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MEMORANDUM

TO: Steve Kirk, City of Charleston

FROM: Meghan Moody, PE & Blake Duke, EIT

DATE: October 4, 2021

SUBJECT: Lake Dotterer Alternative Outfall Design Project & Modeling Results

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Background

The proposed Lake Dotterer Alternative Outfall design project goal is to divert pre-existing flows during extreme storm events that currently flow into Church Creek; this will serve as a method to both mitigate local flooding and remove flow from the Church Creek Basin. By diverting flows to Long Branch, it redirects the outfall of these flows from the Ashley River to the Stono River. The alternatives leading to this project were evaluated via ICPR4 modeling and study efforts conducted by Weston & Sampson on behalf of the City of Charleston. These evaluations were documented in reports titled *Church Creek Basin Flood Reduction Study* and the *Evaluation of Impacts of the Lake Dotterer Diversion*.

The Lake Dotterer Diversion, originally proposed as the Forrest Lakes Flow Restoration, was a recommendation from the 2018 Church Creek Study. Preliminary modeling was conducted by Weston & Sampson at the request of the City to determine a conceptual design for this outfall. Based on the results, it was determined that a connection to Long Branch was beneficial to the local area, and that the connection with Church Creek should be further evaluated. The Lake Dotterer Diversion Study evaluated expected impacts to the Long Branch Basin if the proposed connection were installed, provided a conceptual basis for design of the diversion, and assessed in more detail the proposed connection to Church Creek. The recommendation in the Lake Dotterer Diversion Study was for the outfall to convey a minimum flow of 230 cfs via three 42" equivalent elliptical culverts and assumed a water surface elevation of 0.2 ft NAVD88 within Lake Dotterer. A total of four downstream flow impediments were identified through that study, and Weston & Sampson concluded that the proposed culverts under Glenn McConnell should be plugged until such time as the downstream improvements could be installed.

Charleston County offered to include the City's alternative outfall connection as part of its Glenn McConnell Road Widening construction project. This has made the current construction of the Lake Dotterer Alternative Outfall a project of opportunity. The recommendation is to install the culverts and cap them until a future date when the downstream improvements can be implemented.

At the time of this memorandum, our team has completed the design of the culverts, including the following tasks:

1. Field survey of the project area
2. Met with City of Charleston Parks Department personnel and residents of the neighborhoods adjacent to Lake Dotterer to collect information.
3. Refined model details, based on the current Church Creek – Long Branch ICPR4 model and project site data, collected information, and field survey
4. Incorporated the designed improvements into the model to confirm the design will meet expectations set through discussions with stakeholders.
5. Designed the conceptual control structure requirements for the culverts.

This memorandum serves as a report of the results from incorporating the design details into the model.

Modeled Scenarios

The previously developed existing conditions model scenario was revised with additional survey data collected during design. In the existing conditions scenario, the water surface elevation of Lake Dotterer was revised to the surveyed elevation, approximately 0.8 ft NAVD88. The water surface of Lake Dotterer is variable based on the rice trunk weir and flap gate settings through the berm between Lake Dotterer and Church Creek. The position of the rice trunks was modeled in the existing conditions scenario as an open two-way flow connection of two rectangular 3' x 4' culverts. The existing conditions do not incorporate the downstream improvements of the Long Branch study, or any other improvements considered within the Church Creek Basin.

For the proposed model, the Lake Dotterer Alternative Outfall Design was incorporated using the final design and refined surveyed information along with the downstream improvements recommended in the Lake Dotterer Diversion study. This scenario assumed a berm with top elevation of 8 ft NAVD88 to simulate disconnection of Lake Dotterer from Church Creek. The alternative outfall from Lake Dotterer to Long Branch was modeled with the three proposed 42" circular culverts each having a control weir set in Lake Dotterer at elevation 1.6 ft and outlet structures providing surge protection on the Long Branch (impoundment) side set at elevation 1 ft NAVD88.

Modeled Storms and Boundary Conditions

Following the incorporation of the collected information and proposed design into the ICPR4 model, Weston & Sampson conducted 96-hr simulations of the pre- and post-condition scenarios for the 4% and 1% 24-hr AEP storm events. The dynamic tidal conditions used in the previous modeling effort were set as the baseline boundary condition to simulate tailwater and tidal conditions, shown in Figures 1 and 2. The location of node N-A010 is within Church Creek at the boundary between the Church Creek Basin and the Ashley River, and N-LB010 is in Long Branch at the boundary with the Stono River just outside the West Ashley Greenway. See Table 1 and Figure 3 for descriptions and locations of the the major Long Branch nodes.

