TRAINING MODULE 1

Delaware Urban Runoff Management Model
DURMM v2.5

Quick-Start Guide

DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL

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. 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 2019 Delaware Sediment & Stormwater Regulations (DSSR). The final series of slides describes typical project set-up options.

Users should always make sure they're using the latest version of DURMM v2.5, which is available for download from the Sediment & Stormwater Program website. Contact the Sediment & Stormwater Program (DNREC.Stormwater@delaware.gov) for additional information.

The latest version of DURMM v2.5 can be found here: Plan Review, Engineering, Construction and Maintenance Resources - DNREC Alpha (delaware.gov)

Use the "Save-As" option to download the Microsoft Excel file.

NOTE: Designers proposing redevelopment projects in New Castle County will need to download the alternate version of DURMM for applicable projects.

Users should always make sure they're using the latest version of DURMM v2.5, which is available for download from the Sediment & Stormwater Program website. Contact the Sediment & Stormwater Program (DNREC.Stormwater@delaware.gov) for additional information.

The latest version of DURMM v2.5 can be found here: Plan Review, Engineering, Construction and Maintenance Resources - DNREC Alpha (delaware.gov)

1. Select the "Engineering" tab.
2. Two versions of the DURMM spreadsheets are available for projects
   - The first version depicted is utilized statewide.
   - The second version depicted is utilized for redevelopment projects within the jurisdiction of New Castle County Land Use. All other projects should utilize the first version of DURMM.
3. The RPv Summary Table is used to demonstrate compliance with the RPv requirements under the 2019 DSSR.
4. The BMP Design Worksheet is a spreadsheet used to assist in the design of Sheet Flow to Filter Strips (BMP 9.0), Traditional Constructed Wetlands (BMP 12.0), and Afforestation (BMP 17.0)

Use the "Save-As" option to download the Microsoft Excel file to be edited offline.

Security Settings
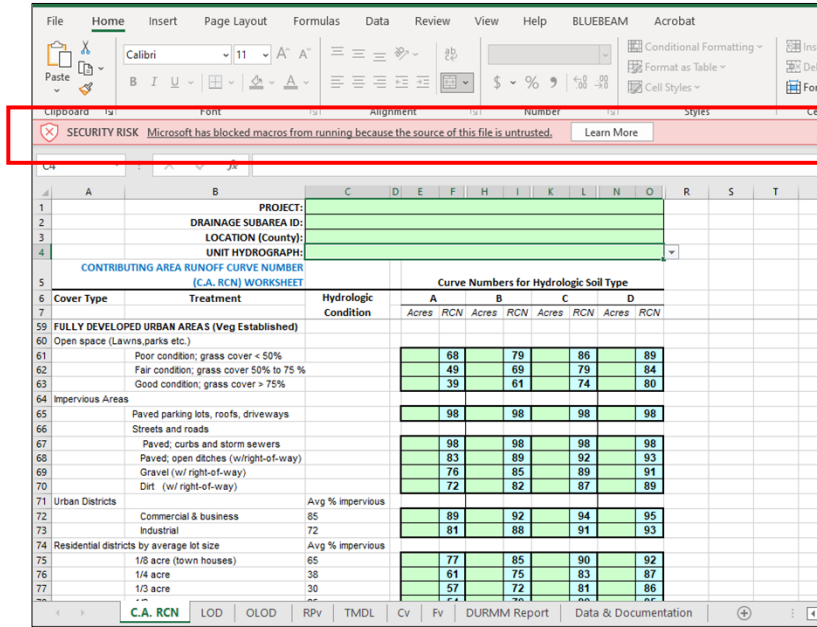
Upon opening a newly downloaded DURMM, you'll notice the "Security Risk" banner at the top. Current Microsoft settings default to disable macros.

For more information or for instructions to enable macros click "Learn More"

DURMM v2.5

Basic Workflow & Data Input

Layout

DURMM v.2.5 was developed using Microsoft's Excel 2016 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 secondary output
- Magenta Cells - cells that contain calculated results for primary output
- Orange Cells – these cells are used to input data from upstream contributing areas as explained further on Page #5

DURMM v2.5

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

"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. User Defined: The spreadsheet includes two (2) lines for user defined land cover, hydrologic condition, acreage and RCN. User defined values require concurrence by DNREC and/or Delegated Agency.
5. Upstream Contributing Areas: The ID, acreage and RCN for up to four (4) previously analyzed upstream areas within the total contributing area can be entered by the user. Data for these cells will be in the separate DURMM Report for those contributing areas.
6. Total acreage and weighted RCN of the total contributing area are computed and reported in their respective fields.
7. The "Clear Table" button can be used to clear all user supplied data from the worksheet and reset any user-defined values.

NOTES:
- Acreage values should be entered to no more than two (2) decimal places. A popup warning to this effect will appear if a user tries to enter values greater than 2 decimal places.
- Acreage values within the project Limit of Disturbance (LOD) for the subarea under analysis is assumed to be fully captured by the BMP(s) entered on the RPv Sheet unless a Project Level Analysis is being performed in accordance with the procedures covered later in this module.

"LOD"
Worksheet

"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 #5 below.)
2. The subarea RPv runoff and target runoff is calculated in this section.
3. Data from up to four (4) previously analyzed upstream subareas are entered in this section. Data is taken from the appropriate DURMM reports for those subareas.
4. 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 is then calculated in watershed inches and percent reduction.
5. The "RESET" button clears any user input data and resets the formulas used in the imperviousness cells.

