MALACH CONSULTING

Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

March 21, 2021

Betsy La Force
Communities & Transportation Project Manager
South Carolina Coastal Conservation League
131 Spring Street
Charleston, SC 29403
Tel: (843) 725-2063
E-mail: BetsyL@scccl.org

Dear Betsy,

On March 18 Jimmy Mazyck documented the 48" stormwater pipe at EME Apartments flowing completely full (see left-hand side of Fig. 1). The parallel 42" stormwater pipe was not flowing since it had been sealed with rocks for an unknown reason (see right-hand side of Fig. 1). The location of the pipes is the center of the green circle in Fig. 2.

I am writing to address the following question: What is the implication of the above event for the validity of the AECOM and Seamon-Whiteside stormwater models? Before answering this question, I will first review the relationship between the AECOM and Seamon-Whiteside stormwater models and what was previously known about their validity.

The AECOM stormwater model is described in "Technical Memorandum—Subject: Evaluations and Recommendations for Central Park Project Area," which was released on August 7, 2020, and which is available at this link:

https://www.charleston-sc.gov/DocumentCenter/View/27211/Central-Park-Tech-Memo---Compiled---Final---08072020?bidId=

The AECOM stormwater model was jointly contracted by the City and County of Charleston at a cost of $400,000. The model was developed based on historical information on stormwater infrastructure that was available from the City, 2017 Lidar data available from the County, engineering drawings from the various existing and proposed developments in the Central Park area, and a minor amount of fieldwork. Although some fieldwork was carried out, it was not sufficiently thorough to discover that a 42" stormwater pipe was completely sealed. The AECOM report clarified that the engineering drawings included the stormwater plans for the Central Park Cluster Development that were prepared by Seamon-Whiteside (see Fig. 3). On that basis, the Seamon-Whiteside stormwater model should be regarded as a subset of the AECOM stormwater model that is applicable in the vicinity of the proposed Central Park Cluster Development. According to the AECOM report, "All models must be calibrated and validated to

MALACH CONSULTING

Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

ascertain that they represent the observed/measured data. No measured flow or stage data exists in the Central Park Study Area. Therefore, no model calibration for specific rain events was performed."

The AECOM report makes no mention of the U.S. Geological Survey (USGS) South Carolina StreamStats model, which was released in 2018. The South Carolina StreamStats model was the result of a four-year collaboration between the USGS and the South Carolina Department of Transportation (SCDOT). The StreamStats model was developed from Lidar data for the entire state and data on stormwater infrastructure (especially culverts) available from SCDOT. The entire USGS StreamStats application is freely available and can be accessed through this link:

https://streamstats.usgs.gov/ss/

Information about the USGS/SCDOT South Carolina StreamStats model is available at this link:

https://pubs.er.usgs.gov/publication/fs20183070

The StreamStats model is not strictly a stormwater model, but a watershed model that allows for the delineation of watersheds and the estimation of streamflow statistics. However, the first step in the creation of a stormwater model would be the delineation of the boundary of the relevant watershed. Fig. 2 compares the watershed boundary used in the AECOM model (black line) with the watershed boundary that can be developed using the StreamStats model (amethyst line). There are considerable differences between the watersheds. In particular, based on the StreamStats model, some of the stormwater improvements recommended in the AECOM report are not even in the Central Park watershed. To the west of the watershed boundary are three proposed pipe improvements and part of a channel improvement that are outside of the watershed. To the southeast of the watershed boundary are two proposed pipe improvements and part of a channel improvement that are outside of the watershed.

When the sealed 42" stormwater pipe was first discovered by Jimmy Mazyck in April 2020, the City of Charleston Department of Stormwater Management said that, based on the AECOM stormwater model, it was irrelevant whether that particular 42-inch stormwater pipe was or was not blocked. According to an e-mail from Matt Fountain, Director of the Department of Stormwater Management, dated April 28, 2020, "We did have AECOM evaluate upsizing or reconstructing this pipe [the blocked 42-inch pipe] in our current model to determine if it has any benefit on reducing flooding. The drainage model shows that there are a number of upstream constrictions that also need to be improved before upsizing this pipe would reduce flooding in the area. For example, the pipes under Central Park Road are a 42" pipe and a 36" pipe, and between Central Park and this drainage box are another pair of 42" pipes, all of which already have less capacity than this downstream 48" pipe."

MALACH CONSULTING

Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

The above results from the AECOM stormwater model are inconsistent with the simplest calculations on pipe flow. In a memo that I wrote to Matt Fountain on September 17, 2020, I used the Chézy Equation for gravity-driven flow to show that two parallel 36" and 42" pipes have the same flow capacity as a single pipe with diameter 51.7". Moreover, two parallel 42" pipes have the same flow capacity as a single pipe with diameter 55.4". In other words, both sets of parallel pipes have greater flow capacity than the single, unsealed 48" pipe at EME Apartments.

