

User's Guide

Pollutant Load Estimation Tool (PLET)

Version 1.0

Developed for U.S. Environmental Protection Agency

**By
Tetra Tech, Inc.
10306 Eaton Place, Suite 340
Fairfax, VA 22030**

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PLET Quick Guide

Note: The Pollutant Load Estimation Tool (PLET) model may be accessed at the PLET web site (<https://epa.gov/nps/plet>) or, for registered Grants Reporting and Tracking System (GRTS) users, by logging into GRTS and navigating to the Tools drop-down menu and selecting *PLET Models*. For more detailed information, refer to the Accessing PLET section of the User's Guide. Optionally, you may obtain the initial model input data from the PLET Input Data Server. However, it is the **user's responsibility** to check and refine the initial data for study areas. The Input Data Server can be accessed from the "Download Input Data Server Data" button at the top of the model page, or outside of the model at <https://ofmpub.epa.gov/apex/grts/f?p=109:333>.

Step 1. Access the PLET model interface and click on the *Create a New Model* button in the upper right hand corner.

Step 2. Name the model and select the state where the modeled area is located. Additional data entry fields will appear.

- Specify the area to be modeled by:
 - selecting the HUC12 watershed from a drop-down list,
 - manually creating a watershed using the *[Custom Watershed]* option, or
 - looking up a HUC12 watershed on a map.
- Select the appropriate weather station. This will automatically specify values for rainfall parameters and the USLE parameters found later in the PLET Input Module.
- Click *Create Model*.

Step 3. Add as many watersheds or modeled areas as needed for the scenario. Click on the *Add Watershed* button near the top of the model to add new rows, each representing a different watershed area. The *Delete Watersheds* button, also located near the top of the model, can be used to remove any extra or erroneous rows.

Step 4. The *Input Module* is composed of ten input tables. The first several tables require local data provided by the user or data from the Input Data Server. Remaining tables contain default values that users are encouraged to update, based on the availability of local data.

- Manually enter land use in acres and specify the representative Soil Hydrologic Group (SHG) in the Land Use Area table (Table 1) or review data provided by the PLET Input Data Server and update, as appropriate.
- Enter total number of agricultural animals by type and number of months per year that manure is applied to croplands and pastureland in the Agricultural Animals (Animal Count) table (Table 2). To calculate the average number of months manure is applied, click on the *Manure Application* button at the top of the PLET interface to open the calculator.
- Enter values for septic system parameters in the Septic and Illegal Wastewater Discharge table (Table 3).
- If the percent nutrient content in soil is known, adjust the default values in Table 4.
- If more local data are available, modify Universal Soil Loss Equation (USLE) parameters associated with the selected county in Table 5.

Step 5. You may stop here and proceed to Step 7. If you have more detailed information on your watershed(s), proceed with adding data to the remaining input tables.

Step 6. Review parameter values for tables 6, 6a, 7, 7a, 8, 9, and 10 and update with more local data, if available:

- Modify the curve number table in Table 6 and Table 6a.
- Modify the nutrient concentrations (mg/L) in surface runoff in Table 7.
- Modify the nutrient concentrations (mg/L) in shallow groundwater in Table 7a.
- Specify the detailed land use distribution in the urban area in Table 8.
- Specify cropland irrigation information in Table 9.
- Specify the wildlife density on cropland by animal type in Table 10.

Step 7. Enter representative dimensions and characteristics for gullies and streambanks, if desired. Click on the *Gullies and Streambanks* button at the top of the PLET interface to open the form. This form can also be used to represent gully and streambank restoration practice efficiencies.

Step 8. Add best management practices (BMPs) to the model scenario. Navigate to the BMP Module by clicking on the BMP tab towards the top of the PLET model.

- Click the *Add BMP* button on the right side to open the BMP entry form.
- Select the appropriate watershed and land use and click Add BMP.
- Double click in the resulting BMP cell and select the desired BMP from the drop-down list.
- Enter the proportion of the land use for which the BMP will be applied.

To represent more than one BMP per land use type, click the *BMP Calculator* button to open the calculator and created a combined BMP efficiency for multiple BMPs. Refer to the complete User's Guide for instructions on how to use the BMP Calculator.

For urban land uses, BMPs are entered using the Urban BMP Tool, which can be accessed by clicking on the *Urban BMP Tool* button near the top of the PLET model interface. Enter BMP information for each urban land use and click *Apply LID/BMP* to add the BMP to the model.

Step 9. View the estimates of loads and load reductions in the Total Loads Module. Loads and load reductions are automatically generated and appear in the Total Loads Module.

To generate the groundwater load information, click the box next to *Groundwater load calculation* to turn on that feature.

The *Treat All Subwatersheds as Part of a Single Watershed* check box changes the sediment delivery ratio. This box is only relevant if there is more than one watershed in the model. Checking the box allows the sediment delivery ratio to be calculated using the total watershed area of all watersheds included in the model.

Important: This feature does not represent routing through the watersheds in a particular order. Unchecking the box allows the sediment delivery ratio to be calculated independently for each watershed in the model.

Results can be downloaded as an Excel spreadsheet by clicking on *Download* in the upper right corner of the Total Loads Module.

Introduction

Overview of PLET

This document is a user's guide to the Pollutant Load Estimation Tool (PLET). PLET provides a user-friendly web interface to create a customized model. It employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs), including Low Impact Development practices (LIDs) for urban areas. It computes surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD); and sediment delivery based on various land uses and management practices. The land uses considered are urban land, cropland, pastureland, feedlot, forest, and a user-defined type. The pollutant sources include major nonpoint sources such as cropland, pastureland, farm animals, feedlots, urban runoff, and failing septic systems. The types of animals considered in the calculation are beef cattle, dairy cattle, swine, horses, sheep, chickens, turkeys, and ducks. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (from sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

PLET is applied at the user's own direction. Neither the U.S. Environmental Protection Agency nor any of its contractors assumes responsibility for the operation, output, interpretation, or use of this tool.

Background and Difference from STEPL

The design for PLET was inspired by the need for a more accessible and functional version of the Spreadsheet Tool for Estimating Pollutant Loads (STEPL). STEPL was initially developed over 20 years ago as a Microsoft Excel-based spreadsheet model. Since then, additional functionality has been added to STEPL and Excel capabilities and support for various code have changed substantially. Therefore, EPA decided to move to a web-based model to improve the interface, efficiency, and user experience that comes with a web-hosted product and to provide integration with EPA's Grants Reporting and Tracking System (GRTS), so state recipients of EPA grants can directly report their project load reduction results to GRTS to more efficiently meet grant reporting requirements. While users may experience a different look and feel using the PLET model, the underlying assumptions, calculations, and functions are identical to the STEPL tool. Using the same inputs in either model produces identical output results.

Unlike STEPL, users no longer need to download and install executable files or spreadsheets to their local computer. PLET is entirely web-based. A web browser and internet connection are the only requirements to access the tool.

Other improvements include an updated approach to BMP inputs. Rather than each land use being represented in a separate table, the PLET model integrates all land uses and BMPs into a single table and lets the user select the land use and watershed for each row in the table. The way in which combined BMPs are added in the model has also been improved through the elimination of the combined BMPs worksheet, and an updated BMP calculator, which accommodates both simple and complex configurations with an improved user interface.

Program Flow

Figure 1 shows the overall model structure of PLET. It is composed of interactive modules for input and BMPs based on user data, and an output module that presents the results of the modeled scenario, as well as hidden processes to handle intermediate calculations. The input data include state name, county name, weather station, land use areas, agricultural animal numbers, manure application months, population using septic tanks, septic tank failure rate, direct wastewater discharges, irrigation amount/frequency, and BMPs for simulated

watersheds. When local data are available, users may choose, and are encouraged, to modify the default values for USLE parameters, soil hydrologic group, nutrient concentrations in soil and runoff, runoff curve numbers, and detailed urban land use distribution. Pollutant loads and load reductions are automatically calculated for total nitrogen, total phosphorus, BOD, and sediment.

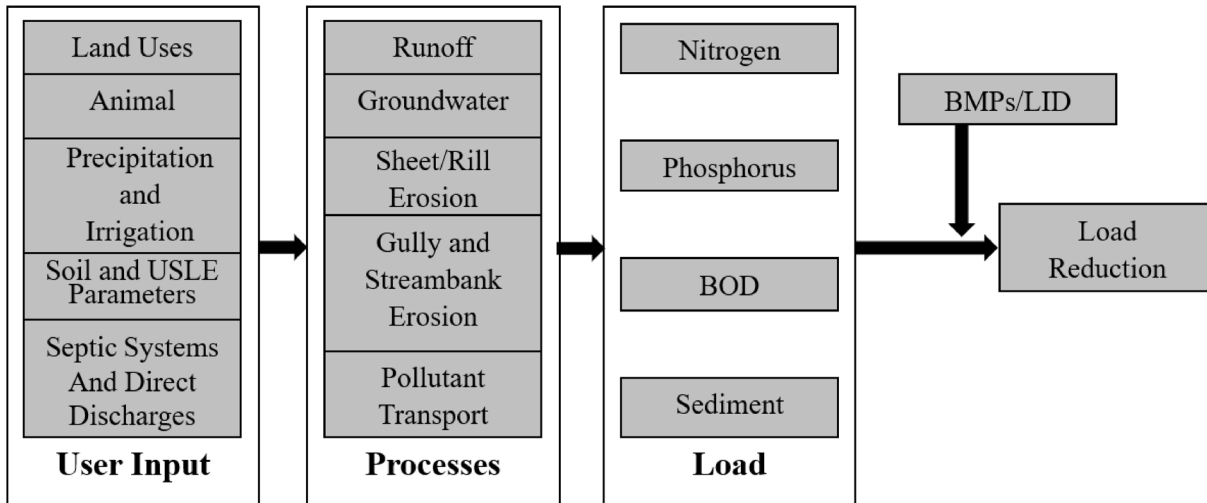


Figure 1. Model structure

Getting Set Up

Technical Requirements

To use PLET, the user must have an internet-connected computer. PLET is compatible with all available internet browsers except for Internet Explorer.

Accessing PLET

The PLET modeling component can be accessed in three ways:

- (1) Registered GRTS users can log into GRTS with their account info (username/password) and then navigate to PLET using the 'Tools' drop-down menu within the GRTS application, as shown in Figure 2.

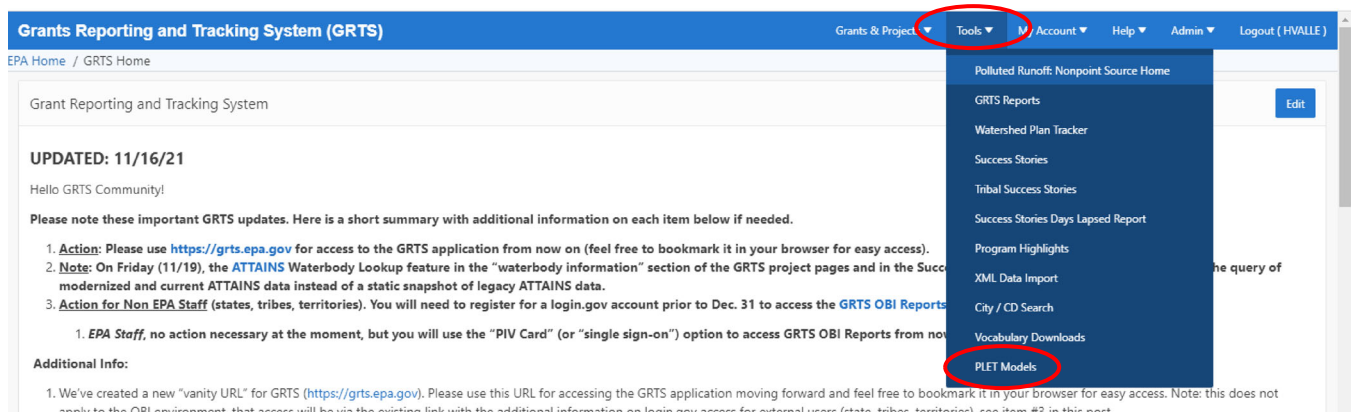
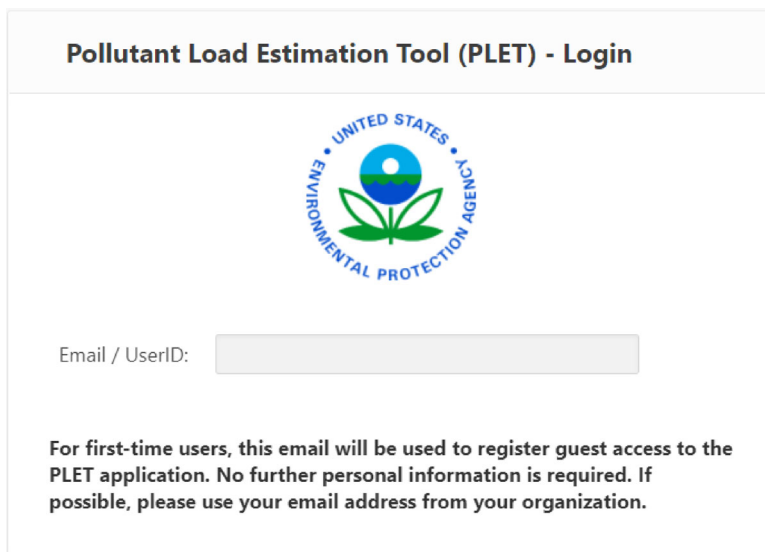



Figure 2. Location of the PLET model in the GRTS program.

- (2) Registered users of GRTS, as well as non-GRTS “guest” users, can access PLET via the [PLET Login Page link](#) (Figure 3) which is also linked from the main PLET webpage at <https://epa.gov/nps/plet>. Then the user may enter either their email or their GRTS user account info. First time users will be sent a link via email to confirm their identity and to set up a password for access to PLET.



Pollutant Load Estimation Tool (PLET) - Login



Email / UserID:

For first-time users, this email will be used to register guest access to the PLET application. No further personal information is required. If possible, please use your email address from your organization.

Figure 3. PLET access page.

Using the Model

PLET is primarily composed of four modules—Inputs, BMPs, Total Loads, and Additional Reference Tables—all designed for user interaction. PLET also includes several other interactive data entry forms. Data entries in the modules and forms are in different colors.

- Orange entries designate values or controls that should be specified (e.g., cropland area in acres) by the user.
- Black entries on the Inputs, BMPs and Additional Reference Tables modules provide useful information and assumptions to help users understand the spreadsheet tool. These can also be adjusted by the user, if more accurate local data are available
- Black entries on the Total Loads module are information calculated by the spreadsheet and cannot be changed.

Data fields can be edited by double clicking within the cell to be edited. Once a cell is edited, the upper right corner will have blue icon. Edits will only be marked during the current session of the tool. If the user exits and returns to the tool, edits from previous sessions will be saved, but unmarked.

All model changes are automatically saved. There is no save button in the tool.

Creating a Model

Upon logging into the PLET tool, the home page provides a list of models created by the user (or an empty list if no models have been created yet). To create a new model, the user clicks on the *Create a New Model* button in the upper right hand corner. To access an existing model, the user clicks on the edit symbol to the left of the desired model in the table (as shown in Figure 4). Once a model is created, it is shown in the list, including the name of the model, the state, county, and 12-digit Hydrologic Unit Code (HUC) of the model domain and the date the model was created.













Pollutant Loads Estimation Tool						
Models						
	Title	State	County	Date Created	Watershed / HUC12	
	Test	AZ	COCONINO	01-JUN-21	140700060406	
	Sakonnet	RI	NEWPORT	27-MAY-21	010900040910	
	New beta test	AL	MARSHALL	07-MAY-21	[Custom Watershed]	
	Beta Test Drive AM	AL	CALHOUN	07-MAY-21	031501060513	
	Emuckfaw Creek	AL	TALLAPOOSA	06-MAY-21	031501090308	
	Blue River Watershed	MO	JACKSON	05-MAY-21	103001010106	
	Shoal Creek	MO	NEWTON	05-MAY-21	110702080305	
	North Fabius HUC 071100020405	MO	LEWIS	05-MAY-21	071100020306	
	WI-TEST	WI	OUTAGAMIE	23-APR-21	040302040402	
	Twelvemile Creek Watershed X2 TEST	MN	WRIGHT	15-APR-21	070102040605	
	Twelvemile Creek -- North Fork Crow-Test	MN	WRIGHT	14-APR-21	070102040605	
	Copy of Beta Demo	CT	HARTFORD	13-APR-21	010802050402	

Figure 4. PLET modeling home page.

Selecting the Modeled Area

After clicking on *Create a Model*, a model set-up screen will open where the user is prompted to name the model run and select the state in which the area to be modeled is located (Figure 5). Upon selecting the state, other data entry fields will automatically appear including the watershed HUC drop-down list, the county drop-down list, and the weather station drop-down list (Figure 6). There are three ways to specify the area to be modeled:

1. Select a HUC12 watershed from a drop-down list,
2. Manually create a watershed, or
3. Look up a watershed on a map.

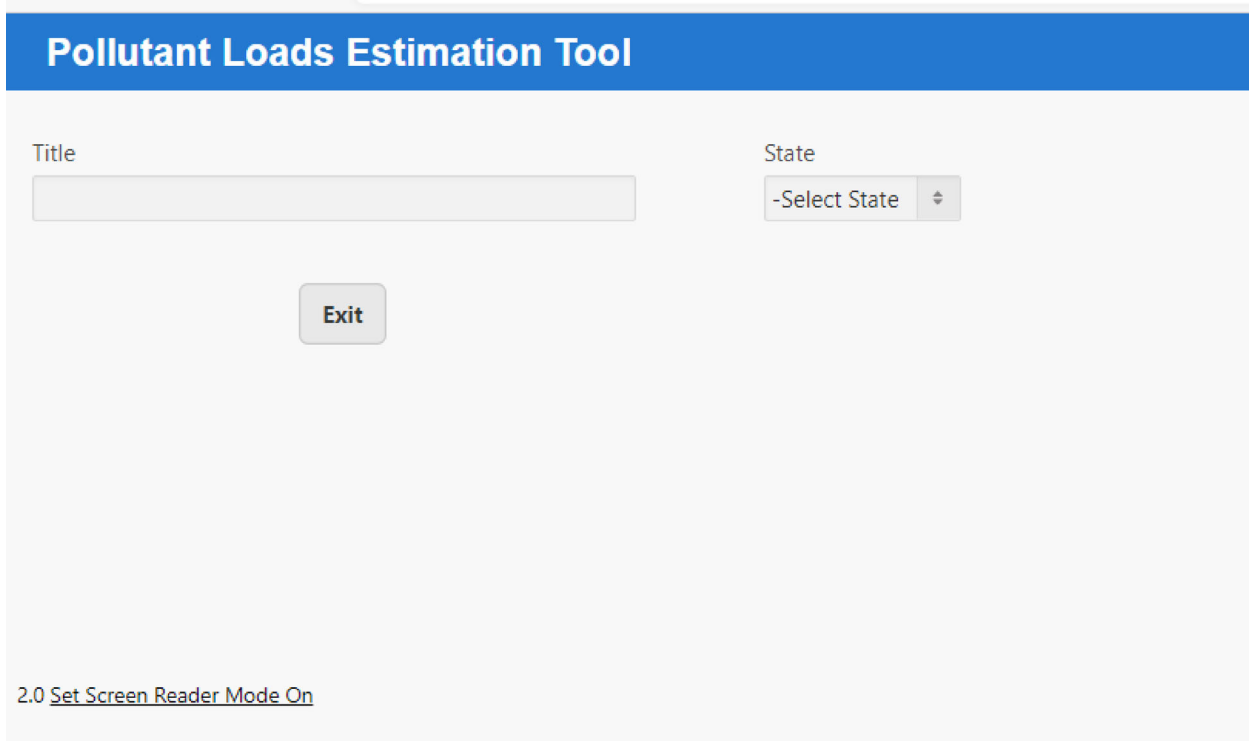


Figure 5. Initial set up page.

