Appendix B. Detroit Lake and Big Cliff Reservoir Model Evaluation for 2011

To ensure that the CE-QUAL-W2 models of Detroit Lake and Big Cliff Reservoir would accurately represent conditions resulting from current dam operations, the models were tested using observed conditions from 2011. Since 2007, operations at Detroit Dam have expanded to include more frequent use of the spillway (elevation 1,541.0 ft; 469.7 m) and the upper regulating outlet (RO, elevation 1,339.9 ft; 408.4 m) to improve downstream temperature management. To better match measured temperatures at the USGS Niagara gaging station (14181500), the CE-QUAL-W2 model line width parameter for the spillway outlet, which was not used in the original model calibration for 2002–03, was set to 25 m through an optimization process. A sensitivity analysis of the line width of the upper RO at Detroit Dam also was conducted, but resulted in little difference in simulated outflow temperatures; therefore, the line width for the ROs was left at 4.0 m. The line width used for the power penstocks was unchanged and remained at 6.8 m.

Comparisons of modeled and measured vertical temperature profiles within Detroit Lake (fig. B1) and Big Cliff Reservoir (fig. B2) show that the models capture the seasonal patterns in the vertical profiles relatively well, with perhaps a slight negative bias for the deepest profiles. The Detroit Lake model also does not capture some of the daily variation in the mid-depth temperature profile data. Modeled daily mean release temperatures from Detroit and Big Cliff Dams (fig. B3) show that significant heat exchange is occurring in Big Cliff Reservoir in August and September; including the Big Cliff Reservoir model, therefore, is useful for capturing these heat-exchange processes. The comparison of Big Cliff Dam modeled release temperatures to measured temperatures downstream at the Niagara gage (fig. B3) shows relatively good agreement with an MAE less than 1.0°C, but a slight negative bias for August through December. A similar comparison between Big Cliff Dam modeled hourly release temperatures and measured hourly temperatures at Niagara is shown in figure B4.

Goodness-of-fit statistics are noted on the figures in this appendix to quantify the overall model performance. Definitions of the mean error (ME), mean absolute error (MAE), and the root mean square error (RMSE) were noted in appendix A. The Nash-Sutcliffe coefficient (NS) is the proportion of variance in the measured values that is explained by the predicted values, and is a more rigorous fit statistic than the coefficient of determination. An NS value of 1.0 represents a perfect fit, an NS value of 0 indicates that the model predictions are only as accurate as the mean of the measured data, and an NS value less than zero means that the measured mean is a better predictor than the model (Nash and Sutcliffe, 1970). In this case, the NS values are all roughly 0.9 or higher, indicating that the model captures most of the variance in the measured data.