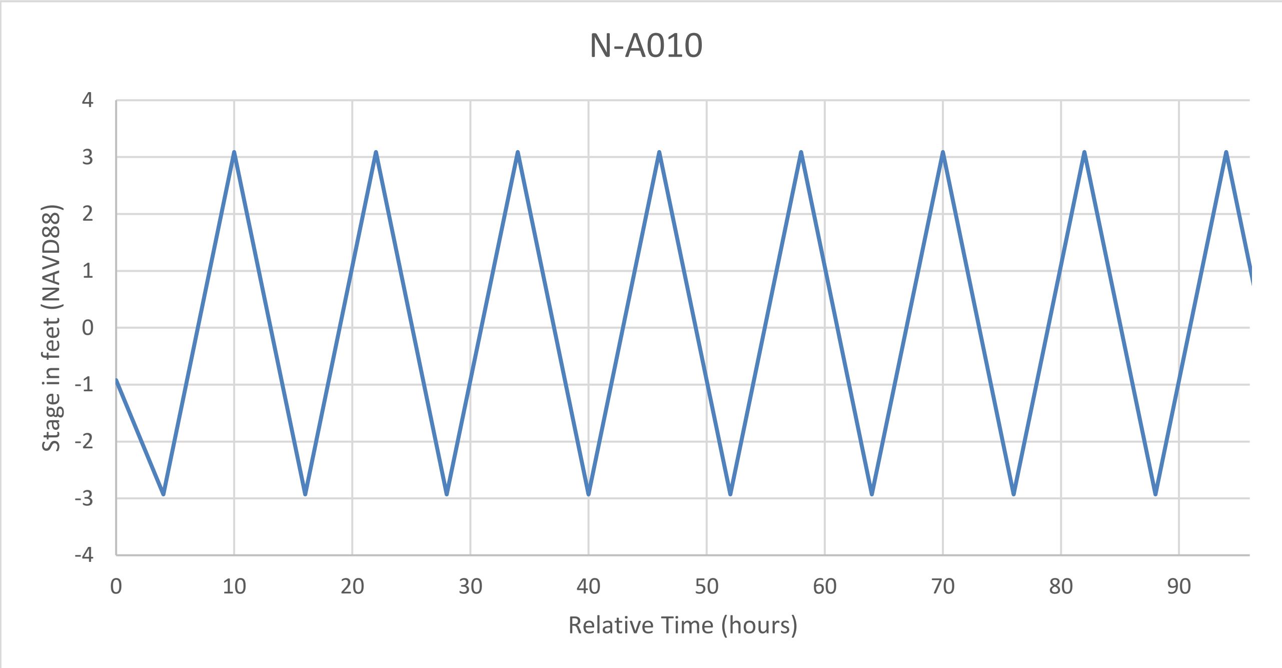


Figure 1 - Ashley River tidal condition set at Node A010 for Church Creek boundary input.

