



MEMORANDUM

TO: Rob McFee, PE
FROM: Tony Maglione
DATE: May 26, 2011
RE: Request for ATM Task Order Deliverables

We have reviewed your request on behalf of the Chairman of the Stormwater Advisory Board (SWAB) concerning deliverables from ATM's services provided to the County as part of ATM's work assisting the County with the development of the Stormwater Volume Control Ordinances for new and redeveloped areas (Step 1) and individual lots of record not built on (Step 2). Specifically the following was requested to be assembled and provided to the SWAB. Our response to each request is noted along with each item:

1. **Request:** Task Order 1 – Deliverables – “List of potential BMP’s that can be implemented to meet the intent of the Ordinance Amendments”

Response: The list of BMPs for Step 1 was initially developed by CDM and was provided to ATM for our review. Using this list and other information ATM proposed a list of BMPs for Step 2 were developed by ATM and are included as part of the BMPs included in the “Step 2 Worksheet” we developed jointly with your staff (see attached)

2. **Request:** Task Order 2 – Sub-task 2 – “Perform percentile analysis for 30 years of rainfall data” – “goal of the percentile analysis to quantify the Stormwater volume that would no longer reach surface waters using the proposed ordinance”

Response: The 30 years of rainfall data was reviewed and compared to a similar computation used for the Georgia DNR Stormwater Coastal Supplement. After considerable discussion with the County, it was determined that the 95 percentile storm event would be the most protective (this came from the *Technical Guidance on Implementing Section 438 of the Energy Independence and Security Act federal facilities guidance*). ATM compiled the rain fall data using the Savannah Airport gauging (the same data set used by Georgia DNR) and determined that a 1.95 inch rain event equated to the 95 percentile storm. See our attached memo of September 9, 2009.

3. **Request:** Task Order 2 – Deliverables – “Comments and recommendations on CDM example BMP’s”

Response: Please refer to Item #1 above.

4. **Request:** Task Order 3 – Sub-task 1 – “technical opinion as to the validity of the development of the four examples developed by other engineers”

Response: ATM reviewed and met with both Thomas & Hutton (residential example review) and Ward Edwards (commercial example review) to discuss their approach and findings on the impact of Step 1 regulations on examples of new commercial and residential developments. Our review is documented in the attached memo dated October 15, 2009.

5. **Request:** Task Order 3 – Deliverables – “technical memo on the results of the meetings with other consultants” (sub-task 1 – “technical opinion as the validity of the development of the four examples developed by other engineers”)

Response: Included as part of #4 above

6. **Request:** Task Order 5 – Deliverables – “technical memorandum from ATM describing the methodology verifying net Stormwater discharge..... description of proposed administrative process, development of the administrative process and forms including concept volume reduction BMP’s”
- a. “ATM will develop alternative methods to compute the net Stormwater discharge so the output of the TR55 method can be checked and/or corrected and the accurate net stormwater flows can be calculated”
 - b. “a table will be developed so the average net stormwater discharge from various size parcels located on different soil types with differing pervious/impervious coverage ratios can be created”
 - c. “Development of parcel based stormwater volume reduction BMP’s... three general categories of parcel level BMP’s will be created...”
 - d. “Development of an Administrative Procedure for parcel owners, contractors and zoning administrator to use to calculate and verify compliance with stormwater volume control requirements”.... “administrative procedures and forms so that parcel owners, building contractors and County zoning staff can quickly and easily determine the amount of stormwater that must be reused within the parcel and the BMP’s that will need to be applied to meet the no net increase requirement”

Response: “a.” ATM reviewed the TR55 methodology and provided our opinion that the modeling concept was too general in nature for use as proposed by the County. Item “b.” is not a deliverable though a number of spreadsheets were developed that formed the basis for the current Step 2 Volume Control Worksheet currently being used by the County. “c” & “d” See item #1 above. This work was all incorporated into the Step 2 Volume Control Worksheet.