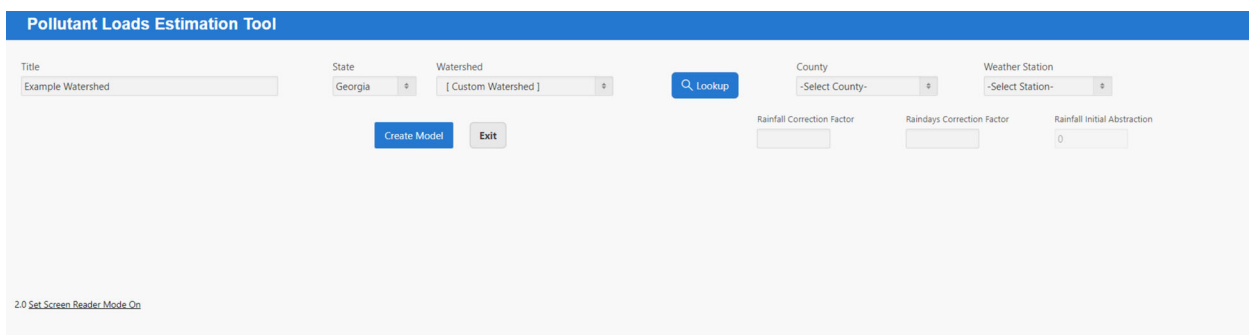


Figure 6. Initial set up page once the Title and State are selected.

Selecting a HUC12 watershed from a drop-down list

If the user is working at the HUC12 scale, knows the HUC12 number of the watershed of interest, and would like to start building the model with default watershed characteristics provided by the Input Data Server, the HUC12 can be selected directly from the Watershed drop-down list.

Upon selecting a HUC, the County and Weather Station fields will be automatically populated with the closest County and weather station, which can be adjusted by the user, if appropriate. The weather station drop-down list will be automatically updated to show the nearest weather stations to the selected county.

Click on *Create Model* to generate the Input tables. Once the model is created, the rainfall correction factor and raindays correction factor will populate. The watershed data in Tables 1-5 (land use, animal counts, etc.) will be pre-populated for the selected watershed. The values provided should be used as a starting point and replaced with local data when available.

Looking up a watershed on a map

If the area to be modeled is known, but the specific HUC12 is unknown, the user may generate location specific data by selecting the state from the drop-down list and then clicking on the *Lookup* button to the right of the Watershed drop-down. This will open an interactive map of the United States. Zoom into the area of interest and click on the map. The HUC12 boundary for watershed containing the area of interest will appear (Figure 7). To change which HUC12 is selected, click another location on the map to display the boundary. Once the correct HUC12 has been selected, click *Submit* to select the watershed. This will return the user to the model setup, which will be populated with the HUC12 name and number, as well as the County, weather station and rainfall and raindays correction factors. Tables 1 through 5 will be populated with initial values.

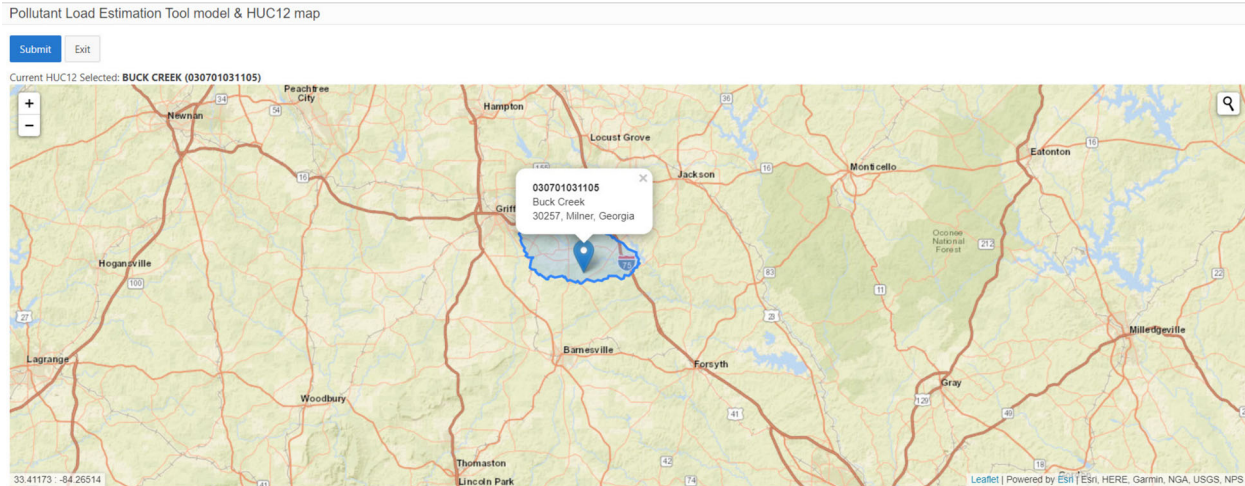


Figure 7. Map view watershed selection with example watershed selected.

Manually Creating a Watershed

If the area to be modeled is not a HUC12 watershed, “Custom Watershed” can be selected from the Watershed drop-down list after selecting the state. The Custom Watershed allows the user to fill in all information about the watershed manually. Select the appropriate county and weather station and click *Create Model*. This will populate the rainfall and raindays correction factors, the hydrologic soil group (HSG) in Table 1, and the universal soil loss equation (USLE) values in Table 5, based on the location information specified by the user. All other user specified data fields in Tables 1-3 will remain set to 0. The pre-populated values should be evaluated by the user and updated if more specific local data are available. The user must also populate Tables 1-3 with land use acreages, agricultural animal counts, and information about septics and illegal wastewater discharges.

Navigation Dashboard

Once the model is set up, the action buttons and summary information at the top of the model page remain visible in any of the submodules in the model. Moving across from left to right and top to bottom, these include (Figure 8):

Share Model – allows the user to share the current version of the model with another user. When clicked it opens a pop-up window with an input field to enter the email address or username of the intended recipient of the model. Enter an email address or username and click Submit. To leave this pop-up without sharing the model, click cancel.

Copy Model – creates a new version of the existing model. When clicked, the user will be brought into a new copy of the model that is named “Copy of...” as part of the model’s title. Changes to this version will not impact the settings and inputs to the original version.

Delete Model – deletes the version of the model. Once deleted, the model cannot be recovered. Prior to deleting a pop-up will ask the user to confirm the model should be deleted. To delete, click ok. To keep the model, click cancel.

Download Input Data Server Data – provides a screen with the Input Server Data for the selected watershed(s) that have been added to the model. These data are specific to the initial data provided by the Input Data Server and does not incorporate any edits that may have been made since populating the model initially.

Exit – brings the user back to the home page with the list of existing models.

Rainfall Correction Factor – automatically populated based on the selected weather station. Provides the percentage of rainfall events that exceed 5 mm per event.

Raindays Correction Factor – automatically populated based on the selected weather station. Provides the percentage of rain days (events) that generate runoff.

Rainfall Initial Abstraction – determines initial rainfall retention on the land surface, ranges from 0 to 0.2. Default is set to zero.

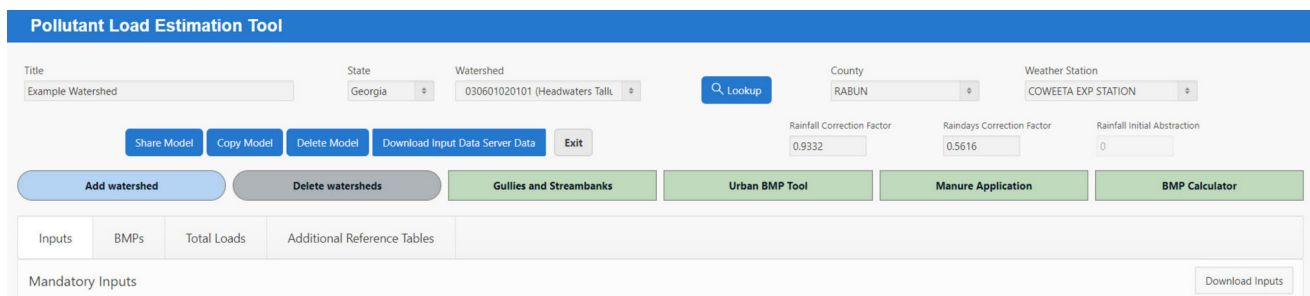


Figure 8. PLET Model Navigation Dashboard.

The *Add Watershed* button brings up a pop-up that will display a new Watershed row, populated with the watershed name and acreages from the initial watershed that was added (Figure 9). These can be overwritten here with new watershed data, or once the watershed is added to the model. Click *Submit* to add a new watershed or click *Cancel* to leave the pop-up without adding a new watershed.

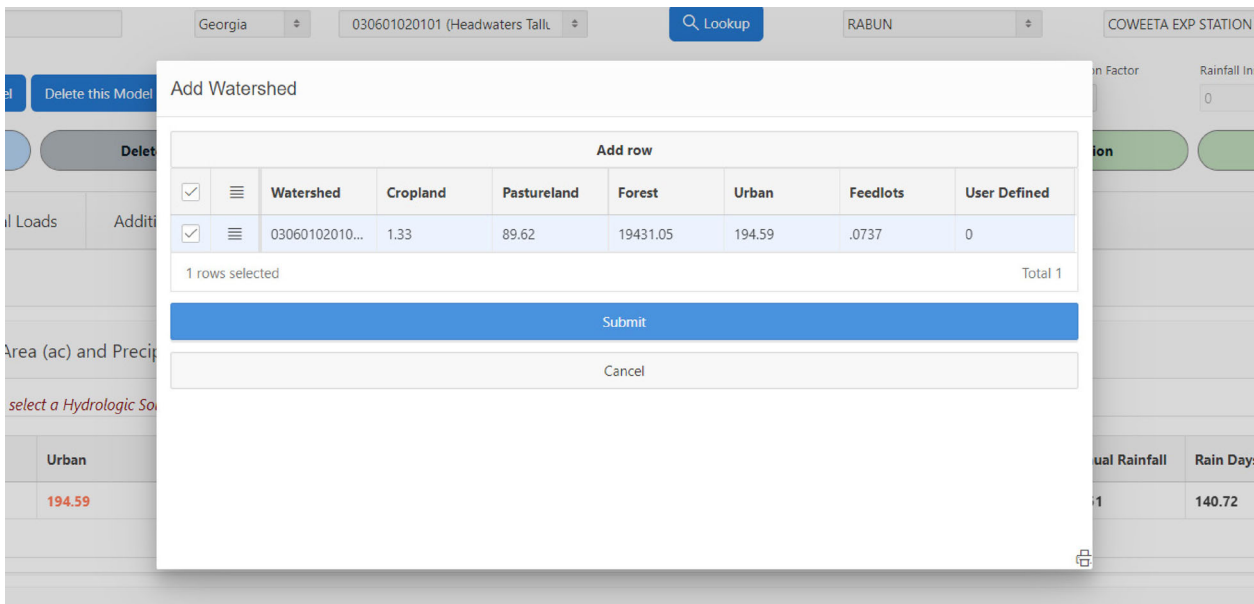


Figure 9. View of the Add Watershed pop-up, used to input additional watersheds and their land use acreages.

If more than one watershed needs to be added, click on the menu icon and select “+ Add Row” to add additional rows in the pop-up table (Figure 10).

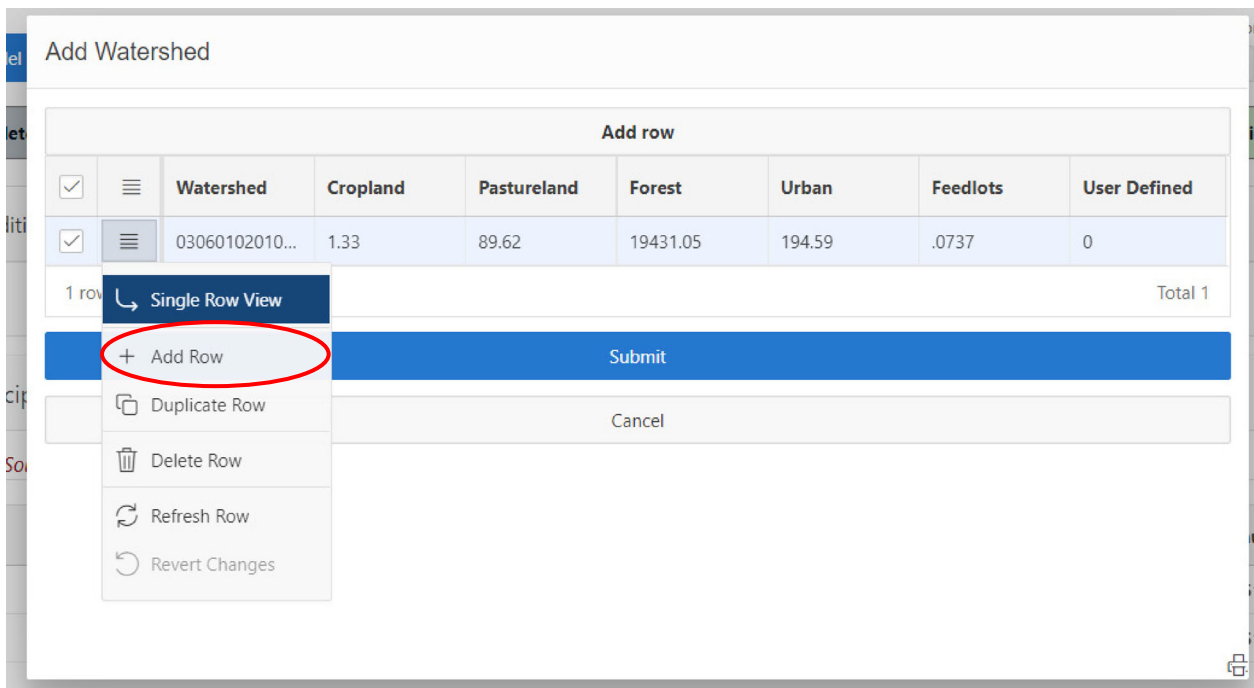


Figure 10. Add row button in the Add Watershed pop-up used to create additional rows for more watersheds.

Delete Watershed will bring up a pop-up with all of the watersheds in the model listed. Click the trash can icon next to the one to be deleted, and another pop-up will ask the user to confirm deletion of the watershed from the model (Figure 11). Click OK to delete the watershed and click Cancel to return to the list of watersheds. If Cancel is selected, to exit the Delete pop-up, hit the Esc key on the keyboard.

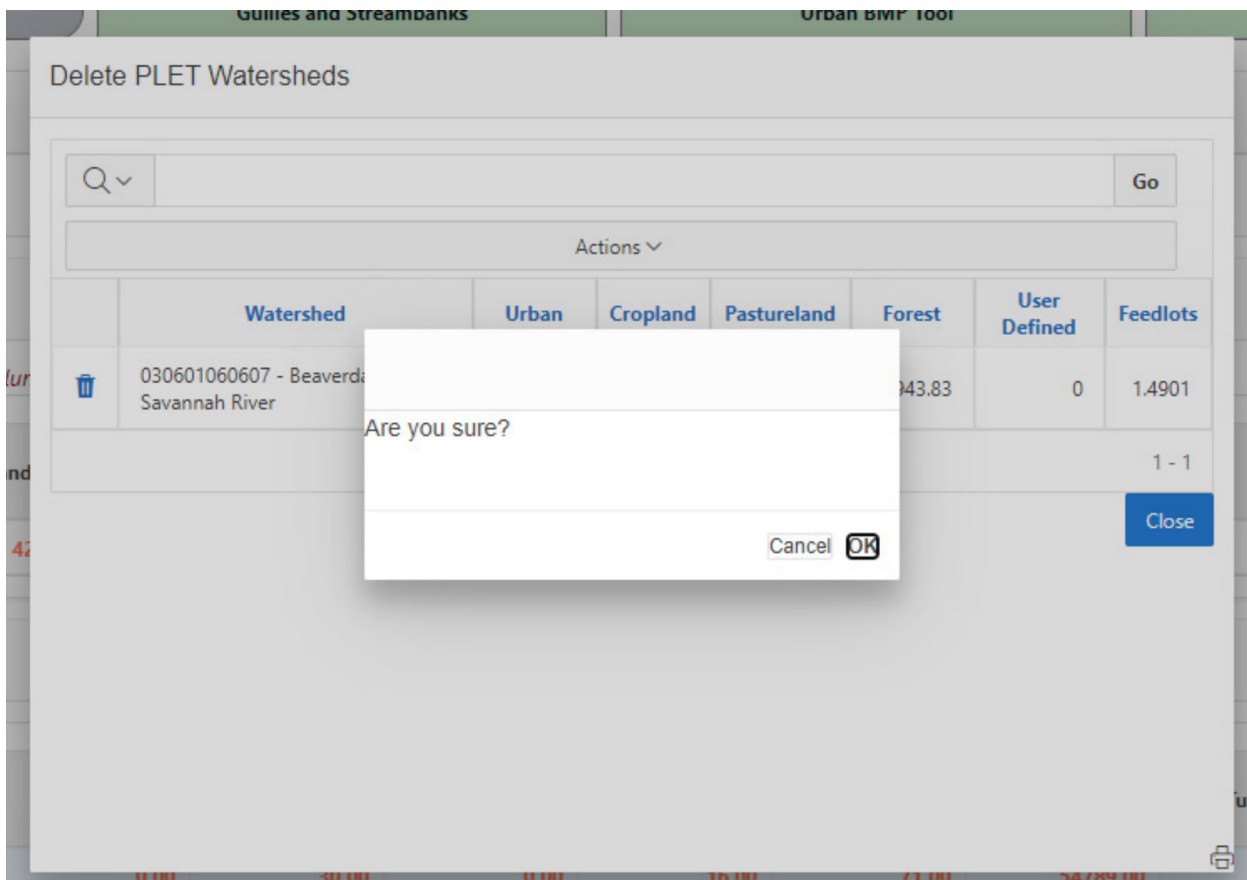


Figure 11. Delete watershed pop-up window, shown with delete confirmation message.