NOTE: Acreage values should be entered to no more than two (2) decimal places. A popup warning to this effect will appear if a user tries to enter values greater than 2 decimal places.
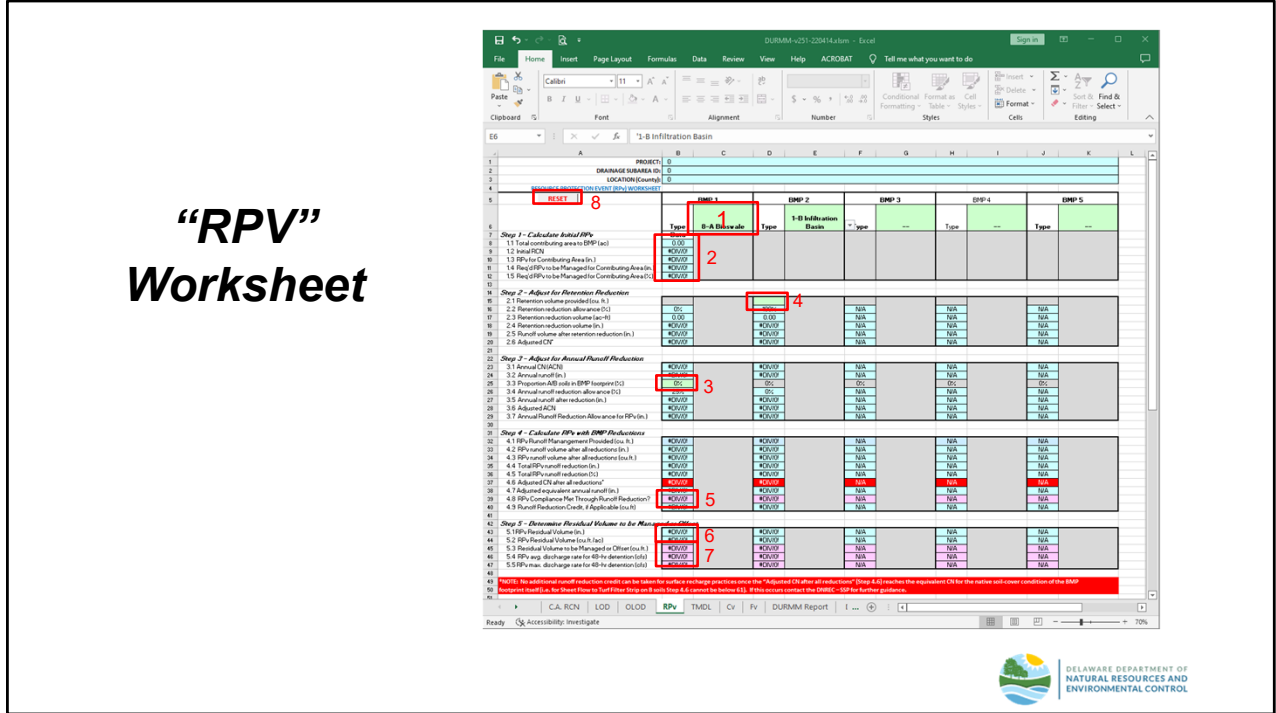
"OLOD" Worksheet

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. If the total contributing drainage area and LOD coincide, the result will display "N/A" for these cells.
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 open 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.

NOTE: The "OLOD" sheet provides a good way to check for errors previously entered on the "C.A. RCN" and "LOD" worksheets. Negative acreage values at Step 1.5 and/or RCN values exceeding 100 at Step 1.4 indicate such errors.

"RPV"
Worksheet

"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.
3. If the BMP selected has an annual runoff reduction component (refer to "Data & Documentation" sheet, Page 14), 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.
4. If the BMP selected has a retention storage component (refer to "Data & Documentation" sheet, Page 14), the available storage in cubic feet is entered in the green cell.
5. The model calculates the retention reduction and/or the annual 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 residual runoff volume that must be managed using detention or other means, such as an on-site credit or off-site offset.
7. If the residual volume will be managed using a detention practice, these cells contain the calculated average and maximum discharge rates to be used for design and compliance.
8. 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 calculate the Total Maximum Daily Load (TMDL). Although compliance is not currently based on specific TMDL targets, the Department is collecting this data to assess attainment of overall watershed TMDL goals. 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 TMDL watershed from the dropdown list.
2. The model calculates the total nitrogen (TN), total phosphorus (TP) and total suspended solids (TSS) annual pollutant load in milligrams and pounds based on the runoff volume calculated previously and the Event Mean Concentrations (EMCs) provided in the model.
3. The adjusted runoff volume is carried over from the RPv worksheet.
4. Load reduction is calculated based on the input loads and adjusted runoff reduction. Additional adjustment is calculated for removal efficiency.
5. The model checks to determine if the pollutant reduction goal for the TMDL watershed has been met and calculates a final adjusted annual load for TN, TP and TSS for reporting purposes.

NOTE: There is currently no regulatory requirement under the 2019 DSSR to meet a specific TMDL target. However, DNREC requires the TMDL Worksheet to be completed for all projects in order to provide data for tracking TMDL progress.

"Cv" Worksheet

This worksheet calculates the effect of runoff reduction practices for the Conveyance (10-YR) 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.

"Fv" Worksheet

This worksheet calculates the effect of runoff reduction practices for the Flooding (100-YR) 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.

"DURMM Report" Worksheet

This worksheet summarizes the results from the previous worksheets in a format suitable for submission with the project application package. Some key elements include:

1. DURMM version.
2. Summary of BMP suite selected.
3. Determination of compliance with runoff reduction requirements and any residual volume to be managed with detention or other means.
4. Determination of final annual pollutant loads.
5. Summary of results for the RPv event.

The remaining sections of the DURMM Report worksheet are continued on the Page 13.

NOTE: The DURMM version is shown in the header of the report using the format:

<div align="center">DURMM v2.5#.yymmdd</div>

The most current version of DURMM v2.5 should always be used for submission.

"DURMM Report"
Worksheet (cont.)

"DURMM Report" Worksheet (cont.)

The information in the remaining sections is largely self-explanatory. However, some key elements include:

6. Results for Conveyance Event (Cv).
7. Results for Flooding Event (Fv).
8. Data to be used for downstream DURMM modeling.
9. Data to be used with the DNREC Nutrient Protocol model.
10. Data to be used for external quantity and/or quality modeling.

The report allows a reviewer to quickly determine if the runoff reduction requirements have been met and the calculated pollutant reductions. 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.

