WOOLPERT

Memo

To: Steve Kirk, PE

From: Brian T. Bates, PE

Date: July 6, 2016
Revised: July 18, 2016

Subject: Church Creek ICPR Model Update – Weir at N-D150

Introduction

At the request of the City of Charleston ("the City"), Woolpert created and has maintained an Interconnected Pond Routing (ICPR) hydrologic and hydraulic model ("the model") for the Church Creek drainage basin due to the history of flooding issues in the watershed. As part of its ongoing efforts to keep the model current, the City asked Woolpert to investigate a specific pond outfall structure (weir) and explore options to reduce property flooding to homes on Gullane Drive during large storm events.

The pond is located between Village Green and Shadowmoss Subdivision, and drains through a weir located on the southwest end of the pond towards Church Creek. The location of the pond and relevant ICPR nodes can be seen in "Figure 3: Pond Location". The outfall structure is located at ICPR node "N-D150". After an initial field investigation, Woolpert noted that the current weir structure in the pond is different from the outfall structure modeled in the previously effective Church Creek ICPR model. The original outfall structure in the effective model included one (1) pipe and two (2) weirs (see "Figure 1: Original Outfall Structure"). The structure currently installed is a multi-tiered weir (see "Figure 2: Current Outfall Structure"). Woolpert contracted Bowman Consulting to provide an updated characterization of the structure, including survey details and pond top-of-bank information.

Figure 1: Original Outfall Structure

Figure 2: Current Outfall Structure

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Figure 3: Pond Location

Model Integration

As previously noted, the outfall structure in the effective ICPR model did not match the structure currently in the field. The model was updated to accurately represent the current hydraulic conditions, and a comparison of the modeling results was developed. In addition, four (4) alternative weir configurations were modeled to determine their effectiveness in reducing maximum water surface elevation (WSE) during large storm events.

Existing Model

The Existing Model is from the 2015 Church Creek Watershed ICPR Addition/Revision Report dated September 1, 2015. It indicated that the outfall structure was a 12 inch concrete pipe with an invert elevation of 7.0 feet. In addition there were two (2) trapezoidal weirs in place. One at an elevation of 10.6 feet and a second overflow weir at an invert of 12.1 feet.

Updated Model

The Existing Model was revised to create an Updated Model with the appropriate weir dimensions indicated by the survey data. The survey indicated that the invert of the weir in the field was 12 inches wide and at an elevation of 7.05 feet. The

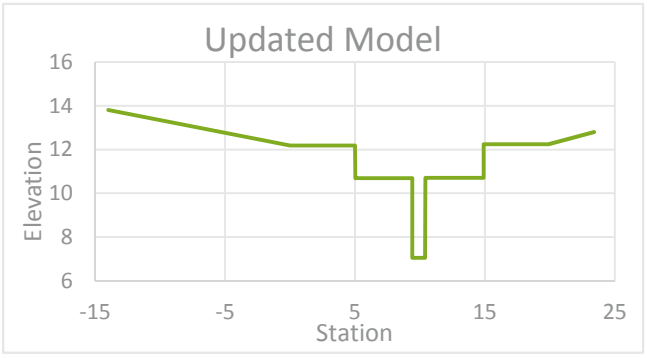

Figure 4: Updated Model Weir

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second tier was 20.9 feet long and at an elevation of approximately 10.7 feet. The overflow portion of the weir was set at an invert of approximately 12.2 feet. See "Figure 4: Updated Model Weir" for a visual representation of the weir.

Alternative A
Alternative A was similar to the Updated Model but lowered the middle tier of the weir from an elevation of 10.7 feet to 10.0 feet. An illustration of the weir is in "Figure 5: Alternative Weir Configurations".

Alternative B
Alternative B was the same as Alternative A but further lowered the middle tier to an invert of 9.5 feet.

Alternative C
Alternative C widened the lowest portion of the weir by one 1.0 foot but left the middle tier at the Updated model elevation of 10.7 feet.

Alternative D
Alternative D was a combination of Alternative B and Alternative C. The middle tier was lowered to an invert of 9.5 feet and the bottom portion was widened by 1.0 foot.