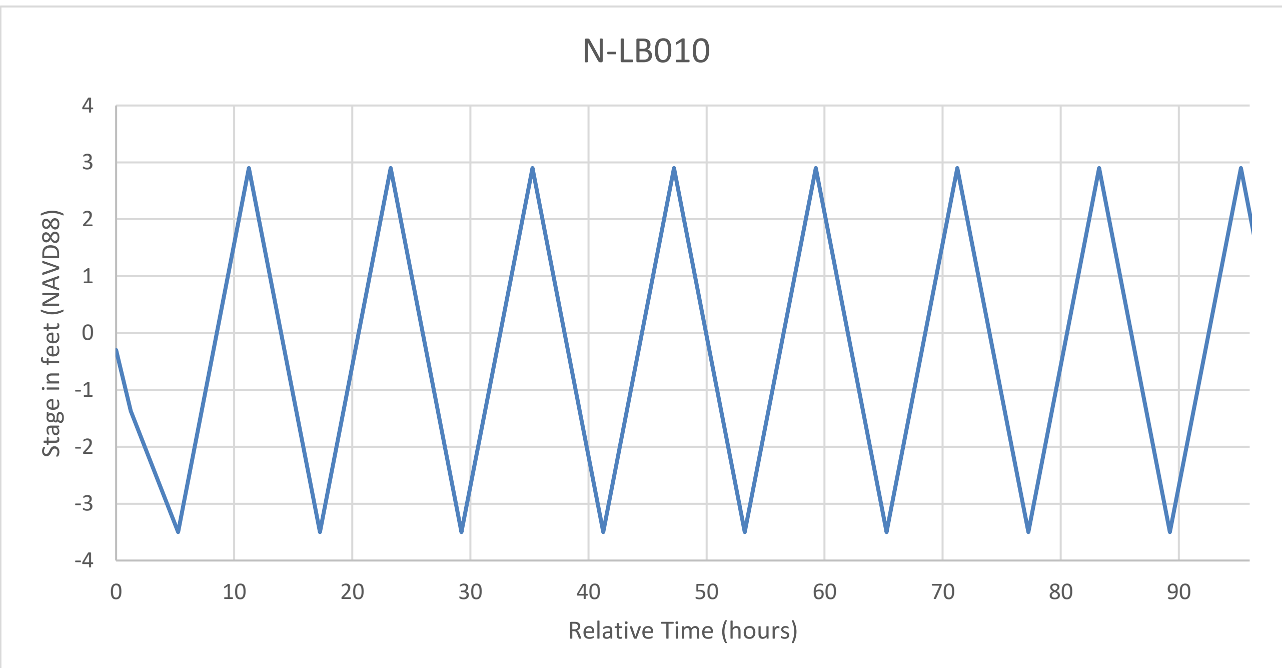


Figure 2 - Stono River tidal condition set at Node LB010 for Long Branch boundary input.

Table 1 - Lake Dotterer and Long Branch Node Descriptions

Node Label	Node Description
N-0210	Church Creek Downstream from Lake Dotterer
N-0530	Lake Dotterer North End
N-A120	Upstream of Railroad Culverts
N-B020	Upstream of Bees Ferry Road
N-B160	Convergence of Church Creek Upstream of Bees Ferry Road
N-LB100	Upstream of West Ashley Greenway
N-LB130	Upstream of Highway 17
N-LB240	Carolina Bay-Melrose Crossing
N-LB370	Upstream of St. Francis Parking Lot Bridge
OFNF-LB300	Carolina Bay Impoundment

