APPENDIX I—WETLAND DEWATERING ANALYSIS

TETRA TECH

TECHNICAL MEMORANDUM

TO: Maryland Aviation Administration (MAA)

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RE: Wetland #3 Water Balance Analysis during future recovery well pumping associated with the Interim Remedial Action (IRA) at Dump Road Area (DRA) of Martin State Airport (MSA)

This technical memorandum summarizes the results of a water balance modeling analysis of Wetland #3 during planned future recovery well pumping at the DRA. The simulated well pumping is associated with the containment of contaminated groundwater by the propose Interim Remedial Action (IRA). The objective of the water balance modeling was to assess the potential effect of recovery well pumping on water levels in Wetland #3 over time. Although recognized as a non-tidal wetland, Wetland #3 has developed through ponding of surface drainage in a depression on top of the Dump Road Area landfill. This area is impounded along the Frog Mortar Creek shoreline by an artificial berm.

A detailed discussion of the modeling approach and results is provided below.

Background Information

Although the designated area of Wetland #3 is approximately 18,960 ft^2, field observations indicate that only a portion of this area has standing water. The estimated depth of the water in Wetland #3 is approximately 2 ft. Based on topographic maps, the estimated elevation of water in Wetland #3 is approximately 8.5 ft feet above North American Vertical Datum (NAVD) 1988. An examination of potentiometric surface maps at DRA indicates that the elevation of the water table is approximately 1.5 ft feet above NAVD 1988 in the vicinity of Wetland #3. The higher water elevation of Wetland #3 than the water table indicates that Wetland #3 is a recharge area for local groundwater. The relatively high difference (7 ft) in hydraulic heads between Wetland #3 and the water table indicates that the sediments beneath Wetland #3 have a low hydraulic conductivity. This is consistent with the clay sediments observed in shallow borings and test pits located near Wetland #3. The hydraulic conductivity of clays range from 10^{-6} to 10^{-9} cm/s, and is typically lower in the vertical direction as a result of anisotropy, Based on design groundwater extraction rates for each of the recovery wells, the calibrated groundwater flow model indicated

that the drawdown of the water table will be approximately 1 ft in the area beneath Wetland #3 during operation of the groundwater IRA recovery well system at DRA. The potential effect on water levels over time in Wetland #3 as a result of the lowered water table from recovery well pumping is discussed below.

Wetland #3 Water Balance Modeling Analysis

A simple water balance modeling approach was applied to examine potential changes in water levels of Wetland #3 over time as a result of the planned groundwater IRA recovery well pumping at DRA. In this modeling analysis, the water level of Wetland #3 is assumed to be initially in a dynamic equilibrium in which the rate of inflow into the wetland from precipitation is equal to the rate of outflow from the wetland as a result of leakage to the water table. The amount of leakage from the wetland was estimated using Darcy's law Q=KiA where K is vertical hydraulic conductivity of sediments beneath wetland, is hydraulic gradient across the sediments, and A is the wetland area. For the model water balance simulation, at time zero, the water table elevation is lowered by 1 ft to represent the effect of recovery well pumping. This increases the vertical hydraulic gradient and thus the amount of leakage of water from Wetland #3.

The water balance model was applied to examine the change in wetland elevation over time as a result of recovery well pumping. Based on the accuracy of water level elevation measurements and seasonal variability of wetland elevations, a 0.1 ft decrease in wetland elevation was chosen as the criterion for concluding that there is a measureable impact to the wetland. Using the calibrated MODFLOW flow model, the estimated water table drawdown is approximately 1 ft. beneath the wetland. Although vertical hydraulic conductivity data are not available for the sediments beneath the wetland, soil logs indicate the presence of lower permeability clays, which is consistent with the approximate 7 ft head difference between the water level of Wetland # 3 and the water table. Based on the uncertainty of the vertical hydraulic conductivity of sediments beneath Wetland #3, a range of possible values was examined in the model calculations.

Modeling Results

The results of the water balance model calculations indicate that the rate of change in the water level of Wetland #3 becomes very slow for low values of the vertical hydraulic conductivity of the sediments beneath this wetland. Based on a 5 year monitoring period, the water balance calculations indicate that the recovery well system will not impact the wetland (< 0.1 ft decrease) if the vertical hydraulic conductivity of the sediments beneath the wetland is less than 1×10^{-8} cm/s. Sensitivity analyses indicate that the vertical hydraulic conductivity and monitoring period are the most sensitive model parameters. Over a longer monitoring period, greater decreases in wetland elevation may occur.

Characterization of the hydrogeologic conditions in and around Wetland #3 is planned in late 2013 and the data from those studies will assist in subsequent assessment of potential long-term impacts to Wetland #3.

Conclusion

Wetland #3 is a non-tidal wetland that has developed in a bermed depression on the landfilled portion of the Dump Road Area. A vertical head difference of about 7 feet exists between the Wetland #3 water level and the underlying water table due to the low hydraulic conductivity of the sediments and soil beneath the wetland. Modeling of groundwater levels during pumping from the proposed extraction wells in the area of Wetland #3 predicts that the pumping will increase the separation between the perched water of Wetlands #3 and the local water table by approximately 1 foot. Based on the low permeability of the clays beneath the wetland, water balance modeling of the potential effects of this water-table drawdown indicates it is unlikely to have a significant impact on the water level in Wetland #3. Characterization of the hydrogeologic conditions in and around Wetland #3 is planned in late 2013, and the data from those studies will assist in assessment of potential long-term impacts to Wetland #3. No additional actions to monitor the current hydrology of Wetland #3 or to assess the potential long term impact from pumping of the extraction wells are recommended at this time.