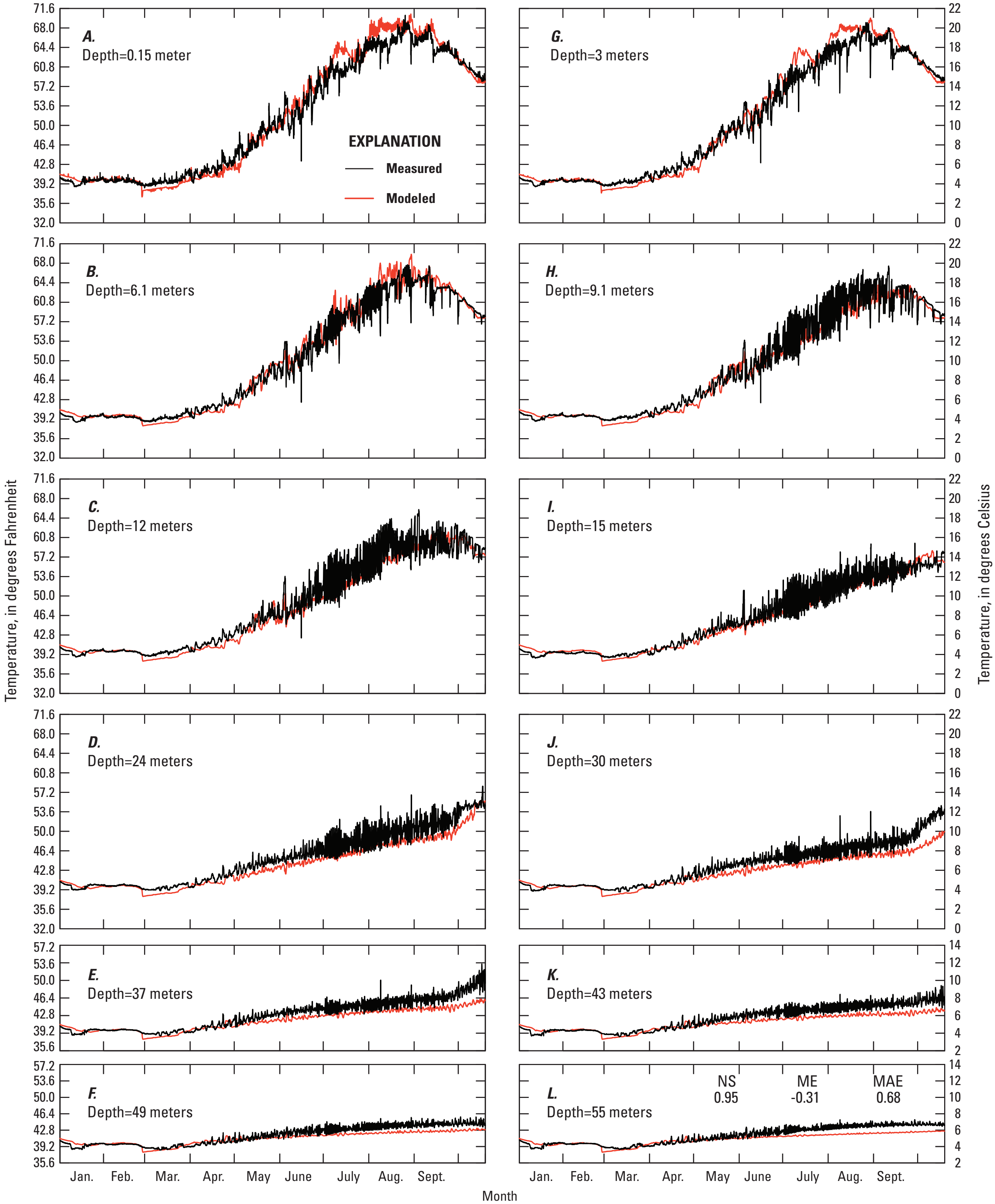

Figure B1. Measured and modeled water temperatures in Detroit Lake, Oregon, at discrete depths within the lake during 2011. NS is the Nash-Sutcliffe coefficient, ME is the mean error, and MAE is the mean absolute error between the measured and modeled water temperature.