As you may recall ATM also provided other important deliverables that were not specifically noted in above and were not in our Task Order Scope of Deliverable. Examples of these were:

- ATM’s detailed memorandum on the steps necessary to implement the upcoming Phase 2 Small MS4 regulations
- ATM’s detailed memo on the issues and concerns with the designation of “volume sensitive” and “non-volume sensitive” waters

Both of these documents have been presented to the SWAB. Our memo relating to our review of the Phase 2 Small MS4 has been extensively distributed throughout the County through the MS4 Implementation Working Group.

Please let me know if you need any additional information and I will be pleased to provide it to you.

Beaufort County

Stormwater Retention Criteria for Single Family Lots

1. Introduction:

Recent scientific studies have shown that increases in stormwater drainage that reaches sensitive saltwater estuarine systems within the County are causing detrimental changes to the ecology of these systems. Increased freshwater flow, in the form of stormwater run-off, creates a number of environmental problems within estuarine systems. These are:

- Dilution of salinity in spawning and nursery area of saltwater creeks. Dilution of salinity impacts the ability of fish to spawn and grown in these areas.
- Transport of bacteria further into saltwater system. Bacteria survive longer in fresh water and the increase in stormwater run-off provides the means to transport bacteria further into the estuary and eventually into sensitive shellfish harvesting areas; thus increasing closures of shellfish harvesting areas within the County.

The County recently adopted new ordinances that will limit the amount of stormwater run-off that is allowed to leave the property for a new or redeveloped property. However, the County contains over 20,000 platted lots that have not been built on. As these "lots of record" are developed, unless a similar regulation for the management of the quantity of stormwater leaving a property is implemented, deterioration of estuaries is expect to continue and increase. As a result the County has developed an ordinance that stipulates stormwater volume control as part of construction on all undeveloped platted lots within the County.

2. Requirements:

Each undeveloped lots of record or lots of record where over improvements to the lot exceeds 50% of the taxable appraised value will be required as part of the process to obtain a building permit to:

- Complete the attached worksheet that will calculate the existing stormwater run-off and additional stormwater run-off that will be created by the new construction on the property.
- The property owner will be required to complete all Sections of the Worksheet so as to:
 - Calculate the quantity of stormwater that must be retained and reused within the property
 - Select Best Management Practices (BMPs) that will be used on the property to retain and reuse the calculated quantity of stormwater. Specific BMPs are outlined in part 3 of this document
 - Using the Worksheet, document how the selected BMPs will retain and reuse the calculated quantity of stormwater.

- Submit a completed Worksheet as part of the plans and specifications presented at the time a building permit is requested and indicate on the plans the location, type and design of selected BMPs.

3. Best Management Practices (BMPs):

BMPs are those systems that are used to capture, retain and reuse excess stormwater created by development of the property. The following BMPs are approved for use on single family lots so as to provide a means to capture, retain and reuse excessive stormwater:

Limitations on Site Clearing:

One of the most effective means to limit the creation of excessive stormwater run-off from a parcel is to limit the amount of clearing that takes place. Land that is left in its existing state, such as wooded areas, does not add to stormwater run-off volumes. To promote limitations on site clearing, especially related to the removal of mature trees, areas that are not cleared of any existing tree will not have to be included in the overall land area used to calculate excessive stormwater run-off. To benefit from use of this BMP, the following criteria must be met:

- No tree over 4 inch DBH can be removed
- The area cannot be filled or re-graded
- If the area is under brushed then the area will need to be replanted as a Rain Garden
- Drainage of stormwater to the area must be maintained to ensure trees and plants are properly hydrated

Trees can be limbed to provide reasonable understory clearance but no higher than 10 feet above existing grade.

Infiltration:

The absorption of stormwater into the ground is infiltration. Infiltration is an effective means to capture, retain and reuse excessive stormwater that may drain from building roofs, patios, driveways and other hard surface structures. The amount of infiltration varies by soil type. Sandy soils allow for more infiltration and clayey soils allow for much less infiltration. In many cases granular fill material is placed on the lot to raise the lot elevation. To be used for infiltration fill material must:

- Have a minimum porosity of 15%
- Is a minimum of one foot thick (except for tapering of grades at property lines, curbs, etc.)
- Direct stormwater run-off from hard surface areas in manner that allows for sheet flow across filled areas
- Only the amount of fill placed above the seasonal ground water level can be used for capture, storage and reuse of excess stormwater
- Only pervious areas can be included in the allowable infiltration area. Impervious areas such as hardscapes, buildings, driveways, walkways, etc. cannot be included in the area designated for infiltration.

