GRTS Model Training

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TETRA TECH, INC.

What Will You Learn?

- STEPL model
  1. Create an Excel Model
  2. Use on-line input data server (for initial model setup and exercise only; for your projects, collect and use real data!!!)
  3. Use BMP calculator
- R5 model (a simple Excel model not just for Region 5)
- Special discussion and feedback

Part 1: STEPL

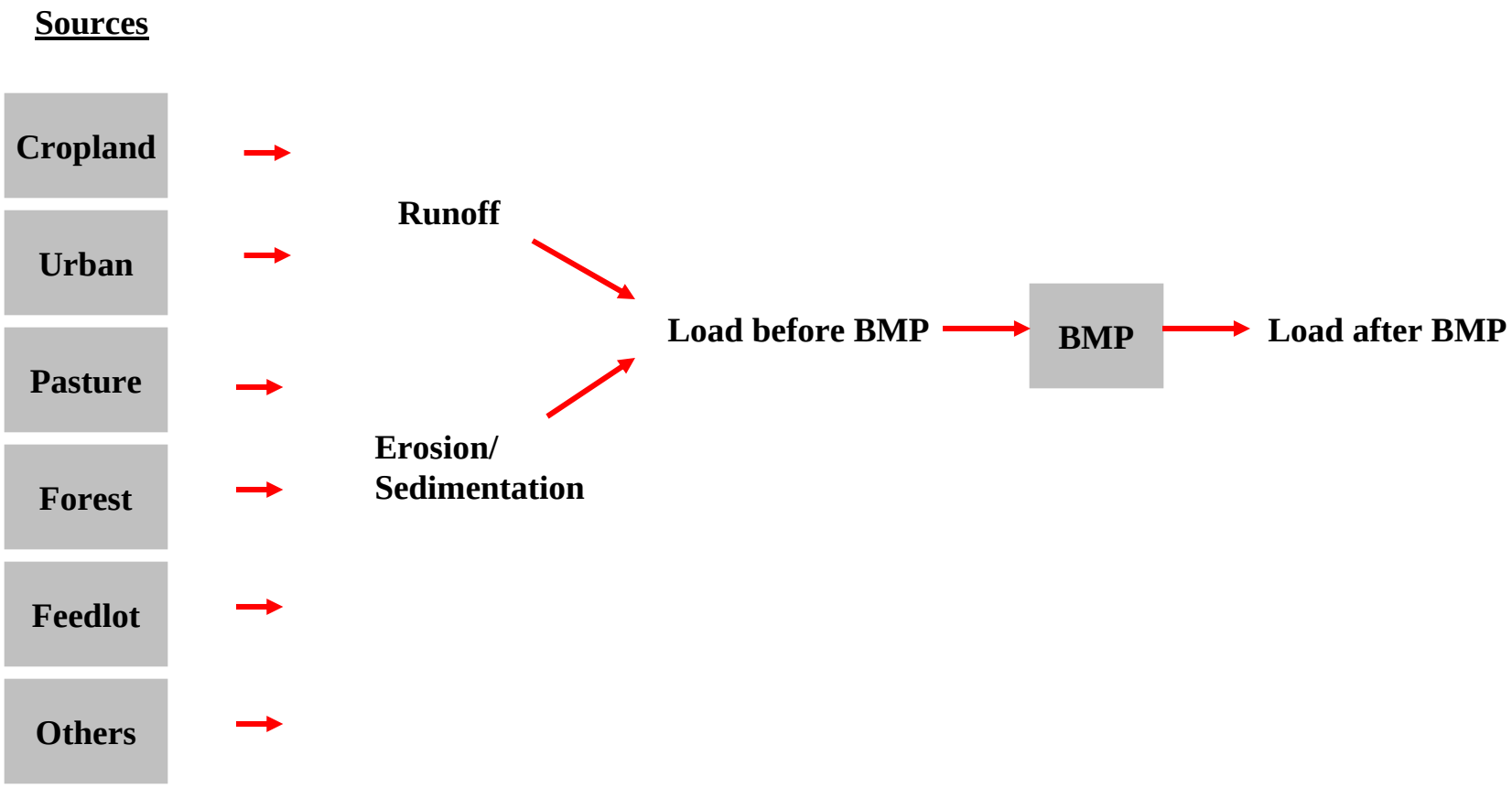
What is STEPL?

- Calculates nutrient (N, P, and BOD pollutants) and sediment loads by land use type and aggregated by watershed
- Calculates load reductions as a result of implementing BMPs
- Data driven and highly empirical
- A customized MS Excel spreadsheet model
  - Simple and easy to use
  - Formulas and default parameter values can be modified by users (optional) with no programming required

STEPL Users?

- Basic understanding of hydrology, erosion, and pollutant loading processes
- Knowledge (use and limitation) of environmental data (e.g., land use, agricultural statistics, and BMP efficiencies)
- Familiarity with MS Excel and Excel Formulas

Process


Sources
Cropland
Urban
Pasture
Forest
Feedlot
Others
Runoff
Erosion/
Sedimentation
Load before BMP
BMP
Load after BMP
STEP 1
STEP 2
STEP 3
STEP 4

STEPL Web Site

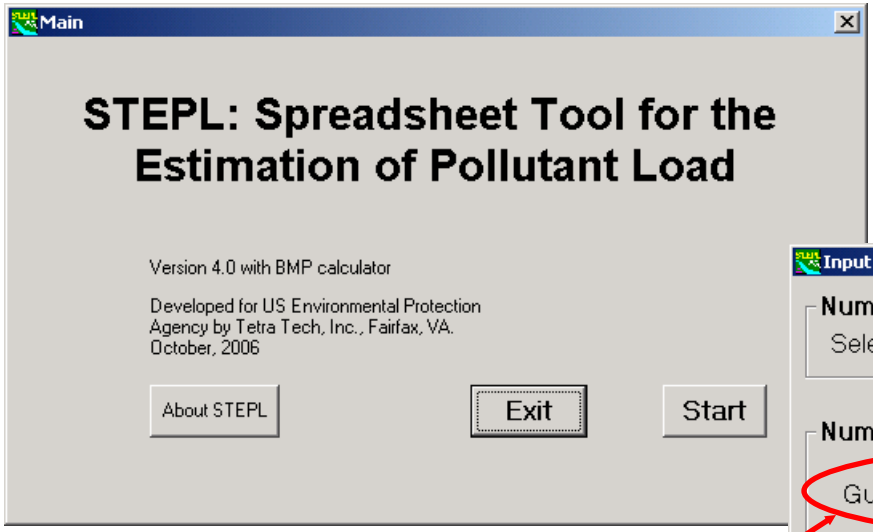
Link to on-line Data server

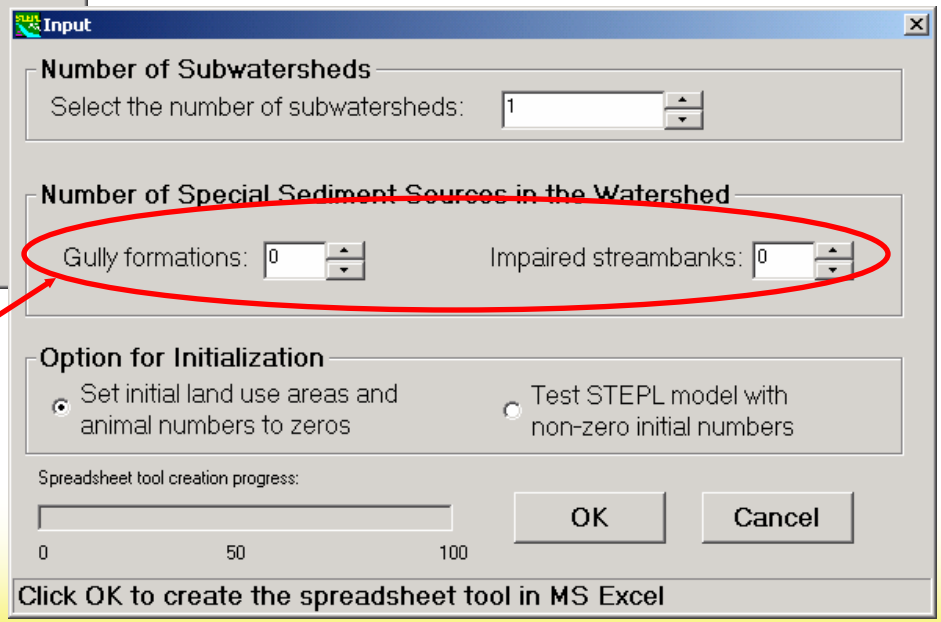
Link to download setup program to install STEPL program and documents

Temporary URL: http://it.tetratech-ffx.com/stepl until moved to EPA server

STEPL Main Program

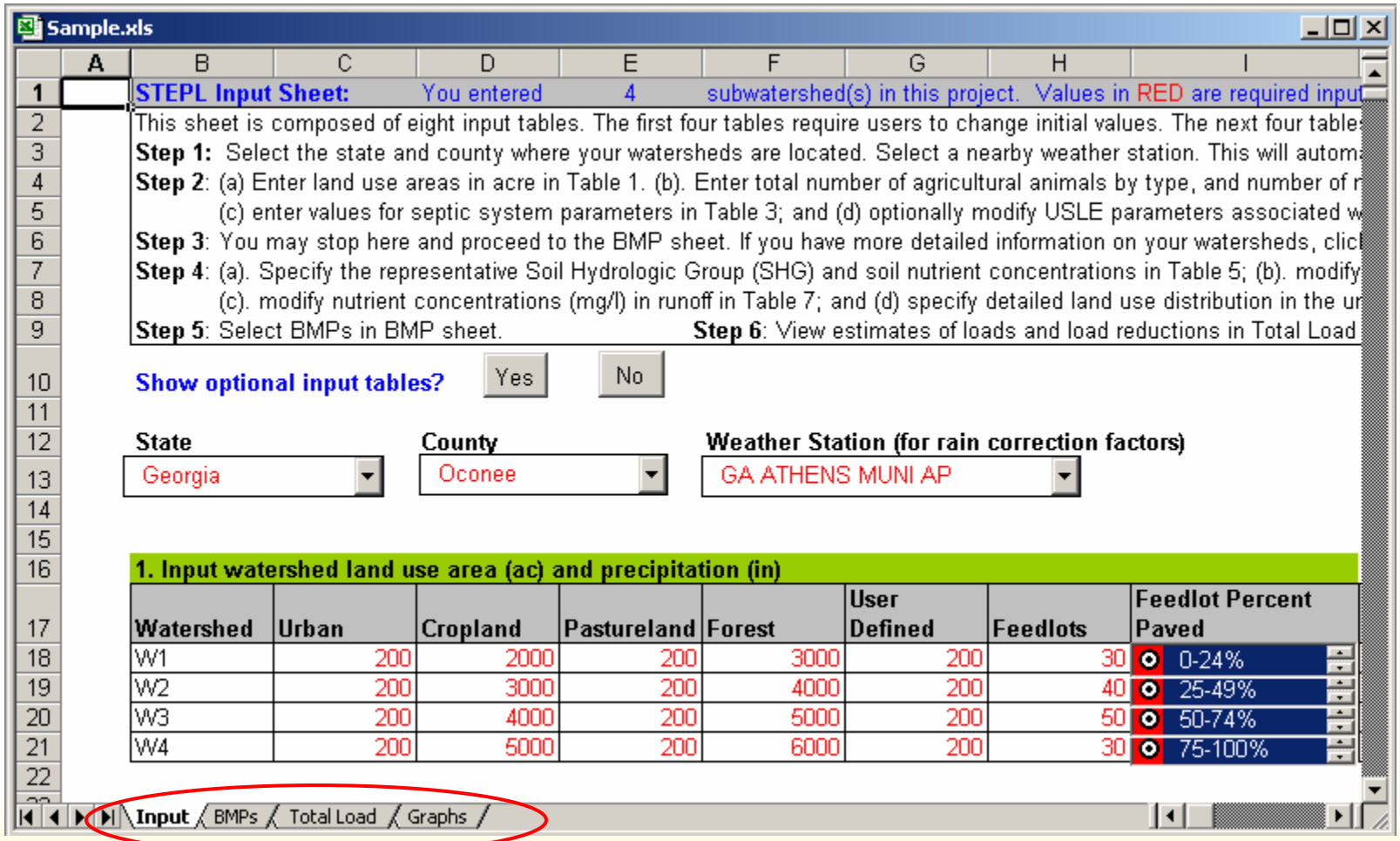
- Run STEPL executable program to create and customize spreadsheet dynamically





