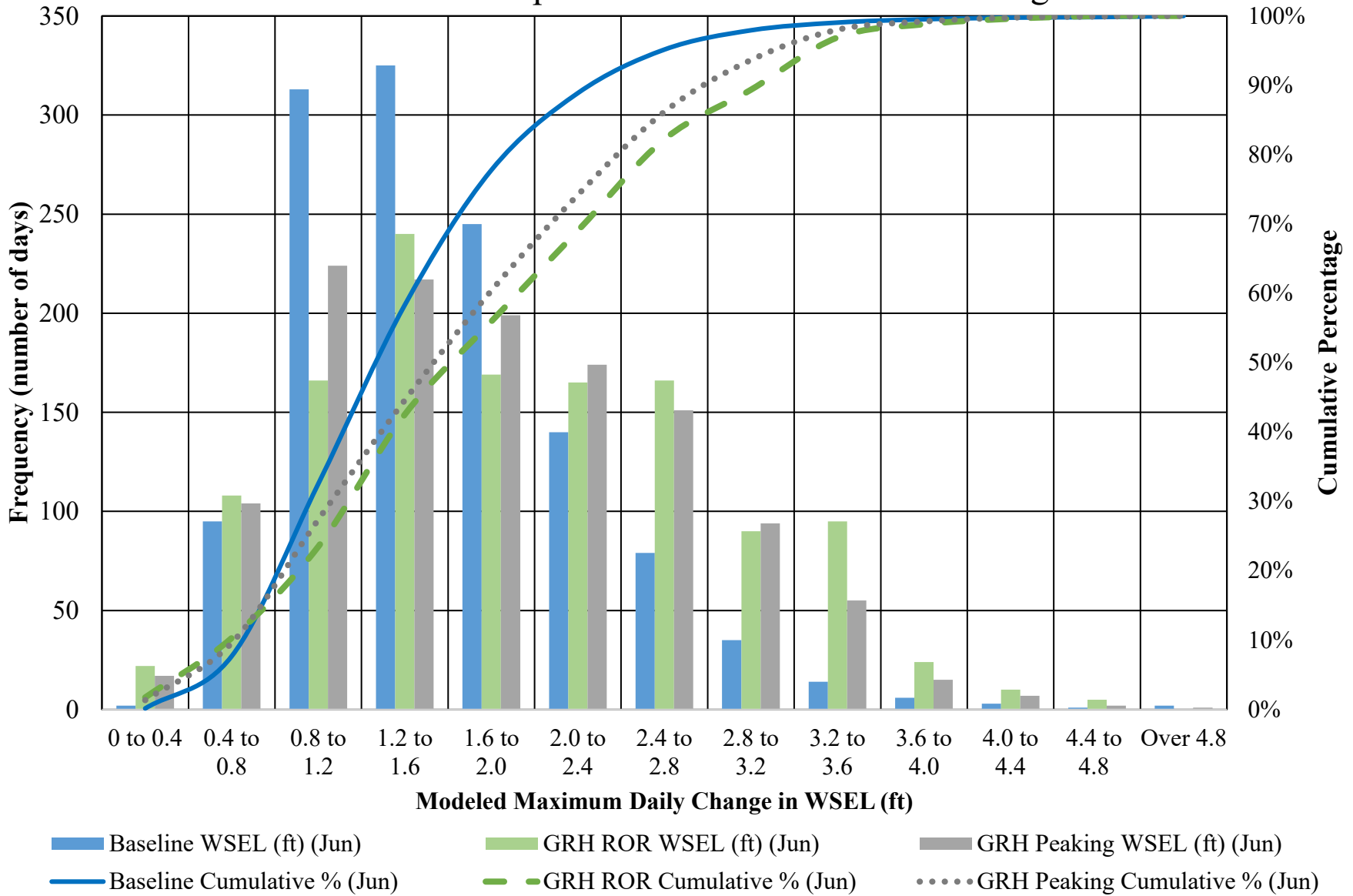
## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - April



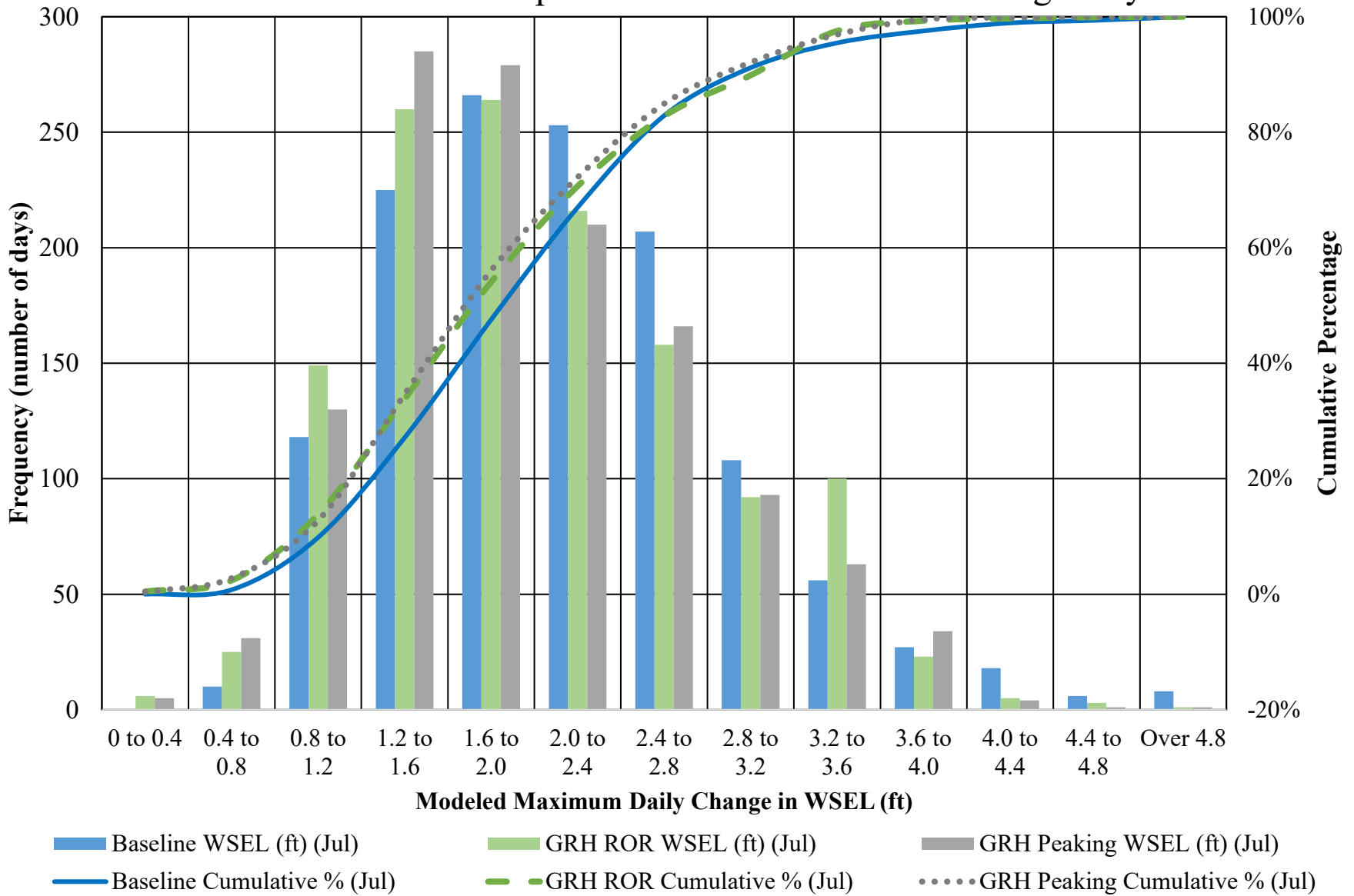
## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - May



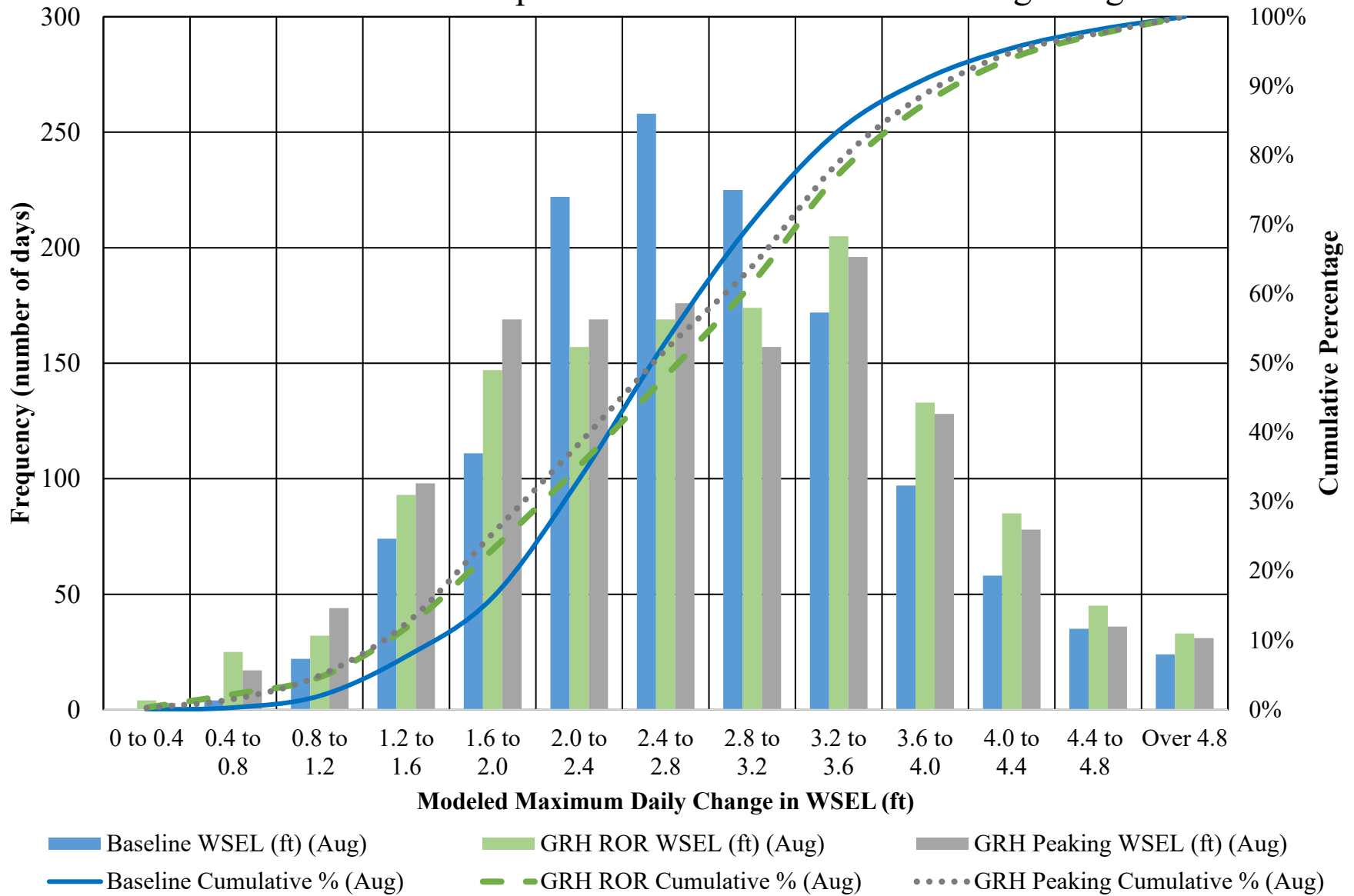
## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - June



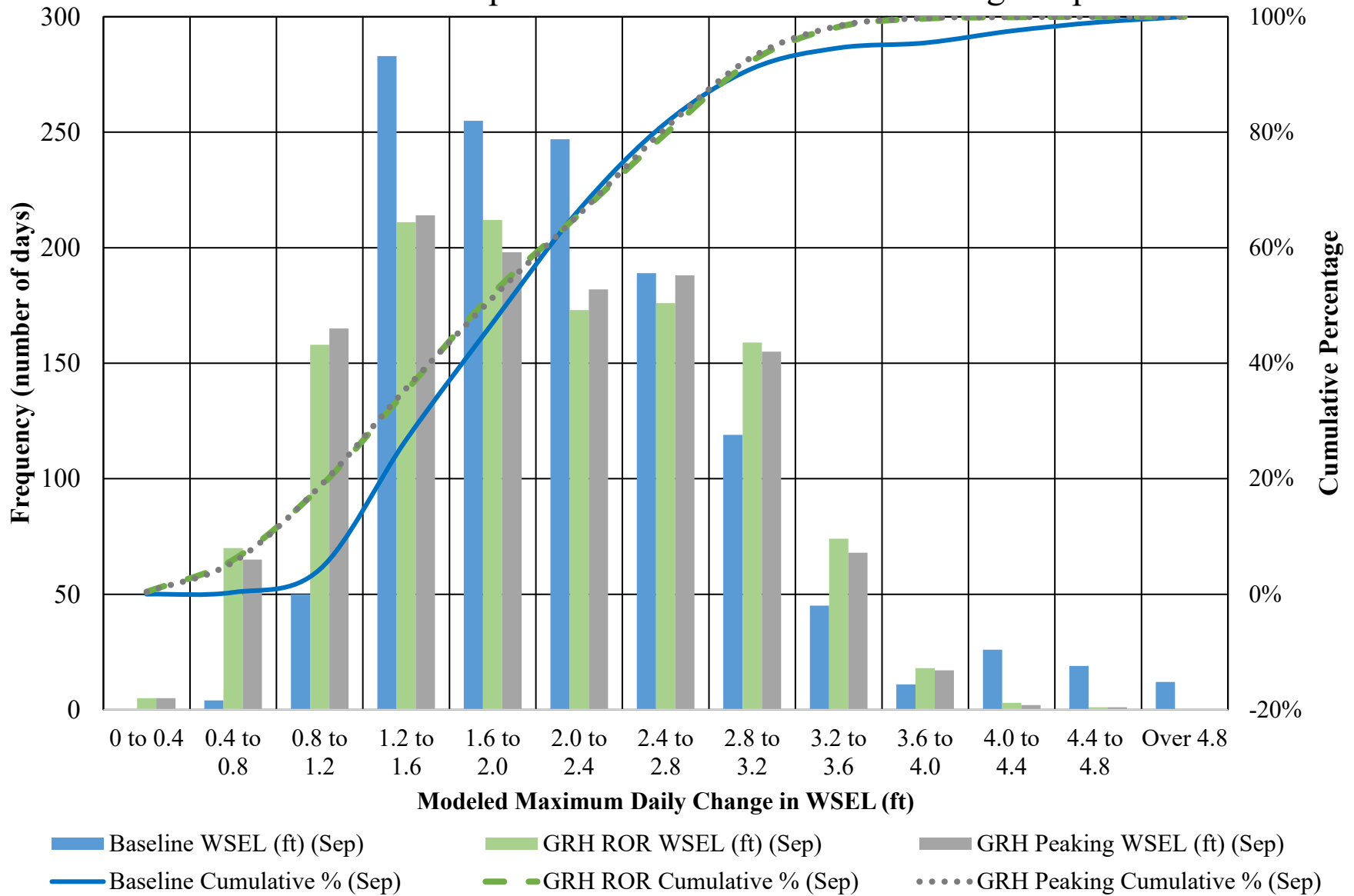
## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - July



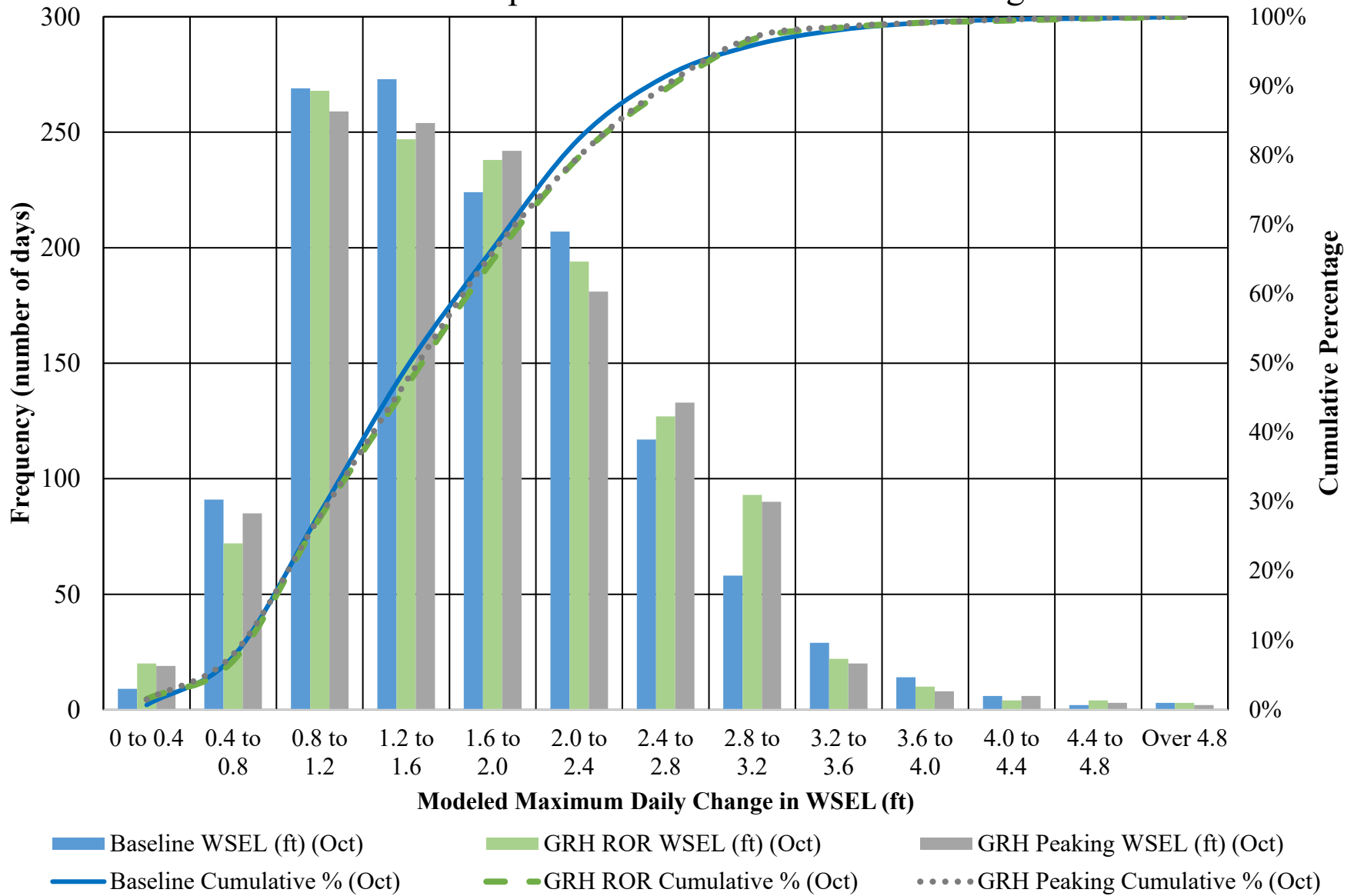
## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - August



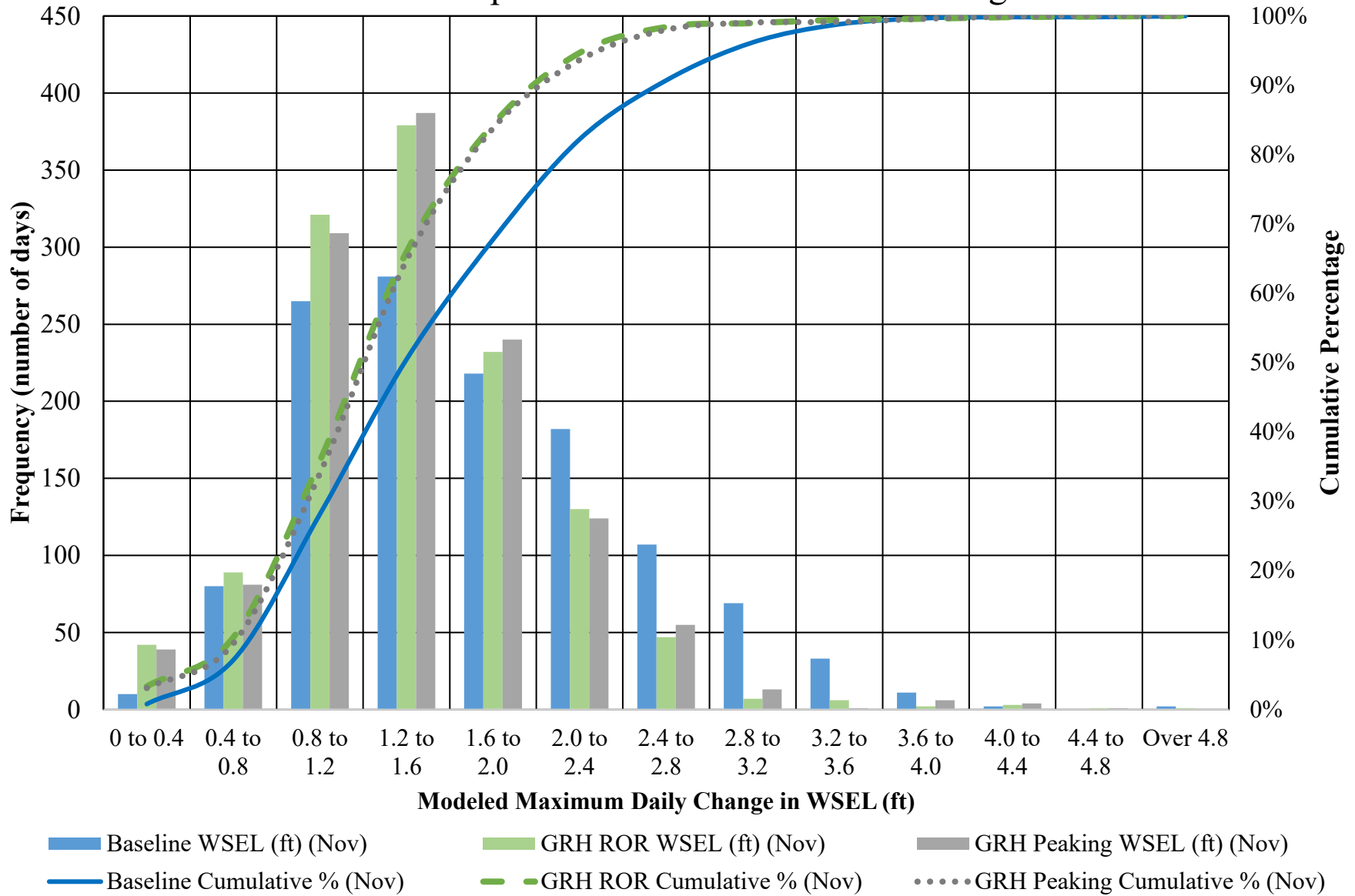
## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - September



## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - October

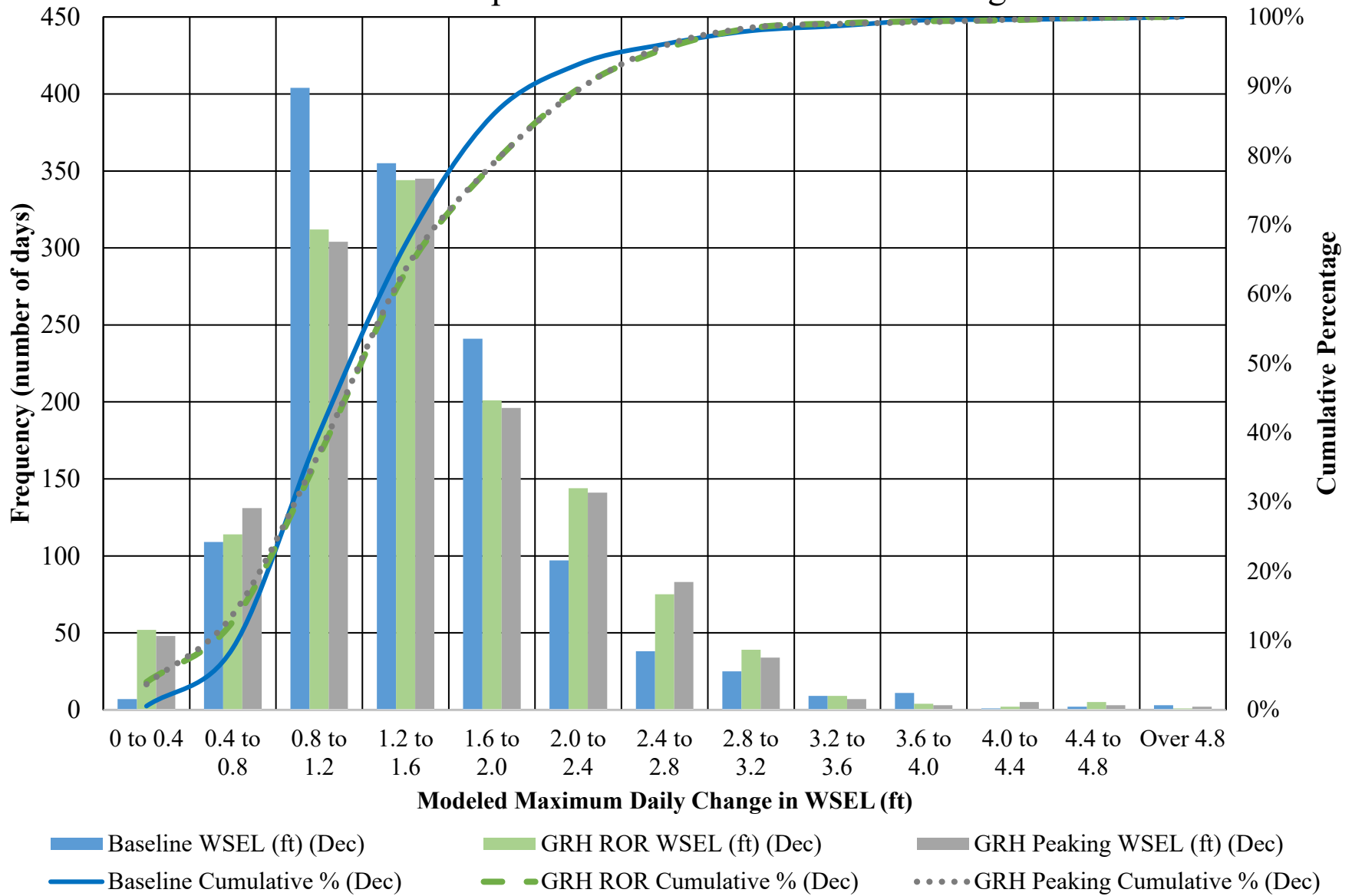


## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - November





## Turners Falls Impoundment (at TFD) WSEL Change Comparison Baseline vs. AFLA Proposal with GRH ROR and Peaking - December



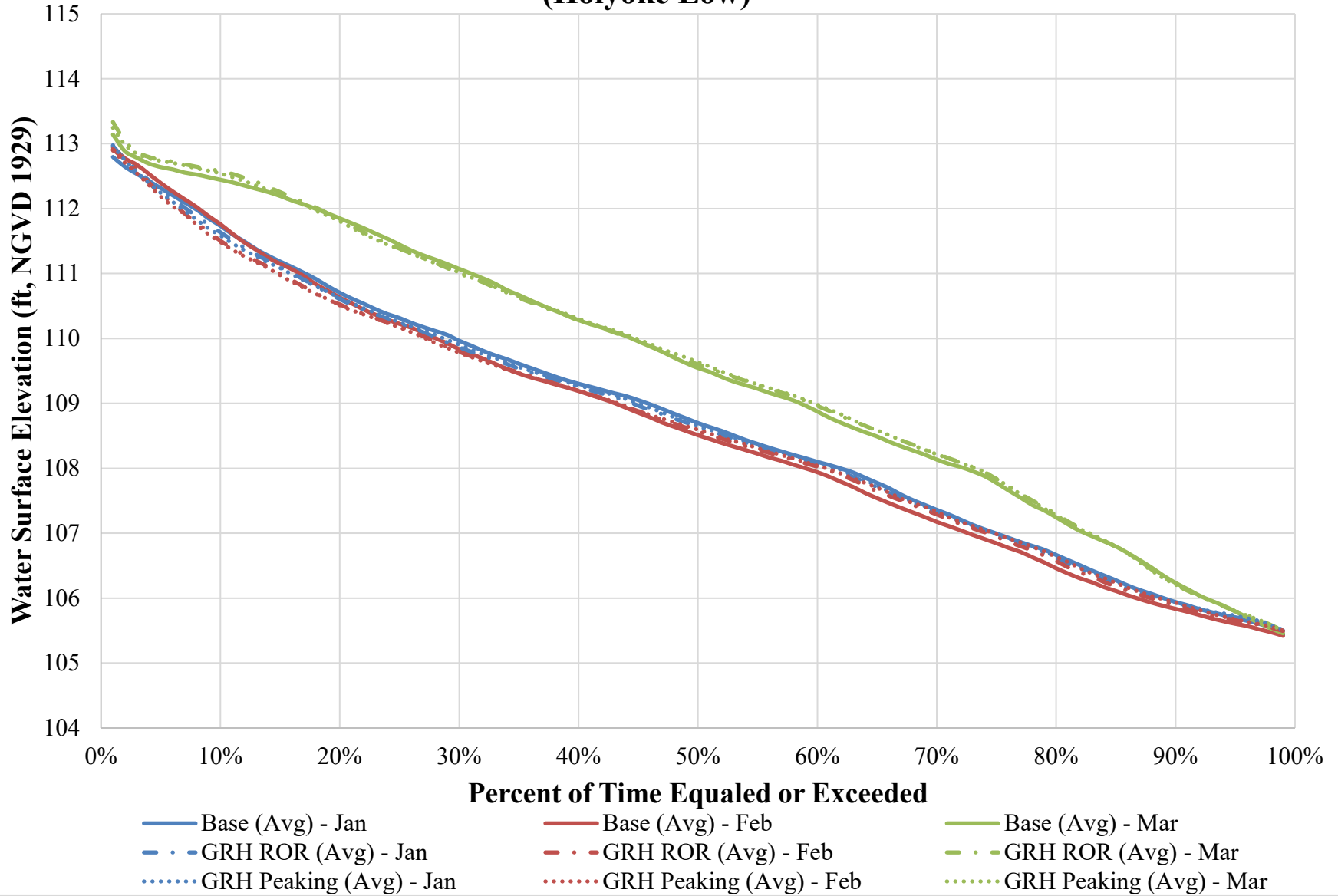
**Appendix TF-AIR#5-DS WSEL Duration Curves for the following locations.**

- \*River Mile 118.508 WSEL Duration Curve (Reach 4 near Montague);
- \*River Mile 115.07 WSEL Duration Curve (Reach 4);
- \*River Mile 112.36 WSEL Duration Curve (Reach 4);
- \*River Mile 109.52 WSEL Duration Curve (Reach 4);
- \*\*River Mile 94.298 Rainbow Beach WSEL Duration Curve (Reach 5)- Low Holyoke; and
- \*\*River Mile 94.298 Rainbow Beach WSEL Duration Curve (Reach 5)- High Holyoke.

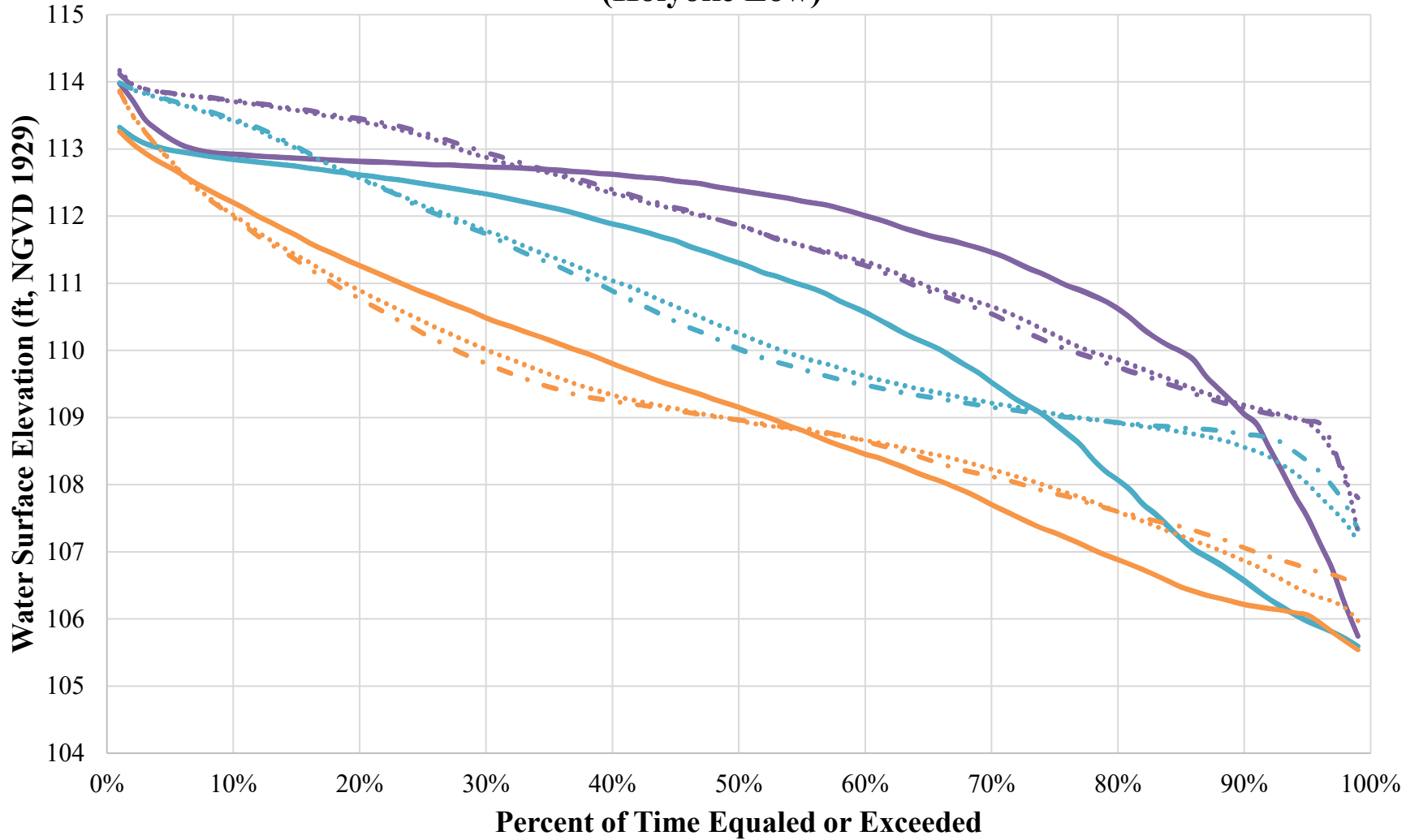
\* The downstream boundary in the model has minimal impact on Reach 4 WSELs. Thus, for these locations the WSEL duration curves are based on Low Holyoke.

\*\*The downstream boundary in the model does have more of an impact on Reach 5 WSELs. Thus, for the Rainbow Beach location two sets of WSEL duration curves were developed for both Low and High Holyoke.

**Water Surface Elevations at HEC-RAS Station 118.508 (near Montague)  
 Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking  
 (Holyoke Low)**

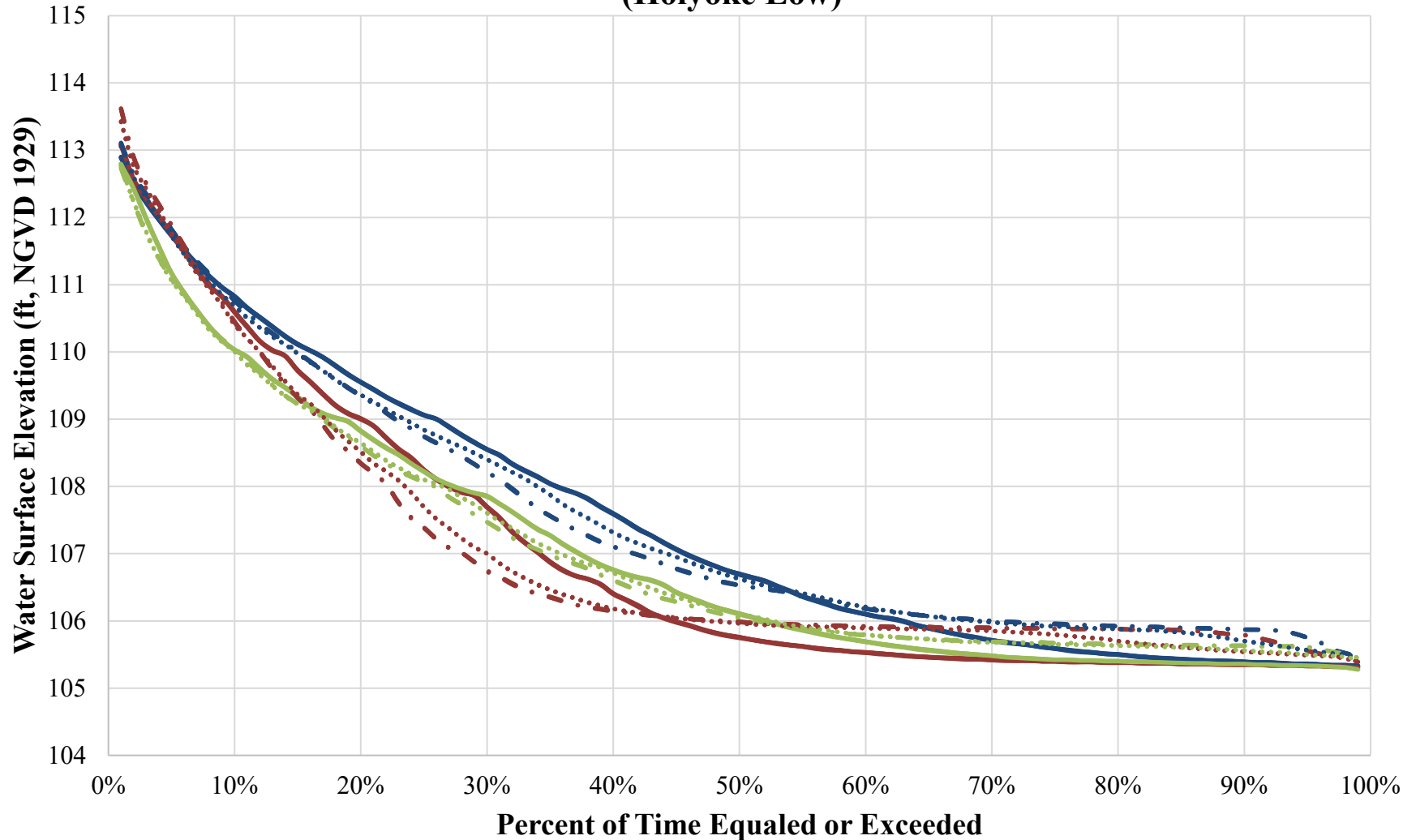


## Water Surface Elevations at HEC-RAS Station 118.508 (near Montague) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



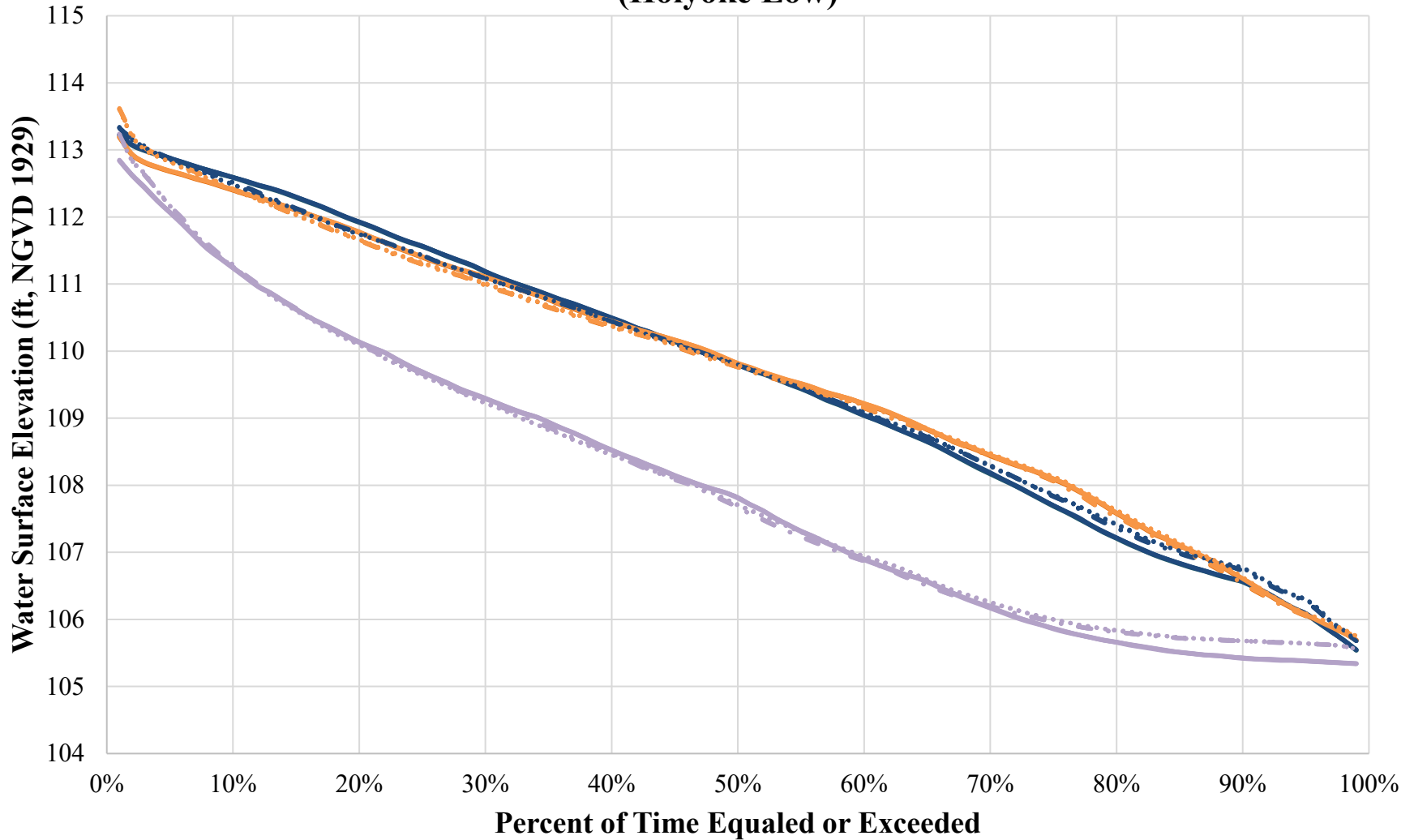
- |   |   |   |
|---|---|---|
| <ul style="list-style-type: none"> <li>— Base (Low) - Apr</li> <li>- - GRH ROR (Low) - Apr</li> <li>..... GRH Peaking (Low) - Apr</li> <li>— Base (High) - Apr</li> </ul> | <ul style="list-style-type: none"> <li>— Base (Low) - May</li> <li>- - GRH ROR (Low) - May</li> <li>..... GRH Peaking (Low) - May</li> <li>— Base (High) - May</li> </ul> | <ul style="list-style-type: none"> <li>— Base (Low) - Jun</li> <li>- - GRH ROR (Low) - Jun</li> <li>..... GRH Peaking (Low) - Jun</li> <li>— Base (High) - Jun</li> </ul> |
|---|---|---|

## Water Surface Elevations at HEC-RAS Station 118.508 (near Montague) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



- Base (Low) - Jul
- - GRH ROR (Low) - Jul
- ..... GRH Peaking (Low) - Jul
- Base (Low) - Aug
- - GRH ROR (Low) - Aug
- ..... GRH Peaking (Low) - Aug
- Base (Low) - Sep
- - GRH ROR (Low) - Sep
- ..... GRH Peaking (Low) - Sep

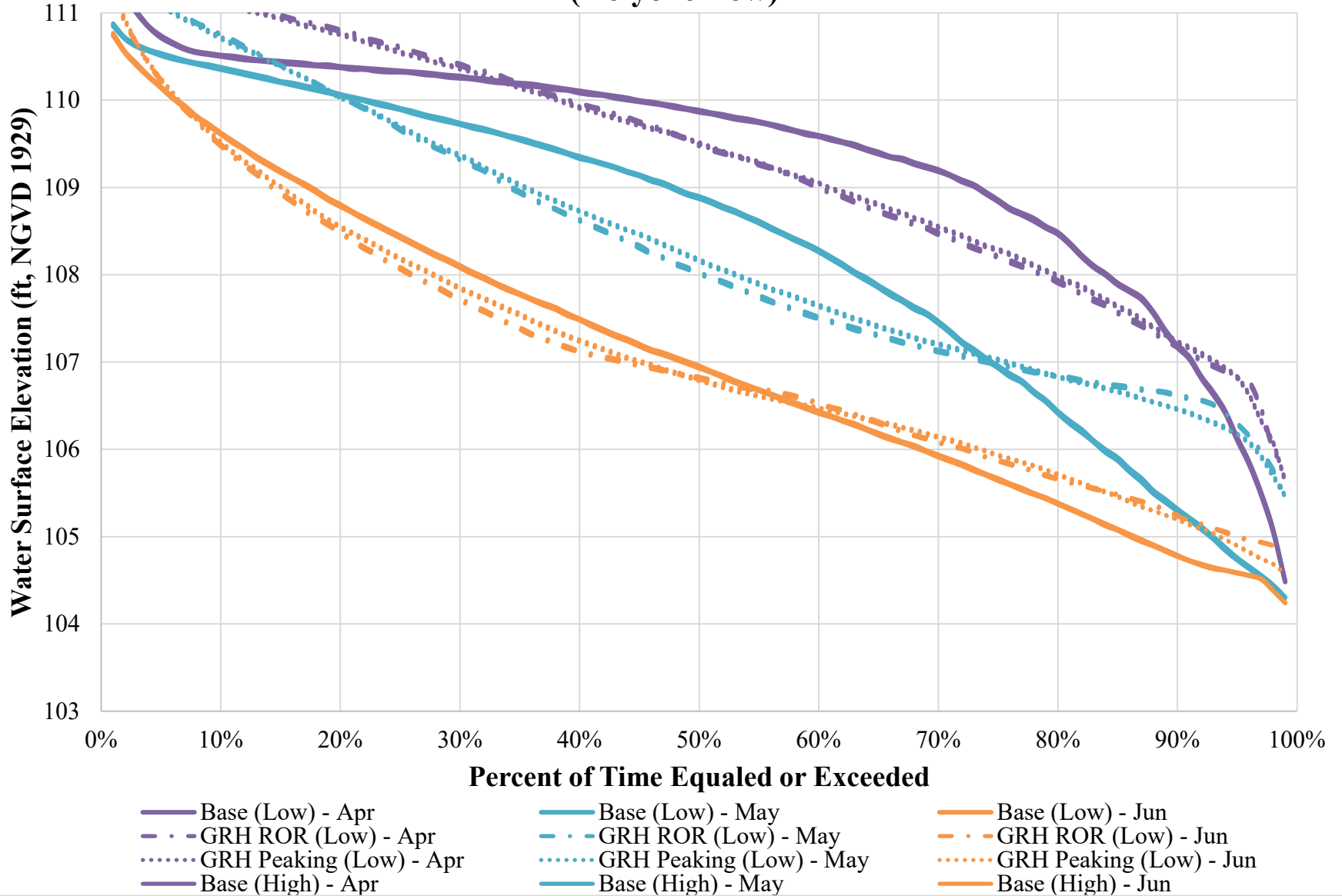
## Water Surface Elevations at HEC-RAS Station 118.508 (near Montague) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



- |                               |                               |                               |
|-------------------------------|-------------------------------|-------------------------------|
| — Base (Low) - Oct            | — GRH ROR (Low) - Nov         | — Base (Low) - Dec            |
| - - GRH ROR (Low) - Oct       | - - GRH ROR (Low) - Nov       | - - GRH ROR (Low) - Dec       |
| ..... GRH Peaking (Low) - Oct | ..... GRH Peaking (Low) - Nov | ..... GRH Peaking (Low) - Dec |

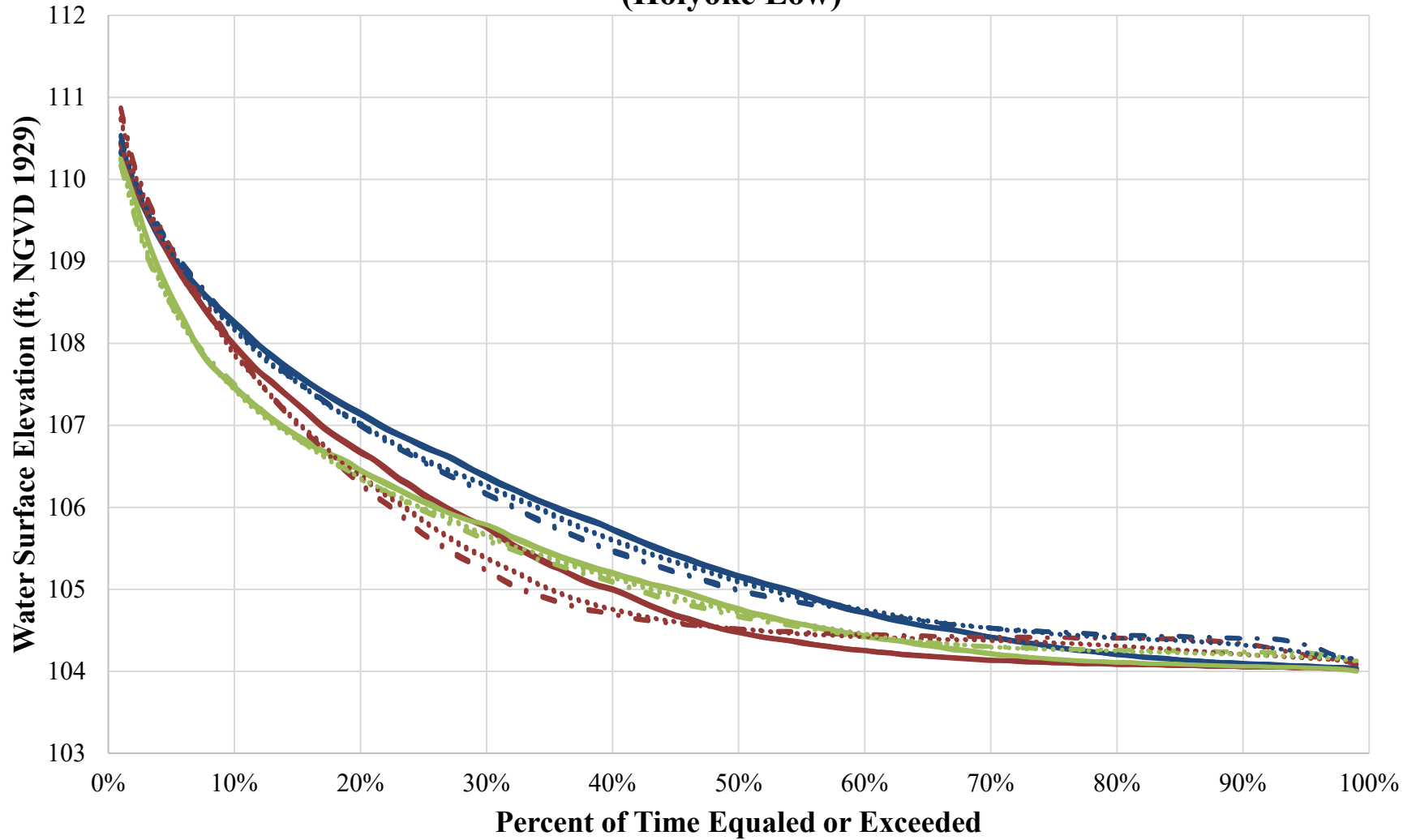


## Water Surface Elevations at HEC-RAS Station 115.07 Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



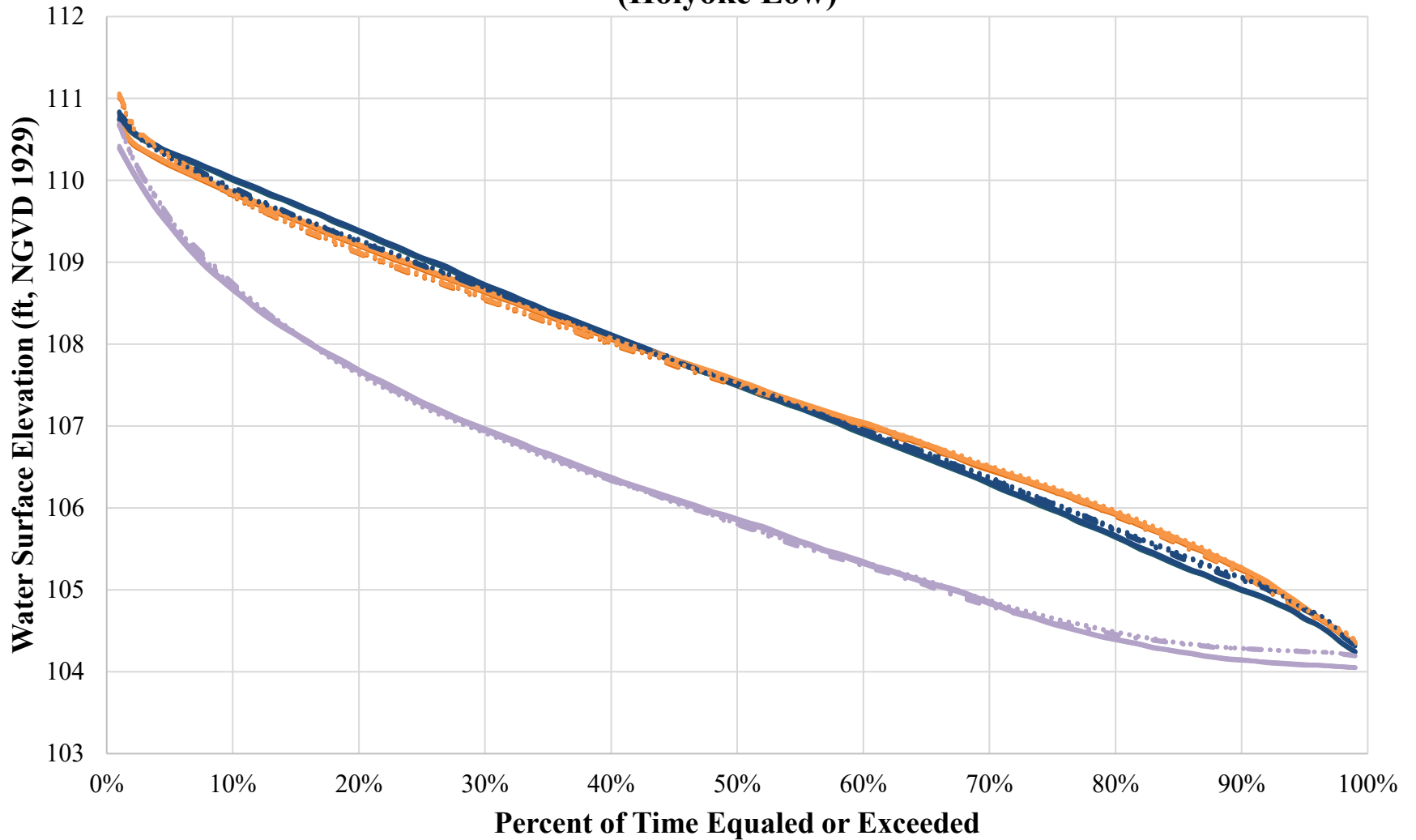


# Water Surface Elevations at HEC-RAS Station 115.07 Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



- Base (Low) - Jul
- - GRH ROR (Low) - Jul
- ..... GRH Peaking (Low) - Jul
- Base (Low) - Aug
- - GRH ROR (Low) - Aug
- ..... GRH Peaking (Low) - Aug
- Base (Low) - Sep
- - GRH ROR (Low) - Sep
- ..... GRH Peaking (Low) - Sep

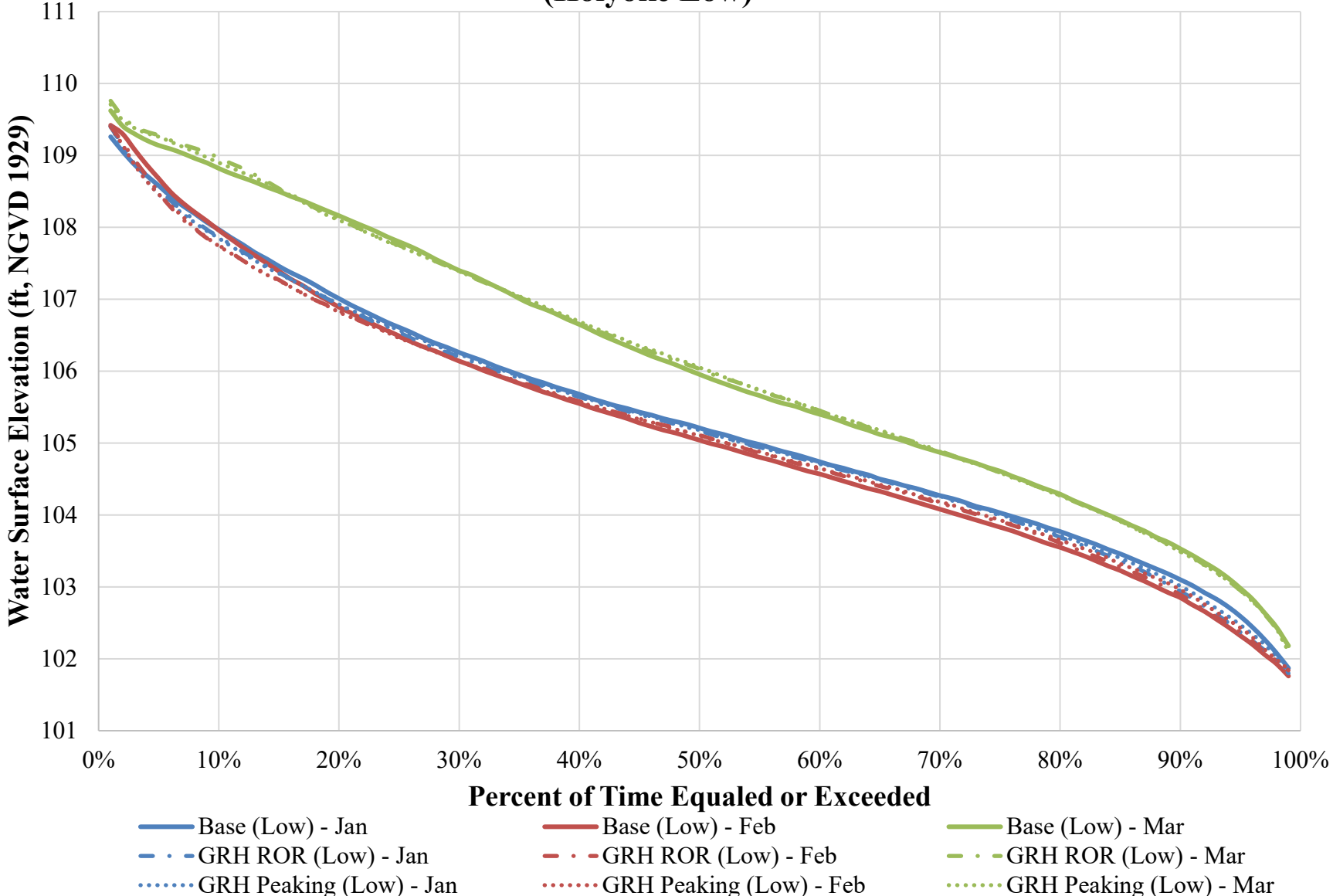
## Water Surface Elevations at HEC-RAS Station 115.07 Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



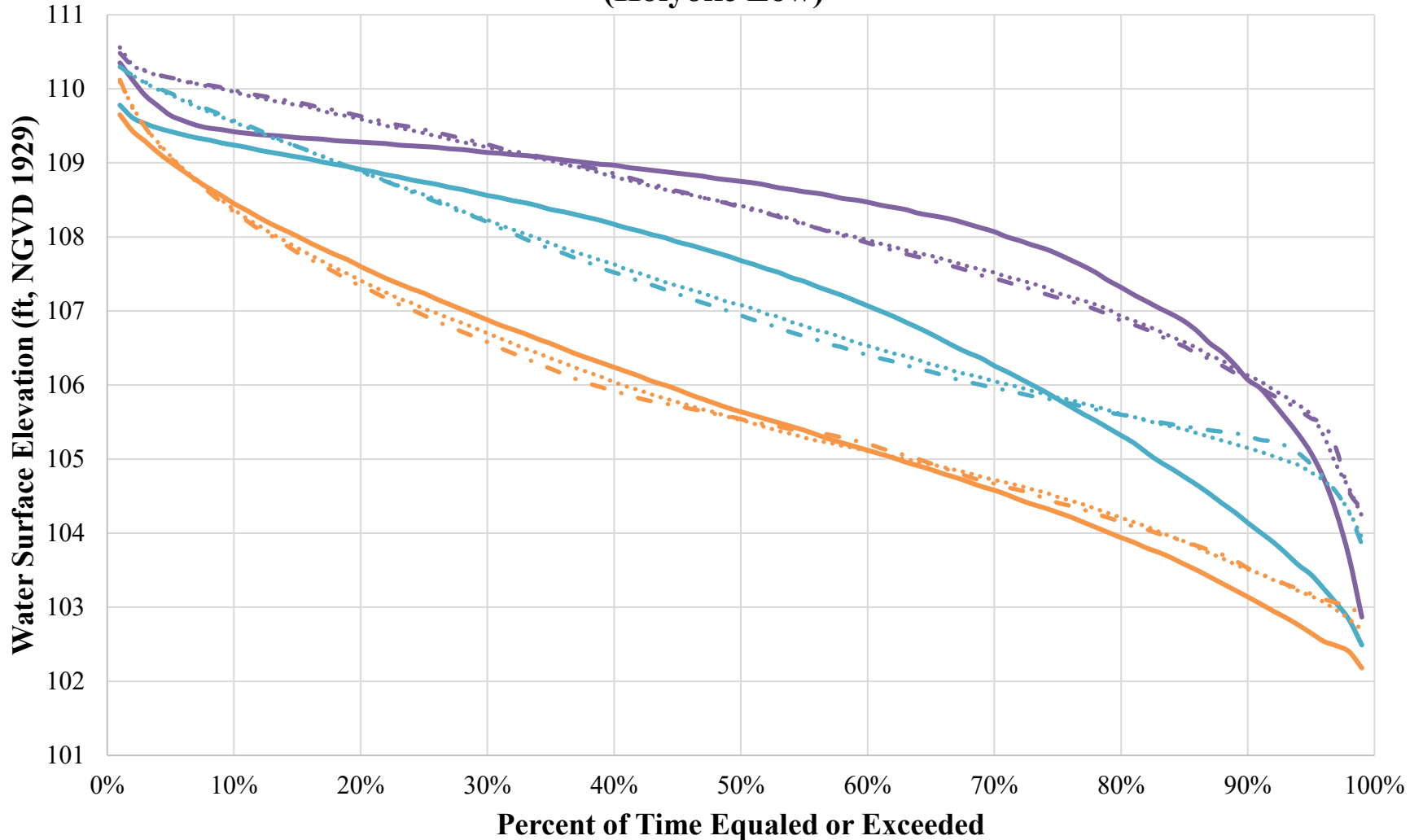
- Base (Low) - Oct
- - GRH ROR (Low) - Oct
- ..... GRH Peaking (Low) - Oct
- Base (Low) - Nov
- - GRH ROR (Low) - Nov
- ..... GRH Peaking (Low) - Nov
- Base (Low) - Dec
- - GRH ROR (Low) - Dec
- ..... GRH Peaking (Low) - Dec

# Water Surface Elevations at HEC-RAS Station 112.36

## Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)

