Delaware

Sediment and Stormwater Program

Technical Document

Article 3.

Plan Review

And Approval

Effective April 2016

3.01
Project Types

General Information
Construction projects that involve disturbance to the land for residential, commercial, industrial, agricultural and institutional land uses are subject to the *Delaware Sediment and Stormwater Regulations*. Construction projects that do not involve land disturbance, or projects that disturb less than 5,000 square feet of land, are exempt from the requirements of the *Delaware Sediment and Stormwater Regulations*. Agricultural land management, which includes tilling the land to plan a crop, is exempt from the requirements of the *Delaware Sediment and Stormwater Regulations*; construction of structures for agricultural use is not exempt. Land development projects as large as a 500-acre mixed use residential and commercial subdivision as well as small projects such as the construction of a single family residential home on single recorded lot on a county road is subject to these regulations.

Residential Construction
Residential subdivisions of all sizes and densities ranging from one acre lots to townhomes are developed in a way that accounts for and manages the stormwater runoff from the entire development. Stormwater rates and volumes are computed based upon all developed areas of the site. All impervious surfaces on the site, including roofs, driveways, sidewalks, roadways, and parking areas are factored into the runoff computations. The quality of the stormwater runoff from all of these impervious surfaces is managed as well.

Some residential subdivisions may be developed without open space or common areas. An example would be a strip-lot development along an existing roadway. When no open space exists for the management of stormwater, stormwater management must be accomplished on individual lots. Stormwater management facilities should be protected from alteration by homeowners through deed restrictions or easements, depending upon the type of stormwater management BMP that is constructed for the project.

When individual lots are developed as part of a residential subdivision, the term often used is “larger common plan of development”, the NPDES general permit coverage to discharge stormwater from construction activities for the subdivision includes each of those individual lots while they are under construction. When a lot is developed that is not part of a larger common plan of development, and the land disturbance exceeds 1.0 acre, the individual lot owner must apply for NPDES general permit coverage to

discharge stormwater from the construction activity by submitting a Notice of Intent (NOI) and developing a plan.

Individual residential lots that are not part of a larger subdivision, or a larger common plan of development, and where the disturbance is less than 1.0 acre, need only to comply with Standard Plan criteria in 3.01.1, an do not need to submit an NOI or develop a plan.

Commercial, Industrial and Institutional Construction

All projects for commercial, industrial and institutional construction where the land disturbance will exceed 5,000 square feet must submit a Sediment and Stormwater Management Plan for review and approval prior to beginning construction, and that plan must be implemented during construction. The Sediment and Stormwater Management Plan will provide for stormwater management of all developed portions of the site as well as erosion and sediment control and construction site stormwater management while the project is under construction.

All commercial, industrial or institutional projects that will exceed 1.0 acre of disturbance also require a permit to discharge stormwater from the construction activity. This permit coverage is gained by submitting a Notice of Intent (NOI) prior to Sediment and Stormwater Management Plan approval. Industrial sites will often have a separate NPDES permit to discharge stormwater from the industrial activity. The requirement for separate permit coverage for discharges from construction activities on a site containing an industrial stormwater discharge permit will be coordinated with the DNREC Division of Water Resources Surface Water Discharges Section.

Non-profit institutions such as churches are not exempt from the requirements of the *Delaware Sediment and Stormwater Regulations*. Small site disturbances of less than one acre on commercial, industrial or institutional sites do not require submittal of an NOI to gain permit coverage to discharge stormwater from a construction activity. Some non-residential construction projects that disturb less than 1.0 acre may be approved through a Standard Plan if the project meets all the Standard Plan criteria in 3.01.1.

Utility Construction

Utility construction poses a potential to discharge pollutants during the construction activity, especially when the utility installation involves stream crossings or disturbance close to the stream. Underground utility installation results in no change in the hydrologic condition after construction. However, any areas that result in a change to the hydrologic condition, due to clearing of trees or construction of impervious for an

access road, substation, pump station, etc., must manage the change in the runoff after construction.

Utility projects that disturb greater than one acre of land must have an approved Sediment and Stormwater Management Plan prior to beginning construction. A Notice of Intent (NOI) is required for these projects as well. Many utility projects result in very little land disturbance and may qualify for a Standard Plan. Please refer to the Standard Plan criteria for minor linear disturbances in 3.01.1.

Roadway Projects

Delaware Department of Transportation (DelDOT) is responsible for the majority of the publicly maintained roadways in the State of Delaware. Municipal governments own and maintain public streets within their jurisdictions, and some privately maintained streets exist within some subdivisions. When DelDOT undertakes the construction or major improvement to a state-maintained roadway, DelDOT reviews and approves the Sediment and Stormwater Management Plan and inspects the project during construction. These major roadway improvements require a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity.

When roadways are improved to support increased traffic due to the construction of new development, the developer is responsible for designing and constructing those roadway improvements to DelDOT standards. The size and scope of the developer-funded roadway improvements determines whether the review and approval of the plan and review during construction is conducted by DelDOT or the local plan approval agency such as a conservation district or the municipality. The reviewing agency is determined at the time of the pre-application meeting for the project. The NPDES general permit coverage for these developer-funded roadway improvement projects may be included with the general permit coverage for the project being developed through a single Notice of Intent (NOI).

Redevelopment

Redevelopment of existing sites and clean-up and development of brownfield sites require Sediment and Stormwater Management Plan approval prior to construction. Alternative stormwater requirements have been established for redevelopment and brownfield cleanup projects.

Redevelopment and brownfield development projects that require a detailed Sediment and Stormwater Management Plan require NPDES permit coverage through submittal of a Notice of Intent (NOI). Small site disturbances of less than one acre on redevelopment and brownfield sites may qualify for a Standard Plan. Please refer to the

Standard Plan criteria for non-residential construction with less than 1.0 acre of disturbance in 3.01.1.

Agriculture

Agricultural land management practices which include tilling the land to plant a crop are exempt from the *Delaware Sediment and Stormwater Regulations* when the agricultural land has a current soil and water conservation plan prepared by the local conservation district. Application of nutrients to agricultural land is regulated by the Delaware Department of Agriculture Nutrient Management Program under 3 *Del.C.* Ch. 22.

Construction of agricultural structures such as barns, machine sheds, grain storage facilities, poultry houses and other livestock facilities that disturb greater than 5,000 square feet during construction are not exempt. Agricultural structures must be constructed in accordance with the approved Sediment and Stormwater Management Plan. NPDES general permit coverage for the stormwater discharges associated with the construction activity must be gained for the agricultural structure construction when land disturbance exceeds 1.0 acre through submittal of a Notice of Intent (NOI).

Agricultural structure construction that meets the Standard Plan criteria may be constructed under the Standard Plan. Please refer to the Standard Plan criteria in 3.01.1. Agricultural structure construction that exceeds 1.0 acre of disturbance will require a NOI for the construction activity and a stormwater pollution prevention plan will need to be developed. Local conservation districts are equipped to provide technical assistance to cooperators in development of these plans.

Commercial forest harvest operations are exempt from the requirements of the *Delaware Sediment and Stormwater Regulations*. Erosion, sediment control and stormwater management for forestry operations are regulated by the Delaware Department of Agriculture under 3 *Del. C.* Ch. 10 Subchapter VI.

Biosolids are the portion of sewage sludge that has undergone adequate treatment to permit land application. Application of biosolids to agricultural or other lands is exempt from the requirements of the *Delaware Sediment and Stormwater Regulations* when the application area has an approved conservation plan, an agricultural utilization permit, agricultural waste plan, or a nutrient management plan. Further information regarding biosolids application can be gained from the DNREC Division of Water Resources Surface Water Discharges Section.

03.01.1
Standard Plan Criteria

Background
Section 3.7 of the *Delaware Sediment and Stormwater Regulations* allows the Department to develop criteria for cases when a standardized Sediment and Stormwater Management Plan may satisfy the requirements in the place of a detailed Sediment and Stormwater Management Plan. When a project meets the Standard Plan applicability criteria for the project type, that project has the option to comply with the conditions of the Standard Plan for the project type in lieu of developing a detailed Sediment and Stormwater Management Plan.

Project types for which Standard Plan applicability criteria and compliance conditions have been developed are included as follows in this document:

3.01.1.1 Residential Construction
3.01.1.2 Non-residential Construction < 1.0 acre disturbed
3.01.1.3 Minor Linear Disturbances
3.01.1.4 Agricultural Structure Construction
3.01.1.5 Tax Ditch Maintenance
3.01.1.6 Stormwater Management Facility Maintenance
3.01.1.7 Demolition
3.01.1.8 BMP Construction and Retrofit
3.01.1.9 Minor Bridge and Culvert Construction
3.01.1.10 Sidewalk, Trail, or Other Linear Impervious Surfaces

A detailed plan may be necessary for the construction activity to be adequately managed for construction site stormwater runoff and/or post construction stormwater management. A detailed plan may be required for any site that may otherwise meet Standard Plan criteria if it is deemed appropriate by the approval agency. The approval agency may require a detailed plan prior to approval or at any time during construction.

Parcels that have previously received approval under a Standard Plan may not be eligible for a Standard Plan in the future, as determined by the approval agency on a case-by-case basis.

A project that does not meet all applicability criteria but does meet the intent of the regulations may be considered for approval under the standard plan as determined by the Department on a case-by-case basis.

An owner or owner's representative may submit to the Department for consideration of development of standard plan criteria and conditions for any project type that may be

submitted on a routine basis and which in the view of the Department would benefit from the development of Standard Plan criteria and conditions.

3.01.1.1
Residential Construction

Definitions:

1. “Forest” means a biological community dominated by trees and other woody plants covering a land area of 10,000 square feet or greater, and that have at least 100 trees per acre with at least 50% of those trees having a 2 inch or greater diameter at 4.5 feet above the ground and larger. Forest does not include orchards. To determine whether a site meets the definition of a forest at the baseline condition of 2007, the Department or its authorized Delegated Agency may use data from various sources, including but not limited to 2007 Land Use/Land Cover data, historic and recent aerial photography, field collected data, etc.
2. “Residential Construction” means single family residence and auxiliary structures such as detached garages, sheds, pole barns, and other structures that create additional imperviousness.

Applicability:

1. The proposed construction is for residential construction on one individual residential parcel.
2. The total land disturbance will not exceed 5.0 acres.
3. At least one of the following is met:
    a. The total impervious area (roof, driveway, sidewalks, auxiliary structures, etc.) will not exceed:
        i. 5,000 square feet for lots of 0.5 acre or less
        ii. 7,500 square feet for lots between 0.51 acres and 2.0 acres
        iii. 8% of the total parcel area for lots greater than 2.0 acres, not to exceed 20,000 square feet
    b. The proposed residential construction results in less than one whole number change in the CN compared to the existing condition.
4. Runoff reduction practices in accordance with the Special Conditions for Additional Imperviousness are employed for any impervious areas above the thresholds of Applicability item 3a.
5. Clearing of forest areas will be done in accordance with the Special Conditions for Forested Areas.

Standard Conditions for All Residential Construction:

1. Standard nutrient management plan recommendations will be followed for the project, during construction and throughout the life of the project.
    a. Application of lawn nutrients will be based upon the recommendations of a soil test.

    b. Nutrients will be applied only to turf areas, not impervious surfaces.
    c. Nutrients will not be applied directly before a runoff event.
2. Discharges from rooftops will be disconnected using one of the following methods or another method approved by the Department or Delegated Agency:
    a. Individual downspouts will discharge to lawn, landscape area, or preserved open space or forested area.
    b. Discharges from downspouts will be collected in rain barrels or cisterns for reuse.
3. Driveways, sidewalks, patios, and other impervious surfaces will be graded to sheet flow to lawn or other pervious areas to the maximum extent practicable.
4. Construction site stormwater management best management practices will be used. Standard Detail and Specification DE-ESC-3.7.1 ESC For Minor Development will be followed during construction.
5. Construction projects exceeding 1.0 acre of total disturbance require submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.
6. Approval of this standard plan does not relieve the applicant from complying with any and all federal, state, county, or municipal laws and regulations.

Special Conditions for Residential Construction for Additional Imperviousness above the thresholds of Applicability item 3a:

1. Rooftop runoff will discharge to in-situ bioretention areas (rain gardens) having a depth of 6 inches and a surface area equal to 1/3 of the contributing roof area, constructed and maintained in accordance with Department guidance.
2. Sidewalks, driveways, patios, and other similar impervious surfaces shall be constructed of permeable pavement, constructed and maintained in accordance with Department guidance.

Special Conditions for Residential Construction with Forest Clearing:

1. Forested area on the parcel will be retained as follows:
    a. For forest clearing of less than 1.0 acre, a minimum of 25% of the forested area on the parcel will remain undisturbed
    b. For forest clearing of 1.0 acre or greater, a forested area equivalent to the forested area cleared will remain undisturbed on the parcel
2. When special condition 1 cannot be met, afforestation in accordance with the Department's specification will occur to bring the total forested area on the parcel into compliance with forest retention requirement of special condition 1.

DNREC Division of Watershed Stewardship
89 Kings Highway
Dover, DE 19901
(302) 739-9921

APPLICATION FOR STANDARD PLAN APPROVAL

RESIDENTIAL CONSTRUCTION

Approval of this Standard Sediment and Stormwater Plan may be granted if all of the following criteria are met:

1. The proposed construction is for residential construction on one individual residential parcel.
2. The total land disturbance will not exceed 5.0 acres.
3. At least one of the following is met:
    a. The total impervious area (roof, driveway, sidewalks, auxiliary structures, etc.) will not exceed:
        i. 5,000 square feet for lots of 0.5 acre or less
        ii. 7,500 square feet for lots between 0.51 acres and 2.0 acres
        iii. 8% of the total parcel area for lots greater than 2.0 acres, not to exceed 20,000 square feet
    b. The proposed residential construction results in less than one whole number change in the CN compared to the existing condition.
4. Runoff reduction practices in accordance with the Special Conditions for Additional Imperviousness are employed for any impervious areas above the thresholds of Applicability item 3a.
5. Clearing of forest areas will be done in accordance with the Special Conditions for Forested Areas.

Site Information

Site Location (911 Address or road name with distance to nearest intersection):_____

_____

Tax Parcel ID:_____

Parcel Total Acres (nearest 0.1ac):_____

Disturbed Acres (nearest 0.1ac):_____

Proposed Impervious Area (square feet):_____

Forested area to be cleared:_____

Applicant Information

Owner:_____

Mailing Address:_____

_____

Owner Phone:_____

Builder:_____

Mailing Address:_____

_____

Builder Phone:_____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval #_____ **Fee Paid: $**_____

Approved by:_____ **Approval Date:**_____

Title:_____ **Expiration Date:**_____

Effective April 2016

Standard Conditions for All Residential Construction

1. Standard nutrient management plan recommendations will be followed for the project, during construction and throughout the life of the project.
    a. Application of lawn nutrients will be based upon the recommendations of a soil test.
    b. Nutrients will be applied only to turf areas, not impervious surfaces.
    c. Nutrients will not be applied directly before a runoff event.
2. Discharges from rooftops will be disconnected using one of the following methods or another method approved by the Department:
    a. Individual downspouts will discharge to lawn or landscape area.
    b. Discharges from downspouts will be collected to discharge to a rain garden.
    c. Discharges from downspouts will be collected in rain barrels or cisterns for reuse.
3. Driveways, sidewalks, patios, and other impervious surfaces will be graded to sheet flow to lawn or other pervious areas to the maximum extent practicable.
4. Construction site stormwater management best management practices will be used. *Sample best management practices provided in the standard detail on the following page.*
5. Construction projects exceeding 1.0 acre of total disturbance require submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.
6. Approval of this Standard Plan does not relieve the applicant from complying with any and all federal, state, county or municipal laws and regulations.

Special Conditions for Residential Construction for Additional Imperviousness above the thresholds of Applicability Item 3a

1. Rooftop runoff will discharge to in-situ bioretention areas (rain gardens) having a depth of 6 inches and a surface area equal to 1/3 of the contributing roof area, constructed and maintained in accordance with Department guidance.
2. Sidewalks, driveways, patios, and other similar impervious surfaces shall be constructed of permeable pavement, constructed and maintained in accordance with Department guidance.

Special Conditions for Residential Construction with Forest Clearing

1. Forested area on the parcel will be retained as follows:
    a. For forest clearing of less than 1.0 acre, a minimum of 25% of the forested area on the parcel will remain undisturbed
    b. For forest clearing of 1.0 acre or greater, a forested area equivalent to the forested area cleared will remain undisturbed on the parcel
2. When special condition 1 cannot be met, afforestation in accordance with the Department's specification will occur to bring the total forested area on the parcel into compliance with forest retention requirement of special condition 1.

Stabilization Conditions

1. Following initial soil disturbance or redisturbance, temporary or permanent stabilization with seed and mulch shall be completed within 14 calendar days to the surface of all disturbed areas not actively under construction.
2. Specific stabilization recommendations may be found in the Delaware Erosion and Sediment Control Handbook, 3.4.3 Standard and Specifications for Vegetative Stabilization.

Applicant Certification

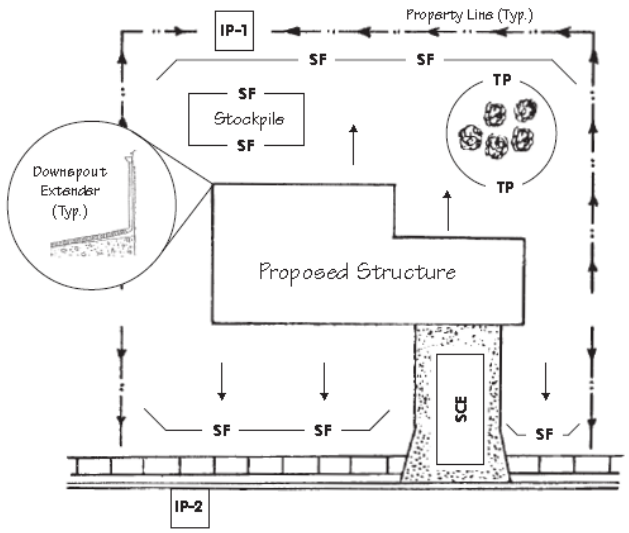
I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, builder, contractor, and owner during construction and post construction.

Applicant Signature:_____ Date:_____

Applicant Printed Name:_____ Title:_____

Standard Detail & Specifications

ESC for Minor Development



LEGEND

Flow	→	Inlet protection - Type 1	IP-1
Silt Fence	—— SF ——		
Tree Protection	—— TP ——	Inlet Protection - Type 2	IP-2
Stabilized Construction Entrance	SCE		

Effective April 2016

3.01.1.2
Non-residential Construction <1.0 acre Disturbed

Applicability:

1. The disturbed area for construction of the improvements will not exceed 1.0 acre.
2. Within the disturbed area, the pre-development land use is not classified as "wooded" based on the 2007 Delaware Land Use/Land Cover data.
3. One of the following is met:
    a. Project site location is within an area previously managed for stormwater quantity and quality under an approved Sediment and Stormwater Plan, AND the post construction condition meets the original stormwater design criteria, OR
    b. Comparison of the existing parcel curve number (CN), based upon 2007 Delaware Land Use/Land Cover data to the proposed CN for the parcel after non-residential construction results in less than one whole number change in the CN, OR
    c. No new impervious area is proposed as a result of construction.

Conditions:

1. Discharges from rooftops will be disconnected using one of the following methods or another method approved by the Department or Delegated Agency:
    a. Individual downspouts will discharge to lawn or landscape area.
    b. Discharges from downspouts will be collected to discharge to a rain garden.
    c. Discharges from downspouts will be collected in rain barrels or cisterns for reuse.
2. Driveways, sidewalks, patios, and other impervious surfaces will be graded to sheet flow to lawn or other pervious areas to the maximum extent practicable.
3. Construction site stormwater management best management practices will be used.

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89 Kings Highway
Dover, DE 19901
(302) 739-9921

APPLICATION FOR STANDARD PLAN APPROVAL

NON-RESIDENTIAL CONSTRUCTION WITH LESS THAN 1.0 ACRE DISTURBED

Approval of this Standard Sediment and Stormwater Plan may be granted if all of the following criteria are met:

1. The disturbed area for construction of the improvements will not exceed 1.0 acre.
2. Within the disturbed area, the pre-development land use is not classified as "wooded" based on the 2007 Delaware Land Use/Land Cover data.
3. One of the following is met:
   a. Project site location is within an area previously managed for stormwater quantity and quality under an approved Sediment and Stormwater Plan, AND the post construction condition meets the original stormwater design criteria, OR
   b. Comparison of the existing parcel curve number (CN), based upon 2007 Delaware Land Use/Land Cover data to the proposed CN for the parcel after non-residential construction results in less than one whole number change in the CN, OR
   c. No new impervious area is proposed as a result of construction.

Site Information

Project Name: _____

Site Location: _____

Previous Plan Name: _____

Previous Plan Approval Number: _____

Tax Parcel ID: _____

Parcel Total Acres (nearest 0.1ac): _____

Disturbed Acres (nearest 0.1ac): _____

Proposed Impervious Area (square feet): _____

Wooded area to be cleared: _____

Pre CN: _____ Post CN: _____

Applicant Information

Owner: _____

Mailing Address: _____

_____

Owner Phone: _____

Applicant: _____

Mailing Address: _____

_____

Applicant Phone: _____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval # _____ **Fee Paid: $** _____

Approved by: _____ **Approval Date:** _____

Title: _____ **Expiration Date:** _____

Applicant Certification

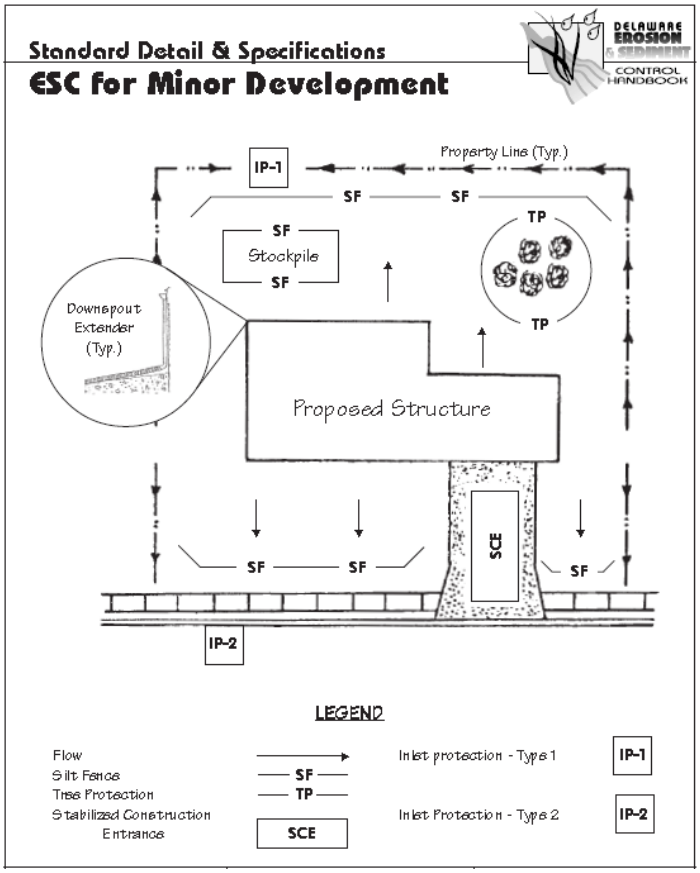
I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, builder, contractor, and owner during construction and post construction.

Applicant Signature:_____ Date:_____

Applicant Printed Name:_____ Title:_____

Conditions

1. Discharges from rooftops will be disconnected using one of the following methods or another method approved by the Department or Delegated Agency:
    a. Individual downspouts will discharge to lawn or landscape area.
    b. Discharges from downspouts will be collected to discharge to a rain garden.
    c. Discharges from downspouts will be collected in rain barrels or cisterns for reuse.
2. Driveways, sidewalks, patios, and other impervious surfaces will be graded to sheet flow to lawn or other pervious areas to the maximum extent practicable.
3. Construction site stormwater management best management practices will be used. *Sample best management practices provided in the standard detail below.*



Stabilization Conditions

1. Following initial soil disturbance or redisturbance, temporary or permanent stabilization with seed and mulch shall be completed within 14 calendar days to the surface of all disturbed areas not actively under construction.
2. Specific stabilization recommendations may be found in the Delaware Erosion and Sediment Control Handbook, 3.4.3 Standard and Specifications for Vegetative Stabilization.

3.01.1.3
Minor Linear Disturbances

Applicability:

1. Disturbance will be linear, as in utility construction, having a maximum width of disturbance of 20 feet, and a maximum length of 2.0 miles.
2. No greater than 1.0 acre will be disturbed at any one time throughout the course of construction.
3. Within the disturbed area, the pre-development land use is not classified as "wooded" based on the 2007 Delaware Land Use/Land Cover data.
4. Land cover will be restored to the pre-construction hydrologic condition. Pre-construction grading and surface cover will remain after construction. No new impervious surfaces will be created as part of the construction.

Conditions:

1. Stabilization with seed and mulch or seed and stabilization matting will occur daily so that no greater than one acre will be disturbed at any one time.
2. Construction site stormwater management best management practices will be used.
3. Construction through sensitive areas, including stream and wetland crossings, will be accomplished through directional drilling, with land disturbance happening outside of the sensitive area.
4. Construction projects exceeding 1.0 acre of total disturbance require submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.

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(302) 739-9921

APPLICATION FOR STANDARD PLAN APPROVAL

MINOR LINEAR DISTURBANCES

Approval of this Standard Sediment and Stormwater Plan may be granted if all of the following criteria are met:

1. Disturbance will be linear, as in utility construction, having a maximum width of disturbance of 20 feet, and a maximum length of 2.0 miles.
2. No greater than 1.0 acre will be disturbed at any one time throughout the course of construction.
3. Within the disturbed area, the pre-development land use is not classified as "wooded" based on the 2007 Delaware Land Use/Land Cover data.
4. Land cover will be restored to the pre-construction hydrologic condition. Pre-construction grading and surface cover will remain after construction. No new impervious surfaces will be created as part of the construction.

Site Information

Site Location (911 Address or road name with distance to nearest intersection):_____

_____

Width of disturbed area (feet):_____ Total Disturbed Acres (nearest 0.1ac):_____

Length of disturbed area (feet):_____ Proposed Impervious Area (square feet):_____

Length of disturbed area (miles):_____ Wooded area to be cleared:_____

Applicant Information

Owner:_____ Applicant:_____

Mailing Address:_____ Mailing Address:_____

_____ _____

Owner Phone:_____ Applicant Phone:_____

Applicant Certification

I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, contractor, and owner during construction and post construction.

Applicant Signature:_____ Date:_____

Applicant Printed Name:_____ Title:_____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval #_____ **Fee Paid: $**_____

Approved by:_____ **Approval Date:**_____

Title:_____ **Expiration Date:**_____

Effective April 2016

Conditions

1. Stabilization with seed and mulch or seed and stabilization matting will occur daily so that no greater than one acre will be disturbed at any one time. *Specific stabilization recommendations may be found in the Delaware Erosion and Sediment Control Handbook, 3.4.3 Standard and Specifications for Vegetative Stabilization.*
2. Construction site stormwater management best management practices will be used.
3. Construction through sensitive areas, including stream and wetland crossings, will be accomplished through directional drilling, with land disturbance happening outside of the sensitive area.
4. Construction projects exceeding 1.0 acre of total disturbance require submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.

3.01.1.4
Agricultural Structure Construction

Applicability:

1. Construction is for an agricultural structure which is defined as a structure on a farm used solely for agricultural purposes in which the use is exclusively in connection with the production, harvesting, storage, drying or raising of agricultural commodities, including the raising of livestock. Structures used for human habitation, public use, or a place of employment where agricultural products are processed, treated, or packaged are not considered agricultural structures.
2. The total land disturbance will not exceed 5.0 acres.
3. The pre-construction land use at the location of the agricultural structure is historically agricultural use (farmstead, crop field, pasture). Within the disturbed area, the pre-development land use is not classified as "wooded" based on the 2007 Delaware Land Use/Land Cover data. If any portion of the pre-construction land use is a wooded condition, a detailed plan is required.
4. The proposed impervious area as a result of construction of an agricultural structure is less than 10% of the watershed area to the point of discharge from the parcel.

Conditions:

1. Nutrient management plan recommendations will be followed for the project, during construction and throughout the life of the project.
2. Discharges from rooftops will be disconnected from impervious surfaces. Downspouts, if applicable, will discharge to a stabilized area, such as grass or gravel.
3. Impervious surfaces, including compacted gravel roadways, will be graded to sheet flow to pervious areas to the maximum extent practicable.
4. Construction site stormwater management best management practices will be used.
5. Construction projects exceeding 1.0 acre of total disturbance required submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.

DNREC Division of Watershed Stewardship
89 Kings Highway
Dover, DE 19901
(302) 739-9921

GENERAL
APPLICATION FOR STANDARD PLAN APPROVAL

Approval of this Standard Sediment and Stormwater Plan may be granted if all applicability items established in Technical Document Article 3.01.1 for the individual standard plan project type are met, and the owner/applicant agrees to comply with the conditions of the individual standard plan project type contained in the same Article.

Standard Plan Project Type (select one)

_____ 3.01.1.4 Agricultural Structure Construction

_____ 3.01.1.5 Tax Ditch Maintenance

_____ 3.01.1.8 BMP Construction and Retrofit

_____ 3.01.1.9 Minor Bridge and Culvert Construction

Site Information

Project Name: _____

Site Location: _____

Tax Parcel ID: _____

Parcel Total Acres (nearest 0.1ac): _____

Disturbed Acres (nearest 0.1ac): _____

Proposed Impervious Area: _____ sq ft / ac

Wooded area to be cleared: _____ sq ft / ac

Applicant Information

Owner: _____

Mailing Address: _____

_____

Owner Phone: _____

Applicant: _____

Mailing Address: _____

_____

Applicant Phone: _____

Applicant Certification

I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, builder, contractor, and owner during construction and post construction.

Applicant Signature: _____ Date: _____

Applicant Printed Name: _____ Title: _____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval # _____ **Fee Paid: $** _____

Approved by: _____ **Approval Date:** _____

Title: _____ **Expiration Date:** _____

Effective April 2016

3.01.1.5
Tax Ditch Maintenance

Applicability:

1. Land disturbance is for maintenance of a recorded tax ditch having a design on file with DNREC.

Conditions:

1. Construction will follow “Principles and Guidelines for Planning, Constructing, and Maintaining Drainage Ditches in the State of Delaware”, DNREC Division of Soil and Water Conservation, June 1995.
2. Following maintenance the tax ditch elevations will be returned to design elevations.
3. Construction site stormwater management best management practices will be used.
4. Construction projects exceeding 1.0 acre of total disturbance required submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.

DNREC Division of Watershed Stewardship
89 Kings Highway
Dover, DE 19901
(302) 739-9921

GENERAL
APPLICATION FOR STANDARD PLAN APPROVAL

Approval of this Standard Sediment and Stormwater Plan may be granted if all applicability items established in Technical Document Article 3.01.1 for the individual standard plan project type are met, and the owner/applicant agrees to comply with the conditions of the individual standard plan project type contained in the same Article.

Standard Plan Project Type (select one)

_____ 3.01.1.4 Agricultural Structure Construction

_____ 3.01.1.5 Tax Ditch Maintenance

_____ 3.01.1.8 BMP Construction and Retrofit

_____ 3.01.1.9 Minor Bridge and Culvert Construction

Site Information

Project Name: _____

Site Location: _____

Tax Parcel ID: _____

Parcel Total Acres (nearest 0.1ac): _____

Disturbed Acres (nearest 0.1ac): _____

Proposed Impervious Area: _____ sq ft / ac

Wooded area to be cleared: _____ sq ft / ac

Applicant Information

Owner: _____

Mailing Address: _____

_____

Owner Phone: _____

Applicant: _____

Mailing Address: _____

_____

Applicant Phone: _____

Applicant Certification

I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, builder, contractor, and owner during construction and post construction.

Applicant Signature: _____ Date: _____

Applicant Printed Name: _____ Title: _____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval # _____ **Fee Paid: $** _____

Approved by: _____ **Approval Date:** _____

Title: _____ **Expiration Date:** _____

Effective April 2016

3.01.1.6
Stormwater Management Facility Maintenance

Applicability:

1. Land disturbance is for maintenance of a stormwater management facility having a design on file with DNREC or a Delegated Agency of the DNREC Sediment and Stormwater Program.

Conditions:

1. Construction will follow an Operation and Maintenance Plan in place for the stormwater management facility if one exists.
2. Following maintenance the stormwater management facility elevations will be returned to design elevations.
3. Construction site stormwater management best management practices will be used.
4. Construction projects exceeding 1.0 acre of total disturbance required submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.

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Dover, DE 19901
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APPLICATION FOR STANDARD PLAN APPROVAL

STORMWATER MANAGEMENT FACILITY MAINTENANCE

Approval of this Standard Sediment and Stormwater Plan may be granted if land disturbance is for maintenance of a stormwater management facility having a design on file with the DNREC Sediment and Stormwater Program.

Site Information

Site Location including Approved Sediment and Stormwater Plan Name:_____

_____

SWM Facility/Facilites to be maintained:_____

_____

Plan Approval Number:_____ Disturbed Acres (nearest 0.1ac):_____

Applicant Information

Owner:_____

Mailing Address:_____

_____

Owner Phone:_____

Applicant:_____

Mailing Address:_____

_____

Applicant Phone:_____

Applicant Certification

I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, contractor, and owner during construction and post construction.

Applicant Signature:_____ Date:_____

Applicant Printed Name:_____ Title:_____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval #_____ **Fee Paid: $**_____

Approved by:_____ **Approval Date:**_____

Title:_____ **Expiration Date:**_____

Effective April 2016

Conditions

1. Construction will follow an Operation and Maintenance Plan in place for the stormwater management facility if one exists.
2. Following maintenance the stormwater management facility elevations will be returned to design elevations.
3. Construction site stormwater management best management practices will be used.
4. Construction projects exceeding 1.0 acre of total disturbance required submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.

Stabilization Conditions

1. Following initial soil disturbance or redisturbance, temporary or permanent stabilization with seed and mulch shall be completed within 14 calendar days to the surface of all disturbed areas not actively under construction.
2. Specific stabilization recommendations may be found in the Delaware Erosion and Sediment Control Handbook, 3.4.3 Standard and Specifications for Vegetative Stabilization.

3.01.1.7
Demolition

Applicability:

1. Land disturbance is for demolition and removal of a structure, building foundation, building slab, roadway, driveway, parking lot, sidewalk, or other amenity resulting in exposed soil, including access and staging for demolition activities.
2. The total land disturbance will not exceed 1.0 acre.
3. Disturbed land will be restored to a stabilized, vegetated open space condition. No new impervious surfaces will be created as part of the demolition project.

Conditions:

1. Stabilization with seed and mulch or seed and stabilization matting will occur within 14 days of completion of demolition.
2. Construction site stormwater management best management practices will be used.

DNREC Division of Watershed Stewardship
89 Kings Highway
Dover, DE 19901
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APPLICATION FOR STANDARD PLAN APPROVAL

DEMOLITION

Approval of this Standard Sediment and Stormwater Plan may be granted if all of the following criteria are met:

1. Land disturbance is for demolition and removal of a structure, building foundation, building slab, roadway, driveway, parking lot, sidewalk, or other amenity resulting in exposed soil, including access and staging for demolition activities.
2. The total land disturbance will not exceed 1.0 acre.
3. Disturbed land will be restored to a stabilized, vegetated open space condition. No new impervious surfaces will be created as part of the demolition project.

Site Information

Site Location including previous Approved Sediment and Stormwater Plan Name, if applicable:_____

_____

Previous Plan Approval Number:_____ Disturbed Acres (nearest 0.1ac):_____

Tax Parcel ID:_____ Proposed Impervious Area (square feet):_____

Parcel Total Acres (nearest 0.1ac):_____ Wooded area to be cleared:_____

Applicant Information

Owner:_____ Applicant:_____

Mailing Address:_____ Mailing Address:_____

_____ _____

Owner Phone:_____ Applicant Phone:_____

Applicant Certification

I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, contractor, and owner during construction and post construction.

Applicant Signature:_____ Date:_____

Applicant Printed Name:_____ Title:_____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval #_____ **Fee Paid: $**_____

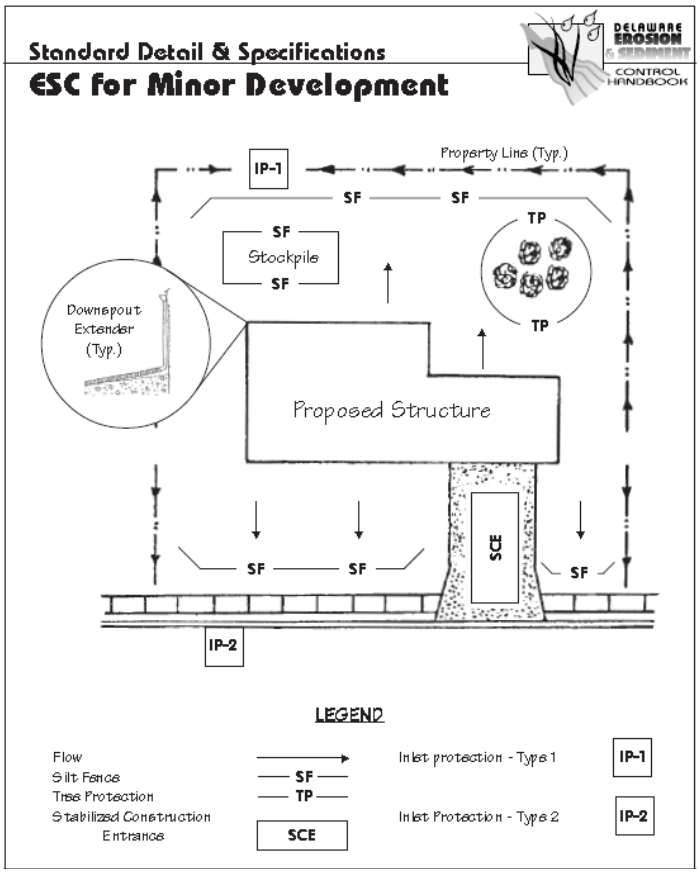
Approved by:_____ **Approval Date:**_____

Title:_____ **Expiration Date:**_____

Effective April 2016

Conditions

1. Stabilization with seed and mulch or seed and stabilization matting will occur within 14 days of completion of demolition. *Specific stabilization recommendations may be found in the Delaware Erosion and Sediment Control Handbook, 3.4.3 Standard and Specifications for Vegetative Stabilization.*
2. Construction site stormwater management best management practices will be used. *Sample best management practices provided in the standard detail below.*



3.01.1.8
BMP Construction and Retrofit

Applicability:

1. The construction will provide either:
    a. RPv, Cv or Fv reduction by implementing Post Construction Stormwater BMP, retrofitting a degraded BMP, or creating a floodplain;
    b. Stabilization of an eroding area.
2. The total land disturbance will not exceed 5.0 acres.
3. Within the disturbed area, the pre-development land use is not classified as "wooded" based on the 2007 Delaware Land Use/Land Cover data.
4. The total impervious area proposed (roof, driveway, sidewalks, auxiliary structures, etc.) will not exceed the lesser of 7,500 square feet or 15% of the disturbed area.

Conditions:

1. The area must be returned grassed or vegetated condition (excluding permeable pavement installation and the allowable impervious areas), after construction and throughout the life of the project.
2. Discharges from added impervious areas will be disconnected using one of the following methods or another method approved by the Department or Delegated Agency:
    a. Impervious areas will discharge to grassed or vegetated area.
    b. Discharges from impervious area will be collected to discharge to a rain garden.
    c. Discharges from impervious areas will be collected in rain barrels or cisterns for reuse.
3. Construction site stormwater management best management practices will be used.
4. Construction projects exceeding 1.0 acre of total disturbance require submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.

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Dover, DE 19901
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GENERAL
APPLICATION FOR STANDARD PLAN APPROVAL

Approval of this Standard Sediment and Stormwater Plan may be granted if all applicability items established in Technical Document Article 3.01.1 for the individual standard plan project type are met, and the owner/applicant agrees to comply with the conditions of the individual standard plan project type contained in the same Article.

Standard Plan Project Type (select one)

_____ 3.01.1.4 Agricultural Structure Construction

_____ 3.01.1.5 Tax Ditch Maintenance

_____ 3.01.1.8 BMP Construction and Retrofit

_____ 3.01.1.9 Minor Bridge and Culvert Construction

Site Information

Project Name: _____

Site Location: _____

Tax Parcel ID: _____

Parcel Total Acres (nearest 0.1ac): _____

Disturbed Acres (nearest 0.1ac): _____

Proposed Impervious Area: _____ sq ft / ac

Wooded area to be cleared: _____ sq ft / ac

Applicant Information

Owner: _____

Mailing Address: _____

_____

Owner Phone: _____

Applicant: _____

Mailing Address: _____

_____

Applicant Phone: _____

Applicant Certification

I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, builder, contractor, and owner during construction and post construction.

Applicant Signature: _____ Date: _____

Applicant Printed Name: _____ Title: _____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval # _____ **Fee Paid: $** _____

Approved by: _____ **Approval Date:** _____

Title: _____ **Expiration Date:** _____

Effective April 2016

3.01.1.9
Minor Bridge and Culvert Construction

Applicability:

1. The disturbed area for construction of the improvements will not exceed 1.0 acre.
2. The net increase in impervious area will not exceed 5,000 square feet.
3. Land cover will be restored to the pre-construction hydrologic condition or better.

Conditions:

1. Impervious surfaces will be graded to sheet flow to pervious areas to the maximum extent practicable.
2. All non-impervious disturbed area will be vegetated to original or better condition.
3. Construction site stormwater management best management practices will be used.

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GENERAL
APPLICATION FOR STANDARD PLAN APPROVAL

Approval of this Standard Sediment and Stormwater Plan may be granted if all applicability items established in Technical Document Article 3.01.1 for the individual standard plan project type are met, and the owner/applicant agrees to comply with the conditions of the individual standard plan project type contained in the same Article.

Standard Plan Project Type (select one)

_____ 3.01.1.4 Agricultural Structure Construction

_____ 3.01.1.5 Tax Ditch Maintenance

_____ 3.01.1.8 BMP Construction and Retrofit

_____ 3.01.1.9 Minor Bridge and Culvert Construction

Site Information

Project Name: _____

Site Location: _____

Tax Parcel ID: _____

Parcel Total Acres (nearest 0.1ac): _____

Disturbed Acres (nearest 0.1ac): _____

Proposed Impervious Area: _____ sq ft / ac

Wooded area to be cleared: _____ sq ft / ac

Applicant Information

Owner: _____

Mailing Address: _____

_____

Owner Phone: _____

Applicant: _____

Mailing Address: _____

_____

Applicant Phone: _____

Applicant Certification

I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, builder, contractor, and owner during construction and post construction.

Applicant Signature: _____ Date: _____

Applicant Printed Name: _____ Title: _____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval # _____ **Fee Paid: $** _____

Approved by: _____ **Approval Date:** _____

Title: _____ **Expiration Date:** _____

Effective April 2016

3.01.1.10
Sidewalk, Trail, or Other Linear Impervious Surfaces

Applicability:

1. Disturbance will be for construction of a sidewalk, trail or other linear impervious surface with total disturbance not to exceed 5.0 acres.
2. No greater than 1.0 acre disturbed at any one time throughout the course of construction.
3. Within the disturbed area, the pre-development land use is not classified as "wooded" based on the 2007 Delaware Land Use/Land Cover data.
4. One of the following is met:
    a. Project site location is within an area previously managed for stormwater quantity and quality under an approved Sediment and Stormwater Plan, AND the post construction condition meets the original stormwater design criteria, or
    b. Comparison of the existing curve number (CN) to the point of discharge as agreed upon with the approval agency, based upon 2007 Delaware Land Use/Land Cover data to the proposed CN to the same point of discharge after sidewalk / trail construction results in less than one whole number change in the CN, or
    c. No new impervious area is proposed as a result of construction.

Conditions:

1. Impervious surfaces will be graded to sheet flow to lawn or other pervious areas to the maximum extent practicable.
2. Stabilization of exposed soil areas with seed and mulch or seed and stabilization matting will occur daily so that no greater than one acre will be disturbed at any one time.
3. Construction site stormwater management best management practices will be used.
4. Construction projects exceeding 1.0 acre of total disturbance require submittal of a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity. A plan fulfilling Stormwater Pollution Prevention Plan (SWPPP) requirements must be developed to obtain general permit coverage for Stormwater Discharges Associated with Construction Activity.

DNREC Division of Watershed Stewardship
89 Kings Highway
Dover, DE 19901
(302) 739-9921

APPLICATION FOR STANDARD PLAN APPROVAL

SIDEWALK, TRAIL, OR OTHER LINEAR IMPERVIOUS SURFACES

Approval of this Standard Sediment and Stormwater Plan may be granted if all of the following criteria are met:

1. Disturbance will be for construction of a sidewalk, trail or other linear impervious surface with total disturbance not to exceed 5.0 acres.
2. No greater than 1.0 acre disturbed at any one time throughout the course of construction.
3. Within the disturbed area, the pre-development land use is not classified as "wooded" based on the 2007 Delaware Land Use/Land Cover data.
4. One of the following is met:
    a. Project site location is within an area previously managed for stormwater quantity and quality under an approved Sediment and Stormwater Plan, AND the post construction condition meets the original stormwater design criteria, or
    b. Comparison of the existing curve number (CN) to the point of discharge as agreed upon with the approval agency, based upon 2007 Delaware Land Use/Land Cover data to the proposed CN to the same point of discharge after sidewalk / trail construction results in less than one whole number change in the CN, or
    c. No new impervious area is proposed as a result of construction.

Site Information

Project Name: _____

Site Location: _____

Previous Plan Name: _____

Previous Plan Approval Number: _____

Tax Parcel ID: _____

Parcel Total Acres (nearest 0.1ac): _____

Disturbed Acres (nearest 0.1ac): _____

Proposed Impervious Area (square feet): _____

Wooded area to be cleared: _____

Pre CN: _____ Post CN: _____

Applicant Information

Owner: _____

Mailing Address: _____

_____

Owner Phone: _____

Applicant: _____

Mailing Address: _____

_____

Applicant Phone: _____

Fees

The review fee is $80 per disturbed acre to the nearest 0.1 acre with a minimum fee of $80 for any standard plan approvals disturbing less than 1.0 acre. Make checks payable to Division of Watershed Stewardship.

Approval Information (for office use only)

Approval # _____ **Fee Paid: $** _____

Approved by: _____ **Approval Date:** _____

Title: _____ **Expiration Date:** _____

Effective April 2016

Applicant Certification

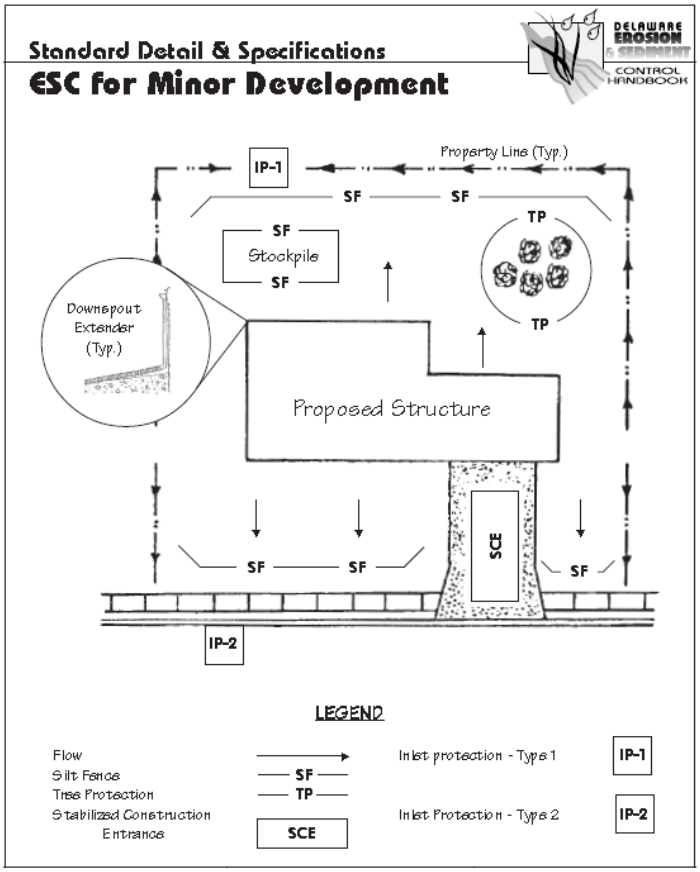
I, the undersigned, certify that the information supplied on this Application for Standard Plan Approval is accurate, the proposed land disturbing activity meets the criteria established, and all conditions of this Standard Plan Approval will be met by the applicant, builder, contractor, and owner during construction and post construction.

Applicant Signature:_____ Date:_____

Applicant Printed Name:_____ Title:_____

Conditions

1. Impervious surfaces will be graded to sheet flow to lawn or other pervious areas to the maximum extent practicable.
2. Construction site stormwater management best management practices will be used. *Sample best management practices provided in the standard detail below.*



Stabilization Conditions

1. Following initial soil disturbance or redisturbance, temporary or permanent stabilization with seed and mulch shall be completed within 14 calendar days to the surface of all disturbed areas not actively under construction.
2. Specific stabilization recommendations may be found in the Delaware Erosion and Sediment Control Handbook, 3.4.3 Standard and Specifications for Vegetative Stabilization.

3.02
Plan Review Process – Detailed Plans

All projects requiring detailed plans shall be submitted to the appropriate Delegated Agency utilizing a 3-step process as outlined below. Applicants are expected to gain approval at each step prior to submission for the next step. The application package for each step shall be reviewed for completeness by the Delegated Agency in accordance with the appropriate checklist. Any application deemed incomplete shall be returned to the applicant with an explanation of the missing material. The Delegated Agency will only be responsible for the review of complete applications.

An application form shall accompany the plans submitted for review. When submitting to DNREC Sediment and Stormwater Program, the application form in Article 3.02.0.1 should be used. When submitting plans for review and approval to one of the Delegated Agencies, the application form of that agency shall be used.

DNREC Division of Watershed Stewardship
89 Kings Highway
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(302) 739-9921

APPLICATION FOR

SEDIMENT AND STORMWATER MANAGEMENT PLAN APPROVAL

PROJECT NAME:_____

PROJECT DESCRIPTION:_____

PROJECT ADDRESS:_____
STREET CITY ZIP

PROJECT LOCATION:_____
COUNTY TAX PARCEL #

PROJECT LIMIT OF DISTURBANCE (LOD) AREA IN ACRES:_____
EXPRESSED TO THE NEAREST TENTH OF AN ACRE (I.E. 4.2 ACRES)

OWNER/DEVELOPER NAME:_____

OWNER/DEVELOPER ADDRESS:_____
STREET CITY ZIP

OWNER/DEVELOPER CONTACT INFO:_____
PHONE EMAIL

CONSULTANT/ENGINEER NAME:_____

CONTACT PERSON/PROJECT ENGINEER:_____

CONSULTANT/ENGINEER ADDRESS:_____
STREET CITY ZIP

CONSULTANT/ENGINEER CONTACT INFO:_____
PHONE EMAIL

FEES

THE REVIEW FEE IS $80 PER DISTURBED ACRE TO THE NEAREST 0.1 ACRE WITH A MINIMUM FEE OF $80 FOR ANY DETAILED PLAN APPROVALS DISTURBING LESS THAN 1.0 ACRE. MAKE CHECKS PAYABLE TO DIVISION OF WATERSHED STEWARDSHIP.

Submittal/ Approval Information (*For Office Use Only*)

- ☐ **Step 1: Stormwater Assessment Study (SAS)/ Stormwater Assessment Report (SAR)** _____ (reviewer's initials)
- ☐ **Step 2: Preliminary Sediment & Stormwater Management Plan Review Checklist** _____ (reviewer's initials)
- ☐ **Step 3: Sediment & Stormwater Management Plan Review Checklist** _____ (reviewer's initials)
- ☐ **Step 2/3: Combined Sediment & Stormwater Management Plan Review Checklist** _____ (reviewer's initials)
- ☐ **Sediment and Stormwater Management Plans (Approval Set)** _____ (reviewer's initials)
- ☐ **NPDES Notice of Intent (NOI) Application (#_____)**

Tracking #:_____ **Fee Paid:** $_____
Amount **Check #**

Approved By:_____ **Approval Date:**_____

Title:_____ **Expiration Date:**_____

Effective April 2016

OWNER/DEVELOPER CERTIFICATION

"I/We certify that the information on this form and the attached plans is true and accurate to the best of my/our knowledge."

"I/We understand that DNREC may request information in addition to that set forth herein as may be deemed appropriate in considering this application."

"I/We will abide by the condition of this approval as issued."

"I/We certify that all land clearing, construction and development shall be done pursuant to the approved attached plans and that responsible personnel (i.e. Blue Card Holder) involved in the land disturbance will have a Certification of Training prior to initiation of the project, at a DNREC sponsored or approved training course for the control of erosion and sediment during construction. In addition, I/We grant the DNREC Sediment and Stormwater Program and/or relevant Delegated Agency the right to conduct on-site reviews, and I/We understand my/our responsibilities under the NPDES Construction General Permit, associated with this site."

_____
Owner/Developer Signature Date

_____
Owner/Developer Name and Title (Printed or Typed)

DESIGNER CERTIFICATION

"I hereby certify that this plan has been prepared under my supervision and to the best of my knowledge complies with the applicable state and local regulations and ordinances."

_____ _____
Designer Signature Date Delaware Reg. No. (if Applicable)

_____ _____
Designer Name and Title (Printed or Typed) Type (P.E., P.L.S., or R.L.A.)

AGENT AUTHORIZATION*

(*If this authorization form is completed with the application, all future correspondence may be signed by the duly authorized agent.)

I,_____ hereby designate and authorize the following identified agent to act on my behalf in the processing of this application and to furnish any information that is requested.

AGENT NAME:_____

AGENT ADDRESS:_____
STREET CITY ZIP

AGENT CONTACT INFO:_____
PHONE EMAIL

_____ _____
Owner/Developer Signature Date Agent Signature Date

Effective April 2016

3.02.1

Step 1: Project Application Meeting

The Sediment and Stormwater Program requires a Project Application Meeting for all proposed land disturbing activities that will require a detailed Sediment & Stormwater Plan approval. These meetings are structured to assist the owner, developer, and designer in the design process, and to provide early notification of approval requirements.

Prior to scheduling the required meeting, the applicant must submit a Stormwater Assessment Study (SAS) and the completed SAS Checklist to the appropriate Delegated Agency. The Stormwater Assessment Study Checklist is available in Appendix 3.02.1.1. Incomplete submittals will be returned in whole with the missing checklist items highlighted.

Responsibilities for the various elements of the project application meeting shall be as follows:

<u>Applicant</u>

1. Provide contact information for both owner/developer and consultant.
2. Submit Stormwater Assessment Study (SAS) and completed SAS checklist.

<u>Delegated Agency</u>

1. Review SAS submittal for completeness and schedule the project application meeting with all necessary parties.
2. Ensure all relevant topics are discussed and/or addressed during the project application meeting.
3. Forward Stormwater Assessment Report (SAR) to appropriate land use planning agency.

Project application meetings will be scheduled within 2 weeks of a complete submittal. Not more than one hour will be allotted for the meeting for a single project.

Items discussed during the meeting shall be documented on the Sediment & Stormwater Program Project Application Meeting Discussion and Agreement Items form. All attendees shall sign this form at the conclusion of the meeting. An example Sediment & Stormwater Program Project Application Meeting Discussion and Agreement Items form is included as Appendix 3.02.1.2.

Copies of the Stormwater Assessment Report shall be provided to the applicant as well as to the appropriate local planning agency. The Stormwater Assessment Report is located in Appendix 3.02.1.3.

An example Project Application Package is included as Appendix 3.02.1.5.

Office Use Only
Date Received:_____
Submittal Complete: Yes / No Reviewer Initials:_____
Meeting date/time:_____
DelDOT Attendance Required? Yes / No

Stormwater Assessment Study (SAS) Checklist

Project Name:_____

Owner/Developer Name:_____

Contact Person:_____

Owner/Developer Phone:_____

Owner/Developer e-mail:_____

Consultant Name:_____

Contact Person:_____

Consultant Phone:_____

Consultant e-mail:_____

This checklist is for guidance only. The Delegated Agency reserves the right to request additional information during the review process as it deems necessary. Compliance with the checklist in no way is meant to relieve the design professional of his/her professional responsibilities.

A. Documents

Items shall be arranged in the following order:

- ☐ Completed Stormwater Assessment Study (SAS) Checklist
- ☐ Narrative of existing site conditions including information on existing downstream conveyance and Points of Analysis (POAs)
  - Identify existing structures
  - Describe condition of existing structures / channels / outfalls
  - Provide photographs of structures / channels / outfalls / POAs
- ☐ Narrative of proposed development project type and description
  - Residential
  - Commercial/Institutional
  - High/Low Density
- ☐ Feedback from DelDOT Maintenance regarding drainage concerns.

  Consultant will contact DelDOT, providing a description of the project location, including road name and project location from the nearest intersection. Parcel ID number should also be provided. DelDOT will respond with any known drainage and flooding problems.

  - *New Castle County – (302) 326-4523*
  - *Kent County – (302) 760-2424*
  - *Sussex County – (302) 853-1340*

This checklist is for guidance only. The Delegated Agency reserves the right to request additional information during the review process as it deems necessary. Compliance with the checklist in no way is meant to relieve the design professional of his/her professional responsibilities.

B. On-Line Background Information

Items shall be arranged in the following order:

- ☐ Stormwater Assessment Study GIS Mapping

  Provide a printout of the site location mapped for each layer represented:

  - ☐ Parcel Boundary showing NHD streams and water features
  - ☐ Existing 2' contours
  - ☐ Tax ditch watershed boundaries
  - ☐ Tax ditch channel locations
  - ☐ Tax ditch rights-of-way
  - ☐ Wellhead protection areas
  - ☐ Aquifer recharge areas
  - ☐ Floodways
  - ☐ Flood hazard areas
  - ☐ 2007 Land Use / Land Cover (LULC)
  - ☐ Hydrologic Soil Groups (HSG)
  - ☐ State Wetland Mapping Project (SWMP)
  - ☐ Runoff Reduction Feasibility *(NOTE: much of New Castle County is not mapped)*

  SAS GIS Web application link:
  http://dnrecgis.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=4e85b5dd93834c669560faa8b338216f

- ☐ StreamStats map showing limit of downstream analysis. (The downstream analysis point will be located at the point in the watershed where the site area comprises less than 10% of the watershed area.)

  StreamStats link: http://water.usgs.gov/osw/streamstats/delaware.html

- ☐ StreamStats Basin Characteristics Report

  StreamStats link: http://water.usgs.gov/osw/streamstats/delaware.html

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- ☐ Customized Web Soil Survey reports for Stormwater Management for proposed developed area of the site.

  Link: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

The following elements are required for submittal:

SWM Soils Report Elements	Map	Table	Desc.	Report
Soil Map Tab	X			
Soil Data Explorer Tab				
Suitabilities and Limitations for Use				
Land Classifications				
Map Unit Hydric Rating	X	X	X	
Water Management				
Embankments, Dikes and Levees	X	X	X	
Excavated Ponds (Aquifer-Fed)	X	X	X	
Pond Resevoir Area	X	X	X	
Soil Properties and Qualities				
Soil Erosion Factors				
K Factor - Whole Soil	X	X	X	
Soil Qualities and Features				
Drainage Class	X	X	X	
Hydrologic Soil Group	X	X	X	
Water Features				
Depth to Water Table	X	X	X	
Flooding Frequency Class	X	X	X	
Ponding Frequency Class	X	X	X	
Soil Reports				
Building Site Development				
Roads & Streets, Shallow Excavations, Lawns & Landscaping				X
Soil Physical Properties				
Engineering Properties				X
Physical Soil Properties				X

- ☐ If DelDOT conveyance will be used to discharge stormwater from proposed development, submit DelDOT Road Plans for background information.

  DelDOT Archive link: http://www.deldot.gov/information/pubs_forms/archived_plans/index.shtml

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C. Existing Hydrology Mapping

Submit an existing drainage features map (1”=100’ scale) showing:

- ☐ flow paths
- ☐ on-site subareas
- ☐ off-site subareas
- ☐ site points of analysis

D. Completed Stormwater Assessment Report

Submit a completed Stormwater Assessment Report, including:

- ☐ Assessment Item ratings for anticipated engineering effort
- ☐ Computation sheet used to determine ratings

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Sediment and Stormwater Program Project Application Meeting

Discussion Items

Project Name: _____

Meeting Date: _____

1. TMDL Watershed: _____
2. Groundwater Mapping
   a. Wellhead Protection Areas:
      - ☐ **YES**
      - ☐ **NO**
   b. Depth to Water Table (Wet): _____
3. Watershed Master Plan
   a. Does this site fall within an area served by a watershed master plan?
      - ☐ Appoquinimink WS
      - ☐ Murderkill WS
      - ☐ Upper Nanticoke WS
      - ☐ Other: _____
      - ☐ Not within an area served by a watershed master plan
   b. What special design criteria are set for this project based upon its location in a watershed having a master plan?

Discussion Items

Project Name: _____

Meeting Date: _____

4. Does the site contain tax ditches?

   ☐ **YES**

   ☐ **NO** (continue to the next item)

Tax Ditch Name	Right-of-way Information

a. Is there a proposal for changing tax ditch watershed boundaries?

   YES

   NO

b. Does the tax ditch require a court order change (COC) for development to occur as planned?

   YES

   NO

c. Additional information regarding court order change:

Sediment and Stormwater Program Project Application Meeting

Discussion Items

Project Name: _____

Meeting Date: _____

5. Proposed grading plan.
   a. Proposed grading plan must not block drainage from offsite areas currently draining onto the site.
      i. Are offsite areas currently draining onto the site?
         - ☐ **YES**
         - ☐ **NO**
      ii. How will offsite areas draining onto the site be managed?
         - ☐ Captured in onsite BMPs
         - ☐ Bypassed
   b. Disturbed areas greater than 20 acres to any single discharge point will require engineered control practices designed for bare earth conditions for a 2-YR, 24-HR storm event.

      Proposed disturbed area: _____

6. The plan areas will be reviewed and approved by the following agency(ies):
   a. Onsite areas: _____
   b. Offsite roadway improvements: _____

7. Is there a proposal to discharge to a DelDOT, municipal or private drainage system?
   - ☐ **YES** – notice of intent to discharge must be provided to system owner
   - ☐ **NO** (continue to next item)

Sediment and Stormwater Program Project Application Meeting

Discussion Items

Project Name: _____

Meeting Date: _____

8. Fees - The fees to be submitted to are as follows:

9. The Notice of Intent (NOI) and $195 NOI fee must be submitted to DNREC prior to Sediment and Stormwater Plan approval, unless one of the following conditions is met:

   ☐ Project site has existing NOI (ID #:_____)

   ☐ Project <1.0ac disturbed

   NOI comments:

Stormwater Assessment Report

Project:_____

Owner/Developer: _____

Consultant:_____

Assessment Item	***Anticipated Engineering Effort***		
	Minor	*Moderate*	*Significant*
1. Soils - On-site soils have low permeability, high water table, or other limitations that could adversely affect adequate stormwater management for the proposed project.	☐	☐	☐
2. Runoff Potential - Change in land cover due to removal of trees, increases in impervious cover, etc. could adversely affect adequate stormwater management for the proposed project.	☐	☐	☐
3. Water Resource Protection - Site conditions may adversely affect runoff reduction and/or pollutant loading reductions.	☐	☐	☐
4. Sump Conditions - Existing topography of site creates depressional areas (closed 2' contours) where runoff tends to collect without direct discharge.	☐	☐	☐
5. Discharge Points - Areas where stormwater runoff leaves the site have limitations due to low gradient, backwater effects, lack of a defined channel or other hydraulic limitations.	☐	☐	☐
6. Off-Site Drainage - Areas draining into the site could adversely affect adequate stormwater management for the proposed project.	☐	☐	☐
7. Conveyance - Downstream conditions such as inadequate pipe or channel capacity could limit adequate drainage from the site.	☐	☐	☐

Mitigation under consideration for “Significant” ratings:

- ☐ Over-management
- ☐ Off-site improvements
- ☐ Easement(s)
- ☐ Offset Option
- ☐ Other: _____

Reporting Agency: _____

Contact Person: _____

Date of Project-Application Meeting: _____

Sediment and Stormwater Program Project Application Meeting

Agreement Items

Project Name: _____

Meeting Date: _____

1. Review Stormwater Assessment Report (SAR) to be sent to County or Municipality as a group and come to agreement on individual ratings.

   a. Site qualifies for Unit Discharge Approach by having all "Minor" ratings?

      YES

      NO (continue to next item)

   b. For Unit Discharge approach, existing conditions land cover will be considered as:

      Non-Woods/Non-Meadow (ac): _____

      Woods/Meadow (ac): _____

      Woods/Meadow HSG-A (ac): _____

      Off-site areas (ac): _____

2. Points of Analysis (POAs)

   a. Onsite points of analysis:

      ☐ POAs in accordance with SAS plan submitted

      ☐ POAs modified as follows:

      ☐ New POA(s) added as follows:

   b. Offsite / downstream points of analysis based upon 10% rule:

      ☐ POAs in accordance with SAS plan submitted

      ☐ POAs modified as follows:

      ☐ New POA(s) added as follows:

Sediment and Stormwater Program Project Application Meeting

Agreement Items

Project Name: _____

Meeting Date: _____

3. Drainage area boundaries:
   - ☐ Existing conditions drainage area boundaries in accordance with SAS drainage area plan submitted
   - ☐ Modified as per project application meeting (see revised plan)

4. Existing drainage features:
   - ☐ In accordance with SAS drainage features map as submitted
   - ☐ Modified as per project application meeting (see marked-up plan)

5. Stormwater Quality Management
   a. The *Delaware Sediment and Stormwater Regulations* require that runoff reduction practices be used to meet the RPv requirements. The following runoff reduction BMPs are being considered for the site:

      ☐ Proposed BMPs are feasible based upon Feasibility criteria in BMP Standards and Specifications

   b. Justification if runoff reduction practices are considered not feasible for the site:

Agreement Items

Project Name: _____

Meeting Date: _____

c. Indicate section of Regulations for complying with RPv:

- ☐ 5.2.3.1 Runoff reduced to equiv wooded condition
- ☐ 5.2.3.2 Equivalent 0% effective imperviousness
- ☐ 5.6.3.1 Redevelopment equiv wooded condition
- ☐ 5.6.3.2 Redevelopment: 30% reduction in effective imperviousness

d. List any other issues related to compliance with RPv requirements:

6. Stormwater Quantity Management

a. The following BMPs are being considered for stormwater quantity management for meeting the Cv and Fv requirements:

b. Indicate section of Regulations for complying with Cv:

- ☐ 5.3.3.1 Management for no adverse impact
- ☐ 5.3.3.2 Tidal Discharge
- ☐ 5.3.3.3 Watershed Location
- ☐ 5.3.3.4 De minimus discharge
- ☐ Management in accordance with watershed management plan

Agreement Items

Project Name: _____

Meeting Date: _____

c. Indicate section of Regulations for complying with Fv:

- ☐ 5.4.3.1 Management for no adverse impact
- ☐ 5.4.3.2 Tidal Discharge
- ☐ 5.4.3.3 Watershed Location
- ☐ 5.4.3.4 De minimus discharge
- ☐ Management in accordance with watershed management plan

d. List any other issues related to compliance with the Cv or Fv requirements.

7. Wetland delineation will be required for the project:
   - ☐ **YES**
   - ☐ **NO**

   Comments:

8. Next submittal step:
   - ☐ Preliminary Sediment and Stormwater Management Plan (complete item 9 below)
   - ☐ Combined Preliminary and Sediment and Stormwater Management Plan (complete items 9 and 10 below)

9. Schematic Plans required with Preliminary plan submittal:
   - ☐ Schematic Pre-Construction Site SWM Plan
   - ☐ Schematic Construction Site SWM Plan
   - ☐ Schematic Post Construction SWM Plan

Sediment and Stormwater Program Project Application Meeting

Agreement Items

Project Name: _____

Meeting Date: _____

10. Sediment and Stormwater Plan Sheets to be prepared and submitted:
    - ☐ Coversheet and General Notes
    - ☐ Overall Construction Site Phasing Plan
    - ☐ Overall Pre-Construction Site Stormwater Management Plan
    - ☐ Pre-Construction Site Stormwater Management Plan #X
    - ☐ Overall Construction Site Stormwater Management Plan
    - ☐ Construction Site Stormwater Management Plan #X
    - ☐ Construction Site Details and Notes (including the Sequence of Construction)
    - ☐ Overall Post Construction Stormwater Management Plan
    - ☐ Post Construction Stormwater Management Plan, Facility #X
    - ☐ Contributing Drainage Area Plan
    - ☐ Pre-Limit of Disturbance Drainage Area Plan
    - ☐ Post Limit of Disturbance Drainage Area Plan

Sediment and Stormwater Program Project Application Meeting

Agreement Items

Project Name: _____

Meeting Date: _____

The Preliminary Sediment & Stormwater Plan shall be based upon the discussion and agreement items from this Project Application Meeting. The Delegated Agency reserves the right to revisit the agreement items from the original Project Application Meeting if the applicant later proposes significant changes to the project which would alter the results of the original Stormwater Assessment Report (SAR). Signing below indicates presence and participation at this Project Application Meeting for the project identified in this document, as well as agreement to the items referenced in this document.

Printed Name	Company/Agency	Email address	Signature

Stormwater Assessment Report

Project:_____

Owner/Developer: _____

Consultant:_____

Assessment Item	***Anticipated Engineering Effort***		
	Minor	*Moderate*	*Significant*
1. Soils - On-site soils have low permeability, high water table, or other limitations that could adversely affect adequate stormwater management for the proposed project.	☐	☐	☐
2. Runoff Potential - Change in land cover due to removal of trees, increases in impervious cover, etc. could adversely affect adequate stormwater management for the proposed project.	☐	☐	☐
3. Water Resource Protection - Site conditions may adversely affect runoff reduction and/or pollutant loading reductions.	☐	☐	☐
4. Sump Conditions - Existing topography of site creates depressional areas (closed 2' contours) where runoff tends to collect without direct discharge.	☐	☐	☐
5. Discharge Points - Areas where stormwater runoff leaves the site have limitations due to low gradient, backwater effects, lack of a defined channel or other hydraulic limitations.	☐	☐	☐
6. Off-Site Drainage - Areas draining into the site could adversely affect adequate stormwater management for the proposed project.	☐	☐	☐
7. Conveyance - Downstream conditions such as inadequate pipe or channel capacity could limit adequate drainage from the site.	☐	☐	☐

Mitigation under consideration for “Significant” ratings:

- ☐ Over-management
- ☐ Off-site improvements
- ☐ Easement(s)
- ☐ Offset Option
- ☐ Other: _____

Reporting Agency: _____

Contact Person: _____

Date of Project-Application Meeting: _____

Assessment Item	***Rating Criteria***		
	Minor	*Moderate*	*Significant*
1. Soils - On-site soils have low permeability, high water table, or other limitations that could adversely affect adequate stormwater management for the proposed project.	<15% of developed portion of the site has soils with limitations to development	15% - 50% of developed portion of the site has soils with limitations to development	>50% of developed portion of the site has soils with limitations to development
2. Runoff Potential - Change in land cover due to removal of trees, increases in impervious cover, etc. could adversely affect adequate stormwater management for the proposed project.	<25% existing woods/meadow to be disturbed **OR** <25% proposed increase in impervious area	25%-50% existing woods/meadow to be disturbed **OR** 25%-50% proposed increase in impervious area	> 50% existing woods/meadow to be disturbed **OR** > 50% proposed increase in impervious area
3. Water Resource Protection - Site conditions may adversely affect runoff reduction and/or pollutant loading reductions.	<15% of developed portion of the site has RR Feasibility rating of Low or Low-Mod **OR** For areas not mapped for RR Feasibility, <15% of developed portion of site has water table <36" (100cm) or HSG "C" or "D" soils	15% - 50% of developed portion of the site has RR Feasibility rating of Low or Low-Mod **OR** For areas not mapped for RR Feasibility, 15% - 50% of developed portion of site has water table <36" (100cm) or HSG "C" or "D" soils	>50% of developed portion of the site has RR Feasibility rating of Low or Low-Mod **OR** For areas not mapped for RR Feasibility, >50% of developed portion of site has water table <36" (100cm) or HSG "C" or "D" soils
4. Sump Conditions - Existing topography of site creates depressional areas (closed 2' contours) where runoff tends to collect without direct discharge.	0% of site area drains to sump areas	≤50% of site area drains to sump areas	>50% of site area drains to sump areas
5. Discharge Points - Areas where stormwater runoff leaves the site have limitations due to low gradient, backwater effects, lack of a defined channel or other hydraulic limitations.	Zero (0) site discharge points with identified problems	At least one (1) site discharge point with an identified problem **OR** < 50% of site area drains to a discharge point with an identified problem	Multiple (more than 1) discharge point with an identified problem **OR** >50% of site area drains to a discharge point with an identified problem **OR** Lack of easements and/or alteration of drainage patterns could raise potential "right-to-discharge" issues.
6. Off-Site Drainage - Areas draining into the site could adversely affect adequate stormwater management for the proposed project.	<25% offsite area relative to site area draining onto site	25% - 50% offsite area relative to site area draining onto site	>50% offsite area relative to site area draining onto site
7. Conveyance - Downstream conditions such as inadequate pipe or channel capacity could limit adequate drainage from the site.	Zero (0) known historic drainage problems **AND** Zero (0) in-line structures prior to the 10% analysis point	At least one (1) known historic drainage problem **OR** At least one (1) in-line structure prior to the 10% analysis point	Multiple (more than 1) known historic drainage problems **OR** Multiple (more than 1) in-line structures prior to the 10% analysis point **OR** Stream channel condition degraded due to vegetation, slope, erosion, etc.

