Upper Neuse Site Evaluation Tool

User's Manual and Guidance

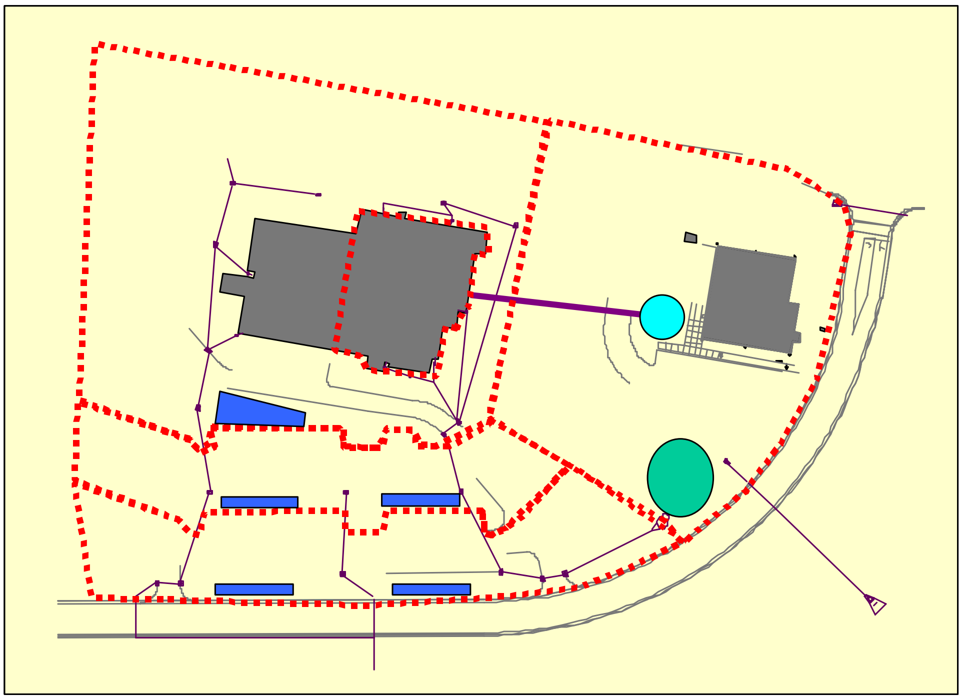

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Table of Contents

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1 Overview

This document provides directions and guidance for using the Upper Neuse Site Evaluation Tool (SET). The Site Evaluation Tool is a Microsoft Excel spreadsheet, and is designed to aid in the assessment of development plans and available Best Management Practices (BMPs) to achieve the region's water quality objectives. The BMPs incorporated within the model address the most important current and future water quality issues that development can potentially influence. The SET can also be used to compare the costs of stormwater BMP systems and estimate the cost savings for reducing impervious surfaces within a site design.

The SET is a useful resource for many in the development community. Developers can use it as a screening tool for testing various site configurations to find ways of helping a site achieve water quality goals in a cost-effective manner. A completed SET can be submitted with a site plan as part of a plan approval process; municipal staff can use the tool to demonstrate compliance with water quality regulations. Other practitioners may find it useful for evaluating impacts of various types of development, and understanding the costs of treatment.

The purpose of this document is to provide training and guidance for effectively using the tool. It should be reviewed in its entirety before attempting to use the model. The manual provides the context for understanding the inputs and what they represent, and provides many pointers for using the SET. A Model Documentation document (Tetra Tech, Inc., 2005)[1] is also available for this tool. The Model Documentation discusses the underlying models and methodologies used by the SET, and provides the assumptions and data sources used to represent the effectiveness and costs of the BMPs.

The SET has two functioning components – the Hydrology/Pollutant Component for assessing water quality impacts of development, and the Cost Component for assessing the costs of BMPs and other infrastructure. They can be used together or separately as needed. In cases where a copy of a completed SET is required to be submitted to regulatory staff, only the Hydrology/Pollutant Component must be completed; the Cost Component is optional and not required. The Hydrology/Pollutant Component is covered in Section 2, and the Cost Component in Section 3. Both sections have subsections that cover the following:

- Introduction to the Component
- Information needed before beginning work
- Helpful notes on navigation and data entry
- Detailed instructions on data input
- Discussion of resulting output
- Detailed site example

The Hydrology/Pollutant Component also contains some examples of how to use the tool more effectively (see *Special Case Drainage Areas*, Section 2.2.8).

The SET provides navigation buttons for switching between the Hydrology/Pollutant Component and the Cost Component. Each component has a number of associated worksheets, and navigating between them can be challenging when all are displayed at the same time. Hiding the sheets of a component allows for easier navigation and helps the user focus on the relevant sheets.

[1] Tetra Tech, Inc. 2005. Upper Neuse Site Evaluation Tool Model Documentation. Prepared for UNRBA.

In the Hydrology/Pollutant Component, the following button is shown at the top of each data input sheet:

Cost Component

If the user clicks on the button, all of the Hydrology/Pollutant Component sheets will disappear, and the Cost Component sheets will appear. Conversely, the following button is available in the Cost Component for switching back to the Hydrology/Pollutant Component:

Hydrology/Pollutant Component

Clicking on the button will remove the Cost Component sheets and make the Hydrology/Pollutant Component sheets reappear.

The SET contains many more aids to navigation, discussed in detail throughout the document.

2 Hydrology/Pollutant Component

2.1 Introduction to the Hydrology/Pollutant Component

Nutrient loading[2], upland sediment loading[3], and stream channel erosion have been identified as critical water quality issues for the Upper Neuse River Basin region. Development generally results in an increase in nutrient and upland sediment loading, and changes in site runoff during storms often lead to streambank and channel erosion downstream. However, the changes may be minor, or there could be an improvement. For instance, conversion of a site previously used for row crops is likely to decrease upland sediment loading. The Hydrology/Pollutant Component of the SET provides an objective way to evaluate impacts on water quality.

BMPs use a variety of techniques to reduce the impact of the increased runoff and pollutant loadings, including reduction in flow velocity and quantity, runoff control, biological uptake, and filtration. The SET has a menu of the most common BMPs used for water quality benefits. The terminology and pollutant removal efficiencies are taken from a number of information sources, some local to North Carolina, and some from national databases. BMPs are assumed to be sized properly for areas draining to them and maintained for continued performance.

Users enter data about the site before and after implementation of the development plan. For clarity, this document was written assuming that existing conditions reflect undeveloped land uses. Existing land use may be a combination of undeveloped, agricultural, and previously developed land uses.

The SET Hydrology/Pollutant Component includes targets for nutrient loading, an optional target for sediment loading, targets for peak flow and for storage of runoff during the type of storm events most likely to cause downstream channel erosion. The sediment target is fixed at 85 percent to reflect NPDES Phase II requirements (and water supply watershed protection where applicable), while the nutrient targets vary depending on the location of the site and the type of development. Peak flow targets are defined as matching the post-development peak flow to the pre-development peak flow, and the user can select from three storm events – the 1-year, 2-year, and/or 10-year 24-hour storms. Four runoff volume targets are available – a uniform ½ inch of runoff from the site, the runoff volume from the first inch of rainfall, and the difference between pre- and post-development runoff for the 1-year 24-hour storm or the 2-year 24-hour storm. Various BMPs can be tested to find a combination that meets the targets. The nutrient targets are based on the Upper Neuse Watershed Management Plan Performance Standards.

The Upper Neuse Watershed Plan Performance Standards were developed based on modeling using the Generalized Watershed Loading Function (GWLF) program. An iterative process was used to determine the density of development allowed within the state's regulations of the maximum nitrogen loading allowed by future development, and pursuant to water quality goals for the local drinking water supplies and Falls Lake. It was determined that 3- to 5-acre lots, with associated loading rates of 0.3 lb/ac/yr TP and 1.7 lb/ac/yr TN, would maintain acceptable surface loading rates within the watershed. However, the scale at which the SET is applied is significantly different from the Upper Neuse GWLF work, which is calibrated at the watershed scale. Significant attenuation of loads may occur as nutrient loads run off from a land surface and are transported to a receiving water. Recent research shows that a large proportion of nutrient uptake occurs in small headwater streams – those that occur between the site-scale and the watershed scale of the Upper Neuse models. Factors in this attenuation include reattachment/settling of soil bound nutrients and plant uptake at stream margins. Based on the attenuation factors and the site-scale loading rates, overall reduction factors of 0.45 and 0.56, for TP and TN

[2] Nutrients are defined as total nitrogen and total phosphorus.
[3] Upland sediment loading is the amount of soil that washes off land areas into streams. Streambank and channel erosion are a separate source of sediment.

respectively, were estimated to translate between site scale loads and the GWLF subwatershed scale at which the performance standards were developed.

The SET TP and TN targets (see below) reflect the maximum loading rate allowable from new development sites to meet the watershed performance and water supply in-lake targets in the Upper Neuse Watershed Management Plan. As discussed above, the watershed performance standard is smaller than the on-site SET target because it reflects attenuation of pollutants during transport to the lakes (i.e., the reduction factors 0.45 and 0.56, for TP and TN respectively, to translate between the site scale and the watershed scale). It is important to note that the Neuse Nutrient Sensitive Waters Rule model stormwater plan specifies a 3.6 lb/ac/yr nitrogen target for new development but allows a developer to "buy-down" to the 3.6 lb/ac/yr target from an upper limit of 6 lb/ac/yr for urban residential development, or 10 lb/ac/yr for urban non-residential development. Thus, the actual loading rate that will be achieved in compliance with the rule will fall between 3.6 and 10 lb/ac/yr for new urban development. The Upper Neuse Watershed Plan is based on a 3.6 lb/ac/yr watershed performance (i.e., exerted to the lake) for new urban development and an annual maximum site-scale loading rate of approximately 6.43 lb/ac/yr.

	TN (lb/ac/yr)	TP (lb/ac/yr)
Rural/Conservation Area	3.04	0.67
Urban Residential	6.0	1.33
Urban Non-Residential	10.0	1.33

2.2 USING THE HYDROLOGY/POLLUTANT COMPONENT

2.2.1 Before Beginning

Prior to using the model, the following information is needed, most or all of which can be obtained from the preliminary development site plan:

1. The size (in acres) of the project.
2. The design storm event that will be evaluated for runoff volume, which includes the following choices:
    a. Uniform ½ inch of runoff from the site (site area x ½ inch)
    b. Runoff from the first inch of rainfall (or, the one-inch storm event)
    c. The difference in runoff volume between pre- and post-developed site conditions for the 1-year, 24-hour storm event.
    d. The difference in runoff volume between pre- and post-developed site conditions for the 2-year, 24-hour storm event.
3. The design storm event(s) that will be evaluated for peak flow (1-year 24-hour, 2-year 24-hour, and/or 10-year 24-hour).

4. The location of the project with respect to the Upper Neuse Nutrient Zone and type of development:
    a. Rural/Conservation Area
    b. Urban Area, with residential development
    c. Urban Area, with non-residential development.
5. The fraction of the project area that is distributed within each of the hydrologic soil groups, A, B, C, or D (refer to NRCS soil survey for hydrological group information).
6. Average site slope. If the average slope is not known, you may estimate the slope and choose from the following ranges: less than 2 percent, between 2 percent and 6 percent, or greater than 6 percent.
7. Land use of the project area prior to *and* after implementation of the site plan. Generally, undeveloped land use is a combination of agricultural land uses, forest, and meadow. However, it may reflect an existing development. Available land uses are broken down as follows (input in square feet):

    Pervious Areas:

    a. Row crops
    b. Pasture (areas with livestock)
    c. Forest
    d. Wetlands
    e. Meadow (unmanaged herbaceous)
    f. Lawn (managed herbaceous)

    Impervious Areas (Residential, Office/Institutional, and Light Industrial):

    a. Rooftops (all buildings and canopied areas, including canopies over gas pumps)
    b. Driveways and/or parking lots (including curb and gutter)
    c. Roads (including curb and gutter)
    d. Sidewalks
    e. Other Impervious Areas (e.g., tennis courts, rock outcroppings)

    Impervious Areas (Commercial & Heavy Industrial):

    f. Rooftops (all buildings and canopied areas, including canopies over gas pumps)
    g. Driveways and/or parking lots (including curb and gutter)
    h. Roads (including curb and gutter)
    i. Sidewalks
    j. Other Impervious Areas (e.g., loading docks, other infrastructure, etc.)

Stormwater Management and BMP Areas:

a. BMPs with standing water (wet ponds, stormwater wetlands)

b. Surface area of permeable pavement

c. Surface area of green roof (vegetated portion)

d. Other BMPs (except for Forested Buffers, which are accounted for under pervious areas).

8. For sites with mixed residential and commercial use, the impervious areas listed above should be broken down appropriately. If the impervious area totals are not yet available, the totals can be estimated. If necessary, the estimated totals can be lumped into rooftop and non-rooftop areas, and the non-rooftop impervious area can be entered in the "Other Impervious Area" category. Note that rooftop areas are treated differently from other impervious surfaces within the SET's internal modeling, so it is important to have a realistic estimate of rooftop area if you are going to lump impervious surfaces.

9. A division of the project area into distinct drainage areas (DAs) that are served by specific stormwater management facilities and/or BMPs. The model allows for up to 10 distinct drainage areas. All of the above land use/land cover areas must be distributed within those drainage areas for the development plan. A drainage area associated with a specific BMP generally includes that BMP and all area within the project draining to it. Usually a stormwater control or BMP associated with a given drainage area serves the entire drainage area. Where multiple BMPs are specified in series, care must be taken in delineation. It is also possible (and sometimes necessary) to lump like areas together even if they are not connected hydrologically. Further guidance is available in a subsequent section.

10. For BMPs that provide storage volume with a minimum drawdown time of 24 hours, the storage volume in cubic feet. Definition of storage volume and design criteria may vary by location and by BMP in jurisdictions of the Upper Neuse Basin; refer to the appropriate design guidance for details.

11. For existing forested buffers, the following is required, provided the average width of the buffer exceeds the width required by the Neuse Buffer Rules:

    a. The average width of the **forested** portion of the buffer (one side). Only the portion of a buffer that has protected forest cover can count toward the buffer width. While all of the zones of a buffer have important functions, only the forested portion is given credit for pollutant removal.

    b. A breakdown of the total forested buffer width into the width protected by the Neuse Buffer Rule regulation, and the additional width beyond the requirement. Pollutant removal credit is given only for the additional buffer width beyond the requirement. If no additional width is protected beyond the regulation, then you do not need to account for the buffer in the SET.

    c. The proportion of the drainage area contributing runoff that enters the buffer as sheet flow. This is generally the area within 150 feet of the edge of the buffer, since runoff tends to become concentrated flow after distances of 150 feet. The area beyond 150 feet cannot be considered for pollutant removal credit unless there are engineering structures in place (such as level spreaders) that divert concentrated flow into sheet flow.

12. You may specify pollutant removal efficiencies and other parameters for BMPs on the site plan that are not included in the menu of BMP choices.

13. The SET estimates time of concentration and peak flow for the entire site area; however, you may specify the pre- and post-developed time of concentration, and post-development peak flow, if known. If the site has multiple physical drainage areas, you should create a separate SET application for each drainage area for the specified time of concentration and/or peak flow to be meaningful.

2.2.2 General Notes

Note: The Site Evaluation Tool is not compatible with Excel 95 or earlier versions.

Open the SET Microsoft Excel workbook file (check http://www.unrba.org/set/ for the most recent version). If you are prompted to make a choice about macros, select "Enable Macros" (or "Yes," depending on the dialog box you see) to allow macros to run. You must enable macros to run the SET. You may also need to change your macro security settings; see Appendix A if one of the following occurs:

- When you open the SET, a message appears warning you that macros are disabled. The message includes a lengthy explanation about macro security and available options (newer versions of Excel, such as Excel 2003).
- When you open the SET, you receive no warnings about macro security, but nothing happens when you click on the navigation buttons (Excel 97 and Excel 2000).

