STEPL & Region 5 Models

Presentation

- Overview of STEPL and R5 models

Part 1: STEPL

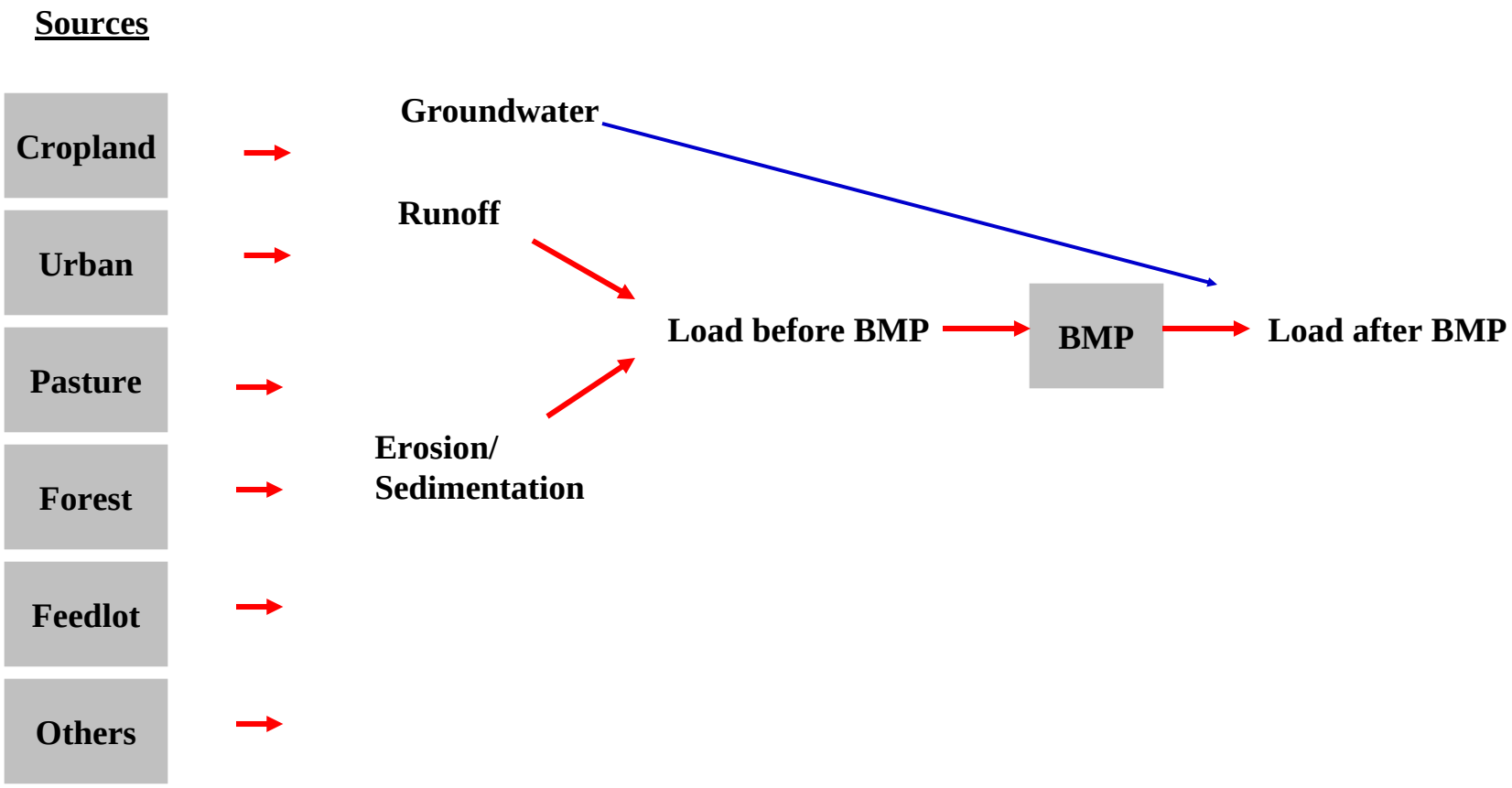
What is STEPL?

- 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?

