APPENDIX D

Information for Crosswalk between the Bull Trout Matrix and the PCEs

This crosswalk information was developed originally for a USFWS BO for a restoration program consultation, however, the thought process is applicable to this effort. Table 1 is a crosswalk summary for the restoration BO. Several additional indicators were evaluated for the FPHCP habitat baseline. Table 2 is a crosswalk summary for the FPHCP analysis.

D.1 CROSSWALK BETWEEN BULL TROUT MATRIX AND CRITICAL HABITAT PCES DEVELOPED FOR DRAFT USFWS RESTORATION BO

The Matrix of Pathway Indicators (Matrix) for bull trout is used to evaluate and document baseline conditions and to aid in determining whether a project is likely to adversely affect or result in the incidental take of bull trout.

The Matrix analysis incorporates 4 biological indicators and 19 physical habitat indicators. The majority of the Matrix analysis consists of specific consideration of the 19 habitat indicators. Analysis of the these indicators should provide a thorough analysis of the existing baseline condition and potential impacts to bull trout habitat. While assessing potential effects to bull trout as a species, biologists can concurrently provide an analysis of effects to the primary constituent elements (PCEs) for bull trout critical habitat. Table 1 shows the relationship between the primary constituent elements (PCE) for bull trout critical habitat and the Matrix habitat indicators. The following information provides the rationale for how the PCEs for bull trout critical habitat can be thoroughly addressed by using the Matrix.

1. ***Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 ºF (0 to 22 ºC) but are found more frequently in temperatures ranging from 36 to 59 ºF (2 to 15 ºC). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.***

   This PCE is addressed directly by the analysis of *temperature*. It is also addressed through consideration of *refugia*, which by definition is high quality habitat of appropriate temperature. Availability of refugia is also considered in analysis of *pool frequency and quality* and *large pools*. *Average wetted width/maximum depth ratio* is an indication of water volume, which indirectly indicates water temperature, i.e., low ratios indicate deeper water, which in turn indicates possible refugia. This indicator in conjunction with *change in peak/base flows* is an indicator of potential temperature and refugia concerns particularly during low flow periods. *Streambank condition, floodplain connectivity,* r*oad density and location* and *riparian conservation areas* address the components of shade and groundwater influence, both of which are important factors of water temperature. Stable streambanks and intact riparian areas, which include part of the floodplain, typically support adequate vegetation to maintain thermal cover to streams during low flow periods. *Road density and location* addresses the potential contributions of warm water discharges from stormwater ponds.

2. ***Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures.***

   Large woody debris increases channel complexity and creates pools and undercut banks, so the analysis of the current amounts and sources of *large woody debris* available for recruitment is pertinent to this PCE. *Pool frequency and quality* considers the number of pools per mile as well as the amount of cover and temperature of water in the pools. *Average wetted width/maximum*

depth ratio is an indicator of channel shape and pool quality. Low ratios suggest deeper, higher quality pools. *Large pools,* consisting of a wide range of water depths, velocities, substrates and cover, are typical of high quality habitat and are a key component of channel complexity. Analysis of *off-channel habitat* describes side-channels and other off-channel areas. *Streambank condition* analyzes the stability of the banks, including features such as undercut banks. The analysis of both *riparian conservation areas,* and *floodplain connectivity, disturbance history, and disturbance regime* includes the maintenance of habitat and channel complexity, the recruitment of large woody debris, and the connectivity to off-channel habitats or side channels. Complex habitats provide refugia for bull trout and in turn, analysis of *refugia* assesses complex stream channels. All of these habitat indicators consider the numerous characteristics of instream bull trout habitat and quantify critical components that are fundamental to creating and maintaining complex instream habitat over time.

3. ***Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter.***

   The analyses for *sediment* and *substrate embeddedness* assess substrate composition and stability in relation to the various life stages of the bull trout as well as the sediment transportation and deposition. *Large woody debris* and *pool frequency and quality* affect sediment transport and redistribution within a stream and assessment of these indicators will clarify substrate composition and amounts. Analysis of *streambank condition* will provide insight into the amount of fine sediment contribution.

4. ***A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation: This rule finds that reservoirs currently operating under a biological opinion that addresses bull trout provides management for PCEs as currently operated.***

   The analysis of *change in peak/base flows* considers changes in hydrograph amplitude or timing with respect to watershed size, geology, and geography. Analyses of *floodplain connectivity, increase in drainage network, road density and location, disturbance history,* and *riparian conservation areas* provides further information regarding possible interruptions in the natural stream hydrology. *Floodplain connectivity* considers the hydrologic linkage of off-channel areas with the main channel. Roads and vegetation management both have effects strongly linked to a stream's hydrograph. *Disturbance regime* ties this information together to consider how a watershed reacts to disturbance and the time required to recover back to pre-disturbance conditions.

5. ***Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.***

   The analysis of *floodplain connectivity* considers the hydrologic linkage of off-channel areas with the main channel and overbank-flow maintenance of wetland function and riparian vegetation and succession. Floodplain and riparian areas provide hydrologic connectivity for springs, seeps, groundwater upwelling and wetlands and contribute to the maintenance of the water table. The

analysis of *changes in peak/base flows* addresses subsurface water connectivity and *substrate embeddedness* addresses inter-gravel flows. *Increase in drainage network* and *road density and location* address potential changes to groundwater sources and subsurface water connectivity. *Streambank condition, floodplain connectivity* and *riparian conservation areas* address groundwater influence. C*hemical contamination/nutrients* addresses concerns regarding groundwater water quality.