Beaufort County Stormwater Retention Worksheet for Single Family Lot

Section 1 - Lot Information:

Total Impervious Area to be created:		Lot Type:
Home	_____ sq. ft.	___ Wooded with mature trees
Patio/Deck	_____ sq. ft.	___ Cleared with no mature trees
Walkways	_____ sq. ft.	___ Partially cleared and wooded
Driveways	_____ sq. ft.	Lot Size: _____ sq. ft.
Shops/Outbuildings	_____ sq. ft.	Soil Type: ___ Sandy ___ Clayey
Total Impervious Area: _____ sq. ft.		

Section 2 – Pre-Construction Stormwater Run-off Calculation:

Area of lot to be cleared _____ sq. ft.
 Area of lot to remain wooded with mature trees _____ sq. ft.
 Amount of rain falling on the cleared area of lot from a 1.95 inch rain event:
 _____ X 1.215 gal/sq. ft. = _____ Total gallons of rainfall
 (Area of Lot to be cleared) (Pre-Construction)

Section 3 – Post Construction Stormwater Run-off Calculation:

Additional run-off to be created by construction of Total Impervious Area
 Gallons of rainfall to be displaced by creation of new impervious areas
 _____ X 1.125 gals/sq.ft. = _____ gallons
 (Total Impervious Area)

Less Equivalent Pre-Construction Run-off for Total Impervious Area
 (_____ X 1.125 X _____ = _____ gallons)
 (Total Impervious Area) (CN)

“CN” = 0.85 for Clayey Soils “CN” = 0.65 for Sandy Soils

Total Additional Run-off: _____ gallons

Section 4 – Application of Best Management Practices:

Total Additional Run-off = _____ gallons – This amount must be retained and reused within the property
 Remaining Previous Area = _____ - _____ = _____ sq.ft.
 (Area to be Cleared) (Total Impervious Area)

Best Management Practices to be used:

1. Infiltration: Imported Granular Fill Material (min. 20% porosity):

_____ cubic feet of fill X 1.12 gals stored per cubic foot =
_____ gallons stored
(Remaining Impervious Area)

2. Stored and reused for irrigation on the property= _____ gallons reused

3. Discharged to Rain Gardens:

_____ sq.ft. of Rain Gardens X _____ gallons per sq. foot of Rain Garden=
_____ gallons reused

Total Capacity of all BMPs = _____ (Total of #1, #2 and #3 above)

Section 5 – Compliance with Regulation:

____ Total Additional Run-off is equal to or less than the Total Capacity of all BMPs
____ Does not Comply

Section 6 – Notes and Conditions:

1. For an area to qualify as “Areas to remain wooded with mature trees” they must comply with the following:
 - a. No trees over 3 inch DBH can be removed
 - b. The area cannot be filled
 - c. If areas are under brushed, the understory area must be reconstructed as a rain garden. Trees can be limbed to provide reasonable understory clearance.
2. Soil classification will be based upon the SCS Soils Maps or by in place hand auger testing of soils (to a minimum of 5 feet below existing grade) by a qualified soils engineer.
3. If Imported Granular Fill Material is to be used as a BMP, it must be a minimum of 1 foot thick and placed at an elevation above the seasonal high groundwater level. The thickness of Granular Fill Material may be tapered to less than 1 foot thick at transitions to adjoining property, existing curbs, drainage structures and/or Rain Gardens. Minimum porosity is 15%.
4. Run-off stored for Irrigation use must be used within 14 days of collection.
5. Rain Gardens must meet the following requirements:
 - a. A minimum of 1 tree per 100 sq. ft. must remain or be planted.
 - b. Trees must be a minimum of 3 inch DBH
 - c. A minimum of 4 understory plants (minimum of one gallon in size) must remain or be planted per 100 sq. ft.
6. Stormwater run-off will need to directed to Rain Gardens as part of the overall site grading plan or can pumped to the Rain Garden via an irrigation system



MEMORANDUM

TO: Dan Ahern

CC: Tony Maglione, Robert Klink

FROM: Chris Ahern

DATE: September 9, 2009

RE: Percentile analysis of Savannah Airport and MCAS Beaufort Rain Fall Data

ATM performed a percentile analysis of the Savannah Airport and MCAS Beaufort daily rainfall data to compare the data and to provide corresponding rainfall events on a percentile basis.