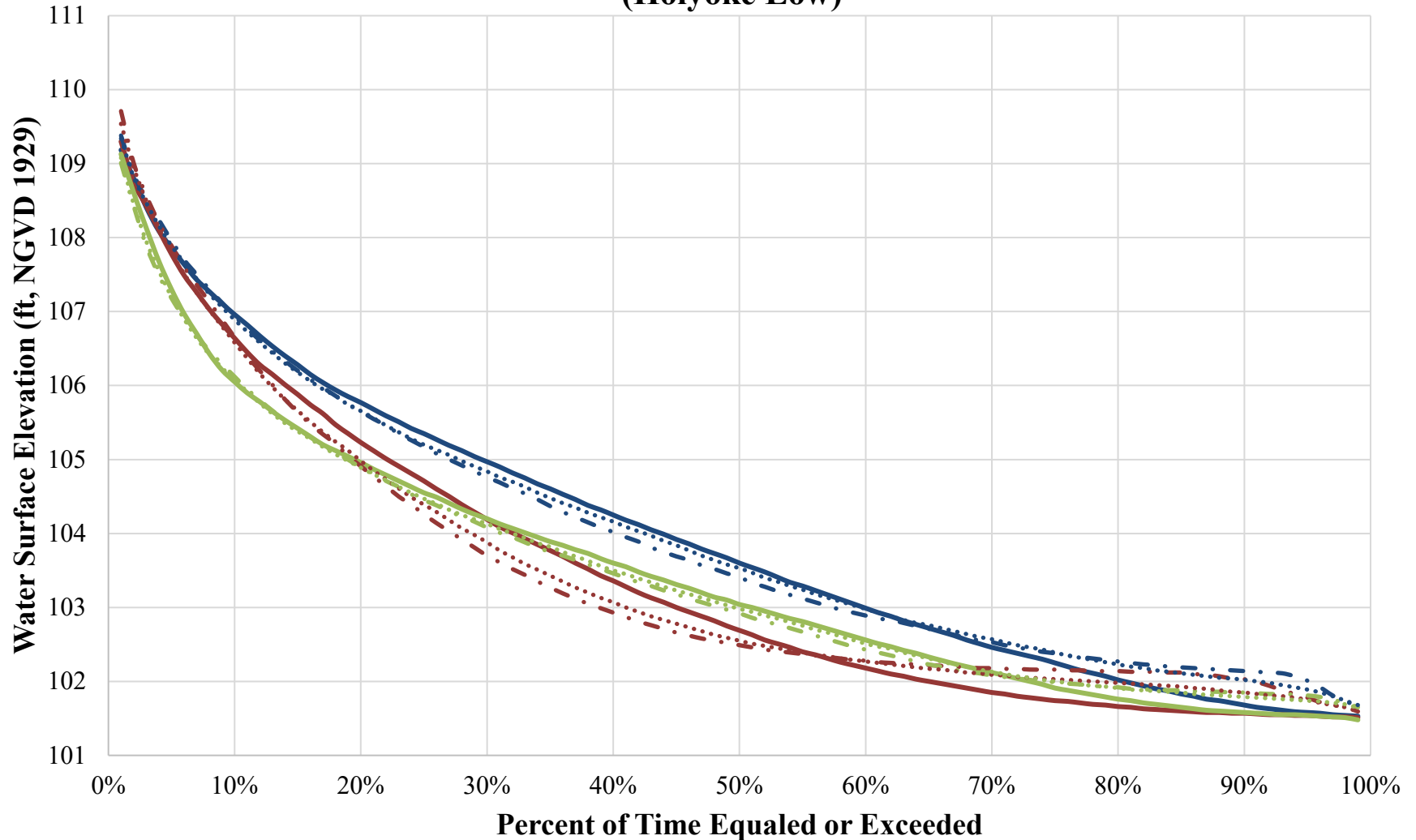


## Water Surface Elevations at HEC-RAS Station 112.36 Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



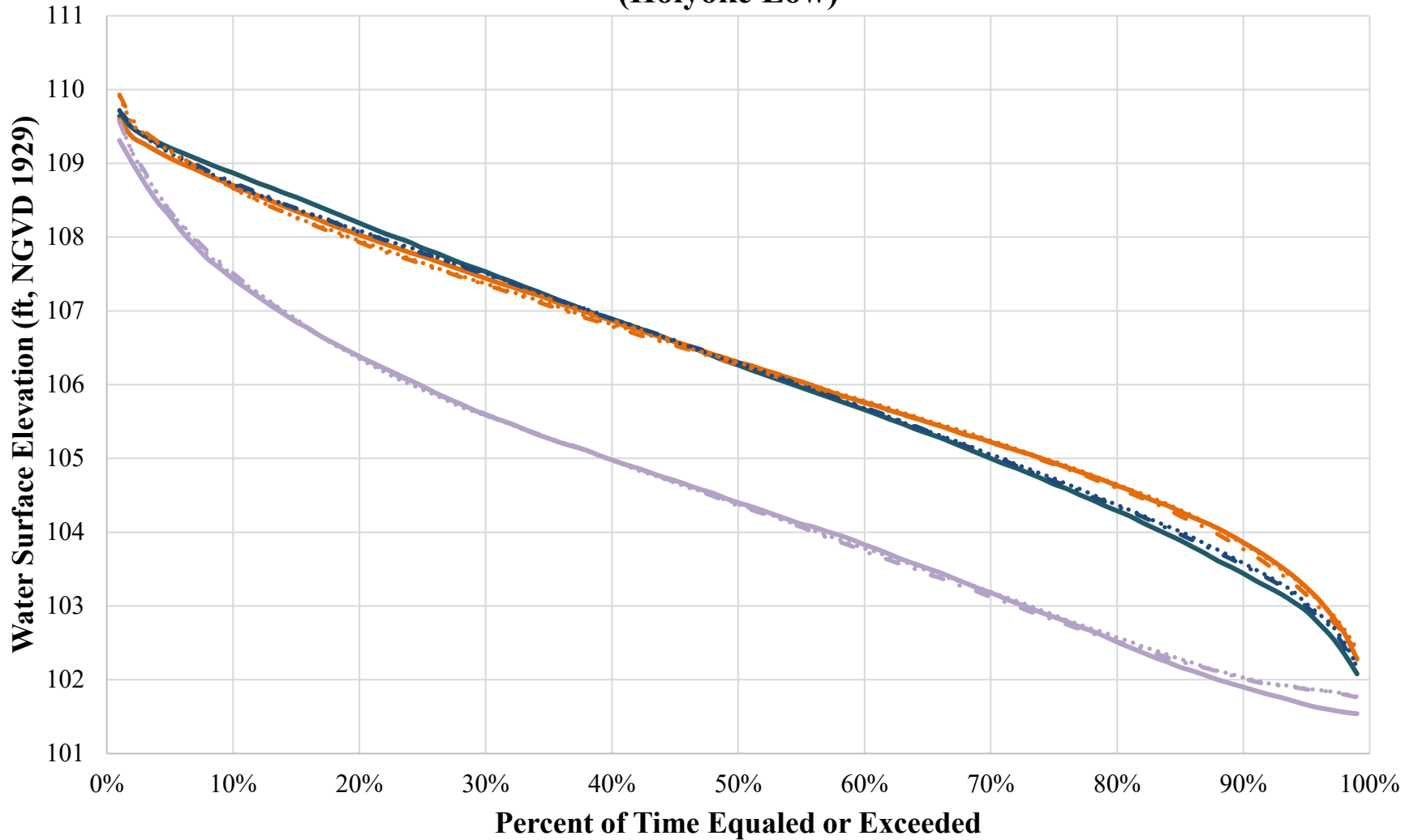
- |                             |                             |                             |
|-----------------------------|-----------------------------|-----------------------------|
| — Base (Low) - Apr          | — Base (Low) - May          | — Base (Low) - Jun          |
| - - GRH ROR (Low) - Apr     | - - GRH ROR (Low) - May     | - - GRH ROR (Low) - Jun     |
| ... GRH Peaking (Low) - Apr | ... GRH Peaking (Low) - May | ... GRH Peaking (Low) - Jun |

## Water Surface Elevations at HEC-RAS Station 112.36 Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



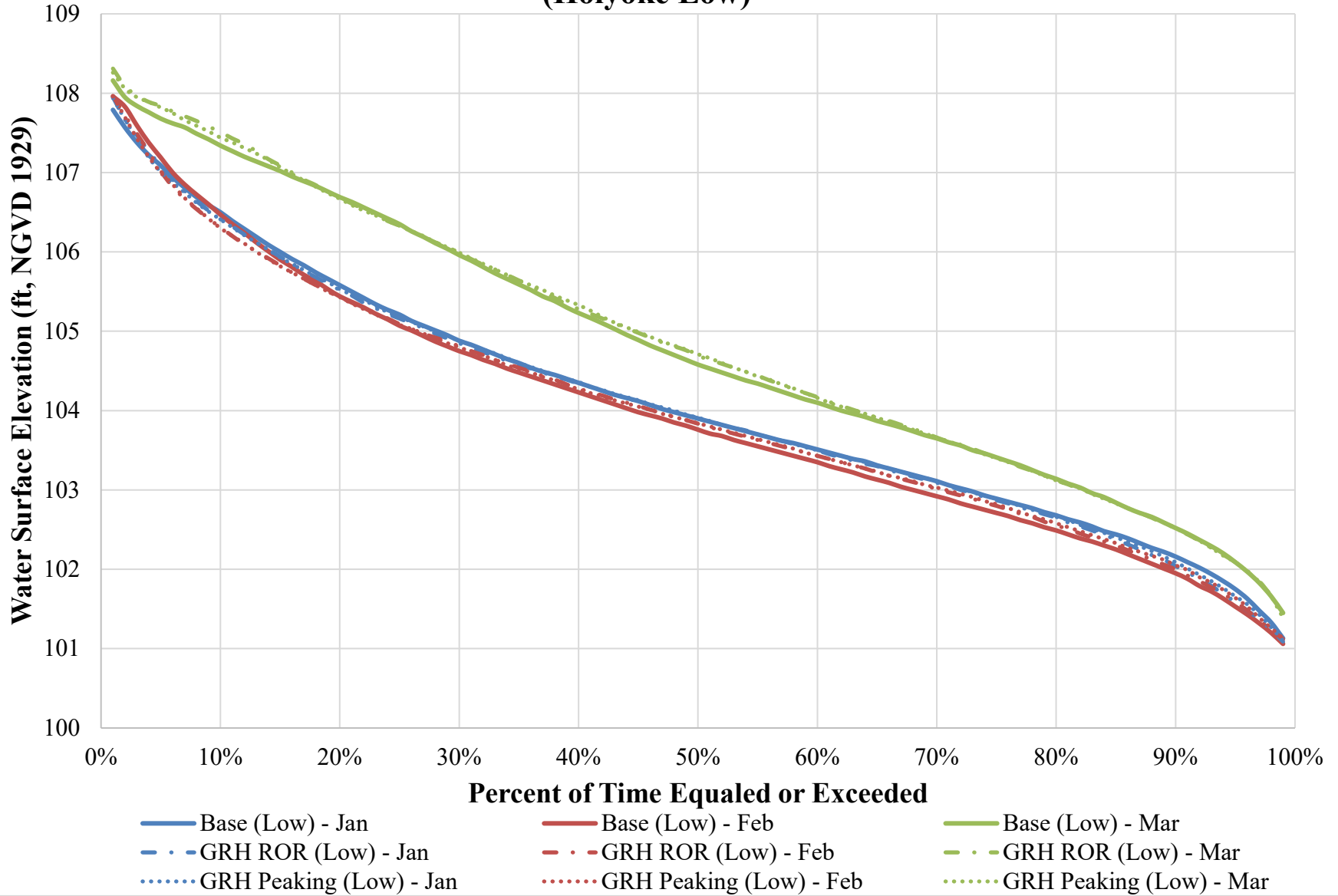
- |                               |                               |                               |
|-------------------------------|-------------------------------|-------------------------------|
| — Base (Low) - Jul            | — Base (Low) - Aug            | — Base (Low) - Sep            |
| - - GRH ROR (Low) - Jul       | - - GRH ROR (Low) - Aug       | - - GRH ROR (Low) - Sep       |
| ..... GRH Peaking (Low) - Jul | ..... GRH Peaking (Low) - Aug | ..... GRH Peaking (Low) - Sep |

## Water Surface Elevations at HEC-RAS Station 112.36 Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)

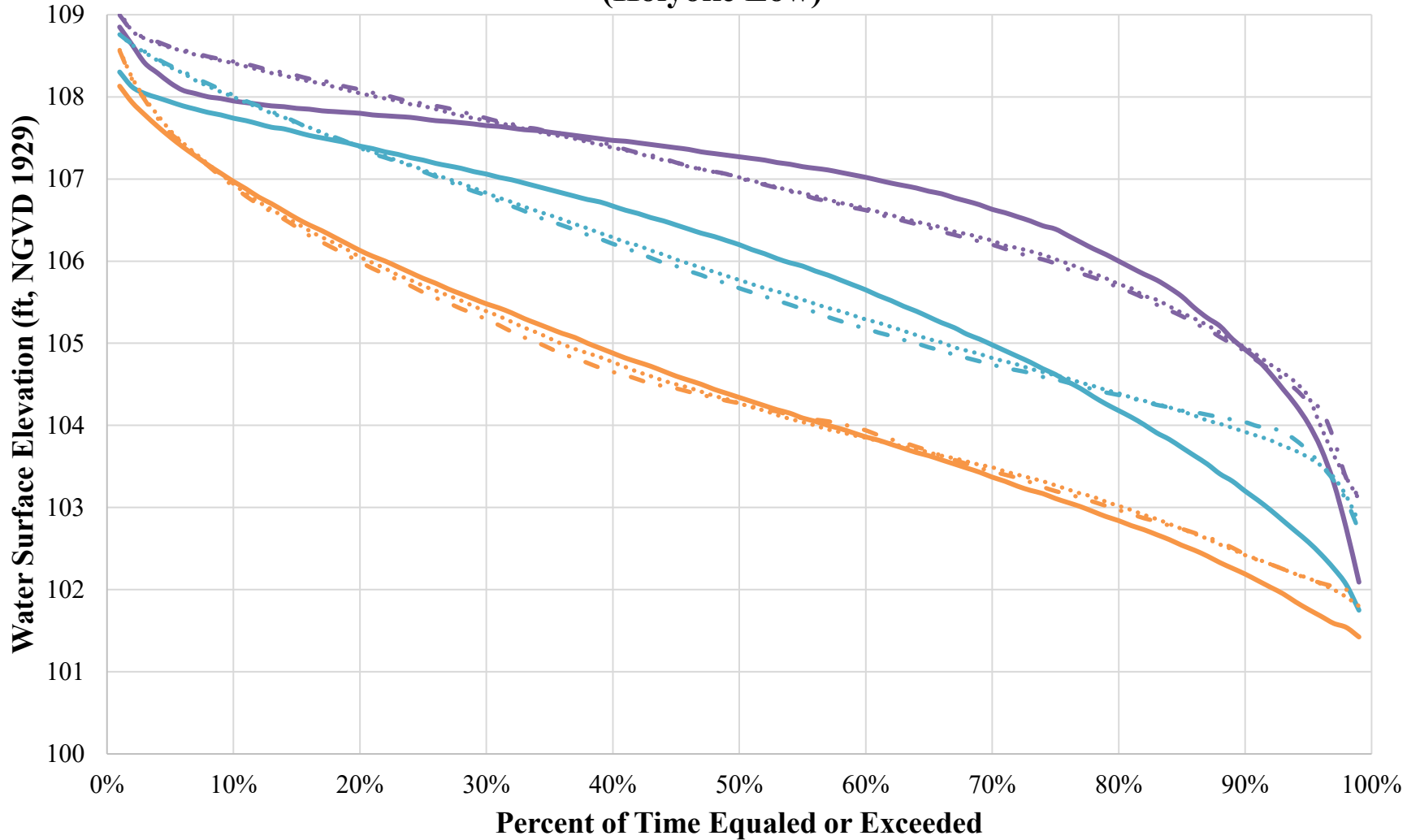


- |                               |                               |                               |
|-------------------------------|-------------------------------|-------------------------------|
| — Base (Low) - Oct            | — Base (Low) - Nov            | — Base (Low) - Dec            |
| - - GRH ROR (Low) - Oct       | - - GRH ROR (Low) - Nov       | - - GRH ROR (Low) - Dec       |
| ..... GRH Peaking (Low) - Oct | ..... GRH Peaking (Low) - Nov | ..... GRH Peaking (Low) - Dec |

**Water Surface Elevations at HEC-RAS Station 109.52 (at Route 116)  
Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking  
(Holyoke Low)**



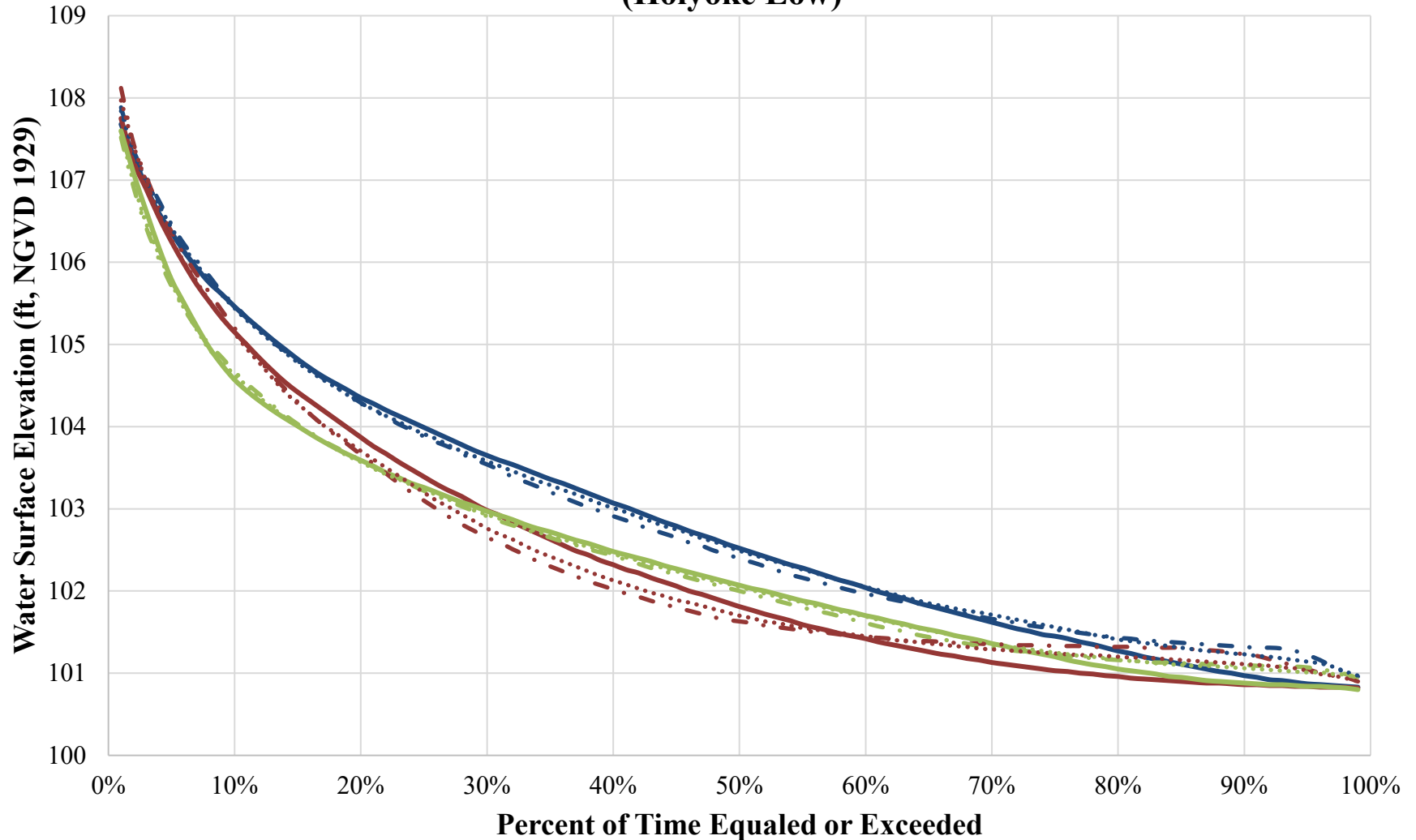
## Water Surface Elevations at HEC-RAS Station 109.52 (at Route 116) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



- Base (Low) - Apr
- - GRH ROR (Low) - Apr
- ..... GRH Peaking (Low) - Apr
- Base (Low) - May
- - GRH ROR (Low) - May
- ..... GRH Peaking (Low) - May
- Base (Low) - Jun
- - GRH ROR (Low) - Jun
- ..... GRH Peaking (Low) - Jun

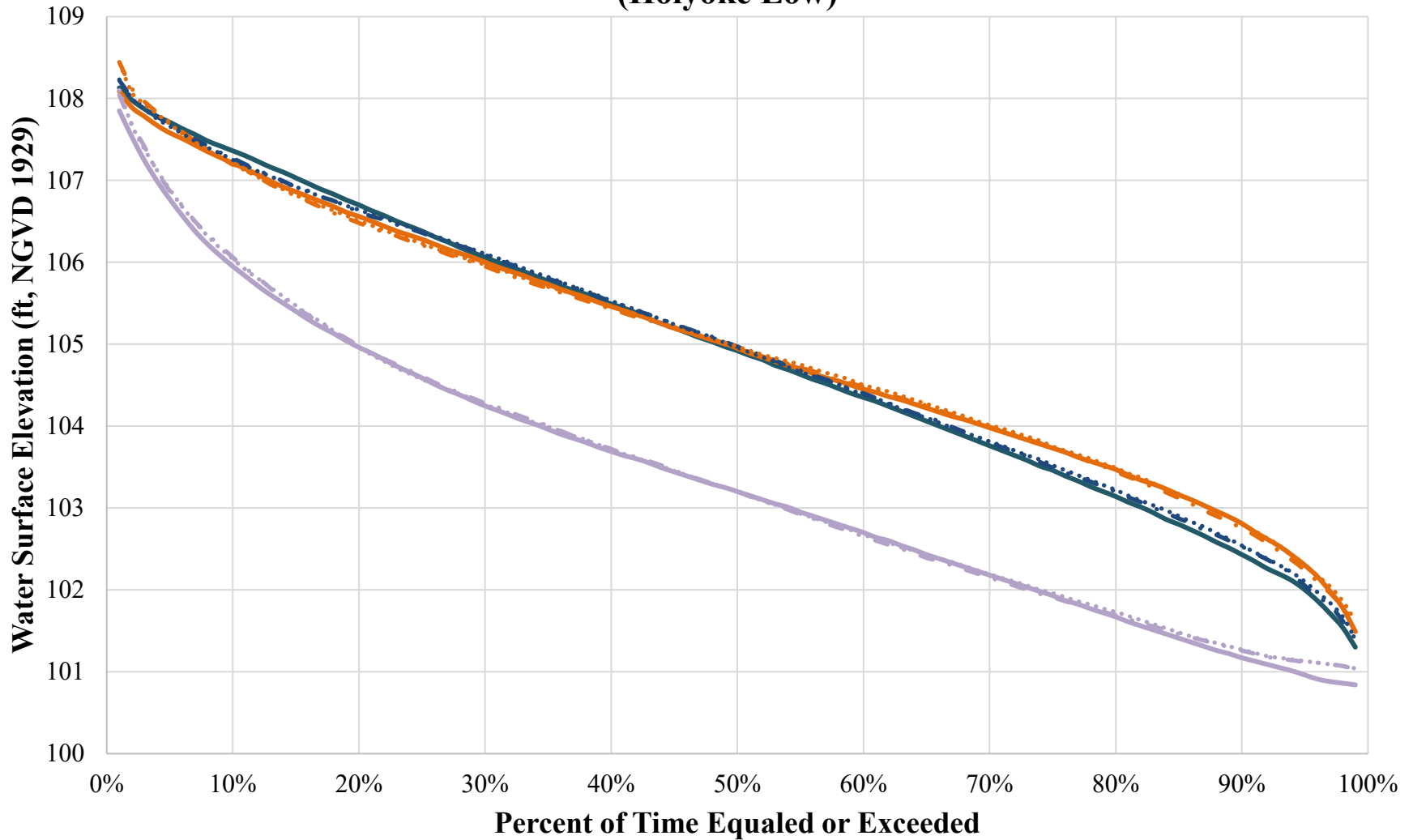


## Water Surface Elevations at HEC-RAS Station 109.52 (at Route 116) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



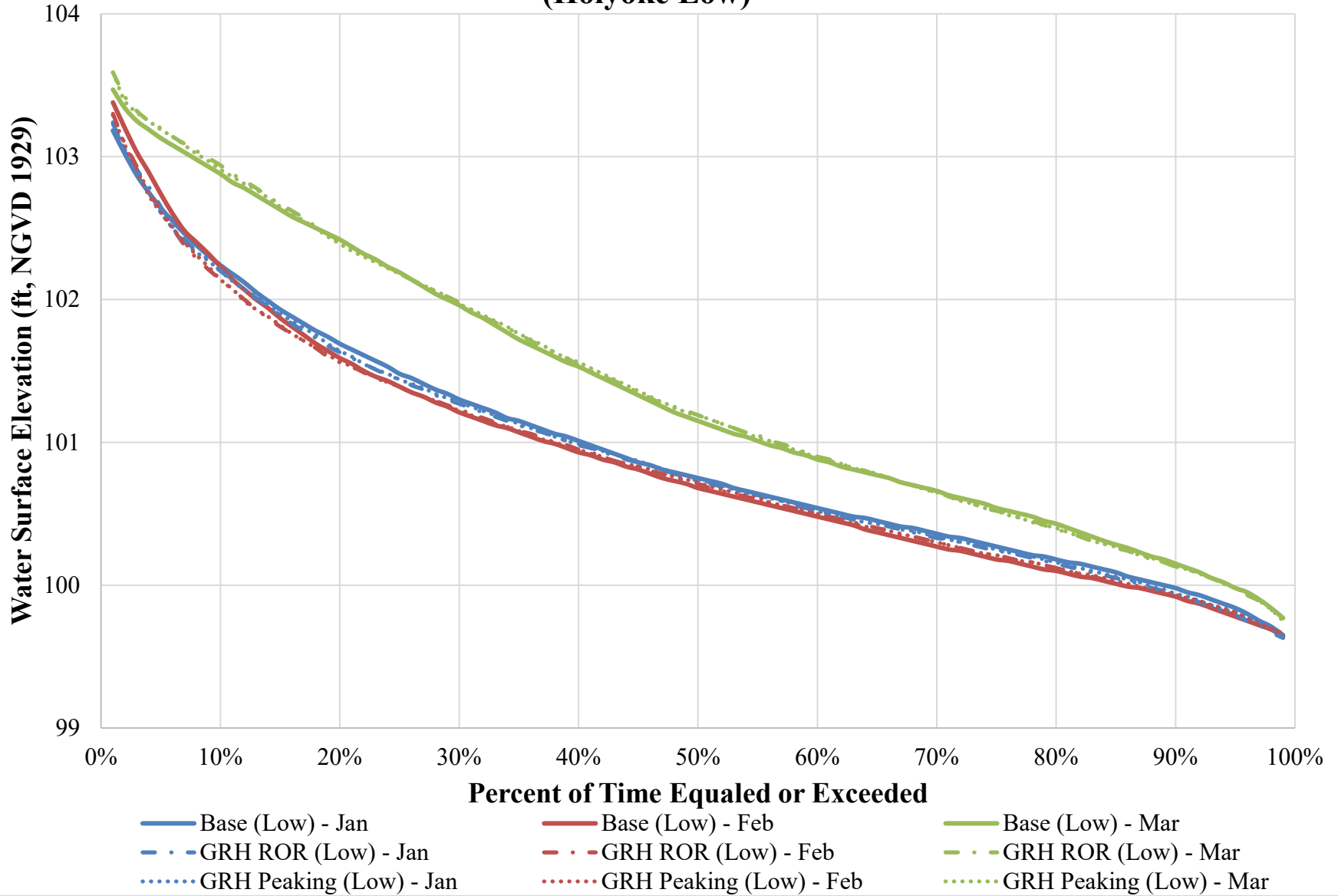
- |                               |                               |                               |
|-------------------------------|-------------------------------|-------------------------------|
| — Base (Low) - Jul            | — Base (Low) - Aug            | — Base (Low) - Sep            |
| - - GRH ROR (Low) - Jul       | - - GRH ROR (Low) - Aug       | - - GRH ROR (Low) - Sep       |
| ..... GRH Peaking (Low) - Jul | ..... GRH Peaking (Low) - Aug | ..... GRH Peaking (Low) - Sep |

## Water Surface Elevations at HEC-RAS Station 109.52 (at Route 116) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)

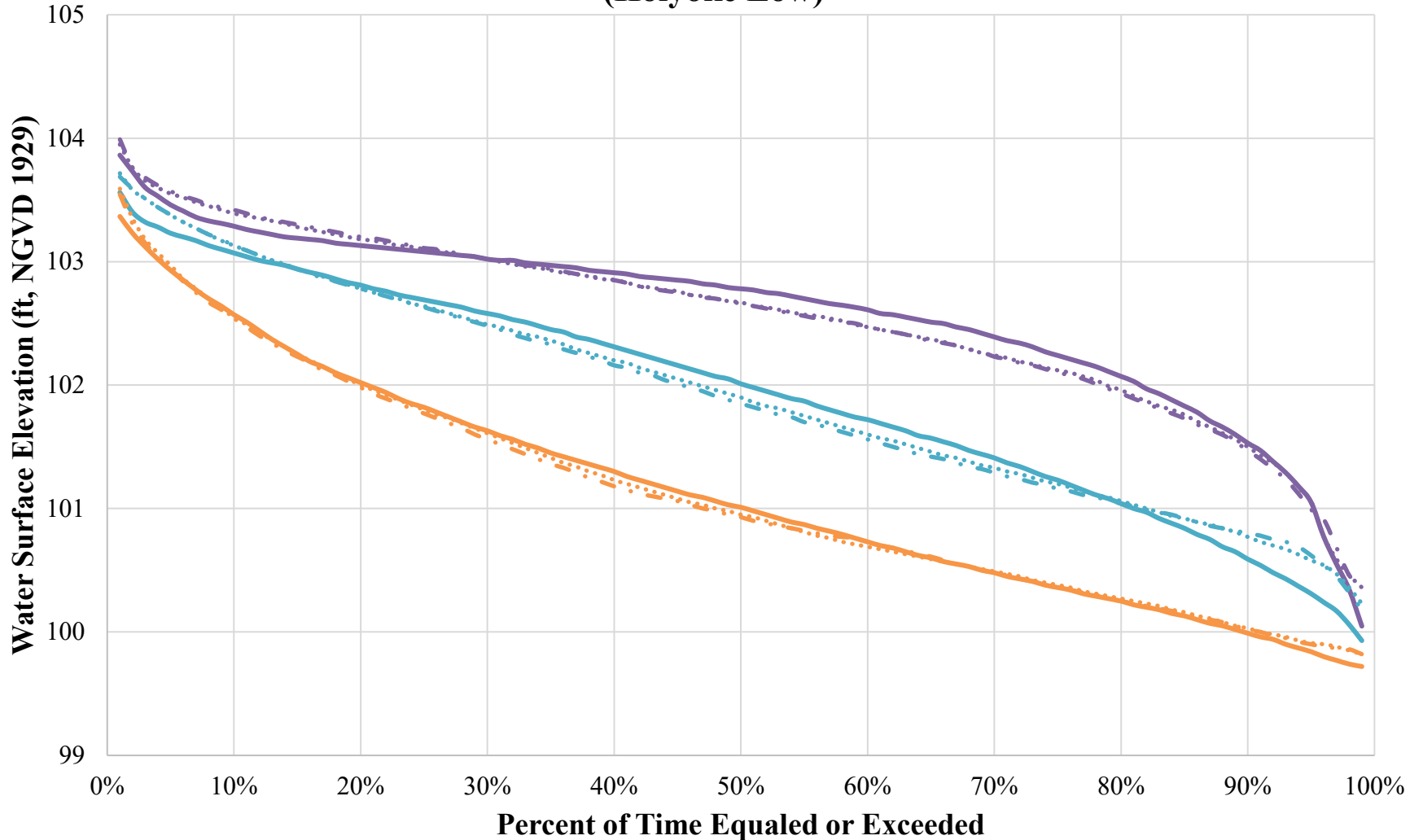


- Base (Low) - Oct
- - GRH ROR (Low) - Oct
- ..... GRH Peaking (Low) - Oct
- Base (Low) - Nov
- - GRH ROR (Low) - Nov
- ..... GRH Peaking (Low) - Nov
- Base (Low) - Dec
- - GRH ROR (Low) - Dec
- ..... GRH Peaking (Low) - Dec

**Water Surface Elevations at HEC-RAS Station 94.298 (at Rainbow Beach)  
 Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking  
 (Holyoke Low)**

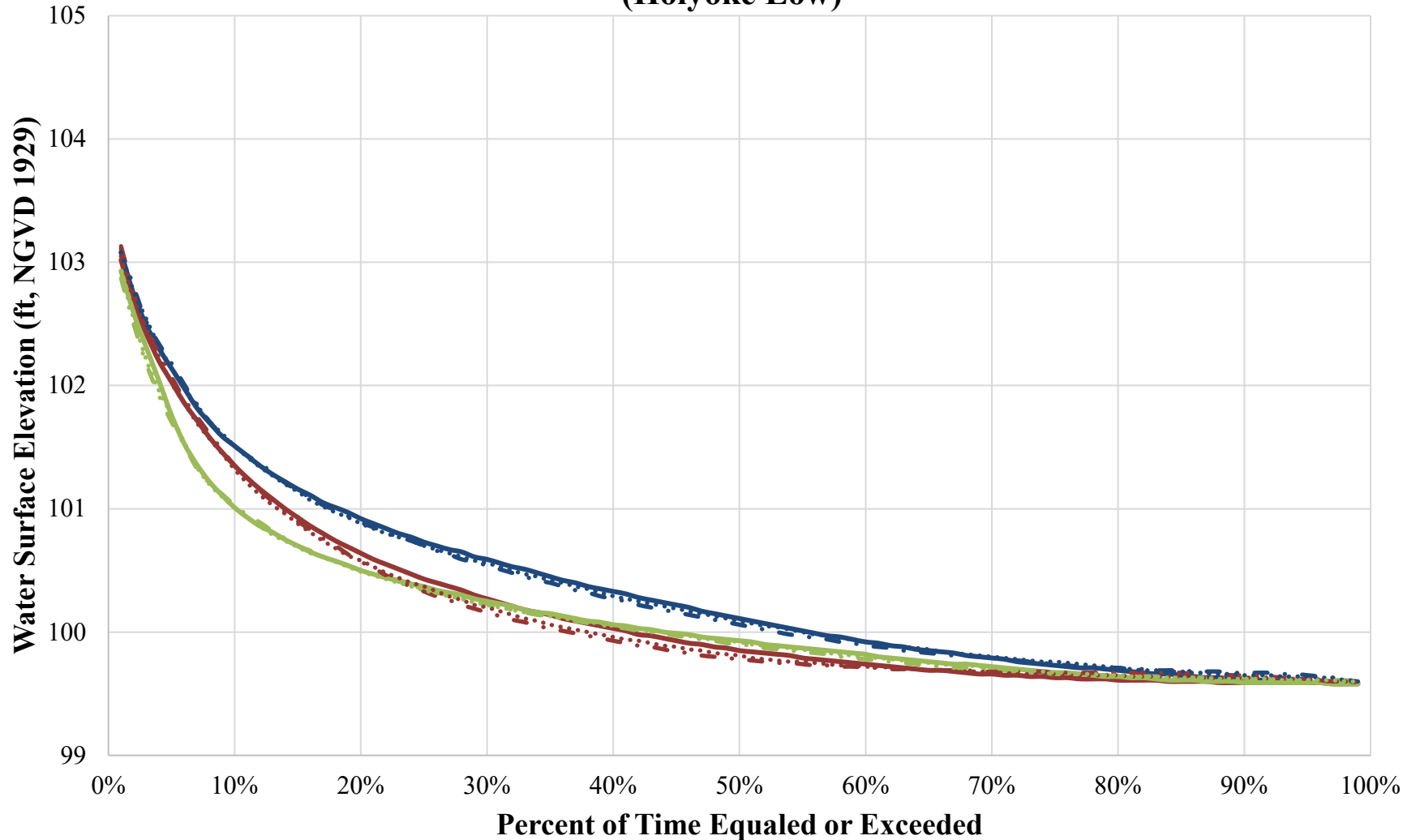


## Water Surface Elevations at HEC-RAS Station 94.298 (at Rainbow Beach) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



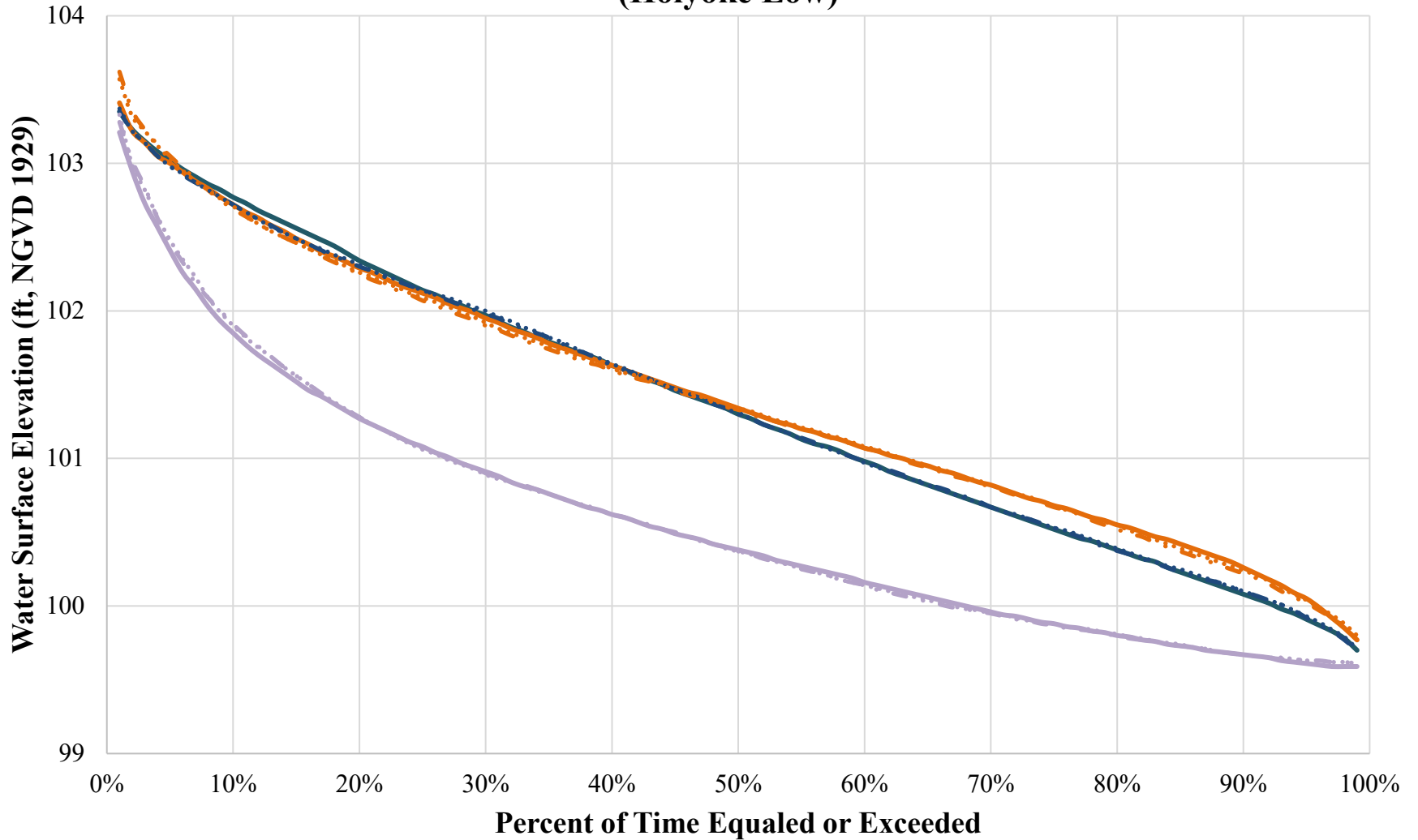
- |   |   |   |
|---|---|---|
| <span style="color: purple;">—</span> Base (Low) - Apr        | <span style="color: teal;">—</span> Base (Low) - May        | <span style="color: orange;">—</span> Base (Low) - Jun        |
| <span style="color: purple;">- -</span> GRH ROR (Low) - Apr   | <span style="color: teal;">- -</span> GRH ROR (Low) - May   | <span style="color: orange;">- -</span> GRH ROR (Low) - Jun   |
| <span style="color: purple;">⋯</span> GRH Peaking (Low) - Apr | <span style="color: teal;">⋯</span> GRH Peaking (Low) - May | <span style="color: orange;">⋯</span> GRH Peaking (Low) - Jun |

### Water Surface Elevations at HEC-RAS Station 94.298 (at Rainbow Beach) Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking (Holyoke Low)



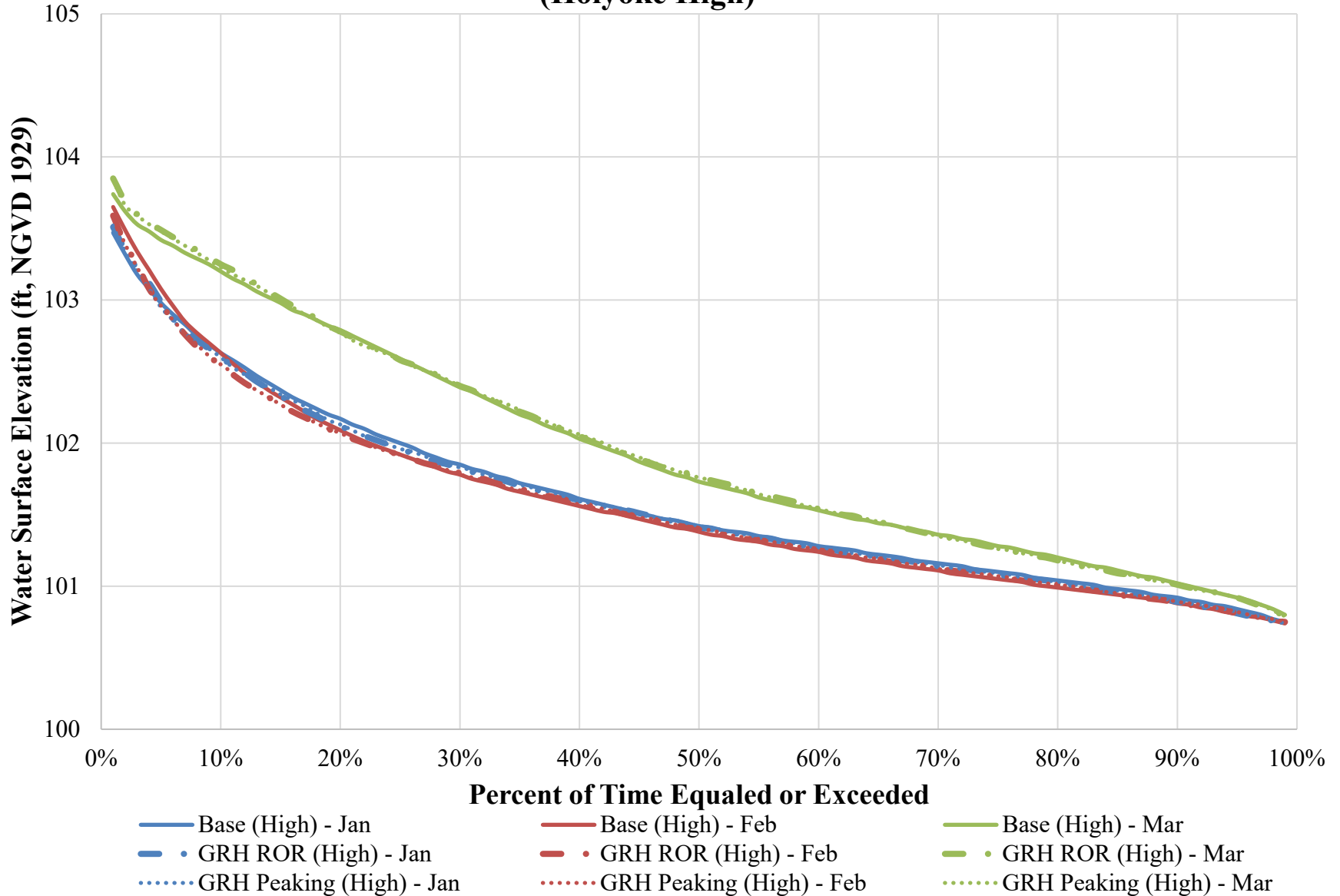
- Base (Low) - Jul
- - GRH ROR (Low) - Jul
- ..... GRH Peaking (Low) - Jul
- Base (Low) - Aug
- - GRH ROR (Low) - Aug
- ..... GRH Peaking (Low) - Aug
- Base (Low) - Sep
- - GRH ROR (Low) - Sep
- ..... GRH Peaking (Low) - Sep

**Water Surface Elevations at HEC-RAS Station 94.298 (at Rainbow Beach)  
Hourly Modeled Baseline vs. AFLA Proposal with GRH ROR and Peaking  
(Holyoke Low)**

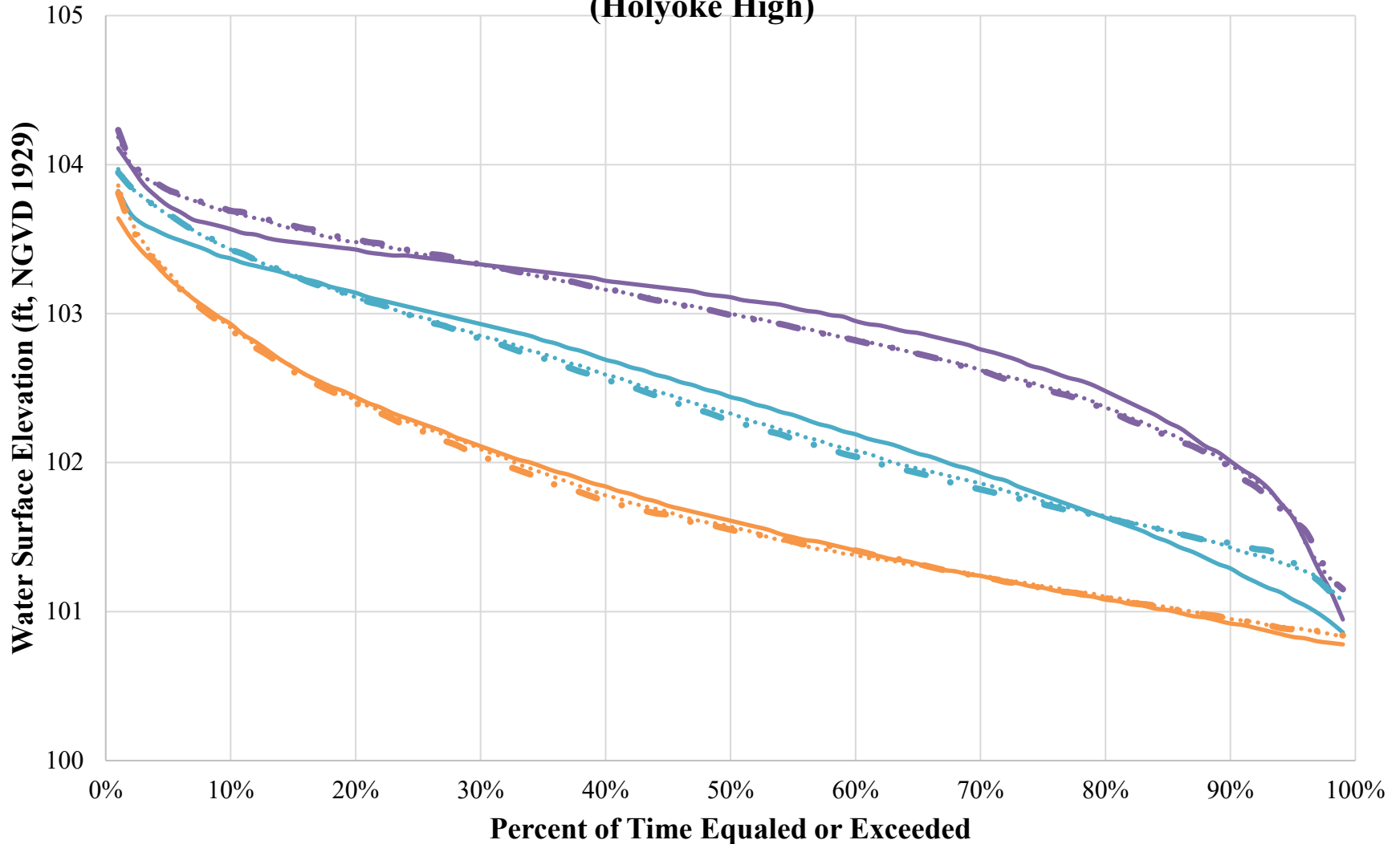


- |                               |                               |                               |
|-------------------------------|-------------------------------|-------------------------------|
| — Base (Low) - Oct            | — Base (Low) - Nov            | — Base (Low) - Dec            |
| - - GRH ROR (Low) - Oct       | - - GRH ROR (Low) - Nov       | - - GRH ROR (Low) - Dec       |
| ..... GRH Peaking (Low) - Oct | ..... GRH Peaking (Low) - Nov | ..... GRH Peaking (Low) - Dec |

## Water Surface Elevations at HEC-RAS Station 94.298 (at Rainbow Beach) Hourly Modeled Baseline vs AFLA Proposal with GRH ROR and Peaking (Holyoke High)



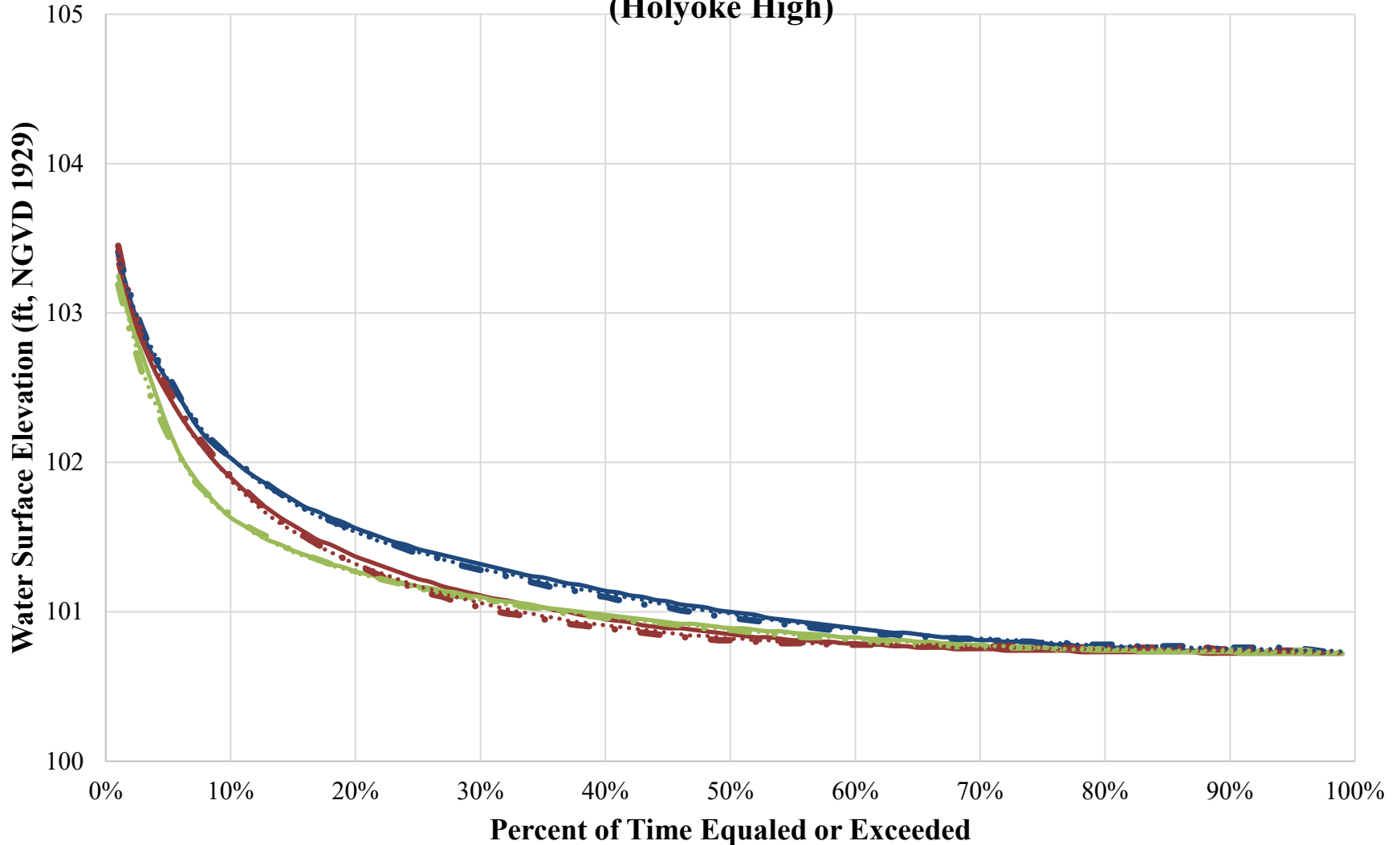
## Water Surface Elevations at HEC-RAS Station 94.298 (at Rainbow Beach) Hourly Modeled Baseline vs AFLA Proposal with GRH ROR and Peaking (Holyoke High)



- Base (High) - Apr
- • GRH ROR (High) - Apr
- ••• GRH Peaking (High) - Apr
- Base (High) - May
- • GRH ROR (High) - May
- ••• GRH Peaking (High) - May
- Base (High) - Jun
- • GRH ROR (High) - Jun
- ••• GRH Peaking (High) - Jun

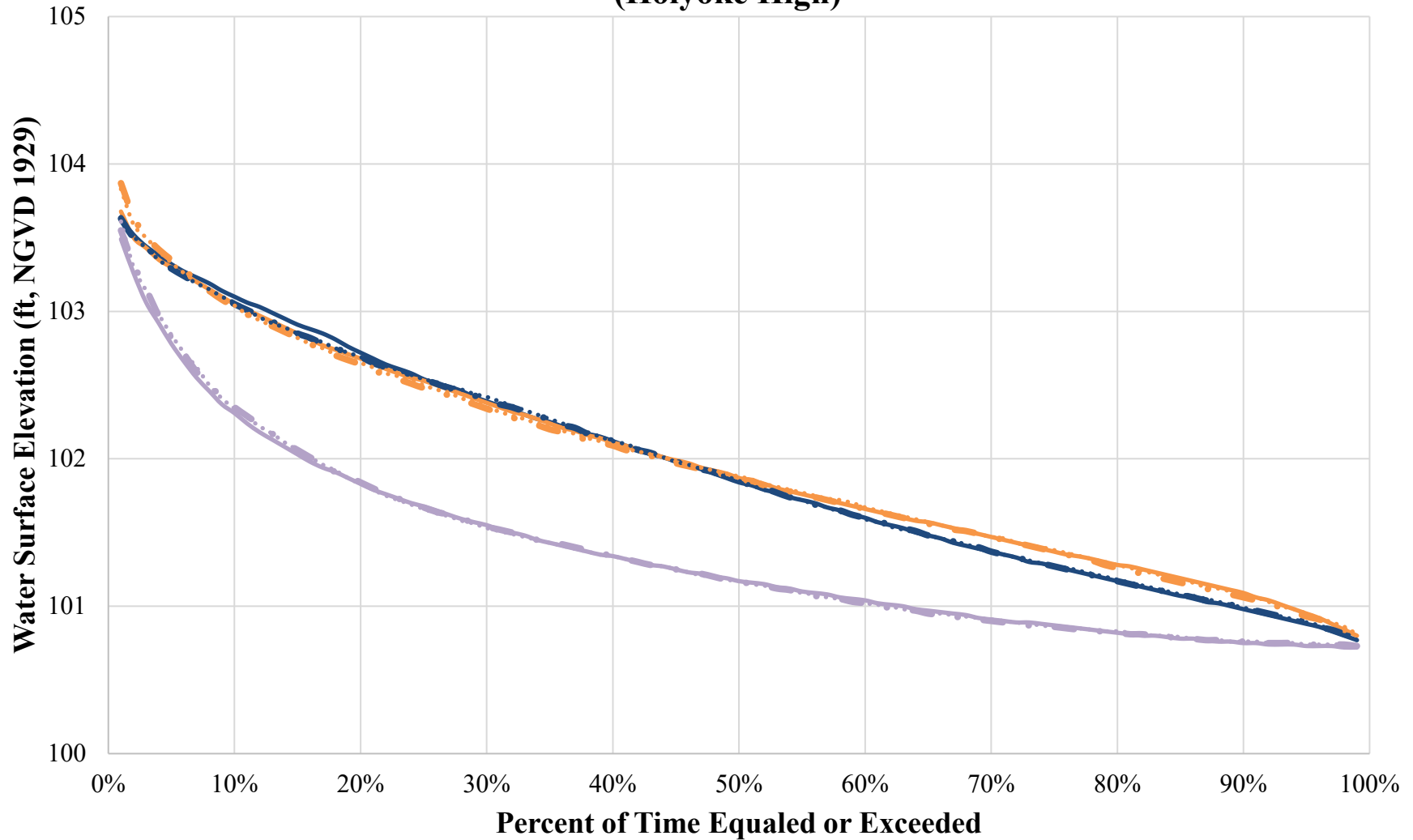


# Water Surface Elevations at HEC-RAS Station 94.298 (at Rainbow Beach) Hourly Modeled Baseline vs AFLA Proposal with GRH ROR and Peaking (Holyoke High)



- Base (High) - Jul
- • GRH ROR (High) - Jul
- GRH Peaking (High) - Jul
- Base (High) - Aug
- • GRH ROR (High) - Aug
- GRH Peaking (High) - Aug
- Base (High) - Sep
- • GRH ROR (High) - Sep
- GRH Peaking (High) - Sep

## Water Surface Elevations at HEC-RAS Station 94.298 (at Rainbow Beach) Hourly Modeled Baseline vs AFLA Proposal with GRH ROR and Peaking (Holyoke High)



- Base (High) - Oct
- GRH ROR (High) - Oct
- ..... GRH Peaking (High) - Oct
- Base (High) - Nov
- GRH ROR (High) - Nov
- ..... GRH Peaking (High) - Nov
- Base (High) - Dec
- GRH ROR (High) - Dec
- ..... GRH Peaking (High) - Dec

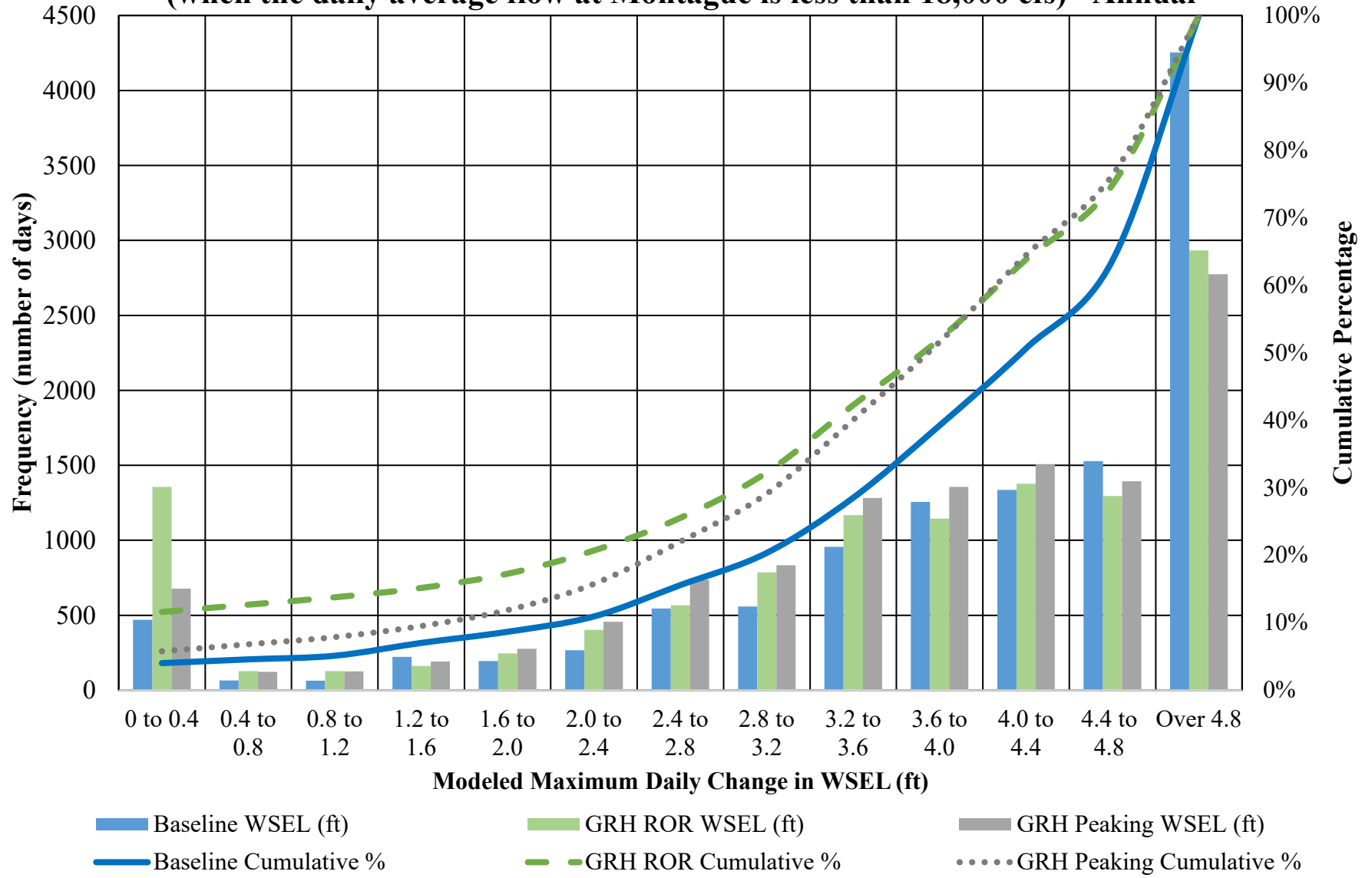
## **Appendix TF-AIR#5- DS Histograms.**

- \*River Mile 118.508 WSEL Histograms (Reach 4 near Montague);
- \*River Mile 115.07 WSEL Histograms (Reach 4);
- \*River Mile 112.36 WSEL Histograms (Reach 4);
- \*River Mile 109.52 WSEL Histograms (Reach 4); and
- \*\*River Mile 94.298 Rainbow Beach WSEL Histograms (Reach 5)- Low Holyoke.

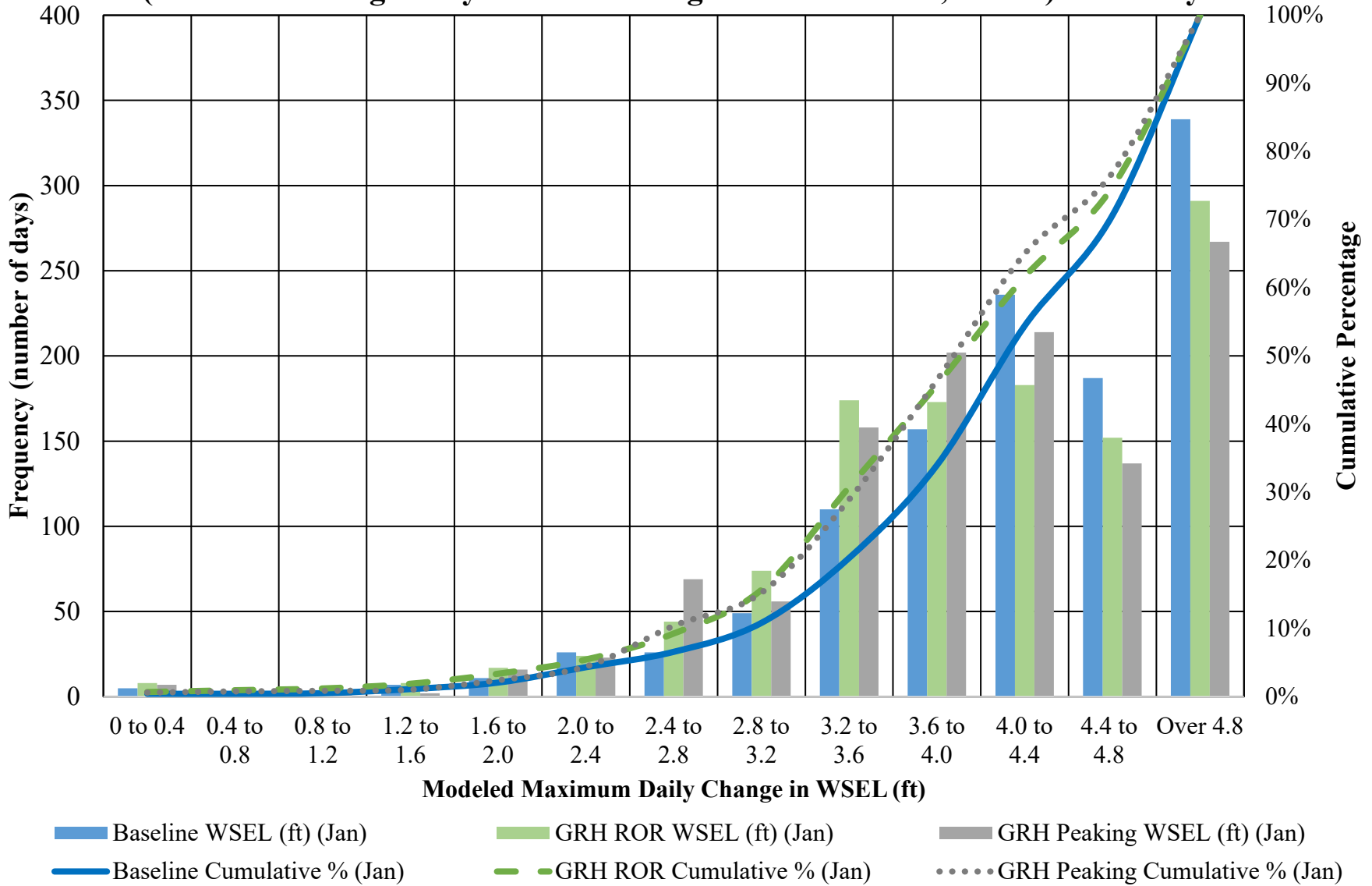
\* The downstream boundary in the model has minimal impact on Reach 4 WSELs. Thus, for these locations the WSEL histograms are based on Low Holyoke.