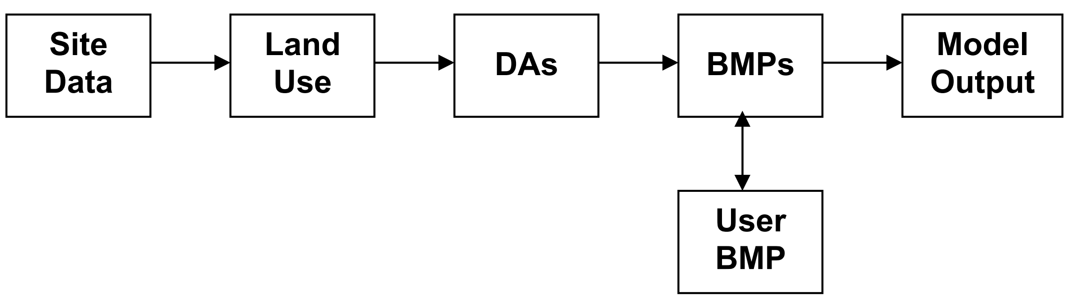
Blue colored cells denote where user input is required throughout the spreadsheet.

The SET contains several navigation and data entry aids to guide you through the process. For instance, some cells allow only for percent values between 0 and 100 and will display an error message if an invalid number is entered. Other cells show error messages in large red text until data entered in that section sums to a previous value. For example:

Error message: **Unassigned: 125,478**

Data entry correct: **Equals Site Area**

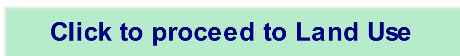
There are six sheets in the Hydrology/Pollutant Component of the SET:



The **Site Data**, **Land Use**, **DAs**, **BMPs**, and **User BMP** sheets are used for data entry. The **Model Output** sheet is for display of results only. Some of the sheets are hidden until you complete data entry on a previous sheet. For instance, you must enter all of your data on both the **Site Data** and **Land Use** sheets before you can move to the **DAs** sheet. However, you can go back to a previous sheet and make corrections by selecting its sheet tab at the bottom.

The SET includes buttons to facilitate navigation between the sheets. When you have completed data entry on a particular sheet, you click on a button at the top to move to the next sheet: This also helps to prevent invalid data entry – you cannot move on to the next sheet while the sheet you are using is being completed:

Once you have completed all required data entry, the button changes to indicate that you may proceed:



Note that if you move back to a previous sheet and perform edits, subsequent sheets may disappear (to prevent display of invalid data), and you will have to click through each sheet's button again.

2.2.3 The *Site Data* Sheet

The left side of the **Site Data** sheet allows you to input general information about the site.

The *Project Information* section contains input fields for the following:

- Name of company or organization
- Project name
- Jurisdiction name
- Scenario name (a way for users to track BMP/site layout scenarios)

The *Site Information* section contains input fields for site area (in acres), and average site slope (percent). If the site slope is known, click the button at the top next to *(enter)* in gray. The box next to the button will turn white and allow you to enter the slope. If the slope is not known, select from the available ranges the option that best reflects site conditions.

The *Soil Hydrologic Group* section contains input fields for percent of site area in each soil hydrologic group. The percentages must sum to 100 percent to account for the entire site area.

General Site Information

Project Information	
Company/Org:	
Project:	
Jurisdiction:	
Scenario:	

Site Information	
Area (acres)	30.000
Average Site Slope (%) (Enter value or select from range)	○ (enter) ○ < 2% ⦿ 2% - 6% ○ > 6%

Soil Hydrologic Groups (% of Site Area)	
Group A	
Group B	50.00%
Group C	50.00%
Group D	

The right side of the **Site Data** sheet allows you to input information related to performance criteria and targets.

The *Design Storm Selection* section allows you to select the type of storm event that will be evaluated for the storm event peak flow and runoff volume targets. The type of storm selected will depend on the applicable ordinances in the site's location. For runoff volume, you should not select a storm event larger than the one required for the site; however, you may select smaller storm events if you would like to see the required capture volume on the **Model Output** sheet. For instance, you may be required to use the 1-year 24-hour storm event criteria, but you may wish to know the capture volume for the one-inch storm for BMP design purposes.

Design Storm Selection

Peak Flow
☐ 1-year 24-hour
☐ 2-year 24-hour
☐ 10-year 24-hour

Runoff Volume (storm event)
☐ 1 inch storm
☐ 1-year 24-hour
☐ 2-year 24-hour

Runoff Volume (uniform depth)
☐ ½ inch

The *Pollutant Target Selection* section allows you to select the appropriate Nutrient Zone and development type combination. This allows the site performance to be evaluated against the nutrient loading target that applies to the site. If TSS removal is also a requirement, you may click the box to select it.

Pollutant Target Selection

Upper Neuse Nutrient Zone
○ Rural/Conservation Area
◉ Urban Residential
○ Urban Non-Residential

☐ 85% TSS Removal Requirement

When you have completed the required input fields on the **Site Data** sheet, the button text will read, "Click to proceed to Land Use." Click on the button to proceed to the **Land Use** sheet.

2.2.4 The *Land Use* Sheet

The **Land Use** sheet has input fields for the overall site land uses described previously, for both proposed and existing conditions. Land areas are entered in square feet and must sum to the total site area. You must account for the surface area of structural BMPs, permeable pavement, and green roofs. It is especially important that:

- The area for ponds/wetlands reflects the surface area of the permanent pool only.
- The surface area of permeable pavement reflects only the permeable portion of a driveway/parking lot.
- The surface area of a green roof reflects only the vegetated portion of the green roof.

If the surface area of other BMPs is not known, you may enter it under the "Lawn" land use category.

The example shown below illustrates how messages are used to assist with data entry. Existing land use totals have been entered and the message at the bottom reads, "Equals Site Area." Proposed land use has not been entered, and the message reports on the number of unassigned square feet.

Land Use Entry	Existing Land Use		Proposed Land Use	
	Area (ft^2)	% of Site	Area (ft^2)	% of Site
Pervious Areas				
Row Crops		0.0%		0.0%
Pasture		0.0%		0.0%
Forest	1,306,800	100.0%		0.0%
Wetland		0.0%		0.0%
Meadow		0.0%		0.0%
Lawn		0.0%		0.0%
Impervious Areas				
Residential & Light Industrial				
Rooftops		0.0%		0.0%
Driveways & Parking Lots		0.0%		0.0%
Other Impervious Area		0.0%		0.0%
Road		0.0%		0.0%
Sidewalk		0.0%		0.0%
Commercial & Heavy Industrial				
Rooftops		0.0%		0.0%
Parking Lots		0.0%		0.0%
Other Impervious Area		0.0%		0.0%
Road		0.0%		0.0%
Sidewalk		0.0%		0.0%
Storm Water Management Facilities				
Pond/Wetland Surface Area		0.0%		0.0%
Permeable Pavement		0.0%		0.0%
Green Roof		0.0%		0.0%
All Other BMPs (except Forested Buffer)		0.0%		0.0%
Site Totals:	1,306,800	100.0%	0	0.0%
Check Land Use Totals:	Equals Site Area		Unassigned: 1,306,800	
Total Site Impervious Cover	0.00%			

When you have completed the required input fields on the **Land Use** sheet, the button text will read, "Click to proceed to DAs." Click on the button to proceed to the **DAs** sheet.

2.2.5 The *DAs* sheet

The **DAs** sheet has input fields for the pervious, impervious, and stormwater management facility land areas, but now you must apportion these by drainage area. The sheet cross-checks that all areas match up properly – that the proportions of each land use match the site totals defined on the **Site Data** page. The sheet contains an "unassigned" area field that assists you in dividing up the areas and shows the total areas by land use entered in the **Site Data** sheet (4 of 10 available drainage areas are shown for clarity).

Proposed Land Use Data by DA	Project Areas (ft^2)	Unassigned Area (ft^2)	Enter drainage area names in next row if			
			DA1	DA2	DA3	DA4
Pervious Areas						
Row Crops	0	0				
Pasture	0	0				
Forest	0	0				
Wetland	0	0				
Meadow	0	0				
Lawn	789,600	789,600				
Impervious Areas						
Residential & Light Industrial						
Rooftops	189,000	189,000				
Driveways & Parking Lots	103,000	103,000				
Other Impervious Area	0	0				
Road	136,800	136,800				
Sidewalk	68,400	68,400				
Commercial & Heavy Industrial						
Rooftops	0	0				
Parking Lots	0	0				
Other Impervious Area	0	0				
Road	0	0				
Sidewalk	0	0				
Storm Water Management Facilities						
Pond/Wetland Surface Area	0	0				
Permeable Pavement	10,000	10,000				
Green Roof	10,000	10,000				
All Other BMPs	0	0				
Total Area	1,306,800	1,306,800				

When you have completed the required input fields on the **DAs** sheet, the button text will read, "Required Entry Complete." Click on the button to proceed to the **BMPs** sheet. At this point, required data entry is complete, and you may view model results if you want to evaluate a site configuration with no BMPs.

2.2.6 The *BMPs* sheet

The **BMPs** sheet has input fields for the BMP(s) that serve each drainage area. You select BMPs that treat each drainage area and enter other BMP properties as needed. You may also specify information related to storm event hydrology and hydraulics, if known.

The BMP Assignment for each DA section allows you to assign a BMP or series of BMPs to each drainage area using check boxes. For instance, in the example shown, both bioretention and conventional dry detention are assigned to drainage area #3, while a stormwater wetland is assigned to drainage area #4.

Note that there are no checkboxes for permeable pavement or green roofs – these are automatically selected and enabled by assigning land use area to them on the **DAs** sheet (see drainage area #1 for an example). Both of these BMPs behave in a fundamentally different way than other BMPs; the entire surface area of permeable pavement or a green roof intercepts and treats runoff, while other BMPs receive runoff from upland land areas. As such, permeable pavement and green roofs are treated as surfaces within the SET, and influence model results based on their surface area.

Forested buffers require entry of buffer width protected by the Neuse Buffer Rule, additional buffer width beyond the requirement, and the buffer "treatment zone" (see drainage area #2). The "treatment zone" is the proportion of the drainage area contributing runoff that enters the forested portion of the buffer as sheet flow. This is generally the area within 150 feet of the edge of the buffer, since runoff tends to become concentrated flow after distances of 150 feet. The area beyond 150 feet cannot be considered for pollutant removal credit unless there are engineering structures in place (such as level spreaders) that divert concentrated flow into sheet flow. In the example shown, the buffer width protected by the Neuse Buffer Rule is 50 feet, the additional forest buffer width is 75 feet (for a total buffer width of 125 feet), and 80 percent of the land area draining to the buffer is within 150 feet of the buffer edge. There is a minimum buffer width of 50 feet; narrower buffers do not receive any pollutant removal credit.

BMP Assignment for each DA	DA1	DA2	DA3	DA4
Wet Pond	☐	☐	☐	☐
Stormwater Wetland	☐	☐	☐	☑
Extended Dry Detention	☐	☐	☐	☐
Conventional Dry Detention	☐	☐	☑	☐
Bioretention	☐	☐	☑	☐
Sand Filter (DE Design)	☐	☐	☐	☐
Infiltration Trench	☐	☐	☐	☐
Grass Swale	☐	☐	☐	☐
WQ Swale (MD Design)	☐	☐	☐	☐
Veg FS w/ Level Spreader	☐	☐	☐	☐
Cistern/Rain Barrels	☐	☐	☐	☐
50' Restored Buffer w/ LS	☐	☐	☐	☐
User-defined BMP	☐	☐	☐	☐
Forested Buffer	☐	☑	☐	☐
Width of existing protected forest buffer (ft):		50		
Additional width beyond requirement (ft):		75		
Percent of DA within treatment zone:		80.0%		
Green Roof	N/A	N/A	N/A	N/A
Permeable Pavement	Selected	N/A	N/A	N/A

Note that Grass Swales and Enhanced Grass Swales cannot both be selected within the same drainage area since only one could reasonably be used in a single drainage area.

If you specify a "User BMP" (one not included in the menu of BMPs), you must enter pollutant removal efficiencies and other properties within the **User BMP** sheet. Click the tab at the bottom to reach the **User BMP** sheet, and enter the requested data. You must also provide a reference to documentation supporting the data you enter. The *BMP Type* selection allows you to specify how the BMP will affect a storm event hydrograph. If you need assistance determining the appropriate selection, click the *Help* button for further guidance.

DA1		
	BMP Name:	
Storage	Extended Detention Storage Volume (cu. ft)	
Infiltration	Annual flow converted to infiltration (percent)	
ET*	Annual flow converted to evaporation (percent)	
Removal Efficiencies (as percent)	Total N	
	Total P	
	TSS	

BMP Type
No Control
Surface Area
Total Capture
Capture Volume
Peak + Ext. Det.
Peak Only
Help

Returning to the **BMPs** sheet, the combined pollutant removal efficiencies of the BMPs serving each drainage area are shown in the middle of the sheet, as well as annual runoff converted to infiltration and/or evapotranspiration.

Net Reductions (single or multiple BMPs)	DA1	DA2	DA3	DA4
Annual runoff converted to Infiltration + ET	15.0%	8.0%	44.9%	10.0%
Total Nitrogen	0.0%	3.7%	35.0%	40.0%
Total Phosphorus	0.0%	4.8%	45.0%	35.0%
TSS	0.0%	5.4%	85.0%	85.0%

The next section allows you to enter BMP storage volume for meeting storage volume performance standards (e.g., capturing runoff from the 1st inch of rainfall). This is the volume of runoff that is stored for water quality treatment, and is sometimes called the "water quality volume" or the "extended detention volume". BMP design requirements typically call for releasing this volume gradually over a certain time period, usually 24 hours or 48 hours. The volume you enter here is compared to the required capture volume calculated by the SET, which depends on which runoff volume target you selected on the ***Site Data*** sheet. You **must** enter storage volume in this section to receive credit on the Model Output sheet (see Section 2.2.7).

	Storage (ft^3)	
BMP Class	User-Entry	SET Estimated
Wet Pond		0
Stormwater Wetland		45,751
Extended Dry Detention		0
Bioretention		17,001
Sand Filter (DE Design)		0
Infiltration Trench		0
WQ Swale (MD Design)		0
Green Roof		0
Permeable Pavement		209
Cistern/Rain Barrels		0
User-defined BMP		(user entry)

The SET highlights cells in blue corresponding to the BMPs you selected previously. If there are multiple instances of the same BMP within the project, enter the lumped volume for that type of BMP. For instance, if there are two extended detention basins providing 13,000 ft^3 and 5,500 ft^3 of extended detention volume respectively, you would enter 18,500 ft^3 for the Extended Dry Detention volume. For a user-defined BMP, enter the storage volume on the **User BMP** sheet, and it will be transferred back to this table.

The SET does provide a suggested estimation of storage volume, based on sizing guidelines from various sources and the volume of storm event runoff from the contributing drainage area. This can provide important information when the SET is being used as a screening tool. You may enter the suggested volume manually if you wish, but you want to consider first whether the suggested volume is feasible given possible site constraints. More information about how the SET estimates storage volume is discussed in the Model Documentation.

The following guidance may be helpful for evaluating the storage volume, especially for non-conventional BMPs:

- Conventional Dry Detention is not included here because the BMPs must be capable of storing and releasing the capture volume over a minimum of 24 hours (longer if called for by the BMP design guidelines). As defined here, Conventional Dry Detention is used for mitigating peak flows only, and may drain within a few hours time.
- The capture volume for Extended Dry Detention must be drained within a minimum of 48 hours, per design guidelines for water quality purposes.
- For Wet Ponds and Stormwater Wetlands, the capture volume does not include the permanent pool volume, but only the volume of runoff for which extended detention is provided (generally a minimum of 48 hours per design guidelines.)
- For Bioretention, the capture volume is the volume ponded above the surface, which is generally drawn down through the bioretention media over a period of 24 to 48 hours. Bioretention is assumed to have an underdrain, since Piedmont soils do not generally allow for much infiltration.
- Water Quality (WQ) Swales are treated similarly to Bioretention; the capture volume is the volume ponded behind the check dams (above the swale surface). This volume is assumed to draw down over a period of 24 to 48 hours, and underdrains are assumed.
- Green roofs do actually provide storm event capture volume. Extensive green roofs generally provide about ½ inch of retention per 3 inches of soil media (see NCSU's green roof website at http://www.bae.ncsu.edu/greenroofs/). This water volume is captured by the soil media like a sponge and evaporated between storm events. Your green roof vendor can provide more details.
- Permeable Pavement can provide some capture volume depending on its design. For instance, an inch or two of gravel can be placed below the underdrain, allowing a space for water to pond and infiltrate between storm events. NCSU has a permeable pavement website at http://www.bae.ncsu.edu/info/permeable-pavement/, which will provide further guidance as information becomes available.