The previously described Navigation Dashboard buttons are used to setup the modeled watersheds. The remaining Navigation Dashboard buttons, which are green, are used to provide inputs to the model. These input buttons, briefly described below, are discussed in more detail in the appropriate section of this User's Guide.

Gullies and Streambanks opens a pop-up window with a form for adding gullies and streambanks to the model.

Urban BMP Tool opens a pop-up to the Urban BMP and LID input form. BMPs applied to urban land uses are added using this form.

Manure Application opens up the manure application calculator, which allows the user to calculate a land use-wide average manure application period for both pasture and cropland.

BMP Calculator opens the BMP Calculator tool that provides a workspace to configure multiple BMPs on a given land use to determine that combined efficiency value.

Input Data Server

For users interested in gathering initial input data for a watershed of interest, the Input Data Server is available. The Input Data Server provides initial model input data that can be used as a starting point in populating the PLET model. It provides HUC12-level land use acreages, agricultural animals, septic system information, and HSG information. These data can be downloaded for use in other applications, or the data can be applied automatically to a PLET model as it is developed. **Note:** for user's downloading data for HUC12 watersheds that cross county lines, the data provided is at the HUC12 scale and is not subdivided by county, so requesting the data for more than one county produces duplicate data. The Input Data Server can be accessed from outside of the model at <https://ofmpub.epa.gov/apex/grts/f?p=109:333>.

The Input Data Server allows the user to select the state and county of interest and then it generates a list of HUC8 watersheds. Once a HUC8 is selected, the list of HUC12 watersheds within the selected HUC8 watershed appears. From here, one or more HUC12 watersheds can be selected (Figure 12). To select more than one watershed, hold down the Shift button while clicking on the desired HUC12 watersheds. After selecting watersheds, click on *Generate* and the Input Data Server will provide data tables that can be downloaded individually by data type, or all together in one Excel spreadsheet (Figure 13).

PLET Input Data Server

Select Geographic Area

Filters

New

State
 Delaware
 District of Columbia
 Florida
 Georgia
 Guam

County
 Bleckley
 Brantley
 Brooks
 Bryan
 Bulloch

HUC8
 -Select HUC8 (optional)-
 03070201 (Satilla)
 03070202 (Little Satilla)
 03070203 (Cumberland-St. Si
 03110201 (Upper Suwannee)

HUC12
 * PLEASE CLICK HERE TO CONFIRM HUC12 SELECTION PRIOR TO USING THE INPUT DATA SERVER

Huc

030702020202 (Lower Sweetwater Creek)
 030702020301 (Fishing Creek)
 030702020302 (Upper Colemans Creek)
 030702020303 (Lower Colemans Creek)
 030702020304 (Lower Big Satilla Creek)
 030702020401 (Keene Bay Branch-Little Satilla Creek)
 030702020402 (Dry Branch-Little Satilla Creek)
 030702020403 (Boagy Creek)

Ctrl+A to select all

Generate **Reset**

Figure 12. Input Data Server watershed selection fields.

Landuse Area **Download**

Watershed Name	HUC12	Urban	Forest	Pastureland	Cropland	Feedlots	Water	Other Landuse
Upper Colemans Creek	030702020302	1623.7	21998.38	1356.6	3763.14	4.8669	16.9	6.89
Lower Big Satilla Creek	030702020304	908.26	16555.04	1717.77	9595.88	2.8867	55.6	28.47
Fishing Creek	030702020301	1452.01	17903.64	2447.46	8229.49	2.607	105.86	1.78
Lower Colemans Creek	030702020303	1174.02	9491.14	1440	9077.92	4.2489	91.63	36.7

Agricultural Animals Count **Download**

Watershed Name	HUC12	Beef Cattle	Dairy Cattle	Swine	Sheep	Horse	Turkey	Chicken	Duck
Upper Colemans Creek	030702020302	337	161	3	0	15	0	196417	0
Lower Big Satilla Creek	030702020304	230	90	3	5	21	0	115366	0
Fishing Creek	030702020301	233	86	3	8	27	0	102971	0
Lower Colemans Creek	030702020303	300	131	2	1	18	0	171495	0

Septic Systems **Download**

Watershed Name	HUC12	Septic Systems	Population per Septic System	% Septic Failure Rate
Upper Colemans Creek	030702020302	292	2	0.57
Lower Big Satilla Creek	030702020304	208	2	0.57
Fishing Creek	030702020301	345	3	0.57
Lower Colemans Creek	030702020303	318	2	0.57

Hydrological Soil Group **Download**

Figure 13. Example partial outputs from the Input Data Server.

Inputs Module

The Input module has 10 tables (shown on the following pages in Figure 14) with a combination of optional and required data inputs. Although some tables do not require data to run the model, it is up to the user to decide whether these optional data tables should be excluded, depending on the purpose of the model run and the characteristics of the watershed. The tables include:

1. Watershed Land Use Area and Precipitation
2. Agricultural Animals
3. Septic and Illegal Wastewater Discharge
4. Percent Nutrient Content in Soil
5. Universal Soil Loss Equation
6. Reference Runoff Curve Number
 - a. Detailed Urban Reference Runoff Curve Number
7. Nutrient Concentration in Runoff
 - a. Nutrient Concentration in Shallow Groundwater
8. Urban Land Use Distribution
9. Input Irrigation Area and Irrigation Amount (optional)
10. Wildlife Density in Cropland (optional)

For most HUC12 watersheds, if they were selected from the drop-down list during model setup, Tables 1-8 will be automatically populated with initial model input data specific to the watershed and/or county derived from the Input Data Server and pre-set default values. It is the user's responsibility to verify and refine the initial data, and EPA highly encourages users to replace initial values with more locally specific and relevant data whenever it is available.

To manually enter data:

1. Enter land use areas in acres, the dominant hydrologic soil group (HSG¹), and the percent imperviousness of feedlots in Table 1;
2. Enter total number of agricultural animals by type and number of months per year that manure is applied to croplands in Table 2, refer to the Manure Calculator section below for more information on calculating the average number of months of manure application for the watershed;
3. Enter values for septic system parameters, population counts that discharge wastewater directly, and reduction percentages on direct wastewater discharge in Table 3; and
4. Optionally modify the percent nutrient concentrations and USLE parameters associated with the selected county in Table 4 and Table 5, respectively.

The user may stop here and proceed to the BMP module, unless there is more detailed information on the watersheds that can be updated in the remaining input tables. The remaining input tables are already populated with default values or are set to zero (0) and should be updated with local data, if available.

¹ HSG A: Low runoff potential and high infiltration rates even when thoroughly wetted. Chiefly deep, well to excessively drained sands or gravels. High rate of water transmission (< 75 cm/hr).

HSG B: Moderate infiltration rates when thoroughly wetted. Chiefly moderately deep to deep, moderately well to well-drained soils with moderately fine to moderately coarse textures. Moderate rate of water transmission (0.4 to 0.75 cm/hr).

HSG C: Low infiltration rates when thoroughly wetted. Chiefly soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. Low rate of water transmission (0.15 to 0.40 cm/hr).

HSG D: High runoff potential. Very low infiltration rates when thoroughly wetted. Chiefly clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, or shallow soils over nearly impervious material. Very low rate of water transmission (0 to 0.15 cm/hr).

The reference curve number default values in Table 6 and 6a are derived using the land use and soil group inputs from Table 1. If watershed-specific pollutant concentrations in runoff or groundwater are known, these can be updated in Tables 7 and 7a. In Table 8, the model will also automatically subdivide the urban land use acreage into preset proportions of urban land uses, such as residential, industrial and institutional. However, these distributions can be adjusted to better reflect the actual urban land use distribution in the project area. The land use proportions in Table 8 must add up to 100. If they are edited and do not add up to 100, a warning will appear below the table (“ERROR – Total % must equal 100”)

If the user wishes to represent irrigation or changes to irrigation, this information should be included in Table 9. The total cropland acres are automatically populated from Table 1. If there are significant wildlife populations on cropland that should be represented, these can be included in Table 10.

Input Module

Pollutant Load Estimation Tool

Title: State: Watershed: County: Weather Station:

Rainfall Correction Factor
 Raindays Correction Factor
 Rainfall Initial Abstraction

Add watershed

Delete watersheds

Gullies and Streambanks

Urban BMP Tool

Manure Application

BMP Calculator

Inputs | BMPs | Total Loads | Additional Reference Tables

Mandatory Inputs

▼ 1. Watershed Land Use Area (ac) and Precipitation (in)

Double-click on the "HSG" field to select a Hydrologic Soil Group category [NOTE: hover over column header for more information].

Watershed	HSG	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Total	Feedlots Percent Paved	Annual Rainfall	Rain Days	Average Rain/Event
030601060607 - Beaver...	C	21429.27	4286.43	3422.20	37943.83	0.00	1.49	67083.2201	0-24%	43.19	106.38	0.7364

▼ 2. Agricultural Animals (Animal Count)

Watershed	Beef Cattle	Young Beef	Dairy Cattle	Young Dairy Stock	Swine (Hog)	Feeder Pig	Sheep	Horse	Chicken	Turkey	Duck	# Of Months Manure Applied to Cropland	# Of Months Manure Applied to Pastureland
030601060607 - Bea...	235.00	0.00	11.00	0.00	30.00	0.00	16.00	71.00	54789.00	3.00	2.00	0.00	0.00

▼ 3. Septic and Illegal Wastewater Discharge

Watershed	Number Of Septic Systems	Population Per Septic System	Septic Failure Rate, %	Waste Water Direct Discharge, # Of People	Direct Discharge Reduction, %
030601060607 - Beaverdam Ditch-Savan...	4559.00	2.00	0.53	0.00	0.00

▼ 4. Percent Nutrient in Soil

Watershed	Soil N conc. %	Soil P conc. %	Soil BOD conc. %
030601060607 - Beaverdam Ditch-Savannah River	0.08	0.0308	0.16

▼ 5. Universal Soil Loss Equation

Watershed	Cropland					Pastureland					Forest					User Defined				
	R	K	LS	C	P	R	K	LS	C	P	R	K	LS	C	P	R	K	LS	C	P
03060...	250.00...	0.16918	0.42499	0.28008	0.91096	250.00...	0.16918	0.42499	0.04000	1.00000	250.00...	0.16918	0.42499	0.00300	1.00000	250.00...	0.16918	0.42499	0.28008	1.00000

Optional Inputs

6. Reference Runoff Curve Number

SHG	A	B	C	D
Urban	83.00	89.00	92.00	93.00
Cropland	67.00	78.00	85.00	89.00
Pastureland	49.00	69.00	79.00	84.00
Forest	39.00	60.00	73.00	79.00
User Defined	50.00	70.00	80.00	85.00

6a. Detailed Urban Reference Runoff Curve Number

SHG	A	B	C	D
Commercial	89.00	92.00	94.00	95.00
Industrial	81.00	88.00	91.00	93.00
Institutional	81.00	88.00	91.00	93.00
Transportation	98.00	98.00	98.00	98.00
Multi-Family	77.00	85.00	90.00	92.00
Single-Family	57.00	72.00	81.00	86.00
Urban Cultivated	67.00	78.00	85.00	89.00
Vacant-Developed	77.00	85.00	90.00	92.00
Open Space	49.00	69.00	79.00	84.00

7. Nutrient Concentration in Runoff (mg/L)

Landuse ↑	N	P	BOD
1. L-Cropland	1.90	0.30	4.00
1a. w/ manure	8.10	2.00	12.30
2. M-Cropland	2.90	0.40	6.10
2a. w/ manure	12.20	3.00	18.50
3. H-Cropland	4.40	0.50	9.20
3a. w/ manure	18.30	4.00	24.60
4. L-Pastureland	4.00	0.30	13.00
4a. w/ manure	4.00	0.30	13.00

7a. Nutrient Concentration in Shallow Groundwater (mg/l)

Landuse	N	P	BOD
Urban	1.50	0.063	0.00
Cropland	1.44	0.063	0.00
Pastureland	1.44	0.063	0.00
Forest	0.11	0.009	0.00
Feedlots	6.00	0.07	0.00
User Defined	0.00	0.00	0.00

7. More Information

8. Urban Land Use Distribution

Watershed	Urban Area (ac.)	Commercial %	Industrial %	Institutional %	Transportation %	Multi Family %	Single Family %	Urban Cultivated %	Vacant (developed) %	Open Space %	Total
030601060607 - Be...	21,429.27	15.00	10.00	10.00	10.00	10.00	30.00	5.00	5.00	5.00	100.00

9. Input Irrigation Area (ac) and Irrigation Amount (in)

Watershed	Total Cropland (ac)	Cropland Acres Irrigated	Water Depth (in) per Irrigation Before BMP	Water Depth (in) per Irrigation After BMP	Irrigation Frequency (#/Year)
030601060607 - Beaverdam Ditch-...	4286.43	0.00	0.00	0.00	0.00

10. Wildlife density in cropland (Cropland / sq. mile)

Goose	Deer	Beaver	Raccoon	Other
0.00	0.00	0.00	0.00	0.00

Figure 14. View of the Input Module Tables 1-10.

User-Defined Land Use

The tool can accommodate one user defined land use, which is added in Table 1. When creating a user-defined land use, the user should be sure to update the USLE values (Table 5), runoff curve number (Table 6) and nutrient concentration in runoff (Table 7) to represent the land use. As a default, the user-defined land use nutrient concentrations in runoff are set to zero, so no pollutant loading is generated from this land use until the concentrations are added by the user.

Replacing initial and default values with local data

EPA strongly encourages the use of local data, when available, to replace default values as well as the initial inputs that are provided in the Input Data Server. In cases where no other information is available, these values are useful, but can be improved upon with more specific information at the local level. It is up to the user to decide whether the default values and initial input data are adequate to represent the watershed being modeled, based on the other available data and the purposes for running the model.

Updating USLE values

The model calculates annual erosion using the Universal Soil Loss Equation (USLE). The default USLE parameter values (R, the rainfall erosivity index; K, the soil erodibility factor; LS, the topographic factor; C, the cropping factor; and P, the conservation practice factor) for different types of rural land uses are included within PLET based on the State/County selection. The USLE parameters provided in the model are based on the 1992 National Resources Inventory (NRI) database. The user can obtain more recent soil erosion parameter values from their local Natural Resources Conservation Service office or more accurately calculate them using NRCS's most recent RUSLE2 tool. The RUSLE2 is a model containing both empirical and process-based science that estimates long-term, average-annual rates of rill and inter-rill (sheet) soil erosion caused by rainfall and runoff (<https://www.ars.usda.gov/southeast-area/oxford-ms/national-sedimentation-laboratory/watershed-physical-processes-research/research/rusle2/revised-universal-soil-loss-equation-2-overview-of-rusle2/>). The RUSLE2 program requires more site specific information which in turn results in parameter and erosion estimates which are more site-specific.

Using PLET for other pollutants

If the user has adequate information on pollutant soil concentrations, concentrations in runoff and BMP reduction efficiencies, PLET may be used to calculate the loads of pollutants other than nitrogen, phosphorus, and BOD by replacing the pollutant data for nitrogen, phosphorus or BOD with data for another pollutant. However, the user should ensure that mg/l is the appropriate unit of expression for the pollutant in question and should consider the appropriateness of a runoff model when opting to use it for other pollutants. If the pollutant is not expressed in mg/l, the calculations will be incorrect. PLET cannot account for impacts on pollutants related to pH, or growth and decay functions. It is the user's responsibility to ensure the model is being used appropriately for the pollutant of interest.

Manure Application

The Manure Calculator supports data entry in Table 2. It calculates the average number of months for manure application per year with varying application frequencies across the watershed. It can be applied separately for cropland and pastureland. All acres of the land use need to be included, even those that do not receive manure, to accurately calculate the average number of months of manure application across the land use. Acres that do not receive manure, should be entered with the number of months set to zero.

After clicking the *Manure Application* button, a pop-up Manure Calculator form will appear (Figure 15). Enter the total land use acres in the watershed, then enter each set of acres with the number of months during which manure is applied. Double click to activate the field for data entry. Click *Add Row* to create additional rows for

data entry. Once all acres are accounted click *Calculate*. Below the table, the average number of months will appear, along with a land use acreage validation. If the total land use acres do not match the total acres in the table, a warning will state “Check to ensure total treatment area matches the total land use area.” Edit the acreages and click Calculate again. The Total Landuse Area Check should now read “OK.” Select the watershed and land use where the months of manure will be included from the respective drop-down lists and click *Apply to Selected Watershed*. A notice will confirm that the data were applied successfully. Click Esc on the keyboard to return to the Input module.

Manure Application

Total Land Use Acres

Add row	
Area	Number of Months
500	8
300	4
3486	0

1 rows selected 1 - 3

Total Land Use Acres **4286** # of Months **1**

Total Landuse Area check: **OK**

Apply To Watershed

Watershed

Landuse

Figure 15. View of the Manure Calculator.

Gullies and Streambanks

The *Gullies and Streambanks* button takes the user to the Gullies and Streambanks Form (Figure 16), which is used for defining the dimensions for the user-specified gully formations and impaired streambanks. This form contains two tables: the first table will show the gully formations, and the second table will show the impaired streambanks. To add new a gully or streambank to the form, select *gully* or *streambank* and click *Submit* to generate a blank form. For each new gully or streambank the required information can be defined in following steps:

Gully:

1. Select the watershed to apply the gully
2. Name the gully
3. Specify the gully dimensions (length, top width, bottom width, and depth).
4. Specify the time (number of years) that the gully has taken to form the current size.
5. Specify the gully stabilization (BMP) efficiency (0-1) and the gully soil textural class.