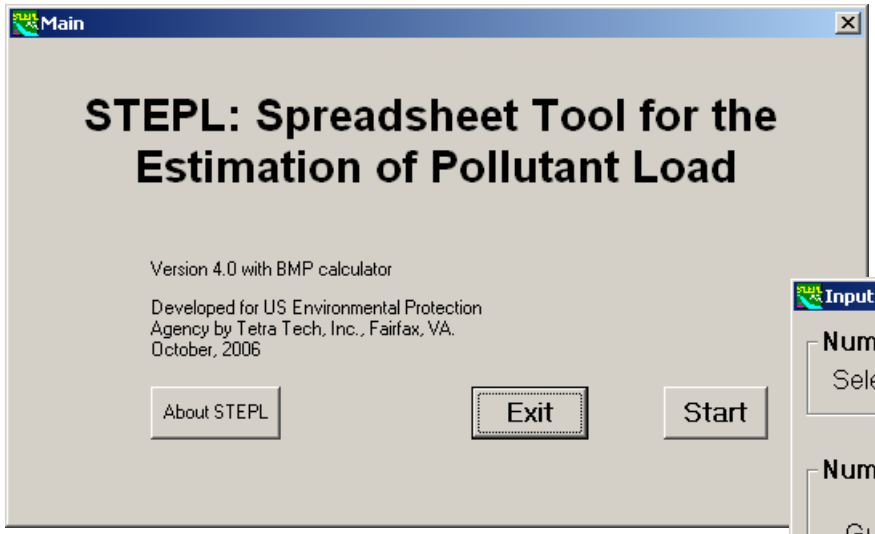
- Basic understanding of hydrology , erosion, and pollutant loading processes
  - Hydrology – CN approach
  - Erosion – USLE and sediment delivery ratio, urban concentration
  - Pollutant load – runoff concentration
- Knowledge (use and limitation) of environmental data (e.g., land use, agricultural statistics, and BMP efficiencies)
- Familiarity with MS Excel and Excel Formulas