The results presented in Table 1 below were determined using the methodology described in the February 2009 document titled “Technical Guidance on Implementing Section 438 of the Energy Independence and Security Act” (referred to as “EISA 438”). In summary the methodology described in EISA 438 excludes daily rainfall events less than 0.1 inches as these rainfall events likely do not contribute to runoff. The events less than 0.1 inch are categorized as “depressional storage” in the EISA 438, which, in general, does not produce runoff from most sites.

Table 1 – Summary of Rainfall event percentile analysis

Percentile	MCAS Beaufort 1972 to 2009 (daily - inches)	Savannah Airport 1947 to 2009 (daily – inches)	*Savannah Airport 1978-2009 (daily – inches)
80%	0.79	0.96	0.96
85%	0.96	1.15	1.16
90%	1.19	1.38	1.38
95%	1.66	1.95	1.94
98%	2.49	2.77	2.73
99%	3.10	3.41	3.32
99.9%	7.19	6.95	6.99
99.99%	9.07	8.47	7.12
record length	~37 yrs	~62 yrs	~31 yrs

Notes:

Events >= 0.1 inches are included in the above analysis.

* Column titled Savannah Airport 1978-2009 was preformed to directly compare to percentile analysis presented in GA Stormwater Manual Coastal Stormwater Supplement dated April 2009 which notes 85th percentile= 1.2 inches.

Based on the analysis performed on the Savannah Rainfall 62 years of rainfall data for Savannah Airport, ATM recommends that Beaufort County reference 1.95 inches as the 95th percentile rain event in future ordinance and BMP Manual Revisions. ATM recommends the use of Savannah Airport Data Record between 1947 and 2009 because of the length of the continuous data record and the proximity of Savannah Airport to Beaufort County .

Figures 1 through 4 present graphical comparisons of the Savannah Airport (1947 to 2009) and the MCAC Beaufort (1972 to 2009). Please note the MCAS data is not continuous and is missing some record of year between 1999 and 2001 then again in 2005 and 2007.