Streambank:

1. Select the watershed to apply the streambank
2. Name the streambank
3. Specify the streambank dimensions (length, height).
4. Specify the lateral recession rate (ft/yr) of the eroding streambank.
5. Specify the streambank stabilization (BMP) efficiency (0-1) and the streambank soil textural class.

The form calculates both the initial loading from gullies and streambanks and also the reductions from stabilization and restoration BMPs. Gully loads are based on annual erosion rates, which are determined by the volume of the gully and the soil weight times the soil nutrient concentration. Stream calculations are similar, except they also include a lateral recession rate. The streambank form requires separate entries for each side of a streambank, while the gully form represents the entire gully in one entry.

Once the soil textural class is selected, the soil dry weight (density) and nutrient correction factor will automatically populate. For streambanks a lateral recession factor is also required. The user can select from categories ranging from slight to severe, corresponding to estimated lateral recession rates, which will populate automatically. For more information about the soil texture classes and associated density and nutrient correction factors and the lateral recession rates, click on the *More Info* drop-down on the right hand side of the Gullies & Streambanks Form. If local data or project-specific data are available on the soil density, nutrient correction factor or lateral recession rate, these can be edited by the user to better reflect local conditions.

The annual load and load reduction will automatically be calculated based on the inputs provided. If the model represents a gully or streambank under current unimproved conditions (i.e. without a restoration BMP) the BMP efficiency field should be set to zero (0). The load reduction will calculate as 0. If the model represents a restoration BMP, the BMP efficiency value should be set to a non-zero value, where 1 equals 100 percent removal of the gully or streambank load.

Click *Submit* for the gully or streambank entry to appear in the Report rows on the Gullies & Streambanks Form. A pop-up in the upper right corner will confirm that the gully or streambank has been submitted. To delete a previously entered gully or streambank, click on the trash can icon on the left side of the row to be deleted, and a pop-up window will ask for confirmation before deleting the row (Figure 17). To add another gully or streambank, select the gully or streambank radio button and enter another gully or streambank. When all entries are complete, click the *Close* button to exit the Gullies & Streambanks Form and return to the main model view.

Gullies and Streambanks Form

Use this form to add a new gully or streambank entry

Select One: Gully Streambank

Watershed:

Gully/Streambank Name: Length (ft): Top Width (ft):

Bottom Width (ft): Depth (ft): Years to Form:

BMP Efficiency (0-1): Soil Textural Class: Soil Dry Weight (ton/ft³):

Annual Load (ton): Nutrient Correction Factor: Load Reduction (ton):

Gully and Streambank Polluta
✓ Gully successfully submitted
✕

This sheet contains two input tables: the first table is for inputting the gully dimensions, and the second is for inputting the eroding streambank dimensions.

GULLY:

Step 1: Specify the gully dimensions and assign each gully to a watershed.

Step 2: Specify the time (number of years) that the gully has taken to form the current size.

Step 3: Specify the gully stabilization (BMP) efficiency (0-1) and the gully soil textural class.

STREAMBANK:

Step 1: Specify the streambank dimensions and assign each bank to a watershed.

Step 2: Specify the lateral recession rate (ft/yr) of the eroding streambank.

Step 3: Specify the streambank stabilization (BMP) efficiency (0-1) and the streambank soil textural class.

Gullies Report

	Watershed Name	Gully Name	Top Width	Bottom Width	Depth	Length	Years To Form	BMP Efficiency	Soil Class	Soil Weight	Nutrient Correction Factor	Annual Load	Load Reduction
	030601060607 - Be...	Gully 1	2	1	2	100	5	0	Loams, sandy ...	0.045	0.85	2.7	0

Streambanks Report

Watershed Name	Streambank Name	Length	Height	Lateral Recession	Rate Range	Rate	BMP Efficiency	Soil Class	Soil Weight	Nutrient Correction Factor	Annual Load	Load Reduction
No data found												

Figure 16. View of the Gullies& Streambanks Form.

Gullies Report

	Watershed Name	Gully Name	Top Width	Bottom Width	Depth	Length	Years To Form	BMP Efficiency	Soil Class	Soil Weight	Nutrient Correction Factor	Annual Load	Load Reduction
	030601060607 - Be...	Gully 1	2	1	2	100	5	0	Loams, sandy ...	0.045	0.85	2.7	0

Figure 17. View of the trash can icon to delete a row.

BMPs Module

The BMPs module provides a single table where the BMPs can be entered for all watersheds and all non-urban land uses. The land uses included in the BMPs module are cropland, feedlots, pasture, forest, and user defined. At its most basic, you select the BMP and the percent of the land use on which it's applied. The effective efficiency will be calculated automatically.

The BMP worksheet is set up to accept one BMP per land use per watershed. If only BMP per land use is being applied in each watershed, this is the only table needed for adding non-urban BMPs. Alternatively, combined BMP efficiencies can be created to account for multiple BMPs on a single land use using the BMP Calculator, which is discussed later in this guide.

To add a BMP to the BMP table, click *Add BMP* on the right side of the table, a pop-up window will open, where the watershed and land use should be specified for the BMP that is being added (Figure 18). After clicking *Add BMP* in the pop-up window, a new line is created in the BMP table. From here, double click on the BMPs cell to activate a drop-down list of BMPs that can be applied. Once a BMP is selected, the pollutant efficiencies will automatically populate in the table. For BMPs with no default efficiency value data, "ND" will be displayed in corresponding efficiency field in the table.

The next step is to add the percentage of the land use on which the BMP is applied to the "% Area BMP Applied" field. Adding a single BMP to a land use means that only one type of BMP is present, but there may be several locations throughout the watershed with this BMP. The user should add up the total acreage of the BMP type in the watershed and determine what percentage of the land use is covered by this BMP.

For example, if Contour Farming is the only cropland BMP in a watershed, add up all the acres of contour farming throughout all of the cropland and divide this by the total acres of cropland in the watershed to determine the percent area of the BMP.

The list of BMPs included in the BMPs drop-down menu will include those specific to the selected land use as well as any custom BMPs the user has previously created.

The screenshot displays the 'Pollutant Load Estimation Tool' interface. At the top, there are input fields for Title (Example Watershed), State (Georgia), Watershed (030601060607 - Beaverdam Ditch), County (RICHMOND), and Weather Station (AUGUSTA BUSH FIELD AP). Below these are buttons for 'Share Model', 'Copy Model', 'Delete Model', 'Download Input Data Server Data', and 'Exit'. A navigation bar includes 'Add watershed', 'Delete watersheds', and several tool buttons: 'Gullies and Streambanks', 'Urban BMP Tool', 'Manure Application', and 'BMP Calculator'. The main area has tabs for 'Inputs', 'BMPs', 'Total Loads', and 'Additional Reference Tables'. A 'Land Use' filter is set to 'Filter By Landuse'. A table titled 'BMPs and Efficiencies' is visible, with a note: 'Double-click on the "BMPs" field to select a Best Management Practice that will be applied'. A pop-up window titled 'Add BMP' is open, showing 'Watershed' (1 - 030601060607 - Beaverdam Ditch-Savannah River) and 'Landuse' (Cropland) selected. The pop-up has 'Add BMP' and 'Cancel' buttons. In the background, a table has columns for 'E.coli', '% Area BMP Applied', and 'Landuse'. Buttons for 'Create a User Defined BMP', 'Delete BMP', and 'Add BMP' are also present.

Figure 18. BMP Module layout and popup window to specify the watershed and land use where a BMP will be applied.

To delete a BMP from a scenario, click on *Delete BMP* on the right side of the BMP table. A popup window will list the BMPs in the scenario. Click the trash can icon next to the BMP that will be deleted. A second popup will ask “Are you sure?” Click *OK* to delete the BMP or *Cancel* to keep it.

User-Defined BMPs (Custom BMPs)

PLET allows the user to create custom BMPs if the user has BMPs that are not represented in the model, or BMPs with efficiencies that are different from the default values included in the model. The advantage to creating user-defined BMPs is that it allows the user to create BMPs with more specific local data than is provided in the default values. Custom BMPs can also represent a suite of practices with a combined BMP efficiency. User-defined BMPs are saved and can be accessed for future use in other modeling scenarios.

To create a User defined BMP, from the BMPs module, click on *Create a User Defined BMP*. This opens a dialog box where the BMP name and pollutant reduction efficiency values can be entered (Figure 19). Efficiencies are values between 0 and 1.00, where 1.00 equals 100% pollutant removal (e.g. 0.4 is 40% removal). After clicking *Save and Close*, the BMP will be saved. To add the new BMP to the scenario, click *Add BMP* and select the watershed and land use where the practice will be applied. Then select the practice from the drop-down list in the BMPs column. Custom BMPs are distinguished from default BMPs with the naming convention “User Defined/Custom BMP (Custom BMP Name)” where the Custom BMP Name is the name entered in the Custom BMP creation dialog box.

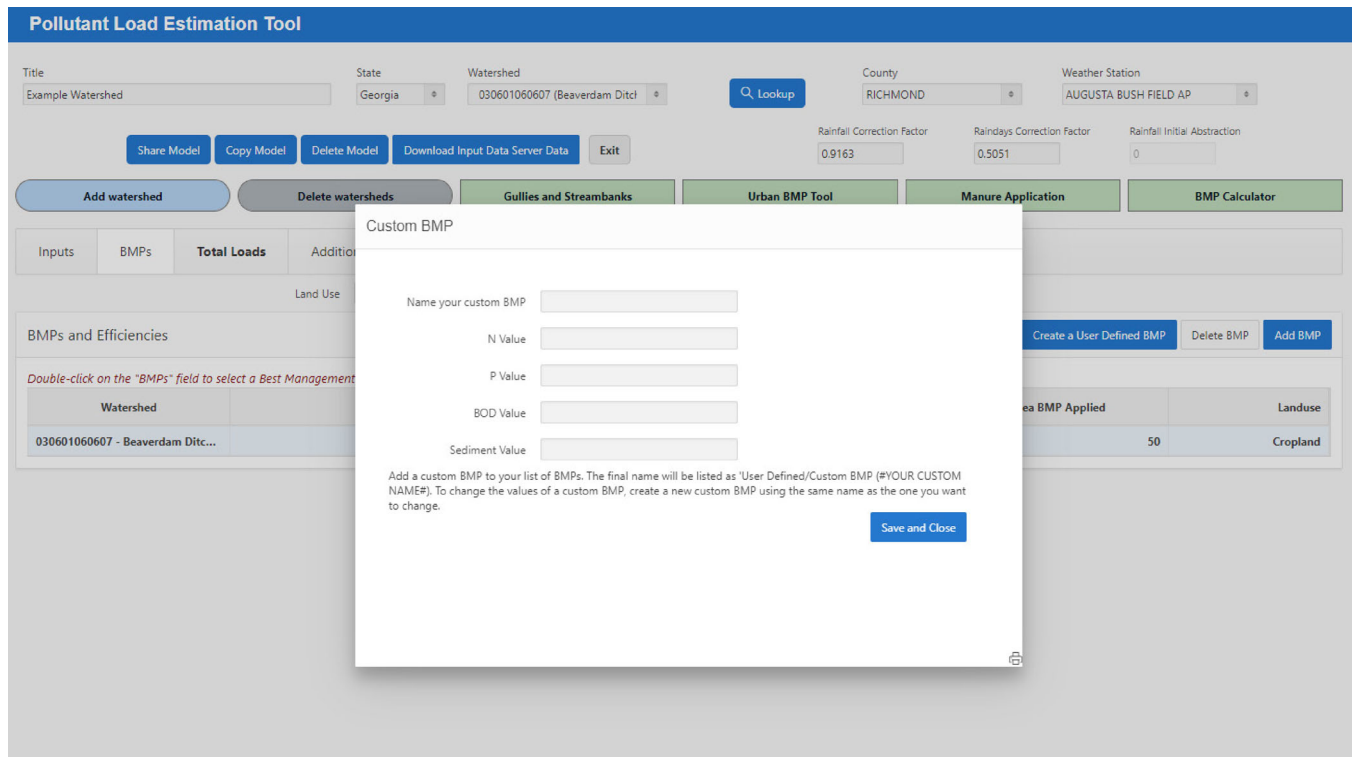


Figure 19. View of the Custom BMP popup where the BMP name and pollutant removal efficiencies are specified.

Editing Default Efficiency Values

While the user can manually adjust the efficiency values of the default BMPs, EPA strongly recommends creating a custom BMP with the desired efficiency values instead. Any manual adjustment to the default values will not be carried over to other models and may result in incorrect values being applied to areas of less than 100%.

Urban BMP Tool

The Urban BMP Tool supports the input of BMPs on urban land uses. All urban BMPs are entered here, rather than on the BMPs module. The Urban BMP Tool uses event mean concentrations (EMCs) in runoff for each of the 9 urban land use types.

There is a default distribution provided for urban land uses in Table 8 in the Input module. This table should be modified to match the desired urban land use distribution in the watershed before working in the Urban BMP Tool. Default values for urban pollutant concentrations are provided in the Urban BMP Tool. These values can be modified/refined if local data are available.

To use the Urban BMP Tool, select the watershed from the drop-down and then select the urban land use where BMPs will be applied (Figure 20). Select the BMP from the Available LID/BMP drop-down list and enter the total acres treated by that type of BMP. The total available acreage for the land use selected will be shown for reference, the BMP drainage area cannot exceed the amount of total available acres. Click on *Apply LID/BMP* and a pop-up will indicate that the BMP has been applied. As BMPs are entered, they will appear in the Selected Urban BMPs table, showing the type of practice on each urban land use. Further down, the Effective BMP Application Area table will indicate the number of acres where BMPs have been applied on each land use. There is also a Percentage of BMP Effective Area table that will show the proportion of each land use with BMPs.

There are generally three types of urban BMP/LID practices: standard efficiency-based reduction BMP practices, BMP and LID practices with runoff capture depths, and LID practices with volume reductions. LID practices with volume reductions are denoted with an asterisk in the Available LID/BMP drop-down list.

Practices that include a runoff capture depth and volume reductions will have additional required inputs. When a runoff capture depth practice is selected, another input window (Runoff) will appear with fields for the percent impervious and the runoff capture depth. The default values are set at 100% impervious and 0.5 inch capture depth. These values should be modified to reflect the local conditions. Based on the BMP drainage area, percent impervious and the runoff capture depth, the Tool will calculate the percent of captured runoff volume from the total area of the selected land use and the BMP storage capacity in gallons. An estimated BMP sizing (required BMP area) is also calculated. The BMP storage volume will be displayed in the Captured Flow Volume table and the required BMP area will be shown in the BMP Surface Area or Number of Units table.

Similarly, if a runoff volume reduction practice is selected, the Runoff input window will appear, as will a second popup window called Runoff Volume Reduction. The Runoff input window will now include a third calculated value – the required number of cisterns/rain barrels to treat the BMP drainage area at the runoff capture depth specified. The Runoff Volume Reduction popup will provide the runoff volume reduced by the selected practice based on the use-specified inputs. This information will be presented in the Captured Flow Volume and BMP Surface Area or Number of Units tables.

Like the BMP module, only one BMP type can be entered for each land use. For example, if there are 12 bioretention systems on the commercial land use, add up the total drainage area for all 12 systems and apply that as the BMP drainage area.

Figure 20. View of the Urban BMP Tool input screen.

Combined Urban BMPs and Custom Urban BMPs

The Combined BMPs-calculated selection from the Available LID/BMP drop-down list provides options for entering either a custom BMP efficiency for a single BMP or a combined BMP efficiency for multiple BMP types. Upon selecting the Combined BMPs-Calculated, an Efficiencies popup window will appear where the pollutant removal efficiencies can be entered directly, and where the BMP Calculator can be accessed (Figure 21). If the custom BMP efficiency is known, the pollutant removal efficiencies should be entered and then click *Apply LID/BMP*.

If there are multiple types of BMP on a given urban land use, the user can click on the BMP Calculator button in the popup. This will open the BMP Calculator, which can be used to calculate a combined BMP efficiency for all of the BMPs on a given land use. Refer to the BMP Calculator section of this guide for details on its use. Once the BMP configuration is submitted from the BMP Calculator, it will return the user to the Urban BMP Tool, where the BMP will automatically be submitted to the scenario. There is no need to click Apply LID/BMP. The combined BMP efficiency will also be displayed in the Efficiencies popup. Note that with combined BMPs, volume reductions calculations are not provided.

Click *Exit* to leave the Urban BMP Tool and return to the main Tool modules.

Figure 21. View of the additional input fields for custom and combined BMPs in the Urban BMP Tool.

BMP Calculator

The BMP Calculator calculates the combined BMP efficiency of combinations of multiple BMPs that can then be applied in the model. The calculator can be used to represent BMPs both in series and parallel. For an explanation of BMPs in series and parallel, refer to Appendix A. To access the BMP calculator, either click on the *BMP Calculator* button, or from the BMP drop-down list, select Combined BMPs-Calculated.

Navigating the BMP Calculator

As shown in Figure 22, when the BMP Calculator is opened, the main screen is a gridded workspace. There are two modules in the BMP Calculator, which can be found along the top of the window: BMP Editor, where BMP configurations can be created and modified, and Configuration List, where the user can review previously created BMP configurations and view the BMPs and efficiency value in each configuration.