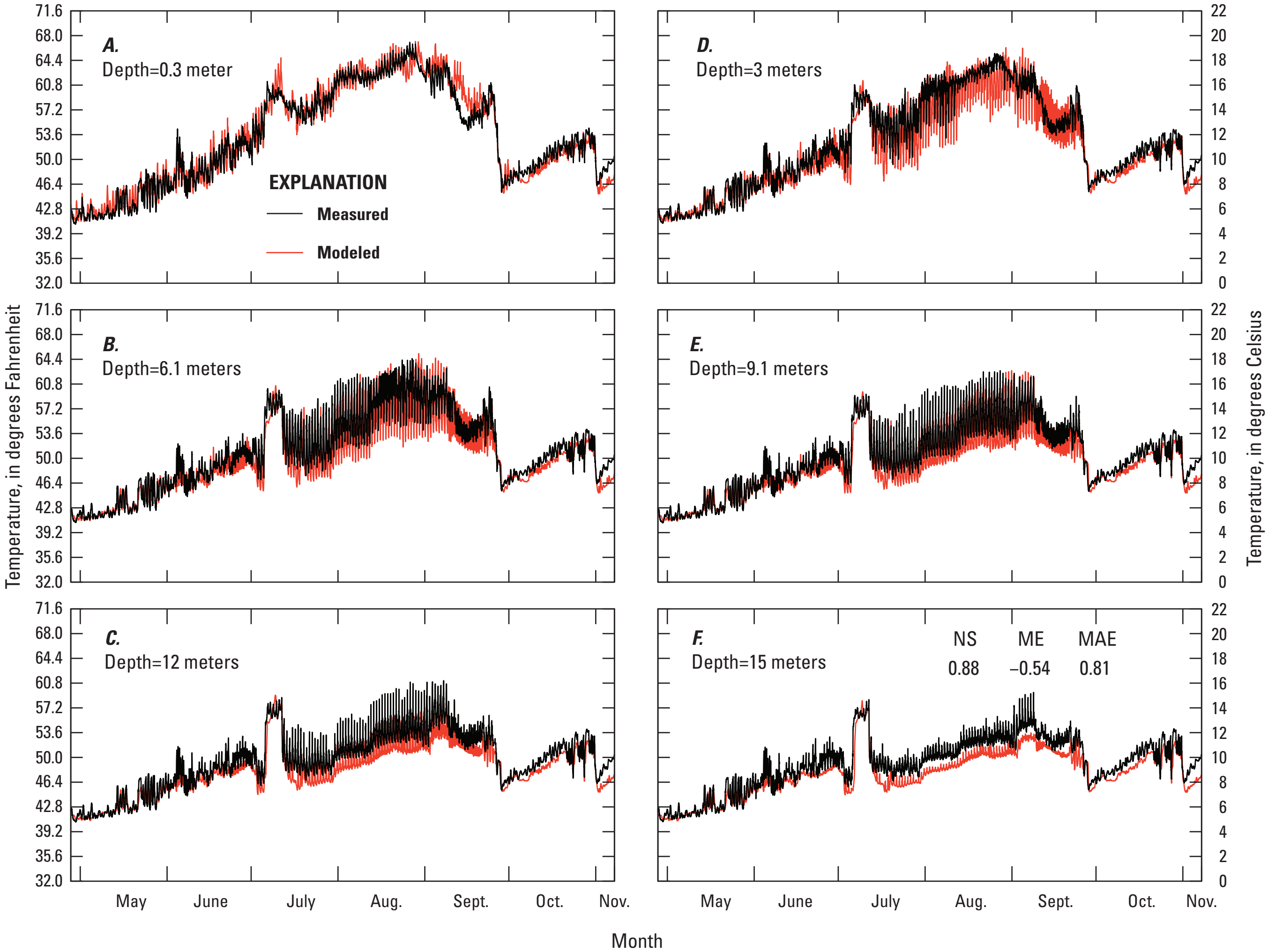

Figure B2. Measured and modeled water temperatures in Big Cliff Reservoir, Oregon, at discrete depths within the lake during 2011. NS is the Nash-Sutcliffe coefficient, ME is the mean error, and MAE is the mean absolute error between the measured and modeled water temperature.