New features

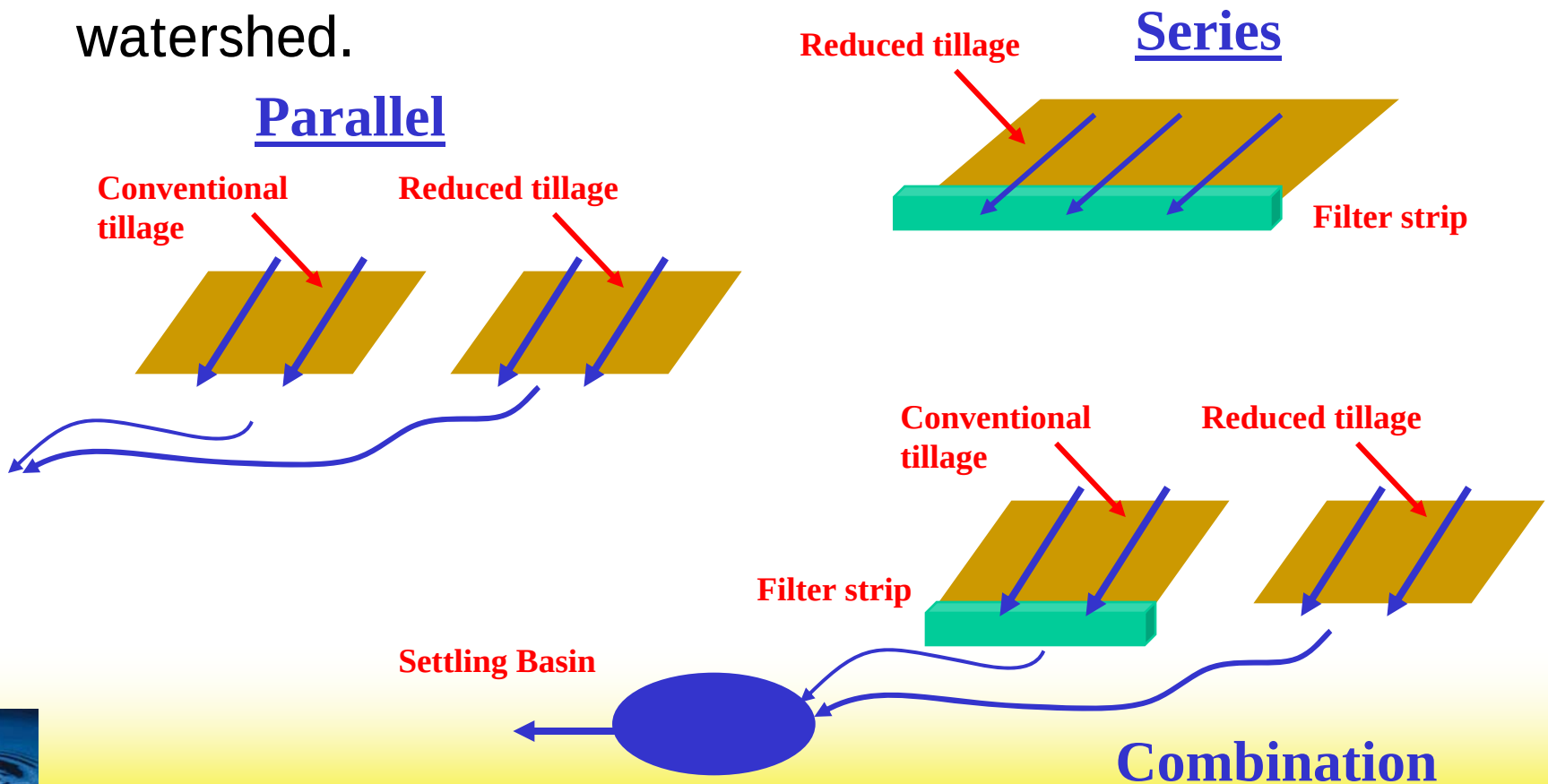
STEPL Spreadsheet



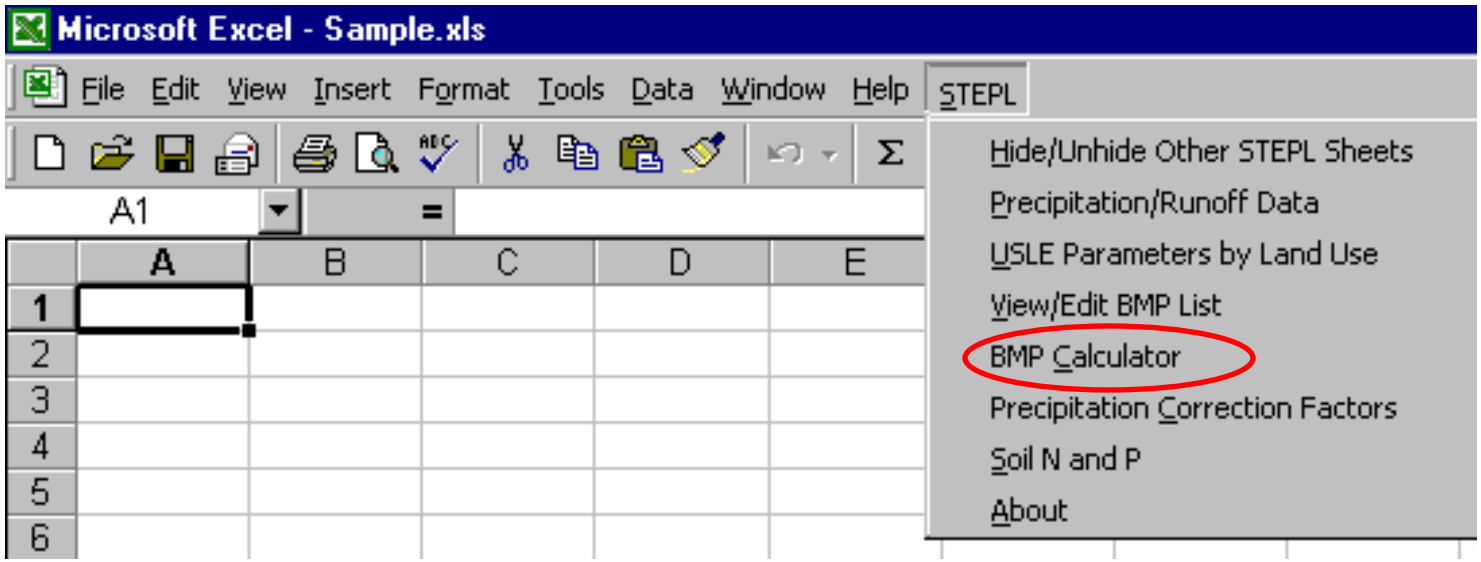
Composed of four worksheets

STEPL BMP Calculator

- Calculates combined efficiency of a BMP train for a given land use. The use of BMP calculator requires the understanding of BMPs and their placement in the watershed.



Customized Menu

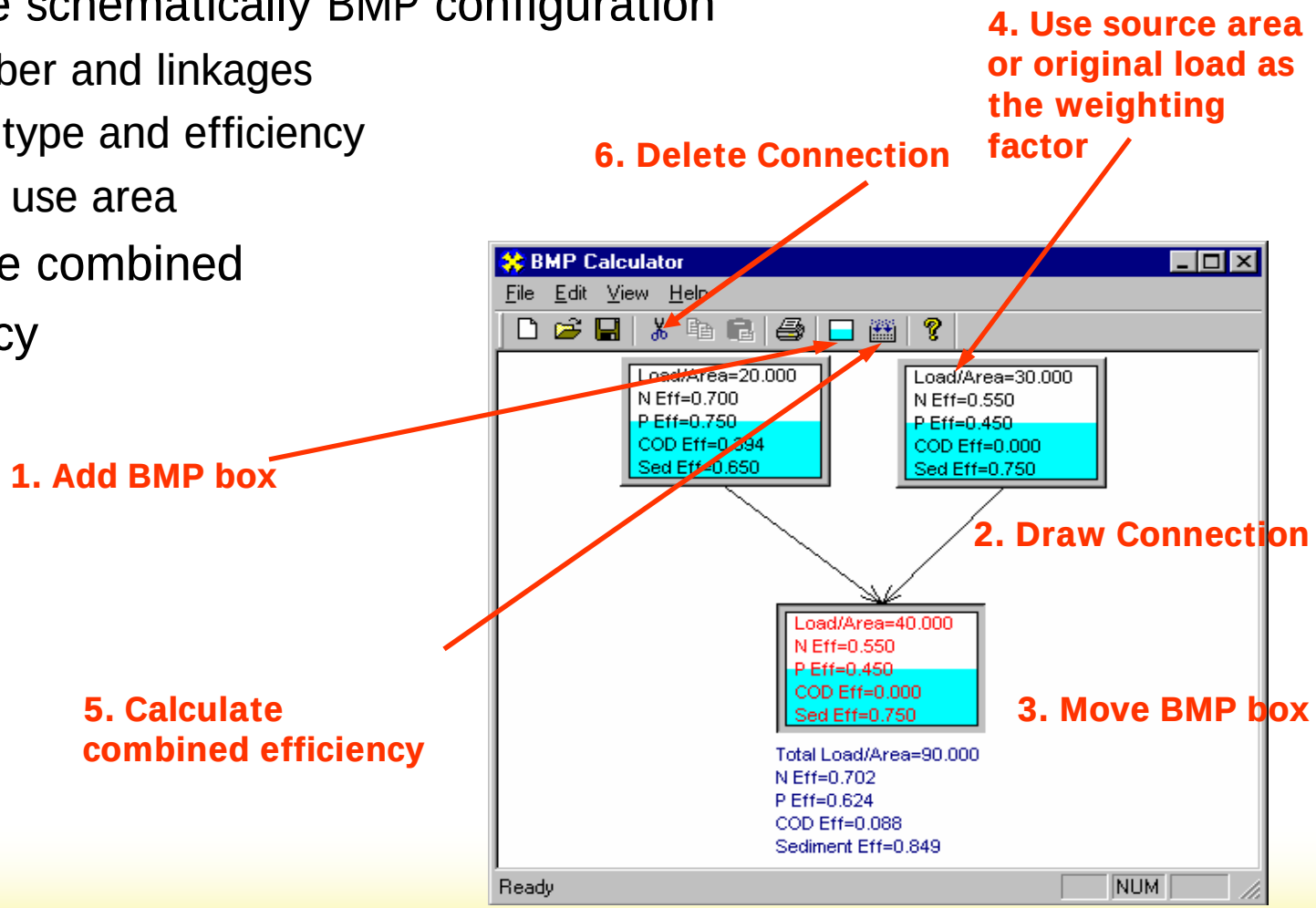


Tip: To ensure that files are linked to the customized menu, set Excel default file location to C\STEPL or D:\STEPL

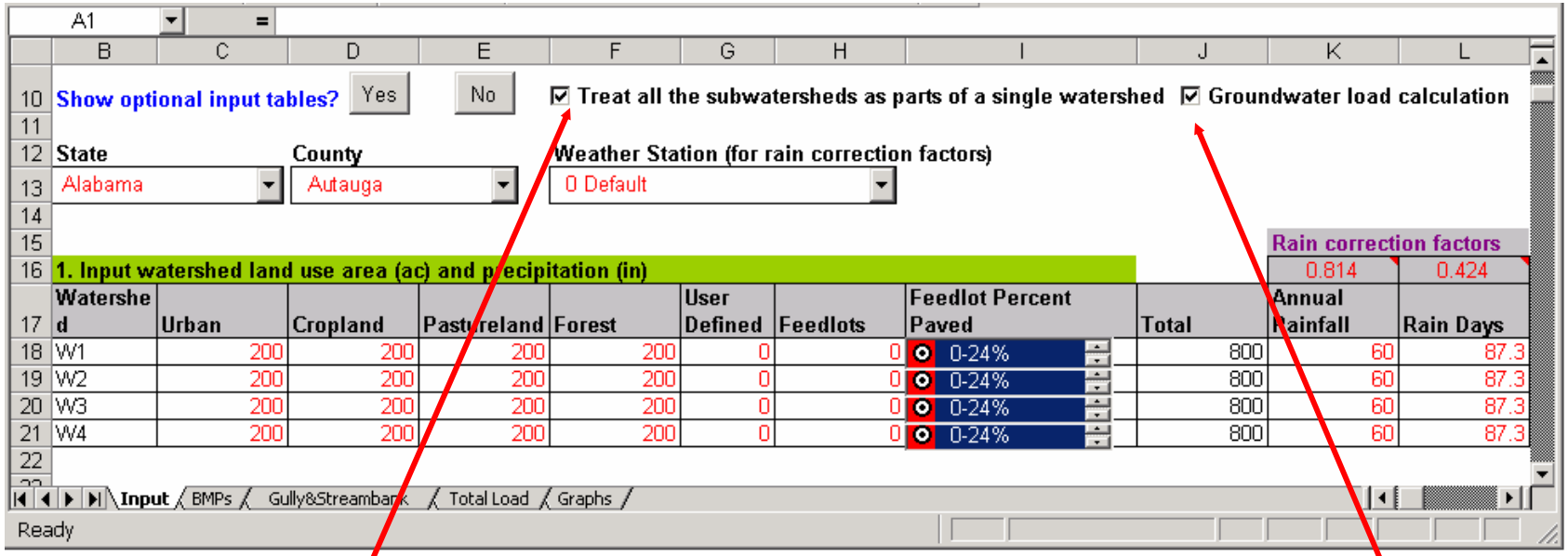
Step: Tools menu > Options submenu> General tab

STEPL BMP Calculator

- Describe schematically BMP configuration
  - Number and linkages
  - BMP type and efficiency
  - Land use area
- Calculate combined efficiency



STEPL New Features 1



Show optional input tables? Yes No

☑ Treat all the subwatersheds as parts of a single watershed ☑ Groundwater load calculation