\*\*The downstream boundary in the model does have an impact on Reach 5 WSELs. Rainbow Beach location has two sets of WSEL duration curves as described on the previous page, however, only Low Holyoke histograms were provided since the maximum daily change is higher in Low Holyoke conditions than High Holyoke conditions.

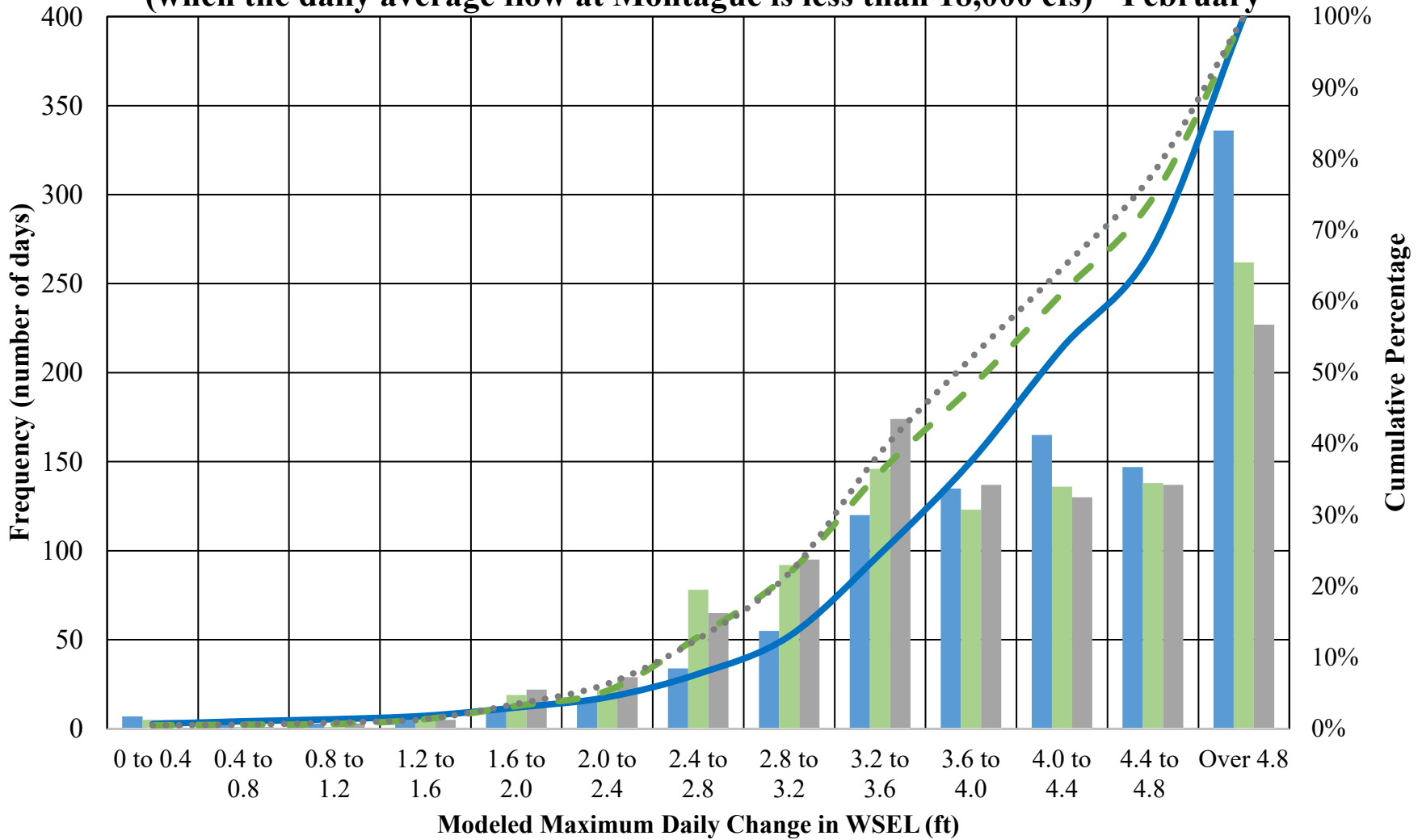
## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - Annual



**HEC-RAS Station 118.508 WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the average daily flow at Montague is less than 18,000 cfs) - January**

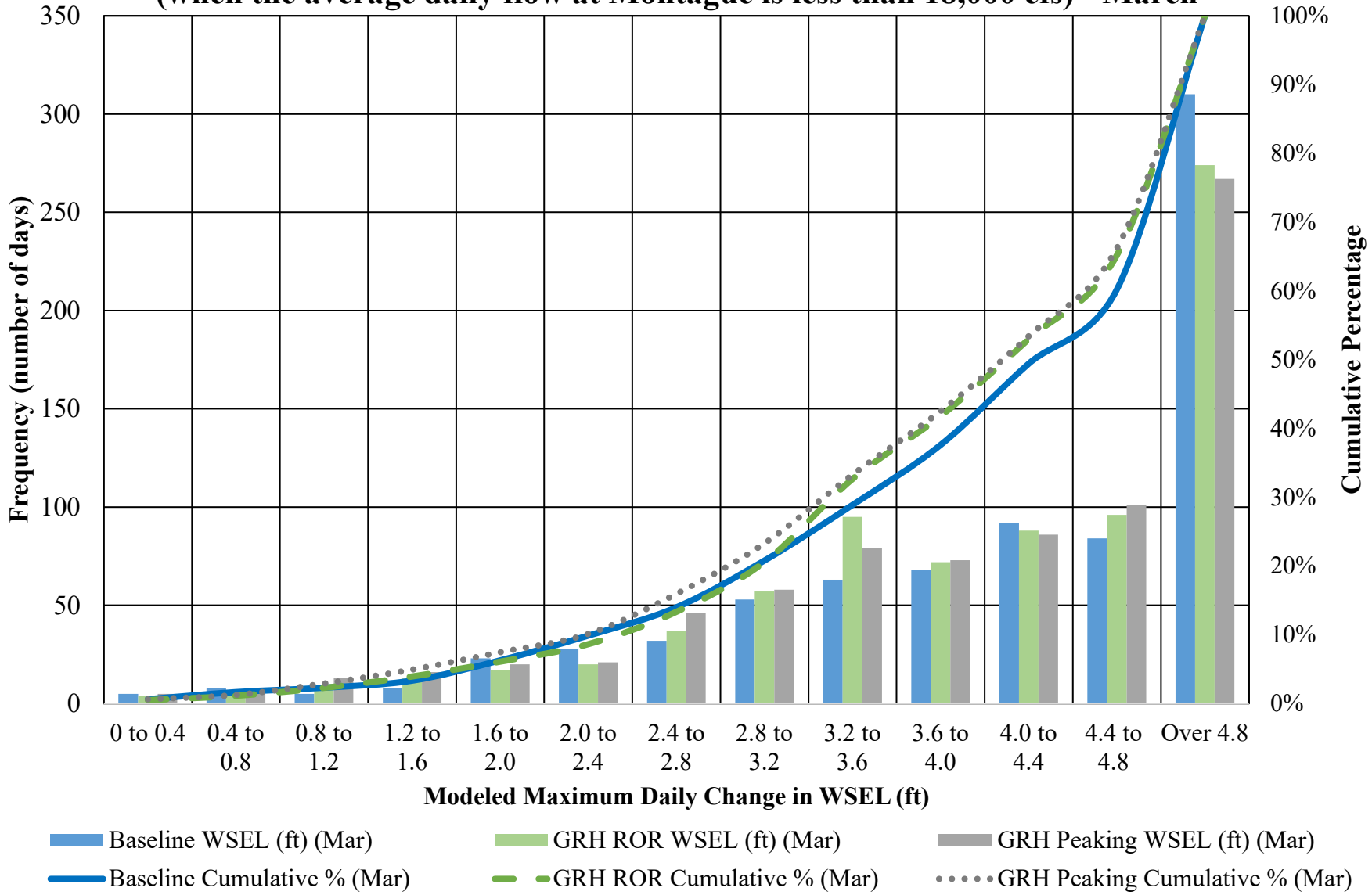


## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - February

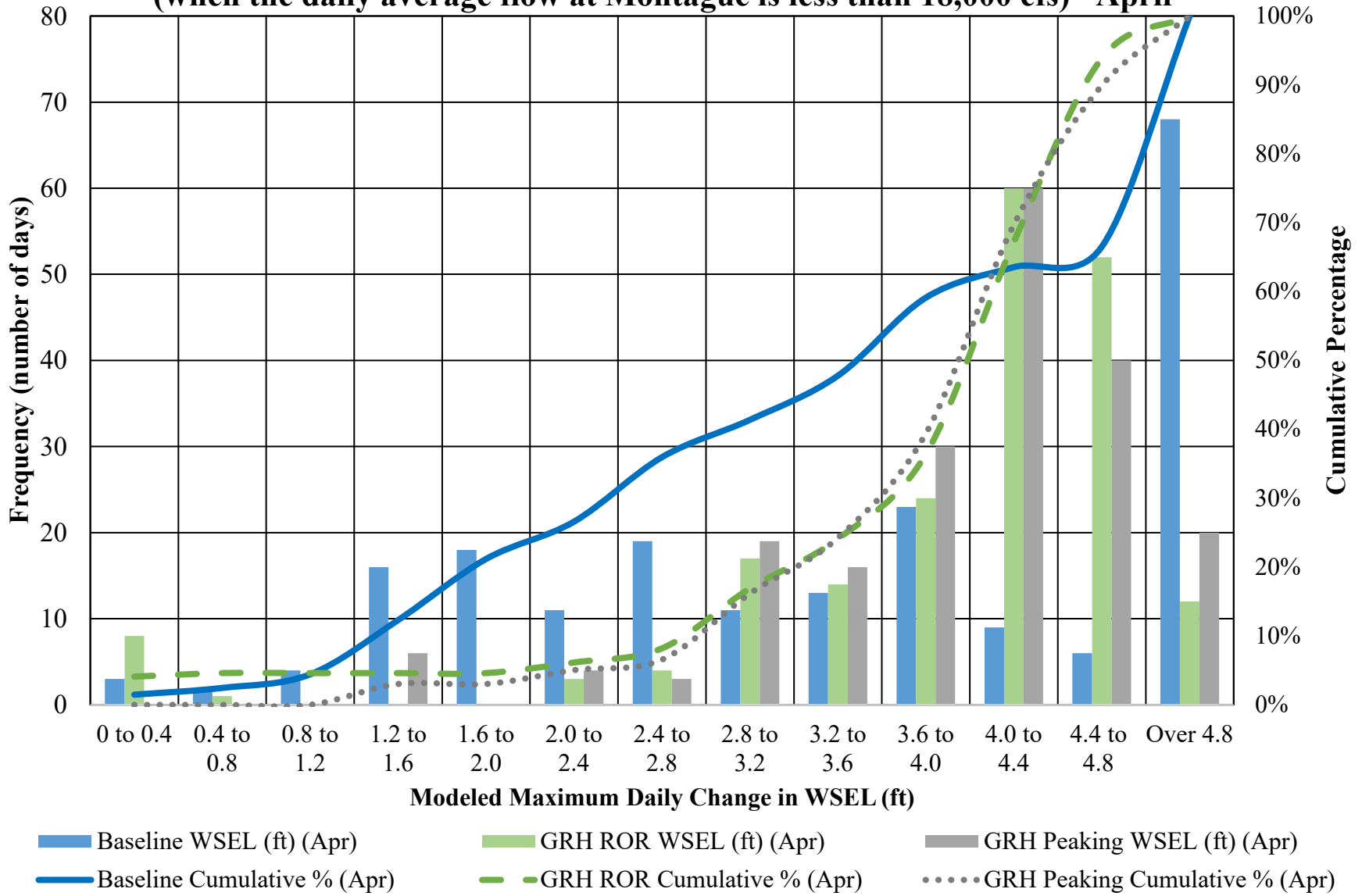


- Baseline WSEL (ft) (Feb)
- GRH ROR WSEL (ft) (Feb)
- GRH Peaking WSEL (ft) (Feb)
- Baseline Cumulative % (Feb)
- - - GRH ROR Cumulative % (Feb)
- ⋯ GRH Peaking Cumulative % (Feb)

## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the average daily flow at Montague is less than 18,000 cfs) - March

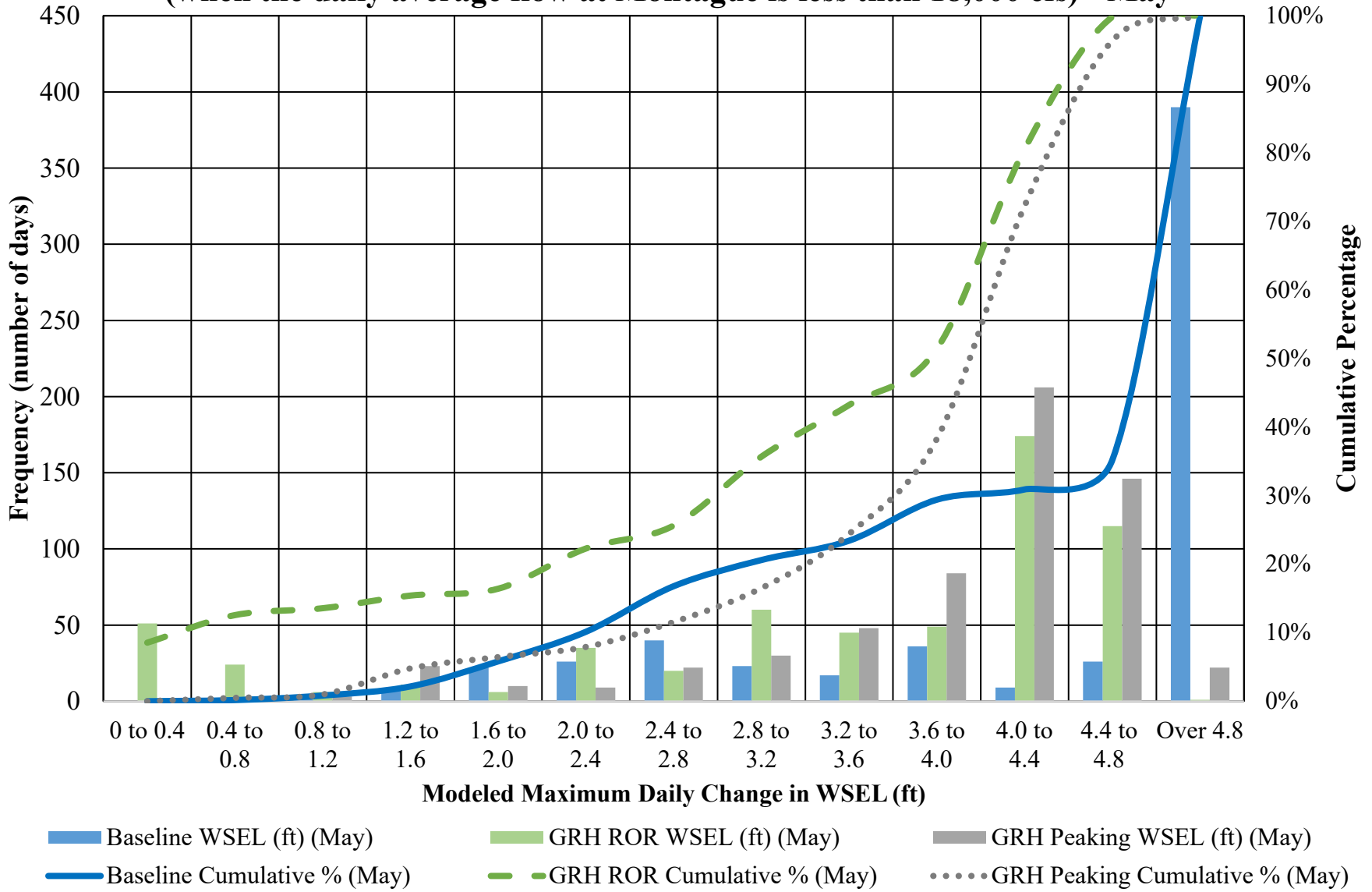


## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - April

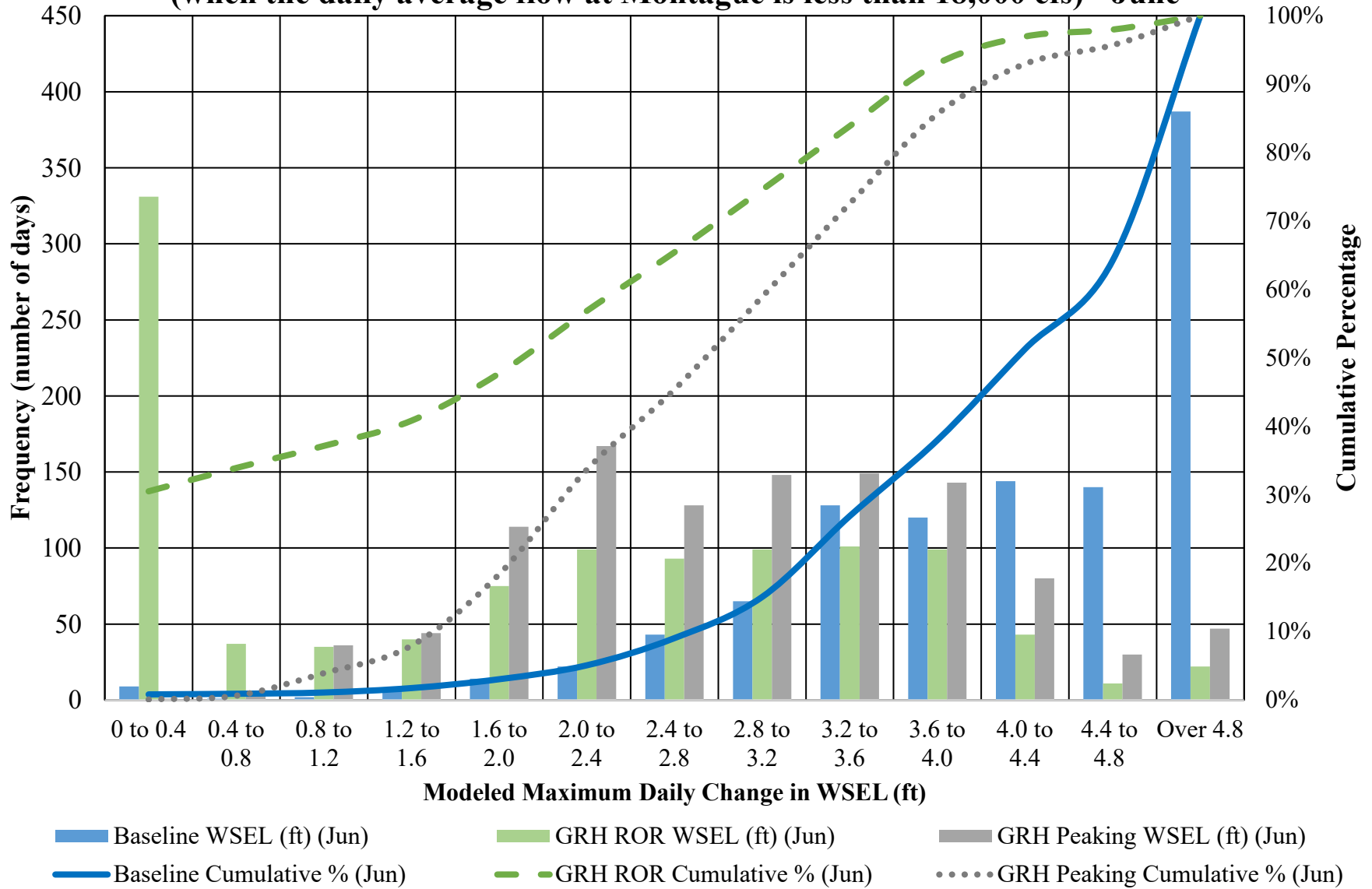




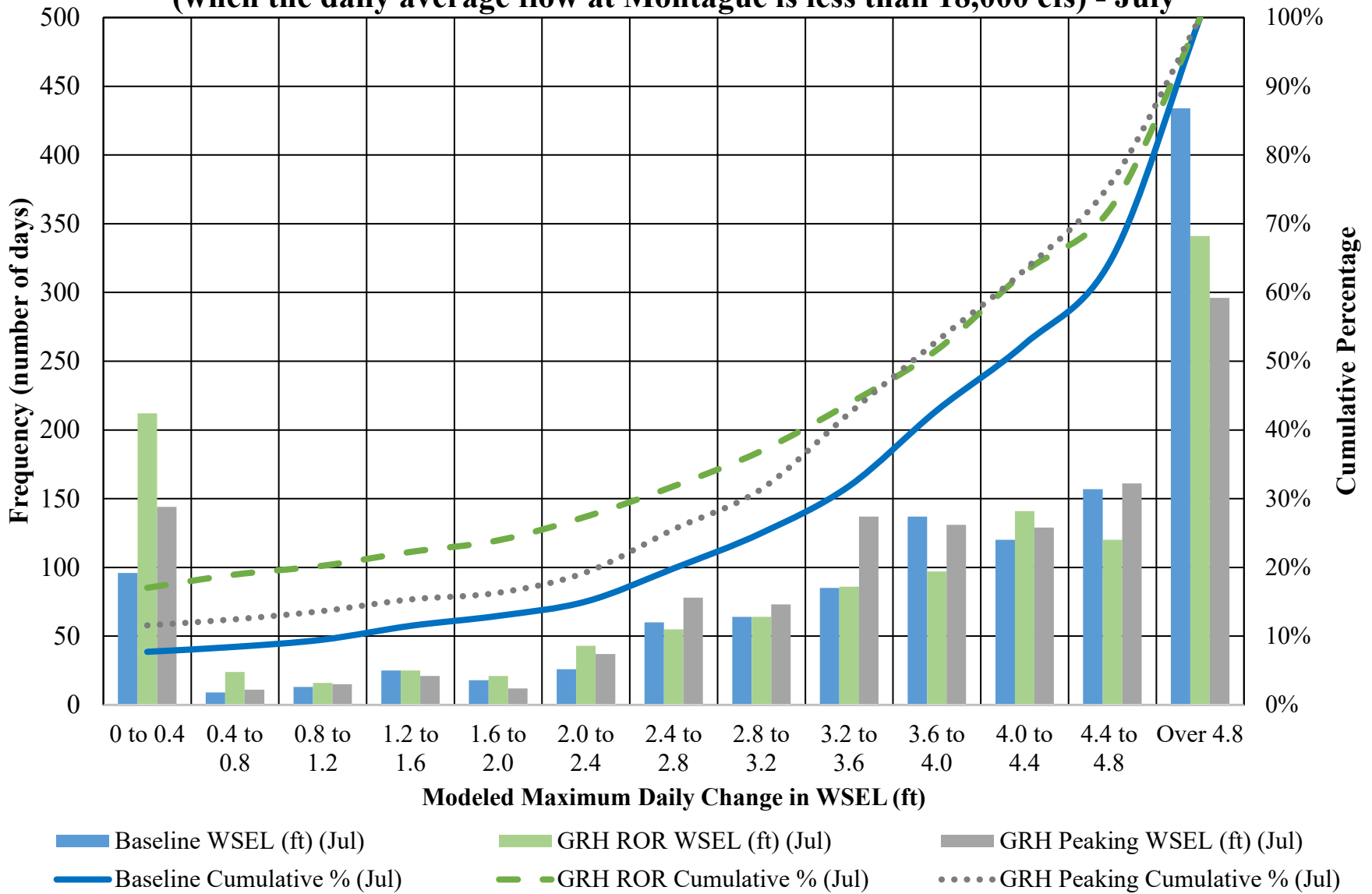
## HEC-RAS Station 118.508WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - May



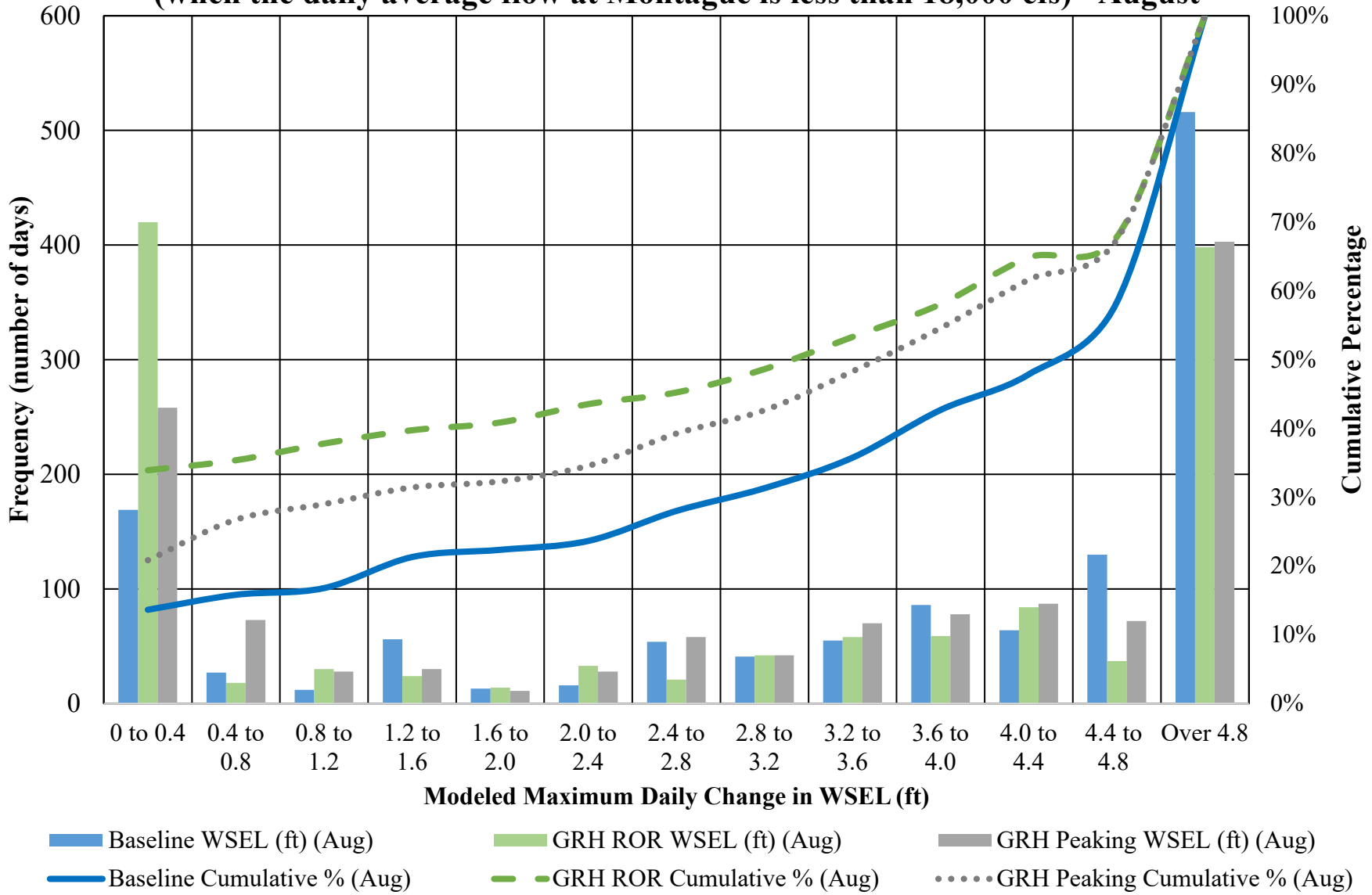
## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - June



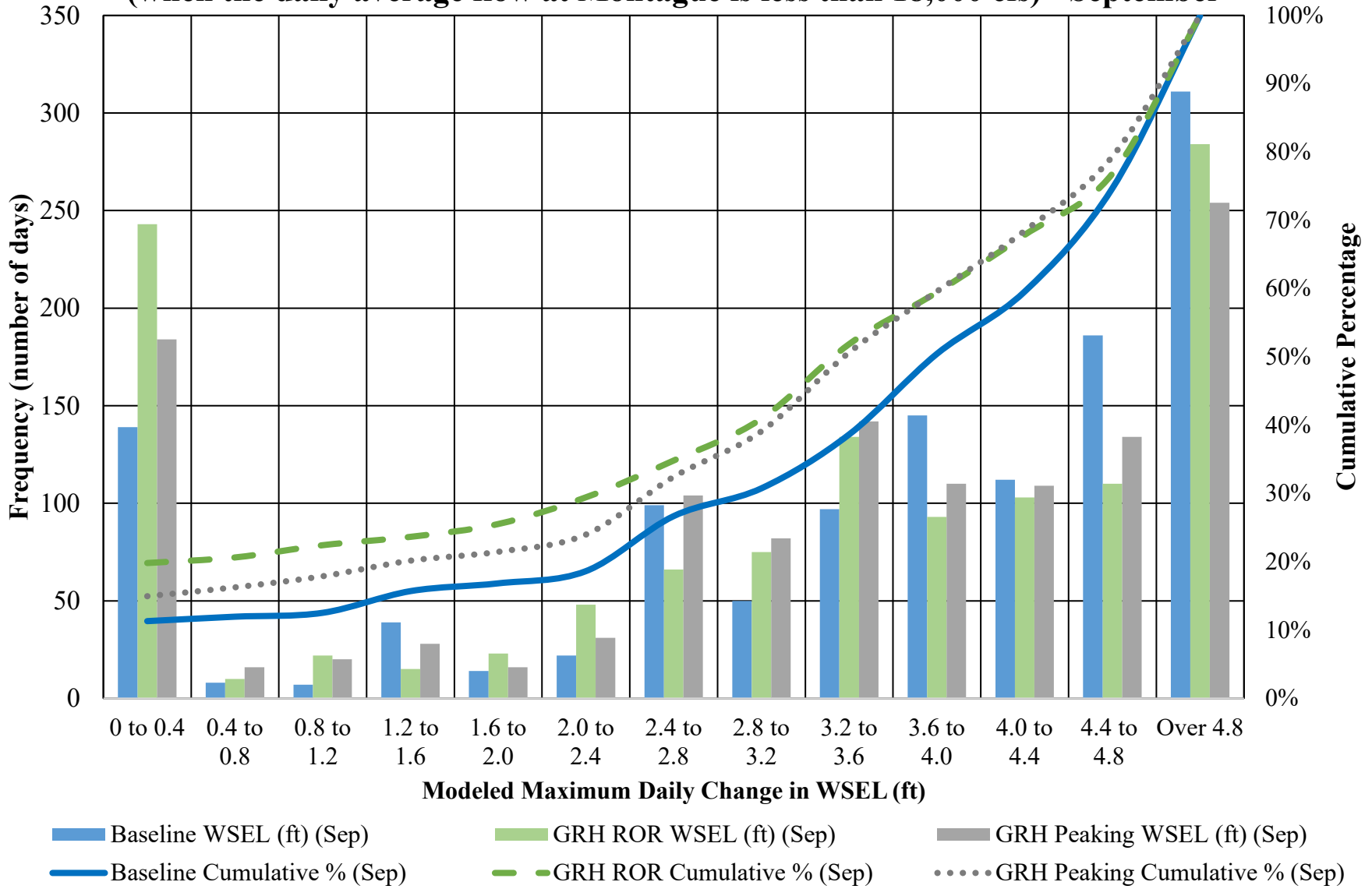
## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - July



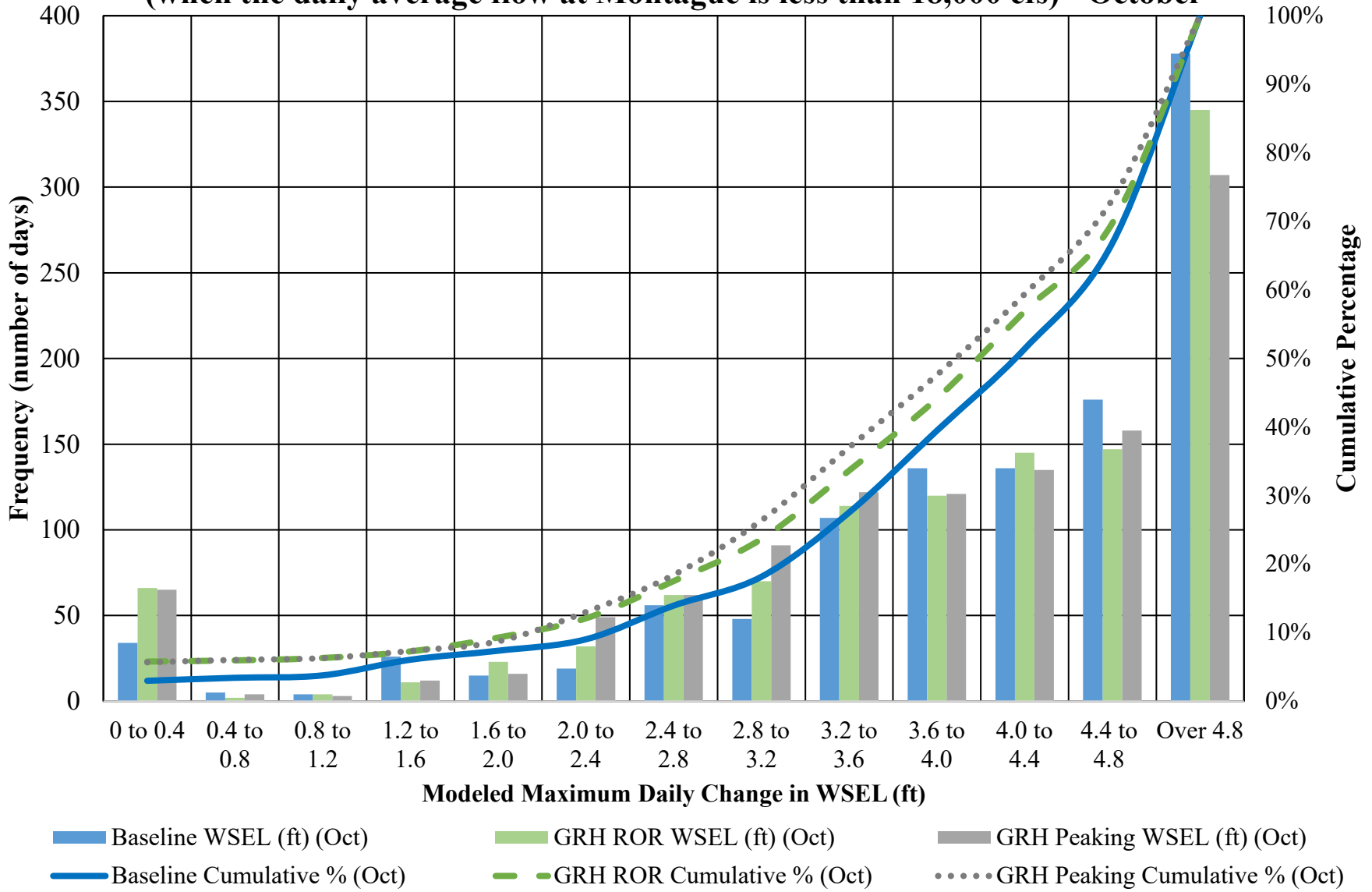
## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - August



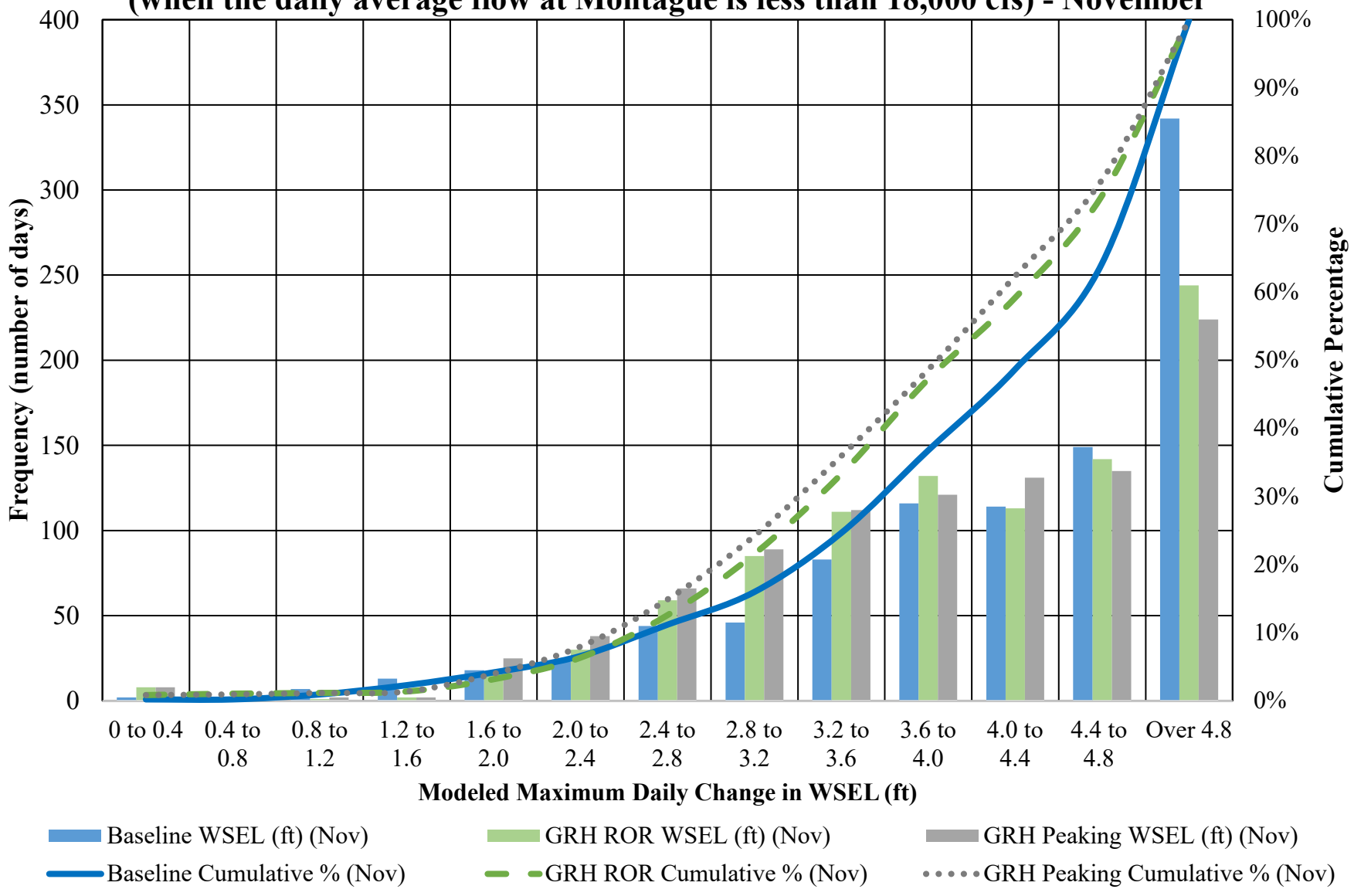
## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - September



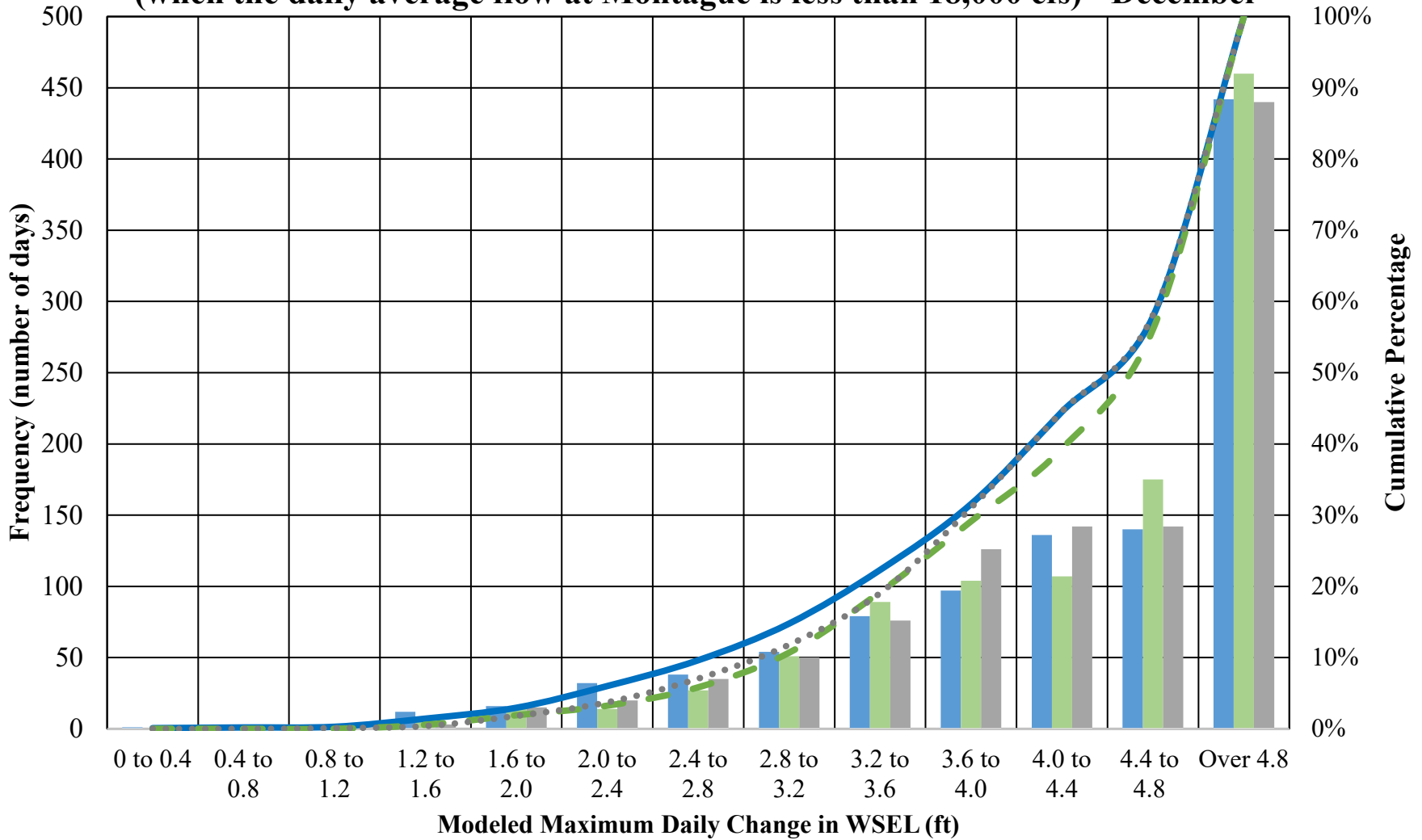
## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - October



## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - November



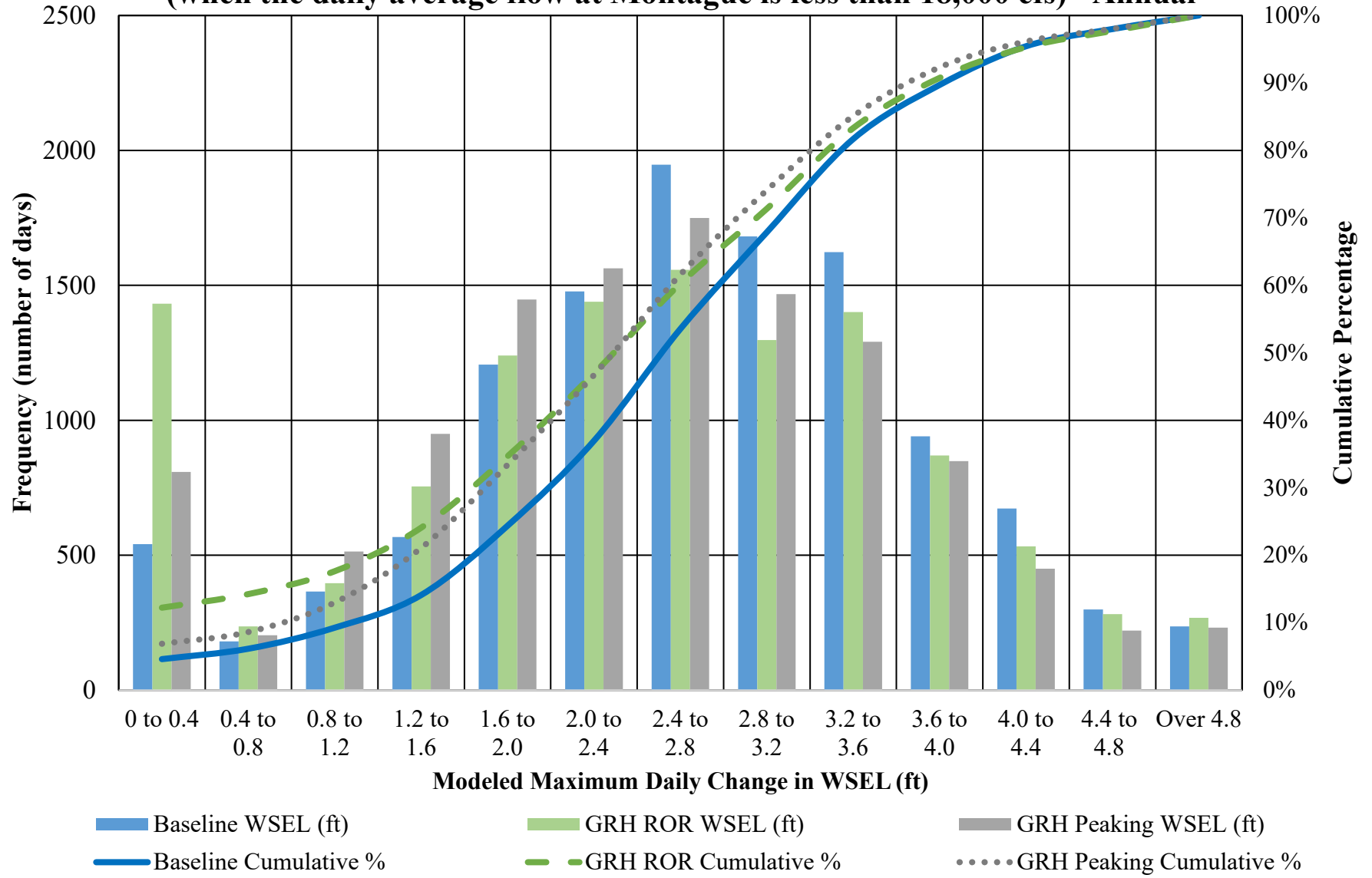
## HEC-RAS Station 118.508 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - December



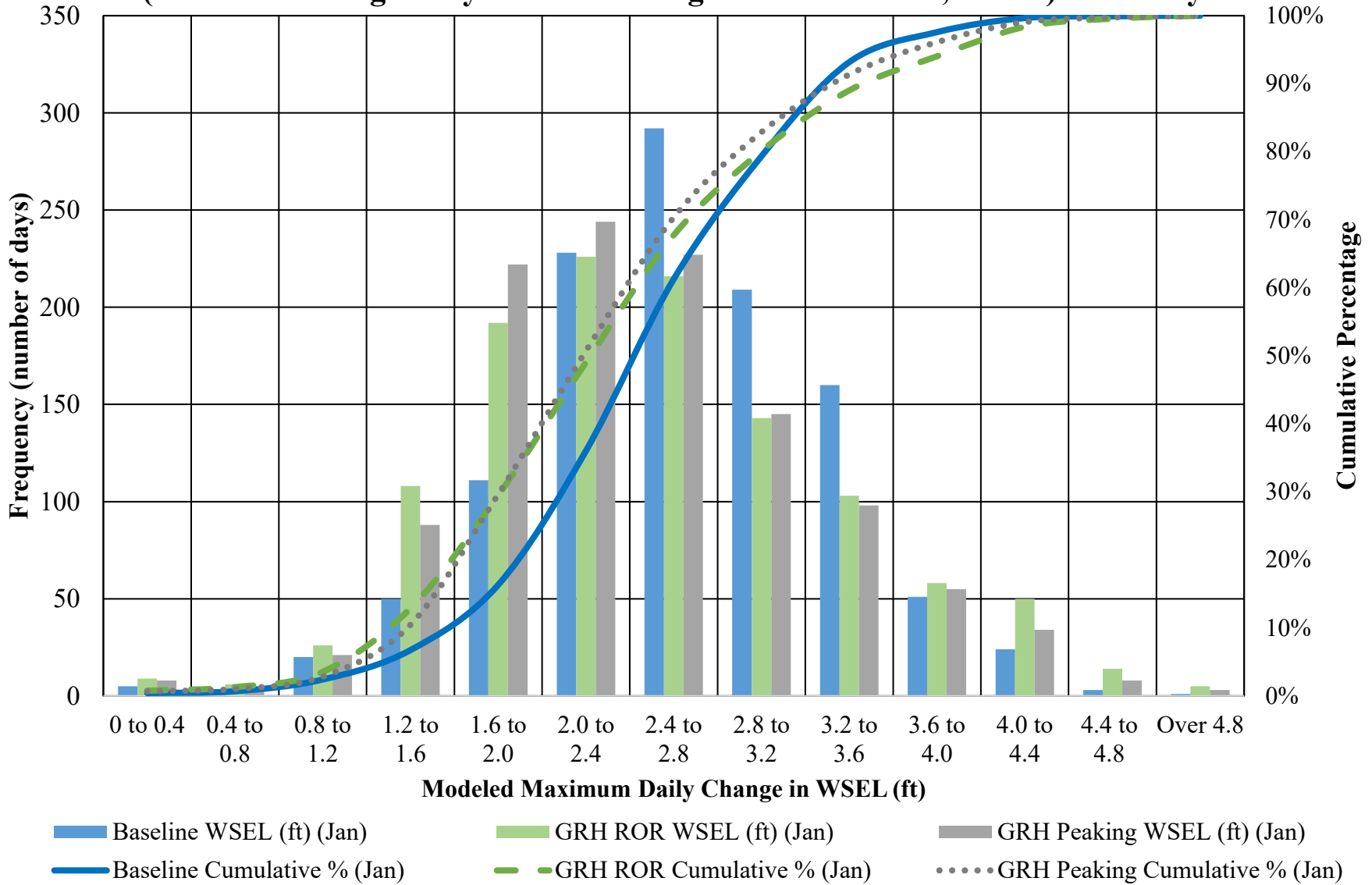
■ Baseline WSEL (ft) (Dec)     
 ■ GRH ROR WSEL (ft) (Dec)     
 ■ GRH Peaking WSEL (ft) (Dec)  
— Baseline Cumulative % (Dec)     
 - - - GRH ROR Cumulative % (Dec)     
 ⋯ GRH Peaking Cumulative % (Dec)



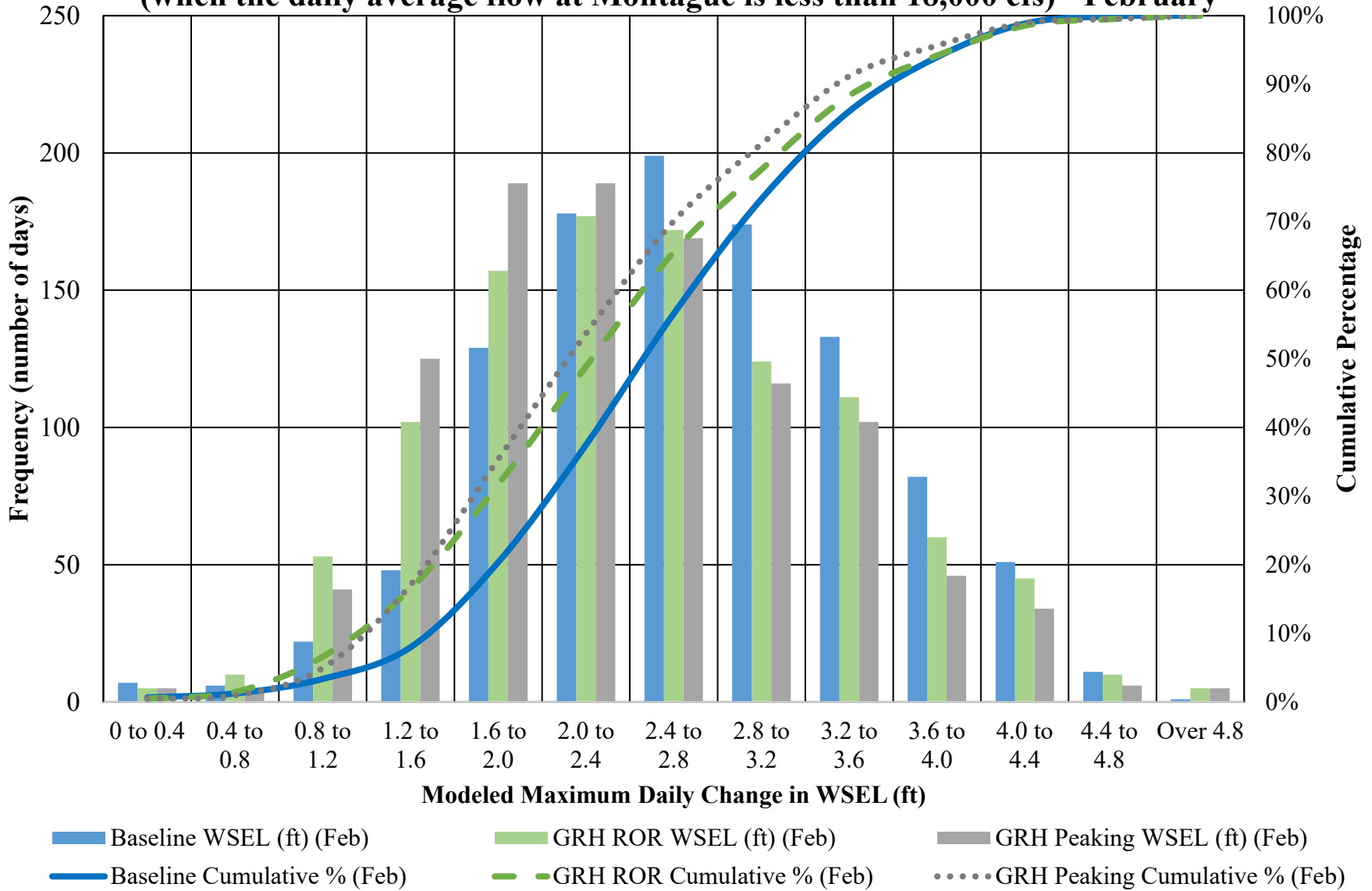
## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - Annual



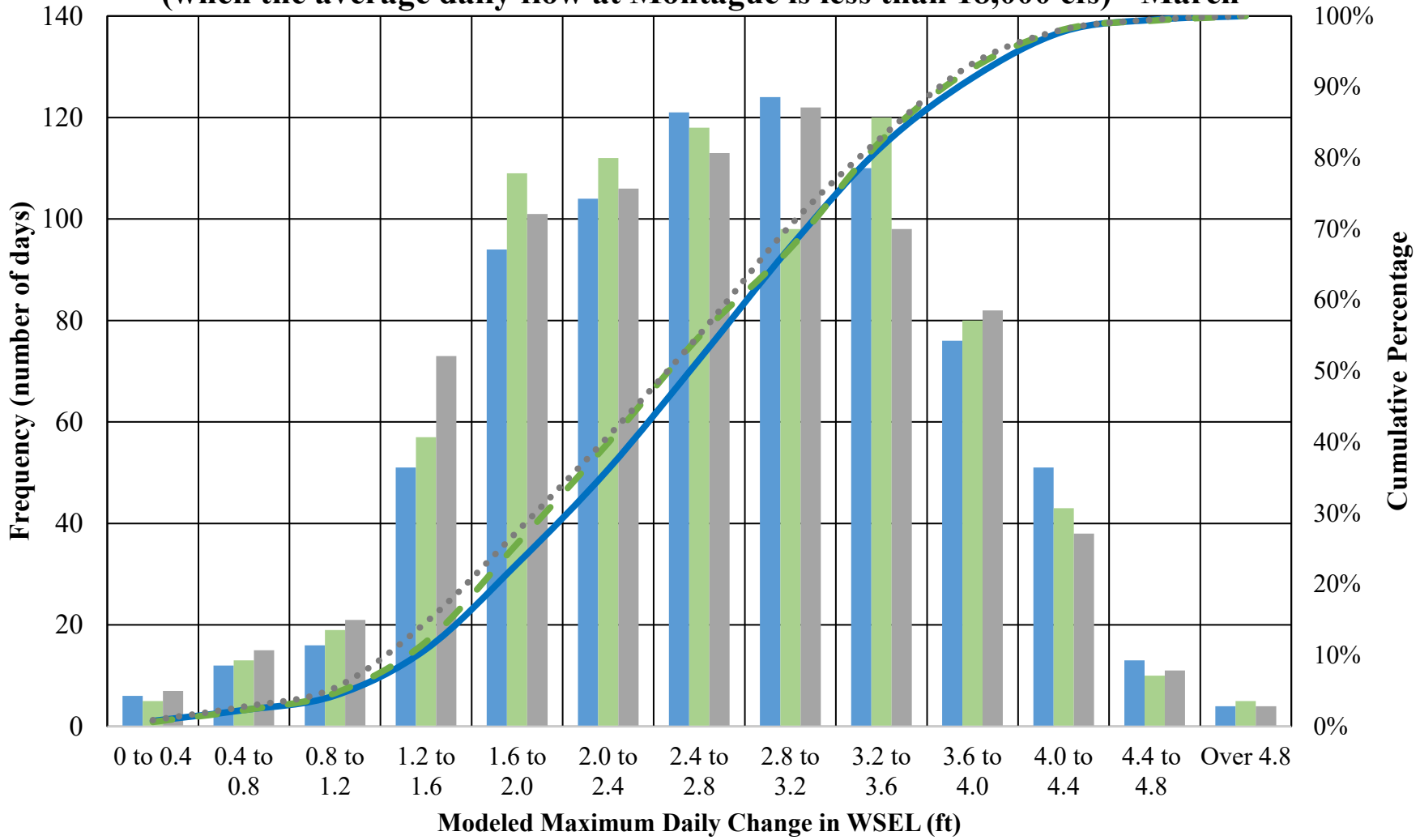
## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the average daily flow at Montague is less than 18,000 cfs) - January



## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - February

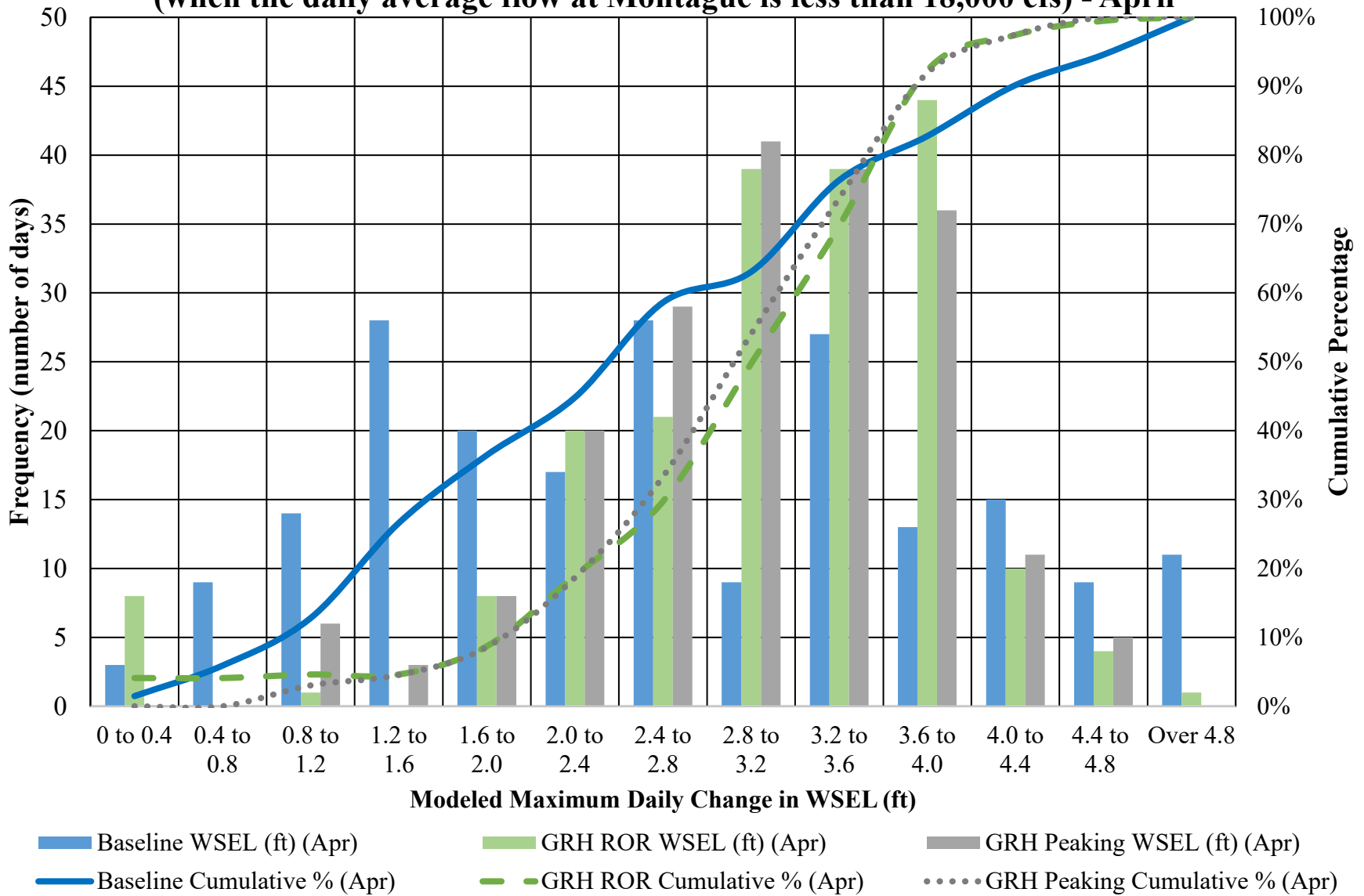


## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the average daily flow at Montague is less than 18,000 cfs) - March