**All elevations provided for nodes are in NAVD88*

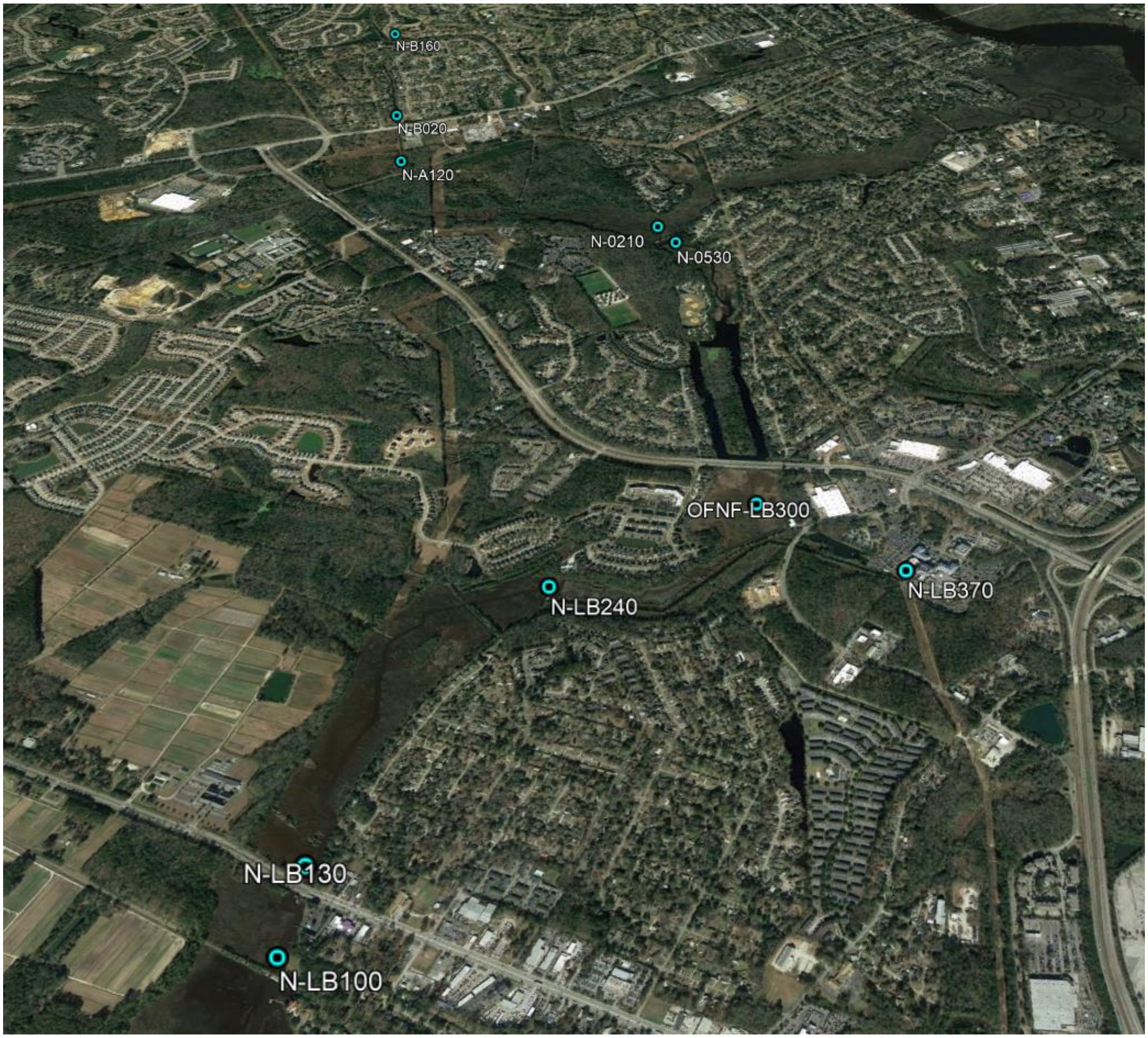


Figure 3 – Lake Dotterer Alternative Outfall Design Project Key Nodes and their locations.

Modeling Results

In the design confirmation model both the Church Creek Basin & Long Branch Basin were simulated and evaluated for any impacts predicted to occur, particularly along the primary channels. In Church Creek, this included Nodes B020 (upstream of Bees Ferry Road) and 0210 (Church Creek Channel Upstream of Lake Dotterer). Shown in the Tables 2 and 3 are summaries of peak staging and flows at these nodes. The impacts at Bees Ferry Road and upstream of the railroad are predicted to be minor during the 4% and 1% AEP event. Likewise, downstream of the railroad in the Church Creek Marsh Channel, just outside Lake Dotterer, we observed that flows remained similar to the existing condition in each the 1% and 4% event. The peak flow rates exhibited minimal change because at the peak of each event, Lake Dotterer was unable to discharge into Church Creek during either the existing or proposed condition. In the existing condition this is due to higher staging in Church Creek than Lake Dotterer, and in the proposed condition from the Church Creek connection being severed by a berm.

Table 2 – Summary of Peak Stage and Flow Rate Changes at Node B020.

N-B020 (Upstream of Bees Ferry Road) Peak Conditions						
Simulation	Existing Peak Stage (ft)	Lake Dotterer Alternative Outfall Design Peak Stage (ft)	Δ Peak Stage (ft)	Existing Peak Outflow Rate (cfs)	Lake Dotterer Alternative Outfall Design Peak Outlow Rate (cfs)	Δ Peak Flow Rate (cfs)
4% 24-HR	6.48	6.47	-0.01	402	405	3
1% 24-HR	7.35	7.33	-0.02	549	555	6

Table 3 – Summary of Peak Stage and Flow Rate Changes at Node 0210.