This section also has a place to enter the following, if known:

- Pre- and post-development time of concentration
- Post-development peak flow reflecting BMP influence

The SET estimates all of these parameters based on several assumptions (discussed in the Model Documentation), but a detailed engineering analysis is likely to provide more accurate figures. Note that the SET estimates time of concentration and peak flow with an assumption that the entire site drains to a single point. If the site has multiple physical drainage areas, you should create a separate SET application for each drainage area for the time of concentration and/or peak flow to be meaningful.

Enter post-BMP Overall Site Peak Flow (cfs) if known

Storm Event	Peak
1-yr 24-hr storm (cfs)	
2-yr 24-hr storm (cfs)	
10-yr 24-hr storm (cfs)	

Specify Time of Concentration (in minutes) if known

	Existing Land Use	Proposed Land Use
1-yr 24-hr storm (min)		
2-yr 24-hr storm (min)		
10-yr 24-hr storm (min)		

When you complete required input fields on the **BMPs** sheet, you may click the "Proceed to Model Output" button to go to the **Model Output** sheet, or the "Cost Tool" button to go to the Cost Component of the SET.

2.2.7 The *Model Output* Sheet

The **Model Output** worksheet is divided into five sections, "Land Use Summary," "Annual Hydrology Summary," "Storm Event Runoff Volume and Target Summary," "Peak Flow and Hydrograph Summary," and "Annual Pollutant Load and Target Summary." The Excel print area has been pre-set to print all the results on two sheets, although you may print any area desired.

The "Land Use Summary" lists site area and pre- and post-impervious percentages and other information relevant to the site.

Land Use Summary

Total Site Area (acres)	30
Pre-development impervious percentage	0.0%
Post-development impervious percentage	39.6%

The "Annual Hydrology Summary" section shows several results calculated by the model for the project area prior to development (purple), without BMPs (teal), and with BMPs (blue). These include annual surface runoff and infiltration (in inches/year). Development generally results in a decrease in infiltration and an increase in runoff, which frequently leads to channel erosion and even flooding downstream from the site. Some BMPs are able to reduce surface runoff and increase infiltration. These values are for information only, but are important for understanding the impact of development on annual hydrology.

Annual Hydrology Summary

	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	2.01	16.36	11.84
Annual Infiltration (inches/yr)	9.00	4.35	4.92

The "Annual Pollutant Load and Target Summary" section provides information about pollutant loads and site performance compared to targets. In the first section, *Total Site Annual Load*, annual loads are shown for sediment, total phosphorus, and total nitrogen for existing land use, site design without BMPs, and site design with BMPs. Design with BMP sediment loading is compared to the sediment removal target, calculated as 85 percent removal of post-development load. A visual indicator shows whether the site design meets the target.

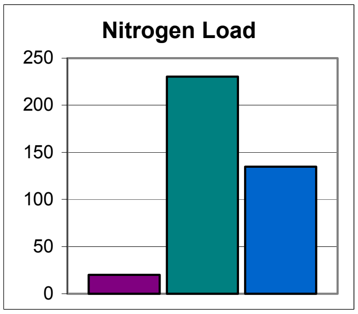
The next section, *Areal Loading Rates*, shows site loads as loading rates on a per acre basis. Nutrient targets are calculated as annual loading rates, so the total phosphorus and total nitrogen loading rates are compared to the target rates. The nutrient targets are set based on whether the site is located in the Rural/Conservation Zone or the Urban Zone; for sites in the Urban Zone, the type of development further determines the target rate. See Section 2.1 for more details about the targets and their derivation.

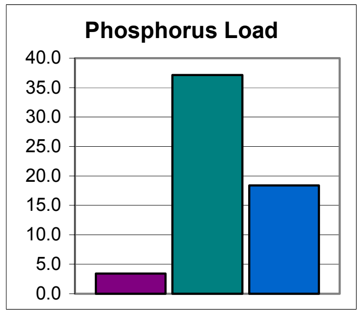
Site performance is compared to the targets, and a visual indicator shows whether the targets are met. The Nutrient Zone/Development Type selected on the **Site Data** sheet is reported below the loading rate table. If the site is located in the Urban Zone, another line of text shows whether the site is below, within, or above the total nitrogen buy down range for the development type.

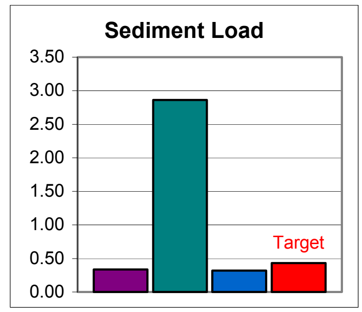
BMPs provide the means for meeting the targets. When you select BMPs, the SET calculates the appropriate load reduction and recalculates the post-development load. Users of the tool may select other BMPs to test various configurations and find the optimal cost-effective solution to BMP siting. The SET provides an easy way to see whether the targets are being met by providing visual indicators.

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	20	230	135		
Total Phosphorus (lb/yr)	3.4	37.1	18.4		
Sediment (ton/yr)	0.34	2.86	0.32	0.43	Yes

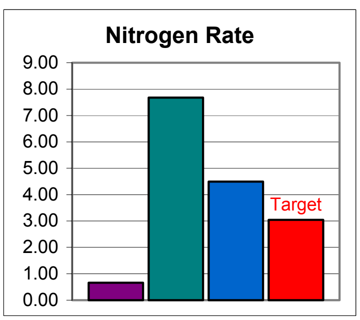


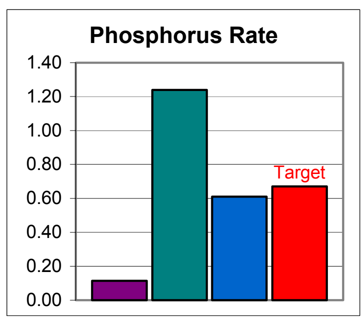


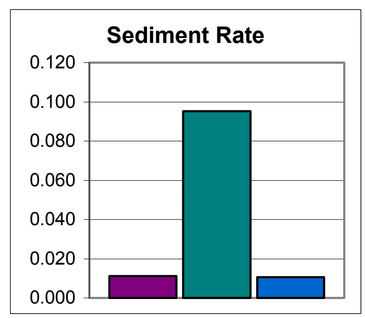


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	0.66	7.68	4.49	3.04	NO!
Total Phosphorus (lb/ac/yr)	0.11	1.24	0.61	0.67	Yes
Sediment (ton/ac/yr)	0.011	0.095	0.011		

Site is located in Rural/Conservation Area Nutrient Zone



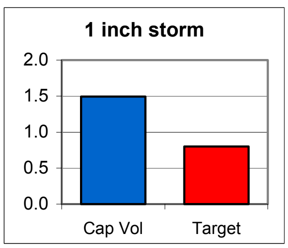


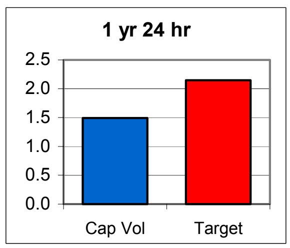


The "Storm Event Runoff Volume and Target Summary" shows the total runoff from the site resulting from the storm events selected in the **Site Data** sheet before and after development, and the target capture volume for each selected storm event. The sum of the storage volumes entered previously on the **BMPs** sheet is shown here as well, and the SET shows whether or not the target is met with a visual indicator. The SET does not use its internally estimated storage volume for evaluating the target; the user must enter the storage volume on the **BMPs** sheet to receive credit. A chart provides visual context for comparing the BMP capture volume to the target. Note that since the stored water is released slowly by most BMPs, this volume is still part of the total runoff volume. However, releasing this volume slowly greatly decreases the risk of downstream channel erosion by reducing the frequency of high stream flows that are related to stream channel and bank erosion.

Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.021	0.800	1.492	0.800	Yes
1-yr 24-hr storm	1.345	3.492	1.492	2.148	NO!





Storm Event Not Selected

Storm Event Not Selected

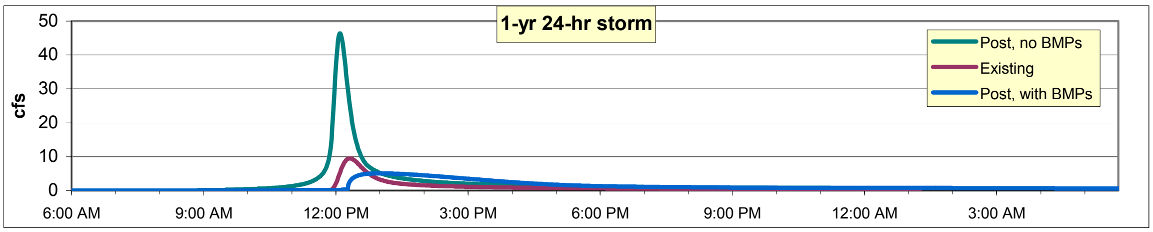
The "Peak Flow and Hydrograph Summary" shows estimated peak flow and storm event hydrographs for existing land use, design configuration without BMPs, and design site configuration with BMPs for the storm events selected in the **Site Data** sheet. Hydrographs for existing land use and design without BMPs are calculated using a Type II 24-hour storm event; excess runoff for each timestep is calculated using the SCS curve number approach, and is convoluted with a unit hydrograph to produce the hydrographs. The post-BMP hydrograph is calculated by routing the design conditions hydrograph through "simulated" BMPs, based on the set of BMPs you selected previously. If the capture volume is not specified, it is estimated using BMP design guidelines coupled with the selected target capture volume. If you have specified the peak flow for design land use with BMPs, it will be displayed under the "Design with BMPs" column, and the "Source" entry will be updated to read "User-defined." Peak flow for Design with BMPs is compared to the peak flow target, defined as the pre-development peak flow.

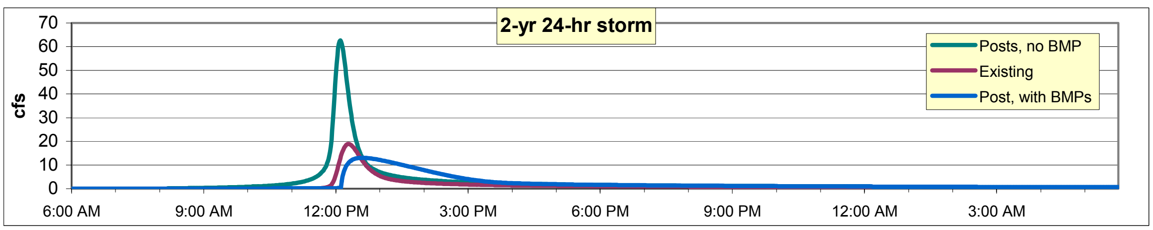
The estimated peak flows and hydrographs are not intended to be a substitute for detailed engineering analysis, but rather a screening and educational tool. The methods employed have a number of limitations. The site is treated as a single drainage area, and time of concentration is estimated with limited information about the site. The BMPs use rule-of-thumb release rates, and the post-BMP hydrograph represents one of many potential outcomes. However, the analysis does provide useful information – it is responsive to the types of BMPs selected and the target capture volume.

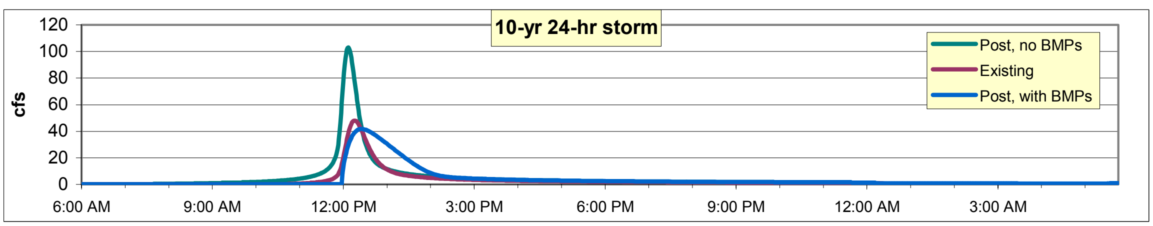
Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	11.66	9.50	53.86	46.39
2-yr 24-hr storm (cfs)	14.80	18.90	68.36	62.63
10-yr 24-hr storm (cfs)	19.25	48.09	88.90	103.00

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	46.39	5.10	Estimated	9.50	Yes
2-yr 24-hr storm (cfs)	62.63	13.06	Estimated	18.90	Yes
10-yr 24-hr storm (cfs)	103.00	41.70	Estimated	48.09	Yes







2.2.8 Special Case Drainage Areas

It is critical that you divide up drainage areas properly in order to receive proper credit for pollutant removal and obtain accurate results. The entire site area must be accounted for when drainage areas are defined. Frequently it is difficult to apply the strict interpretation of drainage areas to the realities of a site plan. This section provides critical guidance to handling some circumstances that might be encountered by the user. In many cases, like areas can be lumped together into one "drainage area" even though in reality they drain to separate locations.

Areas of the site that do not drain to a BMP

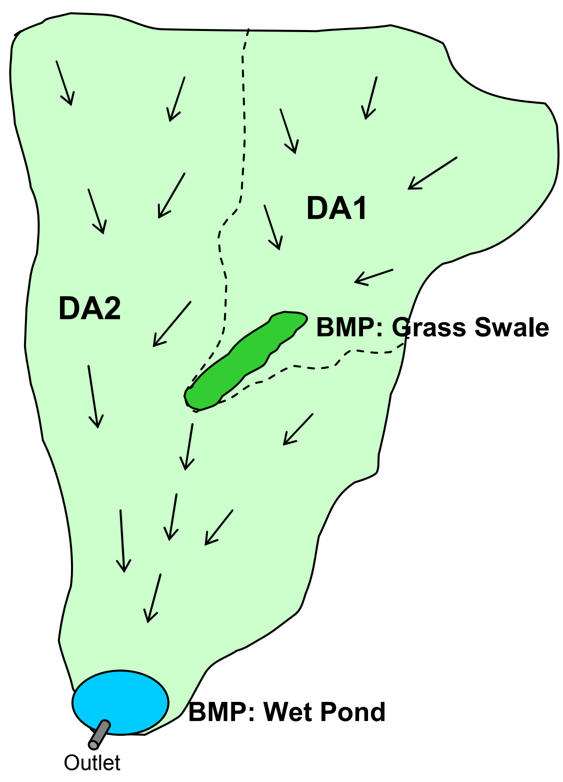
All areas of the site that do not drain to a BMP may be lumped together into a single "drainage area." An example is a case where several edges of the site drain offsite in many directions.

An important note – even though stormwater regulations may not require peak flow control for some areas of a site, ALL areas of the site must be included in the SET.

Connecting Drainage Areas

In some cases, a drainage area with one BMP may drain to another drainage area with a different BMP. The treated water leaving the first drainage area has reduced pollutant levels, and then the water enters the second BMP and receives further treatment. The second BMP receives runoff from both an untreated area and from the first drainage area. The SET allows for this configuration and calculates the total pollutant reduction appropriately.

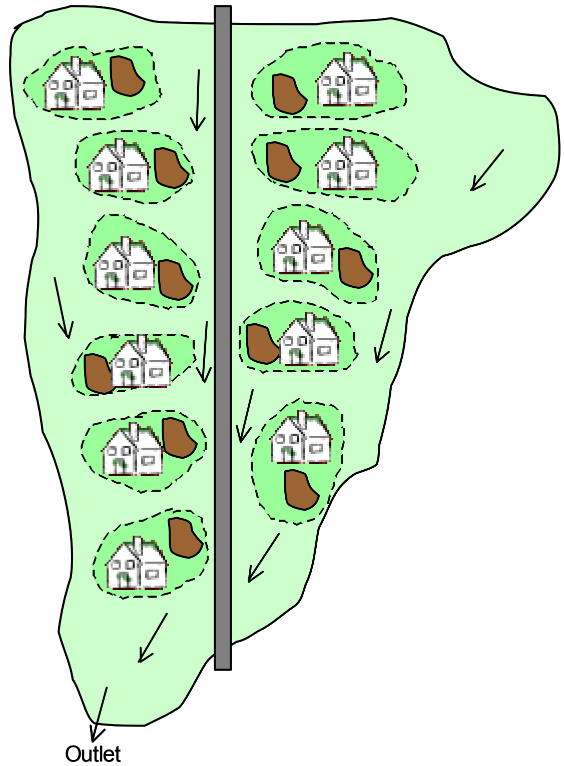
For instance, the figure shows a site with two BMPs – a grass swale and a wet pond. The entire site drains to the wet pond, but the portion inside the dotted line drains to the grass swale.