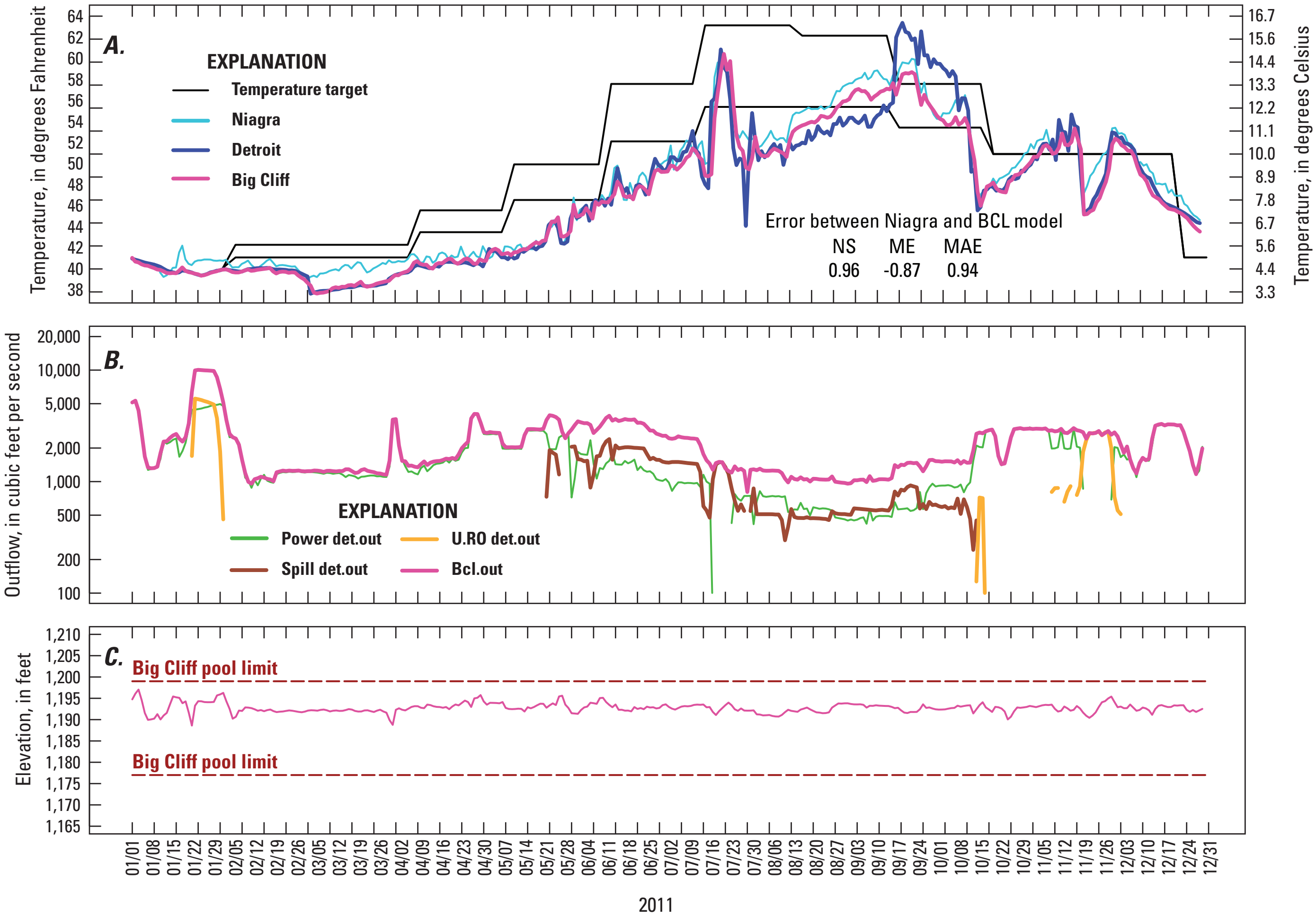

Figure B3. Simulated daily mean water temperatures from Detroit Dam release, Big Cliff Dam release, and measured daily mean temperatures from USGS gaging station 14181500 (North Santiam River at Niagara, Oregon), during 2011. NS is the Nash-Sutcliffe coefficient, ME is the mean error, and MAE is the mean absolute error between the measured and modeled water temperature.