Effective April 2016

Total site area (ac): _____
Total LOD area (ac): _____

Assessment Item	*Rating Value*			
	Number	Yes/No	Acres	%
1. Soils - On-site soils have low permeability, high water table, or other limitations that could adversely affect adequate stormwater management for the proposed project.				
1.1 Hydric Soils within LOD (ac)				
1.2 Drainage class "Poorly drained" or "Very poorly drained" within LOD (ac)				
1.3 Hydrologic Soil Group "D" within LOD (ac)				
1.4 Depth to water table < 100 cm within LOD (ac)				
1.5 Flood frequency class "Frequent" or "Very frequent" within LOD (ac)				
1.6 Ponding frequency class "Frequent" within LOD (ac)				
1.7 Max. acreage for items 1.1 to 1.6 above within LOD (ac)				
2. Runoff Potential - Change in land cover due to removal of trees, increases in impervious cover, etc. could adversely affect adequate stormwater management for the proposed project.				
2.1 Existing wooded or meadow areas to be disturbed within LOD (ac)				
2.2 Proposed increase in impervious area within LOD (ac)				
3. Water Resource Protection - Site conditions may adversely affect runoff reduction and/or pollutant loading reductions.				
3.1 Site area with Runoff Reduction Feasibility rating of Low or Low-Mod within LOD (ac)				
3.2 Site area with water table <36 inches (100 cm) within LOD (ac)				
3.3 Site area with HSG C or D soils within LOD (ac)				
4. Sump Conditions - Existing topography of site creates depressional areas (closed 2' contours) where runoff tends to collect without direct discharge.				
4.1 Site area that drains to sump (ac)				
5. Discharge Points - Areas where stormwater runoff leaves the site have limitations due to low gradient, backwater effects, lack of a defined channel or other hydraulic limitations.				
5.1 Discharge points with identified problems (no.)				
5.2 Site area that drains to discharge point with identified problem (ac)				
6. Off-Site Drainage - Areas draining into the site could adversely affect adequate stormwater management for the proposed project.				
6.1 Off-site areas draining onto site (ac)				
7. Conveyance - Downstream conditions such as inadequate pipe or channel capacity could limit adequate drainage from the site.				
7.1 Known historic drainage problems (no.)				
7.2 In-line structures between site and 10% analysis point (no.)				
7.3 Stream channel condition degraded (yes/no)				

Effective April 2016

Workflow for Performing Site Level Hydrologic Analysis To Prepare Drainage Features Map

1. **Part 1 – LiDAR Pre-Processing using ArcGIS 9.3**

   1.1. Download DEM tile(s): http://datamil.delaware.gov/tiles/

   1.2. If area of interest includes more than 1 tile, create DEM mosaic

      1.2.1. Open ArcCatalog; left-click on directory containing DEM tiles

      1.2.2. Right-click one of the DEM tiles

      1.2.3. Load>Load data…

      1.2.4. Mosaic dialogue box will open; add other tiles to be mosaicked in "Input Rasters" field

      1.2.5. Leave other fields in default values

      1.2.6. Click "OK"

      1.2.7. NOTE: Mosaicked DEM will retain name of original tile; it is recommended that mosaicked DEM be renamed to avoid file management problems

   1.3. Zoom to level adequate to define limits of both off-site and on-site drainage

   1.4. Export LiDAR grid defined by data frame in Step 1.3 (NOTE: When working with digital terrain files in ESRI grid format, file names and paths must not contain spaces and file names must be 13 characters or less.)

      1.4.1. Right-click on grid file in TOC: *Data>Export Data…*

      1.4.2. Extent: Data Frame (Current)

      1.4.3. Spatial Reference: Data Frame (Current)

      1.4.4. Select location for output file

      1.4.5. Format: Grid

2. **Part 2 – Create Hydrologic Data using MapWindow GIS**

   2.1. Open MapWindow GIS and create new MapWindow GIS project

      2.1.1. *File>Save>Projectname.mwproj*

   2.2. Invoke the automated watershed delineation process: *Watershed Delineation>Automatic*

   2.3. Select LiDAR grid "sta.adf" file created in Part 1 as "Base Elevation Data (DEM) Layer"; leave all remaining fields in default settings

2.4. Click “Run All” button

2.5. MapWindow GIS will create several grids and shapefiles in the “Terrain Analysis” layer

2.6. The following shapefiles will be used for further analysis in ArcGIS 9.3

2.6.1. Watershed Shapefile (*projectname*w.shp)

2.6.2. Stream Reach Shapefile (*projectname*net.shp)

2.7. The following grid files will be used for further analysis in ArcGIS 9.2/9.3

2.7.1. Pit Filled Elevation Grid (*projectname*fel.bgd)

2.7.2. Strahler Network Order Grid *(projectname*egord.bgd)

2.7.3. Total Upslope Length Grid (*projectname*tlen.bgd)

2.8. Since grid files identified in 2.7 are in MapWindow GIS’s native binary format, these will have to be converted into a format that ArcGIS 9.3 can import

2.8.1. *GIS Tools>Raster>Change Grid Formats*

2.8.2. Select grid files identified in 2.7; click “OK”

2.8.3. Set Output Options

2.8.3.1. Output File Format: ASCII (*.asc)

2.8.3.2. Output Data Type:

2.8.3.2.1. Pit Filled Elevation: Single Precision Float (4 bytes)

2.8.3.2.2. Strahler Network Order: Short Integer

2.8.3.2.3. Total Upslope Length: Single Precision Float (4 bytes)

3. Part 3 – Site Hydrologic Analysis in ArcGIS 9.3

3.1. Load base grids, shapefiles and/or image files as desired

3.2. Load shapefiles identified in Step 2.6

3.2.1. To display Strahler Stream Order from Stream Reach Shapefile (*projectname*net.shp):

3.2.1.1. Double-click on shapefile name in TOC

3.2.1.2. Click “Symbology” tab

3.2.1.3. Select *Categories>Unique values*

3.2.1.4. Select “Order” from the “Value Field” drop-down menu

3.2.1.5. Click the “Add All Values” button

3.2.1.6. Select desired Color Ramp (ex., Slope); click “OK”

3.3. Load converted “ASCII” grids identified in Step 2.7

3.4. ASCII grid files will need symbology adjustments for proper viewing in ArcGIS

3.4.1. Pit Filled Elevation Grid (*projectname*fel.asc)

3.4.1.1. Double-click on grid name in TOC

3.4.1.2. Click “Symbology” tab

3.4.1.3. Highlight “Stretched”

3.4.1.4. Click “Use hillshade effect”; click “OK”

3.4.2. Strahler Network Order Grid (*projectname*gord.asc)

3.4.2.1. Double-click on grid name in TOC

3.4.2.2. Click “Symbology” tab

3.4.2.3. Select “Classified”;

3.4.2.4. Click “Classify…” button; set number of classes equal to max. whole number value

3.4.2.5. Select desired Color Ramp (ex., Cyan-Light to Blue-Dark)

3.4.2.6. Double click on color button for value “1”; set to “No Color”

3.4.3. Total Upslope Length Grid (*projectname* tlen.asc)

3.4.3.1. Double-click on grid name in TOC

3.4.3.2. Click “Symbology” tab

3.4.3.3. Select “Classified”;

3.4.3.4. Click “Classify…” button

3.4.3.5. Classification Method: Natural Breaks (Jenks)

3.4.3.6. Classification Classes: 20

3.4.3.7. Select desired Color Ramp (ex., Spectrum-Full Bright)

3.4.3.8. Double click on color button for lowest range; set to “No Color”

3.5. Drainage network can now be analyzed by overlaying hydrologic layers on the base layers

4. Part 4 - Optional Analytical Procedures

4.1.1. Tc Path from Stream Reach shapefile using ArcGIS 9.3 3D Analyst Extension

4.1.1.1. Extend upper limit of Stream Reach shapefile to beginning of Tc path

4.1.1.1.1. Editor>Start Editing

4.1.1.1.2. Task: “Create New Feature”

4.1.1.1.3. Target: “projectnamenet.shp”

4.1.1.1.4. Editor>Snapping...; check “End” of “projectnamenet” layer

4.1.1.1.5. Click Sketch tool; snap to end of Stream Reach shapefile

4.1.1.1.6. Use Strahler Network Order Grid as template to digitize Tc path

4.1.1.1.7. To finish digitizing, right-click and select “Finish Sketch”

4.1.1.1.8. Editor>Stop Editing; “Yes” to save edits

4.1.1.2. Trim Stream Network shapefile at terminus of Tc path

4.1.1.2.1. Editor>Start Editing

4.1.1.2.2. Task: Extend/Trim Features

4.1.1.2.3. Target: projectnamenet.shp

4.1.1.2.4. Select Stream Network shapefile with editing pointer tool

4.1.1.2.5. Click Sketch tool

4.1.1.2.6. Place 2 points to define a line across the Stream Network at the clip point

4.1.1.2.7. Right-click>”Finish Sketch” (NOTE: if wrong segment is deleted; click the “Undo” button and place the 2 points again in reverse order)

4.1.1.2.8. Editor>Stop Editing; “Save” edits

4.1.1.3. Use Stream Network shapefile to create sheet, shallow & channel flow segments (NOTE: Pit Filled Elevation Grid may be used to generate a contour layer which can be used to determine appropriate segmentation of flow path)

4.1.1.3.1. 100’ Sheet Flow

4.1.1.3.1.1. Editor>Start Editing; select upper line segment

4.1.1.3.1.2. Editor>Split…; “Split” dialogue box opens

4.1.1.3.1.3. “Distance along the line” (NOTE: linear units of Stream Network is identified on the Properties>Source tab)

4.1.1.3.1.3.1. Enter “30.5” if linear units of Stream Network are in meters

4.1.1.3.1.3.2. Enter “100” if linear units of Stream Network are in feet

4.1.1.3.1.4. Orientation: “From end Point of Line”; click “OK”

4.1.1.3.1.5. Editor>Stop Editing; “Yes” to save edits

4.1.1.3.1.6. Export sheet flow segment as new shapefile

4.1.1.3.1.6.1. Select uppermost segment

4.1.1.3.1.6.2. Right-click Stream Network shapefile

4.1.1.3.1.6.3. Data>Export Data>Selected features

4.1.1.3.1.6.4. Name new shapefile (ex., Tc_sheet) ; “Save”

4.1.1.3.2. Shallow Concentrated Flow

4.1.1.3.2.1.1. Editor>Start Editing

4.1.1.3.2.1.2. Select appropriate segments of Stream Network shapefile to represent shallow concentrated flow path with editing pointer (NOTE: hold “Shift” key to select multiple segments)

4.1.1.3.2.1.3. Editor>Merge; Merge dialogue box will open

4.1.1.3.2.1.4. Accept highlighted segment to merge the selected features to

4.1.1.3.2.1.5. Editor>Stop Editing; “Save” edits

4.1.1.3.2.1.6. If Merge operation was successful, selecting on the Stream Network shapefile should highlight the entire shallow concentrated flow path

4.1.1.3.2.1.7. Repeat as necessary for additional shallow concentrated flow segments

4.1.1.3.2.1.8. Export shallow concentrated flow segment(s) as new shapefile(s)

4.1.1.3.2.1.8.1. Select segment

4.1.1.3.2.1.8.2. Right-click Stream Network shapefile

4.1.1.3.2.1.8.3. Data>Export Data>Selected features

4.1.1.3.2.1.9. Name new shapefile (ex., Tc_shallow) ; “Save”

4.1.1.3.3. Channel Flow

4.1.1.3.3.1.1. The process for preparing channel flow segment(s) is the same as that for shallow concentrated flow described above

4.1.1.3.3.1.2. Export channel flow segment(s) as new shapefile(s)

4.1.1.3.3.1.2.1. Select segment

4.1.1.3.3.1.2.2. Right-click Stream Network shapefile

4.1.1.3.3.1.2.3. Data>Export Data>Selected features

4.1.1.3.3.1.3. Name new shapefile (ex., Tc_channel) ; “Save”

4.1.1.4. Add elevation attributes to Tc segments

4.1.1.4.1. 3D Analyst>Convert>Features to 3D

4.1.1.4.1.1.1. Input features: “Tc_sheet”

4.1.1.4.1.1.2. Raster or TIN surface: Pit Filled Elevation Grid (*projectname* fel.asc)

4.1.1.4.1.1.3. Output features: Name output shapefile (ex., Tc_sheetZ)

4.1.1.4.2. Repeat for other Tc segments

4.1.1.5. Generate profile plot & export to MS Excel

4.1.1.5.1. Select Tc polylineZ segment

4.1.1.5.2. 3D Analyst toolbar>Create Profile Graph button

4.1.1.5.3. Right click on graph>Export

4.1.1.5.4. Click “Data” tab

4.1.1.5.5. Click “Excel” format

4.1.1.5.6. “Save”

4.1.1.5.7. Name file; “Save”

4.1.1.5.8. Close dialogue boxes and repeat steps above for all Tc path segments

4.1.1.5.9. Profile data may be charted and further analyzed in MS Excel

3.02.2
Step 2: Preliminary Sediment & Stormwater Management Plan

The Preliminary Sediment & Stormwater Management Plan shall be submitted only after the Project Application Meeting has been conducted and shall consist of the following elements:

1. Schematic Construction Site Stormwater Management Plan
2. Stormwater Management Report with accompanying Drainage Area Plans

The submittal shall be accompanied by a completed Preliminary Sediment & Stormwater Plan Checklist. An example Preliminary Sediment & Stormwater Plan Checklist is included as Appendix 3.02.2.1.

The submittal package shall be reviewed for completeness by the Delegated Agency. Incomplete submittals will be returned in whole with the missing checklist items highlighted.

If significant changes have been proposed for the site development plan, the Delegated Agency may require the applicant to repeat the Project Application process prior to reviewing the Preliminary Sediment & Stormwater Management Plan.

An example Preliminary Sediment & Stormwater Management Plan is included as Appendix 3.02.2.8.

Schematic Construction Site Stormwater Management Plan (CCSWM)

The Preliminary Sediment & Stormwater Management Plan submitted at Step 2 of the plan review and approval process shall include a Schematic CSSWM Plan which provides an overview of the general measures to be used to control the site during the construction phase.

The Schematic CSSWM Plan shall consist of the following elements (refer to the Preliminary Sediment and Stormwater Plan Checklist for all requirements):

1. A single plan sheet scaled such that the entire site can be shown.
2. Site boundary.
3. Existing topography.
4. Existing natural features, such as wooded areas, wetlands, etc.
5. Proposed rough grading (at minimum flow arrows with approximate spot elevations).
6. Graphic symbols for all ESC measures shown in their approximate proposed locations.

7. Data for those practices having design data criteria.
8. Legend using the symbols from the current Delaware ESC handbook.

Stormwater Management Report and Drainage Area Plans

A draft of the final Stormwater Management Report, including a site narrative, DURMM and other hydraulic and/or hydrologic computations, soils reports, and other supplemental information not previously included in the Stormwater Assessment Study, is to be prepared at the Preliminary stage. The intent is to provide a thorough yet preliminary synopsis of the site's construction and post construction controls. Further in depth information can be supplemented in future submittals.

Computations shall be included supporting the adequacy of proposed runoff reduction practices intended to comply with the requirements for the Resource Protection Event.

Projects which qualify for the standards-based approach to comply with the requirements for the Conveyance Event and Flooding Event shall submit computations supporting the allowable unit discharges.

All projects required or opting to use the performance-based approach to comply with the requirements for the Conveyance Event and Flooding Event shall submit hydrologic and/or hydraulic computations in accordance with Department guidance (see Appendices 3.02.2.3 and 3.02.2.4).

Accompanying Drainage Area Plans should be included that depict the drainage boundaries and landuse covers used with the supplied computations.

Refer to the Preliminary Sediment and Stormwater Plan Review Checklist (Appendix 3.02.2.1) for additional information on both the Stormwater Management Report and the Drainage Area Plans.

Preliminary Sediment & Stormwater Management Plan Review Checklist

DATE RECEIVED: _____ **PROJECT NUMBER:** _____

PROJECT NAME: _____

General Information:

1. _____ Completed application signed by the owner, review fee, one set of plans and reports, and a completed checklist must be submitted for review. Electronic plan and report program files (i.e., AutoCAD, Microstation, DURMM, HydroCAD, and/or equal/similar) shall be transmitted upon agency request.
2. _____ Provide a copy of the notice to DelDOT, a municipality, or a private entity (i.e., neighboring Homeowner's Association) for the intent to discharge or connect to their stormwater system. The notice shall indicate the proposed condition and that any comments regarding the discharge shall be returned within 30 calendar days, and if no comments are received than consent to discharge is assumed. If directly copied on the notice, indicate the date of the notice and the reviewer copied: _____.
3. _____ Hydraulic and Hydrology computations shall reflect the proposed site conditions.
4. _____ All plans should be submitted on 24" x 36" (minimum) sheets unless otherwise approved.
5. _____ When two (2) or more sheets are used to illustrate the plan view, an index sheet is required, illustrating the entire project on one (1) 24" x 36" (minimum) sheet.
6. _____ Provide a north arrow on all plans.
7. _____ Provide all plan views to a defined scale with a scale bar.
8. _____ Provide names of adjacent property owners on all plans.
9. _____ Provide existing and proposed contours (if provided) based on NAVD 88 vertical datum at one (1) foot intervals (2 foot intervals can be provided for offsite drainage information based on the latest Lidar information).
10. _____ For small projects less than ½ acre of disturbance, provide existing and proposed spot elevations based on NAVD 88 vertical datum on a fifty-foot grid system. Include high and low points.
11. _____ Locate the site in NAD83 horizontal datum.
12. _____ Provide the contact information for the person or entity responsible for preparing the plans and report, including name, company, address and telephone number.. Locate on both the plans and report.
13. _____ All detailed plans submitted for review shall be prepared, signed, dated and sealed by a Licensed Professional in the State of Delaware.
14. _____ Provide the Preliminary Sediment and Stormwater Management plans in the following order and title. The sheet list is to appear on the Coversheet, and on each plan sheet shall be respectively titled (include the title of the plan within the title block or lower right-hand corner of the sheet):
    a. _____ Coversheet
    b. _____ Schematic Pre-Construction Site Stormwater Management Plan
    c. _____ Schematic Construction Site Stormwater Management Plan
    d. _____ Overall BMP Contributing Drainage Area Plan
    e. _____ BMP Contributing Drainage Area Plan
    f. _____ Pre-Developed Subarea Limit of Disturbance Drainage Area Plan

Coversheet:

15. _____ Project Header:
    a. _____ Project Name and Phase (to duplicate in the title block on each sheet).
    b. _____ Title of Plan Set: Preliminary Sediment and Stormwater Management Plans (to duplicate in the title block on each sheet)
    c. _____ Project Location (including watershed, hundred, town, county, etc., as applicable).
    d. _____ Project tax map identification number(s).
16. _____ Legend indicating plan symbols and lines, including but not limited to, soils, drainage area information, grading and site information.
17. _____ Provide a vicinity map with a scale appropriate to project size, and indicate the site boundary within the map. The map shall be no smaller than 4"x4" in size and shall clearly indicate at least one intersecting road.
18. _____ Project Notes:
    a. Parcel Data:
        i. _____ Project tax map identification number(s)
        ii. _____ PLUS Number (if applicable)
        iii. _____ DNREC Sediment and Stormwater Program [or relevant Delegated Agency] Number
        iv. _____ Site Address (or Nearest Intersecting Street and Distance between)
        v. _____ Latitude and Longitude State Plane coordinates, with approximate geographical location (ie., Benchmark #1, Northeast Site Corner, etc). Provide in degree decimal format.
        vi. _____ Existing Site Area
        vii. _____ Proposed Site Area
        viii. _____ Existing Wetland Area
        ix. _____ Proposed Discharge Location(s)
        x. _____ Proposed Total Limit of Disturbance per Discharge Location
    b. Contact Data:
        i. Owner's Name, Title: _____ Owner _____ Land Developer _____ Designer
        ii. Company/LLC: _____ Owner _____ Land Developer _____ Designer
        iii. Full Street Address: _____ Owner _____ Land Developer _____ Designer
        iv. Phone Number: _____ Owner _____ Land Developer _____ Designer
19. _____ Include a Licensed Professional Certification that states "I hereby certify that this plan has been prepared under my supervision and to the best of my knowledge complies with the applicable state and local regulations and ordinances." <u>This shall be signed in ink or an original reproducible.</u>
20. _____ Provide a list of all sheets and their corresponding sheet number for all Preliminary Sediment and Stormwater Management Plans.

Schematic Construction Site Stormwater Management Plans:

The purpose of the Schematic Construction Site Stormwater Management Plan is to provide a preliminary design of the site's phasing in relation to the site's existing conditions and its construction and stormwater facility locations. It will eventually be further developed into the Pre-Construction and Construction Site Stormwater Management Plan for the full plan submittal.

21. _____ Schematic Pre-Construction Site Stormwater Management Plan (if required, as determined at the SAS review meeting):
    a. _____ Include the entire site boundary in an existing conditions plan view (i.e., site boundary, existing contours, wetlands, treelines, existing structures/utilities to remain or to be removed, etc).
    b. _____ Indicate the approximate limit of disturbance per phase of construction. Provide a legend indicating the total disturbed acreage per limit of construction.
    c. _____ Indicate the location of all perimeter controls, stockpile locations, sediment trapping facilities, and other construction stormwater management controls needed for demolition and bulk grading (i.e., silt fence, stabilized construction entrances, temporary swales, sediment basins, etc).
    d. _____ Proposed contours are not required.
    e. _____ Provide a legend indicating the lines and symbols used to define the site and construction stormwater controls.
22. _____ Schematic Construction Site Stormwater Management Plan:
    a. _____ Include the entire site boundary in an existing conditions plan view (i.e., site boundary, existing contours, wetlands, treelines, existing structures to remain, etc).
    b. _____ Include a preliminary site plan view overlaid with the existing conditions. Include all lot and/or building outlines; right-of-ways and/or paved areas (whichever is less constrictive); and proposed stormwater locations including facilities, structures and pipes.
    c. _____ Indicate the approximate limit of disturbance per phase of construction. Provide a legend indicating the total disturbed acreage per limit of construction.
    d. _____ Indicate the location of all construction site stormwater controls, including perimeter controls, sediment controls, water controls, and pollution prevention controls. (i.e., silt fence, stabilized construction entrances, temporary swales, sediment basins, etc). Graphic symbols representing the practice can be utilized (ie, sediment basins do not need to be graded out).
    e. _____ Proposed contours are not required, but should be included when available. If not flow arrows showing the drainage intent with sample spot elevations can suffice.
    f. _____ Provide a legend indicating the lines and symbols used to define the site and construction stormwater controls, corresponding to the current *Delaware Erosion and Sediment Control Handbook*.

Drainage Area Plans:

The drainage area plans shall provide a graphic portrayal of the information that is contained within the DURMM worksheets. .

23. _____ Overall BMP Contributing Drainage Area Plan
    a. _____ Provide only for sites that cannot be shown in their entirety at the maximum scale of 1"=100'.
    b. _____ Provide the type and location of Stormwater BMP(s) including the BMP draingage area boundary.
    c. _____ Provide the total area of each sub-drainage area.
    d. _____ Provide a summary table indicating the sub-areas and their respective point of analysis, total area, and RCN.
24. _____ BMP Contributing Drainage Area Plan
    a. _____ Provide a plan correlating to the Contributing Area RCN worksheet (post development model for the entire drainage area) for each subarea (subareas may be combined onto the same sheet, so long as they are clearly distinguishable).
    b. _____ Provide soils mapping on the plan, using the latest NRCS soil information, with a general description of each soil.
    c. _____ Indicate the LOD and the OLOD contributing areas, separated per their respective land cover and soil type classification. Provide the area of each designation.
    d. _____ Provide a legend indicating the various land covers per soil type classification (a hatch shall be provided for each type of land cover; i.e. grass-B soils, impervious-D soils).
    e. _____ Provide a summary table indicating the sub-areas and their respective point of analysis, total area, and RCN.
    f. _____ Indicate the location, type and sizing information for each BMP including a representative cross section.
    g. _____ Show the Tc path for the area outside the LOD as used in the OLOD worksheet.
    h. _____ Show the Tc path for any other areas that require further analysis using other H&H software.
25. _____ Pre-Developed Subarea Limit of Disturbance Data Plan
    a. _____ Provide a plan correlating to the Pre-Developed LOD information requested in the LOD worksheet (location of woods/meadow and impervious conditions within the LOD per sub-area prior to disturbance) for each subarea (subareas may be combined onto the same sheet, so long as they are clearly distinguishable).
    b. _____ Provide soils mapping on the plan, using the latest NRCS soil information, with a general description of each soil.
    c. _____ Indicate the areas of woods/meadow and impervious condition per soil type classification. Provide the area of each designation.
    d. _____ Provide a legend indicating the various land covers per soil type classification (a hatch shall be provided for each type of land cover; i.e. grass-B soils, impervious-D soils).
    e. _____ Provide a summary table indicating the sub-areas and their respective point of analysis, total area, and RCN.

26. _____ Any additional hydraulic or hydrologic computations that are required to show compliance with the *Delaware Sediment and Stormwater Regulations* may require additional drainage area or watershed plans (i.e., to satisfy the Cv and Fv requirements). These plans are not prescribed, but shall follow similar guidelines, clearly indicate the parameters used within the calculations, and be contained within the plan Sediment and Stormwater Management Plan set.

Stormwater Management Report:

27. _____ Provide information in the report in the following order:
    a. _____ Coverpage
    b. _____ Table of Contents
    c. _____ Site Narrative:
        i. _____ Introduction
        ii. _____ Existing Conditions describing the drainage patterns, landuse(s), and existing features. Include 2007 site aerial, 2007 Land Use Land Cover mapping, and photos of the site conditions and at all discharge locations.
        iii. _____ Existing Soils description per the NRCS Web Soil Survey including the hydrologic soil group; and soil testing results from on-site soil testing.
        iv. _____ Post Development Conditions, including summary of the proposed development, the proposed drainage system, indication of why the standards or performance approach was utilized, methods for RPv, Cv, and Fv compliance, requests for waivers and/or offsets, etc.
        v. _____ Construction Site Conditions, describing methods to prevent sediment and pollution discharge and illicit transportation.
        vi. _____ Conclusion
        (Note: It is not the objective to provide in depth information on practices that might change in the future due to the preliminary state of the submittal. The narrative can be elaborated for future submittals once the design becomes finalized; however, the intent of the construction and post construction practices should be described, indicating how the site will be handled with any potential concerns documented.)
    d. _____ DURMM computations and a schematic of the drainage subareas and stormwater practices
    e. _____ Additional hydraulic and hydrologic computations, such as supporting calculations for either the standards or performance based approach for the Cv and Fv events. Detailed information subject to change
    f. _____ Supplementary Construction Site computations (i.e., temporary sediment basin sizing, anti-seep collar sizing, forebay sizing, etc). *[Provide place holder for future information; does not need to be included for Preliminary submittal].*
    g. _____ Soil report(s) including boring locations and log reports.
    h. _____ Appendix containing any supplemental information (information previously included within the Stormwater Assessment Study report does not need to be duplicated).
28. _____ Provide drainage calculations for the RPv, Cv, and Fv events using the latest DURMM model and other approved H&H software as required.
29. _____ All inputted data must be supported by surveys, Lidar information, photos, aerials, maps, etc. and shall be referenced in the report and/or drainage area plans. Information previously included within the Stormwater Assessment Study submittal is acceptable and does not need to be duplicated, though shall be referenced accordingly.
30. _____ The storm duration for computational purposes shall be the 24-hour rainfall event, unless otherwise specified. For projects south of the Chesapeake and Delaware (C&D) Canal, the Delmarva Unit Hydrograph shall be used.
31. _____ The pre-development condition shall be based off of the 2007 aerial photography and the Land Use Land Cover overlay mapping provided by the State of Delaware, through Stormwater Assessment Study GIS Web Application. This may not directly correlate to current site

conditions if the landuse has changed; however, the 2007 landuse shall be used regardless even if more or less conservative than the current landuse.

32. _____ The pre-development condition shall be computed assuming that all existing land uses in the site that are to be developed are in good hydrologic condition.
33. _____ Provide sizing information for the BMP(s) to be used and show they meet sizing guidelines according to section 3.06.2 Post Construction Stormwater BMP Standards and Specifications of the Technical Document.
34. _____ Provide BMP capacity information for any detention practices to be used.

Procedure for Conducting Hydrologic & Hydraulic Analyses For Preliminary Sediment & Stormwater Plans

Background

The Hydrologic & Hydraulic (H&H) Analysis couples field collected data with desktop watershed modeling methodology to provide a tool for stormwater management agencies to help determine the most appropriate method to manage stormwater runoff from developing sites based on "No Adverse Impact" principles. The general approach is one of increasing level of detail and analysis depending on the complexity of the watershed. It is NOT intended to be a substitute for detailed Watershed Master Plans that have been endorsed by the Department. When such detailed plans are available, the peak discharge and/or volume management requirements from the Watershed Master Plan shall take precedence over the requirements of the Level 2 Analysis. Additionally, the methodologies used for this analysis are not considered to be precise enough to be applied at the site level.

Procedure

1. Applicability

1.1. The H&H analysis will be required for all projects using the performance-based option and/or where a sump condition exists.

2. Methodology

2.1. Level 1 Analysis

2.1.1. The Level 1 Analysis combines field reconnaissance data with hydrologic modeling of the upstream watershed and site using latest soils, LULC, and terrain data. Hydrographs are then compared to check for coincidental peaking effects.

2.1.2. Limit of study shall be the most-downstream junction of the site and the upstream contributing area.

2.1.3. To comply at this level of analysis, hydrologic modeling must indicate no adverse impact due to coincidental peaking effects. For purposes of this policy, "no adverse impact" shall mean that the developed site hydrograph peak is less than, and the inflection point occurs before, the peak of the upstream hydrograph OR that it can be demonstrated that on-site detention would exacerbate downstream impacts. If compliance cannot be demonstrated, proceed to Level 2.

2.2. Level 2 Analysis

2.2.1. The Level 2 Analysis combines field measurement data with hydraulic modeling of structures, channels, etc. using an expanded hydrologic model.

2.2.2. Limit of the study shall be the point downstream where the site is 10% of the total contributing drainage area. Points of Analysis (POAs) shall be established at the site boundary and all hydraulic structures within the study reach. In cases where there are no hydraulic structures within the study reach, representative section(s) based on LiDAR data shall be used; locations to be determined at the Project Application Meeting.

2.2.3. To comply at this level of analysis, the applicant must show that:

2.2.3.1. The runoff volume based on the NRCS Runoff Curve Number (RCN) and the rate of runoff based on the calculated peak discharge for the post-developed condition does not exceed that for the pre-developed condition, or;

2.2.3.2. Steady flow hydraulic modeling must indicate no adverse impacts to headwater, water surface elevations and/or areas of inundation at designated POAs. For purposes of this policy, “no adverse impact” shall mean less than 0.05’ increase in the calculated water surface elevations in channels and/or in headwater at hydraulic structures for all points of analysis. In addition, the area of inundation shall not encroach upon buildings or similar structures previously not impacted. If the “no adverse impact” condition can not be met, a remedy must be provided in accordance with Section 3 of this policy. If impacts are uncertain, proceed to Level 3.

2.3. Level 3 Analysis

2.3.1. The Level 3 Analysis shall be used in situations in which the watershed is so complex that a more rigorous analysis is needed to determine the appropriate stormwater management technique(s). It is expected that this would require survey-level field data to support development of an unsteady flow model. This may also require accounting for existing storage structures within the watershed study area.

2.3.2. Limit of the study shall be the point downstream where the site is 10% of the total contributing drainage area. POAs shall be established at the site boundary and all hydraulic structures within the study reach. In cases where there are no hydraulic structures within the study reach, representative section(s) based on LiDAR data shall be used; locations to be determined at Project Application Meeting.

2.3.3. To comply at this level of analysis, unsteady flow hydraulic modeling must indicate no adverse impacts to headwater, water surface elevations and/or areas of inundation at designated POAs. For purposes of this policy, “no adverse impact” shall mean less than 0.05’ increase in water surface elevations in channels and/or in headwater at hydraulic structures for all points of investigation. In

addition, the area of inundation shall not encroach upon buildings or similar structures previously not impacted. If the “no adverse impact” condition cannot be met, a remedy must be provided in accordance with Section 3 of this policy.

3. Remedy

3.1. Option 1: Modify detention design so that the downstream condition meets the “no adverse impact” as defined in Section 2 of this policy.

3.2. Option 2: Improve existing downstream conveyance system so that the downstream condition meets the “no adverse impact” defined above.

3.2.1. Design criteria under this option shall be established by the appropriate review/approval authority (see “Scenario Matrix”). In general, structures within a DelDOT ROW must meet the design criteria of the DelDOT Road Design and/or Bridge Design Manuals. Modifications to a Tax Ditch must meet the design criteria of DNREC/Drainage and approved by the appropriate Tax Ditch Organization. All other proposed modifications to an existing conveyance system or on-site stormwater management facility shall be reviewed on a case-by-case basis by DNREC or its authorized agent.

Workflow for Performing Level 1 H&H Analysis

1. **Part 1 – Watershed Delineation**

   1.1. Use procedures from "Workflow Site Hydrology" document to delineate all watersheds draining to the site discharge Point of Analysis (POA)

2. **Part 2 –HEC-HMS Analysis**

   2.1. Open "HH1_Analysis.hms" template file

   2.2. Save As "Projectname.hms" (If an error occurs, close HEC-HMS and re-open "Projectname.hms" in the newly created "Project name" directory.)

   2.3. In Watershed Explorer window, expand "Basin Models" and click on "Project"; template basin model will open in the Desktop window

   2.4. Left-click "Upstream" subbasin icon; subbasin parameters will open in the Component Editor window

   2.4.1. Subbasin tab:

   2.4.1.1. Enter watershed area in sq. miles as determined in Part 1

   2.4.1.2. Loss Method: SCS Curve Number

   2.4.1.3. Transform Method: SCS Unit Hydrograph

   2.4.2. "Loss" tab:

   2.4.2.1. Enter Curve Number for upstream watershed

   2.4.2.2. Leave remaining fields set to their default values

   2.4.3. "Transform" tab:

   2.4.3.1. Select "Standard" or "Delmarva" from Graph Type dropdown list

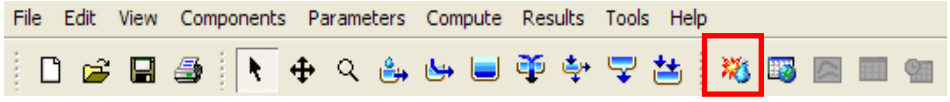
   2.4.3.2. Enter Lag Time in minutes (Lag = 0.6Tc) as used in GISHydro TR-20 run

   2.5. Repeat Step 2.4 for "Site" subarea(s) using data for post-developed condition based on the DURMM v.2 analysis. (NOTE: If the site consists of multiple subareas, they should be combined at the site POA.)

   2.6. Click on the "Compute" tab at the bottom of the Watershed Explorer window; expand "Simulation Runs"

2.7. Select the appropriate pre-formatted storm event for the simulation run

2.8. Click the “Compute Current Run” button on the toolbar



2.9. If all the data has been entered correctly, a progress bar will appear showing 100% completion. Error messages will be shown in red in the Message Log window.

2.10. Right-clicking on the various hydrologic elements will reveal a fly-out menu with options for viewing results; as an alternative, opening the project DSS file in HEC-DSSVue will allow more options for viewing the results.

3. Part 3 – Compliance Check

3.1. Determine the Time of Peak (Tp) for the Upstream subarea hydrograph

3.2. Determine the Time of Inflection Point (Tinf) for the combined site subarea hydrograph

3.2.1. The Tinf can be determined from the Time of Concentration (Tc) as follows:

3.2.1.1. Std. UH: Tinf = 0.4665 Tc

3.2.1.2. DMV UH: Tinf = 0.5665 Tc

3.3. A site is considered in compliance if the site Tinf $\leq$ Tp of the upstream hydrograph.

Workflow for Performing Level 2 H&H Analysis

The following procedure is based on what is considered the minimum requirements for the Level 2 H&H Analysis, which involves determining the water surface elevation for the pre-developed and post-developed conditions at the point of discharge from the site. The hydraulic model consists of three (3) cross sections. The middle cross section is established immediately downstream from the site discharge point. A minimum of one cross section upstream and one cross section downstream must be used to ensure the model will yield reasonable results. It may be necessary to analyze additional sections downstream to the "10% Rule" POA based on current Departmental guidance and/or policy.

1. Part 1 – Watershed Delineation

1.1. Use procedures from "Workflow Site Hydrology" document to delineate all watersheds draining to the Point of Analysis (POA) based on the "10% Rule".

2. Part 2 –HEC-HMS Analysis

2.1. Open "HH2_Analysis.hms" template file

2.2. Save As "Projectname.hms" (If an error occurs, close HEC-HMS and re-open "Projectname.hms" in the newly created "Project name" directory.

2.3. Use procedures from "Workflow H&H Level 1 Analysis" to develop a watershed model for both the "pre-developed" site condition and the "post-developed" site condition to the POA from Part 1.

3. Part 3 – HEC-RAS Analysis

3.1. Create HEC-RAS Project: *File>New Project*

3.2. Click "Edit/Enter geometry data" button or: *Edit>Geometric Data*

3.2.1. Switch to Geometric Data workspace window

3.2.2. Create new river segment

3.2.2.1. Click on the "River Reach" button and sketch a river segment; double-click to complete sketch (NOTE: When sketching the river segment, the model assumes the initial starting point is the most upstream point for the analysis.)

3.2.2.2. Enter "River" and "Reach" names in pop-up window

3.2.3. Add cross section data

3.2.3.1. Click on the “Cross Section” button from the vertical tool bar on the left

3.2.3.2. Switch to Cross Section Data workspace window

3.2.3.3. Add new cross-section data: *Options>Add a new Cross Section*

3.2.3.4. Enter river station for the most upstream section in pop-up window (NOTE: Although HEC-RAS will automatically place cross-sections on the river sketch based on the river station, it is considered best practice to enter the cross section data starting at the most upstream station and proceeding in a downstream direction.)

3.2.3.5. Enter cross section station and corresponding elevation in the appropriate cells in the “Cross Section Coordinates” section.

3.2.3.6. Enter the distances to the next downstream section for the left overbank, channel centerline and right overbank in the “Downstream Reach Lengths” section. (NOTE: Enter “0” values for the final downstream section.)

3.2.3.7. Enter Manning’s n values for the left overbank, channel and right overbank in the “Manning’s n Values” section

3.2.3.8. Enter the stations corresponding to the left bank and right bank in the “Main Channel Bank Stations” section

3.2.3.9. Accept the default values for the contraction and expansion coefficients

3.2.3.10. Once all the data has been entered, click the “Apply Data” button; cross section data will automatically be plotted

3.2.3.11. Repeat process from Step 3.2.3.3 for remaining cross sections.

3.2.3.12. Exit Cross Section Data workspace window and return to Geometric Data workspace window

3.2.4. Save: *File>Save Geometry Data*

3.2.5. Name geometry data file in pop-up window

3.2.6. Close and return to main HEC-RAS window

3.3. Prepare steady flow data

3.3.1. Click “Edit/Enter steady flow data” button or: *Edit>Steady Flow Data*

3.3.2. Switch to Steady Flow Data workspace window

3.3.2.1. Select appropriate River and Reach from drop-down lists

3.3.2.2. Enter number of flow profiles: “2”

3.3.2.2.1. Profile 1: Pre-developed condition

3.3.2.2.2. Profile 2: Post-developed condition

3.3.2.3. Click “Apply Data” button

3.3.2.4. Click “Reach Boundary Conditions” button

3.3.2.4.1. Select “Set boundary for all profiles” or “Set boundary for one profile at a time”

3.3.2.4.2. For subcritical flow, select appropriate “Downstream” boundary condition (NOTE: Typically the “Normal Depth” condition is used; the downstream slope is then entered in the pop-up window.)

3.3.2.4.3. For supercritical flow, select appropriate “Upstream” boundary condition

3.3.2.5. Click “OK” to return to Steady Flow Data workspace

3.3.2.6. “RS” station will automatically be set at most upstream station to enter initial flow data

3.3.2.7. Enter flow data from HEC-HMS analysis from Part 2 in appropriate “PF” window; at least one flow must be entered for each reach

3.3.2.7.1. Enter peak discharge for pre-developed condition in “PF1” cell

3.3.2.7.2. Enter peak discharge for the post-developed condition in the “PF 2” cell

3.3.2.8. Option: If flow increases at downstream section(s), enter new flow data as necessary

3.3.2.8.1. Select appropriate river and reach from drop-down list

3.3.2.8.2. Select cross-section where flow changes from “River Sta.” drop-down list

3.3.2.8.3. Click “Add A Flow Change Location” button

3.3.2.8.4. Enter new flow in the appropriate profile cell

3.3.2.9. Click “Apply Data” button

3.3.2.10. Save: *File>Save Flow Data*

3.3.2.11. Name flow data file in pop-up window

3.3.3. Close and return to main HEC-RAS window

3.4. Prepare to run HEC-RAS

3.4.1. Click “Perform a steady flow simulation” button or: *Run>Steady Flow Analysis*

3.4.2. Switch to Steady Flow Analysis workspace window

3.4.2.1. Create new plan file: *File>New Plan*

3.4.2.1.1. Name plan file in pop-up window

3.4.2.1.2. Enter short name identifier when prompted

3.4.2.2. Select Geometry File from drop-down list

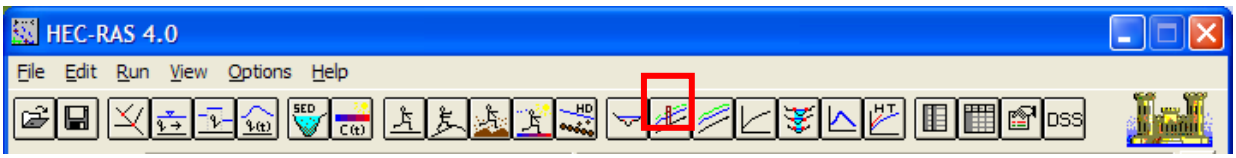
3.4.2.3. Select Steady Flow File from drop-down list

3.4.2.4. Save: *File>Save Plan*

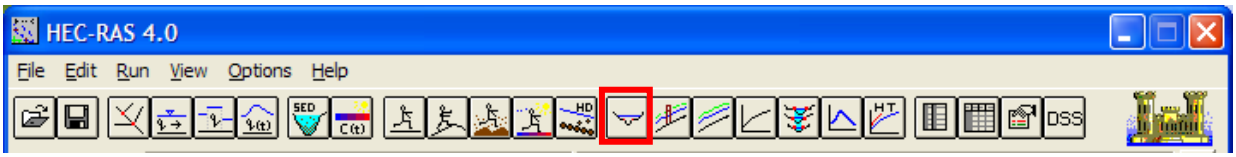
3.4.2.5. Click “Compute” button

3.5. Analyze HEC-RAS Results

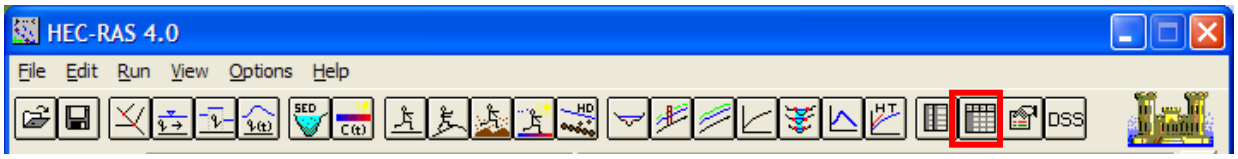
3.5.1. Click the “View profiles” button (NOTE: To view results for multiple profiles, click the “Profiles” button; check profiles to be viewed.)



3.5.2. Click the “View cross sections” button



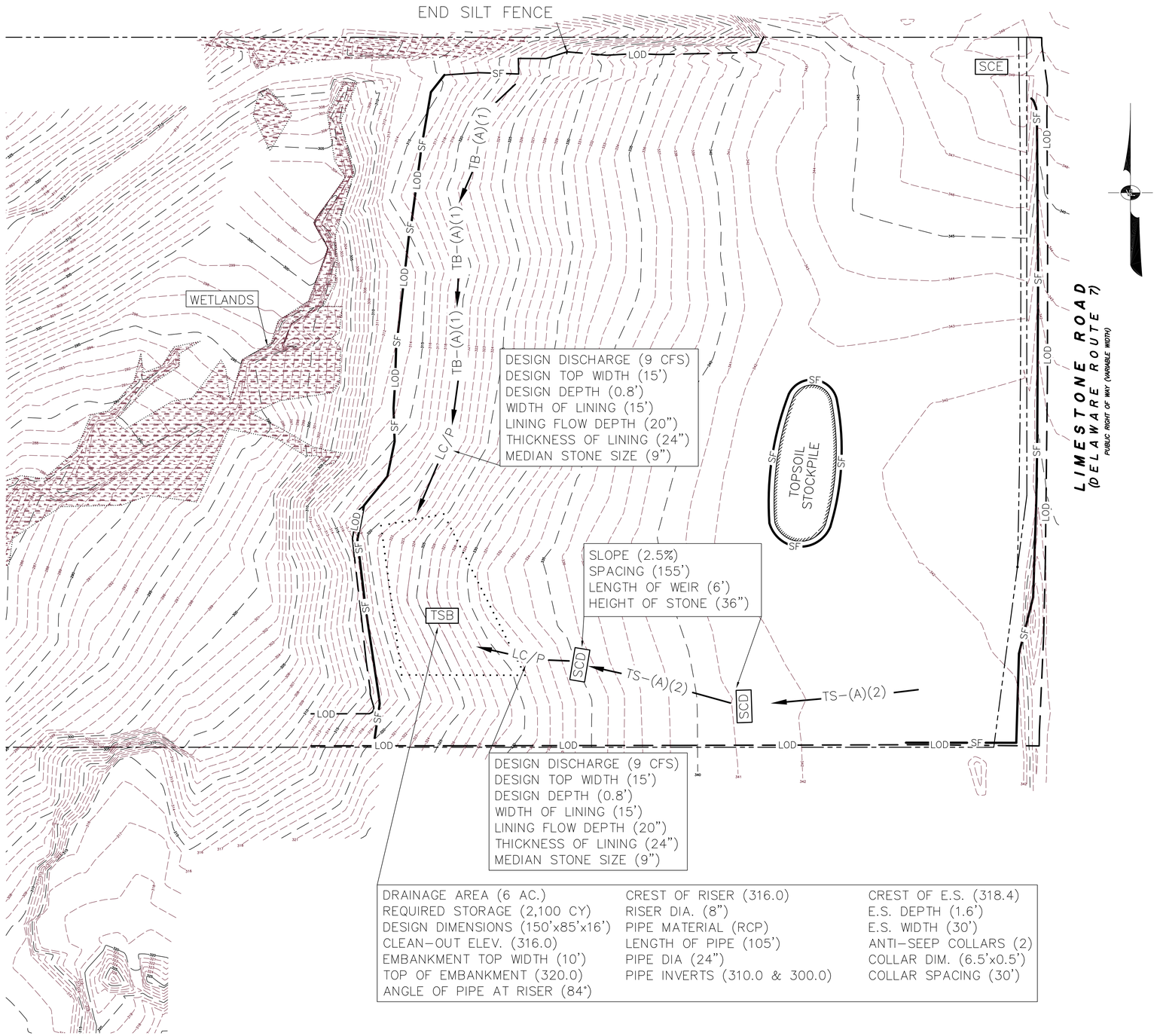
3.5.3. Click the “View summary output tables by profile” button



4. Part 4 – Compliance Check

4.1. Compare the “W.S. Elev” values for the pre-developed profile and the post-developed profile for the POA section and downstream section from the Profile Output Table

4.2. A site is considered in compliance if the difference in water surface elevations at these cross sections is < 0.05’



DRAINAGE AREA (6 AC.)	CREST OF RISER (316.0)	CREST OF E.S. (318.4)
REQUIRED STORAGE (2,100 CY)	RISER DIA. (8")	E.S. DEPTH (1.6')
DESIGN DIMENSIONS (150'x85'x16')	PIPE MATERIAL (RCP)	E.S. WIDTH (30')
CLEAN-OUT ELEV. (316.0)	LENGTH OF PIPE (105')	ANTI-SEEP COLLARS (2)
EMBANKMENT TOP WIDTH (10')	PIPE DIA (24")	COLLAR DIM. (6.5'x0.5')
TOP OF EMBANKMENT (320.0)	PIPE INVERTS (310.0 & 300.0)	COLLAR SPACING (30')
ANGLE OF PIPE AT RISER (84°)		

LEGEND

SM-S	STABILIZATION MATTING – SLOPE
SCD	STONE CHECK DAM
IP-1	STORM INLET PROTECTION (TYPE-1)
IP-2	STORM INLET PROTECTION (TYPE-2)
TSB	TEMPORARY SEDIMENT BASIN
SCE	STABILIZED CONSTRUCT. ENTRANCE
TS-(A)(2)	TEMPORARY SWALE
LC/P	LINED CHANNEL – PARABOLIC
TB-(A)(1)	TEMPORARY EARTH BERM
SF	SILT FENCE
LOD	LIMIT OF DISTURBANCE
	PROPERTY LINE
	WETLANDS
	BASIN AREA
	PROPOSED CONTOUR
	EXISTING CONTOUR

EROSION & SEDIMENT CONTROL SCHEMATIC PLAN PRE-BULK GRADING PHASE

ADARE VILLAGE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

NO.	DATE	REVISION	APPROVED

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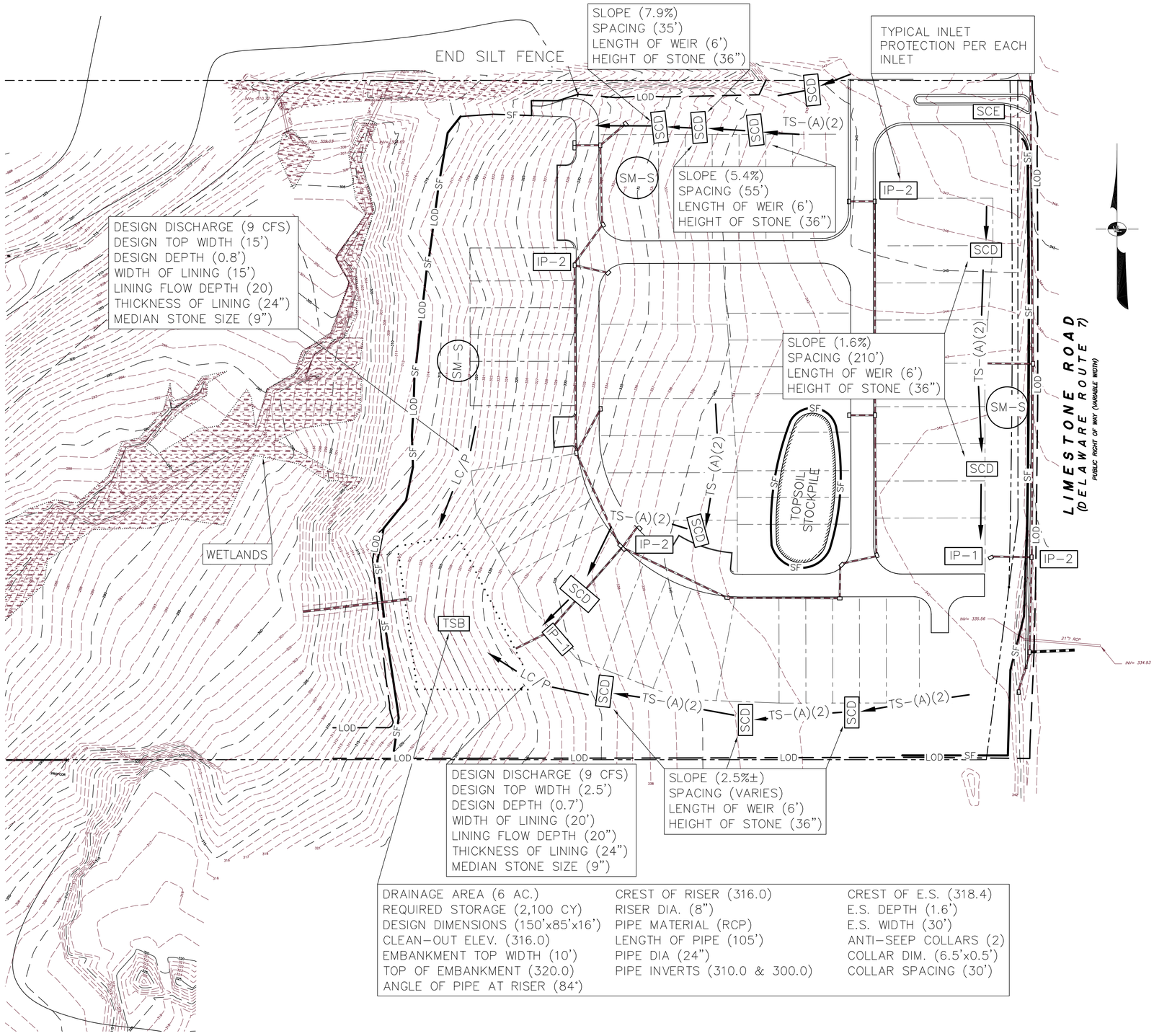
PERMANENT FILE 066/360	QA REVIEW	APPROVED BY
SURVEYED BY / COMPUTED BY	PROJECT MANAGER C. O'KEEFE / DRAWN BY	REFERENCE DRAWINGS
PROJECT NO. 20764	FILE NO. 36959-L	SHEET 1 OF 5 / REVISION

Effective April 2018



DRAINAGE AREA (6 AC.)	CREST OF RISER (316.0)	CREST OF E.S. (318.4)
REQUIRED STORAGE (2,100 CY)	RISER DIA. (8")	E.S. DEPTH (1.6')
DESIGN DIMENSIONS (150'x85'x16')	PIPE MATERIAL (RCP)	E.S. WIDTH (30')
CLEAN-OUT ELEV. (316.0)	LENGTH OF PIPE (105')	ANTI-SEEP COLLARS (2)
EMBANKMENT TOP WIDTH (10')	PIPE DIA (24")	COLLAR DIM. (6.5'x0.5')
TOP OF EMBANKMENT (320.0)	PIPE INVERTS (310.0 & 300.0)	COLLAR SPACING (30')
ANGLE OF PIPE AT RISER (84°)		

LEGEND

SM-S	STABILIZATION MATTING – SLOPE
SCD	STONE CHECK DAM
IP-1	STORM INLET PROTECTION (TYPE-1)
IP-2	STORM INLET PROTECTION (TYPE-2)
TSB	TEMPORARY SEDIMENT BASIN
SCE	STABILIZED CONSTRUCT. ENTRANCE
TS-(A)(2)	TEMPORARY SWALE
LC/P	LINED CHANNEL – PARABOLIC
TB-(A)(1)	TEMPORARY EARTH BERM
SF	SILT FENCE
LOD	LIMIT OF DISTURBANCE
	PROPERTY LINE
	WETLANDS
	BASIN AREA
	PROPOSED CONTOUR
	EXISTING CONTOUR

EROSION & SEDIMENT CONTROL SCHEMATIC PLAN
POST-DEVELOPED PHASE
ADARE VILLAGE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

NO.	DATE	REVISION	APPROVED

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PERMANENT FILE 066/360	QA REVIEW	APPROVED BY
SURVEYED BY / COMPUTED BY	PROJECT MANAGER C. O'KEEFE / DRAWN BY	REFERENCE DRAWINGS
PROJECT NO. 20764	FILE NO. 36959-L	SHEET 2 OF 5 / REVISION

Effective April 2016

Delaware Sediment & Stormwater Regulations: Proposed Quantity Management Methodology

"Broadkill Estates"
Unit Discharge Example

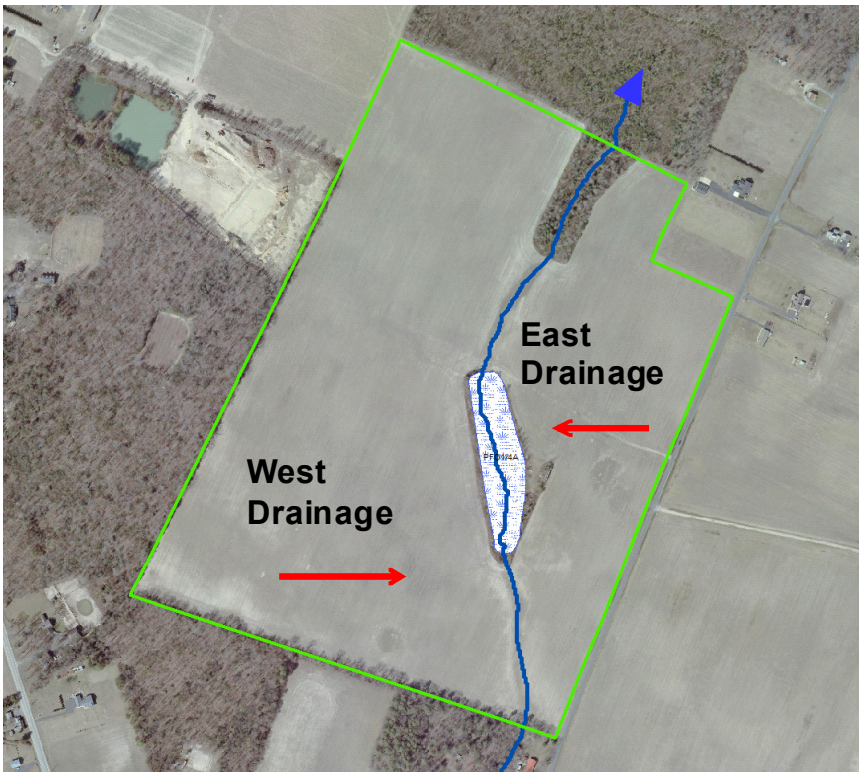
Draft 09/2010

Introduction

This document has been developed to illustrate the Unit Discharge Methodology to meet the standards-based quantity management requirements of the Delaware Sediment & Stormwater Regulations (DSSR).

NOTE: Only those projects that receive all "Minor" ratings on the Stormwater Assessment Report (SAR) qualify for the Unit Discharge Methodology. This document was created using an earlier version of DURMM v2. Although some of the screen shots do not exactly match the latest version, the procedures remain the same.

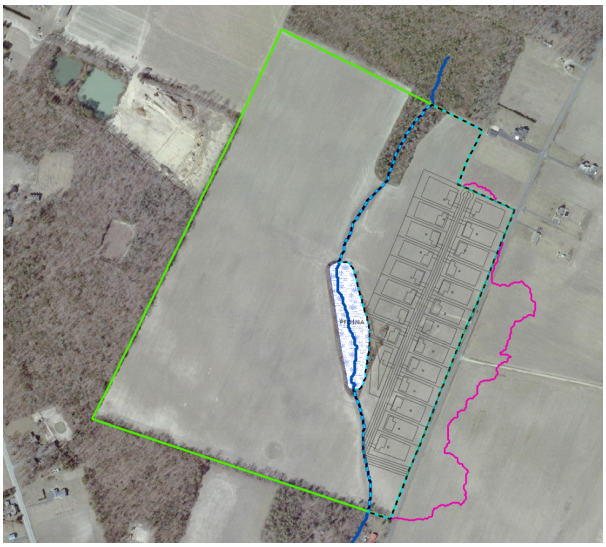
“Broadkill Estates” Example Site



Background

This example builds on the results from the Delaware Urban Runoff Management Model (DURMM) analysis of the fictional “Broadkill Estates” for the Resource Protection Event as illustrated in the DURMM v.2 Quick-Start Guide. The site is bisected by a tributary stream that runs from south to north. This site drainage is therefore characterized by a west drainage subarea and an east drainage subarea. For the purposes of this example, the proposed lot and road layout for the east drainage subarea will be analyzed. The area outside the lots will be designated as common open space.

Unit Discharge Example
East Drainage: Site Data

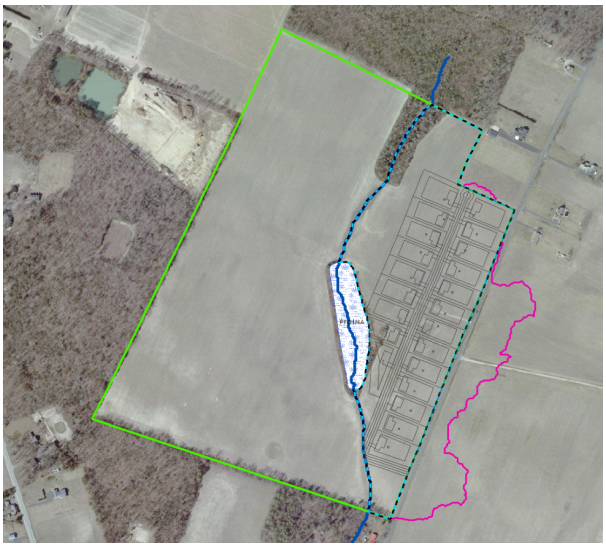


- C.A. RCN Tab
  - 1-ac. residential (20 % imperv.)
    - HSG A: 21.17 ac.
    - HSG B: 0.73 ac
  - Open space
    - HSG A: 8.06 ac.
    - HSG B: 2.26 ac
  - Row Crops, SR + Crop Residue
    - HSG A: 9.68 ac.

<u>Data Inputs – "C.A. RCN" Worksheet</u>

The slide above summarizes the data inputs for the "C.A. RCN" worksheet used for the DURMM v.2 analysis.

Unit Discharge Example
East Drainage: Site Data (cont.)

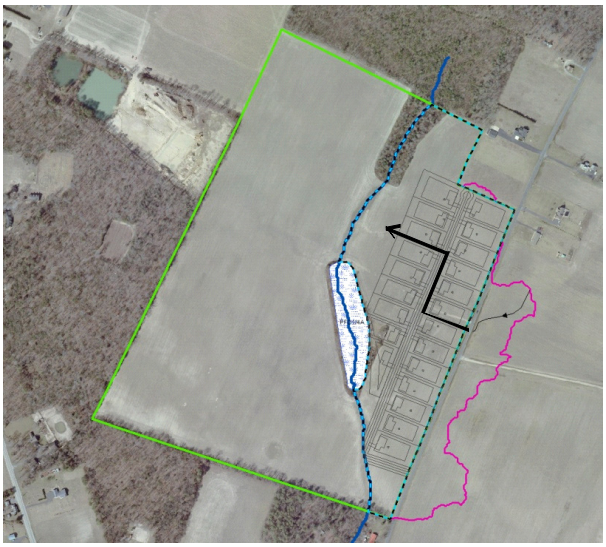


- LOD Tab
  - HSG A
    - LOD area: 29.22 ac.
    - Pre-Dev. Woods: 1.55 ac.
    - Post-Dev. Impervious: 4.23 ac.
  - HSG B
    - LOD area: 2.99 ac.
    - Pre-Dev. Woods: 0 ac.
    - Post-Dev. Impervious: 0.15 ac.

<u>Data Inputs – "LOD" Worksheets</u>

The slide above summarizes the data inputs for the "LOD" worksheet.

Unit Discharge Example
East Drainage: Site Data (cont.)



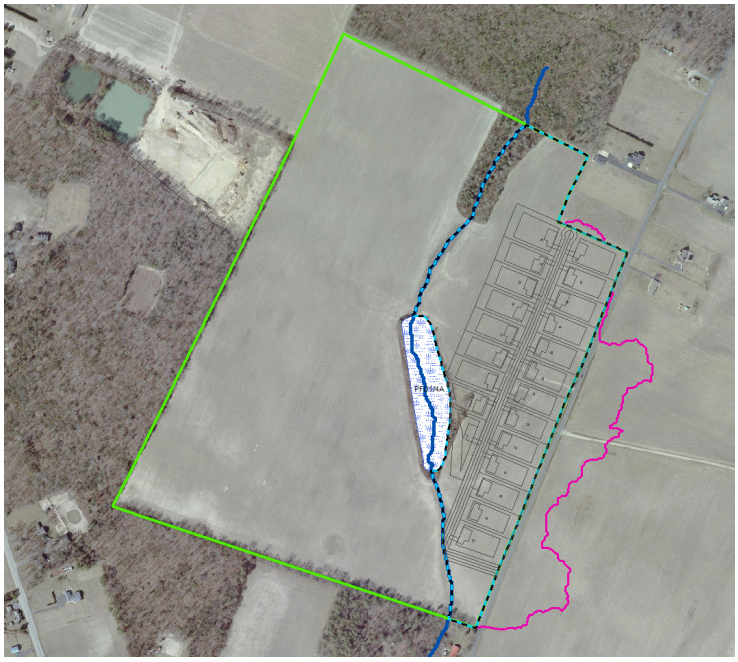
- OLOD Tab
  - Sheet Flow, 100 ft, 0.001 ft/ft, “d”
  - Shallow Conc., 300 ft, 0.002 ft/ft, “u”
  - Open Channel, 1000 ft, 0.01 ft/ft, 1.0 fps

<u>Data Inputs – “OLOD” Worksheets</u>

The slide above summarizes the data inputs for the “OLOD” worksheet.

NOTE: The Time of Concentration (Tc) calculations for the area outside the LOD indicated a relatively long flow time of 0.98 hours from the DURMM v.2 analysis. This flow time should not necessarily be used to represent the Tc for the developed site condition, however, for quantity management purposes. In this case, the majority of the flow will be generated by the lots and roadway. The Tc for this portion of the site was calculated to be 0.2 hours. Since this Tc is deemed to be more representative of the majority of the runoff volume contained in the hydrograph, it should therefore be used as the Tc for the East Drainage subarea for subsequent quantity management calculations.

Unit Discharge Example
Conveyance Event (Cv)



<u>Unit Discharge Example for Conveyance Event (Cv)</u>

The Unit Discharge methodology will initially be illustrated for the Conveyance Event (Cv).

Unit Discharge Example
DURMM Report

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data

Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Pollutant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0

Resource Protection Event (RPV)

RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A

Conveyance Event (Cv)

Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A

Flooding Event (Fv)

Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling	**Rain (in)**	**RCN**
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

DURMM Report

The results from the DURMM v.2 analysis will provide the necessary data for the analysis.

Unit Discharge Example
East Drainage: TR-55 Data

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data

Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Polluant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0

Resource Protection Event (RPV)

RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent < irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent < irreducible concentration, P?	No	No	OK	#N/A	#N/A

Conveyance Event (Cv)

Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A

Flooding Event (Fv)

Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling	**Rain (in)**	**RCN**
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

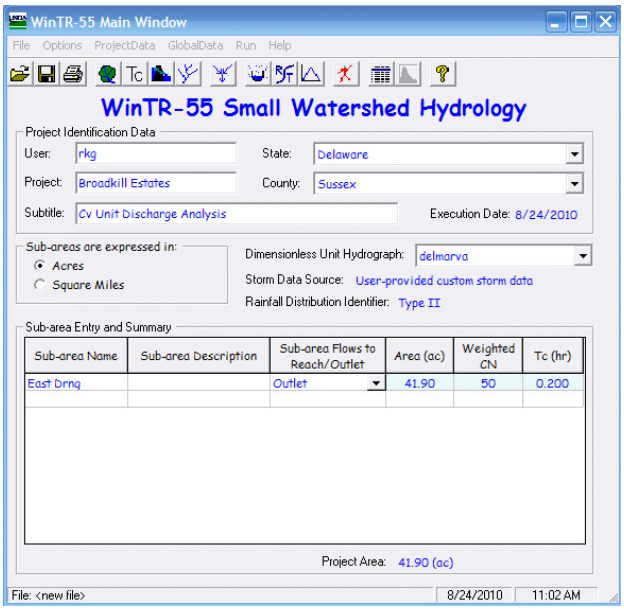
DURMM Report

The highlighted lines from the DURMM Report indicate:

Contributing Area to BMPs: 41.9 ac.
Adjusted RCN for Cv: 49.86

The adjusted RCN reflects the benefit of using runoff reduction techniques to comply with the requirements of the DSSR for the Resource Protection Event (RPv).

Unit Discharge Example
East Drainage: TR-55 Data

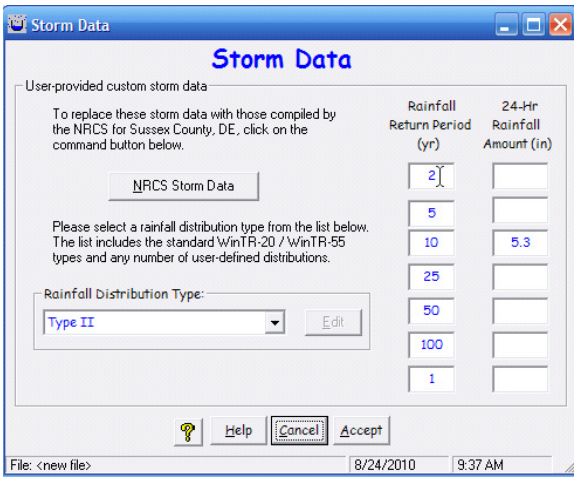


- Drainage Area: 41.9 ac.
- Adjusted RCN_{Cv} : 50
- Tc: 0.2 hrs

<u>TR-55 Site Data</u>

This information is then used as input to a hydrologic analysis software package. In this case, WinTR-55 was used. Typically, the RCN is rounded off to the nearest whole number. Also note that the Tc for the developed portion of the site was used for reasons cited earlier.

Unit Discharge Example
East Drainage: TR-55 Data

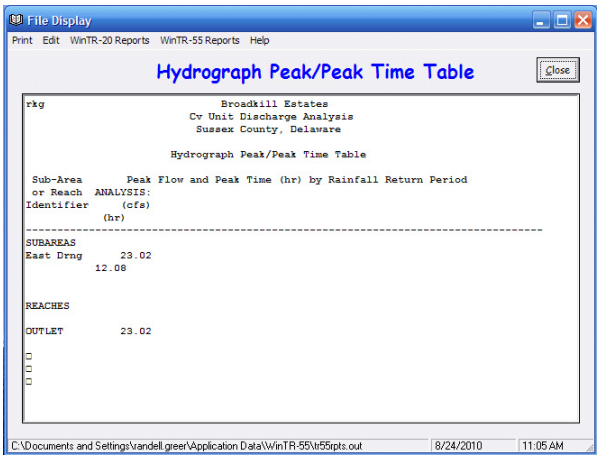


- Rainfall_{Cv} : 5.3 in.

<u>TR-55 Storm Data</u>

The 10-YR rainfall is input in the WinTR-55 “Storm Data” sheet.

Unit Discharge Example
East Drainage: TR-55 Data



- Peak$_{Cv}$: 23.02 cfs

TR-55 Results

Once the user invokes the “Run” function, WinTR-55 calculates the 10-YR peak discharge. Results can then be shown either graphically or in a text report as shown above.

Unit Discharge Example
Conveyance Event (Cv)

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data

Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Pollutant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0

Resource Protection Event (RPV)

RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A

Conveyance Event (Cv)

Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A

Flooding Event (Fv)

Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling

	Rain (in)	RCN
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

- Computed: 23.02 cfs
- Allowable: 28.29 cfs
- ✓ Computed ≤ Allowable

Compliance Check for Cv

The DURMM Report also contains the information necessary to determine whether the site complies with the requirements of the DSSR for the Conveyance Event (Cv). The highlighted line from the report shows the allowable unit discharge as calculated in the DURMM v.2 analysis was 28.29 cfs for the Conveyance Event. Since the 10-YR peak discharge of 23.02 cfs as calculated in WinTR-55 is less than the allowable discharge, the site complies with the DSSR for the Conveyance Event. In this case, meeting the requirements for the Resource Protection Event (RPv) provided enough reduction in the runoff volume for the 10-YR storm that no additional quantity management was needed.

