ITEM 10a:
WAKE COUNTY HYBRID STORMWATER DESIGN TOOL SUBMITTAL
JORDAN LAKE NUTRIANT STRATEGY COMPLIANCE SUBMITTAL
SEPTEMBER 10, 2011

Wake County Hybrid Tool

Wake County is unique in that it has its own volume control SW ordinance, local and state water supply watershed regulations and is subject to three state nutrient management strategies in addition to the Swift Creek Land Management Plan. The complexity of applying multiple and overlapping regulations necessitates a streamlining of development submittal and review processes through the use of a single hybrid stormwater tool.

Wake County administers its own stormwater ordinance for unincorporated areas of Wake County in addition to a different urban stormwater ordinance for three municipalities in eastern Wake County. For the unincorporated areas, Wake County uses a volume-control stormwater ordinance with Target Curve Number (TCN) runoff volume limits for residential development. Both residential and commercial developments adhere to *The Neuse Rules* stormwater requirements for peak flow, nutrient management, and riparian buffer rules. Wake County also adopted the Neuse regulations countywide (including within the Cape Fear Basin).

For stormwater submittals, engineers are currently required to complete the Wake County Stormwater Design Tool, which incorporates the Neuse requirements. The tool calculates pre and post development runoff, peak flow, nitrogen loading, and target curve number volume requirements. With adoption of the Falls Lake and Jordan Lake Nutrient Strategies, it was necessary to adapt the current Wake County tool to include the Falls/Jordan nutrient requirements. With administration of three different regulatory watersheds for review (Falls, Jordan, and Neuse/Cape Fear areas) it became necessary to streamline development submittals into one comprehensive tool.

Wake County is submitting for review/approval a hybrid Stormwater Design Tool incorporating *Wake County Unified Development Ordinance* requirements and nutrient requirements associated with the *Falls Lake Nutrient Strategy, Jordan Lake Nutrient Strategy and The Neuse Rules*. The submitted tool will incorporate requirements as outlined in the *Jordan/Falls Lake Stormwater Load Accounting Tool – User's Manual* and will be as protective as the Jordan/Falls tool. The hybrid tool will also comply with *The Neuse Rules*. All nutrient load calculations for this tool use the same methods used in the Jordan/Falls tool.

Wake County Hybrid Tool Contents

The submitted draft tool is comprised of the following calculation sheets:

- Site Data worksheet
- DA worksheets
- Site Summary worksheet
- DA BMP worksheets
- BMP Summary worksheet
- Calculations sheet

Note: Behind the scenes calculation sheets are also hidden to the public on other tabs. All hidden sheets may be accessed by DENR by right clicking the sheet tabs and selecting *Unhide.* Only cells in blue (engineer inputs) will have editing privileges for public distribution.

Site Data Worksheet

The Site Data Worksheet contains project information including but not limited to:

1. Engineer contact information
2. Site Location (Regulatory Watershed, Geologic Region)
    a. Used to determine target N and P Loads and BMP removal rates
3. Development Type (Residential/Nonresidential) and Zoning
    a. Development type is used to determine Target Curve Number (TCN) applicability and zoning assumptions
4. Precipitation Amounts
5. Stormwater Narrative
    a. Stormwater Narrative should describe the site conditions pre and post development including a description of site improvements and proposed stormwater BMPs.

DA1-6 Worksheets

DA worksheets are designed to account for project requirements per Wake County UDO standards as well as the Neuse, Falls Lake and Jordan Nutrient Strategies. All project information is entered by drainage area. The tool allows for up to six drainage areas for the project. **DA** Worksheets calculate runoff, time of concentration, peak flow, and volume to be managed per drainage area (if applicable). Inputs are also used to calculate the site composite curve numbers for pre and post development and total nitrogen (TN) and phosphorus (TP) loading calculations by drainage area.

