Appendix C

Validation Study

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A limited study was undertaken to validate the methodology by which power potentials of water energy resources were estimated. Four hydroelectric plants each in a different part of the country were chosen as the sites for comparisons of calculated values of hydraulic head, stream flow rate, and power potential values with actual values for each plant. The plants chosen included Fort Peck in Montana, Conowingo in Maryland, Weiss in Alabama, and Keswick in California. The locations of these plants are shown in Figure C-1. These plants were chosen because they are run-of-river projects, meaning that flow through the plant is relatively constant and equal to the river flow rate. Each of these plants has a U.S. Geological Survey stream flow gauge located downstream of the dam in close proximity to the plant.

The methodology used for the validation study was to identify the EDNA stream reach spanning the location of the dam. The hydraulic head associated with this stream reach was compared to the hydraulic head for the plant listed in the Hydroelectric Power Resource Assessment Database (FERC 1998). The calculated flow rate for the reach was compared to the average annual mean flow rate (sum of annual mean flow rates divided by the number of years of record) measured at the gauge station. The annual mean power calculated in the assessment study was then compared with the power value obtained by combining the plant hydraulic head and the average annual mean flow rate from the stream gauge. A further check on the hydraulic head value obtained from the EDNA data was performed by comparing this value with that obtained by taking the difference of the elevations at the geographic coordinates of the upstream and downstream ends of the EDNA stream reach provided by the NED.

C.1 Conowingo

The Conowingo Hydroelectric Plant is located on the Susquehanna River in Maryland, placing it in the Mid-Atlantic Hydrologic Region (HUC 2). The plant has an installed capacity of 512 MW operating at a hydraulic head of 87 ft. The average annual plant generation is 1,738 GWh. U.S. Geological Survey stream gauge No. 01578310 is located at the dam. The upstream end of the EDNA stream reach spanning the plant location is 0.8 mi upstream of the dam, and the downstream end of the reach is 0.4 mi downstream of the dam.

The hydraulic head of 98 ft, which is provided by the EDNA data, is confirmed by a value of 99 ft, which is obtained from NED elevations and agrees reasonably well with the plant hydraulic head of 87 ft. The annual mean flow rate for the EDNA reach was 32,110 cfs, which compares reasonably well with the average annual mean flow rate at the gauge station of 40,019 cfs. Combining the hydraulic head and flow rate values to produce power potential values results in 268 MW for the EDNA reach compared to a measured value of 295 MW. The actual value is 10% higher than predicted. The average annual mean power of the plant based on its reported average annual generation is 198 MW, which is understandably lower than either of the two ideal values, considering equipment efficiencies and actual plan operations.

C.2 Weiss Dam

The Weiss Dam Hydroelectric Plant is located on the Coosa River in Alabama, placing it in the South Atlantic-Gulf Hydrologic Region (HUC 3). The plant has an installed capacity of 88 MW operating at a hydraulic head of 43 ft. The average annual plant generation is 216 GWh. U.S. Geological Survey stream gauge No. 02399500 is located 0.2 mi downstream of the dam. The upstream end of the EDNA stream reach spanning the plant location is 0.6 mi upstream of the dam, and the downstream end of the reach is 4.8 mi downstream of the dam.

The hydraulic head of 40 ft, which is provided by the EDNA data, agrees reasonably well with a value of 53 ft obtained from NED elevations and is in good agreement with the plant hydraulic head of 43 ft. The annual mean flow rate for the EDNA

