Appendix E
Hydraulic Modeling

Two separate hydraulic models were developed for the analyses in this assessment, a 1D model and a 2D model, both developed using U.S. Army Corps of Engineers (USACE) HEC-RAS 5.0.7 (USACE 2016a, 2016b). Because a 2D model produces multi-dimensional velocity results, it provides more accurate results concerning split flows, side channels, and back waters at the lower flows. However, 2D models are much more time consuming to use as the area of inundation increases and can become unstable for very large watersheds. Additionally, the advantages a 2D model provides for isolated side channel and split flows is not as prevalent at the higher flow events when most of the low floodplain is inundated, and the 1D model may provide similar or even better results. Therefore, the 2D model was developed for lower flows and complexity analysis and the 1D model was used for higher flows and connectivity analysis.

1D Hydraulic Model

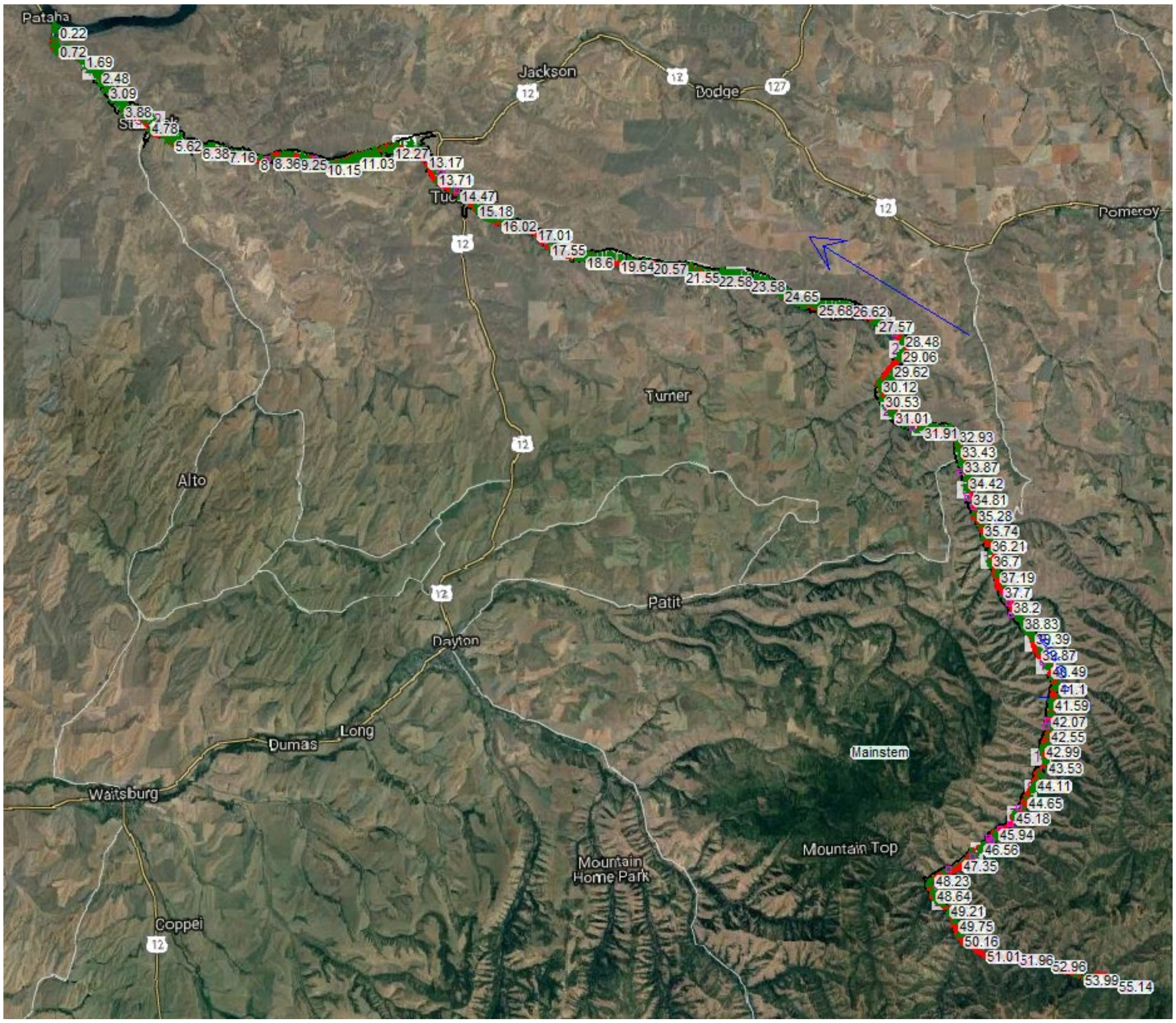
The basin-scale 1D hydraulic model (HEC-RAS 5.0.7; USACE 2016a, 2016b) was developed to provide estimates of main channel and floodplain hydraulic conditions for the discharges shown in Table E-1. The model was created for the mainstem Tucannon River only and does not model any of the tributaries, as shown in Figure E-1.