After I wrote the September 17 memo, Jimmy produced videos showing that the drainage box at EME Apartments is actually fed by a 42" pipe, two 36" pipes, and an 18" pipe. In a follow-up memo that wrote to Matt Fountain on September 27, 2020, I showed that the same Chézy Equation can be used to show that the above set of four parallel pipes has the same flow capacity as a single 60" pipe. That greatly exceeds the flow capacity of the single unsealed 48" pipe that conveys stormwater out of the drainage box. On the other hand, if the 42" outfall pipe were unsealed, the combination of the 42" pipe and the 48" pipe would have the same flow capacity as a single 60" stormwater outfall pipe. I did not think it is a coincidence that the inflow capacity (equivalent to a 60" pipe) would be exactly equal to the outflow capacity (equivalent to a 60" pipe) if the 42" outfall pipe were unsealed. These pipe diameters seem to have been deliberately chosen so as to balance the inflow and outflow capacity at the drainage box at EME Apartments.

The inability of the AECOM stormwater model to reproduce the results of simple gravity-driven pipe flow calculations casts doubt on the validity of the AECOM stormwater model.

On March 19, 2021, the morning after the observation that the 48" stormwater pipe at EME Apartments was flowing completely full, the County of Charleston again confirmed that the AECOM model predicted that the unsealing the 42" stormwater pipe would make no contribution to drainage flow. According to an e-mail from Councilmember Jenny Honeycutt, "I followed up with county again about this. I know it is not what anyone wants to hear, but the AECOM model showed that unblocking the pipe wouldn't make a difference."

I am now directly addressing the significance of the photographs in Fig. 1. If the unsealing of the 42" pipe could make no contribution to drainage, then the 48" pipe could never flow completely full. If the AECOM model predicts that the unsealing of the 42" pipe could make no contribution to drainage, then the AECOM model has questionable validity.

It is important to note that the storm on March 18, 2021, was in no way an extreme storm. According to the Charleston 2.0 S weather station on James Island, 2.38 inches of rain fell on March 18, 2021. In Charleston, a one-year 24-hour storm, that is, a 24-hour storm with 100% probability of occurrence in any given year is 3.48 inches of rain. Information about storm return

MALACH CONSULTING

Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

periods and weather stations on James Island is available in my initial report entitled "Potential Impact of New Urban Development on Flooding on James Island, Charleston, South Carolina" at this link:

https://thrivingearthexchange.org/wp-content/uploads/2020/08/James_Island_Report_Emerman.pdf

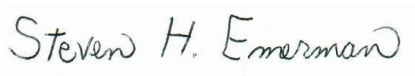
In summary, the AECOM stormwater model should be regarded as highly questionable for the following reasons:

1) The fieldwork behind the model was not sufficiently thorough to discover that a 42" stormwater pipe was completely sealed.
2) The model did not take into account the USGS/SCDOT South Carolina StreamStats model, which had already been freely available for two years.
3) The watershed boundary used in the AECOM model is very different from the watershed model that can be developed from the StreamStats model.
4) The predictions of the AECOM model regarding the sealed 42" stormwater pipe conflict with the results of simple pipe flow calculations.
5) The AECOM model predicts that the 48" stormwater pipe at EME Apartments could never flow completely full (equivalent to the irrelevance of unsealing the parallel 42" pipe), although it was observed to flow completely full after only 2.38 inches of rain (being much less than the one-year 24-hour storm of 3.48 inches).

Since the AECOM stormwater model is based upon the Seamon-Whiteside stormwater model, the stormwater plans for the proposed Central Park Cluster Development should be regarded as equally questionable.

Please let me know if I can help with anything else.

Best wishes,



Steven H. Emerman

MALACH CONSULTING

Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

Figure 1. On March 18, 2021, Jimmy Mazyck documented the 48" stormwater pipe at EME Apartments flowing completely full (see left-hand photo). The parallel 42" stormwater pipe was not flowing since it had been sealed with rocks for an unknown reason (see right-hand photo). The location of the pipes is the center of the green circle in Fig. 2. The left-hand and right-hand photos are stills of a video taken by Jimmy Mazyck at 0:39 and 0:28, respectively.