**_"Data &
Documentation"
Worksheet_**

"Data & Documentation" Worksheet
This worksheet summarizes the runoff reduction values used in calculations on the "RPv"
sheet for all available Best Management Practices (BMPs). These values are derived from
the appropriate Standards & Specifications for those BMPs. They are categorized as either
"Retention Allowance" or "Annual Runoff Reduction" depending on the type of BMP.
Reductions for Cv and Fv are also included where applicable.

DURMM v2.5

"Broadkill Estates" Example Site
Ex. #1: Concept Level Analysis

DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL

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 Stormwater Assessment Study (SAS) will provide the necessary data inputs for the analysis.

Concept Level Analysis
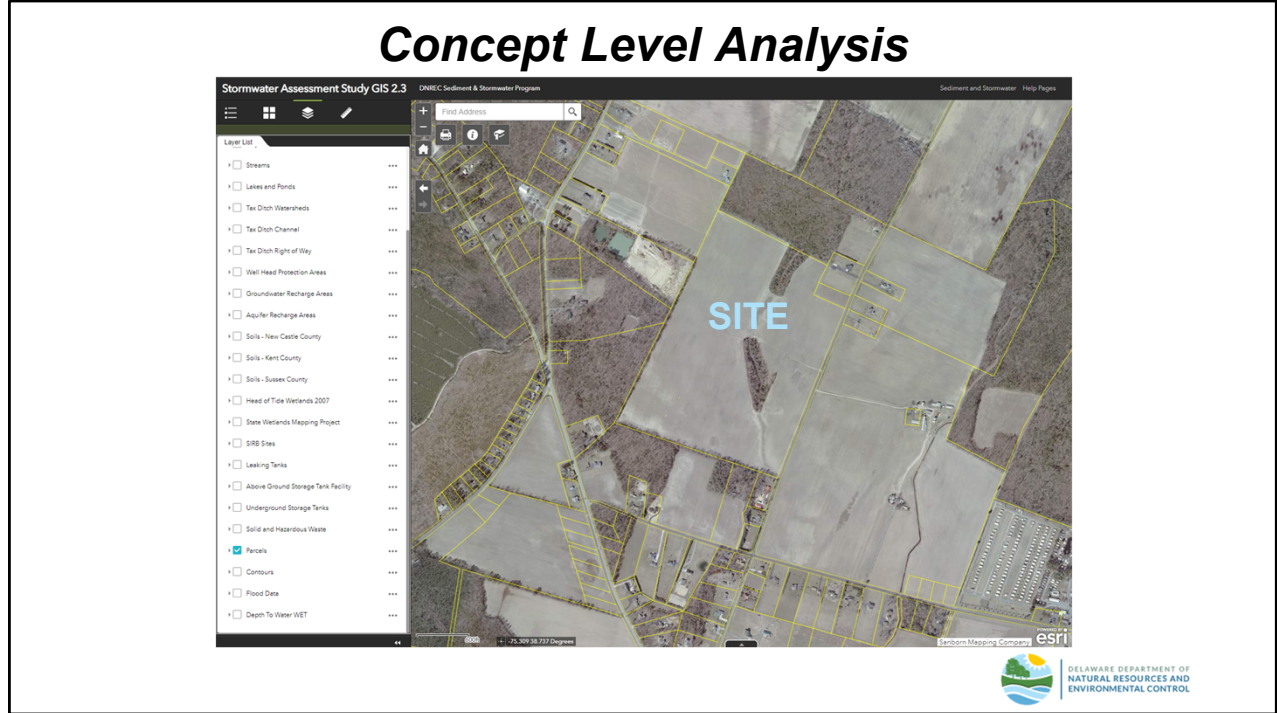
Site GIS Data

The Stormwater Assessment Study GIS App is an on-line GIS tool that can be used for collecting data necessary to perform the DURMM analysis. The SAS GIS App is available at the following link:

https://firstmap.delaware.gov/sasgis
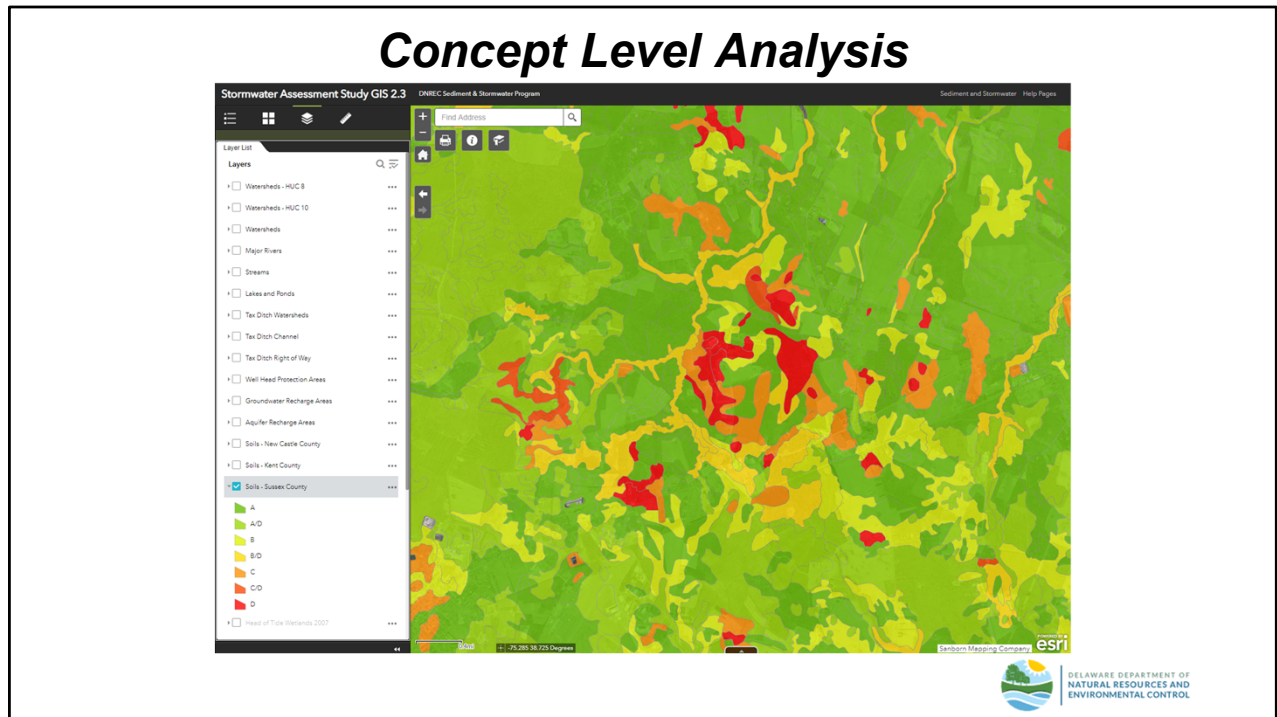
Soils Data