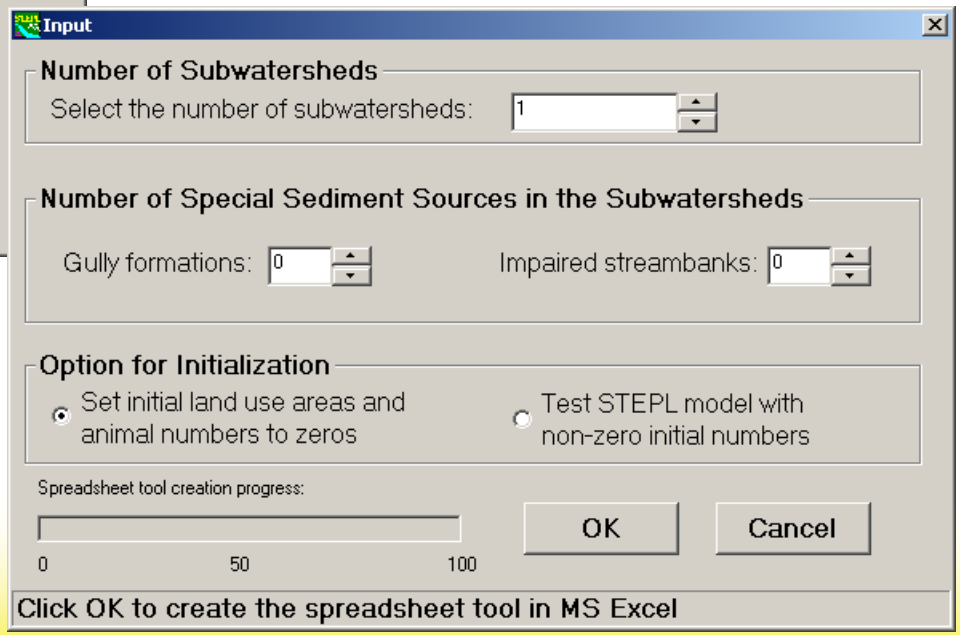
Process


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

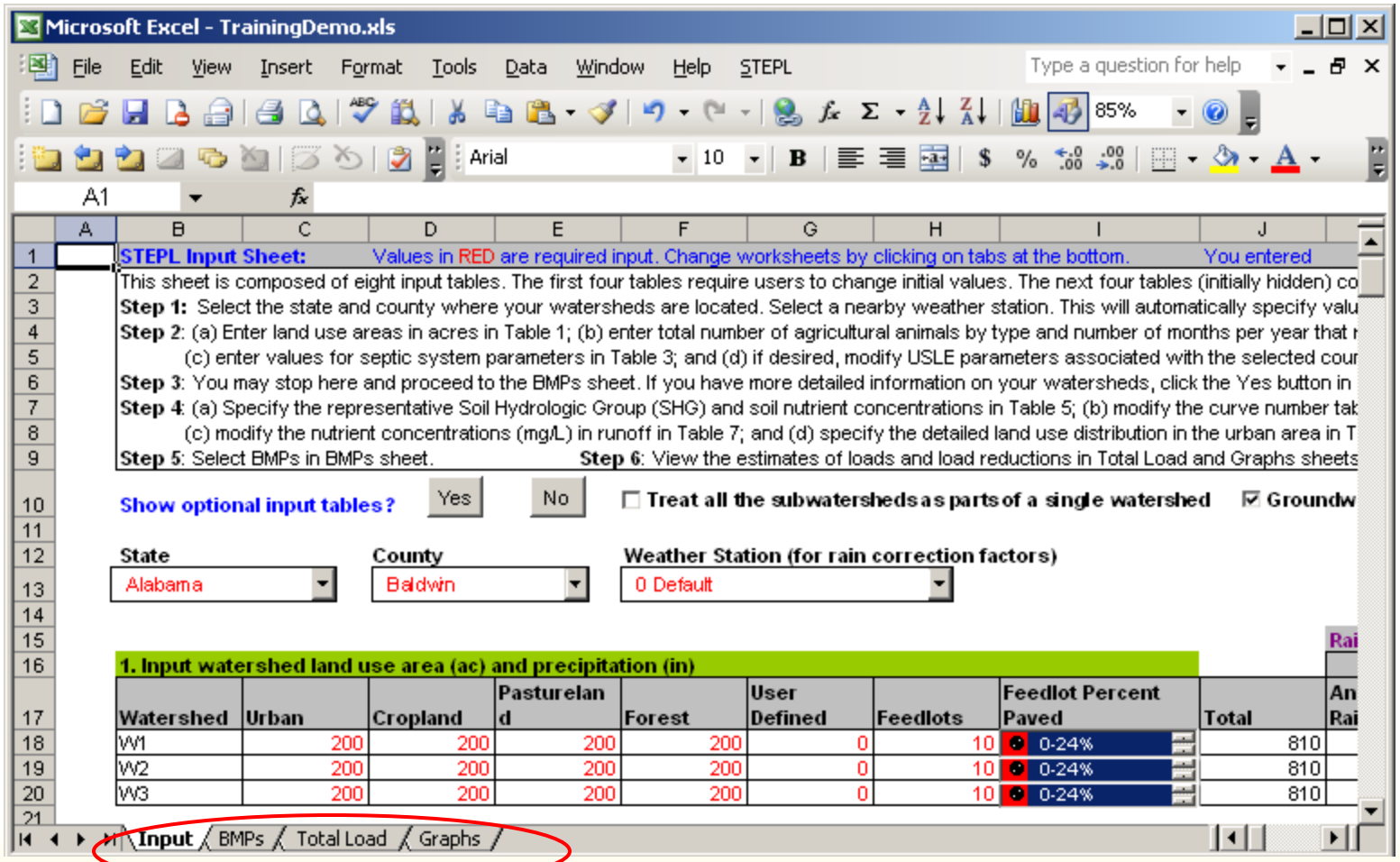
STEPL Main Program

- Run STEPL executable program to create and customize spreadsheet dynamically





STEPL Spreadsheet



Composed of four worksheets

BMPs Worksheet

Urban BMP Tool

Gully and Streambank Erosion

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

Watershed	Cropland					
	N	P	BOD	Sediment	BMPs	% Area BMP Applied
W1	0.485	0.55	ND	0.405	Contour Farming	100
W2	0.1	0.3	ND	0.35	Diversion	100
W3	0	0	0	0	0 No BMP	100

Each land use type within each watershed can have a separate BMP.
Also it can be partial application.