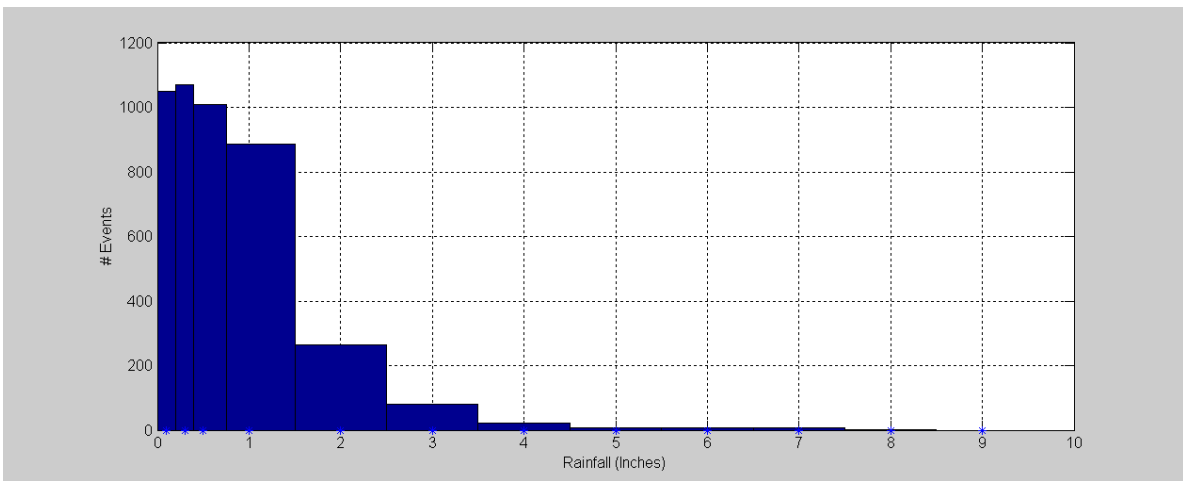


Figure 1: Savannah Histogram

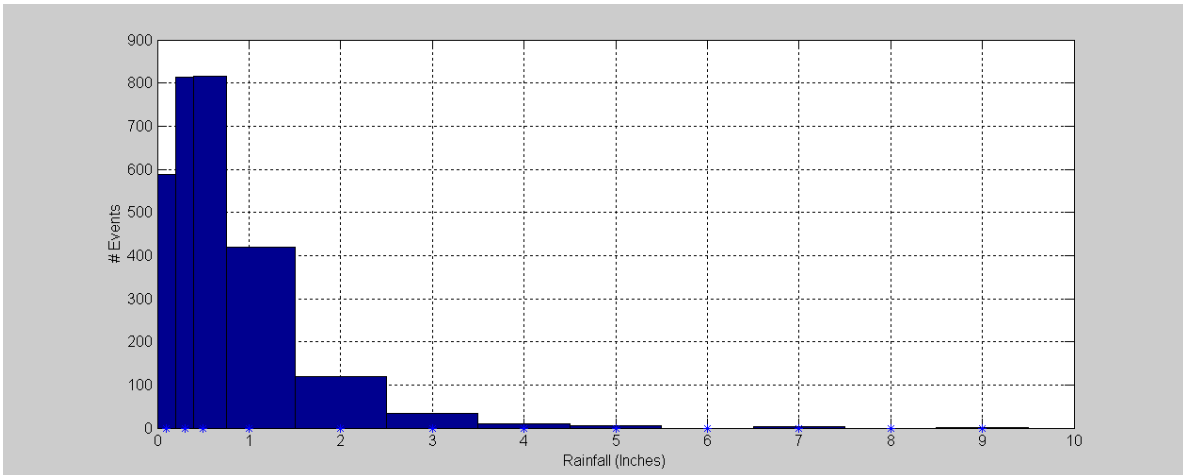


Figure 2: MCAS Histogram

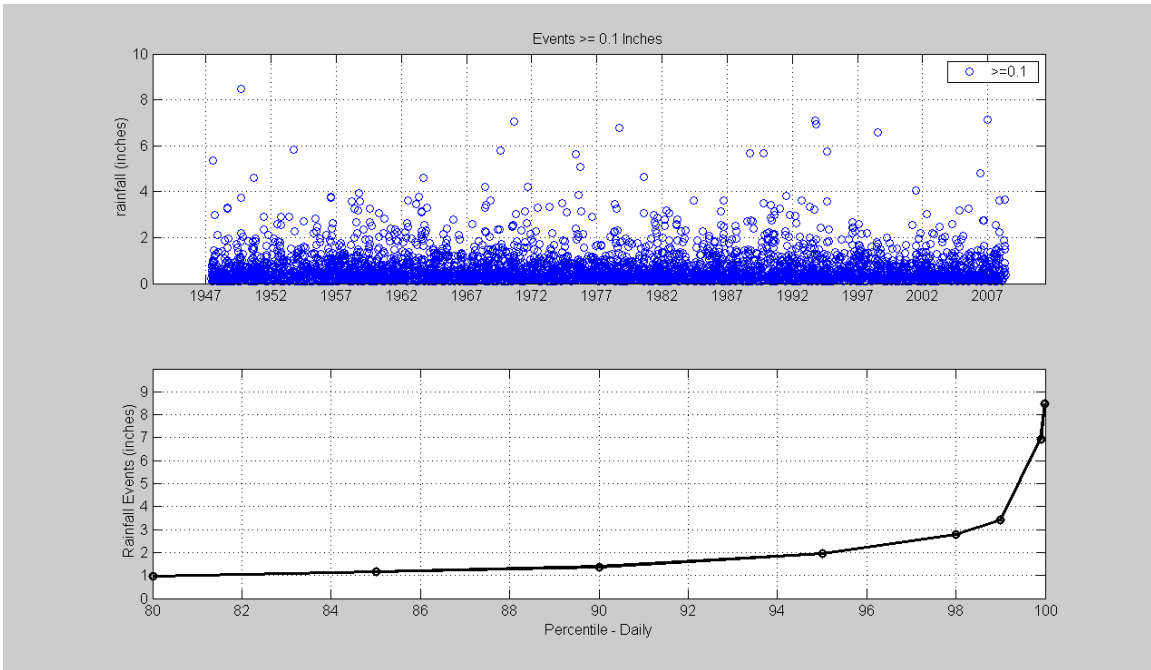


Figure 3: Savannah precipitation events ≥ 0.1 inches

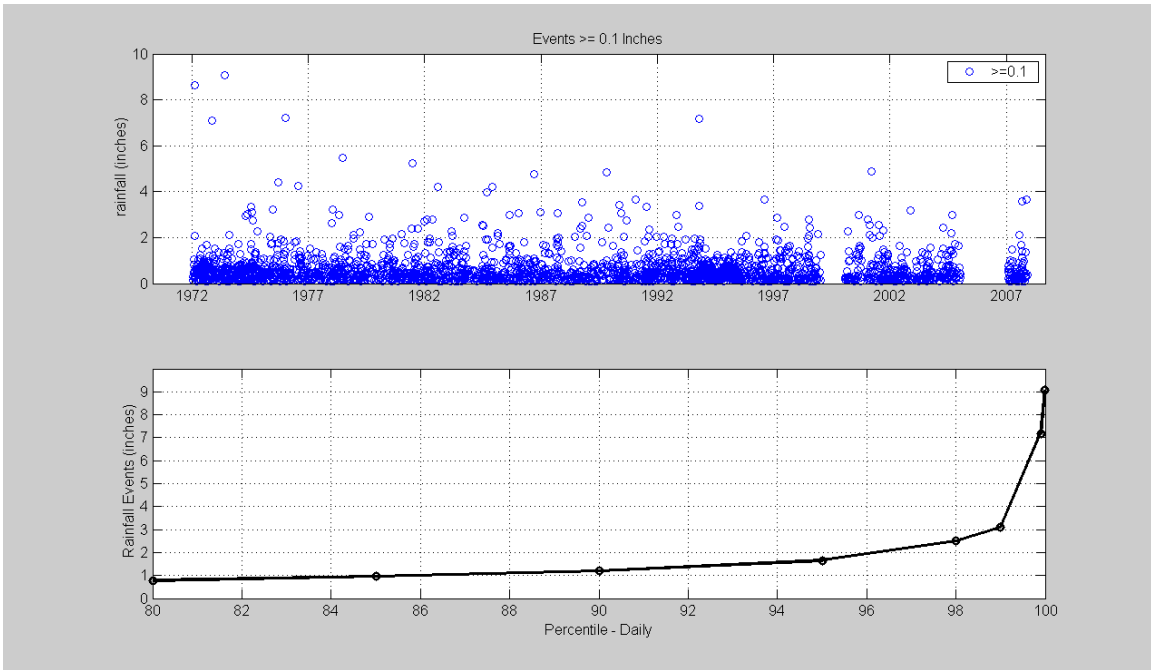


Figure 4: MCAS Beaufort precipitation events ≥ 0.1 inches

Irrigation:

Stormwater run-off from vertical structures can be captured by the use of a gutter and leader system and piped to an underground storage tank.

Stormwater captured in this tank can then be used for irrigation of landscaped areas within the property. If irrigation is used as a BMP then:

- The storage tank, at a minimum, should be capable for storing the excessive stormwater run-off calculated from the Worksheet
- All stored stormwater will need to be used for irrigation within 14 days of the time it is collected and stored.