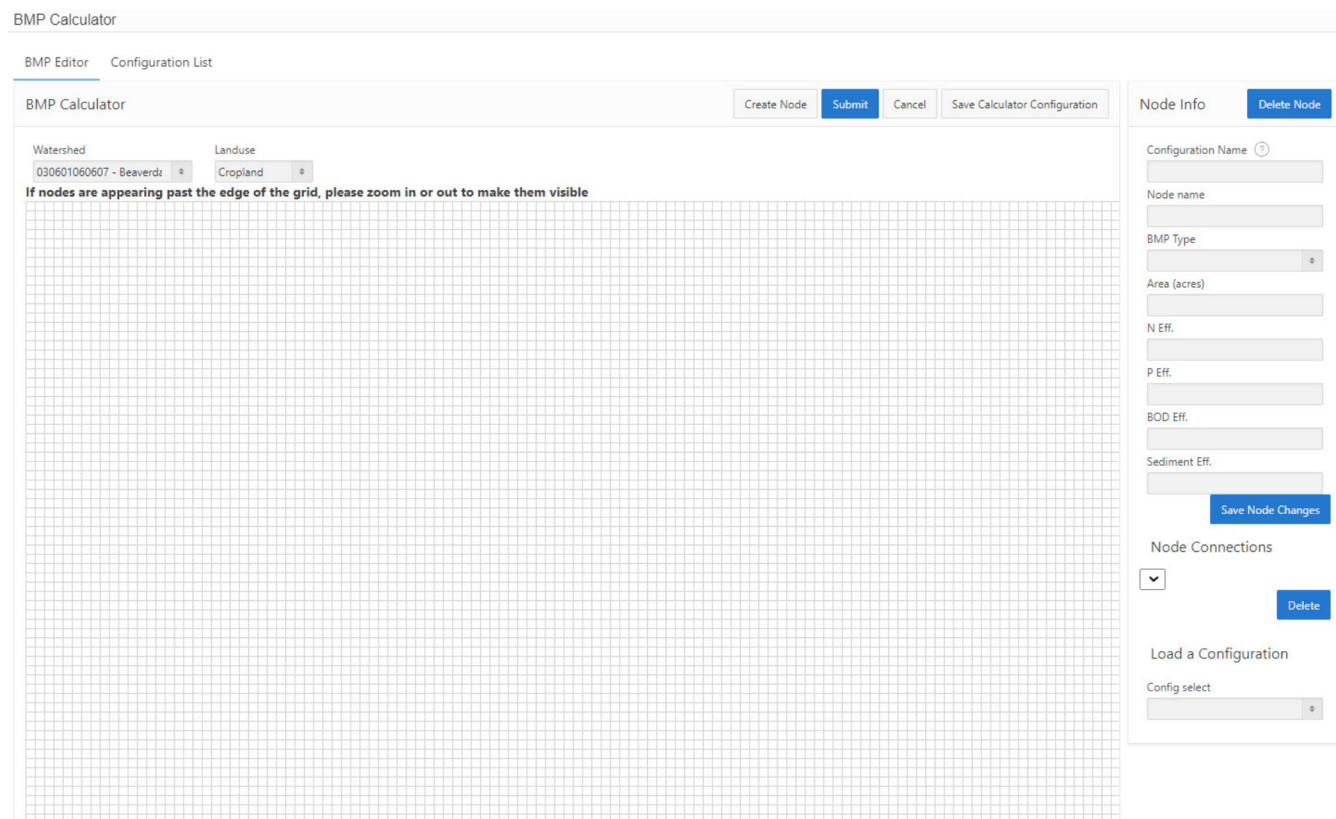


Figure 22. The BMP Calculator layout.

BMP Editor

When in the BMP Editor, the gridded workspace, each BMP is represented graphically by a node. Connecting a series of nodes creates a configuration, which represents multiple BMPs with a single set of combined BMP efficiency values. To build a BMP configuration, click on *Create Node*, and a New Node box will appear in the workspace. Click on the node box to activate data entry for the node. On the righthand side, there is a panel called Node Info, which provides input fields for the various required information for each BMP in the configuration. In the Node Info pane, the user enters the Configuration Name, the name of the node, the BMP in the node, the acres on which it will be applied, and then the efficiency values will automatically populate when a BMP is selected from the BMP Type drop-down list. Click on *Save Node Changes*, to save and move on to the next node. If *Save Node Changes* is not clicked, the data entered will be lost. Continue building the nodes by clicking on *Create Node* again and repeating the process as many times as is necessary to represent all the BMPs. To create the configuration of the BMPs to represent how they are organized on the ground, click on the black

half circle on the right side of a node and drag it to the white half circle on the left side of the node that it will drain to. A line will connect the two nodes. Multiple BMPs can connect to the same node, if needed. The final node in the configuration will provide the resulting total area and combined BMP efficiencies. A more detailed explanation of BMP configurations is provided in Appendix A. Once the configuration is complete, click *Save Calculator Configuration*. This configuration is now available to use in any scenario and will appear in the BMP drop-down list in the BMPs module. Figure 23 shows the finished product of a parallel BMP configuration with three BMPs and a blank final node that connects all three BMPs together and provides the combined efficiency values. The final node in this instance represents the receiving water.

NOTE: When creating a BMP configuration, if *Save Calculator Configuration* is selected, the BMP workspace will be cleared prior to Submitting the BMP to the selected land use. If this occurs reload the BMP from the Configuration List and click *Submit*. If *Save Calculator Configuration* is not clicked, the combined BMP efficiency will be entered into the scenario, but the configuration will not be saved or reviewable at a later time.

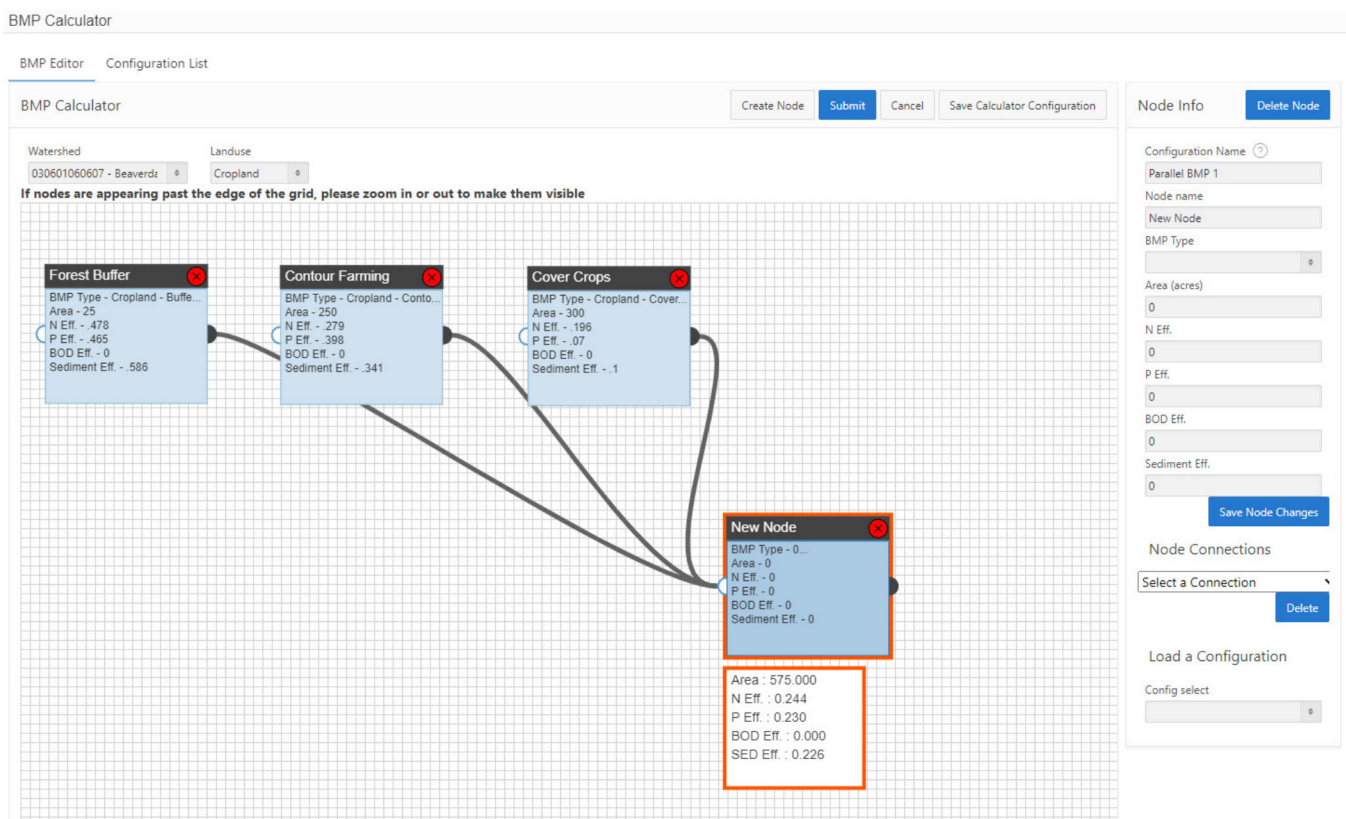


Figure 23. Example Combined BMP efficiency value configuration using the BMP Calculator BMP Editor.

Reviewing and Editing Previously Created Custom or Combined BMPs

To bring up a previously created configuration in the BMP Calculator, at the bottom of the Node Info is a “Load a Configuration” section with a drop-down list of all previously created BMP configurations. Select the BMP configuration of interest and it will load in the workspace.

To change elements of a previously created configuration, once it is loaded in the workspace, make the desired edits and then click *Save Calculator Configuration*. To create a new BMP configuration, based on a previous BMP configuration, load the initial configuration, and then edit the configuration name. Once the name is changed, changes to the configuration will be reflected in the new configuration, while still maintaining the original configuration of the initial BMP configuration.

Configuration List

The Configuration List Provides a summary of all the combined BMP configurations created by (or accessible to) the user. The list shows the combined efficiency value for each configuration. Click *View Configuration* to see an image of the BMP configuration below the list. This is intended as a reference for the user to assist in reviewing and selecting the appropriate BMP configuration from those previously created.

Total Loads Module

The Total Loads module shows the final results of the modeled calculations in terms of watershed pollutant loads and load reduction from BMPs, shown in Figure 24. There are several tables summarizing the results of the scenario:

- Table 1 – A summary of the total pollutant loads for each watershed in the scenario, both with and without pollutant reduction practices. Also provides the percent reduction in pollutants from load reduction practices.
- Table 2 – The total loads by land use for all watersheds cumulatively. Gullies, streambanks, septics and groundwater are each broken out separately from land uses.
- Table 3 – The pollutant loads by land use by watershed with pollutant reduction practices
- Table 4 – The loads from groundwater by land use with BMPs included
- Table 5 – The pollutant loads from just urban areas.

As shown in Figure 24, there is a *Download* button on the top right of the Total Loads module. This will generate an Excel file with the results from the 5 tables, each in its own tab. In addition to the results tables, there are two check boxes in the upper left of the Total Loads module: *Groundwater Load Calculation* and *Treat All Subwatersheds as Part of a Single Watershed*, also visible in Figure 24.

Groundwater loads are optional – check the box to include groundwater loads. These values are based on the infiltration volume using the selected HSG for each watershed in the scenario. Based on the infiltration rate, the annual infiltration volume is calculated for the different land uses. The annual infiltration volume is assumed to be equivalent to the annual groundwater output in the local hydrological cycle.

The groundwater load is not impacted by any of the BMPs entered into the scenario. Changes to groundwater loads can be manually adjusted by the user by editing the HSG applied and/or editing the nutrient concentrations in shallow groundwater to be reflective of the desired practices.

The *Treat All Subwatersheds as Part of a Single Watershed* check box changes the sediment delivery ratio. This box is only relevant if there is more than one watershed in the model. Checking the box allows the sediment delivery ratio to be calculated using the total watershed area of all watersheds included the model. **Important:** This feature does not represent routing through the watersheds in a particular order. Unchecking the box allows the sediment delivery ratio to be calculated independently for each watershed in the model.

Pollutant Load Estimation Tool

Title: Example Watershed State: Georgia Watershed: 030601060607 (Beaverdam Ditch) County: RICHMOND Weather Station: AUGUSTA BUSH FIELD AP

Lookup: 0.9163 Rainfall Correction Factor: 0.5051 Rainfall Initial Abstraction: 0

Share Model Copy Model Delete Model Download Input Data Server Data Exit

Add watershed Delete watersheds Gullies and Streambanks Urban BMP Tool Manure Application BMP Calculator

Inputs BMPs Total Loads Additional Reference Tables

Loads Calculated [Download](#)

Groundwater load calculation Treat all subwatersheds as part of a single watershed

1. Total load by subwatershed(s)

Watershed	N Load (No BMP) (lb/year)	P Load (No BMP) (lb/year)	BOD Load (No BMP) (lb/year)	Sediment Load (No BMP) (tons/year)	N Reduction (lb/year)	P Reduction (lb/year)	BOD Reduction (lb/year)	Sediment Reduction (tons/year)	N Load (With BMP) (lb/year)	P Load (With BMP) (lb/year)	BOD Load (With BMP) (lb/year)	Sediment Load (With BMP) (tons/year)	% N Reduction	% P Reduction	% BOD Reduction	% Sediment Reduction
030601060607 - Beaverdam Ditch-Savannah River	254388.32	44087.39	866672.62	6280.77	8297.19	1841.13	3632.48	551.95	246091.13	42246.27	863140.14	5728.82	3.26	4.18	0.41	8.79
TOTAL	254388.32	44087.39	866672.62	6280.77	8297.19	1841.13	3632.48	551.95	246091.13	42246.27	863140.14	5728.82	3.26	4.18	0.41	8.79

2. Total load by land uses (with BMP)

Source	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	172566.49	26642.99	670154.14	3962.42
Cropland	25057.08	5473.79	61574.17	1331.84
Pastureland	27359.86	2285.89	87976.39	235.79
Forest	11916.77	5886.23	29478.22	196.07
Feedlot	8569.01	1713.80	11425.35	0.00
User Defined	0.00	0.00	0.00	0.00
Septic	618.25	242.15	2524.53	0.00
Gully	3.67	1.41	7.34	2.70
Streambank	0.00	0.00	0.00	0.00
Groundwater	0.00	0.00	0.00	0.00
TOTAL	246091.13	42246.27	863140.14	6728.82

3. Nutrient and sediment load by land uses with BMP (lbs/year)

Watershed	Urban				Cropland				Pastureland				Forest				Feedlot			
	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
030601060607 - Beaverdam Ditch-Savannah River	172566.49	26642.99	670154.14	7924842.30	25057.08	5473.79	61574.17	2663877.92	27359.86	2285.89	87976.39	471571.62	11916.77	5886.23	29478.22	352143.21	8569.01	1713.80	11425.35	0.00

4. Load from groundwater by land uses with BMP (lbs/year)

Watershed	Urban				Cropland				Pastureland				Forest				Feedlot			
	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
030601060607 - Beaverdam Ditch-Savannah River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

5. Pollutant loads from urban (lbs/year)

Watershed	Pre-BMP Load				Load Reduction				After BMP Load			
	N	P	BOD	TSS	N	P	BOD	TSS	N	P	BOD	TSS
030601060607 - Beaverdam Ditch-Savannah River	172566.49	26642.99	670154.14	7924842.30	0.00	0.00	0.00	0.00	172566.49	26642.99	670154.14	7924842.30

Figure 24. Total Loads Module. Note that full visibility of tables 3 and 4 requires scrolling to see all columns.

Additional Reference Tables Module

The Additional Reference Tables module provides default values for animal weights used to calculate animal equivalent units, soil infiltration rates, feedlot nutrient ratios, septic overcharge pollutant concentrations reaching streams, and wastewater nutrients and volume (Figure 25). These values are used in conjunction with the data entered on the Inputs module to generate the loading rates for the land uses and activities. The default values can be adjusted by the user if more accurate local data are available.

Pollutant Load Estimation Tool

Title: Example Watershed State: Georgia Watershed: 030601060607 (Beaverdam Ditch) County: RICHMOND Weather Station: AUGUSTA BUSH FIELD AP

Buttons: Share Model, Copy Model, Delete Model, Download Input Data Server Data, Exit

Correction Factors: Rainfall: 0.9163, Rainsdays: 0.5051, Rainfall Initial Abstraction: 0

Navigation: Add watershed, Delete watersheds, **Gullies and Streambanks**, Urban BMP Tool, Manure Application, BMP Calculator

Inputs | **BMPs** | Total Loads | Additional Reference Tables

Additional Reference Tables

Animal Weight

Beef Cattle	Dairy Cattle	Hog	Sheep	Horse	Chicken	Turkey	Duck	Goose	Deer	Beaver	Raccoon	Other
1000	1400	200	100	1000	4	10	4	6	40	15	7	0

Soil Infiltration

A	B	C	D	SHG	
0.450	0.300	0.150	0.075		Cropland
0.450	0.300	0.150	0.075		Pastureland
0.450	0.300	0.150	0.075		Forest
0.450	0.300	0.150	0.075		User Defined
0.360	0.240	0.120	0.060		Urban

Feedlots Reference

Ratio of nutrients produced by animals relative to 1000 lb of slaughter steer

Animal	N	P	BOD
1. Slaughter Steer	1	1	1
2. Young Beef	0.5	0.51	0.5
3. Dairy Cow	1.853	0.92	1.4
4. Young Dairy Stock	0.662	0.33	0.5
5. Swine	0.306	0.27	0.388
6. Feeder Pig	0.076	0.07	0.097
7. Sheep	0.124	0.06	0.075
8. Horse	0.882	0.42	1.063
9. Chicken	0.01	0.01	0.008
01. Turkey	0.018	0.03	0.013
02. Duck	0.018	0.01	0.011

Assume the average concentrations reaching the stream (from septic overcharge) are:

Parameter	Avg Conc	Remarks
Total Nitrogen	60	mg/L (range of 20 to 100)
Total Phosphorus	23.5	mg/L (range of 18 to 29)
Organics (BOD)	245	mg/L (range of 200 to 290)
Typical septic overcharge flow rate	70	gal/day/person (range of 45 to 100)

Wastewater per capita:

Parameter	Wastewater	Remarks
Total Nitrogen	40	mg/L (range of 20 to 85)
Total Phosphorus	8	mg/L (range of 4 to 15)
Organics (BOD)	220	mg/L (range of 110 to 400)
Typical septic overcharge flow rate	75	gal/day/person (range of 75 to 125)

Figure 25. View of the Additional Reference Tables module.

APPENDIX A – BMPs in Series and Parallel

Series and parallel describe different configurations of BMP placement on the landscape. As shown in Figure 26, parallel BMPs are BMPs that treat areas separately and individual loads are drained to the same waterbody. In a series BMP configuration, more than one BMP treats the same area of the watershed. In other words, the same runoff flows through two or more different BMPs before reaching the waterbody. BMPs in series can also be thought of as a treatment train. Using the BMP calculator tool modelers can develop a singular BMP for common treatment trains applied in their watershed.

There can also be combinations of parallel and series BMPs where one portion of the watershed is treated by multiple BMPs and another portion is treated by one or more other different BMPs.