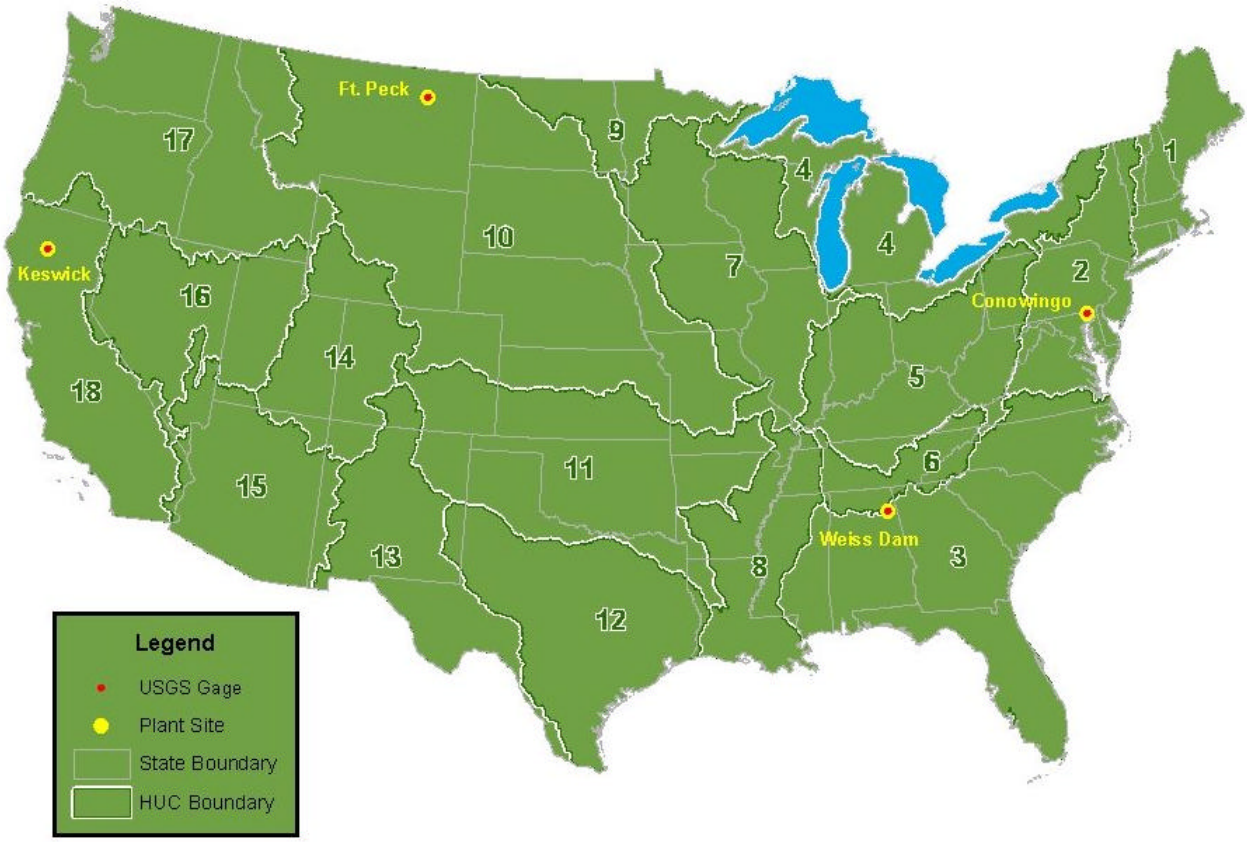

Figure C-1. Hydroelectric plant sites at which the study methodology was assessed.

reach was 8,520 cfs, which compares well with the average annual mean flow rate at the gauge station of 8214 cfs. Combining the hydraulic head and flow rate values to produce power potential values results in 29 MW for the EDNA reach compared to a measured value of 30 MW. The actual value is 3% higher than predicted. The average annual mean power of the plant based on its reported average annual generation is 25 MW.

C.3 Ft. Peck

The Ft. Peck Hydroelectric Plant is located on the Missouri River in Montana, placing it in the Missouri Hydrologic Region (HUC 10). The plant has an installed capacity of 185 MW operating at a hydraulic head of 187 ft. The average annual plant generation is 1044 GWh. U.S. Geological Survey stream gauge No. 006132000 is located 2.5 mi downstream of the dam. The upstream end of the EDNA stream reach spanning the plant location is 1.8 mi upstream of the dam, and the downstream end of the reach is 2.5 mi downstream of the dam.

The hydraulic head of 203 ft, which is provided by the EDNA data, is confirmed by a value of 203 ft obtained from NED elevations and agrees reasonably well with the plant hydraulic head of 187 ft. The annual mean flow rate for the EDNA reach was 3,191 cfs, which compares poorly with the average annual mean flow rate at the gauge station of 9,076 cfs. Combining the hydraulic head and flow rate values to produce power potential values results in 55 MW for the EDNA reach compared to a measured value of 144 MW. The actual value is 162% higher than predicted. The average annual mean power of the plant based on its reported average annual generation is 119 MW.