Check Compliance for Flooding Event (Fv)

Compliance Check for Fv

The next step is to check to see if the site complies with the requirements of the DSSR for the Flooding Event (Fv).

Unit Discharge Example
East Drainage: TR-55 Data

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data					
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Pollutant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RFDiscnct	DBioswale	Infiltration	0	0

Resource Protection Event (RPV)					
RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A

Conveyance Event (Cv)					
Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A

Flooding Event (Fv)					
Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling	Rain (in)	RCN
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

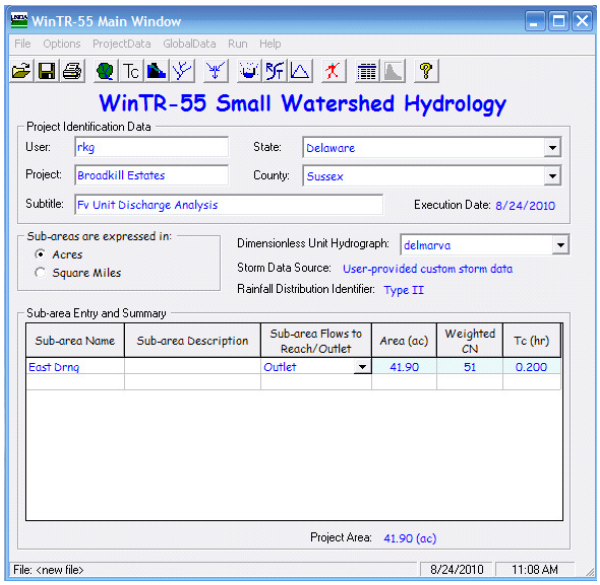
DURMM Report

The procedure is analagous to that for the Cv. The highlighted lines from the DURMM Report indicate:

Contributing Area to BMPs:	41.9 ac.
Adjusted RCN for Cv:	51.07

Note that DURMM v.2 has calculated a higher adjusted RCN for the Flooding Event since the runoff reduction techniques used for the RPv are less effective for a storm of this magnitude.

Unit Discharge Example
East Drainage: TR-55 Data

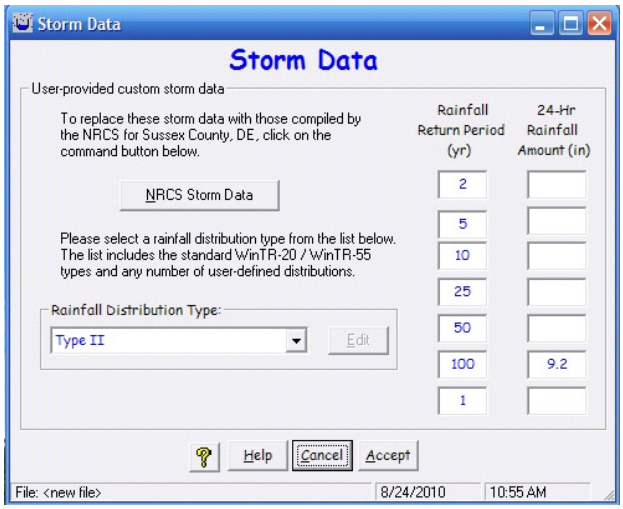


- Drainage Area: 41.9 ac.
- Adjusted RCN_{Fv} : 51
- Tc: 0.2 hrs

<u>TR-55 Site Data</u>

The drainage area, adjusted RCN and Tc are entered into WinTR-55.

Unit Discharge Example
East Drainage: TR-55 Data

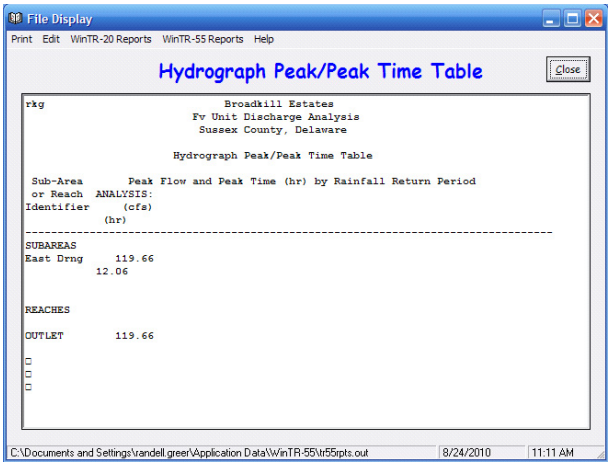


- Rainfall_{Fv} : 9.2

TR-55 Storm Data

The 100-YR rainfall is input in the WinTR-55 “Storm Data” sheet.

Unit Discharge Example
East Drainage: TR-55 Data



- $Peak_{Fv}$: 119.66 cfs

<u>TR-55 Results</u>

Once the user invokes the “Run” function, WinTR-55 calculates the 100-YR peak discharge. Results can then be shown either graphically or in a text report as shown above.

Unit Discharge Example
Flooding Event (Fv)

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data					
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Pollutant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RfDiscnct	DBioswale	Infiltration	0	0
Resource Protection Event (RPV)					
RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A
Conveyance Event (Cv)					
Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A
Flooding Event (Fv)					
Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

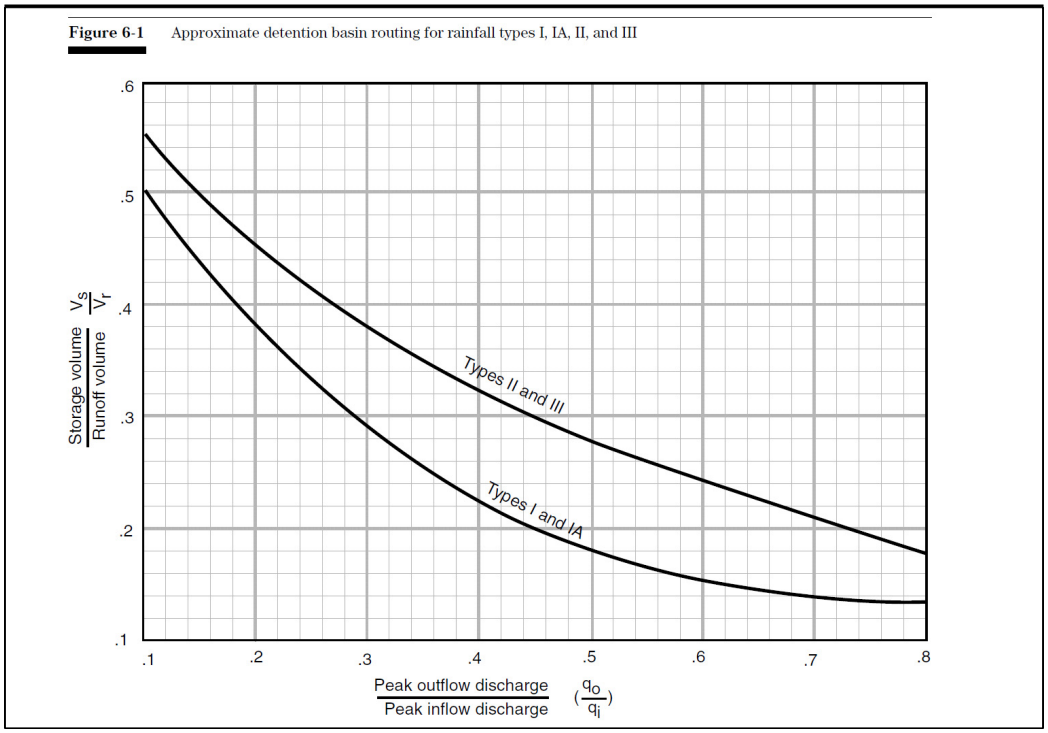
Adjusted Subarea Data for H&H Modeling	Rain (in)	RCN
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

- Computed: 119.66 cfs
- Allowable: 84.99 cfs
- ✘ Computed > Allowable

Compliance Check for Fv

The DURMM Report also contains the information necessary to determine whether the site complies with the requirements of the DSSR for the Flooding Event (Fv). The highlighted line from the report shows the allowable unit discharge as calculated in the DURMM v.2 analysis was 84.99 cfs for the Flooding Event. Since the 100-YR peak discharge of 119.66 cfs as computed in WinTR-55 is greater than the allowable discharge, the site does not comply with the DSSR for the Flooding Event.

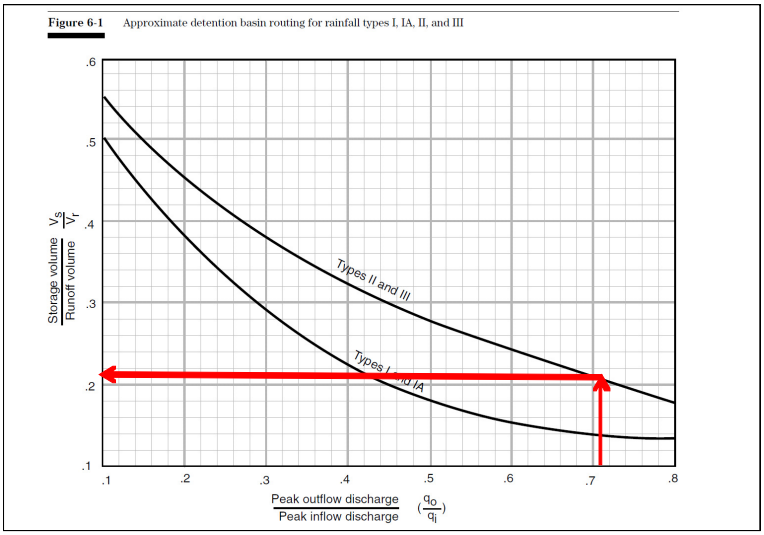
Unit Discharge Example
Flooding Event (Fv)



Management for Fv

Since the calculations indicate the site does not comply with the requirements of the DSSR for the Flooding Event, additional management measures must be provided. For storms of this magnitude, detention storage is a typical solution. Figure 6-1 from the TR-55 Manual can be used to estimate the required storage volume.

Unit Discharge Example
Flooding Event (Fv)



- qo = 85 cfs
- qi = 120 cfs
- qo/qi = 0.71
- Vs/Vr = 0.21

<u>Estimating Required Storage Volume for Fv</u>

1. Calculate “qo/qi” by dividing the allowable discharge determined in the DURMM v.2 analysis by the 100-YR peak discharge as determined in the WinTR-55 analysis.

2. Read up from the “qo/qi” value on the x-axis of Figure 6-1 to the intersection with the “Type II and III” curve.

3. Read the “Vs/Vr” value off the y-axis of Figure 6-1.

Unit Discharge Example
Flooding Event (Fv)

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
TMDL Watershed:	Broadkill River

DURMM v2.2010.07.26

Site Data

Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
Pollutant load, N (lbs)	6.25				
Pollutant load, P (lbs)	0.81				
Required pollutant load reduction , N (%)	40%				
Required pollutant load reduction , P (%)	40%				
BMP Selection	RFDiscrct	DBioswale	Infiltration	0	0

Resource Protection Event (RPV)

RPv for Contributing Area (in)	0.33				
Req'd RPv Reduction for Contributing Area (in)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	0.31	0.29	0.18	#N/A	#N/A
Total RPv runoff reduction (in)	0.02	0.04	0.15	#N/A	#N/A
Total RPv runoff reduction (%)	6%	12%	46%	#N/A	#N/A
Req'd runoff reduction met?	No	No	OK	#N/A	#N/A
BMP TMDL Performance					
BMP pollutant reduction, N (%)	6%	11%	42%	#N/A	#N/A
BMP pollutant reduction, P (%)	6%	11%	42%	#N/A	#N/A
Reduction met, N?	No	No	OK	#N/A	#N/A
Reduction met, P?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, N?	No	No	OK	#N/A	#N/A
Effluent ≤ irreducible concentration, P?	No	No	OK	#N/A	#N/A

Conveyance Event (Cv)

Cv runoff volume (in)	0.97				
Stds-based allowable discharge (cfs)	28.29				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	0.95	0.93	0.81	#N/A	#N/A

Flooding Event (Fv)

Fv runoff volume (in)	3.33				
Stds-based allowable discharge (cfs)	84.99				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	3.29	3.26	3.15	#N/A	#N/A

Adjusted Subarea Data for H&H Modeling

	Rain (in)	RCN
Resource Protection Event, RPv	2.7	57.63
Conveyance Event, Cv	5.3	49.86
Flooding Event, Fv	9.2	51.07

- Vs/Vr = 0.21
- Vr = 3.33 in.
- Vs = (0.21)(3.33)

  = 0.70 in.

  = (0.06 ft)(41.9 ac)

  = 2.4 ac-ft

Estimating Required Storage Volume for Fv (cont.)

Refer to the highlighted line in the DURMM Report to determine the runoff volume (Vr) for the 100-YR storm event. Multiply this number by the "Vs/Vr" value determined from TR-55, Figure 6-1 to calculate the required storage (Vs) in watershed inches. This value can then be converted to feet and multiplied by the watershed drainage area to determine the required storage in acre-feet. Although this procedure generally provides satisfactory results, it is only an estimate. Full compliance must be verified through an actual routing of the storage facility.

NOTE: Figure 6-1 from the TR-55 Manual was developed for the NRCS Standard Unit Hydrograph. Although NRCS apparently developed a separate curve for the Delmarva Unit Hydrograph which calculates a slightly lower "Vs/Vr" value, it is not well documented. Since the final design requires a routing to verify compliance, it is recommended that Figure 6-1 be used for estimating storage volume with the understanding that the results may be more conservative for the Delmarva Unit Hydrograph.

3.02.3
Step 3: Sediment and Stormwater Management Plan

The Sediment and Stormwater Management Plan submitted at Step 3 of the plan review and approval process shall include detailed information on the measures to control both sediment and non-sediment pollutants during the active construction phase as well as those measures to manage post-construction stormwater. The Sediment & Stormwater Management Plan shall be submitted only after the Preliminary Sediment & Stormwater Management plan has been approved by the Delegated Agency.

If significant changes have been made to the site development plan, the Delegated Agency may require the applicant to re-submit a Preliminary Sediment & Stormwater Management Plan prior to reviewing the Sediment & Stormwater Management Plan.

Unless granted prior approval by the Delegated Agency, the Sediment & Stormwater Management Plan shall be developed as a "stand alone" plan independent of other site construction plans. It shall consist of the following elements:

1. Updated Stormwater Management Report and Drainage Area Plans
2. Construction Site Stormwater Management Plan
3. Post Construction Stormwater Management Plan

The submittal shall be accompanied by a completed Sediment and Stormwater Management Plan Checklist (see 3.02.3.1). Refer to the Checklist for all required information; the below is a brief overview. A standardized Sediment and Stormwater Plan coversheet is included in 3.05.2 and an example Sediment & Stormwater Management Plan is included as 3.02.3.2.

The submittal package shall be reviewed for completeness by the Delegated Agency. Incomplete submittals will be returned in whole with the missing checklist items highlighted.

The Sediment and Stormwater Management Plan shall include the following elements:

1. Coversheet including the Standard Sediment and Stormwater Construction Notes, Project Notes, Owner's Certification, Site Designer's Certification, Vicinity Map, and other basic site information.
2. Construction Site Stormwater Management Plans including a Phasing Plan, Pre-Construction Plans, and Construction Plans, which show detailed information on the location, grading and construction data for all proposed Erosion and

Sediment Control practices. A legend using the symbols from the current Delaware Erosion and Sediment Control Handbook (3.06.1) must be included. When more than one detailed sheet is needed to depict the information, an Overall plan showing the site and the construction practices shall be provided.

3. Construction Site Details and Notes, including a Sequence of Construction, details for all proposed ESC practices, Construction Site Pollution Control details, and details of temporary and permanent stabilization measures.

4. Post Construction Stormwater Management Plans, showing the construction and maintenance details for all stormwater facilities.

5. Updated Stormwater Management Report and Drainage Area Plans per the Preliminary requirements.

6. A copy of the project's Site Plan, Grading Plan, and Record Plan.

Coversheet

The Coversheet for the Sediment and Stormwater Management Plan set shall contain basic site information to get a feel for the site's location, size, and proposed conditions by providing information in the Project Header, Project Notes and a Vicinity Map. The Coversheet should contain owner, developer (if different than the owner), designer and agency contact information, with areas designated for each entity's certification (or approval block in case of the agency). A wetland certification shall also be included for the site's determined during the Stormwater Assessment Study as needing a wetland delineation.

Standard Sediment and Stormwater Construction Notes shall be located on the Coversheet, in order to provide consistency between all projects throughout the state. Refer to the Sediment and Stormwater Plan Checklist (3.02.3.1) and the Example Coversheet (3.05.2) for the Standard Notes as required by the Department (note, each Delegated Agency may adopt additional Standard Notes).

In addition to the project information and the standardized notes, the coversheet should also include a list of all the plan sheets within the set and their corresponding sheet number, and a standardized legend of site features and linetypes (note, a legend specific to the erosion and sediment controls is also required for the Construction Site Stormwater Management Plans; see below).

Construction Site Stormwater Management Plans

The Schematic Construction Site Stormwater Management from the Preliminary submittal is elaborated to include detailed design information on the practices that will be utilized to safeguard the site's construction against sediment and erosion, as well general construction pollution. There are five types of plans that should be incorporated into the Construction Site Stormwater Management Plans, all evolving from the initial Schematic:

1. Overall Construction Site Phasing Plan: For sites that have more than one construction phase, indicates the extents of each phase of construction on a site plan view with the total disturbed area of each phase noted.
2. Overall Pre-Construction Site Stormwater Management Plan: For sites that cannot be shown in their entirety at the maximum scale of 1"=100', provides one sheet that depicts the entire project's existing conditions with the demolition and bulk grading controls indicated. Matchlines refer to the location of the detailed sheets. For small project's without massive earthwork, this requirement may be waived at the Project Application Meeting.
3. Pre-Construction Site Stormwater Management Plan: Provides detailed plan views at the maximum scale of 1"=100' of the site's existing conditions with design information for all of the demolition and bulk grading controls. For small project's without massive earthwork, this requirement may be waived at the Project Application Meeting.
4. Overall Construction Site Stormwater Management Plan: For sites that cannot be shown in their entirety at the maximum scale of 1"=100', provides one sheet that depicts the entire project's proposed grading and site features with the erosion, sediment and pollution controls indicated. Matchlines refer to the location of the detailed sheets.
5. Construction Site Stormwater Management Plan: Provides detailed plan views at the maximum scale of 1"=100' of the project's proposed grading and site features with design information for all of the erosion, sediment and pollution controls.

Reference the Sediment and Stormwater Plan Checklist (3.02.3.1) for specific information that should be contained within the Construction Site Stormwater Management Plans. The plans sheets shall contain a legend for the symbols and linetypes used to represent the control practices used on-site; these symbols and linetypes shall be per the latest edition of the *Delaware Erosion and Sediment Control Handbook.*

In addition to the Construction Site plan view sheets, Construction Site Details and Notes are to be incorporated to provide additional design and construction information for the site's controls. The corresponding details for all practices used for sediment, erosion and pollution control within the site shall be included. The detail shall be from the latest version of the *Delaware Erosion and Sediment Control Handbook*, unless an alternative detail has been approved. The required design data for the detail shall be provided within the detail itself, or a note should be included to refer to the relevant chart for the information.

Also included with the details, is be the Sequence of Construction, which should be a step by step order of operation for the initiation, construction and termination of a site's construction, highlighting the erosion, sediment and pollution controls and the any phasing. The Sequence of Construction shall, at a minimum, include the following activities:

1. Pre-construction meeting
2. Clearing and grubbing for those areas necessary for installation of perimeter controls;
3. Construction of perimeter controls;
4. Remaining clearing and grubbing;
5. Road grading;
6. Grading for the remainder of the site;
7. Utility installation;
8. Stormwater facility construction;
9. Final grading, landscaping, or stabilization; and
10. Removal of sediment controls.

Specific Sequence of Construction items are to be included and are referred to in the Sediment and Stormwater Plan Checklist (3.02.3.1) and the typical Sequence of Construction (3.05.1).

Post Construction Stormwater Management Plans

A separate plan sheet shall be provided for each individual stormwater management facility, in order to clearly depict the design and construction of the facility, and outline the future operation and maintenance requirements. The plan sheet shall include, but not be limited to:

1. Plan view showing proposed grading
2. Section view with proposed elevations
3. Details for any appurtenances
4. Planting and/or stabilization information
5. Sequence of construction
6. Operation and Maintenance notes

The Post Construction Stormwater Management facility construction detail sheet will serve as the foundation for the future Operation and Maintenance Plan for each stormwater management BMP, in combination with the Post Construction Verification Document. The elements of the Operation and Maintenance Plan required at the Post Construction Stormwater Management Plan stage, along with all other Post Construction Plan requirements, can be found in the Sediment and Stormwater Plan Checklist (3.02.3.1).

Sediment & Stormwater Management Plan Review Checklist

DATE RECEIVED: _____ **PROJECT NUMBER:** _____

PROJECT NAME: _____

General Information:

1. _____ One set of plans and reports, and a completed checklist must be submitted for each review. An electronic hardcopy of the plan and reports (i.e., PDF) shall also be transmitted for final approval. Electronic program files (i.e., AutoCAD, MicroStation, DURMM, HydroCAD, and/or equal/similar) may be required upon agency request.
2. _____ Hydraulic and Hydrology computations and plans shall be resubmitted, reflecting the updated site conditions, and be revised per the review comments from the preliminary submittal or the previous full submittal. They should continue to follow the requirements specified in the Preliminary Sediment and Stormwater Management Plan Review Checklist.
3. _____ All plans should be submitted on 24" x 36" (minimum) sheets unless otherwise approved.
4. _____ When two (2) or more sheets are used to illustrate the plan view, an index sheet is required, illustrating the entire project on one (1) 24" x 36" (minimum) sheet.
5. _____ Provide a north arrow on all plans.
6. _____ All plan views, cross-sections, profiles, and structural details shall be to a defined scale.
7. _____ Provide a scale bar for all plan views.
8. _____ Provide names of adjacent property owners on all plans.
9. _____ Provide existing and proposed contours based on NAVD 88 vertical datum at one (1) foot intervals (2 foot intervals can be provided for offsite drainage information based on the latest Lidar information).
10. _____ For small projects less than ½ acre of disturbance, provide existing and proposed elevations based on NAVD 88 vertical datum on a fifty-foot grid system. Include high and low points.
11. _____ Locate the site in NAD83 horizontal datum.
12. _____ Provide a copy of the Site Plan(s) and Grading Plan(s) as prepared for the local approval agencies for review and informational purposes.
13. _____ Provide a copy of the preliminary Record Plan as prepared for the local landuse approval agency for review and informational purposes.
14. _____ All detailed plans submitted for review shall be prepared, signed, dated and sealed by a Licensed Professional in the State of Delaware.
15. _____ Provide the Sediment and Stormwater Management plans in the following order and title (sheet list to appear on the Coversheet, and each plan sheet shall be respectively titled):
    a. _____ Coversheet and General Notes
    b. _____ Overall Construction Site Phasing Plan (if applicable)
    c. _____ Overall Pre-Construction Site Stormwater Management Plan (if applicable)
    d. _____ Pre-Construction Site Stormwater Management Plan #X
    e. _____ Overall Construction Site Stormwater Management Plan (if applicable)
    f. _____ Construction Site Stormwater Management Plan #X
    g. _____ Construction Site Details and Notes (including the Sequence of Construction)
    h. _____ Overall Post Construction Stormwater Management Plan
    i. _____ Post Construction Stormwater Management Plan, Facility #X
    j. _____ Overall BMP Contributing Drainage Area Plan (To be included in final Stormwater Report)
    k. _____ BMP Contributing Drainage Area Plan (To be included in final Stormwater Report)

l. _____ Pre-Developed Subarea Limit of Disturbance Drainage Area Plan (To be included in final Stormwater Report)

m.

n.

16. _____ For final approval, the following items shall be submitted:

a. _____ Completed NOI and associated fee must be submitted to DNREC.

b. _____ Provide a copy of the recorded permanent easement when a stormwater facility or outfall is located outside of the property boundary.

c. _____ Provide a wetland permit when construction of a stormwater facility will impact State and/or Federal wetlands.

d. _____ Provide an approval letter from the DNREC Drainage Section for any encroachment or change in runoff discharge to an existing tax ditch or adjacent right-of-way.

Coversheet:

17. _____ Project Header:

a. _____ Project Name (and Phase, if applicable; to duplicate in the title block on each sheet).

b. _____ Title of Plan Set: Sediment and Stormwater Management Plans (to duplicate in the title block on each sheet)

c. _____ Project Location (including watershed, hundred, town, county, etc., as applicable).

d. _____ Project tax map identification number(s).

18. _____ Legend indicating plan symbols and lines, including but not limited to, soils, drainage area information, grading and site information.

19. _____ Provide a vicinity map with a scale appropriate to project size, and indicate the site boundary within the map. The map shall be no smaller than 4"x4" in size and shall clearly indicate at least one intersecting road.

20. _____ Project Notes:

a. Parcel Data:

i. _____ Project tax map identification number(s)

ii. _____ PLUS Number (if applicable)

iii. _____ DNREC Sediment and Stormwater Program [or relevant Delegated Agency] Number

iv. _____ Site Address (or Nearest Intersecting Street and Distance between)

v. _____ Latitude and Longitude State Plane coordinates, with approximate geographical location (ie, Benchmark #1, Northeast Site Corner, etc). Provide in degree decimal format.

vi. _____ Existing Site Area

vii. _____ Proposed Site Area

viii. _____ Existing Wetland Area

ix. _____ Proposed Condition (ie, number of lots, total building square footage, etc)

x. _____ Proposed Discharge Location(s)

xi. _____ Proposed Total Limit of Disturbance per Discharge Location

b. Contact Data:

i. Contact Name, Title: ____ Owner ____ Developer ____ Designer ____ Agency

ii. Company/LLC: ____ Owner ____ Developer ____ Designer ____ Agency

iii. Full Street Address: ____ Owner ____ Developer ____ Designer ____ Agency

iv. Phone Number: ____ Owner ____ Developer ____ Designer ____ Agency

21. _____ Include a signed Owner's Certification that states "I, the undersigned, certify that all land clearing, construction and development shall be done pursuant to the approved plan and that responsible personnel (i.e., Blue Card Holder) involved in the land disturbance will have a Certification of Training prior to initiation of the project, at a DNREC sponsored or approved training course for the control of erosion and sediment during construction. In addition, I grant the DNREC Sediment and Stormwater Program and/or the relevant Delegated Agency the right to conduct on-site reviews, and I understand my responsibilities under the NPDES Construction General Permit, as referenced on this Coversheet." <u>This must be signed in ink on each plan submitted or on an original reproducible.</u> Include the owner's name and title printed under the signature line.
22. _____ If during the SAS review meeting it is determined that a wetland delineation is required onsite, include a Wetland Certification, signed in ink, stating the site has been examined to both State and Federal requirements. The following shall be used unless an alternate has been approved: "This property, tax map #XXX, has been examined by [company name] for the presence of Waters of the United States, including wetlands (Section 404 and Section 10), State subaqueous lands and State regulated wetlands as established by the reviewing agencies in the form of manuals, policies and procedures in place at the time that the investigation was conducted. The wetland information contained in this plan set is in accordance with this criteria [or, There were no wetlands found within the subject property], per State JD #XXX and/or Army Corps JD #XXX [as applicable].
23. _____ Include a signed Licensed Professional Certification that states "I hereby certify that this plan has been prepared under my supervision and to the best of my knowledge complies with the applicable state and local regulations and ordinances."
24. _____ Include the following Standard Sediment and Stormwater Construction Notes:
    a. _____ "The DNREC Sediment and Stormwater Program must be notified in writing five (5) days prior to commencing with construction. Failure to do so constitutes a violation of the approved Sediment and Stormwater Management Plan."
    b. _____ "Review and or approval of the Sediment and Stormwater Management Plan shall not relieve the contractor from his or her responsibilities for compliance with the requirements of the *Delaware Sediment and Stormwater Regulations*, nor shall it relieve the contractor from errors or omissions in the approved plan."
    c. _____ "If the approved plan needs to be modified, additional sediment and stormwater control measures may be required as deemed necessary by DNREC or the Delegated Agency".
    d. _____ "Following soil disturbance or redisturbance, permanent or temporary stabilization shall be completed for all perimeter sediment controls, soil stockpiles, and all other disturbed or graded areas on the project site within 14 calendar days unless more restrictive Federal requirements apply."
    e. _____ "All erosion and sediment control practices shall comply with the *Delaware Erosion and Sediment Control Handbook*, latest edition."
    f. _____ "At any time a dewatering operation is used, it shall be previously approved by the Agency Construction Site Reviewer for a non-erosive point of discharge, and a dewatering permit shall be approved by the DNREC Well Permitting Branch."
    g. _____ "Approved plans remain valid for 3 years from the date of approval."
    h. _____ "Post construction verification documents are to be submitted to the DNREC Sediment and Stormwater Program [or, the relevant Delegated Agency] within 60-days of stormwater management facility completion."

i. _____ "Approval of a Sediment and Stormwater Management Plan does not grant or imply a right to discharge stormwater runoff. The owner/developer is responsible for acquiring any and all agreements, easements, etc., necessary to comply with State drainage and other applicable laws."

j. _____ "The Notice of Intent for Storm Water Discharges Associated with Construction Activity under a NPDES General Permit for this project is #_____ *(to be filled in once received)*. At any time the ownership for this project changes, a Transfer of Authorization or a Co-Permittee Application must be submitted to DNREC. The permittee of record shall not be relieved of their responsibilities until a Notice of Termination has been processed by DNREC."

k. _____ "The owner shall be familiar with and comply with all aspects of the NPDES Construction General Permit associated with the project, including, but not limited to, performing weekly site inspections during construction and after rain events, and maintaining written logs of these inspections."

l. _____ "Before any earthwork or excavation takes place, the contractor shall call Miss Utility at 811 or 1.800.282.8555 at least 48 hours prior to construction, to have all existing utilities marked onsite."

m. _____ "The contractor shall at all times protect against sediment or debris laden runoff or wind from leaving the site. Perimeter controls shall be checked daily and adjusted and/or repaired to fully contain and control sediment from leaving the site. Accumulated sediment shall be removed when it has reached half of the effective capacity of the control. In addition, the contractor may need to adjust or alter measures in times of adverse weather conditions, or as directed by the Agency Construction Site Reviewer."

n. _____ "Best available technology (BAT) shall be employed to manage turbid discharges in accordance with requirements of 7. Del C. Ch 60, *Regulations Governing the Control of Water Pollution*, Section 9.1.02, known as Special Conditions for Stormwater Discharges Associated with Construction Activities, and Department policies, procedures, and guidance."

o. _____ "Documentation of soil testing and materials used for temporary or permanent stabilization including but not limited to soil test results, seed tags, soil amendment tags, etc. shall be provided to the Department or Delegated Agency to verify that the permanent or temporary stabilization has been completed in accordance with the approved plan. The Department or Delegated Agency may require additional soil testing and reapplication of permanent or temporary stabilization in accordance with specifications provided in the *Delaware Erosion and Sediment Control Handbook*, or alternative measures that provide functional equivalency.

25. _____ Provide a list of all sheets and their corresponding sheet number for all Sediment and Stormwater Management Plans.

26. _____ Provide a minimum 3"x5" clear area for an approval stamp on the right third of the coversheet.

Construction Site Stormwater Management Plans:

27. _____ Overall Construction Site Phasing Plan:

a. _____ Provide only when the site has more than one limit of disturbance. Projects must be phased so that no more than 20 acres are disturbed at any one time. Grading of the next phase cannot proceed until temporary or permanent stabilization of the first 20-acre section is accomplished.

b. _____ Clearly indicate the extents of each phase in relation to the site plan (no existing or proposed grading).

c. _____ Indicate the location of the detailed sheets by matchline and page number reference.

d. _____ Provide a summary/legend for the limit of disturbance areas, indicating their total disturbed acreage and the lots, buildings and/or stormwater facilities that are included within the limit of disturbance.

28. _____ For ***all*** of the subsequent Pre-Construction and Construction Site Stormwater Management Plans include the following:

a. _____ Provide the "limit of disturbance" line(s).

b. _____ Include the total disturbed acreage on the plan if an Overall Phasing Plan has not been included.

c. _____ Existing contours shall be provided a minimum of 100' beyond the limit of disturbance. LiDAR 2' contours are acceptable for off-site areas.

d. _____ State and Federal wetlands must be accurately delineated.

e. _____ All streams and drainage ways must be delineated.

f. _____ The National Flood Insurance Program 100 Year Flood Zone must be delineated.

g. _____ Show the project benchmark and identify the elevation and datum.

29. _____ Overall Pre-Construction Site Stormwater Management Plan (if required, as determined at the SAS review meeting):

a. _____ Provide only for sites that cannot be shown in their entirety at the maximum scale of 1"=100'.

b. _____ Include the entire site boundary in an existing conditions plan view (ie, site boundary, existing contours, wetlands, treelines, existing structures/utilities to remain or to be removed, etc).

c. _____ Indicate the location of all perimeter controls, stockpile locations, sediment trapping facilities, and other construction stormwater management controls needed for demolition and bulk grading (i.e., silt fence, stabilized construction entrances, temporary swales, inlet protection for existing inlets, sediment basins, etc).

d. _____ Indicate the location of the detailed sheets by matchline and page number reference.

e. _____ Provide a Legend for all of the construction site lines and symbols used within the Pre-Construction Plan (ie, silt fence, limit of disturbance, temporary berm, etc). The lines and symbols should be as specified in the *Delaware Erosion and Sediment Control Handbook*, latest edition. If an Overall plan is not needed, provide the legend on the singular Pre-Construction Site Stormwater Management Plan.

30. _____ Pre-Construction Site Stormwater Management Plan (if required, as determined at the SAS review meeting):

a. _____ Provide for all sites at a maximum scale of 1" = 100'.

b. _____ Include the entire site boundary in an existing conditions plan view (ie, site boundary, existing contours, wetlands, treelines, existing structures/utilities to remain or to be removed, etc).

c. _____ Indicate the location of all perimeter controls, stockpile locations, sediment trapping facilities, and other construction stormwater management controls needed for demolition and bulk grading (i.e., silt fence, stabilized construction entrances, temporary swales, sediment basins, etc).

d. _____ Provide detailed labels and specifications for the controls utilized (i.e. “Data to be Provided” or “Data” blocks from the Delaware Erosion & Sediment Control Handbook, latest edition, details).

31. _____ Overall Construction Site Stormwater Management Plan:
    a. _____ Provide only for sites that cannot be shown in their entirety at the maximum scale of 1”=100’.
    b. _____ Clearly indicate all of the construction stormwater management controls for the site in relation to the site’s grading and stormwater facilities.
    c. _____ Indicate the location of the detailed sheets by matchline and page number reference.
    d. _____ Provide a Legend for all of the construction site lines and symbols used within the plan set (ie, silt fence, limit of disturbance, inlet protection, etc). The lines and symbols should be as specified in the *Delaware Erosion and Sediment Control Handbook*, latest edition. If an Overall plan is not needed, provide the legend on the singular Construction Site Stormwater Management Plan.
32. _____ Construction Site Stormwater Management Plan(s):
    a. _____ Provide for all sites at a maximum scale of 1” = 100’.
    b. _____ Clearly indicate all of the construction stormwater management controls for the site in relation to the site’s grading and stormwater facilities.
    c. _____ Provide detailed labels and specifications for the controls utilized (i.e. “Data to be Provided” or “Data” blocks from the Delaware Erosion & Sediment Control Handbook, latest edition, details).
    d. _____ Locate all utilities, construction staging areas, geothermal well-fields, and any/all other areas that construction equipment will traverse or disturb. These areas must be within the limit of disturbance and be provided with appropriate construction site controls.
33. _____ For ***all*** Pre-Construction and Construction Site Stormwater Management Plans locate *and* label all construction site stormwater control practices on the plans as previously mentioned. The following shall be included, unless supporting evidence of why they are not necessary is addressed in the revised Stormwater Management Report. The list is not exhaustive and the construction site design shall include any/all control practices contained within the *Delaware Erosion and Sediment Control Handbook*, or others as approved by DNREC, that are necessary to prevent sediment and pollution discharge from the site.
    a. _____ An approved perimeter control shall be placed downslope of all disturbed areas (or surrounding “flat areas”) to protect against sediment laden runoff from leaving the site or entering non-disturbed areas. It should be placed parallel to the contours and keyed perpendicular to the contours at the limits to prevent sediment from washing around the ends. Locate and denote the type with any specifications.
    b. _____ Reinforced and/or super silt fence should be utilized in areas of steep slopes and/or adjacent to sensitive areas such as wetlands, streams, and drainage ways.
    c. _____ Orange safety fencing shall be provided around all infiltration areas and noted that no heavy construction equipment shall traverse the future infiltration area.
    d. _____ Orange safety fencing is recommended to be placed around the drip line of all preserved trees.
    e. _____ Soil stockpile areas must be delineated for each phase of construction. Locate stockpiles on areas with little or no slope. Stockpiles must be surrounded with an approved perimeter control.

f. _____ Locate a stabilized construction entrance(s) for each phase of construction, and provide appropriate measures to ensure traffic utilizes the entrance (ie, keying silt fence up to the entrance).

g. _____ Sediment traps and basins shall be utilized as appropriate and sized to accommodate 3600 cubic feet of storage per acre of contributing drainage area until project stabilization is complete. These structures must be located at the base of the drainage area. The following information is required: top of slope elevation, bottom elevation, outlet elevation, dimensions, proposed volume, required volume, type of trap or basin, a minimum 2:1 length to width ratio and contributing drainage area. Include details, cross-sections and specifications. This information can be combined with the facility's Post Construction Stormwater Management Plan as appropriate.

h. _____ Specify the location, DNREC denoted type, and an example product for all stabilization practices, including any treatments, seeding, mulching and/or matting, both temporary and permanent.

i. _____ Erosion control matting is required on slopes of 3:1 or greater and in areas of concentrated flow. Specify the DNREC denoted type, with an example product, and the location of the matting.

j. _____ Channel interruptions are required in all swales, ditches and channels, with velocities greater than 2 ft/sec. Locate and denote the type with any specifications.

k. _____ Provide steep slope interruption by use of straw wattles, coir logs, etc. Locate and denote the type with any specifications.

l. _____ Provide appropriate inlet protection for all catchbasins and culvert inlets. Locate and denote the type with any specifications.

m. _____ Diversions must be used to direct run-off into traps. When sediment laden stormwater is directed to traps and basins by closed pipe systems, temporary diversions must be used to direct stormwater to traps and basins until closed pipe systems are operational. Locate and denote the type with any specifications.

n. _____ Outlet protection is required at all points of discharge from pipes, channels and spillways. Locate and provide details, cross-sections and specifications, including d50 stone size, stone depth, outlet dimensions and type of geotextile fabric.

o. _____ All stone, with the exception of check dams, must be underlain with a geotextile fabric, or approved equivalent practice. Geotextile fabric specifications must be provided for various applications, with the DNREC denoted type and an example product.

p. _____ Provide a location a concrete washout station and construction staging areas, including dumpster(s). Note that if the locations are to be moved, it shall be approved in writing by the Agency Construction Site Reviewer.

Construction Site Details and Notes:

34. _____ Specify whose responsibility it will be to maintain and repair all erosion and sediment control and stormwater management practices during construction and utility installation.
35. _____ Specify what stabilization measures shall be initiated if dust control becomes a problem.
36. _____ Provide the volume of any spoil or borrow material.
37. _____ Provide a detailed sequence of construction, and at a minimum include the following activities:
    a. _____ pre-construction meeting;

b. _____ clearing and grubbing for those areas necessary for installation of perimeter controls;
c. _____ construction of perimeter controls;
d. _____ remaining clearing and grubbing;
e. _____ road grading;
f. _____ grading for the remainder of the site,
g. _____ utility installation;
h. _____ stormwater facility construction;
i. _____ final grading, landscaping or stabilization;
j. _____ removal of sediment control practices.

38. _____ Include the following specific items as appropriate within the Sequence of Construction:
a. _____ "Notify the DNREC Sediment and Stormwater Program [or relevant Delegated Agency] in writing at least five (5) days prior to the start of construction. Failure to do so constitutes a violation of the approved Sediment and Stormwater Management Plan."
b. _____ "Prior to any clearing, installation of sediment control measures or grading, a pre-construction meeting must be scheduled and conducted with the Agency Construction Site Reviewer. The landowner/developer, contractor, and Certified Construction Reviewer are required to be in attendance at the pre-construction meeting; the designer is recommended to attend."
c. _____ "All perimeter controls are to be reviewed by the Agency Construction Site Reviewer and approved prior to proceeding with further site disturbance or construction."
d. _____ "The contractor shall at all times protect against sediment or debris laden runoff or wind from leaving the site. Perimeter controls should be checked daily and adjusted and/or repaired to fully contain and control sedimentation on the site. Accumulated sediment shall be removed when it has reached half of the effective capacity of the control. In addition, the contractor may need to adjust or repair measures in times of adverse weather conditions, or as directed by the Agency Construction Site Reviewer."
e. _____ "Notify the person responsible for stormwater system construction review at least three (3) days prior to the start of the stormwater system construction; stormwater facilities must be reviewed throughout their construction."
f. _____ "Erosion and sediment control devices should be removed only after work in an area has been completed and stabilized, with written approval from the Agency Construction Site Reviewer."
g. _____ "Prior to commencing a new phase of construction, the contractor shall receive approval from the Agency Construction Site Reviewer that the previous phase has been sufficiently stabilized."
h. _____ "The termination of the Construction General Permit will require submission and acceptance of the Post Construction Verification Documents, including final stabilization throughout the site, all elements of the Sediment and Stormwater Management Plan implemented, and acceptance of the final Operation and Maintenance Plan."

39. _____ Provide details and specifications for all erosion and sediment control management practices used. All details shall be from the *Delaware Erosion and Sediment Handbook* (any unusual practices must be approved for use by the Department). The following details must be incorporated:

a. _____ Stabilized Construction Entrance
b. _____ Perimeter Control (i.e., Silt Fence, Temporary Berm, etc)
c. _____ Temporary and Permanent Seeding and Stabilization
d. _____ Sediment Trapping (i.e., Inlet Protection, Sediment Basins, etc)
e. _____ Site Pollution Prevention including Concrete Washout
f. _____ Dewatering Practice(s)
g. _____ Individual Lot Control (for residential use only)
h. _____ All other applicable details to the site.

40. _____ Provide the "Data to be Provided" for all Erosion and Sediment Control practices having design data criteria. The data should be provided in the corresponding detail, or a note should be provided to refer to the relevant chart for the information.

Post Construction Stormwater Management Plan

41. _____ Provide an Overall Post Construction Stormwater Management Plan indicating the location and identification of all stormwater facilities in relation to the proposed site and the existing and proposed grading.
    a. _____ The National Flood Insurance Program 100 Year Flood Zone must be delineated.
    b. _____ Show project benchmark and identify elevation and datum.
    c. _____ The plan shall indicate any easements, rights-of-way, and/or demarcation of where public maintenance responsibility ends and private maintenance begins throughout the stormwater and drainage system, and clearly distinguish who is responsible for the maintenance in each area.

42. _____ Provide a detailed Post Construction Stormwater Management Plan per facility clearly showing the proposed construction and specifications, including:
    a. _____ Plan view of the facility indicating any/all: benches, inlets, outlets and their associated elevation; seed and stabilization type and locations; cross-section locations; grading of the facility; forebays; subsurface testing boring locations; etc. The maximum scale of facility shall be 1" = 30'.
    b. _____ Cross-section view of the facility to a defined scale, indicating any/all: benches; water surface elevations; depth of construction; location of liners or underdrains; slopes; structures and/or pipes; seed and stabilization type and locations; embankment specifications; existing and proposed grade; fill locations; etc.
    c. _____ Cross-section view of the principal spillway to a defined scale, including the entire length of the discharge pipe, indicating any/all: water surface elevations; location of liners; slopes; phreatic lines; structure details; embankment specifications; anti-seep collar location(s); crossings; outfall details; existing and proposed grade; etc. Extend the view to include the opposite side of any outfall ditch, and location of any wetlands, as applicable.
    d. _____ Cross-section views of the emergency spillway(s) to a defined scale, both through the width and length of the spillway, indicating any/all: water surface elevations; location of liners; slopes; embankment specifications; stabilization specifications; outfall details; existing and proposed grade; etc. Extend the view to include the opposite side of any outfall ditch, and location of any wetlands, as applicable.
    e. _____ Plan and section views to a defined scale for any structures within the facility including any/all construction specifications, inverts, water surface elevations, etc.
    f. _____ Notes and specifications for the facility, including, but not limited to, seed and stabilization type and locations, de-watering specifications,

groundwater/subsurface information, construction information and facility specific information (i.e., type of liner, biosoil, stone, etc.).

g. _____ If the vegetation within the facility is used for quality management purposes, a separate Landscape Plan shall be prepared indicating the species type, number and planting locations, and be signed by a licensed Landscape Architect in the State of Delaware.

h. _____ The plan shall indicate any easements, rights-of-way, and/or demarcation of where public maintenance responsibility ends and private maintenance begins within or around the facility, and clearly distinguish who is responsible for the maintenance in each area.

i. _____ Provide directional stormwater flow arrows for all existing and proposed channels, pipes, etc.

j. _____ Provide details, cross-sections and specifications (including appropriate channel lining, type of vegetation, or type of stabilization) for any diversions, ditches, swales, etc., not classified as a facility but are being proposed or accepting discharge.

k. _____ All stormwater designs shall be in accordance with standards developed and/or approved by the DNREC Sediment and Stormwater Program.

l. _____ Maintenance set aside areas for disposal of sediments removed from stormwater management facilities that provide a forebay must be provided. Set aside areas shall accommodate at least 2% of the stormwater management facility volume to the elevation of the 2 year storage volume elevation, maximum depth of the set aside volume shall be one foot, and the slope of the set aside area shall not exceed 5%.

m. _____ Include in the agency submittal any design checklists for the specific type of facility as provided by DNREC.

n. _____ Provide a Sequence of Construction specific to the facility, indicating the methods for excavation, construction of structures or other controls, stabilization, dewatering, temporary or permanent sediment controls, etc.

o. _____ Provide Operation and Maintenance (O&M) notes and/or details (if more than one sheet is required per facility, then the O&M requirements shall all be combined on the same sheet). Including the below statements and requirements shall satisfy the Operation and Maintenance Plan requirements for this stage of plan review (once the facility is constructed, a full Operation and Maintenance Plan shall be prepared and include the post verification construction drawing.

i. _____ "The DNREC Sediment and Stormwater Program and/or the relevant Delegated Agency reserves the right to enter private property for purposes of periodic site reviews."

ii. _____ "The DNREC Sediment and Stormwater Program [or the relevant Delegated Agency] shall be notified within 30 business days if the property ownership is transferred to a new person or entity."

iii. _____ "The DNREC Sediment and Stormwater Program and/or the relevant Delegated Agency may seek enforcement action against any owner deemed negligent in fulfilling the Operation and Maintenance requirements of the *Delaware Sediment and Stormwater Regulations*."

iv. _____ "The DNREC Sediment and Stormwater Program [or, the relevant Delegated Agency] shall be contacted if a concern arises regarding a

stormwater management facility, before any non-routine maintenance, or if modifications to the facility are desired."

v. _____ "Any design modifications made to the stormwater system shall require the creation of a new Post Construction Stormwater Management Plan and/or Operations and Maintenance Plan, with approval of the plan(s) by the DNREC Sediment and Stormwater Program [or the relevant Delegated Agency]."

vi. _____ "For all stormwater easement areas (i.e., access, maintenance, or offsite) and the minimum 10-foot wide accessways to all stormwater facilities and their structural components, regular mowing shall be performed to keep the grass 6" or less; no trees or shrubs shall be planted, and any found growing shall be removed; and no permanent structures, such as fences or sheds, shall be located within the easement or accessway."

vii. _____ "Trees shall not be planted, and shall be removed if found growing, on and within 15 feet of all pond embankments, on pond slopes or safety benches, and within 10 feet of structural components, such as pipe inlets."

viii. _____ "When the facility is excavated to remove accumulated sediment, the disposal area shall be permanently stabilized so that it does not recreate an erosion problem. Any material taken off-site shall still be utilized or disposed of in an approved DNREC manner."

ix. _____ "Before any earthwork or excavation takes place, the contractor shall call Miss Utility at 811 or 1.800.282.8555 at least 48 hours prior to construction, to have all existing utilities marked onsite."

x. _____ Include the O&M notes specified for the type of facility proposed, as per Appendix 5.01.1 and/or section 3.06.2 Post Construction Stormwater BMP Standards and Specifications of the Technical Document.

xi. _____ Include any facility specific routine or non-routine maintenance, and/or operational requirements not listed in the above-mentioned standard requirements for the type of facility. May include, but is not limited to any mowing, sediment removal, pipe inspections, watering, re-seeding/planting, trash removal, etc

1. _____ The notes shall indicate the frequency of the maintenance inspections.
2. _____ Any O&M specifications for proprietary systems must be included on the plans.
3. _____ Any details necessary to complete the O&M procedures must be included.

43. _____ For stormwater management practices incorporating infiltration, the following apply:

a. _____ Infiltration practices designed to handle runoff from impervious parking areas must maintain a separation distance of 100 feet from domestic wells and 150 feet from public wells from their periphery.

b. _____ Infiltration practices greater than three feet deep shall be located at least 20 feet from basement walls. Any infiltration practice shall be located at least 10 feet from a building structure.

c. _____ Areas draining to these practices must be stabilized and vegetative filters established prior to runoff entering the system. If individual lot construction is to drain towards an already established infiltration area, the facility shall be protected with perimeter controls around the top of bank.

d. _____ The infiltration practice shall be designed to drain completely within 48 hours.

e. _____ The bottom of the infiltration practice shall be at least three feet above the seasonal high water table, unless a BMP specification indicates otherwise.

f. _____ Infiltration practices are limited to soils having a field tested infiltration rate of at least 1 inch per hour; the design infiltration rate shall be half of the field tested infiltration rate. Onsite soil borings and textural classification must be done to verify site conditions and seasonal high water table, this information must be submitted with the plan.

g. _____ Infiltration practices shall not be installed in fill material.

Note: For any language that contains "[or the relevant Delegated Agency]", the preparer shall substitute the name of the appropriate Delegated Agency in place of the DNREC Sediment and Stormwater Program. For example, if the Sussex Conservation District is the Delegated Agency for the project, the checklist item "I am to notify the DNREC Sediment and Stormwater Program [or the relevant Delegated Agency]" would be prepared as "I am to notify the Sussex Conservation District". Any "and/or" statements shall remain as prescribed. For example, "I grant the DNREC Sediment and Stormwater Program and/or the relevant Delegated Agency" can be copied verbatim, and grants either agency the right to enter the property as may become necessary throughout the duration of the project.

3.03
Construction Site Stormwater Management

Background

The principal effect land development activities have on the natural or geologic erosion process consists of exposing disturbed soils to precipitation and to surface storm runoff. Results from both field studies and erosion models indicate that erosion rates from construction sites are typically about an order of magnitude greater than row crops and several orders of magnitude greater than rates from well-vegetated areas such as forests or pastures. Stormwater discharges generated while construction activities are occurring have a potential for serious water quality impacts as well. A number of pollutants are preferentially absorbed onto mineral or organic particles found in fine sediment. The erosion and delivery of sediment into aquatic ecosystems is the primary pathway for delivering key pollutants such as nutrients (particularly phosphorous), metals, and organic compounds. In addition to the environmental impacts associated with sediment discharges, there are economic impacts as well. Obstruction of stream channels and navigable rivers by masses of deposited sediment reduces their hydraulic capacity which, in turn, causes an increase in subsequent flood crests and a consequent increase in the frequency of damaging storm events. Sediment fills drainage channels, especially along highways and railroads, and plugs culverts and storm drainage systems, thus necessitating frequent and costly maintenance. Other potential non-sediment pollutants associated with construction activities include fertilizers, pesticides, trace metals, concrete wash-out and miscellaneous construction wastes. The temporary practices included in the Sediment & Stormwater Plan are intended to control both sediment and non-sediment pollutants during the construction phase of the land disturbing activity. The most effective measures for controlling sediment are those that prevent erosion from occurring in the first place. Similarly, many non-sediment pollutants can best be controlled by excluding their exposure to rainfall.

Delaware Erosion & Sediment Control (ESC) Handbook

Unless granted prior approval by the Department or Delegated Agency as discussed at the project application meeting, all construction site stormwater management practices shall be consistent with the standards, specifications and details included in the current version of the Delaware Erosion & Sediment Control Handbook, including the DelDOT and Tax Ditch Maintenance supplements.

An applicant proposing to use temporary control measures that are not included in the current Delaware ESC Handbook shall submit supporting documentation to the Department for determination as to its appropriateness for the proposed use.

Limits on Land Disturbance
Use of the standard details from the Delaware ESC Handbook for design of construction site stormwater management practices is limited to sites where no more than 20 acres will be disturbed at any one time.

Projects proposing to disturb more than 20 acres shall:

1. Phase the project such that no more than 20 acres are disturbed at any one time during the project; or
2. Prepare an engineered plan for controlling both sediment and stormwater runoff during the active construction phase. Construction Site Sediment and Stormwater control measures shall be designed to manage the runoff from the 2-YR storm event assuming a bare earth condition. Conveyance measures shall be designed to have adequate capacity for conveyance of flows in a non-erosive manner. Storage practices shall be designed to adequately contain the volume of the design storm event.

Maintenance of Construction Site Stormwater Management BMPs
The person(s) or entity responsible for maintenance of the temporary control measures during the active construction phase shall be clearly identified on the plan.

In cases where shared responsibilities are proposed (co-permittees), the plan shall include a table identifying the person(s) and/or entities responsible for maintenance of the various elements of the construction site stormwater management plan. Refer to the Guidance Document to support the Special Conditions for Storm Water Discharges Associated with Construction Activities for further information regarding co-permittee responsibilities (1.02.2).

Use of Best Available Technology (BAT) to Control Turbid Discharges
Sites that have been identified as problematic due to turbid discharges shall employ increasing levels of Best Available Technology (BAT) until the problem has been rectified. Such measures can include, but are not limited to:

1. Flocculation treatment
2. On-site re-use
3. Mechanical filtering
4. Flow diversion
5. Treatment trains
6. Other practices as approved by the Department

The Department's current policy on employing BAT to control turbid discharges is included as 3.03.1.

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

OFFICE OF THE DIRECTOR

TELEPHONE: (302) 739-9921
FAX: (302) 739-6724

Memorandum

DATE: March 24, 2009

TO: All Delegated Agencies

FROM: Randy Greer, Engineer VI RKG
Sediment & Stormwater Program

RE: Policy Memo
Employing BAT for Turbid Discharges

CC: Jamie Rutherford, Program Manager
Sediment & Stormwater Program Staff

Dear Delegated Agent,

The Department has received several requests recently for guidance on making recommendations when a turbid discharge condition occurs, even when traditional ESC practices have been implemented in accordance with an approved plan. This policy memo is intended to provide such guidance. It is important to understand that merely implementing an approved plan does not relieve a permittee from his/her obligation under the Federal Clean Water Act to take whatever measures are reasonably necessary to minimize environmental impacts associated with land development and construction activities.

Regulatory Background

Under the Federal Clean Water Act, stormwater runoff from construction activities is classified as an industrial discharge subject to the permitting requirements of the National Pollutant Discharge Elimination System (NPDES). The USEPA has developed a General Permit for these construction activities which is administered in Delaware through 7 Del. C. Chapter 60.

Since numeric effluent limits have not been established for this industrial class, the "Best Available Technology", or BAT, is the standard that is applied at the Federal level for managing stormwater runoff from construction activities. In order to be granted delegation authority for permitting industrial discharges, State regulations must be consistent with the Federal requirements. Part 2 of Section 9 – Special Conditions For Storm Water Discharges Associated With Construction Activities, of the *Regulations Governing the Control of Water Pollution* defines BAT as:

> "*a level of technology based on the very best (State of the art) control and treatment measures that have been developed or are capable of being developed and that are economically achievable within the appropriate industrial category.*"

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Effective April 2016

In order to gain coverage under the General Permit program in Delaware, a permittee must have an approved Sediment & Stormwater Plan in accordance with the requirements of 7 Del. C. Chapter 40, and file a Notice of Intent (NOI) prior to any land disturbing activity. Therefore, the requirements under Chapter 60 and Chapter 40 are inextricably linked.

Regulatory Authority for Amending Deficient Plans

Part 2, Section 9.1.02.5.D.1.d Special Conditions For Storm Water Discharges Associated With Construction Activities, of the *Regulations Governing the Control of Water Pollution* requires a permittee to amend a plan whenever:

> *"The Plan proves to be ineffective in eliminating or significantly minimizing the discharge of pollutants, or in otherwise achieving the general objectives of controlling pollutants in storm water discharges with construction activity;"*

In addition, the *Delaware Sediment & Stormwater Regulations*, Section 14.6 states that:

> *"The appropriate plan approval agency may require a revision to the approved plans as necessary due to differing site conditions."*

It is important to note that a permittee implicitly accepts these conditions if they wish to gain coverage under the General Permit program. If an individual does not wish to abide by any one of the conditions contained in the General Permit, they have the option to apply for an Individual Permit directly with USEPA.

Department Guidance on Addressing Turbid Discharges

It is the Department's position that unless a site has taken all reasonable measures to employ BAT to reduce turbid discharges, the Sediment & Stormwater Plan must be revised accordingly. Therefore, the following actions should be taken when this situation occurs:

1. The CCR and/or agency site reviewer shall prepare an inspection report documenting the turbid discharge.
2. Whenever possible, the inspection report should be supported with photographic evidence, both on-site and off-site as applicable, of this discharge.
3. The inspection report shall state that the plan must employ BAT to address the turbid discharge condition. This may be addressed initially with appropriate field changes to the plan.
4. If previous attempts to control a turbidity problem through field changes have not been successful, the inspection report shall state that the owner must submit a revised plan to address the turbid discharge condition, along with a reasonable time limit to make such revision.
5. If the plan is not revised within the allowable time frame and continues to discharge turbid water, the site will be considered in violation.

BAT alternatives to be considered include, though are not limited to, flocculent application, on-site re-use, mechanical filtering, flow diversion, etc. While it may be helpful to include a note on the plan regarding use of Best Available Technology as necessary, the responsibility for choosing an appropriate solution lies with the permittee. In some cases, it may require a "treatment train" approach to meet the regulatory requirements. The Department recognizes that it is not reasonable to expect construction activities to have "zero impacts". However, permittees must also recognize that there are often additional measures that can be taken when an approved plan does not adequately address those impacts.

3.04
Post Construction Stormwater Management

Background

Introducing impervious surfaces to a landscape can substantially impact receiving streams and water bodies by increasing both stormwater runoff and its associated pollutants. It has been estimated that a site with 35-50% imperviousness has three times the runoff compared to a more natural groundcover. By limiting the ability of the soil to infiltrate, an increase in impervious surfaces leads to reduced groundwater recharge as well as increased stormwater runoff volume, peak rate and duration of flow, all of which tends to increase the potential for flooding. In addition, data indicates a direct relationship between the amount of imperviousness in a given watershed and the degree of degradation. A recent report to Congress by the National Academies of Science places additional emphasis on the habitat impacts from urban stormwater runoff. Highly impervious watersheds tend to be flashier and exhibit lower base flows. The frequency of out-of-bank occurrences also increases, leading to increased bank erosion and sediment deposition. All these factors stress aquatic organisms, potentially shifting the aquatic ecosystem to favor less desirable species.

Sediment has been determined to be the most significant pollutant of concern associated with stormwater runoff. Suspended sediment particles cause turbidity problems in the water treatment process and act as an environmental stressor on aquatic life. In addition, as soil particles wash off the land through the erosion process, their chemically active nature makes them particularly conducive to transporting adsorbed nutrients, metals, toxics, and other contaminants into the receiving waters. Typical loadings for total suspended solids from urban land uses range from less than 100 lb/ac/yr for low density residential development to over 500 lb/ac/yr for urban highways. In addition to these land-based sources, urban stream channel erosion can lead to sediment loads that are an order of magnitude greater in the receiving waters themselves depending on the effective imperviousness of the watershed.

Nitrogen is a nutrient associated with the soluble component of stormwater runoff. Although necessary for plant growth, excess nitrogen in water becomes a pollutant by stimulating the growth of algae and other less desirable plants. Nitrogen enrichment is typically more problematic in estuarine ecosystems. Major sources associated with urban stormwater runoff include fertilizers and atmospheric deposition. Typical loadings for total nitrogen from urban land uses range from 10 to 15 lbs/ac/yr. Phosphorus is a nutrient more associated with the particulate component of stormwater runoff, since it readily adsorbs to sediment. Also necessary for plant growth, excess phosphorous becomes a pollutant typically more problematic in freshwater ecosystems. The major source of phosphorus associated with urban runoff is fertilizer. Some soluble phosphorus can be traced to septic systems; however, the use of low phosphorus detergents has significantly reduced this source. Typical loadings for total phosphorus from urban land uses range from 0.75 to 1.25 lbs/ac/yr. Other pollutants in urban stormwater runoff include bacteria, trace metals and hydrocarbon derivatives.

The traditional approach to stormwater management was one of quantity control to prevent flooding. Later, greater emphasis was placed on managing stormwater runoff from a water quality perspective. A wide selection of best management practices (BMPs), including manmade ponds, filtration systems, and infiltration structures have been successfully used to manage stormwater runoff. Until recently, however, such BMPs have largely sought to control the particulate pollutants found in surface runoff, such as sediment and those pollutants which tend to adsorb to sediment, such as phosphorus. Soluble pollutants, such as nitrogen, can be found in both surface runoff and subsurface flow. BMPs that have a vegetative component designed for nutrient uptake and/or an anaerobic component to induce denitrification, such as constructed wetlands, biofiltration systems, and bioretention structures, can reduce these pollutants. Current urban BMP designs remove 10 to 50 percent of total nitrogen, and 45 to 75 percent of total phosphorous. With the recent recognition of the habitat impacts associated with urban stormwater runoff, stream stability issues must also be addressed. The traditional approach of "collect and convey" using a single BMP is no longer seen as adequate to manage the complex problems associated with urban stormwater runoff. Contemporary designs aim to reduce runoff volume utilizing distributed techniques and "treatment trains" tailored to the problems associated with a specific site. The post-construction stormwater management component adheres to this philosophy.

General Requirements

All post construction stormwater management BMPs shall be designed and constructed in accordance with the standards and specifications developed or endorsed by the Department. These include, but are not limited to:

A. Natural Resource Conservation Service (NRCS) National Engineering Handbook

B. Water Environment Federation (WEF) Manual of Practice FD-20, "Design and Construction of Urban Stormwater Management Systems"

C. Federal Highway Administration (FHWA) Hydraulic Design Series No. 5, "Hydraulic Design of Highway Culverts"

D. Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 22, "Urban Drainage Design Manual"

E. U.S. Army Corps of Engineers (USACE) Engineer Manual 1110-2-2300, "Earth and Rock-Fill Dams – General Design and Construction Considerations"

F. Delaware Dept. of Transportation (DelDOT) Road Design Manual

G. Delaware DNREC Standards & Specifications for Post Construction Stormwater Management BMPs

H. Delaware DNREC Erosion & Sediment Control Handbook

I. NRCS Small Pond Code 378 for Delaware

All hydrologic computations shall be in accordance with Natural Resource Conservation Service (NRCS) methodologies. In addition, the Delmarva Unit Hydrograph shall be used for all projects south of the Chesapeake and Delaware (C&D) canal. Computations for estimating annual runoff shall be based on the methodologies from the Source Loading and Management Model (WinSLAMM). Hydrologic references include, but are not limited to:

A. Natural Resource Conservation Service (NRCS) National Engineering Handbook, Part 630, "Hydrology"

B. Natural Resource Conservation Service (NRCS) Technical Release 55 (TR-55)

C. Delaware DNREC Runoff Reduction Guidance Document (see 3.04.2)

D. WinSLAMM User's Guide

All water surface profile computations shall be in accordance with U.S. Army Corps of Engineers (USACE) methodologies. References include, but are not limited to:

A. U.S. Army Corps of Engineers (USACE) Engineer Manual 1110-2-1416, "River Hydraulics"

B. U.S. Army Corps of Engineers (USACE) HEC-RAS, River Analysis System Hydraulic Reference Manual

Any hydrologic or hydraulic software program proposed for performing computations to comply with the Delaware Sediment & Stormwater Regulations must be endorsed by the Department. The USACE HEC-HMS and HEC-RAS software programs shall be used as the standards to resolve conflicting computational results between different software programs.

Pre-engineered and/or proprietary devices proposed for compliance with the Delaware Sediment & Stormwater Regulations must meet the Standards & Specifications for Post Construction Stormwater Management BMPs contained in 3.06.2.15.

A soils investigation report shall be provided for any post construction stormwater management BMP that relies on full or partial infiltration. Procedures for conducting the infiltration testing shall be in accordance with Department guidance (see 3.06.2.A-1).

Compliance Criteria for Regulatory Storm Events
(see Stormwater Management Compliance Flowchart, 3.04.1)

Resource Protection Event

A. The design parameter for the Resource Protection Event shall be the annualized runoff volume produced by a storm having a 99% probability of occurring annually (i.e., the 1-YR event) based on post-developed conditions.

B. The Resource Protection Event volume (RPv) shall be determined in accordance with Department guidance (see Runoff Reduction Guidance 3.04.2).

C. Compliance with the Resource Protection Event may be accomplished by:

   i. Reducing the RPv in accordance with Department guidance (see Runoff Reduction Guidance 3.04.2). For new development, the RPv shall be reduced to an equivalent 0% effective imperviousness. For redevelopment, the RPv shall be reduced to an equivalent 70% of the existing effective imperviousness. The RPv shall be further reduced to an equivalent wooded condition for any existing meadow or wooded areas within the limit of disturbance based on the 2007 Delaware Land Use/Land Cover data; or

   ii. In cases in which only partial reduction can be achieved, releasing the residual RPv at a rate not to exceed the equivalent 24-hr extended detention of the full RPv and providing an offset in accordance with Department guidance (see Article 2.04); or

   iii. Limiting the reconstruction of existing paved areas, re-grading and replacement of existing turfgrass areas, rebuilding or repairing of structures damaged by fire, flood, wind, or other natural disaster and where the disturbed area will return to the original hydrologic condition and land cover at the conclusion of the project.

D. If compliance cannot be achieved in accordance with Section C above after employing all runoff reduction practices to the Maximum Extent Practicable

(MEP), an offset shall be provided in accordance with the guidelines included in Article 2.04.

Conveyance Event

A. The primary design parameter for the Conveyance Event shall be the additional runoff volume (above the RPv) produced by a storm having a 10% probability of occurring annually (i.e., the 10-YR event) based on post-developed conditions. The peak discharge may be considered a secondary design parameter under certain circumstances.

B. The Conveyance Event volume (Cv) shall be determined using the NRCS runoff equation. Peak discharge for the Conveyance Event shall be based on the NRCS Type II, 24-HR design storm.

C. Compliance with the Conveyance Event may be accomplished by:

i. Discharging into either a closed drainage system or open channel having adequate capacity for the Conveyance Event to tidal waters under non-erosive conditions; or

ii. Reducing the entire Cv in accordance with Department guidance (see Runoff Reduction Guidance 3.04.2).; or

iii. For projects that qualify by receiving all “Minor” ratings on the Stormwater Assessment Report (SAR) and opt for the Unit Discharge approach, releasing the Cv at a rate not to exceed the weighted average based on the following pre-developed land use as determined from the 2007 Delaware Land Use/Land Cover data:

a. Non-woodland/Non-meadow: 0.75 cfs/ac

b. Woodland/meadow: 0.375 cfs/ac

c. Woodland (Hydrologic Soil Group A): 0 cfs/ac; or

iv. For projects that are required or opt for the performance-based approach, complying with Department guidance (see 3.02.2.3); or

v. A “de minimis” discharge rate determined on a case-by-case basis.

Flooding Event

A. The primary design parameter for the Flooding Event shall be the additional runoff volume (above the Cv) produced by a storm having a 1% probability of occurring annually (i.e., the 100-YR event) based on post-developed conditions. The peak discharge may be considered a secondary design parameter under certain circumstances.

B. The Flooding Event volume (Fv) shall be determined using the NRCS runoff equation. Peak discharge for the Flooding Event shall be based on the NRCS Type II, 24-HR design storm.

C. Compliance with the Flooding Event may be accomplished by:

i. Discharging into either a closed drainage system or open channel having adequate capacity for the Conveyance Event to tidal waters under non-erosive conditions; or

ii. For projects that qualify and opt for the Unit Discharge approach, releasing the Cv at a rate not to exceed the weighted average based on the following pre-developed land use as determined from the 2007 Delaware Land Use/Land Cover data:

a. Non-woodland/Non-meadow: 2.25 cfs/ac

b. Woodland/meadow: 1.25 cfs/ac

c. Woodland (Hydrologic Soil Group A): 0.25 cfs/ac; or

iii. For projects that are required or opt for the performance-based approach, complying with Department guidance (see 3.02.2.3.)

Alternative Criteria

A. In cases where a watershed master plan has been developed and endorsed by the Department, the management criteria defined by that master plan shall take precedence over the criteria in Compliance Criteria for Regulatory Storm Events above.

B. In cases where a receiving waterbody has been identified as impaired, or designated with a specific pollutant reduction target necessary to meet State or Federal water quality regulations, additional stormwater treatment practices or alternative criteria may be required in accordance with Department guidance. Examples include, but are not limited to, a Total Maximum Daily Load (TMDL)

requirement for nutrients and/or sediment which would require specific pollutant reductions for compliance.