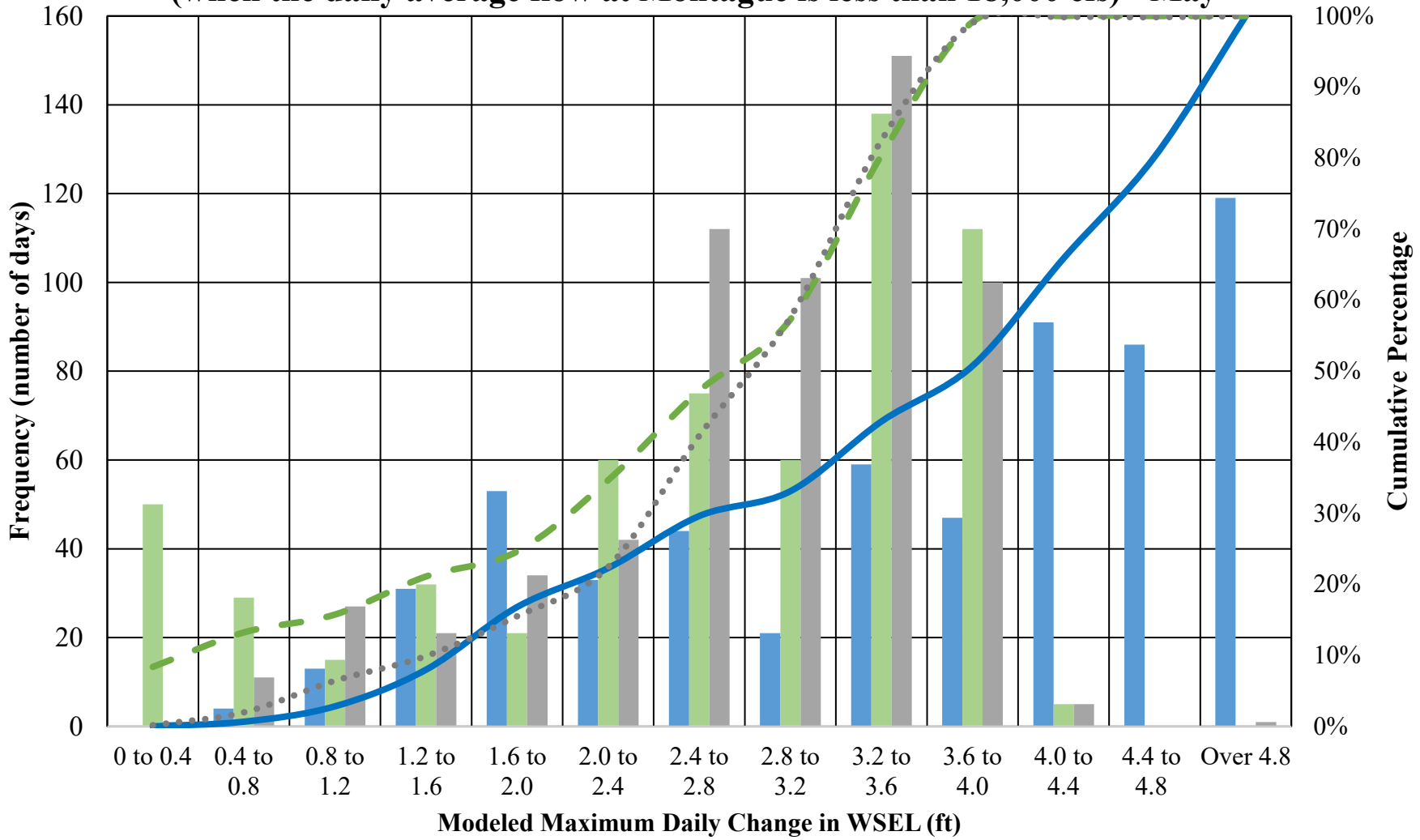


■ Baseline WSEL (ft) (Mar)     
 ■ GRH ROR WSEL (ft) (Mar)     
 ■ GRH Peaking WSEL (ft) (Mar)  
— Baseline Cumulative % (Mar)     
 — GRH ROR Cumulative % (Mar)     
 ⋯ GRH Peaking Cumulative % (Mar)

### HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - April

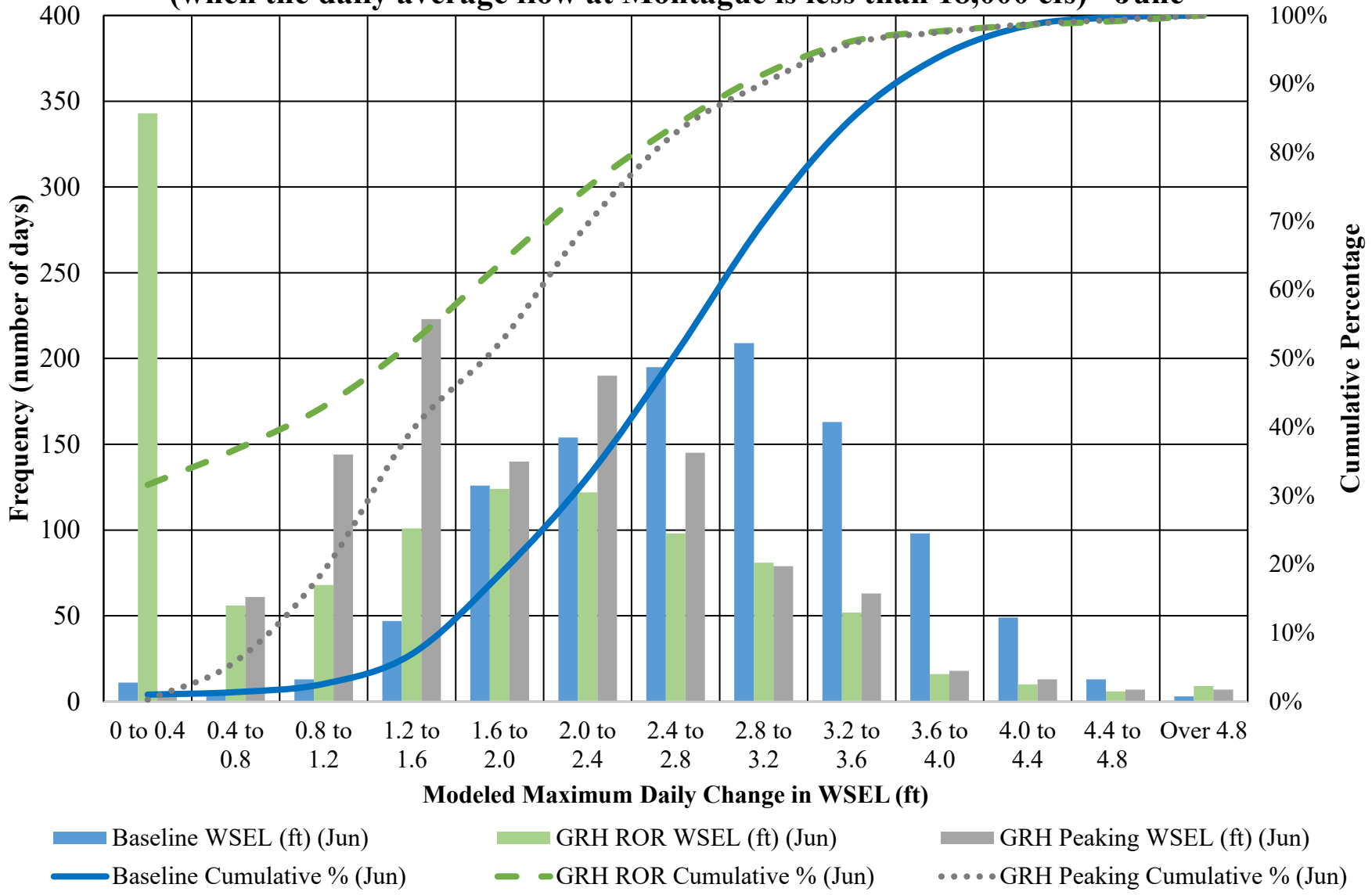


**HEC-RAS Station 115.07 WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - May**

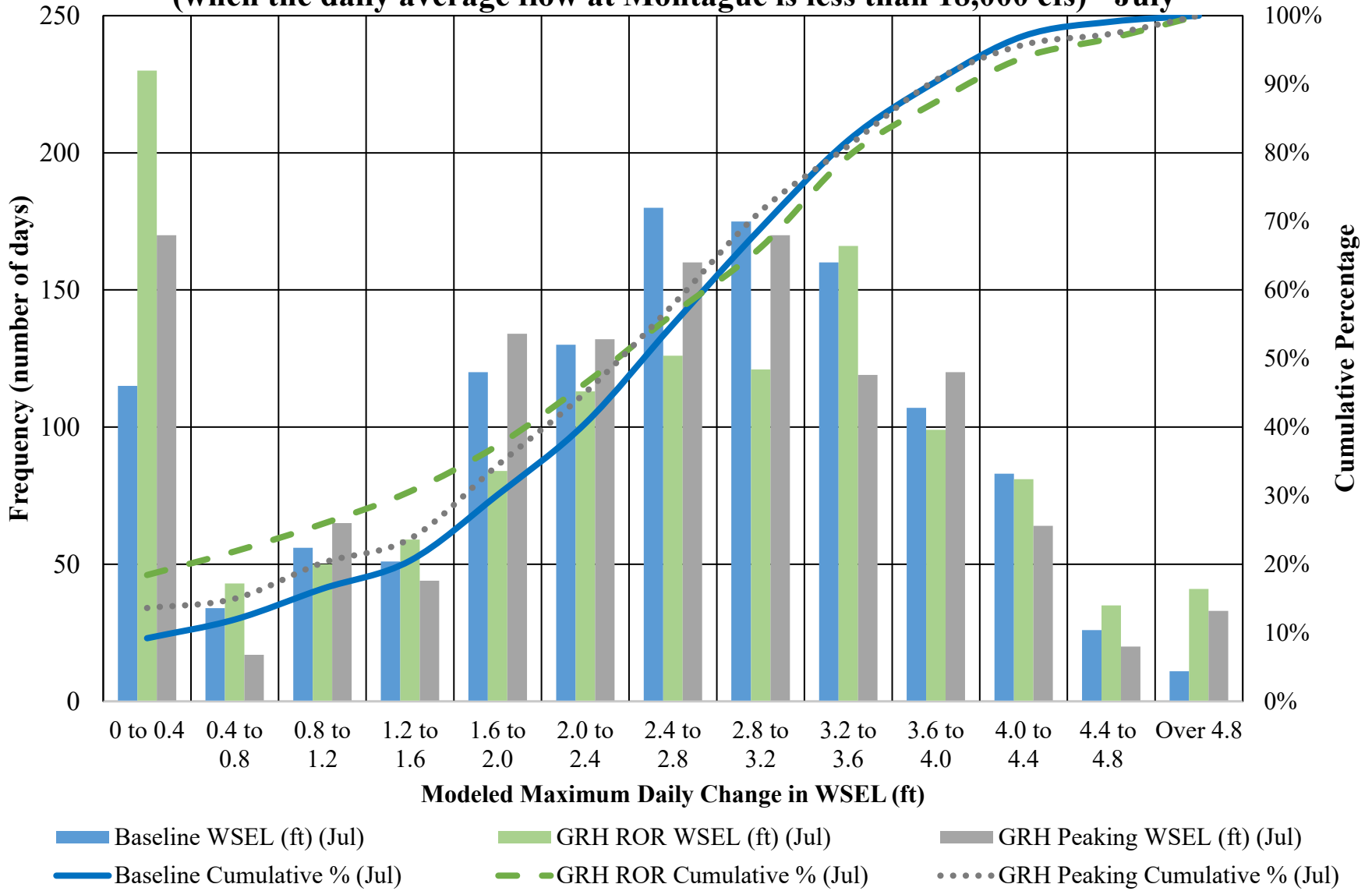


■ Baseline WSEL (ft) (May)     
 ■ GRH ROR WSEL (ft) (May)     
 ■ GRH Peaking WSEL (ft) (May)  
— Baseline Cumulative % (May)     
 - - - GRH ROR Cumulative % (May)     
 ⋯ GRH Peaking Cumulative % (May)

## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - June

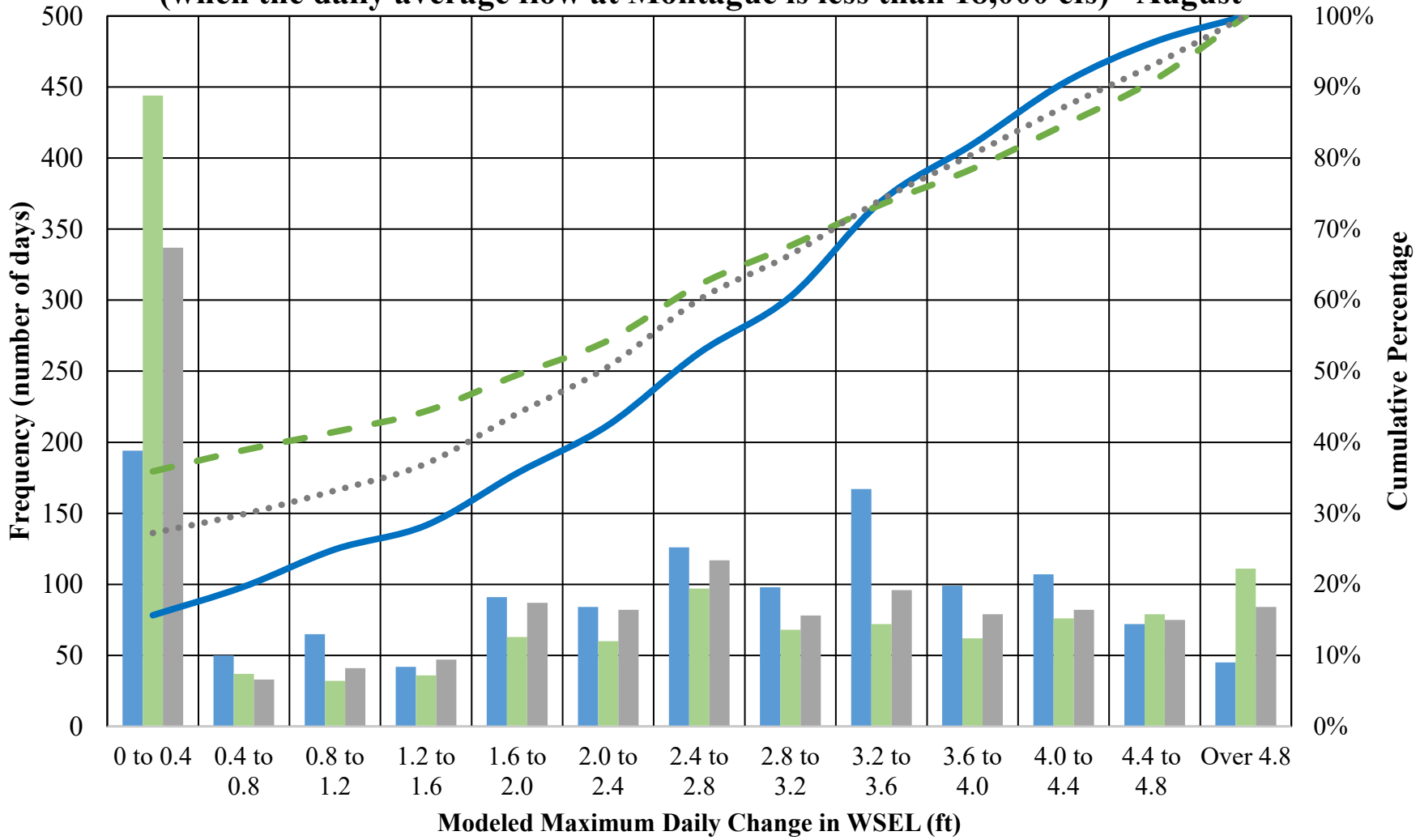


## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - July



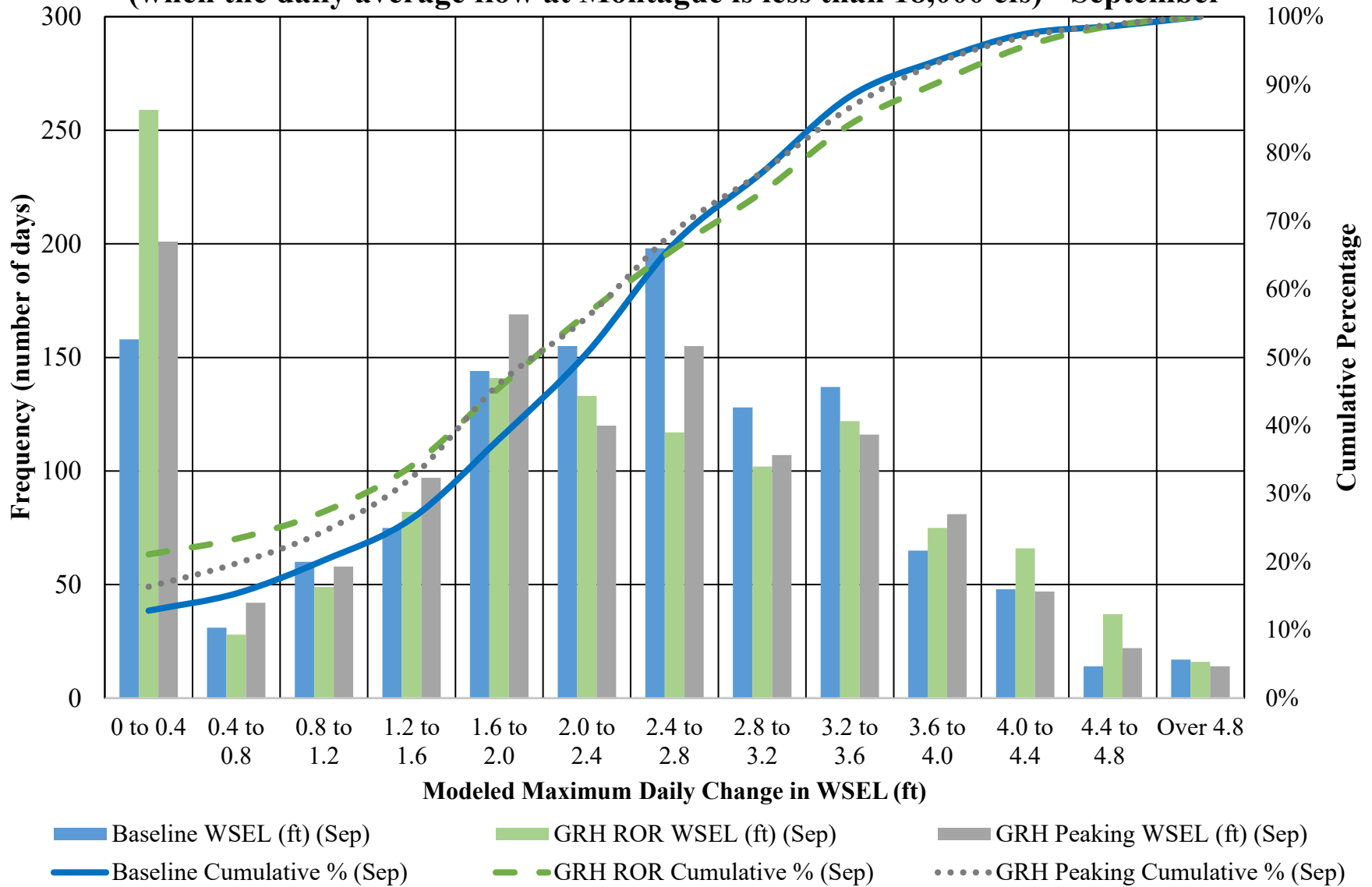


## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - August

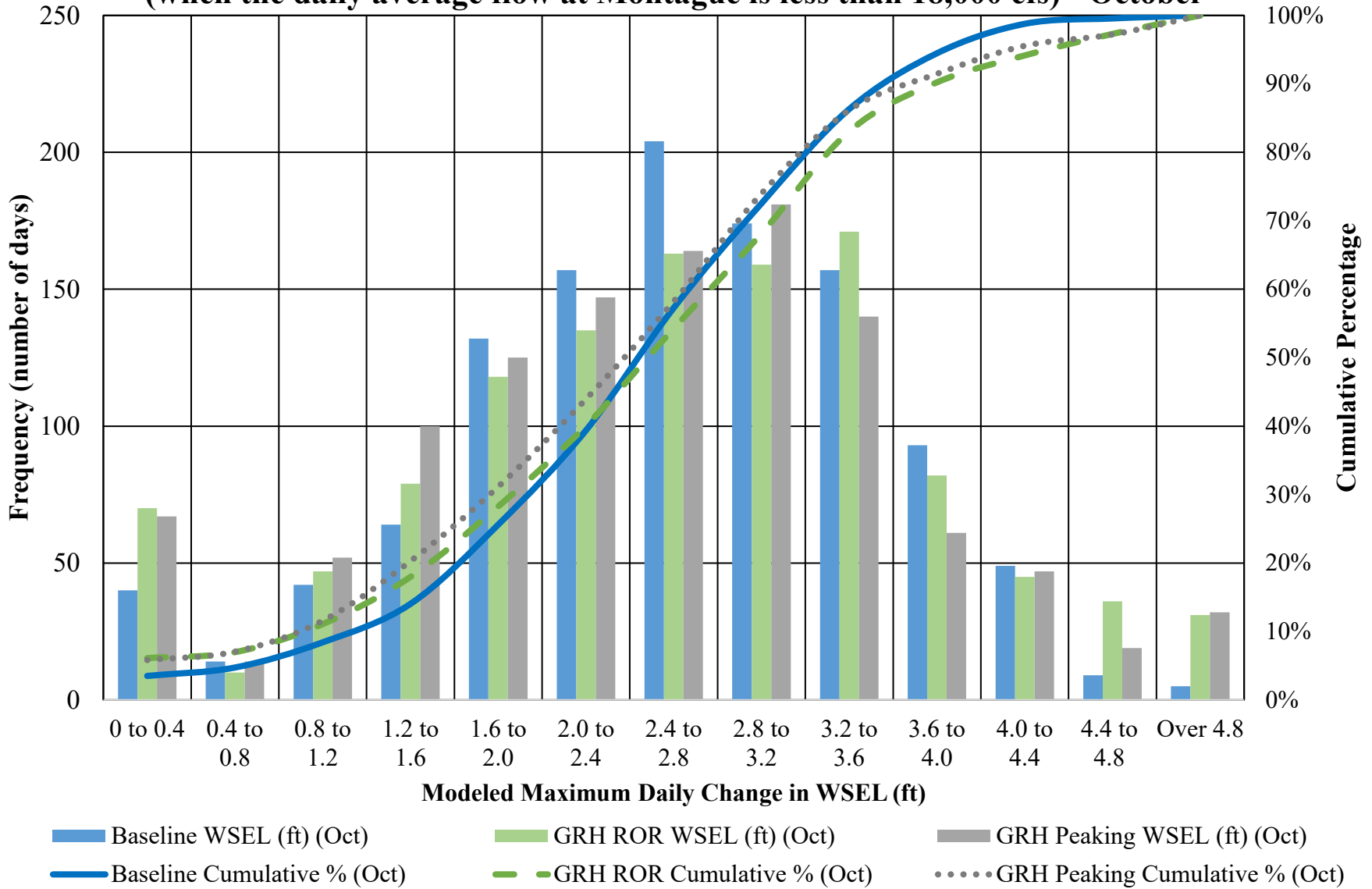


- Baseline WSEL (ft) (Aug)
  GRH ROR WSEL (ft) (Aug)
  GRH Peaking WSEL (ft) (Aug)
- Baseline Cumulative % (Aug)
  GRH ROR Cumulative % (Aug)
  GRH Peaking Cumulative % (Aug)

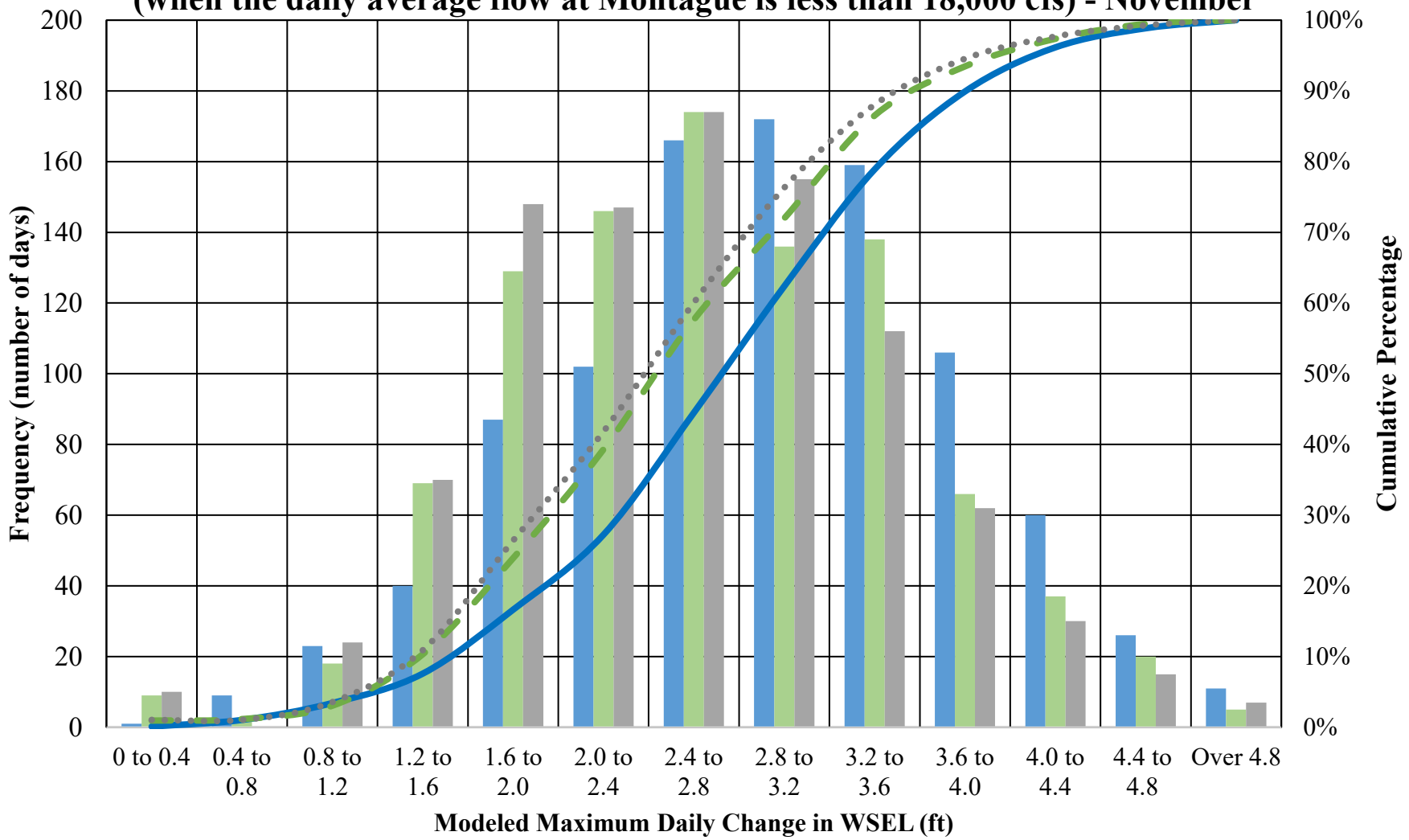
## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - September



## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - October

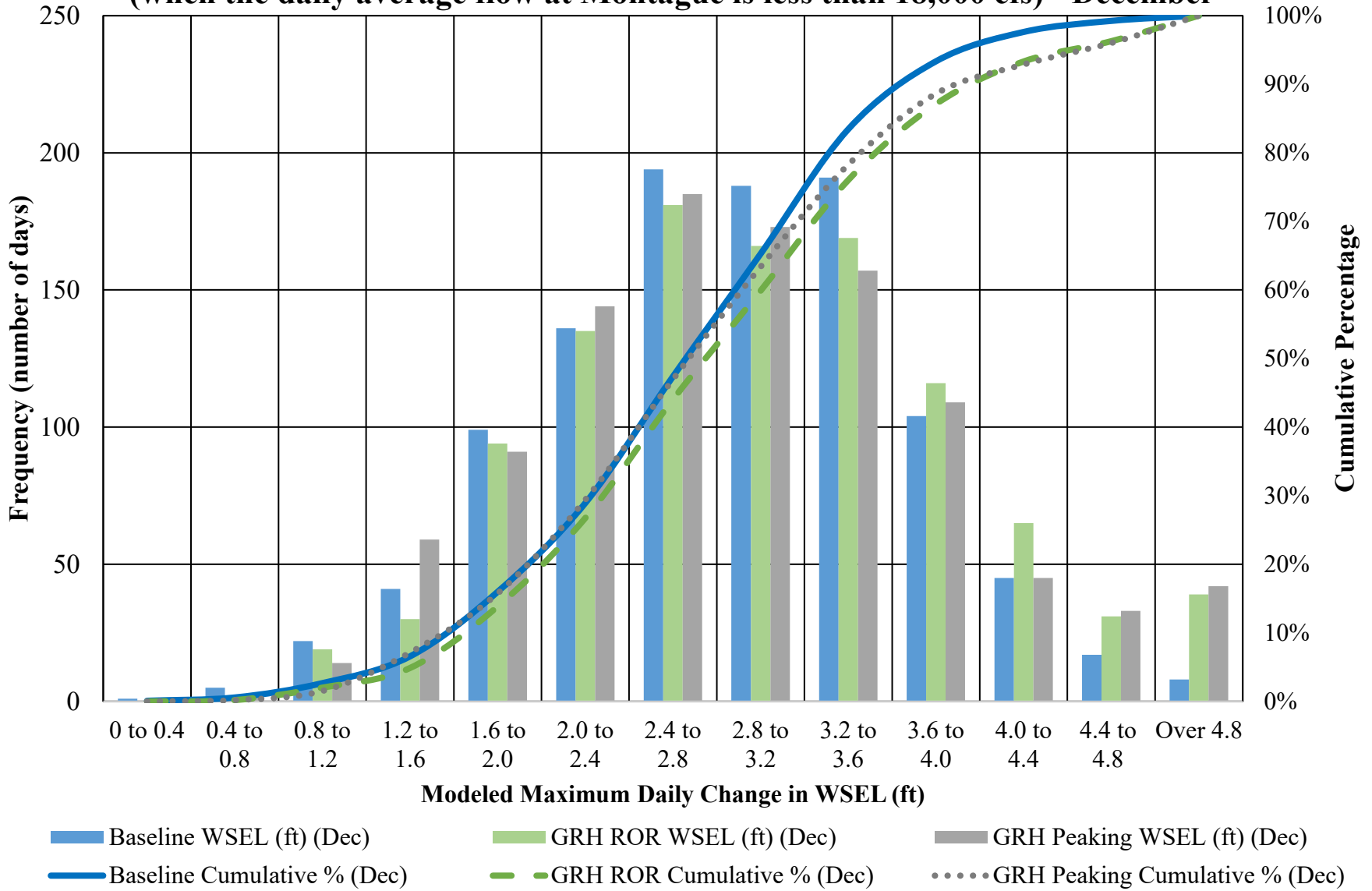


## HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - November

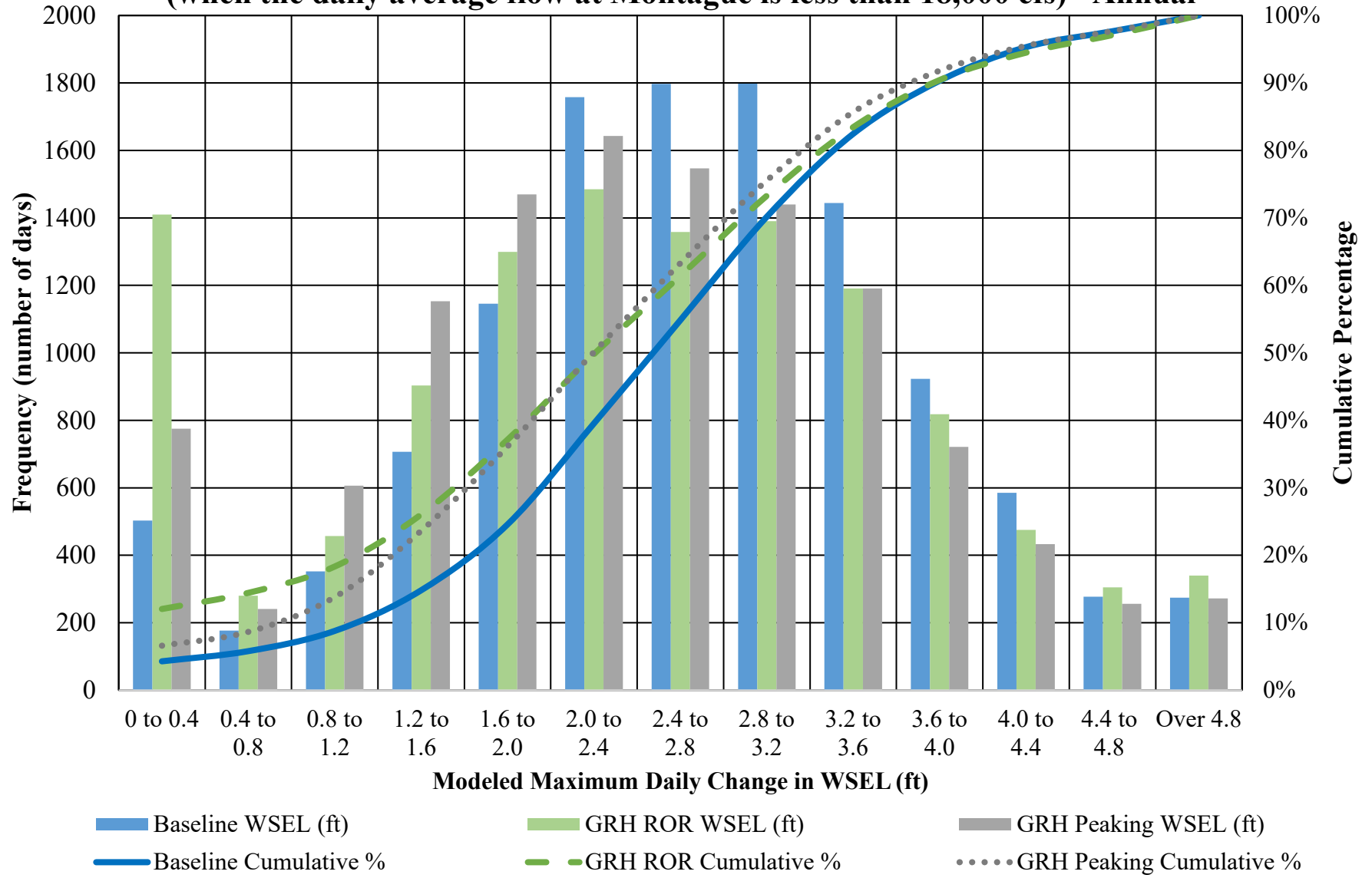


- Baseline WSEL (ft) (Nov)
- GRH ROR WSEL (ft) (Nov)
- GRH Peaking WSEL (ft) (Nov)
- Baseline Cumulative % (Nov)
- - - GRH ROR Cumulative % (Nov)
- ⋯ GRH Peaking Cumulative % (Nov)

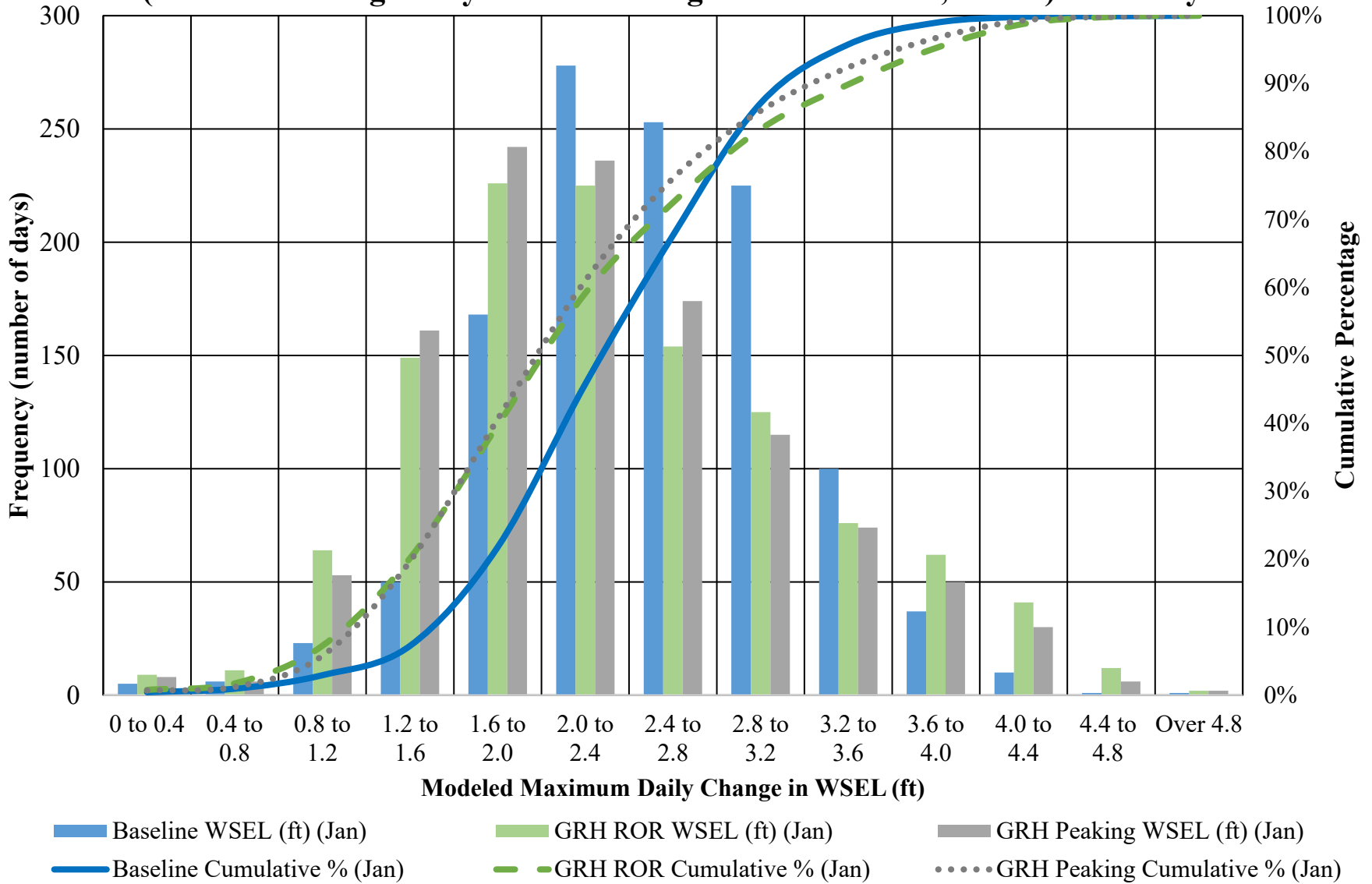
### HEC-RAS Station 115.07 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - December



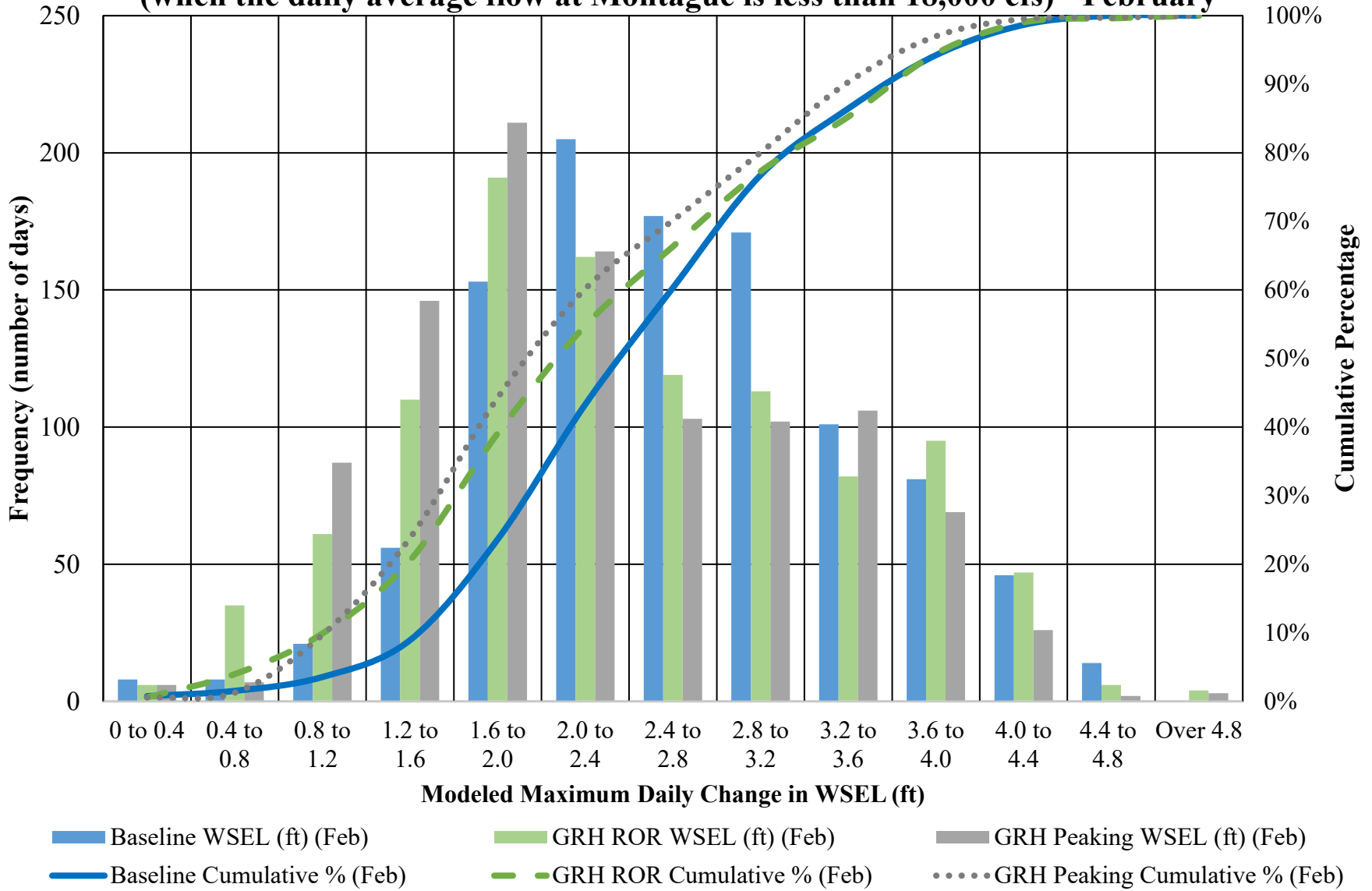
## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - Annual



## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the average daily flow at Montague is less than 18,000 cfs) - January

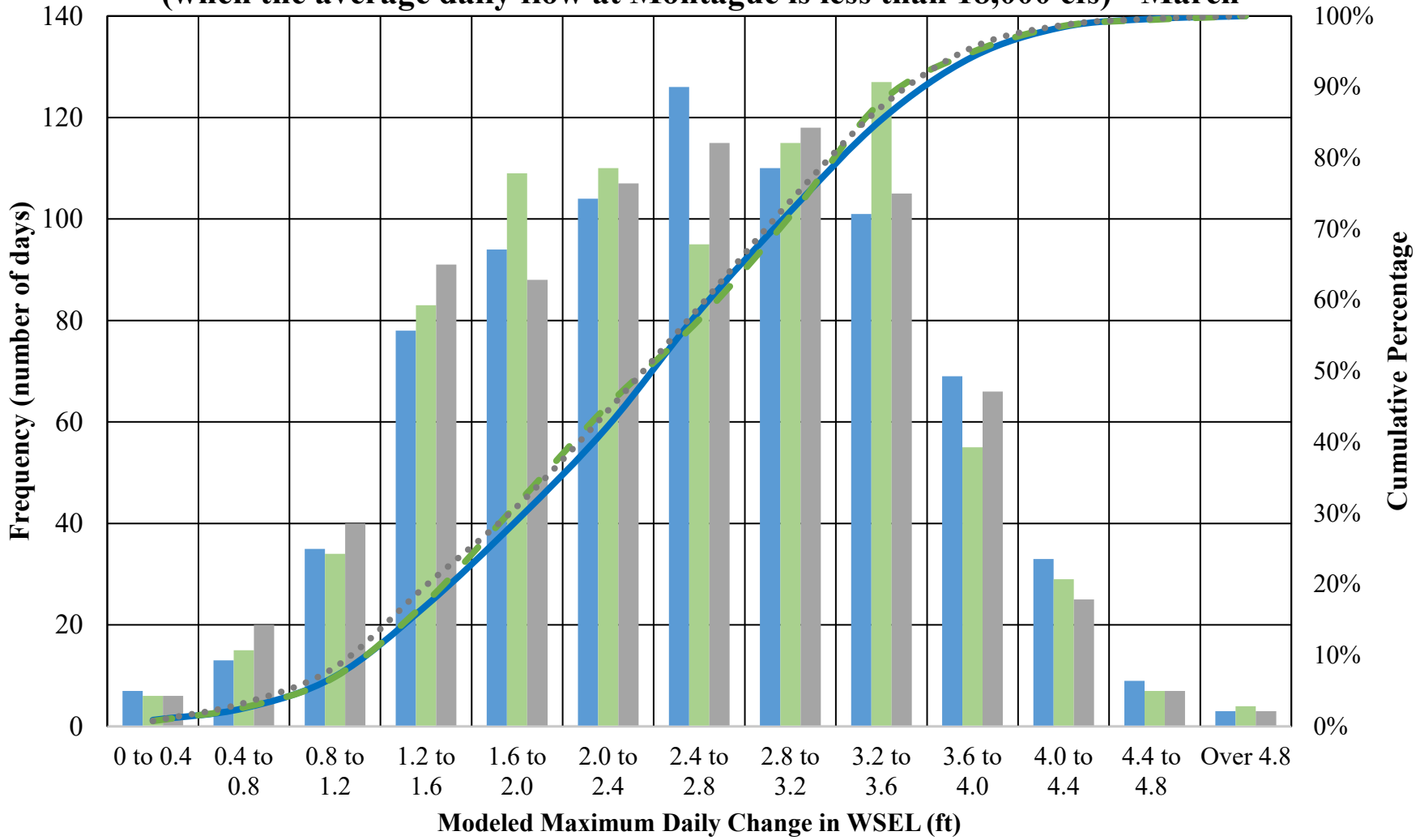


## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - February



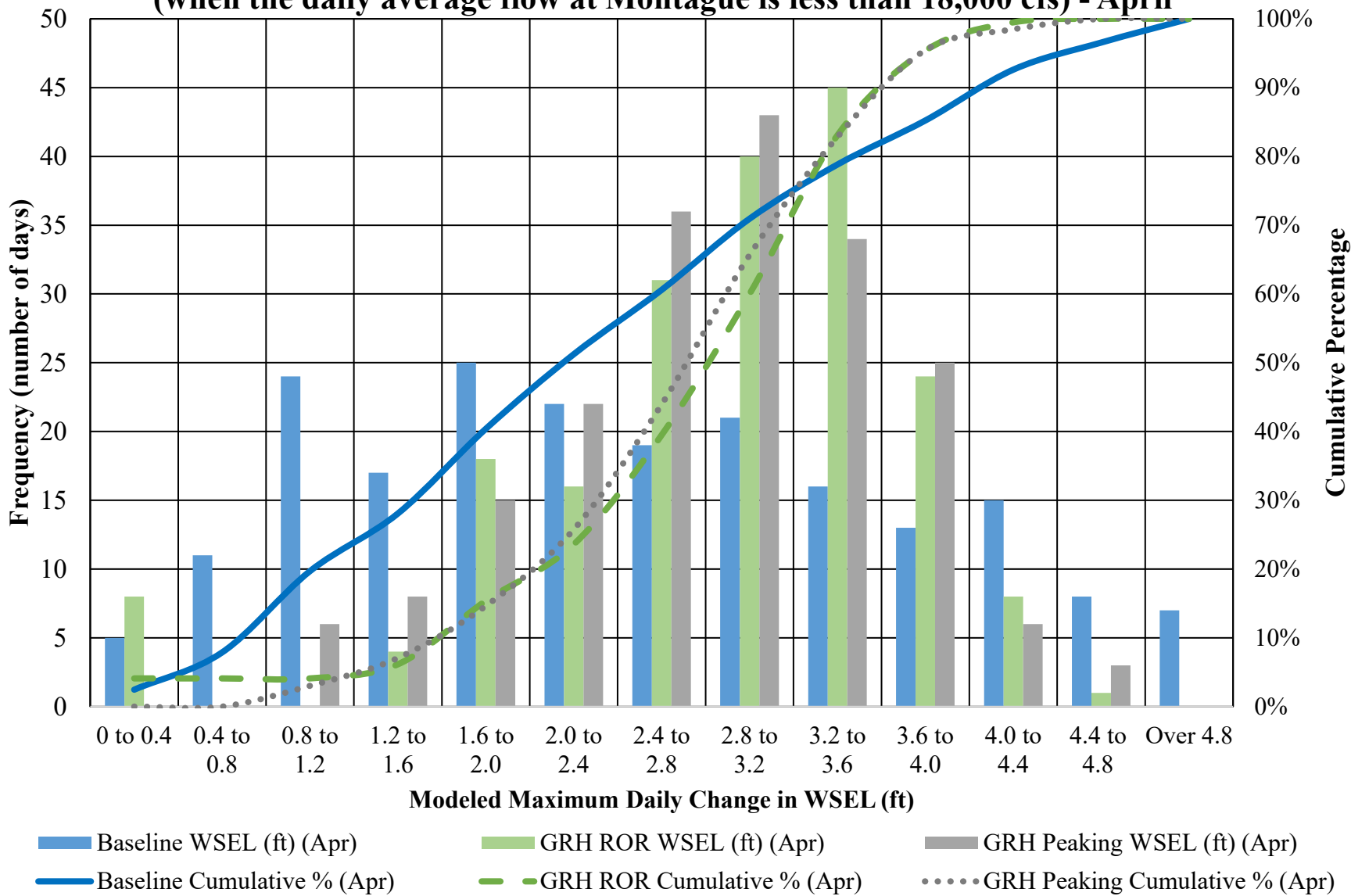


## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the average daily flow at Montague is less than 18,000 cfs) - March

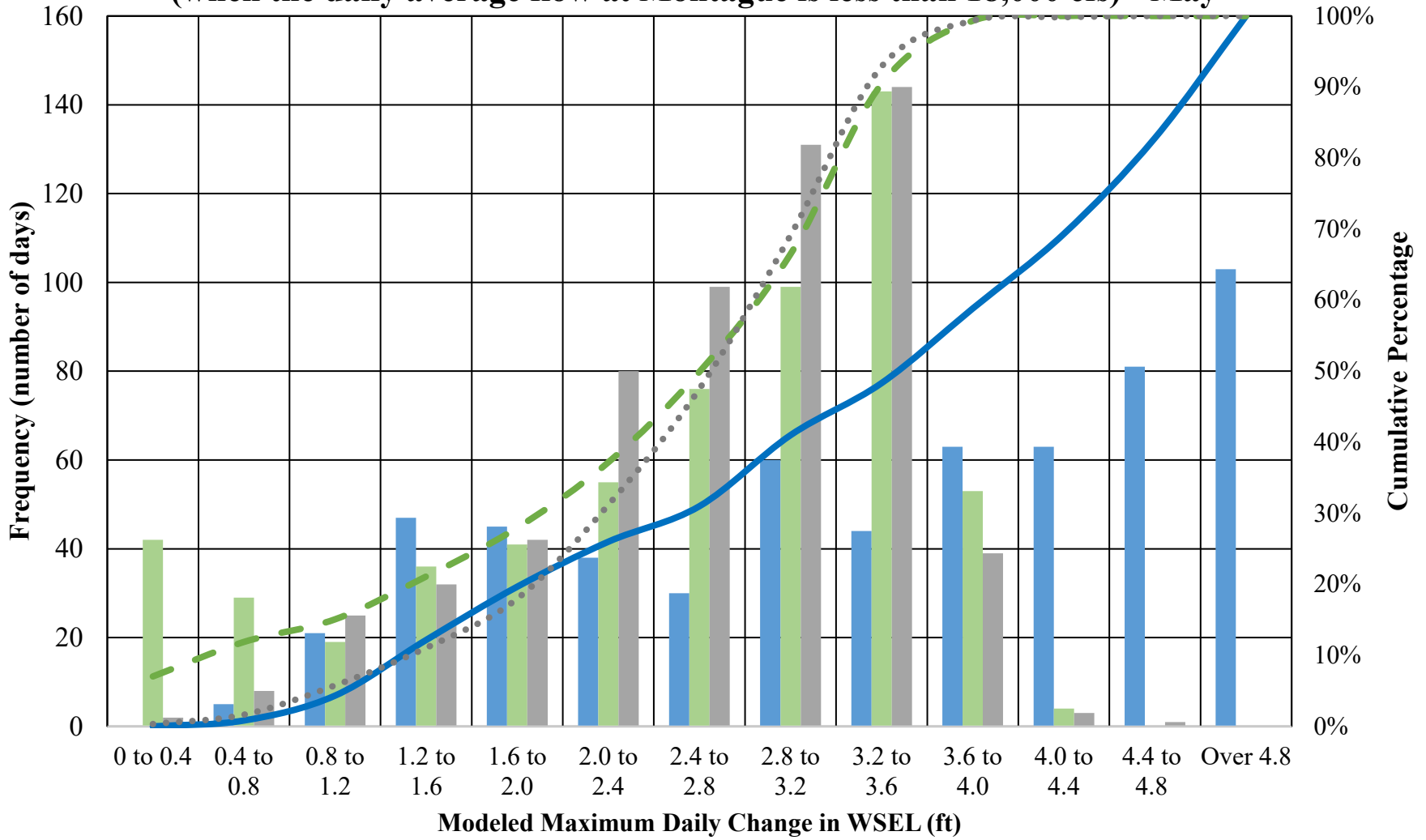


- █ Baseline WSEL (ft) (Mar)
- █ GRH ROR WSEL (ft) (Mar)
- █ GRH Peaking WSEL (ft) (Mar)
- Baseline Cumulative % (Mar)
- GRH ROR Cumulative % (Mar)
- ⋯ GRH Peaking Cumulative % (Mar)

### HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - April

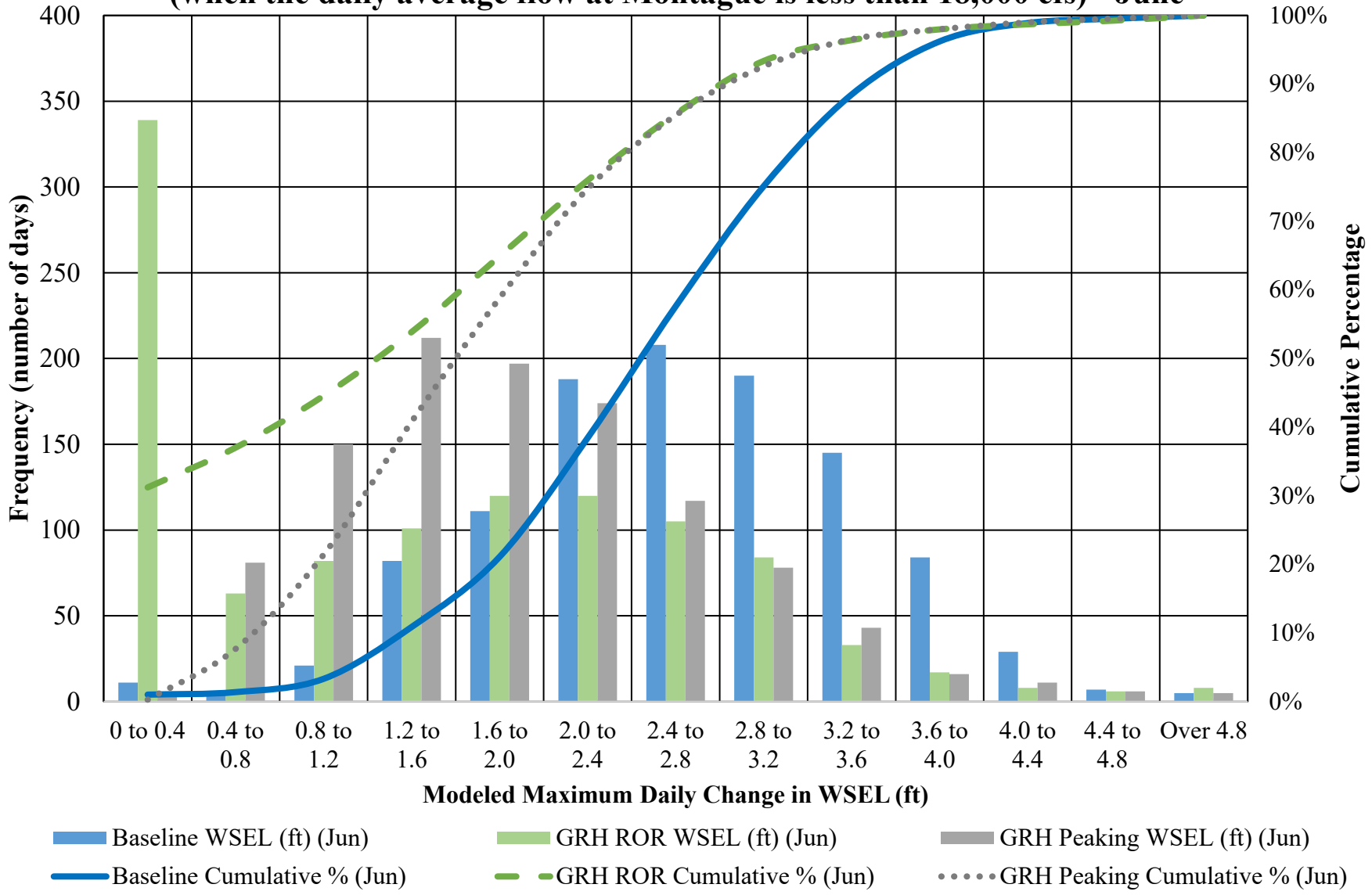


**HEC-RAS Station 112.36 WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - May**

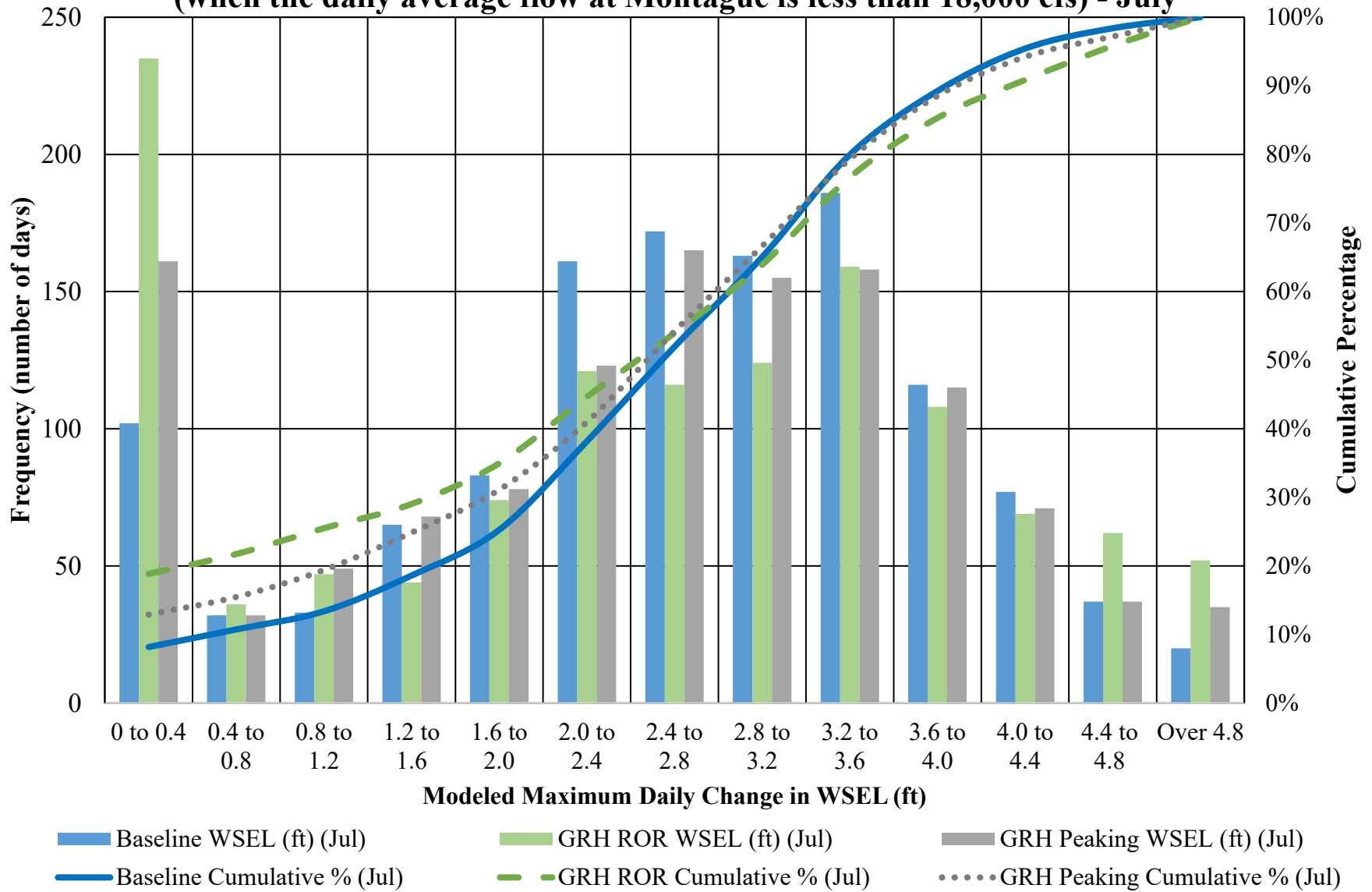


- Baseline WSEL (ft) (May)
- Baseline Cumulative % (May)
- GRH ROR WSEL (ft) (May)
- - - GRH ROR Cumulative % (May)
- GRH Peaking WSEL (ft) (May)
- ⋯ GRH Peaking Cumulative % (May)

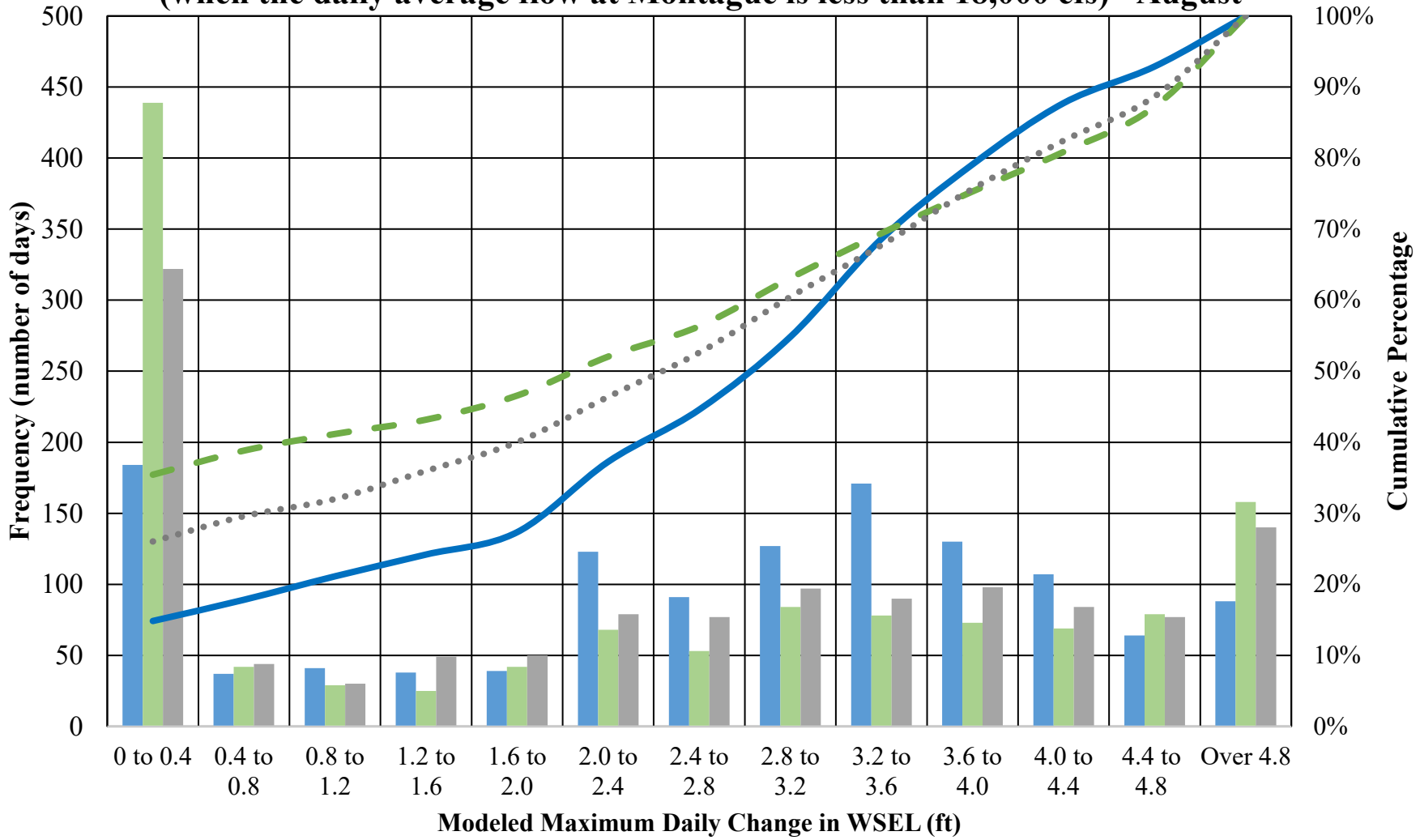
## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - June



## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - July

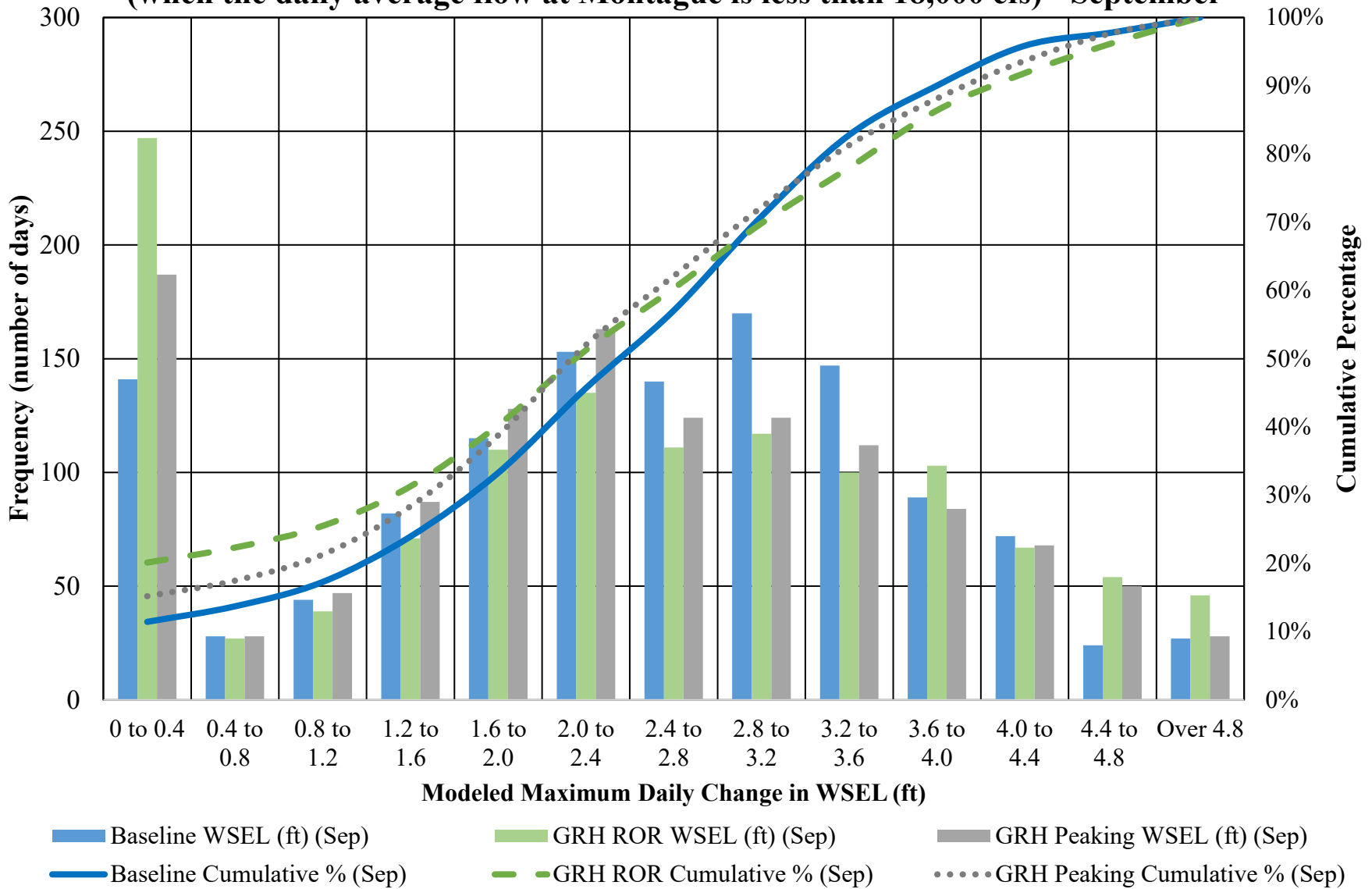


## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - August

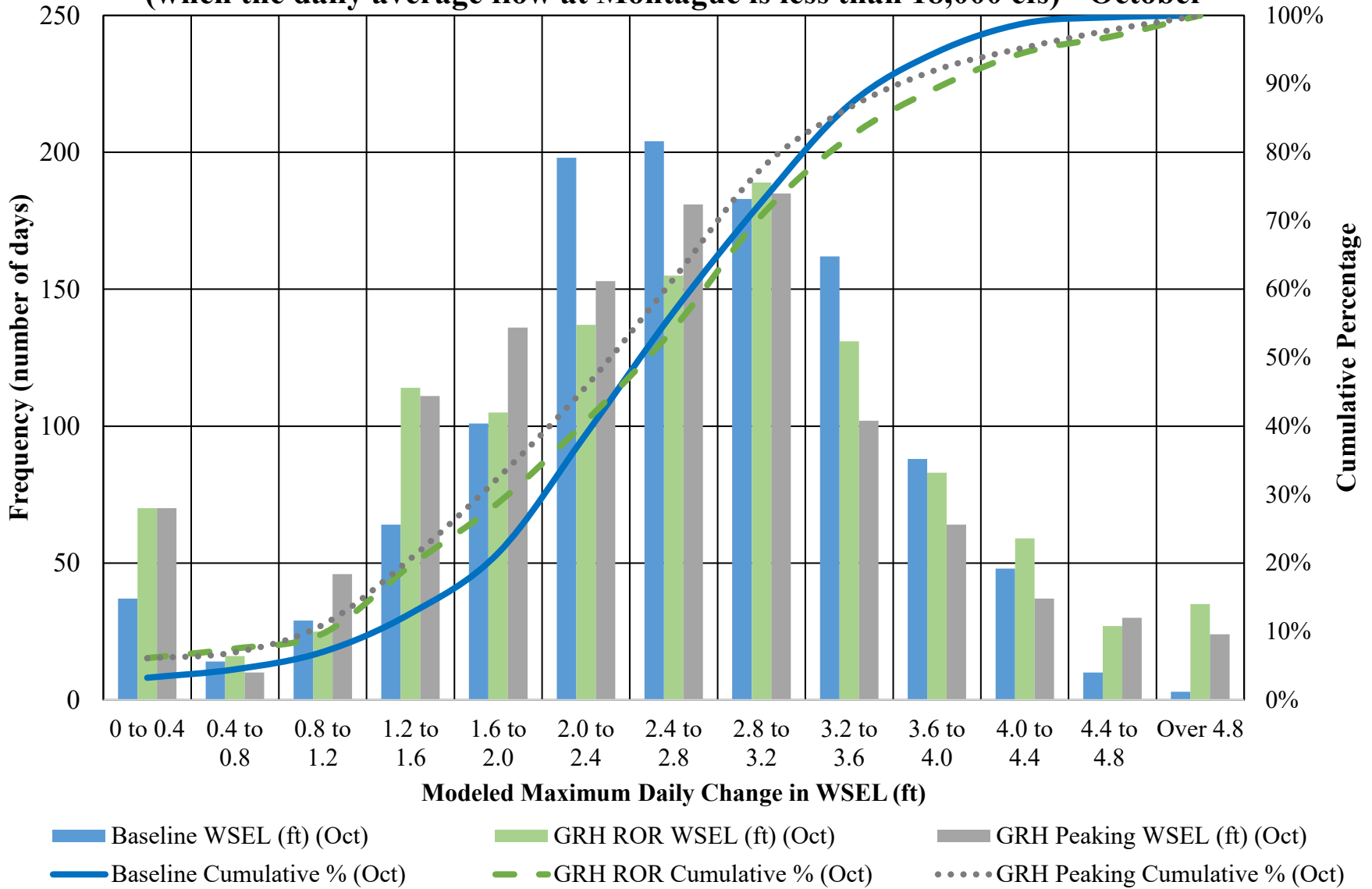


- Baseline WSEL (ft) (Aug)
- GRH ROR WSEL (ft) (Aug)
- GRH Peaking WSEL (ft) (Aug)
- Baseline Cumulative % (Aug)
- - - GRH ROR Cumulative % (Aug)
- · · · · GRH Peaking Cumulative % (Aug)

## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - September

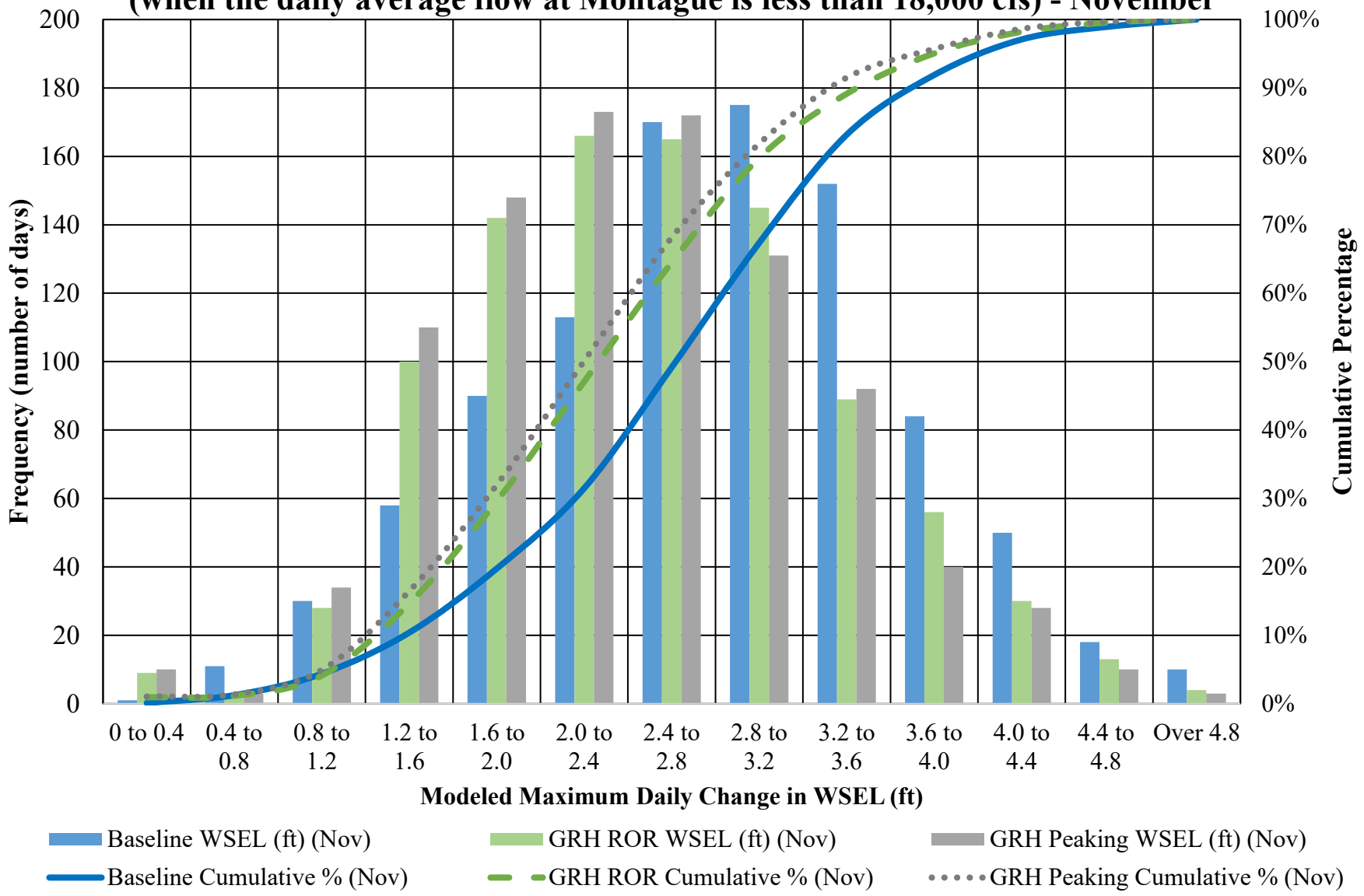


## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - October

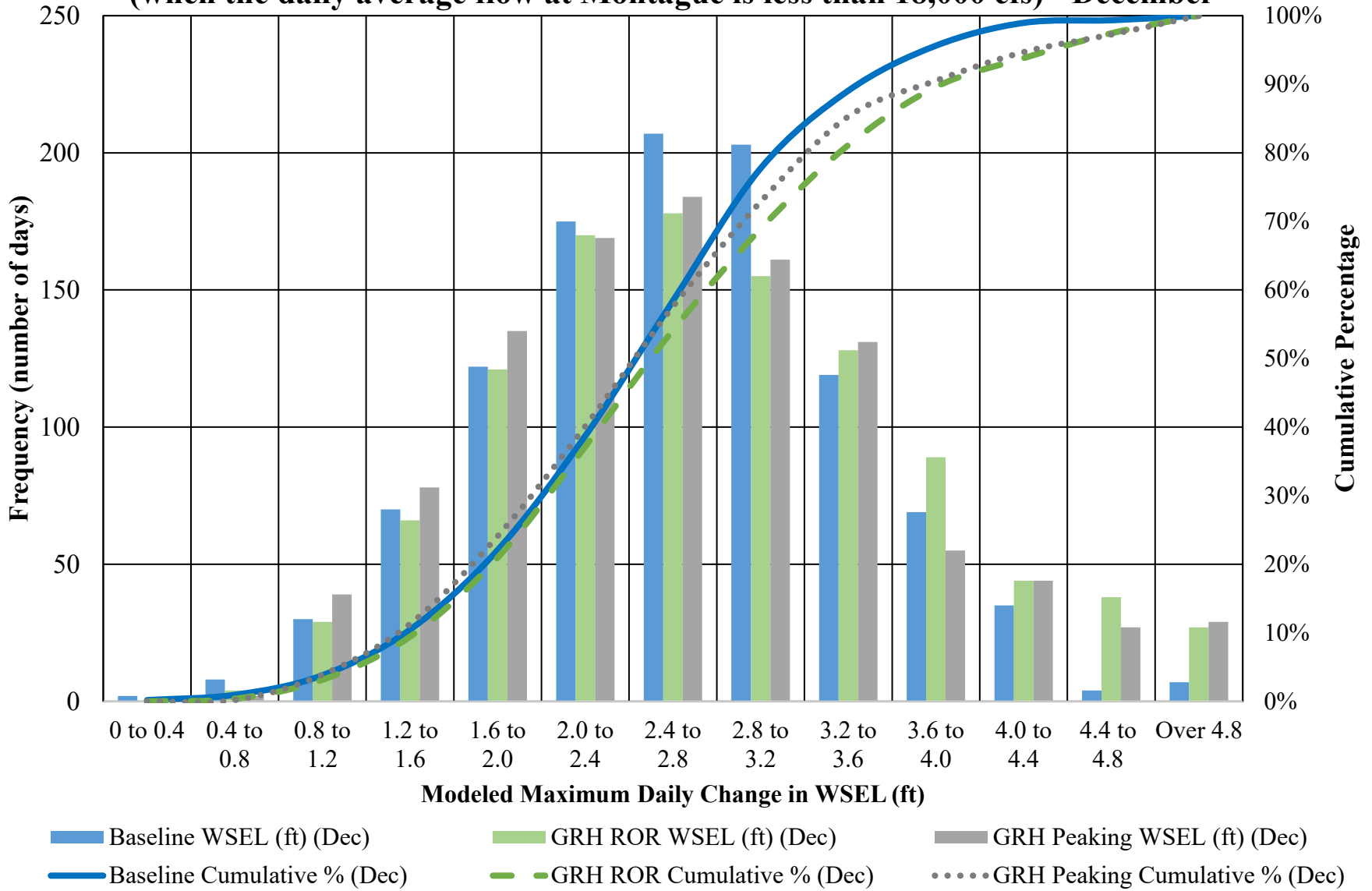




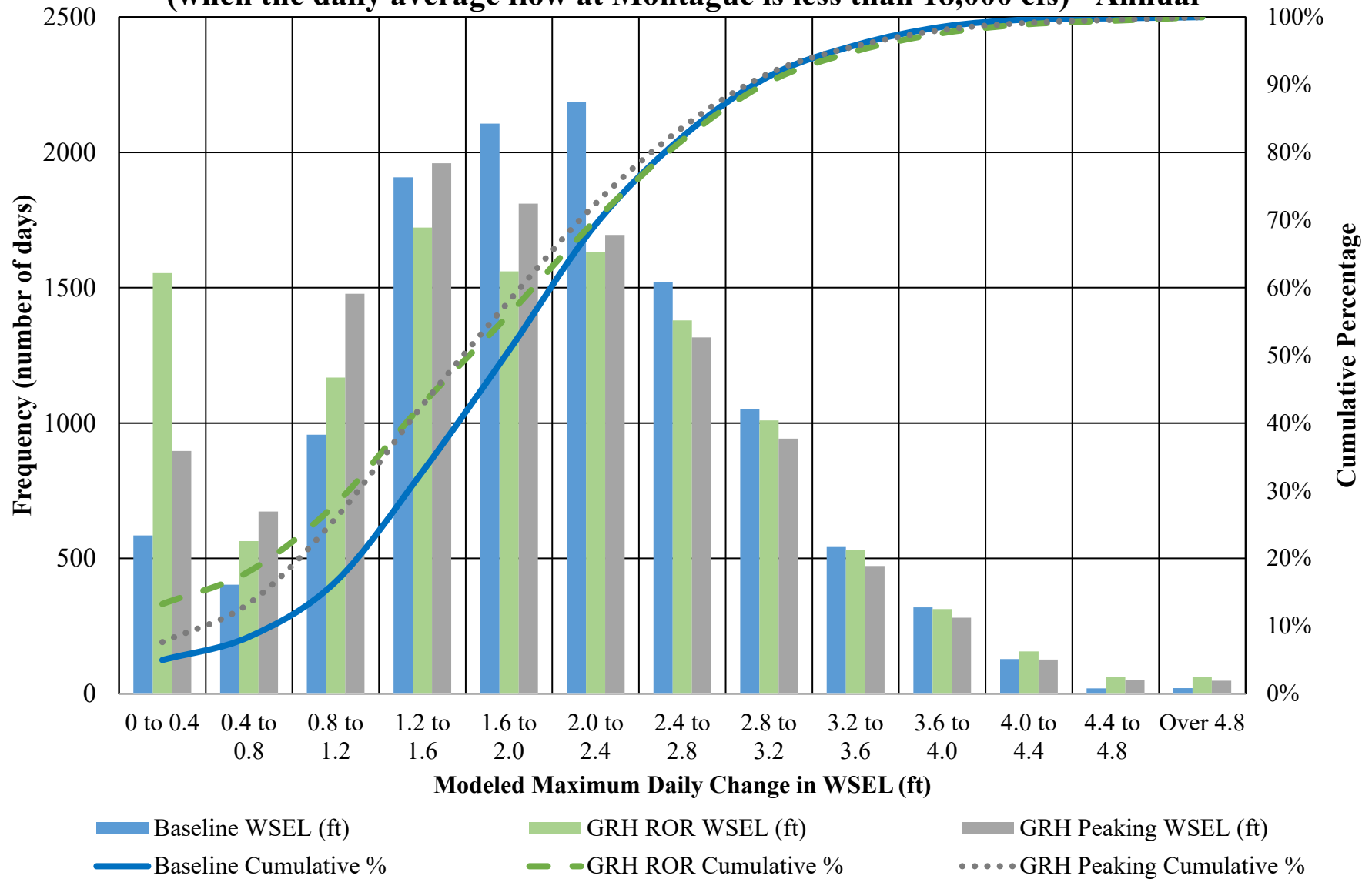
## HEC-RAS Station 112.36 WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - November



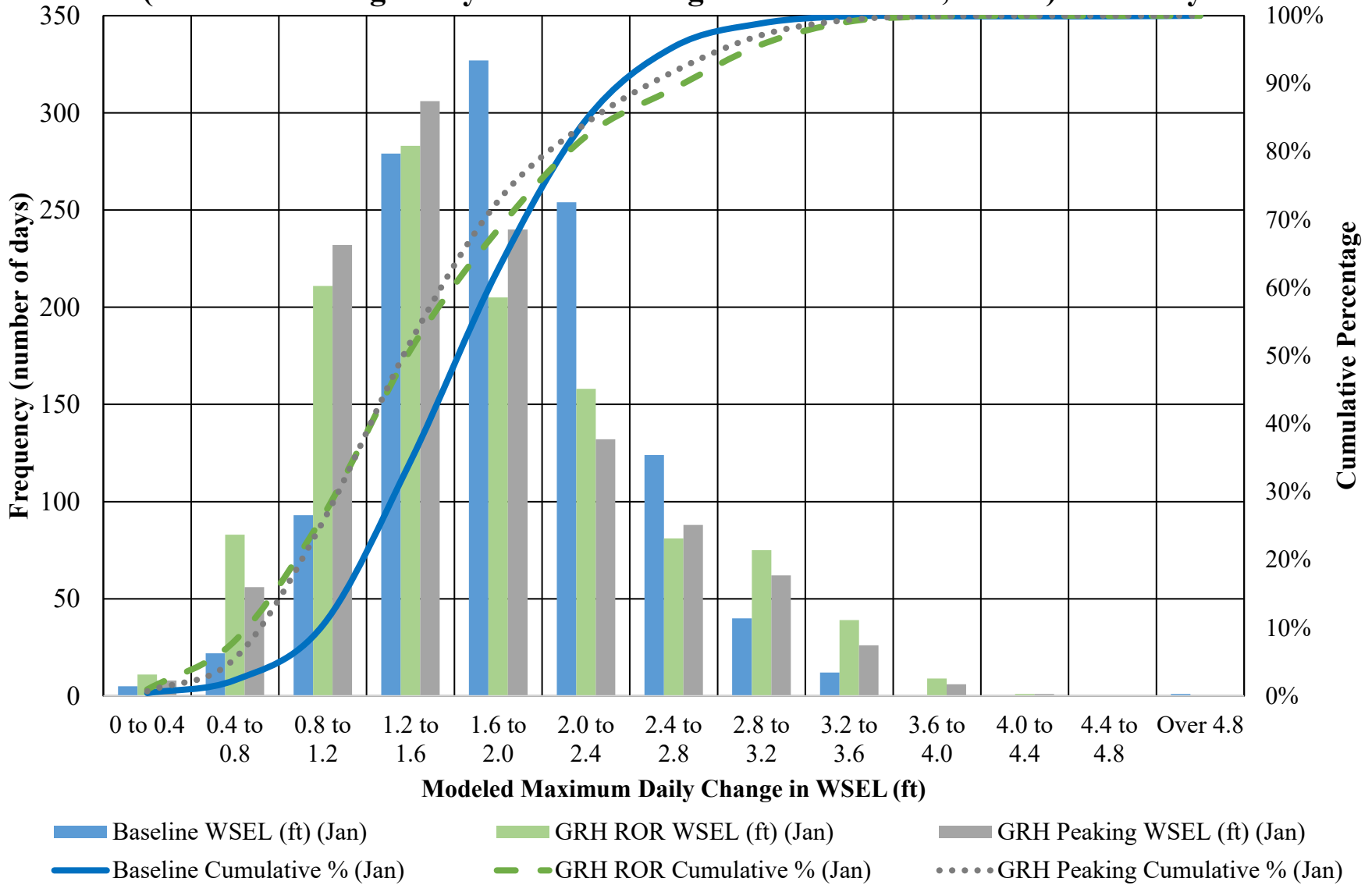
**HEC-RAS Station 112.36 WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - December**



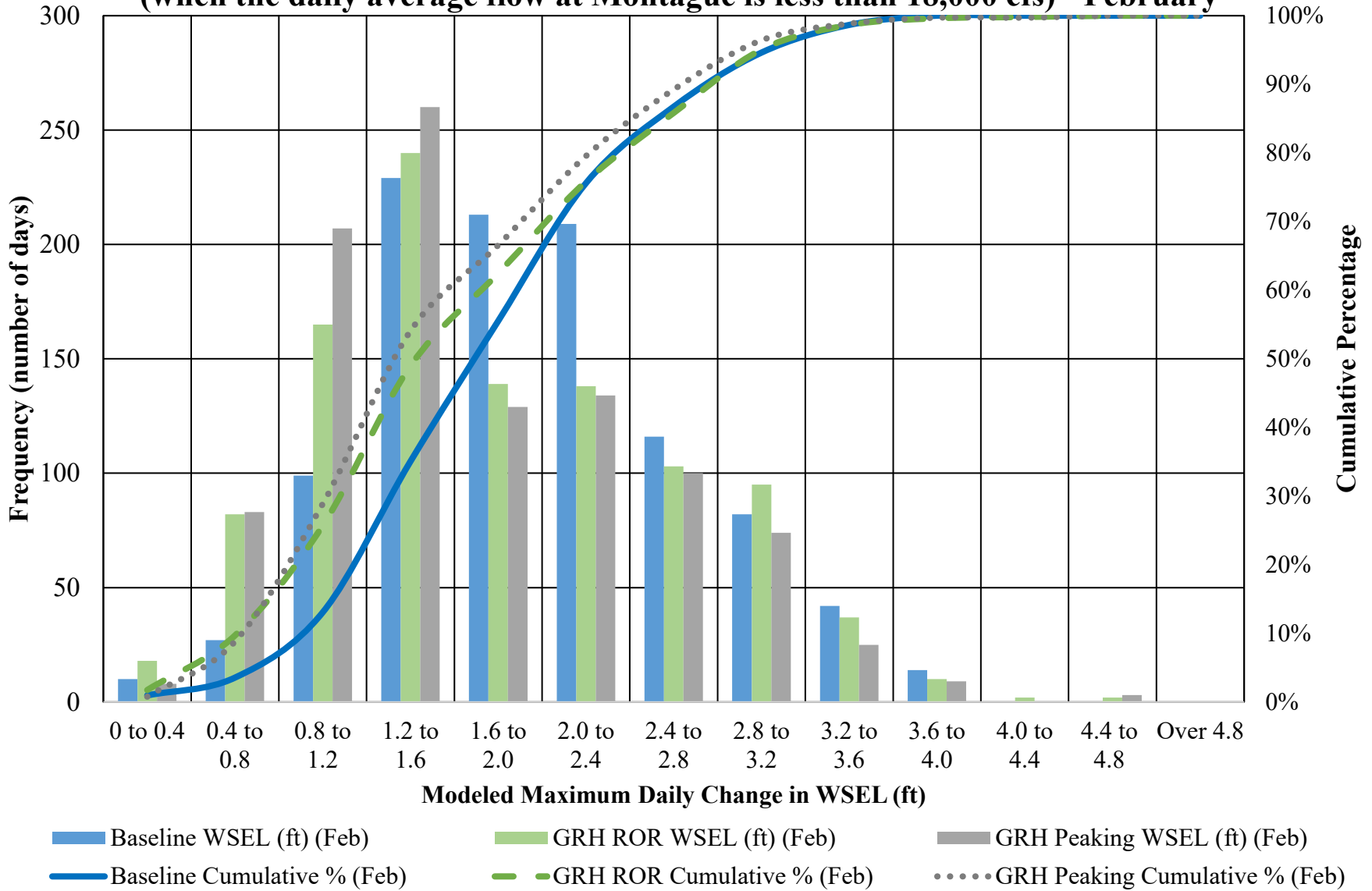
**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - Annual**



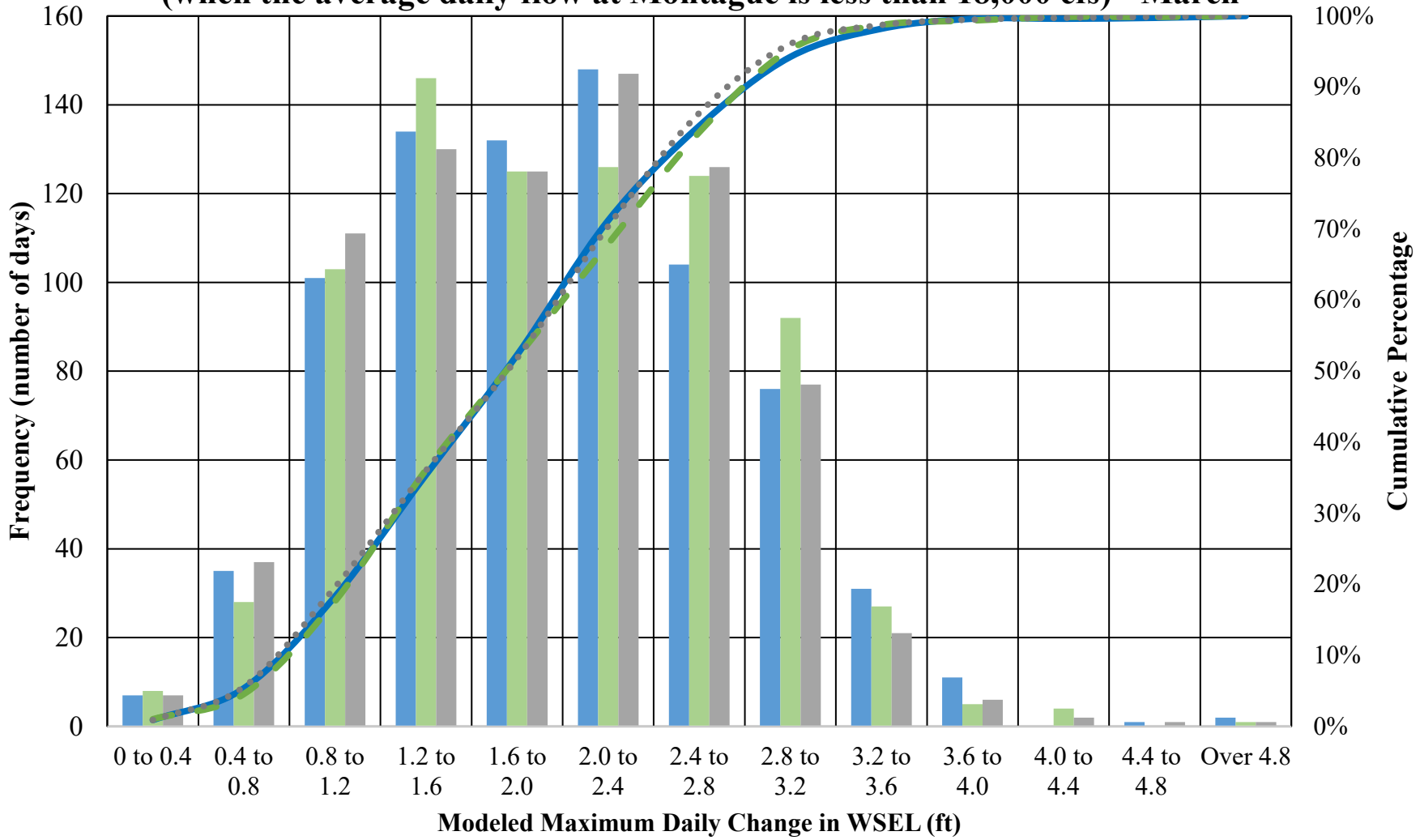
**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the average daily flow at Montague is less than 18,000 cfs) - January**



**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - February**

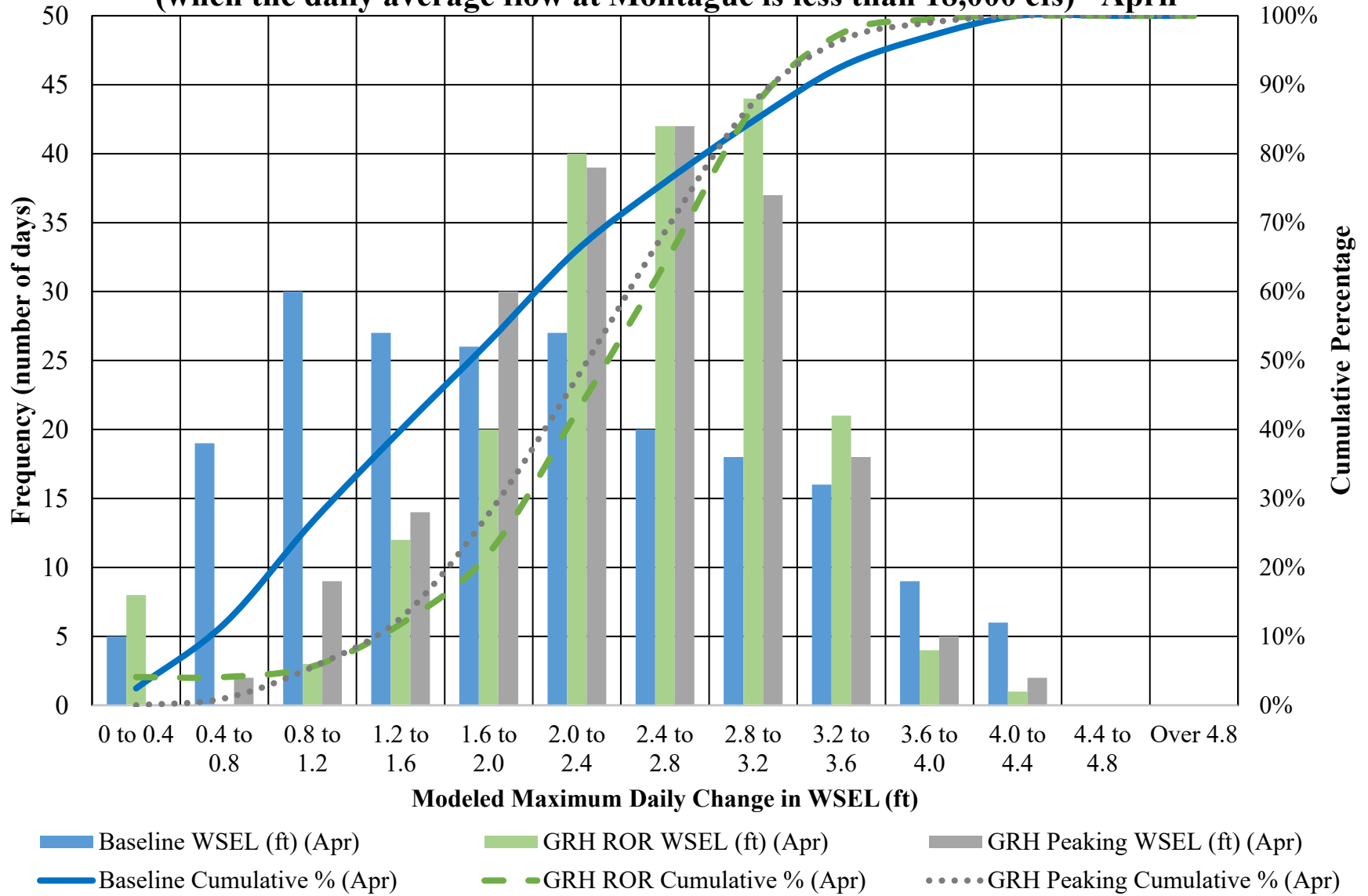


**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the average daily flow at Montague is less than 18,000 cfs) - March**

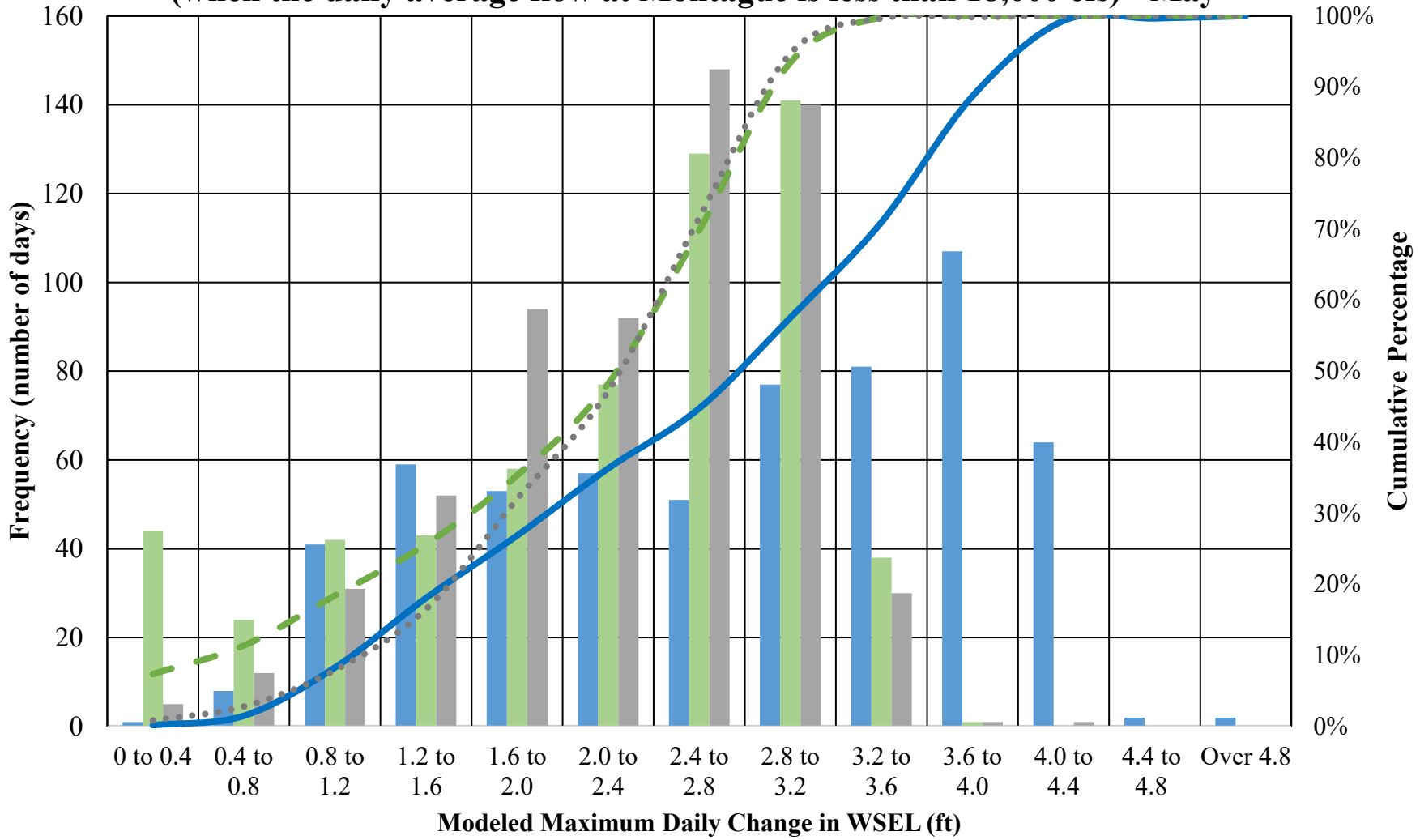


■ Baseline WSEL (ft) (Mar)     
 ■ GRH ROR WSEL (ft) (Mar)     
 ■ GRH Peaking WSEL (ft) (Mar)  
— Baseline Cumulative % (Mar)     
 — GRH ROR Cumulative % (Mar)     
 ⋯ GRH Peaking Cumulative % (Mar)

**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - April**



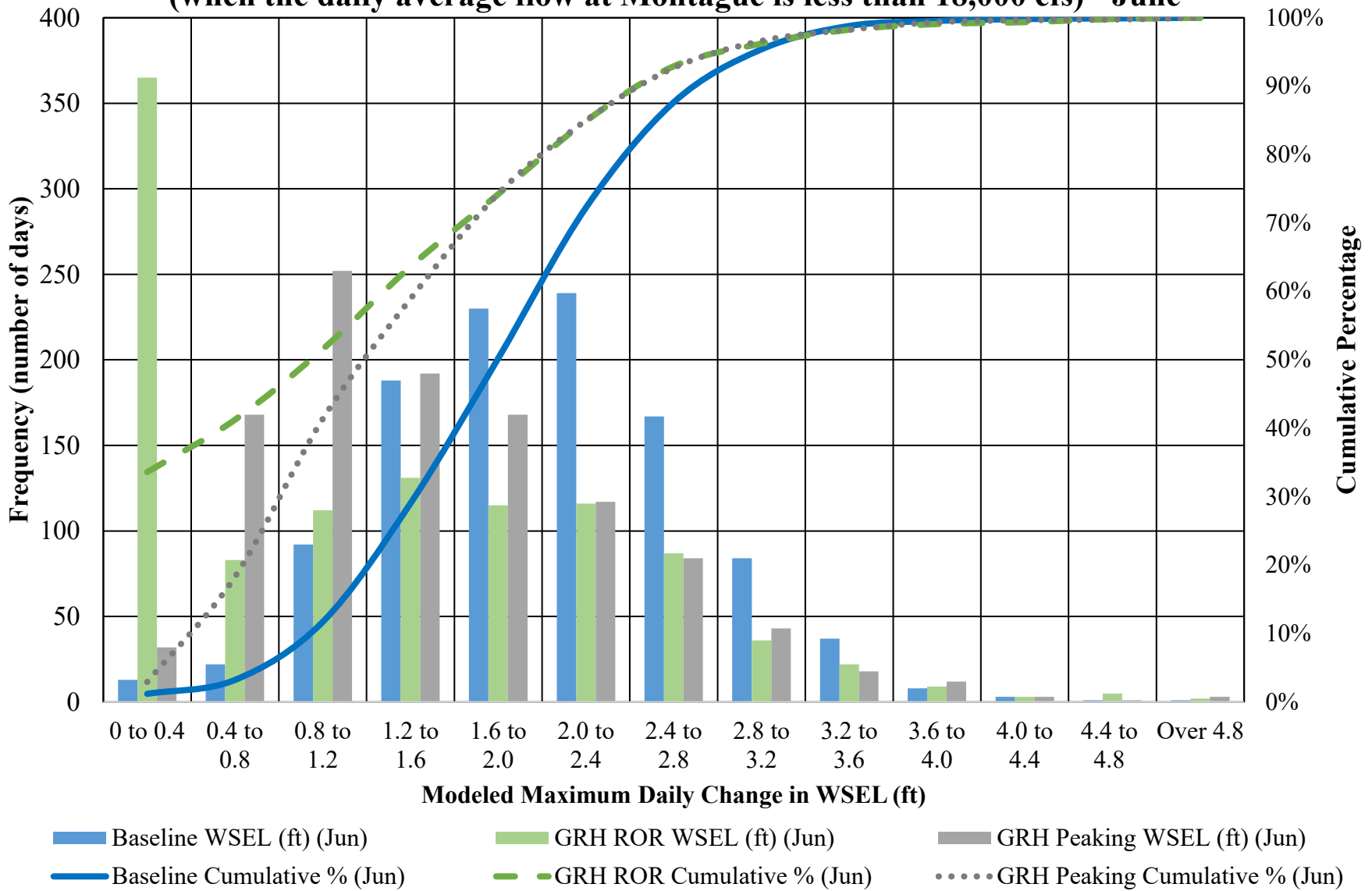
**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - May**



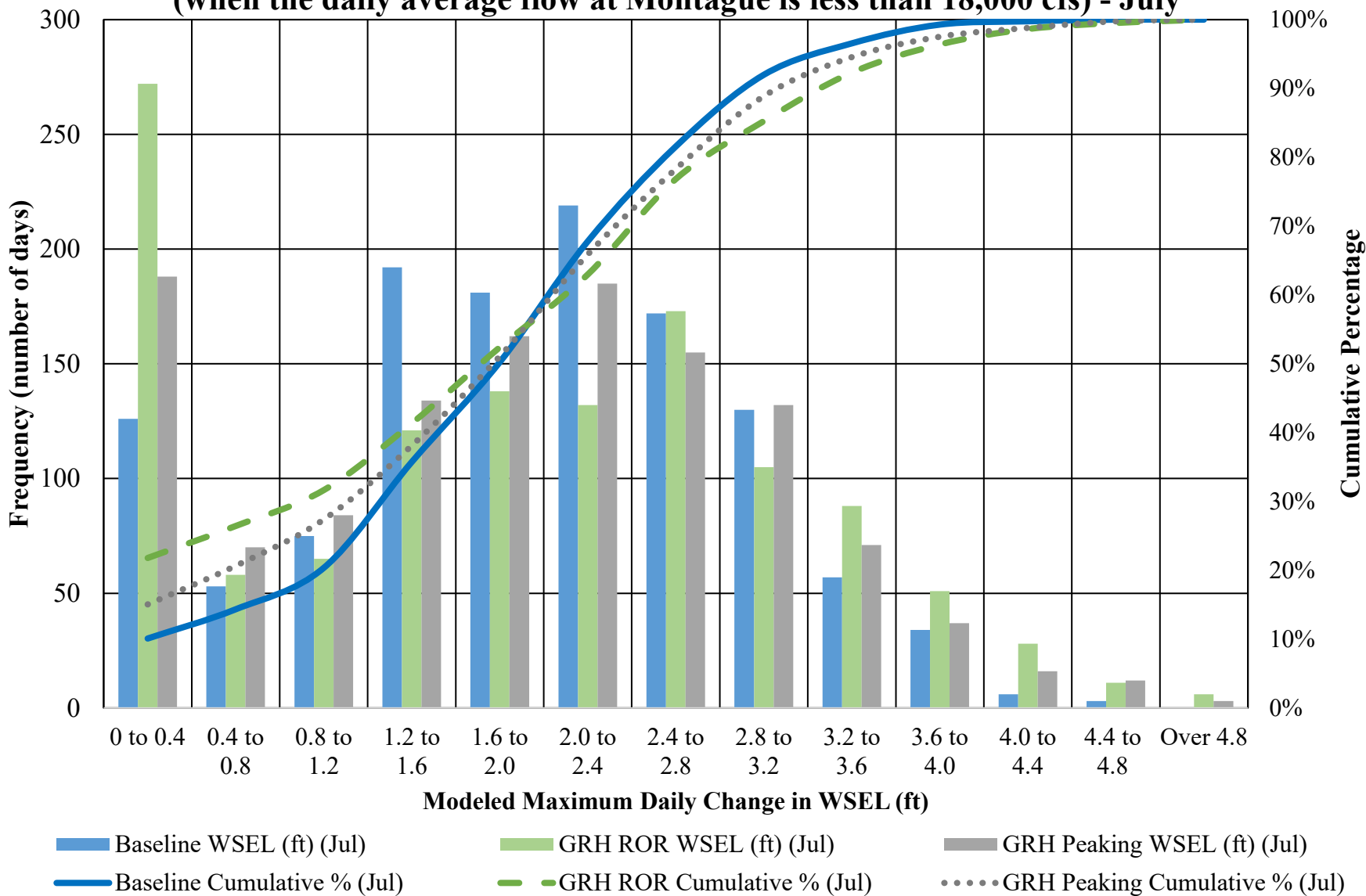
■ Baseline WSEL (ft) (May)     
 ■ GRH ROR WSEL (ft) (May)     
 ■ GRH Peaking WSEL (ft) (May)  
— Baseline Cumulative % (May)     
 - - - GRH ROR Cumulative % (May)     
 ⋯ GRH Peaking Cumulative % (May)



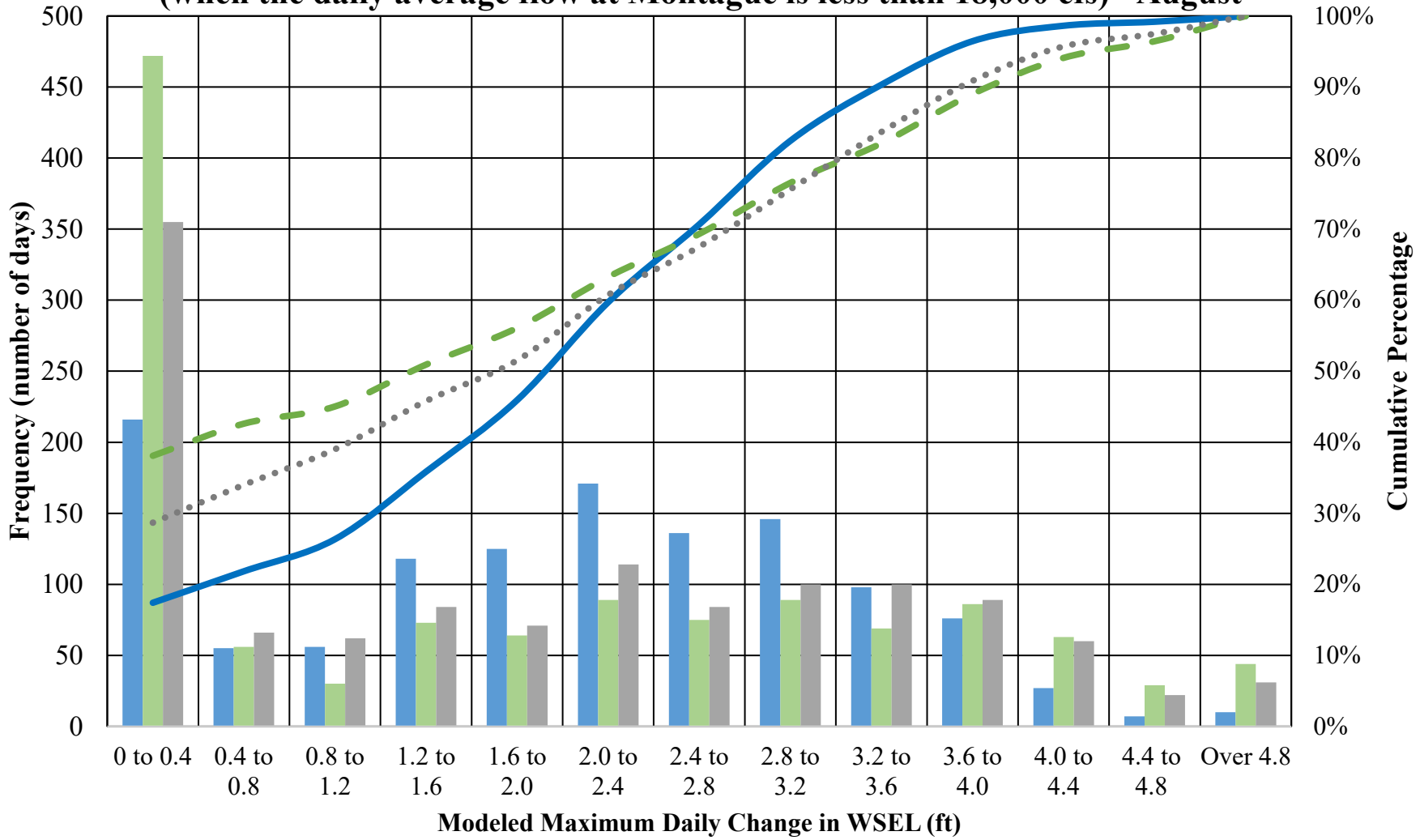
**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - June**



### HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - July

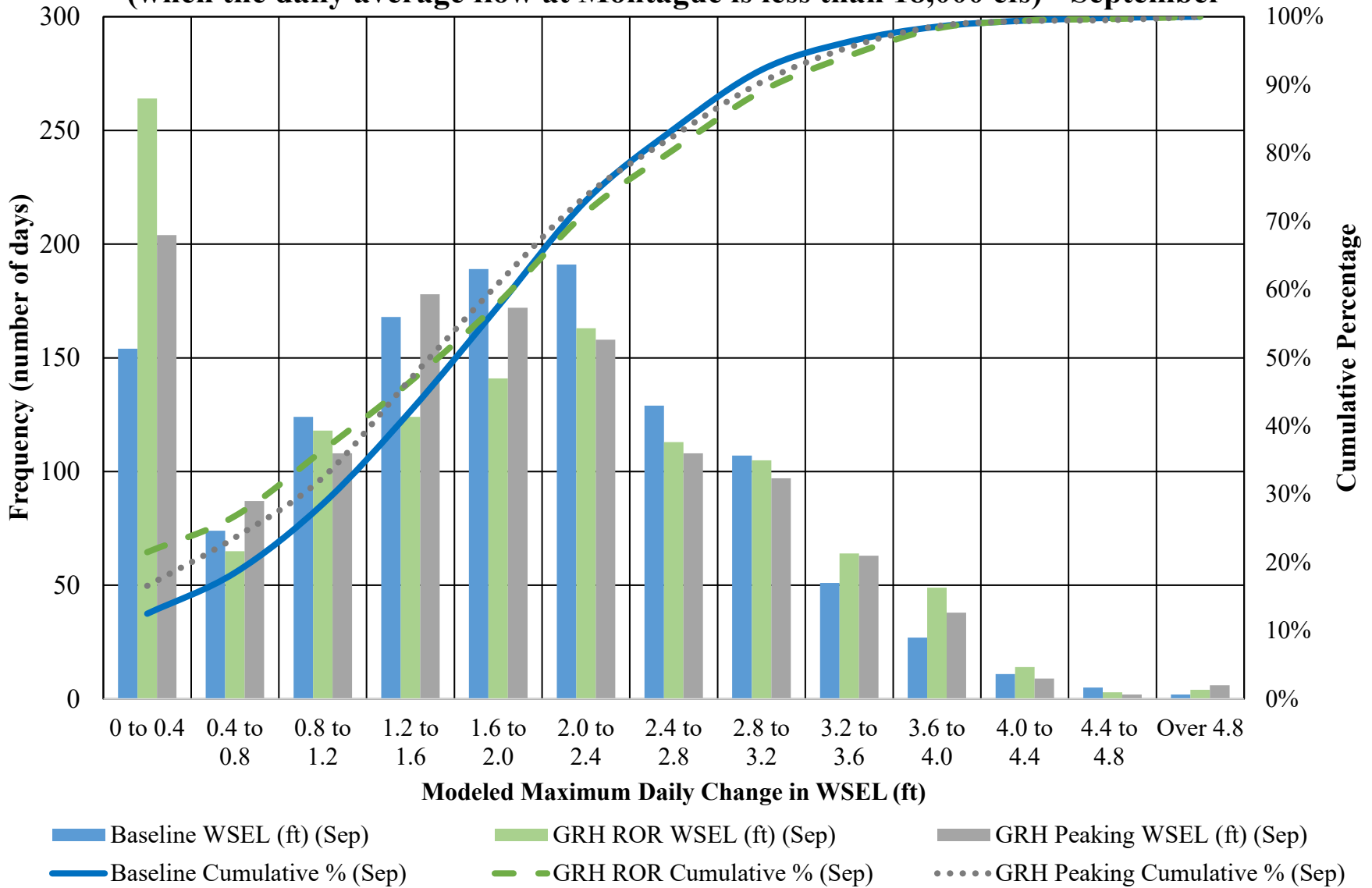


## HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - August

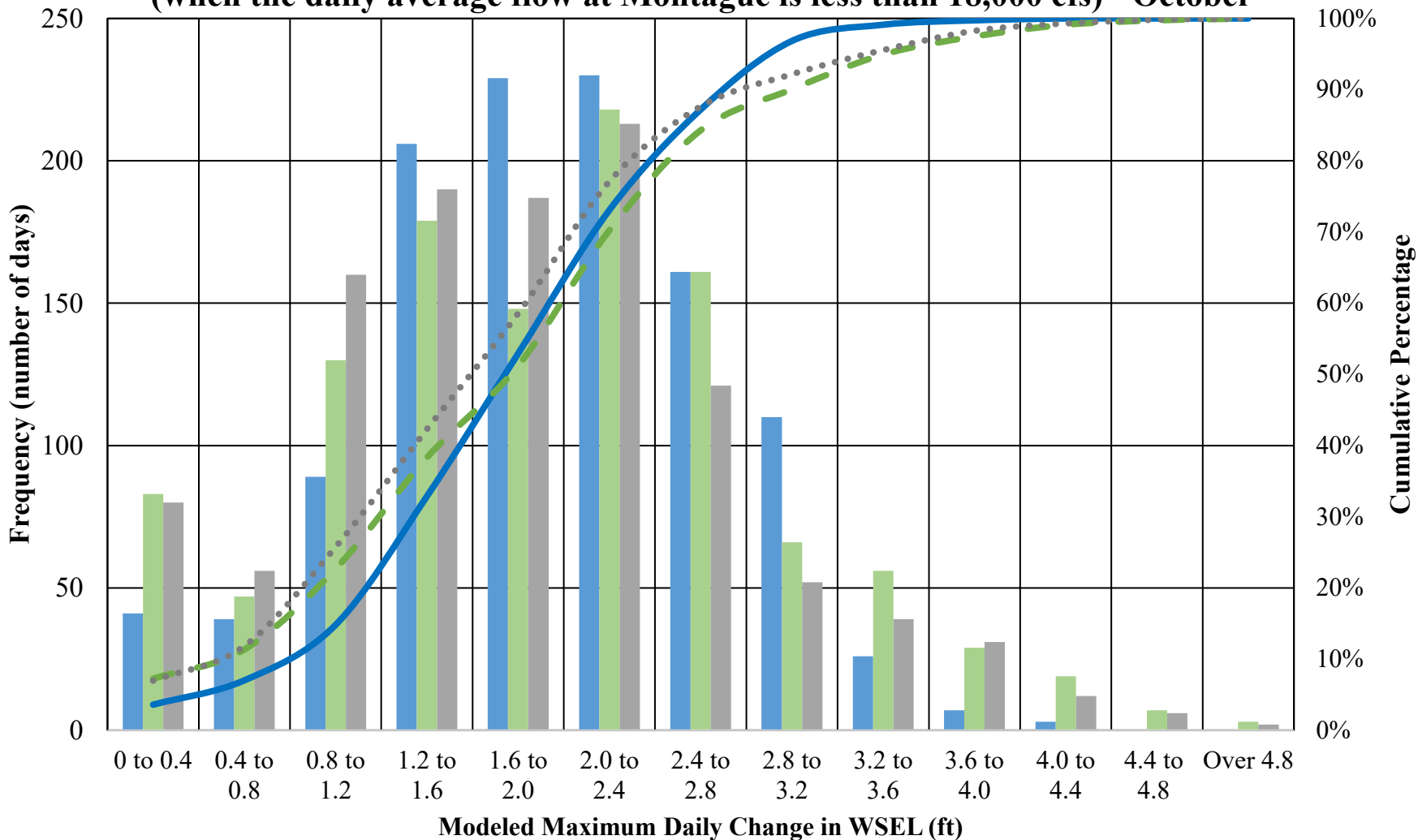


- Baseline WSEL (ft) (Aug)
- GRH ROR WSEL (ft) (Aug)
- GRH Peaking WSEL (ft) (Aug)
- Baseline Cumulative % (Aug)
- - - GRH ROR Cumulative % (Aug)
- · · · · GRH Peaking Cumulative % (Aug)

**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - September**

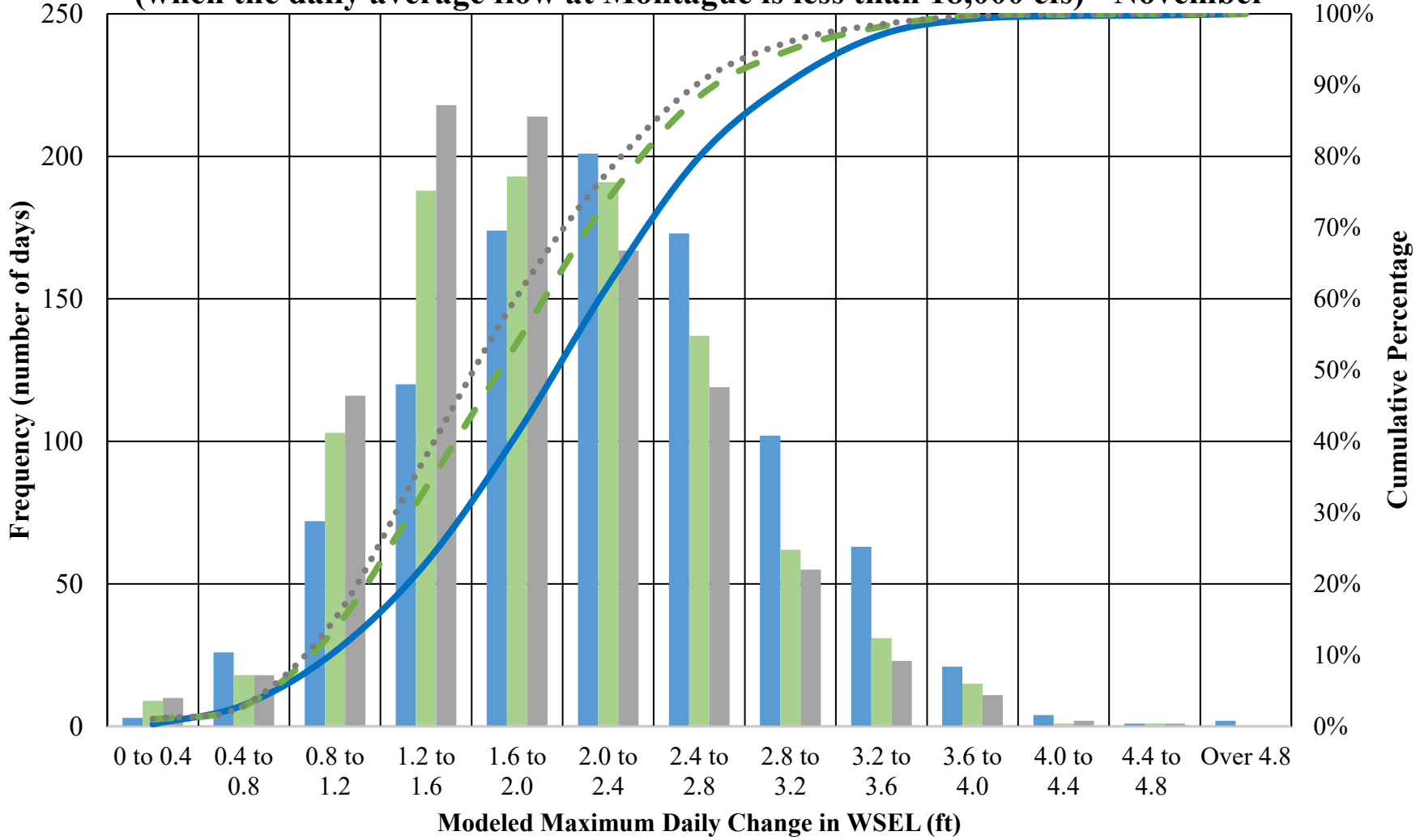


### HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - October



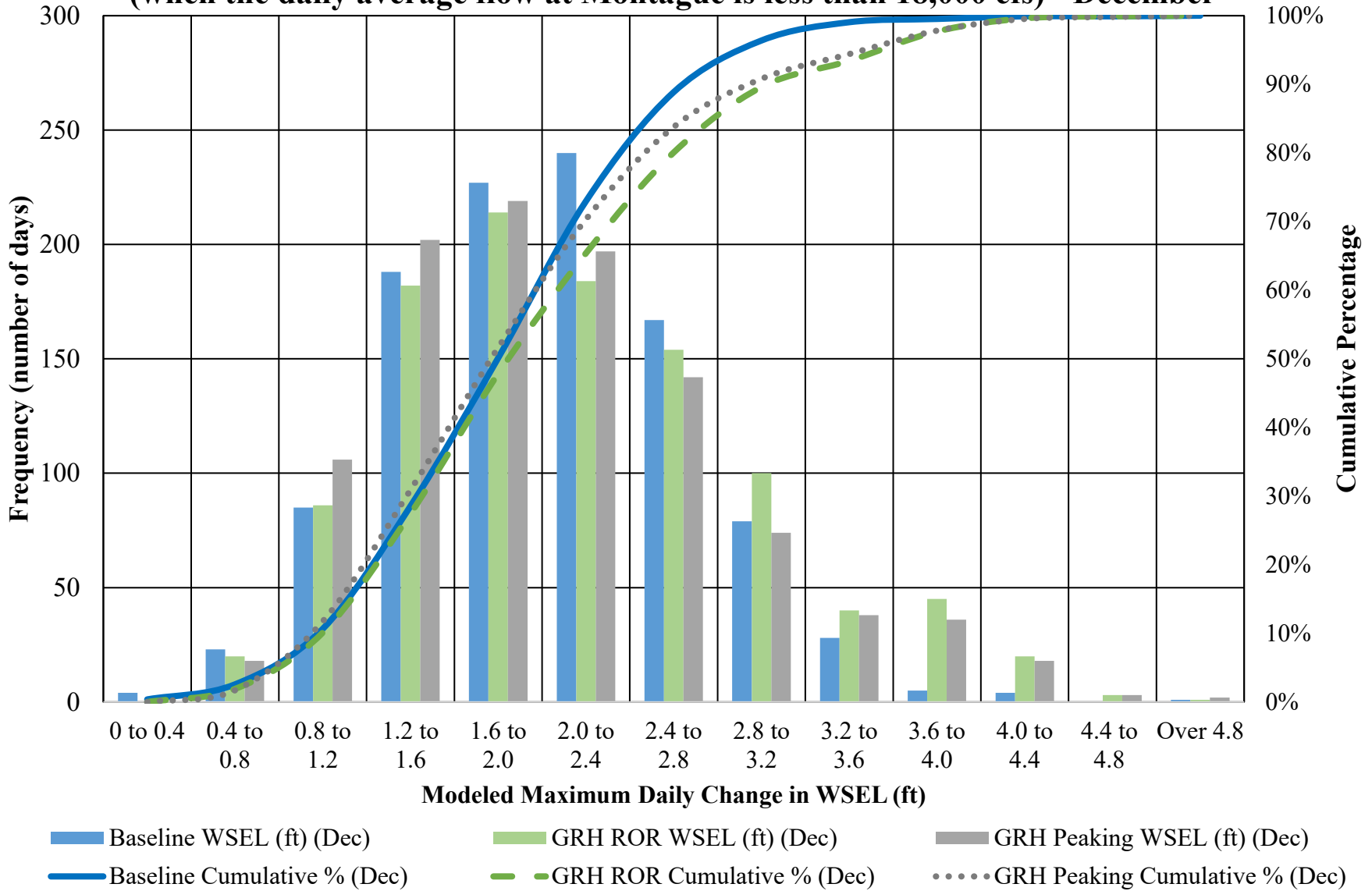
- Baseline WSEL (ft) (Oct)
- GRH ROR WSEL (ft) (Oct)
- GRH Peaking WSEL (ft) (Oct)
- Baseline Cumulative % (Oct)
- - - GRH ROR Cumulative % (Oct)
- · · · · GRH Peaking Cumulative % (Oct)

