Bacteria Source Load Calculator

V 4.0

Users Manual

BSE Document No. 2007-0002

A product from the

CENTER for WATERSHED STUDIES at VIRGINIA TECH

Biological Systems Engineering

VirginiaTech
Invent the Future

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1

Introductory Material

User Guide Icons

This icon indicates an important note.

This icon indicates a tip.

This icon indicates a caution note.

This icon indicates a step-by-step procedure follows.

Background

The presence of pathogen indicator bacteria, such as fecal coliform and *Escherichia coli* (*E. coli*), is reported to be the most widespread cause of water quality impairment in the United States (USEPA, 2005). Watershed-scale simulation models, such as the Hydrological Simulation Program–FORTRAN (HSPF, Bicknell et al., 2000), can help stakeholders and watershed planners make informed management decisions to control such contamination and improve water quality. However, use of such models requires detailed characterization and processing of bacterial source information to generate bacterial loadings to land and receiving waters. These loadings vary both in time and space.

The Bacteria Source Load Calculator (BSLC) is a software tool designed to simplify the complex and time-consuming work involved in determining bacterial loadings. The program automates many of the characterization steps, while providing a high level of consistency in data development and processing. The BSLC is an especially useful tool for developing Total Maximum Daily Load (TMDL) studies, including the allocation scenario development process.

The BSLC characterizes how the bacterial loads are spatially and temporally distributed, organizing and processing source data to calculate monthly land loadings and hourly stream loadings. The program uses a systematic process that includes the following steps:

1. inventorying bacterial sources (including livestock, wildlife, humans, and pets)
2. estimating loads generated from these sources
3. distributing estimated loads to streams and land, as a function of source type and land use
4. generating bacterial load input parameters for watershed-scale simulation models

BSLC outputs are specifically formatted for use with HSPF, a program that has been used extensively to develop bacteria impairment TMDLs in Virginia and other states. However, you can also format this information for alternative watershed simulation models.

Preparing for data entry

The BSLC does not eliminate the need for baseline data collection such as land use distribution and livestock, wildlife, and human population estimates. The methods you use to inventory sources and determine the type and distribution of land uses within the impaired watershed are critical to the source characterization process, and are an important first step in effective modeling. Collecting this data must be done by you, the user, before using the BSLC. The program is not capable of remedying errors caused by incorrect source characterization/determination of land use and source population estimates; therefore, great care should be exercised in determining these inputs. See Appendix B for possible data resources and collection methodologies.

Version 4 of the BSLC is written using Visual Basic for Applications (VBA) in Microsoft Excel 2010 (Microsoft, 2010). The BSLC and its underlying methodology have been used in the development of more than 40 bacterial TMDLs in Virginia.

This document employs step-by-step information to direct you through the program and to generate results about a particular watershed. In the appendices you will find supplemental, detailed information about each required user-generated input, as well as information regarding interpretation of raw data and results.

What's New in Version 4.0?

Version 4.0 addresses some issues involved with the Office 2010 upgrade and provides many additional features to the user. The formatting upgrades mean that version 4 is NOT backwards compatible without some tweaks by the user.

1. The Calendar Control, no longer available in Office 2010, has been replaced with a series of restricted combo-boxes to enter year, month, and day.
2. The Common Dialog Control, no longer available in Office 2010, has been replaced by open or save dialogs as appropriate.
3. The default defecation areas for wildlife have been updated to represent the current methodologies used by the Center for Watershed Studies to estimate wildlife populations. As always, these defaults can be changed by the user.
4. Wildlife can now defecate on ALL land use types and can differentially defecate on different pasture types.
5. The user can now alter the land use names in the LandUseTable worksheet to match entries in his or her GEN-INFO table.
6. The user can now specify which groupings of land uses he or she would like to use for his or her report appendix tables (outputted to Word).
7. The user now specifies which residential land uses can receive sewered or unsewered pet defecations and failed septic system discharges.
8. The program is no longer restricted the file name "FecalColiformWorkbook.xls" (the user can change the name of the workbook and it will still function).