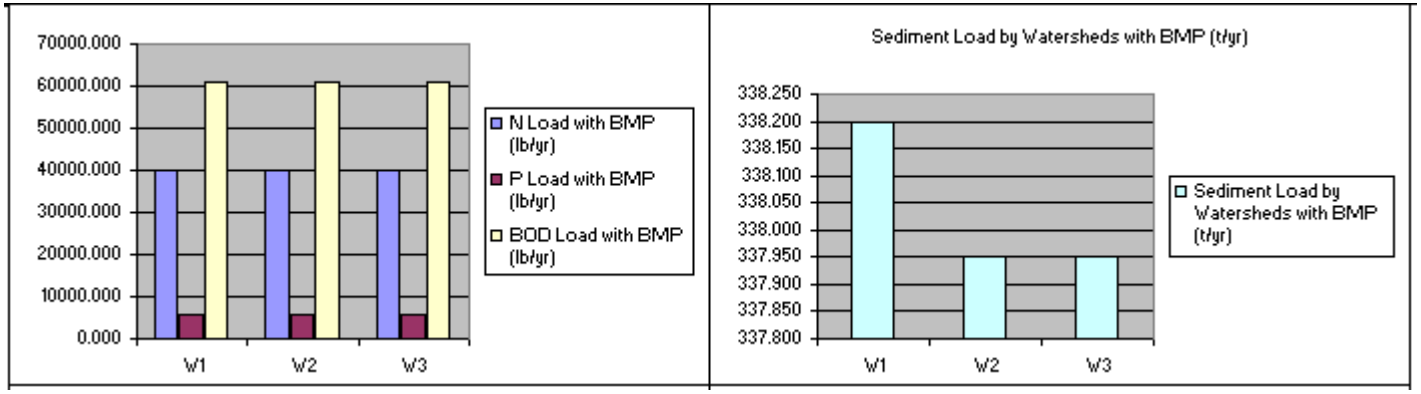
Total Load Worksheet

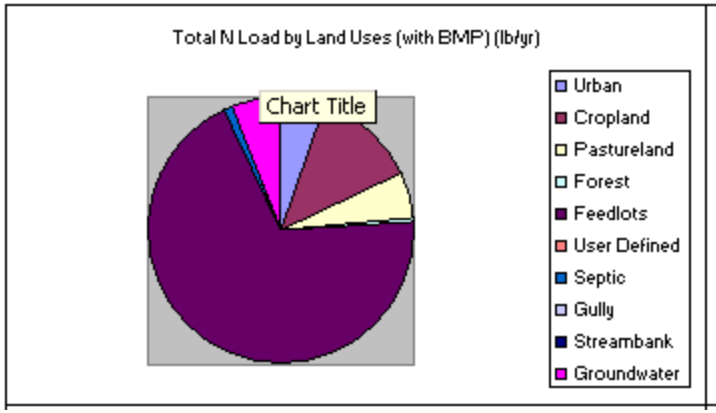
1. Total load by subwatershed(s)

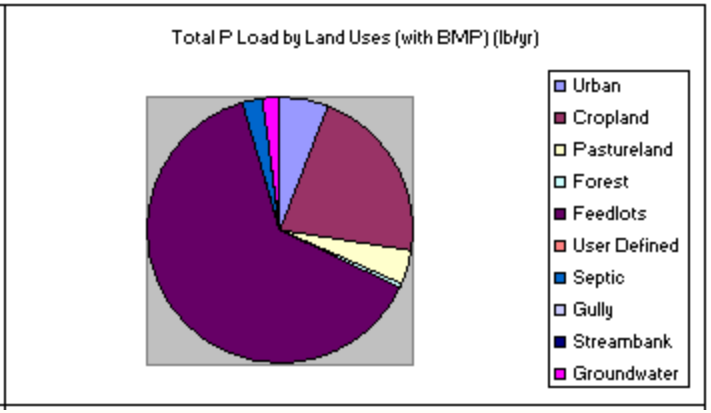
Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1	39888.8	5615.6	60882.3	342.9	8.6	3.3	17.1	4.7
W2	39879.8	5612.2	60864.2	338.0	0.0	0.0	0.0	0.0
W3	39879.8	5612.2	60864.2	338.0	0.0	0.0	0.0	0.0
Total	119648.4	16839.9	182610.8	1018.8	8.6	3.3	17.1	4.7

Each row of results corresponds to a different watershed or project.