State	County	Weather Station (for rain correction factors)
Alabama	Autauga	0 Default

1. Input watershed land use area (ac) and precipitation (in)

										Rain correction factors	
										0.814	0.424
Watershed	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Feedlot Percent Paved	Total		Annual Rainfall	Rain Days
W1	200	200	200	200	0	0	0-24%	800		60	87.3
W2	200	200	200	200	0	0	0-24%	800		60	87.3
W3	200	200	200	200	0	0	0-24%	800		60	87.3
W4	200	200	200	200	0	0	0-24%	800		60	87.3

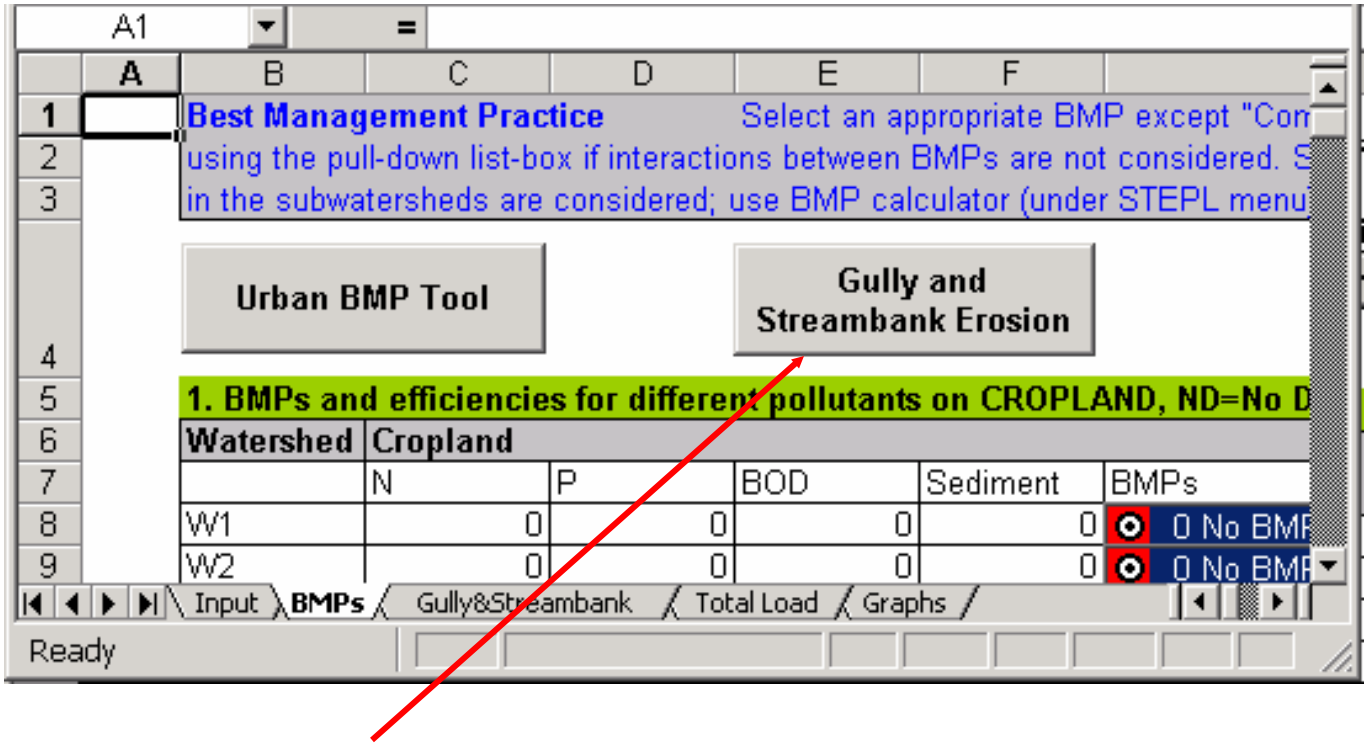
Input / BMPs / Gully&Streambank / Total Load / Graphs

Ready

Option to (1) treat all the subwatersheds as parts of a larger watershed so that the sediment transport is considered to route sediment to the watershed outlet; (2) treat each subwatershed as an independent project so that the transport effect in the larger watershed is not considered.

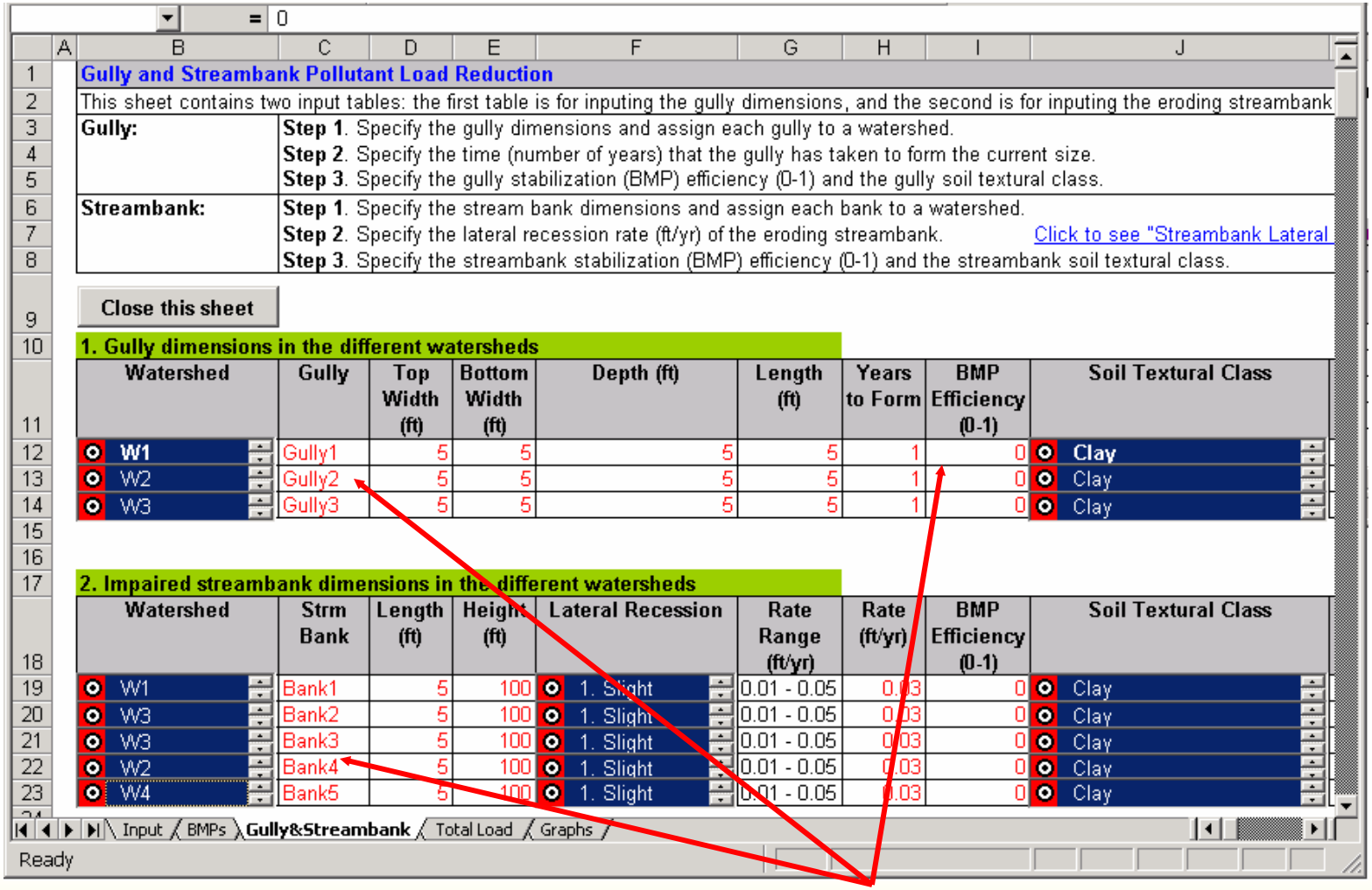
Option to calculate pollutant loads from the shallow groundwater as parts of total watershed loads

STEPL New Features 2



STEPL now can let you calculate gully and streambank erosion provided that you have the local data.

STEPL New Features 3



Gully and Streambank Pollutant Load Reduction

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

Gully:	**Step 1**. Specify the gully dimensions and assign each gully to a watershed. **Step 2**. Specify the time (number of years) that the gully has taken to form the current size. **Step 3**. Specify the gully stabilization (BMP) efficiency (0-1) and the gully soil textural class.
Streambank:	**Step 1**. Specify the stream bank dimensions and assign each bank to a watershed. **Step 2**. Specify the lateral recession rate (ft/yr) of the eroding streambank. Click to see "Streambank Lateral **Step 3**. Specify the streambank stabilization (BMP) efficiency (0-1) and the streambank soil textural class.

Close this sheet

1. Gully dimensions in the different watersheds

Watershed	Gully	Top Width (ft)	Bottom Width (ft)	Depth (ft)	Length (ft)	Years to Form	BMP Efficiency (0-1)	Soil Textural Class
W1	Gully1	5	5	5	5	1	0	Clay
W2	Gully2	5	5	5	5	1	0	Clay
W3	Gully3	5	5	5	5	1	0	Clay

2. Impaired streambank dimensions in the different watersheds

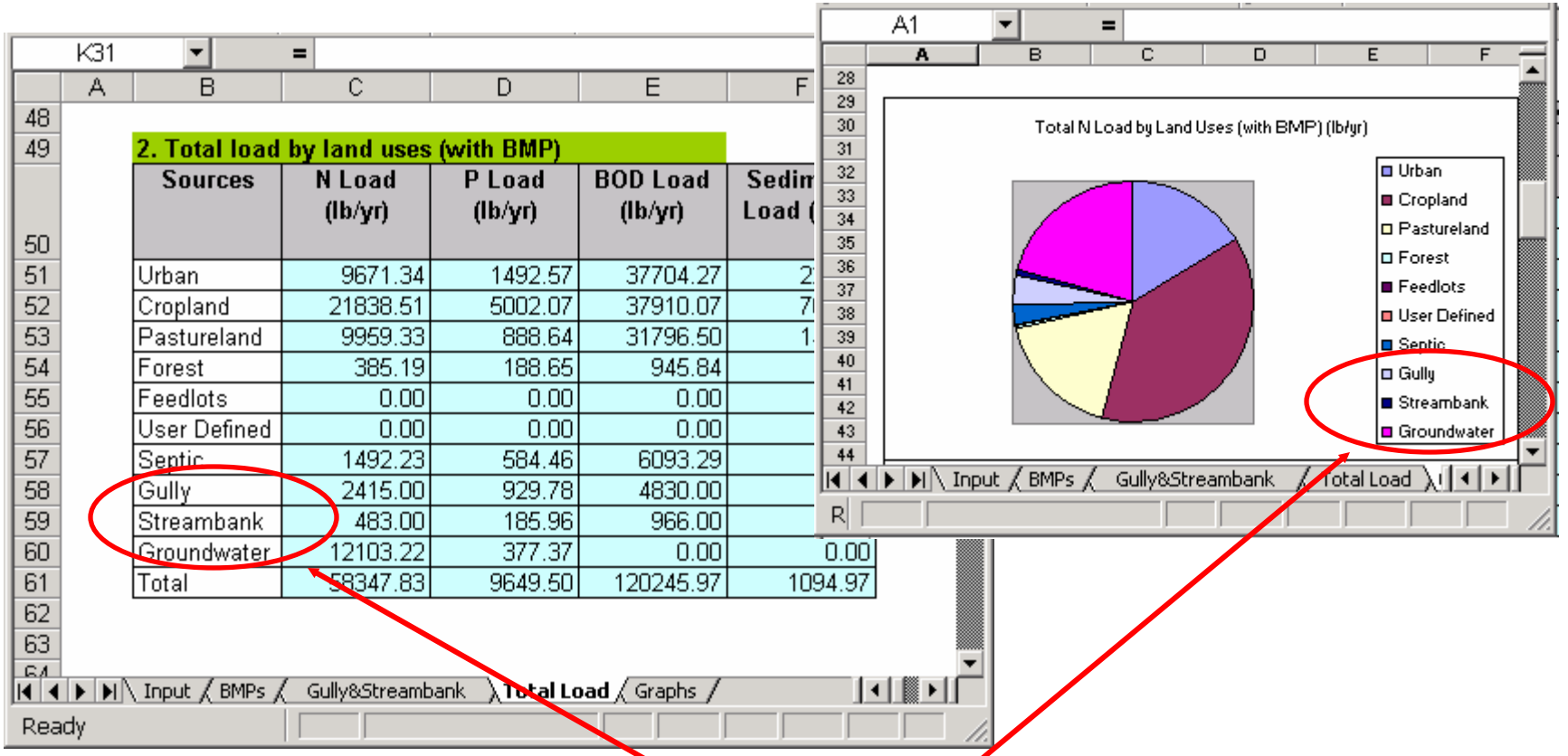
Watershed	Strm Bank	Length (ft)	Height (ft)	Lateral Recession	Rate Range (ft/yr)	Rate (ft/yr)	BMP Efficiency (0-1)	Soil Textural Class
W1	Bank1	5	100	1. Slight	0.01 - 0.05	0.03	0	Clay
W3	Bank2	5	100	1. Slight	0.01 - 0.05	0.03	0	Clay
W3	Bank3	5	100	1. Slight	0.01 - 0.05	0.03	0	Clay
W2	Bank4	5	100	1. Slight	0.01 - 0.05	0.03	0	Clay
W4	Bank5	5	100	1. Slight	0.01 - 0.05	0.03	0	Clay

Input | BMPs | Gully&Streambank | Total Load | Graphs

Ready

STEPL let you input gully and eroding streambank dimensions as well as the stabilization efficiencies.