Disclaimer

The BSLC incorporates many assumptions into its processing. A watershed is a very complex system that cannot be feasibly represented without some simplifying assumptions. An overall assumption is that the number and types of land uses and animals represented by the BSLC characterize the watershed appropriately for the uses of the output. There are a few known limiting assumptions that will be addressed in future versions of the program. These include the assumptions that:

- sheep, goats, and horses do not spend significant time in confinement; and
- the amount of time spent by cattle in loafing lots is constant throughout the year.

Other defining assumptions include:

- poultry are always confined;
- all animals of a particular species are managed in the same way and/or have the same behavior;
- poultry litter is completely mixed prior to land application (i.e., calculation of poultry litter application in each subwatershed applies an amount of fecal coliform that is a conglomerate of all poultry sources in that subwatershed);
- liquid dairy manure is applied preferentially before poultry litter, which is applied before solid cattle manure; and
- manure is applied first to cropland and then to pasture.

Before You Begin

The BSLC requires an adjustment to Excel's security settings.

1. **When you open the file, click the button to "Enable Content."**

2. **If you receive a pop-up window prompt regarding making the file a Trusted Document, click "Yes."**

If you are planning to use BSLC data with HSPF, additional preparation is necessary.

If you are planning to use BSLC data with HSPF, you should create a User Control Input (UCI) file that contains a General Information (GEN-INFO) table saved in an accessible computer folder.

UCI files typically contain detailed information regarding the watershed, including essential data for HSPF. A GEN-INFO table is a section in the UCI file where pervious land segments (PLS) are named for HSPF use. See Appendix A for more information about UCI files and GEN-INFO tables.

General Notes, Tips, and Cautions

Navigating among worksheets

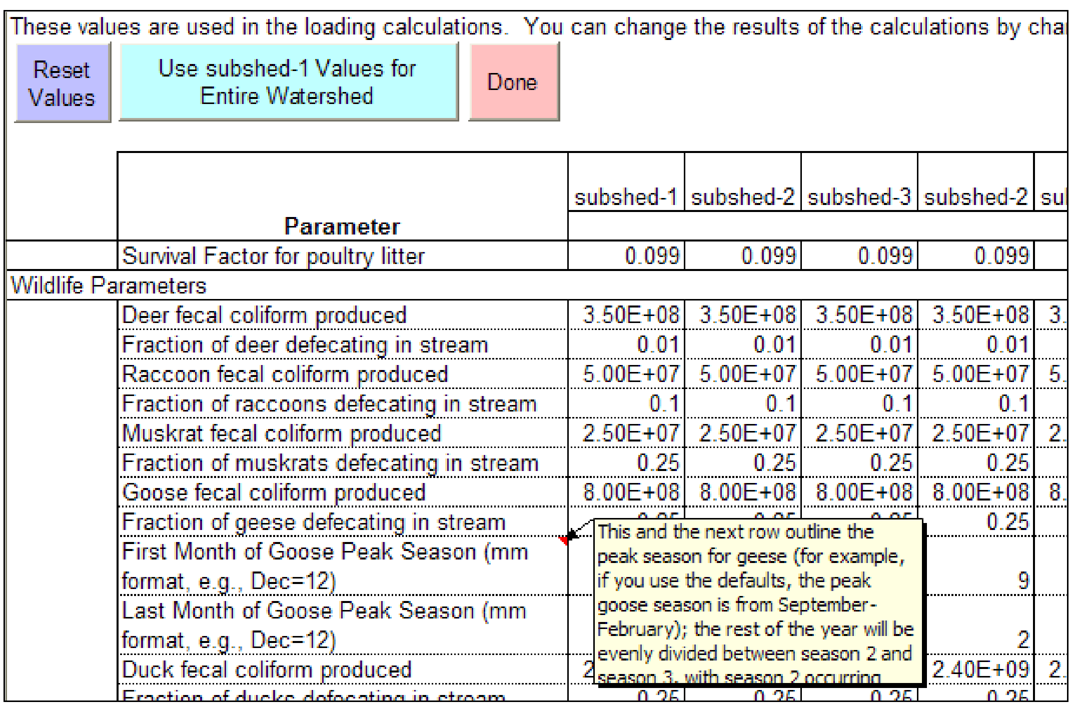
Like other Excel files, the BSLC has worksheet tabs at the bottom of the screen. The program functions best when these tabs are not used for navigation from one worksheet to the next. Instead, use the appropriate “Done” and “Click Here When You Have Finished Entering Data” buttons on each worksheet. Once you have entered all or most of the initial/baseline data, processed, and saved the results, it is safe to use the bottom-of-the-page tabs.