Graphs Worksheet

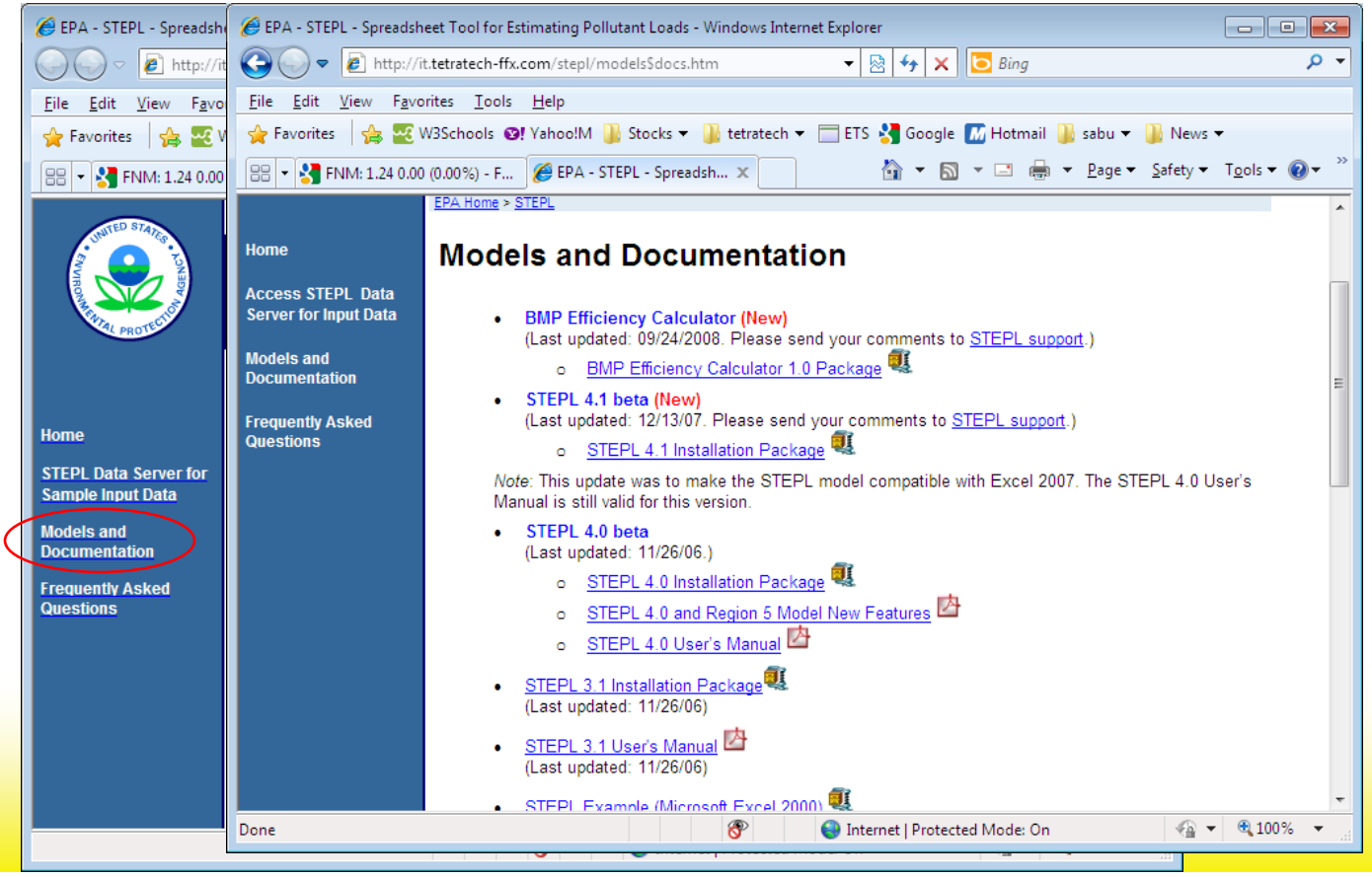






Accessing STEPL Model

- STEPL Site: http://it.tetratech-ffx.com/stepl/



STEPL Model – User Defined Data Requirements

- Watershed level data
  - Land use distribution
  - Agricultural animal population and manure application information
  - Septic system information
  - Soil information (USLE [county - NRI] and HSG)
  - Irrigation information (optional)
- Land use specific
  - BMP type and application area

STEPL Model – System Defaults

- Curve Numbers (land use/soil group)
- Nutrient concentration in runoff/shallow groundwater
- Urban land use distribution

BMPs Available

- Cropland
  - Combined BMPs-Calculated
  - Contour Farming
  - Diversion
  - Filter strip
  - Reduced Tillage Systems
  - Streambank stabilization and fencing
  - Terrace