STEPL New Features 4



2. Total load by land uses (with BMP)

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sedim Load (
Urban	9671.34	1492.57	37704.27	2
Cropland	21838.51	5002.07	37910.07	7
Pastureland	9959.33	888.64	31796.50	1
Forest	385.19	188.65	945.84	
Feedlots	0.00	0.00	0.00	
User Defined	0.00	0.00	0.00	
Septic	1492.23	584.46	6093.29	
Gully	2415.00	929.78	4830.00	
Streambank	483.00	185.96	966.00	
Groundwater	12103.22	377.37	0.00	0.00
Total	58347.83	9649.50	120245.97	1094.97

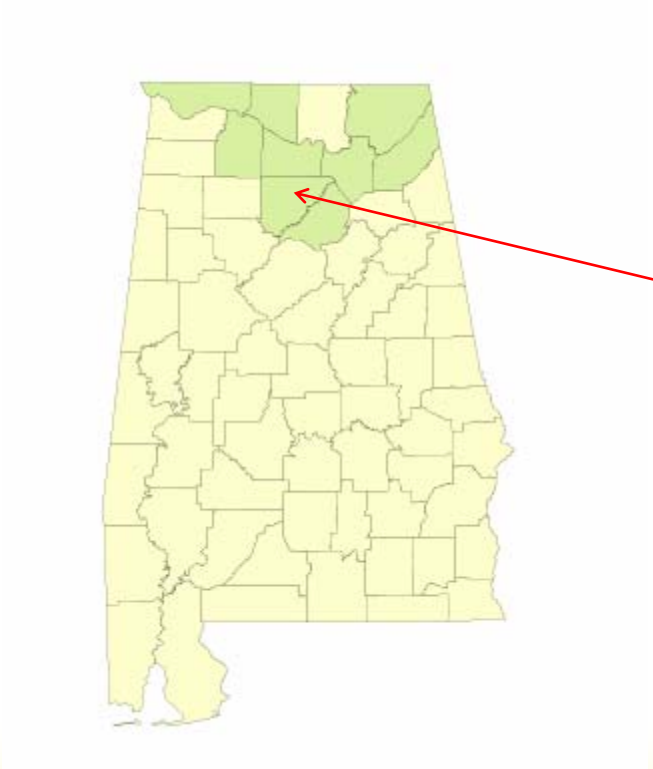
STEPL summary table lets you see the loads from the gully erosion, streambank erosion, and groundwater pollution .

Sample Problem Exercises

- Exercise #1
  - Estimate total annual load for a specific farm, and total load reduction resulting to implementation of a (single) BMP on croplands
    - Hypothetical watersheds based on Agricultural Statistics and NRCS data
- Exercise #2
  - Similar to Exercise #1 but with multiple BMPs
- Exercise #3
  - Similar to Exercise #1 but BMP trains implemented on croplands, and a single BMP on urban land
- Exercise #4
  - Similar to Exercise #1 but for multiple subwatersheds and BMP trains implemented on croplands, and pasture land

Sample Problem Exercise #1

Estimate total annual load for a farm in Cullman County in Alabama



Sample Problem Exercise #1

- Generate a new custom spreadsheet. Note that you may reuse a spreadsheet you created previously for a different project.
  - Click Start button (e.g., normally located at the Windows bottom left corner), then Program, STEPL, and STEPL to run the STEPL main executable program (stepl.exe in /STEPL folder) and display main interface
  - Select options. For Exercise #1, specify the following:
    - Specify number of watershed = 1
    - Select first option under Option for Initialization (default selection – Set initial land use areas and animal numbers to zeros)
  - Click ok to create new spreadsheet
  - Click ok to the following message box
  - Save the spreadsheet using a new file name
    - For this example, you may save it to exercise1.xls
  - When the new spreadsheet is opened, click Ok button to enable stored formulas/equations in the spreadsheet

Sample Problem Exercise #1

- Enter data in the Input Worksheet (numbers in red in spreadsheet)
  - By default, optional tables are not shown. Click yes to show the optional tables (Table 5-8) with their default values. Click no to hide them.
  - Uncheck groundwater load calculation
  - Select state = Alabama, and county = Cullman. Notice that initial values for Annual Rainfall and Number of Rain Days are automatically specified in Table 1 as you select a state or county.
  - Select a weather station = Al Birmingham FAA. Notice that correction factors change with the selected weather station.
  - In Table 1, enter the land use areas for your watershed (Refer next slide)
  - Also in Table 1, Select the feedlot percent paved assuming feedlot area is not zero. Default value = 0-24%.

Sample Problem Exercise #1

- Enter data in the Input Worksheet (numbers in red in spreadsheet), cont'd.
  - Also enter data into Tables 2 and 3. Set the number of months manure applied to 3
  - In Table 4, examine the initial USLE parameter values for each land use type which were automatically specified as you selected the state and county.

Table 1	
Cropland	75
Pastureland	20
Feedlots	5

Table 2	
Beef Cattle	10
Dairy Cattle	10
Swine (Hog)	5
Sheep	10
Chicken	100

Table 3	
No. of Septic Systems	5
Population per Septic System	2.38
Septic Failure Rate, %	0.87

You can always change the default and initial data when local data are available.

Sample Problem Exercise #1

- Examine estimated load in Total Load and Graph worksheets and enter the results below:

Total Annual N Load (lb/yr): _____ 4699.1
Total Annual P Load (lb/yr): _____ 1042.7
Total Annual Sediment Load (ton/yr): _____ 428.5

Amount and source with highest annual load contribution:
N load (lb/yr): __2276.2.0 What source: ___ Cropland
P load (lb/yr): __705.6 What source: ___ Cropland
Sediment load (lb/yr): _406.1 What source: ___ Cropland

Check groundwater load calculation on "Input" sheet to see load changes

Note that load reduction = 0 since you have not specified any BMP yet – see next slide

Sample Problem Exercise #1

For the same farm area, estimate total annual load reduction assuming reduced tillage is practiced in cropland areas

- Enter BMP data in BMPs worksheet
  - In Table 1 which is for cropland areas, select Reduced Tillage System under BMP column. Note that initial values of BMP efficiencies are automatically specified with the selected BMP.

Sample Problem Exercise #1

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

Total Annual N Load Reduction (lb): _____ 1511.8
Total Annual P Load Reduction (lb): _____467.6
Total Annual Sediment Load Reduction (ton): _____304.6

Source with highest annual load contribution after BMP:
N load (lb): ___2135.9 What source: __Feedlots
P load (lb): ___292.9 What source: __ Feedlots
Sediment load (lb): ___101.5 What source: __Cropland

End of Problem Exercise #1 – Try adjusting your input data and reexamine the results.

Sample Problem Exercise #2

For the same farm area, estimate total annual load reduction assuming reduced tillage is practiced in cropland areas and Solids Separation Basin BMP on feedlots

- Create a spreadsheet for this project or exercise.
  - Instead of generating a new custom spreadsheet using the STEPL main executable program, you will be using the spreadsheet in the previous exercise.
  - Save the spreadsheet used for Exercise #1 to save recent changes.
  - Save this spreadsheet with a new name (exercise2.xls, be sure to **save the file as *.xls type**). This new spreadsheet will be used for Exercise #2.

Sample Problem Exercise #2

- Enter new data in the Input Worksheet
  - Note that all the input data entered in the previous spreadsheet are still valid
  - Only modification is an additional BMP

Sample Problem Exercise #2

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

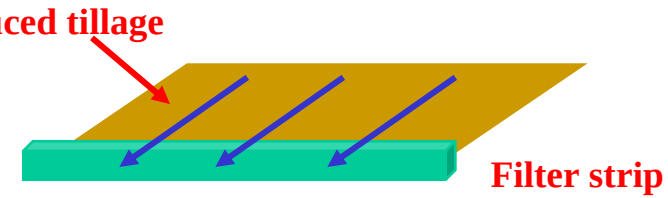
Total Annual N Load Reduction (lb): ____2259.4
Total Annual P Load Reduction (lb): _____ 558.4
Total Annual Sediment Load Reduction (ton): ____ 304.6

Source with highest annual load contribution after BMP:
N load (lb): _1388.3 What source: __Feedlots
P load (lb): _238.0 What source: __Cropland
Sediment load (lb): _101.5 What source: __Cropland

Note that load reductions have been calculated since BMPs have been already specified in the previous exercise. For this exercise, assume that the same BMPs are installed for all cropland and urban areas in the 8-digit watershed.

Sample Problem Exercise #3

Estimate total annual load and load reduction for a watershed that consists more than one farm where all croplands are practicing reduced tillage and filter strips (shown below) and urban open spaces has LID/Bioretention:



Assume all croplands is implementing the above BMP train

Sample Problem Exercise #3

- Create a spreadsheet for this project or exercise.
  - Save the spreadsheet used in Exercise #2 to exercise3.xls.
  - Enter new data in the Input Worksheet

1. Input watershed land use area (ac) and precipitation (in)

Watershed	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Feedlot Percent Paved
W1	100	500	50	25	0	5	0-24%

2. Input agricultural animals

Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure applied
W1	20	10	0	10	0	2000	0	0	3

3. Input septic system and illegal direct wastewater discharge data

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Wastewater Direct Discharge, # of People	Direct Discharge Reduction, %
W1	50	2.38	0.87	0	0

Sample Problem Exercise #3

- Examine estimated load in Total Load and Graph worksheets and enter the results below:

Total Annual N Load (lb): ____17015.2
Total Annual P Load (lb): ____ 4108.5
Total Annual Sediment Load (ton): ___ 1526.7

Source with highest annual load contribution:
N load (lb): __11208.3 What source: ___Cropland
P load (lb): __3176.6 What source: ____Cropland
Sediment load (lb): __1467.7 What source: __Cropland

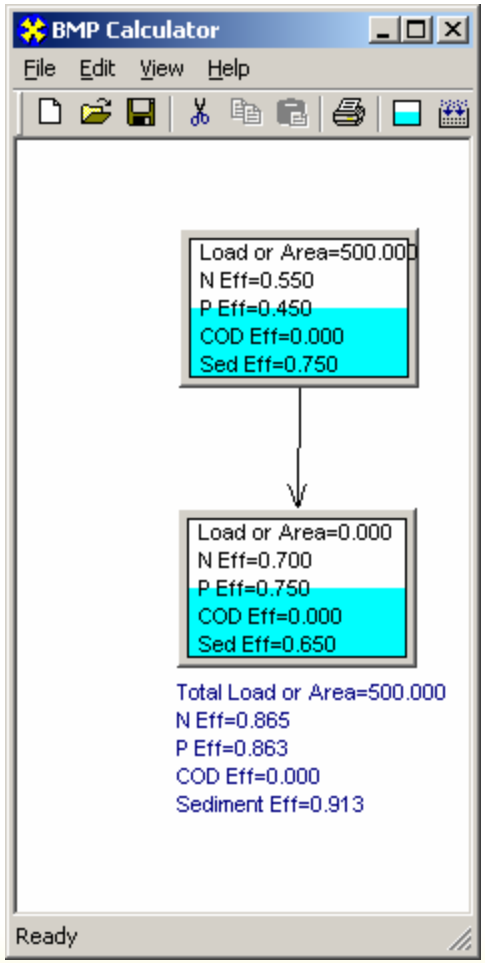
Hint: Check BMPs page to make sure no BMP is selected.