The Soils layer 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
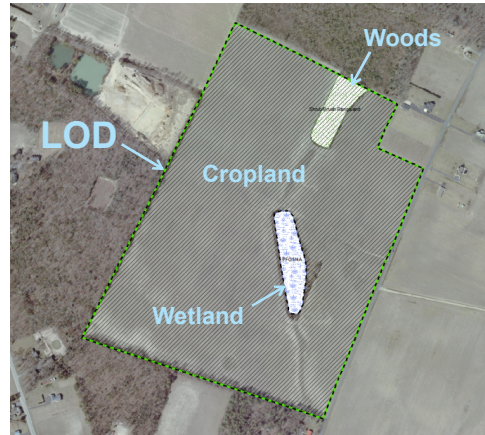
Proposed LU: Residential, 1 ac. lots

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.

Data Inputs – "C.A. RCN" Worksheet
The slide above summarizes the data that will be input to the "C.A. RCN" worksheet. The colored soil mapping areas are considered the total LOD for the Conceptual Level Analysis. The unshaded area is a delineated wetland that will remain undisturbed.

**Concept Level Analysis
Site Data**
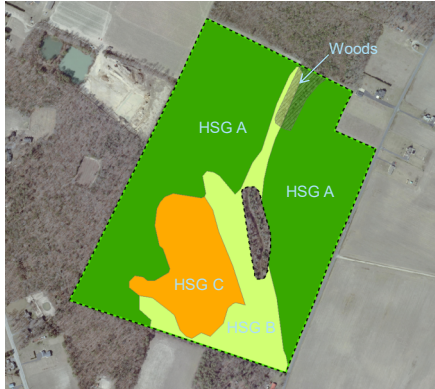
- LOD Tab
  - HSG A
    - LOD Area: 70.07 ac.
    - Pre-Dev. Woods: 1.55 ac.
    - Post-Dev. Impervious: 20%
  - HSG B
    - LOD area: 17.10 ac.
    - Pre-Dev. Woods: 0.80 ac.
    - Post-Dev. Impervious: 20%
  - HSG C
    - LOD Area: 15.56 ac.
    - Pre-Dev. Woods: 0 ac.
    - Post-Dev. Impervious: 20%

Data Inputs – "LOD" Worksheet

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 for the Concept Level Analysis.

"C.A. RCN" Worksheet

"C.A. RCN" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. Acreage values should be entered to no more than two (2) decimal places, otherwise a popup error message will appear. 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.

"LOD" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. Again, acreage values should be entered to no more than two (2) decimal places to avoid a popup error message. The model has calculated the following results:

- Total LOD Area: 102.73
- Weighted LOD RCN: 57.97
- Weighted RPV runoff volume: 0.57"
- Estimated annual runoff: 5.93"
- Required runoff reduction: 0.16" (29%)

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.

"RPV" Worksheet

"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 grassed channels for all rooftops and roadways draining to infiltrating bioretention. It is estimated approximately 75% of the grass channels will be located in soils with Hydrologic Soil Group (HSG) A or B. The model has calculated the following results:

- RPv for total contributing area: 0.57"
- Reduction after BMP 1: 0.07" (12%)
- Residual volume to be managed after BMP 1: 34,664 cu. ft.
- Reduction after BMP 2: 0.16" (29%)

Annualized runoff reductions are used for BMPs that do not have a storage component, such as the grassed channels 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. A "YES" in the magenta cells indicates the required reduction has been met. In this case, the residual volume to be managed after BMP 1 was used to estimate the storage provided for BMP 2. 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. This will need to be verified by the Design Level Analysis. Any residual runoff subject to additional management or an offset for the RPv is calculated in Step 5 and shown in the magenta cells. Since this example was able to meet the required runoff reduction with two BMPs, the residual volume to be managed after BMP 2 is reported as "N/A".

"TMDL" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. Once the user selects the appropriate TMDL watershed from the dropdown list, 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: 3.77 lb/ac/yr-TN; 0.66 lb/ac/yr-TP; 121 lb/ac/yr-TSS
- Pollutant load after BMP 1: 3.11 lb/ac/yr-TN; 0.54 lb/ac/yr-TP; 100 lb/ac/yr-TSS
- Pollutant load after BMP 2: 2.33 lb/ac/yr-TN; 0.41 lb/ac/yr-TP; 75 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". A "YES" in the magenta cells indicates that the load reduction has been met. In this example, the TN load reduction has been met as a result of meeting the RPv runoff reduction attributed to BMP 1. The TP reduction was only met with the addition of BMP 2. There is currently no regulatory requirement under the 2019 DSSR to meet a specific TMDL target. However, DNREC requires the TMDL Worksheet to be completed for all projects in order to provide data for tracking TMDL progress.

"Cv" Worksheet

"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 runoff volume: 1.34"
- Cv runoff volume after BMP 1: 1.33" (0% reduction)
- Cv runoff volume after BMP 2: 1.24" (7% reduction)

The runoff reduction values for the Cv event are adjusted downward, as discussed in the Cv Worksheet overview section.

"Fv" Worksheet

"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 runoff volume: 4.00"
- Fv runoff volume after BMP 1: 4.00" (0% reduction)
- Fv runoff volume after BMP 2: 3.91" (2% reduction)

The runoff reduction values for the Fv event are adjusted downward, as discussed in the Fv Worksheet overview section.

