U.S.Department
of Transportation
Federal Highway Administration

Technical Memorandum

Date: January 22, 2021

To: Emilio Burgos, Project Manager, CFLHD, Lakewood CO

From: Luis Calderón, Hydraulics Engineer, CFLHD, Lakewood CO

CC: File N:\WY\cn10-277(1)\Hydraulics\9_Final-Report

Subject: Stream Diversion Recommendations for the WY FLAP CN10 - 277(1) – Replacement of the Wiggins Fork Bridge project

1 PROJECT BACKGROUND INFORMATION

This memorandum presents the hydrologic and hydraulic analysis to support the stream diversion recommendations for the WY FLAP CN10 - 277(1) – Replacement of the Wiggins Fork Bridge project. The project is located in Fremont County, Wyoming, see **Figure 1**. The project proposes to replace an existing bridge over Wiggins Fork, which is a tributary to the East Fork Wind River. Maintenance of traffic during construction is required and a temporary traffic diversion will be constructed over Wiggins Fork. Stream flows are required to be maintained through the crossing for the duration of the construction.

2 HYDRAULIC DESIGN CRITERIA

The Federal Lands Highway Project Development and Design Manual (PDDM) (Federal Lands Highway 2012) provides criteria for temporary stream crossings as shown below:

- High Standard road: Culverts for temporary detours will convey runoff from the 10-year flood, unless seasonal construction justifies a lower standard.
- Low Standard road: Culverts for temporary detours will convey runoff from the 2-year flood, unless seasonal construction justifies a lower standard.

The bridge construction will take advantage of the seasonal low flow period on Wiggins Creek. It is assumed for the purposes of this analysis that this will take place between September and April. Due to the seasonal construction for this project, a flow duration analysis was conducted to the temporary crossing requirements as discussed in the following sections.

3 FLOW DURATION ANALYSIS

The project is located on Wiggins Creek, upstream of the confluence with the East Fork Wind River. The contributing drainage area to the bridge is approximately 212 square miles. There are no streamflow gages on Wiggins Creek near the project site. USGS streamflow station 06220500 - East Fork Wind River near Dubois, WY is located approximately 7 miles downstream of the confluence of Wiggins Creek with the East Fork Wind River. Information from this gage was used to conduct the flow duration analysis. Figure 1 shows the gage location in relation to the project site.