C. In cases where a specific pollutant source or “hot spot” has been identified, additional stormwater treatment practices or alternative criteria may be required in accordance with Department guidance. An example of this would be specific permits required under the National Pollutant Discharge Elimination System when discharges are a combination of stormwater and industrial or domestic wastewater or which must comply with Parts 122, 123, and 124 of Title 40 of the Code of Federal Regulations.

   i. When a land disturbing activity that falls under the applicability of these Regulations occurs on a site with an existing NPDES stormwater discharge permit, the Department shall determine if:

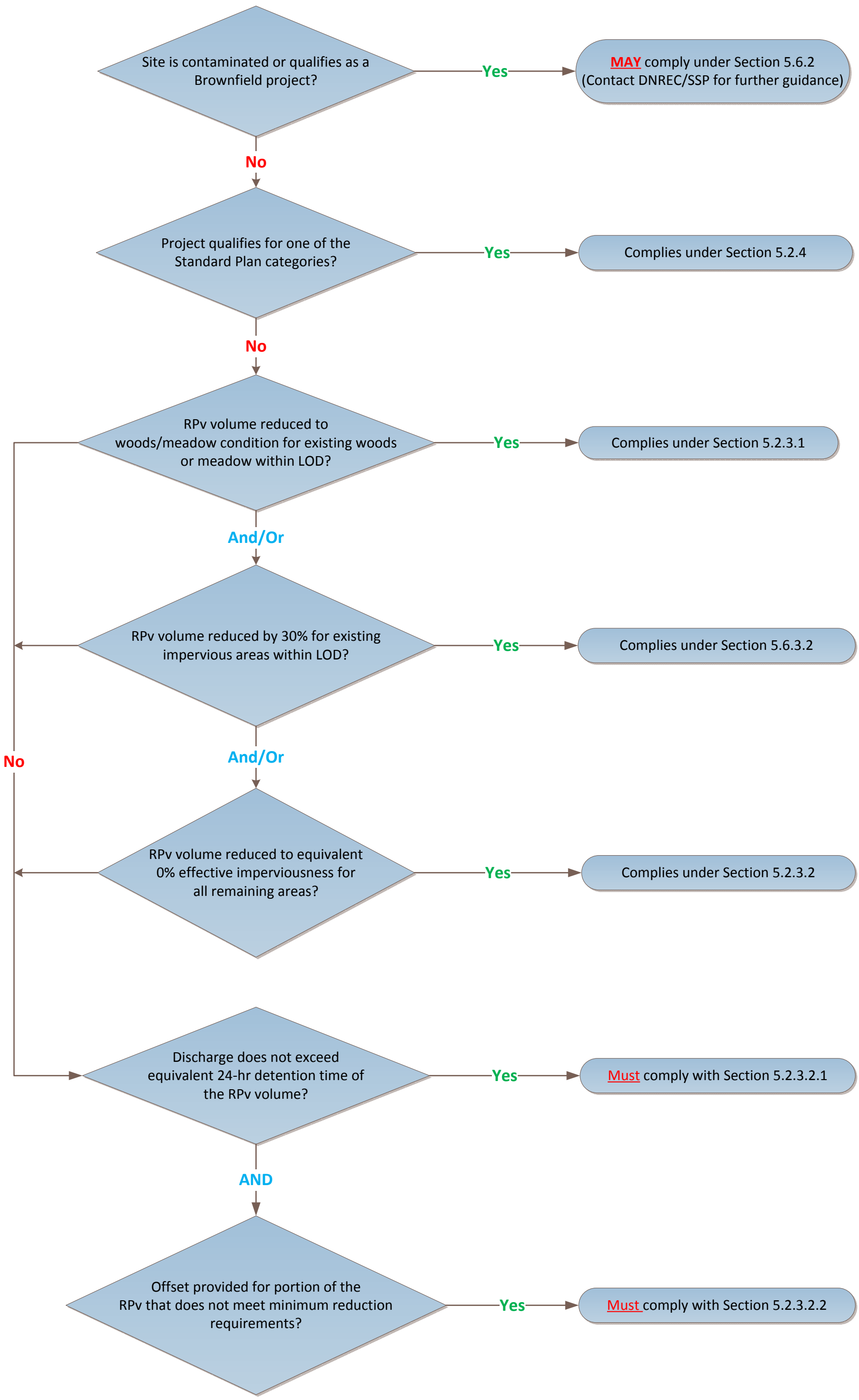
      a. The post-construction discharge is covered under the existing Federal NPDES permit; or

      b. The post-construction discharge will be covered under a revision to the existing Federal NPDES permit; or

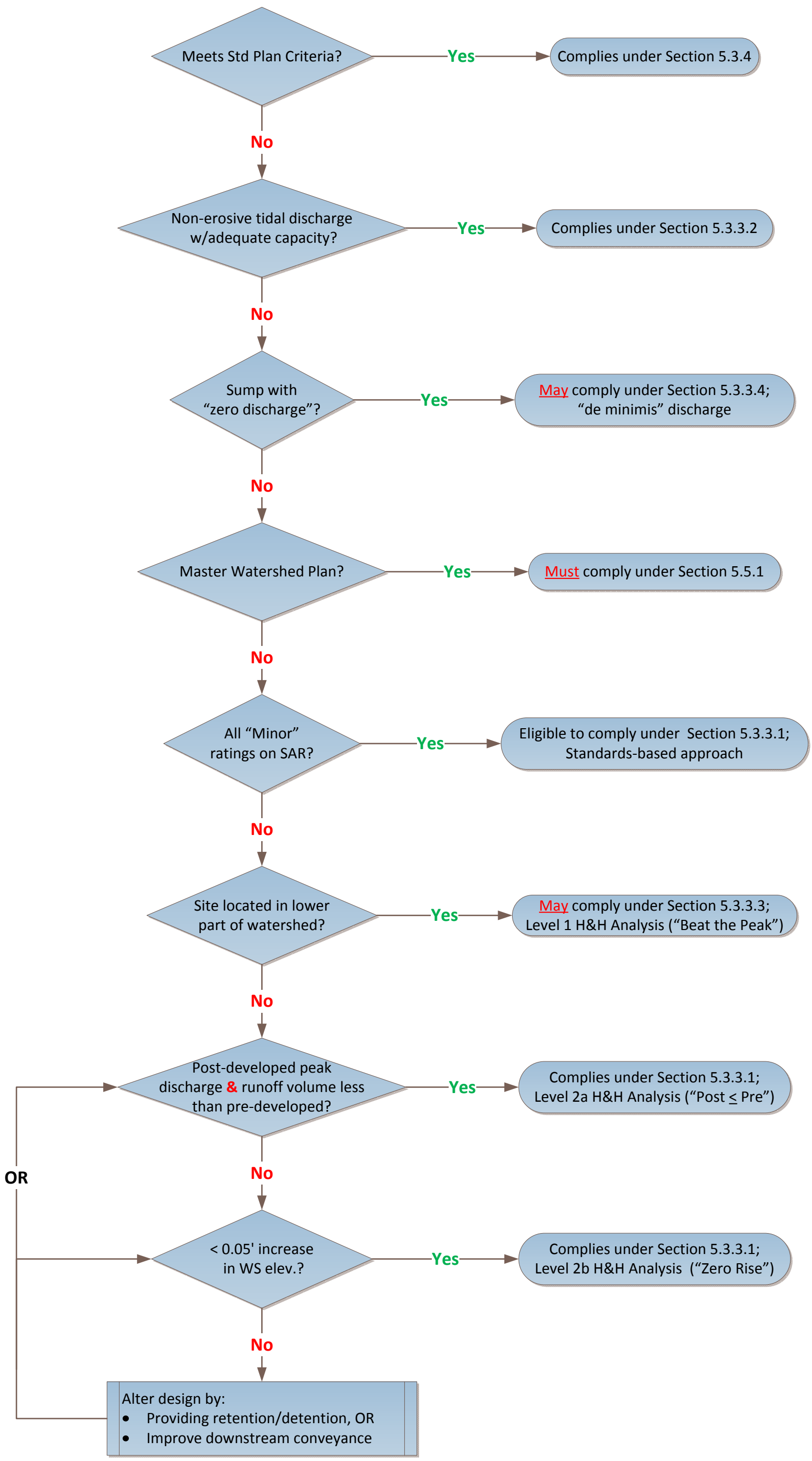
      c. The post-construction discharge must comply with the requirements for the Resource Protection Event (RPv) in accordance with the Compliance Criteria for Regulatory Storm Events above.

   ii. Projects that must meet the requirements of this section for water quality purposes must nonetheless meet the quantity management requirements for the Conveyance Event (Cv) and Flooding Event (Fv) in accordance with the Compliance Criteria for Regulatory Storm Events above.

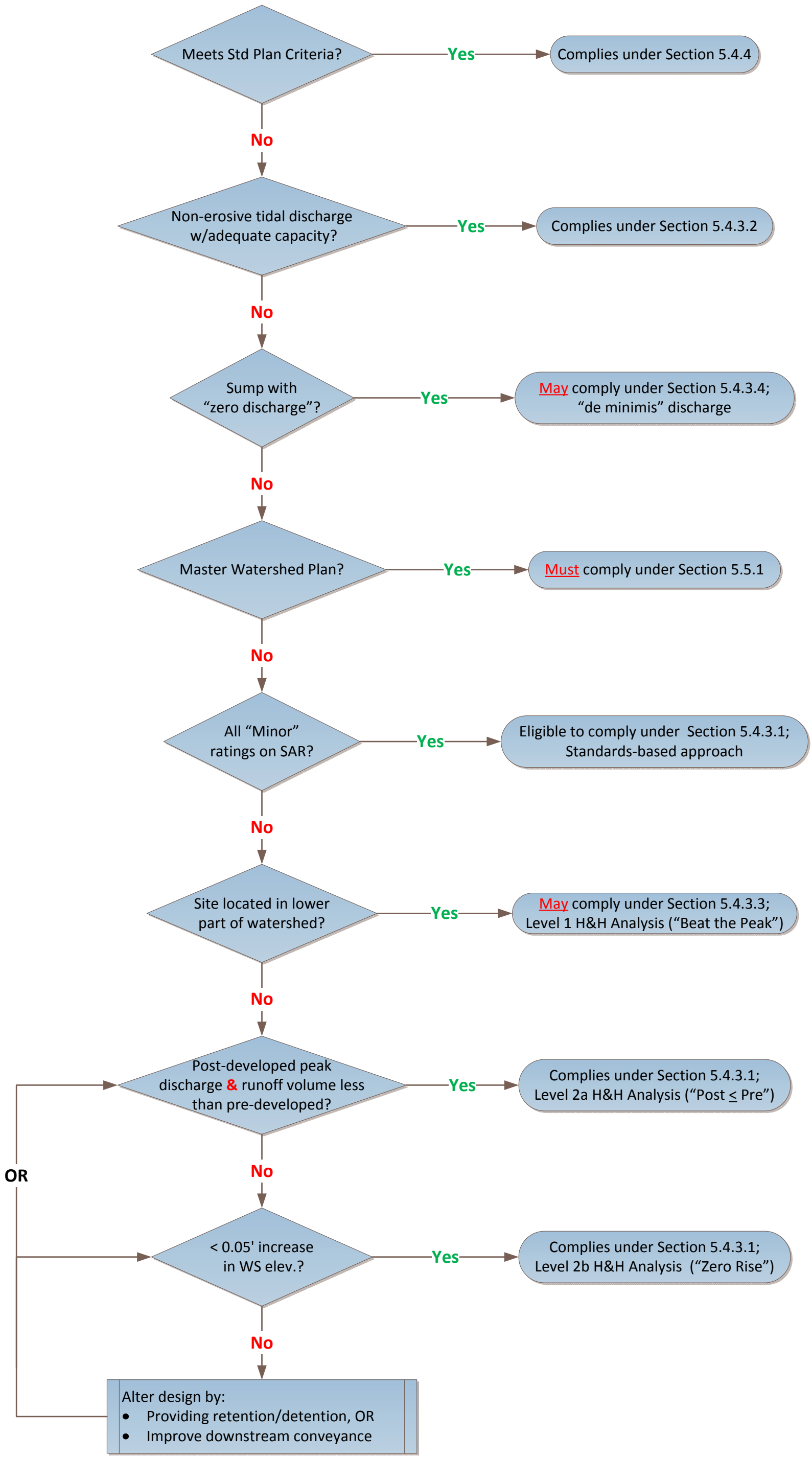
RPv Compliance Check Flowchart



Cv Compliance Check Flowchart



Fv Compliance Check Flowchart

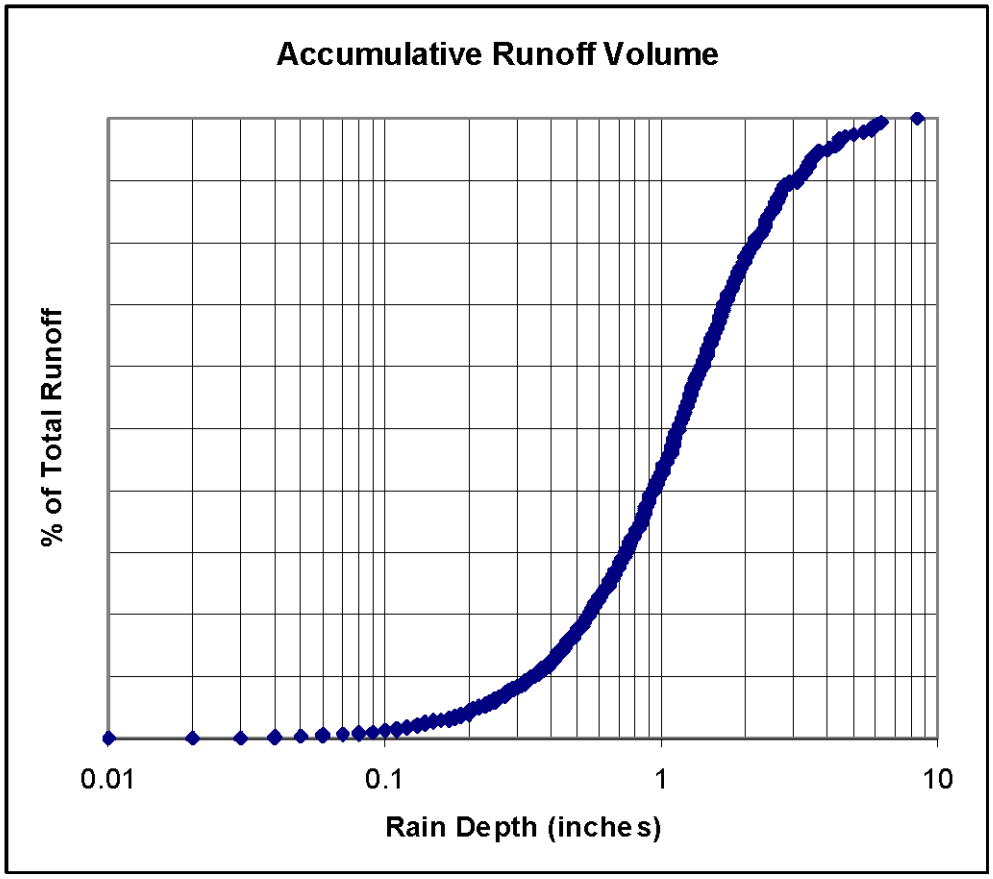


Introduction

The benefits of controlling stormwater runoff volume that results from land development activities have been well documented and are generally accepted by contemporary stormwater management practitioners. Although infiltration practices have been used for many years to mitigate the impacts associated with increased stormwater runoff, the benefits of more passive and non-structural approaches have only recently been recognized. Unfortunately, methods to quantify and assess those benefits have been limited, ranging from relatively simple empirical methods based on percentage of impervious cover to highly complex deterministic models which are beyond the needs of site-level analysis. In addition, the benefits from these so-called "green infrastructure" practices are generally associated with reductions in the annual runoff volume. Traditional stormwater management has relied on event-based methods to evaluate stormwater impacts and verify regulatory compliance. The Delaware Sediment & Stormwater Program has developed a methodology based on the Natural Resource Conservation Service's Runoff Curve Number (RCN) methodology to estimate the annual runoff from developing lands and runoff reduction benefits associated with Green Technology Best Management Practices (GTBMPs). This guidance document presents the scientific background behind, derivation of, and application of the methodology for compliance with the Delaware Sediment & Stormwater Regulations.

Background

It has been shown that the majority of the annual stormwater runoff is generated by small storm events accumulating over time. Dr. Robert Pitt of the University of Alabama is recognized in the scientific community as a national leader on the subject of small storm hydrology. Figure 1 illustrates his findings that rain events between 0.35" and 3" are responsible for about 80% of the total annual runoff volume based on data collected from BWI airport and modeled in his WinSLAMM model. Although rainfall events less than 0.1" can account for up to 20% of the annual precipitation, as Figure 1 shows, they produce little if any runoff, which tends to skew the annual rainfall-runoff relationship. Based on Pitt's data, it was determined that the median runoff event was about 1.25 inches, which is approximately the 90th percentile rainfall event for the Delmarva region. That is, the 90th percentile rainfall event only accounts for about 50% of the annual runoff. This has important implications for stormwater management, particularly from a water quality and resource protection perspective. In order to manage the 90th percentile annual runoff volume, one would need to capture the runoff generated by the 99th percentile rainfall event.



Plot showing accumulative runoff (100% full scale) against rain depth (Baltimore rains and typical medium density residential areas with silty soils).

Fig. 1 (from Pitt & Vorhees, 2004)

Derivation of the Methodology

The research cited earlier by Pitt (2004) also included tabulated annual flow-weighted Rv values for various land uses and soils as calculated by his WinSLAMM model. Analysis of this data indicated that one could reasonably derive conjugate RCN values for the Rv values in the table. Several values were selected as representative of the typical RCN values used in Delaware for land development activities, ranging from ultra-low density residential site with sandy soils to commercial shopping center with clay soils. Figure 2 shows the Rv values selected for the analysis. Figure 3 shows the respective conjugate RCN values from the NRCS Technical Release 55.

		% Pervious	% Impervious (directly connected)	% Impervious (disconnected)	Clay RV	Silt RV	Sand RV
Residential	Ultra low density	90.4	5.6	4.0	0.11	0.09	0.05
	Low density						
	typical	79.6	14.9	5.5	0.16	0.14	0.11
	connected	79.6	20.4	0	0.22	0.20	0.17
	disconnected	79.6	7.0	13.4	0.12	0.10	0.07
	Medium density						
	typical	62.3	24.2	13.5	0.26	0.23	0.19
	connected	62.3	37.7	0	0.35	0.34	0.32
	disconnected	62.3	12.8	24.9	0.19	0.14	0.11
	High density						
	typical	47.0	39.9	13.1	0.37	0.34	0.32
	connected	47.0	53.0	0	0.46	0.45	0.43
	disconnected	47.0	13.5	39.5	0.29	0.24	0.21
Commercial (shopping center)		8.28	91.72	0	0.72	0.72	0.72
Industrial		16.7	62.8	20.5	0.52	0.52	0.52

Fig. 2 (from Pitt & Vorhees, 2004)

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82

Fig. 3 (from Table 2-2a, USDA-NRCS TR-55)

Based on rainfall data from Wilmington, Dover and Georgetown, it was determined that the grand mean annual rainfall for Delaware was 43.85". Using this annual rainfall amount, the selected WinSLAMM Rv values from Figure 2 were used to calculate the annual runoff for those land use/soil conditions. The Rv values were then paired with their conjugate RCN values, which were in turn plotted against the calculated annual runoff on log-log axes. Figure 4 is a graphic of this plot.

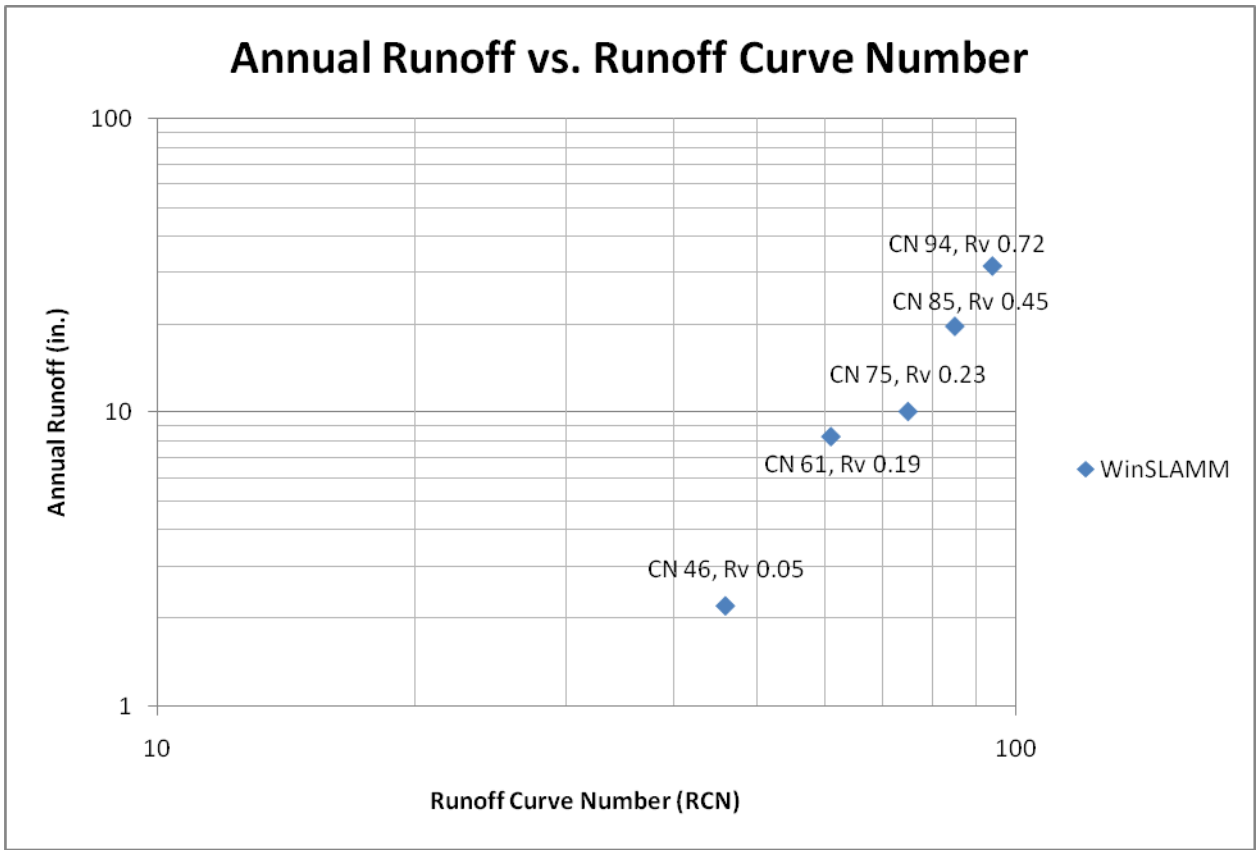


Fig. 4 Log-Log Plot of Conjugate RCN/Rv Pairs vs. Annual Runoff

A regression analysis of Runoff Curve Number vs. annual runoff was then performed using the tools contained in Microsoft Excel™. Results from this analysis are shown in Figure 5.

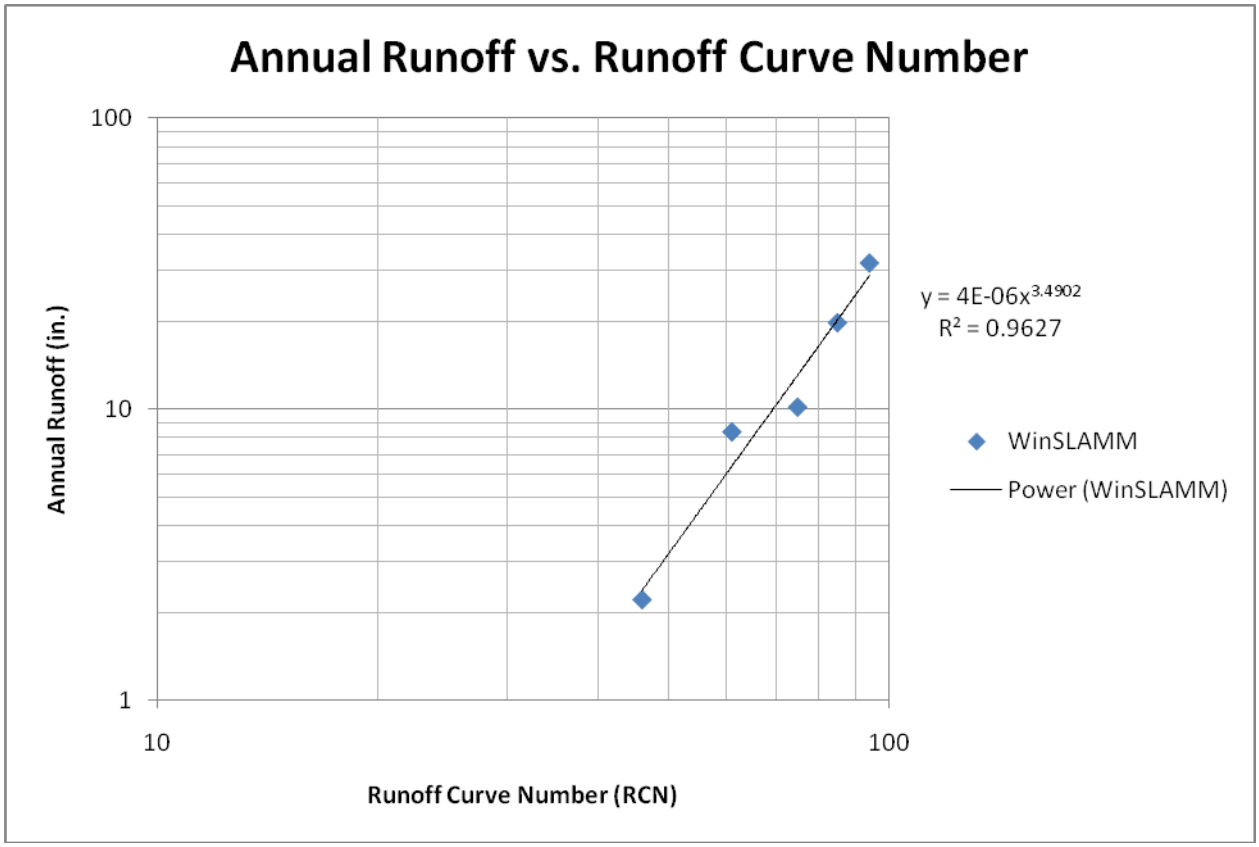


Fig. 5 Regresssion Analysis of RCN vs. Annual Runoff

It was determined that the best fit for the data was a power function of the form $y = aX^b$, where a = 4.00034E-6 and b = 3.4902. The R^2 value for the regression was 0.9627. For regulatory purposes, it was decided that using a = 4.0E-6 and b = 3.5 would yield acceptable results that were within the uncertainty of the data, while simplifying the equations. Thus the equation to be used for compliance purposes under this methodology is:

$$\text{Annual Runoff (in.)} = 0.000004(\text{RCN})^{3.5} \qquad (\textit{Equation 1})$$

Application of the Methodology

If the NRCS Runoff Curve Number is known for a given drainage subarea, Equation 1 can be used to determine the annual runoff in watershed inches. This information is of limited use, however, without the benefits of runoff reduction practices being factored in. Although there is relatively little long-term data available on the ability of these practices to reduce runoff volume, the data that are available are typically based on the percentage of annual runoff reduction. The best source for this information currently available is the Chesapeake Stormwater Network's Technical Bulletin No. 4. While this document also contains a methodology for determining the appropriate "treatment volume" for these practices based on the 90th percentile annual rainfall, it was determined that a larger percentage of the annual runoff should be targeted for management under the Delaware Sediment & Stormwater Regulations. However, the information in this document related to runoff reduction is still deemed to be appropriate, albeit at some reduced level. Figure 6 is a table which summarizes the runoff reduction capabilities of various stormwater management practices as proposed to meet the requirements of the Delaware Sediment & Stormwater Regulations. The runoff reduction allowance for retention practices is based on their storage capacity and is independent of the soil type. Practices that rely on passive infiltration and recharge have variable runoff reduction allowances based on the soil Hydrologic Soil Group (HSG).

The annual runoff reduction values from this table are used to determine the change in the annual runoff from a given drainage subarea. The adjusted Runoff Curve Number for that subarea can then be determined by rearranging Equation 1 and solving for RCN:

RCN = (Reduced Annual Runoff/0.000004) ^ (1/3.5) (*Equation 2*)

The steps required to perform the runoff reduction analysis can be summarized as follows:

Step 1: Determine annual runoff for subarea using Equation 1.

Step 2: Apply runoff reduction for selected practice based on values from Fig. 6.

Step 3: Adjust the Runoff Curve Number for the subarea using Equation 2.

This process can be repeated for other practices in a "treatment train" within the subarea. The final adjusted Runoff Curve Number can then be used in traditional hydrologic programs to route more complex sites with multiple subareas.

DURMM v.2 BMP Suite	RR, A/B Soil	RR, C/D Soil
Runoff Reduction Practices		
Urban Infiltration Practices with Sand/Vegetation (including Bioretention w/o Underdrain)	100% of Storage	100% of Storage
Urban Infiltration Practices without Sand/Vegetation	100% of Storage	100% of Storage
Bioretention with Underdrain (including planter boxes, etc.)	50% of Storage	50% of Storage
Permeable Pavement with Sand/Vegetation	100% of Storage	100% of Storage
Permeable Pavement without Sand/Vegetation	100% of Storage	100% of Storage
Vegetated Roofs	100% of Storage	100% of Storage
Rainwater Harvesting	75% of Storage	75% of Storage
Impervious Disconnection	20%	10%
Bioswale	50%	25%
Vegetated Open Channels	20%	10%
Filter Strip	20%	15%
Urban Riparian Forest Buffers	25%	15%
Urban Tree Planting	0%	0%
Soil Amendments	0%	0%
Sheetflow to Turf Open Space	40%	40%
Sheetflow to Forested Open Space	65%	40%
Wet Swales and Ephemeral Wetlands	0%	10%
Stormwater Treatment Practices		
Dry Extended Detention Basins	10%	10%
Dry Detention Ponds	0%	0%
Hydrodynamic Structures	0%	0%
Urban Filtering Practices	0%	0%
Wetlands and Wet Ponds	0%	0%
Source Control Practices		
Urban Nutrient Management	0%	0%
Street Sweeping	0%	0%
Other Practices		
Urban Stream Restoration	0%	0%

Fig. 6: Runoff Reduction Allowances for Select Stormwater Management Practices

Delaware Urban Runoff Management Model (DURMM)

The runoff reduction methodology lends itself well to the use of an automated spreadsheet solution. The DNREC Sediment & Stormwater Program has modified the DURMM spreadsheet program to include the runoff reduction procedures outlined in this guidance document. It is expected this updated version will become available upon adoption of the revised Regulations.

Runoff Reduction Methodology Caveats

- The methodology is proposed as an empirical compliance tool, not a physically-based solution of the rainfall-runoff relationship for developed sites.
- Under actual rainfall conditions, low magnitude events would be expected to be fully captured by the runoff reduction practices. However, as magnitude increases, the percentage of runoff volume captured decreases. Therefore, the runoff reduction calculated using this methodology for the Resource Protection Event should be viewed as an average value based on the annual rainfall distribution, not the reduction for a 1-YR storm event.
- The adjusted curve number (CN*) for infiltration and other retention practices having a storage component may be used for the Conveyance Event and the Flooding Event with modifications to the equations. The ability of runoff reduction practices to manage the runoff from these higher magnitude events is limited, though some nominal reduction allowance is warranted.

General Form of the Equation for Estimating Annual Runoff

The equations used in the methodology were developed specifically for use in Delaware. However, the DNREC Sediment & Stormwater Program has developed a general form of the equations that could be used in other locations assuming results can be verified under local conditions.

I. General equation for estimating annual runoff:

$$Annual\,Runoff\ (in.) = C_{Ra}(RCN)^{Exp}$$

Where:

C_{Ra} = annual runoff coefficient

RCN = NRCS runoff curve number

Exp = 3.5

II. Derivation of the annual runoff coefficient (C_{Ra}):

$$C_{Ra} = \frac{(P)(R_v)}{RCN_{R_v}{}^{3.5}}$$

Where:

P = annual precipitation (in.)

R_v = percent annual precipitation converted to runoff

RCN_{Rv} = conjugate NRCS runoff curve number at R_v

III. The analysis based on Pitt's results using WinSLAMM found that R_v = 0.85 at RCN = 98.

Substituting:

$$C_{Ra} = \frac{(P)(0.85)}{98^{3.5}}$$

References

CSN. 2009. Technical Support for the Bay-Wide Runoff Reduction Method, Version 2.0. Chesapeake Stormwater Network, CSN Technical Bulletin No. 4.

Lucas, William, 2005. "Green Technology: The Delaware Urban Runoff Management Approach. A Technical Manual for Designing Nonstructural BMPs to Minimize Stormwater Impacts from Land Development", Delaware DNREC, Dover, DE.

Pitt, R., 1998. "Small storm hydrology and why it is important for the design of stormwater control practices". In: *Advances in Modeling the Management of Stormwater Impacts, Volume 7* (W. James, ed.), Computational Hydraulics International, Guelph, Ontario and Lewis Publishers/CRC Press.

Pitt, R. and J. Voorhees. 2004. "The use of WinSLAMM to evaluate the benefits of low impact development." *Low Impact Development Conference: Putting the LID on SWM*. College Park, MD. Sept. 21-23, 2004.

USDA-NRCS, 1986. Technical Release 55, "Urban Hydrology for Small Watersheds".

APPENDIX 3.04.3

McCUEN'S CHANGE IN CURVE NUMBER METHOD

Ref: Queen Anne's County, MD; Environmental Site Design Manual (2007)

McCUEN'S CHANGE IN CURVE NUMBER METHOD*

(* Adapted from MDE 1983)

There are three different methods that can be used with the TR-20 program for modeling infiltration systems. The TR-20 methods include: 1) the change in curve number method, 2) the truncated hydrograph method, or 3) the hydrograph routing method. Method 1, the change in curve number method is described below.

Background

The method described below describes a volume based approach to control increases in discharge rates by storing the increased runoff depth due to changes in land use. This method was developed by Dr. Richard McCuen as part of the development of the Maryland Standards and Specifications for Stormwater Management Infiltration Practices (MDE 1984) and described by MDE in the publication titled, "Modelling Infiltration Practices Using TR-20) (MDE, 1983). The materials presented below have been adapted from these two publications.

Most stormwater management policies require the peak discharge for a selected return period(s). The before development peak discharge (qb) can be determined using the SCS graphical method:

$$q_b = (q_{ub})(A)(Q_b) \qquad \text{Equation 1}$$

In which q_{ub} is the unit peak discharge, in cubic feet per second per square mile per inch of runoff (csm/in.), from Exhibit 4-II, page 4-5 of the NRCS TR-55 (NRCS, 1986) based on the before development time of concentration (t_{cb}) in hours, and Q_b is the before development depth of runoff in inches, and A is the drainage area in square miles. Using a subscript "a" to indicate "after development", the after development peak discharge (q_a) is given by:

$$q_a = (q_{ua})(A)(Q_a) \qquad \text{Equation 2}$$

While the total drainage area (A) will remain constant, both the unit peak discharge (q_u) and the runoff depth (Q) will typically be greater for the after development conditions. If the development causes a decrease in the time of concentration, then the unit peak discharge will increase. Similarly, an increase in the percent of imperviousness will cause an increase in the volume of runoff. If the stormwater management policy requires qa to be equal to q_b, then the policy could be met if a difference in depths of runoff ΔQ was controlled; this is determined as follows:

$$Q_{ua}(A)(Q_a - Q_b) = q_{ub}(A)Q_b \qquad \text{Equation 3}$$

Therefore solving for ΔQ yields:

$$\Delta Q = Q_a - (q_{ub} / q_{ua})(Q_b) \qquad \text{Equation 4}$$

If there is no significant change in t_c, then (q_{ub} / q_{ua}) equals 1.0, and $\Delta Q = q_a - q_b$.
If the development increases the t_c significantly, q_{ub} will usually be less than q_{ua} and ΔQ will be greater than the difference in the runoff depth (Q_a-Q_b).

Method 1 - Change in Curve Number Method

The change in curve number method is used by reducing the after development curve number to reflect the runoff volume stored by the infiltration practices. The runoff volume stored by the infiltration practices will be the total increased runoff volume as defined by Equation 4 above, or a volume based on the size of the infiltration practices. The revised after development curve number (CN*) is determined by the following equation:

$$CN^* = 200 / [(P+2Q+2) - \sqrt{(5PQ+4Q^2)}]$$

where P is the design rainfall depth in inches, and Q is the after development runoff depth minus the runoff depth stored by the infiltration practices *(ΔQ)* in inches. The after-development hydrograph computed by the TR-20 program with the revised curve number is the downstream Q hydrograph that accounts for infiltration storage.

The revised curve number method is most applicable for cases where several Infiltration practices are distribute evenly over the drainage area. For example, the method is best applied for residential land uses where each lot may have an infiltration practice. The level of peak discharge reduction is achieved by distributing the runoff storage volume over the entire watershed area and is reflected by adjusting the curve number.

Case Study

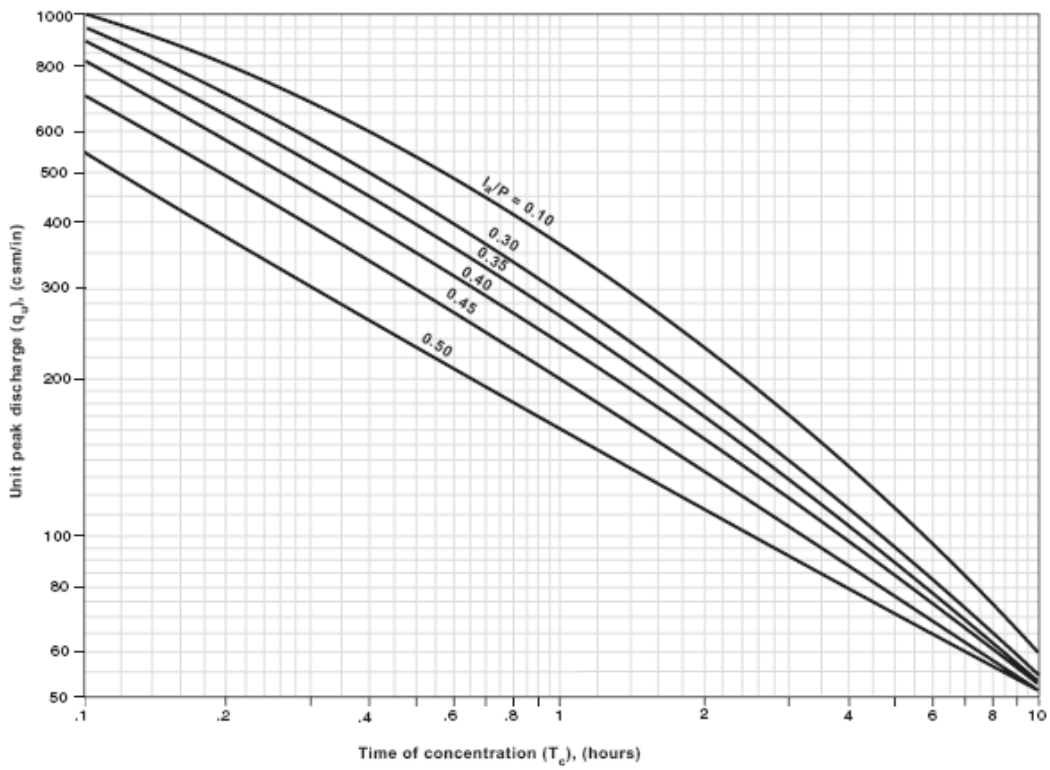
A 25 acre wooded area is to be converted to 1/4 acre residential lots. The change in curve number method will be used to determine the volume of storage required to release the 2-year pre-development discharge rate, and develop the outflow hydrograph below an infiltration basin.

Hydrologic Data
D.A. = 25 acres = 0.0390 square miles
P (2-year storm) = 3.3 inches)
CN_b = 66 t_b = 0.75 hrs
CN_a = 75 t_a = 0.37 hrs
q_{ub} = 375 csm/in (from Exhibit 4-II, page 4-5 of the NRCS TR-55 (NRCS, 1986)
q_{ua} = 590 csm/in (From Exhibit 4-II, page 4-5 of the NRCS TR-55 (NRCS, 1986)

2-Year Peak Discharges (TR-20 Program)
q_a = 23.0 cf s
q_b = 8.0 cfs (the predevelopment discharge is our goal)

Effective April 2016

Exhibit 4-II Unit peal discharge (q_u) for NRCS (SCS) type II rainfall distribution



Method 1 - Change in Curve Number Method

Step 1: Compute the increased upland runoff depth for the 2-year storm.

$Q = Q_a - (q_{ub} / q_{ua})Q_b$

$Q = 1.16 - (375 / 590)\ (0.69) = 0.72$ inches

The infiltration basin is sized to store 0.72 inches (65,340 ft3)of runoff.

Step 2 : Compute the adjusted curve number (CN*) associated with the revised after development runoff depth (Q).

$Q = 1.16 - 0.72 = 0.44$ inches

$CN^* = 200 / [(P+2Q+2) - \sqrt{(5PQ + 4Q^2)}$

$CN^* = 200 / [(3.3+2(.44)+2) - \sqrt{(5(3.3)(.44) + 4(.44)^2)}$

$CN^* = 59.78$

Step 3 - Compute the revised peak discharge and outflow hydrograph from the TR-20 Program.

Input: D.A. = 0.0390 square miles

CN* = 59. 78

t_c = 0.37 hrs

P = 3.3 inches

Output: q_a (with infiltration basin) = 6.1 cfs

See Figure 1 for the resultant outflow hydrograph.

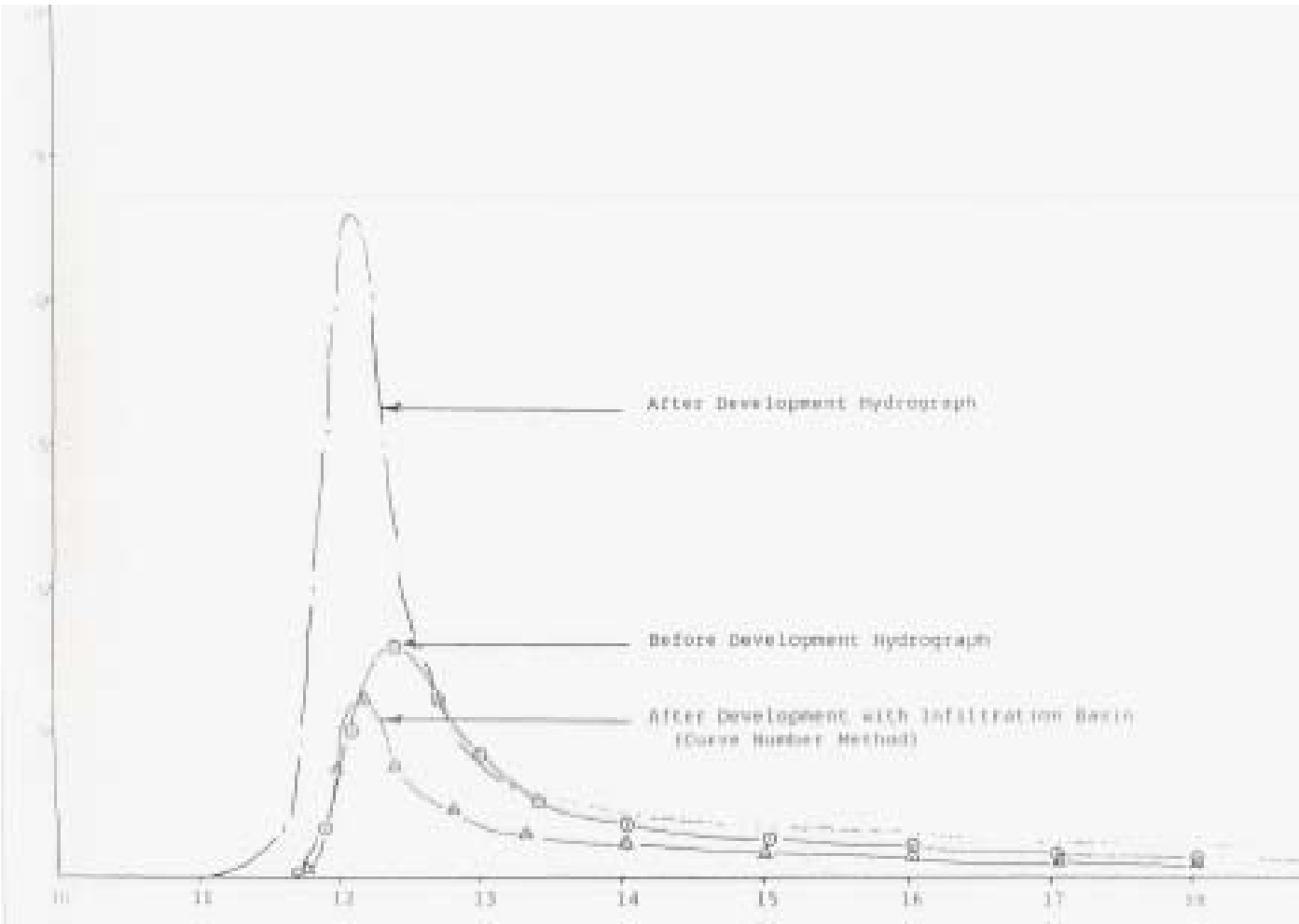


Figure 1 Change in Curve Number Method

PROJECT:
DRAINAGE SUBAREA ID:
LOCATION (County):
UNIT HYDROGRAPH:

CONTRIBUTING AREA RUNOFF CURVE NUMBER (C.A. RCN) WORKSHEET

Cover Type	Treatment	Hydrologic Condition	Curve Numbers for Hydrologic Soil Type: A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
CULTIVATED AGRICULTURAL LANDS										
Fallow	Bare soil	----		77		86		91		94
	Crop residue (CR)	poor		76		85		90		93
	Crop residue (CR)	good		74		83		88		90
Row Crops	Straight row (SR)	poor		72		81		88		91
	Straight row (SR)	good		67		78		85		89
	SR + Crop residue	poor		71		80		87		90
	SR + Crop residue	good		64		75		82		85
	Contoured (C)	poor		70		79		84		88
	Contoured (C)	good		65		75		82		86
	C + Crop residue	poor		69		78		83		87
	C + Crop residue	good		64		74		81		85
	Cont & terraced(C&T)	poor		66		74		80		82
	Cont & terraced(C&T)	good		62		71		78		81
	C&T + Crop residue	poor		65		73		79		81
	C&T + Crop residue	good		61		70		77		80
Small Grain	Straight row (SR)	poor		65		76		84		88
	Straight row (SR)	good		63		75		83		87
	SR + Crop residue	poor		64		75		83		86
	SR + Crop residue	good		60		72		80		84
	Contoured (C)	poor		63		74		82		85
	Contoured (C)	good		61		73		81		84
	C + Crop residue	poor		62		73		81		84
	C + Crop residue	good		60		72		80		83
	Cont & terraced(C&T)	poor		61		72		79		82
	Cont & terraces(C&T)	good		59		70		78		81
	C&T + Crop residue	poor		60		71		78		81
	C&T + Crop residue	good		58		69		77		80
Close-seeded	Straight row	poor		66		77		85		89
or broadcast	Straight row	good		58		72		81		85
legumes or	Contoured	poor		64		75		83		85
rotation	Contoured	good		55		69		78		83
meadow	Cont & terraced	poor		63		73		80		83
	Cont & terraced	good		51		67		76		80
OTHER AGRICULTURAL LANDS										
	Pasture, grassland or range	poor		68		79		86		89
		fair		49		69		79		84
		good		39		61		74		80
	Meadow -cont. grass (non grazed)	----		30		58		71		78
	Brush - brush, weed, grass mix	poor		48		67		77		83
		fair		35		56		70		77
		good		30		48		65		73
	Woods - grass combination	poor		57		73		82		86
		fair		43		65		76		82
		good		32		58		72		79
	Woods	poor		45		66		77		83
		fair		36		60		73		79
		good		30		55		70		77
	Farmsteads	----		59		74		82		86
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%			39		61		74		80
Impervious Areas										
	Paved parking lots, roofs, driveways			98		98		98		98
	Streets and roads									
	Paved; curbs and storm sewers			98		98		98		98
	Paved; open ditches (w/right-of-way)			83		89		92		93
	Gravel (w/ right-of-way)			76		85		89		91
	Dirt (w/ right-of-way)			72		82		87		89
Urban Districts		Avg % impervious								
	Commercial & business	85		89		92		94		95
	Industrial	72		81		88		91		93
Residential districts by average lot size		Avg % impervious								
	1/8 acre (town houses)	65		77		85		90		92
	1/4 acre	38		61		75		83		87
	1/3 acre	30		57		72		81		86
	1/2 acre	25		54		70		80		85
	1 acre	20		51		68		79		84
	2 acre	12		46		65		77		82
DEVELOPING URBAN AREA (No Vegetation)										
	Newly graded area (pervious only)			77		86		91		94
USER DEFINED										

Subarea Contributing Area per Soil Type (ac) 0 0 0 0

Subarea Contributing Area (ac) 0
Subarea Weighted RCN 0

UPSTREAM CONTRIBUTING AREAS

Upstream Contributing Area 1		
Upstream Contributing Area 2		
Upstream Contributing Area 3		
Upstream Contributing Area 4		

Total Contributing Area w. Upstream Areas (ac) 0

Weighted Runoff Curve Number (RCN) 0

Effective April 2016

PROJECT:	0
DRAINAGE SUBAREA ID:	0
LOCATION (County):	0
UNIT HYDROGRAPH:	0

LIMIT OF DISTURBANCE (LOD) WORKSHEET

Step 1 - Subarea LOD Data	**HSG A**	**HSG B**	**HSG C**	**HSG D**
1.1 HSG Area Within LOD (ac)				
1.2 Pre-Developed Woods/Meadow Within LOD (ac)				
1.3 Pre-Developed Impervious Within LOD (ac)				
1.4.a Post-Developed Imperviousness Within LOD, Option #1 (ac); ***OR***				
1.4.b Post-Developed Imperviousness Within LOD, Option #2 (%)	0%	0%	0%	0%

Step 2 - Subarea LOD Runoff Calculations				
2.1 RCN per HSG	0.00	0.00	0.00	0.00
2.2 RPv per HSG (in.)	0.00	0.00	0.00	0.00
2.3 Target Runoff per HSG (in.)	0.00	0.00	0.00	0.00
2.4 Cv Weighted Unit Discharge per HSG (cfs/ac)	0.00	0.00	0.00	0.00
2.5 Fv Weighted Unit Discharge per HSG (cfs/ac)	0.00	0.00	0.00	0.00

2.6 Subarea LOD (ac)	0.00
2.7 Subarea Weighted RCN	0.00
2.8 Subarea Weighted RPv (in.)	0.00
2.9 Subarea Weighted Target Runoff (in.)	0.00

Step 3 - Upstream LOD Areas ***(from previous DURMM Report as applicable)***	**Area 1**	**Area 2**	**Area 3**	**Area 4**
3.1 Upstream Sub-Area ID				
3.2 Upstream LOD Area (ac)				
3.3 Target Runoff for Upstream Area (in.)				
3.4 Adjusted CN after all reductions				
3.5 Adjusted RPv (in.)				
3.6 Adjusted Cv (in.)				
3.7 Adjusted Fv (in.)				

Step 4 - RPv Calculations for Combined LOD	
4.1 Combined LOD (ac)	0.00
4.2 Weighted RCN	#DIV/0!
4.3 Weighted RPv (in.)	#DIV/0!
4.4 Weighted Target Runoff (in.)	#DIV/0!
4.5 Estimated Annual Runoff (in.)	#DIV/0!
4.6 Req'd Runoff Reduction within LOD (in.)	#DIV/0!
4.7 Req'd Runoff Reduction within LOD (%)	#DIV/0!

Step 5 - Cv Unit Discharge	
5. LOD Allowable Unit Discharge (cfs/ac)	#DIV/0!

Step 6 - Fv Unit Discharge	
6. LOD Allowable Unit Discharge (cfs/ac)	#DIV/0!

PROJECT:	0
DRAINAGE SUBAREA ID:	0
LOCATION (County):	0
UNIT HYDROGRAPH:	0

OUTSIDE LIMIT OF DISTURBANCE (OLOD) WORKSHEET

Step 1 - Site Data

1.1 Total Contributing Area (ac)	N/A
1.2 C.A. RCN	N/A
1.3 LOD Area (ac)	N/A
1.4 LOD RCN	N/A
1.5 Outside LOD Area (ac)	N/A
1.6 Outside LOD RCN	N/A

Step 2 - Time of Concentration

FLOW TYPE	2.1 LENGTH (feet)	2.2 SLOPE (ft./ft.)	2.3 SURFACE CODE	2.4 MANNINGS "n"	2.5 VELOCITY (ft./sec.)	2.6 TRAVEL TIME (hrs)
Sheet				----------	N/A	0.00
				----------	N/A	0.00
				----------	N/A	0.00
Shallow Concentrated				N/A	----------	0.00
				N/A	----------	0.00
				N/A	----------	0.00
Open Channel			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00

2.7 Time of Concentration (Tc) 0.10

Sheet Flow Surface Codes

a smooth surface
b fallow (no residue)
c cultivated < 20% Res.
d cultivated > 20% Res.
e grass - range, short
f grass, dense
g grass, bermuda
h woods, light
i woods, dense
j range, natural

Shallow Concentrated Surface Codes

u unpaved surface
p paved surface

Step 3 - Peak Discharge

3.1 Unit Hydrograph Type	0	
3.2 Frequency (yr)	10	100
3.3 24-HR Rainfall, P (in.)	#N/A	#N/A
3.4 Initial Abstraction, Ia (in.)	#N/A	#N/A
3.5 Ia/P ratio	#N/A	#N/A
3.6 Unit Peak Discharge, qu (csm/in)	#N/A	#N/A
3.7 Runoff (in.)	#N/A	#N/A
3.8 Peak Discharge, qp (cfs)	#VALUE!	#VALUE!
3.9 Equiv. unit peak discharge (cfs/ac)	0.00	0.00

PROJECT:	0
DRAINAGE SUBAREA ID:	0
LOCATION (County):	0

RESOURCE PROTECTION EVENT (RPv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type	--	Type	--	Type	--	Type	--	Type	--
Step 1 - Calculate Initial RPv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	0.00		0.00		0.00		0.00		0.00	
1.2 Equivalent TR-55 RCN for H&H modeling **before BMP**	N/A		N/A		N/A		N/A		N/A	
1.3 Initial RCN	#DIV/0!									
1.4 RPv for Contributing Area (in.)	#DIV/0!									
1.5 Req'd RPv Reduction for Contributing Area (in.)	#DIV/0!									
1.6 Req'd RPv Reduction for Contributing Area (%)	#DIV/0!									
1.7 RPv allowable discharge rate (cfs)	#DIV/0!									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)										
2.2 Retention reduction allowance (%)	N/A		N/A		N/A		N/A		N/A	
2.3 Retention reduction volume (ac-ft)	N/A		N/A		N/A		N/A		N/A	
2.4 Retention reduction volume (in.)	N/A		N/A		N/A		N/A		N/A	
2.5 Runoff volume after retention reduction (in.)	N/A		N/A		N/A		N/A		N/A	
2.6 Adjusted CN*	N/A		N/A		N/A		N/A		N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Annual CN (ACN)	#DIV/0!		N/A		N/A		N/A		N/A	
3.2 Annual runoff (in.)	#DIV/0!		N/A		N/A		N/A		N/A	
3.3 Proportion A/B soils in BMP footprint (%)	0%		0%		0%		0%		0%	
3.4 Annual runoff reduction allowance (%)	N/A		N/A		N/A		N/A		N/A	
3.5 Annual runoff after reduction (in.)	N/A		N/A		N/A		N/A		N/A	
3.6 Adjusted ACN	N/A		N/A		N/A		N/A		N/A	
3.7 Annual Runoff Reduction Allowance for RPv (in.)	N/A		N/A		N/A		N/A		N/A	
Step 4 - Calculate RPv with BMP Reductions										
4.1 RPv runoff volume after all reductions (in.)	N/A		N/A		N/A		N/A		N/A	
4.2 RPv runoff volume after all reductions (cu.ft.)	N/A		N/A		N/A		N/A		N/A	
4.3 Total RPv runoff reduction (in.)	N/A		N/A		N/A		N/A		N/A	
4.4 Total RPv runoff reduction (%)	N/A		N/A		N/A		N/A		N/A	
4.5 Adjusted CN after all reductions	N/A		N/A		N/A		N/A		N/A	
4.6 Adjusted equivalent annual runoff (in.)	N/A		N/A		N/A		N/A		N/A	
4.7 Equivalent TR-55 RCN for H&H modeling **after BMP**	N/A		N/A		N/A		N/A		N/A	
4.8 Required reduction met?	N/A		N/A		N/A		N/A		N/A	
4.9 If required reduction met, reduction credit (cu.ft)	N/A		N/A		N/A		N/A		N/A	
Step 5 - Determine Runoff Reduction Shortfall										
5.1 Runoff Reduction Shortfall (in.)	N/A		N/A		N/A		N/A		N/A	
5.2 Runoff Reduction Shortfall (cu.ft./ac)	N/A		N/A		N/A		N/A		N/A	
5.3 Total Shortfall Volume (cu.ft.)	N/A		N/A		N/A		N/A		N/A	

PROJECT:	0
DRAINAGE SUBAREA ID:	0
LANDUSE TYPE:	
TMDL WATERSHED:	

TOTAL MAXIMUM DAILY LOAD (TMDL) WORKSHEET

	BMP 1				BMP 2				BMP 3				BMP 4				BMP 5			
	Type:	--			Type:	--			Type:	--			Type:	--			Type:	--		
Step 1 - Calculate Annual Runoff Volume	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS
1.1 Total contributing area to BMP (ac)	0.00																			
1.2 Initial RCN	#DIV/0!																			
1.3 Annual runoff volume (in.)	#DIV/0!																			
1.4 Annual runoff volume (liters)	#DIV/0!																			
Step 2 - Calculate Annual Pollutant Load																				
2.1 EMC (mg/L)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
2.2 Load (mg/yr)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
2.3 Stormwater Load (lb/ac/yr)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
Step 3 - Adjust for Pollutant Reduction																				
3.1 BMP annual runoff reduction (%)	N/A				N/A				N/A				N/A				N/A			
3.2 Adjusted annual runoff volume (in)	N/A				N/A				N/A				N/A				N/A			
3.3 Adjusted annual runoff volume (liters)	N/A				N/A				N/A				N/A				N/A			
3.4 Adjusted load from annual reductions (lb/ac/yr)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
3.5 BMP removal efficiency (%)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
3.6 Treatment train removal efficiency (%)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
3.7 BMP effluent concentration (mg/L)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
3.8 Final Adjusted load (lb/ac/yr)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
3.9 Final Adjusted load (lb/yr)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
Step 4 - Pollutant Reduction Met? *(For Informational Purposes)*																				
4.1 TMDL (lb/ac/yr)		#N/A	#N/A	#N/A																
4.2 Reduction met?		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A
4.3 Removed Load (lb/yr)		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A

PROJECT:	0
DRAINAGE SUBAREA ID:	0
LOCATION (County):	0

CONVEYANCE EVENT (Cv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	--	**Type:**	--	**Type:**	--	**Type:**	--	**Type:**	--
Step 1 - Calculate Initial Cv	**Data**		**Data**		**Data**		**Data**		**Data**	
1.1 Total contributing area to BMP (ac)	0.00		0.00		0.00		0.00		0.00	
1.2 Initial RCN	#DIV/0!									
1.3 10-Year Rainfall (in.)	#N/A									
1.4 Cv runoff volume (in.)	#N/A									
1.5 LOD allowable unit discharge (cfs/ac)	#DIV/0!									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Cv allowable discharge rate (cfs)	#DIV/0!									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	N/A		N/A		N/A		N/A		N/A	
2.2 Storage volume (ac-ft)	N/A		N/A		N/A		N/A		N/A	
2.3 Storage volume (in.)	N/A		N/A		N/A		N/A		N/A	
2.4 Runoff volume after reduction (in.)	N/A		N/A		N/A		N/A		N/A	
2.5 CN*	N/A		N/A		N/A		N/A		N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	N/A		N/A		N/A		N/A		N/A	
3.2 Annual runoff after reduction (in.)	N/A		N/A		N/A		N/A		N/A	
3.3 Adjusted ACN	N/A		N/A		N/A		N/A		N/A	
3.4 Event-based runoff reduction (in.)	N/A		N/A		N/A		N/A		N/A	
Step 4 - Calculate Cv with BMP Reductions										
4.1 Cv runoff volume after all reductions (in.)	N/A		N/A		N/A		N/A		N/A	
4.2 Total Cv runoff reduction (%)	N/A		N/A		N/A		N/A		N/A	
4.3 Adjusted RCN for H&H modeling	N/A		N/A		N/A		N/A		N/A	

PROJECT:	0
DRAINAGE SUBAREA ID:	0
LOCATION (County):	0

FLOODING EVENT (Fv) WORKSHEET

	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	--	**Type:**	--	**Type:**	--	**Type:**	--	**Type:**	--
Step 1 - Calculate Initial Fv	**Data**		**Data**		**Data**		**Data**		**Data**	
1.1 Total contributing area to BMP (ac)	0.00		0.00		0.00		0.00		0.00	
1.2 Initial RCN	#DIV/0!									
1.3 100-Year Rainfall (in.)	#N/A									
1.4 Fv runoff volume (in.)	#N/A									
1.5 LOD allowable unit discharge (cfs/ac)	#DIV/0!									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Fv allowable discharge rate (cfs)	#DIV/0!									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	N/A		N/A		N/A		N/A		N/A	
2.2 Storage volume (ac-ft)	N/A		N/A		N/A		N/A		N/A	
2.3 Storage volume (in.)	N/A		N/A		N/A		N/A		N/A	
2.4 Runoff volume after reduction (in.)	N/A		N/A		N/A		N/A		N/A	
2.5 CN*	N/A		N/A		N/A		N/A		N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	N/A		N/A		N/A		N/A		N/A	
3.2 Annual runoff after reduction (in.)	N/A		N/A		N/A		N/A		N/A	
3.3 Adjusted ACN	N/A		N/A		N/A		N/A		N/A	
3.4 Event-based runoff reduction (in.)	N/A		N/A		N/A		N/A		N/A	
Step 4 - Calculate Fv with BMP Reductions										
4.1 Fv runoff volume after all reductions (in.)	N/A		N/A		N/A		N/A		N/A	
4.2 Total Fv runoff reduction (%)	N/A		N/A		N/A		N/A		N/A	
4.3 Adjusted RCN for H&H modeling	N/A		N/A		N/A		N/A		N/A	

PROJECT:	0		
DRAINAGE SUBAREA ID:	0		
COUNTY:	0	**UNIT HYDROGRAPH:**	0
TMDL Watershed:	0	**LANDUSE:**	0

DURMM OUTPUT WORKSHEET **DURMM v2.00.150120**

Site Data

Contributing Area to BMPs (ac.)	0.00			
C.A. RCN	0.00			
Subarea LOD (ac.)	0.00			
Subarea RCN	0.00			
Upstream Subarea ID				
Upstream Subarea LOD (ac.)	0.00	0.00	0.00	0.00
Combined LOD with Upstream Areas (ac.)	0.00			
Combined RCN with Upstream Areas (ac.)	#DIV/0!			
Watershed TMDL-TN (lb/ac/yr)	#N/A			
Watershed TMDL-TP (lb/ac/yr)	#N/A			
Watershed TMDL-TSS (lb/ac/yr)	#N/A			

BMP Data	**BMP 1**	**BMP 2**	**BMP 3**	**BMP 4**	**BMP 5**
	--	--	--	--	--
RPv runoff volume after all reductions (in.)	N/A	N/A	N/A	N/A	N/A
Total RPv runoff reduction (in.)	N/A	N/A	N/A	N/A	N/A
Total RPv runoff reduction (%)	N/A	N/A	N/A	N/A	N/A
Req'd runoff reduction met?	N/A	N/A	N/A	N/A	N/A
RPv Offset Volume (cu. ft.)	N/A	N/A	N/A	N/A	N/A
Adjusted pollutant load, TN (lb/ac/yr)	N/A	N/A	N/A	N/A	N/A
Adjusted pollutant load, TP (lb/ac/yr)	N/A	N/A	N/A	N/A	N/A
Adjusted pollutant load, TSS (lb/ac/yr)	N/A	N/A	N/A	N/A	N/A
Cv runoff volume after all reductions (in.)	N/A	N/A	N/A	N/A	N/A
Fv runoff volume after all reductions (in.)	N/A	N/A	N/A	N/A	N/A

Resource Protection Event (RPV)

RPv for Contributing Area (in.)	#DIV/0!	
Annual Runoff for Contributing Area (in.)	#DIV/0!	
Req'd RPv Reduction for Contributing Area (in.)	#DIV/0!	
Req'd RPv Reduction for Contributing Area (%)	#DIV/0!	
RPv Runoff Reduction Shortfall or Credit (cu.ft.)	0.00	CREDIT
C.A. allowable discharge rate (cfs)	#DIV/0!	
Adjusted CN after all reductions	0.00	
Equivalent RCN for H&H Modeling	0.00	

Conveyance Event (Cv)

Cv runoff volume (in.)	#N/A
Stds-based allowable discharge (cfs)	#DIV/0!
Equivalent RCN for H&H Modeling	0.00

Flooding Event (Fv)

Fv runoff volume (in.)	#N/A
Stds-based allowable discharge (cfs)	#DIV/0!
Equivalent RCN for H&H Modeling	0.00

Adjusted Subarea Data for Downstream DURMM Modeling

Subarea ID	0.00
Contributing Area (ac.)	0.00
C.A. RCN	0.00
LOD Area (ac.)	0.00
Weighted Target Runoff (in.)	#DIV/0!
Adjusted CN after all reductions	0.00
Adjusted RPv (in.)	0.00
Adjusted Cv (in.)	0.00
Adjusted Fv (in.)	0.00

Adjusted Subarea Data for Nutrient Protocol Modeling

Contributing Area (ac.)	0.00
LOD Area (ac.)	0.00
TN Pollutant Load (lb/yr)	0.00
TP Pollutant Load (lb/yr)	0.00
TSS Pollutant Load (lb/yr)	0.00
Percent Impervious Cover	#DIV/0!

Adjusted Subarea Data for the Summary Table for Sub-Areas Draining to a Common Point of Interest

Subarea ID	0.00	
Contributing Area (ac.)	0.00	
Runoff Reduction Shortfall or Credit (cu.ft.)	0.00	CREDIT
Adjusted CN after all reductions	0.00	
Cv RCN for H&H Modeling	0.00	
Fv RCN for H&H Modeling	0.00	
TN Pollutant Load (lb/yr)	0.00	
TP Pollutant Load (lb/yr)	0.00	
TSS Pollutant Load (lb/yr)	0.00	

Class	BMP Category	DURMM Variant	TN Reduction	TP Reduction	TSS Reduction	Retention Allowable	Annual Runoff Reduction, RPv, A/B Soil	Annual Runoff Reduction, RPv, C/D Soil	Runoff Reduction, Cv	Runoff Reduction, Fv
No BMP	N/A	0-No BMP	0%	0%	0%	0%	0%	0%	0%	0%
Retention Practice	1.0 Infiltration	1-A Infiltration Trench	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	1.0 Infiltration	1-B Infiltration Basin	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	1.0 Infiltration	1-C Underground Infiltration	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-A Traditional Bioretention - Underdrain	30% Removal Efficiency (+ 100% of Load Reduction)	40% Removal Efficiency (+ 100% of Load Reduction)	80% Removal Efficiency (+ 100% of Load Reduction)	50%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-A Traditional Bioretention - Infiltration	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-B In-Situ Bioretention - Underdrain	30% Removal Efficiency (+ 100% of Load Reduction)	40% Removal Efficiency (+ 100% of Load Reduction)	80% Removal Efficiency (+ 100% of Load Reduction)	50%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-B In-Situ Bioretention - Infiltration	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-C Streetscape Bioretention - Underdrain	30% Removal Efficiency (+ 100% of Load Reduction)	40% Removal Efficiency (+ 100% of Load Reduction)	80% Removal Efficiency (+ 100% of Load Reduction)	50%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-C Streetscape Bioretention - Infiltration	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-D Engineered Tree Pits - Underdrain	30% Removal Efficiency (+ 100% of Load Reduction)	40% Removal Efficiency (+ 100% of Load Reduction)	80% Removal Efficiency (+ 100% of Load Reduction)	50%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-D Engineered Tree Pits - Infiltration	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-E Stormwater Planters - Underdrain	30% Removal Efficiency (+ 100% of Load Reduction)	40% Removal Efficiency (+ 100% of Load Reduction)	80% Removal Efficiency (+ 100% of Load Reduction)	50%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-E Stormwater Planters - Infiltration	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-F Advanced Bioretention - Underdrain	30% Removal Efficiency (+ 100% of Load Reduction)	40% Removal Efficiency (+ 100% of Load Reduction)	80% Removal Efficiency (+ 100% of Load Reduction)	50%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	2.0 Bioretention	2-F Advanced Bioretention - Infiltration	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	3.0 Permeable Pavement	3-A Porous Asphalt (PA)	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	3.0 Permeable Pavement	3-B Pervious Concrete (PC)	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	3.0 Permeable Pavement	3-C Permeable Concrete Pavers (PP) & (CP)	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	3.0 Permeable Pavement	3-D Plastic & Composite Grid Pavers (GP)	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	100%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Annual Runoff Reduction Practice	4.0 Vegetated Roofs	4-A Extensive Vegetated Roofs	100% of Load Reduction	100% of Load Reduction	0% of Load Reduction	0%	50% Annual RR	0% Annual RR	5% Runoff Reduction	1% Runoff Reduction
Annual Runoff Reduction Practice	4.0 Vegetated Roofs	4-B Intensive Vegetated Roofs	100% of Load Reduction	100% of Load Reduction	0% of Load Reduction	0%	75% Annual RR	0% Annual RR	8% Runoff Reduction	2% Runoff Reduction
Retention Practice	5.0 Rainwater Harvesting	5-A Seasonal Rainwater Harvesting	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	50%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Retention Practice	5.0 Rainwater Harvesting	5-B Continuous Rainwater Harvesting	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	75%	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage	0% of Retention Storage
Annual Runoff Reduction Practice	6.0 Restoration Practices	6-A Step Pool RSCS	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	6.0 Restoration Practices	6-B Seepage Wetland RSCS	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	6.0 Restoration Practices	6-C Streambank Stabilization	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	7.0 Rooftop Disconnection	7-A Rooftop Disconnection	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	25% Annual RR	10% Annual RR	1% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	8.0 Vegetated Channels	8-A Bioswale	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	50% Annual RR	25% Annual RR	2% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	8.0 Vegetated Channels	8-B Grassed Channel	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	20% Annual RR	10% Annual RR	1% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	9.0 Sheet Flow	9-A Sheet Flow to Turf Filter Strip	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	25% Annual RR	10% Annual RR	10% of RPv Allowance	1% of RPv Allowance
Annual Runoff Reduction Practice	9.0 Sheet Flow	9-A Sheet Flow to Forested Filter Strip	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	40% Annual RR	20% Annual RR	10% of RPv Allowance	1% of RPv Allowance
Annual Runoff Reduction Practice	9.0 Sheet Flow	9-B Sheet Flow to Turf Open Space	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	50% Annual RR	20% Annual RR	10% of RPv Allowance	1% of RPv Allowance
Annual Runoff Reduction Practice	9.0 Sheet Flow	9-B Sheet Flow to Forested Open Space	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	65% Annual RR	40% Annual RR	10% of RPv Allowance	1% of RPv Allowance
Stormwater Treatment Practice	10.0 Detention Practices	10-A Dry Detention Pond	5% Removal Efficiency	10% Removal Efficiency	10% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	10.0 Detention Practices	10-B Dry Extended Detention (ED) Pond	20% Removal Efficiency	20% Removal Efficiency	60% Removal Efficiency	0%	10% Annual RR	10% Annual RR	1% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	10.0 Detention Practices	10-C Underground Detention Facilities	5% Removal Efficiency	10% Removal Efficiency	10% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	11.0 Stormwater Filtering Systems	11-A Non-Structural Sand Filter	40% Removal Efficiency	60% Removal Efficiency	80% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	11.0 Stormwater Filtering Systems	11-B Surface Sand Filter	40% Removal Efficiency	60% Removal Efficiency	80% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	11.0 Stormwater Filtering Systems	11-C 3-Chamber Underground Sand Filter	40% Removal Efficiency	60% Removal Efficiency	80% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	11.0 Stormwater Filtering Systems	11-D Perimeter Sand Filter (DE Sand Filter)	40% Removal Efficiency	60% Removal Efficiency	80% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	12.0 Wetlands	12-A Traditional Constructed Wetlands	30% Removal Efficiency	40% Removal Efficiency	80% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	12.0 Wetlands	12-B Wetland Swales	20% Removal Efficiency (+ 100% of Load Reduction)	30% Removal Efficiency (+ 100% of Load Reduction)	60% Removal Efficiency (+ 100% of Load Reduction)	0%	15% Annual RR	10% Annual RR	1% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	12.0 Wetlands	12-C Ephemeral Constructed Wetlands	20% Removal Efficiency (+ 100% of Load Reduction)	30% Removal Efficiency (+ 100% of Load Reduction)	60% Removal Efficiency (+ 100% of Load Reduction)	0%	40% Annual RR	10% Annual RR	1% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	12.0 Wetlands	12-D Submerged Gravel Wetlands	0% Removal Efficiency	0% Removal Efficiency	0% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	13.0 Wet Pond	13-A Wet Pond	20% Removal Efficiency	45% Removal Efficiency	60% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	13.0 Wet Pond	13-B Wet Extended Detention (ED) Pond	20% Removal Efficiency	45% Removal Efficiency	60% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	14.0 Soil Amendments	14-A Compost Amended Soil - HSG A	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	38% Annual RR	0% Annual RR	4% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	14.0 Soil Amendments	14-B Compost Amended Soil - HSG B	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	50% Annual RR	0% Annual RR	5% Runoff Reduction	1% Runoff Reduction
Annual Runoff Reduction Practice	14.0 Soil Amendments	14-C Compost Amended Soil - HSG C	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	0% Annual RR	29% Annual RR	3% Runoff Reduction	0% Runoff Reduction
Annual Runoff Reduction Practice	14.0 Soil Amendments	14-D Compost Amended Soil - HSG D	100% of Load Reduction	100% of Load Reduction	100% of Load Reduction	0%	0% Annual RR	13% Annual RR	1% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	15.0 Proprietary Practices	15-A Hydrodynamic Structures	5% Removal Efficiency	10% Removal Efficiency	10% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	16.0 Source Controls	16-A Nutrient Management	17% Removal Efficiency	22% Removal Efficiency	0% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction
Stormwater Treatment Practice	16.0 Source Controls	16-B Street Sweeping	3% Removal Efficiency	3% Removal Efficiency	9% Removal Efficiency	0%	0% Annual RR	0% Annual RR	0% Runoff Reduction	0% Runoff Reduction

Effective April 2016

Summary Table for Sub-Areas Draining to a Common Point of Interest (POI)[1]

POI: _____

Ref. #	Sub-Area ID[2]	Contributing Area (ac)	RPv Runoff Reduction Shortfall(+) or Credit(-) (cu.ft.)[3]	Adjusted RPv CN after all reductions[4]	Cv RCN for H&H Modeling[4]	Fv RCN for H&H Modeling[4]	TN Pollutant Load (lb/yr)	TP Pollutant Load (lb/yr)	TSS Pollutant Load (lb/yr)
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
Totals to Common POI		**0.00 ac**	**0 cu.ft.**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.00 lb/yr**	**0.00 lb/yr**	**0.00 lb/yr**
RPv Runoff Reduction Goal Met?			**YES**						
If Not, Total Offset Volume Required			**N/A**						

Notes:

1. As long as the site lies within the same watershed, all sub-areas within the site can be tallied to reflect global site conditions; or, the summary table can be used to show conditions to a specific POI.
2. Only the most downstream sub-area information should be entered for a series of sub-areas that drain directly into each other, as the upstream areas will already be accounted for in the DURMM computations.
3. A RPv runoff reduction shortfall should be entered as a positive number, as it is the runoff volume still needed to be reduced. A RPv credit should be entered as a negative number, as it indicates the additional volume that was reduced past the requirement.
4. To portray an accurate total weighted CN value for the RPv, Cv and Fv events, an entry must be made for every defined sub-area. If a sub-area's contributing drainage acreage is entered, but not its corresponding CN value, then the total weighted CN will be skewed.