Notes and Assumptions for DA1-6 worksheets:

1. Site and offsite land uses
    - Not all land uses from the Jordan/Falls tool were used in the Wake County tool. All residential land uses use the custom lot option instead of the general lot sizing method. Detailed breakdown of residential land use is required by Wake County UDO for Target Curve Number (TCN) requirements.
    - Land uses are assigned curve numbers (CNs) adapted from TR-55 as well as Event Median Concentrations (EMCs) as defined by the *Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool User Manual.*

- The following additional land uses have been added to comply with Wake County TCN requirements: Transportation-High Density (right-of-ways, grassed), Transportation-Low Density (right-of-ways, grassed) and Residential-Roadway (right-of-ways, grassed). These land uses have the same EMCs as the associated roadways but have differing CNs.
- Site land uses are used to determine pre and post development CNs and nutrient loading. Since the *loads contributed by the proposed new development activity shall not shall not exceed the unit area mass loading rate for nitrogen and phosphorus* [NCAC 02B.0277(4)(a)], site nutrient loading is only calculated from site land uses.
- Offsite and site land uses are used to determine pre and post development runoff and peak flow.
- All pre and post nutrient loading back calculations can be found on the **Pre-Post NP Calcs_Hidden** sheet. To view this sheet, right click the sheet tabs and select *Unhide*. This sheet closely resembles the WS Calcs hidden sheet in the Jordan/Falls tool.

2. The Wake County tool uses the Discrete SCS Curve Number Method for runoff volume (the Simple Method is used for the loading calculations) and TR-55 Graphical Peak Discharge Method for Type II Distribution for peak flow.
    - Wake County is currently examining the use of the Rational Method and Simple Method for runoff and peak flow calculations. Results of a comparison between these methods and the CN methods will be used to determine the best method for Wake County runoff and peak flow calculations and compliance with applicable nutrient management strategy. Rational C values will be converted from inputted CNs for the *Rational* peak flow approach. The final version of the Wake County tool will have this issue resolved if DENR is interested in this aspect of the tool.

Site Summary Worksheet

SITE SUMMARY worksheet summarizes the pre and post runoff and peak flow per drainage area based on inputs from **DA1-6** worksheets. TCN and composite curve numbers for pre and post development are also calculated and summarized. If the TCN is exceeded, this worksheet calculates total volume to be managed for the entire site based on TCN requirements.

Nutrient loading rates for the site are compiled and calculated from **DA1-6** worksheets. Target rates for nutrients are also summarized based on regulatory watershed.

Notes and Assumptions for SITE SUMMARY worksheet:

1. There is only one engineer input on this sheet. Disconnected Impervious - this area will be used to provide an adjusted post development composite curve number ($CN_{adjusted}$) to allow a credit for the use of disconnected impervious per Wake County stormwater ordinance.

DA BMP Worksheets

DA BMP1-6 worksheets require engineers to input proposed BMP information. BMPs are characterized by sub-basins within the drainage area. Engineers input BMP sub-basin land uses, BMP device name, type, and volume managed by device.

Notes and Assumptions for DA BMP worksheets:

1. BMPs within a sub-basin are assumed to be in a series with the same drainage area. Engineers may specify if sub-basins contribute to other sub-basins within the drainage area. This concept is very similar to Catchment Routing in the Jordan/Falls tool. The exception is that the Jordan/Falls tool allows for BMPs in a series to have different drainage areas. The Wake County tool accounts for this with the sub-basin approach. Both tools accommodate the same site scenarios.

2. Engineers input site land uses by sub-basin. Off-site drainage to the sub-basin is also required (if said drainage is routed through the BMP). Loading calculations are only based on site land uses/volume. Offsite values are used in addition to onsite values to calculate the required water quality volume (1" runoff). Consequently, while site loading is based on onsite land uses only, required BMP storage volume includes offsite drainage to obtain BMP removal credits. This concept differs from the Jordan/Falls tool assumption of including offsite land uses at built out conditions. Wake County has several issues with this assumption:
    - Very often in Wake County, developers choose not to bypass offsite drainage. Due to county volume control requirements, the device is often oversized. In many cases, it is more cost efficient to use this additional capacity rather than design and construct bypass options.
    - None of the nutrient strategies Wake County administers (Neuse/Falls/Jordan) state a requirement that new development treat offsite runoff at an assumed built-out condition in addition to the load from the new development.
    - Additionally, requiring built-out conditions assumes that offsite development is not responsible for their own nutrient loading. The built-out conditions assumption overestimates the load contributing to the new development downstream.
    - [15A NCAC 02B.0265] states…*loads contributed by the proposed <u>new development activity</u> shall not shall not exceed the unit area mass loading rate for nitrogen and phosphorus…*[this cannot be interpreted to include assumed maximum built-out conditions for offsite drainage].
    - [15A NCAC 02B.0273] distinguishes offsite nutrient removal as an offsite offsetting <u>option</u> that the developer may choose to use or not.