Sample Problem Exercise #3

- Enter BMP data in BMP worksheet
  - In Table 1, which is for cropland areas, select “Combined-BMP calculated” under BMP column to indicate that we have a “Reduced Tillage-Filter Strip” BMP train in croplands.
  - Note that the N, P, BOD, and Sediment BMP efficiencies remained zero. If you have the combined efficiency values for this particular BMP train, enter them in Table 7 (number in red). These values will be reflected in Table 1 and in other tables (i.e., if the same BMP train is implemented for other land uses).
  - If you do not have the values, you may use the BMP calculator (next step)

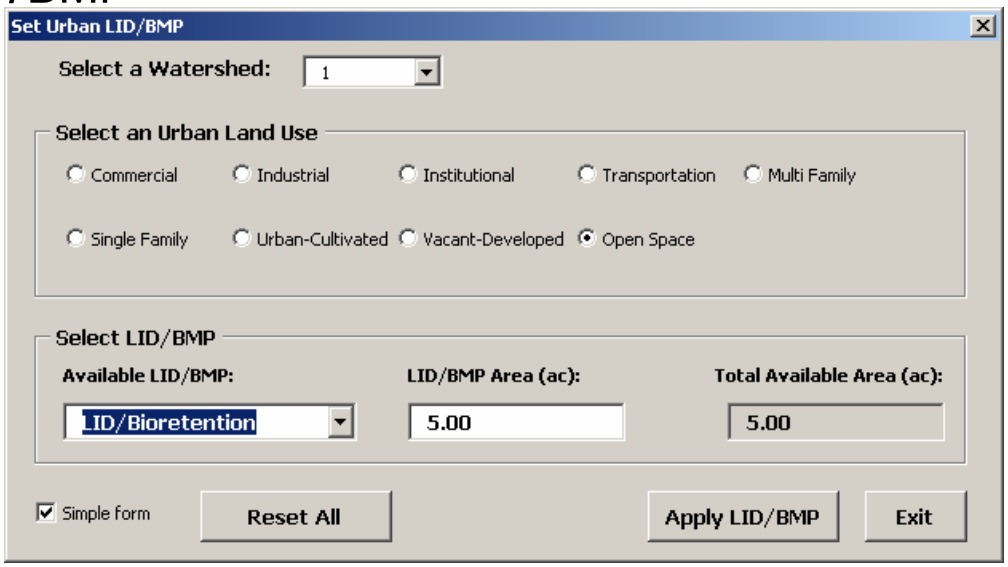
Sample Problem Exercise #3

- Use BMP Calculator to estimate combined efficiencies of the BMP train
  - Run the BMP Calculator by selecting the STEPL/BMP Calculator menu of the STEPL spreadsheet. If the system cannot find the BMP Calculator program, navigate to /STEPL folder and select BMPCalculator.exe
  - Using the BMP Calculator interface, do the following (refer back to slide 13 for steps in using BMP Calculator):
    - Add two BMP boxes (one each for Reduced Tillage, and Filter Strip)
    - Enter BMP information (type, area, etc.) for each BMP box by double-clicking the box (Question: What is the area associated with the filter strip)
    - Specify the connection between the two BMPs (Question: Which BMP should be upstream). You may move the boxes to make them more readable
    - Calculate the combined efficiencies for N, P, BOD, and Sediment (0.865, 0.863, ND, 0.913).
    - Enter the combined efficiencies in Table 7 of STEPL spreadsheet. Note the efficiencies are reflected in Table 1.



Sample Problem Exercise #3

- Click Urban BMP Tool
  - Select Open Space under urban land use options->Select LID/Bioretention under Available LID/BMP -> Click Apply LID/BMP



You can always manually change the initial BMP efficiencies if local data are available.

If your BMP is not in the selection list, you may use STEPL-View/Edit BMP List menu to add your BMP to the database (pls refer to the user manual)

Sample Problem Exercise #3

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

Total Annual N Load Reduction (lb): ___9929.3
Total Annual P Load Reduction (lb): ____ 2833.4
Total Annual Sediment Reduction (ton): ____ 1340.0

Source with highest annual load contribution after BMP:
N load (lb): __3952.4 What source: __ Feedlot
P load (lb): __658.6 What source: __Feedlot
Sediment load (lb): __127.7 What source: __Cropland

End of Problem Exercise #3 – Try adjusting your input data and reexamine the results.

Sample Problem Exercise #4

- Generate a new custom spreadsheet.
  - Similar to exercise 1 create a new spreadsheet, but specify two watersheds this time (Program-> STEPL-> STEPL)
  - Select options. For Exercise #2, specify the following:
    - Specify number of watershed = 2
    - Select first option under Option for Initialization (default selection – Set initial land use areas and animal numbers to zeros)
  - Click ok to create new spreadsheet
  - Click ok to the following message box
  - Save the spreadsheet using a new file name
    - For this example, you may save it to exercise4.xls
  - When the new spreadsheet is opened, click Ok button to enable stored formulas/equations in the spreadsheet

Sample Problem Exercise #4

- Enter data in the Input Worksheet (numbers in red in spreadsheet)
  - Select state = Alabama, and county = Cullman.
  - Select a weather station = Al Birmingham FAA.

Sample Problem Exercise #4

- Enter data in the Input Worksheet (numbers in red in spreadsheet), cont'd

1. Input watershed land use area (ac) and precipitation (in)

Watershed	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Feedlot Percent Paved
W1	10	100	50	0	0	0	0-24%
W2	10	200	60	0	0	10	0-24%

2. Input agricultural animals

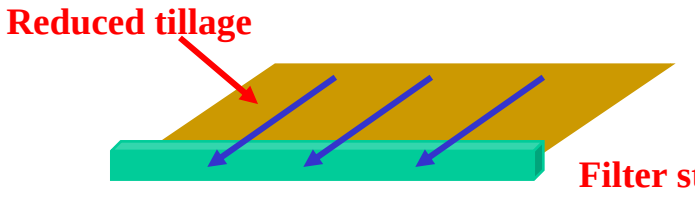
Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure applied
W1	10	10	10	10	0	1000	10	0	3
W2	10	10	10	10	0	1000	10	0	3
Total	20	20	20	20	0	2000	20	0	

3. Input septic system and illegal direct wastewater discharge data

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Wastewater Direct Discharge, # of People	Direct Discharge Reduction, %
W1	10	2.43	2	0	0
W2	20	2.43	2	0	0

Sample Problem Exercise #4

- Cropland in watershed 1 has the same BMP train as in example 2,
- Cropland in watershed 2 has filter strip
- Pastureland in both watersheds has filter strip



Assume all croplands in watershed 1 is implementing the above BMP train

Sample Problem Exercise #4

- Cropland in watershed 1 has the same BMP train as in example 2,
- Cropland in watershed 2 has filter strip
- Pastureland in both watersheds has filter strip

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data

Watershed	Cropland				
	N	P	BOD	Sediment	BMPs
W1	0.865	0.863	0	0.913	Combined BMPs-Calculated
W2	0.7	0.75	ND	0.65	Filter strip

7. Combined watershed BMP efficiencies from the BMP calculator

Watershed	Watershed Combined BMP Efficiencies				
	N	P	BOD	Sediment	BMPs
W1-Crop	0.865	0.863	0	0.913	Combined BMPs
W2-Crop	0	0	0	0	Combined BMPs
W1-Pasture	0.7	0.75	0	0.65	Combined BMPs
W2-Pasture	0.7	0.75	0	0.65	Combined BMPs
W1-Forest	0	0	0	0	Combined BMPs
W2-Forest	0	0	0	0	Combined BMPs
W1-User	0	0	0	0	Combined BMPs
W2-User	0	0	0	0	Combined BMPs

Sample Problem Exercise #4

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

Total Annual N Load Reduction (lb): ___ 3102.3 + 3807.2 = 6909.5
Total Annual P Load Reduction (lb): _____ 882.9 + 1037.1 = 1920.0
Total Annual Sediment Reduction (ton): ___ 500.5 + 479.7 = 980.3

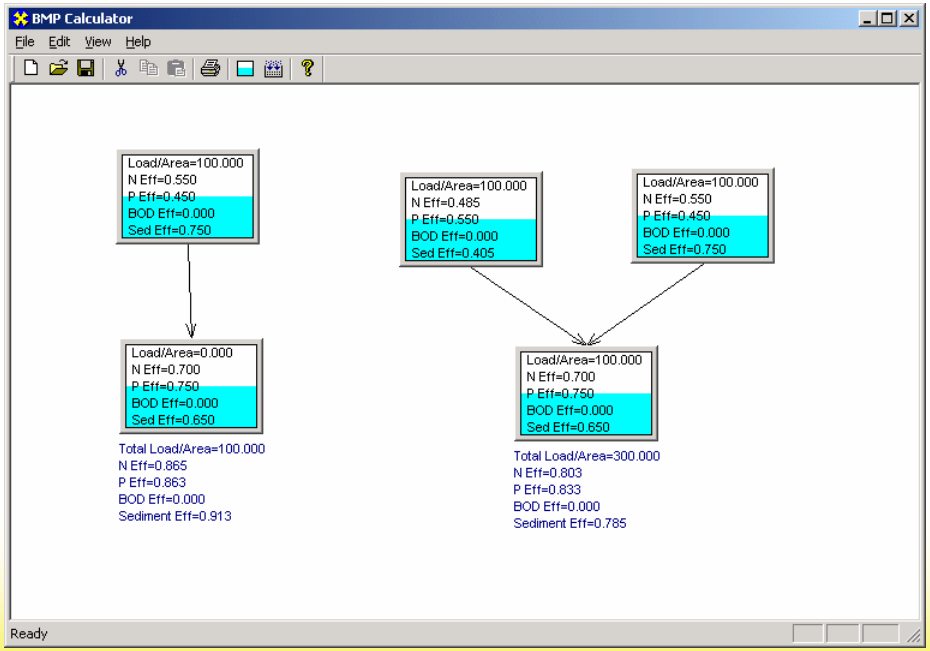
Source with highest annual load contribution after BMP:
N load (lb): __2844.1 What source: __ Feedlot
P load (lb): __528.7 What source: __Cropland
Sediment load (lb): __287.6 What source: __Cropland

Check and uncheck the subwatershed option on the "Input" sheet to see the effect on results.

End of Problem Exercise #4 – Try adjusting your input data and reexamine the results.

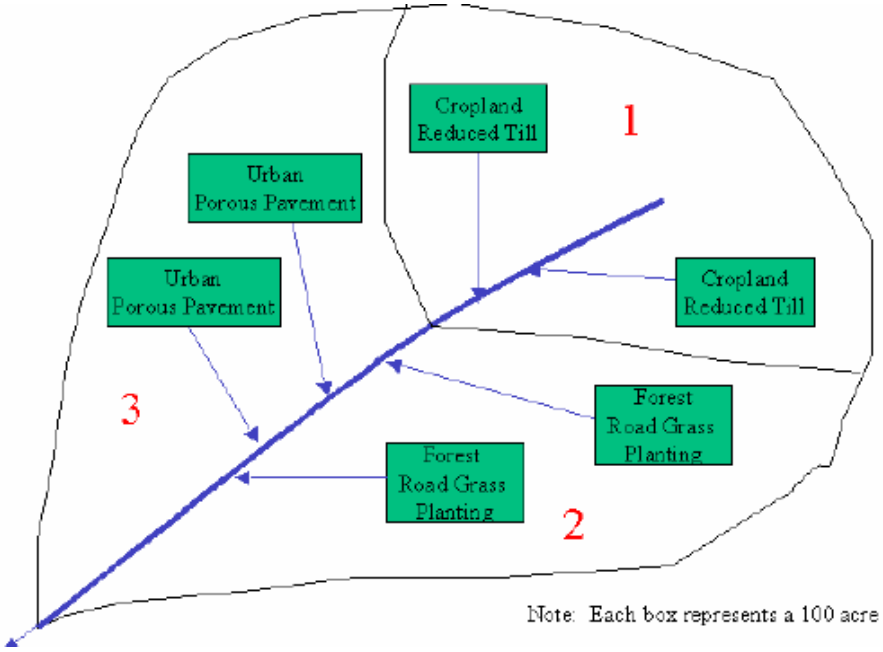
More Exercises for BMP Calculator

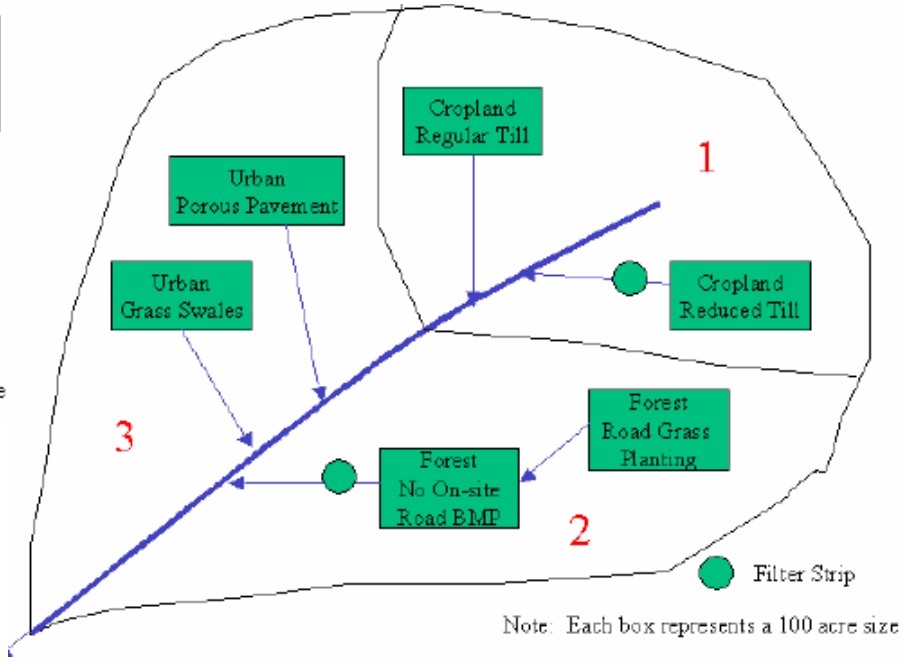
- Try different BMP trains in the BMP Calculator. Note that you may define as many trains as you want and calculate each BMP train's combined efficiency at the same time in the same window. You don't need to open a separate BMP window for each BMP train (see illustration below).



