10 Conclusions and Recommendations

The MIKE 21 coastal hydrodynamic model simulations for the 10% -, 2%- and 1%- annual chance coastal storm surge events for the three proposed "Resist" alternatives show that the "Resist" barrier will provide varying levels of flood risk reduction benefits by preventing the overland flow of coastal storm surge into the study area. The "Resist" Alternative 1 provides the maximum flood risk reduction benefits followed by the "Resist" Alternative 2 and 3 respectively. The potential residual flooding impacts to properties within the study area are the highest for Alternative 2 and 3 but the lowest for Alternative 1. Out of the total of 5 public and private properties that have potential residual flood impacts in Alternatives 2 and 3; 2 properties are located in the southern portion of the study area, one in Hoboken and the other being the New Jersey Transit yard and the remaining 3 properties are located in the northern portion of the study area in Hoboken and Weehawken. Model results show that each of these three "Resist" alternatives will prevent the overland flow of coastal storm surge from the project's study area into portions of Jersey City that are located outside the study area (between 14th street and 18th street and west of Marin Boulevard) during the 10% and 2% annual chance storm events.

The MIKE URBAN and MIKE FLOOD model simulations for the various rainfall and tide combination events shows that the proposed "Delay, Store, Discharge" alternative will provide varying levels of flood risk reduction benefits for each rainfall/tide combination events. Model results show that the proposed "DSD" alternative provides the maximum flood risk reduction benefits during the 5-year and low tide combination event. The model results show that the level of flood risk reduction benefits gradually decreases as the rainfall intensity increases along with a high tide in the Hudson River.

Model results from the "Resist" and "DSD" alternatives will be used as part of the Task 5 feasibility assessment to inform the choice of the preferred alternative that can be advanced to the design phase upon acceptance from the stakeholders and the community. It is our understanding that NJDEP would advance further development of the coastal hydrodynamic model developed as part of this study in the design phase to evaluate and finalize the potential residual flooding impacts from the final "Resist" alignment. The stormwater model methodology used as part of this study should satisfy the interior drainage analysis requirements for the FEMA levee certification.

Dewberry proposes the following recommendations for the design phase of the project –

1. Utilize the latest Danish Hydraulic Institute's MIKE model version 2016. Simulate the NAA and preferred alternative model scenarios using MIKE 2016 version instead of the currently used MIKE 2014 version. This model version update will ensure that the latest modeling package is utilized during the design phase to evaluate residual flooding impacts.
2. If possible, utilize the coastal model mesh to reflect the actual footprint and the Design Flood Elevation (DFE) of the proposed "Resist" alignment. In order to reflect the actual footprint and DFE, the coastal

model mesh from this feasibility study would require modification such as removal of building footprints immediately adjacent to the proposed "Resist" alignment. Additionally, we recommend to utilize the "dike" option in the MIKE 21 model program with the appropriate footprint and design flood elevation as well and model results from these two methods should be compared which can be included as part of the model sensitivity analysis.

3. If needed, perform uncertainty and sensitivity analysis to evaluate any potential changes to residual flooding impacted properties with the final detailed alternative alignment. It is quite possible that the number of properties impacted by residual flooding may increase or decrease depending on the model parameters that are tweaked during the sensitivity analysis.
4. In order to develop operational protocols for the proposed deployable "Resist" structures, it is recommended to simulate intrusion of coastal storm surge still water level at every 0.5 feet interval starting from an elevation of 5 feet-NAVD up to the minimum DFE of the proposed "Resist" barrier in NAA and with various gate closing scenarios as part of the final "Resist" alternative.
5. For the emergency action plan that needs to be developed as part of the maintenance and operations plan, it is important to understand the extent of flooding that may occur if the coastal storm surge water peak water level exceeds the design DFE of the "Resist" barrier. It is recommended to develop synthetic boundary condition with time-varying peak water levels above the DFE of the "Resist" barrier. These synthetic water level time series should be propagated from the boundary at Battery into the study area which will allow to simulate areas that will be flooded due to overtopping from the peak water level of the coastal storm surge that exceeds the DFE. The extent of flooding from this type of overtopping is dependent on the length of time that the water level overtops the "Resist" barrier. Floodplain maps should be developed for various scenarios that show flood extent for various overtopping depths and durations which then would be used to inform the emergency action plans.
6. It is our understanding that NDJEP intends to submit a Conditional Letter of Map Revision (CLOMR) to FEMA which would allow FEMA to review the proposed floodplain mapping changes and the levee certification documents. The CLOMR documentation would require updates to the Wave Height Analysis for Flood Insurance Study (WHAFIS) model developed by FEMA for the study area as part of the 2015 preliminary Flood Insurance Study for Hudson County. Updates to WHAFIS model would require utilizing the latest 1% annual chance stillwater elevation and wave height data published by FEMA at the time of the design study. The results from the WHAFIS model simulation would be utilized to re-map the 2015 preliminary FEMA floodplain maps with the final "Resist" alignment in place. It is quite possible that due to availability of newer topographic data, the remapped FEMA floodplain may be different than the 2015 preliminary FEMA floodplain map that currently exists on the unprotected side of the "Resist" alignment. If needed, sea level rise may also be considered in the WHAFIS model runs to confirm DFE.
7. The levee accreditation would require an interior drainage analysis per 44 CFR65.10 requirements that would be used by FEMA to determine the 1% annual chance floodplain area from rainfall events on the protected side of the final "Resist" coastal barrier structure. It is assumed that the "Resist" coastal barrier

structure will be designed to the USACE and ASCE standards as required for FEMA levee accreditation standards. It is recommended to update the MIKE URBAN and MIKE FLOOD stormwater model developed as part of the feasibility study with any additional data provided by North Hudson Sewerage Authority (NHSA) to reflect the drainage conditions that would exist with the "Resist" coastal structure barrier in place. Another option would be to utilize NHSA's Long Term Control Plan (LTCP) hydrologic and hydraulic model that NHSA intends to develop in the near future. NHSA's model can be used to simulate the various rainfall and tide combination events to develop a range of potential flooding areas that can be used to determine the 1% annual chance floodplain behind the proposed "Resist" coastal structure.