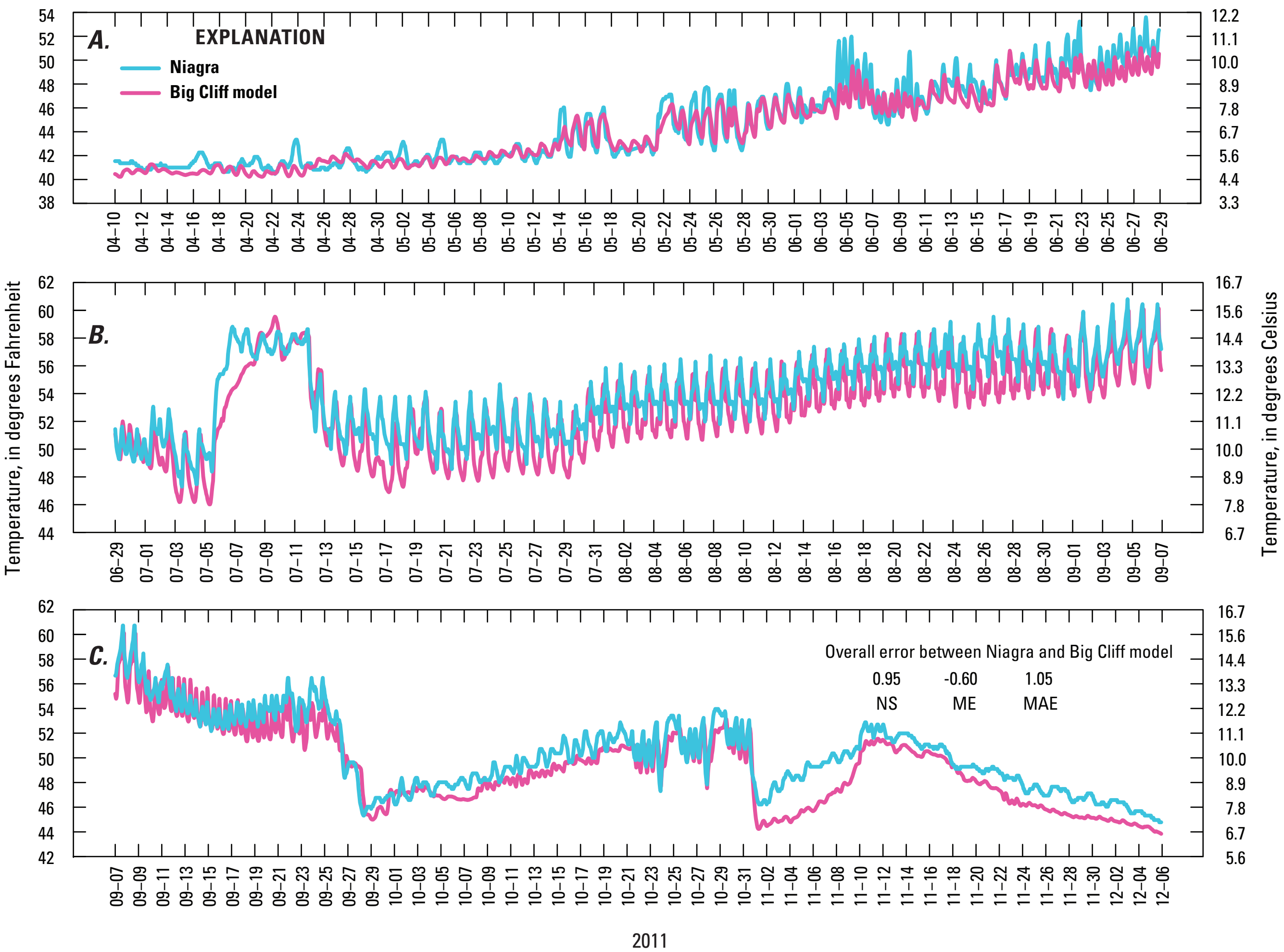

Figure B4. Simulated hourly water temperatures from modeled Big Cliff Dam, Oregon, releases during 2011, compared to measured hourly temperatures from USGS gaging station 14181500 (North Santiam River at Niagara).