MALACH CONSULTING

Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

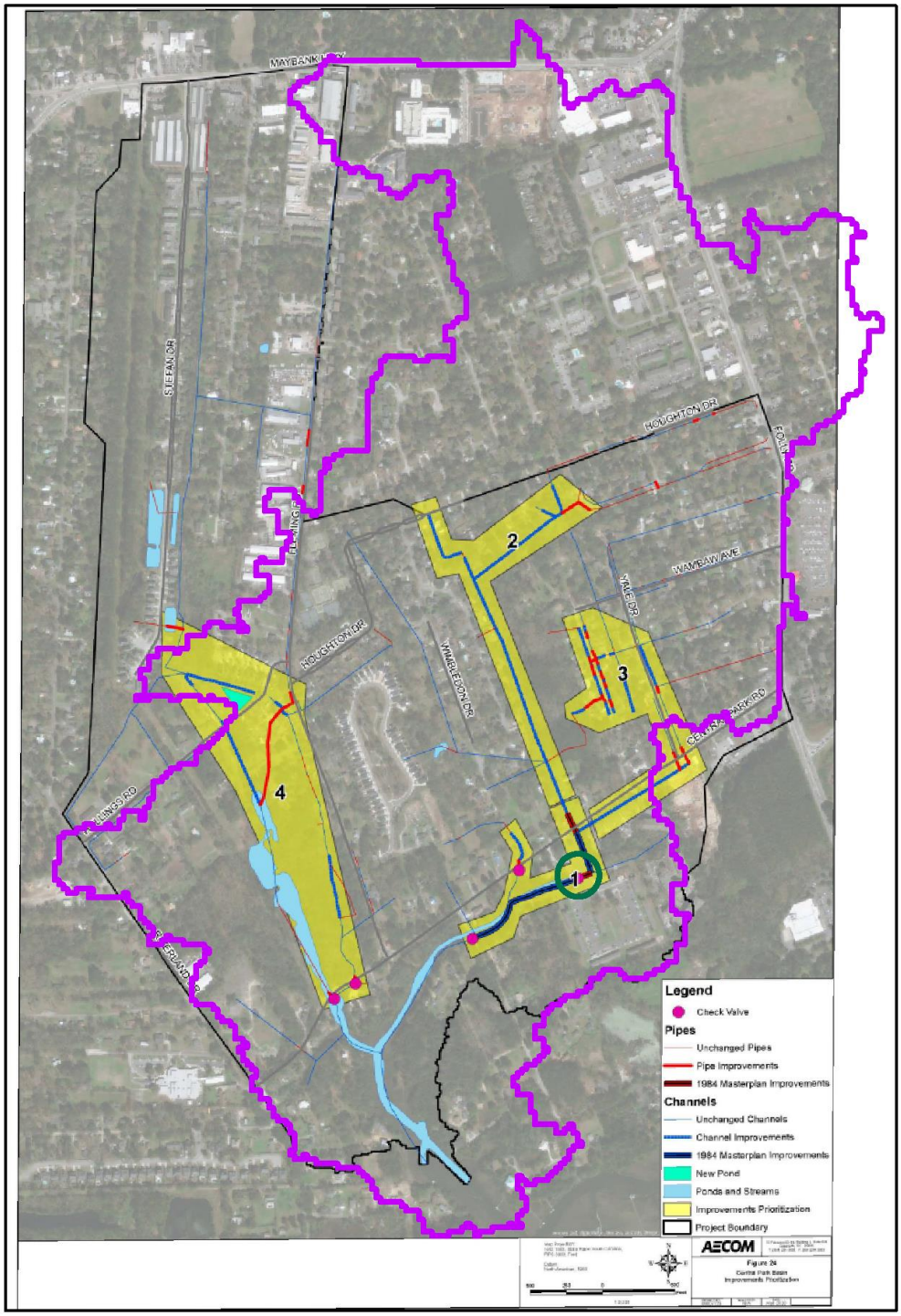


Figure 2. The black line is the watershed boundary used in the AECOM study, while the amethyst line is the watershed boundary developed from the USGS/SCDOT StreamStats model. Green circle is location of Fig. 1.

MALACH CONSULTING

Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

Table 3 – List of Previous Master Plans, Drainage Studies, Drawings, and Manuals

Year	Title of Document	By
1984	Master Drainage and Floodplain Management Plan	Davis and Floyd, Inc.
2007	City of Charleston Stormwater Management Ordinance	City of Charleston
2013	Stormwater Design Standards Manual	City of Charleston
2016	City of Charleston Redevelopment Standards for Stormwater	AECOM
2019	Central Park Cluster Development SWPPP	Seamon Whiteside
2018	Brisbane Cluster Development	Empire Engineering, LLC
2018	Fleming Road Cluster Subdivision as Built Drawings	Foresight Surveying, LLC
2019	Stormwater Management Report James Island Drainage Study	Thomas and Hutton

Figure 3. The AECOM stormwater model was developed from engineering drawings, including the drawings by Seamon-Whiteside for the proposed Central Park Cluster Development.