Clicking buttons

Buttons on some worksheets will not function when the cursor is left in a data entry cell. Move your cursor outside of a data cell to any white space on the worksheet, click, and then click your desired button. The screen will sometimes flash as the program is processing your input.

Reference corners

Throughout the program, you will see columns that have a corner highlighted in red. Direct the cursor to these areas to display information that may help clarify what type of information belongs in the respective column.



These values are used in the loading calculations. You can change the results of the calculations by cha

Reset Values | Use subshed-1 Values for Entire Watershed | Done

	Parameter	subshed-1	subshed-2	subshed-3	subshed-2	su
	Survival Factor for poultry litter	0.099	0.099	0.099	0.099	
Wildlife Parameters						
	Deer fecal coliform produced	3.50E+08	3.50E+08	3.50E+08	3.50E+08	3.
	Fraction of deer defecating in stream	0.01	0.01	0.01	0.01	
	Raccoon fecal coliform produced	5.00E+07	5.00E+07	5.00E+07	5.00E+07	5.
	Fraction of raccoons defecating in stream	0.1	0.1	0.1	0.1	
	Muskrat fecal coliform produced	2.50E+07	2.50E+07	2.50E+07	2.50E+07	2.
	Fraction of muskrats defecating in stream	0.25	0.25	0.25	0.25	
	Goose fecal coliform produced	8.00E+08	8.00E+08	8.00E+08	8.00E+08	8.
	Fraction of geese defecating in stream				0.25	
	First Month of Goose Peak Season (mm format, e.g., Dec=12)				9	
	Last Month of Goose Peak Season (mm format, e.g., Dec=12)				2	
	Duck fecal coliform produced	2			2.40E+09	2.
	Fraction of ducks defecating in stream					

Figure 1. Red Reference Corners with Helpful Information

Exiting the BSLC

When exiting the program, you will be asked if you would like to save changes made to 'FecalColiformWorkbook.xls'. This is the core BSLC program and no changes should ever be saved using this prompt or the save command under the File menu. You will be prompted to save your work in the separate worksheet file you named at the beginning of the program.

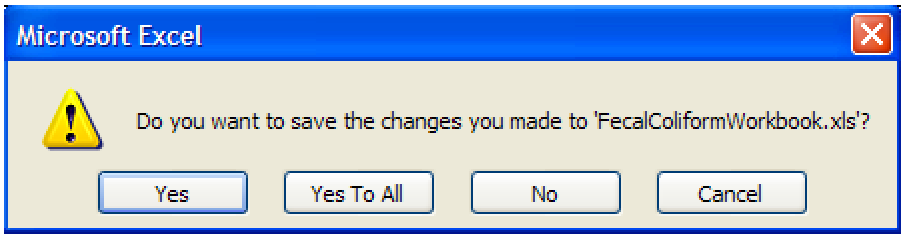


Figure 2. Do Not Save Changes to the BSLC Program

(While the "Yes" button is highlighted in the graphic above, you must click "No")

Section

2

Entering Data

Introduction Worksheet

The BSLC is designed so that watershed data can be entered into program worksheets, saved, and then retrieved later for any number of updates or revisions.