In this example, let's say the entire site is 10 acres and the portion draining to the grass swale is 3 acres. You would set up two drainage areas (DAs) in the SET. DA1 has a total area of 3 acres, and DA2 has a total area of 7 acres, totaling 10 acres.

You would then select "Wet Pond" for DA2. The portion of the site called DA2 drains to the pond only and receives no other treatment. For DA1, you would select both "Grass Swale" and "Wet Pond." DA1 drains to the grass swale, and the treated water continues on to the pond and receives further treatment.

Dispersed Bioretention Cells



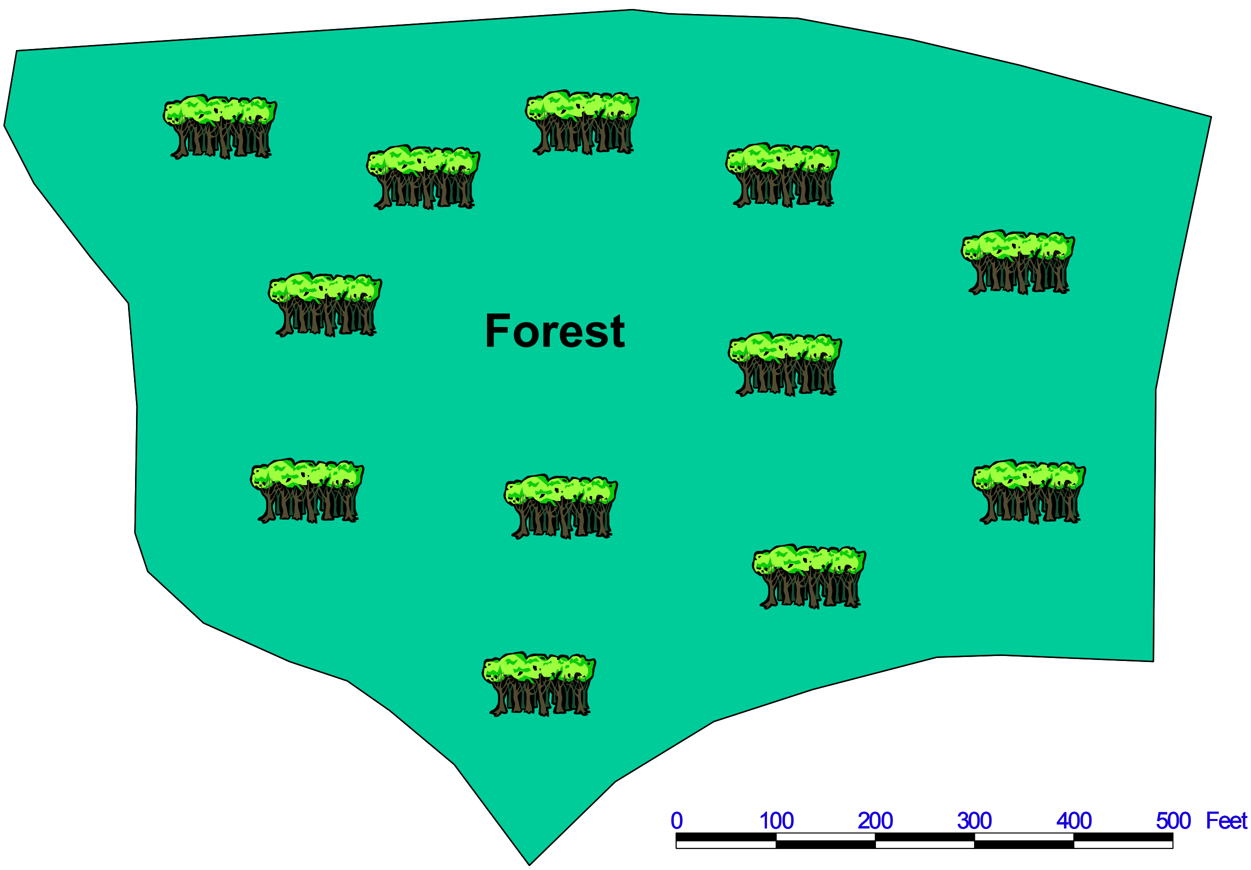
Bioretention cells (sometimes called "Rain Gardens") are frequently designed to treat very small areas (a fraction of an acre) and are dispersed throughout the site. For instance, a housing development might have individual bioretention cells treating runoff at each house. Obviously it would be difficult to define 20+ drainage areas. In this case, you would take the true drainage area and divide it up into two "virtual" drainage areas – the portion of the drainage area treated by bioretention, and the portion not treated by bioretention.

In the example shown, there are 11 houses on the 10-acre site. The bioretention cells are shown in brown next to the houses, and the area surrounding each house draining to the house's bioretention cell is shown in darker green. Let's say that each of the darker green sub-drainage areas is 0.4 acres in size. That means 4.4 acres of the true 10-acre drainage area are treated by bioretention cells. The remaining 5.6 acres is not treated. You would set up two drainage areas in the SET. The first has land use and impervious areas contained inside the darker green zones, with a total area of 4.4 acres. You would then set up a second drainage area for the remaining land use, with a total area of 5.6 acres. Even though technically there are 11 BMPs, they can be aggregated since they serve the same purpose.

2.3 EXAMPLE SITE DESIGN

The following example illustrates how modifications of site design can help a project achieve water quality targets and goals. Two designs are discussed – a "conventional" design using traditional means of stormwater management, and an "innovative" design that uses some non-standard approaches, resulting in better pollutant removal. Differences in site design cost are also explored in Section 3.3.

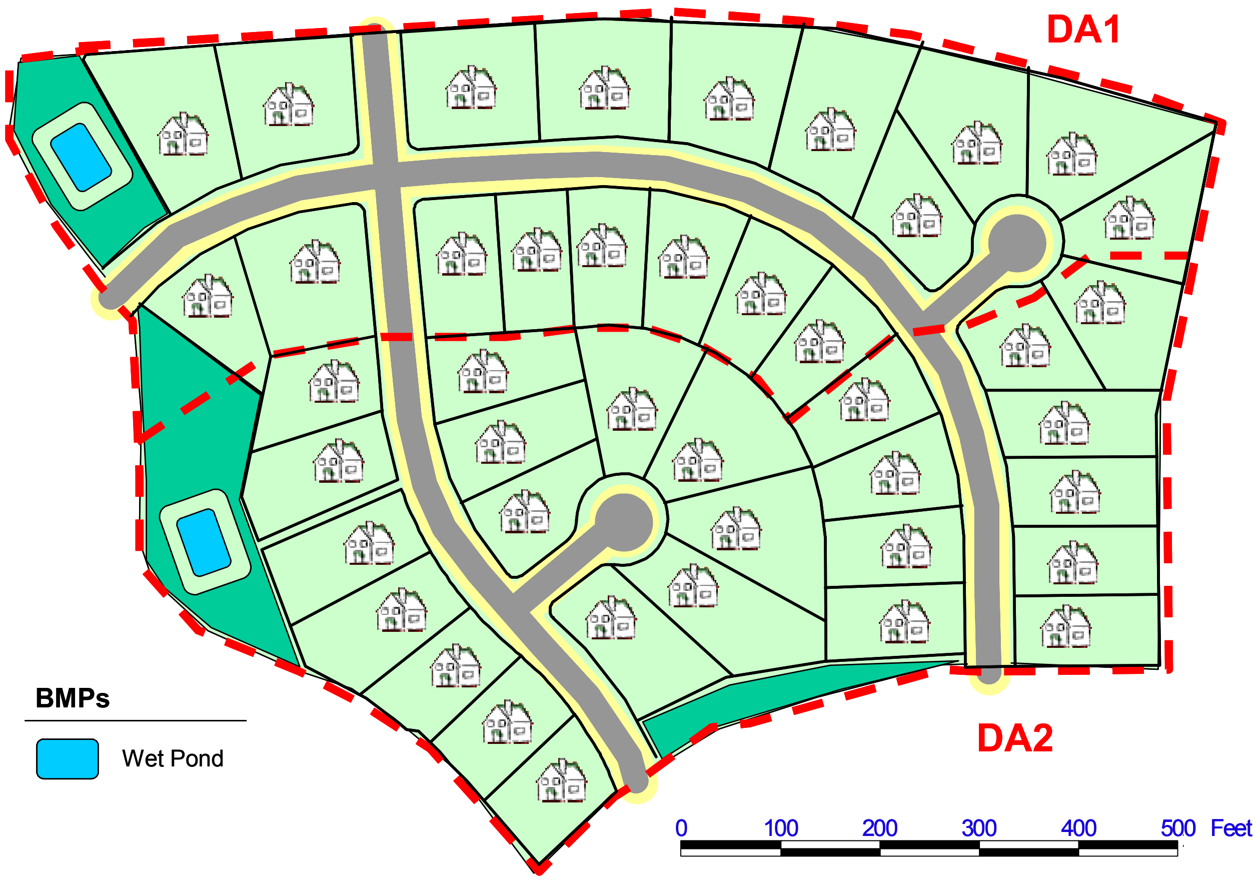
The site is based on a real development located in Durham County, although the specific location and original design have been altered to provide a more suitable example. It is 17 acres in size, and the developer plans to place 43 new homes on the site. In its undeveloped state, the site is entirely forested. The site has 22 percent Group B soils and 78 percent Group D soils. The average site slope is 3.4 percent.



The site is located in a water supply watershed in Durham County, inside the Urban/Suburban Zone of the Upper Neuse Watershed Management Plan. The following performance standards apply:

- Control and treat runoff volume from the 1st inch of rainfall (water supply watershed rule)
- Peak control for the 1-year 24-hour storm event (City of Durham)
- 85 percent sediment removal for post-development conditions (water supply watershed rule)
- Post-developed total nitrogen loading rate of 3.6 lb/ac/yr. Developer has option to exceed this rate, up to 6 lb/ac/yr for residential development, and buy down to the 3.6 lb/ac/yr (Neuse Nutrient Sensitive Waters Rule, and Upper Neuse Watershed Management Plan goal).
- Post-developed total phosphorus loading rate of 1.33 lb/ac/yr (Upper Neuse Watershed Management Plan goal).

In the first development scenario, the site is divided into two drainage areas according to site topography. Each drainage area is treated by a wet pond. The average road width is 32 feet (including curb and gutter), and sidewalks 5 feet wide are present on both sides of the street. The average lot size is 0.3 acres.



The user enters the relevant data into the **Site Data** sheet, and selects the appropriate performance standards. The total nitrogen and total phosphorus targets are selected by choosing the appropriate Upper Neuse Nutrient Zone. Pre- and post-development land cover is entered on the **Land Use** sheet:

General Site Information

Project Information	
Company/Org:	UNRBA
Project:	Example Site
Jurisdiction:	Durham City, Falls Lake
Scenario:	Conventional Site Design

Site Information	
Area (acres)	16.970
Average Site Slope (%) (Enter value or select from range)	(●) 3.40% ( ) < 2% ( ) 2% - 6% ( ) > 6%

Soil Hydrologic Groups (% of Site Area)	
Group A	
Group B	22.00%
Group C	
Group D	78.00%

Design Storm Selection

Peak Flow
☑ 1-year 24-hour
☐ 2-year 24-hour
☐ 10-year 24-hour

Runoff Volume (storm event)
☑ 1 inch storm
☐ 1-year 24-hour
☐ 2-year 24-hour

Runoff Volume (uniform depth)
☐ ½ inch

Pollutant Target Selection

Upper Neuse Nutrient Zone
☐ Rural/Conservation Area
⦿ Urban Residential
☐ Urban Non-Residential

☑ 85% TSS Removal Requirement

Land Use Entry	Existing Land Use		Proposed Land Use	
	Area (ft^2)	% of Site	Area (ft^2)	% of Site
Pervious Areas				
Row Crops		0.0%		0.0%
Pasture		0.0%		0.0%
Forest	739,213	100.0%	87,120	11.8%
Wetland		0.0%		0.0%
Meadow		0.0%		0.0%
Lawn		0.0%	403,033	54.5%
Impervious Areas				
Residential & Light Industrial				
Rooftops		0.0%	98,900	13.4%
Driveways & Parking Lots		0.0%	43,000	5.8%
Other Impervious Area		0.0%		0.0%
Road		0.0%	77,760	10.5%
Sidewalk		0.0%	24,300	3.3%
Commercial & Heavy Industrial				
Rooftops		0.0%		0.0%
Parking Lots		0.0%		0.0%
Other Impervious Area		0.0%		0.0%
Road		0.0%		0.0%
Sidewalk		0.0%		0.0%
Storm Water Management Facilities				
Pond/Wetland Surface Area		0.0%	5,100	0.7%
Permeable Pavement		0.0%		0.0%
Green Roof		0.0%		0.0%
All Other BMPs (except Forested Buffer)		0.0%		0.0%
Site Totals:	739,213	100.0%	739,213	100.0%
Check Land Use Totals:	Equals Site Area		Equals Site Area	
Total Site Impervious Cover	0.00%		33.69%	

The site is divided into two drainage areas, both of which are served entirely by wet ponds. The user calculates the land cover areas for each individual drainage area and puts the totals into the **DAs** sheet: This includes the wet pond surface area (normal pool).

Proposed Land Use Data by DA	Project Areas (ft^2)	Unassigned Area (ft^2)	DA1	DA2
Pervious Areas				
Row Crops	0	0		
Pasture	0	0		
Forest	87,120	0	16,500	70,620
Wetland	0	0		
Meadow	0	0		
Lawn	403,033	0	187,686	215,347
Impervious Areas				
Residential & Light Industrial				
Rooftops	98,900	0	41,400	57,500
Driveways & Parking Lots	43,000	0	18,000	25,000
Other Impervious Area	0	0		
Road	77,760	0	42,474	35,286
Sidewalk	24,300	0	13,273	11,027
Commercial & Heavy Industrial				
Rooftops	0	0		
Parking Lots	0	0		
Other Impervious Area	0	0		
Road	0	0		
Sidewalk	0	0		
Storm Water Management Facilities				
Pond/Wetland Surface Area	5,100	0	2,400	2,700
Permeable Pavement	0	0		
Green Roof	0	0		
All Other BMPs	0	0		
Total Area	739,213	0	321,733	417,480

The user then checks off the BMPs applied to each drainage area in the **BMPs** sheet.

BMP Assignment for each DA	DA1	DA2
Wet Pond	☑	☑
Stormwater Wetland	☐	☐
Extended Dry Detention	☐	☐
Conventional Dry Detention	☐	☐
Bioretention	☐	☐
Sand Filter (DE Design)	☐	☐
Infiltration Trench	☐	☐
Grass Swale	☐	☐
WQ Swale (MD Design)	☐	☐
Veg FS w/ Level Spreader	☐	☐
Cistern/Rain Barrels	☐	☐
50' Restored Buffer w/ LS	☐	☐
User-defined BMP	☐	☐
Forested Buffer	☐	☐
Width of existing protected forest buffer (ft):		
Additional width beyond requirement (ft):		
Percent of DA within treatment zone:		
Green Roof	N/A	N/A
Permeable Pavement	N/A	N/A

The net reduction efficiencies for the selected BMPs for each drainage area are:

Net Reductions (single or multiple BMPs)	DA1	DA2
Annual Runoff converted to infiltration	0.0%	0.0%
Total Nitrogen	25.0%	25.0%
Total Phosphorus	40.0%	40.0%
TSS	85.0%	85.0%

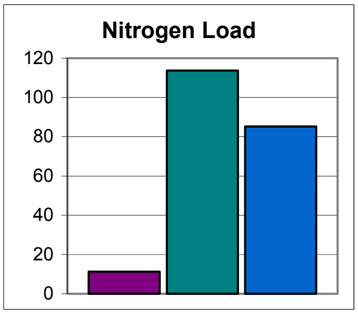
The user enters the combined storage volume of each of the wet ponds. For wet ponds, the appropriate volume for water quality treatment is the volume of the temporary pool only.