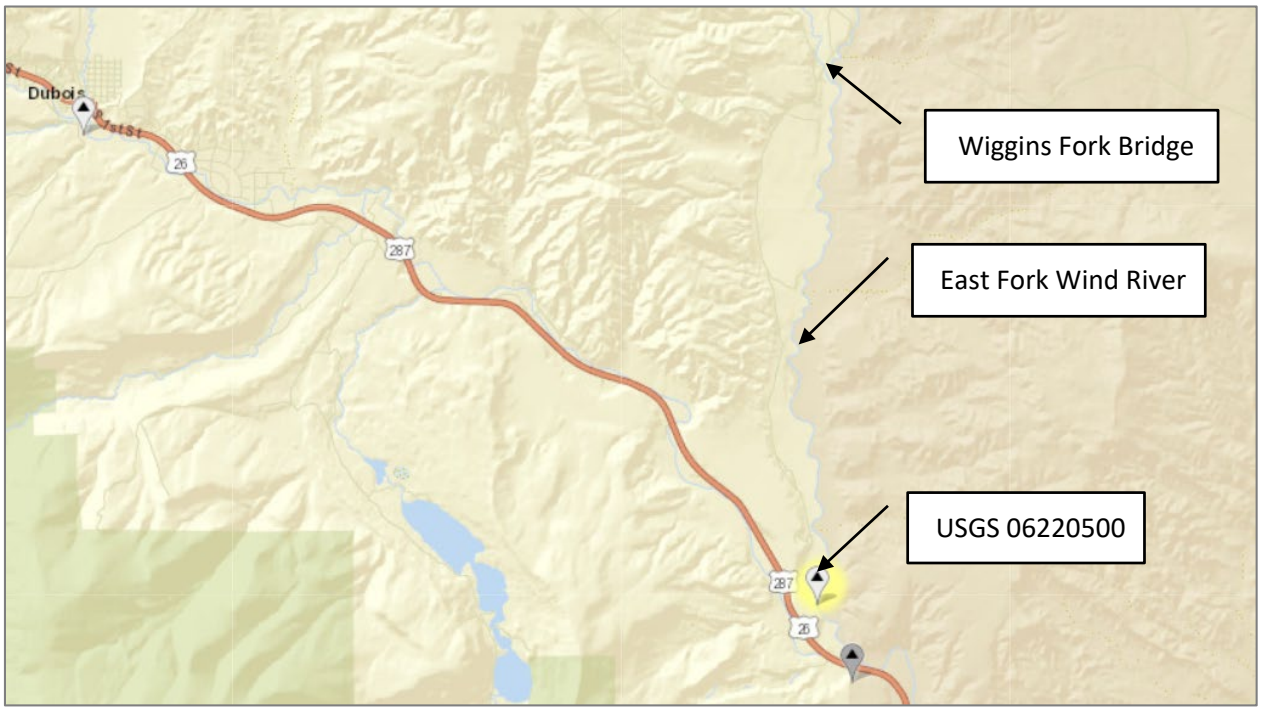

Figure 1: USGS 06220500 East Fork Wind River near Dubois, WY

Daily streamflow information was collected at the gage. The gage has daily flow values for the period of May 1950 to September 1957, and October 1975 to September 1997. A plot of the daily streamflow information is shown in Figure 2. A flow duration analysis of the daily streamflow values was conducted using HEC-SSP (U.S. Army Corps of Engineers 2017). Flow duration curves for each month are shown in Figure 3. Table 1 shows the results in tabular format. The table shows flow values per month and the percentage of time exceeded. For example: in the month of February flows of 75 cubic feet per second were exceeded 1 percent of the time. A ratio of drainage areas was used to transfer the flow values to the project site. The contributing area to the USGS gage is 427 square miles, resulting in a 0.5 ratio of flows at the gage compared to flows at the bridge site. Table 2 shows the monthly flow values and percentage of time exceeded for the Wiggins bridge location.