Delaware Urban Runoff Management Model DURMM v2

Quick-Start Guide

Introduction

This Quick-Start Guide has been developed as an overview of the basic use of the 2nd version of the Delaware Urban Runoff Management Model (DURMM). It is not intended to serve as a detailed description of each cell in the spreadsheet or the algorithms used in those cells. A separate User's Guide has been developed to serve that purpose. The Quick-Start Guide first describes the general workflow and data input, then continues with two examples illustrating typical uses of the model to meet the requirements of the Delaware Sediment & Stormwater Regulations (DSSR).

NOTE: This Quick-Start Guide was created for an earlier version of DURMM v2. Although some of the screen shots do not exactly match the latest version, the procedures remain the same.

Comparison: DURMM REL 1.1 vs. DURMM v.2

DURMM REL 1.1

- Event-based only
- Pre- vs. Post-developed comparison
- Impervious runoff & pervious runoff calculated separately
- BMP designer
- No ability to link BMPs
- Compliance based on 80% reduction of TSS

DURMM v.2

- Capable of estimating event & annual runoff
- Post-dev. condition only
- Single regression curve used to calculate runoff using composite RCN
- Compliance tool only
- "Treatment train"
- Compliance based on:
  - 0% Effective Impervious
  - TMDL Reduction

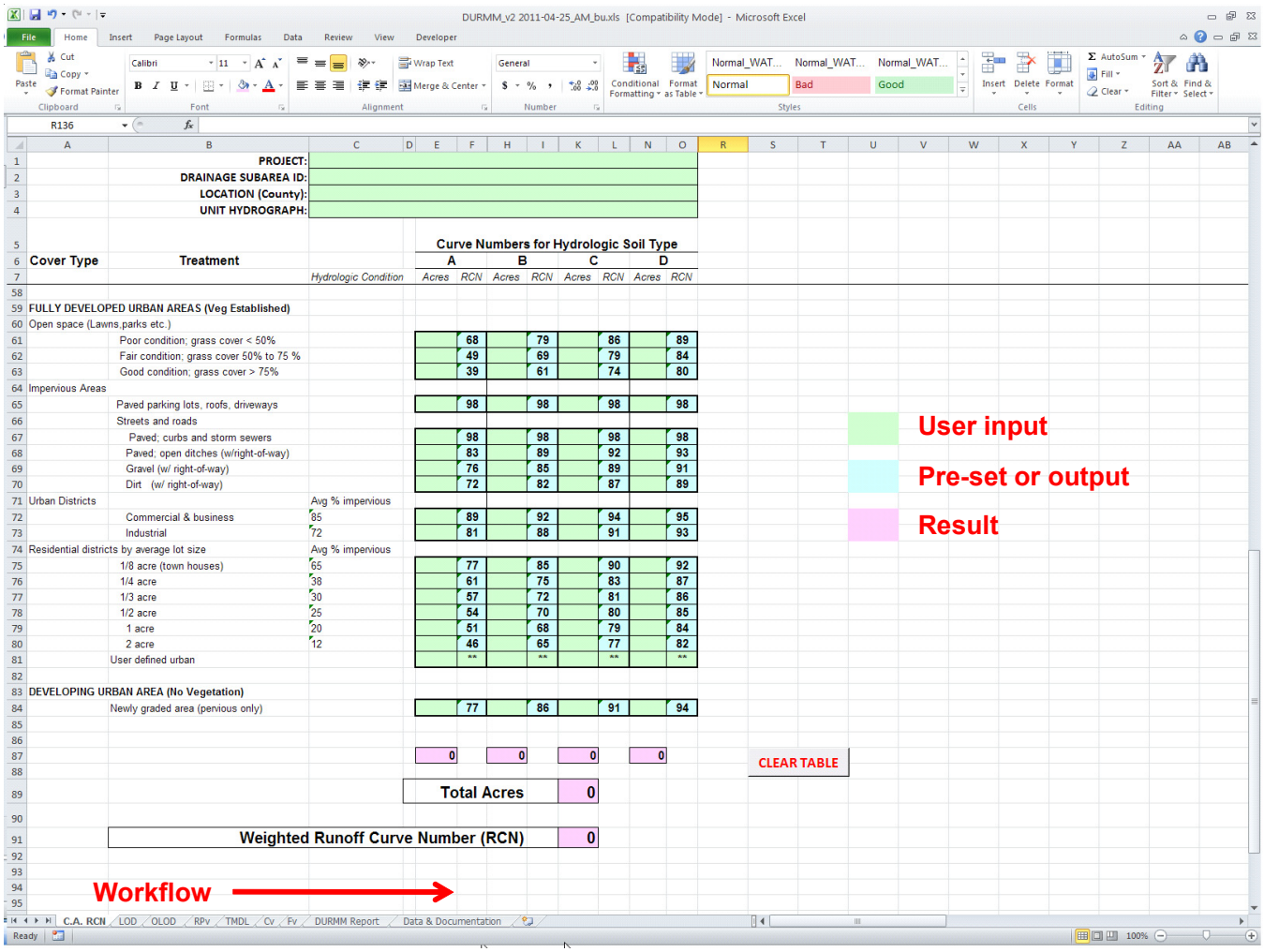
Background

The original version of DURMM was developed to aid in the design of Green Technology Best Management Practices (GTBMPs), which were an important component of DNREC's "Conservation Design for Stormwater Mangement" document released in 1997. As stormwater management has evolved to include the concepts of treatment trains and runoff reduction, some of the limitations of DURMM REL 1.1 have become more apparent. DURMM v.2 has been developed to provide stormwater management designers with a tool to address these limitations based on the latest research and data within the profession. Nevertheless, there are some important differences between the two versions, as outlined in the slide above. Most importantly, DURMM v.2 was developed as a compliance tool, not as a BMP design aid. Adding this capability back into the model is being considered for future releases, however.

DURMM v.2

Basic Workflow & Data Input

Effective April 2016



Layout

DURMM v.2 was developed using Microsoft's Excel 2010 spreadsheet program. However, it should be compatible with any version back to Excel 97. There are several macros that allow clearing and resetting some of the user input cells, however these are not absolutely necessary for the model to function properly. Upon initial use of the model, the user will be prompted to allow the use of the macros. Enabling macros varies depending on the version of Excel being used.

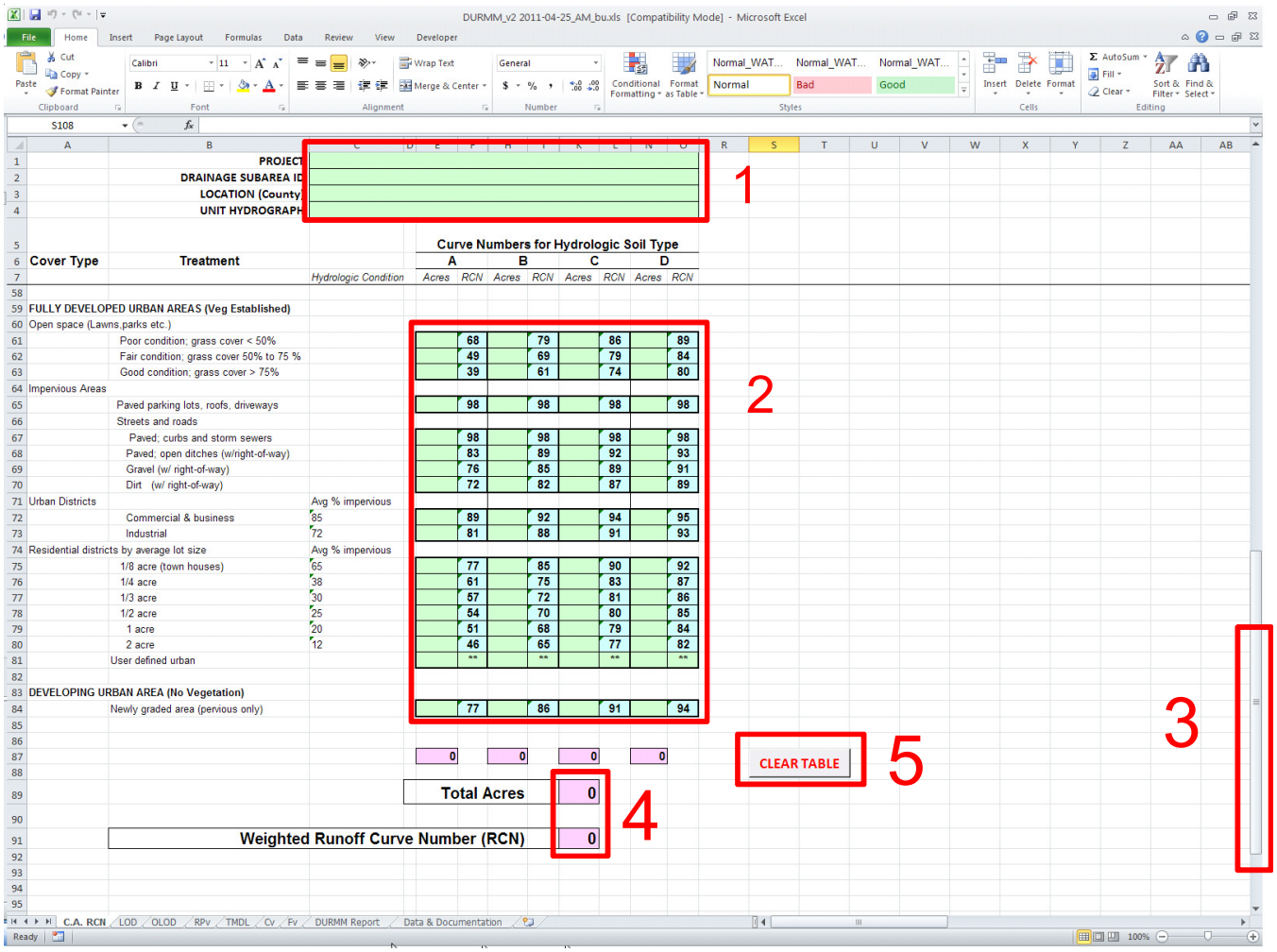
The model itself consists of 8 worksheets. The general workflow proceeds from one worksheet to the next in a left-to-right direction. The cells within each worksheet are color-coded, as follows:

- Green Cells – cells intended for user input
- Cyan Cells – cells that contain either pre-set values or ancillary output
- Magenta Cells - cells that contain calculated results

DURMM v.2

Explanation of Worksheets

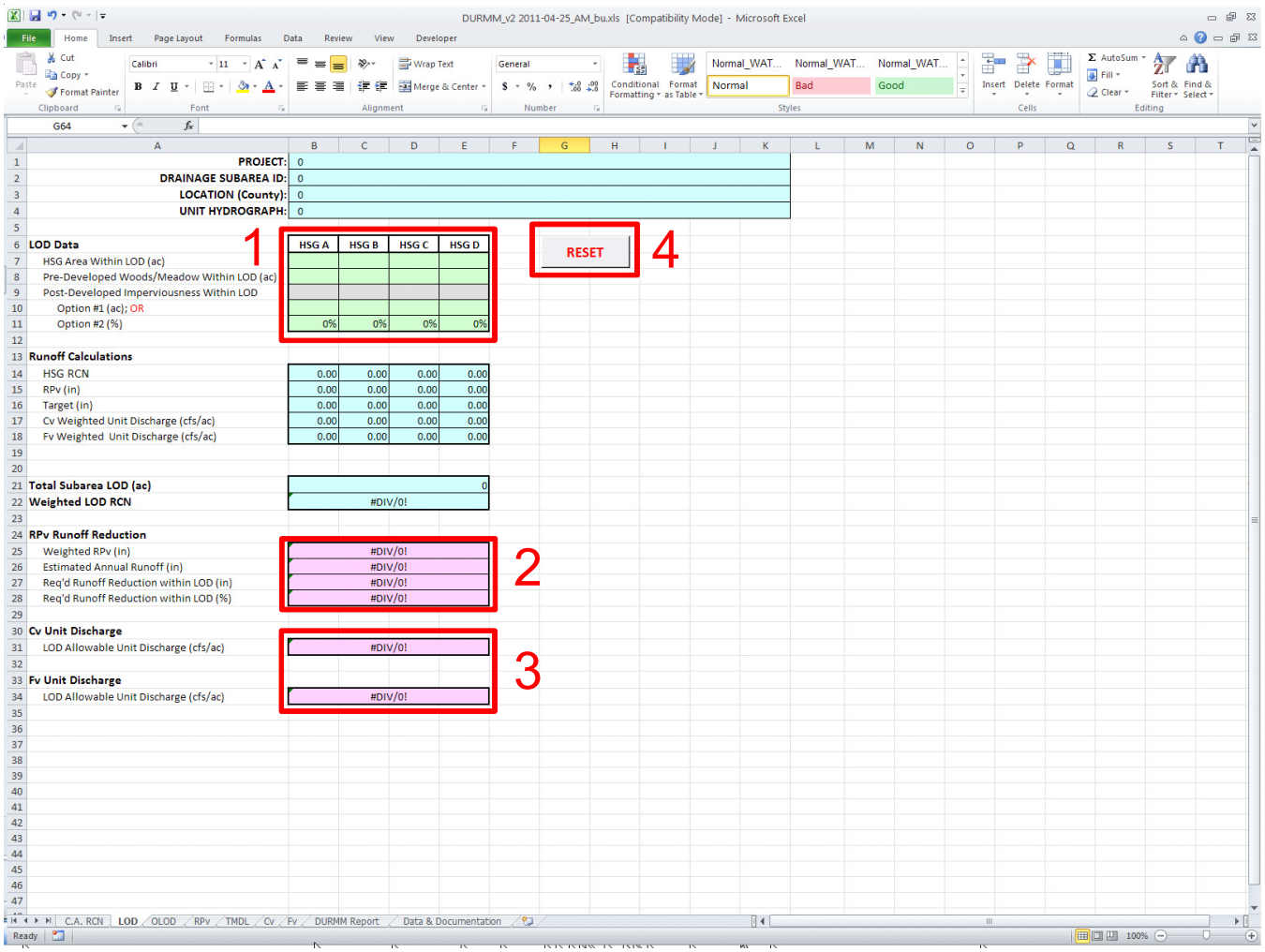
The next series of slides describe each of the 8 worksheets included in the model and some of the important elements contained in that sheet.



"C. A. RCN" Worksheet

The "C. A. RCN" worksheet is used to determine the weighted Runoff Curve Number (RCN) for the entire contributing area under analysis. Key elements of this worksheet include:

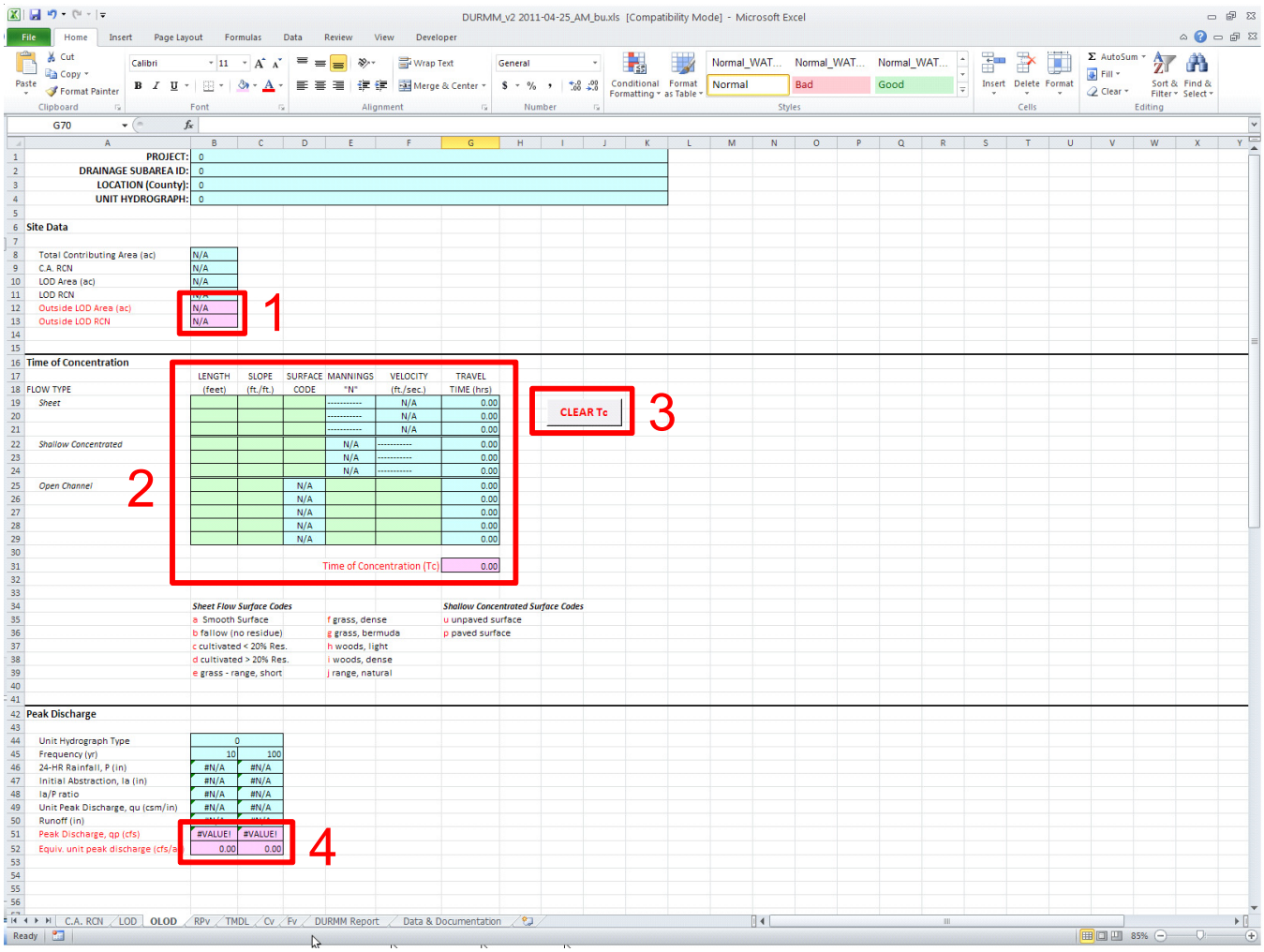
1. Project Data: Project name and subarea ID are entered in the green cells provided. The county location and unit hydrograph are then selected from their respective dropdown lists. This information will be carried over to other worksheets without the need for additional user input.
2. Land Cover Data: Acres of land cover by Hydrologic Soil Group (HSG) and hydrologic condition within the contributing area are entered in the green cells. The table is set up similar to the standard RCN tables in TR-55. The "User defined urban" cells can be used to enter RCN values not included in the standard table, with prior approval.
3. The default setting for this worksheet opens to the urban land cover data. However, the scroll button can be used to scroll up to other land cover descriptions as used in TR-55.
4. Total acreage and weighted RCN of the total contributing area are computed and reported in their respective fields.
5. The "Clear Table" button can be used to clear all user supplied data from the worksheet and reset any user-defined values.



"LOD" Worksheet

This worksheet is used to determine the runoff reduction requirement within the proposed limit of disturbance of the drainage subarea. Since the DSSR only require management of disturbed areas, this may or may not coincide with the total contributing area that drains to the BMPs within that subarea. Key elements of this worksheet include:

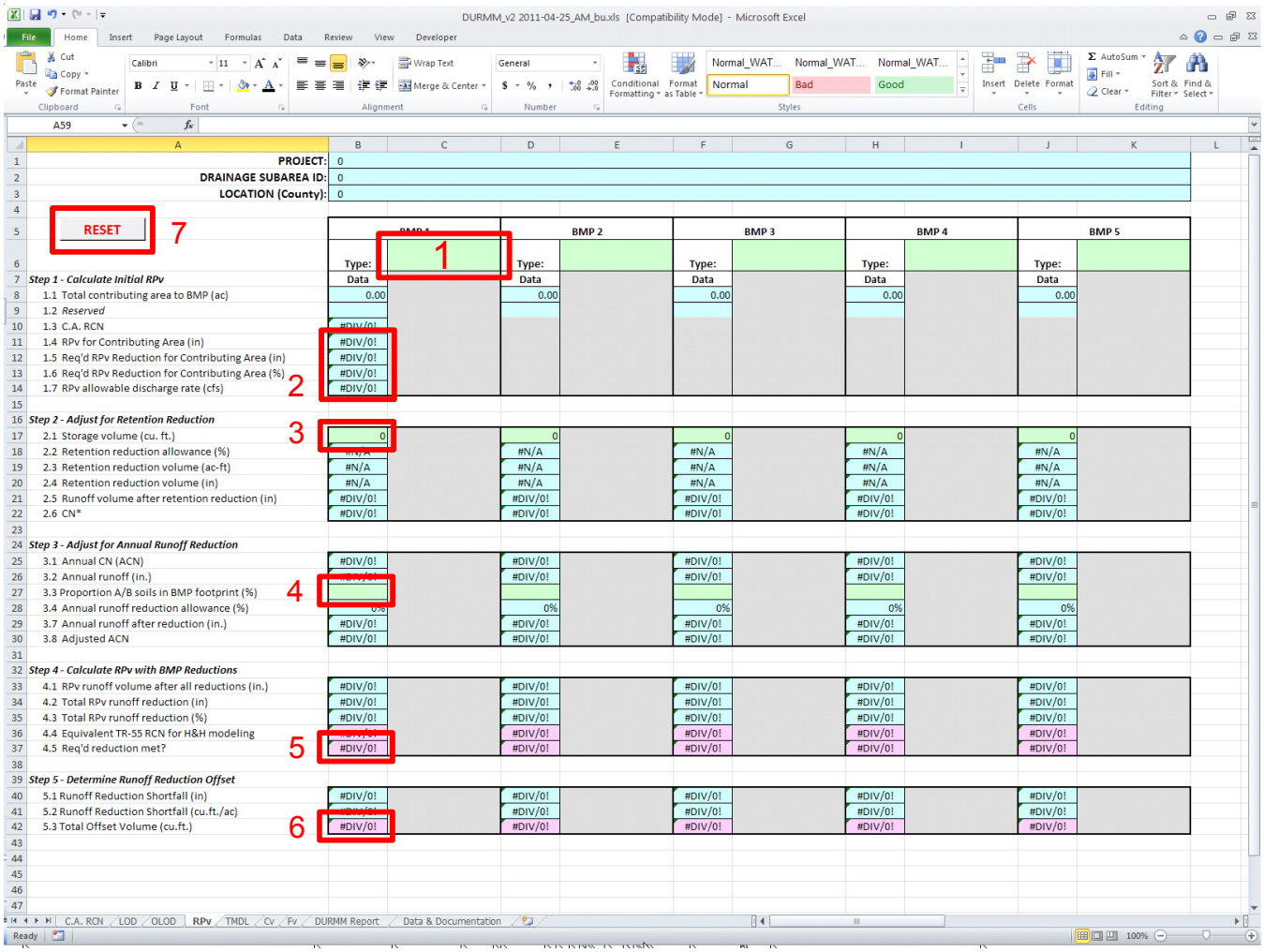
1. Total LOD acreage by HSG is entered in the first row of green cells. Acreage of any pre-developed woods/meadow within the LOD is entered in the next row. Post-developed imperviousness is then entered as either an acreage or as a percentage in the respective cells provided. (NOTE: Entering imperviousness as a percentage will over-write a formula in those cells. See #4 below.)
2. A weighted runoff volume for the Resource Protection Event is calculated based on the data entered above along with an estimate of the annual runoff volume. The required runoff reduction based on a "0% Effective Imperviousness" criterion is then calculated in watershed inches and percent reduction.
3. The data entered above is also used to determine the allowable unit discharge for the Conveyance Event and the Flooding Event if the site qualifies for this under the DSSR.
4. The "RESET" button clears any user input data and resets the formulas used in the imperviousness cells.



"*OLOD" Worksheet*

This worksheet is used to account for runoff that is outside the LOD, but within the total contributing area of the BMP drainage subarea. If the total contributing area and the LOD coincide, this worksheet may be skipped. Key elements on this sheet include:

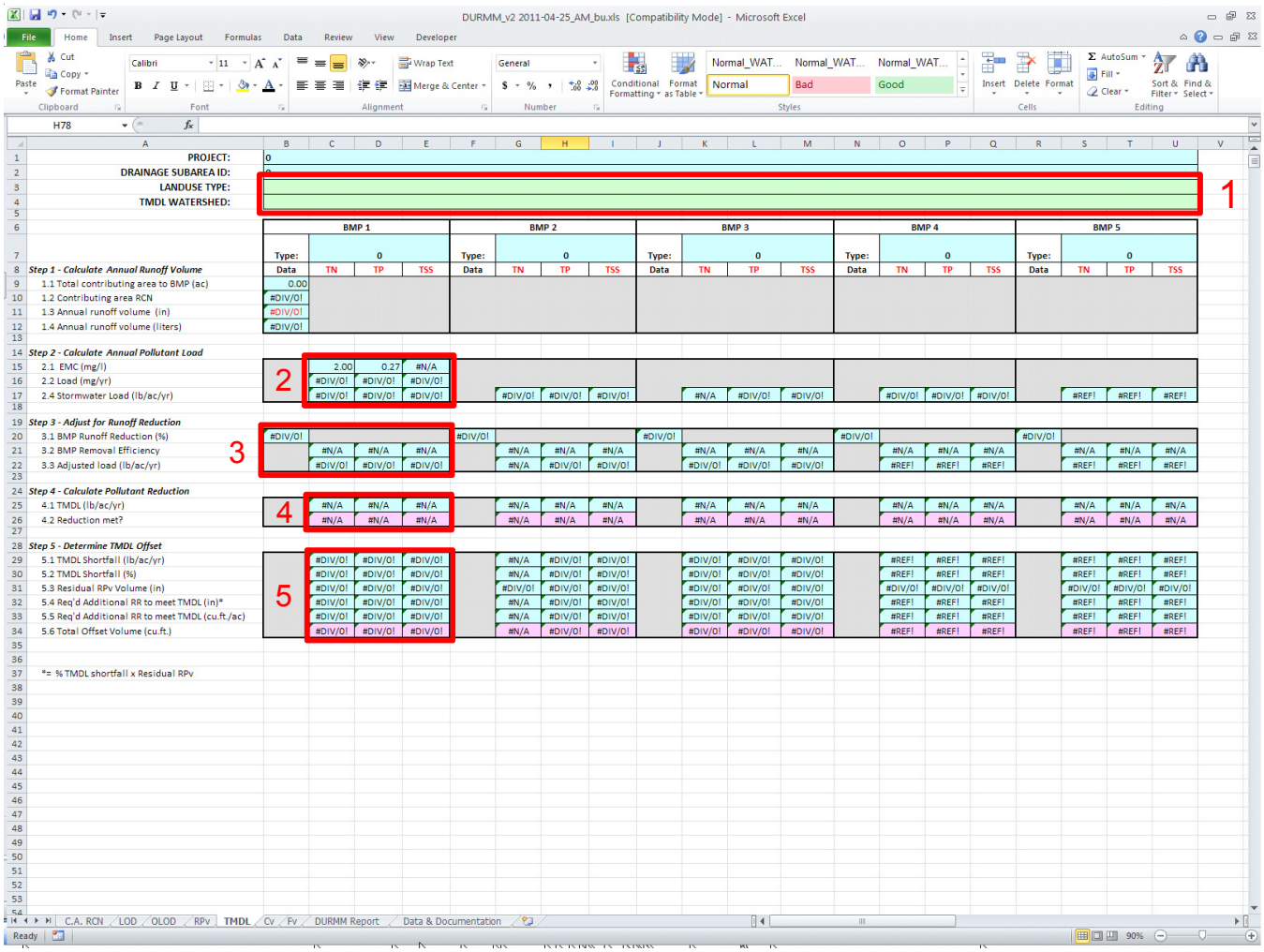
1. Data entered previously for the "C.A. RCN" and "LOD" worksheets are used to calculate the area outside the LOD and the RCN for that area.
2. Data used to determine the time of concentration for the area outside the LOD is entered in the green cells. There are allowances for 3 sheet flow, 3 shallow concentrated flow and 5 open channel flow segments. (NOTE: The user must supply an estimated velocity for the channel flow segments; it is not calculated within the model.) The total time of concentration for the area outside the LOD is calculated in the magenta cell.
3. The "Clear Tc" button can be used to clear any user input for the Time of Concentration calculation.
4. The peak discharge for the Conveyance Event and the Flooding Event are calculated in their respective magenta cells. These discharges are then divided by the area outside the LOD to determine the respective equivalent unit discharges in the magenta cells.



"RPv" Worksheet

This worksheet is used to calculate the runoff reduction for the selected BMP suite and check for compliance for the Resource Protection Event. Key elements on this sheet include:

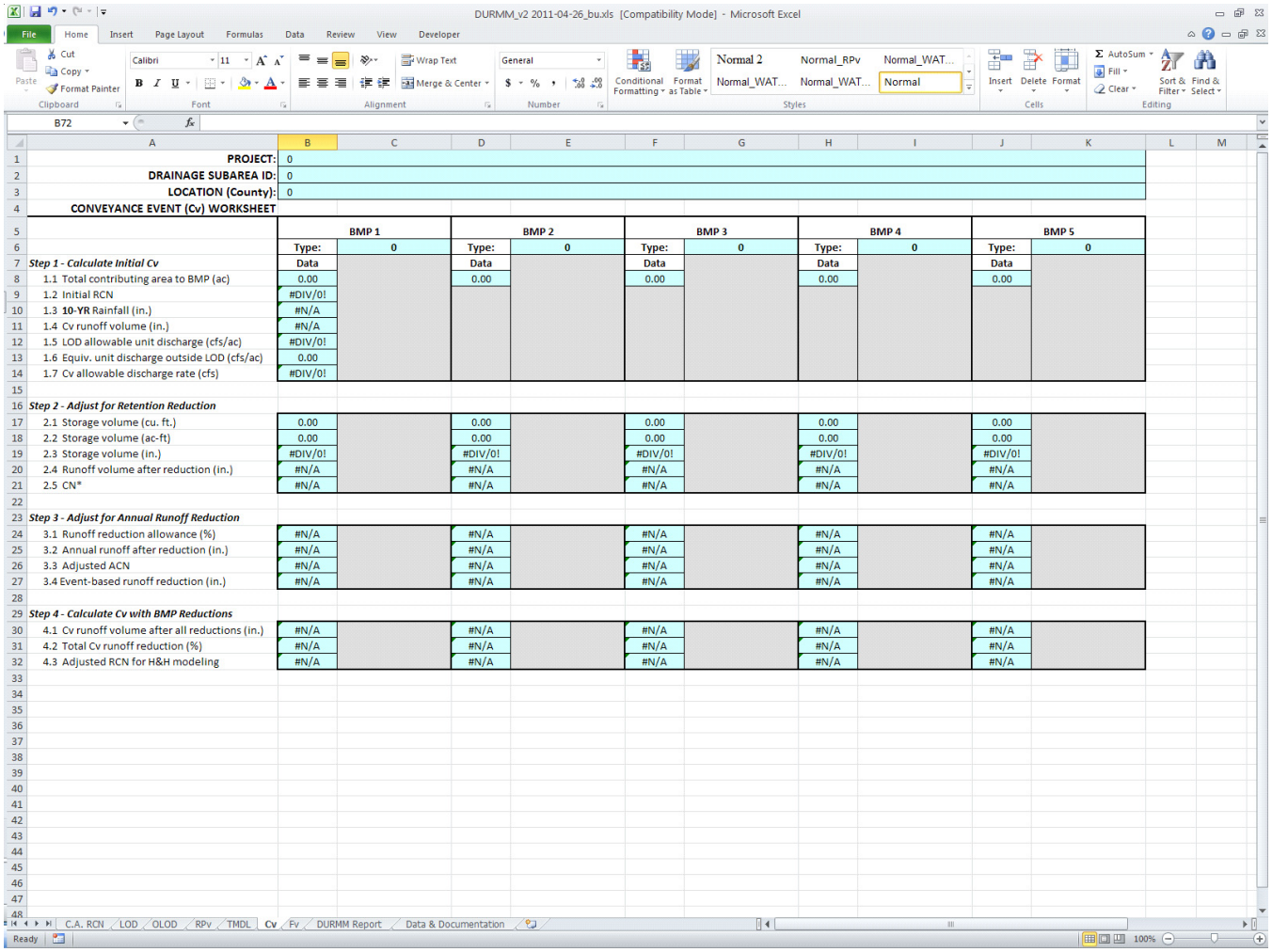
1. User selects a BMP from the dropdown list. BMP 1 would represent the most upstream BMP if a treatment train is proposed. Numbering then proceeds downstream for subsequent BMPs.
2. The model adjusts the runoff reduction requirement for the LOD to the total contributing area. It also checks to ensure any weighted adjustment is no less than the requirement for the LOD itself. The required reduction is calculated in both watershed inches and as a percentage. The allowable discharge for any runoff that can't be reduced is also calculated.
3. If the BMP selected has a retention storage component, the available storage in cubic feet is entered in the green cell.
4. If the BMP selected has a runoff reduction component, the proportion of the BMP footprint in soils in HSG A/B is entered in the green cell and the appropriate runoff reduction value is entered by the model.
5. The model calculates the retention reduction and/or the runoff reduction and checks to see if the required reduction has been met.
6. If the required runoff reduction is not met, the model calculates the offset shortfall.
7. The "RESET" button can be used to clear user input data from the worksheet to model a different BMP suite.



"TMDL" Worksheet

This worksheet is used to check for compliance with Total Maximum Daily Load (TMDL) requirements. The BMP suite selected on the RPv worksheet is carried over to this sheet, precluding the need to input any BMP data. Key elements on this sheet include:

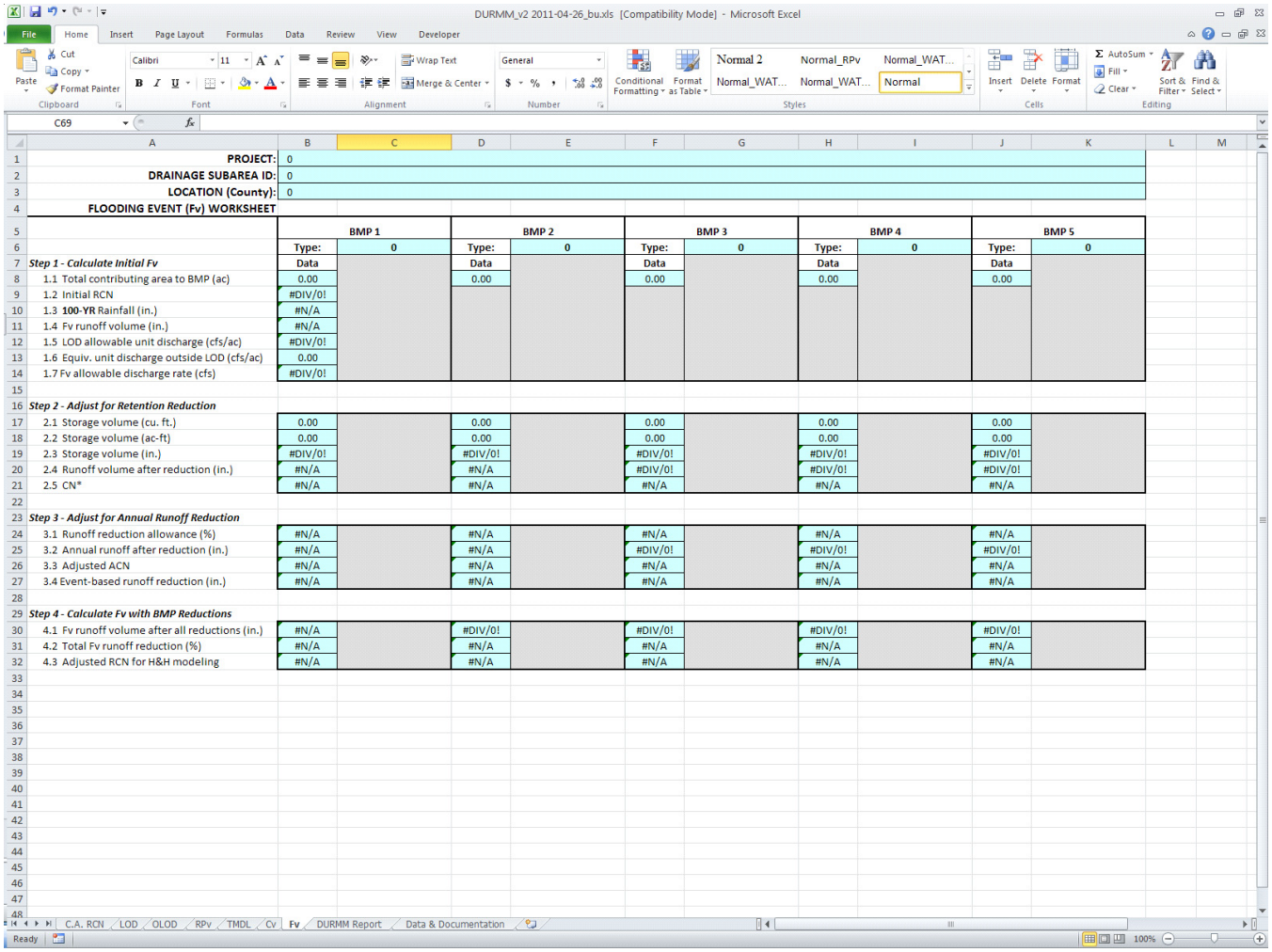
1. The user selects the appropriate landuse category and TMDL watershed from the dropdown lists.
2. The model calculates the total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS) pollutant load in milligrams and pounds based on the runoff volume calculated previously and the Event Mean Concentrations (EMCs) provided in the model.
3. Load reduction is calculated based on the runoff reduction from the RPv worksheet. Additional adjustment is calculated for removal efficiency.
4. The model checks to determine if the required pollutant reduction has been met.
5. If the required reduction has not been met, the model determines the shortfall of the pollutant load and calculates an equivalent runoff volume to be used for any offset requirement.



1	PROJECT:	0								
2	DRAINAGE SUBAREA ID:	0								
3	LOCATION (County):	0								
4	CONVEYANCE EVENT (Cv) WORKSHEET									
5		BMP 1		BMP 2		BMP 3		BMP 4		BMP 5
6		Type:	0	Type:	0	Type:	0	Type:	0	Type:	0
7	*Step 1 - Calculate Initial Cv*	Data		Data		Data		Data		Data	
8	1.1 Total contributing area to BMP (ac)	0.00		0.00		0.00		0.00		0.00	
9	1.2 Initial RCN	#DIV/0!									
10	1.3 **10-YR** Rainfall (in.)	#N/A									
11	1.4 Cv runoff volume (in.)	#N/A									
12	1.5 LOD allowable unit discharge (cfs/ac)	#DIV/0!									
13	1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
14	1.7 Cv allowable discharge rate (cfs)	#DIV/0!									
15											
16	*Step 2 - Adjust for Retention Reduction*										
17	2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
18	2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
19	2.3 Storage volume (in.)	#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!	
20	2.4 Runoff volume after reduction (in.)	#N/A		#N/A		#N/A		#N/A		#N/A	
21	2.5 CN*	#N/A		#N/A		#N/A		#N/A		#N/A	
22											
23	*Step 3 - Adjust for Annual Runoff Reduction*										
24	3.1 Runoff reduction allowance (%)	#N/A		#N/A		#N/A		#N/A		#N/A	
25	3.2 Annual runoff after reduction (in.)	#N/A		#N/A		#N/A		#N/A		#N/A	
26	3.3 Adjusted ACN	#N/A		#N/A		#N/A		#N/A		#N/A	
27	3.4 Event-based runoff reduction (in.)	#N/A		#N/A		#N/A		#N/A		#N/A	
28											
29	*Step 4 - Calculate Cv with BMP Reductions*										
30	4.1 Cv runoff volume after all reductions (in.)	#N/A		#N/A		#N/A		#N/A		#N/A	
31	4.2 Total Cv runoff reduction (%)	#N/A		#N/A		#N/A		#N/A		#N/A	
32	4.3 Adjusted RCN for H&H modeling	#N/A		#N/A		#N/A		#N/A		#N/A	

"Cv" Worksheet

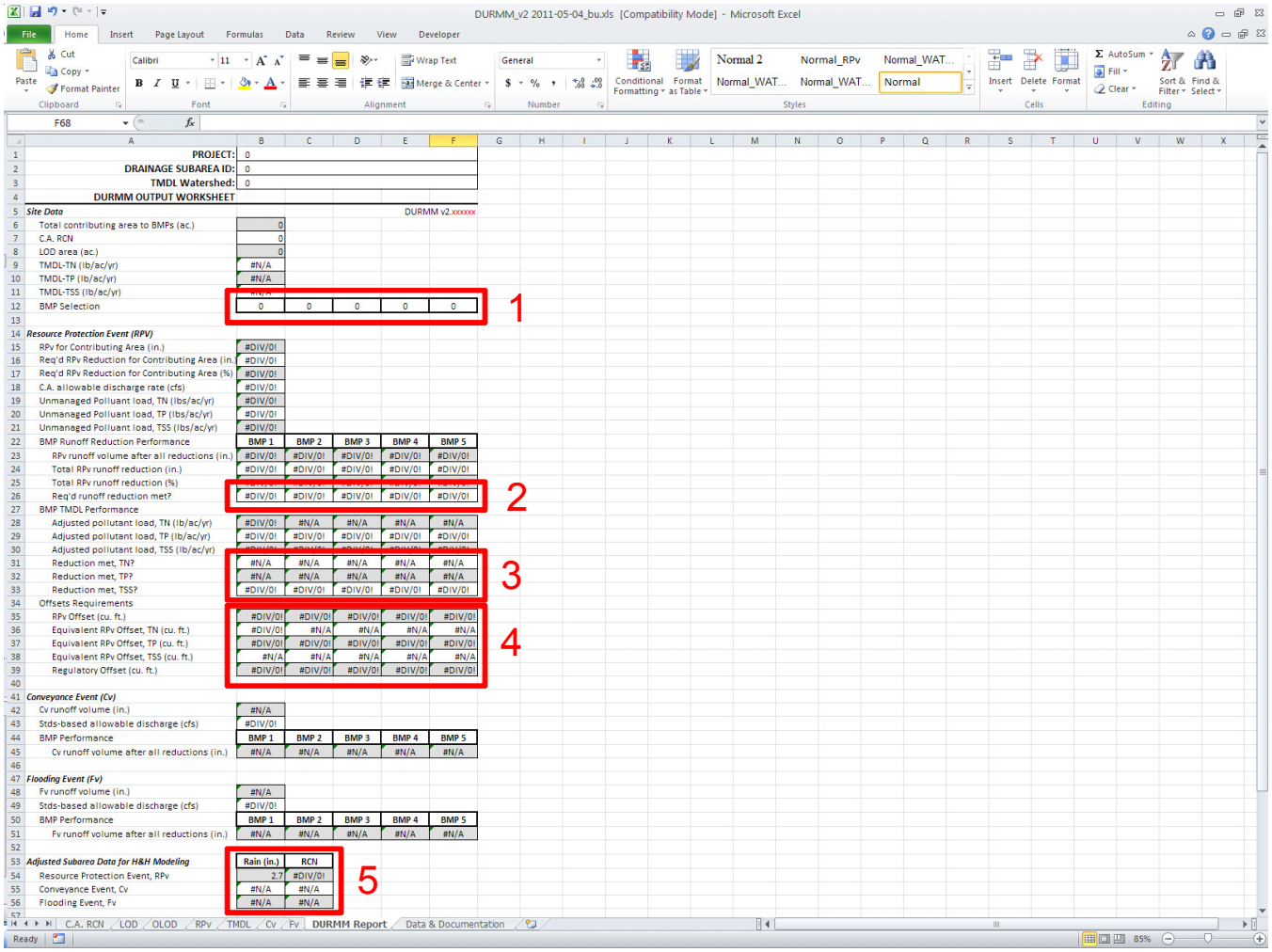
This worksheet calculates the effect of runoff reduction practices for the Conveyance Event. The BMP suite selected on the RPv worksheet is carried over to this sheet, precluding the need to input any BMP data. All other cells are calculated based on data entry and results from previous worksheets. Reductions based on available storage are given full credit. However, the adjustments for runoff reduction BMPs are lower than those for the Resource Protection Event since they are less able to mitigate runoff from a storm of this magnitude.



	PROJECT:	0								
	DRAINAGE SUBAREA ID:	0								
	LOCATION (County):	0								
	FLOODING EVENT (Fv) WORKSHEET									
		BMP 1		BMP 2		BMP 3		BMP 4		BMP 5
		Type:	0	Type:	0	Type:	0	Type:	0	Type:	0
	Step 1 - Calculate Initial Fv	Data		Data		Data		Data		Data
	1.1 Total contributing area to BMP (ac)	0.00		0.00		0.00		0.00		0.00
	1.2 Initial RCN	#DIV/0!								
	1.3 **100-YR** Rainfall (in.)	#N/A								
	1.4 Fv runoff volume (in.)	#N/A								
	1.5 LOD allowable unit discharge (cfs/ac)	#DIV/0!								
	1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00								
	1.7 Fv allowable discharge rate (cfs)	#DIV/0!								
	Step 2 - Adjust for Retention Reduction									
	2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00
	2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00
	2.3 Storage volume (in.)	#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!
	2.4 Runoff volume after reduction (in.)	#N/A		#N/A		#DIV/0!		#DIV/0!		#DIV/0!
	2.5 CN*	#N/A		#N/A		#N/A		#N/A		#N/A
	Step 3 - Adjust for Annual Runoff Reduction									
	3.1 Runoff reduction allowance (%)	#N/A		#N/A		#N/A		#N/A		#N/A
	3.2 Annual runoff after reduction (in.)	#N/A		#N/A		#DIV/0!		#DIV/0!		#DIV/0!
	3.3 Adjusted ACN	#N/A		#N/A		#N/A		#N/A		#N/A
	3.4 Event-based runoff reduction (in.)	#N/A		#N/A		#N/A		#N/A		#N/A
	Step 4 - Calculate Fv with BMP Reductions									
	4.1 Fv runoff volume after all reductions (in.)	#N/A		#DIV/0!		#DIV/0!		#DIV/0!		#DIV/0!
	4.2 Total Fv runoff reduction (%)	#N/A		#N/A		#N/A		#N/A		#N/A
	4.3 Adjusted RCN for H&H modeling	#N/A		#N/A		#N/A		#N/A		#N/A

"Fv" Worksheet

This worksheet calculates the effect of runoff reduction practices for the Flooding Event. The BMP suite selected on the RPv worksheet is carried over to this sheet, precluding the need to input any BMP data. All other cells are calculated based on data entry and results from previous worksheets. Reductions based on available storage are given full credit. However, the adjustments for runoff reduction BMPs are even lower than those for the Conveyance Event since they have minimal ability to mitigate runoff from a storm of this magnitude.



PROJECT:	0				
DRAINAGE SUBAREA ID:	0				
TMDL Watershed:	0				
DURMM OUTPUT WORKSHEET					
Site Data					DURMM v2.xxxxxx
Total contributing area to BMPs (ac.)	0				
C.A. RCN	0				
LOD area (ac.)	0				
TMDL-TN (lb/ac/yr)	#N/A				
TMDL-TP (lb/ac/yr)	#N/A				
TMDL-TSS (lb/ac/yr)	#N/A				
BMP Selection	0	0	0	0	0
Resource Protection Event (RPV)					
RPv for Contributing Area (in.)	#DIV/0!				
Req'd RPv Reduction for Contributing Area (in.)	#DIV/0!				
Req'd RPv Reduction for Contributing Area (%)	#DIV/0!				
C.A. allowable discharge rate (cfs)	#DIV/0!				
Unmanaged Polluant load, TN (lbs/ac/yr)	#DIV/0!				
Unmanaged Polluant load, TP (lbs/ac/yr)	#DIV/0!				
Unmanaged Polluant load, TSS (lbs/ac/yr)	#DIV/0!				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Total RPv runoff reduction (in.)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Total RPv runoff reduction (%)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Req'd runoff reduction met?	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
BMP TMDL Performance					
Adjusted pollutant load, TN (lb/ac/yr)	#DIV/0!	#N/A	#N/A	#N/A	#N/A
Adjusted pollutant load, TP (lb/ac/yr)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Adjusted pollutant load, TSS (lb/ac/yr)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Reduction met, TN?	#N/A	#N/A	#N/A	#N/A	#N/A
Reduction met, TP?	#N/A	#N/A	#N/A	#N/A	#N/A
Reduction met, TSS?	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Offsets Requirements					
RPv Offset (cu. ft.)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Equivalent RPv Offset, TN (cu. ft.)	#DIV/0!	#N/A	#N/A	#N/A	#N/A
Equivalent RPv Offset, TP (cu. ft.)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Equivalent RPv Offset, TSS (cu. ft.)	#N/A	#N/A	#N/A	#N/A	#N/A
Regulatory Offset (cu. ft.)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Conveyance Event (Cv)					
Cv runoff volume (in.)	#N/A				
Stds-based allowable discharge (cfs)	#DIV/0!				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	#N/A	#N/A	#N/A	#N/A	#N/A
Flooding Event (Fv)					
Fv runoff volume (in.)	#N/A				
Stds-based allowable discharge (cfs)	#DIV/0!				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	#N/A	#N/A	#N/A	#N/A	#N/A
Adjusted Subarea Data for H&H Modeling	Rain (in.)	RCN			
Resource Protection Event, RPv	2.7	#DIV/0!			
Conveyance Event, Cv	#N/A	#N/A			
Flooding Event, Fv	#N/A	#N/A			

1 2 3 4 5

"DURMM Report" Worksheet

This worksheet summarizes the results from the previous worksheets in a format suitable for submission with the project application package. The information is largely self-explanatory. However, some key elements include:

1. Summary of BMP suite selected.
2. Determination of compliance with runoff reduction requirements.
3. Determination of compliance with pollutant reduction requirements.
4. Offset requirements.
5. Runoff reduction adjustments to the RCN for the Resource Protection, Conveyance, and Flooding events that can be used for hydrologic and hydraulic modeling for more complex situations.

The report allows a reviewer to quickly determine if the runoff reduction and pollutant reduction requirements have been met. If these requirements could not be satisfied due to site constraints or other justifiable technical reasons, the site would be subject to the offset provisions of the DSSR.

DURMM v.2

"Broadkill Estates" Example Site
Ex. #1: Concept Level Analysis

Example #1: Concept Level Analysis

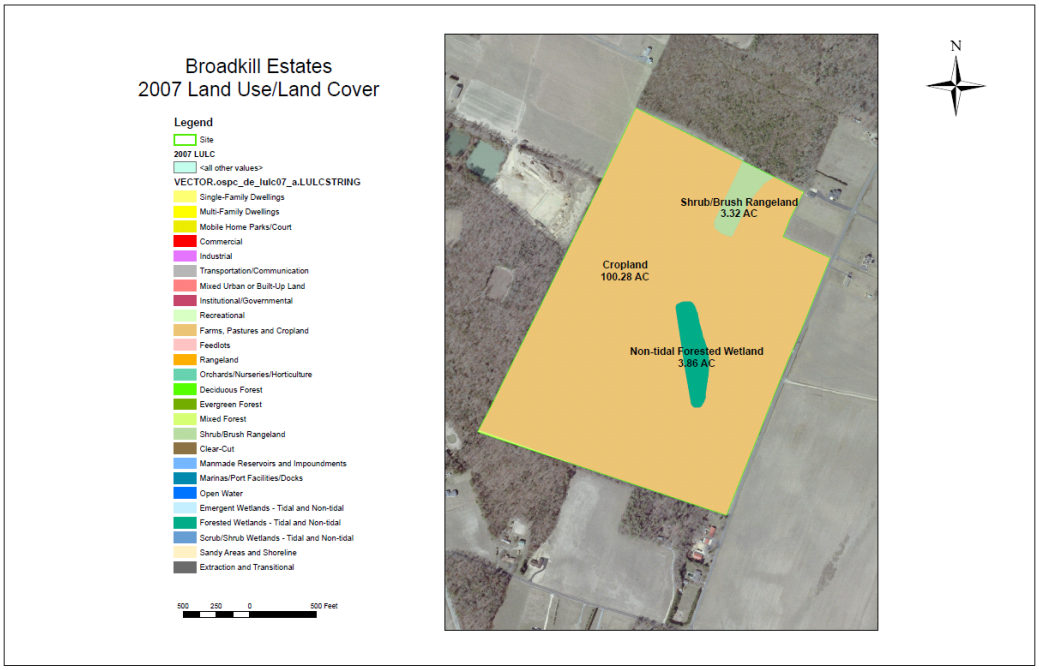
The procedures outlined in the previous section will now be used to perform a typical concept level analysis for a fictional land development project named "Broadkill Estates". For the purposes of this example, a concept level analysis assumes an artificial watershed boundary that coincides with the parcel boundary.

Concept Level Analysis

Data Sources

The information compiled for the Project Application Package will provide the necessary data inputs for the analysis.

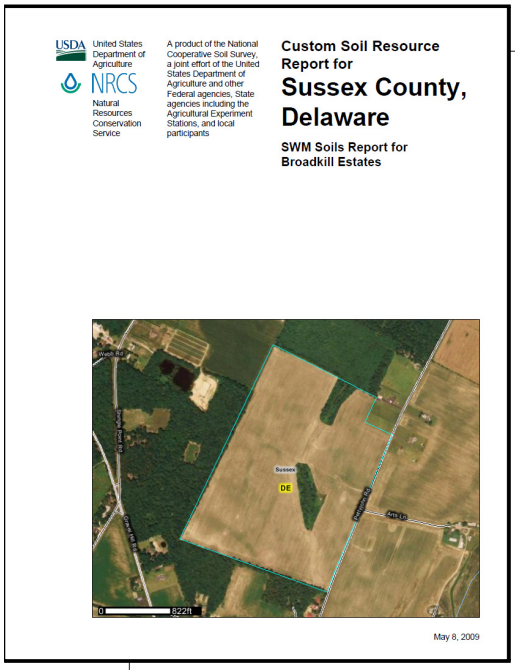
Concept Level Analysis

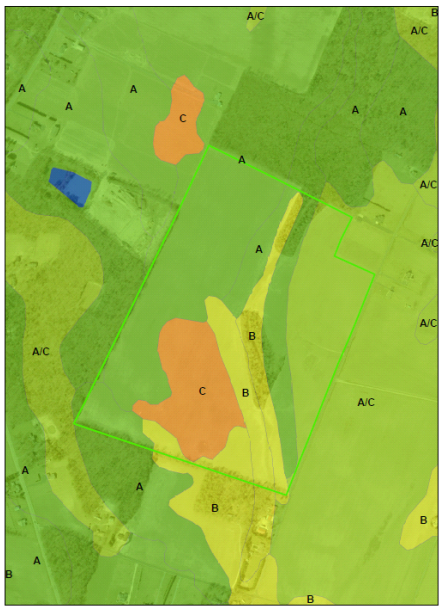


Land Use Data

The existing land use is used to determine the runoff reduction requirements for the project.

Concept Level Analysis

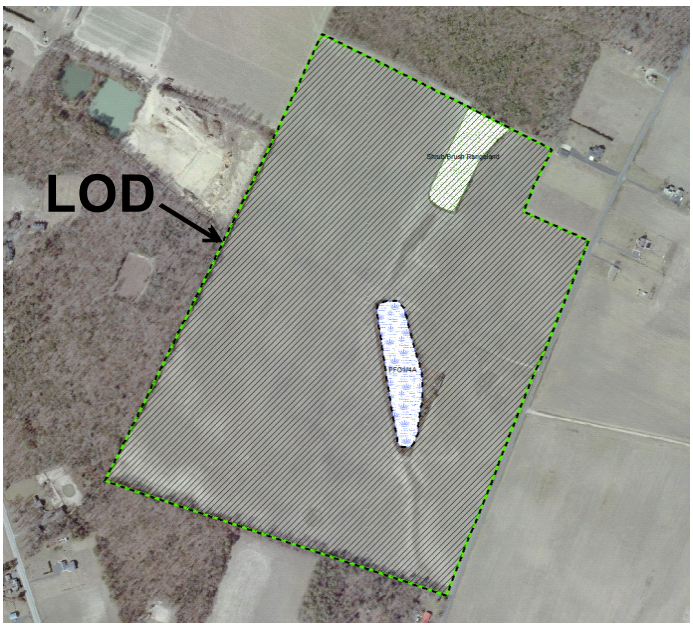




Soils Data

The Soils Report contains information on Hydrologic Soil Group (HSG) of the various soils on the site that is used by the model to determine runoff volume.

Concept Level Analysis



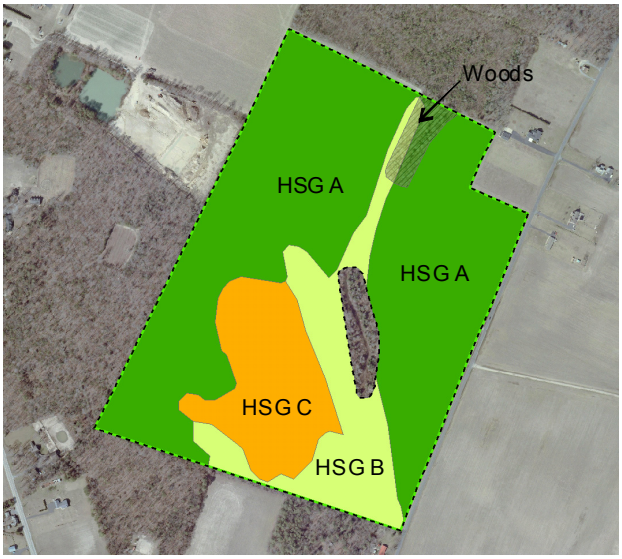
Proposed LU: Residential, 1 ac. lots

Existing and Proposed Conditions

The majority of the site consists of existing cropland. A small tributary bisects the site into two major drainage subareas. Although the tributary has been partially piped to facilitate cultivation, a small wetland area is located near the center of the site. There is also a small area of scrub/shrub forest at the downstream discharge point of the site.

"Broadkill Estates" has been proposed as a single-family residential site with an average lot size of 1 acre. For purposes of the concept level analysis, the Limit of Disturbance (LOD) has been assumed to coincide with the parcel boundary, except for the wetland area which will remain undisturbed.

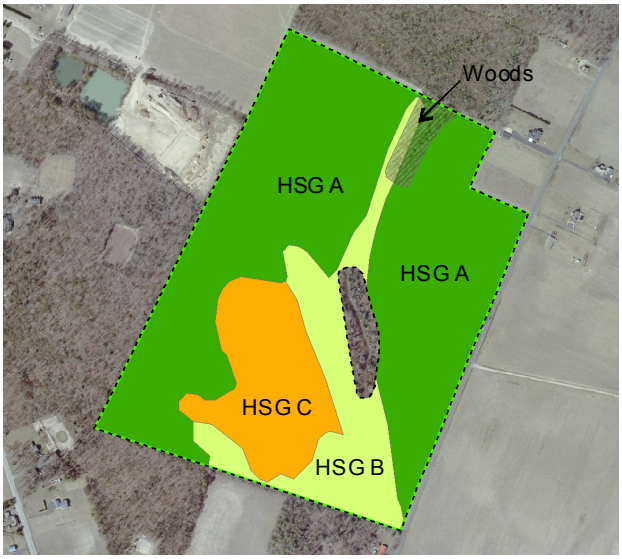
Concept Level Analysis
Site Data



- C.A. RCN Tab
  - Residential, 1-ac. (20% imperv.)
    - HSG A: 70.07 ac.
    - HSG B: 17.10 ac.
    - HSG C: 15.56 ac.

<u>Data Inputs – "C.A. RCN" Worksheet</u>
The slide above summarizes the data that will be input to the "C.A. RCN" worksheet.

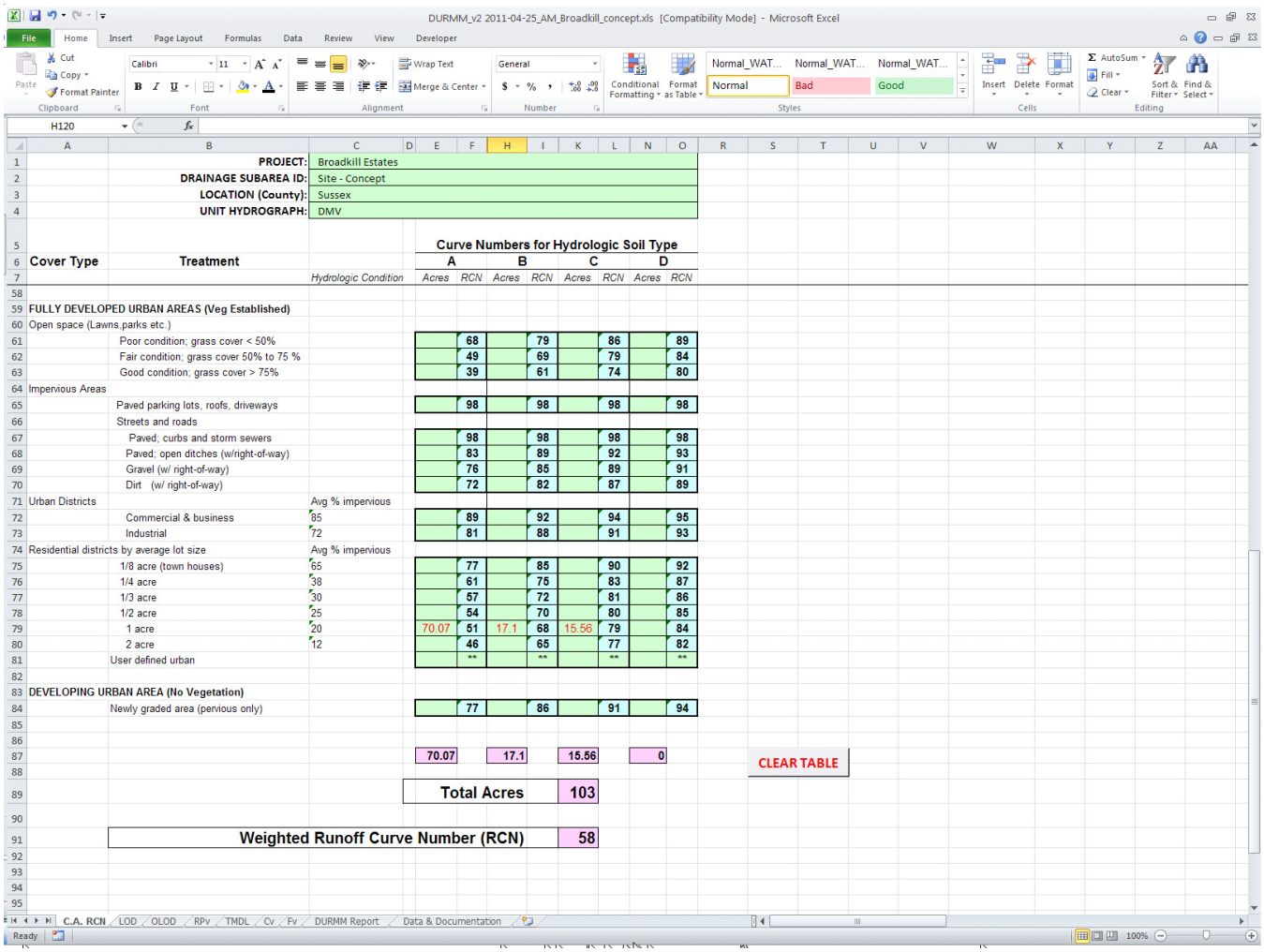
Concept Level Analysis
Site Data



- LOD Tab
  - HSG A
    - LOD Area: 70.07 ac.
    - Pre-Dev. Woods: 1.55 ac.
    - Post-Dev. Impervious: 20%
  - HSG B
    - LOD area: 17.10 ac.
    - Pre-Dev. Woods: 0.80 ac.
    - Post-Dev. Impervious: 20%
  - HSG C
    - LOD Area: 15.56 ac.
    - Pre-Dev. Woods: 0 ac.
    - Post-Dev. Impervious: 20%

<u>Data Inputs – "LOD" Worksheet</u>

The slide above summarizes the data that will be input to the "LOD" worksheet. Since the analysis assumes an artificial watershed boundary that coincides with the parcel boundary and LOD, the "OLOD" worksheet is not needed in this case.



DURMM_v2 2011-04-25_AM_Broadkill_concept.xls [Compatibility Mode] - Microsoft Excel

PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	Site - Concept
LOCATION (County):	Sussex
UNIT HYDROGRAPH:	DMV

Cover Type	Treatment	Hydrologic Condition	A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%			39		61		74		80
Impervious Areas										
	Paved parking lots, roofs, driveways			98		98		98		98
	Streets and roads									
	Paved; curbs and storm sewers			98		98		98		98
	Paved; open ditches (w/right-of-way)			83		89		92		93
	Gravel (w/ right-of-way)			76		85		89		91
	Dirt (w/ right-of-way)			72		82		87		89
Urban Districts		Avg % impervious								
	Commercial & business	85		89		92		94		95
	Industrial	72		81		88		91		93
Residential districts by average lot size		Avg % impervious								
	1/8 acre (town houses)	65		77		85		90		92
	1/4 acre	38		61		75		83		87
	1/3 acre	30		57		72		81		86
	1/2 acre	25		54		70		80		85
	1 acre	20	70.07	51	17.1	68	15.56	79		84
	2 acre	12		46		65		77		82
	User defined urban			**		**		**		**
DEVELOPING URBAN AREA (No Vegetation)										
	Newly graded area (pervious only)			77		86		91		94
			70.07		17.1		15.56		0	

Total Acres: 103

Weighted Runoff Curve Number (RCN): 58

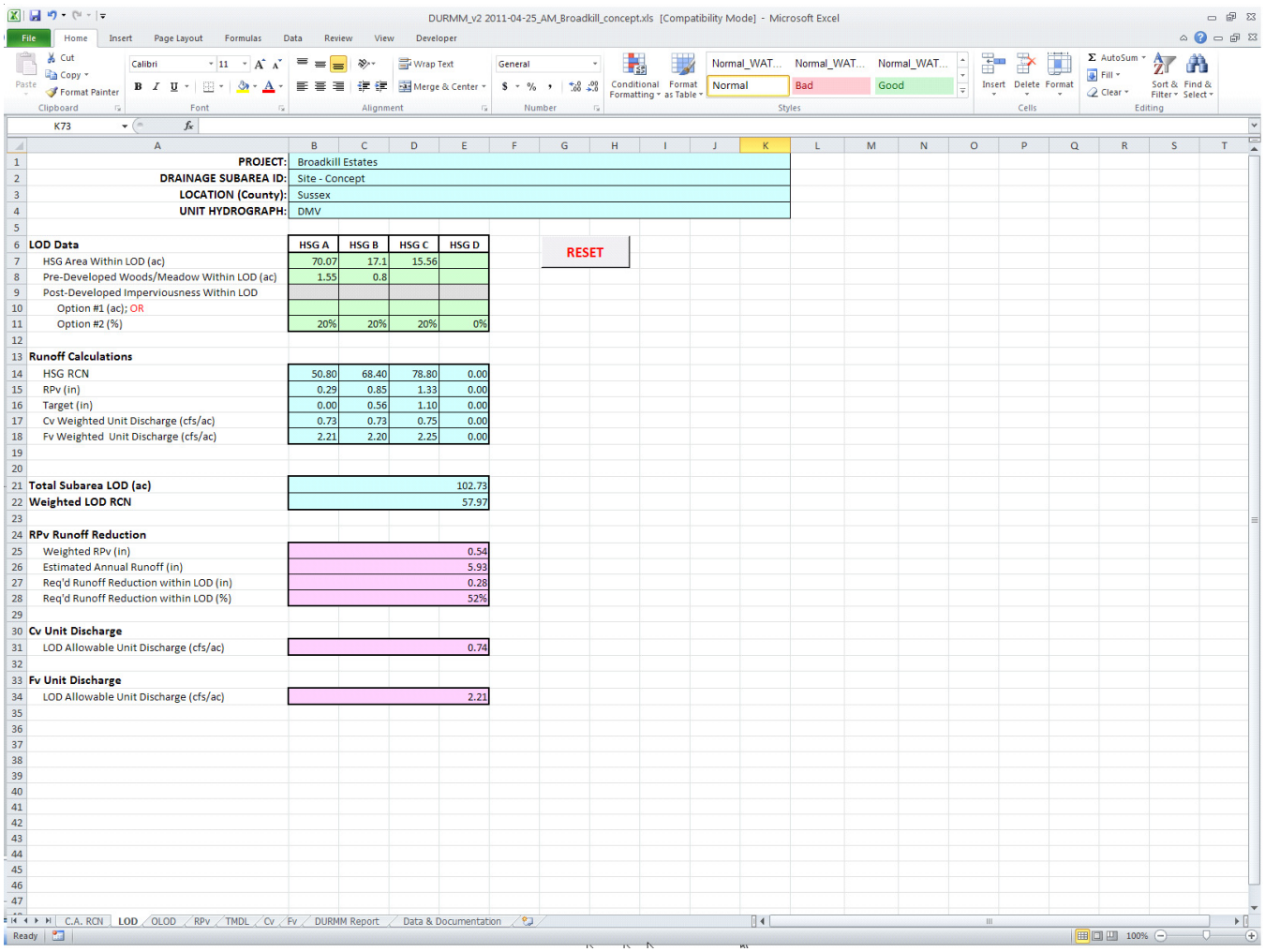
CLEAR TABLE

"C.A. RCN" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The model has calculated the following results:

- Total Acreage: 103
- Weighted RCN: 58

In keeping with NRCS tradition, results for the RCN are reported in rounded whole numbers on this worksheet even though the internal calculations are performed at the standard level of precision used in Excel.



PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	Site - Concept
LOCATION (County):	Sussex
UNIT HYDROGRAPH:	DMV

RESET

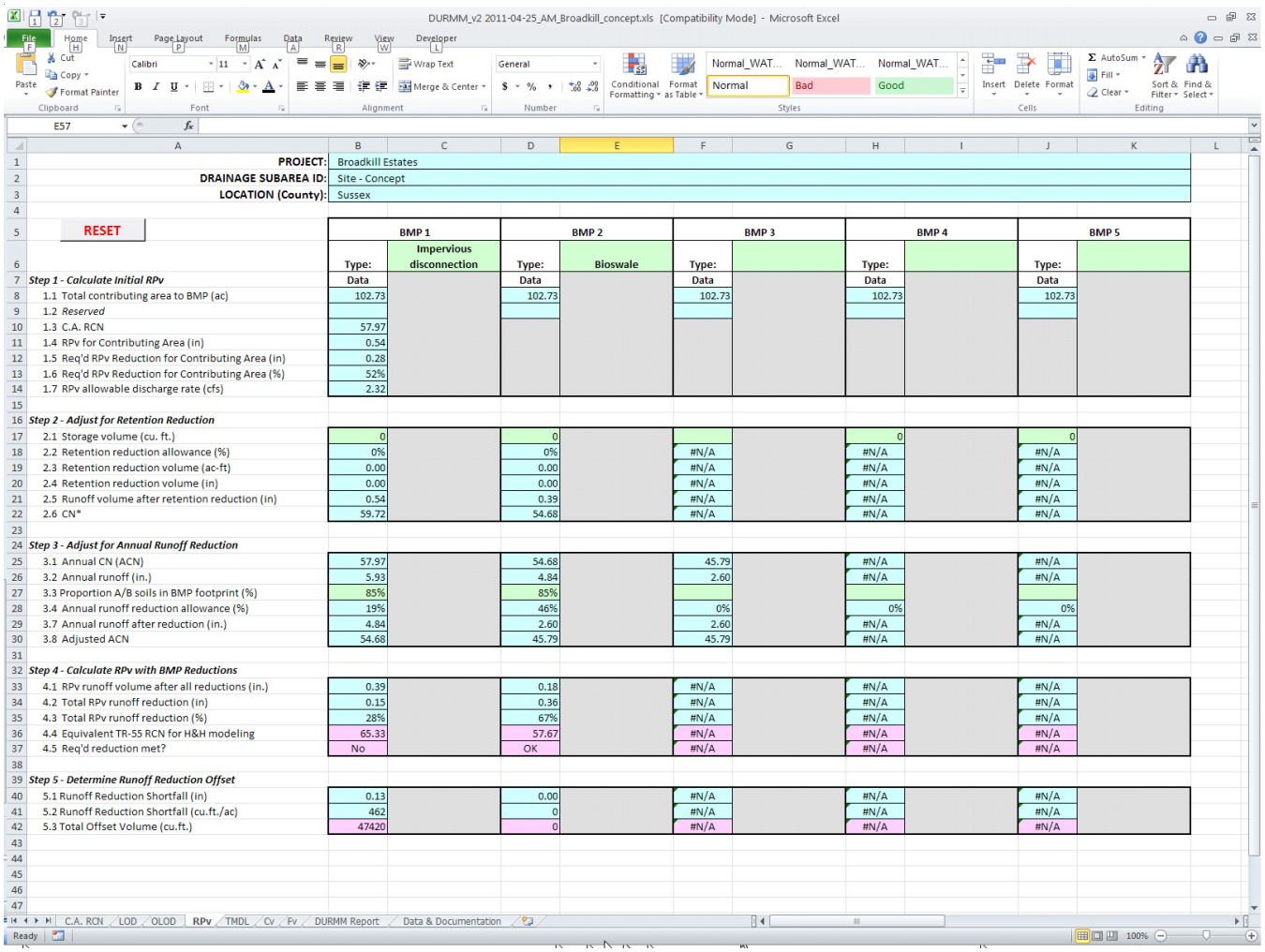
LOD Data	HSG A	HSG B	HSG C	HSG D
HSG Area Within LOD (ac)	70.07	17.1	15.56	
Pre-Developed Woods/Meadow Within LOD (ac)	1.55	0.8		
Post-Developed Imperviousness Within LOD				
Option #1 (ac); OR				
Option #2 (%)	20%	20%	20%	0%
Runoff Calculations				
HSG RCN	50.80	68.40	78.80	0.00
RPv (in)	0.29	0.85	1.33	0.00
Target (in)	0.00	0.56	1.10	0.00
Cv Weighted Unit Discharge (cfs/ac)	0.73	0.73	0.75	0.00
Fv Weighted Unit Discharge (cfs/ac)	2.21	2.20	2.25	0.00
Total Subarea LOD (ac)				102.73
Weighted LOD RCN				57.97
RPv Runoff Reduction				
Weighted RPv (in)				0.54
Estimated Annual Runoff (in)				5.93
Req'd Runoff Reduction within LOD (in)				0.28
Req'd Runoff Reduction within LOD (%)				52%
Cv Unit Discharge				
LOD Allowable Unit Discharge (cfs/ac)				0.74
Fv Unit Discharge				
LOD Allowable Unit Discharge (cfs/ac)				2.21

"LOD" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The model has calculated the following results.

- Total LOD Area: 102.73
- Weighted LOD RCN: 57.97
- Weighted RPV runoff volume: 0.54"
- Estimated annual runoff: 5.93"
- Required runoff reduction: 0.28" (52%)
- Allowable unit discharge for Cv: 0.74 cfs/ac
- Allowable unit discharge for Fv: 2.21 cfs/ac

The results on this sheet are carried out to 2 decimal places. In some cases, the user may detect a slight discrepancy between the computed RCN on the "LOD" worksheet and the previous "C.A. RCN" worksheet if the typical TR-55 land use descriptions were used on the "C.A. RCN" worksheet. This is the result of rounding of impervious area when the typical land use descriptions are used. If the user wishes better agreement between these worksheets, impervious and pervious (open space) acreages should be entered directly on the "C.A. RCN" worksheet. In either case, the results from the "LOD" worksheet are used for all subsequent worksheet calculations.



DURMM_v2 2011-04-25_AM_Broadkill_concept.xls [Compatibility Mode] - Microsoft Excel

PROJECT:	Broadkill Estates	
DRAINAGE SUBAREA ID:	Site - Concept	
LOCATION (County):	Sussex	

RESET

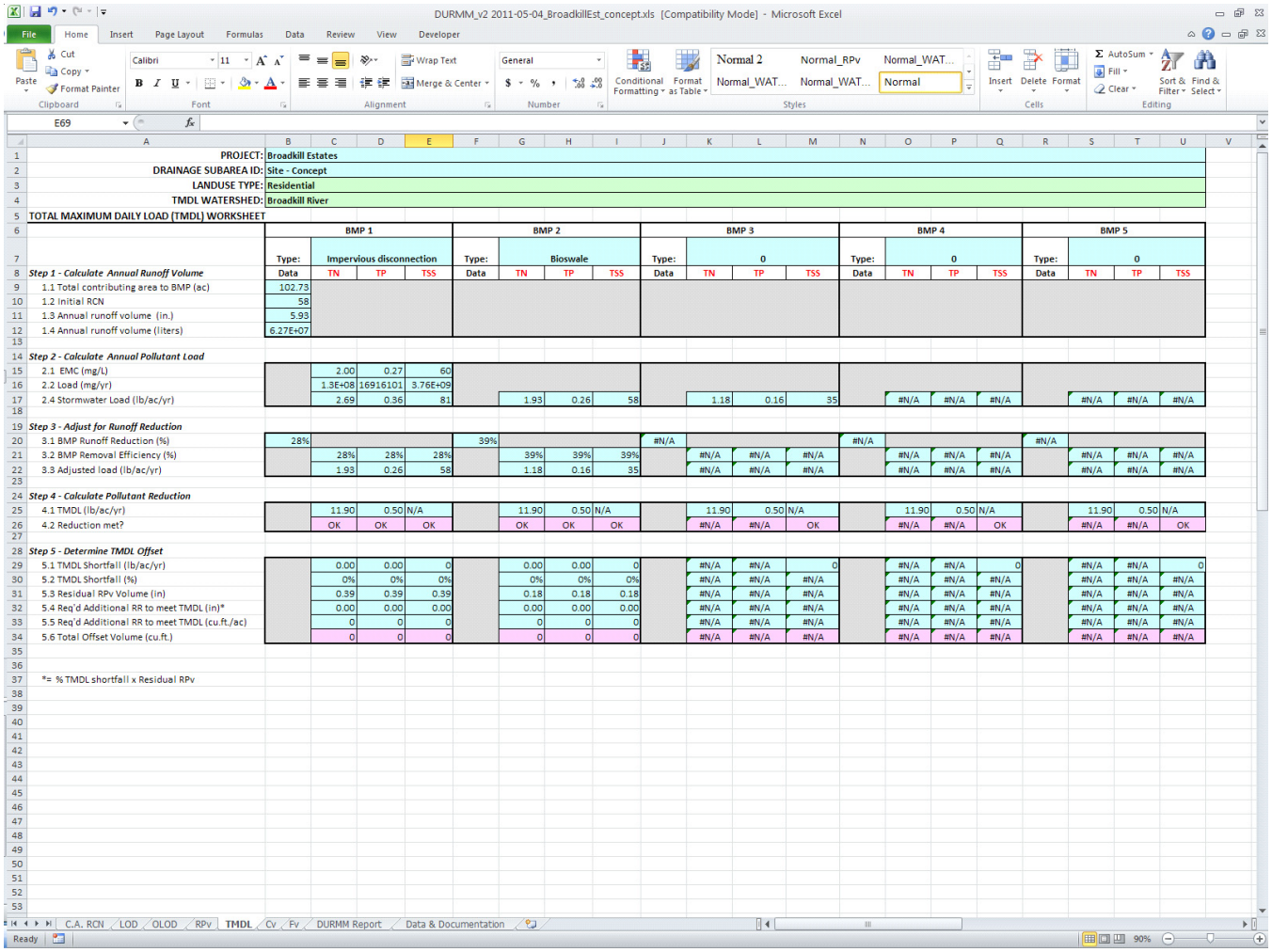
	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
	Type:	Impervious disconnection	Type:	Bioswale	Type:		Type:		Type:	
Step 1 - Calculate Initial RPv	Data		Data		Data		Data		Data	
1.1 Total contributing area to BMP (ac)	102.73		102.73		102.73		102.73		102.73	
1.2 *Reserved*										
1.3 C.A. RCN	57.97									
1.4 RPv for Contributing Area (in)	0.54									
1.5 Req'd RPv Reduction for Contributing Area (in)	0.28									
1.6 Req'd RPv Reduction for Contributing Area (%)	52%									
1.7 RPv allowable discharge rate (cfs)	2.32									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0		0				0		0	
2.2 Retention reduction allowance (%)	0%		0%		#N/A		#N/A		#N/A	
2.3 Retention reduction volume (ac-ft)	0.00		0.00		#N/A		#N/A		#N/A	
2.4 Retention reduction volume (in)	0.00		0.00		#N/A		#N/A		#N/A	
2.5 Runoff volume after retention reduction (in)	0.54		0.39		#N/A		#N/A		#N/A	
2.6 CN*	59.72		54.68		#N/A		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Annual CN (ACN)	57.97		54.68		45.79		#N/A		#N/A	
3.2 Annual runoff (in.)	5.93		4.84		2.60		#N/A		#N/A	
3.3 Proportion A/B soils in BMP footprint (%)	85%		85%							
3.4 Annual runoff reduction allowance (%)	19%		46%		0%		0%		0%	
3.7 Annual runoff after reduction (in.)	4.84		2.60		2.60		#N/A		#N/A	
3.8 Adjusted ACN	54.68		45.79		45.79		#N/A		#N/A	
Step 4 - Calculate RPv with BMP Reductions										
4.1 RPv runoff volume after all reductions (in.)	0.39		0.18		#N/A		#N/A		#N/A	
4.2 Total RPv runoff reduction (in)	0.15		0.36		#N/A		#N/A		#N/A	
4.3 Total RPv runoff reduction (%)	28%		67%		#N/A		#N/A		#N/A	
4.4 Equivalent TR-55 RCN for H&H modeling	65.33		57.67		#N/A		#N/A		#N/A	
4.5 Req'd reduction met?	No		OK		#N/A		#N/A		#N/A	
Step 5 - Determine Runoff Reduction Offset										
5.1 Runoff Reduction Shortfall (in)	0.13		0.00		#N/A		#N/A		#N/A	
5.2 Runoff Reduction Shortfall (cu.ft./ac)	462		0		#N/A		#N/A		#N/A	
5.3 Total Offset Volume (cu.ft.)	47420		0		#N/A		#N/A		#N/A	

"RPV" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The designer has selected a BMP treatment train consisting of impervious disconnection and dry bioswale. For conceptual purposes, the proportion of HSG A/B soils in the BMP footprint was assumed to be equal to the proportion of HSG A/B soils for the site itself (85%). The model has calculated the following results:

- Contributing area allowable discharge: 2.32 cfs
- Reduction after BMP 1: 0.15" (28%)
- Reduction after BMP 2: 0.36" (67%)

The contributing area allowable discharge is the equivalent 24-hr detention of the RPv runoff volume. This would be the maximum allowable discharge rate for any runoff volume that does not meet the required reduction. Annualized runoff reductions are used for BMPs that do not have a storage component, such as the impervious area disconnection and dry bioswale used in this example. Since infiltration BMPs will store and retain all the captured runoff, their reduction values are based on their storage capacity. A "No" in the magenta cells of Step 4 indicate additional runoff reduction is required in order to comply with the RPv. An "OK" in the magenta cells indicates the required reduction has been met. The reduction allowances for the BMP suite should be considered representative of the subarea as a whole rather than a strict hydraulic routing from one BMP to the next. Any shortfall subject to an offset for the RPv is calculated in Step 5 and shown in the mangenta cells. Since this example was able to meet the required runoff reduction with two BMPs, the total offset volume after BMP 2 is reported as "0".



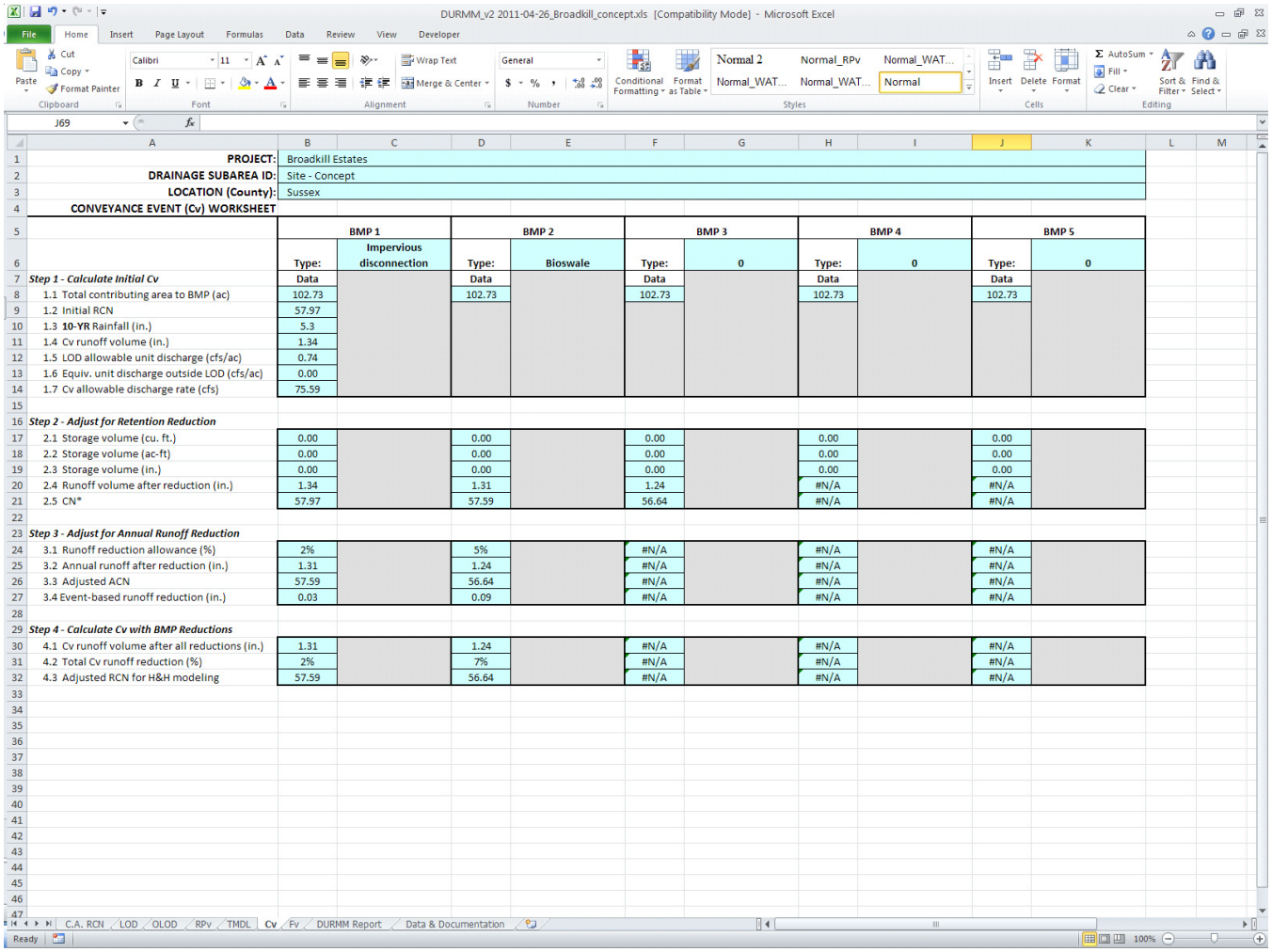
PROJECT:	Broadkill Estates																				
DRAINAGE SUBAREA ID:	Site - Concept																				
LANDUSE TYPE:	Residential																				
TMDL WATERSHED:	Broadkill River																				
TOTAL MAXIMUM DAILY LOAD (TMDL) WORKSHEET																					
	BMP 1				BMP 2				BMP 3				BMP 4				BMP 5				
	Type:	Impervious disconnection			Type:	Bioswale			Type:	0			Type:	0			Type:	0			
Step 1 - Calculate Annual Runoff Volume	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	
1.1 Total contributing area to BMP (ac)	102.73																				
1.2 Initial RCN	58																				
1.3 Annual runoff volume (in.)	5.93																				
1.4 Annual runoff volume (liters)	6.27E+07																				
Step 2 - Calculate Annual Pollutant Load																					
2.1 EMC (mg/L)		2.00	0.27	60																	
2.2 Load (mg/yr)		1.3E+08	16916101	3.76E+09																	
2.4 Stormwater Load (lb/ac/yr)		2.69	0.36	81		1.93	0.26	58		1.18	0.16	35		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	
Step 3 - Adjust for Runoff Reduction																					
3.1 BMP Runoff Reduction (%)	28%				39%				#N/A				#N/A				#N/A				
3.2 BMP Removal Efficiency (%)		28%	28%	28%		39%	39%	39%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	
3.3 Adjusted load (lb/ac/yr)		1.93	0.26	58		1.18	0.16	35		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	
Step 4 - Calculate Pollutant Reduction																					
4.1 TMDL (lb/ac/yr)		11.90	0.50	N/A		11.90	0.50	N/A		11.90	0.50	N/A		11.90	0.50	N/A		11.90	0.50	N/A	
4.2 Reduction met?		OK	OK	OK		OK	OK	OK		#N/A	#N/A	OK		#N/A	#N/A	OK		#N/A	#N/A	OK	
Step 5 - Determine TMDL Offset																					
5.1 TMDL Shortfall (lb/ac/yr)		0.00	0.00	0		0.00	0.00	0		#N/A	#N/A	0		#N/A	#N/A	0		#N/A	#N/A	0	
5.2 TMDL Shortfall (%)		0%	0%	0%		0%	0%	0%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	
5.3 Residual RPv Volume (in)		0.39	0.39	0.39		0.18	0.18	0.18		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	
5.4 Req'd Additional RR to meet TMDL (in)*		0.00	0.00	0.00		0.00	0.00	0.00		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	
5.5 Req'd Additional RR to meet TMDL (cu.ft./ac)		0	0	0		0	0	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	
5.6 Total Offset Volume (cu.ft.)		0	0	0		0	0	0		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A	
*= % TMDL shortfall x Residual RPv																					

"TMDL" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. Once the user selects the appropriate landuse category and TMDL watershed from the dropdown lists, the model calculates the total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS) loads for the subarea, as well as the reductions from the BMP suite selected on the "RPv" worksheet. The model has calculated the following results:

- Pollutant Load: 2.69 lb/ac/yr-TN; 0.36 lb/ac/yr-TP; 81 lb/ac/yr-TSS
- Pollutant load after BMP 1: 1.93 lb/ac/yr-TN; 0.26 lb/ac/yr-TP; 58 lb/ac/yr-TSS
- Pollutant load after BMP 2: 0.88 lb/ac/yr-TN; 0.16 lb/ac/yr-TP; 35 lb/ac/yr-TSS

Pollutant load is calculated using the RPv runoff volume and the Event Mean Concentration (EMC) values for the various pollutants that are integrated into the model. The model checks to determine whether the required pollutant reduction has been met. Since the Broadkill River does not have a regulatory TMDL for TSS, these cells are shown as "N/A". An "OK" in the magenta cells indicates that the load reduction has been met. In this example, the load reduction has been met as a result of meeting the RPv runoff reduction attributed to BMP 1, even though an additional BMP was needed to meet the runoff reduction requirement. In cases where runoff reduction practices have been used to the maximum extent practicable (MEP) without meeting the required pollutant reduction, the model uses removal efficiencies to determine the load reduction for stormwater treatment practices. Any shortfall for meeting the TMDL is shown as an equivalent volume offset in the magenta cells in Step 5.



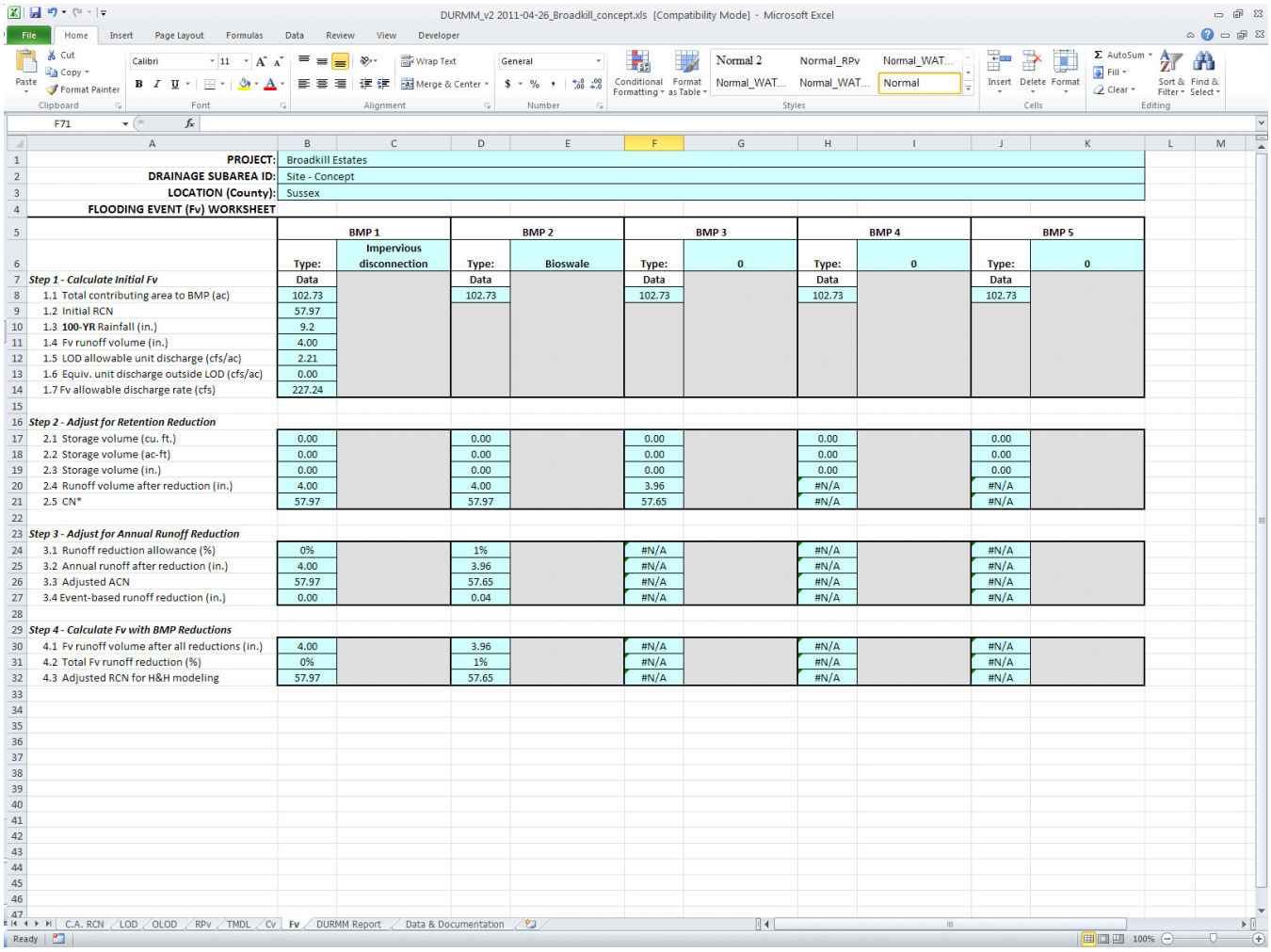
1	PROJECT:	Broadkill Estates								
2	DRAINAGE SUBAREA ID:	Site - Concept								
3	LOCATION (County):	Sussex								
4	CONVEYANCE EVENT (Cv) WORKSHEET									
5		BMP 1		BMP 2		BMP 3		BMP 4		BMP 5
6		Type:	Impervious disconnection	Type:	Bioswale	Type:	0	Type:	0	Type:	0
7	*Step 1 - Calculate Initial Cv*	Data		Data		Data		Data		Data	
8	1.1 Total contributing area to BMP (ac)	102.73		102.73		102.73		102.73		102.73	
9	1.2 Initial RCN	57.97									
10	1.3 **10-YR** Rainfall (in.)	5.3									
11	1.4 Cv runoff volume (in.)	1.34									
12	1.5 LOD allowable unit discharge (cfs/ac)	0.74									
13	1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
14	1.7 Cv allowable discharge rate (cfs)	75.59									
15											
16	*Step 2 - Adjust for Retention Reduction*										
17	2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
18	2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
19	2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
20	2.4 Runoff volume after reduction (in.)	1.34		1.31		1.24		#N/A		#N/A	
21	2.5 CN*	57.97		57.59		56.64		#N/A		#N/A	
22											
23	*Step 3 - Adjust for Annual Runoff Reduction*										
24	3.1 Runoff reduction allowance (%)	2%		5%		#N/A		#N/A		#N/A	
25	3.2 Annual runoff after reduction (in.)	1.31		1.24		#N/A		#N/A		#N/A	
26	3.3 Adjusted ACN	57.59		56.64		#N/A		#N/A		#N/A	
27	3.4 Event-based runoff reduction (in.)	0.03		0.09		#N/A		#N/A		#N/A	
28											
29	*Step 4 - Calculate Cv with BMP Reductions*										
30	4.1 Cv runoff volume after all reductions (in.)	1.31		1.24		#N/A		#N/A		#N/A	
31	4.2 Total Cv runoff reduction (%)	2%		7%		#N/A		#N/A		#N/A	
32	4.3 Adjusted RCN for H&H modeling	57.59		56.64		#N/A		#N/A		#N/A	

"Cv" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. There are no user-input cells on the "Cv" worksheet. The model has calculated the following results:

- Cv allowable discharge: 75.59 cfs
- Cv runoff volume after BMP 1: 1.31" (2% reduction)
- Cv runoff volume after BMP 2: 1.24" (7% reduction)

The allowable discharge is the previously calculated unit discharge for the Cv event multiplied by the acreage of the total contributing area. This is only applicable if the site qualifies for the standards-based approach for compliance. The runoff reduction values for the Cv event are adjusted downward, as discussed in the worksheet overview section.



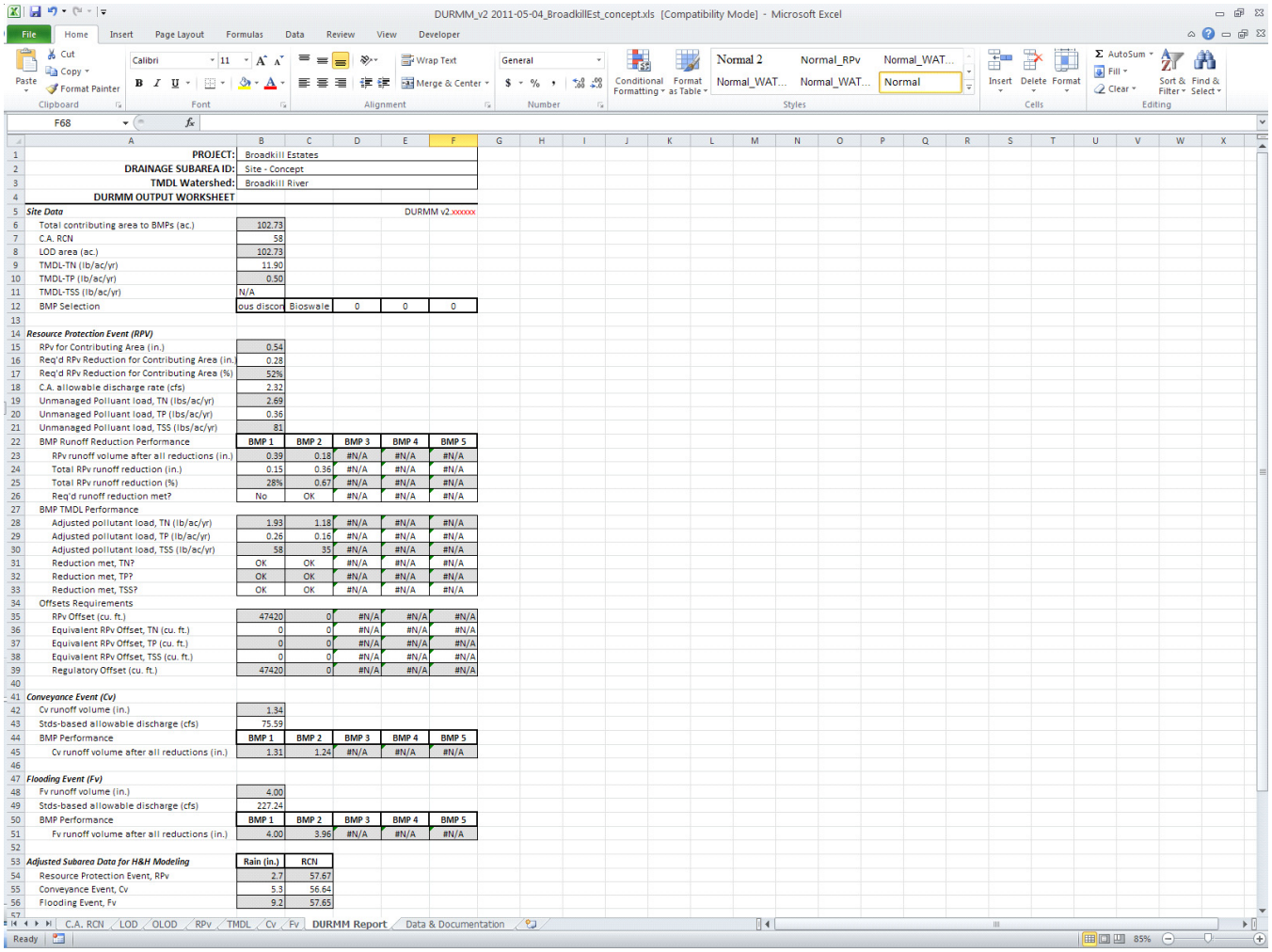
PROJECT:	Broadkill Estates									
DRAINAGE SUBAREA ID:	Site - Concept									
LOCATION (County):	Sussex									
FLOODING EVENT (Fv) WORKSHEET										
	BMP 1		**BMP 2**		**BMP 3**		**BMP 4**		**BMP 5**	
	Type:	**Impervious disconnection**	**Type:**	**Bioswale**	**Type:**	**0**	**Type:**	**0**	**Type:**	**0**
Step 1 - Calculate Initial Fv	**Data**		**Data**		**Data**		**Data**		**Data**	
1.1 Total contributing area to BMP (ac)	102.73		102.73		102.73		102.73		102.73	
1.2 Initial RCN	57.97									
1.3 **100-YR** Rainfall (in.)	9.2									
1.4 Fv runoff volume (in.)	4.00									
1.5 LOD allowable unit discharge (cfs/ac)	2.21									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.00									
1.7 Fv allowable discharge rate (cfs)	227.24									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	4.00		4.00		3.96		#N/A		#N/A	
2.5 CN*	57.97		57.97		57.65		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	0%		1%		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	4.00		3.96		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	57.97		57.65		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.00		0.04		#N/A		#N/A		#N/A	
Step 4 - Calculate Fv with BMP Reductions										
4.1 Fv runoff volume after all reductions (in.)	4.00		3.96		#N/A		#N/A		#N/A	
4.2 Total Fv runoff reduction (%)	0%		1%		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	57.97		57.65		#N/A		#N/A		#N/A	

"Fv" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. There are no user-input cells on the "Fv" worksheet. The model has calculated the following results:

- Fv allowable discharge: 227.24 cfs
- Fv runoff volume after BMP 1: 4.00" (0% reduction)
- Fv runoff volume after BMP 2: 3.96" (1% reduction)

The allowable discharge is the previously calculated unit discharge for the Fv event multiplied by the acreage of the total contributing area. This is only applicable if the site qualifies for the standards-based approach for compliance. The runoff reduction values for the Fv event are adjusted downward, as discussed in the worksheet overview section.



PROJECT:	Broadkill Estates				
DRAINAGE SUBAREA ID:	Site - Concept				
TMDL Watershed:	Broadkill River				
DURMM OUTPUT WORKSHEET					
Site Data				DURMM v2.xxxxx	
Total contributing area to BMPs (ac.)	102.73				
C.A. RCN	58				
LOD area (ac.)	102.73				
TMDL-TN (lb/ac/yr)	11.90				
TMDL-TP (lb/ac/yr)	0.50				
TMDL-TSS (lb/ac/yr)	N/A				
BMP Selection	ous discon	Bioswale	0	0	0
Resource Protection Event (RPV)					
RPv for Contributing Area (in.)	0.54				
Req'd RPv Reduction for Contributing Area (in.)	0.28				
Req'd RPv Reduction for Contributing Area (%)	52%				
C.A. allowable discharge rate (cfs)	2.32				
Unmanaged Polluant load, TN (lbs/ac/yr)	2.69				
Unmanaged Polluant load, TP (lbs/ac/yr)	0.36				
Unmanaged Polluant load, TSS (lbs/ac/yr)	81				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	0.39	0.18	#N/A	#N/A	#N/A
Total RPv runoff reduction (in.)	0.15	0.36	#N/A	#N/A	#N/A
Total RPv runoff reduction (%)	28%	0.67	#N/A	#N/A	#N/A
Req'd runoff reduction met?	No	OK	#N/A	#N/A	#N/A
BMP TMDL Performance					
Adjusted pollutant load, TN (lb/ac/yr)	1.93	1.18	#N/A	#N/A	#N/A
Adjusted pollutant load, TP (lb/ac/yr)	0.26	0.16	#N/A	#N/A	#N/A
Adjusted pollutant load, TSS (lb/ac/yr)	58	35	#N/A	#N/A	#N/A
Reduction met, TN?	OK	OK	#N/A	#N/A	#N/A
Reduction met, TP?	OK	OK	#N/A	#N/A	#N/A
Reduction met, TSS?	OK	OK	#N/A	#N/A	#N/A
Offsets Requirements					
RPv Offset (cu. ft.)	47420	0	#N/A	#N/A	#N/A
Equivalent RPv Offset, TN (cu. ft.)	0	0	#N/A	#N/A	#N/A
Equivalent RPv Offset, TP (cu. ft.)	0	0	#N/A	#N/A	#N/A
Equivalent RPv Offset, TSS (cu. ft.)	0	0	#N/A	#N/A	#N/A
Regulatory Offset (cu. ft.)	47420	0	#N/A	#N/A	#N/A
Conveyance Event (Cv)					
Cv runoff volume (in.)	1.34				
Stds-based allowable discharge (cfs)	75.59				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	1.31	1.24	#N/A	#N/A	#N/A
Flooding Event (Fv)					
Fv runoff volume (in.)	4.00				
Stds-based allowable discharge (cfs)	227.24				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	4.00	3.96	#N/A	#N/A	#N/A
Adjusted Subarea Data for H&H Modeling	Rain (in.)	RCN			
Resource Protection Event, RPv	2.7	57.67			
Conveyance Event, Cv	5.3	56.64			
Flooding Event, Fv	9.2	57.65			

"DURMM Report" Worksheet

The "DURMM Report" worksheet summarizes the results from the other worksheets. Information is filled into the cells automatically as the user progresses from worksheet to worksheet. The report includes the runoff volumes for the RPv, Cv and Fv, as well as the reductions for the various BMPs selected to manage the subarea. It also summarizes whether the site meets the required runoff reduction for the RPv and the required TMDL pollutant load reductions.

The last section of the report summarizes the adjustments to the RCN for the RPv, Cv and Fv that can be used for more detailed hydrologic and hydraulic modeling in more complex situations. These adjustments account for the equivalent lower RCN that results from using runoff reduction techniques.

In this example, the designer was able to show at the concept level that the use of runoff reduction practices could meet both the runoff reduction and pollutant reduction requirements of the DSSR.

DURMM v.2

"Broadkill Estates" Example Site
Ex. #2: Design Level Analysis

Example #2: Design Level Analysis

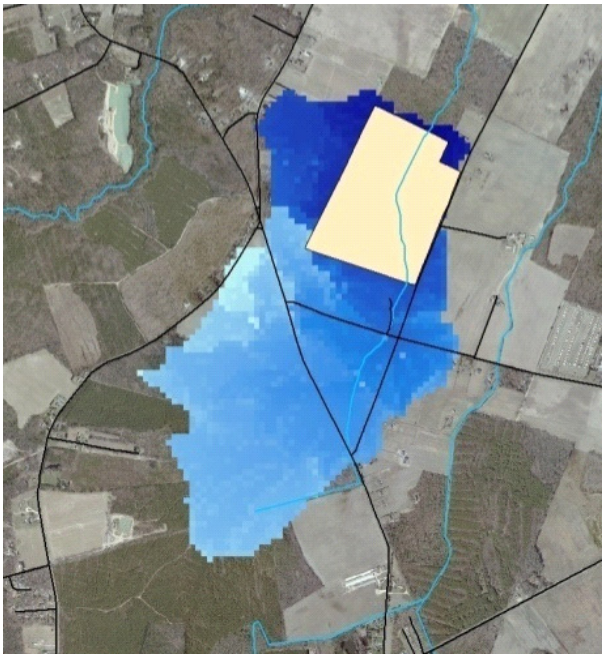
The procedures used for the concept level analysis will now be further refined to perform a design level analysis for one of the drainage subareas of "Broadkill Estates".

Design Level Analysis

Site Layout

At the design level, the lot and road layout have typically been determined, as well as the general proposed grading and drainage patterns.

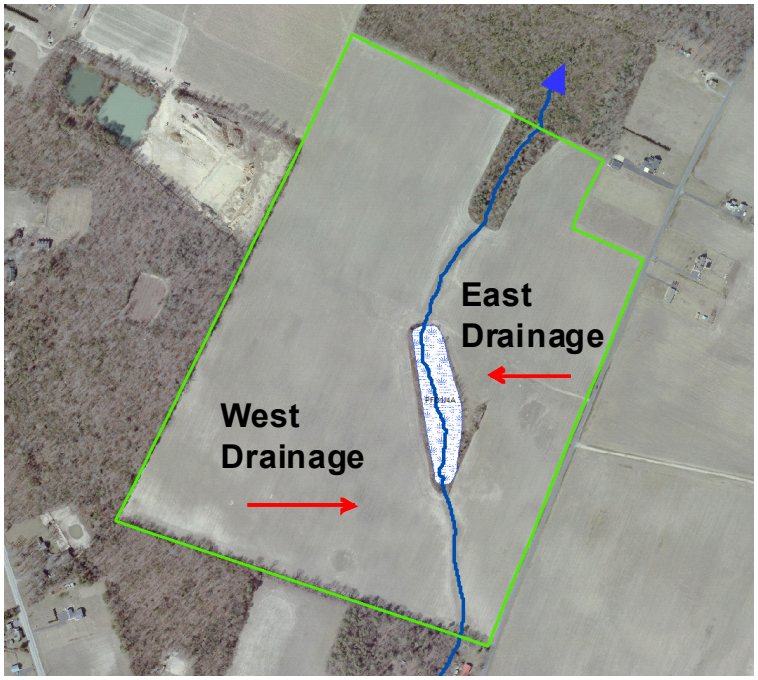
Design Level Analysis



Hydrologic Analysis

The concept level analysis assumed an artificial drainage boundary that coincided with the parcel boundary. This is rarely the case in practice. The more typical situation is illustrated by the "Broadkill Estates" example site in which significant offsite areas drain through the site. In addition, there are incidental areas which drain onto the site around the site boundary. Both these situations must ultimately be considered in the final design. For the purposes of this example, it will be assumed that the larger upstream area will be allowed to pass through the site relatively unmanaged. This will require that the site runoff be managed prior to discharge into the tributary stream. Although incidental offsite areas that would be captured by the selected BMP suite do not need to be managed to the same level as the area within the site LOD, they will still need to be accounted for in the design of the BMPs. The following slides illustrate how DURMM v.2 is used to perform the analysis and check for compliance with the requirements of the DSSR.

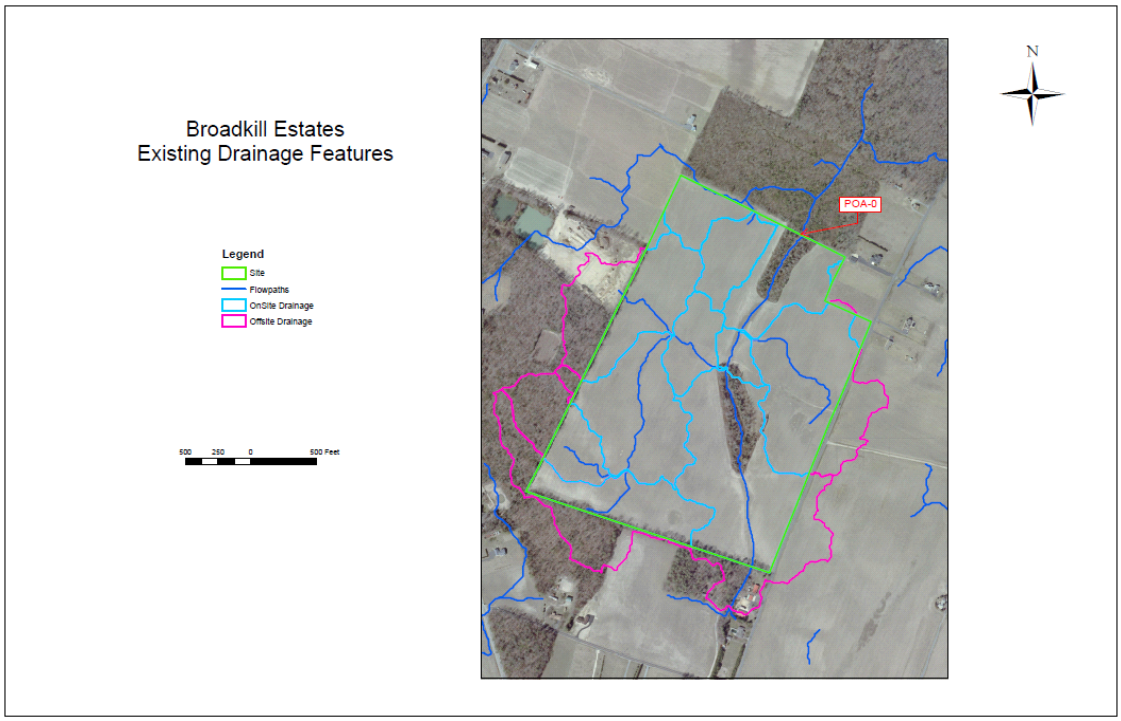
Design Level Analysis



Onsite Drainage

As described in the concept level analysis, the site is bisected by a tributary stream that runs from south to north. This site drainage is therefore characterized by a west drainage subarea and an east drainage subarea.

Design Level Analysis



Offsite Drainage

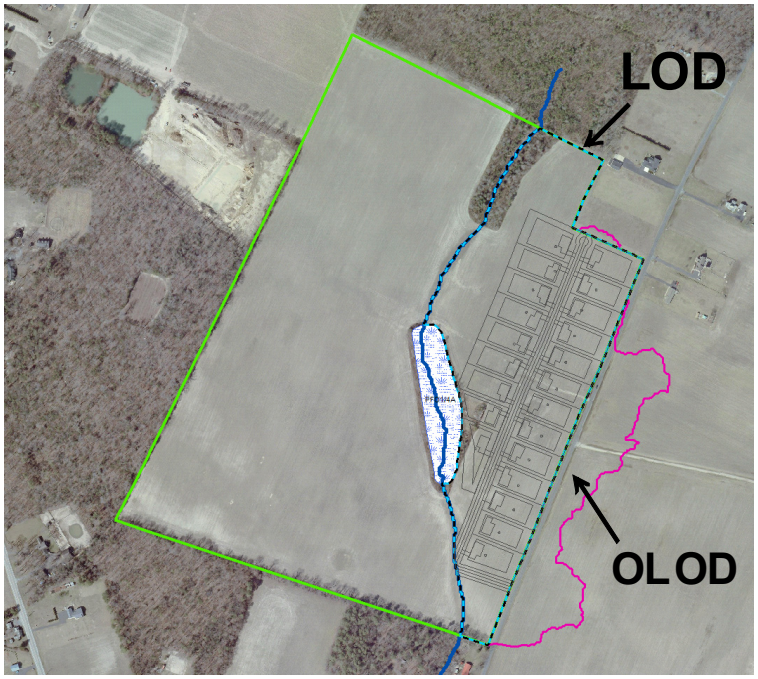
The “Existing Drainage Features” map included in the Project Application Package is helpful to determine any offsite drainage areas that must be accounted for in the final BMP design for the site.

Design Level Analysis

Site Design

For the purposes of this example, the proposed lot and road layout for the east drainage subarea will be analyzed. The area outside the lots will be designated as common open space.

Design Level Analysis



LOD vs. OLOD

The DSSR require that only those areas that are disturbed during the construction of the project must be managed. When designing BMPs to manage those areas, however, it is likely that undisturbed areas may contribute drainage to them. These undisturbed areas which are outside the limit of disturbance may be either onsite or offsite. DURMM v.2 can account for this situation by calculating a weighted RPv runoff volume that reflects the LOD runoff as well as the OLOD runoff. The runoff reduction requirement for the LOD is then adjusted for the total contributing area.

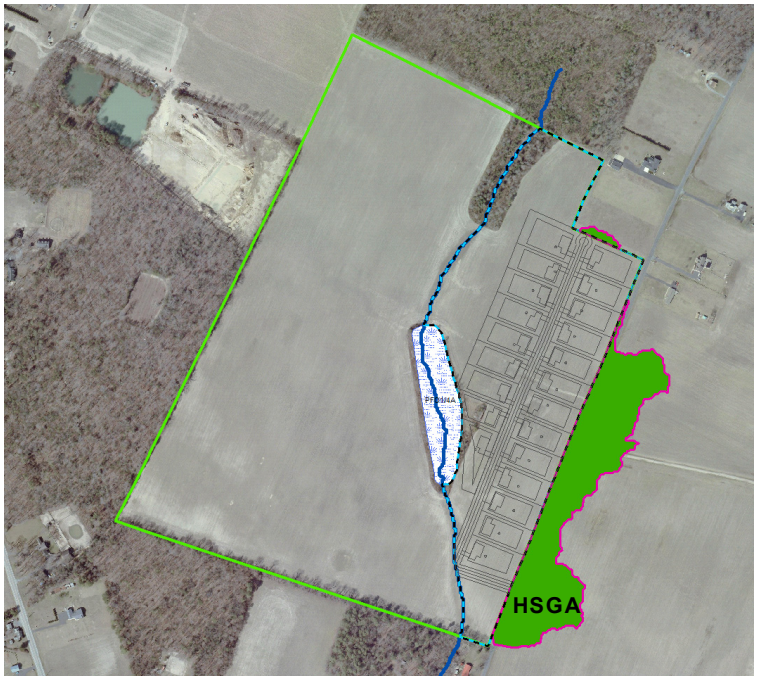
For the purposes of this example, the LOD for the east drainage subarea is bounded by the tributary stream and parcel boundary, excluding the wetland area. The OLOD consists of an area to the east of the property boundary that is currently in cropland.

Design Level Analysis

Soils Data - LOD

The LOD area consists mainly of soils in HSG A, with a small area of soils in HSG B adjacent to the stream.

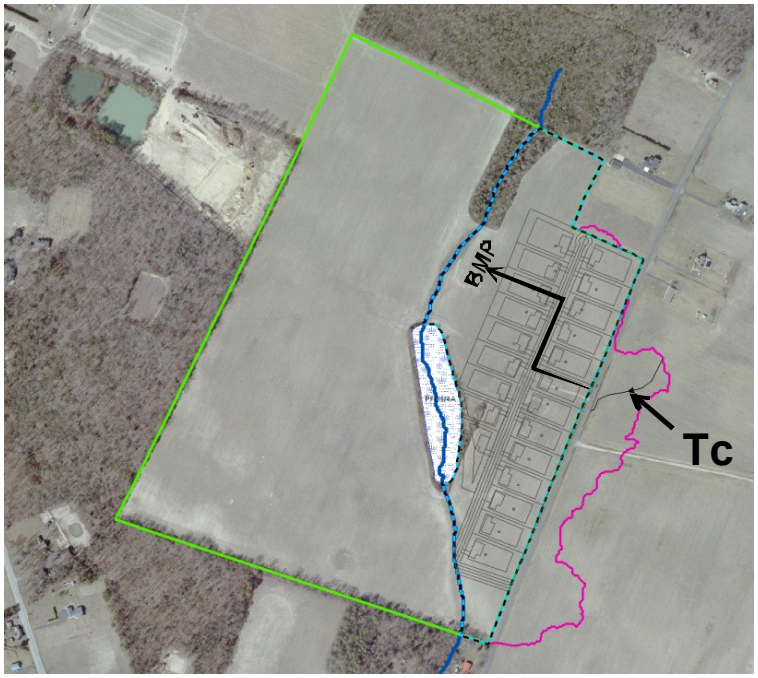
Design Level Analysis



Soils Data – OLOD

The area outside the LOD consists entirely of soils in HSG A.

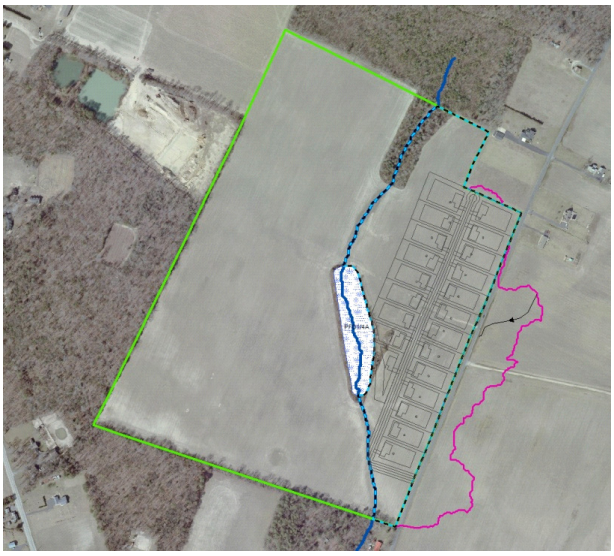
Design Level Analysis



OLOD – Time of Concentration

For areas within the LOD, the allowable discharges for the Cv and Fv under the standards-based approach are prescribed in the DSSR. However, these allowable discharges do not apply to areas outside the LOD. DURMM v.2 is capable of determining a weighted allowable discharge for the entire contributing area. This requires the user to enter an estimate of the time of concentration (Tc) for the area outside the LOD. Since the OLOD areas are often irregular in shape, it is adequate for the user to designate a single representative Tc path for the entire OLOD area for any particular subarea under analysis. The Tc path should be carried through to the final onsite stormwater management BMP in the flowpath.

Design Level Analysis
Site Data

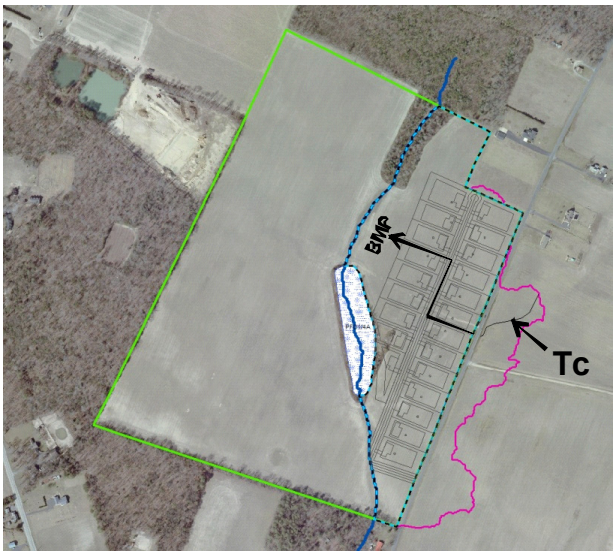


- C.A. RCN Tab
  - Row Crops, SR + Crop Residue
    - HSG A: 9.68 ac.
  - Open space
    - HSG A: 8.06 ac.
    - HSG B: 2.26 ac
  - 1-ac. residential (20 % imperv.)
    - HSG A: 21.17 ac.
    - HSG B: 0.73 ac

<u>Data Inputs – "C.A. RCN" Worksheet</u>

The slide above summarizes the data that will be input to the "C.A. RCN" worksheet.

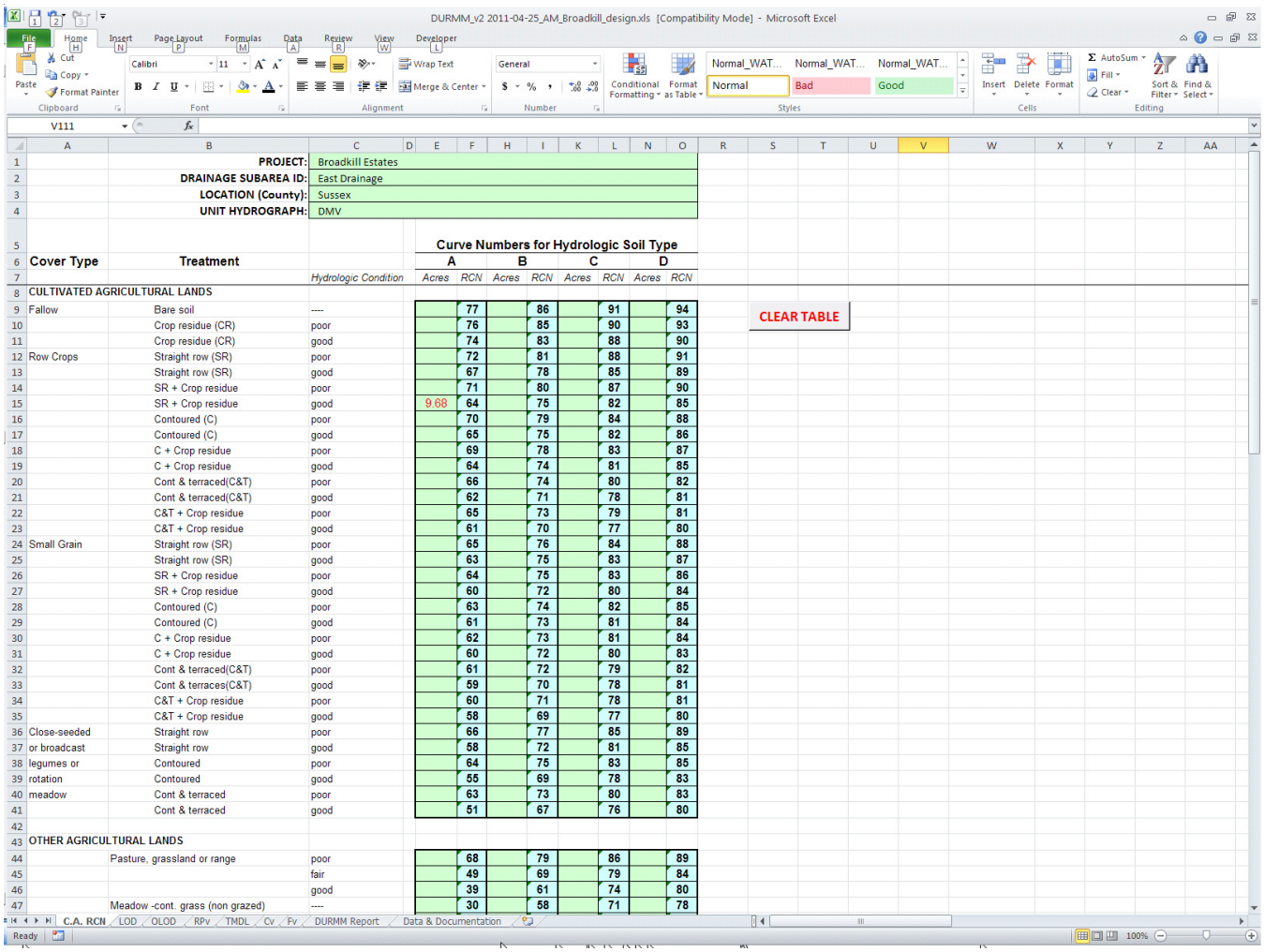
Design Level Analysis
Site Data (cont.)



- LOD Tab
  - HSG A
    - LOD area: 29.22 ac.
    - Pre-Dev. Woods: 1.55 ac.
    - Post-Dev. Impervious: 4.23 ac.
  - HSG B
    - LOD area: 2.99 ac.
    - Pre-Dev. Woods: 0 ac.
    - Post-Dev. Impervious: 0.15 ac.
- OLOD Tab
  - Sheet Flow, 100 ft, 0.001 ft/ft, "d"
  - Shallow Conc., 300 ft, 0.002 ft/ft, "u"
  - Channel Flow, 1000 ft, 0.01 ft/ft, 1 fps

<u>Data Inputs – "LOD" and "OLOD" Worksheets</u>

The slide above summarizes the data that will be input to the "LOD" and "OLOD" worksheets.



DURMM_v2 2011-04-25_AM_Broadkill_design.xls [Compatibility Mode] - Microsoft Excel

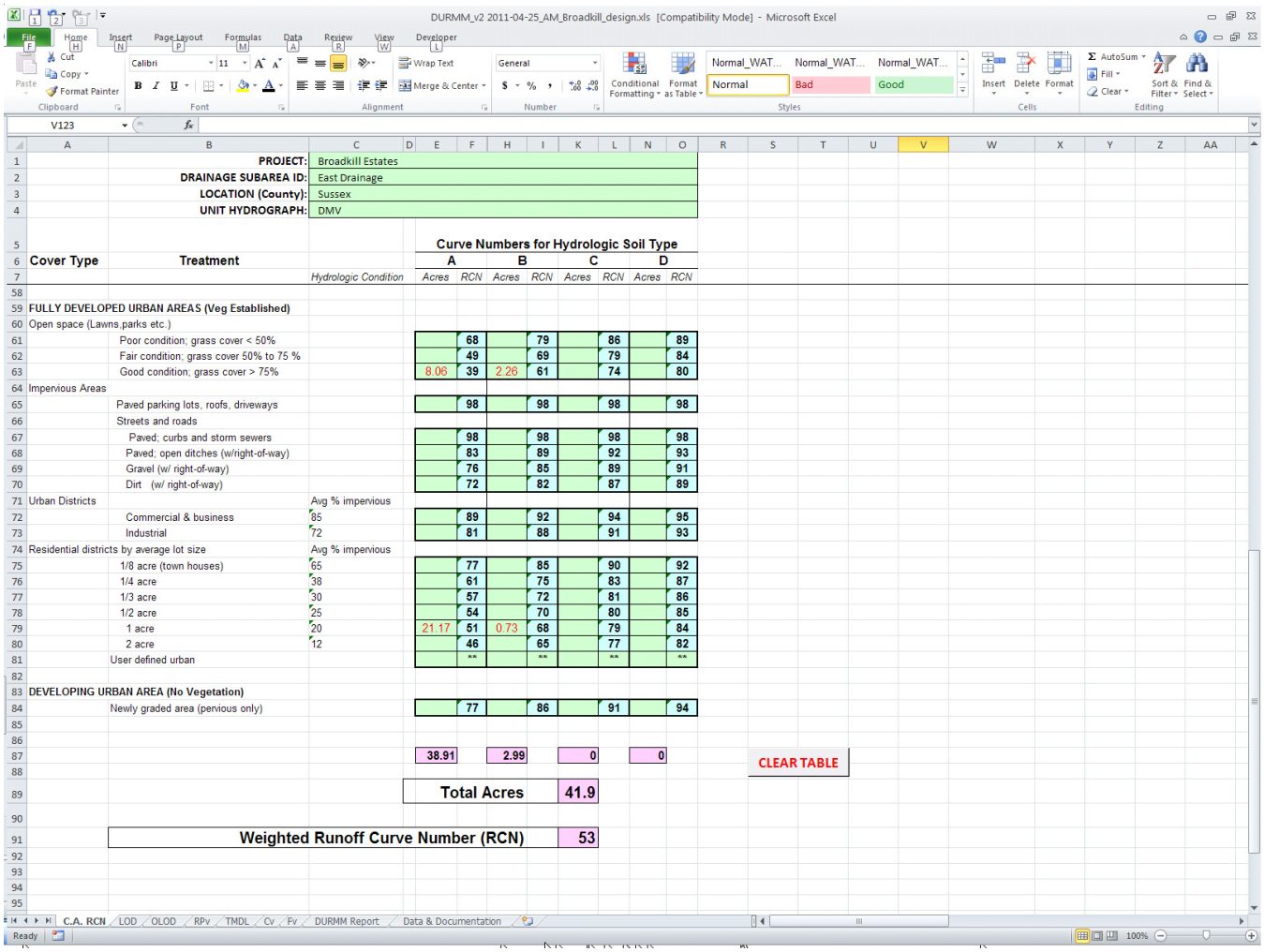
PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
LOCATION (County):	Sussex
UNIT HYDROGRAPH:	DMV

CLEAR TABLE

Cover Type	Treatment	Hydrologic Condition	A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
CULTIVATED AGRICULTURAL LANDS										
Fallow	Bare soil	----		77		86		91		94
	Crop residue (CR)	poor		76		85		90		93
	Crop residue (CR)	good		74		83		88		90
Row Crops	Straight row (SR)	poor		72		81		88		91
	Straight row (SR)	good		67		78		85		89
	SR + Crop residue	poor		71		80		87		90
	SR + Crop residue	good	9.68	64		75		82		85
	Contoured (C)	poor		70		79		84		88
	Contoured (C)	good		65		75		82		86
	C + Crop residue	poor		69		78		83		87
	C + Crop residue	good		64		74		81		85
	Cont & terraced(C&T)	poor		66		74		80		82
	Cont & terraced(C&T)	good		62		71		78		81
	C&T + Crop residue	poor		65		73		79		81
	C&T + Crop residue	good		61		70		77		80
Small Grain	Straight row (SR)	poor		65		76		84		88
	Straight row (SR)	good		63		75		83		87
	SR + Crop residue	poor		64		75		83		86
	SR + Crop residue	good		60		72		80		84
	Contoured (C)	poor		63		74		82		85
	Contoured (C)	good		61		73		81		84
	C + Crop residue	poor		62		73		81		84
	C + Crop residue	good		60		72		80		83
	Cont & terraced(C&T)	poor		61		72		79		82
	Cont & terraces(C&T)	good		59		70		78		81
	C&T + Crop residue	poor		60		71		78		81
	C&T + Crop residue	good		58		69		77		80
Close-seeded	Straight row	poor		66		77		85		89
or broadcast	Straight row	good		58		72		81		85
legumes or	Contoured	poor		64		75		83		85
rotation	Contoured	good		55		69		78		83
meadow	Cont & terraced	poor		63		73		80		83
	Cont & terraced	good		51		67		76		80
OTHER AGRICULTURAL LANDS										
	Pasture, grassland or range	poor		68		79		86		89
		fair		49		69		79		84
		good		39		61		74		80
	Meadow -cont. grass (non grazed)	----		30		58		71		78

"C.A. RCN" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above for the OLOD area. Note that the user must scroll up to the input cells associated with agricultural land uses. RCN data for the urban land uses within the LOD area are shown on the next slide.



DURMM_v2 2011-04-25_AM_Broadkill_design.xls [Compatibility Mode] - Microsoft Excel

PROJECT:	Broadkill Estates	
DRAINAGE SUBAREA ID:	East Drainage	
LOCATION (County):	Sussex	
UNIT HYDROGRAPH:	DMV	

Cover Type	Treatment	Hydrologic Condition	Curve Numbers for Hydrologic Soil Type A Acres	A RCN	B Acres	B RCN	C Acres	C RCN	D Acres	D RCN
FULLY DEVELOPED URBAN AREAS (Veg Established)										
Open space (Lawns,parks etc.)										
	Poor condition; grass cover < 50%			68		79		86		89
	Fair condition; grass cover 50% to 75 %			49		69		79		84
	Good condition; grass cover > 75%		8.06	39	2.26	61		74		80
Impervious Areas										
	Paved parking lots, roofs, driveways			98		98		98		98
	Streets and roads									
	Paved; curbs and storm sewers			98		98		98		98
	Paved; open ditches (w/right-of-way)			83		89		92		93
	Gravel (w/ right-of-way)			76		85		89		91
	Dirt (w/ right-of-way)			72		82		87		89
Urban Districts		Avg % impervious								
	Commercial & business	85		89		92		94		95
	Industrial	72		81		88		91		93
Residential districts by average lot size		Avg % impervious								
	1/8 acre (town houses)	65		77		85		90		92
	1/4 acre	38		61		75		83		87
	1/3 acre	30		57		72		81		86
	1/2 acre	25		54		70		80		85
	1 acre	20	21.17	51	0.73	68		79		84
	2 acre	12		46		65		77		82
	User defined urban			**		**		**		**
DEVELOPING URBAN AREA (No Vegetation)										
	Newly graded area (pervious only)			77		86		91		94
			38.91		2.99		0		0	

Total Acres 41.9

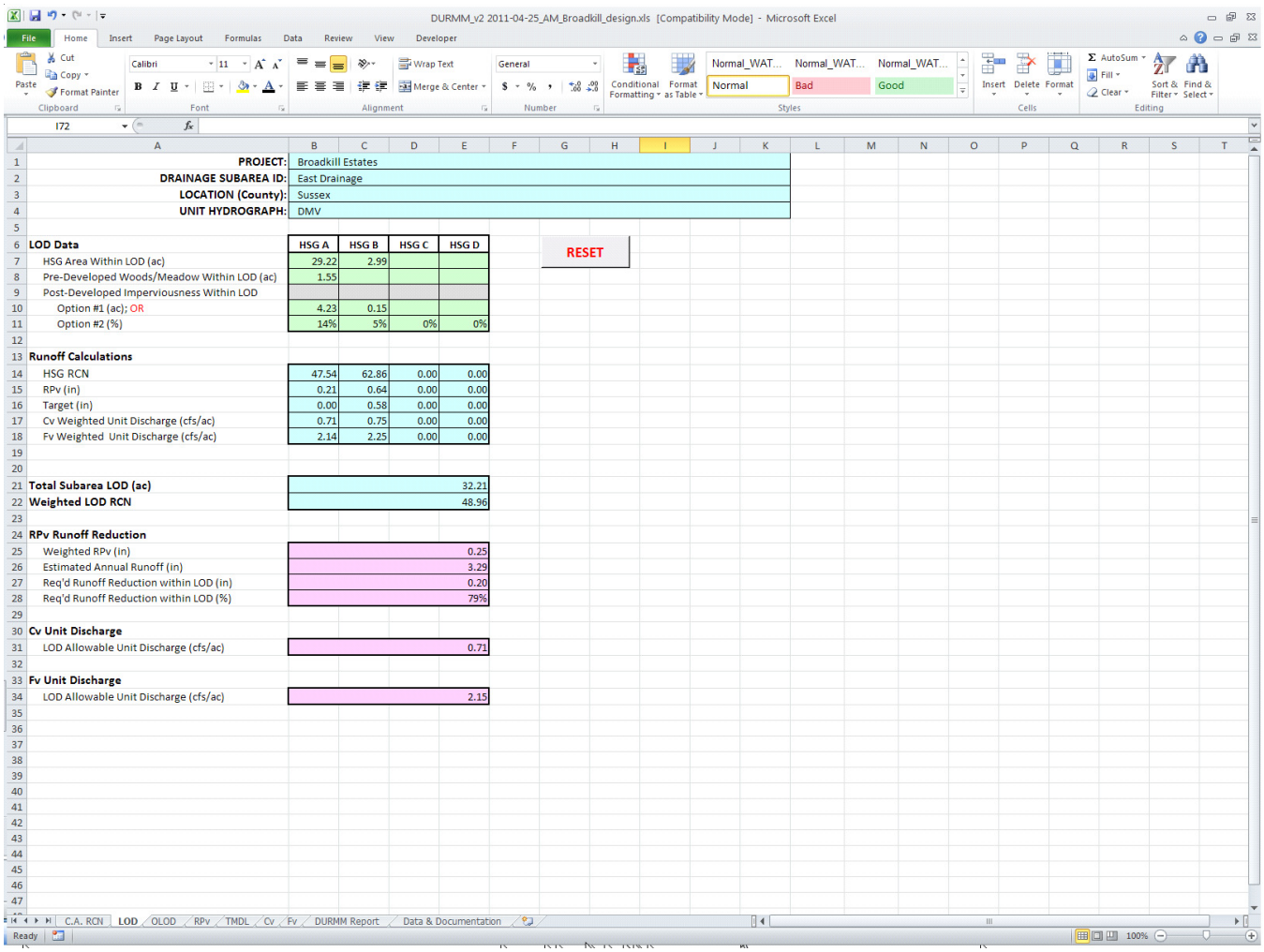
Weighted Runoff Curve Number (RCN) 53

CLEAR TABLE

"C.A. RCN" Worksheet (cont.)

The remaining data inputs/outputs for this worksheet are illustrated in the slide above. The model has calculated the following results:

- Total Acreage: 41.9
- Weighted RCN: 53



PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
LOCATION (County):	Sussex
UNIT HYDROGRAPH:	DMV

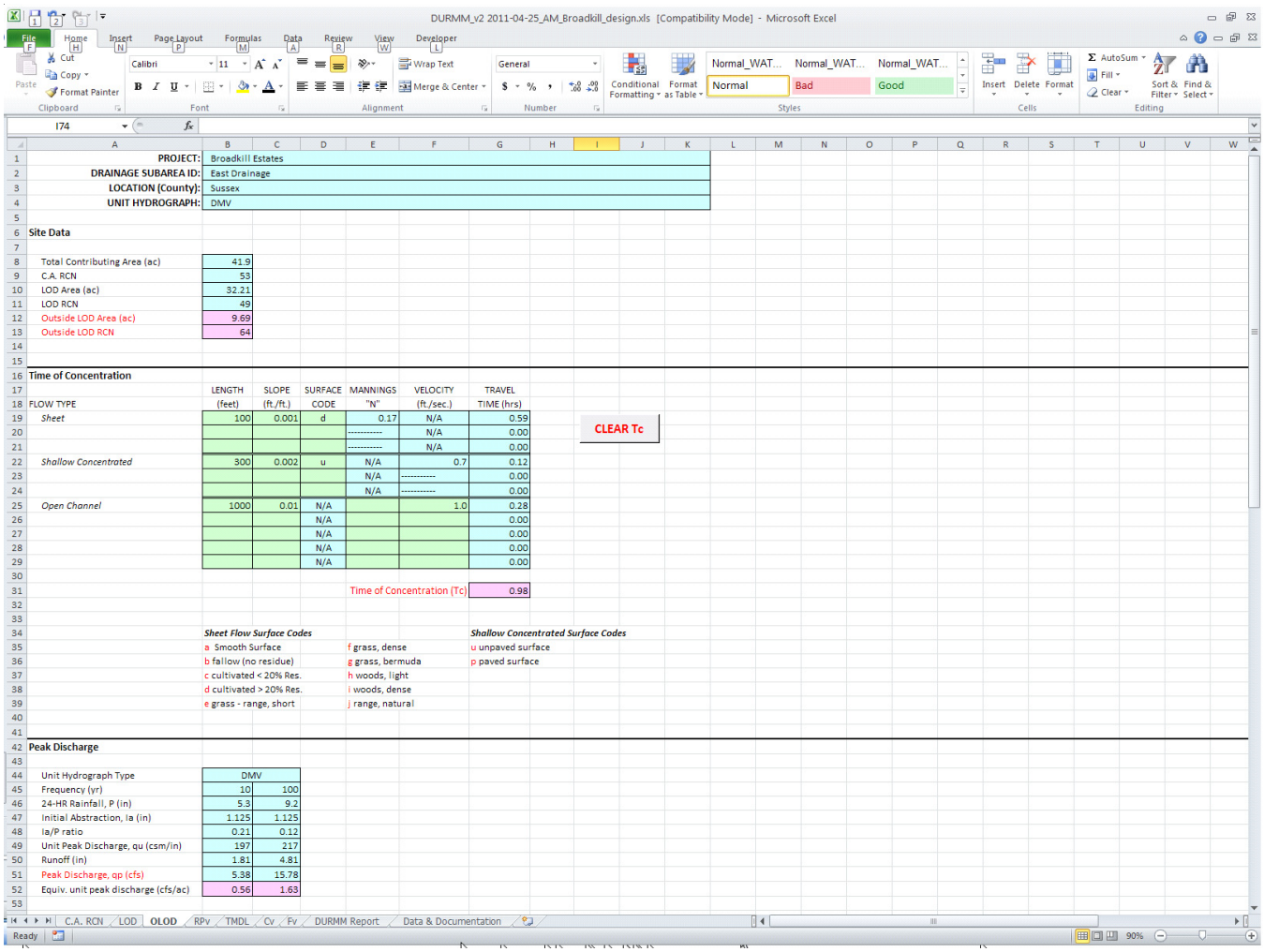
RESET

LOD Data	HSG A	HSG B	HSG C	HSG D
HSG Area Within LOD (ac)	29.22	2.99		
Pre-Developed Woods/Meadow Within LOD (ac)	1.55			
Post-Developed Imperviousness Within LOD				
Option #1 (ac); OR	4.23	0.15		
Option #2 (%)	14%	5%	0%	0%
Runoff Calculations				
HSG RCN	47.54	62.86	0.00	0.00
RPv (in)	0.21	0.64	0.00	0.00
Target (in)	0.00	0.58	0.00	0.00
Cv Weighted Unit Discharge (cfs/ac)	0.71	0.75	0.00	0.00
Fv Weighted Unit Discharge (cfs/ac)	2.14	2.25	0.00	0.00
Total Subarea LOD (ac)				32.21
Weighted LOD RCN				48.96
RPv Runoff Reduction				
Weighted RPv (in)				0.25
Estimated Annual Runoff (in)				3.29
Req'd Runoff Reduction within LOD (in)				0.20
Req'd Runoff Reduction within LOD (%)				79%
Cv Unit Discharge				
LOD Allowable Unit Discharge (cfs/ac)				0.71
Fv Unit Discharge				
LOD Allowable Unit Discharge (cfs/ac)				2.15

"LOD" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The model has calculated the following results.