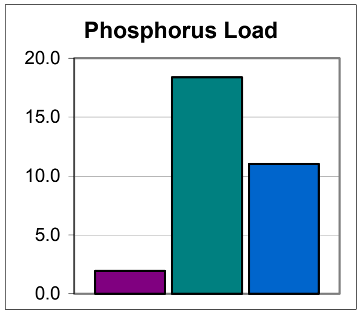
	Storage (ft^3)	
BMP Class	User-Entry	SET Estimated
Wet Pond	19,000	18,996
Stormwater Wetland		0
Extended Dry Detention		0
Bioretention		0
Sand Filter (DE Design)		0
Infiltration Trench		0
WQ Swale (MD Design)		0
Green Roof		0
Permeable Pavement		0
Cistern/Rain Barrels		0
User-defined BMP		(user entry)

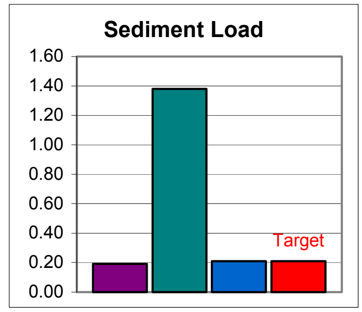
As it is currently designed, the site meets all performance standards and goals: For total nitrogen, the loading rate is higher than 3.6 lb/ac/yr, but is within the buy-down range of 3.6 to 6 lb/ac/yr.

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	11	114	85		
Total Phosphorus (lb/yr)	1.9	18.4	11.0		
Sediment (ton/yr)	0.19	1.38	0.21	0.21	Yes

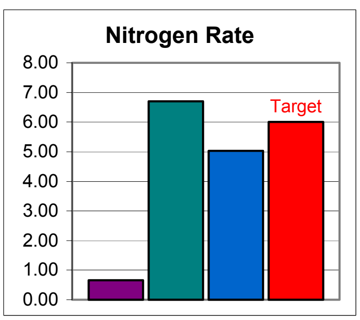


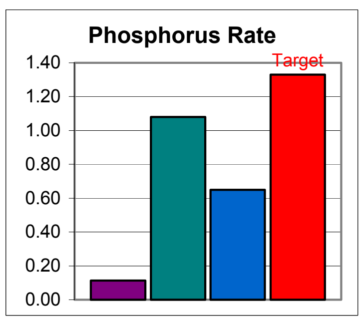


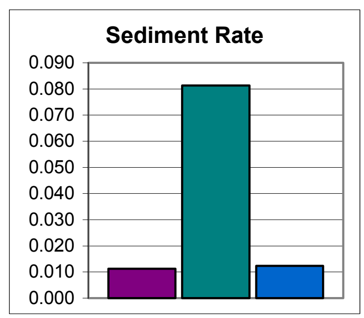


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	0.66	6.70	5.03	6.00	Yes
Total Phosphorus (lb/ac/yr)	0.11	1.08	0.65	1.33	Yes
Sediment (ton/ac/yr)	0.011	0.081	0.012		

Site is located in Urban Residential Nutrient Zone
TN loading rate is within the buy-down range of 3.6 to 6 lb/ac/yr

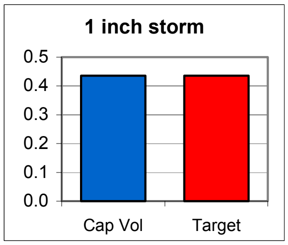






Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.077	0.436	0.436	0.436	Yes



Storm Event Not Selected

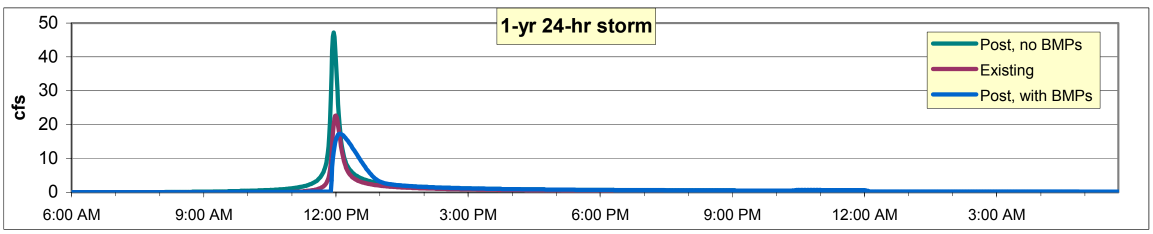
Storm Event Not Selected

Storm Event Not Selected

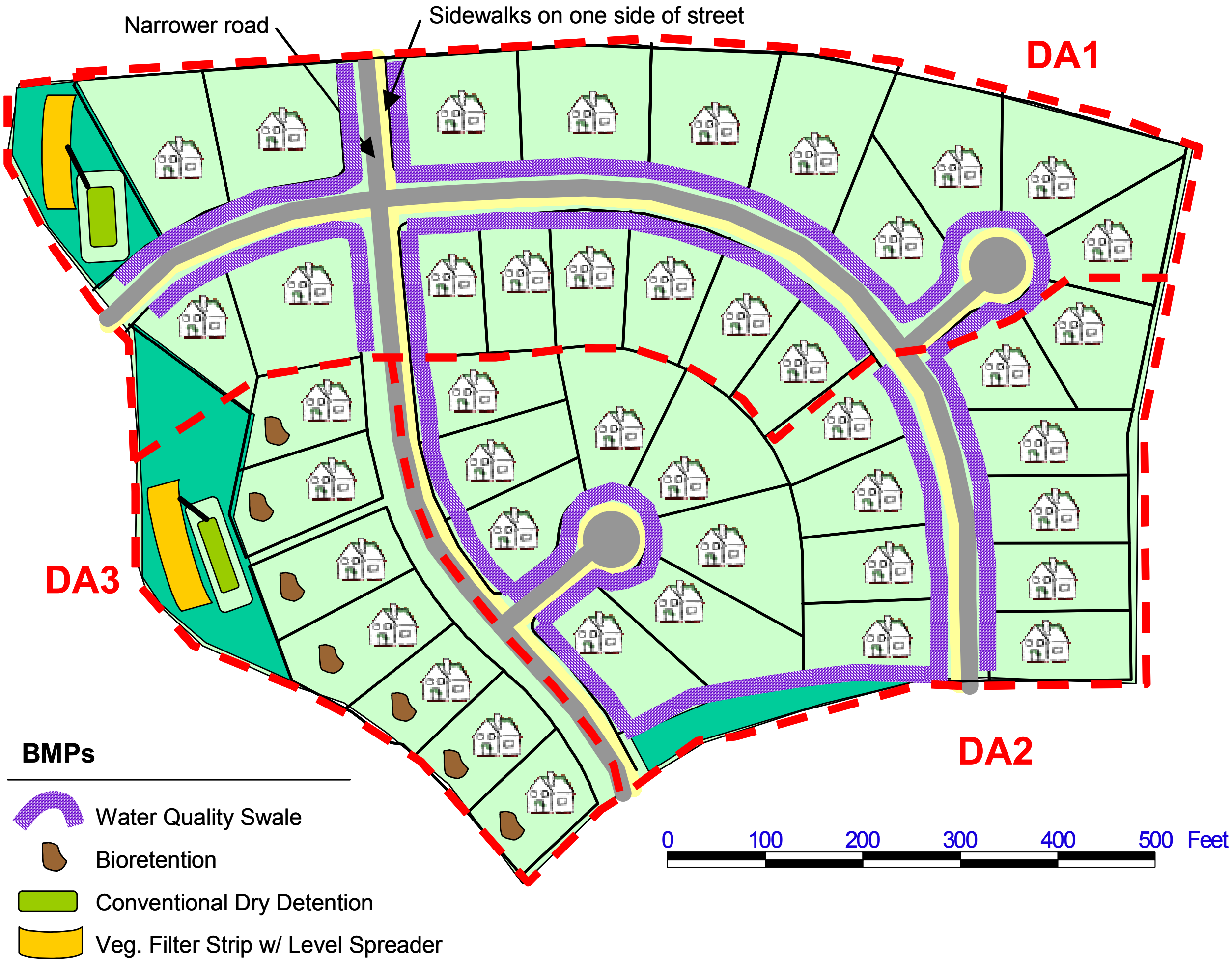
Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	12.57	22.68	38.59	47.24

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	47.24	17.31	Estimated	22.68	Yes



How can this project be modified to meet the Upper Neuse Nutrient Management goal of 3.6 lb/ac/yr, and achieve better overall pollutant removal? There are several options. Decreasing impervious area decreases runoff, which in turn may decrease pollutant loading. Alternate BMPs may also be selected that have better removal rates. The following scenario incorporates both of these options. It is important to realize that the targets are not fixed for a particular development, but are tied to the land use and impervious area. As a result, different site plan configurations may result in an increase or decrease in pollutant removal targets.



The site has the same general layout, but impervious area has been reduced by reducing road width from 32 feet with curb and gutter to 22 feet without curb and gutter. Sidewalks have also been eliminated from one side of the street. The most notable differences are a change in BMPs and overall stormwater management. Drainage Area 2 has now been split into Drainage Areas 2 and 3, reflecting a different set of BMPs in each. The water quality capture volume is now handled entirely by a combination of water quality swales in Drainage Areas 1 and 2 and dispersed bioretention in Drainage Area 3. The elimination of curb and gutter allows the swales and bioretention to capture runoff from both the lots and the roads. Since neither of these BMPs is appropriate for peak control, conventional dry detention is used to reduce peak flow to pre-developed levels. Further improvements to water quality are achieved by treating the runoff exiting the dry detention basins through vegetated filter strips with level spreaders. It is important to note that this is just an example – impervious area can be reduced in other ways besides leaving out sidewalks or reducing road width, and the chosen BMPs may not be realistic for many developments.

The purpose of the example is to understand in general what steps can be taken to reduce pollutant loading, and also to show how to represent various scenarios in the Site Evaluation Tool.

The user first modifies the areas in the **Land Use** sheet:

Land Use Entry	Existing Land Use		Proposed Land Use	
	Area (ft^2)	% of Site	Area (ft^2)	% of Site
Pervious Areas				
Row Crops		0.0%		0.0%
Pasture		0.0%		0.0%
Forest	739,213	100.0%	87,120	11.8%
Wetland		0.0%		0.0%
Meadow		0.0%		0.0%
Lawn		0.0%	430,583	58.2%
Impervious Areas				
Residential & Light Industrial				
Rooftops		0.0%	98,900	13.4%
Driveways & Parking Lots		0.0%	43,000	5.8%
Other Impervious Area		0.0%		0.0%
Road		0.0%	53,460	7.2%
Sidewalk		0.0%	12,150	1.6%
Commercial & Heavy Industrial				
Rooftops		0.0%		0.0%
Parking Lots		0.0%		0.0%
Other Impervious Area		0.0%		0.0%
Road		0.0%		0.0%
Sidewalk		0.0%		0.0%
Storm Water Management Facilities				
Pond/Wetland Surface Area		0.0%		0.0%
Permeable Pavement		0.0%		0.0%
Green Roof		0.0%		0.0%
All Other BMPs (except Forested Buffer)		0.0%	14,000	1.9%
Site Totals:	739,213	100.0%	739,213	100.0%
Check Land Use Totals:	Equals Site Area		Equals Site Area	
Total Site Impervious Cover	0.00%		28.07%	

Note that the total site impervious cover has been reduced from 33.69 percent to 28.07 percent just by removing the sidewalks and reducing road width. The areas of the bioretention cells and water quality swales have been accounted for under the "Storm Water Management Facilities" section at the bottom.

Next, the user modifies the area distribution on the **DAs** sheet:

Proposed Land Use Data by DA	Project Areas (ft^2)	Unassigned Area (ft^2)	DA1	DA2	DA3
Pervious Areas					
Row Crops	0	0			
Pasture	0	0			
Forest	87,120	0	16,500	14,520	56,100
Wetland	0	0			
Meadow	0	0			
Lawn	430,583	0	204,445	165,468	60,670
Impervious Areas					
Residential & Light Industrial					
Rooftops	98,900	0	41,400	41,400	16,100
Driveways & Parking Lots	43,000	0	18,000	18,000	7,000
Other Impervious Area	0	0			
Road	53,460	0	29,201	18,759	5,500
Sidewalk	12,150	0	6,637	5,513	
Commercial & Heavy Industrial					
Rooftops	0	0			
Parking Lots	0	0			
Other Impervious Area	0	0			
Road	0	0			
Sidewalk	0	0			
Storm Water Management Facilities					
Pond/Wetland Surface Area	0	0			
Permeable Pavement	0	0			
Green Roof	0	0			
All Other BMPs	14,000	0	5,550	5,100	3,350
Total Area	739,213	0	321,733	268,760	148,720

Recall that DA2 and DA3 occupy the same area as DA2 in the first site plan.

The user now selects the appropriate BMPs. The runoff from the site is treated by a series of BMPs (a BMP "train") in each drainage area – first the water quality swales or bioretention, followed by conventional dry detention and the vegetated filter strip with level spreader. Note that the same dry detention basin and vegetated filter strip/level spreader treats DA2 and DA3.

BMP Assignment for each DA	DA1	DA2	DA3
Wet Pond	☐	☐	☐
Stormwater Wetland	☐	☐	☐
Extended Dry Detention	☐	☐	☐
Conventional Dry Detention	☑	☑	☑
Bioretention	☐	☐	☑
Sand Filter (DE Design)	☐	☐	☐
Infiltration Trench	☐	☐	☐
Grass Swale	☐	☐	☐
WQ Swale (MD Design)	☑	☑	☐
Veg FS w/ Level Spreader	☑	☑	☑
Cistern/Rain Barrels	☐	☐	☐
50' Restored Buffer w/ LS	☐	☐	☐
User-defined BMP	☐	☐	☐
Forested Buffer	☐	☐	☐
Width of existing protected forest buffer (ft):			
Additional width beyond requirement (ft):			
Percent of DA within treatment zone:			
Green Roof	N/A	N/A	N/A
Permeable Pavement	N/A	N/A	N/A

The new removal efficiencies are:

Net Reductions (single or multiple BMPs)	DA1	DA2	DA3
Annual Runoff converted to infiltration	11.8%	11.8%	8.9%
Total Nitrogen	44.0%	44.0%	48.0%
Total Phosphorus	61.0%	61.0%	64.3%
TSS	91.4%	91.4%	93.6%

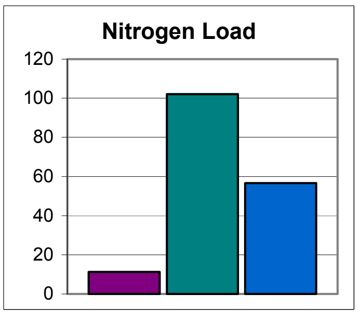
The removal efficiencies reflect the dual removal from the selected BMPs. The new storage volumes for water quality swales and bioretention are entered into the SET:

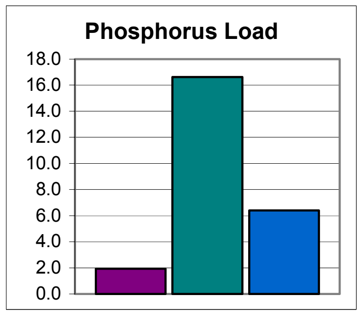
	Storage (ft^3)	
BMP Class	User-Entry	SET Estimated
Wet Pond		0
Stormwater Wetland		0
Extended Dry Detention		0
Bioretention	2,500	2,488
Sand Filter (DE Design)		0
Infiltration Trench		0
WQ Swale (MD Design)	14,100	13,995
Green Roof		0
Permeable Pavement		0
Cistern/Rain Barrels		0
User-defined BMP		(user entry)

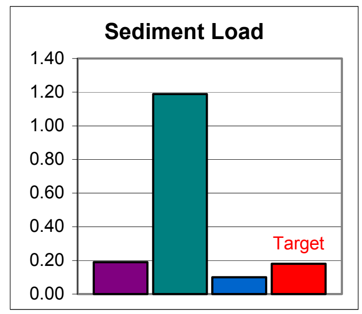
The combination of a decrease in impervious area and an increase in overall BMP pollutant removal efficiency has led to a project that meets the 3.6 lb/ac/yr total nitrogen goal, and offers better overall pollutant removal. The next logical question is how the costs of each approach differ. This example is continued in Section 3.3 to show how that question can be answered.