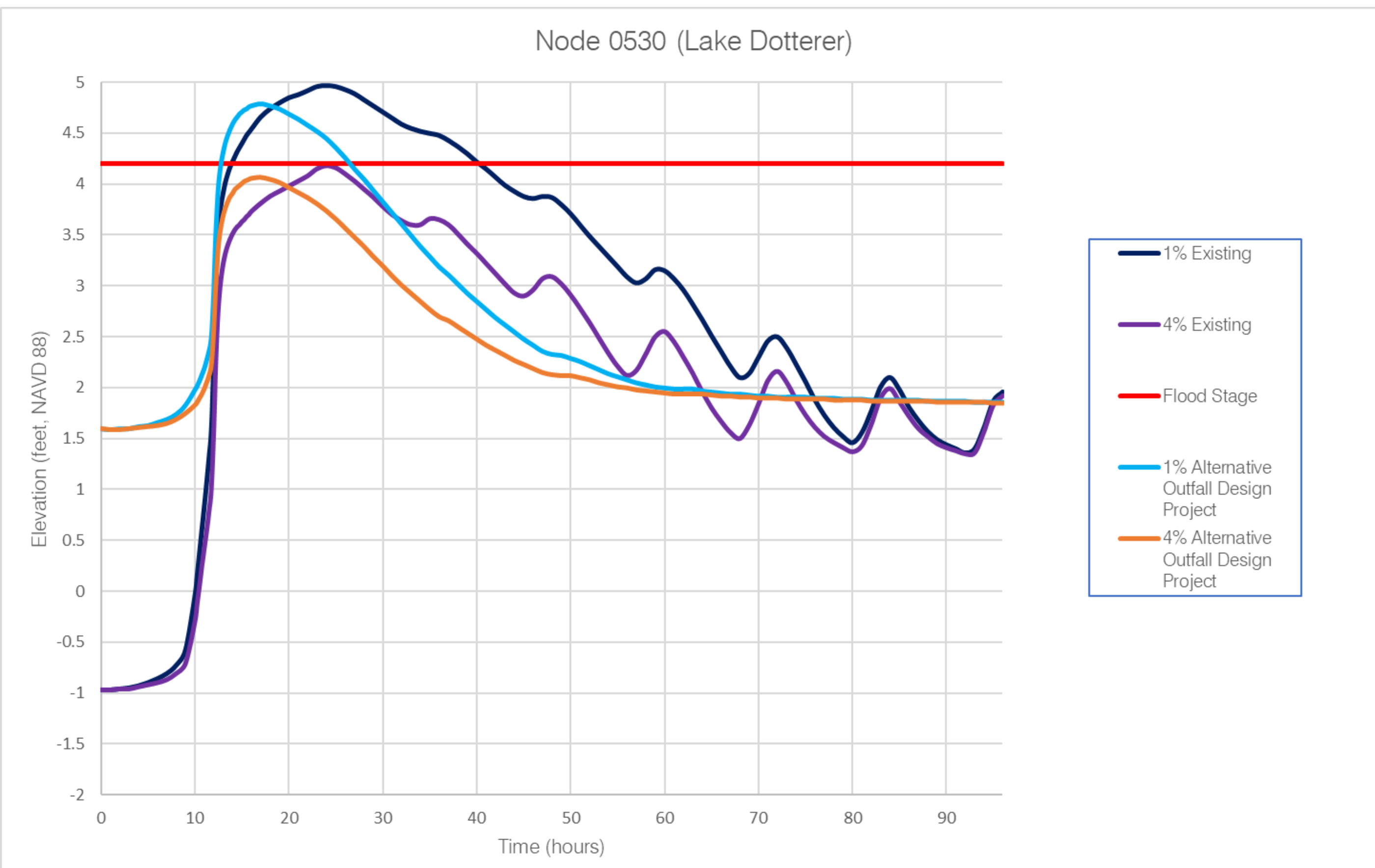
N-0210 (Church Creek Upstream of Lake Dotterer) Peak Conditions						
Simulation	Existing Peak Stage (ft)	Lake Dotterer Alternative Outfall Design Peak Stage (ft)	Δ Peak Stage (ft)	Existing Peak Flow Rate (cfs)	Lake Dotterer Alternative Outfall Design Peak Outflow Rate (cfs)	Δ Peak Flow Rate (cfs)
4% 24-HR	4.16	4.15	-0.01	432	433	1
1% 24-HR	4.96	4.90	-0.06	471	472	1

Our evaluation of flows from Lake Dotterer into Long Branch and ultimately the Stono River predict an improved drawdown and reduced peak stage in Lake Dotterer. Peak staging in Lake Dotterer under 1% and 4% AEP conditions has improved 0.11 and 0.18 feet respectively for each event. Relief rates in Lake Dotterer currently rely on the drawdown of Church Creek, these rates are increased by allowing it to discharge into an improved Long Branch Basin, see Table 4. The drawdown of Lake Dotterer by diverting to the alternative outfall route has decreased water levels above the "flood stage" from 26 hours to 14 hours during the 1% event. For the 4% event, in addition to water surface levels being decreased, the recovery time is decreased as shown in Figure 4. The peak flow rate leaving Lake Dotterer is lower than the original recommendation of 230 cfs. This is due to the increase in the normal water surface elevation between the previously modeled 0.2' and the proposed normal water surface elevation of 1.6'. Despite this increase in normal water surface elevation, the peak stages in Lake Dotterer under the modeled 4% and 1% AEP storm events are reduced.

