stem balanced hydrographs and local inflow hydrographs) required for the subsequent unsteady flow modeling efforts were developed for the EOE/WET condition.

The Governors' Task Force recommended that the Project should use the POR hydrology instead of the EOE/WET hydrology, which presented challenges to the study effort. First, while POR hydrology is being used to report Project impacts in this report, USACE is still required to assess impacts based on EOE/WET hydrology. However, in acknowledgement of the Governors' Task Force recommendation and because a comparison of EOE results to POR results indicates that water surface elevations are similar, results based on the POR hydrology will be presented in this document. Second, as mentioned in the preceding paragraph, the detailed hydrology required for the unsteady flow modeling had been developed for the EOE/WET condition, not the POR. The non-Federal sponsor's consultant, the Houston-Moore Group (HMG), developed the inflow hydrographs needed for the POR unsteady flow modeling efforts. HMG's efforts are documented in the attached Technical Memorandum, POR Hydrology Development (Attachment 1).

It is important to note that both the EOE/WET and POR hydrology developed up to this point do not include flood events after 2009. After Project completion, USACE will perform a levee system evaluation of the Project in support of FEMA's accreditation effort, as specified in EC 1110-2-6067, *USACE Process for the National Flood Insurance Program (NFIP) Levee System Evaluation*. USACE's levee system evaluation will rely upon the best available data, hydrologic methods, and most up-to-date guidance available at the time of the evaluation. As stated in the Advisory Committee on Water Information Bulletin 17C (2018), "As more years of record become available at each location, the determination of flood potential may change. Thus, an estimate may be outdated a few years after it is made." As a result of changing guidance (i.e.: Bulletin 17C) and advancements in the application of more advanced statistical techniques (i.e.: stochastic hydrology), it is very likely that the hydrology will need to be updated at the time of Project completion. A cursory investigation of updating the hydrology through 2017 indicates that peak flows could increase approximately 10 percent.

3 SOUTHERN EMBANKMENT FEATURES

Since the dam is located south of the Fargo-Moorhead Metropolitan Area, the dam has been referred to as the Southern Embankment in many Project documents. The Southern Embankment consists of the earthen embankment, three gated structures (the Diversion Inlet Structure (DIS), the Wild Rice River Structure (WRRS), and the Red River Structure (RRS)), and one ungated structure (the Wolverton Creek Crossing). Figure 2 shows the alignment of the Southern Embankment and the location of the four structures. Except for the location of the DIS, the alignment and structure locations have changed from what was presented in the 2013 SEA. The western-most portion of the Southern Embankment is referred to as the Western Tieback. A portion of the Western Tieback is designed to be overtopped in the event of a significant gate failure at one of the gated structures. The eastern-most portion of the Southern Embankment is referred to as the Eastern Tieback and ensures that breakout flows under Plan B conditions do not exceed breakout flows under Existing conditions during the Probable Maximum Flood (PMF) event.

It is noted that detailed design of the Southern Embankment has not yet been conducted and that all values reported in this document are subject to change during the detailed design phase. In particular, a primary design criterion for the Southern Embankment is the maximum pool elevation. The maximum pool elevation along the Western Tieback will be limited to 924.0 feet (if necessary the gated structures and/or the operation plan will be modified to keep the maximum pool elevation at or below 924.0 feet). However, the detailed design phase of this Project will attempt to achieve a maximum pool of 923.5 feet, which appears achievable based on preliminary modeling results.

3.1 Wind-Wave Analysis

An updated wind-wave analysis was performed due to the modification of the alignment of the Southern Embankment, particularly the shift of the alignment between the DIS and the WRRS, which increases the longest fetch length. The updated analysis involves a coupled two-dimensional modeling approach for capturing both wind setup and wave growth across areas inundated upstream of the Southern Embankment. Two wind speeds of 40 mph and 50 mph were considered, which roughly bound the 50% Annual Chance Exceedance (ACE) and 1% ACE wind speeds, adjusted to a 1-hour fetch-limited duration for over-water winds. These winds were considered for wind directions ranging from southeast to northwest (SE, SSE, S, SSW, SW, WSW, W, WNW, and NW) in order to capture the influence of wind from any hazardous direction across the pool. A maximum pool elevation of 924.0 feet was assumed for the analysis based on an early estimate of the PMF pool elevation. The pool's sloping water surface is also incorporated so that wind fetch lengths are accurately captured in the model. The results of this modeling indicate that 5 feet of freeboard is sufficient to keep wave overtopping associated with 40 mph and 50 mph winds well below allowable rates of wave overtopping flow. The 50 mph wind model runs indicate a few areas along the northern-most portion of the embankment have 2% wave runup values exceeding 5 feet of freeboard; however, the estimated coincident probability of this event occurring is approximately 1.97×10^{-5} ACE (or 1 in 50,800). In the event that this rare combination of pool and wind occurs, wave overtopping is still not expected to lead to damage on the downstream slope of the embankment and initiation of dam failure is extremely remote. For additional information on the wind-wave analysis, please see *Southern Embankment Wind-Wave Analysis* (Attachment 2).

3.2 Crest Profile

The maximum pool elevation profile plus the required freeboard, which is controlled by the results of the wind-wave analysis, determine the required crest elevation of the dam, except in the tieback reaches where overtopping will be accounted for in the design. The design elevations of the Southern Embankment crest profile are provided in Figure 2 (non-tieback reaches), Figure 3 (Western Tieback), and Figure 4 (Eastern Tieback). Between the DIS and the RRS, the dam crest will have an elevation of 929.0 feet. The gated structures and a short reach of the embankment on either side of these structures will have a crest elevation of 931.0 feet. While the wind-wave analysis indicates that a crest elevation of 929.0 feet is sufficient, the portion of the Southern Embankment between the RRS and the Eastern Tieback will transition from a crest elevation of 929.0 feet just east of the RRS to a crest elevation of 931.0 feet at its southern end just prior to transitioning to the Eastern Tieback. This transition is necessary to maintain five (5) feet of freeboard above the sloping maximum pool elevation, which is produced by the PMF event.