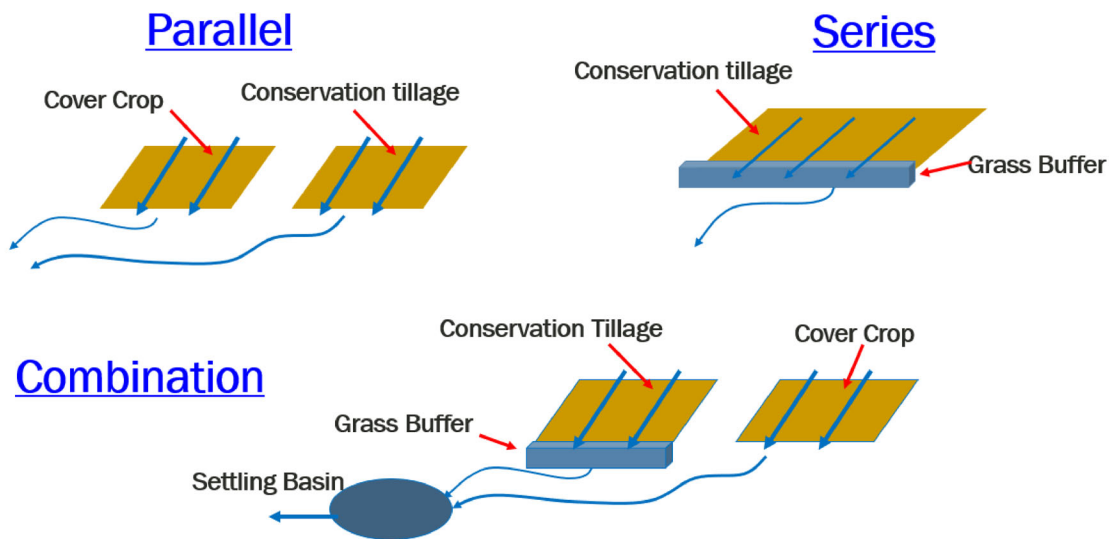


Figure 26. Illustration of BMPs in parallel and series configurations, and a combination of both.

Parallel BMPs Example

The first example is a watershed with parallel BMPs only (Figure 27). In this example, there are 2,000 acres of cropland in the watershed. It has 3 BMPs: forest riparian buffer (25 acres), contour farming (250 acres) and cover crops (300 acres), leaving 1,425 acres of cropland untreated by BMPs. Each of these BMPs treats a separate area of the watershed. To build this configuration in the BMP calculator, create separate nodes for each of the BMPs and connect them to a node representing the remaining acres in the watershed, as shown in Figure 28. The results box below the final node in the configuration shows that there are 2,000 acres. In this configuration 100 percent of the cropland is represented. The resulting efficiency values can be applied to cropland and denote that the Percent Applied in the BMP module row for crop land is 100%. Alternatively, a scenario can be built that only represents the areas of the watershed treated by BMPs, as shown in Figure 29. In this case, the node at the end of the configuration is left blank and the area reflected is only 575 acres, the sum of the BMP acreages. Notice that since all acreage in the calculator is treated by a BMP, the efficiencies are higher. However, if this configuration is to be added to the same scenario, the Percent Area Applied would be 28.75% (575/2000 acres). Both of these configurations will result in identical load reductions in this scenario. However, the first configuration representing all cropland may be most useful when building a single watershed scenario, where the second option could be used to build a BMP combination that is saved and frequently applied across many watersheds and different scenarios.

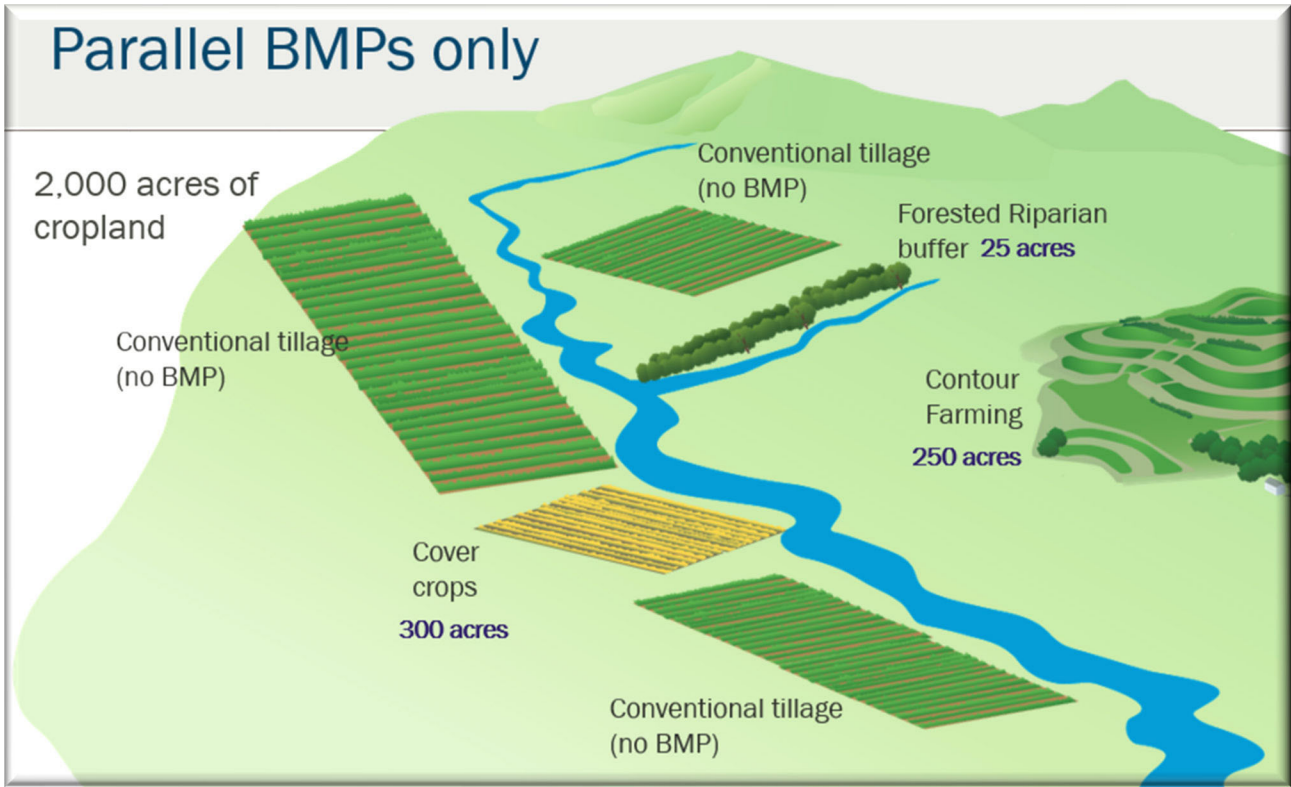


Figure 27. Example of parallel BMPs on the landscape.

BMP Calculator

BMP Editor Configuration List

BMP Calculator

Watershed: 030601060607 - Beaverdam Ditch-Sa
Landuse: Cropland

If nodes are appearing past the edge of the grid, please zoom in or out to make them visible

Node Info

Configuration Name: Parallel BMPs
Node name: Entire Watershed
BMP Type: [dropdown]
Area (acres): 1425
N Eff: 0
P Eff: 0
BOD Eff: 0
Sediment Eff: 0

Node Connections
Select a Connection: [dropdown]
Delete

Load a Configuration
Config select: Parallel BMPs

Grid nodes:

- Cover Crops**
BMP Type: Cropland - Cover...
Area: 300
N Eff: .204
P Eff: .15
BOD Eff: 0
Sediment Eff: .2
- Buffer**
BMP Type: Cropland - Buffer
Area: 25
N Eff: .478
P Eff: .465
BOD Eff: 0
Sediment Eff: .586
- Contour Farming**
BMP Type: Cropland - Conto...
Area: 250
N Eff: .279
P Eff: .395
BOD Eff: 0
Sediment Eff: .341
- Entire Watershed**
BMP Type: --
Area: 1425
N Eff: 0
P Eff: 0
BOD Eff: 0
Sediment Eff: 0

Summary for Entire Watershed:

- Area: 2000.000
- N Eff: 0.071
- P Eff: 0.078
- BOD Eff: 0.000
- SED Eff: 0.080

Figure 28. Example configuration of parallel BMPs in the BMP Calculator representing all cropland.

BMP Editor Configuration List

BMP Calculator

Watershed: 030601060607 - Beaverdam Ditch-Sa Landuse: Cropland

If nodes are appearing past the edge of the grid, please zoom in or out to make them visible

Node Info

Configuration Name: Parallel BMPs

Node name: New Node

BMP Type: [Dropdown]

Area (acres): 0

N Eff.: 0

P Eff.: 0

BOD Eff.: 0

Sediment Eff.: 0

Save Node Changes

Node Connections

Select a Connection: [Dropdown]

Delete

Load a Configuration

Config select: Parallel BMPs

Node Data (highlighted):

BMP Type	- 0...
Area	- 0
N Eff.	- 0
P Eff.	- 0
BOD Eff.	- 0
Sediment Eff.	- 0
Area	: 575.000
N Eff.	: 0.249
P Eff.	: 0.272
BOD Eff.	: 0.000
SED Eff.	: 0.278

Figure 29. Example configuration of parallel BMPs in the BMP Calculator representing only cropland with BMPs.

Series BMPs Example

This example demonstrates a watershed with series BMPs (Figure 30). There are 625 acres of pasture in this watershed. All of the pasture flows through a forested riparian buffer, but 525 acres also have livestock exclusion fencing. The practices are arranged in such a way that runoff from the fenced pasture will also travel through the buffer – two practices in series. For this configuration, it is necessary to ensure the proper number of acres are represented in the BMP Calculator. The acres treated by fencing are routed to the riparian buffer, which treats an additional 100 acres of pasture. The configuration is shown in Figure 31. The 525 fenced acres are routed to the riparian buffer, where those 525 acres plus an additional 100 acres only treated by the buffer are represented. The results box below the buffer node confirms that the total acreage in the scenario is 625 acres. A common mistake in this type of configuration would be to enter 525 acres treated by the fencing and then 625 acres treated by buffer. However, the results box provides an indication that this is incorrect because the total acreage would be shown as 1,150 acres rather than 625 acres.

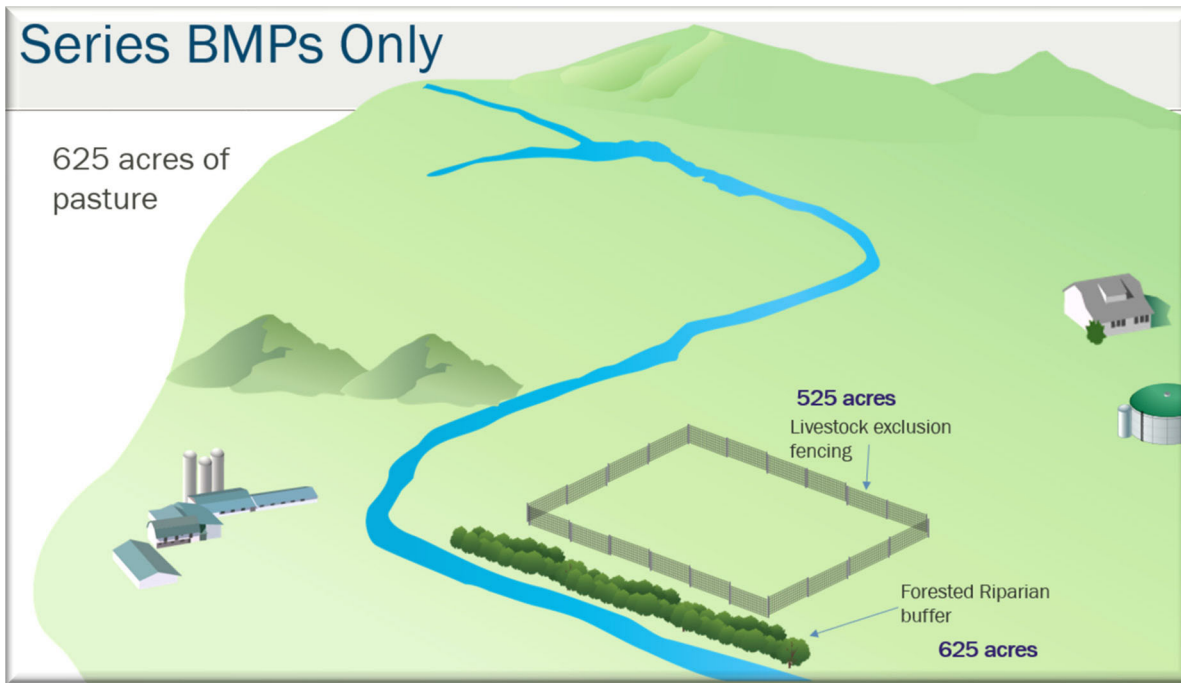


Figure 30. Example of series BMPs on the landscape.

BMP Calculator

BMP Editor Configuration List

BMP Calculator

Watershed: 030601060607 - Beaverdam Ditch-Sa Landuse: Pastureland

If nodes are appearing past the edge of the grid, please zoom in or out to make them visible

Fencing

BMP Type - Pastureland - Li.

Area - 525

N Eff. - .203

P Eff. - .304

BOD Eff. - 0

Sediment Eff. - .62

Buffer

BMP Type - Pastureland - Fo.

Area - 100

N Eff. - .452

P Eff. - .4

BOD Eff. - 0

Sediment Eff. - .533

Area - 625.000

N Eff. : 0.545

P Eff. : 0.553

BOD Eff. : 0.000

SED Eff. : 0.776

Node Info

Configuration Name: Series BMPs

Node name: Fencing

BMP Type: Pastureland - Livestock Exclusion Fencing

Area (acres): 525

N Eff.: .203

P Eff.: .304

BOD Eff.: 0

Sediment Eff.: .62

Save Node Changes

Node Connections

Select a Connection

Delete

Load a Configuration

Config select

Figure 31. Example of series BMP configuration in the BMP Calculator.

Parallel and Series BMPs Combined

Next is an example of parallel and series BMPs in the same configuration. In this scenario there are 975 acres of pasture in the watershed. There are several BMPs across the pastureland: 100 acres of forage planting high in the watershed, 25 acres draining to forested riparian buffer on one side of the stream, and 750 acres of livestock exclusion fenced pasture draining through a forest buffer before reaching the stream. This leaves 100 acres of pasture untreated by BMPs (Figure 32).

In the BMP Calculator, the forage planting and 25 acres of forested riparian buffer are two parallel BMPs, so they can be linked directly to a downstream node representing the entire watershed. The livestock exclusion fencing and riparian buffer represent a BMP series, so these should be linked together, with 0 acres in the buffer node to denote that the buffer is treating the same pasture acres as the fencing. This series BMP can also be connected to the node representing the entire watershed. This final downstream node represents all of the upstream acreages and BMPs plus the 100 untreated acres, so the 100 untreated acres are entered but the BMP type is left blank. The results box shows the combined efficiencies for this configuration on 975 acres. Figure 33 illustrates the completed configuration for this scenario.

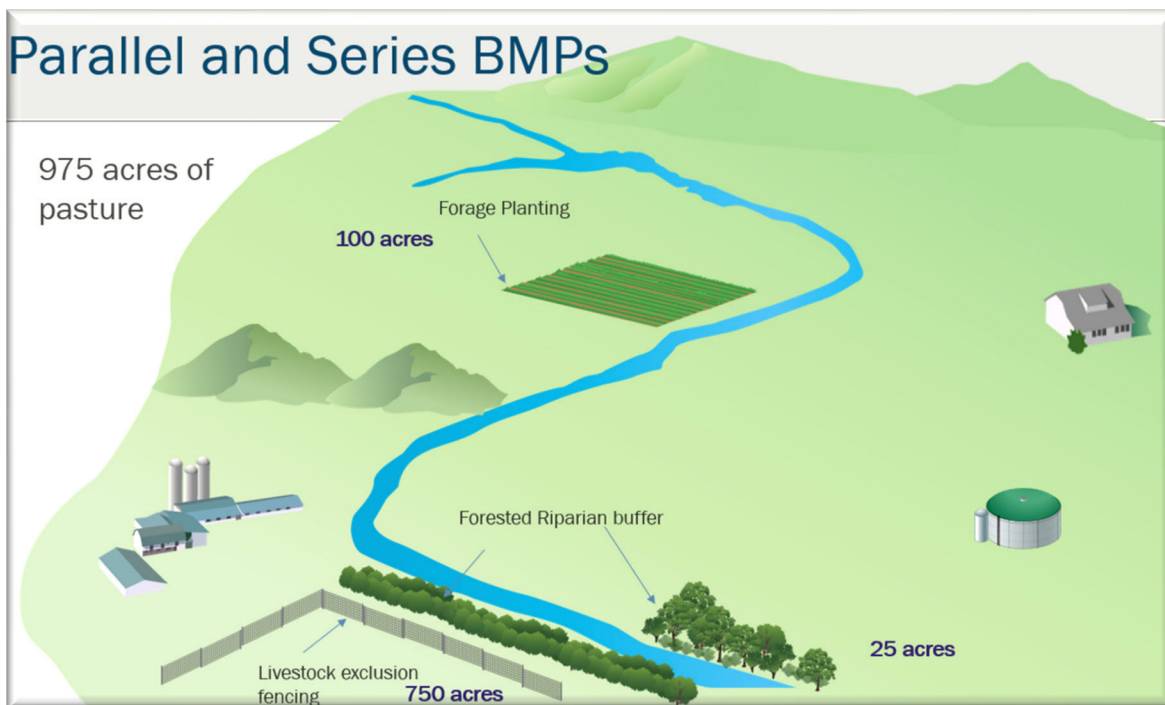
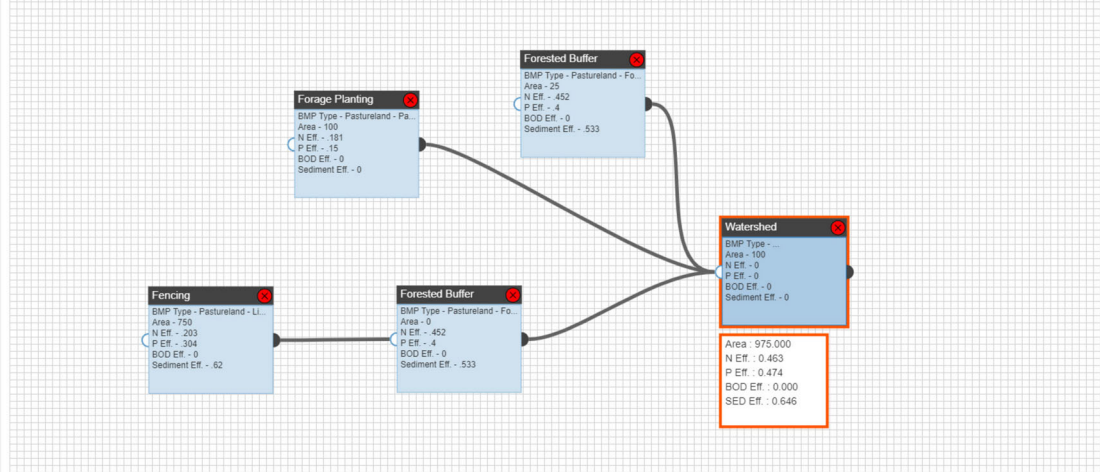


Figure 32. Example of combined series and parallel BMPs.