3. Rainwater Harvesting is a BMP type in the WC tool. However, removal of loading and volume has not been added to the tool. Rainwater harvesting will be addressed with resubmittal of this tool following DENR comments and will follow guidelines outlined in the Jordan/Falls User Manual.

4. BMP nutrient calculations are automatically calculated from sheet inputs. All BMP nutrient loading calculations can be found on the **BMP NP Calcs_Hidden** sheet. To view this sheet, right click the sheet tabs and select *Unhide*. This sheet closely resembles the **BMP Calcs** hidden sheet in the Jordan/Falls tool.

5. BMPs are required in each DA where post-development peak flow is higher than pre-development peak flow. Only under special circumstances will a BMP not be required.

BMP SUMMARY Worksheet

BMP SUMMARY worksheet summarizes the post development and post BMP runoff and peak flow per drainage area based on inputs from **DA BMP** worksheets. Nitrogen and Phosphorus loading for the site is calculated based on the results from **DA1-6 BMP** worksheets. Project compliance with the Wake County UDO, Falls Lake Nutrient Strategy, and/or the Jordan Lake Nutrient Strategy is presented on this sheet.

Notes and Assumptions for BMP SUMMARY worksheet:

All BMP nutrient loading calculations can be found on the **BMP NP Calcs_Hidden** sheet. To view this sheet, right click the sheet tabs and select *Unhide*. There are no engineer inputs on this sheet and all exceedances from **DA BMP** worksheets will be flagged in red with the final version of the tool.

CALCULATIONS Worksheet

All calculations and table references are included on this worksheet.

Notes and Assumptions for CALCULATIONS worksheet:

Some links to CALCULATIONS worksheet can be found throughout the other worksheets. The final version of the Wake County tool will provide additional links for calculation references.

Additional comments regarding the *Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool*:

1. The Wake County Hybrid Tool has been enhanced since the tool version submitted for Falls Lake on 8/10/11. The WC Tool provided with the Jordan submittal is the current version.

2. This submittal does not have all of the user-friendly features planned for the final version. Regulation red flags and warnings messages, complete Wake County ordinance requirements, final formatting, and engineer testing modifications will be added at a later date.

3. The Wake County Hybrid Tool (WC Tool) differs in basic structure from the Jordan/Falls Tool (JF Tool). The difference primarily deals with the organization of the site by actual Drainage Areas (DA) instead of the JF Tool *Catchments* (which may include more than one drainage area). The WC Tool drainage areas do not contribute runoff into other drainage areas as with the catchments in the JF Tool. Alternatively, the WC Tool does allow for sub-drainage areas (subDAs) to contribute to other subDAs; however these subDAs are always within the same DA. Example test scenarios are provided in this document to demonstrate this basic difference. We believe

the use of actual drainage areas is needed in order to better suit the type of low-density development that occurs in Wake County.

Additional assumptions regarding the *Wake County Hybrid Tool:*

1. The mass metric (lbs) used on the **BMPCalcs** worksheet of the Jordan/Falls tool will not be used in the Wake County tool. Ms. DeBusk confirmed that ultimately these values are not necessary in the Jordan/Falls tool (Discussed via telephone with Kathy DeBusk on August 9, 2011).

2. BMP oversizing – The Wake County tool ensures that each BMP has met the "water quality volume" (first flush) by calculating volume of runoff from the first inch of rain (including any offsite drainage being routed through the BMP). If the "provided storage volume" on the DA_BMP worksheets does not equal at least this amount, a red flag is raised. In most cases, BMPs will be oversized (greater than the NC BMP Manual water quality volume) in Wake County due to additional BMP design requirements (i.e.: TCN volume). The Wake County tool does not assume oversizing for nutrient removal if the BMP is designed larger to meet Wake County volume standards. Based on a meeting with Kathy DeBusk on July 6, 2011, Ms. DeBusk confirmed with Bill Hunt that this assumption would have minimal impact to loading calculations.