BMPs Available - Cont

- Pastureland
  - Combined BMPs-Calculated
  - User
- Forest
  - Combined BMPs-Calculated
  - Road dry seeding
  - Road grass and legume seeding
  - Road grass and legume seeding-New
  - Road hydro mulch
  - Road straw mulch
  - Road tree planting
  - Site preparation/hydro mulch/seed/fertilizer
  - Site preparation/hydro mulch/seed/fertilizer/transplants
  - Site preparation/steep slope seeder/transplant
  - Site preparation/straw/crimp seed/fertilizer/transplant
  - Site preparation/straw/crimp/net
  - Site preparation/straw/net/seed/fertilizer/transplant
  - Site preparation/straw/polymer/seed/fertilizer/transplant

BMPs Available - Cont

- Feedlots
  - Diversion
  - Filter strip
  - Runoff Mgmt System
  - Solids Separation Basin
  - Solids Separation Basin w/Infilt Bed
  - Terrace
  - Waste Mgmt System
  - Waste Storage Facility

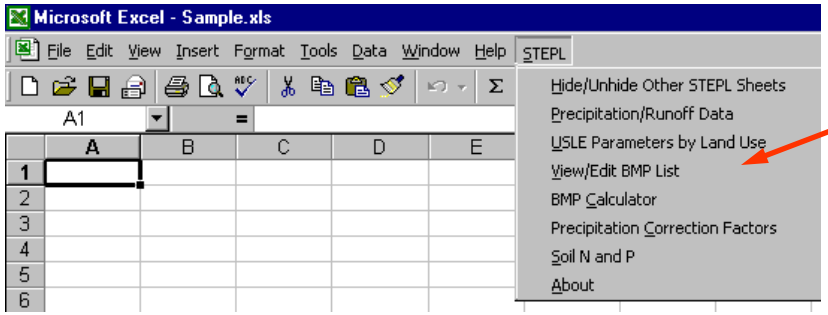
BMPs Available - Cont

- Urban

- Alum Treatment
- Bioretention facility
- Combined BMPs-Calculated
- Concrete Grid Pavement
- Dry Detention
- Extended Wet Detention
- Filter Strip-Agricultural
- Grass Swales
- Infiltration Basin
- Infiltration Devises
- Infiltration Trench
- LID*/Cistern
- LID*/Cistern+Rain Barrel
- LID*/Rain Barrel
- LID/Bioretention
- LID/Dry Well
- LID/Filter/Buffer Strip
- LID/Infiltration Swale
- LID/Infiltration Trench
- LID/Vegetated Swale
- LID/Wet Swale
- Oil/Grit Separator
- Porous Pavement
- Sand Filter/Infiltration Basin
- Sand Filters
- Settling Basin
- Vegetated Filter Strips
- Weekly Street Sweeping
- Wet Pond
- Wetland Detention
- WQ Inlet w/Sand Filter
- WQ Inlets

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 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.