The poor comparison of the calculated and actual power potential values is the result of the discrepancy in the calculated and measured flow rates. The uncertainty of the flow rate predictions in the Missouri Region were the second highest in all 20 hydrologic regions, but a difference of a factor of three is not expected. The best that can be

said for the predicted power potential is that it is highly conservative relative to the actual potential at the site.

C.4 Keswick

The Keswick Hydroelectric Plant is located on the Sacramento River in California, placing it in the California Hydrologic Region (HUC 18). The plant has an installed capacity of 117 MW operating at a hydraulic head of 87 ft. The average annual plant generation is 478 GWh. U.S. Geological Survey stream gauge No. 11370500 is located 0.7 mi downstream of the dam. The upstream end of the EDNA stream reach spanning the plant location is 1.1 mi upstream of the dam, and the downstream end of the reach is 0.2 mi downstream of the dam.

The hydraulic head of 108 ft, which is provided by the EDNA data, is confirmed by a value of 107 ft obtained from NED elevations and agrees reasonably well with the plant hydraulic head of 87 ft. The annual mean flow rate for the EDNA reach was 6,307 cfs, which when compared with the average annual mean flow rate at the gauge station of 9,427 cfs yields only a fair comparison. Combining the hydraulic head and flow rate values to produce power potential values results in 58 MW for the EDNA reach compared to a measured value of 62 MW. The actual value is only 7% higher than predicted because of the offsetting effect of a high hydraulic head prediction and a low flow rate prediction. The average annual mean power of the plant based on its reported average annual generation is 55 MW.

C.5 Conclusions

The validation study results listed in Table C-1 show that EDNA hydraulic head values were in reasonably good agreement with the actual plant values; being generally higher than the plant value. In three out of four cases, the hydraulic heads obtained from NED elevations agreed with the EDNA values within 1 ft. The accuracy with which flow rate was predicted reflected the differences in expected levels of accuracy for the four regions in which the validation sites were located. However, the poor accuracy of the flow rate prediction for the Ft. Peck site appears to be anomalous and suggests additional validation study is clearly needed for the Missouri Region. Predicted power potential values for three of the four sites were within 10% or less of the measured values with the predicted values being conservative estimates. If we assume that the Ft. Peck data point is an outlier, the limited validation study indicates that the study methodology can predict the power potential of water energy resources with an accuracy that is acceptable to meet the objectives of the study.

C.6 Reference

Federal Energy Regulatory Commission, 1998, Hydroelectric Power Resources Assessment (HPRA) Database.

Table C-1. Validation study results.

Conowingo Susquehanna River Maryland Mid-Atlantic Region (HUC 2) USGS Gauge #: 01578310			
Data Source	**NED**	**Measured[a]**	**Study Value**
Hydraulic Head (ft)	99	87	98
Average Annual Mean Flow Rate (cfs)		40,019	32,110
Power Potential(MW)		295	268
Weiss Coosa River Alabama South Atlantic-Gulf (HUC-3) USGS Gauge #: 02399500			
Data Source	**NED**	**Measured[a]**	**Study Value**
Hydraulic Head (ft)	53	43	40
Average Annual Mean Flow Rate (cfs)		8,214	8,520
Power Potential (MW)		30	29
Fort Peck Missouri River Montana Missouri Region (HUC 10) USGS Gauge #: 06132000			
Data Source	**NED**	**Measured[a]**	**Study Value**
Hydraulic Head (ft)	203	187	203
Average Annual Mean Flow Rate (cfs)		9,076	3,191
Power Potential (MW)		144	55
Keswick Sacramento River California California Region (HUC 18) USGS Gauge #: 11370500			
Data Source	**NED**	**Measured[a]**	**Study Value**
Hydraulic Head (ft)	107	87	108
Average Annual Mean Flow Rate (cfs)		9,427	6,307
Power Potential (MW)		62	58

a. “Measured” data includes hydraulic head listed for the plant in the HPRA Database, the flow rate from the stream gauge, and the power potential calculated using these two values.