Rain Gardens:

Rain Gardens are planted areas that capture stormwater run-off and contain existing or planted trees and plants. As trees and plant root systems uptake considerable amounts of water in order to grow, creation of new and/or enhancement of existing tree and plant areas can be used to capture, store and reuse excessive stormwater run-off. The amount of stormwater that can be absorbed by plants in a Rain Garden has been calculated to be ____ gallons per sq. foot of Rain Garden based upon the minimum requirements outlined below. In order to use Rain Gardens as a BMP the minimum requirements must be met:

- A minimum of 1 tree per 100 sq. ft. must remain or be planted.
- Trees must be a minimum of 3 inch DBH
- A minimum of 4 understory plants (minimum of one gallon in size) must remain or be planted per 100 sq. ft.
- Trees and plants must be native plant types
- Stormwater run-off will need to be directed to Rain Gardens as part of the overall site grading plan or can be pumped to the Rain Garden by an irrigation system



MEMORANDUM

TO: Dan Ahern

CC: Tony Maglione, Ed Modzeleski

FROM: Chris Ahern

DATE: October 15, 2009

RE: Review of interim submittals for Technical Feasibility and Cost impact studies to support DRAFT Excess Stormwater Ordinance

ATM has completed a review of the interim submittals from Ward Edward (WE) and Thomas & Hutton (TH) for their respective studies to support the development of the Excess Stormwater Ordinance. Our findings for each report are summarized below.

WE Preliminary dated 24 September 2009:

- Page 1: Estimated Construction costs for each scenario area based on recent bid responses for similar projects. Estimated construction costs estimate hard costs only.
- Page 1: Volume of stormwater runoff volume for the pre and post development scenarios is determined by applying single 1.95" rainfall event. The Average Annual Volume Difference is determined by multiplying the volume for the single 1.95" rainfall event by 26 to estimate the stormwater volume to be retained and eventually disposed of over a year. The multiplier of 26 was determined as the number of 1.95" events to achieve a total of 48" of rainfall in a year (ref: SCDNR 2004 Report Figures 6, 7 and 8).
- Page 1: Difference in pre and post development stormwater runoff volume is determined by comparing ICPR model runs for each scenario (e.g., 2 acre commercial site on A soils). ICPR model input is Curve number for property determined by TR-55 Method. Both the application of ICPR and TR-55 are good applications for this study as Beaufort County would likely require similar demonstrations to demonstrate the difference in pre and post development stormwater volume to be retained on site.
- Page 1: Total volume to be retained on site in this study is only the impervious area. No stormwater volume for pre and post development for pervious areas is included. It is likely that converting a cilva culture to lawn in a given property would create a difference in volume between pre and post development. However, these stormwater controls would already be included in the base hard cost estimate.
- Page 1: ATM agrees with the WE methodology to calculate volumes using ICPR and TR-55 and believes the County will rely on a similar methodology to demonstrate pre and post development.
- Page 1: Rate of ET is assumed to be 0.5 inches per day per ft² of grass. The assumed rate of ET is conservative. Additional volume of ET could be achieved using greater rates for forested areas, specific trees species and rain gardens however, these rates are currently theorhetical and based on ATM's preliminary research, not immediately

defensible. For the purposes of this feasibility and cost estimate study, the conservative rate of 0.5 inches per day per ft². Future BMP Manual revisions should revisit the assumptions for ET and potentially provide ET rate assumptions for specific plant species and forest densities as these data become available.

- Page 2: The volumes of ET vs. Infiltration are determined in two different portions of the year; Nov-March and Apr-Oct. ATM considered the partitioning of months a viable approach since difference in solar radiation and growing season can be accounted for. Assumptions for volume calculation will be better explained in Final Report.
- Page 2: Average Annual Treatment volumes are calculated from portions of year volume calculations using weighting factors. Weighting factors will be better explained in Final Report although the assumptions seem reasonable based on a preliminary review of the weighting factors in a spreadsheet.
- Page 2: Emptying of volume of cisterns (volume of cistern calculated on page 1) assumes a 10-day pumping disposal rate. ATM believes the 1.95" rainfall event (95th percentile daily rain event) is a significant event that another rainfall event within the 10 days is unlikely however a WE should present a statistical analysis of the frequency of 1.95" and less events (i.e., 1.75", 1.5", 1.0", 0.5") immediately following a 1.95" event to evaluate if this assumption is reasonable.