"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 next section of the report summarizes the adjustments to the RCN for the 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 <u>could</u> meet both the runoff reduction requirements of the 2019 DSSR and the TMDL goals in the watershed. The results of the Concept Level Analysis will need to be verified through the more detailed Design Level Analysis to show the site complies with the requirements of the 2019 DSSR.

<div style="border:1px solid black; text-align:center;">

DURMM v2.5

"Broadkill Estates" Example Site
Ex. #2: Design Level Analysis

DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL

</div>

Example #2: Design Level Analysis

The procedures outlined in the previous section will now be used to perform a more detailed design level analysis for the fictional land development project "Broadkill Estates".

NOTE: This approach can also be used for a Total Site Analysis as noted later in this Quick-Start Guide.

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
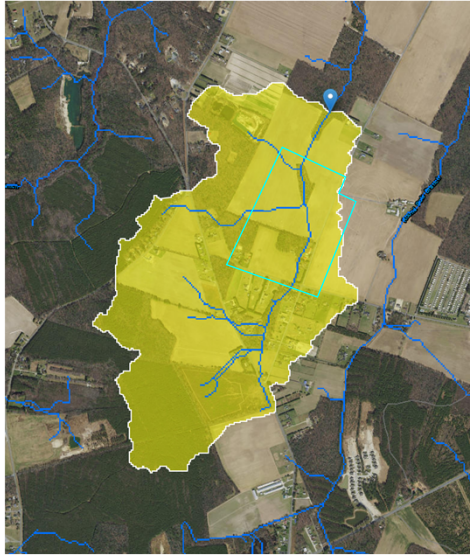
Hydrologic Analysis

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 pages illustrate how DURMM v2.5 is used to perform the analysis and check for compliance with the requirements of the DSSR.
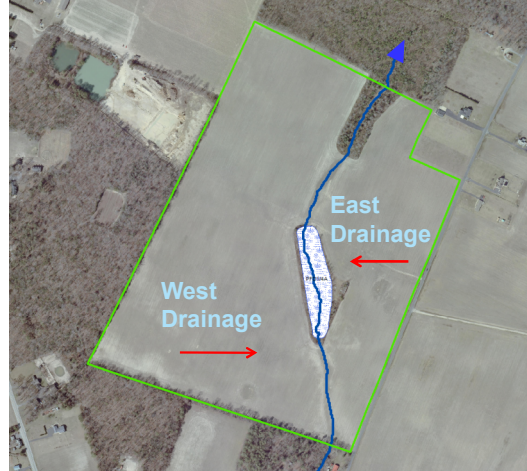
Onsite Drainage

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.
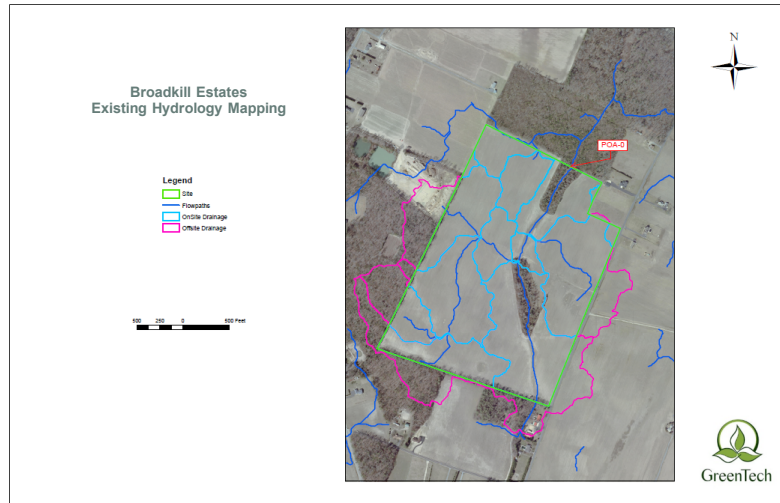
Offsite Drainage
The "Existing Drainage" map included in the Project Application Package is helpful to determine any offsite drainage areas that must be accounted for in the final BMP design for the site.

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.

NOTE: For a Total Site Analysis, both the East and West subareas would need to be combined into a single subarea.

LOD vs. OLOD

The 2019 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 v2.5 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.

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

DURMM v2.5 is capable of determining a peak discharge for OLOD areas if they will be managed by BMPs that are discharge-based, such as grassed channels and bioswales. 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 flow path.

**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: 21.16 ac.
    - HSG B: 0.73 ac

*DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL*

Data Inputs – "C.A. RCN" Worksheet
The slide above summarizes the data that will be input to the "C.A. RCN" worksheet. It includes both LOD and OLOD areas.

Data Inputs – "LOD" and "OLOD" Worksheets

The slide above summarizes the data that will be input to the "LOD" and "OLOD" worksheets.

"C.A. RCN"
Worksheet

"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 page.

"C.A. RCN"
Worksheet
(cont.)