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	11	102	57		
Total Phosphorus (lb/yr)	1.9	16.6	6.4		
Sediment (ton/yr)	0.19	1.19	0.10	0.18	Yes

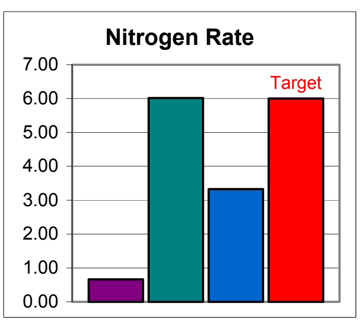


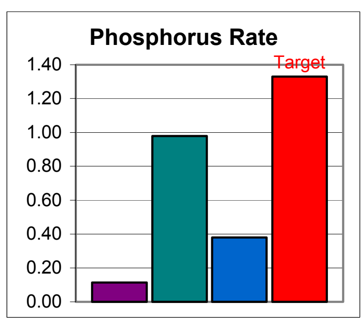


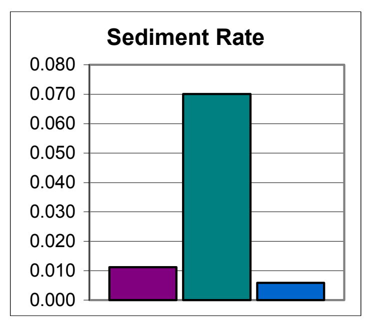


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	0.66	6.02	3.33	6.00	Yes
Total Phosphorus (lb/ac/yr)	0.11	0.98	0.38	1.33	Yes
Sediment (ton/ac/yr)	0.011	0.070	0.006		

Site is located in Urban Residential Nutrient Zone
TN loading rate is below the buy-down range of 3.6 to 6 lb/ac/yr

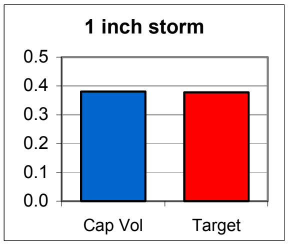






Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.077	0.378	0.381	0.378	Yes



Storm Event Not Selected

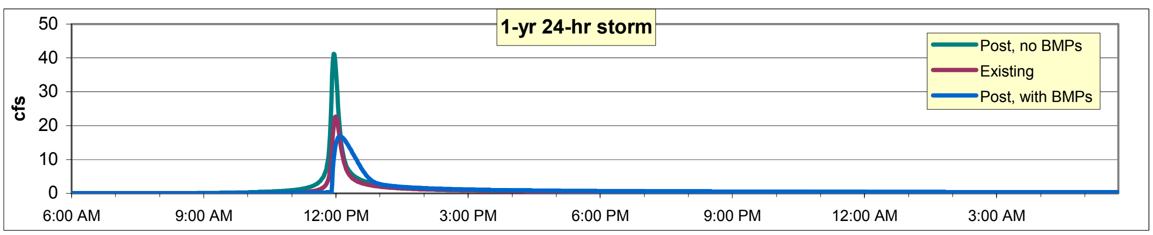
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	12.57	22.68	35.99	41.21

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	41.21	16.85	Estimated	22.68	Yes



3 Cost Component

3.1 Introduction to the Cost Component

The SET Cost Component estimates BMP costs to facilitate the preliminary selection of BMPs. The cost component allows a user to compare the costs of stormwater BMP systems and estimate the cost savings for reducing impervious surfaces within a site design. The tool was primarily designed for development applicants to assist them in determining the most cost-effective site designs and associated stormwater BMP systems.

The SET Cost Component addresses:

- Construction, design, and engineering costs for BMPs, treatment train connections, additional stormwater conveyance structures, and total site pavement,
- Inspection and maintenance costs for BMPs, and
- Opportunity cost of land devoted solely to BMPs (as a user-input).

To estimate BMP costs, SET users enter square feet of surface area, cubic feet of storage volume, or other whole BMP size units. The SET cost component reports a cost range, including design and engineering, to the right of the input. In a report sheet, the cost component displays the total site cost range, opportunity cost of land, inspection and maintenance cost range, and cost-effectiveness ratios, formatted for printing. The administrator, or distributor, of the SET Cost Component can update the cost data as new BMP cost data become available. The tool also provides options for user-defined costs.

During the stage of design at which the SET will be used, a user will not have accurate estimates of BMP components like excavation, soil mixture, gravel, and other materials. Therefore, the SET Cost Component estimates costs based on whole BMP size units. The tool also reports costs with lower and upper limits to express the uncertainty of using whole BMP sizes to estimate costs. The cost output should be used to choose BMP configurations and should not be used in place of more detailed budget estimates.

The SET Cost Component is an optional part of the SET. The user can use the SET Pollutant/Hydrology Component without using the cost component.

3.2 Using the Cost Component

3.2.1 Before Beginning

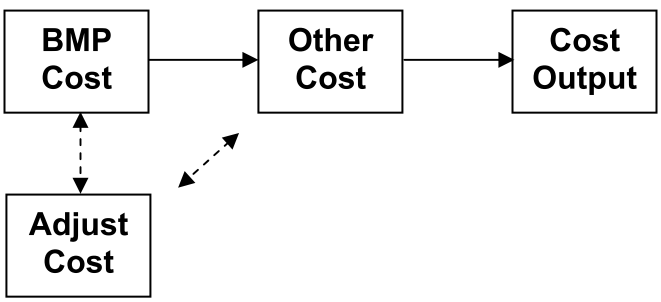
Before using the SET Cost Component, the following information is needed, most or all of which can be obtained from the preliminary development site plan:

1. The approximate total storage volume, up to the emergency spillway, of each wet pond and dry detention basin;
2. The approximate surface area of all BMPs;
3. The length of level spreaders;
4. The volume of infiltration trenches;
5. The estimated dimensions of stormwater conveyance in addition to the BMPs;
6. The estimated dimensions of all sidewalks, walking paths, roads, and parking lots;

7. Estimated total base construction cost of user-defined BMPs;
8. Specific type of BMP or structure, as outlined in the **BMP Cost** and **Other Cost** sheets;
9. A list of unit costs of BMPs, conveyance, and pavement, if you choose to define your own cost ranges; and
10. Knowledge of which BMPs will be constructed by your organization and which BMPS will be constructed by subcontractors.

3.2.2 General Notes

There are four sheets in the SET Cost Component:



The **BMP Cost, Other Cost, and Adjust Cost** sheets are used for data entry. The **Adjust Cost** sheet inputs are optional and are mainly used by the tool administrator, or distributor, to update cost data. The **Cost Output** sheet is for display of results only.

Blue colored cells denote where user input is required throughout the spreadsheet.

Input cells for the BMP size quantities are within the "Input" columns of the **BMP Cost** and **Other Cost** sheets. When entering quantities in an input sheet, look in the "Site Element" column for the row that applies to each type of BMP or other structure that you are using. Check that you have the correct units as stated in the "Unit" column (e.g., storage volume in CF). Enter the BMP quantity in the blue "Input" column. The cost range will appear in the "SET Cost Range" column. You can enter an alternative unit cost range in the "User-Defined Unit Cost" columns. Select the check box in the "Overhead and Profit" column if you wish to add overhead and profit to the cost range. Repeat these steps for each type of BMP or structure.

The SET Cost Component contains the following data entry aids to guide you through the process:

- The cost tool displays the message "Input Beyond Threshold" in the cost range column when an input is below or above the input range set in the Adjust Cost sheet.
- Some cells contain embedded comments that provide guidance. If you see a red triangle in the right hand corner of the cell, place your mouse pointer over the cell. The guidance will be displayed as long as the mouse pointer remains in the cell.

3.2.3 The *BMP Cost* Sheet

The **BMP Cost** sheet contains input fields for the following:

- Year of the project
- Dimensions of BMPs
- User-defined unit cost ranges for each BMP
- Checkboxes for adding overhead and profit to the cost range.

Enter desired year of project if different from current year. This input is used to adjust prices for inflation. The cost component automatically enters the current year in this cell when you open a blank copy of the SET. If you wish to estimate costs based on a different year, enter the desired year in the input cell, as shown in the following figure. You may also adjust the default inflation rate, as discussed in Section 3.2.5.

BMP Cost Estimation Quantities	Year	2005	(enter year if different from current year)
LF = linear feet SF = square feet CF = cubic feet			

Enter dimensions for each type of BMP. For the first five types of BMPs, enter the volume or surface area with the correct units (as specified in the "Units" column) for each individual BMP. For example, if a site uses two wet ponds, enter the storage volume of each pond separately across from Pond #1 and Pond #2. If you want to hide the unused rows, select the number of BMPs in the "Number" scroll down menu.

When the tool calls for storage volume, enter the volume of the pond up to the emergency spillway. For dry detention basins, storage volume is equal to the detention volume. For wet ponds, storage volume is equal to the permanent pool plus the detention volume.

For the remaining BMPs, enter the summed dimensions of all BMPs of each type. For example, if a site has 20 bioretention cells, sum the surface areas of the 20 cells and enter the total surface area.

You have two choices for bioretention based the imperviousness of your site. Use "Ultra-Urban Bioretention" if your site is highly impervious (i.e., greater than 85 percent impervious) and may require additional grading and structures beyond non-ultra-urban bioretention designs. Use "Not Ultra-Urban Bioretention" if your site will use bioretention cells typical of medium density residential developments.

Optional: Check the box to the right of each BMP input if you want to add overhead and profit to the cost (default rate is 31 percent). Overhead and profit should be added if you are hiring another firm for design and construction of the BMP.

Optional: Define a unit cost range that is different from the default cost range. Enter your preferred lower and upper limits under "User-Defined Unit Cost." Enter base unit construction cost only – the tool will add design and engineering to the cost. Enter the cost range limits in the same units as the default range. For example, the input for bioretention is in square feet (SF), so the user-defined unit cost range should be in $/SF.

The following figures show excerpts from the BMP Cost sheet.

Site Element	Unit		Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost		Overhead and Profit
					Lower	Upper	
Wet Pond	**Number:**	8					
Pond #1	Storage volume in CF						
Pond #2	Storage volume in CF						
Pond #3	Storage volume in CF						
Pond #4	Storage volume in CF						
Pond #5	Storage volume in CF						
Pond #6	Storage volume in CF						
Pond #7	Storage volume in CF						
Pond #8	Storage volume in CF						
Dry Detention (Extended)	**Number:**	8					
Basin #1	Storage volume in CF						
Basin #2	Storage volume in CF						
Basin #3	Storage volume in CF						
Basin #4	Storage volume in CF						
Basin #5	Storage volume in CF						
Basin #6	Storage volume in CF						
Basin #7	Storage volume in CF						
Basin #8	Storage volume in CF						
Dry Detention (Conventional)	**Number:**	8					
Basin #1	Storage volume in CF						
Basin #2	Storage volume in CF						
Basin #3	Storage volume in CF						
Basin #4	Storage volume in CF						
Basin #5	Storage volume in CF						
Basin #6	Storage volume in CF						
Basin #7	Storage volume in CF						
Basin #8	Storage volume in CF						
Stormwater Wetland	**Number:**	8					
Wetland #1	Surface area in SF						
Wetland #2	Surface area in SF						
Wetland #3	Surface area in SF						
Wetland #4	Surface area in SF						
Wetland #5	Surface area in SF						
Wetland #6	Surface area in SF						
Wetland #7	Surface area in SF						
Wetland #8	Surface area in SF						
Sand Filter (DE Design)	**Number:**	8					
Sand Filter #1	Surface area in SF						
Sand Filter #2	Surface area in SF						
Sand Filter #3	Surface area in SF						
Sand Filter #4	Surface area in SF						
Sand Filter #5	Surface area in SF						
Sand Filter #6	Surface area in SF						
Sand Filter #7	Surface area in SF						
Sand Filter #8	Surface area in SF						

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost		Overhead and Profit
				Lower	Upper	
Veg. Filter Strip with Level Spreader						
a. Veg. Filter Strip: Seeded	Surface area in SF					
b. Veg. Filter Strip: Sodded	Surface area in SF					
c. Level Spreader (not concrete)	Length in LF					
Forest Buffer						
a. Existing buffer area beyond 50-foot buffer	Surface area in acres					
b. Restored Buffer	Surface area in acres					
Permeable pavement						
a. Grass/gravel parking reinforced with plastic grid	Surface area in SF					
b. Porous Concrete	Surface area in SF					
c. Porous Asphalt	Surface area in SF					
d. Honeycomb Pavers	Surface area in SF					
e. Other (TBD)	Surface area in SF					
f. Other (TBD)	Surface area in SF					
g. Other (TBD)	Surface area in SF					
Green Roofs						
a. Extensive: no public access	Surface area in SF					
b. Intensive: public access	Surface area in SF					
Cisterns and Rain Barrels						
a. Galvanized Steel (Small, 27 CF units)	Storage volume in CF					
(Large, 267 CF units)	Storage volume in CF					
b. Polyethylene (Small, 22 CF units)	Storage volume in CF					
(Large, 241 CF units)	Storage volume in CF					
c. Fiberglass (Small, 47 units)	Storage volume in CF					
(Large, 1337 CF units)	Storage volume in CF					
d. Fiberglass/Steel Composite (Small, 40 CF units)	Storage volume in CF					
(Large, 668 CF units)	Storage volume in CF					
e. Rainbarrels (9 CF units)	Storage volume in CF					
Bioretention (ultra-urban)						
	Surface area in SF					
Bioretention (not ultra-urban)						
	Surface area in SF					
Water Quality Swale (MD Design)						
	Filter Media area in SF					
Grass Swale						
	Swale surface area in SF					
Infiltration Trench						
	Storage volume in CF					
Other BMP (TBD)						
	TBD					
Other BMP (TBD)						
	TBD					
Other BMP (TBD)						
	TBD					

3.2.4 The *Other Cost* Sheet

The **Other Cost** sheet contains input fields for the following:

- Dimensions of additional stormwater conveyance
- Dimensions of pavement
- User-defined unit cost ranges for additional stormwater conveyance and pavement
- Costs of User-Defined BMPs
- Area and unit cost relating to opportunity cost of land
- Checkboxes for adding overhead and profit to cost range.

Enter the dimensions of additional stormwater conveyance and pavement. Two inputs are required for pipes and trenches. For pipes, enter the diameter in inches and the length in linear feet as indicated to the left of the input cell. For trenches, enter the depth and length in feet. The cost range will appear as zero if the length is not entered and blank if the diameter or depth is not entered.

If "Beyond Input Threshold" appears to the right of the input, the diameter or depth is not within the range specified in the default cost data. Either enter a different input or enter a user-defined unit cost for your desired depth or diameter. If your trench width is different from the default widths, you also may choose to enter a user-defined unit cost. See the optional step below for a more detailed description of user-defined unit costs.

One input is required for each of the remaining stormwater conveyance and pavement types. An extra row entitled "User-Defined" allows you to enter the dimension input and unit cost range for one additional type of stormwater conveyance.

Enter the total cost range of user-defined BMPs and indicate choice for overhead and profit. Enter the total cost, not the unit cost, for any BMPs you defined in the **User BMP** sheet. Select the check box if you wish to add overhead and profit to the cost. **Enter base construction cost only – the tool will automatically add design and engineering to the cost.**

Enter the area for opportunity cost of land and enter optional user-defined cost range. Identify which BMPs exist on land devoted solely to BMPs. For example, a dry detention basin with no public access serves a sole purpose of stormwater control and treatment and does not provide a recreational or other use. Enter the total area of land devoted to such BMPs.

Next, identify the BMPs that share land with other uses. This category includes any BMP that will serve an additional use beyond stormwater control and treatment. For example, green roofs share land with building uses, and bioretention areas provide aesthetic landscaping. Enter the total area of land devoted to such BMPs.

These land area inputs will be reported in the **Cost Report** sheet so that you can compare the results of different BMP configurations. The final step is optional: if you wish to consider the opportunity cost of using land solely for BMPs, enter a unit cost range that reflects the value of land on your development site. The cost range should represent the lost profit from using the land solely for stormwater control instead of building an additional home site or commercial space. Enter the cost range in $/SF.

Optional: Define a unit cost range that is different from the default cost range. Enter your preferred lower and upper limits under "User-Defined Unit Cost." For pipes and trenches, enter the cost range in $/linear foot ($/LF). For your own reference, enter the depth or diameter that pertains to the unit cost range – the cost component will not use depth or diameter to calculate the pipe or trench cost ranges.