Need of BMP Calculator

- When is BMP Calculator needed?

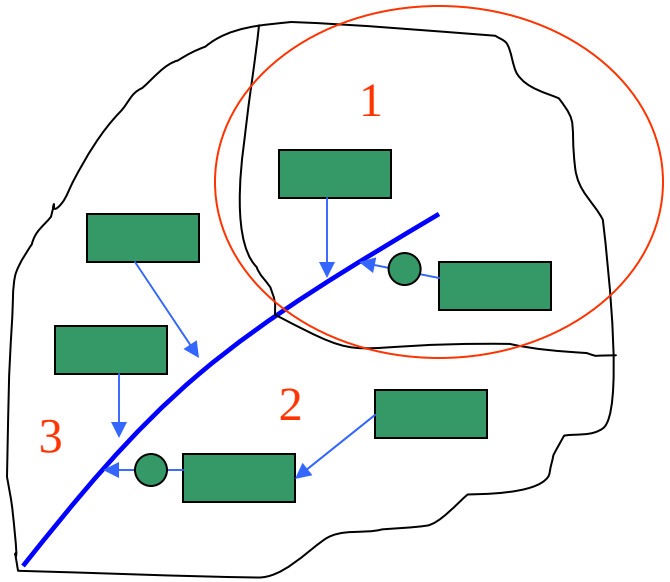




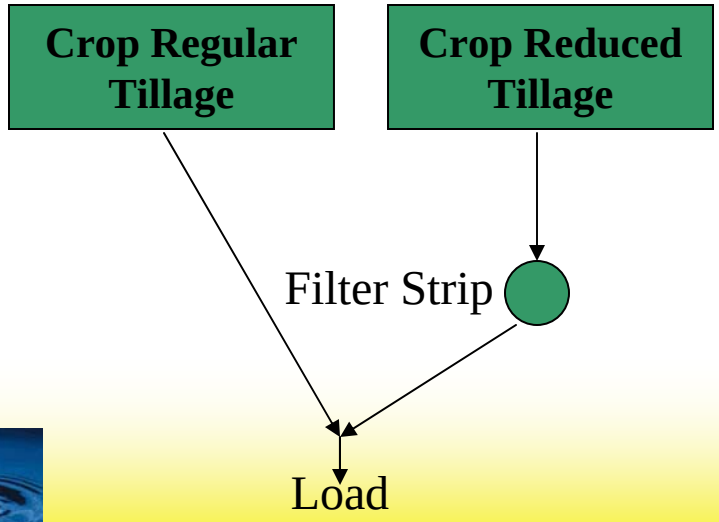
Not needed -► No combined efficiency calculation

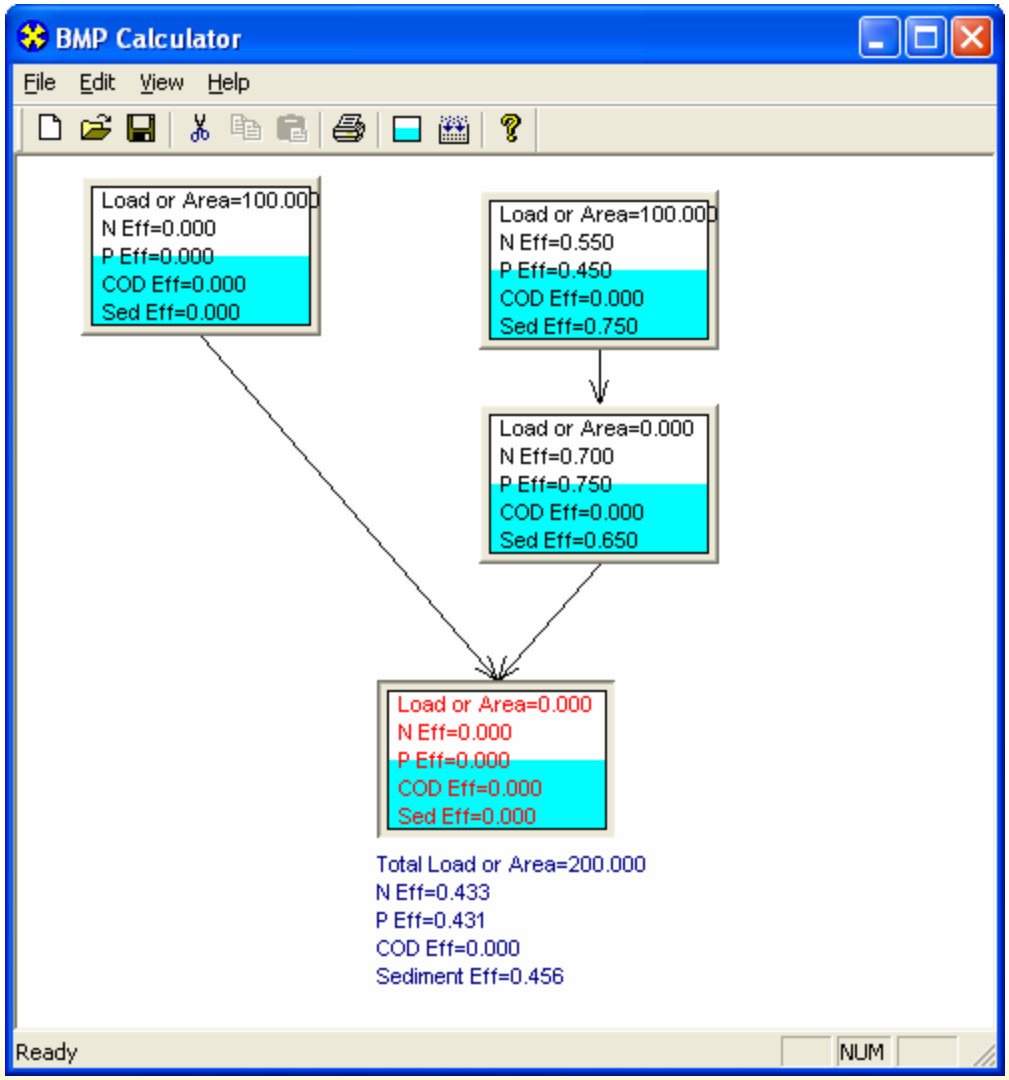
Needed -► Each land use type uses more than one type of BMP