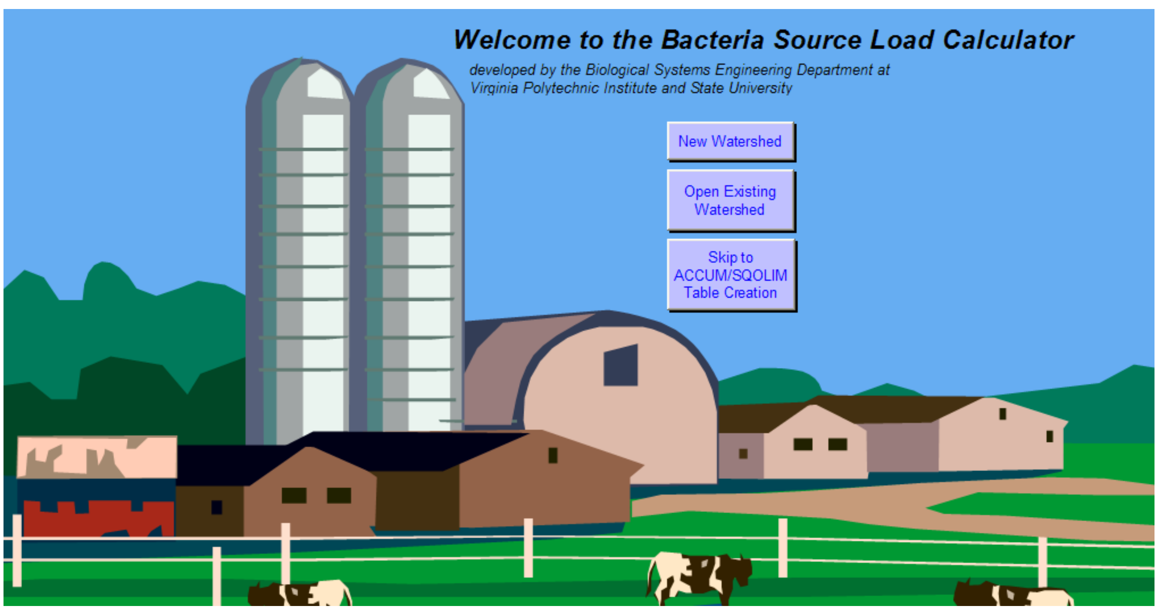


Figure 3. Image of Introduction Worksheet

Choose which of the following is most appropriate for your situation.

1. Generate new results by clicking “New Watershed**.”**

   Use this option when initially entering new watershed data.

2. Use “Open an Existing Watershed” to update saved results from previously entered watershed data.

   Use this option when retrieving previously entered watershed data for updates or revisions.

3. Create only HSPF inputs by choosing “Skip to ACCUM/SQOLIM Table Creation.”

   The BSLC can generate a monthly bacteria accumulation (ACCUM) table, a monthly limit on surface storage (SQOLIM) table, and direct deposit tables, also known as multiple sequential input (MUTSIN) files. All are required inputs for bacteria simulation using HSPF. Use this option when working on hypothetical allocation scenarios, when you are trying to represent various management practices in the model. You could reduce the loading to reflect a best management practice that has been installed in pastured areas, for example. This option, like the second option, requires that you have previously entered data into the BSLC. It also requires that you have already generated ACCUM/SQOLIM tables for that watershed using the “New Watershed” or “Open an Existing Watershed” buttons.

Data Entry Worksheets

The BSLC includes three watershed-specific data input sheets: an animal sheet (Figure 5), a farm and land use sheet (Figure 7), and a human activity sheet (Figure 8). The inputs from these three sheets are the only watershed-specific data that are required by the program.

Beginning a New Watershed

1. **Click “New Watershed”.**
2. **At the pop-up window, name and save a new Excel worksheet.**

This file is where some results generated by the program will be saved. Name the file so that you can easily locate it for future reference.