**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
 Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
 (when the daily average flow at Montague is less than 18,000 cfs) - November**

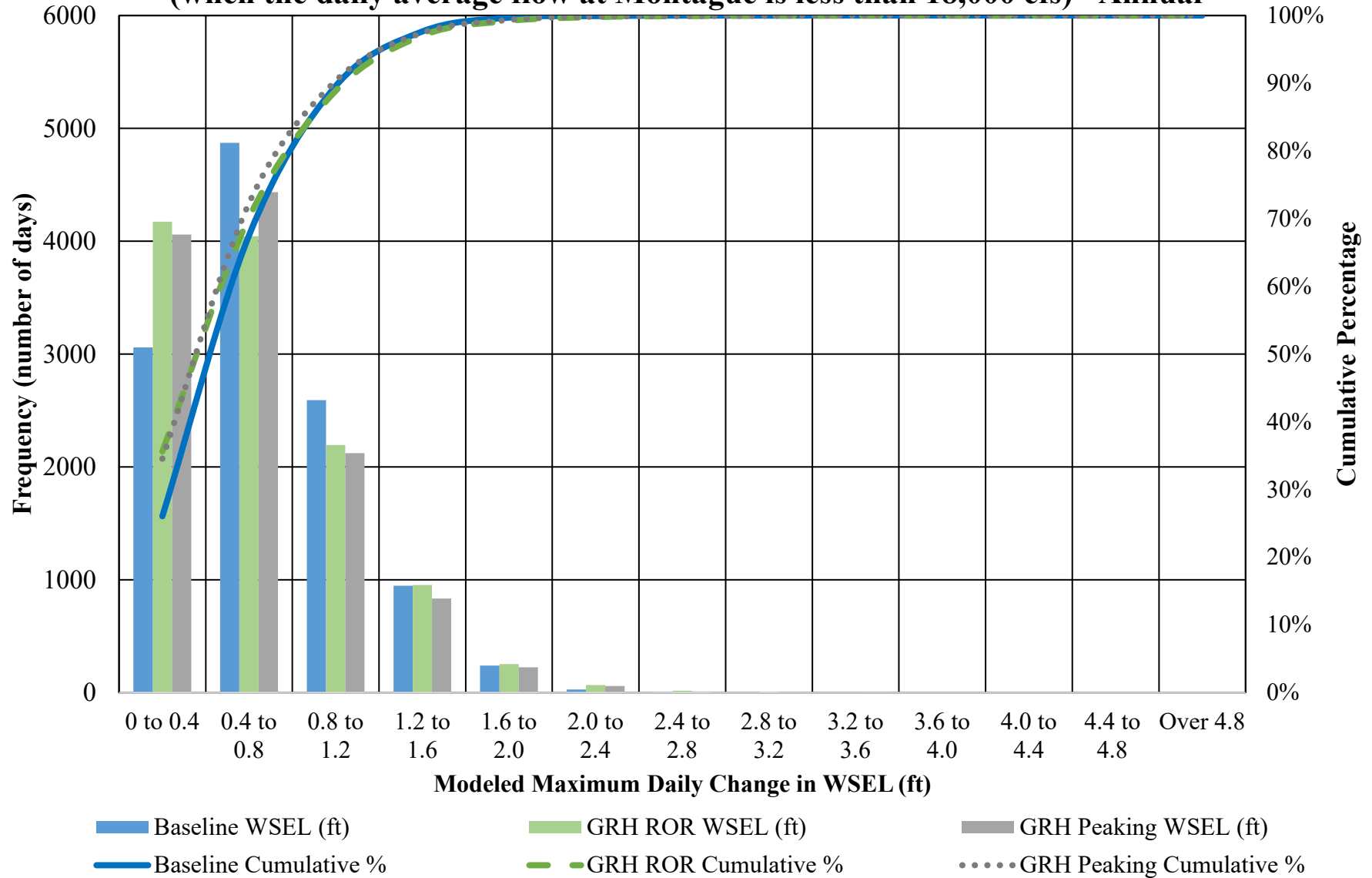


- █ Baseline WSEL (ft) (Nov)
- █ GRH ROR WSEL (ft) (Nov)
- █ GRH Peaking WSEL (ft) (Nov)
- Baseline Cumulative % (Nov)
- - - GRH ROR Cumulative % (Nov)
- ⋯ GRH Peaking Cumulative % (Nov)

**HEC-RAS Station 109.52 (at Route 116) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - December**

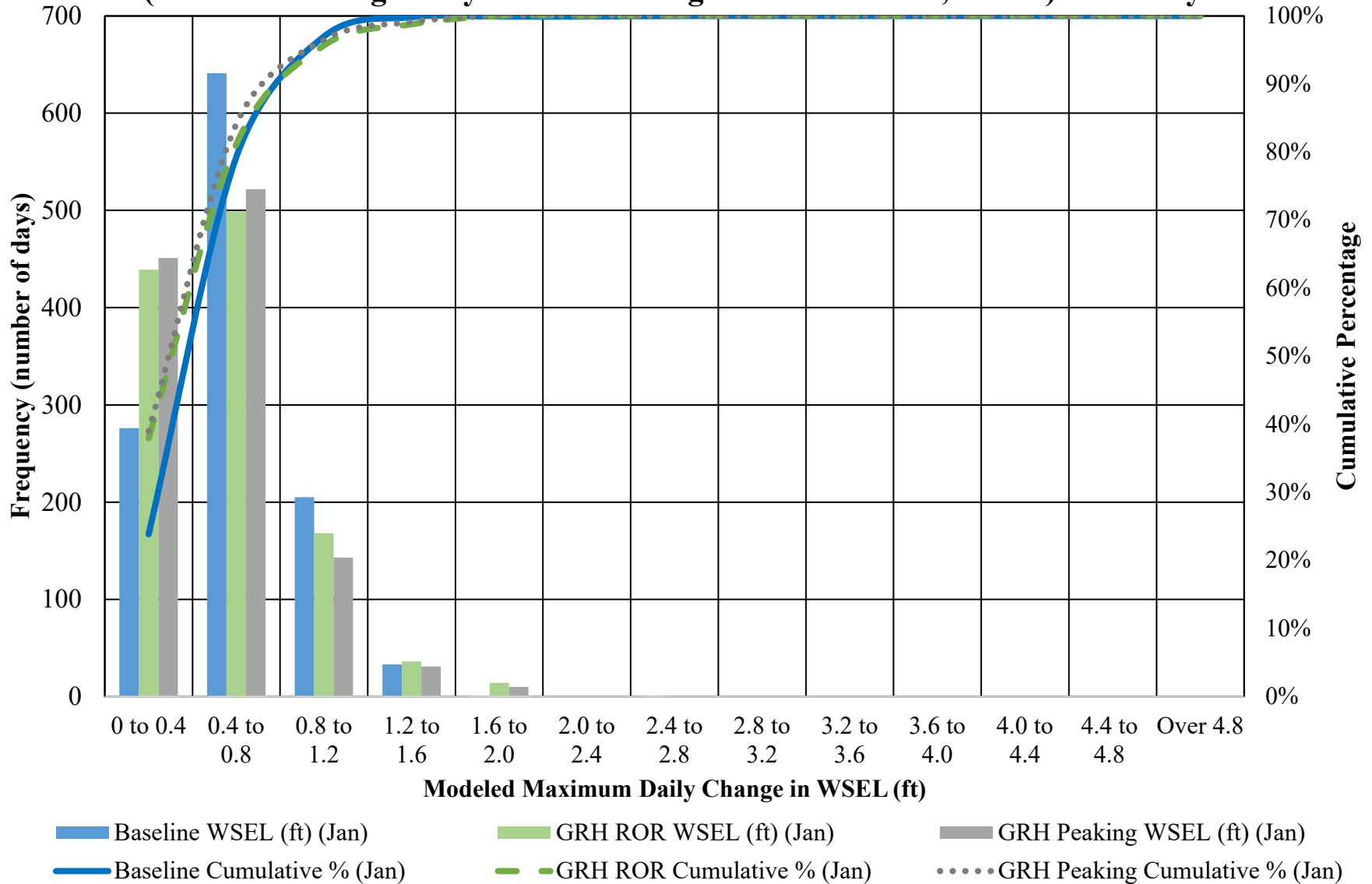


## HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - Annual

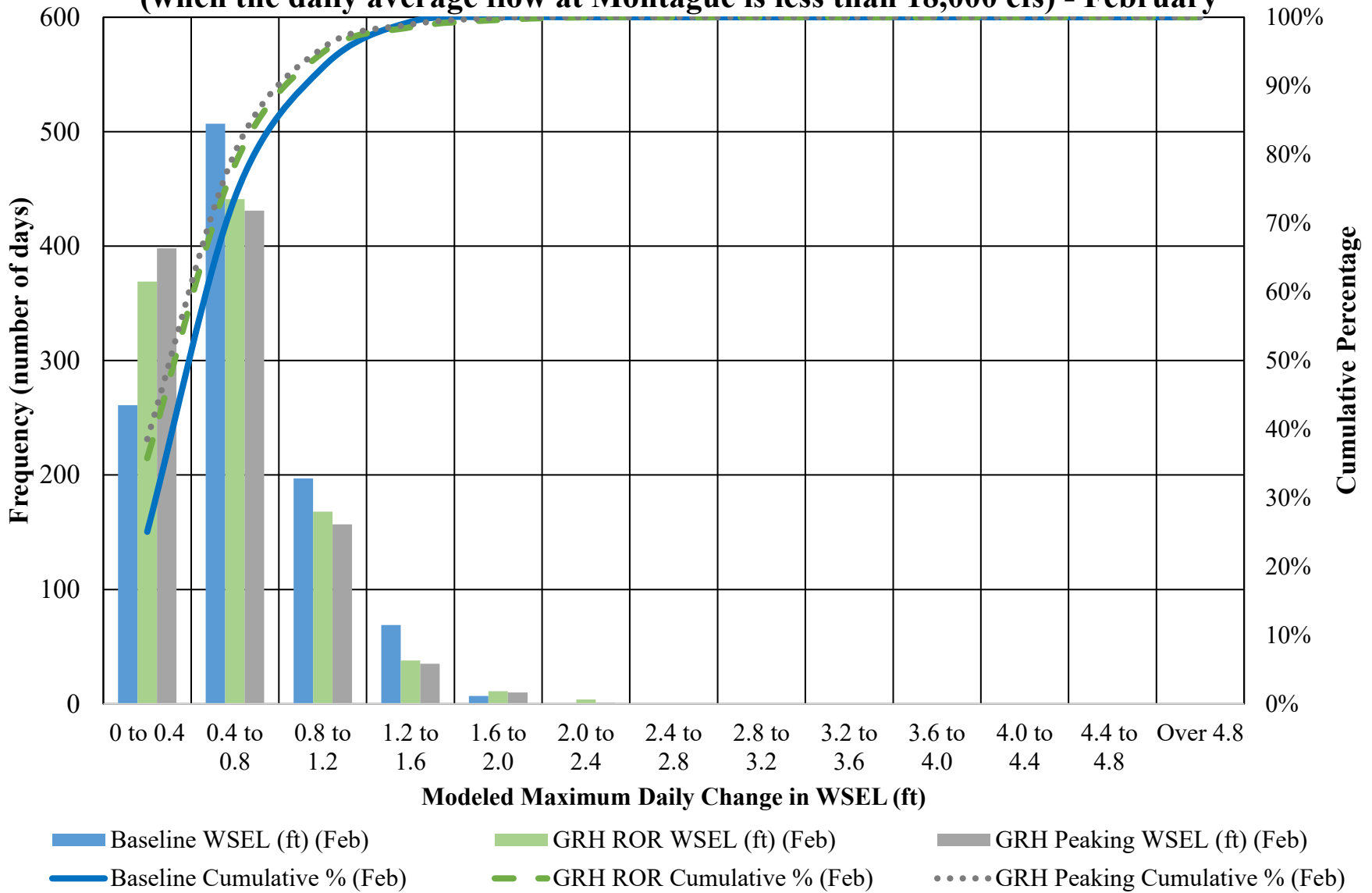




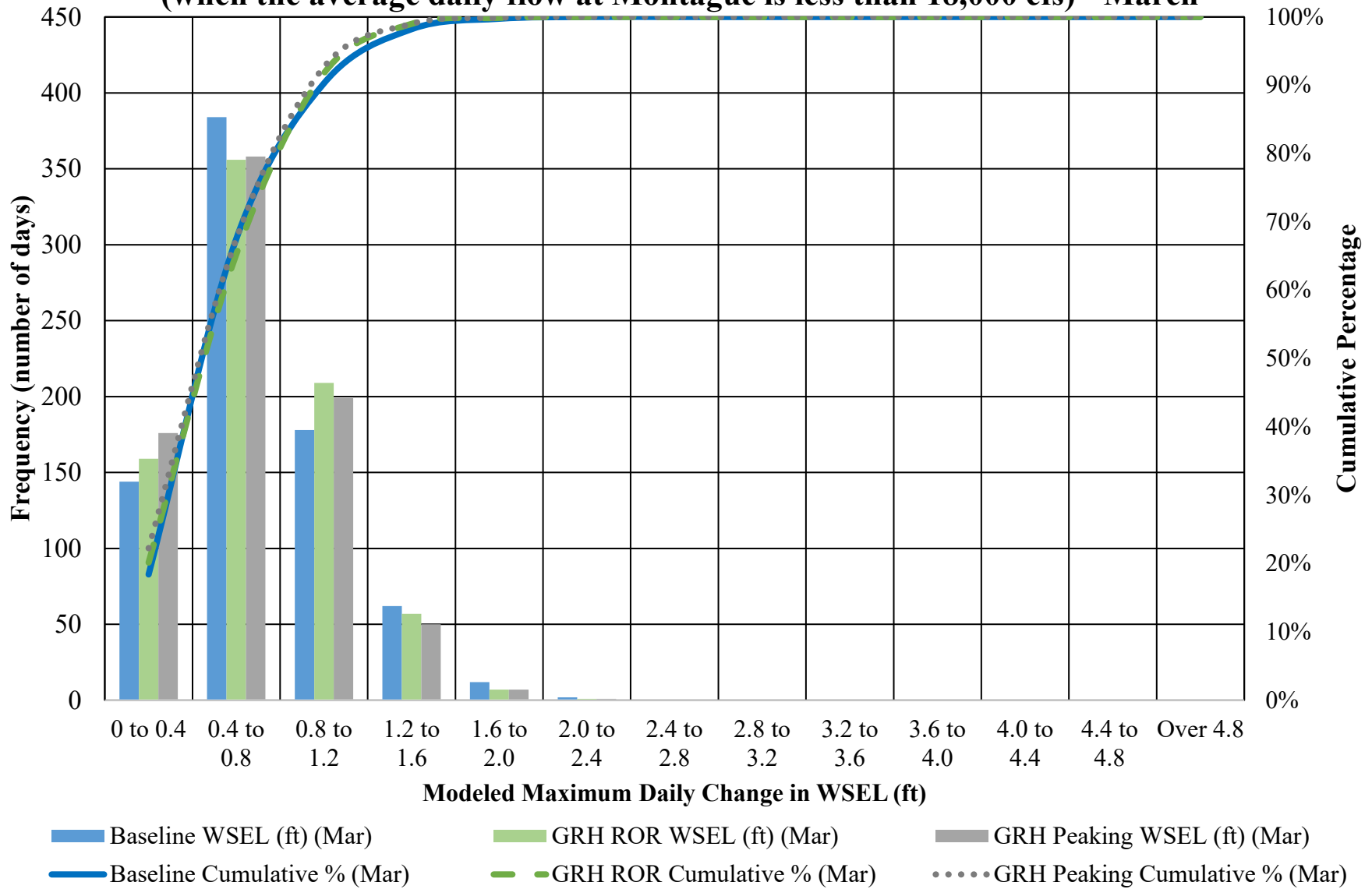
## HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the average daily flow at Montague is less than 18,000 cfs) - January



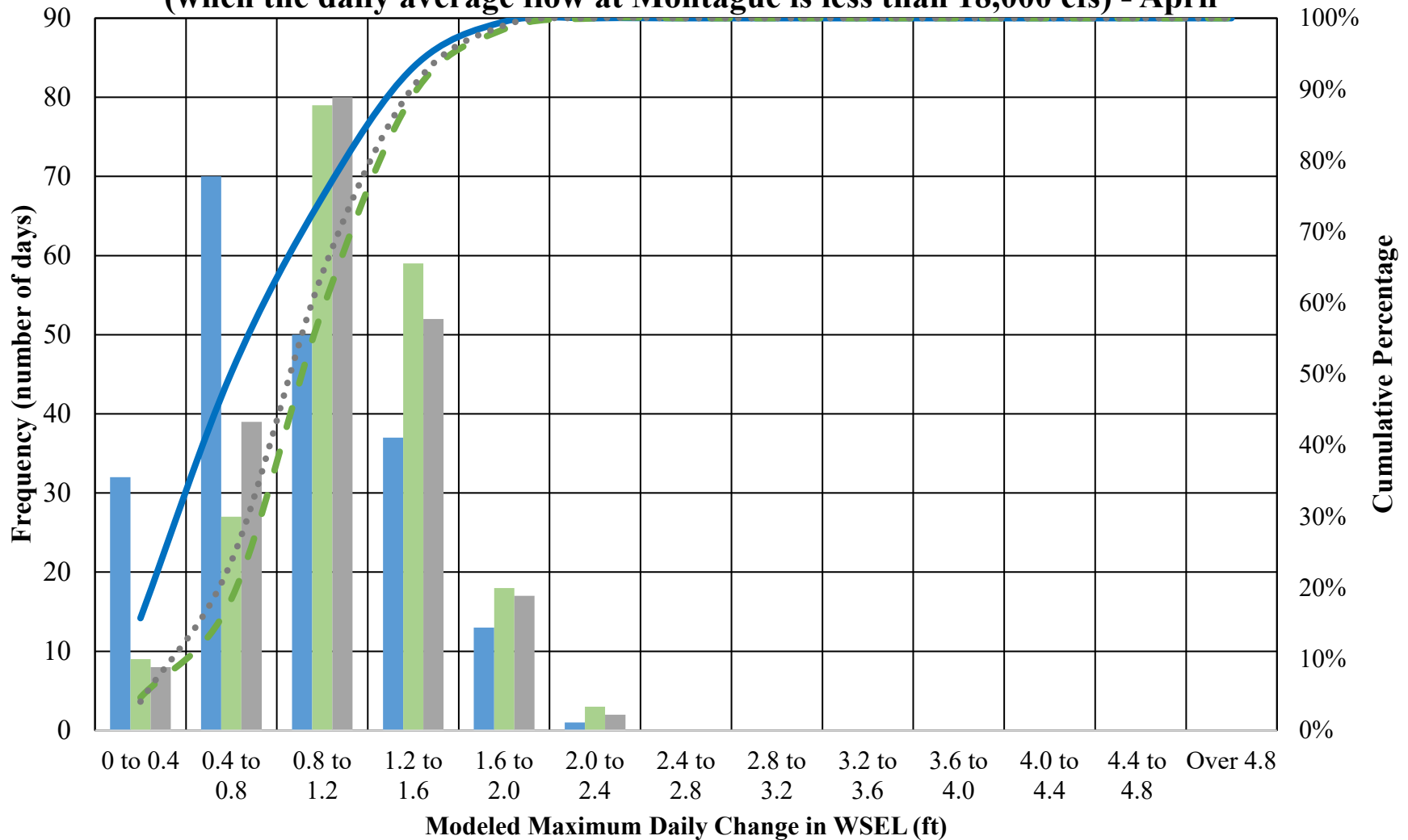
## HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - February



### HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the average daily flow at Montague is less than 18,000 cfs) - March

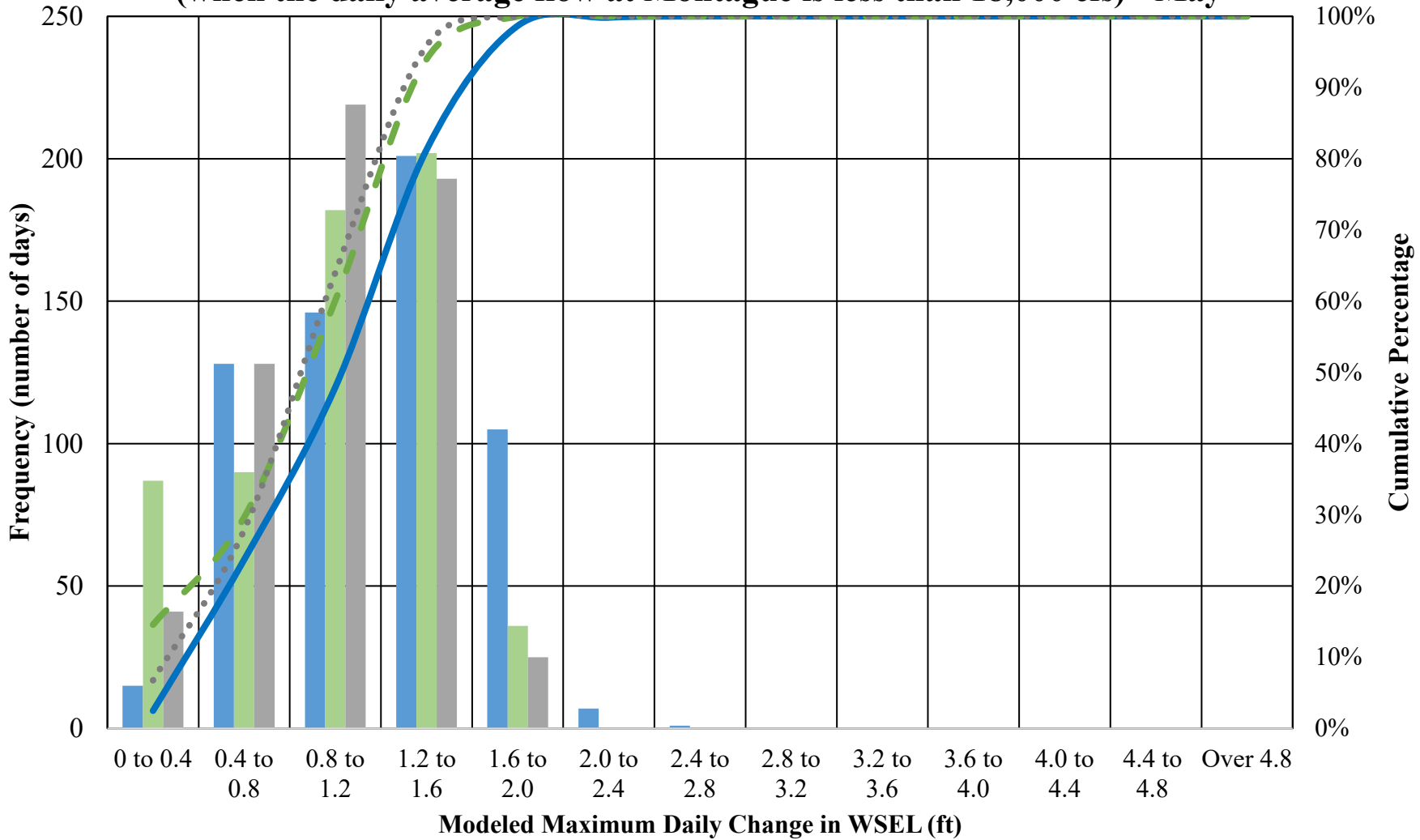


### HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - April



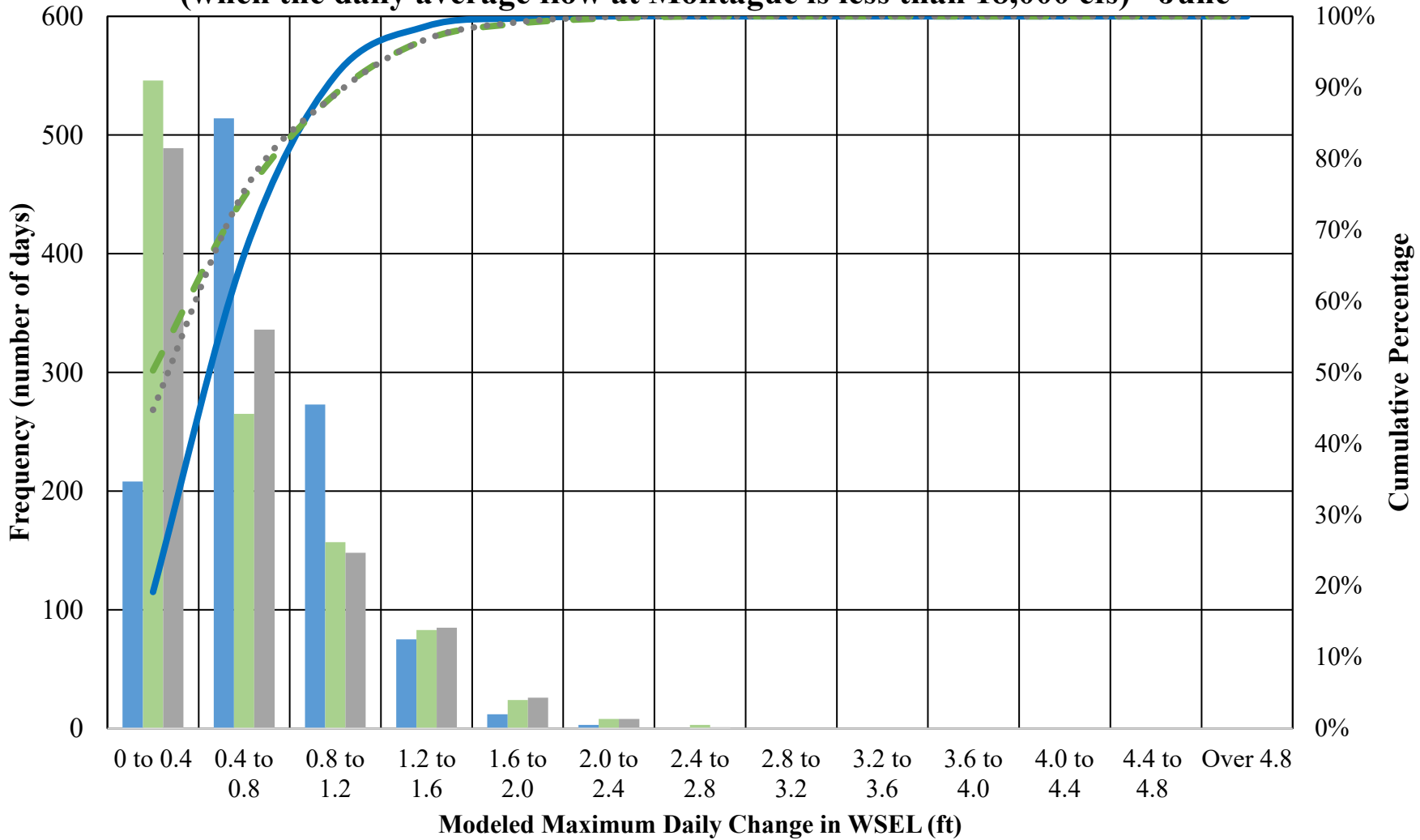
- Baseline WSEL (ft) (Apr)
- GRH ROR WSEL (ft) (Apr)
- GRH Peaking WSEL (ft) (Apr)
- Baseline Cumulative % (Apr)
- - - GRH ROR Cumulative % (Apr)
- · · · · GRH Peaking Cumulative % (Apr)

### HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - May



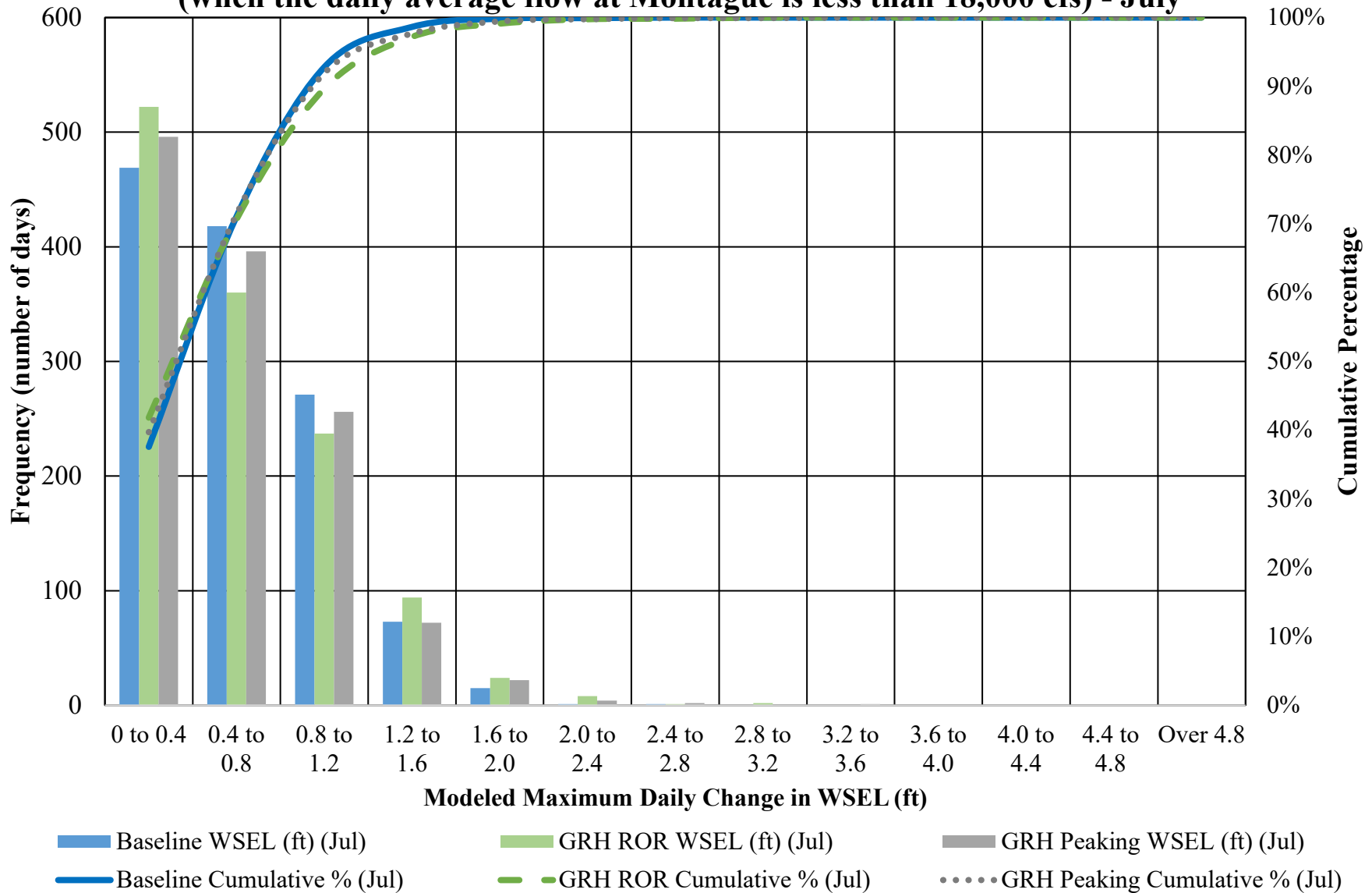
- Baseline WSEL (ft) (May)
- GRH ROR WSEL (ft) (May)
- GRH Peaking WSEL (ft) (May)
- Baseline Cumulative % (May)
- - - GRH ROR Cumulative % (May)
- · · · GRH Peaking Cumulative % (May)

## HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - June

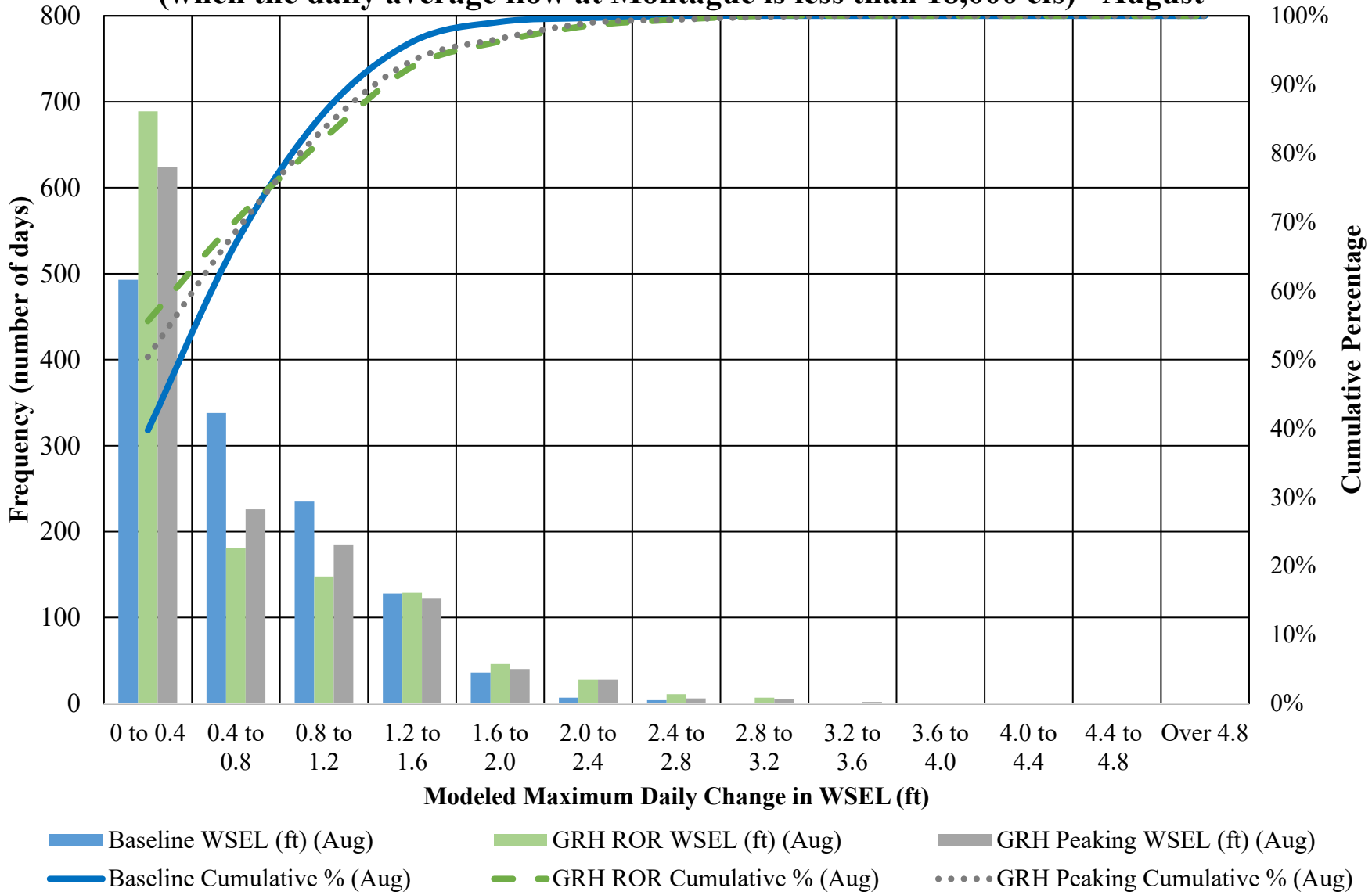


- █ Baseline WSEL (ft) (Jun)
- █ GRH ROR WSEL (ft) (Jun)
- █ GRH Peaking WSEL (ft) (Jun)
- Baseline Cumulative % (Jun)
- - - GRH ROR Cumulative % (Jun)
- ⋯ GRH Peaking Cumulative % (Jun)

## HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - July

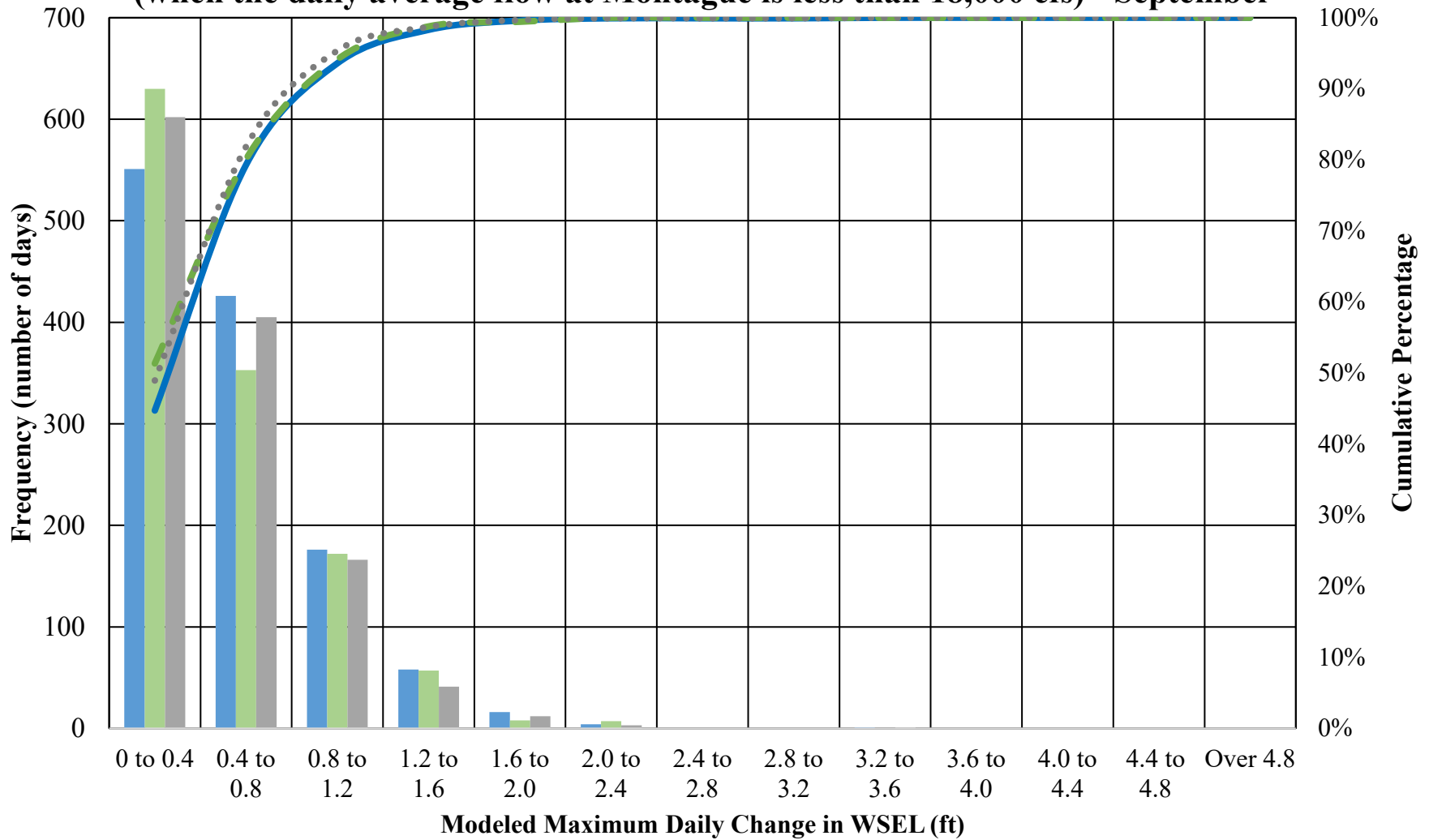


## HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - August



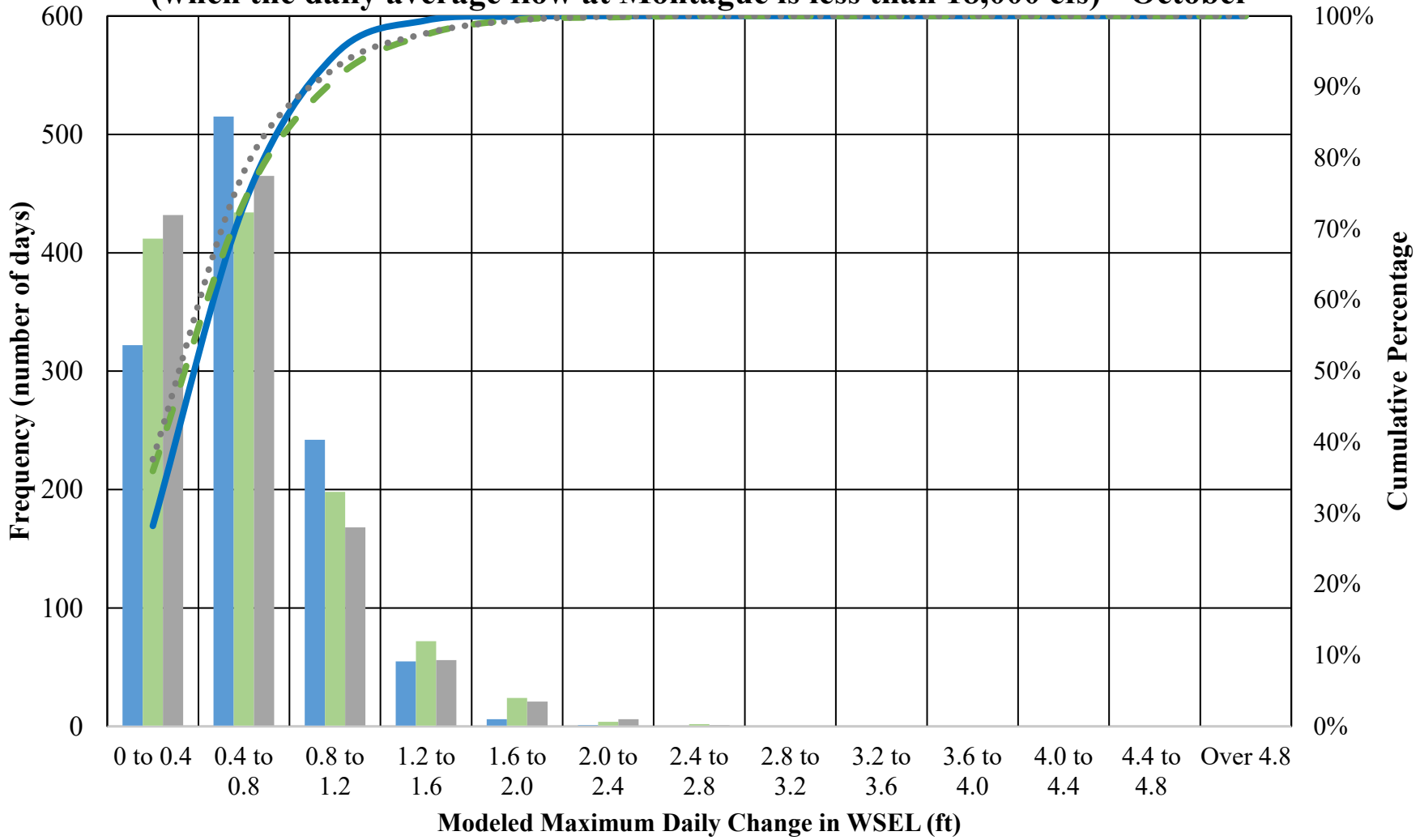


## HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - September



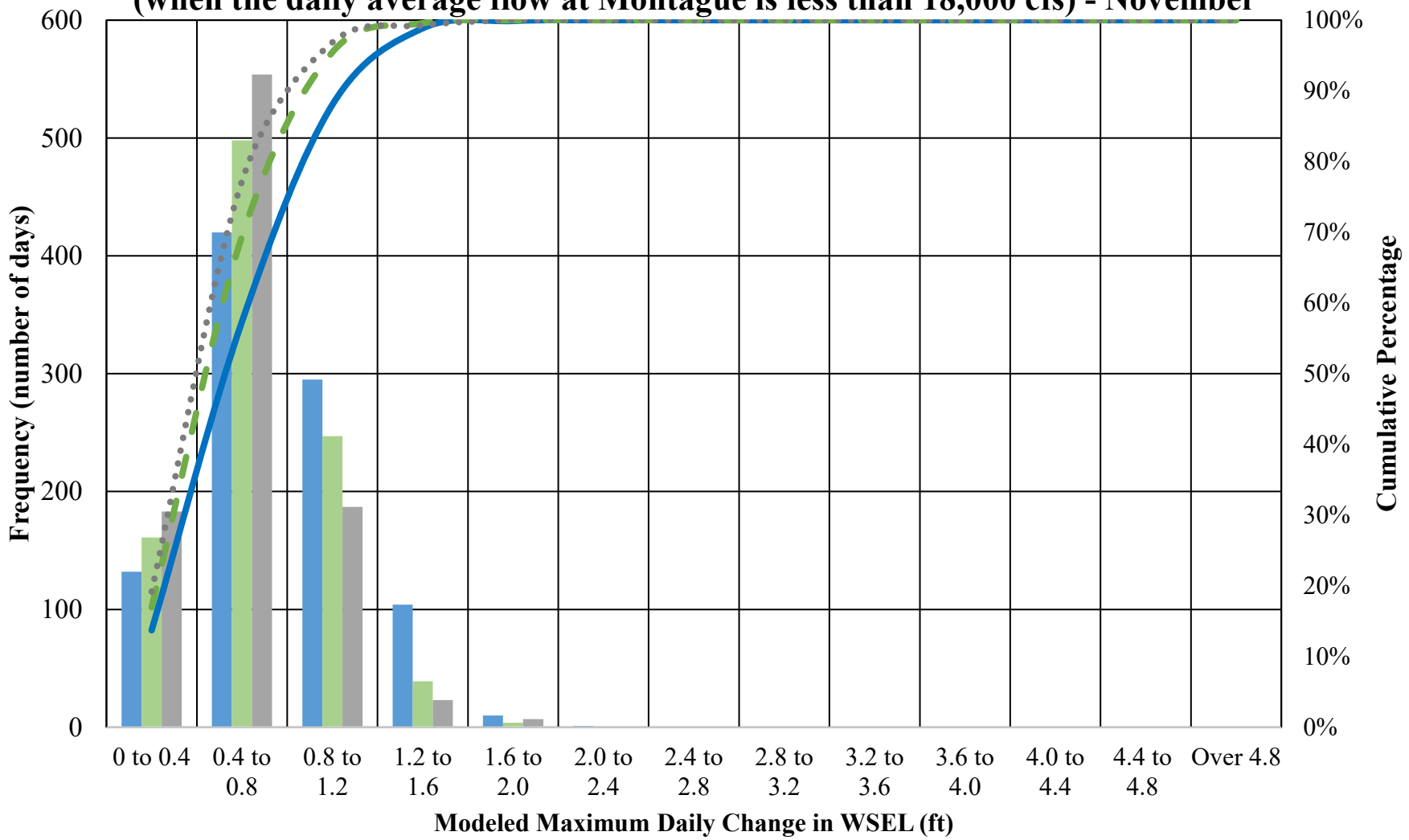
- █ Baseline WSEL (ft) (Sep)
- █ GRH ROR WSEL (ft) (Sep)
- █ GRH Peaking WSEL (ft) (Sep)
- Baseline Cumulative % (Sep)
- GRH ROR Cumulative % (Sep)
- GRH Peaking Cumulative % (Sep)

**HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - October**



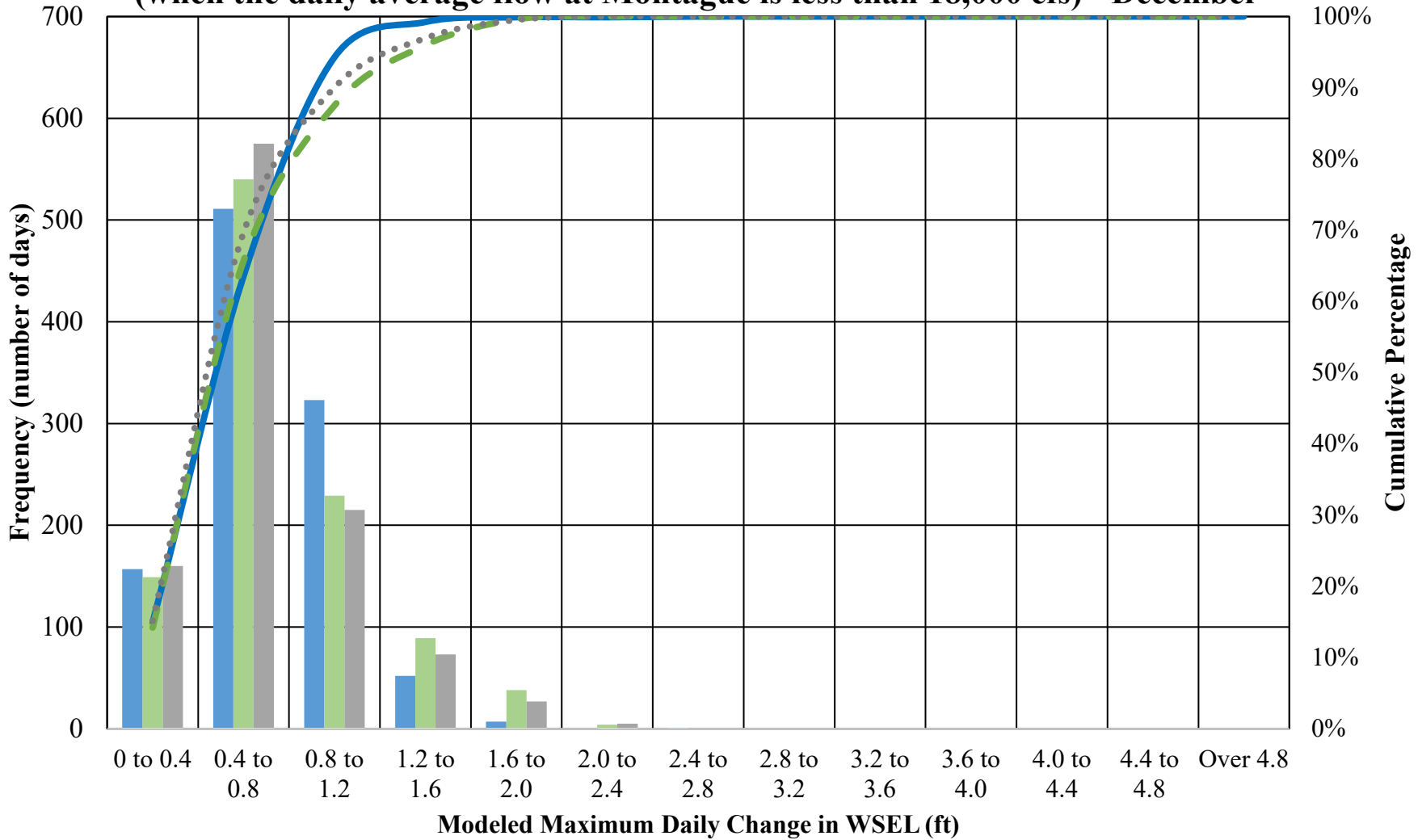
- Baseline WSEL (ft) (Oct)
  GRH ROR WSEL (ft) (Oct)
  GRH Peaking WSEL (ft) (Oct)
- Baseline Cumulative % (Oct)
  GRH ROR Cumulative % (Oct)
  GRH Peaking Cumulative % (Oct)

## HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking (when the daily average flow at Montague is less than 18,000 cfs) - November



- Baseline WSEL (ft) (Nov)
- GRH ROR WSEL (ft) (Nov)
- GRH Peaking WSEL (ft) (Nov)
- Baseline Cumulative % (Nov)
- - - GRH ROR Cumulative % (Nov)
- ⋯ GRH Peaking Cumulative % (Nov)

**HEC-RAS Station 94.298 (at Rainbow Beach) WSEL Change Comparison  
Baseline (Holyoke Low) vs. AFLA Proposal with GRH ROR and Peaking  
(when the daily average flow at Montague is less than 18,000 cfs) - December**

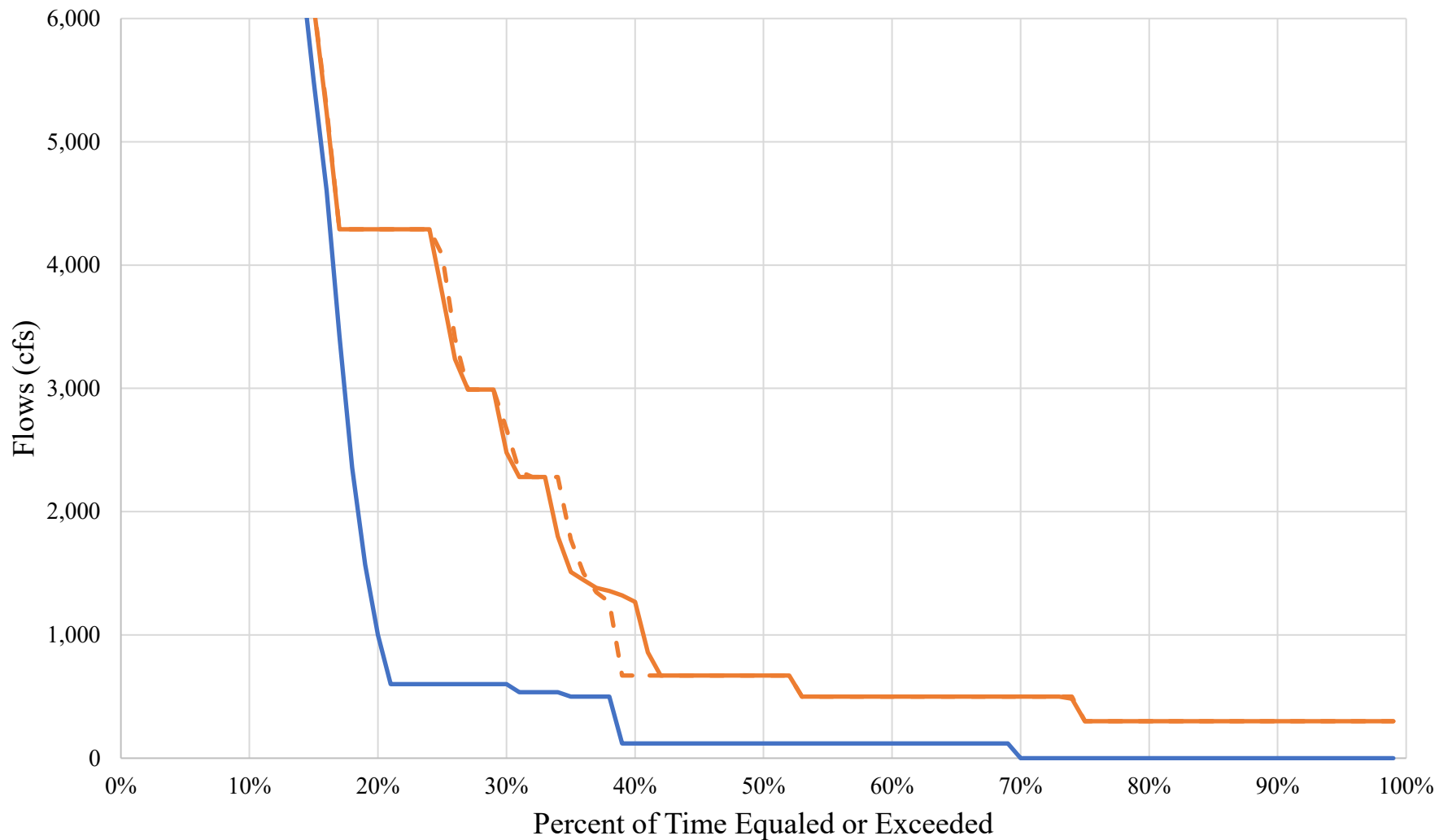


- Baseline WSEL (ft) (Dec)
  GRH ROR WSEL (ft) (Dec)
  GRH Peaking WSEL (ft) (Dec)
- Baseline Cumulative % (Dec)
  GRH ROR Cumulative % (Dec)
  GRH Peaking Cumulative % (Dec)

## **Appendix TF-AIR#5-Flow Duration Curves**

- Turners Falls Dam Spill Flow Duration Curve;
- Station No. 1 Discharge Duration Curve;
- Total Bypass Reach Flow Duration Curve (reflects bypass flow upstream of Cabot);
- Cabot Station Discharge Duration Curve; and
- Montague USGS gage Flow Duration Curve (includes total bypass flow, Cabot Station Discharge, and Deerfield River flow).