- Total LOD Acreage: 32.21
- Weighted LOD RCN: 48.96
- Weighted RPV runoff volume: 0.25"
- Estimated annual runoff: 3.29"
- Required runoff reduction: 0.20" (79%)
- Allowable unit discharge for Cv: 0.71 cfs/ac
- Allowable unit discharge for Fv: 2.15 cfs/ac



PROJECT:	Broadkill Estates
DRAINAGE SUBAREA ID:	East Drainage
LOCATION (County):	Sussex
UNIT HYDROGRAPH:	DMV

Site Data

Total Contributing Area (ac)	41.9
C.A. RCN	53
LOD Area (ac)	32.21
LOD RCN	49
Outside LOD Area (ac)	9.69
Outside LOD RCN	64

Time of Concentration

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE CODE	MANNINGS "N"	VELOCITY (ft./sec.)	TRAVEL TIME (hrs)
Sheet	100	0.001	d	0.17	N/A	0.59
				----------	N/A	0.00
				----------	N/A	0.00
Shallow Concentrated	300	0.002	u	N/A	0.7	0.12
				N/A	----------	0.00
				N/A	----------	0.00
Open Channel	1000	0.01	N/A		1.0	0.28
			N/A			0.00
			N/A			0.00
			N/A			0.00
			N/A			0.00
				Time of Concentration (Tc)		0.98

CLEAR Tc

Sheet Flow Surface Codes		*Shallow Concentrated Surface Codes*
a Smooth Surface	f grass, dense	u unpaved surface
b fallow (no residue)	g grass, bermuda	p paved surface
c cultivated < 20% Res.	h woods, light	
d cultivated > 20% Res.	i woods, dense	
e grass - range, short	j range, natural	

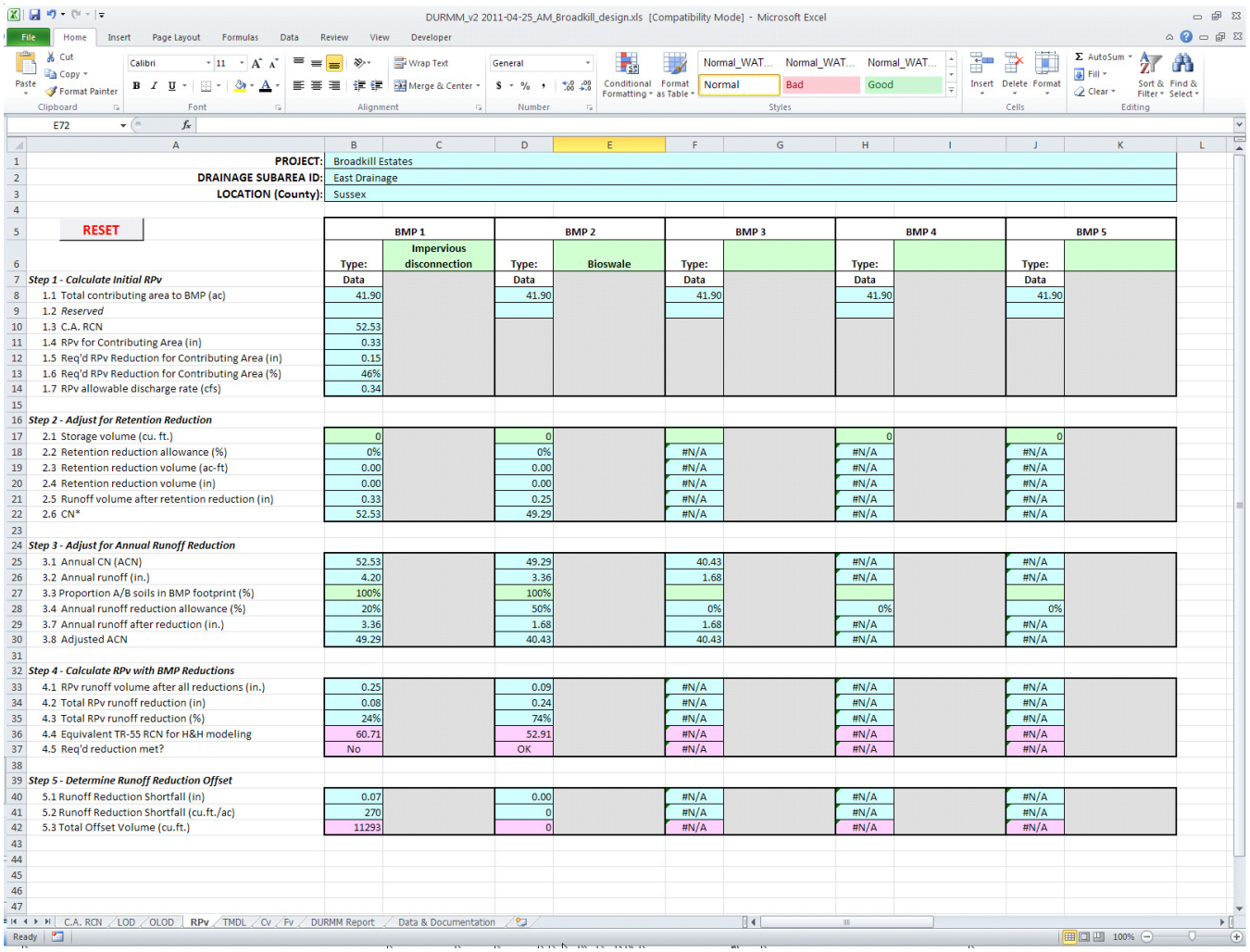
Peak Discharge

Unit Hydrograph Type	DMV	
Frequency (yr)	10	100
24-HR Rainfall, P (in)	5.3	9.2
Initial Abstraction, Ia (in)	1.125	1.125
Ia/P ratio	0.21	0.12
Unit Peak Discharge, qu (csm/in)	197	217
Runoff (in)	1.81	4.81
Peak Discharge, qp (cfs)	5.38	15.78
Equiv. unit peak discharge (cfs/ac)	0.56	1.63

"OLOD" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The model has calculated the following results:

- OLOD Acreage: 9.69
- OLOD RCN: 64
- OLOD Tc: 0.98 hrs
- OLOD Peak Discharge (Cv): 5.38 cfs
- OLOD Equiv. Unit Discharge (Cv): 0.56 cfs/ac
- OLOD Peak Discharge (Fv): 15.78 cfs
- OLOD Equiv. Unit Discharge (Fv): 1.63 cfs/ac



DURMM_v2 2011-04-25_AM_Broadkill_design.xls [Compatibility Mode] - Microsoft Excel

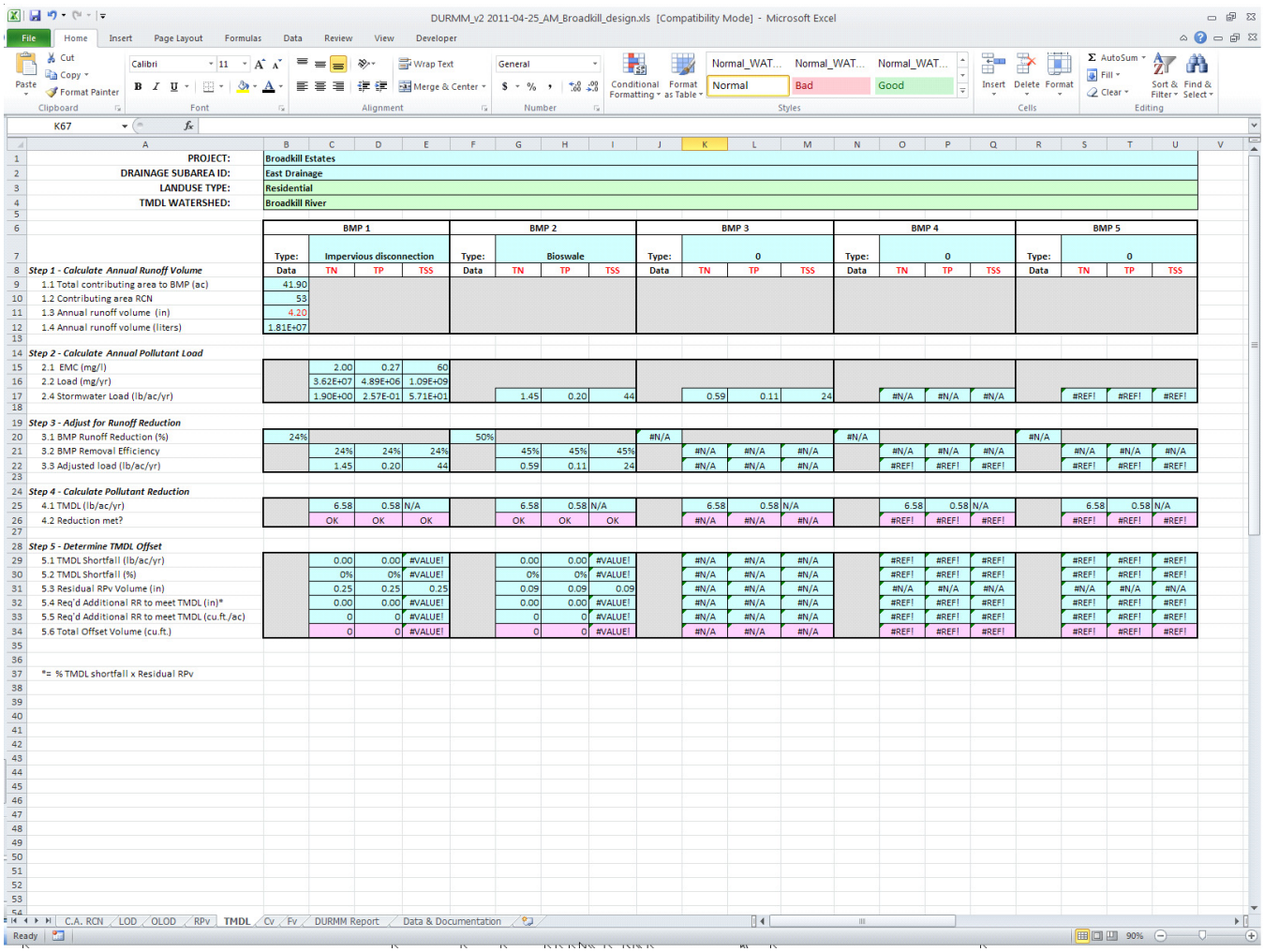
1	PROJECT:	Broadkill Estates									
2	DRAINAGE SUBAREA ID:	East Drainage									
3	LOCATION (County):	Sussex									
4											
5	RESET	BMP 1		BMP 2		BMP 3		BMP 4		BMP 5	
6		Type:	Impervious disconnection	Type:	Bioswale	Type:		Type:		Type:	
7	*Step 1 - Calculate Initial RPv*	Data		Data		Data		Data		Data	
8	1.1 Total contributing area to BMP (ac)	41.90		41.90		41.90		41.90		41.90	
9	1.2 *Reserved*										
10	1.3 C.A. RCN	52.53									
11	1.4 RPv for Contributing Area (in)	0.33									
12	1.5 Req'd RPv Reduction for Contributing Area (in)	0.15									
13	1.6 Req'd RPv Reduction for Contributing Area (%)	46%									
14	1.7 RPv allowable discharge rate (cfs)	0.34									
15											
16	*Step 2 - Adjust for Retention Reduction*										
17	2.1 Storage volume (cu. ft.)	0		0				0		0	
18	2.2 Retention reduction allowance (%)	0%		0%		#N/A		#N/A		#N/A	
19	2.3 Retention reduction volume (ac-ft)	0.00		0.00		#N/A		#N/A		#N/A	
20	2.4 Retention reduction volume (in)	0.00		0.00		#N/A		#N/A		#N/A	
21	2.5 Runoff volume after retention reduction (in)	0.33		0.25		#N/A		#N/A		#N/A	
22	2.6 CN*	52.53		49.29		#N/A		#N/A		#N/A	
23											
24	*Step 3 - Adjust for Annual Runoff Reduction*										
25	3.1 Annual CN (ACN)	52.53		49.29		40.43		#N/A		#N/A	
26	3.2 Annual runoff (in.)	4.20		3.36		1.68		#N/A		#N/A	
27	3.3 Proportion A/B soils in BMP footprint (%)	100%		100%							
28	3.4 Annual runoff reduction allowance (%)	20%		50%		0%		0%		0%	
29	3.7 Annual runoff after reduction (in.)	3.36		1.68		1.68		#N/A		#N/A	
30	3.8 Adjusted ACN	49.29		40.43		40.43		#N/A		#N/A	
31											
32	*Step 4 - Calculate RPv with BMP Reductions*										
33	4.1 RPv runoff volume after all reductions (in.)	0.25		0.09		#N/A		#N/A		#N/A	
34	4.2 Total RPv runoff reduction (in)	0.08		0.24		#N/A		#N/A		#N/A	
35	4.3 Total RPv runoff reduction (%)	24%		74%		#N/A		#N/A		#N/A	
36	4.4 Equivalent TR-55 RCN for H&H modeling	60.71		52.91		#N/A		#N/A		#N/A	
37	4.5 Req'd reduction met?	No		OK		#N/A		#N/A		#N/A	
38											
39	*Step 5 - Determine Runoff Reduction Offset*										
40	5.1 Runoff Reduction Shortfall (in)	0.07		0.00		#N/A		#N/A		#N/A	
41	5.2 Runoff Reduction Shortfall (cu.ft./ac)	270		0		#N/A		#N/A		#N/A	
42	5.3 Total Offset Volume (cu.ft.)	11293		0		#N/A		#N/A		#N/A	

"RPV" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The same BMP treatment train consisting of impervious area disconnection and dry bioswale as used in the concept level analysis will be used. However, since the entire developed site area consists of HSG A/B soils, the proportion of HSG A/B soils in the BMP footprint has been increased to 100%. The model has calculated the following results:

- Contributing area allowable discharge: 0.34 cfs
- Reduction after BMP 1: 0.08" (24%)
- Reduction after BMP 2: 0.24" (74%)

Note that the required reduction of 0.20" for the 32.21 acre LOD as determined on the "LOD" worksheet has been adjusted to 0.15" for the entire contributing area of 41.9 acres. Similarly, the required 79% reduction requirement has been adjusted to 46% based on the combined LOD and OLOD areas. As with the conceptual design, impervious disconnection and a dry bioswale are adequated to meet the runoff reduction requirements for the RPv thus the offset volume is "0".



DURMM_v2 2011-04-25_AM_Broadkill_design.xls [Compatibility Mode] - Microsoft Excel

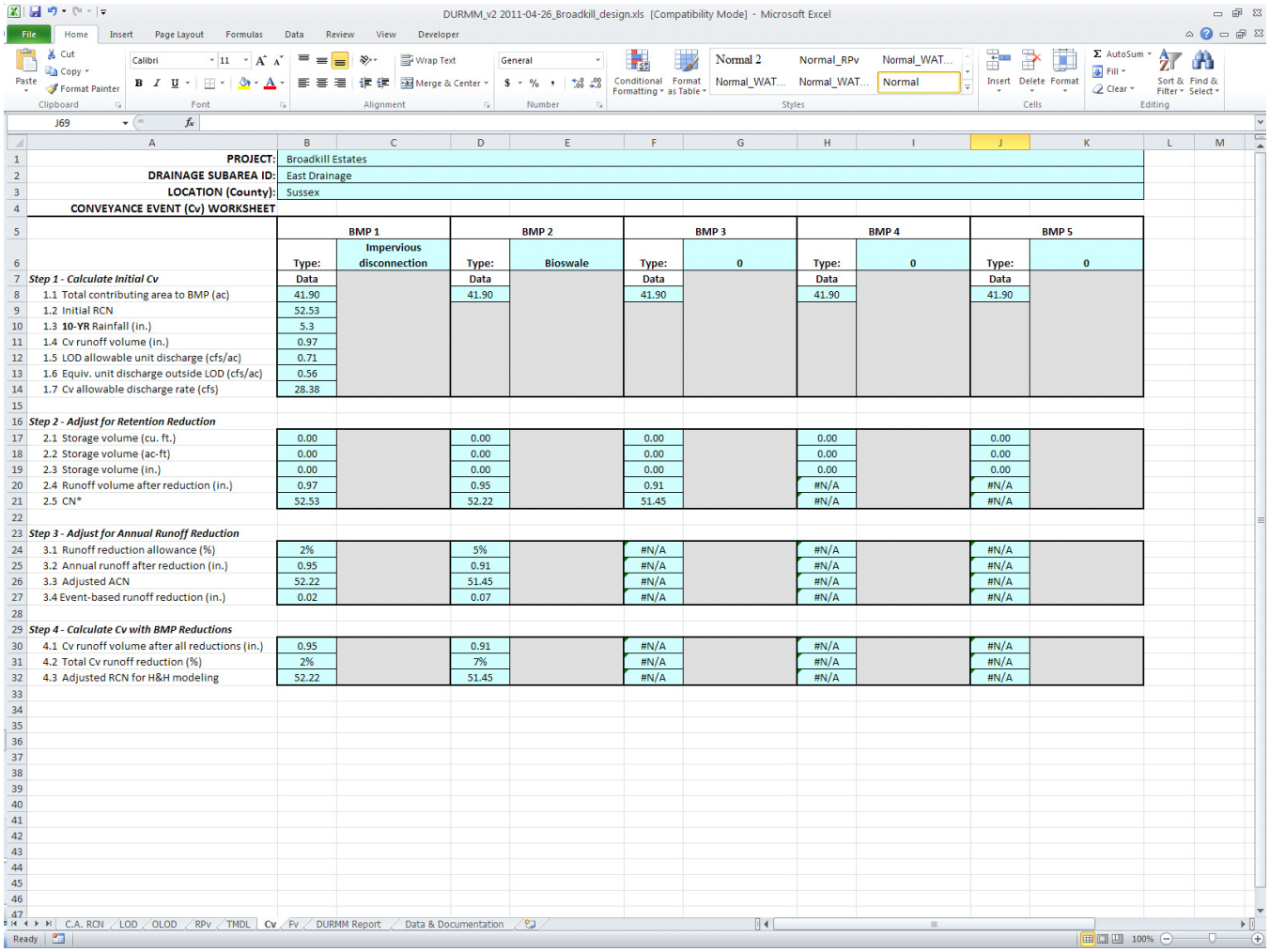
1	PROJECT:	Broadkill Estates																			
2	DRAINAGE SUBAREA ID:	East Drainage																			
3	LANDUSE TYPE:	Residential																			
4	TMDL WATERSHED:	Broadkill River																			
6		BMP 1				BMP 2				BMP 3				BMP 4				BMP 5			
7		Type:	Impervious disconnection			Type:	Bioswale			Type:	0			Type:	0			Type:	0		
8	*Step 1 - Calculate Annual Runoff Volume*	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS	Data	TN	TP	TSS
9	1.1 Total contributing area to BMP (ac)	41.90																			
10	1.2 Contributing area RCN	53																			
11	1.3 Annual runoff volume (in)	4.20																			
12	1.4 Annual runoff volume (liters)	1.81E+07																			
14	*Step 2 - Calculate Annual Pollutant Load*																				
15	2.1 EMC (mg/l)		2.00	0.27	60																
16	2.2 Load (mg/yr)		3.62E+07	4.89E+06	1.09E+09																
17	2.4 Stormwater Load (lb/ac/yr)		1.90E+00	2.57E-01	5.71E+01		1.45	0.20	44		0.59	0.11	24		#N/A	#N/A	#N/A		#REF!	#REF!	#REF!
19	*Step 3 - Adjust for Runoff Reduction*																				
20	3.1 BMP Runoff Reduction (%)	24%				50%				#N/A				#N/A				#N/A			
21	3.2 BMP Removal Efficiency		24%	24%	24%		45%	45%	45%		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
22	3.3 Adjusted load (lb/ac/yr)		1.45	0.20	44		0.59	0.11	24		#N/A	#N/A	#N/A		#REF!	#REF!	#REF!		#REF!	#REF!	#REF!
24	*Step 4 - Calculate Pollutant Reduction*																				
25	4.1 TMDL (lb/ac/yr)		6.58	0.58	N/A		6.58	0.58	N/A		6.58	0.58	N/A		6.58	0.58	N/A		6.58	0.58	N/A
26	4.2 Reduction met?		OK	OK	OK		OK	OK	OK		#N/A	#N/A	#N/A		#REF!	#REF!	#REF!		#REF!	#REF!	#REF!
28	*Step 5 - Determine TMDL Offset*																				
29	5.1 TMDL Shortfall (lb/ac/yr)		0.00	0.00	#VALUE!		0.00	0.00	#VALUE!		#N/A	#N/A	#N/A		#REF!	#REF!	#REF!		#REF!	#REF!	#REF!
30	5.2 TMDL Shortfall (%)		0%	0%	#VALUE!		0%	0%	#VALUE!		#N/A	#N/A	#N/A		#REF!	#REF!	#REF!		#REF!	#REF!	#REF!
31	5.3 Residual RPv Volume (in)		0.25	0.25	0.25		0.09	0.09	0.09		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
32	5.4 Req'd Additional RR to meet TMDL (in)*		0.00	0.00	#VALUE!		0.00	0.00	#VALUE!		#N/A	#N/A	#N/A		#REF!	#REF!	#REF!		#REF!	#REF!	#REF!
33	5.5 Req'd Additional RR to meet TMDL (cu.ft./ac)		0	0	#VALUE!		0	0	#VALUE!		#N/A	#N/A	#N/A		#REF!	#REF!	#REF!		#REF!	#REF!	#REF!
34	5.6 Total Offset Volume (cu.ft.)		0	0	#VALUE!		0	0	#VALUE!		#N/A	#N/A	#N/A		#REF!	#REF!	#REF!		#REF!	#REF!	#REF!
37	*= % TMDL shortfall x Residual RPv																				

"TMDL" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The model has calculated the following results:

- Pollutant Load: 1.90 lb/ac/yr-TN; 0.0.26 lbac/yr-TP; 57 lb/ac/yr-TSS
- Pollutant load after BMP 1: 1.45 lb/ac/yr-TN; 0.20 lb/ac/yr-TP; 44 lb/ac/yr-TSS
- Pollutant load after BMP 2: 0.59 lb/ac/yr-TN; 0.11 lb/ac/yr-TP; 24 lb/ac/yr-TSS

The pollutant loads and reductions are likewise adjusted to account for the total contributing area to the BMPs. In this case, the annual runoff is low enough that the pollutant loads do not exceed the TMDL values. Therefore, no BMPs were needed for pollutant reductions and the equivalent volume offset is "0".



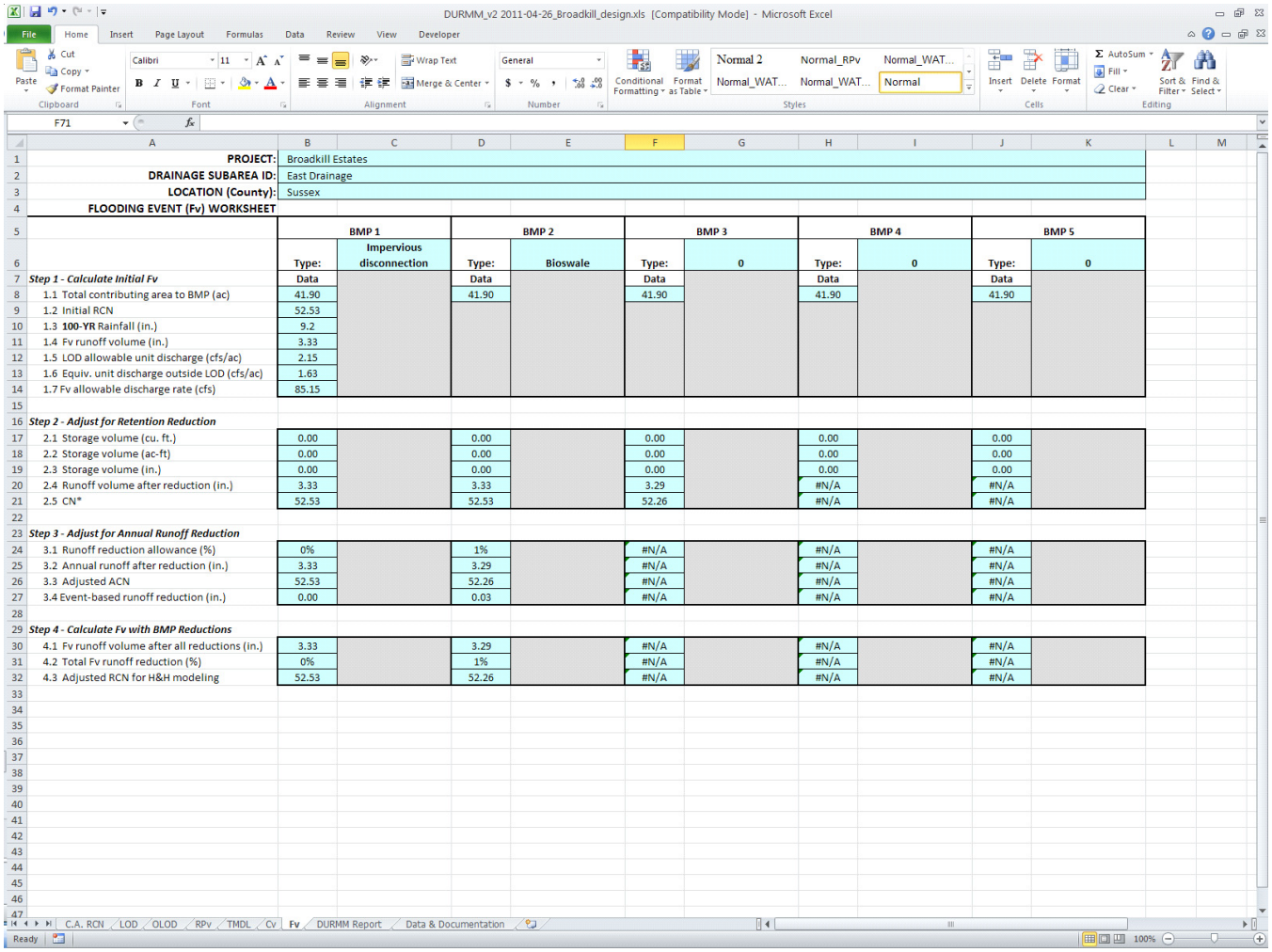
PROJECT:	Broadkill Estates									
DRAINAGE SUBAREA ID:	East Drainage									
LOCATION (County):	Sussex									
CONVEYANCE EVENT (Cv) WORKSHEET										
	BMP 1		**BMP 2**		**BMP 3**		**BMP 4**		**BMP 5**	
	Type:	**Impervious disconnection**	**Type:**	**Bioswale**	**Type:**	**0**	**Type:**	**0**	**Type:**	**0**
Step 1 - Calculate Initial Cv	**Data**		**Data**		**Data**		**Data**		**Data**	
1.1 Total contributing area to BMP (ac)	41.90		41.90		41.90		41.90		41.90	
1.2 Initial RCN	52.53									
1.3 **10-YR** Rainfall (in.)	5.3									
1.4 Cv runoff volume (in.)	0.97									
1.5 LOD allowable unit discharge (cfs/ac)	0.71									
1.6 Equiv. unit discharge outside LOD (cfs/ac)	0.56									
1.7 Cv allowable discharge rate (cfs)	28.38									
Step 2 - Adjust for Retention Reduction										
2.1 Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2 Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3 Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4 Runoff volume after reduction (in.)	0.97		0.95		0.91		#N/A		#N/A	
2.5 CN*	52.53		52.22		51.45		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction										
3.1 Runoff reduction allowance (%)	2%		5%		#N/A		#N/A		#N/A	
3.2 Annual runoff after reduction (in.)	0.95		0.91		#N/A		#N/A		#N/A	
3.3 Adjusted ACN	52.22		51.45		#N/A		#N/A		#N/A	
3.4 Event-based runoff reduction (in.)	0.02		0.07		#N/A		#N/A		#N/A	
Step 4 - Calculate Cv with BMP Reductions										
4.1 Cv runoff volume after all reductions (in.)	0.95		0.91		#N/A		#N/A		#N/A	
4.2 Total Cv runoff reduction (%)	2%		7%		#N/A		#N/A		#N/A	
4.3 Adjusted RCN for H&H modeling	52.22		51.45		#N/A		#N/A		#N/A	

"Cv" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. There are no user-input cells on the "Cv" worksheet. The model has calculated the following results:

- Cv allowable discharge: 28.38 cfs
- Cv runoff volume after BMP 1: 0.95" (2% reduction)
- Cv runoff volume after BMP 2: 0.91" (7% reduction)

When the total contributing area consists of both an LOD and an OLOD, the model uses an areal weighted average of the previously determined LOD allowable unit discharge and the OLOD equivalent unit discharge to calculate the adjusted allowable discharge for the Cv. In this example, the allowable discharge for the LOD was determined to be 0.71 cfs/ac and the equivalent unit discharge for the OLOD was determined to be 0.56 cfs/ac, as indicated on the worksheet.



DURMM_v2 2011-04-26_Broadkill_design.xls [Compatibility Mode] - Microsoft Excel

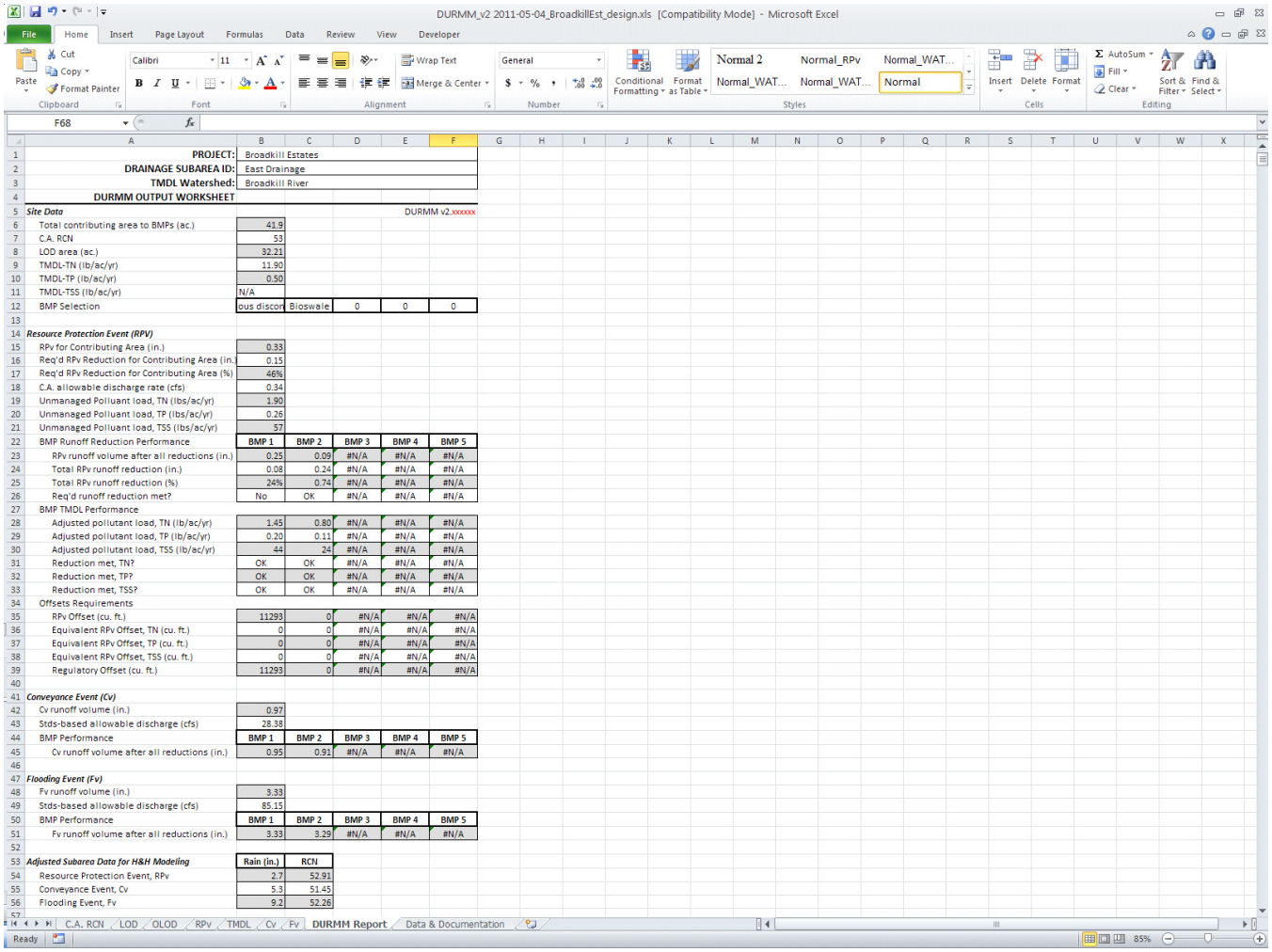
	PROJECT:	Broadkill Estates								
	DRAINAGE SUBAREA ID:	East Drainage								
	LOCATION (County):	Sussex								
	FLOODING EVENT (Fv) WORKSHEET									
		BMP 1		**BMP 2**		**BMP 3**		**BMP 4**		**BMP 5**
		Type:	**Impervious disconnection**	**Type:**	**Bioswale**	**Type:**	**0**	**Type:**	**0**	**Type:**	**0**
Step 1 - Calculate Initial Fv		**Data**		**Data**		**Data**		**Data**		**Data**	
1.1	Total contributing area to BMP (ac)	41.90		41.90		41.90		41.90		41.90	
1.2	Initial RCN	52.53									
1.3	**100-YR** Rainfall (in.)	9.2									
1.4	Fv runoff volume (in.)	3.33									
1.5	LOD allowable unit discharge (cfs/ac)	2.15									
1.6	Equiv. unit discharge outside LOD (cfs/ac)	1.63									
1.7	Fv allowable discharge rate (cfs)	85.15									
Step 2 - Adjust for Retention Reduction											
2.1	Storage volume (cu. ft.)	0.00		0.00		0.00		0.00		0.00	
2.2	Storage volume (ac-ft)	0.00		0.00		0.00		0.00		0.00	
2.3	Storage volume (in.)	0.00		0.00		0.00		0.00		0.00	
2.4	Runoff volume after reduction (in.)	3.33		3.33		3.29		#N/A		#N/A	
2.5	CN*	52.53		52.53		52.26		#N/A		#N/A	
Step 3 - Adjust for Annual Runoff Reduction											
3.1	Runoff reduction allowance (%)	0%		1%		#N/A		#N/A		#N/A	
3.2	Annual runoff after reduction (in.)	3.33		3.29		#N/A		#N/A		#N/A	
3.3	Adjusted ACN	52.53		52.26		#N/A		#N/A		#N/A	
3.4	Event-based runoff reduction (in.)	0.00		0.03		#N/A		#N/A		#N/A	
Step 4 - Calculate Fv with BMP Reductions											
4.1	Fv runoff volume after all reductions (in.)	3.33		3.29		#N/A		#N/A		#N/A	
4.2	Total Fv runoff reduction (%)	0%		1%		#N/A		#N/A		#N/A	
4.3	Adjusted RCN for H&H modeling	52.53		52.26		#N/A		#N/A		#N/A	

"Fv" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. There are no user-input cells on the "Cv" worksheet. The model has calculated the following results:

- Fv allowable discharge: 85.15 cfs
- Fv runoff volume after BMP 1: 3.33" (0% reduction)
- Fv runoff volume after BMP 2: 3.29" (1% reduction)

As with the Cv, the model uses an areal weighted average of the previously determined LOD allowable unit discharge and the OLOD equivalent unit discharge to calculate the adjusted allowable discharge for the Fv. In this example, the allowable discharge for the LOD was determined to be 2.15 cfs/ac and the equivalent unit discharge for the OLOD was determined to be 1.63 cfs/ac, as indicated on the worksheet.



PROJECT:	Broadkill Estates				
DRAINAGE SUBAREA ID:	East Drainage				
TMDL Watershed:	Broadkill River				
DURMM OUTPUT WORKSHEET					
Site Data				DURMM v2.xxxxxx	
Total contributing area to BMPs (ac.)	41.9				
C.A. RCN	53				
LOD area (ac.)	32.21				
TMDL-TN (lb/ac/yr)	11.90				
TMDL-TP (lb/ac/yr)	0.50				
TMDL-TSS (lb/ac/yr)	N/A				
BMP Selection	ous discon	Bioswale	0	0	0
Resource Protection Event (RPV)					
RPv for Contributing Area (in.)	0.33				
Req'd RPv Reduction for Contributing Area (in.)	0.15				
Req'd RPv Reduction for Contributing Area (%)	46%				
C.A. allowable discharge rate (cfs)	0.34				
Unmanaged Polluant load, TN (lbs/ac/yr)	1.90				
Unmanaged Polluant load, TP (lbs/ac/yr)	0.26				
Unmanaged Polluant load, TSS (lbs/ac/yr)	57				
BMP Runoff Reduction Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
RPv runoff volume after all reductions (in.)	0.25	0.09	#N/A	#N/A	#N/A
Total RPv runoff reduction (in.)	0.08	0.24	#N/A	#N/A	#N/A
Total RPv runoff reduction (%)	24%	0.74	#N/A	#N/A	#N/A
Req'd runoff reduction met?	No	OK	#N/A	#N/A	#N/A
BMP TMDL Performance					
Adjusted pollutant load, TN (lb/ac/yr)	1.45	0.80	#N/A	#N/A	#N/A
Adjusted pollutant load, TP (lb/ac/yr)	0.20	0.11	#N/A	#N/A	#N/A
Adjusted pollutant load, TSS (lb/ac/yr)	44	24	#N/A	#N/A	#N/A
Reduction met, TN?	OK	OK	#N/A	#N/A	#N/A
Reduction met, TP?	OK	OK	#N/A	#N/A	#N/A
Reduction met, TSS?	OK	OK	#N/A	#N/A	#N/A
Offsets Requirements					
RPv Offset (cu. ft.)	11293	0	#N/A	#N/A	#N/A
Equivalent RPv Offset, TN (cu. ft.)	0	0	#N/A	#N/A	#N/A
Equivalent RPv Offset, TP (cu. ft.)	0	0	#N/A	#N/A	#N/A
Equivalent RPv Offset, TSS (cu. ft.)	0	0	#N/A	#N/A	#N/A
Regulatory Offset (cu. ft.)	11293	0	#N/A	#N/A	#N/A
Conveyance Event (Cv)					
Cv runoff volume (in.)	0.97				
Stds-based allowable discharge (cfs)	28.38				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Cv runoff volume after all reductions (in.)	0.95	0.91	#N/A	#N/A	#N/A
Flooding Event (Fv)					
Fv runoff volume (in.)	3.33				
Stds-based allowable discharge (cfs)	85.15				
BMP Performance	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5
Fv runoff volume after all reductions (in.)	3.33	3.29	#N/A	#N/A	#N/A
Adjusted Subarea Data for H&H Modeling	Rain (in.)	RCN			
Resource Protection Event, RPv	2.7	52.91			
Conveyance Event, Cv	5.3	51.45			
Flooding Event, Fv	9.2	52.26			

"DURMM Report" Worksheet

In this example, the designer was able to show that the use of runoff reduction practices could meet both the runoff reduction and pollutant reduction requirements of the DSSR. Since DURMM v.2 does not include a BMP design module, the designer must next use an appropriate methodology to ensure the BMPs selected for analysis are designed in accordance with the standards and specifications required under the DSSR. Additional information is available by contacting the Delaware Sediment & Stormwater Program.

The below is a cell by cell reference guide for the Delaware Urban Runoff Management Model (DURMM) Version 2 Excel program, as prepared and issued by the Delaware Department of Natural Resources and Environmental Control Sediment and Stormwater Program. The Quick Start Guide for DURMM v2 can also be referenced for additional information.

C.A. RCN Worksheet (Contributing Area Runoff Curve Number):	
Project Information	
Project (cell C1)	Enter the project name or description.
Drainage Subarea ID (cell C2)	Enter the subarea number or description.
Location (County) (cell C3)	Select "New Castle", "Kent", or "Sussex" from the drop down list (or the information can be typed as listed above). No calculations can be performed if the County cell is left blank. This field determines the storm event rainfall amounts used for the 10-year and 100-year storms. Rainfall amounts for each County are shown in the reference table starting at cell N5 on the OLOD worksheet.
Unit Hydrograph (cell C4)	Select "DMV" to use the Delmarva Unit Hydrograph or "STD" to use the standard dimensionless unit hydrograph from the drop down list (or the information can be typed as listed above). The Delmarva Unit Hydrograph shall be used for all projects south of the Chesapeake and Delaware (C&D) Canal.
Note: The above information will replicate on the subsequent worksheets, and is not repeated below.	
Contributing Area Information	
Landcover Area in A soil (cells E9→84)	Enter the area, in acres, for the corresponding cover type, treatment, and hydrologic condition listed in Columns A, B and C that are within the Hydrologic Soil group A for the current subarea's contributing area (excluding any area accounted for in an upstream subarea). Any pre-development conditions shall be selected as good hydrologic condition.
Landcover Area in B soil (cells H9→84)	Enter the area, in acres, for the corresponding cover type, treatment, and hydrologic condition listed in Columns A, B and C that are within the Hydrologic Soil group B for the current subarea's contributing area (excluding any area accounted for in an upstream subarea). Any pre-development conditions shall be selected as good hydrologic condition.
Landcover Area in C soil (cells K9→84)	Enter the area, in acres, for the corresponding cover type, treatment, and hydrologic condition listed in Columns A, B and C that are within the Hydrologic Soil group C for the current subarea's contributing area (excluding any area accounted for in an upstream subarea). Any pre-development conditions shall be selected as good hydrologic condition.

Landcover Area in D soil (cells N9→84)	Enter the area, in acres, for the corresponding cover type, treatment, and hydrologic condition listed in Columns A, B and C that are within the Hydrologic Soil group D for the current subarea's contributing area (excluding any area accounted for in an upstream subarea). Any pre-development conditions shall be selected as good hydrologic condition.
User Defined Cells (cells B87 → O88)	Enter the cover type and condition, and the corresponding acreage and RCN per Hydrologic Soil Group for any special circumstances that require a unique curve number. If an acreage is entered, the corresponding RCN value must be entered, or else the RCN will be misinterpreted as "0" and skew the results.
Subarea Contributing Area per Soil Type (ac) (cells E90, H90, K90, N90)	Calculates the subarea's contributing area, in acres, per soil type, by summing the individual landcover areas. Example cell E90: ∑E9→88.
Subarea Contributing Area (ac) (cell C91)	Calculates the total subarea contributing area by summing the subarea contributing area per soil type; ∑E→N90
Upstream Contributing Areas (cells C93 → F96)	Enter the subarea ID, total contributing area (in acres) and the contributing area RCN for any upstream areas in columns C, E and F, respectively. If there are no upstream subareas, than the cells in this section should be left blank. If there is a series of LOD areas that contribute to the current subarea in a treatment train, than only the subarea nearest upstream to the current area should be entered, as the other areas upstream will be accounted for in this nearest upstream subarea. The upstream subarea contributing acreage and corresponding RCN can be taken directly from the DURMM report, cells B55 and B56, respectively, for each upstream subarea.
Total Contributing Area (ac) (cell K98)	Calculates the total contributing area, in acres, by summing the total acres per soil type, plus the acreage from each upstream contributing area; ∑E→N90+∑E93→96.
Weighted Runoff Curve Number (RCN): (cell K100)	Calculates the composite curve number for the contributing area, by summing the product of each landcover area times the respective RCN for each soil type, then all divided by the total acres; ∑(E9→88*F9→88+H9→88*I9→88+ K9→88*L9→88+ N9→88*O9→88+E93*F93+E94*F94+E95*F95+E96*F96)/K98. Note: some calculations are performed within hidden cells.
Note: The clear table icon (cell S9 and S89) will clear all entries within the worksheet, and reset any altered cells.	
<u>LOD Worksheet (Limit of Disturbance Calculations):</u>	
<u>Step1 – Subarea LOD Data</u>	

1.1 HSG Area Within LOD (ac) (cells B→E7)	Enter the total land area *within the limit of disturbance*, in acres, per the corresponding hydrologic soil group. If all of the contributing area lies within the LOD than this number should equal the total contributing area per soil type from the C.A. RCN worksheet, cells E90, H90, K90 and N90.
1.2 Pre-Developed Woods/Meadow within LOD (ac) (cell B→E8)	Enter the total *existing* woods or meadow area, in acres, from the pre-development state that is contained within the limit of disturbance, per the corresponding hydrologic soil group, even if the woods/meadow is disturbed in the post developed condition.
1.3 Pre-Developed Impervious within LOD (ac) (cell B→E9)	Enter the total *existing* impervious, in acres, from the pre-development state that is contained within the limit of disturbance, per the hydrologic soil group, even if the impervious area is disturbed in the post developed condition. Gravel areas should be considered impervious.
1.4.a Post Developed Imperviousness within LOD, Option #1 (ac) (cell B→E10)	Enter the total impervious area, in acres, from the post development state that is contained within the limit of disturbance, per the corresponding hydrologic soil group. Gravel areas and permeable pavement should be considered impervious.
1.4.b Post Developed Imperviousness within LOD, Option #2 (%) (cell B→E11)	Enter the total impervious area, in percent of the total limit of disturbance area, from the post development state that is contained within the limit of disturbance, per the corresponding hydrologic soil group. Note: This cell will automatically calculate if Option #1 is entered (B→E10 / B→E7); If Option #2 is manually entered, click the reset icon to regenerate the original equation, if desired.
Step 2 – Subarea LOD Runoff Calcs.	
2.1 RCN per HSG (cell B→E14)	Calculates the composite runoff curve number per hydrologic soil group within the LOD based on the percent of imperviousness times a runoff coefficient of 98, plus the percent of perviousness (total LOD area minus the impervious area) times a runoff coefficient corresponding to "grass cover, good" per the respective soil class (A = 39, B = 61, C = 74, D = 80). Example cell B14: B11*98+(1-B11)*39, where 39 represents the curve number for grass cover, good within the A soil group.
2.2 RPv per HSG (in.) (cell B→E15)	Calculates the Resource Protection runoff volume, in inches, per hydrologic soil group, using the previously calculated RCN per HSG within the event based runoff equation. Reference the LOD worksheet explanation for further details. Example cell B15: $0.000466*B14^2-0.023230*B14+0.263672$.

2.3 Target Runoff per HSG (in.) (cell B→E16)	Calculates the target runoff volume, in inches, based on the pre-developed woods and/or meadow area and the percent pre-developed impervious area, per hydrologic soil group. The first step multiplies the pre-developed woods and/or meadow area by the pre-determined RPv target runoff factor for a woods condition to establish the runoff from the woods and/or meadow. The second step calculates the runoff from the non-wood and/or non-meadow area by multiplying this area (the difference of the total LOD area minus the woods/meadow area) by the runoff generated based on the percent impervious within the LOD. Reference the LOD worksheet explanation for further details on the equation to derive this target runoff for the non-woods/non-meadow area. The result from the two steps are added together, and then divided by the total LOD area to produce the total target runoff per acre. Note that the pre-developed impervious area is multiplied by 30% since for redevelopment purposes, only 30% of the existing impervious needs to be accounted for. Example cell B16: ((B8*N15)+((B7-B8)*(1.4687*((B9/B7*0.3)^2)+0.9813*(B9/B7*0.3)+0.0125)))/B7, where N15 is the RPv target runoff factor for woods (0.00 for HSG A), and $1.4687x^2+0.9813x+0.0125$ is the RPv target factor for non-woods/non-meadow in HSG A based on the percent of effective impervious, x.
2.4 Cv Weighted Unit Discharge (cfs/ac) (cell B→E17)	Calculates the target runoff discharge for the Conveyance event, in cfs/ac, based on established unit discharges for wood/meadow and non-woods/meadow conditions per hydrologic soil group, similar to the target runoff above. This is done by summing the pre-developed woods/meadow area multiplied by the respective discharge rate plus the pre-developed non-woods/meadow area (the total HSG area minus the pre woods/meadow area) multiplied by the respective discharge rate, all divided by the total HSG area. Reference the LOD worksheet explanation for further details. Example cell B17: (B8*0+(B7-B8)*0.75)/B7, where 0 and 0.75 are the established Cv unit discharges for the A soil group for woods/meadow and non-woods/meadow, respectively.
2.5 Fv Weighted Unit Discharge (cfs/ac) (cell B→E18)	Calculates the target runoff discharge for the Flooding event, in cfs/ac, based on established unit discharges for wood/meadow and non-woods/meadow conditions per hydrologic soil group, similar to the target runoff above. This is done by summing the pre-developed woods/meadow area multiplied by the respective discharge rate plus the pre-developed non-woods/meadow area (the total HSG area minus the pre woods/meadow area) multiplied by the respective discharge rate, all divided by the total HSG area. Reference the LOD worksheet explanation for further details. Example cell B18: (B8*0.25+(B7-B8)*2.25)/B7, where 0.25 and 2.25 are the established Fv unit discharges for the A soil group for woods/meadow and non-woods/ meadow, respectively.

2.6 Subarea LOD (ac) (cell B20)	Adds the LOD area per hydrologic soil group for a combined subarea LOD, in acres. ∑B→E7.
2.7 Subarea Weighted RCN (cell B21)	Calculates the composite runoff curve number for the subarea LOD by adding the sum of each LOD area per HSG times its respective HSG RCN, and then dividing by the total subarea LOD. ∑(B7*B14+C7*C14+D7*D14+E7*E14)/B20.
2.8 Subarea Weighted RPv (in.) (cell B22)	Calculates the composite runoff for the subarea LOD during the RPv event, by adding the sum of each LOD area per HSG times its respective RPv per HSG, and then dividing by the total subarea LOD. ∑(B7*B15+C7*C15+D7*D15+E7*E15)/B20.
2.9 Subarea Weighted Target Runoff (in.) (cell B23)	Calculates the composite target runoff for the subarea LOD by adding the sum of each LOD area per HSG times its respective target runoff per HSG, and then dividing by the total subarea LOD. ∑(B7*B16+C7*C16+D7*D16+E7*E16)/B20.
Step 3 – Upstream LOD Areas *(from previous DURMM Report as applicable)*	
3.1 Upstream Subarea ID (cells B→E26)	Enter the ID name for each upstream LOD area that contributes to the current subarea (will auto-generate from the C.A. RCN worksheet if entered in cells C93→97). If there are no upstream LOD subareas, than the cells in the Step 3 section should be left blank. If there is a series of LOD areas that contribute to the current subarea in a treatment train, than only the subarea nearest upstream to the current area should be entered, as the other LOD areas upstream will be accounted for in this nearest upstream area. The upstream subarea ID name, and all subsequent upstream subarea information can be taken directly from the DURMM report for the corresponding subarea.
3.2 Upstream LOD Area (ac) (cells B→E27)	Enter the acreage of the contributing upstream LOD area, in acres, as stated in the corresponding DURMM Report, cell B58.
3.3 Target Runoff for Upstream Area (in.) (cells B→E28)	Enter the weighted target runoff for the upstream area, in inches, as stated in the corresponding DURMM Report, cell B59.
3.4 Adjusted CN after all Reduction (cells B→E29)	Enter the final curve number for the upstream area after all runoff and retention reductions are accounted for, as stated in the corresponding DURMM Report, cell B60.
3.5 Adjusted RPv (in.) (cells B→E30)	Enter the final runoff volume for the RPv event, in inches, for the upstream area after all runoff and retention reductions are accounted for, as stated in the corresponding DURMM Report, cell B61.
3.6 Adjusted Cv (in.) (cells B→E31)	Enter the final runoff volume for the Cv event, in inches, for the upstream area after all runoff and retention reductions are accounted for, as stated in the corresponding DURMM Report, cell B62.
3.6 Adjusted Fv (in.) (cells B→E32)	Enter the final runoff volume for the Fv event, in inches, for the upstream area after all runoff and retention reductions are accounted for, as stated in the corresponding DURMM Report, cell B63.

Step 4 - RPv Calculations for Combined LOD	
4.1 Combined LOD area (ac) (cell B35)	Calculates the total contributing LOD area, in acres, by adding the total subarea LOD to each of the upstream LOD areas. B20+B27+C27+D27+E27.
4.2 Weighted RCN (cell B36)	Calculates the weighted runoff curve number for the combined LOD area by summing the product of the subarea LOD times the subarea RCN and each upstream LOD area times its respective RCN, and then dividing by the total combined LOD area. ∑(B21*B20+B29*B27+C29*C27+D29*D27+E29*E27)/B35
4.3 Weighted RPv (in.) (cell B37)	Calculates the composite runoff volume for the LOD, in inches, by summing the product of the subarea LOD times the subarea RPv and each upstream LOD area times its respective adjusted RPv, and then dividing by the total combined LOD area. ∑(B22*B20+B30*B27+C30*C27+D30*D27+E30*E27)/B35
4.4 Weighted Target Runoff (in.) (cell B38)	Calculates the total weighted runoff volume for the LOD, in inches, by summing the product of the subarea LOD times the subarea target and each upstream LOD area times its respective target, and then dividing by the total combined LOD area. ∑(B23*B20+B28*B27+C28*C27+D28*D27+E28*E27)/B35
4.5 Estimated Annual Runoff (in.) (cell B39)	Calculates the amount of runoff generated throughout the course of the year, in inches, based on the weighted RCN for the combined LOD, $0.000004*B36^{3.5}$. Reference the LOD worksheet explanation for further details.
4.6 Required Runoff Reduction within LOD (in.) (cell B40)	Calculates the required reduction volume in runoff, in inches, by subtracting the combined target runoff from the total RPv runoff, B37-B38.
4.7 Required Runoff Reduction within LOD (%) (cell B41)	Calculates the percent of runoff reduction required for the RPv event by dividing the Required Runoff Reduction by the Weighted RPv, B40/B37.
Step 5 - Cv Unit Discharge	
5. LOD Allowable Unit Discharge (cfs/ac) (cell B44)	Calculates the maximum Cv unit discharge for the combined LOD, in cfs/acre, by summing each LOD area per hydrologic soil group times its respective Cv unit discharge and each upstream LOD area times its respective adjusted Cv, and then dividing by the total combined LOD area. ∑(B7*B17+C7*C17+D7*D17+E7*E17+B27*B31+C27*C31+D27*D31+E27*E31)/B35.

Step 6 - Fv Unit Discharge	
6. LOD Allowable Unit Discharge (cfs/ac) (cell B47)	Calculates the maximum Fv unit discharge for the combined LOD, in cfs/acre, by summing each LOD area per hydrologic soil group times its respective Fv unit discharge and each upstream LOD area times its respective adjusted Fv, and then dividing by the total combined LOD area. ∑(B7*B18+C7*C18+D7*D18+E7*E18+B27*B32+C27*C32+D27*D32+E27*E32)/B35.
Note: The Reset icon (cell G6) will clear all entries within the worksheet, and reset any altered cells.	
OLOD Worksheet (Outside the Limit of Disturbance Calculations):	
Step 1 - Site Data	
1.1 Total Contributing Area (ac) (cell B8)	Returns the total contributing area from the C.A. RCN worksheet, cell K98.
1.2 C.A. RCN (cell B9)	Returns the weighted runoff curve number for the contributing area from the C.A. RCN worksheet, cell K100.
1.3 LOD Area (ac) (cell B10)	Returns the limit of disturbance area for the current subarea from the LOD worksheet, cell B20.
1.4 LOD RCN (cell B11)	Returns the weighted runoff curve number for the current subarea's limit of disturbance from the LOD worksheet, cell B21.
1.5 Outside LOD Area (ac) (cell B12)	Calculates the area, in acres, outside of the limit of disturbance by subtracting the LOD area from the total contributing area. B8-B10.
1.6 Outside LOD RCN (cell B13)	Calculates the weighted runoff curve number for the outside limit of disturbance by subtracting the product of the LOD area times the LOD RCN from the product of the C.A. times the C.A. RCN, then dividing by the outside LOD area. ((B8*B9)-(B10*B11))/B12.
Step 2 - Time of Concentration	
2.1 Length (ft) (cells B19→29)	Enter the length, in feet, for each type of flow within the time of concentration (Tc) path. Three entries of sheet flow and shallow concentrated flow can be entered, and five entries of open channel flow can be entered. The maximum combined sheet flow length should be 100 feet.
2.2 Slope (ft/ft) (cells C19→29)	Enter the slope for each section of the Tc path given a defined length. The slope should be entered as foot per foot. The average slope should be entered; however, any major changes in slope should result in a separate entry.

2.3 Surface Code (cells D19→D24)	Enter the code corresponding to the type of surface cover for each entered segment of sheet and shallow concentrated flow. Surface codes do not need to be entered for open channel segments. The surface codes can be found starting at cell B34, and are as below. Sheet Flow Surface Codes: a, smooth surface; b, fallow (no residue); c, cultivated <20% residue; d, cultivated >20% residue; e, grass – range, short; f, grass, dense; g, grass, bermuda; h, woods, light; i, woods, dense; j, range, natural Shallow Concentrated Surface Codes: u, unpaved surface; p, paved surface
2.4.a Manning's n, sheet flow (cells E19→21)	Returns the corresponding Manning's n value for the entered type of surface per section of sheet flow. Reference the OLOD worksheet explanation for the Manning's n values used for each surface code.
2.4.b Manning's n, open channel flow (cells E25→29)	Enter the corresponding Manning's n value for the type of surface per section of open channel flow, i.e., 0.012 for plastic pipe, 0.013 for concrete, 0.022 for clean excavated channels, etc. The values used shall be per standard literature regarding open channel flow.
2.5.a Velocity, shallow concentrated flow (ft/sec) (cells F22→24)	Calculates the velocity, in ft/sec, for each section of shallow concentrated flow, using TR-55 average velocity equations based on the slope of the Tc path. Reference Figure 3-1 and Appendix F in the TR-55 manual. Example cell F22, Unpaved: $16.1345*C22^{0.5}$; Paved: $20.3282*C22^{0.5}$.
2.5.b Velocity, open channel flow (ft/sec) (cells F25→29)	Enter the velocity, in ft/sec, for each section of open channel flow, using Manning's equation, $v=1.49/n*R^{2/}3*S^{1/2}$.
2.6.a Travel Time, sheet flow (hrs) (cells G19→21)	Calculates the time of travel for each section of sheet flow, in hours, using TR-55 methodology. Example cell G19: $(0.007*(E19*B19)^{0.8})/(O31^{0.5}*C19^{0.4})$. Note: the 2-year, 24-hour rainfall used is 3.3" as defined in cell O31.
2.6.b Travel Time, shallow concentrated flow and open channel flow (hrs) (cells G22→29)	Calculates the time of travel for each section of shallow concentrated flow and/or each section of open channel flow, in hours, using TR-55 methodology. Example cell G22: B22/(3600*F22).
2.7 Time of Concentration (Tc) (hrs) (cell G31)	Calculates the total travel time, in hours, by adding the time for each section of flow, ∑G19→29. Note: If Step 2 is left blank than the minimum time of 0.10 hour is defaulted.
Step 3 - Peak Discharge	
3.1 Unit Hydrograph Type (cell B44)	Returns the Unit Hydrograph Type from the Project Information, cell B4.
3.2 Frequency (yr) (cells B→C 45)	Headers for the 10 year and 100 year storm events, whose data will be calculated below.
3.3 24-Hour Rainfall, P (in) (cells B→C46)	Returns the 24-hour rainfall amount, in inches, for the respective storm frequency and per which county the project is located within. Values are stored within cells O8→10 for the Cv and P8→10 for the Fv. Reference the OLOD worksheet explanation for the values used.

3.4 Initial Abstraction, Ia (in) (cells B→C47)	Returns the initial abstraction value, in inches, per the OLOD RCN (the same Ia value is used for both the 10 and 100 year storms). Ia lookup values are stored within cells V45→113. Reference the OLOD worksheet explanation for the values used.
3.5 Ia/P Ratio (cells B→C48)	Calculates the ratio of the Initial Abstraction divided by the rainfall amount. Example cell B48: B47/B46.
3.6 Unit Peak Discharge, q_u (csm/in) (cells B→C49)	Calculates the peak unit discharge, in csm/in, for the 10 and 100 year storm event depending on whether the Standard or Delmarva Unit Hydrograph is being used. Reference the OLOD worksheet explanation for further details. Example cell B49, STD: 10^{R52}; DMV: 10^{R64}.
3.7 Runoff (in.) (cells B→C50)	Calculates the volume of runoff, in inches, for the OLOD area by employing the SCS equations for runoff and the potential maximum retention, combined into one equation. Reference the OLOD worksheet explanation for further details. Example cell B50: $(B46-0.2*(1000/B13-10))^2/(B46+0.8*(1000/B13-10))$.
3.8 Peak Discharge, q_p (cfs) (cells B→C51)	Calculates the peak discharge for the OLOD, in cubic feet per second, by multiplying the outside LOD area, converted to square miles, times the unit peak discharge and times the runoff. Example cell B51: (B12/640)*B49*B50.
3.9 Equivalent Unit Peak Discharge (cfs/ac) (cells B→C52)	Calculates the per acre peak discharge for the OLOD area, in cubic feet per second per acre, by dividing the peak discharge by the outside LOD area. Example cell B52: B51/B12.
Note: The Clear Tc icon (cell I19) will clear all entries within the worksheet, and reset any altered cells.	
RPv Worksheet (1-Year, Resource Protection Event Modeling):	
BMP Type (cells C6, E6, G6, I6, K6)	Select the type of Best Management Practice from the drop down list of defined practices. Reference the Data and Documentation worksheet for a complete listing of the BMPs and their corresponding design parameters. The initial, furthest upstream practice shall be BMP 1, with each subsequent BMP being the next downstream. If a BMP is not needed for a specified column, <u>than "--" must be chosen from the drop down list.</u> If a desired BMP is not listed or additional BMP computation areas are needed, contact the DNREC Sediment and Stormwater Program for assistance.
<u>Step 1 – Calculate Initial RPv</u>	
1.1 Total contributing area to BMP (ac) (cells B8, D8, F8, H8, J8)	Returns the contributing area, in acres, from the C.A. RCN worksheet, cell K98.
1.2 Reserved	
1.3 Initial RCN (cell B10)	Returns the Runoff Curve Number previously calculated for either the contributing area or the combined LOD area; if the two area values are equal then the combined LOD RCN is returned; if the contributing area is greater, than the C.A. RCN is returned. Returns either cell K100 on the C.A. RCN worksheet, or B36 on the LOD worksheet based on the above logic.

1.4 RPv for Contributing Area (in.) (cell B11)	Returns the combined RPv runoff calculated in the LOD worksheet, cell B37, if the contributing area is equal to the combined LOD area. If the contributing area is greater than the combined LOD area, calculates the runoff generated for the RPv event for the entire contributing area, in inches, using the same methodology as used in the LOD worksheet to calculate the RPv, but uses the initial RCN, rather than the LOD RCN (the initial RCN will be the C.A. RCN if the equation is being utilized); $0.000466*B10^2-0.02323*B10+0.263672$. However, if the contributing area times this value, is less than the combined LOD area times the combined LOD runoff, then the RPv for the contributing area is calculated by taking the weighted average from the LOD, by multiplying the combined LOD area times the LOD runoff, divided by the contributing area; (LOD!B35*LOD!B37)/B8. This clause prevents any offsite contributions from creating a runoff that is less than the runoff calculated on the LOD worksheet.
1.5 Required RPv Reduction for Contributing Area (in.) (cell B12)	Calculates the required reduction in runoff for the RPv event, in inches, for the contributing area based on the required reduction for the combined LOD area. This is done by multiplying the required reduction for the LOD RPv by the total LOD area, and then dividing by the contributing area; LOD!B40*LOD!B35/B8.
1.6 Required RPv Reduction for Contributing Area (%) (cell B13)	Calculates the required reduction in runoff for the RPv event, in percent form, for the contributing area by dividing the required RPv reduction in inches by the total RPv for the contributing area, also in inches; B12/B11.
1.7 RPv Allowable Discharge Rate (cfs) (cell B14)	Calculates the allowable discharge rate, in cubic feet per second, for the contributing area, by multiplying the total LOD area times the runoff volume for the RPv event, and by applying the appropriate conversion factors to get cubic feet per second; LOD!B35*LOD!B37*43560/12/86400.
Step 2 – Adjust for Retention Reduction	
2.1 Storage Volume (cu. ft.) (cell B17, D17, F17, H17, J17)	Enter the volume of retention, in cubic feet, for retention practices only (cell will be green if entry is needed). Note that if a volume is entered for a BMP that does not have any retention capabilities, i.e., a vegetated open channel, the entered volume will not be utilized and will not affect any calculations. Reference the BMP Suite table, on the Data and Documentation Worksheet, column J – Retention Allowable, to determine if retention occurs within the BMP. Also note that the storage volume for a BMP may need to be split amongst several subareas based on the percent contribution (i.e., the total storage volume cannot be entered for multiple sub-areas; a percent of the total storage volume would need to be entered).
2.2 Retention Reduction Allowance (%) (cell B18, D18, F18, H18, J18)	Returns the percent of retention reduction that is allowable per the chosen BMP by comparing the BMP Type from cell C6, E6, G6, I6, K6 to the BMP Suite table on the Data and Documentation worksheet, column J – Retention Allowable.

2.3 Retention Reduction Volume (ac-ft) (cells B19, D19, F19, H19, J19)	Calculates the actual retention volume for the chosen BMP by multiplying the storage volume by the percentage of retention that is allowable, and then converting to acre-feet; Example cell B19: B17*B18/43560.
2.4 Retention Reduction Volume (in.) (cells B20, D20, F20, H20, J20)	Calculates the retention volume in inches on a per contributing area basis, by dividing the retention reduction volume in acre-feet, by the contributing area, and converting the units to achieve a volume in inches; Example cell B20: B19/B8*12.
2.5 Runoff Volume after Retention Reduction (in.) (cells B21, D21, F21, H21, J21)	Calculates the total runoff volume, in inches, for the contributing area after the retention reduction is accounted for, by subtracting the retention reduction volume from the contributing area runoff for BMP 1, or for the higher order BMPs, from the runoff volume after all reductions from the previous BMP. Example cell B21: B11-B20; Example cell D21: B34-D20.
2.6 Adjusted CN* (cells B22, D22, F22, H22, J22)	Calculates the revised runoff curve number for the contributing area based off of the runoff volume after retention reduction, using the Annual Curve Number equation. Reference the RPv worksheet explanation for further details. Example cell B22: 46.3241*√(B21+0.025831)+0.538054.
Step 3 - Adjust for Annual Runoff Reduction	
3.1 Annual CN (ACN) (cells B25, D25, F25, H25, J25)	Calculates the annual runoff curve number for the contributing area based of the runoff volume after reductions have been accounted for from the previous BMP. Reference the RPv worksheet explanation for further details about the annual curve number equation. Example cell D25: 46.3241*√(B34+0.025831)+0.538054. Note: for BMP 1, the annual CN is equal to the initial RCN, cell B10, since no previous BMP reductions have taken place.
3.2 Annual Runoff (in.) (cells B26, D26, F26, H26, J26)	Calculates the annual runoff volume, in inches, for the contributing area by using the annual CN value in the Annual Runoff Equation. Reference the LOD worksheet explanation for further details on the Annual Runoff Equation. Example cell B26: $0.000004*B25^{3.5}$.
3.3 Proportion A/B soils in BMP footprint (%) (cells B27, D27, F27, H27, J27)	Enter the combined percent of A and B soils within the footprint of the BMP (not the entire contributing area) for any BMPs that receive annual runoff reduction credit (cell will be green if entry is needed). Note that if a percentage is entered for a BMP that does not have any annual runoff reduction capabilities, i.e., a bioretention system, the entered percentage will not be utilized and will not affect any calculations. Reference the BMP Suite table, on the Data and Documentation Worksheet, column K and M – Annual RR, to determine if annual runoff reduction occurs within the BMP depending on the soil type. Note that vegetated roofs are always used on A/B soils to represent the growing media, not the native soil beneath the structure.

3.4 Annual runoff reduction allowance (%) (cells B28, D28, F28, H28, J28)	Returns the percent of annual runoff reduction allowed per the BMP type and per the amount of the BMP area in A and B soils versus C and D soils, by utilizing the specified reduction percent in the BMP Suite table in the Data and Documentation worksheet, columns K and M – Annual RR.
3.5 Annual runoff after reduction (in.) (cells B29, D29, F29, H29, J29)	Calculates the annual runoff volume, in inches, for the contributing area after the annual runoff reduction is accounted for, by multiplying the annual runoff by the difference of one minus the percent reduction allowed for the BMP. Example cell B29: B26*(1-B28).
3.6 Adjusted ACN (cells B30, D30, F30, J30, J30)	Calculates the revised runoff curve number based off of the amount of annual runoff once the reduction from the BMP is taken into account. This is done by solving for the ACN in the Annual Runoff equation, and using the resulting equation, ACN = 34.8553*Annual Runoff$^{0.285714}$. Example cell B30: 34.8553*B29$^{0.285714}$.
3.7 Annual Runoff Reduction Allowance for RPv (in.) (cells B31, D31, F31, H31, J31)	Calculates the amount of reduction created for the annual runoff, in inches, by using the RPv runoff equation with the adjusted ACN to determine the amount of runoff generated and then subtracting that value from the initial RPv runoff in order to determine the amount of reduction. B11-(0.000466*B30^2-0.02323*B30+0.263672).
Step 4 – Calculate RPv with BMP Reductions	
4.1 RPv runoff volume after all reductions (in.) (cells B34, D34, F34, H34, J34)	Calculates the final RPv runoff, in inches, after all adjustments are made for each BMP, by subtracting the retention reduction volume and the annual runoff reduction allowance from the initial RPv for the contributing area. Example cell B34: B11-B20-B31.
4.2 Total RPv runoff reduction (in.) (cells B35, D35, F35, H35, J35)	Calculates the total amount of runoff reduction, in inches, by subtracting the runoff volume after all reductions are accounted for from the original RPv runoff amount (equivalent to summing the retention reduction value and the annual runoff reduction value) for each BMP. Example cell B35: B11-B34.
4.3 Total RPv runoff reduction (%) (cells B36, D36, F36, H36, J36)	Calculates the percent of total runoff reduction for the Resource Protection Event, by dividing the total runoff reduction for each BMP by the original runoff amount. Example cell B36: B35/B11.
4.4 Adjusted CN after all reductions (cells B37, D37, F37, H37, J37)	Returns the lesser of the adjusted curve number after retention reduction and the adjusted curve number after annual runoff reduction for each BMP. Example cell B37: If B22<B30, than B22, if not B30.
4.5 Adjusted equivalent annual runoff (in.) (cells B38, D38, F38, H38, J38)	Calculates the annual runoff volume, in inches, for each BMP by using the adjusted CN after all reductions value in the Annual Runoff Equation. Reference the LOD worksheet explanation for further details on the Annual Runoff Equation. Example cell B38: 0.000004*B37$^{3.5}$.