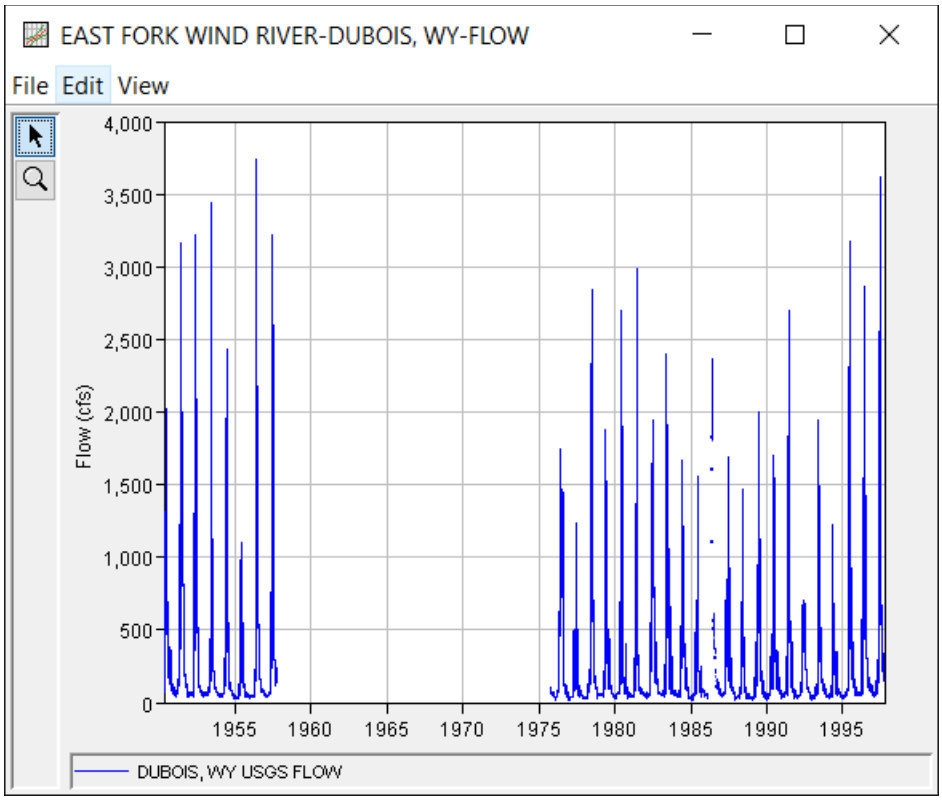

Figure 2: USGS 06220500 Daily Streamflow

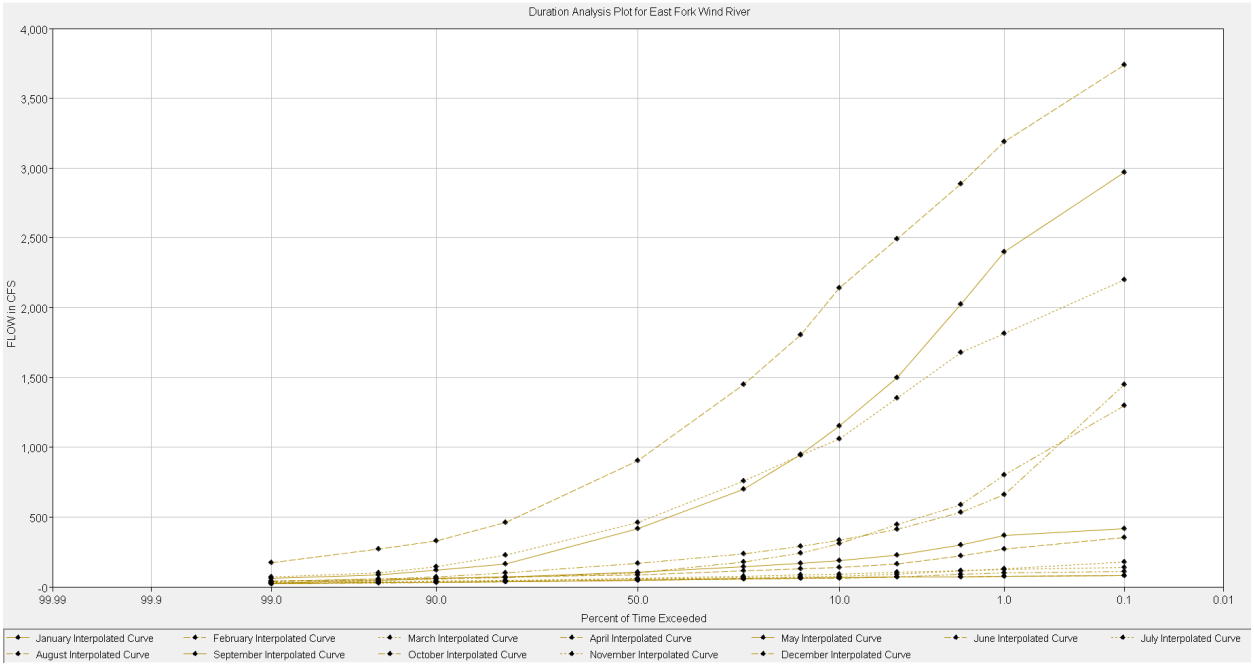

Figure 3: USGS 06220500 Flow Duration Analysis - Monthly

Table 1: Monthly Flow Duration Analysis at USGS 06220500 (DA = 427 mi^2)

Percent Time Exceeded (%)	Flow (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99	24	22	30	40	62	174	69	36	28	42	24	23
95	30	30	36	48	87	272	99	56	48	55	33	28
90	32	32	40	54	118	329	145	72	62	61	35	32
80	36	37	45	64	163	461	226	98	72	70	42	35
50	45	48	58	102	419	903	460	167	105	85	59	50
25	56	56	65	176	700	1,448	760	238	142	113	74	59
15	60	60	70	242	949	1,805	943	290	168	129	83	64
10	64	62	75	308	1,150	2,143	1,060	332	186	141	92	68
5	70	69	90	447	1,500	2,490	1,350	412	224	163	106	72
2	72	72	116	589	2,024	2,888	1,677	535	300	222	115	91
1	75	75	128	801	2,400	3,189	1,814	659	368	270	126	100
0.1	80	80	177	1,300	2,970	3,740	2,200	1,450	415	355	139	111