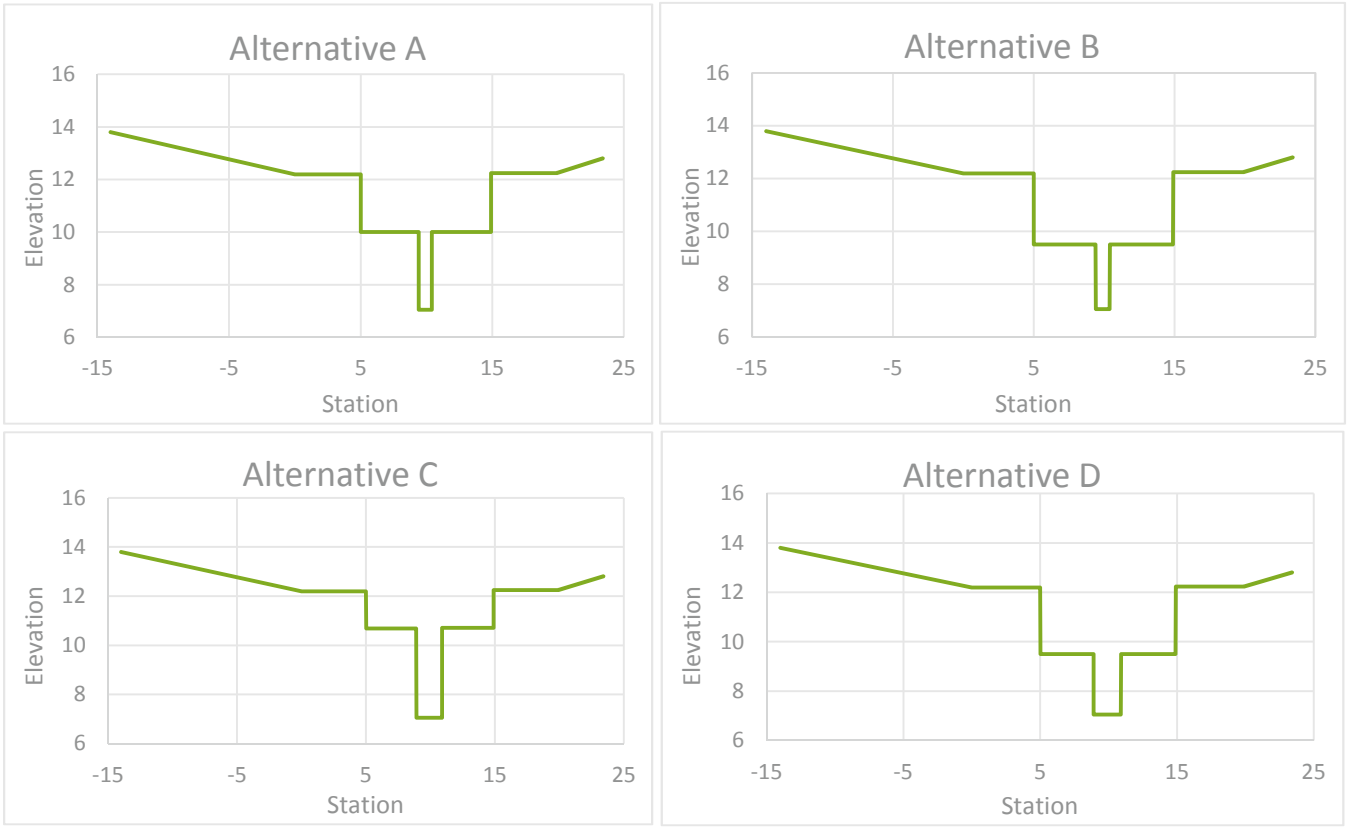

Figure 5: Alternative Weir Configurations

Model Results
The model results for the relevant ICPR nodes are included in "Table 1: Weir Results Summary Table". The table shows the max water surface elevation (WSE) for the 2-, 10-, 25-, 50-, and 100-year storm event at each node listed for the Existing Model, Updated Model, and Alternative models A – D. The nodes chosen represent locations both upstream and downstream of the weir outfall structure and the pond. It is imperative that both upstream and downstream locations are analyzed to determine that changes to the weir structure do not cause additional flooding in other locations of the Church Creek Watershed.