4.6 Equivalent TR-5 RCN for H&H modeling (cells B39, D39, F39, H39, J39)	Calculates the comparative runoff curve number from an event-based approach to the derived annual runoff curve number, by using McCuen's change in curve number method. Reference the RPV worksheet explanation for further details. Example cell B39: 200/((2.7+2*B34+2)-√(5*2.7*B34+4*B34^2)).
4.7 Required reduction met? (cells B40, D40, F40, H40, J40)	Determines if the amount of reduction in runoff for the RPv event meets the required reduction amount needed for the contributing area by comparing the two values and returning "NO" if the reduction amount is not met, and "YES" if the reduction is met. If the reduction is not met, than additional BMP's should be employed until the reduction is met, or the corresponding offset fee is paid if BMP's have been utilized to the maximum extent practicable and the reduction is still not met. Example cell B40: If B35 ≥ B12, than YES, if not NO.
4.8 If required reduction met, reduction credit (cu.ft.) (cells B41, D41, F41, H41, J41)	If the required reduction has been met as determined in step 4.7, than the amount of over reduction, or reduction credit, is calculated in cubic feet. Note this value will always be negative. The credit can then be applied to downstream subareas or site point of discharge comparisons. Example cell B41: If B40 = YES, than (B12-B35)*43560/12*B8, if not N/A.
Step 5 – Determine Runoff Reduction Offset	
5.1 Runoff Reduction Shortfall (in.) (cells B44, D44, F44, H44, J44)	Calculates the difference in the required reduction compared to the total provided reduction for the RPv event, in inches, if the required reduction has not been met. If the required reduction has been met, then no shortfall will be calculated. Example cell B44: B12-B35.
5.2 Runoff Reduction Shortfall (cu.ft./ac) (cells B45, D45, F45, H45, J45)	Calculates the reduction shortfall in cubic feet per acre by applying the appropriate conversion. Example cell B45: B44*43560/12.
5.3 Total Offset Volume (cu.ft.) (cells B46, D46, F46, H46, J46)	Calculates the required offset volume, in cubic feet, by multiplying the contributing area times the reduction shortfall. Example cell D46: D8*D45. The initial shortfall, cell B46, uses the required reduction in cell B12 to calculate the shortfall, B12*43560/12*B8.
Note: The Reset icon (cell A5) will clear all entries within the worksheet, and reset any altered cells.	
TMDL Worksheet (Total Maximum Daily Load Modeling):	
Landuse Type (cell B3)	Select "Urban Open Space", "Residential", "Commercial", "Institutional", "Industrial", "Rural Road", or "Urban Road/Highway" from the drop down list, for the landuse that bests describes the contributing LOD area (or the information can be typed as listed above). If more than one description is applicable, the more conservative option shall be selected (i.e., the landuse type that has higher EMC values, see step 2.1 below).

TMDL Watershed (cell B4)	Select the watershed that the project site is within from the drop down list so that the appropriate total maximum daily load values can be applied per pollutant type. The water shed names are categorized per drainage basin, i.e., Piedmont, Delaware Bay, Chesapeake Bay and the Inland Bays/Atlantic Ocean.
BMP Type (cells C7, G7, K7, O7, S7)	Returns the type of Best Management Practice that was chosen on the RPv worksheet.
Step 1 – Calculate Annual Runoff Volume	
1.1 Total contributing area to BMP (ac) (cells B9)	Returns the contributing area, in acres, from the RPv worksheet, cell B8.
1.2 Initial RCN (cell B9)	Returns the initial Runoff Curve Number from the RPv worksheet, cell B10.
1.3 Annual runoff volume (in.) (cell B11)	Returns the annual runoff volume, in inches, as calculated in the RPv worksheet, cell B26.
1.4 Annual runoff volume (liters) (cell B12)	Converts the annual runoff volume to liters by applying the necessary unit conversions and then calculates the total volume for the subarea by multiplying by the total contributing area; B9*B11*102790.
Step 2 –Calculate Annual Pollutant Load	
2.1 EMC (mg/L) (cells C→E15, G→I15, K→M15, O→Q15, S→U15)	Returns the event mean concentration (EMC), in milligrams per liter, for each pollutant: Total Nitrogen (TN), Total Phosphorus (TP), and Total Suspended Solids (TSS). For BMP 1 looks up the value per defined Landuse Type from the EMC chart starting at cell Z1. Reference the TMDL worksheet explanation for additional information. For the subsequent BMPs, the effluent concentration from the previous BMP is returned as the initial EMC. Example cell G15 = C25.
2.2 Load (mg/yr) (cells C16, D16, E16)	Calculates the pollutant load in milligrams per year, by multiplying the EMC by the total annual runoff volume in liters for BMP 1, and by the Adjusted annual runoff volume for subsequent BMPs. Example cell C16: B12*C15; example cell G16: B22*G15.
2.3 Stormwater Load (lb/ac/yr) (cells C→E17, G→I17, K→M17, O→Q17, S→U17)	Calculates the pollutant load in pounds per acre per year, by multiplying the load calculated in step 2.2 by conversion factors and dividing by the total contributing area, for BMP 1. Example cell C17: C16*0.000002205/B9. Note: any latter BMPs use the adjusted load calculated in Step 3.7 from the previous BMP; Example cell G17: C26.
Step 3 – Adjust for Runoff Reduction	
3.1 BMP Annual Runoff Reduction (%) (cells B20, F20, J20, N20, R20)	Calculates the percent of runoff reduction on an annual basis per BMP based on the RPv worksheet results by subtracting the adjusted annual runoff from the initial annual runoff and then dividing by the initial annual runoff to determine the percent of reduction. Example cell B20: (RPv!B26–RPvB38)/RPv!B26.
3.2 Adjusted annual runoff volume (in.) (cells B21, F21, J21, N21, R21)	Returns the adjusted annual runoff volume, in inches, from the RPv worksheet for the corresponding BMP. Example cell B21: RPv!B38.

3.3 Adjusted annual runoff volume (liters) (cells B22, F22, J22, N22, R22)	Converts the annual runoff volume to liters per BMP by applying the necessary unit conversions and then calculates the total volume for the subarea by multiplying by the total contributing area. Example cell B22: B9*B21*102790.
3.4 Adjusted load from annual reductions (lb/ac/yr) (cells C→E23, G→I23, K→M23, O→Q23, S→U23)	Calculates the adjusted stormwater load due to annual runoff reductions, in pounds per acre per year, for each BMP and pollutant by multiplying the initial event mean concentration times the adjusted annual runoff volume times a conversion factor and dividing by the total contributing area. If the annual runoff reduction is 0%, then the initial stormwater load from step 2.3 is returned. Example cell C23: If B20=0 then C17, if not C15*B22*0.000002205/B9.
3.5 BMP Removal Efficiency (%) (cells C→E24, G→I24, K→M24, O→Q24, S→U24)	Returns the efficiency of the BMP to remove the specified pollutant, in percent form from the Data & Documentation worksheet, column D for TN, F for TP and H for TSS. If the pollutant removal is based on the annualized load reduction then "N/A" is returned, as this was accounted for in the previous calculations.
3.6 Treatment Train Removal Efficiency (%) (cells C→E25, G→I25, K→M25, O→Q25, S→U25)	Accounts for the reduction in efficiency for subsequent BMPs by multiply the BMP removal efficiency by 75% for all BMPs after the first (i.e., BMP 1's treatment train removal efficiency is still equal to the original amount).
3.7 BMP effluent concentration (mg/L) (cells C→E26, G→I26, K→M26, O→Q26, S→U26)	Calculates the revised pollutant concentration in milligrams per liter within the effluent of each BMP due to the BMP's reduction efficiency by multiplying the EMC of the influent by one minus the treatment train removal efficiency. If the BMP does not have any pollutant removal efficiency, the EMC of the influent is returned. Example cell C26: If C25="N/A" then C15, if not, C15*(1-C25).
3.8 Final Adjusted Load (lb/ac/yr) (cells C→E27, G→I27, K→M27, O→Q27, S→U27)	Calculates the final adjusted load, in pounds per acre per year, by multiplying the adjusted stormwater load due to annualized reductions by one minus the treatment train removal efficiency. If the BMP does not have any pollutant removal capabilities, then the adjusted stormwater load due to annualized reductions is returned. Example cell C27: If C25="N/A" then C23, if not, C23*(1-C25).
3.9 Final Adjusted Load (lb/yr) (cells C→E28, G→I28, K→M28, O→Q28, S→U28)	Calculates the final adjusted load in pounds per year by multiplying the result from step 3.8 by the total contributing area. Example cell C28: C27*B9.
Step 4 – Calculate Pollutant Reduction (for informational purposes)	
4.1 TMDL (lb/ac/yr) (cells C→E31)	Returns the allowable TMDL requirement, in pounds per acre per year, per the type of pollutant and per the selected watershed, by searching these parameters within the TMDL Reduction Requirements table, column AA for TN, AB for TP and AC for TSS.

4.2 Reduction met? (cells C→E32, G→I32, K→M32, O→Q32, S→U32)	Determines if the final adjusted pollutant load calculated in step 3.8 is less than or equal to the prescribed TMDL requirement for the watershed (or if the initial pollutant load calculated in step 2.3 is less than or equal to the TMDL) for each pollutant. If the adjusted load is less than the required TMDL than "YES" is returned; if not, "NO" is returned.
4.3 Removed Load (lb/yr) (cells C→E33, G→I33, K→M33, O→Q33, S→U33)	Calculates the total pollutant load removed by the BMP in pounds per year by subtracting the final adjusted load from the stormwater load and multiplying by the total contributing area. Example cell C33: (C17-C27)*B9.

Cv Worksheet (10-Year, Conveyance Event Modeling):	
BMP Type (cells C6, E6, G6, I6, K6)	Returns the type of Best Management Practice that was chosen on the RPv worksheet.
Step 1 – Calculate Initial Cv	
1.1 Total contributing area to BMP (ac) (cells B8, D8, F8, H8, J8)	Returns the contributing area, in acres, from the RPv worksheet, cell RPv!B8.
1.2 Initial RCN (cell B9)	Returns the initial Runoff Curve Number from the RPv worksheet, cell RPv!B10.
1.3 10-Year Rainfall (in.)(cell B10)	Returns the 24-hour rainfall amount, in inches, for the 10-year storm depending on which county the project is located within. For the values used, reference the OLOD worksheet explanation, step 3.3, for the 24-Hour Rainfall Table.
1.4 Cv runoff volume (in.) (cell B11)	Calculates the runoff volume for the Cv event, in inches, using the event-based runoff equation, explained within the OLOD worksheet explanation. $(B10-0.2*((1000/B9)-10))^2/(B10+0.8*((1000/B9)-10)))$.
1.5 LOD allowable unit discharge (cfs/ac) (cell B12)	Returns the allowable unit peak discharge, in cubic feet per second per acre, for the LOD area calculated for the Cv event in the LOD worksheet, cell LOD!B44.
1.6 Equivalent unit discharge outside LOD (cfs/ac) (cell B13)	Returns the equivalent allowable unit peak discharge, in cubic feet per second per acre, for the outside LOD area calculated for the Cv event in the OLOD worksheet, cell OLOD!B52.
1.7 Cv Allowable Discharge Rate (cfs) (cell B14)	Calculates the allowable discharge rate, in cubic feet per second, by adding the product of the LOD allowable unit discharge times the LOD area to the product of the OLOD allowable unit discharge times the OLOD area. B12*LOD!B35+B13*OLOD!B12. However, if the equivalent unit discharge rate is 0, the product of the total contributing area times the LOD allowable discharge rate is returned, B8*B12.
Step 2 – Adjust for Retention Reduction	
2.1 Storage volume (cu.ft.) (cells B17, D17, F17, H17, J17)	Returns the storage volume entered for the respective BMP on the RPv worksheet, row 17.
2.2 Storage volume (ac-ft) (cells B18, D18, F18, H18, J18)	Calculates the storage volume for the respective BMP, in acre-feet, by converting the previously defined storage volume. Example cell B18: B17/43560.
2.3 Storage volume (in.) (cells B19, D19, F19, H19, J19)	Calculates the storage volume for the respective BMP, in inches, by multiplying the previously defined storage volume by the total contributing area and applying the appropriate conversion factors. Example cell B19: B18*12/B8.
2.4 Runoff volume after reduction (in.) (cells B20, D20, F20, H20, J20)	Calculates the total runoff volume, in inches, after the retention reduction is accounted for, by subtracting the BMP storage volume from the Cv runoff volume for BMP 1; or for the higher order BMPs, from the runoff volume after all reductions are accounted for from the previous BMP. Example cell B20: B11-B19; Example cell D20: B30-D19.

2.5 CN* (cells B21, D21, F21, H21, J21)	Calculates the revised runoff curve number based off of the runoff volume after retention reduction, using the McCuen's change in curve number method. Reference the RPv worksheet explanation for further details. Example cell B21: 200/((B10+2*B20+2)-√((5*B10*B20)+4*B20^2)).
Step 3 – Adjust for Annual Runoff Reduction	
3.1 Runoff reduction allowance (%) (cells B24, D24, F24, H24, J24)	Returns the percent of runoff reduction allowed per the BMP type for the Cv event, by utilizing the specified reduction percent in the BMP Suite table in the Data and Documentation worksheet, column O.
3.2 Annual runoff after reduction (in.) (cells B25, D25, F25, H25, J25)	Calculates the annual runoff, in inches, after the runoff reduction for the respective BMP is accounted for, by multiplying the initial Cv runoff volume by one minus the percent of reduction allowed for the specified BMP. Example cell B25: B11*(1-B24). For the latter BMPs, the initial Cv runoff volume is replaced by the previous BMP's Cv runoff volume after all reductions were accounted for. Example cell D25: B30*(1-D24).
3.3 Adjusted ACN (cells B26, D26, F26, H26, J26)	Calculates the revised runoff curve number based off of the runoff volume after retention reduction, using the McCuen's change in curve number method. Reference the RPv worksheet explanation for further details. Example cell B26: 200/((B10+2*B25+2)-√((5*B10*B25)+4*B25^2)).
3.4 Event-based runoff reduction (in.) (cells B27, D27, F27, H27, J27)	Calculates the amount of reduction created for the Cv runoff, in inches, by using the event-based runoff equation with the adjusted ACN to determine the amount of runoff generated and then subtracting that value from the initial Cv runoff in order to determine the amount of reduction. Example cell B27: B11-(B10-0.2*(1000/B26-10))^2/(B10+0.8*(1000/B26-10)).
Step 4 – Calculate Cv with BMP Reductions	
4.1 Cv runoff volume after all reductions (in.) (cells B30, D30, F30, H30, J30)	Calculates the final runoff volume for the Cv event, in inches, by subtracting the retention reduction volume and the event based runoff reduction from the initial Cv runoff volume. Example cell B30: B11-B19-B27.
4.2 Total Cv runoff reduction (%) (cells B31, D31, F31, H31, J31)	Calculates the percent of reduction by subtracting the final runoff volume from the initial runoff volume and then dividing by the initial runoff volume. Example cell B31: (B11-B30)/B11.
4.3 Adjusted RCN for H&H modeling (cells B32, D32, F32, H32, J32)	Calculates the revised runoff curve number based off of the final runoff volume after all reductions, by using the McCuen's change in curve number method. Reference the RPv worksheet explanation for further details. Example cell B32: 200/((B10+2*B30+2)-√((5*B10*B30)+4*B30^2)).

Fv Worksheet (100-Year, Flooding Event Modeling):	
BMP Type (cells C6, E6, G6, I6, K6)	Returns the type of Best Management Practice that was chosen on the RPv worksheet.
Step 1 – Calculate Initial Fv	
1.1 Total contributing area to BMP (ac) (cells B8, D8, F8, H8, J8)	Returns the contributing area, in acres, from the RPv worksheet, cell RPv!B8.
1.2 Initial RCN (cell B9)	Returns the initial Runoff Curve Number from the RPv worksheet, cell RPv!B10.
1.3 100-Year Rainfall (in.)(cell B10)	Returns the 24-hour rainfall amount, in inches, for the 100-year storm depending on which county the project is located within. For the values used, reference the OLOD worksheet explanation, step 3.3, for the 24-Hour Rainfall Table.
1.4 Fv runoff volume (in.) (cell B11)	Calculates the runoff volume for the Fv event, in inches, using the event-based runoff equation, explained within the OLOD worksheet explanation. $(B10-0.2*((1000/B9)-10))^2/(B10+0.8*((1000/B9)-10)))$.
1.5 LOD allowable unit discharge (cfs/ac) (cell B12)	Returns the allowable unit peak discharge, in cubic feet per second per acre, for the LOD area calculated for the Fv event in the LOD worksheet, cell LOD!B47.
1.6 Equivalent unit discharge outside LOD (cfs/ac) (cell B13)	Returns the equivalent allowable unit peak discharge, in cubic feet per second per acre, for the outside LOD area calculated for the Fv event in the OLOD worksheet, cell OLOD!C52.
1.7 Fv Allowable Discharge Rate (cfs) (cell B14)	Calculates the allowable discharge rate, in cubic feet per second, by adding the product of the LOD allowable unit discharge times the LOD area to the product of the OLOD allowable unit discharge times the OLOD area. B12*LOD!B35+B13*OLOD!B12. However, if the equivalent unit discharge rate is 0, the product of the total contributing area times the LOD allowable discharge rate is returned, B8*B12.
Step 2 – Adjust for Retention Reduction	
2.1 Storage volume (cu.ft.) (cells B17, D17, F17, H17, J17)	Returns the storage volume entered for the respective BMP on the RPv worksheet, row 17.
2.2 Storage volume (ac-ft) (cells B18, D18, F18, H18, J18)	Calculates the storage volume for the respective BMP, in acre-feet, by converting the previously defined storage volume. Example cell B18: B17/43560.
2.3 Storage volume (in.) (cells B19, D19, F19, H19, J19)	Calculates the storage volume for the respective BMP, in inches, by multiplying the previously defined storage volume by the total contributing area and applying the appropriate conversion factors. Example cell B19: B18*12/B8.

2.4 Runoff volume after reduction (in.) (cells B20, D20, F20, H20, J20)	Calculates the total volume of storage, in inches, after accounting for the retention reduction volume, by subtracting the BMP storage volume from the Fv runoff volume for BMP 1; or for the higher order BMPs, from the runoff volume after all reductions are accounted for from the previous BMP. Example cell B20: B11-B19; Example cell D20: B30-D19.
2.5 CN* (cells B21, D21, F21, H21, J21)	Calculates the revised runoff curve number based off of the runoff volume after retention reduction, using the McCuen's change in curve number method. Reference the RPv worksheet explanation for further details. Example cell B21: 200/((B10+2*B20+2)-√((5*B10*B20)+4*B20^2)).
Step 3 – Adjust for Annual Runoff Reduction	
3.1 Runoff reduction allowance (%) (cells B24, D24, F24, H24, J24)	Returns the percent of annual runoff reduction allowed per the BMP type for the Fv event, by utilizing the specified reduction percent in the BMP Suite table in the Data and Documentation worksheet, column Q.
3.2 Annual runoff after reduction (in.) (cells B25, D25, F25, H25, J25)	Calculates the annual runoff, in inches, after the runoff reduction for the respective BMP is accounted for, by multiplying the initial Fv runoff volume by one minus the percent of reduction allowed for the specified BMP. Example cell B25: B11*(1-B24). For the latter BMPs, the initial Fv runoff volume is replaced by the previous BMP's Fv runoff volume after all reductions were accounted for. Example cell D25: B30*(1-D24).
3.3 Adjusted ACN (cells B26, D26, F26, H26, J26)	Calculates the revised runoff curve number based off of the runoff volume after retention reduction, using the McCuen's change in curve number method. Reference the RPv worksheet explanation for further details. Example cell B26: 200/((B10+2*B25+2)-√((5*B10*B25)+4*B25^2)).
3.4 Event-based runoff reduction (in.) (cells B27, D27, F27, H27, J27)	Calculates the amount of reduction created for the Fv runoff, in inches, by using the event-based runoff equation with the adjusted ACN to determine the amount of runoff generated and then subtracting that value from the initial Fv runoff in order to determine the amount of reduction. Example cell B27: B11-(B10-0.2*(1000/B26-10))^2/(B10+0.8*(1000/B26-10)).
Step 4 – Calculate Fv with BMP Reductions	
4.1 Fv runoff volume after all reductions (in.) (cells B30, D30, F30, H30, J30)	Calculates the final runoff volume for the Fv event, in inches, by subtracting the retention reduction volume and the event based runoff reduction from the initial Fv runoff volume. Example cell B30: B11-B19-B27.
4.2 Total Fv runoff reduction (%) (cells B31, D31, F31, H31, J31)	Calculates the percent of reduction by subtracting the final runoff volume from the initial runoff volume and then dividing by the initial runoff volume. Example cell B31: (B11-B30)/B11.

4.3 Adjusted RCN for H&H modeling (cells B32, D32, F32, H32, J32)	Calculates the revised runoff curve number based off of the final runoff volume after all reductions, by using the McCuen's change in curve number method. Reference the RPv worksheet explanation for further details. Example cell B32: 200/((B10+2*B30+2)-√((5*B10*B30)+4*B30^2)).

Notes:

1. If an entry is defined by a group of cells (i.e., one merged cell), then only the first represented cell number is listed in the above definitions.
2. If a step has more than one input or output cell associated with it (i.e., for the multiple BMPs), then only one respective cell is shown as an example.
3. The runoff volume is expressed in terms of inches as it is on a per acre unit basis.
4. Many of the defined cells include logic testing in order to eliminate negative numbers, provide a comparison between different values, or indicate "N/A" if a BMP is not selected. Any of this logic testing is not included in the example equations included within the definition.
5. The DURMM Report worksheet is not explained within the User Guide since all of the cells return previously defined information and it serves merely as a summary sheet. The only calculations performed are to return the minimum of a series of values, or to return the average of a series of values.
6. The Data and Documentation worksheet is not explained within the User Guide. This page references all of the Stormwater BMPs and their associated variants and lists the following information per column:
   - A. Class: Retention Practice, Annual Runoff Reduction Practice or Stormwater Treatment Practice are the three classes listed.
   - B. BMP Category: Lists the name and number of the practice as it appears on the corresponding Standard and Specification.
   - C. DURMM Variant: Lists the name and number of any variants for the BMP.
   - D. & E. TN Reduction: Lists the total nitrogen removal efficiency of the BMP as a percentage, or for Annual Runoff Reduction and Retention practices, that 100% of the total nitrogen within the adjusted load is reduced.
   - F. & G. TP Reduction: Lists the total phosphorus removal efficiency of the BMP as a percentage, or for Annual Runoff Reduction and Retention practices, that 100% of the total phosphorus within the adjusted load is reduced.
   - H. & I. TSS Reduction: Lists the total suspended solids removal efficiency of the BMP as a percentage, or for Annual Runoff Reduction and Retention practices, that 100% of the total suspended solids within the adjusted load is reduced.
   - J. Retention Allowable: Lists the allowable amount of retention in percent form for applicable BMPs.
   - K. & L. Annual RR, RPv, A/B Soil: Lists the allowable amount of annual runoff reduction for the Resource Protection Event in percent form for the applicable BMPs that are on HSG A or B.
   - M. & N. Annual RR, RPv, C/D Soil: Lists the allowable amount of annual runoff reduction for the Resource Protection Event in percent form for the applicable BMPs that are on HSG C or D.
   - O. & P. RR, Cv: Lists the allowable amount of runoff reduction for the Conveyance Event in percent form for the applicable BMPs.
   - Q. & R. RR, Fv: Lists the allowable amount of runoff reduction for the Flooding Event in percent form for the applicable BMPs.
7. The Summary Table for Sub-Areas Draining to a Common Point of Interest is not explained within the User Guide, but should be used to determine the net inputs to a common Point of Interest (POI) or global watershed. The inputs can be found on the DURMM Report worksheet. For a series of sub-areas

that drain into each other, only the furthest downstream sub-area should be entered as the upstream areas will already be accounted for in the downstream node.

Abbreviations:

Abbreviation	Definition	Abbreviation	Definition
ac	Acres	Fv	Flooding Event (100-Year)
ac-ft	Acre-ft	Ia	Initial Abstraction
ACN	Annual Curve Number	in.	Inch
Avg	Average	lbs	Pounds
BMP	Best Management Practice	lb/ac/yr	Pound per Acre per Year
C	Contoured	LOD	Limit of Disturbance
C&D	Chesapeake and Delaware Canal	mg/L	Milligram per Liter
C&T	Contoured and Terraced	mg/yr	Milligram per Year
C.A.	Contributing Area	OLOD	Outside the Limit of Disturbance
cfs	Cubic Feet per Second	P	Precipitation
cfs/ac	Cubic Feet per Second, per Acre	q_p	Peak Discharge
CN	Curve Number	q_u	Unit Peak Discharge
CR	Crop Residue	RCN	Runoff Curve Number
cu. ft.	Cubic Feet	RPv	Resource Protection Event (1-Year)
cu. ft./ac	Cubic Feet per Acre	RR	Runoff Reduction
Cv	Conveyance Event (10-Year)	SR	Straight Row
DMV	Delmarva Unit Hydrograph	STD	Standard Unit Hydrograph
DURMM	Delaware Urban Runoff Management Model	TMDL	Total Maximum Daily Load
		TN	Total Nitrogen
EMC	Event Mean Concentration	TP	Total Phosphorus
ft/ft	Foot per Foot	TR-55	Technical Release 55
ft/sec	Foot per Second	TSS	Total Suspended Solids
H&H	Hydraulic and Hydrology	WS	Watershed
HSG	Hydrologic Soil Group	yr	Year
hr (hrs)	Hour (Hours)		

Contributing Area Runoff Curve Number (C.A. RCN) Worksheet Explanation:

The calculations to determine the runoff curve number for the contributing area are derived through standard TR-55 methodologies. For additional information regarding the content and processes, reference the *Urban Hydrology for Small Watersheds Technical Release 55 (TR-55) Manual*, prepared by the United States Department of Agriculture, Natural Resources Conservation Service, last revised June 1986.

Limit of Disturbance (LOD) Worksheet Explanation:

The Resource Protection Runoff was derived by utilizing a Composite CN per the four hydrologic soil groups (based on the percent pervious versus the percent impervious), and plotting those values versus their respective runoff generated for a 1 year storm event using the original DURMM v.1 runoff equations. The original DURMM analyzed the runoff by calculating the amount generated in the pervious section, and adding to the amount generated in the impervious section. The combined amount was the total runoff for a 1 year storm. To simplify,

DURMM v.2 has used a polynomial regression equation to best fit the relationship between the Composite CN and the 1 year runoff. This produces, the RPv runoff equation of:

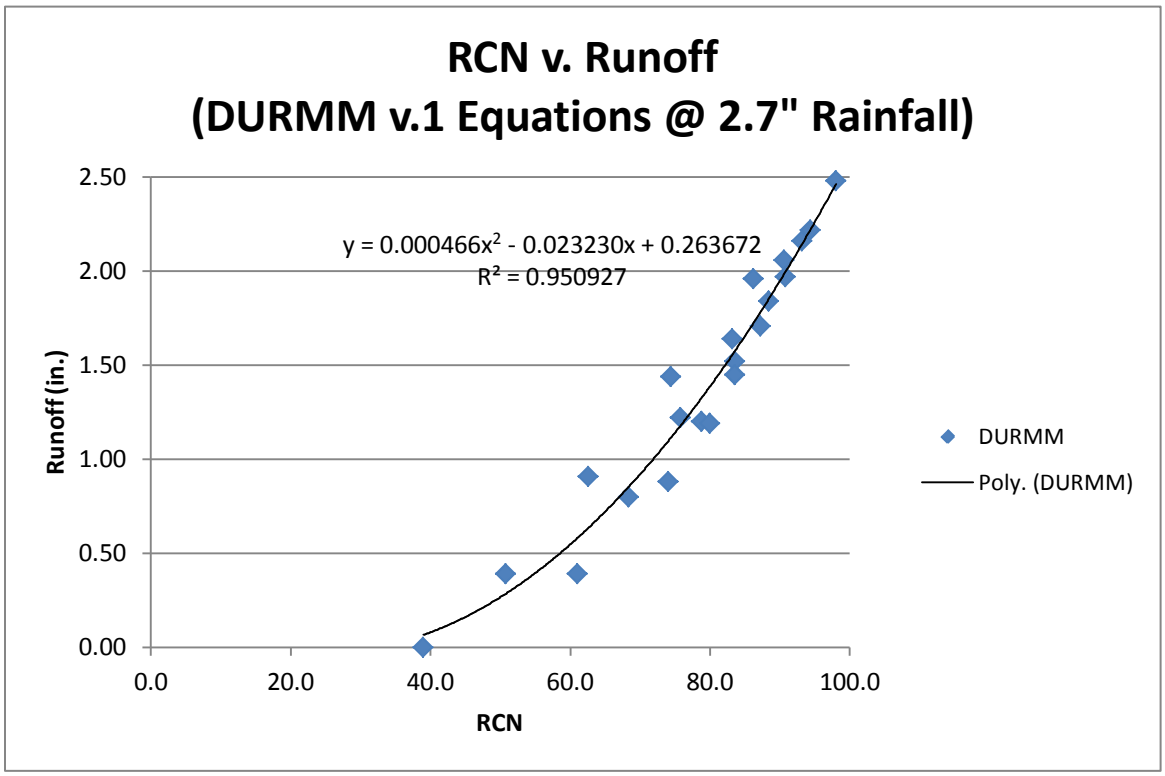
$$y = 0.000466x^2 - 0.023230x + 0.263672,$$

where y is the runoff in inches, and x is the composite CN. The R^2 value is equal to 0.950927 for the regression equation. See the below input data for the derivation of the RPv equation.

Input data:

	Pervious		Impervious		Composite	DURMM v.1 Runoff
Soil HSG	%	CN	%	CN	CN	(2.7" Rainfall) (in.)
HSG A	100%	39	0%	98	39.0	0.00
	80%	39	20%	98	50.8	0.39
	60%	39	40%	98	62.6	0.91
	40%	39	60%	98	74.4	1.44
	20%	39	80%	98	86.2	1.96
HSG B	100%	61	0%	98	61.0	0.39
	80%	61	20%	98	68.4	0.80
	60%	61	40%	98	75.8	1.22
	40%	61	60%	98	83.2	1.64
	20%	61	80%	98	90.6	2.06
HSG C	100%	74	0%	98	74.0	0.88
	80%	74	20%	98	78.8	1.20
	60%	74	40%	98	83.6	1.52
	40%	74	60%	98	88.4	1.84
	20%	74	80%	98	93.2	2.16
HSG D	100%	80	0%	98	80.0	1.19
	80%	80	20%	98	83.6	1.45
	60%	80	40%	98	87.2	1.71
	40%	80	60%	98	90.8	1.97
	20%	80	80%	98	94.4	2.22
N/A	0%	N/A	100%	98	98.0	2.48

Plot of the Composite CN versus DURMM v.1 for 1-Year Runoff:



The 1 year runoff generated within the LOD using the RPv equation, is then compared to the Target runoff that was generated in the pre-developed condition. RPv target runoff values for each of the four hydrologic soil groups in a woods state were established based on historical data. These values, shown below, are multiplied by the respective amount of pre-developed woods and/or meadow per soil group to establish the pre-developed runoff generated from the existing woods and/or meadow area.

Pre-Developed Woods/Meadow Factors				
	HSG A	HSG B	HSG C	HSG D
RPv Target Runoff (in)	0.00	0.12	0.55	0.87

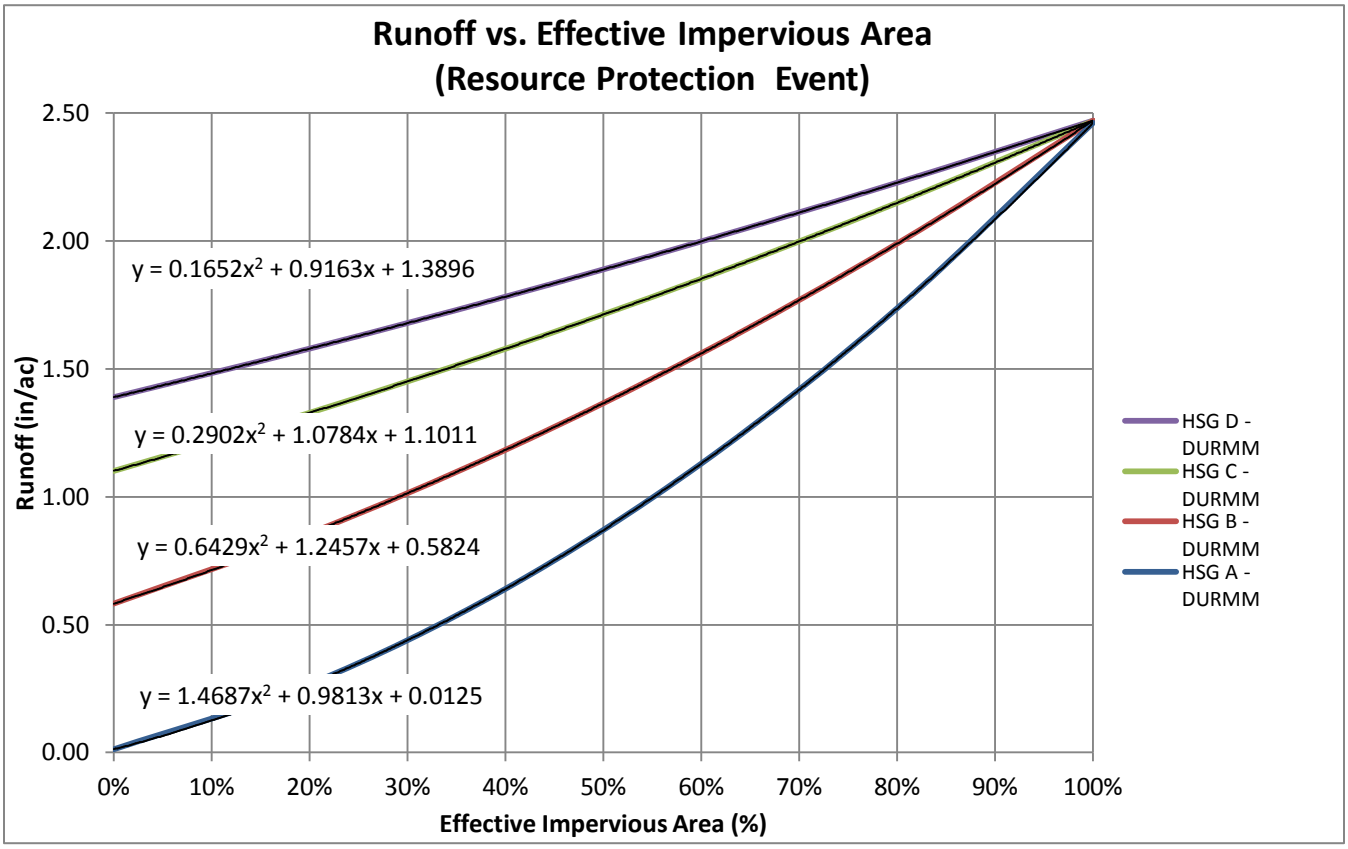
The amount of runoff produced from the non-woods and/or non-meadow area is also evaluated by multiplying the respective area per hydrologic soil group times the runoff generated based on the percent of impervious (only 50% of the impervious area is utilized for redevelopment purposes). This impervious percent, the impervious area within the HSG times 50% and divided by the total HSG area, is inputted into the equation of best fit per HSG for the amount of runoff generated by using the composite CN in the runoff equation described above. The sum of the woods/meadow and non-woods/non-meadow runoff values are added together and divided by the total LOD area for that soil group, to determine the target runoff amount for the RPv event per site acre.

Pre-developed Non-Woods/Non-Meadow Factors								
	HSG A		HSG B		HSG C		HSG D	
% Effective Impervious	Composite RCN	Runoff (in.)	Composite RCN	Runoff (in.)	Composite RCN	Runoff (in.)	Composite RCN	Runoff (in.)
0%	39	0	61	0.58	74	1.10	80	1.39
20%	50.8	0.29	68.4	0.86	78.8	1.33	83.6	1.58
40%	62.6	0.64	75.8	1.18	83.6	1.58	87.2	1.78
60%	74.4	1.12	83.2	1.56	88.4	1.85	90.8	2.00
80%	86.2	1.73	90.6	1.99	93.2	2.15	94.4	2.23
100%	98	2.47	98	2.47	98	2.47	98	2.47

Notes:

1. The curve numbers noted in the above table correspond to the Composite CN values described previously in the LOD explanation.
2. The runoff is generated by inserting the RCN values into the runoff equation: $y = 0.000466x^2 - 0.023230x + 0.263672$, where y is the runoff in inches, and x is the composite CN.

The effective impervious equations are generated by plotting the percent effective impervious versus the runoff and applying the line of best fit:



The Cv and Fv weighted unit discharges, indicate the discharge rate per LOD acre that would be generated per hydrologic soil group in the pre-developed condition. These values are determined by multiplying the respective amount of pre-developed woods/meadow and non-woods/meadow per soil group by set unit discharge amounts, and then dividing the sum by total LOD area for that soil type. The factor values were established by using historic data for the amount of discharge per soil and cover type in a per acre basis, and the values can be seen below:

Cv/Fv Unit Discharge
Woodland/Meadow (HSG A)
10-YR: 0 cfs/ac
100-YR: 0.25 cfs/ac
Woodland/Meadow (HSG B,C,D)
10-YR: 0.375 cfs/ac
100-YR: 1.25 cfs/ac
Non-Woodland/Non-Meadow (HSG A, B, C, D)
10-YR: 0.75 cfs/ac
100-YR: 2.25 cfs/ac

The estimated annual runoff within the LOD area is determined by using a power equation derived from the log-log plot of the Weighted LOD RCN versus the annual runoff calculated using WinSLAMM. The line of best fit results in the following equation:

$$y = 0.000004x^{3.5},$$

where y equals the Annual Runoff in inches, and x is the Weighted LOD RCN.

OLOD Worksheet Explanation:

The below table shows the Manning's n values used in step 2.3 on the OLOD worksheet to calculate the time of concentration. For each possible surface cover under sheet flow conditions a corresponding Manning's n value is given. The surface code used in step 2.2 is also referenced.

	Sheet Flow Surface Code & Type	Manning's "n"
a	Smooth Surface	0.01
b	fallow (no residue)	0.05
c	cultivated < 20% Res.	0.06
d	cultivated > 20% Res.	0.17
e	grass - range, short	0.15
f	grass, dense	0.24

g	grass, bermuda	0.41
h	woods, light	0.40
i	woods, dense	0.80
j	range, natural	0.13

The table below shows the 24-hour rainfall amounts per County used to determine the Cv and Fv peak discharge rates as referenced in step 3.3 on the OLOD worksheet.

24-Hour Rainfall per County (in.)

County	10-YR	100-YR
Kent	5.2	8.9
New Castle	4.8	8.0
Sussex	5.3	9.2

The lookup table used to determine the initial abstraction value (Ia) based upon the curve number for the OLOD area is shown below. This value is referenced in step 3.4 on the OLOD worksheet.

Curve Number	Ia (in)	Curve Number	Ia (in)
30	4.667	65	1.077
31	4.452	66	1.030
32	4.250	67	0.985
33	4.061	68	0.941
34	3.882	69	0.899
35	3.714	70	0.857
36	3.556	71	0.817
37	3.405	72	0.778
38	3.263	73	0.740
39	3.128	74	0.703
40	3.000	75	0.667
41	2.878	76	0.632
42	2.762	77	0.597
43	2.651	78	0.564
44	2.545	79	0.532
45	2.444	80	0.500
46	2.348	81	0.469
47	2.255	82	0.439
48	2.167	83	0.410
49	2.082	84	0.381
50	2.000	85	0.353
51	1.922	86	0.326

52	1.846	87	0.299
53	1.774	88	0.273
54	1.704	89	0.247
55	1.636	90	0.222
56	1.571	91	0.198
57	1.509	92	0.174
58	1.448	93	0.151
59	1.390	94	0.128
60	1.333	95	0.105
61	1.279	96	0.083
62	1.226	97	0.062
63	1.175	98	0.041
64	1.125		

The Unit Peak Discharge is calculated for the 10 and 100 year storm events for the OLOD area, by developing coefficient tables that represent the Type II storm data for the Standard SCS (STD) and the Delmarva (DMV) Unit Peak Discharge models. The coefficients, C_0, C_1, and C_2, that create the line of best fit for six Ia/P values are given for both the STD and DMV peak discharge curves, using the equation:

$$\log(q_u) = C_0 + C_1\log(Tc) + C_2,\log(Tc)^2$$

where q_u = unit peak discharge and Tc = time of concentration in hours . The actual Ia/P value for the site is then interpolated between these established values, so that the site specific coefficients can be determined, and then used in the line of best fit equation. This results in obtaining the log of the peak unit discharge, which is used in the output cells, B49 and C49, to determine the peak unit discharge by raising the log to the 10th power in step 3.6. The coefficient tables, which start at cell M43, can be seen below with example Ia/P site specific values being entered for the 10 and 100 year storms of 0.21 and 0.12, respectively:

STD Unit Peak Discharge Coefficient Table - Type II Storm

		Ia/P	C0	C1	C2	
	1	0.10	2.55323	-0.61512	-0.16403	
	2	0.30	2.46532	-0.62257	-0.11657	
	3	0.35	2.41896	-0.61594	-0.08820	
	4	0.40	2.36409	-0.59857	-0.05621	
	5	0.45	2.29238	-0.57005	-0.02281	
	6	0.50	2.20282	-0.51599	-0.01259	$\log(q_u)$
10-YR		0.21	2.52762	-0.62747	-0.13961	2.532455668
100-YR		0.12	2.55208	-0.62068	-0.16172	2.556857013

DMV Unit Peak Discharge Coefficient Table - Type II Storm

	Ia/P	C0	C1	C2	
1	0.10	2.33733	-0.68709	-0.10847	
2	0.30	2.22599	-0.68545	-0.03220	
3	0.35	2.17707	-0.66476	-0.00830	
4	0.40	2.12341	-0.63854	0.01624	
5	0.45	2.06447	-0.59720	0.02867	
6	0.50	1.99673	-0.53417	0.03114	$\log(q_u)$
10-YR	0.21	2.288136	-0.69299	-0.07442	2.293480471
100-YR	0.12	2.330644	-0.68859	-0.10391	2.335952591

The amount of runoff generated for both the 10 and 100 year storms is determined by using the SCS equation for runoff, $Q = (P-0.2S)^2/(P+0.8S)$, where P equals the precipitation in inches, and S is the potential maximum retention after runoff begins, and is defined by $S = 1000/CN - 10$, where CN equals the runoff curve number. These two equations are combined together to make one event-based runoff equation that is used within DURMM v.2:

$$y = (P - 0.2*(1000/RCN - 10))^2 / (P + 0.8*(1000/RCN - 10)),$$

where y equals the runoff volume in inches, and the other variables are as defined above.

RPv worksheet

In order to determine a comparative runoff curve number for the sub-area in question after all runoff reductions have been incorporated, the McCuen's Change in Curve Number Method is employed, as developed by Dr. Richard McCuen for the Maryland Standards and Specifications for Stormwater Management Infiltration Practices, 1984. The equation uses the 24-hour design storm precipitation value along with the final runoff volume after all reductions have been incorporated to calculate an adjusted curve number. The resulting curve number will be higher than the original curve number derived for the contributing area in order to account for the higher runoff values that are calculated using the WinSLAMM method compared to TR-55 methods. The McCuen's equation for the adjusted curve number, $CN_{adjusted}$, is:

$$CN_{adjusted} = 200 / ((P + 2*Q + 2) - \sqrt{(5*P*Q+4*Q^2)}),$$

where P equals the 24-hour design storm precipitation value, in inches (2.7" for the 1-year storm is used for the RPv event), and Q is the runoff volume after all reductions have been accounted for, in inches.

TMDL worksheet

The event mean concentration for each pollutant, TN, TP and TSS is listed in the below table per specified landuse type. The values are referenced in cells C15, D15 and E15 respectively per pollutant type in step 2.1 on the TMDL worksheet.

	EMC (mg/L)		
Landuse Type	TN	TP	TSS
Urban Open Space	2.0	0.27	50
Residential	2.0	0.27	60
Commercial	2.0	0.27	60
Institutional	2.0	0.27	60
Industrial	2.0	0.27	80
Rural Road	2.0	0.27	80
Urban Road/Highway	2.0	0.27	100

The established TMDL limits for each watershed are listed below for TN, TP and TSS:

TMDL Requirements (lb/ac/year)

Drainage Basin	TMDL Watershed	WS Code	TN TMDL	TP TMDL	TSS TMDL
Piedmont	Naamans Creek	1	10.40	0.72	N/A
	Shellpot Creek, above Rt. 13	2	6.30	0.43	N/A
	Shellpot Creek, below Rt. 13	2			
	Brandywine Creek	3	10.10	0.67	N/A
	Red Clay Creek	4	5.30	0.49	N/A
	White Clay Creek	5	8.00	0.46	N/A
	Christina River	6	5.70	0.35	N/A
Delaware Bay	Delaware River	7			
	Army Creek	8	2.10	0.18	N/A
	Mispillion River, King's Causeway Br.	20	5.70	0.10	N/A
	Mispillion River, Remaining WS	20	5.70	0.10	N/A
	Cedar Creek	21	6.40	0.25	N/A
	Broadkill River	22	11.90	0.50	N/A
Chesapeake Bay	Elk Creek	23	6.58	0.58	129
	Perch Creek	24	6.58	0.58	129
	C&D Canal West	25	6.58	0.58	129
	Bohemia Creek	26	6.58	0.58	129
	Sassafras River	27	6.58	0.58	129
	Chester River	28	6.58	0.58	129
	Choptank River	29	6.58	0.58	129
	Marshyhope Creek	30	6.58	0.58	129
	Nanticoke River	31	6.58	0.58	129
	Gum Branch	32	6.58	0.58	129
	Gravelly Branch	33	6.58	0.58	129
	Deep Creek	34	6.58	0.58	129
	Broad Creek	35	6.58	0.58	129

	Wicomico River	36	6.58	0.58	129
	Pocomoke River	37	6.58	0.58	129
Inland Bays/ Atlantic Ocean	Lewes-Rehoboth Canal	38	5.70	0.23	N/A
	Rehoboth Bay	39	5.70	0.23	N/A
	Indian River, Upper	40	3.30	0.18	N/A
	Indian River, Lower	40	5.70	0.23	N/A
	Iron Branch	41	3.30	0.18	N/A
	Indian River Bay	42	5.70	0.23	N/A
	Buntings Branch	43	11.90	0.39	N/A
	Assawoman Bay	44			
	Little Assawoman Bay	45	5.70	0.23	N/A

3.05
General Plan Requirements

Background

In order to improve the efficiency of the plan review process, the Department is standardizing the formatting, as well as the information contained in the plans themselves. In accordance with the 3 Step plan review and approval process, the Preliminary Sediment & Stormwater Management Plan is submitted at Step 2 and the Sediment & Stormwater Management Plan is submitted at Step 3. Additional information regarding specific elements required for these plans is outlined below.

Elements of the Preliminary Sediment & Stormwater Management Plan

The Preliminary Sediment & Stormwater Management Plan submitted at Step 2 of the plan review and approval process shall include a Schematic Erosion and Sediment Control (ESC) Plan which provides an overview of the general measures to be used to control the site during the construction phase. The Schematic ESC Plan shall consist of the following elements:

1. A single plan sheet scaled such that the entire site can be shown.
2. Site boundary.
3. Existing topography.
4. Existing natural features, such as wooded areas, wetlands, etc.
5. Proposed rough grading.
6. Graphic symbols for all ESC measures shown in their approximate proposed locations.
7. Data for those practices having design data criteria.
8. Legend using the symbols from the current Delaware ESC handbook.

The Preliminary Sediment & Stormwater Management Plan shall also include a Schematic Stormwater Management (SWM) Plan which provides an overview of the general measures to be used to manage the post-construction stormwater runoff. The Schematic SWM Plan shall consist of the following elements:

1. A single plan sheet scaled such that the entire site can be shown.
2. Site boundary.
3. Existing topography.
4. Existing natural features, such as wooded areas, wetlands, etc.
5. Proposed rough grading.
6. Graphic symbols for all SWM measures shown in their approximate proposed locations.

7. Data for those practices based on the design criteria from the appropriate standards and specifications.
8. Legend for the proposed permanent SWM measures.

Elements of the Sediment & Stormwater Management Plan

The Sediment & Stormwater Management Plan submitted at Step 3 of the plan review and approval process shall include detailed information on the measures to control both sediment and non-sediment pollutants during the active construction phase as well as those measures to manage post-construction stormwater. It shall consist of the following elements:

1. Updated Schematic ESC and SWM Plans.
2. Bulk grading and/or final grading conditions, as required by the appropriate Delegated Agency.
3. A legend using the symbols from the current Delaware ESC Handbook.
4. A sequence of construction describing the relationship between the implementation and maintenance of sediment controls, including permanent and temporary stabilization and the various stages or phases of earth disturbance and construction. The sequence of construction shall, at a minimum, include the following activities:

    a. Clearing and grubbing for those areas necessary for installation of perimeter controls;

    b. Construction of perimeter controls;

    c. Remaining clearing and grubbing;

    d. Road grading;

    e. Grading for the remainder of the site;

    f. Utility installation and whether stormdrains will be used or blocked until after completion of construction;

    g. Final grading, landscaping, or stabilization; and

    h. Removal of sediment controls.

5. General ESC notes as specified by the appropriate Delegated Agency.

a. Following documentation of turbid discharges, the Department or delegated agency may request that the Sediment and Stormwater Management Plan be revised accordingly to address use of BAT. (Regs §4.2.2)

b. Following soil disturbance or re-disturbance, permanent or temporary stabilization shall be completed within 14 calendar days for all perimeter sediment controls, topsoil stockpiles, and all other disturbed or graded areas on the project site. Temporary stabilization is required if grading will not change for 14 calendar days or more for those areas which are shown on the plan and are currently being used for material storage, or for those areas on which actual earth moving activities are currently being performed. (Regs §4.5.1)

c. If within 60 calendar days permanent or temporary stabilization applied to a disturbed area results in insignificant germination as determined by the Department or delegated agency, a soil test must be completed. Permanent or temporary stabilization shall be re-applied to the disturbed area in accordance with that soil test and the plan requirements within 14 calendar days following the 60-calendar day threshold. The Department or delegated agency shall have the discretion to require soil testing sooner than 60 calendar days if evidence exists that the permanent or temporary stabilization measures were not applied in accordance with the specification provided in the Delaware Erosion and Sediment Control Handbook. (Regs §4.5.2)

6. Detailed information on the location, grading, and construction data for all proposed ESC practices.

7. Details for all proposed ESC practices.

8. Construction Site Pollution Control details.

9. Details of temporary and permanent stabilization measures.

10. Owner's certification block with signature.

11. Construction details for all permanent stormwater management BMPs. A separate plan sheet shall be provided for each individual SWM BMP. The plan sheet shall include, but not be limited to

    a. Plan view showing proposed grading

b. Section view with proposed elevations

c. Details for any appurtenances

d. Planting and/or stabilization information

e. Sequence of construction

f. Maintenance notes

12. In cases where the Department has developed standardized requirements for a “common look and feel” for specific elements of the Sediment & Stormwater Plan, those requirements shall prevail.

GENERAL EROSION AND SEDIMENT CONTROL SEQUENCE OF CONSTRUCTION

The below sequence of construction is a generalization, and should be enhanced per the specifics of the site, including but not limited to the existing site features; the proposed stormwater management, utilities, and building/lot construction; and the site's phasing.

1. Notify the DNREC Sediment and Stormwater Program [or relevant Delegated Agency] in writing at least five (5) days prior to the start of construction. Failure to do so constituents a violation of the approved Sediment and Stormwater Management Plan. ***[Required Sequence Item]***

2. Prior to any clearing, installation of sediment control measures, or grading, schedule and conduct a pre-construction meeting with the Agency Construction Site Reviewer. The landowner/developer representative, site contractor, and Certified Construction Reviewer are required to be in attendance at the pre-construction meeting; the site designer is recommended to attend. ***[Required Sequence Item]***

3. Install the stabilized construction entrance(s) as indicated on the plan, followed by the perimeter controls (i.e., berms, silt fence, compost logs) and inlet protection on any existing inlets. Mark the limits of sensitive areas, such as preserved trees, infiltration areas, and other sections that are not to be disturbed with a physical barrier. Only clear woods that are needed to install the perimeter controls (as needed).

4. Schedule a perimeter control review with the Agency Construction Site Reviewer.

5. All perimeter controls are to be reviewed by the Agency Construction Site Reviewer and approved prior to proceeding with further site disturbance or construction. ***[Required Sequence Item]***

6. Check perimeter controls daily and adjust and/or repair to fully contain and control sediment from leaving the site. Accumulated sediment shall be removed when it has reached half of the effective capacity of the control. Adjust or alter measures in times of adverse weather conditions, as needed or as directed by the Agency Construction Site Reviewer. ***[Required Sequence Item]***

7. Clear and grub the sediment trap and basin area(s).

8. Notify the person responsible for stormwater system construction review at least three (3) days prior to the start of the stormwater system construction; stormwater facilities must be reviewed throughout their construction. ***[Required Sequence Item]***

9. Construct the sediment trap and/or basin(s), starting with the outlet device and discharge pipe, and stabilize immediately with seed and mulch. For basin construction, see the specific construction sequence for the facility. *[Additional sequence of construction to be provided for all stormwater facilities.]*

10. Stockpile topsoil and excavated subsoils. Stockpiles should be surrounded with a perimeter control, located on land with slight to no slope, and stabilized once inactive.

11. Construct temporary earth dikes, berms, and/or swales needed for sediment and erosion control as indicated on the plan and stabilize immediately as per the vegetation specifications. All conveyance areas, and slopes greater than 3:1, require seeding and matting at a minimum.

12. Perform any demolition work, and clear, grub, and rough grade the site's roadways. Stockpile appropriately.

13. Construct roadside ditches and temporarily stabilize. Stone check dams shall be installed at this time. *[As Applicable]*

14. Clear and grub remaining areas within the limits of disturbance for the phase of construction. Stockpile appropriately.

15. Construct the stormwater conveyance system, starting at the lowest elevation within the network and working upwards. Install necessary inlet protection as shown on plan. Install any remaining non-infiltration stormwater management facilities, following its respective sequence of construction. *[Additional sequence of construction to be provided for all stormwater facilities.]*

16. Install remaining roadway utilities. *[As Applicable]*

17. Install the curb and gutter *[as applicable]*, followed by the sub-base and base course sections of the roadways to design grades. Install any sidewalks.

18. Rough grade lot or building areas and individual utility connections. Temporary stabilization is to be applied in accordance with the stabilization notes and details.

19. Commence building construction. *[As Applicable]*

20. Final grade swales or ditches, and apply permanent stabilization as soon as final grade is achieved.

21. Final grade lot or building areas and apply permanent stabilization.

22. Flush out the stormwater pipes for any accumulated sediment, and remove sediment from within any forebays, with inspection by the Certified Construction Reviewer and/or the Agency Construction Site Reviewer. Upon approval of the Agency Construction Site Reviewer, convert the sediment basin to final pond design as specified on the pond conversion notes, and/or fill in any sediment traps. Provide permanent stabilization as per the vegetation specifications.

23. When all upstream contributing areas have been stabilized, commence construction of any infiltration stormwater management facilities. Care should be taken to prohibit compaction of the underlying soils during construction. Provide permanent stabilization. *[As Applicable]*

24. Install topcoat to the roadways.

25. The erosion and sediment control devices should be removed only after work in an area has been completed and stabilized, with written approval from the Agency Construction Site Reviewer. ***[Required Sequence Item]*** Coordinate the inspection, and after the written approval, remove the remaining construction site controls.

26. If any individual lots are sold and developed, provide on-site erosion and sediment controls for that lot (perimeter controls and a stabilized construction entrance, at a minimum). *[As Applicable]*

27. Prior to commencing a new phase of construction, receive written approval from the Agency Construction Site Reviewer that the previous phase has been sufficiently stabilized. ***[Required Sequence Item, As Applicable]***

28. Terminate coverage of the Construction General Permit, which requires submission and acceptance of the Post Construction Verification Documents, including final stabilization throughout the site, all elements of the Sediment and Stormwater Management Plan implemented, acceptance of the final Operation and Maintenance Plan, and submittal of the Notice of Termination. ***[Required Sequence Item]***

Project Name

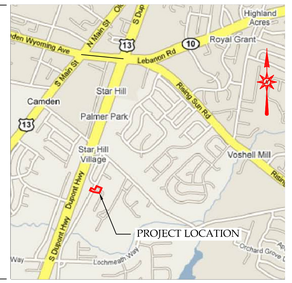
Sediment and Stormwater Management Plans

XXXX Hundred

XXXX Watershed

Tax Parcel[s]: XXXX

[City/Town of XXXX,] XXXX County, Delaware



LOCATION MAP
1" = 1/2 mile

4" min.

PROJECT NOTES:

1. PARCEL DATA:
   TAX MAP #:
   PLUS #: (if applicable)
   DNREC SEDIMENT AND STORMWATER PROGRAM # (OR RELEVANT DELEGATED AGENCY) :
   ADDRESS (OR DISTANCE TO NEAREST INTERSECTING STREET) :
   LATITUDE/LONGITUDE:
   EXISTING SITE AREA:
   PROPOSED SITE AREA:
   EXISTING WETLAND AREA:
   PROPOSED CONDITION:
   PROPOSED DISCHARGE LOCATION(S):
   PROPOSED LIMIT OF DISTURBANCE PER DISCHARGE LOCATION:
2. OWNER DATA:
   OWNER'S NAME, TITLE
   COMPANY/LLC
   STREET ADDRESS
   TOWN, STATE, ZIP CODE
   PHONE #
   FAX #
3. LAND DEVELOPER DATA:
   DEVELOPER'S NAME, TITLE
   COMPANY/LLC
   STREET ADDRESS
   TOWN, STATE, ZIP CODE
   PHONE #
   FAX #
4. DESIGNER DATA:
   DESIGNER'S NAME, TITLE
   COMPANY/LLC
   STREET ADDRESS
   TOWN, STATE, ZIP CODE
   PHONE #
   FAX #
5. REVIEW AGENCY DATA:
   REVIEWER'S NAME, TITLE
   AGENCY NAME
   STREET ADDRESS
   TOWN, STATE, ZIP CODE
   PHONE #
   FAX #

SEDIMENT AND STORMWATER CONSTRUCTION NOTES:

1. THE DNREC SEDIMENT AND STORMWATER MANAGEMENT PROGRAM MUST BE NOTIFIED IN WRITING FIVE (5) DAYS PRIOR TO COMMENCING WITH CONSTRUCTION. FAILURE TO DO SO CONSTITUTES A VIOLATION OF THE APPROVED SEDIMENT AND STORMWATER MANAGEMENT PLAN.
2. REVIEW AND OR APPROVAL OF THE SEDIMENT AND STORMWATER MANAGEMENT PLAN SHALL NOT RELIEVE THE CONTRACTOR FROM HIS OR HER RESPONSIBILITIES FOR COMPLIANCE WITH THE REQUIREMENTS OF THE SEDIMENT AND STORMWATER REGULATIONS, NOR SHALL IT RELIEVE THE CONTRACTOR FROM ERRORS OR OMISSIONS IN THE APPROVED PLAN.
3. IF THE APPROVED PLAN NEEDS TO BE MODIFIED, ADDITIONAL SEDIMENT AND STORMWATER CONTROL MEASURES MAY BE REQUIRED AS DEEMED NECESSARY BY DNREC.
4. FOLLOWING SOIL DISTURBANCE OR REDISTURBANCE, PERMANENT OR TEMPORARY STABILIZATION SHALL BE COMPLETED FOR ALL PERIMETER SEDIMENT CONTROLS, SOIL STOCKPILES, AND ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT SITE WITHIN 14 CALENDAR DAYS UNLESS MORE RESTRICTIVE FEDERAL REQUIREMENTS APPLY.
5. ALL EROSION AND SEDIMENT CONTROL PRACTICES SHALL COMPLY WITH THE DELAWARE EROSION AND SEDIMENT CONTROL HANDBOOK, LATEST EDITION.
6. AT ANY TIME A DEWATERING OPERATION IS USED, IT SHALL BE PREVIOUSLY APPROVED BY THE AGENCY CONSTRUCTION SITE REVIEWER FOR A NON-EROSIVE POINT OF DISCHARGE, AND A DEWATERING PERMIT SHALL BE APPROVED BY THE DNREC WELL PERMITTING BRANCH.
7. APPROVED PLANS REMAIN VALID FOR 3 YEARS FROM THE DATE OF APPROVAL.
8. POST CONSTRUCTION VERIFICATION DRAWINGS ARE TO BE SUBMITTED TO THE DISTRICT WITHIN 60-DAYS OF STORMWATER MANAGEMENT FACILITY COMPLETION.
9. APPROVAL OF A SEDIMENT AND STORMWATER PLAN DOES NOT GRANT OR IMPLY A RIGHT TO DISCHARGE STORMWATER RUNOFF. THE OWNER/DEVELOPER IS RESPONSIBLE FOR ACQUIRING ANY AND ALL AGREEMENTS, EASEMENTS, ETC., NECESSARY TO COMPLY WITH STATE DRAINAGE AND OTHER APPLICABLE LAWS.
10. THE NOTICE OF INTENT FOR STORM WATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITY UNDER A NPDES GENERAL PERMIT FOR THIS PROJECT IS #_____ . AT ANY TIME THE OWNERSHIP FOR THIS PROJECT CHANGES, A TRANSFER OF AUTHORIZATION OR A CO-PERMITTEE APPLICATION MUST BE SUBMITTED TO DNREC. THE PERMITTEE OF RECORD SHALL NOT BE RELIEVED OF THEIR RESPONSIBILITIES UNTIL A NOTICE OF TERMINATION HAS BEEN PROCESSED BY DNREC.
11. THE OWNER SHALL BE FAMILIAR WITH AND COMPLY WITH ALL ASPECTS OF THE NPDES CONSTRUCTION GENERAL PERMIT ASSOCIATED WITH THE PROJECT, INCLUDING, BUT NOT LIMITED TO, PERFORMING WEEKLY SITE INSPECTIONS DURING CONSTRUCTION AND AFTER RAIN EVENTS, AND MAINTAINING WRITTEN LOGS OF THESE INSPECTIONS.
12. BEFORE ANY EARTHWORK OR EXCAVATION TAKES PLACE, THE CONTRACTOR SHALL CALL MISS UTILITY AT 811 OR 1.800.282.8555 AT LEAST 48 HOURS PRIOR TO CONSTRUCTION, TO HAVE ALL EXISTING UTILITIES MARKED ONSITE.
13. THE CONTRACTOR SHALL AT ALL TIMES PROTECT AGAINST SEDIMENT OF DEBRIS LADEN RUNOFF OR WIND FROM LEAVING THE SIDE. PERIMETER CONTROLS SHALL BE CHECKED DAILY AND ADJUSTED AND/OR REPAIRED TO FULLY CONTAIN AND CONTROL SEDIMENT FROM LEAVING THE SITE. ACCUMULATED SEDIMENT SHALL BE REMOVED WHEN IT HAS REACHED HALF OF THE EFFECTIVE CAPACITY OF THE CONTROL. IN ADDITION, THE CONTRACTOR MAY NEED TO ADJUST OR ALTER MEASURES IN TIMES OF ADVERSE WEATHER CONDITIONS, OR AS DIRECTED BY THE AGENCY SITE REVIEWER.
14. BEST AVAILABLE TECHNOLOGY (BAT) SHALL BE EMPLOYED TO MANAGE TURBID DISCHARGES IN ACCORDANCE WITH REQUIREMENTS OF 7. DEL C. CH 60, *REGULATIONS GOVERNING THE CONTROL OF WATER POLLUTION* , SECTION 9.1.02, KNOWN AS SPECIAL CONDITIONS FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES AND DEPARTMENT POLICIES, PROCEDURES, AND GUIDANCE.
15. DOCUMENTATION OF SOIL TESTING AND MATERIALS USED FOR TEMPORARY OR PERMANENT STABILIZATION INCLUDING BUT NOT LIMITED TO SOIL TEST RESULTS, SEED TAGS, SOIL AMENDMENT TAGS, ETC, SHALL BE PROVIDED TO THE DEPARTMENT OR DELEGATED AGENCY TO VERIFY THAT THE PERMANENT OR TEMPORARY STABILIZATION HAS BEEN COMPLETED IN ACCORDANCE WITH THE APPROVED PLAN AND THE STANDARDS AND SPECIFICATIONS OF *THE DELAWARE EROSION AND SEDIMENT CONTROL HANDBOOK*, LATEST EDITION. THE DEPARTMENT OF THE DELEGATED AGENCY SHALL HAVE THE DISCRETION TO REQUIRE ADDITIONAL SOIL TESTING AND REAPPLICATION OF PERMANENT OR TEMPORARY STABILIZATION IN ACCORDANCE WITH THE SPECIFICATION PROVIDED WITHIN *THE DELAWARE EROSION AND SEDIMENT CONTROL HANDBOOK,* LATEST EDITION.

Example Legend

Property Line
Adjacent Property Line
Benchmark Symbol
Lot Line/Right-of-Way
Easement Line (Utility, Drainage, Stormwater, Access, etc)
Buffer Line (Wetland, Wellhead Protection, etc)
Contours
Wetland Line
Treeline
Soils Divide Line
Drainage Divide Line
Time of Concentration Path
Utility Lines and Symbols (Storm Pipe, Catchbasin, Water Main, Fire Hydrant, etc)
Soil Type Abbreviation Legend

Note:
1. *The above list is not exhaustive and should be adapted for each site.*
2. *The features should be distinguished as existing or proposed.*
3. *A legend for all Construction Site Stormwater Controls symbols and lines shall appear on the Construction Site Stormwater Management Plan(s).*

SHEET INDEX:

1. COVERSHEET AND GENERAL NOTES
2. OVERALL CONSTRUCTION SITE PHASING PLAN
3. OVERALL PRE-CONSTRUCTION SITE STORMWATER MANAGEMENT PLAN
4. PRE-CONSTRUCTION SITE STORMWATER MANAGEMENT PLAN 1
5. PRE-CONSTRUCTION SITE STORMWATER MANAGEMENT PLAN 2
6. OVERALL CONSTRUCTION SITE STORMWATER MANAGEMENT PLAN
7. CONSTRUCTION SITE STORMWATER MANAGEMENT PLAN 1
8. CONSTRUCTION SITE STORMWATER MANAGEMENT PLAN 2
9. CONSTRUCTION SITE DETAILS AND NOTES
10. OVERALL POST CONSTRUCTION STORMWATER MANAGEMENT PLAN
11. POST CONSTRUCTION STORMWATER MANAGEMENT PLAN - FACILITY #1
12. POST CONSTRUCTION STORMWATER MANAGEMENT PLAN - FACILITY #2
13. CONTRIBUTING DRAINAGE AREA PLAN
14. PRE-LIMIT OF DISTURBANCE DRAINAGE AREA PLAN
15. POST LIMIT OF DISTURBANCE DRAINAGE AREA PLAN

OWNER'S CERTIFICATION:

"I, THE UNDERSIGNED, CERTIFY THAT ALL LAND CLEARING, CONSTRUCTION AND DEVELOPMENT SHALL BE DONE PURSUANT TO THE APPROVED PLAN AND THAT RESPONSIBLE PERSONNEL (I.E., BLUE CARD HOLDER) INVOLVED IN THE LAND DISTURBANCE WILL HAVE A CERTIFICATION OF TRAINING PRIOR TO INITIATION OF THE PROJECT, AT A DNREC SPONSORED OR APPROVED TRAINING COURSE FOR THE CONTROL OF EROSION AND SEDIMENT DURING CONSTRUCTION. IN ADDITION, I GRANT THE DNREC SEDIMENT AND STORMWATER PROGRAM AND/OR THE RELEVANT DELEGATED AGENCY THE RIGHT TO CONDUCT ON-SITE REVIEWS, AND I UNDERSTAND MY RESPONSIBILITIES UNDER THE NPDES CONSTRUCTION GENERAL PERMIT, AS REFERENCED ON THIS COVERSHEET."

OWNER'S NAME, TITLE DATE
COMPANY/LLC
STREET ADDRESS
TOWN, STATE, ZIP CODE
PHONE #
FAX #

WETLAND CERTIFICATION:

THIS PROPERTY, TAX MAP #xxxx, HAS BEEN EXAMINED BY [COMPANY NAME] FOR THE PRESENCE OF WATERS OF THE UNITED STATES, INCLUDING WETLANDS (SECTION 404 AND SECTION 10), STATE SUBAQUEOUS LANDS AND STATE REGULATED WETLANDS AS ESTABLISHED BY THE REVIEWING AGENCIES IN THE FORM OF MANUALS, POLICIES AND PROCEDURES IN PLACE AT THE TIME THAT THE INVESTIGATION WAS CONDUCTED. THE WETLAND INFORMATION CONTAINED IN THIS PLAN SET IS IN ACCORDANCE WITH THIS CRITERIA [or, THERE WERE NO WETLANDS FOUND WITHIN THE SUBJECT PROPERTY], PER STATE JD #xxxx AND/OR ARMY CORP'S JD #xxxx [as applicable].

WETLAND DELINEATOR'S NAME, TITLE DATE
COMPANY/LLC
STREET ADDRESS
TOWN, STATE, ZIP CODE
PHONE #
FAX #

SITE DESIGNER CERTIFICATION:

I HEREBY CERTIFY THAT THIS PLAN HAS BEEN PREPARED UNDER MY SUPERVISION AND TO THE BEST OF MY KNOWLEDGE COMPLIES WITH THE APPLICABLE STATE AND LOCAL REGULATIONS AND ORDINANCES.

SITE DESIGNER'S NAME, TITLE DATE
COMPANY/LLC
STREET ADDRESS
TOWN, STATE, ZIP CODE
PHONE #
FAX #

2"x3" Clear Area for Sediment and Stormwater Approval Stamp

REVISIONS

REVISION	DATE	DESCRIPTION

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
Division of Soil and Water Conservation
Drainage Program
Dover Office
89 Kings Highway
Dover DE, 19901
Phone: (302) 739 - 9921
Fax: (302) 739 - 6724
Georgetown Office
21389 Berlin Rd, Unit 6
Georgetown DE, 19947
Phone: (302) 855 - 1930
Fax: (302) 677 - 7059

[Seal]

Designer's Name
License #XXXXXX

COVER SHEET & GENERAL NOTES
PROJECT NAME
SEDIMENT AND STORMWATER MANAGEMENT PLANS
XXXX Hundred
XXXX Watershed
Tax Parcel[s]: XXXX
[City/Town of XXXX,] XXXX County, Delaware

Scale:	As Shown
Designed:	XXX
Planned:	XXX
Drawn:	XXX
Approved:	XXX

Sheet No. 1 / X

Effective April 2016

Delaware

Sediment and Stormwater Program

Technical Document

Article 3.06

Sediment and Stormwater BMP Standards and Specifications

3.06.1

Delaware Erosion and Sediment Control Handbook

3.06.2

Post Construction Stormwater BMP Standards and Specifications

Effective April 2016

3.06
Sediment and Stormwater BMP Standards and Specifications

Best Management Practices (BMPs) are the tools used to prevent erosion and discharges of sediment during construction, as well as those used to mitigate the effects of a land use change on stormwater runoff. Two broad categories of Sediment and Stormwater BMPs exist: construction site BMPs and post construction BMPs.

Erosion and Sediment Control BMPs
Construction site erosion and sediment control BMPs are implemented prior to and throughout construction to prevent erosion and capture sediment. The Delaware Erosion and Sediment Control Handbook, included as Appendix 3.06.1, contains standard details for erosion and sediment control BMPs to be implemented on construction sites. These standard details may be included, as provided in the Handbook, on the Sediment and Stormwater Management Plan. Some of these standard details require data block information to be provided based upon site conditions.

Erosion and sediment controls used on construction sites time and time again are standardized so that the individuals that implement these BMPs may implement the BMP in practically the same way each time. Construction site erosion and sediment control BMPs included in the Delaware Erosion and Sediment Control Handbook are not permanent BMPs; they are temporary BMPs to be implemented during construction.

Stormwater Management BMPs
Following construction of a project, the land use change and/or manipulation and compaction of the soil can cause an increase in the amount of stormwater runoff from the project site. In addition, pollutants in the runoff need to be managed post construction.

The Standards and Specifications for Post Construction Stormwater BMPs contained in Appendix 3.06.2 provide criteria for design of permanent post construction stormwater management BMPs. Standard details are not provided; post construction stormwater BMPs require individual design and individual details.

Additional Resources
Also included in this article are resources for design of ponds, conveyance systems, and structures. Appendicies have been provided for soil investigation procedures, hotspots, and landscaping criteria. All of this information supports the design criteria for the Post Construction Stormwater Management BMPs.