Abstract-
The South Florida Water Management District (SFWMD) manages and operates various water control structures that are subject to scour. In an effort to reduce scour downstream of these gated structures, laboratory experiments were performed to investigate the effect of a bubble curtain introduced downstream of the terminal structure of a gated spillway on the depth of the scour hole. Experiments were performed in a laboratory channel consisting of a 1:30 scale model of the SFWMD S65E spillway structure. Experiments were conducted without air entrainment and for high, medium, and low air entrainment rates for high and low headwater conditions. For the cases with no air entrainment, it was found that there was excessive scour downstream of the structure due to a downward roller formed upon exiting the downstream sill of the stilling basin. When air was introduced vertically just downstream of, and at the same level as, the stilling basin sill, it was found that air entrainment does reduce scour depth depending on the air flow rate by up to 58%, but shifts the deepest scour location to the sides of the channel bed instead of the center. Future work will focus on identifying diffuser geometry that minimizes the air required to reduce bed scour.

Background-
The South Florida Water Management District is Florida's largest water management district. The agency operates and maintains 2,600 miles of canals and levees, 63 pumping facilities, and 1,300 water control structures. They are committed to improving flood control and securing a water supply for the 7.5 million residents in its jurisdiction. The agency is also dedicated to improving water quality and restoring ecosystems in areas such as the Southern and Northern Everglades.

Problem-
Water control structure S65E is a gated weir stilling basin located approximately 10 miles Northwest of Lake Okeechobee on the Kissimmee River in Glades County. The area surrounding S65E is largely agricultural. There is a residential neighborhood within 200 ft of S65E consisting of about 125 homes. The structure is SFWMD's largest measuring over 180 feet wide. During maintenance, significant erosion was discovered near the structure. A large scour hole approximately 26 feet below the floor of the stilling basin had formed downstream of the structure. If the scour hole were left unchecked, it could lead to structure failure due to undermining the foundation.

S65E during high flow conditions

Results-

![Images of S65E during operation with and without air injection]

Subsequent bed profile downstream of model structure. Collected after scour equilibrium is established.

Conclusion-
It was evident that experimental runs with a high headwater to tailwater ratio resulted in the worst bed erosion. A 58% reduction in erosion was achieved in this case by utilizing air entrainment at a rate of 25 cfs. Although scour depth is not directly scalable between model and prototype due to cohesion of small particles, the scour depths found in the model show significant depths comparable qualitatively to those found in the SFWMD S65E spillway structure, thereby providing confidence in the proposed concept and laboratory setup.

Future work-
Although scour reduction via air injection was proven conceptually, further research is required in order to define its true potential. Future work will investigate the effectiveness of various diffuser material, geometry, and orientation. The goal is to minimize bed scour while using the smallest amount of air. This will reduce the operational costs of air injection to be inline with the cost of routine bed maintenance.

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