For the remaining structures and pavements, enter the cost range limits in the same units as the default range. For example, the input for street or parking lot is in SF, so the user-defined unit cost range should be in $/SF. **Enter base unit construction cost only – the tool will add design and engineering to the cost.**

Optional: Check the box to the right of each BMP input if you want to add overhead and profit to the cost (default rate is 31 percent). Overhead and profit should be added if you are hiring another firm for design and construction of the structure.

Other Cost Estimation Quantities

Hydrology/Pollutant Component

LF = linear feet VF = vertical feet SF = square feet CY = cubic yards

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost		Overhead and Profit
				Lower	Upper	
Additional Stormwater Conveyance						
Pipes						
a. Corrugated metal pipe, galvanized and coated	Diameter in inches					
	Length in LF					
b. Galvanized, uncoated, 20' lengths	Diameter in inches					
	Length in LF					
c. Piping, drainage & sewage, corrugated HDPE Type S	Diameter in inches					
	Length in LF					
d. Reinforced Concrete Pipe, Class 3, no gaskets	Diameter in inches					
	Length in LF					
Trench (includes excavation, backfill around pipe, and compaction)						
a. 2-Foot Wide	Depth in VF					
	Length in LF					
b. 4-Foot Wide	Depth in VF					
	Length in LF					
Other Conveyence Costs						
Curb and Gutter	Length in LF					
Catch Basins	Number of units					
Rip Rap	Volume of material in CY					
Other (TBD)	TBD					
User Defined						
Total Site Pavement Costs						
Street or Parking Lot - asphalt	Surface area in SF					
Sidewalks - cement, 3-foot width	Length in LF					
Sidewalks - cement, 4-foot width	Length in LF					
Sidewalks - cement, 5-foot width	Length in LF					
Sidewalks - asphalt, 3-foot width	Length in LF					
Sidewalks - asphalt, 4-foot width	Length in LF					
Sidewalks - asphalt, 5-foot width	Length in LF					
User-Defined BMPs						
a. BMP 1	Total Construction Cost of BMP in $					
b. BMP 2	Total Construction Cost of BMP in $					
c. BMP 3	Total Construction Cost of BMP in $					
d. BMP 4	Total Construction Cost of BMP in $					
Opportunity Cost of Land						
Land area devoted solely to BMPs	SF					
Land area shared by BMPs and other land uses	SF					
Estimated opportunity cost of land (optional)	$/SF					

3.2.5 The *Adjust Cost* Sheet

The **Adjust Cost** sheet contains input fields for the following default parameters:

- Inflation rate,
- Design and engineering rate,
- Project duration and discount rate, relating to maintenance costs,
- Construction cost data,
- Overhead and profit rate, and
- Inspection and maintenance cost data.

Inputs in this sheet are optional.

You can adjust the following parameters, as shown in the figure below:

Adjust inflation rate (default is 3 percent). Enter rate as a proportion. For example, 3 percent inflation should be entered as 0.03.

Adjust design and engineering rate (default is 25 percent). Enter the rate as a proportion. For example, 25 percent inflation should be entered as 0.25.

Adjust length of project duration (default is 20 years). You should only adjust the project duration if 1) unit maintenance costs are specified, or 2) the maintenance percent rates are updated and apply to a different project duration than the default.

The cost component uses project duration if unit maintenance costs (as opposed to percent rates of construction cost) are entered in the **Adjust Cost** sheet. The length of project duration specifies how many years of maintenance costs will be accrued. You should enter the approximate number of years that the BMPs will be maintained. You may consider, for the project duration, the length of time until a major structural replacement since the cost component does not consider major replacement costs. You also may consider the length of time that your organization will be responsible for the maintenance of the BMPs.

If unit maintenance costs are not specified, the project duration is still displayed in the **Cost Report** sheet so that the user knows how many years of inspection and maintenance costs were estimated.

Adjust discount rate (default is 10 percent). Enter the rate as a proportion. This input is only used if unit maintenance costs (as opposed to percent rates of construction cost) are entered in the **Adjust Cost** sheet. When maintenance costs are summed over the project term, the costs are discounted each year. The discounting accounts for the fact that funds can be invested in other projects before inspection and maintenance costs accrue. If you do not wish to discount the maintenance costs, enter "0" for this input.

Rates and Indices				Project Duration	20
Inflation	0.03	Design and Engineering	0.25	Discount Rate	0.1

The following inputs should only be adjusted by the administrator, or distributor, of the tool. When updating any cost data, the administrator needs to update the reference and year columns as specified below. This part of the adjust cost sheet is password protected. If these inputs are changed, the version number of the SET should be updated.

Adjust construction cost data for BMPs with economies of scale. The unit costs for the following BMPs tend to decrease with increasing size: wet ponds, dry detention basins, stormwater wetlands, and sand filters. Therefore, the cost component uses increments of size and cost for these BMPs. When the administrator wants to update the cost of these BMPs, he or she will need to enter the size range associated with each cost range. The administrator should enter the cost ranges as total cost, not unit cost. For example, the wet pond costs can be updated by entering a range of storage volumes in the "Quantity" lower and upper columns and the associated range shown below.

Site Element	Unit	Quantity		Construction Cost	
		Lower	Upper	Lower	Upper
BMPs					
Wet Pond				$/BMP	$/BMP
	Storage Volume in CF	5,554	8,812	$11,810	$16,101
	Storage Volume in CF	8,812	13,700	$16,101	$21,654
	Storage Volume in CF	13,700	21,696	$21,654	$29,487
	Storage Volume in CF	21,697	34,433	$29,487	$40,209
	Storage Volume in CF	34,434	53,317	$40,209	$53,930
	Storage Volume in CF	53,317	83,308	$53,930	$72,775
	Storage Volume in CF	83,309	130,553	$72,775	$98,399
	Storage Volume in CF	130,554	204,383	$98,399	$132,954
	Storage Volume in CF	204,384	318,423	$132,955	$179,063
	Storage Volume in CF	318,424	496,148	$179,064	$241,180
	Storage Volume in CF	496,148	777,545	$241,181	$326,108
	Storage Volume in CF	777,546	1,221,857	$326,108	$441,747
	Storage Volume in CF	1,221,858	1,888,325	$441,747	$591,732
	Storage Volume in CF	1,888,326	2,925,053	$591,732	$793,867
	Storage Volume in CF	2,925,054	4,554,197	$793,868	$1,068,717
	Storage Volume in CF				
	Storage Volume in CF				
	Storage Volume in CF				
	Storage Volume in CF				
	Storage Volume in CF				

Adjust construction cost data for BMPs without economies of scale. For the BMPs not specified above, the administrator only needs to update the unit cost data. The administrator should enter the lower and upper limits as shown in the following figure.

Site Element	Unit	Quantity Lower	Quantity Upper	Construction Cost Lower	Construction Cost Upper
Veg. Filter Strip with Level Spreader				$/SF	$/SF
a. Veg. Filter Strip: Seeded	Surface area in SF			$0.15	$0.22
b. Veg. Filter Strip: Sodded	Surface area in SF			$0.35	$0.52
				$/LF	$/LF
c. Level Spreader (not concrete)	Length in LF			$5.10	$12.70
Forest Buffer				$/acre	$/acre
a. Existing buffer area beyond 50-foot buffer	Surface area in acres			$0.00	$0.00
b. Restored Buffer	Surface area in acres			$65.00	$88.00
Permeable pavement				$/SF	$/SF
a. Grass/gravel parking reinforced with plastic grid	Surface area in SF			$1.30	$5.10
b. Porous Concrete	Surface area in SF			$1.80	$5.80
c. Porous Asphalt	Surface area in SF			$0.40	$0.90
d. Honeycomb Pavers	Surface area in SF			$4.50	$8.90
e. Other (TBD)	Surface area in SF				
f. Other (TBD)	Surface area in SF				
g. Other (TBD)	Surface area in SF				
Green Roofs				$/SF	$/SF
a. Extensive: no public access	Surface area in SF			$8.00	$15.00
b. Intensive: public access	Surface area in SF			$16.00	$30.00

Adjust construction cost data for BMPs with two dimension inputs. As described under the **Other Cost** sheet, pipes and trenches require two dimension inputs. Therefore, when the administrator updates the cost data, he or she needs to specify a range of diameters or depths for each linear foot cost. The following figure provides an example of the pipe cost data.

Site Element	Unit	Quantity Lower	Quantity Upper	Construction Cost Lower	Construction Cost Upper
Additional Stormwater Conveyance					
Pipes					
a. Corrugated metal pipe, galvanized and coated				$/LF	$/LF
	Diameter in inches	8.0	10.2	$5.40	$7.30
	Diameter in inches	10.2	13.0	$7.30	$10.00
	Diameter in inches	13.0	16.6	$10.00	$13.60
	Diameter in inches	16.6	21.0	$13.60	$18.40
	Diameter in inches	21.0	26.6	$18.40	$24.80
	Diameter in inches	26.6	33.6	$24.80	$33.40
	Diameter in inches	33.6	42.6	$33.40	$45.30
	Diameter in inches	42.6	54.0	$45.30	$61.20
	Diameter in inches	54.0	69.0	$61.20	$83.70
	Diameter in inches	69.0	72.0	$83.70	$88.40

Adjust overhead and profit rate (default is 31 percent). The administrator should adjust the overhead and profit rate in the cell to the right of the construction cost ranges. This input is shown in the first column of the figure below.

Adjust inspection and maintenance cost data. The SET cost component allows inspection and maintenance costs to be estimated with two methods: 1) percent of base construction cost over the project duration, and 2) annual unit cost. For the first method, the default rate is 50 percent of the base construction cost over a 20-year project duration. When updating the percent rate, the administrator should enter the number of years that the percent represents in the "Project Duration" input. Although the cost component will not use the project duration in calculations with percent rate, the **Cost Report** sheet will report how many years the inspection and maintenance estimate represents.

The second method requires inputs of annual cost per unit (length, area, or volume, depending on BMP). If the annual unit cost is entered, the tool calculates inspection and maintenance by the annual unit cost. If the annual unit cost is left blank, the tool calculates inspection and maintenance by the percent rate.

The inspection and maintenance cost inputs are shown in the second, third, and fourth columns in the figure below. When updating the annual unit costs, the administrator needs to update the reference and year of maintenance price columns, as explained below.

Update Reference column. It is important to keep track of which reference sources are used for the cost data. When the administrator updates cost data, he or she needs to update the reference for that particular BMP or structure in the "Reference" column. If the maintenance cost data source is specific to that BMP or structure, the administrator may also specify the maintenance reference in the reference column. Use the column for a short citation only and then add the full reference to the **References** sheet. The "Reference" column is shown in the figure below.

Update Year columns for construction or inspection and maintenance cost data. Since prices change due to inflation, the administrator needs to specify the year that applies to the cost data. The SET will adjust the cost data in later years, based on the inflation rate. If the administrator updates the cost data for any BMP or structure, he or she needs to update the year that refers to that data. For example, if the administrator estimates that bioretention costs in 2005 range from $15 to $20 per square foot, then he or she should enter "2005" in the "Year of Construction Price" column. If the administrator estimates that annual maintenance costs for bioretention in 2004 range from $1 to $2 per square foot, then he or she should enter "2004" in the "Year of Maintenance Price" column. These columns are shown in the following figure.

Overhead and Profit	Maintenance (proportion of const. cost)	Maintenance ($/BMP size)		Reference	Year of Construction Price	Year of Maintenance Price
		Lower	Upper			
		$/CF	$/CF			
0.31	0.50			Wossink and Hunt, 2003	2004	2004

3.2.6 The *Cost Report* Sheet

The **Cost Report** worksheet is divided into three sections, "Opportunity Cost of Land," "Cost Summary," and "Cost-Effectiveness." The Excel print area has been pre-set to print all the results on one sheet, although you may print any area desired. Project, watershed, and scenario headings will appear automatically, according to inputs in the **Site Data** sheet.

The "Opportunity Cost of Land" section shows the inputs for land devoted solely to BMPs and land shared by BMPs and other land uses. This section shows the user-defined land unit cost and calculates the cost of land devoted solely to BMPs.

Upper Neuse Site Evaluation Tool - Cost Estimation Report

User Entry for Project
User Entry for Jurisdiction
User Entry for Scenario

Opportunity Cost of Land

	Land devoted solely to BMPs		Land shared by BMPs and other land uses
	Lower	Upper	
BMP Surface Area (acres)	0.00	0.00	0.00
User-defined Land Cost ($/acres)	$0	$0	
Cost of Land	$0	$0	

The "Cost Summary" section breaks out the Total Construction Cost into four subtotals: SET-defined BMPs, user-defined BMPs, additional stormwater conveyance, and pavement costs. The SET-defined BMPs category includes all BMPs listed in the **BMP Cost** sheet. User-defined BMP cost is the sum of the user-defined BMP costs entered in the **Other Cost** sheet. Additional Stormwater Conveyance and Pavement Costs are calculated from the respective **Other Cost** inputs. Total Infrastructure Construction Cost is the sum of these four subtotals.

Below the Total Infrastructure Construction Cost, the "Cost Summary" section displays the opportunity cost of land from the previous section, labeled as "Cost of Land Devoted Solely to BMPs." The total operation and maintenance cost over the project duration is also reported. These two subtotals are added to the Total Infrastructure Construction Cost to calculate the Overall Site Costs.

Cost Summary

Site Component	Lower	Upper
Construction Components		
SET-defined BMPs	$0	$0
User-defined BMPs	$0	$0
Additional Stormwater Conveyance	$0	$0
Pavement Costs	$0	$0
Total Infrastructure Construction Cost	$0	$0
Cost of Land Devoted Solely to BMPs	$0	$0
Inspection and Maintenance Cost (20 years)	$0	$0
Overall Site Costs	$0	$0

The "Cost-Effectiveness" section displays ratios of cost per pollutant removed. Cost-effectiveness ratios are calculated separately for total construction cost, maintenance cost over project duration, and overall site costs.

These figures are useful when comparing different BMP configurations for the same site design. For example, the BMP configuration with the lowest cost per pollutant removed provides the most pollutant removal per dollar spent. However, the most cost-effective measure may not always achieve required targets. When your site is required to achieve a pollutant-loading target, always check the annual pollutant load removed, as reported in the **Model Output** sheet of the SET Pollutant/Hydrology Component.

Cost Effectiveness of BMPs for Pollutant Removal

	Total Infrastructure Construction Cost		Inspection and Maintenance Cost		Overall Site Costs	
	Lower	Upper	Lower	Upper	Lower	Upper
Total Nitrogen ($/lb)	--	--	--	--	--	--
Total Phosphorus ($/lb)	--	--	--	--	--	--
TSS ($/ton)	--	--	--	--	--	--

3.3 EXAMPLE SITE DESIGN

The example site design discussed in the Hydrology/Pollutant Component in Section 2.3 was applied to the Cost Component to demonstrate how to estimate site costs and how to use SET cost estimates in the decision-making process. The BMP and infrastructure dimensions used in this example were estimated from the following sources: 1) information in the site design, 2) publicly available information on BMP sizing, 3) and a brief consultation with a stormwater engineer. These methods produced approximate figures for the purposes of comparing the relative costs of a conventional and innovative development design.

As described in the Pollutant/Hydrology Component Site Example, the SET user produces two development designs: one conventional and one innovative. The user estimates the cost of the conventional design first. The first step in the cost estimation process is to enter the BMP Quantities in the **BMP Cost** sheet. Two wet ponds are used in the conventional design. The user enters the estimated volume of each pond under the input column.

After entering the volume of each pond, the user checks the overhead and profit box because -- for this particular development site -- a company other than the developer will design and build the wet ponds.

BMP Cost Estimation Quantities — Year: 2005 (enter year if different from current year) — Hydrology/Pollutant Component

LF = linear feet SF = square feet CF = cubic feet

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost Lower	User-Defined Unit Cost Upper	Overhead and Profit
Wet Pond	Number: 2					
Pond #1	Storage volume in CF	14,600	$34,794 - $47,380			☑
Pond #2	Storage volume in CF	16,400	$34,794 - $47,380			☑

Next, the user inputs the quantities of other stormwater infrastructure that is likely to be used on the site. Since the SET cost component is used to compare relative costs between development designs, it is not necessary to estimate the cost of all site infrastructure, just the facilities or materials that will differ between designs. In this example, the user enters the dimensions of storm drains, the total length of curb and gutter, and the number of catch basins. The overhead and profit boxes are left unchecked because the developer plans to design and construct the stormwater infrastructure without hiring a subcontractor.