TH Letter Report dated 25 September 2009:

- Overall: Preliminary deliverable does not include detention of 1.95" rainfall from impervious surface in stormwater volume calculations. Calculation of stormwater volume is instead focused on pre and post development volume difference for an entire development resulting in typical rainfall year. Cost estimates for options of disposing of the stormwater volume difference therefore do not consider the intent of detaining the 95th percentile rainfall event (1.95").
- Page 3: TH analyzed the rainfall record to determine a typical rainfall volume by month. The results of their analysis is validated by the sum of the monthly averages totaling 47.99 inches of annual rainfall, almost exactly what the 2004 SCDNR Study states. However, ATM believes averaging of the rainfall events by month eliminates the peak rainfall events that need to be considered to evaluate if design for detention of a single 95th rainfall event is sufficient to capture the necessary volume.
- Page 3: Scenario 1 is Golf Course irrigation using detained stormwater from pre and post development difference. No application rates of irrigation (to determine emptying rate of ponds), ET (to estimate how much water is taken up and released to atmosphere by plants) and infiltration (to estimate how much water is assumed) are included. In order for multiple reviewers to understand how the volume is to be drawn down over BMP's over time, these rate assumptions should be included.
- Page 6: Similar to Scenario 1, Scenario 2 does not provide rates on how the retained water is disposed of on residential lots.
- Page 5 and 7: Cost estimates are presented in high-low format. Beaufort County and ATM will need to determine if average of high-low cost is best method to present cost estimate to County Council. However, the construction costs presented in this report should be considered unusable because the retention of 95th percentile rain event is not included in the cost estimate.

Path Forward

The approaches of studies are significantly different and do not allow for direct comparison, therefore the studies must be revised to allow for direct comparison in support of the Draft Excess Stormwater Ordinance. As the 3rd reading of the ordinance is scheduled for 26 October 2009, I recommend that WE and TH receive the following instructions to be completed by **9 AM, Friday 23 October**. The submittals can be revised preliminary submittals to demonstrate the results of the revised approach. Final Reports can be submitted at a later date and will be written to support the ordinance directly.

Instruction #1: TH study should be revised to include the retention of first 1.95" rain event from impervious surfaces.

Instruction #2: For the purposes of comparison, both studies should estimate hard construction costs (e.g., infrastructure and vertical construction) and allow Beaufort County to apply multiplier to the hard cost estimates to estimate total construction costs.

Instruction #3: WE and TH studies should both calculate the difference of pre and post development stormwater volume to be retained for a site, for both pervious and impervious area, by using a single 1.95" and specifying a duration to empty the cistern or other BMP's they select. Then, in order to confirm the stormwater volume assumptions of 26 single 1.95" events is a reasonable, an SWMM model should be run with 30 years of rainfall data to determine maximum peaks in volume to be retained over historic record. The rainfall record can be provided to Beaufort County for distribution to WE and TH to ensure the same results are received. If the volumes to be retained at any one time are more than 50% of the volume difference for a single 1.95" event including the time assumed for emptying the BMPs, the study should identify how the design could be augmented to improve capture during periods in time when the maximum volume is created.

Instruction #4: Allocation of water to empty the BMP that capture the excess stormwater should reference "irrigation", "roof misting", "(other proposed BMP to reduce retained volume)" and "evaporation" so that multiple reviewers of the study can understand how the individual BMPs reduce retained stormwater volume.

Instruction #5: ET and EV rate assumptions should include at least two seasons to reflect changes in seasonality. For example, WE study includes Nov-Mar and Apr-Oct to reflect the changes in solar radiation and growing season for the plants.

ATM has received the scopes of both WE and TH to prepare these studies and in a subsequent memorandum will describe how the text of each scope of work or task order can be revised to serve as references for the Draft Excess Stormwater Ordinance. Please note the proposed revisions to the scopes recommended by ATM may result in a change in cost for the Consultants to perform the revised scope. ATM will be providing the suggested revisions to the scopes and task order as a suggested starting point in negotiations between Beaufort County and the consultants, WE and T&H.