Table E-1
Standard Manning's n Values

Land Cover Type	Manning's n Value
River Channel	0.035–0.04
Agricultural Field	0.045
Developed: Low Intensity, Shrub/Scrub	0.06
Developed: Medium Intensity	0.08
Developed: High Intensity, Evergreen Forest, Deciduous Forest	0.1

The cross section locations in the 1D model developed for the 2010 assessment were projected onto the terrain from the 2017 Light Detection and Ranging (LiDAR) data where they were originally located to capture significant changes in channel and floodplain planform as well as changes in channel gradient, with the spacing of cross sections varying in proportion to planform complexity of the channel and floodplain. Adjustments to these cross sections were made based on changes in channel locations, changes in features, and land use changes affecting the roughness coefficients. Roughness values were chosen based on land use information and aerial imagery and corresponding to the land use categories described by the U.S. Geological Survey (USGS 2014). Manning's n values, shown in Table E-1, are based on those described in Janssen 2016. Additionally, approximately 50% more cross sections were added to better capture the channel features and utilize the higher resolution elevation data available with the 2017 LiDAR.

Figure E-1
HEC-RAS Model Extents



2D Hydraulic Model

2D hydraulic models are typically developed for short reaches, usually no more than a few miles in length and often as short as a quarter mile for complicated systems. This is due to the difficulty in stabilizing and obtaining accurate results from larger models. Therefore, the 2D hydraulic model for this assessment (HEC-RAS 5.0.7; USACE 2016a, 2016b) was developed using a simplified method. The 2D model for this assessment is actually a series of results of individual 2D models based on more manageable reach lengths of 1 to 3 miles. Developing the model in this manner was possible due to several simplifications and assumptions.

First, the 2D model was run for only the lower three steady state flows shown in Table E-2, and was not run with a dynamic realistic hydrograph, but rather an artificial hydrograph designed to ramp up slowly to the studied flows, stay at that flow for enough time to stabilize results, and then ramp up slowly to the next flow. Therefore, the results are only accurate for the three targeted flows described in Table E-2.

Table E-2
Flow Used for 2D Hydraulic Model

Flow Description	Data Source	Flow Rate at Starbuck
Low-Winter Flow	Water Surface DEM	130 cfs
Mean-Winter Flow	2D Hydraulic Model	300 cfs
1-year Flood Event	2D Hydraulic Model	552 cfs