Other Cost Estimation Quantities — Hydrology/Pollutant Component

LF = linear feet VF = vertical feet SF = square feet CY = cubic yards

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost Lower	User-Defined Unit Cost Upper	Overhead and Profit
Additional Stormwater Conveyance						
Pipes						
a. Corrugated metal pipe, galvanized and coated	Diameter in inches					☐
	Length in LF					
b. Galvanized, uncoated, 20' lengths	Diameter in inches					☐
	Length in LF					
c. Piping, drainage & sewage, corrugated HDPE Type S	Diameter in inches					☐
	Length in LF					
d. Reinforced Concrete Pipe, Class 3, no gaskets	Diameter in inches	24	$72,133 - $97,666			☐
	Length in LF	2,479				
Trench (includes excavation, backfill around pipe, and compaction)						
a. 2-Foot Wide	Depth in VF					☐
	Length in LF					
b. 4-Foot Wide	Depth in VF					☐
	Length in LF					
Other Conveyence Costs						
Curb and Gutter	Length in LF	5,000	$59,869 - $81,113			☐
Catch Basins	Number of units	36	$36,246 - $49,038			☐
Rip Rap	Volume of material in CY					☐
Other (TBD)	TBD					☐
User Defined						☐

After the stormwater infrastructure cost is estimated, the user estimates the site pavement costs. The surface area of the street and the length of sidewalks are estimated and entered into the appropriate input cell. Again, the overhead and profit boxes are left unchecked because the developer plans to design and construct the pavement without hiring a subcontractor.

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost		Overhead and Profit
				Lower	Upper	
Total Site Pavement Costs						
Street or Parking Lot - asphalt	Surface area in SF	77,760	$2,917 - $3,946			
Sidewalks - cement, 3-foot width	Length in LF					
Sidewalks - cement, 4-foot width	Length in LF					
Sidewalks - cement, 5-foot width	Length in LF	4,860	$96,987 - $132,028			
Sidewalks - asphalt, 3-foot width	Length in LF					
Sidewalks - asphalt, 4-foot width	Length in LF					
Sidewalks - asphalt, 5-foot width	Length in LF					

Finally, the opportunity cost of land is estimated. The user estimates that for each square foot of land used solely for BMPs, the developer will lose $1 to $2 in profit. This concludes the cost estimation inputs for the conventional design.

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost		Overhead and Profit
				Lower	Upper	
Opportunity Cost of Land						
Land area devoted solely to BMPs	SF	17,500				
Land area shared by BMPs and other land uses	SF					
Estimated opportunity cost of land (optional)	$/SF			$1.00	$2.00	

The user repeats the above steps for the innovative design as shown below. As discussed in the Hydrology/Pollutant Component example (Section 2.3), the innovative design uses a treatment train involving water quality swales and bioretention cells draining to two conventional dry detention basins. Each detention basin then drains to a vegetated filter strip with level spreader. The user estimates the appropriate BMP dimensions and enters them in the SET Cost Component. The overhead and profit boxes are left unchecked because the developer plans to design and construct the BMPs without hiring a subcontractor.

BMP Cost Estimation Quantities — Year: 2005 (enter year if different from current year) — Hydrology/Pollutant Component

LF = linear feet SF = square feet CF = cubic feet

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost		Overhead and Profit
				Lower	Upper	
Wet Pond	Number: 1					
Pond #1	Storage volume in CF					
Dry Detention (Extended)	Number: 1					
Basin #1	Storage volume in CF					
Dry Detention (Conventional)	Number: 2					
Basin #1	Storage volume in CF	10,575	$3,167 - $9,898			
Basin #2	Storage volume in CF	11,925	$3,167 - $9,898			
Stormwater Wetland	Number: 1					
Wetland #1	Surface area in SF					
Sand Filter (DE Design)	Number: 1					
Sand Filter #1	Surface area in SF					
Veg. Filter Strip with Level Spreader						
a. Veg. Filter Strip: Seeded	Surface area in SF					
b. Veg. Filter Strip: Sodded	Surface area in SF	1,000	$451 - $670			
c. Level Spreader (not concrete)	Length in LF	200	$1,313 - $3,270			
Bioretention (not ultra-urban)						
	Surface area in SF	3,350	$25,879 - $51,758			
Water Quality Swale (MD Design)						
	Filter Media area in SF	10,650	$41,136 - $68,559			

Since the innovative design uses water quality swales to treat and convey stormwater runoff from the roads, storm drain pipes are only needed as driveway culverts. Note that a smaller diameter pipe is assumed for the driveway culverts: 18 inches instead of 24 inches for the conventional storm drain. Curb and gutter and catch basins are not required.

Other Cost Estimation Quantities Hydrology/Pollutant Component

LF = linear feet VF = vertical feet SF = square feet CY = cubic yards

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost Lower	User-Defined Unit Cost Upper	Overhead and Profit
Additional Stormwater Conveyance						
Pipes						
a. Corrugated metal pipe, galvanized and coated	Diameter in inches					
	Length in LF					
b. Galvanized, uncoated, 20' lengths	Diameter in inches					
	Length in LF					
c. Piping, drainage & sewage, corrugated HDPE Type S	Diameter in inches					
	Length in LF					
d. Reinforced Concrete Pipe, Class 3, no gaskets	Diameter in inches	18	$23,944 - $32,517			
	Length in LF	1,148				
Trench (includes excavation, backfill around pipe, and compaction)						
a. 2-Foot Wide	Depth in VF					
	Length in LF					
b. 4-Foot Wide	Depth in VF					
	Length in LF					
Other Conveyence Costs						
Curb and Gutter	Length in LF					
Catch Basins	Number of units					
Rip Rap	Volume of material in CY					
Other (TBD)	TBD					
User Defined						

As discussed in the Pollutant/Hydrology example section, the streets in the innovative design are narrower than the conventional design, and the sidewalk was reduced to one side of the street. The reduced areas for street and sidewalk are entered accordingly.

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost Lower	User-Defined Unit Cost Upper	Overhead and Profit
Total Site Pavement Costs						
Street or Parking Lot - asphalt	Surface area in SF	53,460	$2,005 - $2,713			
Sidewalks - cement, 3-foot width	Length in LF					
Sidewalks - cement, 4-foot width	Length in LF					
Sidewalks - cement, 5-foot width	Length in LF	2,430	$48,494 - $66,014			
Sidewalks - asphalt, 3-foot width	Length in LF					
Sidewalks - asphalt, 4-foot width	Length in LF					
Sidewalks - asphalt, 5-foot width	Length in LF					

The land area devoted solely to BMPs includes the area of dry detention, level spreader, and vegetated filter strip. The land area shared by BMPs and other land uses includes water quality swales and bioretention cells because these BMPs are either incorporated into the road right-of-way or function as aesthetic landscaping. The same user-defined opportunity cost is assumed for both the conventional and innovative designs.

Site Element	Unit	Input	SET Cost Range (Construct./Design/Engineering)	User-Defined Unit Cost Lower	User-Defined Unit Cost Upper	Overhead and Profit
Opportunity Cost of Land						
Land area devoted solely to BMPs	SF	21,500				
Land area shared by BMPs and other land uses	SF	14,000				
Estimated opportunity cost of land (optional)	$/SF			$1.00	$2.00	

Once the inputs are completed for the conventional and innovative development designs, the user then compares the two cost estimation reports in the **Cost Report** sheets. The first section "Opportunity Cost of Land" shows that the innovative design produces a higher opportunity cost of land. The innovative design has a higher opportunity cost because more land is used solely for BMPs than in the conventional design.

Upper Neuse Site Evaluation Tool - Cost Estimation Report

Example Site
Durham City, Falls Lake
Conventional Site Design

Opportunity Cost of Land

	Land devoted solely to BMPs		Land shared by BMPs and other land uses
	Lower	Upper	
BMP Surface Area (acres)	0.40	0.40	0.00
User-defined Land Cost ($/acres)	$43,560	$87,120	
Cost of Land	$17,500	$35,000	

Upper Neuse Site Evaluation Tool - Cost Estimation Report

Example Site
Durham City, Falls Lake
Innovative Site Design

Opportunity Cost of Land

	Land devoted solely to BMPs		Land shared by BMPs and other land uses
	Lower	Upper	
BMP Surface Area (acres)	0.49	0.49	0.32
User-defined Land Cost ($/acres)	$43,560	$87,120	
Cost of Land	$21,500	$43,000	

The user can then compare the costs of the BMPs. Under "Cost Summary" in the **Cost Report** sheet, the innovative design BMPs are slightly more expensive than the BMPs in the conventional design. The conventional design BMPs are estimated to cost between $70,000 and $95,000, while the innovative BMPs are estimated to cost between $75,000 and $144,000. The ranges overlap, which indicates that the BMP costs of the designs could be similar in reality; but with an upper limit of $144,000, the innovative BMPs are likely to be more expensive.

Next, the user compares the stormwater conveyance and pavement costs. The range in costs for the conventional design is substantially higher than the innovative design for both these categories. This leads to an overall innovative design cost estimate that is much less expensive than the overall conventional design, as shown by comparing the overall site costs. The costs include infrastructure, opportunity cost, and inspection and maintenance.

Cost Summary (Conventional Site Design)

Site Component	Lower	Upper
Construction Components		
SET-defined BMPs	$69,587	$94,759
User-defined BMPs	$0	$0
Additional Stormwater Conveyance	$168,247	$227,817
Pavement Costs	$99,904	$135,974
Total Infrastructure Construction Cost	$337,739	$458,551
Cost of Land Devoted Solely to BMPs	$17,500	$35,000
Inspection and Maintenance Cost (20 years)	$125,790	$170,765
Overall Site Costs	$481,029	$664,316

Cost Summary (Innovative Site Design)

Site Component	Lower	Upper
Construction Components		
SET-defined BMPs	$75,113	$144,053
User-defined BMPs	$0	$0
Additional Stormwater Conveyance	$23,944	$32,517
Pavement Costs	$50,499	$68,727
Total Infrastructure Construction Cost	$149,556	$245,297
Cost of Land Devoted Solely to BMPs	$21,500	$43,000
Inspection and Maintenance Cost (20 years)	$58,080	$95,261
Overall Site Costs	$229,136	$383,558

When the user compares the cost effectiveness of the two designs, the innovative design is more cost effective at removing all three modeled pollutants. In other words, the innovative design costs less than the conventional design per unit of pollutant removed.

The overall site cost estimates are useful to most SET users since these figures include all costs considered. By comparing these costs, the user can tell which design is likely to be less expensive overall. This comparison can be used by decision makers who are accounting for the costs of all parties involved in the project.

The SET Cost Component reports infrastructure costs separately from the inspection and maintenance costs in the event that overall costs will be born by more than one party. In the example shown here, the developer will be paying for the construction, design, and engineering of the site, so the developer will look at the cost and cost-effectiveness under total infrastructure cost. The developer will also consider the opportunity cost of land. For the developer, the innovative site design is the less expensive option. It is assumed for this example that the county will bare the inspection and maintenance costs; therefore, a county representative would compare the inspection and maintenance costs between designs and determine that the most cost-effective design from the county's perspective is also the innovative design. For both parties, the SET Cost Component illustrates that the innovative design is less costly and more cost-effective than the conventional design.

Cost Effectiveness of BMPs for Pollutant Removal (Conventional Site Design)

	Total Infrastructure Construction Cost		Inspection and Maintenance Cost		Overall Site Costs	
	Lower	Upper	Lower	Upper	Lower	Upper
Total Nitrogen ($/lb)	$594	$806	$221	$300	$846	$1,168
Total Phosphorus ($/lb)	$2,296	$3,117	$855	$1,161	$3,270	$4,515
TSS ($/ton)	$14,433	$19,596	$5,376	$7,298	$20,557	$28,390

Cost Effectiveness of BMPs for Pollutant Removal (Innovative Site Design)

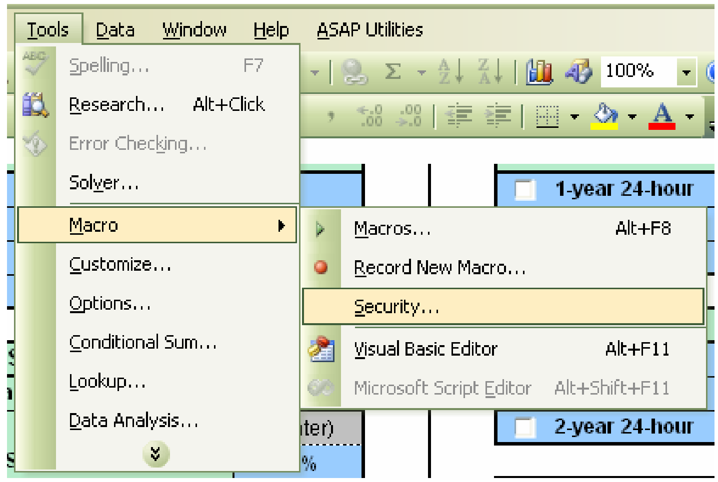
	Total Infrastructure Construction Cost		Inspection and Maintenance Cost		Overall Site Costs	
	Lower	Upper	Lower	Upper	Lower	Upper
Total Nitrogen ($/lb)	$164	$269	$64	$105	$252	$421
Total Phosphorus ($/lb)	$731	$1,200	$284	$466	$1,121	$1,876
TSS ($/ton)	$6,860	$11,252	$2,664	$4,370	$10,511	$17,594

Appendix A. Macro Security in the SET

The SET makes extensive use of Microsoft Visual Basic for Applications (VBA) script, both for navigation and for more complicated internal calculations. The use of these "macros" is essential to the SET. However, macros are also a potential vehicle for malicious code, and there are a number of settings built into Excel that allow the user to tailor the level of security.

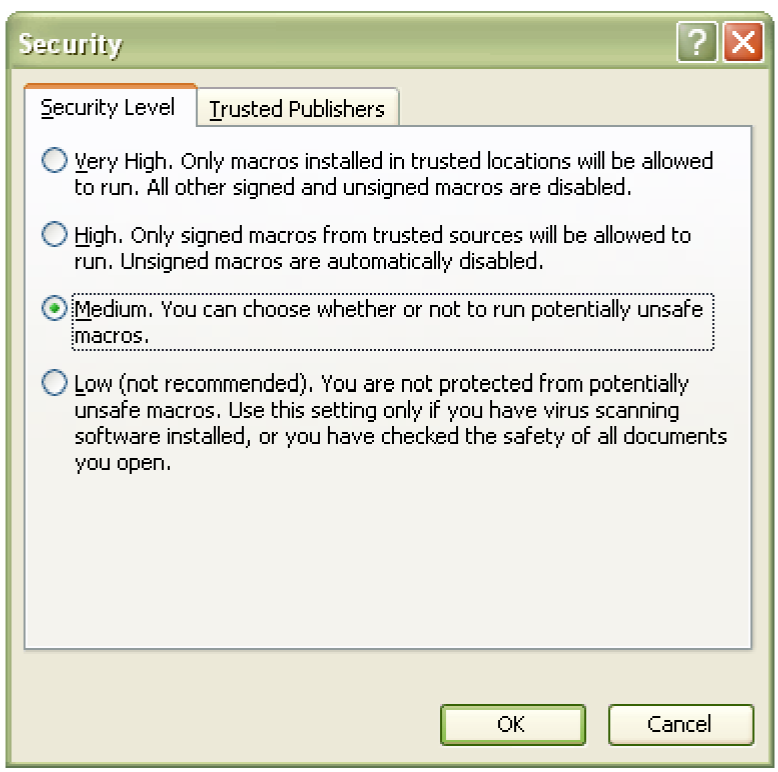
One of these settings (frequently enabled by default in Excel) prevents all macros from running, and also may not warn the user that macros are disabled. In the case of the SET, the user cannot proceed past the initial input screen.

To enable the SET to use its VBA Script, please make the following changes to your Excel security settings. On the menu, select **Tools**, choose **Macro**, and then choose **Security…** In the window that opens, select the **Security Level** tab.



Select the button next to **Medium**, and click the **OK** button. Now when you open the SET, you should be given a choice to enable macros. You must enable macros for the SET to operate properly.

The **Security Level** will remain set to **Medium** even after you close the SET – this setting applies to Excel as a whole, not just the SET. You may change the **Security Level** to a higher setting after you have finished using the SET, but you would need to reset it to **Medium** whenever you use the SET.



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