Table 4 – Summary of Peak Stage and Flow Rate Changes at Node 0530.

N-0530 (Lake Dotterer) Peak Conditions						
Simulation	Existing Peak Stage (ft)	Lake Dotterer Alternative Outfall Design Peak Stage (ft)	Δ Peak Stage (ft)	Existing Peak Flow Rate (cfs)	Lake Dotterer Alternative Outfall Design Peak Outflow Rate (cfs)	Δ Peak Flow Rate (cfs)
4% 24-HR	4.18	4.07	-0.11	125	115	-10
1% 24-HR	4.97	4.79	-0.18	142	143	1

Figure 4 – Lake Dotterer Staging under existing and proposed conditions.



As was the intent in the Lake Dotterer Diversion Study, the impacts downstream of the alternative outfall were modeled and show that the flow rates entering the Long Branch Basin are increased due to the outfall of Lake Dotterer into Long Branch. Peak staging reductions in the Tables 5 through 8 are inclusive of proposed downstream improvements in Long Branch, and the capacity for additional flows from Lake Dotterer are achieved by removing these restrictions. Capacity of the future improvements put forth in the Lake Dotterer Diversion Study should be evaluated during detailed design to ensure proper sizing.

Table 5 – Summary of Peak Stage and Flow Rate Changes at Node LB300.

N-LB300 (Carolina Bay Impoundment) Peak Conditions						
Simulation	Existing Peak Stage (ft)	Lake Dotterer Alternative Outfall Design Peak Stage (ft)	Δ Peak Stage (ft)	Existing Peak Flow Rate (cfs)	Lake Dotterer Alternative Outfall Design Peak Outflow Rate (cfs)	Δ Peak Flow Rate (cfs)
4% 24-HR	3.56	3.09	-0.47	22	164	142
1% 24-HR	4.35	3.59	-0.76	22	221	199

Table 6 – Summary of Peak Stage and Flow Rate Changes at Node LB240.

N-LB240 (CB - Melrose Crossing) Peak Conditions						
Simulation	Existing Peak Stage (ft)	Lake Dotterer Alternative Outfall Design Peak Stage (ft)	Δ Peak Stage (ft)	Existing Peak Flow Rate (cfs)	Lake Dotterer Alternative Outfall Design Peak Outflow Rate (cfs)	Δ Peak Flow Rate (cfs)
4% 24-HR	3.63	2.66	-0.97	93	523	430
1% 24-HR	4.31	3.10	-1.21	178	669	491

Table 7 – Summary of Peak Stage and Flow Rate Changes at Node LB130.

N-LB130 (Upstream of Highway 17) Peak Conditions						
Simulation	Existing Peak Stage (ft)	Lake Dotterer Alternative Outfall Design Peak Stage (ft)	∆ Peak Stage (ft)	Existing Peak Flow Rate (cfs)	Lake Dotterer Alternative Outfall Design Peak Outflow Rate (cfs)	∆ Peak Flow Rate (cfs)
4% 24-HR	2.87	2.73	-0.14	269	1144	875
1% 24-HR	4.09	2.77	-1.32	287	1462	1175

Table 8 – Summary of Peak Stage and Flow Rate Changes at Node LB100.

N-LB100 (West Ashley Greenway) Peak Conditions						
Simulation	Existing Peak Stage (ft)	Lake Dotterer Alternative Outfall Design Peak Stage (ft)	∆ Peak Stage (ft)	Existing Peak Flow Rate (cfs)	Lake Dotterer Alternative Outfall Design Peak Outflow Rate (cfs)	∆ Peak Flow Rate (cfs)
4% 24-HR	2.82	2.86	0.04	277	1259	982
1% 24-HR	3.80	2.86	-0.94	319	1627	1308

In summary, the proposed diversion project is predicted to have a positive impact to the Church Creek Basin and surrounding areas, in particular the neighborhoods and City facilities adjacent to Lake Dotterer based on the modeling results. The proposed alternative outfall will provide relief for rain induced flow imposed on Lake Dotterer, thus mitigating flooding of private properties and road rights-of-way and reducing the drawdown time for larger storm events.