BMP Calculator – Example 1

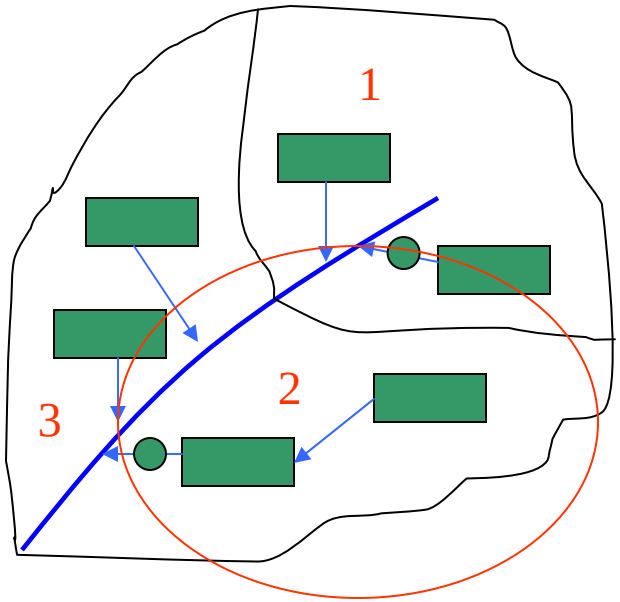


Each box represents 100 ac

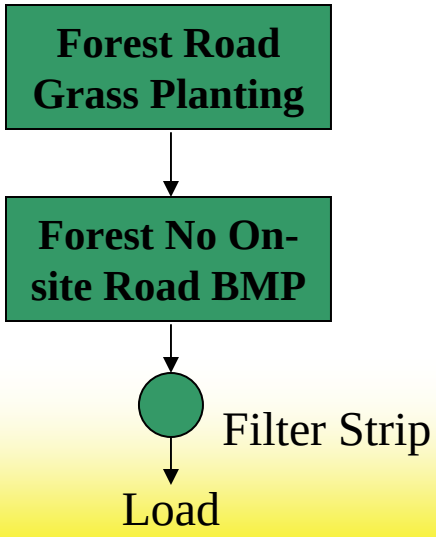


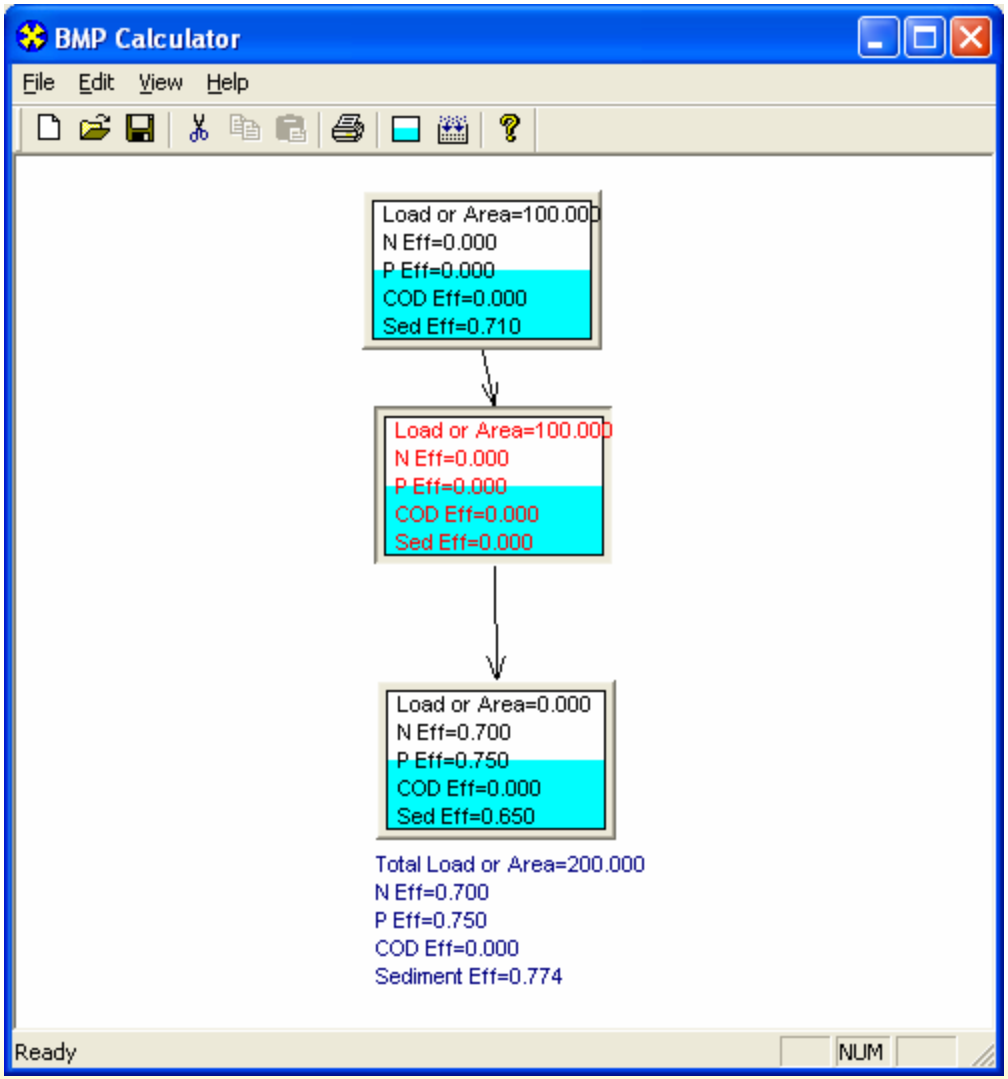


BMP Calculator – Example 2

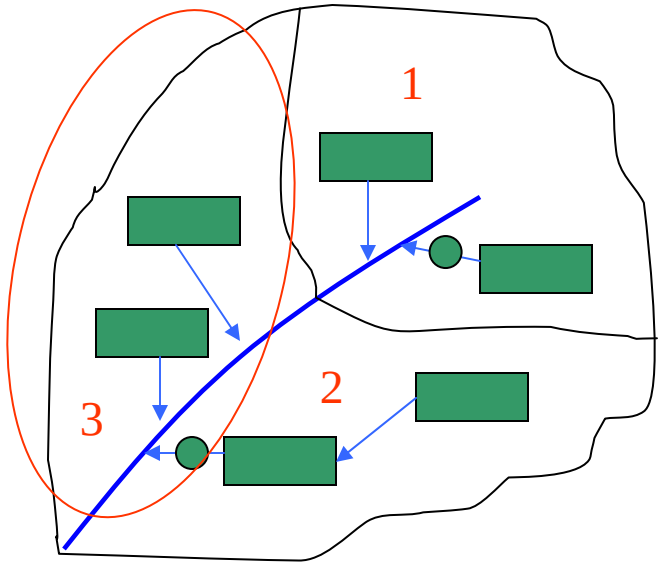


Each box represents 100 ac

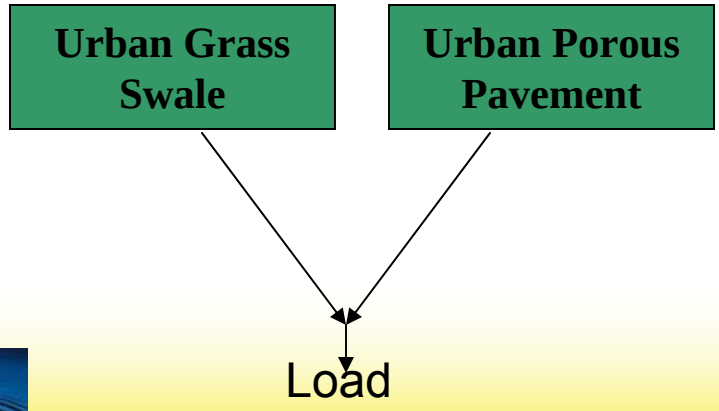


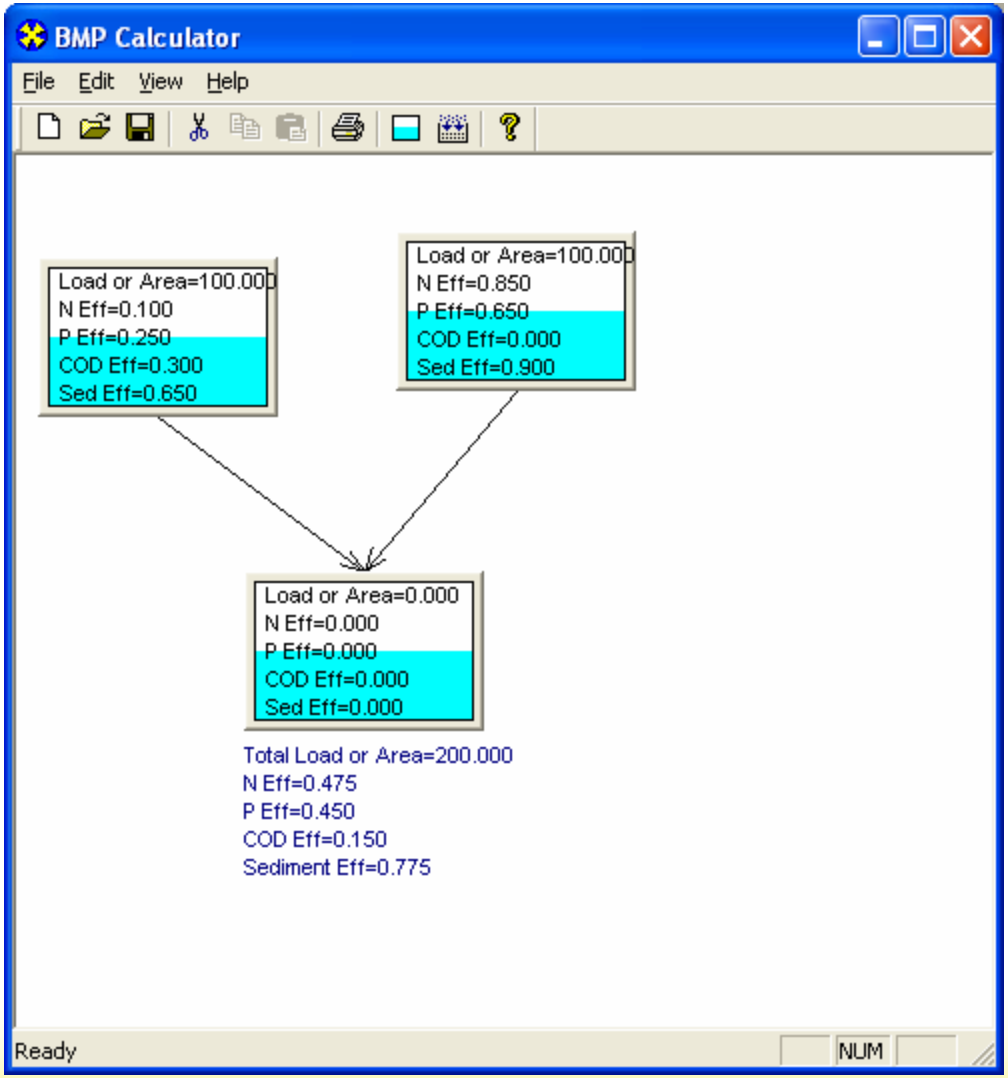


BMP Calculator – Example 3



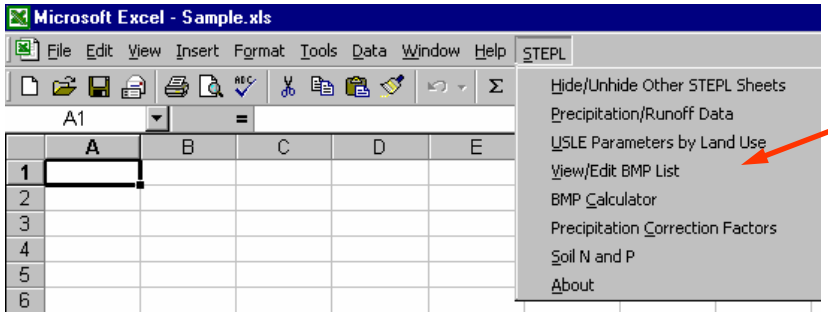
Each box represents 100 ac





Add New Data to BMP List

- In STEPL customized menu, click “View/Edit BMP List”
- BMPList worksheet is shown, add or delete BMPs



Customized menu

Landuse	BMP & Eff	N	P	BOD	Sediment
Cropland					
Cropland	0 No BMP	0	0	0	0
Cropland	Combined	0	0	0	0
Cropland	Contour Fa	0.485	0.55	ND	0.405
Cropland	Diversion	0.1	0.3	ND	0.35
Cropland	Filter strip	0.7	0.75	ND	0.65
Cropland	Reduced T	0.55	0.45	ND	0.75
Cropland	Streambar	0.75	0.75	ND	0.75
Cropland	Terrace	0.2	0.7	ND	0.85
Pastureland					
Pasturelan	0 No BMP	0	0	0	0
Pasturelan	Combined	0	0	0	0
Pasturelan	User Defin	0.5	0.5	0.5	0.75

Example: New data inserted here

STEPL: Add New Data to BMP List

A	B	C	D	E	F	G
Landuse	**BMP & Efficiency**	**N**	**P**	**BOD**	**Sediment**	
Cropland						<Don't Delete
Cropland	0 No BMP	0	0	0	0	<Don't Delete
Cropland	Combined BMPs-Calculated	0	0	0	0	
Cropland	Contour Farming	0.485	0.55	ND	0.405	
Cropland	Diversion	0.1	0.3	ND	0.35	
Cropland	Filter strip	0.7	0.75	ND	0.65	
Cropland	Reduced Tillage Systems	0.55	0.45	ND	0.75	
Cropland	Streambank stabilization and fencing	0.75	0.75	ND	0.75	
Cropland	Terrace	0.2	0.7	ND	0.85	
Pastureland						<Don't Delete
Pastureland	0 No BMP	0	0	0	0	<Don't Delete
Pastureland	Combined BMPs-Calculated	0	0	0	0	
Pastureland	User Defined	0.5	0.5	0.5	0.75	
Forest						<Don't Delete
Forest	0 No BMP	0	0	0	0	<Don't Delete

Instruction:
1. Do not delete the greyed rows.
2. BMP efficiencies should be <=1.
3. If you add a row for a new BMP, you must specify landuse, BMP name, and pollutant removal efficiencies.
4. Type "ND" for no data.
5. Click "Update BMP Data" to update selection boxes on the BMPs sheet.
6. Click "Save Updates" to save the BMP list to external text files in the STEPL/Support folder.

Update BMP Data

Update BMP button

(BMPList worksheet)

New BMP added!

New BMP added!

(BMPs worksheet)

2. BMPs and efficiencies for different pollutants on pastureland, ND=No Data					
Watershed	**Pastureland**				
	N	P	BOD	Sediment	BMPs
W1	0.5	0.5	0.5	0.75	User Defined

- Click “Update BMP Data” button to update the BMP selections in the BMPs worksheet
- Click “Save Updates” to save changes to text files (comma delimited)
  - C:or D:\Stepl\Support\AllBMPstepl.csv
  - C: or D:\Stepl\Support\AllBMP.csv

Part 2: Region 5 Model

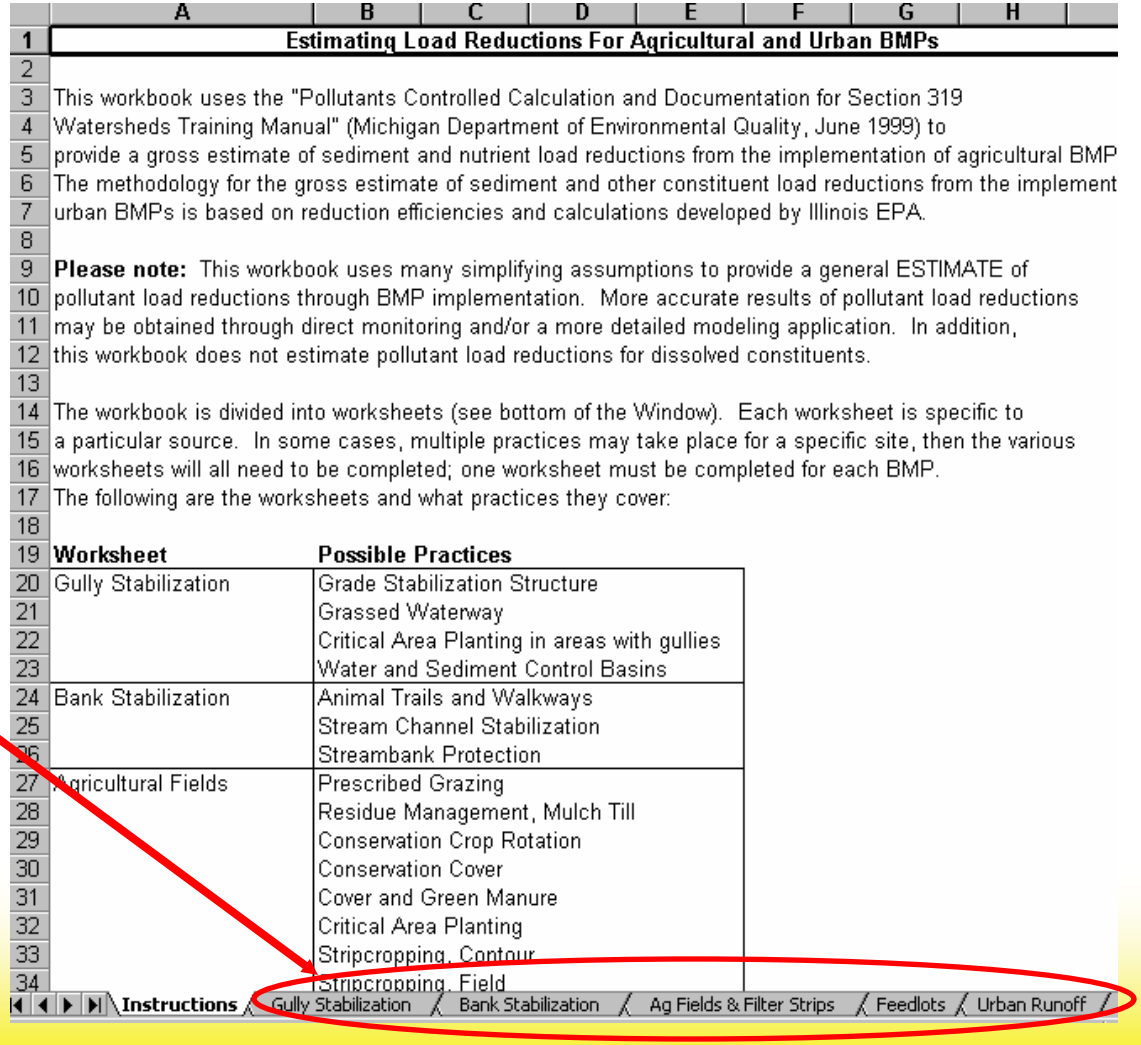
Region 5 model vs. STEPL

- Region 5 model
  - Calculates load at the source level
  - Sources are independent (no relationship between worksheets)
- STEPL
  - Calculates load for different sources at source and watershed level
  - Sources can set to be related in watershed or to be independent
  - User can specify and update BMP list
  - BMP calculator for complex BMP arrangements
  - On-line input data server for initial model setup (do not substitute the on-line data for real local data!!!)

R5 model is not limited to Region 5

If controls of the model does not work, set EXCEL > Tools > Macro >Macros >Security to Medium

Region 5 model has five functional worksheets.



Estimating Load Reductions For Agricultural and Urban BMPs

This workbook uses the "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual" (Michigan Department of Environmental Quality, June 1999) to provide a gross estimate of sediment and nutrient load reductions from the implementation of agricultural BMP The methodology for the gross estimate of sediment and other constituent load reductions from the implement urban BMPs is based on reduction efficiencies and calculations developed by Illinois EPA.