3. **Enter the number of subwatersheds in the Number of Subwatersheds window and click "OK".**

   Since version 3.0, has been no restriction on the number of sub-watersheds you can have.

4. **Read the Subwatershed Naming Conventions pop-up window.**

Subwatershed naming conventions
It is important to name watersheds in a format that will be recognized by the BSLC, which must communicate with the UCI file in order to generate ACCUM and SQOLIM tables later in the program. Ignore the rest of this information if you do not plan to input BSLC data to HSPF. However, other modeling programs may have other naming formats to consider. UCI files typically contain detailed information regarding the watershed, including essential data for HSPF. A GEN-INFO table is a section in the UCI file where pervious land segments (PLS) used by HSPF are given a name that makes sense to the modeler. The basic rule in entering subwatershed names in the BSLC is to follow your chosen name with a hyphen and the number corresponding to that particular subwatershed. For example, if your first subwatershed is named Slow Creek, a possible name could be SLC-1. To ensure that the BSLC communicates properly with the UCI file, land segments within subwatershed 1 would then be followed by a "1" when listed in the GEN-INFO table. Land segments in subwatershed 2 would have a "2" suffix. See Figure 4 and Appendix A for an example and more information.

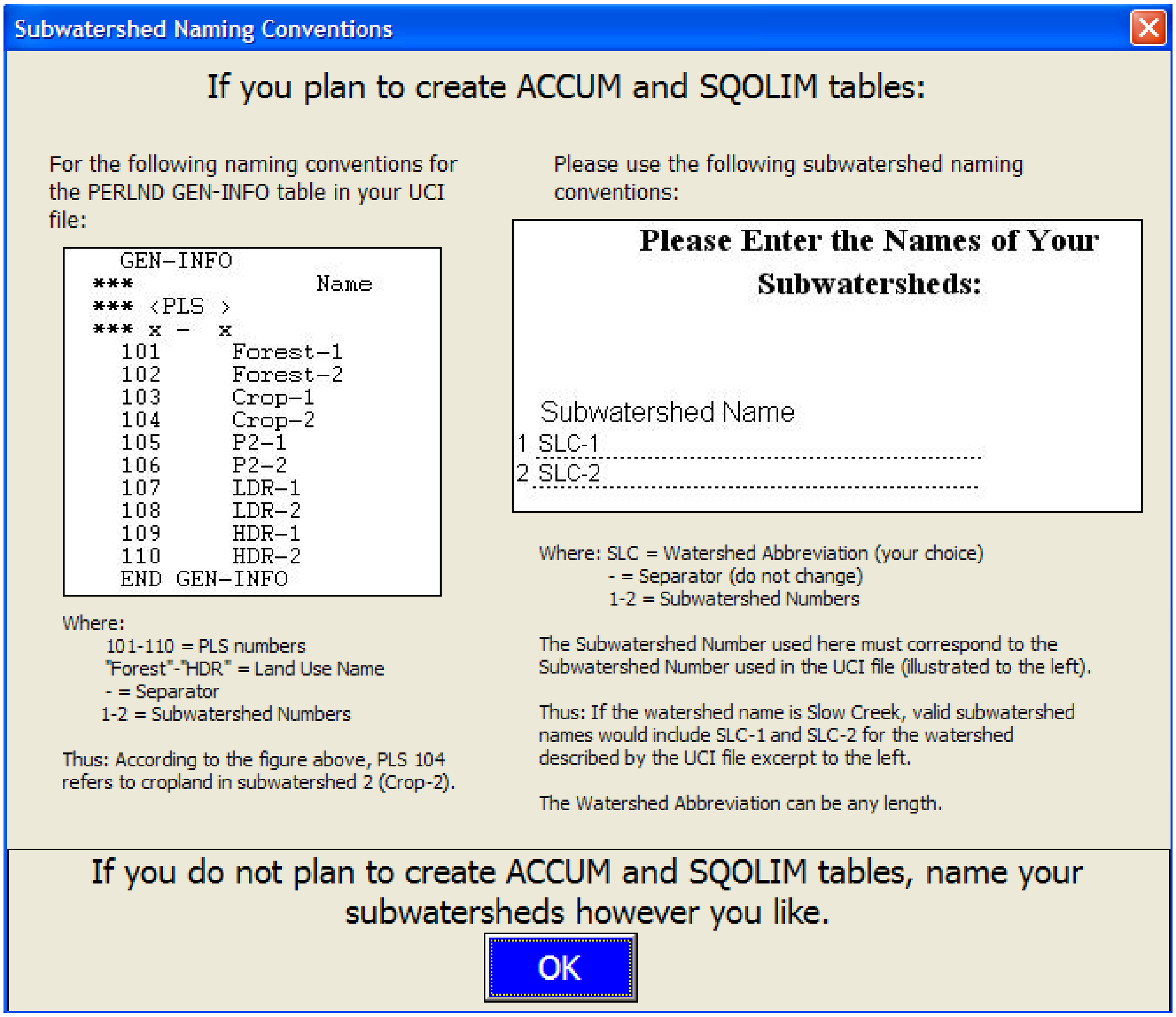


Figure 4. Subwatershed Naming Conventions

5. **Click “Done” when finished reading.**

Subwatersheds Worksheet

The BSLC requires names for all subwatersheds to be characterized.

1. **Type names for all subwatersheds.**

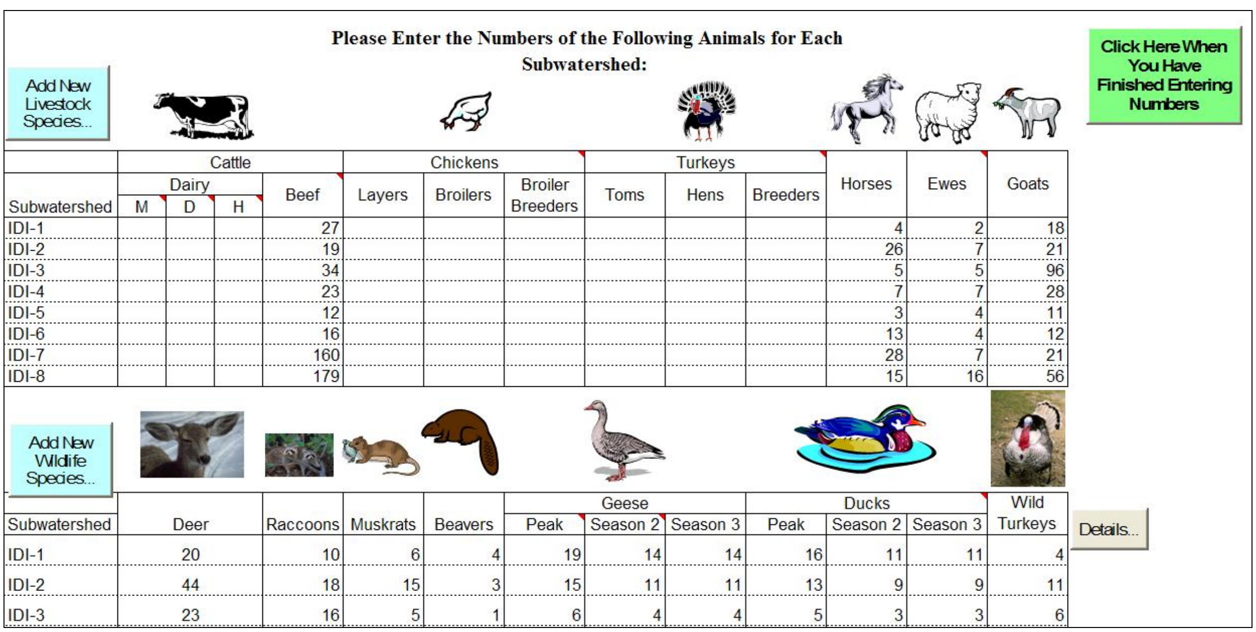
   If appropriate, keep the previously mentioned naming conventions in mind as you name your subwatersheds.