"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

"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: 0.38"
- Weighted RPv target runoff volume: 0.24"
- Estimated annual runoff: 3.29"
- Required runoff reduction: 0.14" (36%)
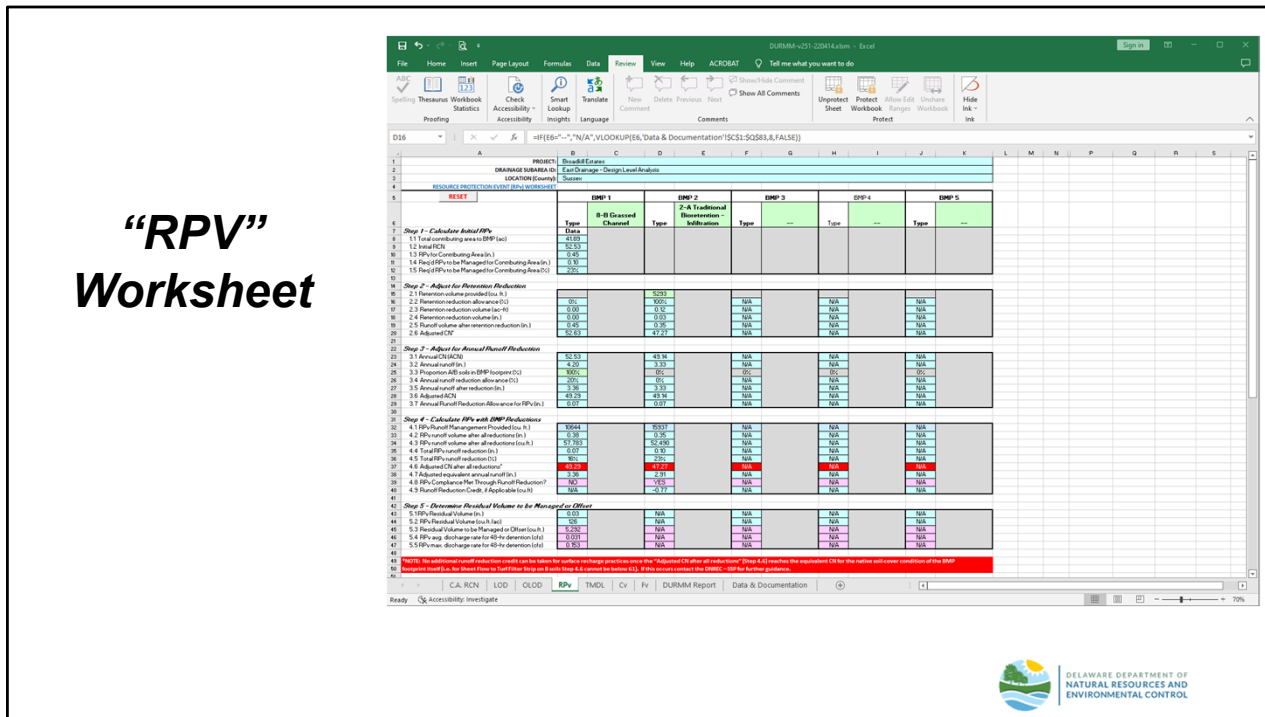
"OLOD" Worksheet

"OLOD" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The model has calculated the following results:

- OLOD Acreage: 9.68
- 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): 15.77 cfs
- OLOD Equiv. Unit Discharge (Fv): 1.63 cfs/ac

"RPV" Worksheet

The data inputs/outputs for this worksheet are illustrated in the slide above. The same BMP treatment train consisting of grassed channels for the road drainage and infiltrating bioretention as used in the concept level analysis will be used. For the East Drainage, the grassed channels are completely within HSG A soils. The infiltrating bioretention facility will be sized to store any residual runoff required to be managed after the reduction from the grassed channels. The model has calculated the following results:

- RPv for total contributing area: 0.45"
- Reduction after BMP 1: 0.07" (16%)
- Reduction after BMP 2: 0.10" (23%)

Note that the required reduction of 0.14" for the 32.21 acre LOD as determined on the "LOD" worksheet has been adjusted to 0.10" for the total contributing area of 41.89 acres. Similarly, the required 36% reduction requirement has been adjusted to 23% based on the combined LOD and OLOD areas. As with the conceptual design, grassed channels and an infiltrating bioretention facility are adequate to meet the runoff reduction requirements for the RPv, thus the residual volume to be managed or offset is "N/A".

NOTE: Select the "No BMP" option if performing a Total Site Analysis. The "RPv Residual Volume" calculated at Step 5.3 is the total runoff volume in cubic feet that is required to be managed for RPv compliance for the entire site. Only those subareas with BMPs then need to be further analyzed in DURMM.

"TMDL" Worksheet

<u>***"TMDL" Worksheet***</u>
The data inputs/outputs for this worksheet are illustrated in the slide above. The model
has calculated the following results:

- Pollutant Load:
  - 2.67 lb/ac/yr-TN
  - 0.47 lbac/yr-TP
  - 86 lb/ac/yr-TSS

- Pollutant load after BMP 1:
  - 2.13 lb/ac/yr-TN
  - 0.37 lb/ac/yr-TP
  - 69 lb/ac/yr-TSS

- Pollutant load after BMP 2:
  - 1.84 lb/ac/yr-TN
  - 0.32 lb/ac/yr-TP
  - 59 lb/ac/yr-TSS

The pollutant loads and reductions are likewise adjusted to account for the total
contributing area to the BMPs. For the East Drainage, the grassed channels were
adequate to meet both the TN and TP goals for the watershed.

"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 runoff volume: 0.97"
- Cv runoff volume after BMP 1: 0.97" (0% reduction)
- Cv runoff volume after BMP 2: 0.94" (4% reduction)

When the total contributing area consists of both an LOD and an OLOD, the model calculates an adjusted RCN for the combined LOD and OLOD that can be used as input to another DURMM analysis for a downstream subarea or for additional H&H modeling using an external program such as HydroCAD.

"Fv" Worksheet

"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 runoff volume: 3.33"
- 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 calculates an adjusted RCN for the combined LOD and OLOD that can be used as input to another DURMM analysis for a downstream subarea or for additional H&H modeling using an external program such as HydroCAD.

"DURMM Report" Worksheet

"DURMM Report" Worksheet

In this example, the designer was able to show that the use of runoff reduction practices complies with the requirements of the 2019 DSSR and TMDL pollutant reduction goals for the watershed. Since DURMM v2.5 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 Post Construction Stormwater BMP Standards & Specifications in accordance with the 2019 DSSR.

Once BMP design has been completed, the user will need to complete the Summary Table for RPv Compliance as shown in the next series of slides.

DURMM v2.5

"Broadkill Estates" Example Site Summary Table for RPV Compliance

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

Summary Table for RPv Compliance

The Summary Table for RPv Compliance is used to demonstrate compliance with the RPv requirements under the 2019 DSSR.

Summary Table for RPv Compliance
Sheet 1

Sheet 1

The cell coloring scheme used in the Summary Table for RPv Compliance is the same as that used in DURMM v2.5:

- Green Cells – cells intended for user input
- Cyan Cells – cells that contain either pre-set values or secondary output
- Magenta Cells - cells that contain calculated results for primary output

Input data for the Summary Table is taken from the DURMM Report worksheet or from an approved hydrologic model. If DURMM v2.5 was used for the BMP analysis, the data from the DURMM Report is entered in the appropriate columns on the Summary Table. A key is included at the bottom of Sheet 1 identifying what cell from the DURMM Report should be entered in which column.