If nodes are appearing past the edge of the grid, please zoom in or out to make them visible



Configuration Name [?]
Series and Parallel BMPs
Node name
Watershed
BMP Type [?]
Area (acres)
100
N Eff.
0
P Eff.
0
BOD Eff.
0
Sediment Eff.
0
Save Node Changes
Node Connections
Select a Connection [?]
Delete
Load a Configuration
Config select [?]

Figure 33. BMP Calculator configuration for series and parallel BMPs on the same watershed.

APPENDIX B – References Used in PLET

The following references describe where the default values and data assumptions are derived.

<i>Data Type</i>	<i>Source</i>	<i>Note</i>
HUC12	USEPA/OW/WBD_WMERC (Map Server)	EPA ArcGIS Server https://watersgeo.epa.gov/ArcGIS/rest/services/OW/WBD_WMERC/MapServer
Weather Data	USEPA, 2019 Calculated based on daily and hourly timeseries from WDM files provided within BASINS.	Based on long-term (30 years) quality controlled precipitation data from USEPA's BASINS system
Land Use	Multi-Resolution Land Characteristics Consortium. NLCD and USDA Cropland Data Layer (CDL) 2011, HICCAP_land_cover_2005_2011_Enviroatlasversion AK_NLCD_2011 landcover	2011 landcover
Agricultural Animal Counts	USDA, National Agricultural Statistics Service. 2014 & USDA 2012.	2014 animal count data The agricultural animal data source is at the County level and is summarized at the HUC12 level based on the pastureland area weighted ratio
Animal weights	ASAE 1998	Standard animal weights
Feedlot Nutrient Concentrations associated with animal weights	DEQ 1999	Nutrient Ratios
Nutrient Adjustment Factor by Animal Density	Evans et al. 2001	Based on the density of agricultural animals in the study area (PLET calculates animal density automatically)
Number of septic systems	1992 and 1998 National Small Flows Clearinghouse (Defunct, now part of the National Environmental Services Center) (https://www.nesc.wvu.edu/)	The septic system data source is at the County level and is summarized at the HUC12 level based on the low-density residential area weighted ratio.
Population per septic system	1992 and 1998 National Small Flows Clearinghouse (Defunct, now part of the National Environmental Services Center) (https://www.nesc.wvu.edu/)	The septic system data source is at the County level and is summarized at the HUC12 level based on the low-density residential area weighted ratio

<i>Data Type</i>	<i>Source</i>	<i>Note</i>
Septic failure rate	1992 and 1998 National Small Flows Clearinghouse (Defunct, now part of the National Environmental Services Center) (https://www.nesc.wvu.edu/)	The septic system data source is at the County level and is summarized at the HUC12 level based on the low-density residential area weighted ratio.
Septic overcharge concentrations reaching stream	Horsley & Whitten, 1996, USEPA, 1980	
Wastewater per capita concentrations	Metcalf & Eddy, 2003	2 nd Edition. Table - Typical composition of untreated domestic wastewater
USLE parameters: USDA-NRCS, National Resources Inventory (no date)	NRI, 1992	National Resource Inventory study 1992 by county
Hydrologic soil group (HSG)	USDA NRCS 2002 SSURGO database	Area-weighted within each HUC12
Soil N, P, BOD concentrations	Haith et al. 1992	National average from GWLF manual.
Runoff Curve Numbers	USDA NRCS, 1986	TR55 manual Table 2-2b Cropland - Row Crops – Good condition Table 2-2b Pasture - Pasture – Fair condition Forest – Woods – Fair condition
Soil cover Curve Number for feedlot based on percent paved	DEQ, 1999	Page 39, Figure 8 in DEQ, 1999
Infiltration Fraction by Hydrologic Soil Group for groundwater infiltration volume calculation	Caraco, 2001.	Taken from Page 7-16, Table 7.7 of Caraco, 2021 (by HSG; same for all land use types). Urban land use infiltration fraction value was assumed to be 20 percent less for each HSG.
Sediment delivery ratio	USDA-NRCS 1983, Vanoni, 1975	Drainage area power function relationships
Urban Runoff Curve Numbers	USDA NRCS, 1986	TR55 manual Table 2-2a
Urban Land pollutant concentrations in runoff	Caraco, 2001.	Default suggested TN, TP, and TSS concentrations taken from Tables 6.2, 6.3, and 6.4 for Commercial, Industrial, Transportation, and Residential.

<i>Data Type</i>	<i>Source</i>	<i>Note</i>
Nutrient Concentration in Runoff	Haith et al. 1992, Haith & Shoemaker. 1987	<p>Dissolved Nutrients in Agricultural Runoff (Table 2 in Haith & Shoemaker, 1987)</p> <p>Cropland-Low</p> <ul style="list-style-type: none"> ○ N & P taken from <i>Small Grains</i> ○ N with manure estimated from ratios estimated from reported values of Cropland-Medium with and without manure (see Cropland-Medium) <p>Cropland-Medium</p> <ul style="list-style-type: none"> ○ N with and without manure taken from <i>Corn</i>, ○ P scaled based on ratio of Cropland Lo and High since reported <i>Corn</i> P was less than small grain P, ratio of ~1.5 was used to scale Cropland L to Cropland M for P) <p>Cropland-High</p> <ul style="list-style-type: none"> ○ N and P estimated based on ratio of 1.5 from Cropland- Medium ○ Cropland-High N estimated based ratio of N with and without manure for Medium condition <ul style="list-style-type: none"> • Manured P concentrations taken based on best professional judgment using the range provided for Corn, Small Grains, and Hay from manured lands (reported range was 1.9 to 8.7 mg/L). P concentration of 2, 3, and 4 mg/L were assigned for low, medium and High with manure condition. • BOD was taken as ~2 times N for without manure and ~1.5 times N for with manure applied. • Pasture values are currently same for all low, medium and high with and without manure. These should be updated is literature is available. Haith & Shoemaker 1987 report N and P as 3 mg/L and 0.25 mg/L which is slightly lower than that in PLET which has 4 mg/L and 0.3 mg/L. BOD was taken as 13 mg/L for which we do not have reference. Most likely based on best professional judgement.
Nutrient Concentration in Shallow Groundwater	Haith et al. 1992, Haith & Shoemaker. 1987	<p>Taken as mean value of reported (inorganic forms of N and P) Central, Eastern, and Western US in Table 3 for mean dissolved concentration in streamflow</p> <p>Forested~ 90% forested; Agriculture~ >=75%; Pasture taken same as that of Agriculture; Urban N from Caraco, 2001, P taken same as Pasture.</p>
Urban Land Use Distribution		Percent Urban land use distribution. These area Placeholder values provided that should be adjusted by the user based on the distribution found in their watershed
Gully and Streambank Soil dry density and correction factor	DEQ, 1999	Figure 1. Lateral Recession Rate Exhibit 1 Dry Density Soil Weights & Exhibit 2. Soil Textural Class

References:

HUC12 Watershed Boundary

USEPA/OW/WBD_WMERC (Map Server)

https://watersgeo.epa.gov/ArcGIS/rest/services/OW/WBD_WMERC/MapServer

Weather Data:

US EPA (2019). BASINS 4.5 (Better Assessment Science Integrating point & Non-point Sources) Modeling Framework. National Exposure Research Laboratory, RTP, North Carolina.

<https://www.epa.gov/sites/production/files/2019-03/documents/basins4.5scoremanual.2019.03.pdf>

Land Use:

Multi-Resolution Land Characteristics Consortium (MRLC) and Crop Data Layer (CDL), 2011 CONUS Land Cover.

MRLC. 2011 AK Land Cover

National Oceanic and Atmospheric Administration, Office for Coastal Management. "Name of Data Set." Coastal Change Analysis Program (C-CAP) High-Resolution Land Cover. Charleston, SC: NOAA Office for Coastal Management.

Agricultural Animal Counts

USDA National Agricultural Statistics Service, 2012 Census of Agriculture. Complete data available at https://agcensus.library.cornell.edu/census_year/2012-census/.

USDA, National Agricultural Statistics Service. 2014. 2012 Agricultural Census Data by County

AEU equivalents (animal weights):

ASAE (American Society of Agricultural Engineers). 1998. ASAE standards: Standards, engineering practice, and data. 45th ed. American Society of Agricultural Engineers. St. Joseph, Michigan.

Animal nutrient concentrations by AEU:

Evans, B.M., S. A. Sheeder, K. J. Corradini, and W. S. Brown. 2001. AVGWLF version 3.2, users guide. Software. Environmental Resources Research Institute, Pennsylvania State University, University Park, Pennsylvania.

DEQ, 1999. Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual, June 1999 Revision; Michigan Department of Environmental Quality - Surface Water Quality Division - Nonpoint Source Unit. EQP 5841.

Number of septic systems:

1992 and 1998 National Small Flows Clearinghouse (Defunct, now part of the National Environmental Services Center) (<https://www.nesc.wvu.edu/>)

Population per septic system:

1992 and 1998 National Small Flows Clearinghouse (Defunct, now part of the National Environmental Services Center) (<https://www.nesc.wvu.edu/>)

Septic failure rate:

1992 and 1998 National Small Flows Clearinghouse (Defunct, now part of the National Environmental Services Center) (<https://www.nesc.wvu.edu/>)

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APPENDIX C – PLET Underlying Formulas Documentation

1. Introduction

The purpose of this document is to provide all relevant equations and methods used in the PLET model. PLET employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs), including Low Impact Development practices (LIDs) for urban areas. It computes surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD); and sediment delivery based on various land uses and management practices. The land uses considered are urban land, cropland, pastureland, feedlot, forest, and a user-defined type. The pollutant sources include major nonpoint sources such as cropland, pastureland, farm animals, feedlots, urban runoff, and failing septic systems. The types of animals considered in the calculation are beef cattle, dairy cattle, swine, horses, sheep, chickens, turkeys, and ducks. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (from sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

Total Load from various Sources

$$\begin{aligned} &= \text{Urban} + \text{Cropland} + \text{Pastureland} + \text{Forest} + \text{Feedlots} \\ &+ \text{User - Defined} + \text{Septic} + \text{Gully} + \text{Streambank} \\ &+ \text{Groundwater} \end{aligned}$$

Equation 1

2. Surface Runoff

The Runoff Curve Number (CN) method is used to estimate runoff from urban land, cropland, pastureland, forest and a user-defined land use. The runoff equation used is:

$$Q = \frac{(P - Ia)^2}{(P - Ia) + S} \text{ or } Q = \frac{(P - \alpha \cdot S)^2}{P - \alpha \cdot S + S} \quad \text{Equation 2}$$

Where:

Q = Surface Runoff (in/day)

P = Rainfall (in) per event.

PLET calculates the average rainfall per even as follows:

P = (Annual Rainfall x Rainfall correction factor) ÷ (Rain days x Rain day correction factor)

$$P = (AR \cdot R_{cor}) / (Rdays \cdot RD_{cor}) \quad \text{Equation 3}$$

Where:

AR = Average Annual rainfall

Rdays = Average rain days in a year

R_{cor} = Rainfall correction factor refers to the percentage of rainfall events that exceed 5 mm/event

RD_{cor} = Rain day correction factor refers to the percentage of rain day events that generate runoff

Ia = Initial abstraction which determines the initial rainfall retention on the land surface. Ia is given by αS (where α ranges from 0 to 0.2). Note that PLET uses zero initial abstraction factor as a default value. This is because rainfall and rainy days correction factors are already considering that runoff occurs when it rains more than 5mm in a day, a criterion used to calculate the correction factors. For example, for a value of $\alpha = 0$ Equation 2 reduces to $P^2/(P+S)$

S = Potential maximum retention after runoff begins (in). S is related to the soil and cover conditions of the drainage area through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \left(\frac{1000}{CN} \right) - 10 \quad \text{Equation 4}$$

The estimated average daily runoff volume is multiplied by the corrected number of average rain days in a year to calculate the annual runoff volume.

$$\text{Annual Runoff Volume (ac - ft)} = \frac{Q}{12} \times A \times (Rdays \cdot RD_{cor}) \quad \text{Equation 5}$$

Where:

Q = surface runoff (in)

A = area of land use (acres)

Rdays = Average rain days in a year

RD_{cor} = Rain day correction factor refers to the percentage of rain day events that generate runoff

PLET also includes the Irrigation runoff contribution to Croplands when irrigation is applied. The irrigation runoff depth (Q_{irr}) is calculated using Equation 1. The water depth per irrigation (inches) is used instead of the rainfall (P). The annual runoff volume for cropland is calculated as the sum of the surface runoff volume and irrigation volume.

$$\begin{aligned} \text{Annual Runoff Volume Cropland (ac - ft)} &= \text{Runoff Volume of Cropland} + \text{Irrigated Runoff volume} \\ &= \frac{Q}{12} \times A \times (Rdays \cdot RD_{cor}) + \frac{Q_{irr}}{12} \times A_{irr} \times IF \end{aligned} \quad \text{Equation 6}$$

Where:

Q_{irr} = Irrigation runoff (in)

A_{irr} = Cropland acres irrigated

IF = Irrigation frequency (#/year)

Urban load is calculated based on the loading from nine separate land use categories – Commercial, Industrial, Institutional, Transportation, Multi-Family, Single-Family, Urban-Cultivated, Vacant (developed), and Open Space. The surface runoff depth for each Urban category is calculated using Equation 5.

3. Nutrient Load from Runoff

Urban

The following equations refers to the total load calculation for Urban land. The loading is calculated using the calculated annual runoff volume and assumed nutrient EMC concentration in runoff, for each of the nine urban land use categories:

$$W_N = [V \cdot C_N] \times 4047 \cdot 0.3048/1000 \quad \text{Equation 7}$$

$$W_P = [V \cdot C_P] \times 4047 \cdot 0.3048/1000 \quad \text{Equation 8}$$

$$W_{BOD} = [V \cdot C_{BOD}] \times 4047 \cdot 0.3048/1000 \quad \text{Equation 9}$$

$$W_{TSS} = [V \cdot C_{TSS}] \times 4047 \cdot 0.3048/1000 \quad \text{Equation 10}$$

Where:

$W_N, W_P, W_{BOD}, W_{TSS}$ = annual N, P, BOD, and TSS (sediment) loads from Urban land (Kg)

V = the total calculated annual runoff volume from the various urban land use categories (ac-ft)

$C_N, C_P, C_{BOD}, C_{TSS}$ = urban pollutant (N, P, BOD, and TSS) concentration in runoff in mg/L

Cropland and Pasture

The following equations refer to the total load calculation for Cropland and Pastureland. The loading is calculated using the calculated annual runoff and assumed nutrient concentration in runoff.

$$W_N = V \times \left[\left(1 - \frac{N_m}{12}\right) \cdot C_N + \left(\frac{N_m}{12}\right) \cdot C_{N_{mn}} \right] \times 4047 \cdot \frac{0.3048}{454} \quad \text{Equation 11}$$

$$W_P = V \times \left[\left(1 - \frac{N_m}{12}\right) \cdot C_P + \left(\frac{N_m}{12}\right) \cdot C_{P_{mn}} \right] \times 4047 \cdot \frac{0.3048}{454} \quad \text{Equation 12}$$

$$W_{BOD} = V \times \left[\left(1 - \frac{N_m}{12}\right) \cdot C_{BOD} + \left(\frac{N_m}{12}\right) \cdot C_{BOD_{mn}} \right] \times 4047 \cdot \frac{0.3048}{454} \quad \text{Equation 13}$$

Where:

W_N, W_P, W_{BOD} = annual N, P, and BOD loads from Cropland and Pastureland (lbs)

V = the calculated annual runoff volume (ac-ft)

N_m = number of months manure is applied

C_N, C_P, C_{BOD} = N, P, or BOD nutrient concentration in agricultural area or pasture area in mg/L

$C_{N_{mn}}, C_{P_{mn}}, C_{BOD_{mn}}$ = N, P, or BOD nutrient concentration in manured agricultural area or manured pasture area in mg/L

Note that nutrient concentrations are calculated based on input of number of agricultural animals in the watershed. Animal Equivalent Counts (AEU; 1 AEU = 1000 lb/ac) are first calculated based on typical animal mass (lb) and counts of animals. The calculated AEU for each watershed is then used to estimate the nutrients in cropland and pasture runoff, based on literature values (for manured and non-manured areas).

Forested and User Defined

The Forested and User-Defined land use annual runoff loading is calculated using the calculated annual runoff and assumed nutrient concentration in runoff for forested land use.

$$W_N = [V \cdot C_N] \times 4047 \cdot 0.3048/454 \quad \text{Equation 14}$$

$$W_P = [V \cdot C_P] \times 4047 \cdot 0.3048/454 \quad \text{Equation 15}$$

$$W_{BOD} = [V \cdot C_{BOD}] \times 4047 \cdot 0.3048/454 \quad \text{Equation 16}$$

Where:

W_N, W_P, W_{BOD} = annual N, P, and BOD loads from Forested or User-Defined land use (lbs)

V = the calculated annual runoff volume (ac-ft)

C_N, C_P, C_{BOD} = N, P, or BOD nutrient concentration in Forested or User-Defined land use area

4. Sediment Loading Calculations

Sediment loads (from Cropland, Pastureland, Forest, and User-defined land uses) are calculated based on the Universal Soil Loss Equation (USLE) equation and sediment delivery ratio (DR). The USLE equation to calculate the mean annual soil loss (E) is calculated as follows:

$$E = R \cdot K \cdot LS \cdot C \cdot P \cdot DA \quad \text{Equation 17}$$

Where:

E = the computed annual soil loss (sheet and rill erosion) in tons/year

R = the rainfall factor

K = the soil erodibility factor

LS = the topographic factor which combines the slope length and gradient

C = the cropping management factor

P = the erosion control practice factor

$$W_{sed} = E \cdot DR \quad \text{Equation 18}$$

Where:

DR = sediment delivery ratio,

Wsed = Sediment Load in tons/year

Sediment delivery ratio is calculated using:

$$DR = 0.42 \cdot A^{-0.125} \quad \text{if } A < 200 \text{ acres} \quad \text{Equation 19}$$

$$DR = 0.417662 \cdot A^{-0.134958} - 0.127097 \quad \text{if } A > 200 \text{ acres} \quad \text{Equation 20}$$

Where:

A = watershed area (mi²).