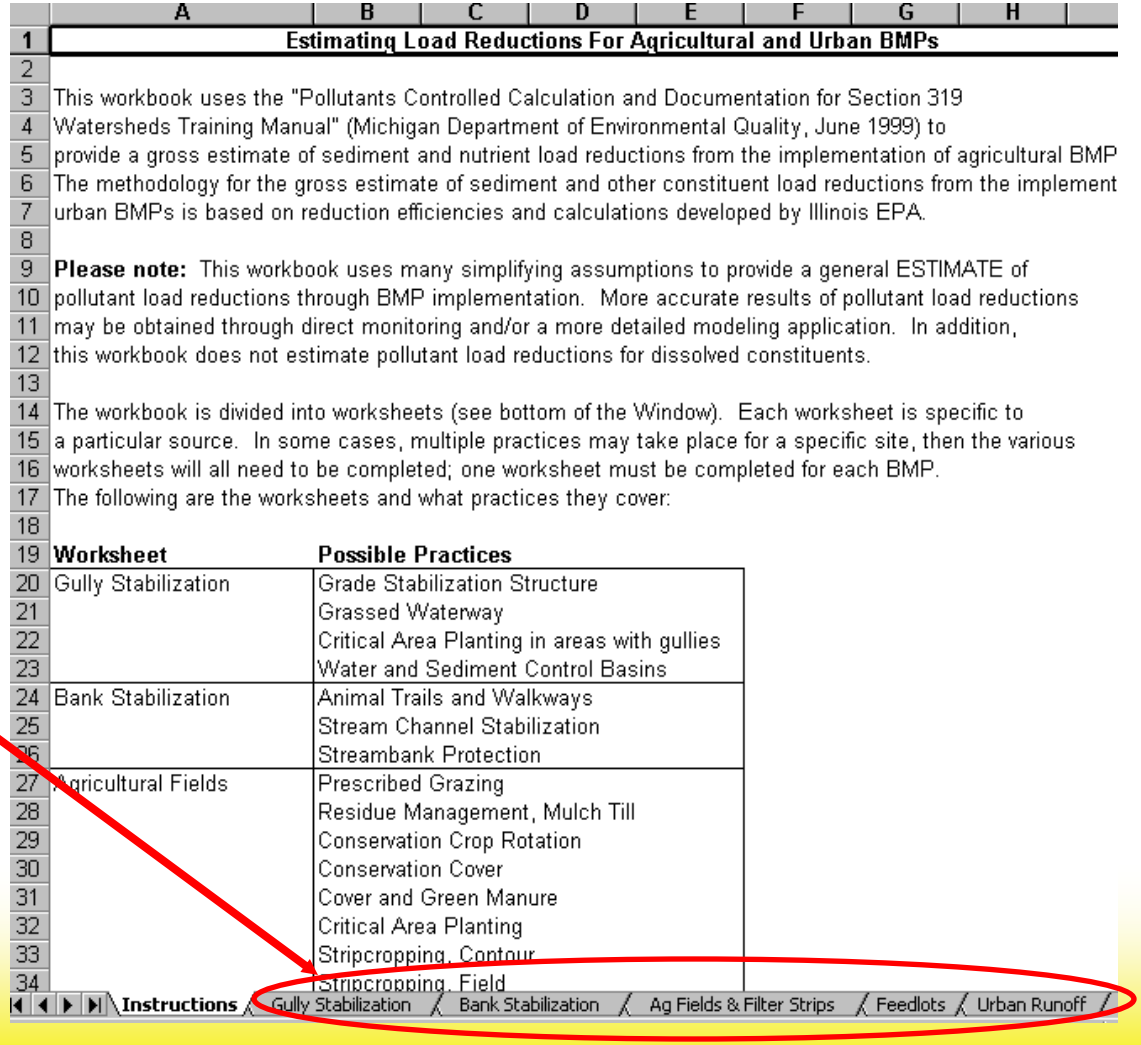
Source	BMP
Gully	Gully Stabilization
Streambank	Streambank Stabilization
Agricultural Fields	Field Management Practices and Filter Strips
Feedlot	Animal Waste System
Urban Runoff	Various BMPs

- Spreadsheet based model
- No watershed concepts
- Deals with single source and control

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

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

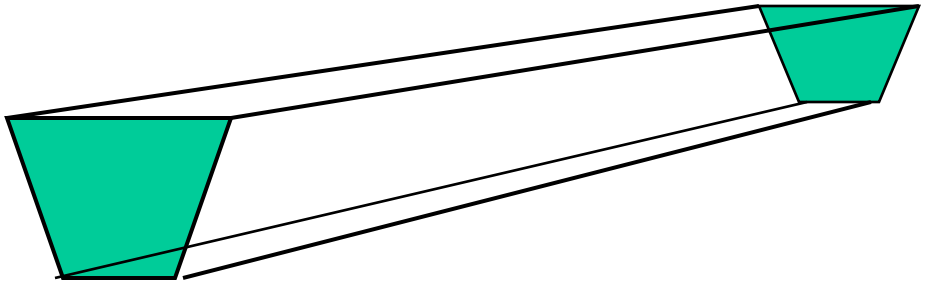
  Average annual erosion during the life of the gully (t/y)

  = 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:

☑ Agricultural Field Practices

☑ * Filter Strips

Please select a state and a county, and default USLE parame

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**

Region 5 model vs. STEPL 1

- 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 are related in watershed
  - User can specify and update BMP list
  - BMP calculator for complex BMP arrangements

Conclusion

- STEPL and R5 are simple models in terms of data needs, level of effort, etc.
- EPA can provide user support and customized versions, if needed
- Any observations, suggestions, or data that could improve the models are welcome