Potential Problems/Issues with the *Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool:*

Note: Potential problems identified below may affect comparison scenarios between the Wake County Tool and the Jordan/Falls Tool as well as produce inaccurate results for users of Jordan/Falls Tool if not addressed.

1. Jordan/Falls tool (JF Tool): Watershed loading value on the **BMP Calcs** worksheet (Rows 31 and 42) does not include the "Land Taken by BMP" except for BMP#1 in each catchment. All subsequent BMPs exclude this land use from the N/P totals. After speaking with Kathy DeBusk, this is a calculation error and Land Taken by BMP should be added to all of the BMP loads. The Wake County tool has "Land Taken by BMP" loading entering all BMPs. If not addressed, this issue has a potential for calculation errors for all development scenarios using the JF Tool.

2. JF Tool **BMP Calcs** BMP#3 (in all catchments) _Rows 55 and 66: *Previous BMP Overflow* TN and TP EMC (mg/L) reference an incorrect value. Cells should reference the *Composite EMC* (Rows 108 and 109) leaving the BMPs (BMP#2) in each catchment. Cells affected are E55, F55, I55, J55, M55, N55, Q55, R55, U55, V55, Y55, Z55, E66, I66, M66, Q66, U66, and Y66. The Wake County tool assumes this correction. If not addressed, this issue has a potential for calculation errors for all development scenarios with a 3rd BMP using the JF Tool.

3. Jordan/Falls tool: BMP Calcs worksheet references incorrect Rv values for Roadways in the summary N and P (lb) calculations producing underestimated loading for roadway areas.
    - Cells AD516 & AD623: reference to AD353 should be AD354
    - Cell AC516 reference to AC353 should be AC354
    - Cell AE623 reference to AE353 should be AE354

    If not addressed, this issue has a potential for calculation errors for all development scenarios with residential roadways.

4. It is assumed for the Wake County tool that for BMPs in a series, the total drainage area to all three BMPs includes the contributing drainage area plus the contributing drainage area from any additional subDAs that are routed through the BMP series. For scenarios where there are BMPs in a series with contributing catchments, the JF Tool results in errors in inflow drainage area calculations for some scenarios and in errors in inflow volume calculations for others.

    - <u>Example</u>: Catchment 1 has 3 BMPs (all with the same drainage area of 1 acre). Catchment 1 is also a contributing watershed to Catchment 2. The JF Tool assigns the same drainage area from BMP#1 to #'s 2-3 in Catchment 1(ie: **BMP Calcs**, D10, E11 & F11 would have the same 1 acre drainage area).

      A "Yes" value is required in the Catchment 2 column for BMP#1 (**BMP Characteristics**, L30) to show that Catchment 1 contributes to Catchment 2.

      Problem A: If a "No" value for BMP #'s 2-3 (**BMP Characteristics**, N30 & P30) is inputted the reported values for *Contributing Catchment* (**BMP Calcs**, I12 & J12) do not include the 1 acre from Catchment 1 for BMP #'s 2-3, producing errors in loading.

      Problem B: If a "Yes" value for BMP #'s 2-3 (**BMP Characteristics**, N30 & P30) is inputted, Problem A is addressed, however the total volume entering BMPs #2 and #3 are double counted (**BMP Calcs**, I23 & J23), producing errors in loading.

    As seen with this example, Wake County believes that **BMP Calcs**, Rows 12-17 may contain a errors. The Wake County tool addresses this scenario through a different platform that assumes that BMPs in a series do share the same drainage area. If comparing loading results to the JF Tool, this difference in theory does produce differing results. If not addressed in the JF Tool, this issue has a potential for calculation errors for all development scenarios using BMPs in a series with contributing catchments. <u>Wake County requests that DENR advice on our interpretation of this issue</u>.

Example Test Scenarios Performed by Wake County

Wake County performed test scenarios with the Wake County Hybrid Tool (WC tool) as well as the Jordan/Falls Tool (JF Tool). Inputs and results were compared and contrasted for both tools. The scenarios provide demonstration of calculation accuracy as well as direction on how the WC Tool and JF Tool, while different in structure, can be used for the same scenarios to comply with the New Development Rule. The example test scenarios, comparison results, and comments are listed below. Additional testing is still needed and further changes may be necessary.