Reach 1 Downstream of Turners Falls Dam Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) Annual

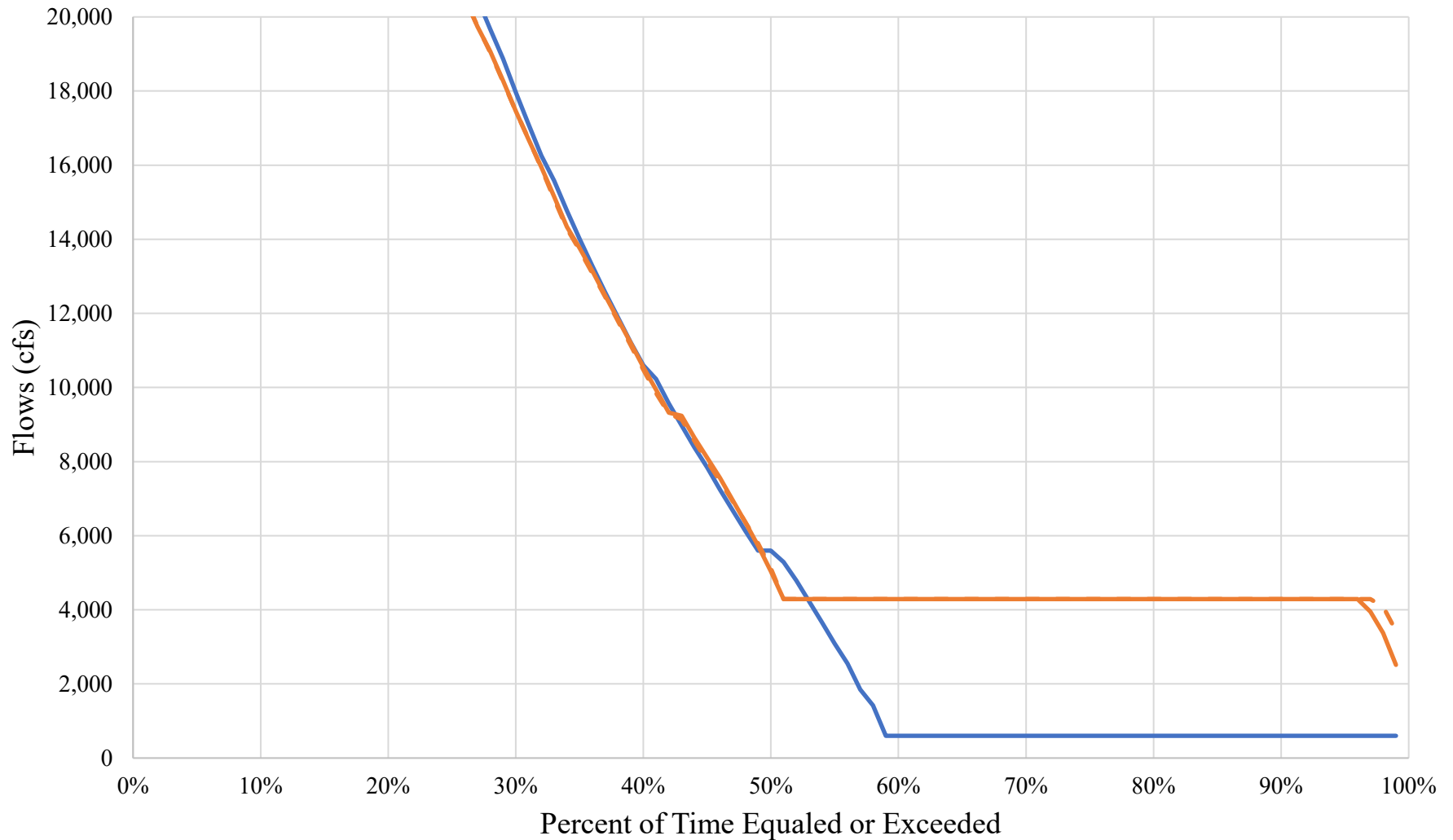


— Baseline Reach 1 Flows

- - FL AFLA (GRH ROR) Reach 1 Bypass

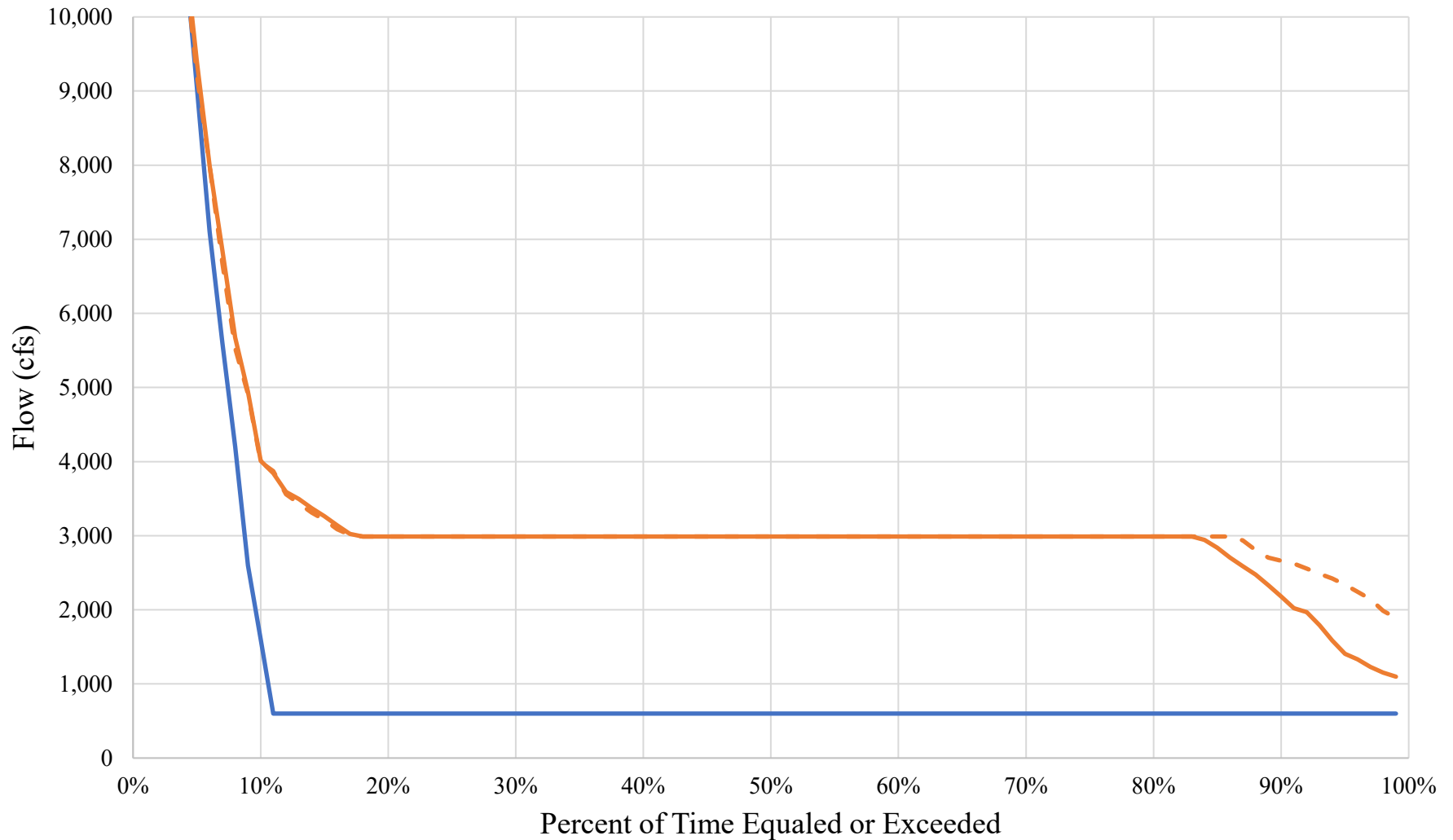
— FL AFLA (GRH Peaking) Reach 1 Bypass

Reach 1 Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) April 1 - May 31



- Baseline Reach 1 Flows
- FL AFLA (GRH Peaking) Reach 1 Bypass
- - FL AFLA (GRH ROR) Reach 1 Bypass

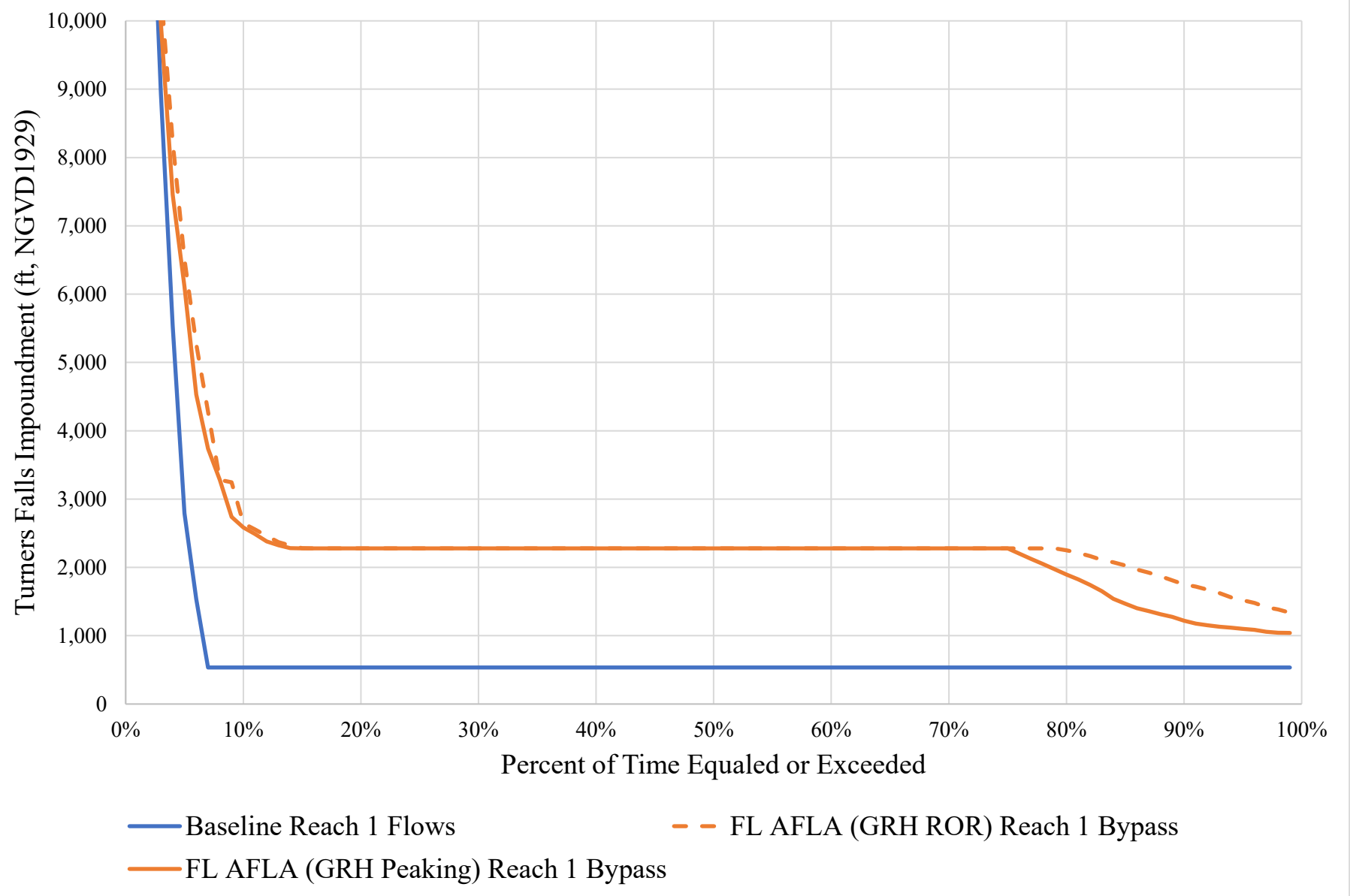
Reach 1 Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 1 - 15



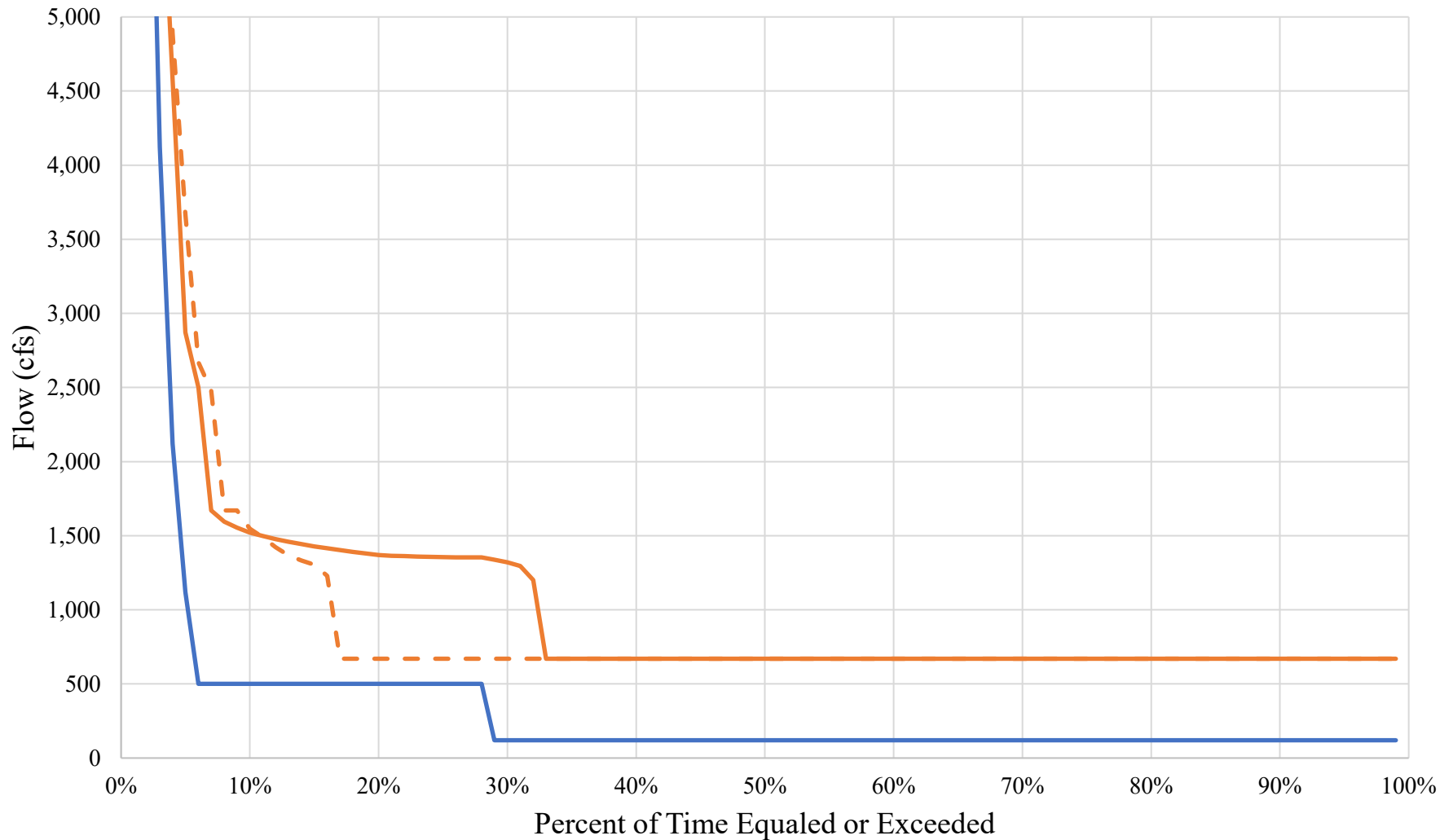
- Baseline Reach 1 Flows
- FL AFLA (GRH Peaking) Reach 1 Bypass
- - FL AFLA (GRH ROR) Reach 1 Bypass



Bypass Reach 1 Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 16 - 30



Reach 1 Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) July 1 - August 31

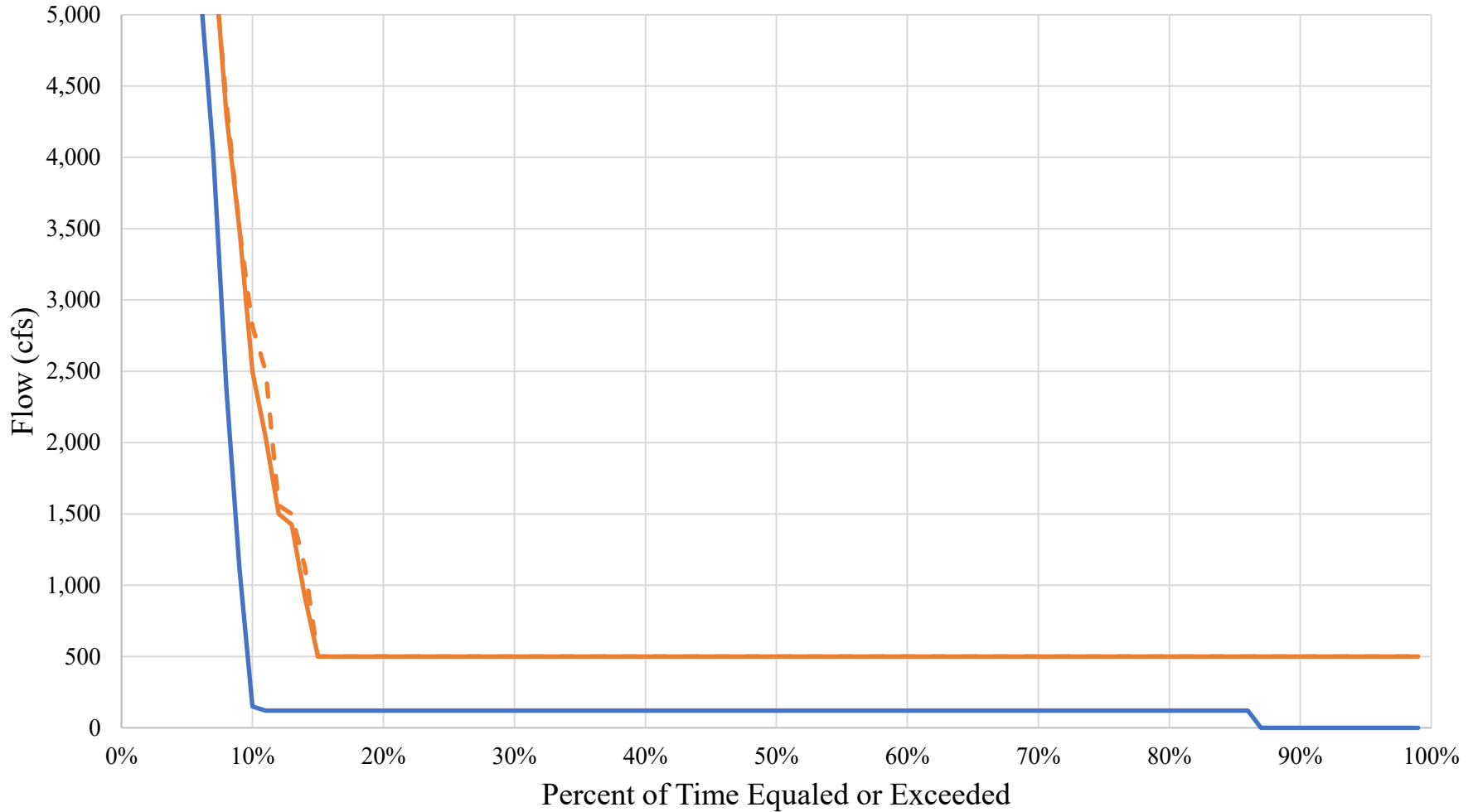


— Baseline Reach 1 Flows

- - FL AFLA (GRH ROR) Reach 1 Bypass

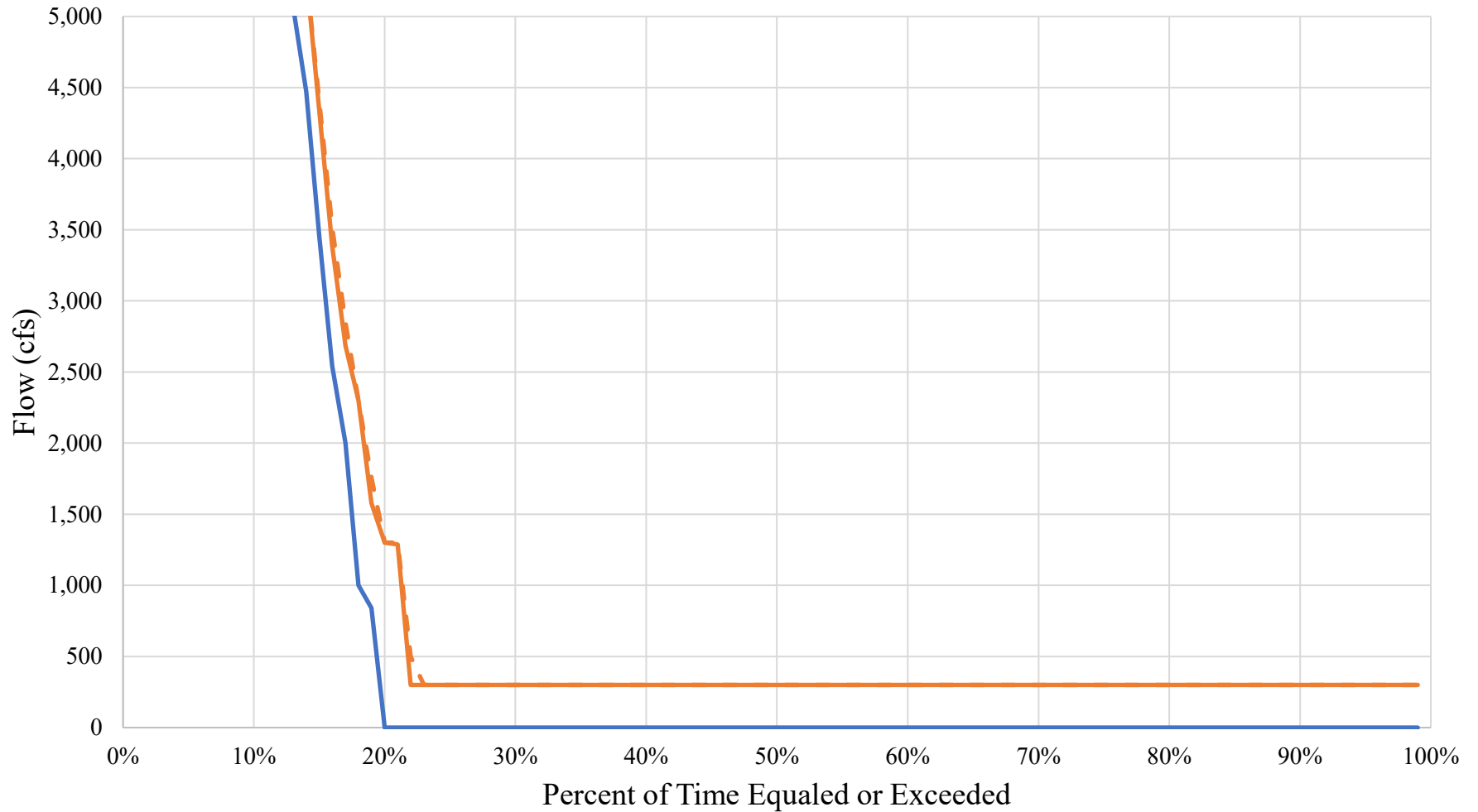
— FL AFLA (GRH Peaking) Reach 1 Bypass

# Reach 1 Bypass Modeled Hourly Flows (Baseline and FL AFLA Proposal with GRH ROR and Peaking) September 1 - November 30



- Baseline Reach 1 Flows
- FL AFLA (GRH Peaking) Reach 1 Bypass
- - FL AFLA (GRH ROR) Reach 1 Bypass

### Bypass Reach 1 Modeled Hourly Flows (Baseline and FL AFLA Proposal with GRH ROR and Peaking) December 1 - March 31

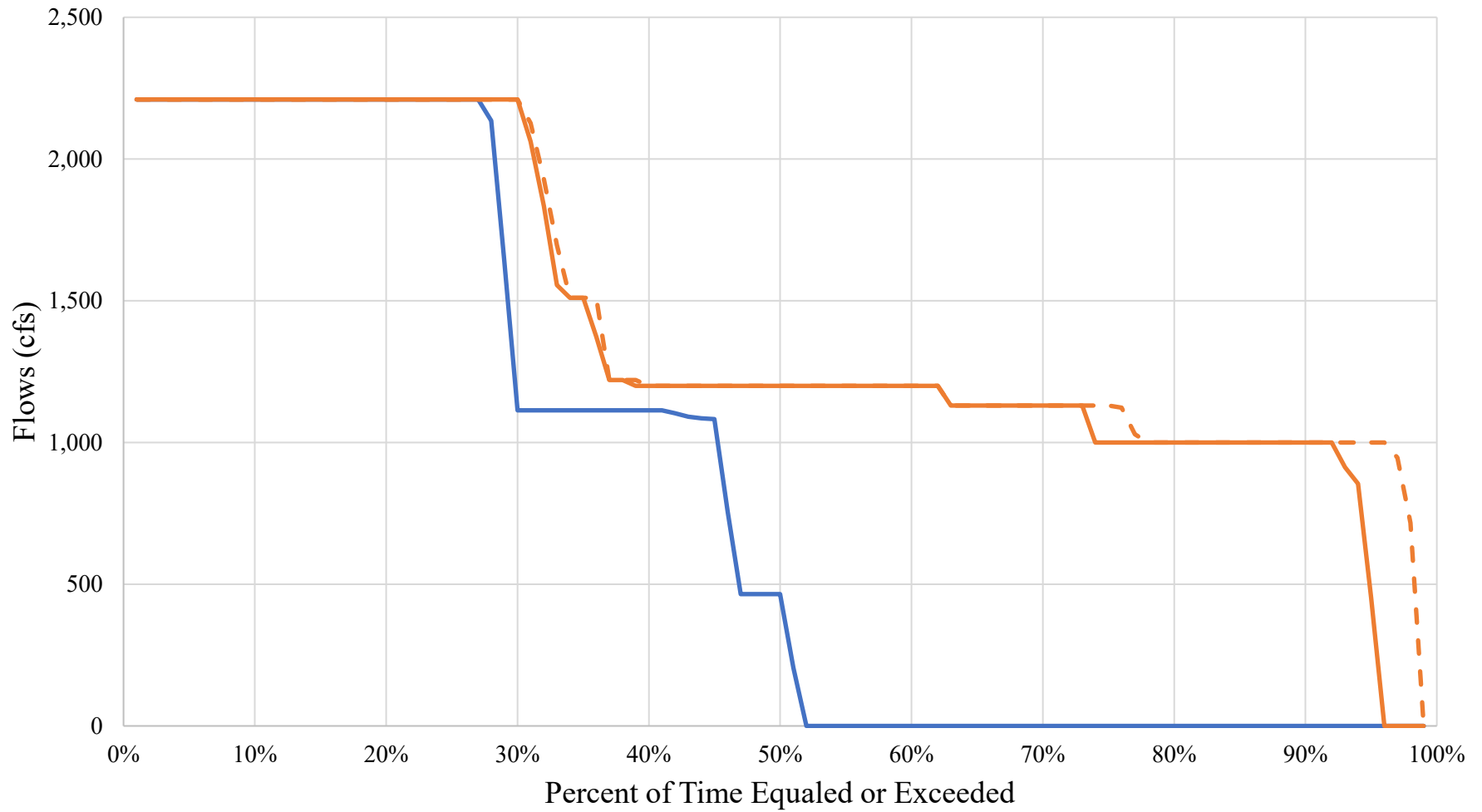


— Baseline Reach 1 Flows

- - FL AFLA (GRH ROR) Reach 1 Bypass

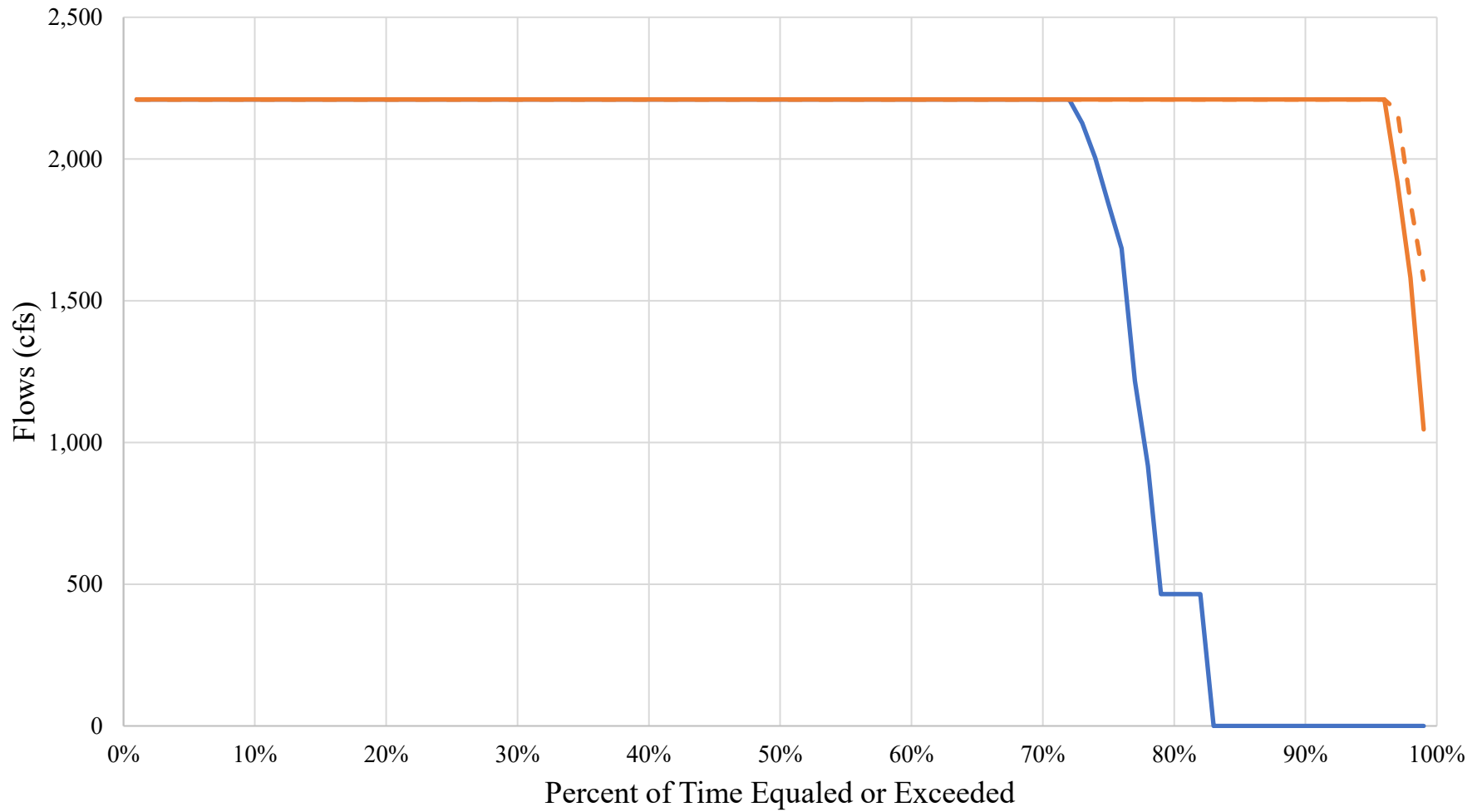
— FL AFLA (GRH Peaking) Reach 1 Bypass

Station No.1 Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) Annual



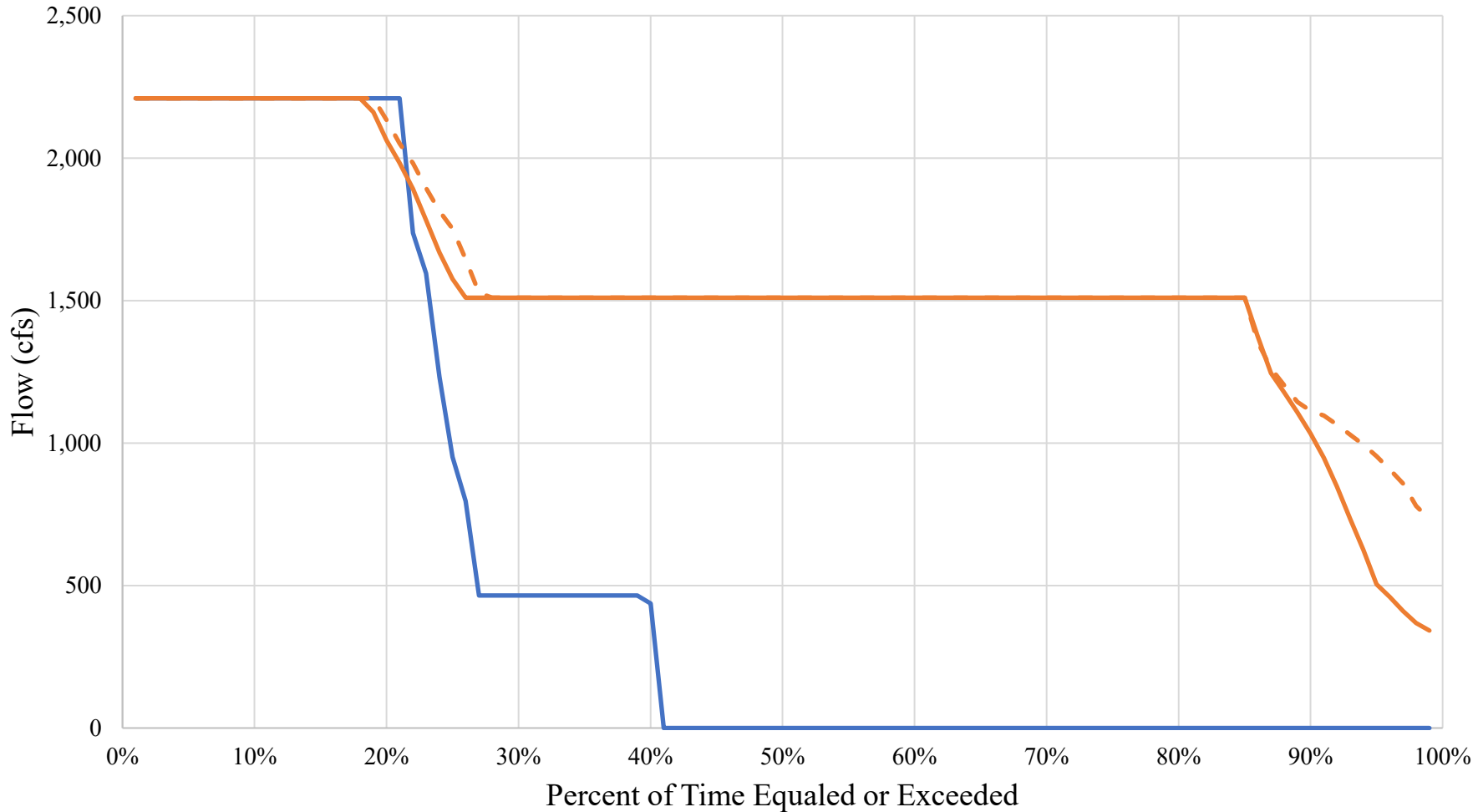
- Baseline Station No. 1 Flows
- - - FL AFLA (GRH ROR) Proposal Station No. 1
- FL AFLA (GRH Peaking) Proposal Station No. 1

Station No.1 Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) April 1 - May 31



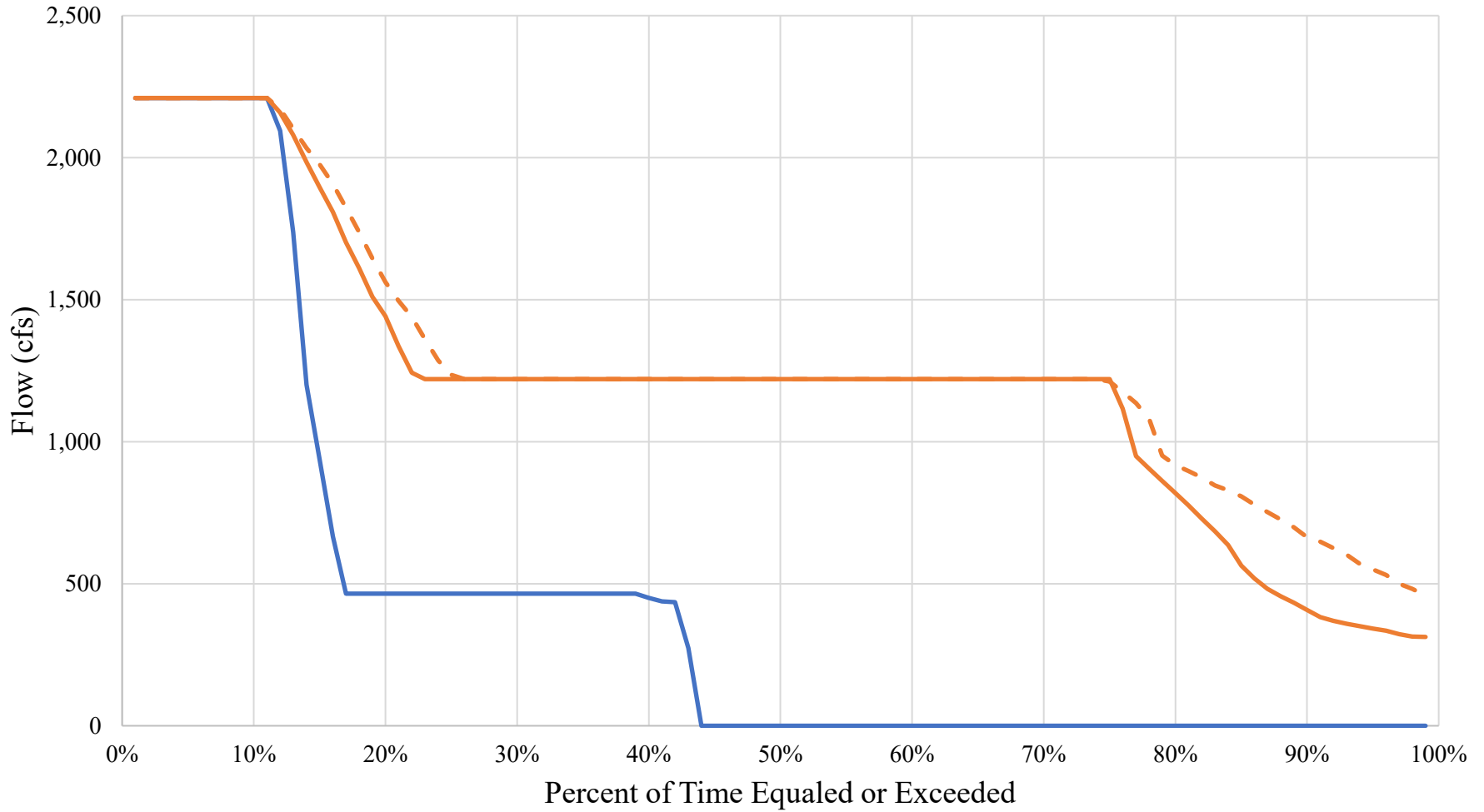
- Baseline Station No. 1 Flows
- - FL AFLA (GRH ROR) Proposal Station No. 1
- FL AFLA (GRH Peaking) Proposal Station No. 1

Station No.1 Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 1 - 15



- Baseline Station No. 1 Flows
- - FL AFLA (GRH ROR) Proposal Station No. 1
- FL AFLA (GRH Peaking) Proposal Station No. 1

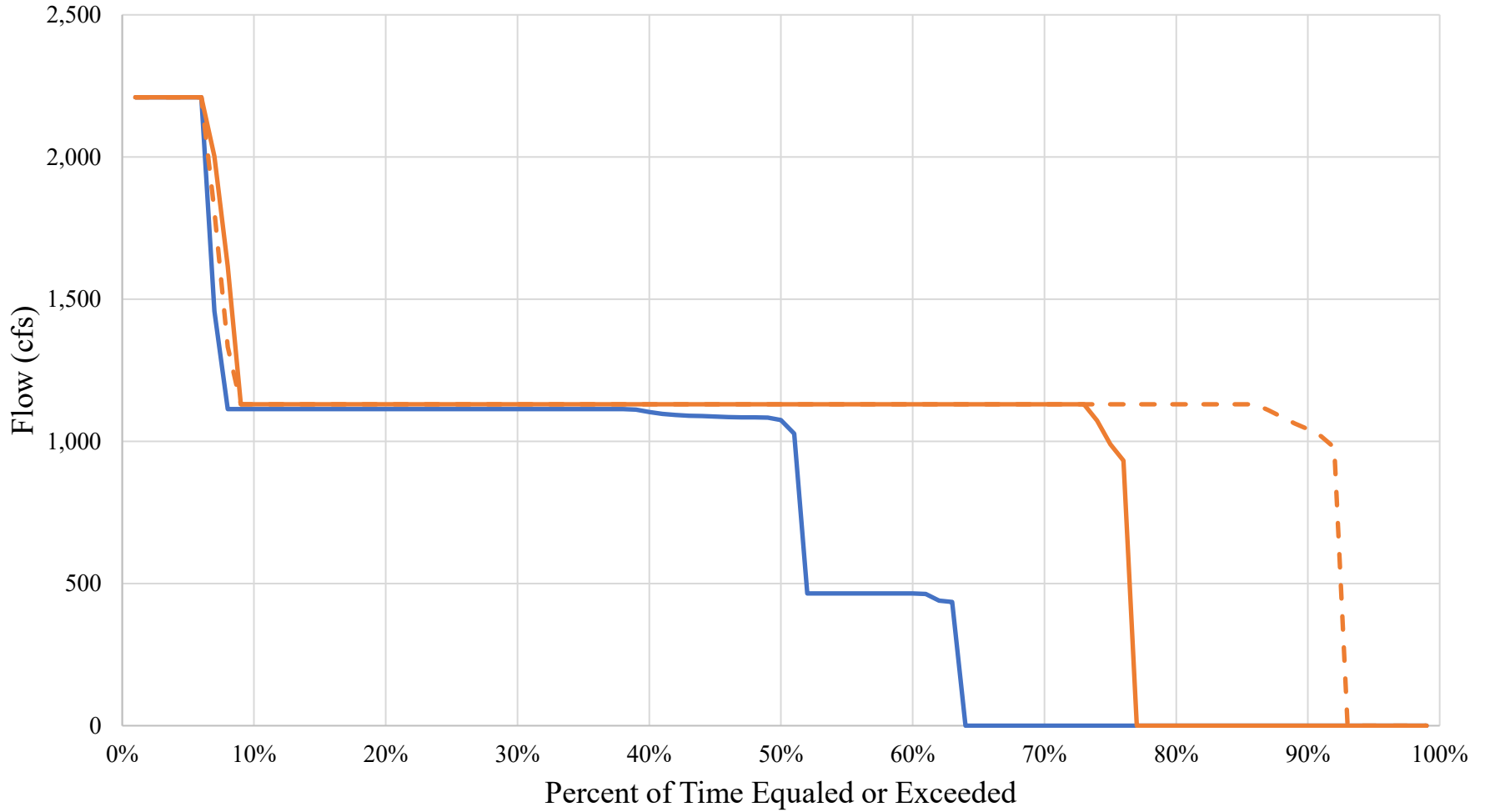
Station No.1 Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 16 - 30



- Baseline Station No. 1 Flows
- - FL AFLA (GRH ROR) Proposal Station No. 1
- FL AFLA (GRH Peaking) Proposal Station No. 1

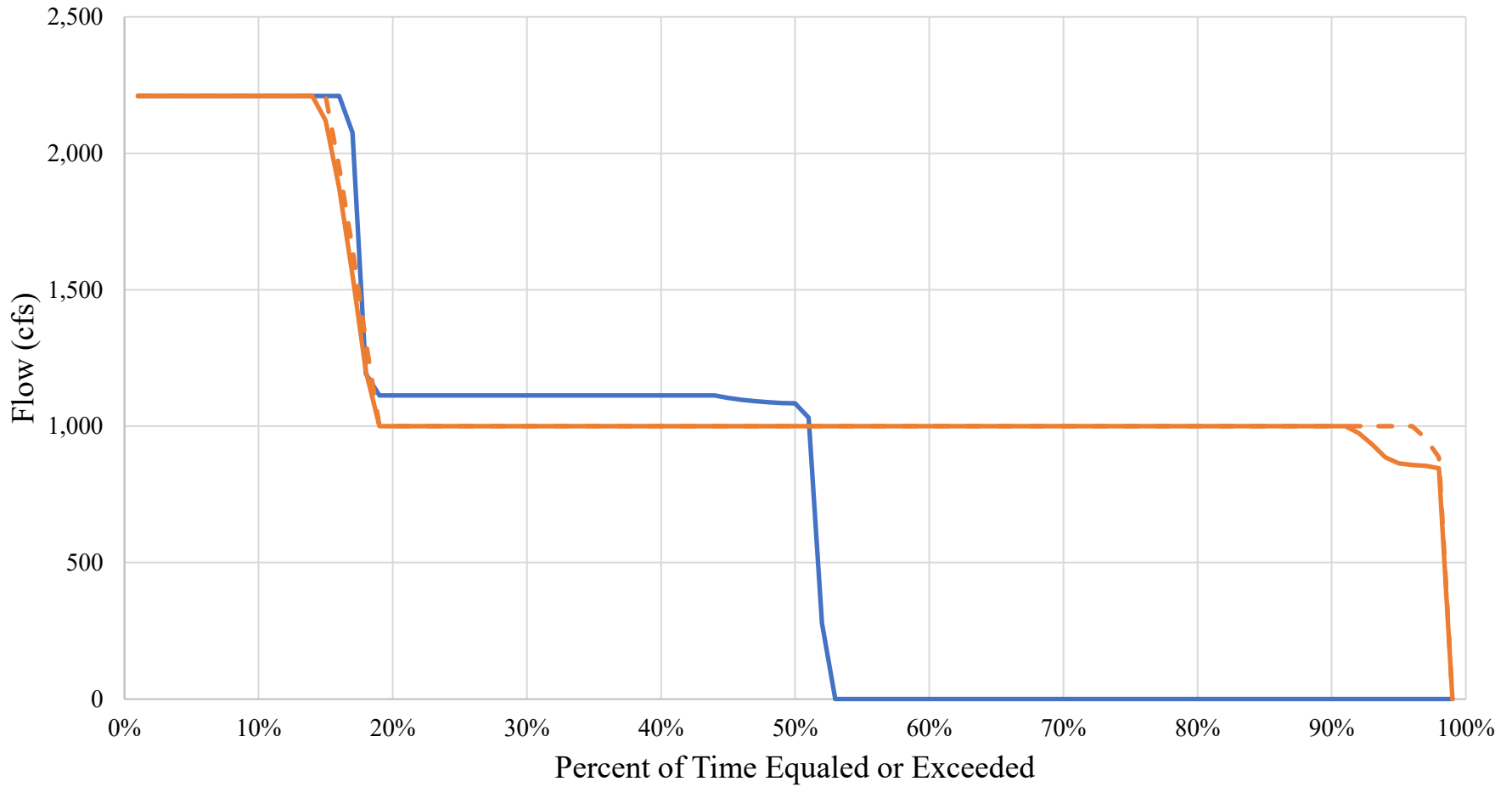


Station No.1 Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) July 1 - August 31



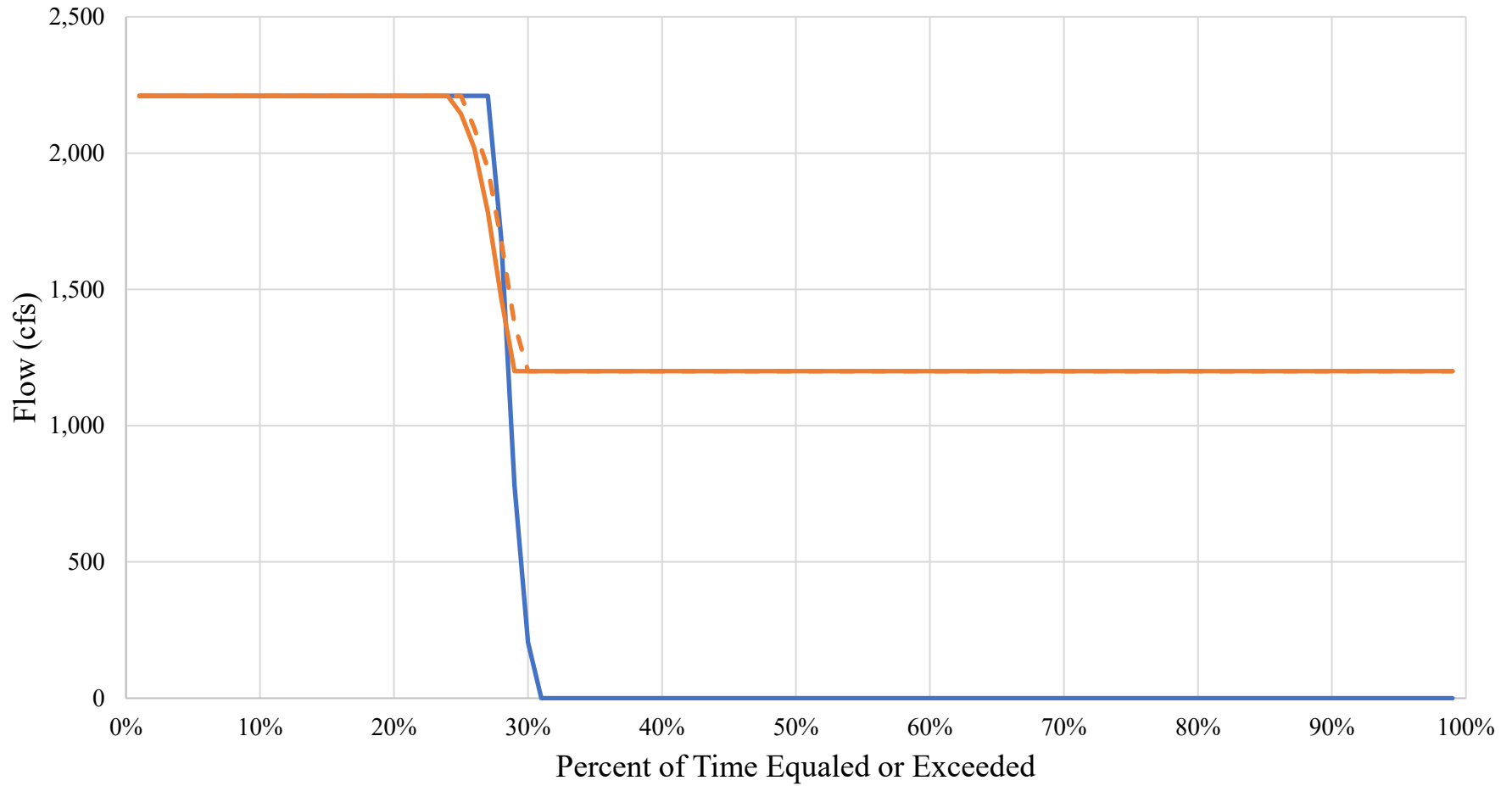
- Baseline Station No. 1 Flows
- - FL AFLA (GRH ROR) Proposal Station No. 1
- FL AFLA (GRH Peaking) Proposal Station No. 1

Station No.1 Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) September 1 -  
November 30



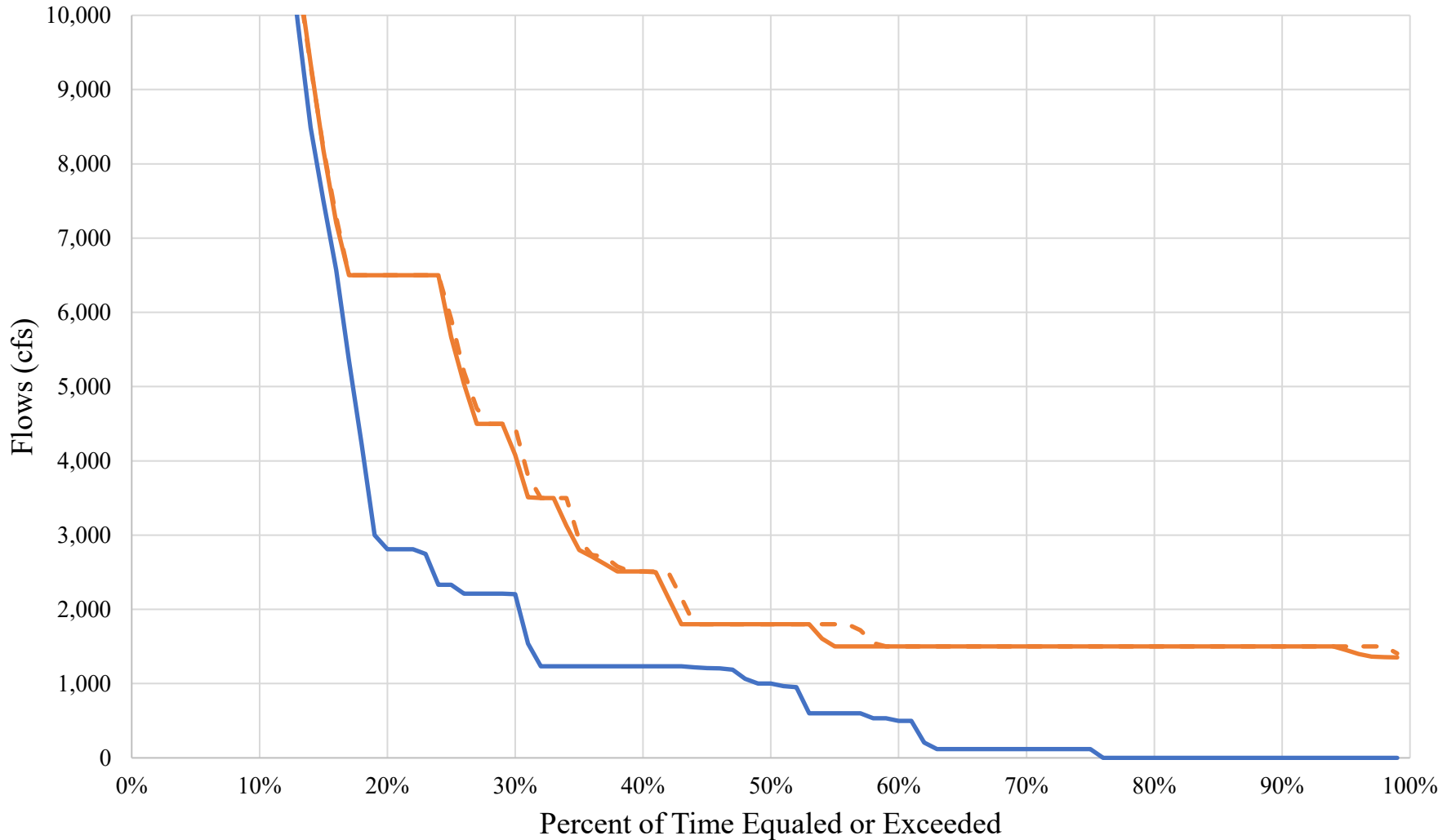
- Baseline Station No. 1 Flows
- - FL AFLA (GRH ROR) Proposal Station No. 1
- FL AFLA (GRH Peaking) Proposal Station No. 1

Station No.1 Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) December 1 -  
March 31



- Baseline Station No. 1 Flows
- - FL AFLA (GRH ROR) Proposal Station No. 1
- FL AFLA (GRH Peaking) Proposal Station No. 1

Total Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) Annual

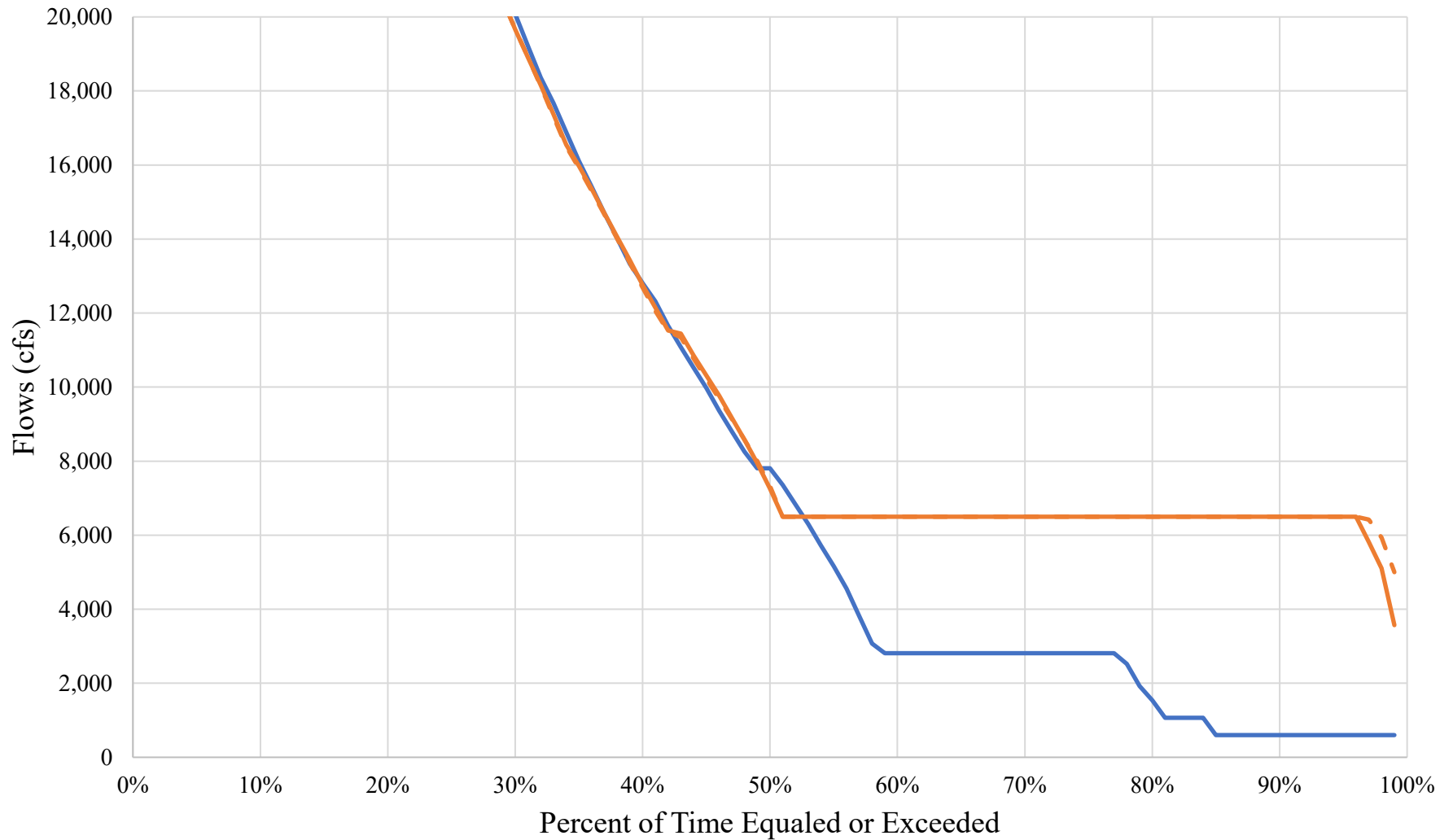


— Baseline Total Bypass Flow (cfs)

- - FL AFLA (with GRH ROR) Total Flow (cfs)

— FL AFLA (with GRH Peaking) Total Flow (cfs)

Total Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) April 1 - May 31

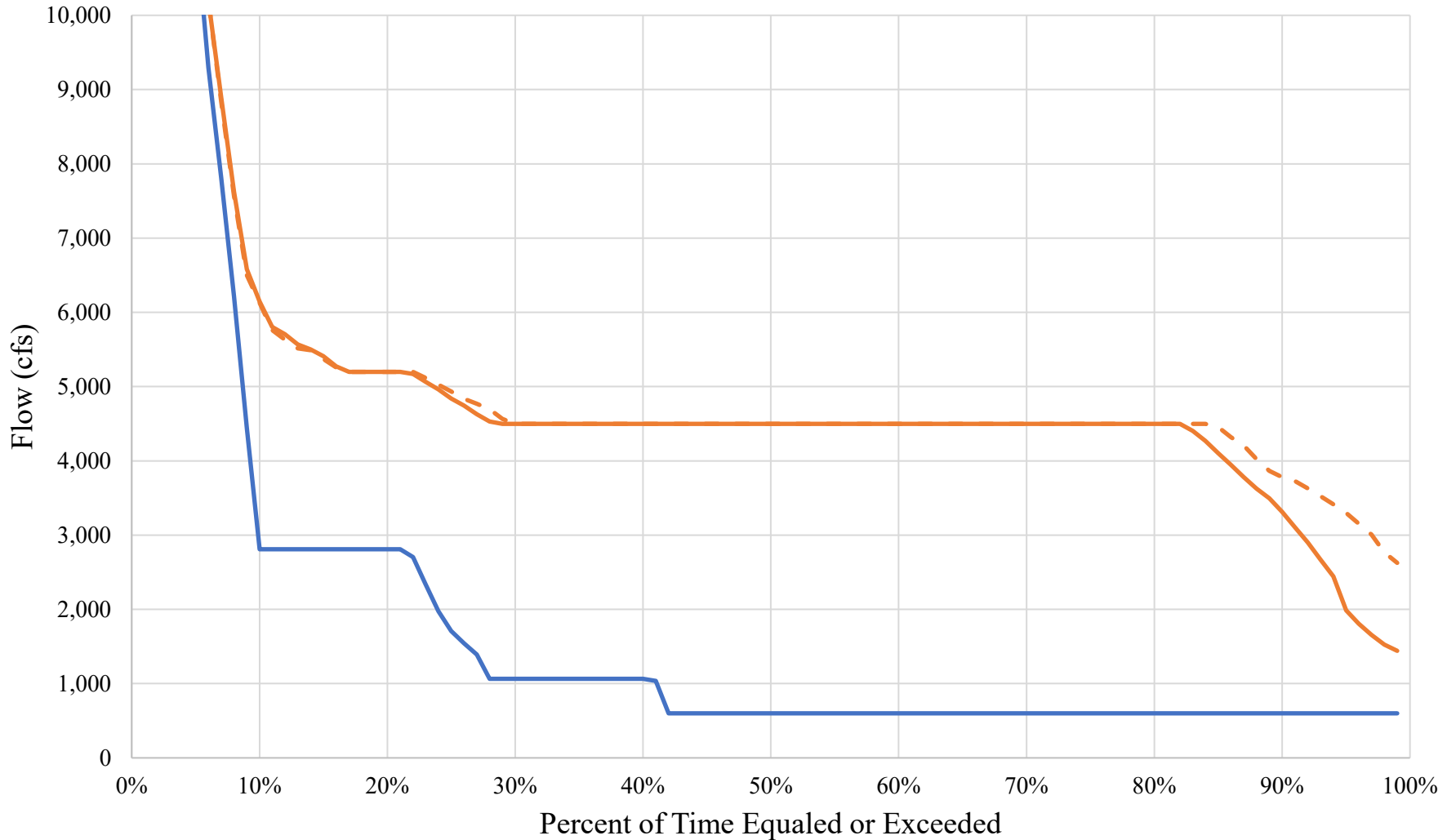


— Baseline Total Bypass Flow (cfs)

- - FL AFLA (with GRH ROR) Total Flow (cfs)

— FL AFLA (with GRH Peaking) Total Flow (cfs)

Total Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 1 - 15

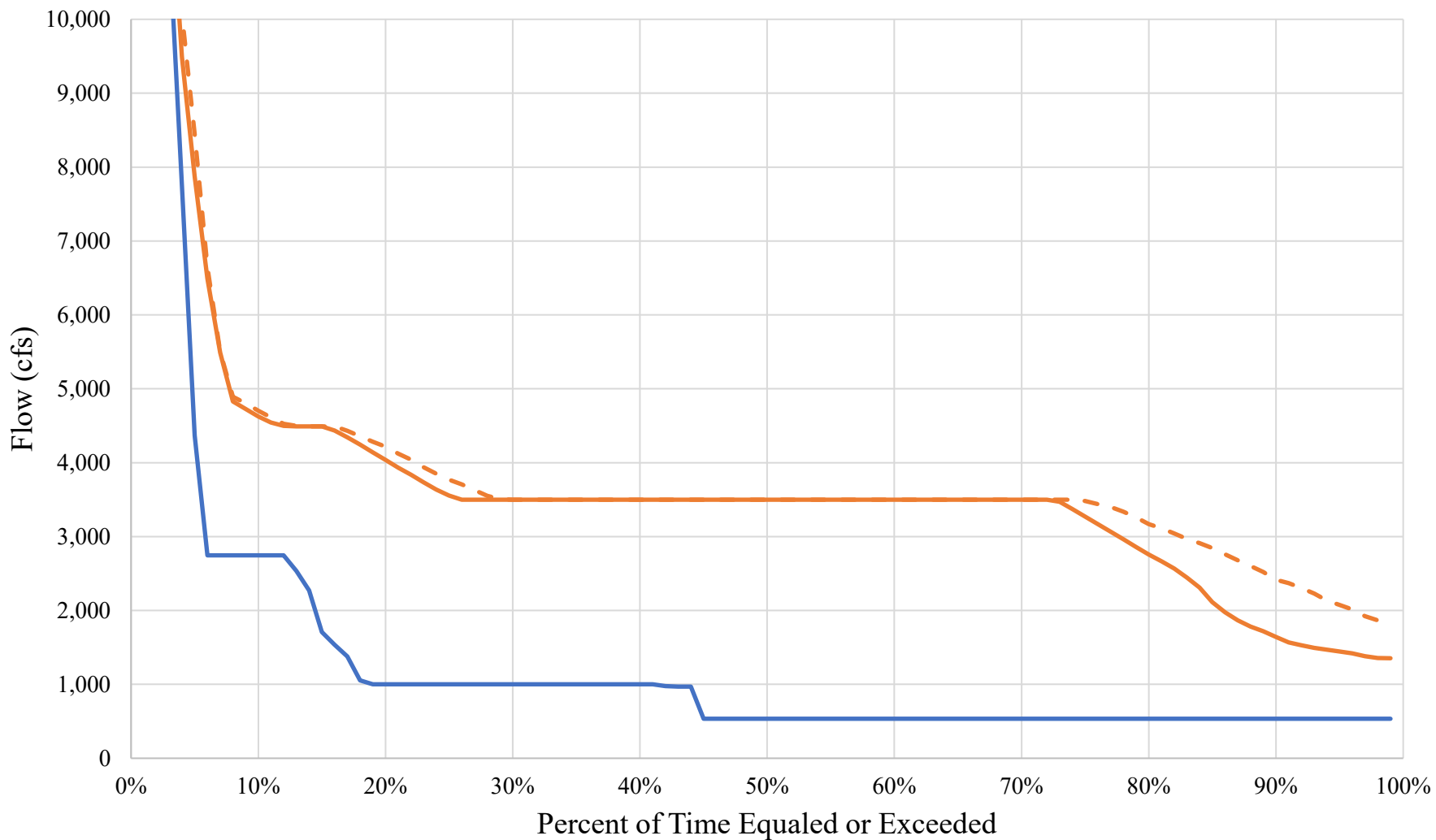


— Baseline Total Bypass Flow (cfs)

- - FL AFLA (with GRH ROR) Total Flow (cfs)

— FL AFLA (with GRH Peaking) Total Flow (cfs)

Total Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 16 - 30

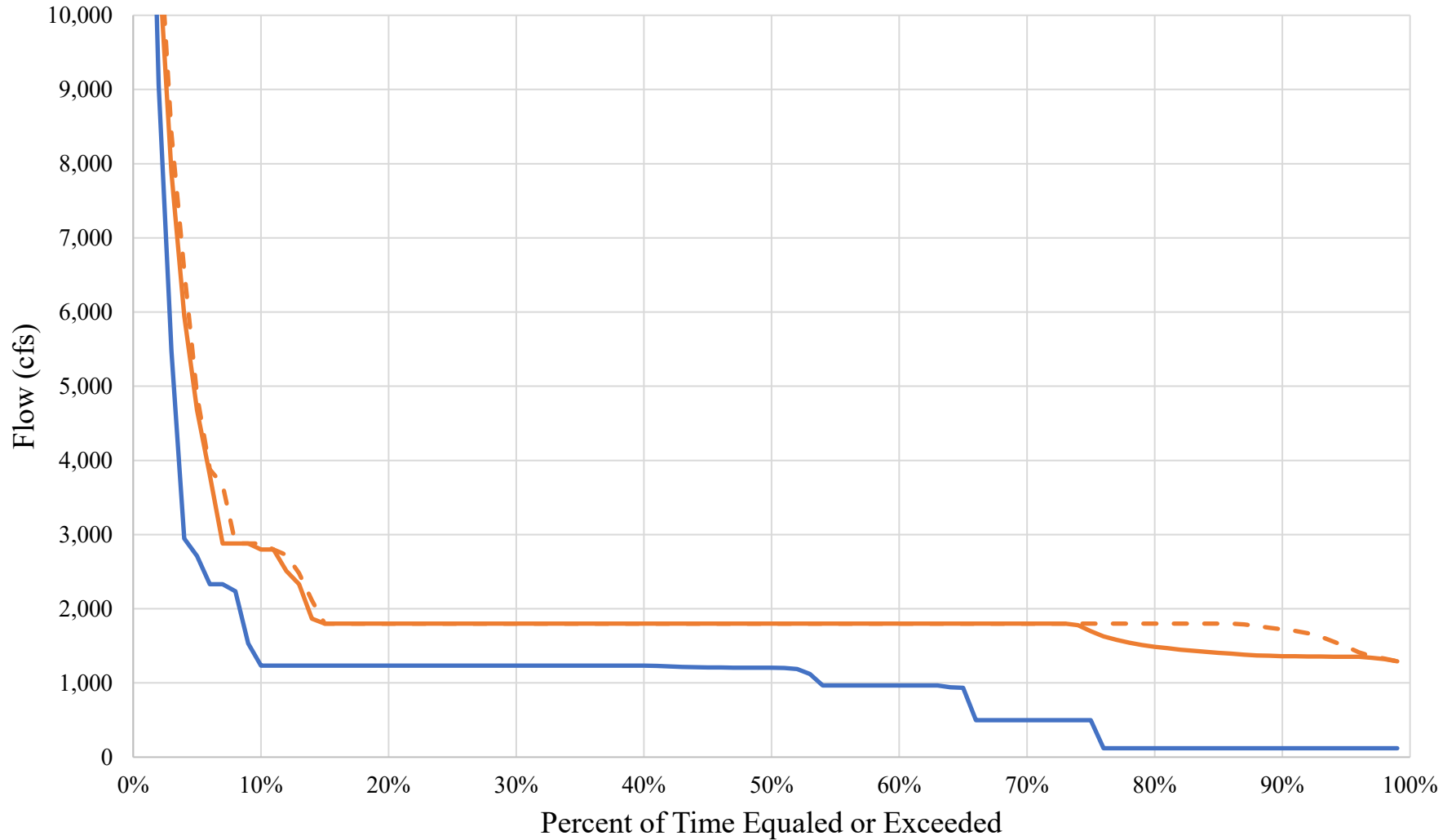


— Baseline Total Bypass Flow (cfs)