Table 2: Monthly Flow Duration Analysis at Wiggins Fork Bridge (DA = 212 mi^2)

Percent Time Exceeded (%)	Flow (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99	12	11	15	20	31	87	35	18	14	21	12	12
95	15	15	18	24	44	136	50	28	24	28	17	14
90	16	16	20	27	59	164	73	36	31	31	18	16
80	18	19	23	32	81	230	113	49	36	35	21	18
50	23	24	29	51	210	452	230	83	53	43	30	25
25	28	28	33	88	350	724	380	119	71	56	37	30
15	30	30	35	121	474	902	471	145	84	65	42	32
10	**32**	**31**	**38**	**154**	575	1,072	530	166	**93**	**71**	**46**	**34**
5	35	35	45	223	750	1,245	675	206	112	81	53	36
2	36	36	58	295	1,012	1,444	839	268	150	111	58	46
1	38	38	64	400	1,200	1,595	907	329	184	135	63	50
0.1	40	40	89	650	1,485	1,870	1,100	725	208	178	70	56

The construction season flows are highlighted in Table 2. For stream diversion sizing, the maximum flow during the construction period with a 10 percent time exceeded is recommended. The maximum value occurs in April and results in a design flow of 154 cubic feet per second. Note that this value is higher than the 0.1 exceedance value for the months of November to March.

4 HYDRAULIC ANALYSIS

A hydraulic evaluation to estimate proposed culvert sizes was conducted using HY-8 (Federal Highway Administration 2017). It is assumed that the culverts will be constructed matching the stream slope. The overtopping elevation shown is the road profile elevation near the culvert location, and was specified in the HY-8 model as a constant roadway elevation. Tailwater was assumed to be normal depth in the downstream channel. Two alternatives were evaluated: 1) standard corrugated metal pipes, and 2) embedded corrugated metal pipes to comply with environmental permitting requirements. For constructability of the embedded culvert a minimum culvert diameter of 60" is recommended. In addition, multi-barrel culverts are recommended for resiliency of the stream diversion. The proposed culvert alternatives are shown in Table 3. The hydraulic results are shown in Table 4.

Table 3: Proposed Culvert Characteristics

Alternative	Type	Embedment Depth (inI	Diameter (in)	Number of Barrels	Assumed Length (ft)	Assumed Slope (%)	Overtopping Elevation (ft)
1	CMP	0	48	2	40	2.9	6,720
2	Embedded CMP	12	60	2	40	2.9	6,720

Table 4: Proposed Culvert Hydraulic Results

Alternative	Design Discharge (cfs)	Headwater Elevation (ft)	Headwater Depth (ft)	HW/D Ratio	Roadway Overtopping Discharge (cfs)
1	154	6,718.1	4.6	1.2	217
2	154	6,716.1	2.6	0.7	307

5 RECOMMENDATIONS

A summary of minimum stream diversion recommendations is provided in Table 5.

Table 5: Summary of Recommendations

Alternative	Recommendation
1	• Double 48" CMP installed at streambed level
2	• Double 60" CMP installed a minimum of 1 foot below streambed level, backfilled with native streambed material sourced on site.

6 REFERENCES

Federal Highway Administration. 2017. *HY-8 Culvert Analysis Program.* Version 7.50.

Federal Lands Highway. 2012. "Project Development and Design Manual, Chapter 7 Hydrology and Hydraulics." https://flh.fhwa.dot.gov/resources/design/pddm/.

U.S. Army Corps of Engineers. 2017. *HEC-SSP, Hydrologic Engineering Center Statistical Software Package.* Version 2.1.1. Davis, CA.