6. ***Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.***

   Physical, biological or chemical barriers to migration are addressed directly through water quality habitat indicators, including *temperature, sediment, chemical contamination/nutrients* and *physical barriers*. The analysis of these indicators assess whether barriers have been created due to impacts such as high temperatures or high concentrations of turbidity or contaminants. Analysis of *change in peak/base flows* and *average wetted width/maximum depth ratio* assess whether changes in flow might create a seasonal barrier to migration. An analysis of *refugia* considers the habitat's ability to support strong, well distributed, and connected populations for all life stages and forms of bull trout.

7. ***An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.***

   Floodplain connectivity and *riparian conservation areas* provide habitat to aquatic invertebrates, which in turn provide a forage base for bull trout. *Pool frequency and quality* and *substrate embeddedness* contributes to the variety and density of aquatic invertebrates and other fish species. Changes in *temperature, sediment,* and *chemical contaminants and nutrients* affect aquatic invertebrate production.floodplain and riparian areas provide habitat to aquatic invertebrates, which in turn provide a forage base for bull trout. The combined analyses of all the Matrix habitat indicators and the other seven PCEs provide information to assess whether there is an abundant food base in the analysis area. Therefore, any impairment to the food base will be addressed by way of summarizing the biological and habitat indicators.

8. ***Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.***

   The quantity of permanent water will be considered in the analyses for PCE 4 natural hydrograph and PCE 5 springs, seeps, and groundwater, which include *floodplain connectivity, changes in peak/base flows, drainage network increase, disturbance history,* and *disturbance regime*.

   Analysis of *temperature, sediment, and chemical contaminates and nutrients* consider the quality of permanent water. Current listing under 303(d) and 305(d) status should be considered, as well as the causes for that listing. Analysis pertinent to sediment should address turbidity.

Table 1. Relationship of Matrix habitat indicators to the Primary Constituent Elements of bull trout critical habitat.

Indicator	PCE 1 - Temperature	PCE 2 - Complex Stream Channel	PCE 3 - Substrate	PCE 4 - Natural Hydrograph	PCE 5 - Springs, seeps, groundwater	PCE 6 - Migratory corridors	PCE 7 - Abundant food base	PCE 8 - Permanent water
Water Quality								
Temperature	x					x	x	x
Sediment			x			x	x	x
Chemical Contaminants and Nutrients					x	x	x	x
Habitat Access								
Physical Barriers						x		
Habitat Elements								
Substrate Embeddedness			x		x		x	
Large Woody Debris		x	x					
Pool Frequency and Quality		x	x				x	
Large Pools	x	x						
Off-Channel Habitat		x						
Refugia	x	x				x		
Channel Conditions and Dynamics								
Wetted Width/Maximum Depth Ratio	x	x				x		
Streambank Condition	x	x	x		x			
Floodplain Connectivity	x	x		x	x		x	x
Flow/Hydrology								
Changes in Peak/Base Flows	x			x	x	x		x
Drainage Network Increase				x	x			x
Watershed Conditions								
Road Density and Location	x			x	x			
Disturbance History		x		x				x
Riparian Conservation Areas	x	x		x	x		x	
Disturbance Regime		x		x				x

Table 2. The crosswalk table used for the crosswalk for the PCEs for the FPHCP.

Indicator	PCE 1 - Temperature	PCE 2 - Complex Stream Channel	PCE 3 - Substrate	PCE 4 - Natural Hydrograph	PCE 5 - Springs, seeps, groundwater	PCE 6 - Migratory corridors	PCE 7 - Abundant food base[1]	PCE 8 - Permanent water
Water Quality								
Temperature	x*				x*	x*	x	x*
Sediment	x*		x	x*		x*	x	x*
Chemical Contaminants and Nutrients					x*	x*	x	x*
Habitat Access								
Physical Barriers	x*			x*		x*		x*
Habitat Elements								
Substrate Embeddedness		x*	x*		x*		x	
Large Woody Debris	x	x*	x*			x*	x	
Pool Frequency and Quality		x*	x*			x*	x	
Large Pools	x	x*	x*		x*	x*		
Off-Channel Habitat		x*			x*	x*		
Refugia	x	x*	x*		x*	x*		x
Channel Conditions and Dynamics								
Wetted Width/Maximum Depth Ratio	x	x*	x	x*		x*		x*
Streambank Condition	x	x*	x		x	x*	x	
Floodplain Connectivity	x	x*		x*	x	x*	x	x*
Flow/Hydrology								
Changes in Peak/Base Flows	x	x*	x	x*	x*	x		x
Drainage Network Increase	x	x*	x	x*	x*			x
Watershed Conditions								
Road Density and Location	x*	x*	x*	x*	x	x*	x	x*
Disturbance History	x*	x*	x*	x*	x	x*	x	x*
Riparian Conservation Areas	x*	x*	x*	x*	x	x*	x	x*
Disturbance Regime	x*	x*	x*	x*		x*	x	x*
Prey Base		x*	x*			x*	x	

Notes:

1/ Prey base is affected by changes in most habitat conditions and can be related to Water quality, Habitat elements, Channel conditions, and Watershed condition changes in the matrix. Changes to PCEs 2,3,6,and 7 directly affect amounts of food available in streams. Changes to headwater stream affect the primary production in the stream system or the 1st couple of levels in the trophic food pyramid for fish.

* Asterisks indicate PCEs affected by the associated habitat indicators for the FPHCP crosswalk.