Table 1: Weir Results Summary Table

Name	Location	Storm	Existing Model Max WSE (ft)	Updated Model Max WSE (ft)	Alternative A Max WSE (ft)	Alternative B Max WSE (ft)	Alternative C Max WSE (ft)	Alternative D Max WSE (ft)
N-D140	2,300' DS of Weir	002YR	9.57	9.61	9.60	9.59	9.62	9.57
		010YR	10.80	10.81	10.80	10.79	10.80	10.79
		025YR	11.11	11.12	11.11	11.10	11.11	11.10
		050YR	11.32	11.32	11.31	11.31	11.31	11.31
		100YR	11.52	11.53	11.52	11.52	11.52	11.51
N-D150	DS of Weir	002YR	9.59	9.63	9.61	9.60	9.64	9.61
		010YR	10.80	10.81	10.80	10.79	10.81	10.79
		025YR	11.12	11.12	11.11	11.10	11.11	11.10
		050YR	11.32	11.32	11.31	11.31	11.32	11.31
		100YR	11.53	11.53	11.52	11.52	11.52	11.51
N-D160	US of Pond (southern side)	002YR	11.29	11.29	10.89	10.66	10.83	10.52
		010YR	11.88	11.88	11.57	11.40	11.60	11.29
		025YR	12.08	12.08	11.78	11.64	11.82	11.55
		050YR	12.25	12.25	11.98	11.84	12.02	11.75
		100YR	12.41	12.41	12.19	12.06	12.23	11.97
N-D170	Near Gullane Dr.	002YR	11.29	11.15	10.89	10.66	10.83	10.52
		010YR	11.88	11.79	11.57	11.40	11.60	11.29
		025YR	12.08	12.00	11.78	11.64	11.82	11.55
		050YR	12.25	12.19	11.98	11.84	12.02	11.75
		100YR	12.40	12.38	12.19	12.06	12.23	11.97
N-D180	US of Gullane Dr.	002YR	11.31	11.17	11.04	10.97	11.03	10.96
		010YR	11.86	11.78	11.57	11.50	11.60	11.44
		025YR	12.06	11.98	11.76	11.64	11.80	11.57
		050YR	12.22	12.17	11.95	11.82	11.99	11.74
		100YR	12.38	12.35	12.17	12.04	12.20	11.95
N-D200	US of Pond (northern side)	002YR	11.32	11.19	10.98	10.80	10.92	10.70
		010YR	11.94	11.86	11.66	11.52	11.69	11.42
		025YR	12.15	12.08	11.88	11.76	11.91	11.68
		050YR	12.32	12.27	12.08	11.96	12.11	11.87
		100YR	12.49	12.46	12.29	12.17	12.32	12.09

Updated Model

As previously mentioned, the current weir structure was modified in the field from its original shape. The Updated Model was revised to reflect this change and the results were reviewed. The change in WSE at most of the nodes is less than 0.1 feet for the large storm events indicating that the change in structure had a minimal impact on the overall stormwater system. However, during the 2-year storm event, the WSE at the nodes upstream of the pond decreased by 0.12 – 0.14 feet compared to the original outfall structure. This small decrease in the small storm is due to the change of shape of the lower portion of the outfall structure. Previously, a 12 inch circular orifice was used at the bottom with an additional weir located at a higher elevation. The updated structure includes a 12 inch rectangular weir that is open all the way to the top of the structure allowing more stormwater to leave the pond more quickly during small storm events. However, the additional discharge is not enough to impact downstream WSEs.

Alternatives A – D

Alternatives A – D were modeled and compared to the Updated Model in an attempt to reduce WSEs around Gullane Drive (near Node N-D170) during large storm events. All five (2-, 10-, 25-, 50-, and 100-year) storm events were modeled and reviewed for significant changes; however for this report, the 100-year storm event results for N-D170 were the focus since

it is the node closest the area of concern. "Table 2: 100-Year Storm Event WSE at N-D170" compares the Alternative Model WSEs near Gullane Drive to the Updated Model for the 100 year storm event. Alternative A and C had similar results of less than 0.2 feet of decrease in the WSE for the 100-year storm event. Alternative B and D provided a reduction of 0.32 feet and 0.41 feet respectively.

Table 2: 100-Year Storm Event WSE at N-D170

Updated Model Max WSE (ft)	Alternative A Max WSE (ft)	Alternative A vs. Updated (ft)	Alternative B Max WSE (ft)	Alternative B vs. Updated (ft)	Alternative C Max WSE (ft)	Alternative C vs. Updated (ft)	Alternative D Max WSE (ft)	Alternative D vs. Updated (ft)
12.38	12.19	-0.19	12.06	-0.32	12.23	-0.16	11.97	-0.41

There were small reductions in the WSEs of other upstream locations for the alternatives as well. Downstream of the weir, the changes were minimal for all of the alternatives in all of the modeled storm events. There was less than 0.05 feet of difference in the WSEs compared to the Updated Model. Although more water is being released more quickly from the pond in the Alternatives, the effect is very minimal due to the size of the pond compared to the scale of the watershed.

Conclusion

All of the alternatives provided less than 0.5 feet of reduced WSE during the 100 year storm event. Woolpert recommends that the City consider obtaining Finished Floor Elevations (FFE) of structures that have potential for flooding along Gullane Drive before making any changes to the weir structure. Alternative D provides the most relief, however, if 0.41 feet of reduction is not enough to prevent flooding in homes, then much of the benefit of adjusting the weir is lost.

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1671 Belle Isle Avenue, Suite 125
Mount Pleasant, SC 29464-8338
843.216.0401