PLET calculates only sheet and rill erosion using USLE. Gully erosion and stream bank erosion are calculated separately.

5. Nutrient and Sediment Runoff Loads with BMP application

Pasture, Forested, and User-Defined

The nutrient, BOD, and sediment load calculations after BMP application for Pasture, Forested and User-Defined land use are given below:

$$W_{N1} = W_N - W_N \cdot e + SED_N \times 2000 \quad \text{Equation 21}$$

$$W_{P1} = W_P - W_P \cdot e + SED_P \times 2000 \quad \text{Equation 22}$$

$$W_{BOD1} = W_{BOD} - W_{BOD} \cdot e + SED_{BOD} \times 2000 \quad \text{Equation 23}$$

$$SED = E \cdot DR (1 - e) \cdot 2000 \quad \text{Equation 24}$$

Where:

W_N, W_P, W_{BOD} = annual N, P, or BOD loads (lbs)

SED = sediment load (lbs/year)

SED_N, SED_P, SED_{BOD} , are the nutrient loading (tons/year) from the sediment

SED_N, SED_P , and SED_{BOD} are calculated as follows:

$$SED_N = E \cdot DR (1 - e) \cdot \%soil\ N\ conc \cdot 2/100 \quad \text{Equation 25}$$

$$SED_P = E \cdot DR (1 - e) \cdot \%soil\ P\ conc \cdot 2/100 \quad \text{Equation 26}$$

$$SED_{BOD} = E \cdot DR (1 - e) \cdot \%soil\ BOD\ conc \cdot 2/100 \quad \text{Equation 27}$$

Where:

e = BMP efficiency

Cropland

The nutrient, BOD, and sediment load calculations after BMP application for Cropland are as follows:

$$W_{N1} = (W_N - (V_{irr} \cdot C_N) \times 4047 \cdot 0.3048/454) \cdot e + (V_{irr} \cdot C_N) \times 4047 \cdot 0.3048/454 + SED_N \times 2000 \quad \text{Equation 28}$$

$$W_{P1} = (W_P - (V_{irr} \cdot C_P) \times 4047 \cdot 0.3048/454) \cdot e + (V_{irr} \cdot C_P) \times 4047 \cdot 0.3048/454 + SED_P \times 2000 \quad \text{Equation 29}$$

$$W_{BOD1} = (W_{BOD} - (V_{irr} \cdot C_{BOD}) \times 4047 \cdot 0.3048/454) \cdot e + (V_{irr} \cdot C_{BOD}) \times 4047 \cdot 0.3048/454 + SED_{BOD} \times 2000 \quad \text{Equation 30}$$

Where:

C_N, C_P, C_{BOD} = N, P, or BOD nutrient concentration in agricultural area

Urban

The nutrient, BOD, and sediment load calculations after BMP application for Urban land areas are given below. A separate loading value is calculated for each of the Urban land use categories depending on whether a BMP is applied on it or not. The resulting loading from each of the nine Urban land use categories is then summed up to calculate the total Urban load.

$$W_{N1} = W_N - W_N \cdot e \cdot \%A_{eff} \quad \text{Equation 31}$$

$$W_{P1} = W_P - W_P \cdot e \cdot \%A_{eff} \quad \text{Equation 32}$$

$$W_{BOD1} = W_{BOD} - W_{BOD} \cdot e \cdot \%A_{eff} \quad \text{Equation 33}$$

$$W_{TSS1} = W_{TSS} - W_{TSS} \cdot e \cdot \%A_{eff} \quad \text{Equation 34}$$

Where:

$W_{N1}, W_{P1}, W_{BOD1}, W_{TSS1}$ = annual N, P, BOD, and TSS (sediment) loads from Urban land (Kg) after application of BMP

$W_N, W_P, W_{BOD}, W_{TSS}$ = annual N, P, BOD, and TSS (sediment) loads from Urban land (Kg)

e = BMP efficiency application to the Urban land use category

$\%A_{eff}$ = percentage of BMP effective area for each of the Urban land use categories.

$$\text{Total N Load (lb/year)} = 2000 \times \sum_{i=1}^9 W_{N1} \quad \text{Equation 35}$$

$$\text{Total P Load (lb/year)} = 2000 \times \sum_{i=1}^9 W_{P1} \quad \text{Equation 36}$$

$$\text{Total BOD Load (lb/year)} = 2000 \times \sum_{i=1}^9 W_{BOD1} \quad \text{Equation 37}$$

$$\text{Total TSS Load (lb/year)} = 2000 \times \sum_{i=1}^9 W_{TSS1} \quad \text{Equation 38}$$

Where:

i refers to each of individual Urban land use category

PLET also calculates flow volume reductions for selected Urban LID and infiltration BMP practices for each of the Urban land use categories.

The approach involves calculation of BMP storage capacity and the runoff volume per event. The computed BMP storage capacity is then compared with the runoff volume per event to determine the captured volume per event for the BMP (based on the minimum of both the computed volumes).

$$\text{BMP storage capacity (ac – ft)} = \text{DA} \cdot \text{PI} \cdot \text{RD}/12 \quad \text{Equation 39}$$

$$\text{Runoff volume per event (ac – ft)} = \text{DA} \cdot \text{PI} \cdot \text{P}/12 \quad \text{Equation 40}$$

$$\text{Captured volume per event} = \text{minimum}(\text{BMP storage capacity, Runoff volume}) \quad \text{Equation 41}$$

$$\begin{aligned} \text{Captured volume per year (gal)} & \quad \text{Equation 42} \\ & = (\text{Per_captured_Vol_per_Event}/100 \\ & \quad \cdot \text{DA_Runoff_volume}) \times 325850.58 \end{aligned}$$

Where:

DA = BMP drainage area (acre)

PI = Percent imperviousness within the drainage area, assuming 100% by default (%)

RD = Impervious area runoff depth to be captured (in)

P = Rainfall (in) per event.

$$\begin{aligned} \text{Percent Captured Volume per Event} & \quad \text{Equation 43} \\ & = (\text{BMP storage capacity}/\text{Runoff volume per event}) \times 100 \end{aligned}$$

Note that when the capture volume per event is equal to the runoff volume in Equation 41 then the percent captured volume is 100 percent.

$$\text{DA_Runoff_volume} = \text{LU_Runoff_volume} * \text{BMPDAAr} / \text{LUArea} \quad \text{Equation 44}$$

In addition, PLET also provides an estimate of the required BMP surface area or the required number of BMP units depending the type of BMP chosen.

$$\text{Required BMP surface area (acres)} = \frac{\text{BMP storage capacity(ac-ft)}}{\text{Typical design BMP storage depth(ft)}} \quad \text{Equation 45}$$

$$\text{Required BMP units} = \frac{\text{BMP storage capacity(ac-ft)} \cdot 325850.58 \text{ (gal/acft)}}{\text{Typical design unit volume (e. g., rain barrel) (gal)}} \quad \text{Equation 46}$$

6. Groundwater

Groundwater infiltration is estimated as a fraction of the precipitation. PLET uses reference soil infiltration fractions for precipitation (P) for the various land uses based on hydrologic soil group (HSG) to calculate the amount of infiltration to groundwater.

$$\text{Infiltration (in)} = \text{Infiltration Fraction} \times P \text{ (in)} \quad \text{Equation 47}$$

The infiltrated volume or groundwater volume is then calculated as follows:

$$\text{Infiltration Volume (ac-ft)} = \frac{\text{Infiltration (in)}}{12} \times A \text{ (ac)} \times (\text{Rdays} \cdot \text{RD}_{cor}) \quad \text{Equation 48}$$

Note that for urban areas, in order to calculate the amount infiltrated, the pervious areas are first calculated. The pervious area is calculated based on the difference between the total urban area and impervious area. The impervious area is calculated based on assumed percent imperviousness for the various urban land use categories.

$$\begin{aligned} \text{Pervious Urban Area(ac)} & \quad \text{Equation 49} \\ & = \text{Total Urban Area} - (\text{Commercial} \cdot 0.85 + \text{Industrial} \cdot 0.7 \\ & + \text{Institutional} \cdot 0.5 + \text{Transportation} \cdot 0.95 + \text{Multi - Family} \\ & \cdot 0.75 + \text{Single - Family} \cdot 0.3 + \text{Urban - Cultivated} \cdot 0.01 \\ & + \text{Vacant - developed} \cdot 0.7 + \text{Open Space} \cdot 0.01) \end{aligned}$$

Groundwater volumes from Feedlot areas are calculated using the calculated infiltration from Urban areas and the Feedlot pervious area. The Feedlot pervious area is calculated based on the contribution from Feedlot areas and a fraction based on Feedlot percent paved area as shown below:

$$\begin{aligned} \text{Feedlot Pervious Area(ac)} & \quad \text{Equation 50} \\ & = \text{Feedlot Area pervious} \times \text{fraction based on feedlot \% paved} \end{aligned}$$

Feedlot Percent Paved and associated fraction used in PLET:

Percent paved	Pervious Fraction
0-24%	0.875
25-49%	0.625
50-74%	0.375
75-100%	0.125

7. Feedlot Calculations

Pollutant loads from feedlots in PLET are based on animal types, weight, and average rainfall. Runoff volume from the feedlots are calculated based on contributing area in acres, feedlot percent paved, and average event rainfall in inches.

$$V (ac-in) = Q (in) \cdot A(ac) \quad \text{Equation 51}$$

Where:

A = contributing feedlot area (acres)

Q = surface runoff (inches) and is calculated as

The surface runoff (Q) calculations are based on the SCS runoff curve number method. Note that the CN used in the runoff calculations is estimated based on the selected range of percent imperviousness in the feedlot.

Nutrient contributions in cropland from animals are used to derive load estimates for feedlots. The equivalent animal units (EAU) for N, P, and BOD are first calculated using the equation below for each watershed.

$$EAU = No. \times Factor \quad \text{Equation 52}$$

Where:

No. = number of animals

Factor = Ratio of nutrients produced by animals relative to 1000 lb. of slaughter steer

The Animal Unit Density (AUD) and % manure pack using the following equation:

$$AUD = EAU / A \quad \text{Equation 53}$$

If $AUD < 100$, percent manure pack = AUD;

If $AUD > 100$, percent of manure pack = 100%

Finally, the pollutant concentration of in the feedlot runoff is calculated using the following equation:

$$C_{feedlot} = Fraction\ of\ manure\ pack \times Constant \quad \text{Equation 54}$$

Where:

$C_{feedlot}$ = runoff concentration from Feedlot (mg/L)

Fraction of manure pack = manure pack/100

Constant is pollutant specific and based on 100% manure pack. N constant = 1500 mg/L, P constant = 300 mg/L, and BOD constant = 2000 mg/L

The calculated runoff volume and concentration from Feedlots (Equation 51 and Equation 54) are then used to calculate the Feedlot loading.

$$W_{feedlot}(lb/year) = V (ac-in) \cdot (Rdays \cdot RD_{cor}) \cdot C_{feedlot}(mg/L) \cdot 0.227 \quad \text{Equation 55}$$

8. Septic Load

The septic load is calculated as the sum of the failing septic load and the direct wastewater loading.

$$\begin{aligned} \text{Septic Load } \left(\frac{\text{lb}}{\text{year}} \right) & \qquad \qquad \qquad \text{Equation 56} \\ & = \left[\text{Failing Septic Load } \left(\frac{\text{lb}}{\text{hr}} \right) + \text{Direct Wastewater Load } \left(\frac{\text{lb}}{\text{hr}} \right) \right] \\ & \quad \times 24 \times 365 \end{aligned}$$

The Failing Septic Load and Direct Wastewater Load calculations are shown below.

Failing Septic Load

The failing septic load is calculated using the failing septic flow and an average concentration reaching the stream from septic overcharge. The failing septic flow is calculated using the number of septic systems (tanks), the failure rates (percentage), and the ratio of persons per septic system.

$$\begin{aligned} \text{Failing Septic Load } \left(\frac{\text{lb}}{\text{hr}} \right) & \qquad \qquad \qquad \text{Equation 57} \\ & = \left[\text{Failing Septic Flow } \left(\frac{\text{L}}{\text{hr}} \right) \right. \\ & \quad \times \text{Avg. concentration reaching stream from septic overcharge } \left(\frac{\text{mg}}{\text{L}} \right) \left. \right] / 453592 \end{aligned}$$

Where:

$$\begin{aligned} \text{Failing Septic Flow (L/hr)} & \qquad \qquad \qquad \text{Equation 58} \\ & = \text{Population of Failing Septic (persons)} \\ & \quad \times \text{Typical Septic Overcharge Flow Rate (gal/day/person)} \\ & \quad \times (3.785412/24) \end{aligned}$$

The population of failing septic is calculated as follows:

$$\begin{aligned} \text{Population of Failing Septic (persons)} & \qquad \qquad \qquad \text{Equation 59} \\ & = \text{No. of Septic Systems} \times \text{Population per Septic System} \\ & \quad \times \text{Septic Failure Rate\%} \end{aligned}$$

Typical Septic Overcharge Flow Rate in PLET is 70 gal/day/person (range of 45 to 100).

The average concentration reaching the stream from septic overcharge are determined based on ranges observed in literature for Total Nitrogen, Total Phosphorous, and Organics (BOD) (as specified in the PLET model).

Direct Wastewater Load

$$\begin{aligned} \text{Direct Wastewater Load } \left(\frac{\text{lb}}{\text{hr}} \right) & \qquad \qquad \qquad \text{Equation 60} \\ & = \left[\text{Direct Wastewater Flow } \left(\frac{\text{L}}{\text{hr}} \right) \times \text{Avg. concentration } \left(\frac{\text{mg}}{\text{L}} \right) \right] \\ & \quad / 453592 \end{aligned}$$

Direct wastewater flow is calculated based on per capita flow 75 gal/day/person (range of 75 to 125) and the specified direct discharge population as:

$$\begin{aligned} \text{Direct Wastewater Flow } \left(\frac{\text{L}}{\text{hr}} \right) & \qquad \qquad \qquad \text{Equation 61} \\ & = \text{percapita flow (gal/day/person)} \\ & \quad \times \text{direct discharge population(persons)} \times (3.785412/24) \end{aligned}$$

Average concentrations reaching the stream from wastewater load as specified in PLET for Total Nitrogen, Total Phosphorous, and Organics (BOD).

9. Gully Erosion Load

The annual load due to Gully Erosion (GE) for each watershed is calculated as the sum of the all the impaired Gully loading as follows:

$$\text{GE Sediment Load (lb/year)} = 2000 \times \sum_{i=1}^n [(\text{TW} + \text{BW}) \cdot \text{D} \cdot \text{L} \cdot \text{Wt}/\text{T}/2] \quad \text{Equation 62}$$

$$\begin{aligned} \text{GE Nitrogen Load (lb/year)} & \quad \text{Equation 63} \\ & = 2000 \times \% \text{ Soil N Conc} \times \sum_{i=1}^n [(\text{TW} + \text{BW}) \cdot \text{D} \cdot \text{L} \cdot \text{Wt} \cdot \text{NCF}/\text{T}/2] \end{aligned}$$

$$\begin{aligned} \text{GE Phosphorous Load (lb/year)} & \quad \text{Equation 64} \\ & = 2000 \times \% \text{ Soil P Conc} \times \sum_{i=1}^n [(\text{TW} + \text{BW}) \cdot \text{D} \cdot \text{L} \cdot \text{Wt} \cdot \text{NCF}/\text{T}/2] \end{aligned}$$

$$\begin{aligned} \text{GE BOD Load (lb/year)} & \quad \text{Equation 65} \\ & = 2000 \times \% \text{ Soil BOD Conc} \times \sum_{i=1}^n [(\text{TW} + \text{BW}) \cdot \text{D} \cdot \text{L} \cdot \text{Wt} \cdot \text{NCF}/\text{T}/2] \end{aligned}$$

Where:

TW = top width (ft)

BW = bottom width (ft)

D = depth (ft)

L = length (ft)

Wt. = Soil Dry Weight (ton/ft³) – based on soil textural class

NCF = Nutrient correction factor – based on soil textural class

T = time (number of years) that the gully has taken to form the current size

PLET uses default 0.08, 0.031, and 0.160 % soil nitrogen, phosphorous and BOD values which can be updated.

The gully erosion load reduction is calculated using a specified BMP efficiency due to gully stabilization (0 to 1) as follows:

$$\text{GullyErosionLoad Reduction} = \text{GullyErosionLoad} \times \text{BMP Efficiency} \quad \text{Equation 66}$$

10. Impaired Streambank Load

The annual load due to Streambank (SB) Erosion for each watershed is calculated as the sum of the all the impaired stream bank loading as follows:

$$\text{SB Sediment Load (lb/year)} = 2000 \times \sum_{i=1}^n L \cdot H \cdot \text{LRR} \cdot \text{Wt} \quad \text{Equation 67}$$

$$\text{SB Nitrogen Load (lb/year)} = 2000 \times \% \text{ Soil N Conc} \times \sum_{i=1}^n L \cdot H \cdot \text{LRR} \cdot \text{Wt} \cdot \text{NCF} \quad \text{Equation 68}$$

$$\text{SB Phosphorous Load (lb/year)} = 2000 \times \% \text{ Soil P Conc} \times \sum_{i=1}^n L \cdot H \cdot \text{LRR} \cdot \text{Wt} \cdot \text{NCF} \quad \text{Equation 69}$$

$$\text{SB BOD Load (lb/year)} = 2000 \times \% \text{ Soil BOD Conc} \times \sum_{i=1}^n L \cdot H \cdot \text{LRR} \cdot \text{Wt} \cdot \text{NCF} \quad \text{Equation 70}$$

Where:

L = length (ft)

H = height (ft)

LRR = lateral recession rate (ft/yr) – based on categorization of LRR i.e. slight, moderate, severe or very severe

Wt. = Soil Dry Weight (ton/ft³) – based on soil textural class

NCF = Nutrient correction factor – based on soil textural class

PLET uses default 0.08, 0.031, and 0.160 % soil nitrogen, phosphorous and BOD values.

The stream bank load reduction is calculated using a specified BMP efficiency due to stream bank stabilization (0 to 1) as follows:

$$\text{StreamBankLoad Reduction} = \text{StreamBankErosionLoad} \times \text{BMP Efficiency} \quad \text{Equation 71}$$