Please note: This workbook uses many simplifying assumptions to provide a general ESTIMATE of pollutant load reductions through BMP implementation. More accurate results of pollutant load reductions may be obtained through direct monitoring and/or a more detailed modeling application. In addition, this workbook does not estimate pollutant load reductions for dissolved constituents.

The workbook is divided into worksheets (see bottom of the Window). Each worksheet is specific to a particular source. In some cases, multiple practices may take place for a specific site, then the various worksheets will all need to be completed; one worksheet must be completed for each BMP. The following are the worksheets and what practices they cover:

Worksheet	Possible Practices
Gully Stabilization	Grade Stabilization Structure
	Grassed Waterway
	Critical Area Planting in areas with gullies
	Water and Sediment Control Basins
Bank Stabilization	Animal Trails and Walkways
	Stream Channel Stabilization
	Streambank Protection
Agricultural Fields	Prescribed Grazing
	Residue Management, Mulch Till
	Conservation Crop Rotation
	Conservation Cover
	Cover and Green Manure
	Critical Area Planting
	Stripcropping, Contour
	Stripcropping, Field

Instructions | Gully Stabilization | Bank Stabilization | Ag Fields & Filter Strips | Feedlots | Urban Runoff

Region 5 Load Estimation Model

- Introduction
  - Provide a general estimate of pollutant reduction at the source level
  - Initially developed by Indiana Department of Environmental Management (IDEM) based on Michigan DEQ's pollution control manual for section 319 watersheds.
  - STEPL version 4.0 includes all the features of Region 5 model.

Source	BMP
Gully	Gully Stabilization
Streambank	Streambank Stabilization
Agricultural Fields	Field Management Practices and Filter Strips
Feedlot	Animal Waste System
Urban Runoff	Various BMPs

Gully Erosion: Calculate Load Reduction

- Select a soil texture (e.g. sand, loamy sand)
- Enter gully dimensions and the number of years since the gully formed

Please fill in the gray areas below:

Parameter	Gully	Example
Top Width (ft)	13	**15**
Bottom Width (ft)	2	**4**
Depth (ft)	1.5	**5**
Length (ft)	300	**20**
Number of Years	5	**5**
Soil Weight (tons/ft3)	0.0425	**0.05**
Soil P Conc (lb/lb soil)* USER	0.0005	**0.0005** *
Soil N Conc (lb/lb soil)* USER	0.001	**0.001** *

* If not using the default values, users must provide input (in red) for Total P and Total N soil concentrations

Estimated Load Reductions

	BMP Efficiency*	Gully	Example
Sediment Load Reduction (ton/year)	1.0	28.7	**10**
Phosphorus Load Reduction (lb/year)		28.7	**8**
Nitrogen Load Reduction (lb/yr)		57.4	**16**

* BMP efficiency values should be between 0 and 1, and 1 means 100% pollutant removal efficiency.

Gully Stabilization

- Load

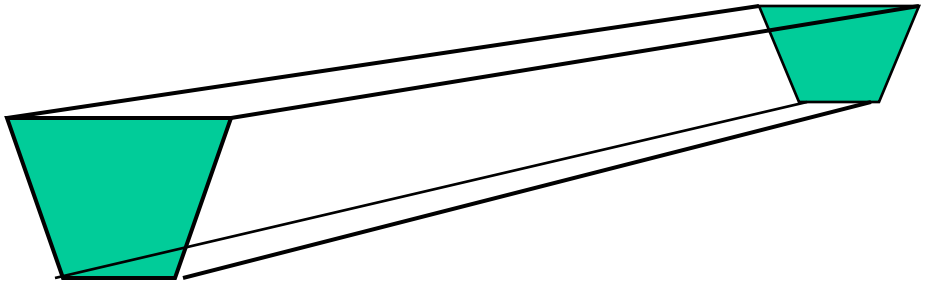
  Average annual erosion during the life of the gully (t/y)

  = Volume x Soil Weight / Years

  Nutrient load

  = Annual Erosion x Soil Nutrient Conc x Correction Factor

- Load Reduction after implementing gully stabilization
  - Specify reduction efficiency (100% efficiency by default)
  - Reduction is equal to annual erosion x user-specified efficiency



Volume = (Top Width +Bottom Width) x Depth x Length / 2

Gully Erosion: Nutrient Correction Factor

- Correction Factor
  - Smaller soil particles -> larger aggregated surface area -> more nutrients attached

Soil Texture	Nutrient Correction Factor
Clay	1.15
Silt	1.00
Sand	0.85
Peat	1.50

Stream Bank Erosion—Calculation

- Select a soil texture (e.g. silty clay)
- Enter the dimensions of the eroding stream banks

Please fill in the gray areas below:

Parameter	Bank #1	Bank #2	Example	
Length (ft)	500	500	**500**	
Height (ft)	10	10	**15**	
Lateral Recession Rate (ft/yr)*	0.2	0.2	**0.5**	
Soil Weight (tons/ft3)	0.0425	0.0425	**0.04**	
Soil P Conc (lb/lb soil)** USER	0.0005	0.0005	**0.0005**	**
Soil N Conc (lb/lb soil)** USER	0.001	0.001	**0.001**	**

** If not using the default values, users must provide input (in red) for Total P and Total N soil concentrations

*Lateral Recession Rate (LRR) is the rate at which bank deterioration has taken place and is measured in feet per year. This rate may not be easily determined by direct measurement. Therefore best professional judgement may be required to estimate the LRR. Please refer to the narrative descriptions in Table 1.

Estimated Load Reductions

	BMP Efficiency* Bank #1	BMP Efficiency* Bank #2	Bank #1	Bank #2	Example
Sediment Load Reduction (ton/year)	1.0	1.0	42.5	42.5	**150**
Phosphorus Load Reduction (lb/year)			42.5	42.5	**150**
Nitrogen Load Reduction (lb/yr)			85.0	85.0	**300**

* BMP efficiency values should be between 0 and 1, and 1 means 100% pollutant removal efficiency.

Stream Bank Erosion

- Load (Channel Erosion)
  = Length * Height * Lateral Recession rate * Soil weight
- Load Reduction
  = Load * Load reduction efficiency

Determining Lateral Recession Rate by Field Observation

Lateral Recession Rate (ft/yr)	Category	Description
0.01 – 0.05	Slight	Some bare bank, no exposed roots
0.06 – 0.2	Moderate	Bank is mostly bare
0.3 – 0.5	Severe	Bank is bare with exposed roots
0.5+	Very Severe	Bank is bare with fallen trees

Agricultural Practices—Usage

- Check BMPs: Agricultural field practices and filter strips (check both)
- Select a state and a county for default USLE parameter values
- Modify the default USLE parameter values for local conditions, especially the cover factor C and the supporting practice factor P to reflect the before and after treatment effects

Please check which BMPs apply: **Please select a state and a county, and default USLE parame**

☑ Agricultural Field Practices

☑ * Filter Strips

Users should use the local USLE parameter values if available!

State: Alabama County: Autauga

Please fill in the gray areas below:

			Example	
USLE or RUSLE	Before Treatment	After Treatment	**Before Treatment**	**After Treatment**
Rainfall-Runoff Erosivity Factor (R)	374.69	374.69	**120**	**120**
Soil Erodibility Factor (K)	0.20	0.20	**0.35**	**0.35**
Length-Slope Factor (LS)	0.29	0.29	**0.44**	**0.44**
Cover Management Factor (C<=1.0)*	0.20	0.04	**0.7**	**0.5**
Support Practice Factor (P<=1.0)*	0.99	0.99	**0.775**	**0.11**
Predicted Avg Annual Soil Loss (ton/acre/year)	4.21	0.84	**10.03**	**1.02**

* User must use the local C and/or P values (in red) to obtain the reduction due to the field practices.

Agricultural Practices—Usage 2

- Enter contributing areas (e.g. 50 acres)
- Select a soil texture (e.g. silt)

Estimated Load Reductions for Agricultural Field Practices

	Treated	Example
Sediment Load Reduction (ton/year)	97	**85**
Phosphorus Load Reduction (lb/year)	118	**100**
Nitrogen Load Reduction (lb/yr)	236	**200**

Estimated Additional Load Reductions through Filter Strips

	Filter-Strip Efficiency	Filter-Strip Treated	Example
Sediment Load Reduction (ton/year)	0.65	16	**92**
Phosphorus Load Reduction (lb/year)	0.75	34	**114**
Nitrogen Load Reduction (lb/yr)	0.70	63	**227**

Total Estimated Load Reductions

	Total	Example
Sediment Load Reduction (ton/year)	113	**177**
Phosphorus Load Reduction (lb/year)	152	**214**
Nitrogen Load Reduction (lb/yr)	298	**427**

Note: This worksheet is also applicable to other cases (mining, construction sites) when USLE is used.

Feedlot Pollution Reduction

- Load
  - Enter a contributing area (e.g. 1.74 acre)
  - Specify the percentage of paved area (e.g. 75-100%)
  - Select state and a county (Pennsylvania, Lycoming)
  - Select Weather Station (NY New York Central Park)
  - Enter animal count for each type

Animal Numbers	Animal Type	Design Weight*
0	Slaughter Steer	1,000
0	Young Beef	500
100	Dairy Cow	1,400
30	Young Dairy Stock	500
0	Swine	200
0	Feeder Pig	50
0	Sheep	100
0	Turkey	10
0	Chicken	4
0	Duck	4
0	Horse	1,000

Feedlot Pollution Reduction

- Load Reduction
  - Select a feedlot best management practice (e.g. waste management system)
  - System calculates load reduction using pre-assigned (BOD, P, N) efficiencies for the selected BMP

Estimated Load and Load Reductions

Pollutants	Load before BMP	**Load Reduction**	Load after BMP
Biochemical Oxygen Demand load (lbs/yr)	**8,598**	**NA**	**NA**
Phosphorus load (lbs/yr)	**848**	**763**	**85**
Nitrogen load (lbs/yr)	**7,239**	**5,791**	**1,448**

Urban Pollution Reduction

- Load
  - Enter size (acres) of storm water sewered and unsewered areas for each urban land use subclass
  - System calculates load using default unit loads for each land use sub class

Please enter landuse of contributing/drainage area in acres:

	Sewered	Unsewered
Commercial	100	10
Industrial	100	10
Institutional	50	10
Transportation	50	0
Multi-Family	100	10
Residential	200	10
Agriculture	0	20
Vacant	20	0
Open Space	250	250

Note: Storm sewers

Urban Pollution Reduction

- Load Reduction
  - Select BMP
  - System calculates load using default BMP efficiencies for the selected BMP

	Pre-BMP Loading (lbs/yr)		Post-BMP Loading (lbs/yr)		Load Reduction (lbs/yr)
BOD	30,640		13,482		17,158
COD	234,750		U		U
TSS	681,250		126,031		555,219
LEAD	531		U		U
COPPER	102		U		U
ZINC	785		U		U
TDS	1,210,084		U		U
TN	7,850		U		U
TKN	4,293		U		U
DP	363		U		U
TP	928		450		478
CADMIUM	6		U		U

U = Removal Efficiency for the particular BMP and constituent unavailable.

Other Alternative Load Models - Simple

Model	Field or Watershed	Land Use	Pollutant	Event or Continuous	BMP	Data Reqt's	Level of Effort
Simple							
Simple Method	Watershed	Urban	N, P	Event		Low	Low
FHWA	Both	Urban	N, P	Event		Low	Low
SLOSS/ PHOSPH	Both	Rural	P, Sed	Event		Low	Low
Watershed	Both	Both	P	Event	Simple	Medium	Medium

Reference: List of alternative load and load reduction models, STEPL Web site.

Other Alternative Load Models – Mid Range

Model	Field or Watershed	Land Use	Pollutant	Event or Continuous	BMP	Data Reqt's	Level of Effort
Mid Range							
AGNPS	Both	Rural	N, P, Sed	Both	Detailed	Medium to High	Medium to High
GWLF	Both	Both	N, P, Sed	Both	Simple	Low to Medium	Low to Medium

Other Alternative Load Models - Detailed

Model	Field or Watershed	Land Use	Pollutant	Event or Continuous	BMP	Data Reqt's	Level of Effort
Detailed/Complex							
ANSWERS	Both	Rural	N, P, Sed	Both	Detailed	Medium to High	Medium to High
GLEAMS	Field	Rural	N, P, Sed	Both	Detailed	Medium to High	Medium to High
HSPF	Both	Both	N, P, Sed	Both	Detailed	Medium to High	Medium to High
SWAT	Both	Rural	N, P, Sed	Both	Detailed	Medium	Medium
SWMM	Both	Both	N, P, Sed	Both	Detailed	High	High
WEPP	Both	Rural	Sed	Continuous	Detailed	Low to High	Low to High

Part 3: Special Discussion and Feedback

STEPL: Discussion

- Watershed vs. subwatershed
  - STEPL model is not limited to subwatershed (can apply to farms, scenarios, etc.)
  - Watershed size (make the subwatershed small enough to reflect BMP effectiveness.
  - You want to know the reduction at the local subwatershed level (Sum of loads from subwatersheds ≠ load at the watershed outlet because of the transport loss in the main stem.)
- Local weather data
- How to use the user-defined land use?
- Septic failure rate clarification
- Add new BMPs to the list
- Small treated area vs. large watershed
- R5 model 100% efficiency assumptions