- - FL AFLA (with GRH ROR) Total Flow (cfs)

— FL AFLA (with GRH Peaking) Total Flow (cfs)

Total Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) July 1 - August 31



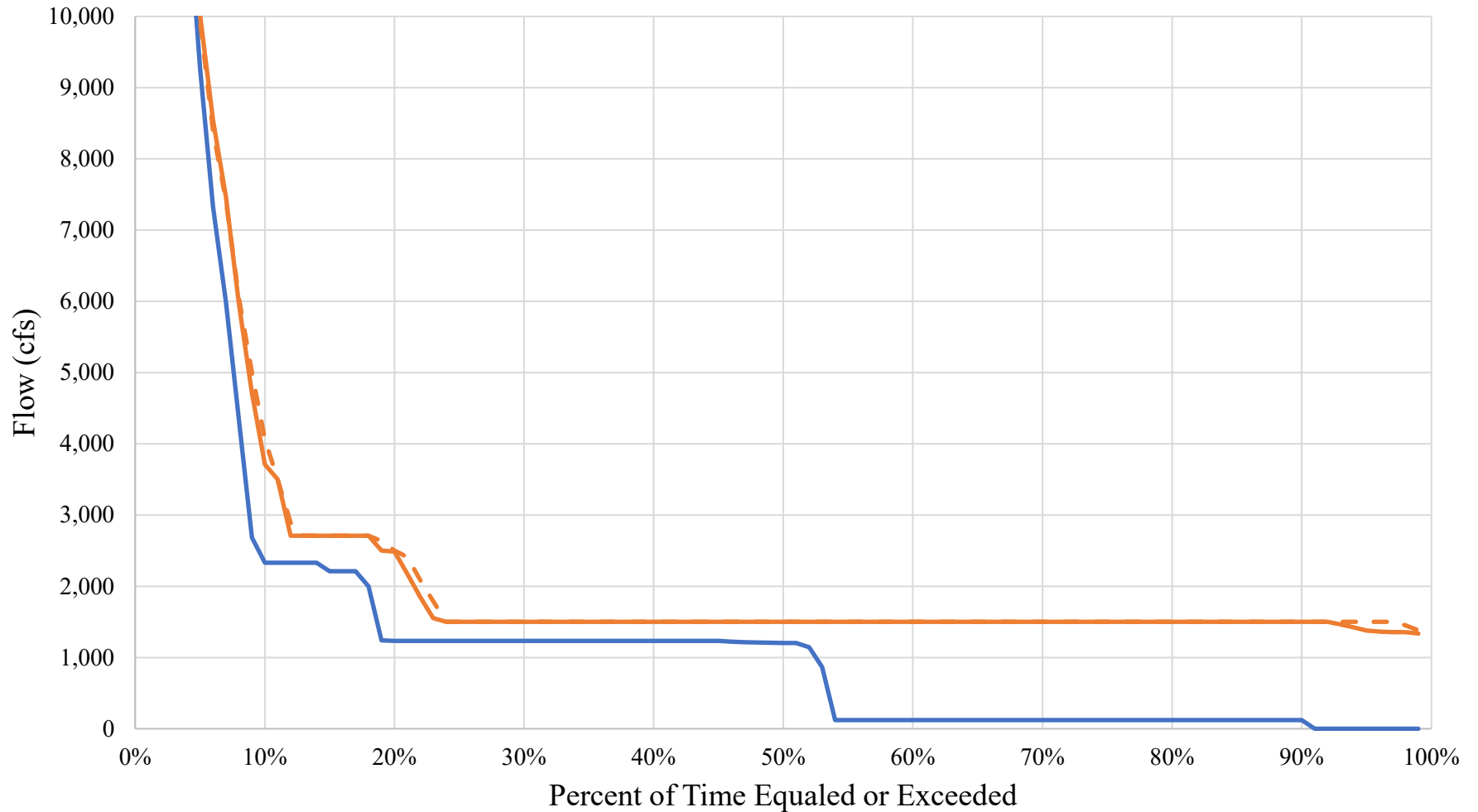
— Baseline Total Bypass Flow (cfs)

- - FL AFLA (with GRH ROR) Total Flow (cfs)

— FL AFLA (with GRH Peaking) Total Flow (cfs)



Total Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) September 1 -  
November 30

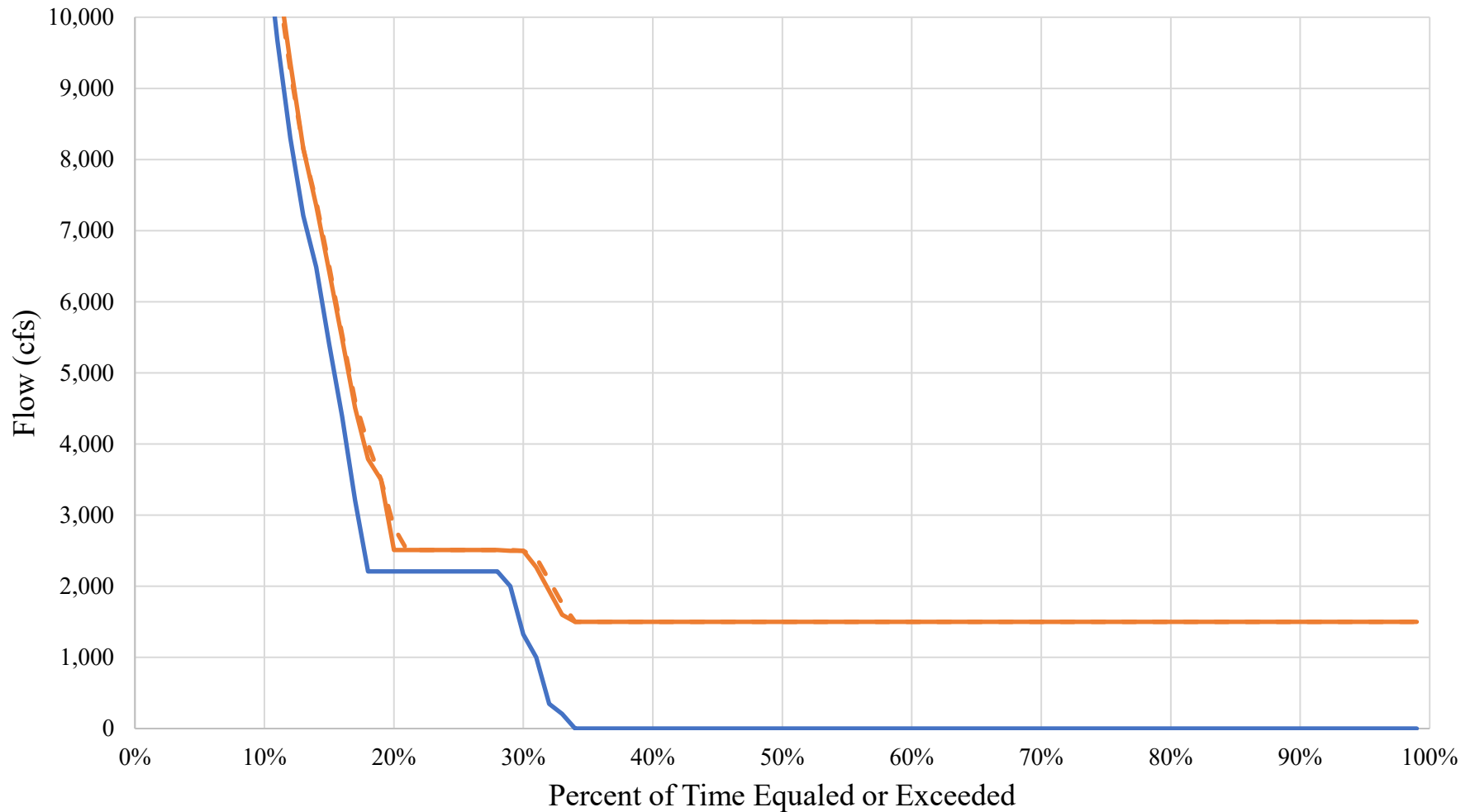


— Baseline Total Bypass Flow (cfs)

- - FL AFLA (with GRH ROR) Total Flow (cfs)

— FL AFLA (with GRH Peaking) Total Flow (cfs)

Total Bypass Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) December 1 -  
March 31

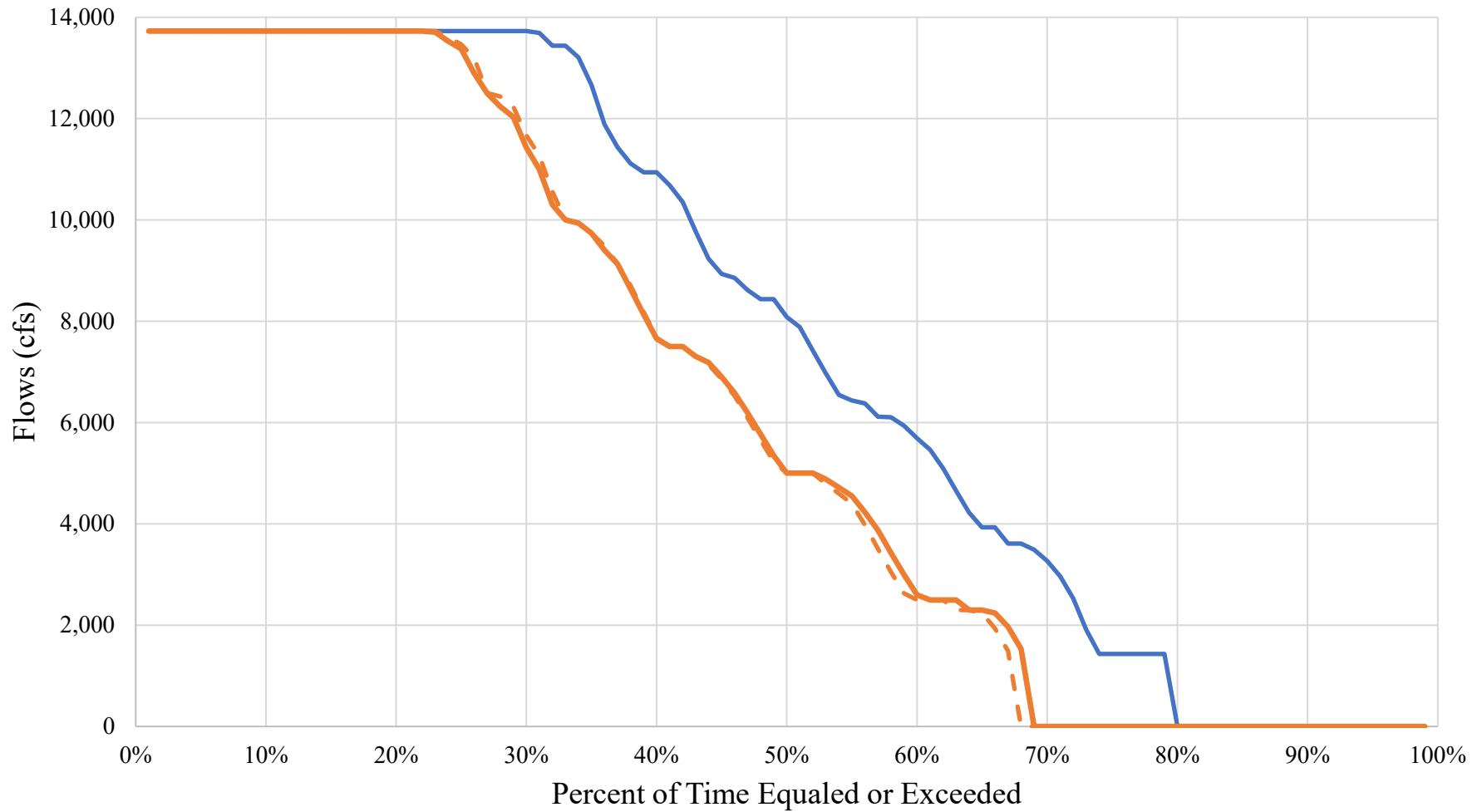


— Baseline Total Bypass Flow (cfs)

- - FL AFLA (with GRH ROR) Total Flow (cfs)

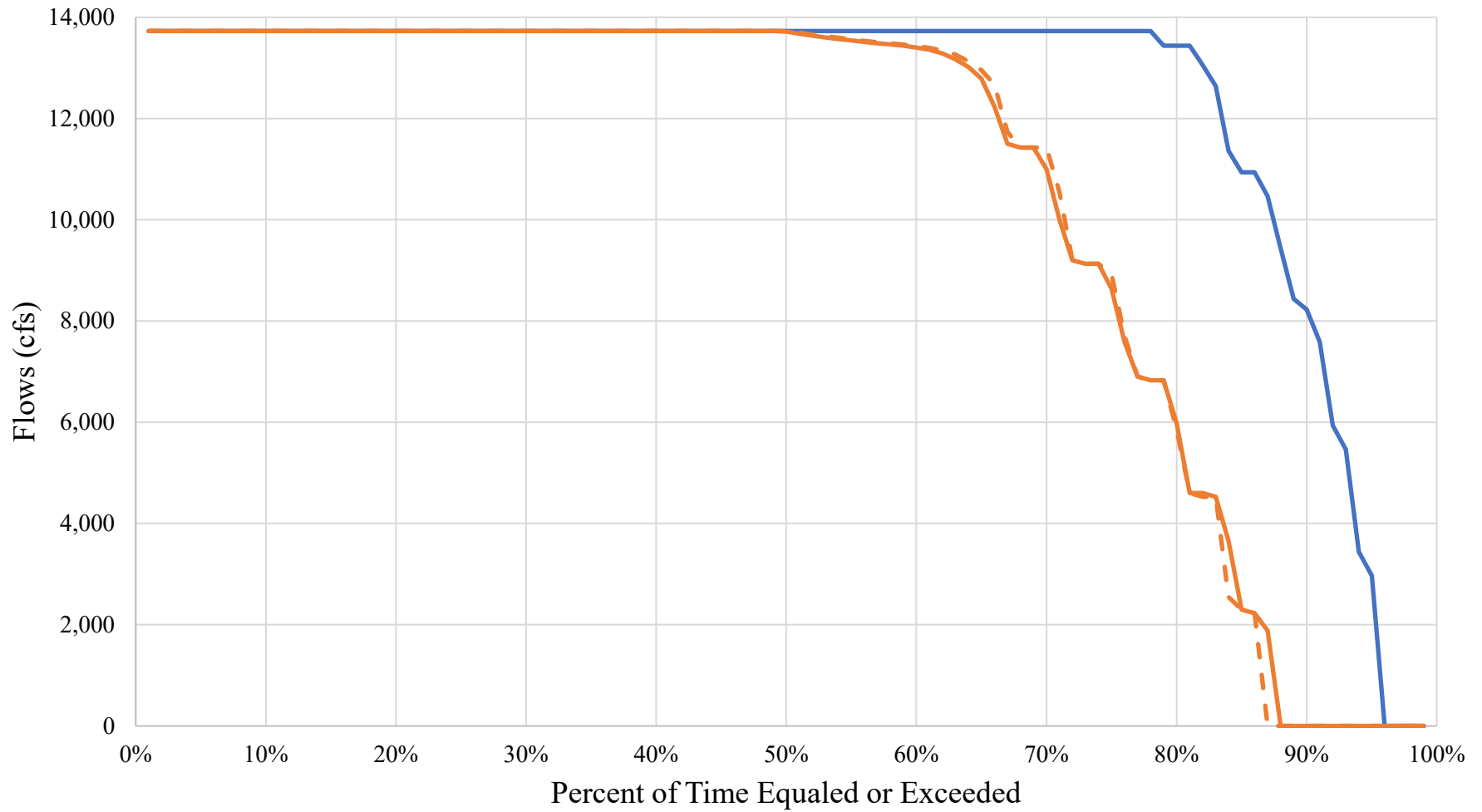
— FL AFLA (with GRH Peaking) Total Flow (cfs)

Cabot Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) Annual



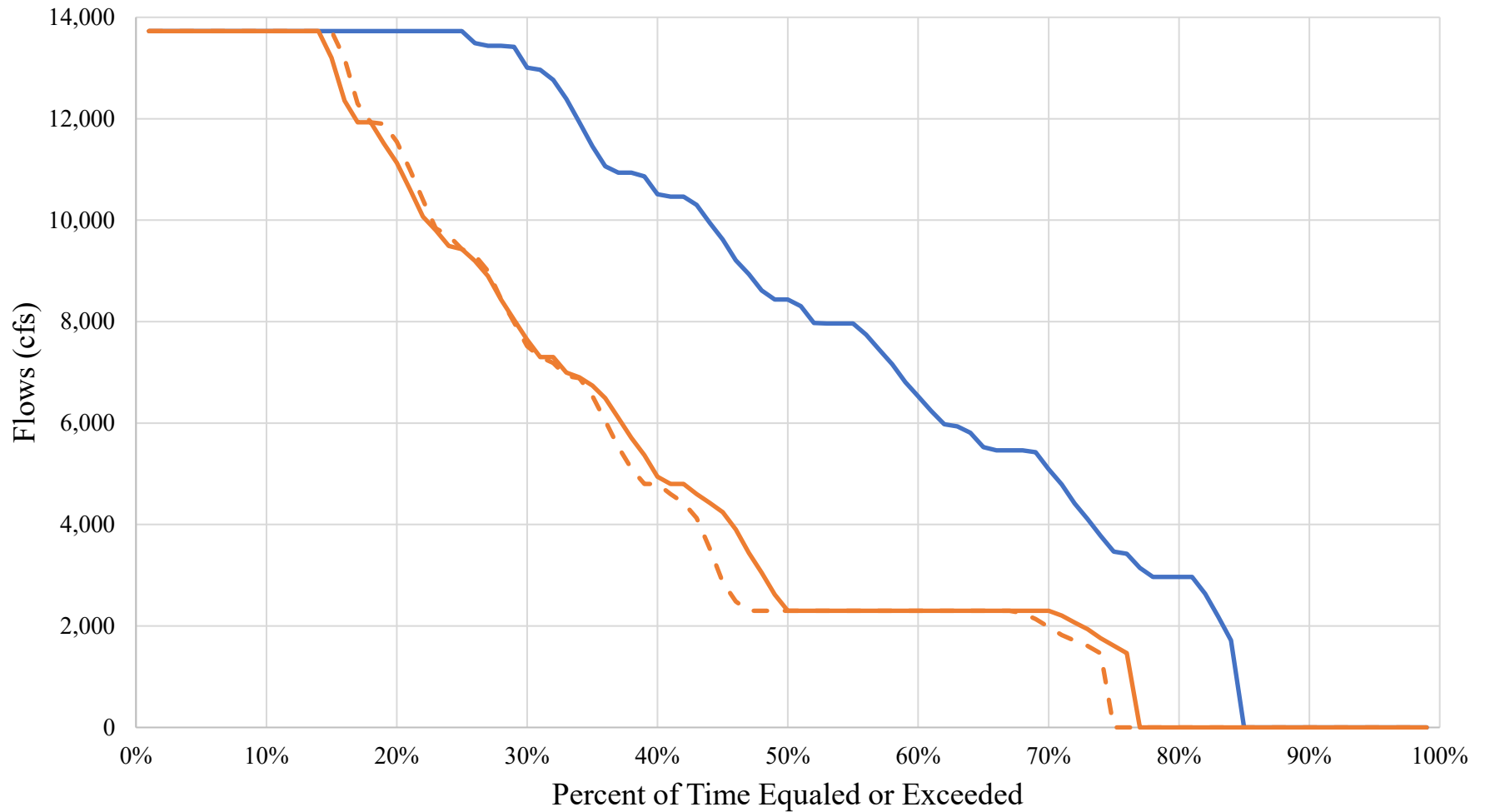
- Baseline Cabot Station Flows
- - FL AFLA (GRH ROR) Proposal Cabot Station (Flows)
- FL AFLA (GRH Peaking) Proposal Cabot Station (Flows)

Cabot Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) April 1 - May 31



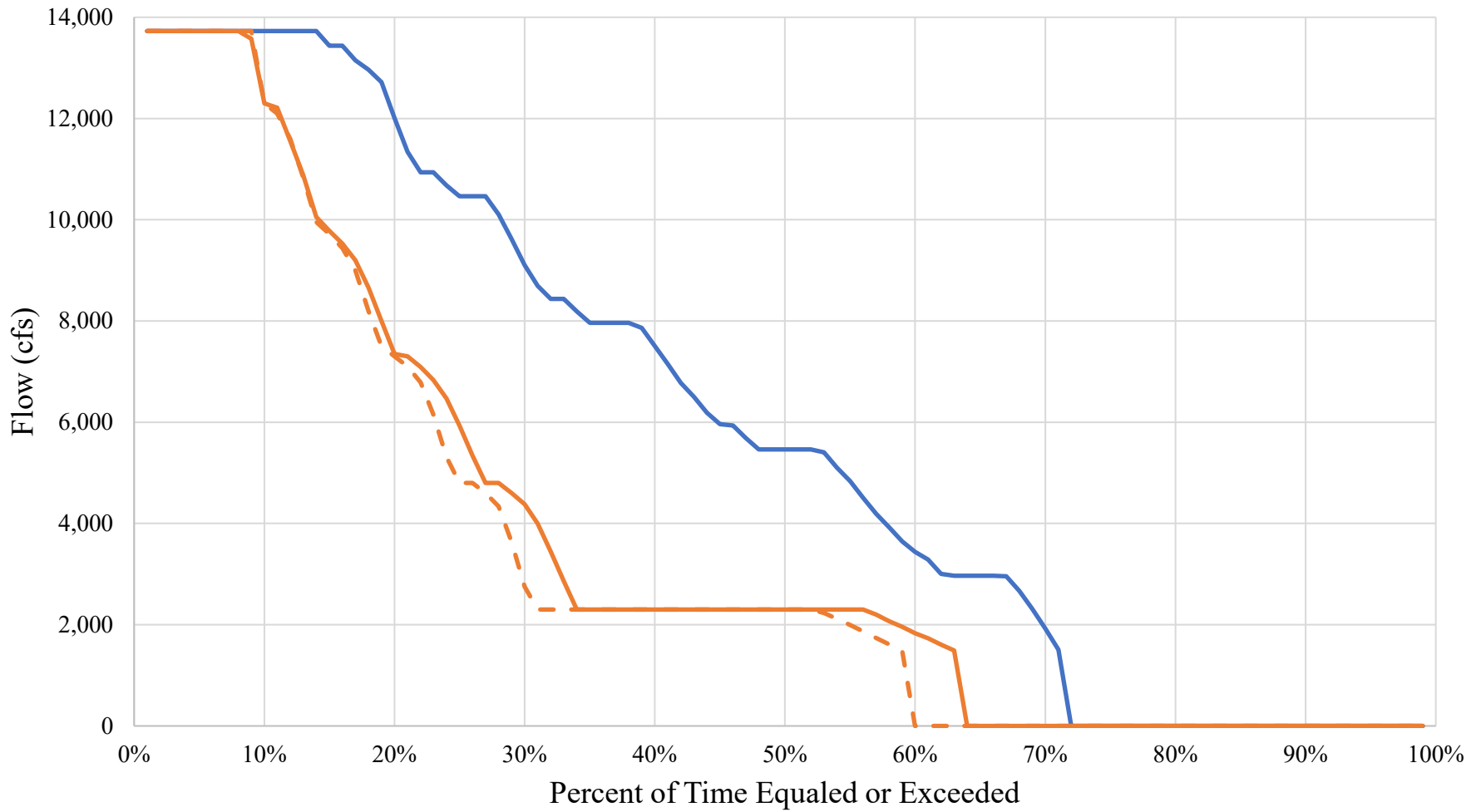
- Baseline Cabot Station Flows
- - FL AFLA (GRH ROR) Proposal Cabot Station (Flows)
- FL AFLA (GRH Peaking) Proposal Cabot Station (Flows)

Cabot Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) Jun 1- 15



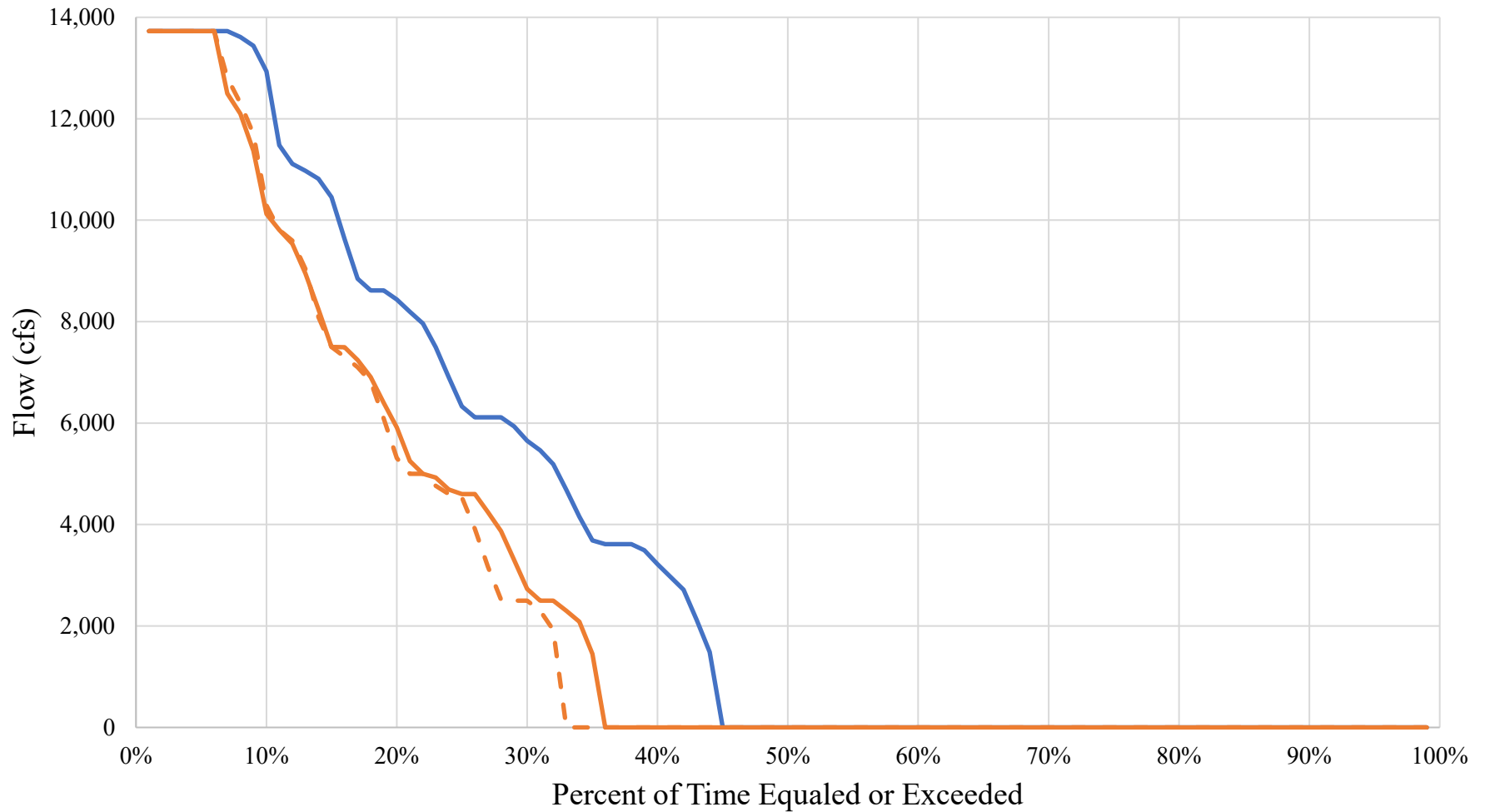
- Baseline Cabot Station Flows
- - FL AFLA (GRH ROR) Proposal Cabot Station (Flows)
- FL AFLA (GRH Peaking) Proposal Cabot Station (Flows)

Cabot Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 16 - 30



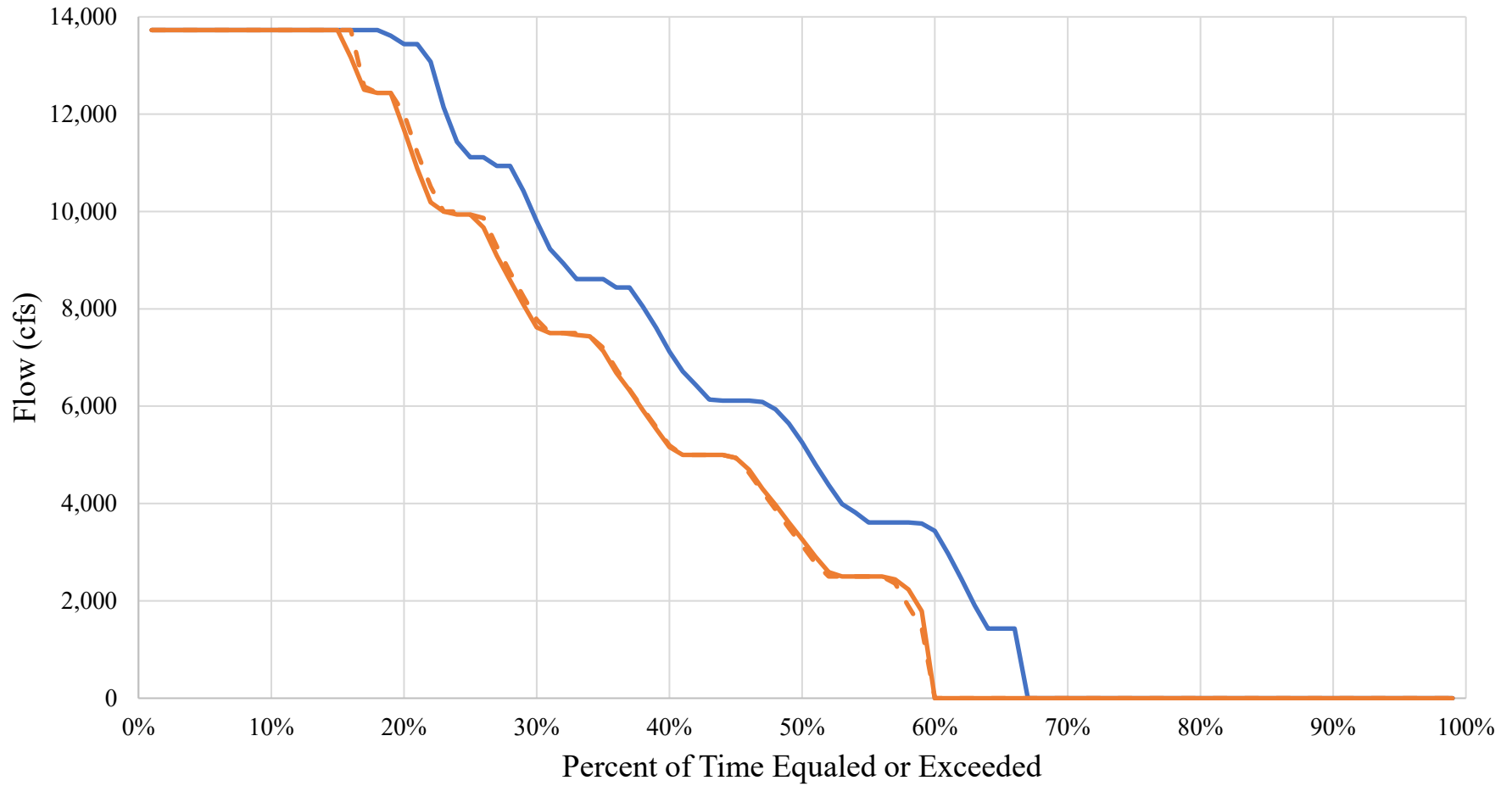
- Baseline Cabot Station Flows
- - FL AFLA (GRH ROR) Proposal Cabot Station (Flows)
- FL AFLA (GRH Peaking) Proposal Cabot Station (Flows)

Cabot Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) July 1 - August 31



- Baseline Cabot Station Flows
- - FL AFLA (GRH ROR) Proposal Cabot Station (Flows)
- FL AFLA (GRH Peaking) Proposal Cabot Station (Flows)

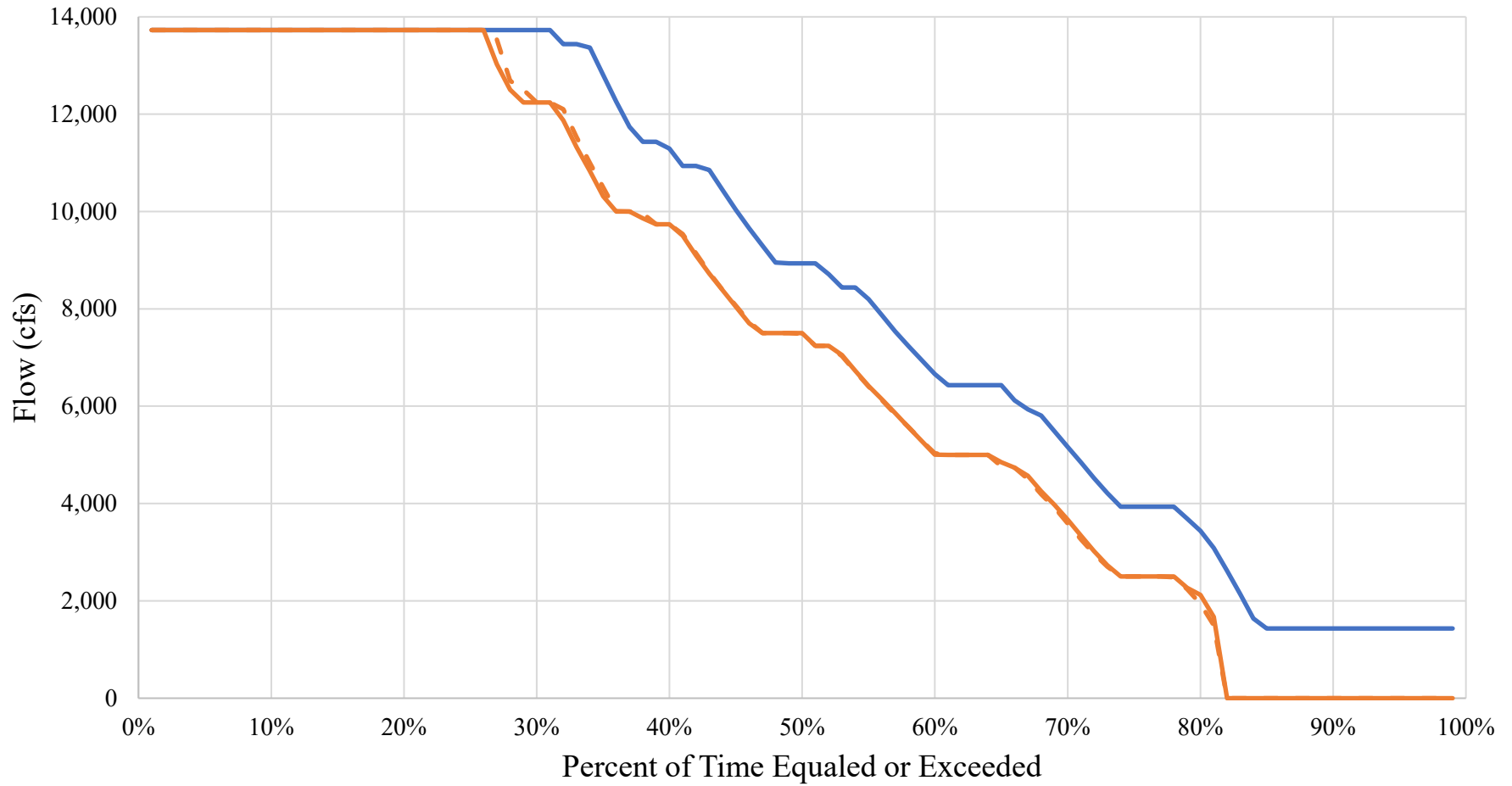
Cabot Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) September 1 -  
November 30



- Baseline Cabot Station Flows
- - FL AFLA (GRH ROR) Proposal Cabot Station (Flows)
- FL AFLA (GRH Peaking) Proposal Cabot Station (Flows)

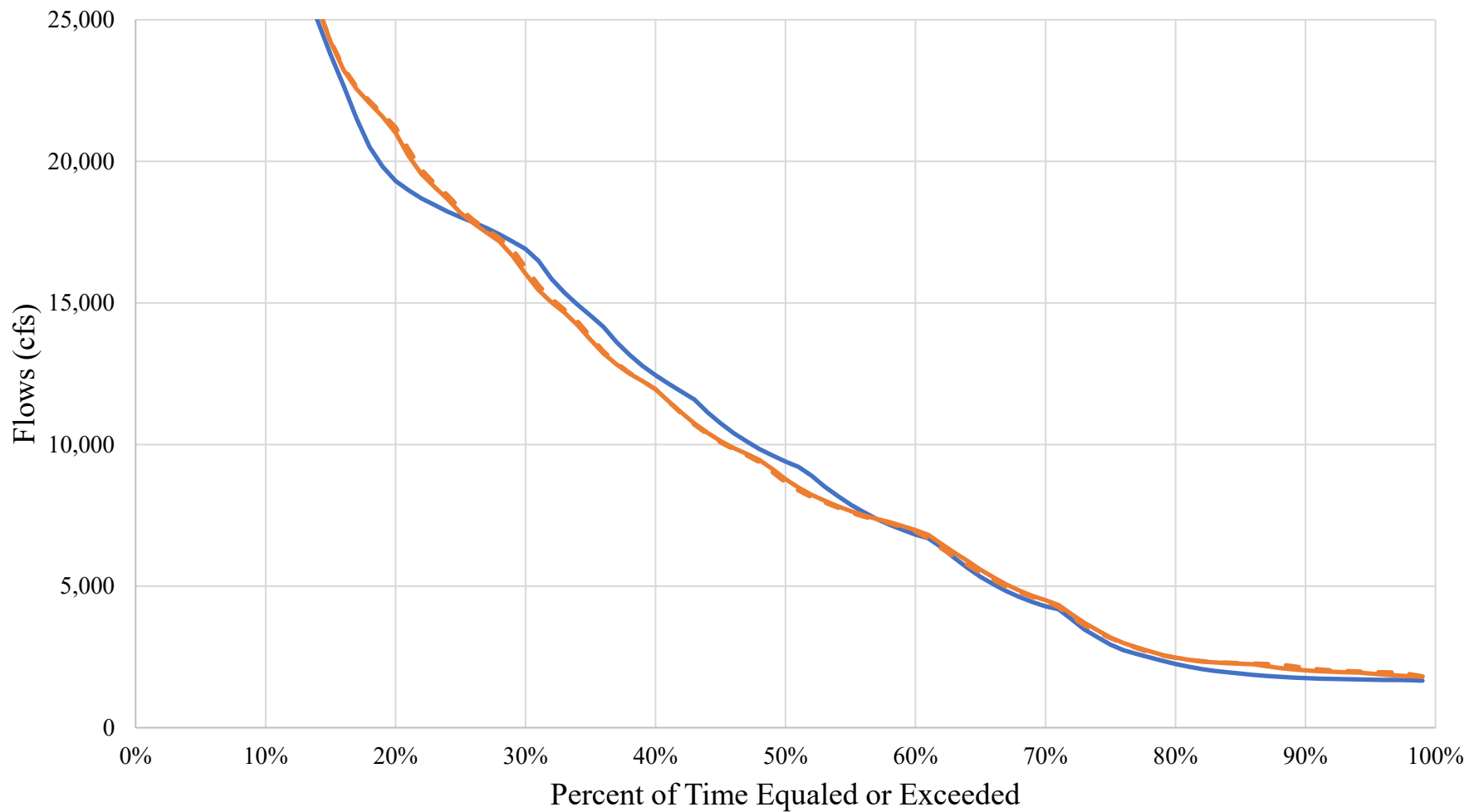


Cabot Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) December 1 -  
March 31



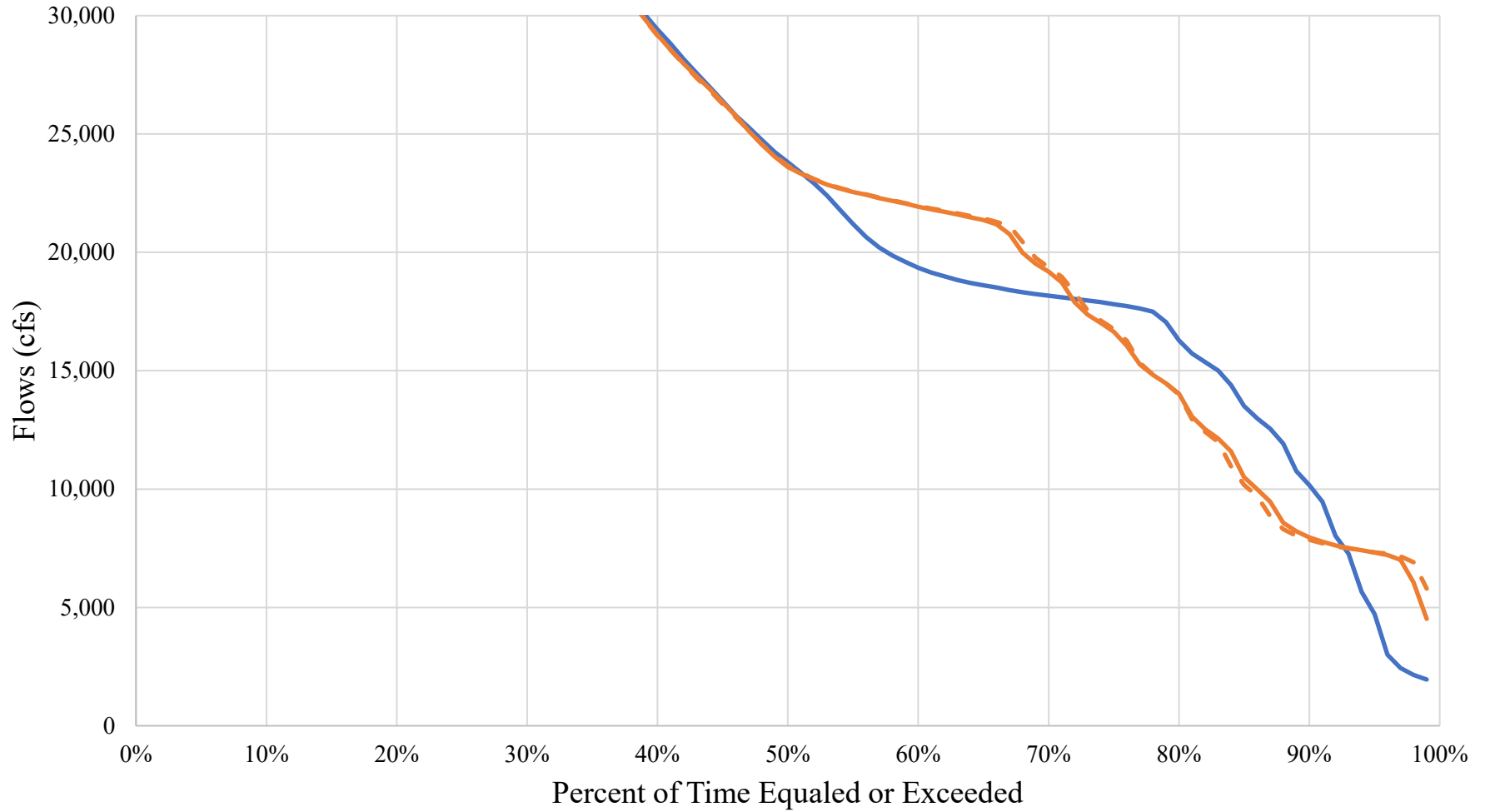
- Baseline Cabot Station Flows
- - FL AFLA (GRH ROR) Proposal Cabot Station (Flows)
- FL AFLA (GRH Peaking) Proposal Cabot Station (Flows)

Montague Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) Annual



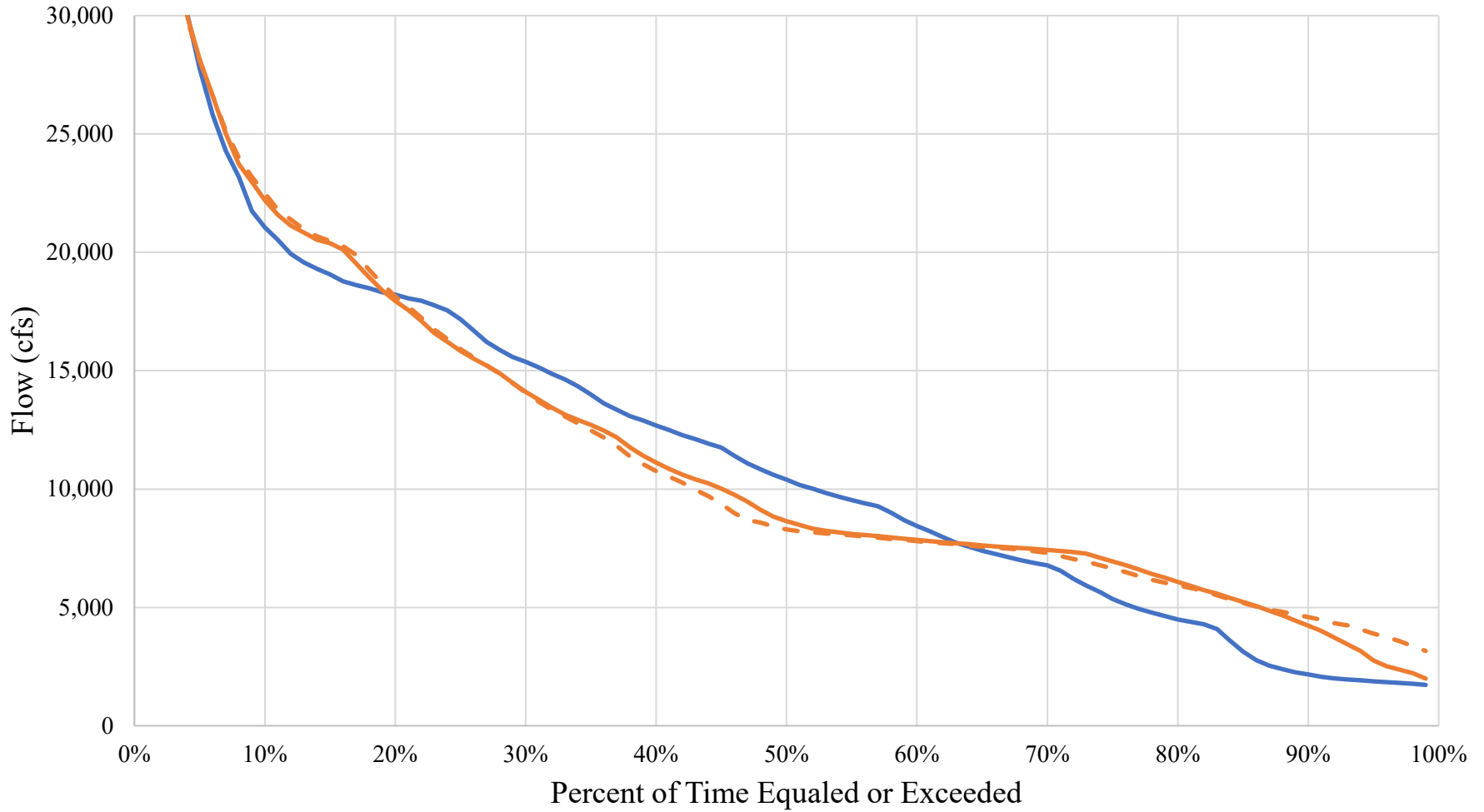
- Baseline Montague Flow (cfs)
- - FL AFLA (with GRH ROR) Montague Flow (cfs)
- FL AFLA (with GRH Peaking) Montague Flow (cfs)

Montague Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) April 1 - May 31



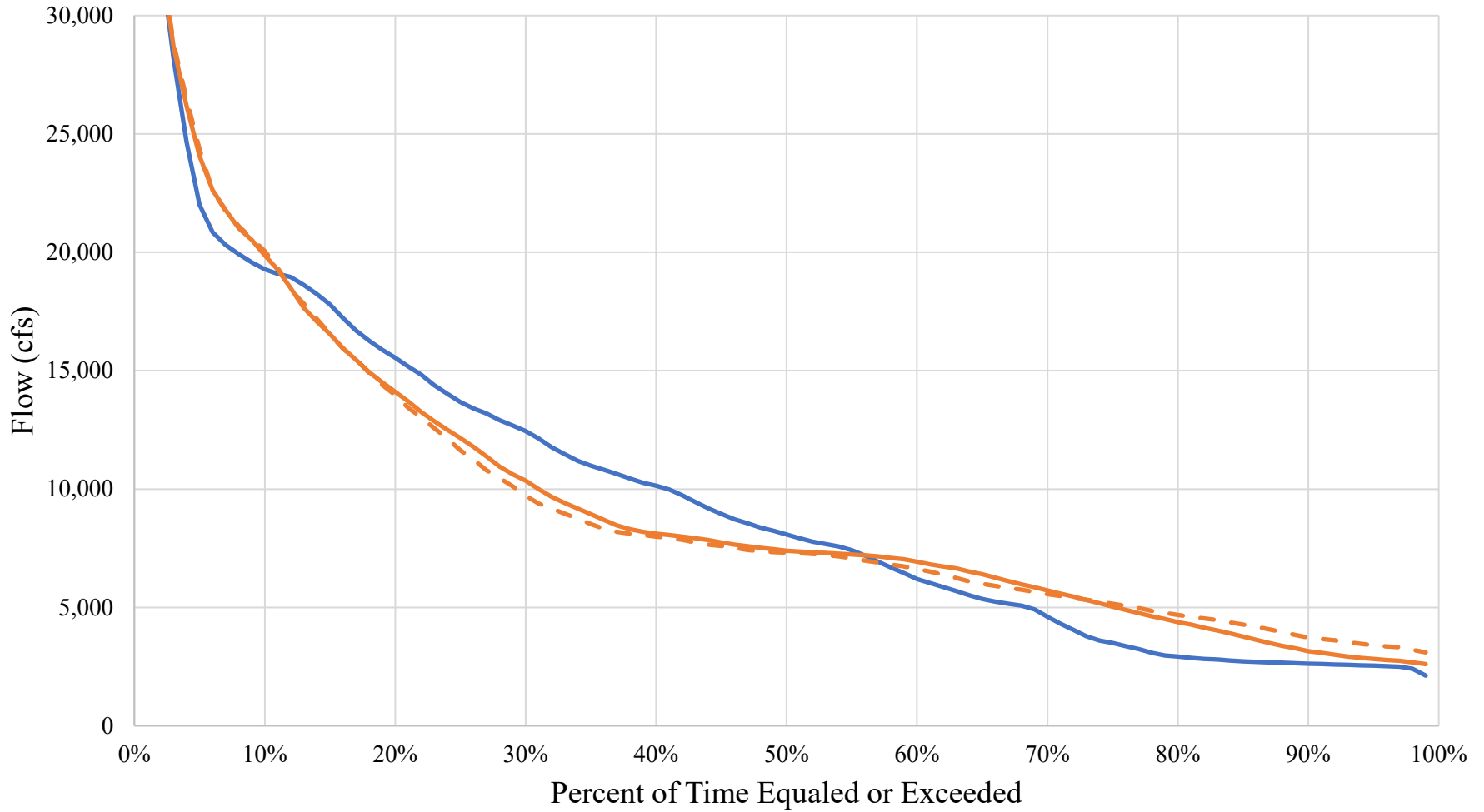
- Baseline Montague Flow (cfs)
- - FL AFLA (with GRH ROR) Montague Flow (cfs)
- FL AFLA (with GRH Peaking) Montague Flow (cfs)

Montague Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 1 - 15



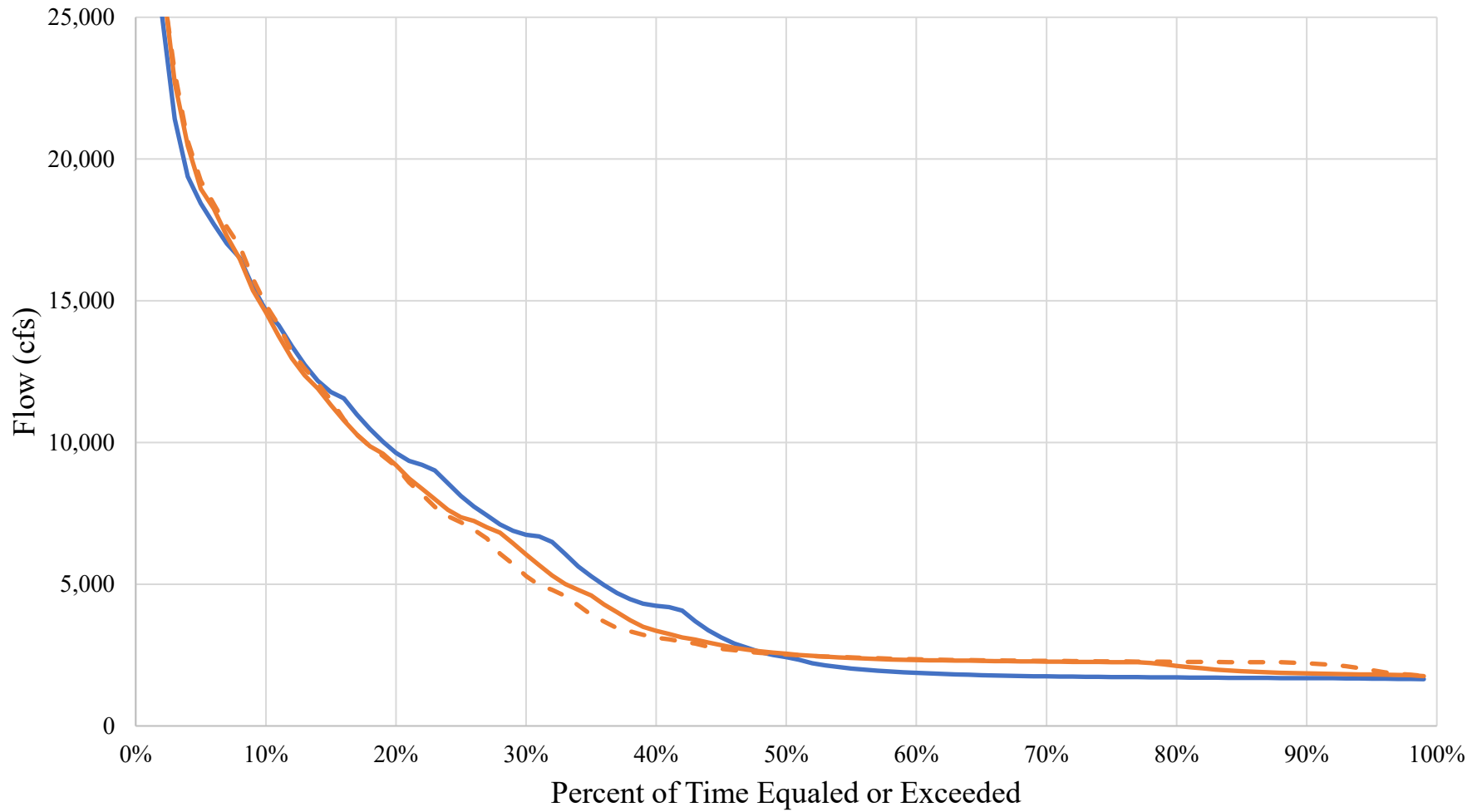
- Baseline Montague Flow (cfs)
- - FL AFLA (with GRH ROR) Montague Flow (cfs)
- FL AFLA (with GRH Peaking) Montague Flow (cfs)

Montague Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) June 16 - 30



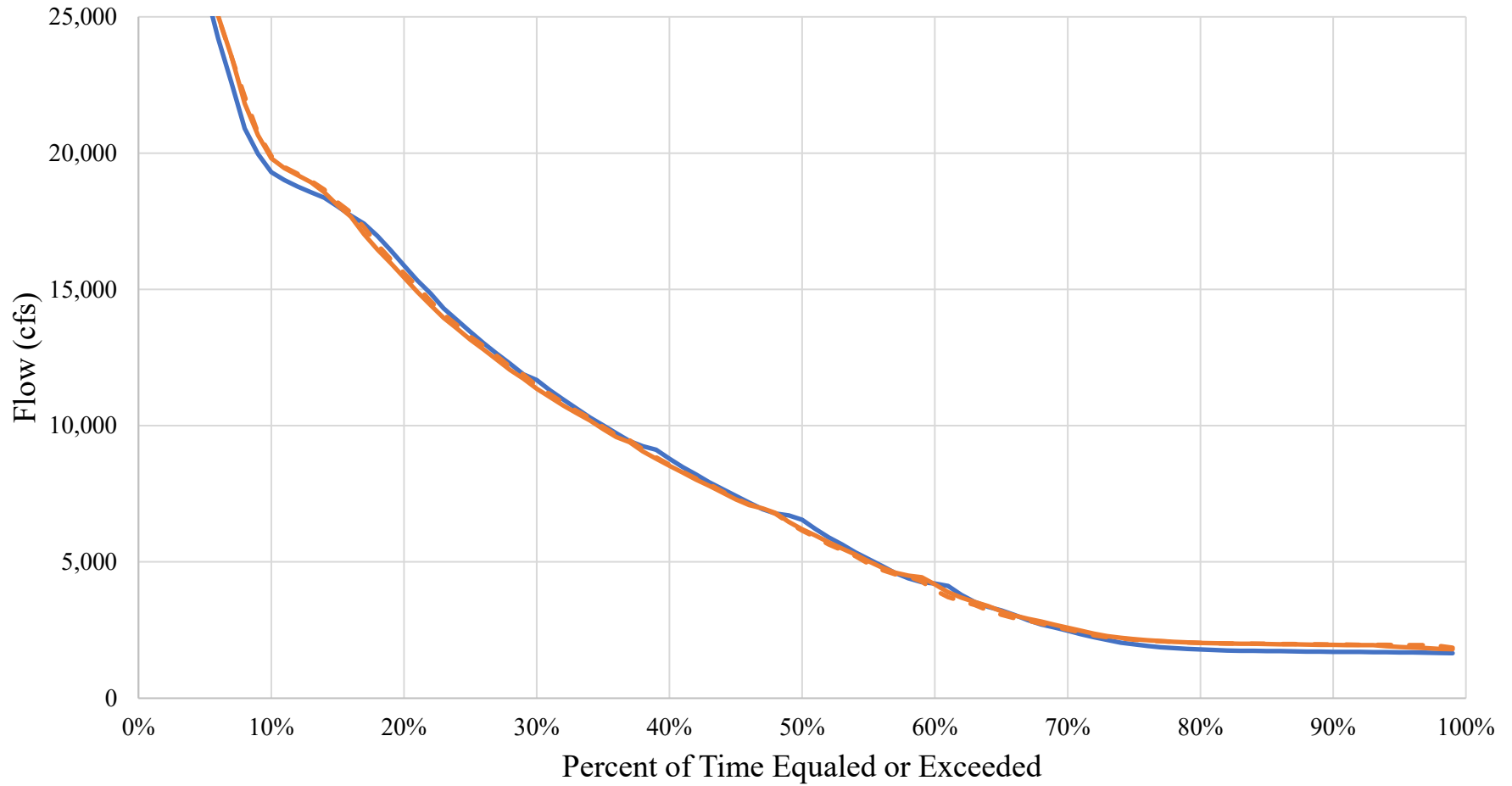
- Baseline Montague Flow (cfs)
- - FL AFLA (with GRH ROR) Montague Flow (cfs)
- FL AFLA (with GRH Peaking) Montague Flow (cfs)

Montague Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) July 1 - August 31



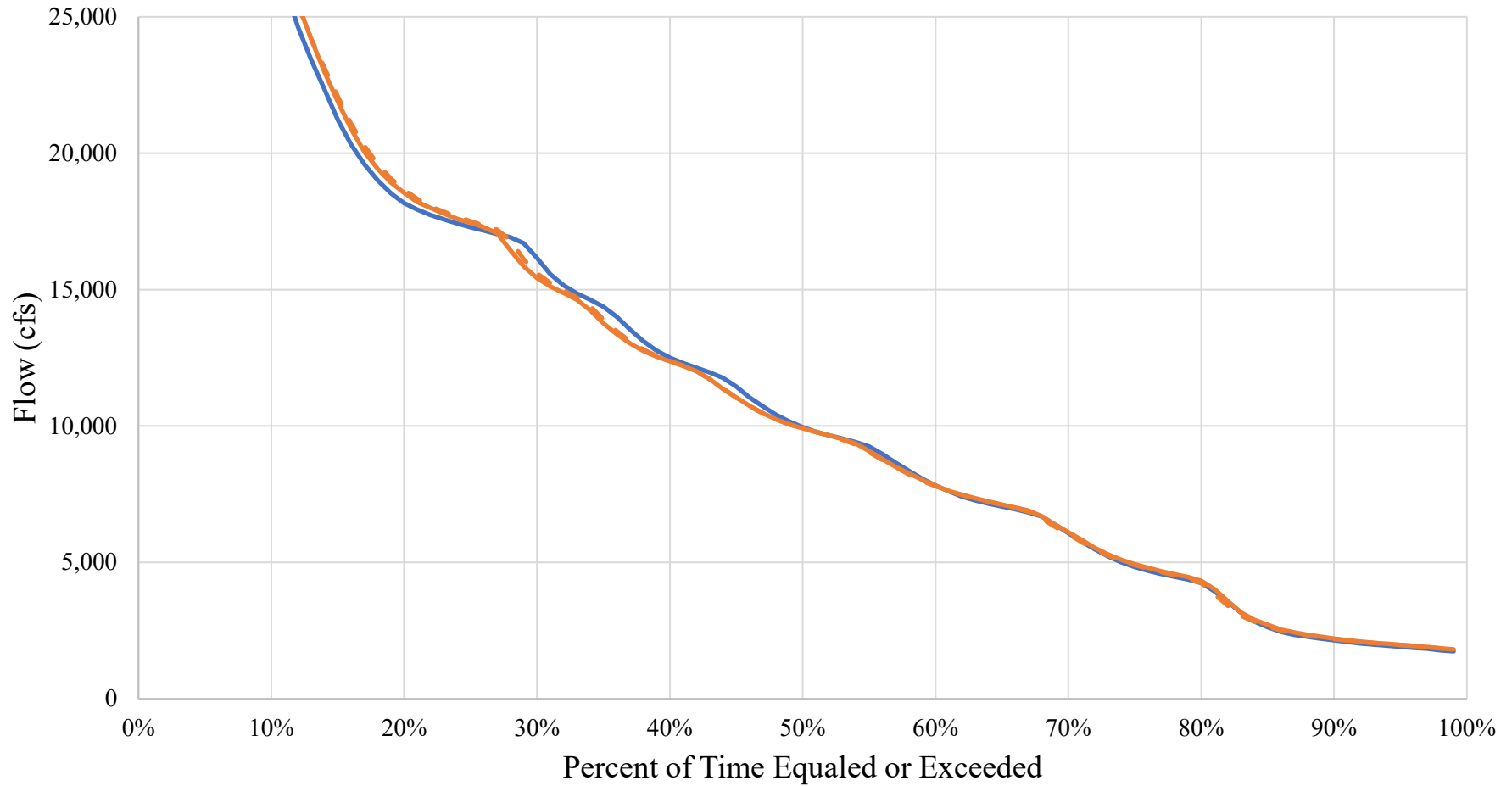
- Baseline Montague Flow (cfs)
- - FL AFLA (with GRH ROR) Montague Flow (cfs)
- FL AFLA (with GRH Peaking) Montague Flow (cfs)

Montague Modeled Hourly Flows  
(Baseline and FL AFLA Proposal with GRH ROR and Peaking) September 1 -  
November 30



- Baseline Montague Flow (cfs)
- - FL AFLA (with GRH ROR) Montague Flow (cfs)
- FL AFLA (with GRH Peaking) Montague Flow (cfs)

# Montague Modeled Hourly Flows (Baseline and FL AFLA Proposal with GRH ROR and Peaking) December 1 - March 31



- Baseline Montague Flow (cfs)
- - FL AFLA (with GRH ROR) Montague Flow (cfs)
- FL AFLA (with GRH Peaking) Montague Flow (cfs)