Data entry and results are further coded in accordance with the following coloring scheme:

- Yellow – invalid entry; managed volume entered is greater than runoff volume generated in the subarea
- Dk. Green – the site has an overall credit
- Red – the site has an overall shortfall

Summary Table for RPv Compliance
Sheet 2

Sheet 2

Sheet 2 is only used in those cases where the design-level analysis was done using an external model, such as HydroCAD. Since these external models do not typically model water quality, Sheet 2 is used to determine the pollutant reductions based on the proposed BMPs for the project. The results are then transferred to the appropriate columns on Sheet 1.

Summary Table for RPv Compliance
User Guide
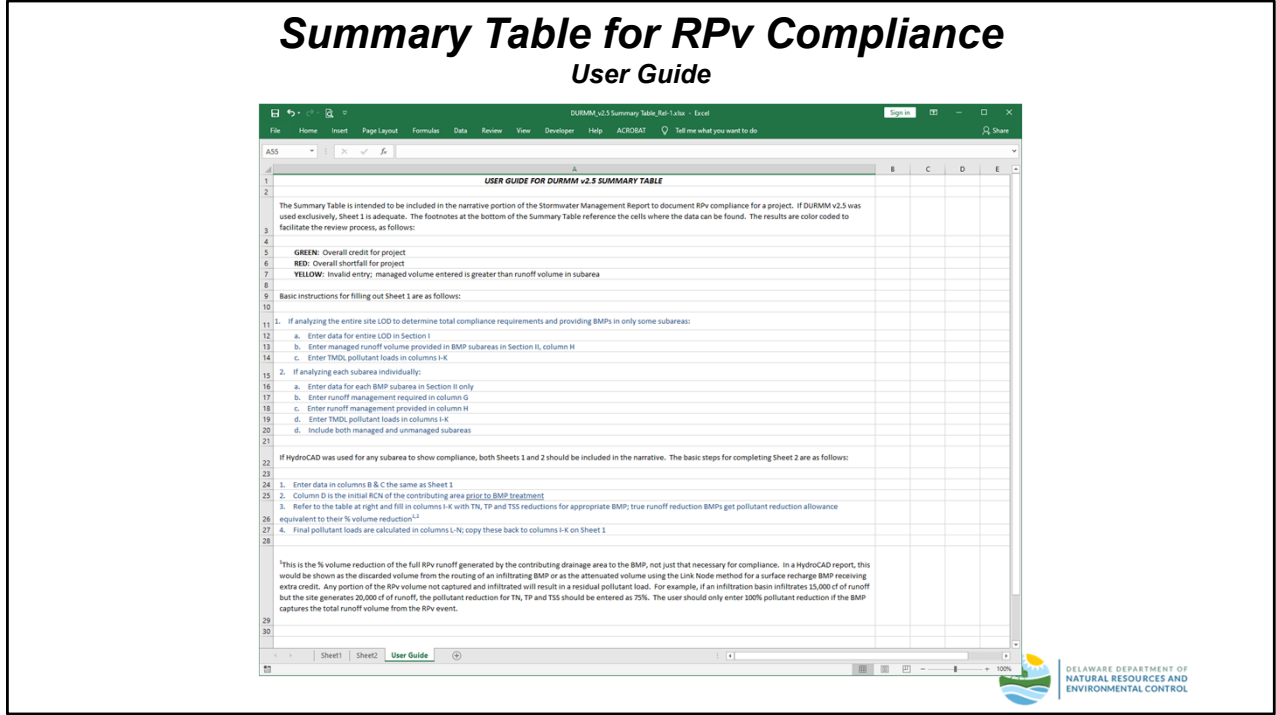
User Guide

The third worksheet in the Summary Table workbook is a basic user guide for completing Sheet 1 and Sheet 2.

Summary Table for RPv Compliance
Sheet 1 for Broadkill Estates Example

Sheet 1 for Broadkill Estates Example

This slide shows the data for the east drainage from the DURMM v2.5 Report Worksheet for the Broadkill Estates example as it should be entered into Section II of the Summary Table for RPv Compliance. A similar design level analysis would need to be completed for the west drainage and the resulting data also entered into Section II of this Summary Table to show RPv compliance for each sub-area within the total site. All subareas, including any unmanaged areas, must be entered in Section II when using this approach in order to ensure any shortfall is mitigated by BMPs in the managed subareas.

For a Total Site Analysis, the East and West drainage areas would be combined into a single sub-area and results using the "No BMP" option would be entered into Section I of the Summary Table for RPv compliance. Only those subareas that contain BMPs then need to be entered in Section II. DURMM will automatically calculate any shortfall based on the "No BMP" values from Section I. Additional examples of completing the "Summary Table for RPv Compliance" are included in Module 3.

The DURMM v2.5 worksheets would be included with the other H&H computations in the SWM Report.

Include the Summary Table for RPv Compliance in the narrative summary portion of the SWM Report.

DURMM v2.5

Project Setup Options

DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL

There is more than one way to use DURMMv2.5 to demonstrate RPv compliance.

Project Setup Options

- ○ *Total Site Analysis*
  - • *aka Project Level DURMM, or PLD, Method*
- ○ *BMP Drainage Area Analysis*
  - • *Single BMP*
  - • *BMPs in Series / Treatment Train*

DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL

DURMM v2.5 may be used to analyze the entire site LOD to determine the total site RPv volume to be managed, which is often referred to as a Project Level DURMM (PLD).

Alternately, DURMM may be set up to have separate DURMM workbooks for the drainage area of each BMP or BMP treatment train.

Both options require the use of the Summary Table for Site RPv Compliance when the site LOD contains more than one subarea.

