RAN Stormwater BMP Evaluator Tool (Version 1.3)

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Background: This model was originally developed by Evan Fitzgerald, a graduate student in the Rubenstein School, as part of Simulation Modeling (NR 285) class during spring semester 2005 taught by Alexey Voinov in UVM's Gund Institute for Ecological Economics. It has since evolved into a tool designed specifically for cost-benefit analysis of Stormwater Best Management Practices (BMP) and Low Impact Designs (LID) in Vermont. Since the model's original creation, various members of the RAN team have provided significant input into its development, and the model continues to evolve under the wing of the RAN project. In essence, the model is intended to bridge the gap of understanding between the scientists and engineers working intimately with stormwater problems and the homeowners, homebuilders, and planners directly impacted by these problems. By organizing a spectrum of calculations under one roof, the tool is capable of providing quick answers to important questions surrounding the stormwater in Vermont.

This tool is specific to Vermont because the calculations associated with compliance are based on the regulations found in Vermont Agency of Natural Resources Stormwater Management Manual (3rd Edition - April 2002). Although specific ANR's regulations, the model's analysis of rainfall-runoff for peak flow rates and BMP/LID cost-benefit can be used anywhere in the Northeast, as these data and calculations are applicable region-wide.

Model Components

Rainfall-Runoff Calculations: The standard rainfall-runoff relationships and equations used in NRCS TR-55 and TR-20 models have been written into the Stella model to produce near identical results to the NRCS models. These relationships include the Curve Number approach as well as the Type II mass rainfall curve used for the Northeast. A comparative analysis between TR-55 and Stella model results was performed for the time of concentration variable at the fixed scale of ten acres, and it was determined that the effect of not including this variable in the Stella model was negligible for peak flow rate calibration. Therefore, this normally sensitive variable has not been included in the current version of the model. It is possible that future versions of the model with greater or varying subdivision areas may need to incorporate this important variable.

Subdivision Data: The subdivision data interface has been designed to allow for the user to control the overall development layout and footprint of impervious surfaces. While the total area is fixed at 10 acres, various lot acreages can be selected for preferred build-out densities. Roadway, driveway, and sidewalk widths, as well as house footprints can also be adjusted by the user per LID specification. Impervious cover calculations associated with the hydrologic modeling and attainment of ANR's regulations will be automatically updated by the model per the user's selection of subdivision layout.

ANR Stormwater Regulations and Compliance: Calculations included in ANR's 2002 Stormwater Management Handbook have been incorporated into the model such that required treatment volumes are updated with each model run according to the input parameters chosen by the user. The Water Quality (WQv) and Channel Protection (CPv) Volumes are calculated separately but are summed in the interface. Required Recharge Volume (Rev) is also calculated and is displayed separately from WQv and CPv. Peak flow rates for Predevelopment Conditions, Post-development Conditions without BMP mitigation, and Post-development Conditions with BMP mitigation are included in the hydrographs in the interface. Although required peak flow reduction for the 1 year storm event is inherent when CPv is met, peak flow reduction (as a percent) has also been included in the interface with respect to post-development peak flow without mitigation, as well as percent reduction from pre-development conditions.

BMP Selection and Cost Analysis: Three options for BMPs include: rain barrels; raingardens; and wet detention ponds. All BMP specifications for performance are described in brief in the interface, and a number of options for routing of water through one or more structures exists. These routing options, which include the specification of type of runoff collection system as well as routing rain barrel overflow into raingardens, are also described in brief in the interface. Cost ranges for each BMP have been included in the interface, but the model allows for user control of cost data if specific values are known. Lastly, costs associated with the stormwater collection system are automatically calculated in the model when the option of including this system is turned "ON". Collection system costs, at $28/linear foot, were calculated to be the costs above and beyond those associated w/ LID grassed swales, where:

Grassed Swales - $9
Curb/Gutter/Culvert - $37

Source: 1997 BMP Fact Sheet – Bay Area Stormwater Management Agencies Association (www.basmaa.org)

To operate this model

1. Download the PC or McIntosh trial version of the STELLA modeling software from here (or http://www.hps-inc.com/community/downloads/STELLA /STELLADemo.aspx). This trial version will allow you to operate the RAN-55 model, but you won't be able to save any output or changes to the model structure.
2. Open the RAN-55 program file (.STM) with the STELLA and follow the instructions above and embedded in the model.

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