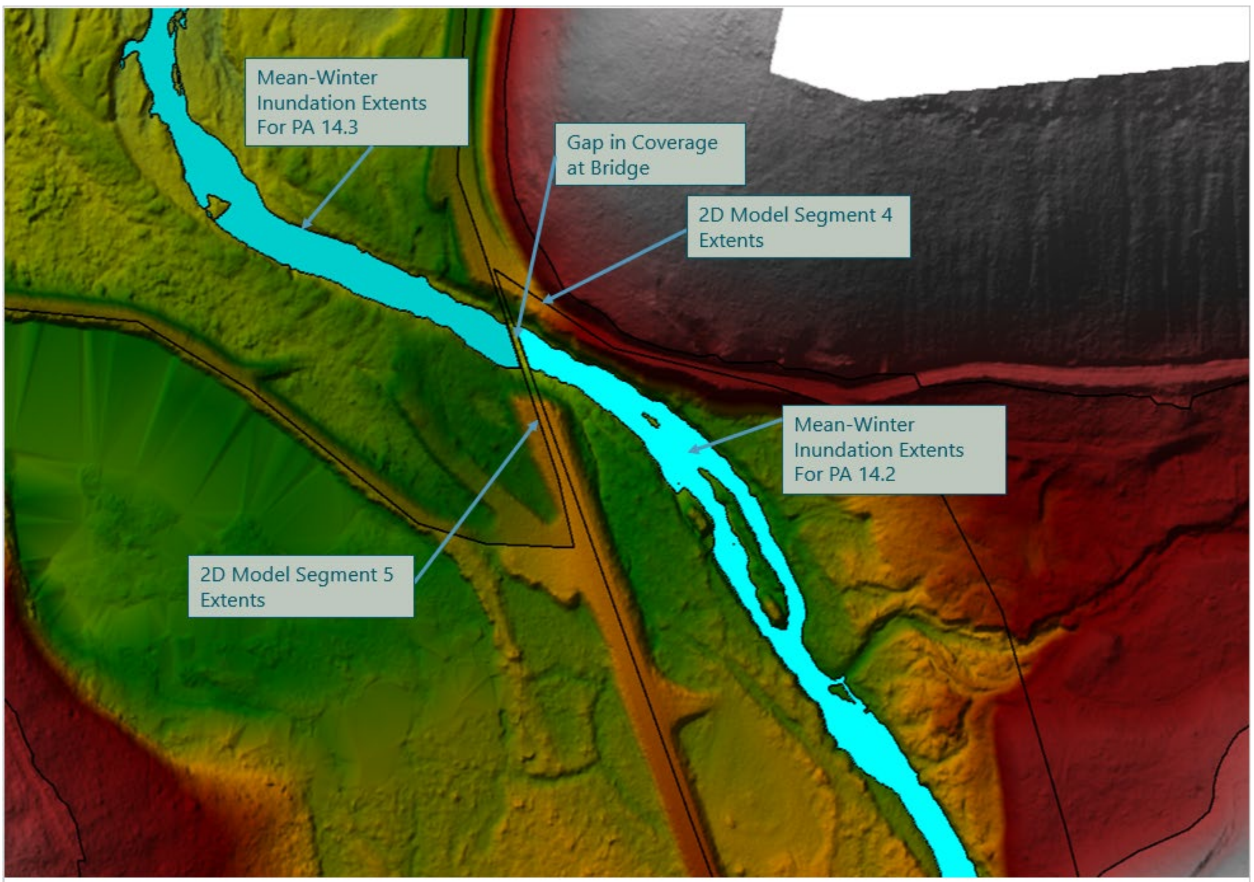
cfs: cubic foot per second
DEM: digital elevation model

Next, hydrologic inputs such as small tributaries were not modeled as 2D inputs, but rather the targeted flows for the low-winter flow, mean-winter flow, and 1-year flow for the individual model sections were adjusted based on the same adjustments made in the 1D model. These flow changes are described previously in the 1D Hydraulic Modeling section. This was made easier by ending individual model sections at each major flow input and beginning a new model section with the modified flows. This does create some minor inconsistencies at the intersection point of model sections with flow changes, but not enough to affect the results. Additionally, model section intersection points were chosen to occur in areas with very uniform flow. These areas include road crossing bridges, flow between levees, or in channel sections that were relatively straight and uniform in the 1D model. Figure E-2 shows an example of the intersection point between two model sections. Because the 2D model is only run at low flows, these change locations are uniform and predictable during all three events analyzed. The models begin and end slightly offset from each other to avoid conflicting results; this small gap in coverage was removed through interpolation after the results were determined.

Finally, the 2D model relies on an assumption of the simplification of roughness. A single roughness value was used for the model and does not vary across the floodplain, nor were any changes made to reaches that had been treated with restoration actions. The roughness for the whole model was set to the channel roughness value of n=0.04, a typical value for river channel. While not ideal because roughness effect does change with terrain, there are several strong justifications for this assumption. First, the model only deals with the lower flows of the 1-year level or less, and therefore the vast majority of flow will be in channel, not in the floodplain, and will by definition be within the bankfull flow. Additionally, any attempt at assigning more detailed roughness values to areas in channel would be assumptions in and of themselves and would not necessarily provide more accurate results. The simplification of roughness for lower flows makes the development of this 2D model feasible.

Once the 2D model sections were completed, the inundation results were then imported into GIS where they were modified slightly to fit together into a single inundation shapefile. The 2D model provides much more detailed results for side channels and split flows and is an essential piece of the complexity analysis.

Figure E-2
Gap in Coverage in 2D Model Results



Project Area 14.2 to 14.3

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