DURMM v2.5

**Project Setup – Total Site Analysis
(aka PLD Method)**

When utilizing DURMM v2.5 at the total site analysis level, all the proposed Land Cover Data (in acres) within the project LOD is entered into the RCN tab of one DURMM workbook. With the remainder of the workbook completed, the BMP 1 selection in cell B6 of the RPv Tab should be set to "No BMP". The resulting residual runoff volume in Step 5.3 of the RPv tab is the total runoff volume that must be managed in BMPs or otherwise offset to meet RPv compliance.

Total Site Analysis
Project Level DURMM (PLD)

Step #1 Complete one DURMM for the total site.
• DURMM Residual Runoff Volume (CF)

Step #2
• 2A: Hydrologic Modeling Software
  • Size BMP to manage the Residual Runoff Volume
• AND/OR
• 2B: Complete on DURMM for each BMP
  • Runoff Reduction Credit

Step #3 Complete the RPv Summary Table

DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL

First, complete one DURMM workbook for the total site LOD. If Step 5.3 of the RPv tab results in "N/A" and Step 4.8 indicates "yes" no further analysis is necessary. RPv compliance is met based on the land use changes.

Otherwise, once the total site residual runoff volume has been calculated, separate DURMMs are created for each BMP, and/or the BMPs sized using hydrologic modeling software to manage the RPv volume.

Information from the Project Level DURMM is entered into the RPv Summary Table spreadsheet in Section I. Information from the hydrologic modeling of BMPs and/or the BMP DURMM information is entered in Section II. The RPv Summary Table spreadsheet calculates the total RPv credit/shortfall. To comply with DSSR 5.2 or 5.6, the project must show a net RPv credit.

DURMM v2.5

Project Setup – BMP Drainage Area

DELAWARE DEPARTMENT OF
NATURAL RESOURCES AND
ENVIRONMENTAL CONTROL

When utilizing DURMM v2.5 at the BMP drainage area level, each BMP or BMP treatment train drainage area has an individual DURMM workbook. Areas within the LOD that do not discharge to a BMP will have a "No BMP" DURMM workbook for the unmanaged areas. Some of the DURMM workbooks, including the "No BMP" workbooks, may show an RPv shortfall and some DURMM workbooks may demonstrate an RPv credit.

BMP Drainage Area DURMM

Step #1 Complete DURMM Workbooks for each BMP or BMP Treatment Train
- Drainage areas with BMPs should select one or more BMPs in the RPv tab
- Drainage areas without BMPs should select "No BMP" and will show a shortfall volume in Step 5.3 of the RPv tab.

Step #2 Hydrologic Modeling Software
- Size BMP to manage or overmanage the Residual Runoff Volume

Step #3 Complete the RPv Summary Table

Once completed, some of the DURMM workbooks will show a shortfall and some will show credits.

During the design process drainage areas with proposed BMPs may select "No BMP" in the RPv tab to calculate the shortfall in residual runoff volume (Step 5.3), thereby assisting in the sizing of a given BMP. This "No BMP" selection should then be modified to a specific BMP type to calculate the partial or extra RPv credit.

Information from the BMP Drainage Area DURMM workbooks are entered into the RPv Summary Table spreadsheet in Section II. The RPv Summary Table spreadsheet will calculate the total credit or shortfall for the site. To comply with DSSR 5.2 or 5.6, the project must show a net credit.
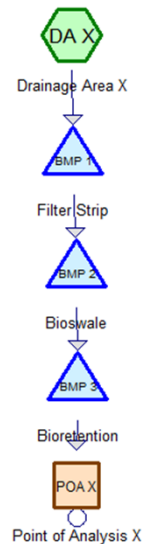
DURMM v2.5

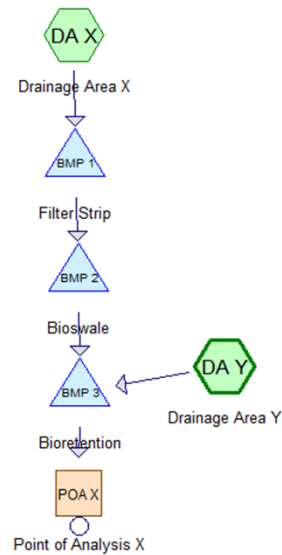## *Project Setup – BMPs in Series (Treatment Train)*

Multiple BMPs in series (Treatment Train):

When a series of BMPs are receiving the same flow conditions with no other drainage area being discharged to the downstream BMPs, multiple BMPs may be entered within the same DURMM. For example, in the scenario pictured, all of drainage area X is routed first through a filter strip, then to a bioswale, and finally to a bioretention basin. No additional drainage area is discharging to BMPs 2 or 3. The DURMM model for drainage area X would include the filter strip as BMP 1 in the RPv tab, the bioswale as BMP 2 and the bioretention as BMP 3. Refer to Example 2, page 45, in this Module for an example of BMP treatment train set-up in DURMM.

Multiple BMPs in series (Treatment Train):

When a series of BMPs are not all receiving the same flow conditions, a DURMM model should created for each BMP drainage area. Information from an upstream DURMM workbook upstream will be entered into the next downstream DURMM model and so forth. Any new drainage areas unique to a given BMP will be incorporated into that given model. Refer to Example 2D in training Module 2.

In the scenario depicted in the slide above, all of drainage area X is routed through a filter strip, bioswale, and bioretention basin, but drainage area Y is also being managed by the bioretention basin. In this case a DURMM model (DURMM DA-X) for drainage area X would include the filter strip as BMP 1 in the RPv tab, the bioswale as BMP 2.

A separate DURMM model (DURMM DA-Y) would be developed for the bioretention basin, BMP 3. The upstream contributing drainage area from DURMM DA-X will be entered on the CA-RCN and LOD tabs of DURMM DA-Y, reducing in the inlet runoff flows into the bioretention basin from DA-X to account for the upstream management. Only the bioretention BMP is entered into the RPv sheet as BMP1 for DURMM DA-Y.

Results from each DURMM model should be entered into the RPv Summary Table.

(THIS CONCLUDES THE DURMM V2.5 QUICK-START GUIDE. FOR ADDITIONAL INFORMATION CONTACT THE DELAWARE SEDIMENT & STORMWATER PROGRAM.)