TEST #1

WC Tool Inputs	JF Tool Inputs	Initial Results/Problems Identified	Comments
➢ 1 Drainage Area (2 Ac) ➢ 2 SubDAs (1 Ac each) ➢ 1 BMP in each sub DA ➢ SubDA (a) contributes to SubDA (b)	➢ 2 Catchments (1 Ac each) ➢ 1 BMP in each Catchment ➢ Catchment 1 contributes to Catchment 2	Test Passed with Modifications Pre and Post Development, Untreated, Leaving BMPs, and Post Development with BMPs calculations validated by both tools (See Summary tables on **BMP Calcs** (JF) and **BMP NP Calcs_Hidden** (WC).	Initial Results/Problems were identified and modifications to the JF were made as described in Potential Problem #1 & #3 prior to Test#1. Without these modifications, test scenario validation would have failed.

TEST #2

WC Tool Inputs	JF Tool Inputs	Initial Results /Problems Identified	Comments
➢ 1 Drainage Area (2 Ac) ➢ 1 SubDAs (1 Ac each) ➢ 3 BMPs in each subDA ➢ No contributing subDAs	➢ 1 Catchments (2 Ac) ➢ 3 BMP in Catchment ➢ No contributing catchments	Test passed with JF Tool Modifications N(lb), P(lb), TN EMC, and TP EMC values produced errors for these specific calculations with a margin of error of +/- 0.06 (See **BMP Calcs** and **BMP NP Calcs_Hidden** sheets).	Initial results included modifications to the JF Tool (Potential Problems #1 & #3) as described in Test #1 *Comments*. With modification to JF Tool as described in Potential Problem #2, test scenario was validated by both tools with no errors.

TEST #3

WC Tool Inputs	JF Tool Inputs	Results	Comments
➢ 1 Drainage Area (3 Ac) ➢ 3 SubDAs (1 Ac each) ➢ 3 BMPs in each subDA ➢ SubDA(a) contributes to subDA(b)	➢ 3 Catchments (1 Ac each) ➢ 3 BMPs in each catchment (all with same DA of 1 Ac) ➢ Catchment 1 contributes to Catchment 2	Test failed for Post Development, Untreated, Leaving BMPs, and Post Development with BMPs calculations (See Summary tables on **BMP Calcs** (JF) and **BMP NP Calcs_Hidden** (WC).	With modification to JF Tool as described in Potential Problem #4, test scenario could not be validated by both tools without errors. A comparison cannot be made between both tools for this type of scenario until Potential Problem #4 is addressed.

TEST #4

WC Tool Inputs	JF Tool Inputs	Initial Results/Problems Identified	Comments
➢ 3 Drainage Areas (1 Ac each) ➢ 1 SubDA (1 Ac) ➢ 1 BMP in subDA	➢ 3 Catchments (1 Ac each) ➢ 1 BMP in each Catchment ➢ No cross-contributing Catchments	Test passed with JF Tool Modifications Pre and Post Development, Untreated, Leaving BMPs, and Post Development with BMPs calculations validated by both tools (See Summary tables on **BMP Calcs** (JF) and **BMP NP Calcs_Hidden** (WC).	Initial results included modifications to the JF Tool (Potential Problems #1 & #3) as described in Test #1 *Comments*.

TEST #5

WC Tool Inputs	JF Tool Inputs	Initial Results/Problems Identified	Comments
➢ 3 Drainage Areas (1 Ac each) ➢ 2 SubDA (0.5 Ac each) ➢ 1 BMP in subDA ➢ SubDA(a) contributes to subDA(b	➢ 6 Catchments (0.5 Ac each) ➢ 1 BMP in each Catchment ➢ Catchment 1 contributes to Catchment 2; 3 to 4; and 5 to 6	Test passed with JF Tool Modifications Pre and Post Development, Untreated, Leaving BMPs, and Post Development with BMPs calculations validated by both tools (See Summary tables on **BMP Calcs** (JF) and **BMP NP Calcs_Hidden** (WC).	Initial results included modifications to the JF Tool (Potential Problems #1 & #3) as described in Test #1 *Comments*.