2. **Move your cursor to the white space on the page, click, and then select “Finish” when you have entered names for your subwatersheds.**

   The screen will flash as it is processing your input.

More detailed information
See Appendix A for further instructions on naming.

Animals Worksheet



	Cattle				Chickens			Turkeys					
	Dairy			Beef	Layers	Broilers	Broiler Breeders	Toms	Hens	Breeders	Horses	Ewes	Goats
Subwatershed	M	D	H										
IDI-1				27							4	2	18
IDI-2				19							26	7	21
IDI-3				34							5	5	96
IDI-4				23							7	7	28
IDI-5				12							3	4	11
IDI-6				16							13	4	12
IDI-7				160							28	7	21
IDI-8				179							15	16	56

					Geese			Ducks			Wild
Subwatershed	Deer	Raccoons	Muskrats	Beavers	Peak	Season 2	Season 3	Peak	Season 2	Season 3	Turkeys
IDI-1	20	10	6	4	19	14	14	16	11	11	4
IDI-2	44	18	15	3	15	11	11	13	9	9	11
IDI-3	23	16	5	1	6	4	4	5	3	3	6

Figure 5. Animals Worksheet

The first step in bacterial source characterization is to estimate the number of livestock and wildlife in the impaired watershed. Suggested methods for inventorying animals are described in Appendix B beginning on page 63.

Livestock
The livestock identified in this worksheet were chosen based on animals typically found in Virginia's rural areas.

1. **Cattle—Enter cattle population estimates for the three subcategories.**

   Use the red **reference corners** and the following definitions to guide your data entry.
   a. Milk (M): lactating cows counted individually
   b. Dry (D): non-lactating cows counted individually
   c. Heifers (H): young cows counted individually
   d. Beef: Beef cattle counted in cow/calf pairs

Beef populations represent cow/calf operations where the total mass of beef cow changes throughout the year. The Beef Number in the Monthly Variables worksheet is a factor multiplied by 1000 lb to estimate the weight of a cow/calf pair for the corresponding month. For instance, if the Beef Number for January is 1.05, the average mass of a cow/calf pair in January is 1050 lb. You can change these default values in the Monthly Variables worksheet. For example, if your watershed consists primarily of non-cow/calf operations, you may want to enter a 1 for every month in the Beef Number table.

2. **Chickens—Enter population estimates for the three subcategories of chickens.**

   Use the red **reference corners** and the following definitions to guide your data entry. Each subcategory is entered as the number of animals per cycle.
   a. Layers: hens used for laying eggs for human consumption
   b. Broilers: chickens raised for human consumption
   c. Broiler Breeders: chickens used to breed more broilers

3. **Turkeys—Enter population estimates for the three subcategories of turkeys.**

   Use the red **reference corners** and the following definitions to guide your data entry. Each subcategory is entered as the number of animals per cycle.
   a. Toms: male turkeys bred for human consumption
   b. Hens: female turkeys bred for human consumption

c. Breeders: turkeys used to breed more turkeys

4. **Horses—Enter a population estimate for the number of individual horses in each subwatershed.**

5. **Ewes—Enter a population estimate for the number of individual ewes in each subwatershed.**

Ewes are entered into one category as Ewes ONLY. Lambs are estimated based on this number and so are encompassed within this category. They are not to be included in the number of animals entered into the worksheet. The BSLC default is based on the assumption that each ewe has two lambs. You can change this default value in the References worksheet. Use the red **reference corners** to guide your data entry.

6. **Goats—Enter a population estimate for the number of individual goats in each subwatershed.**

7. **New Livestock Species**

If you would like to enter a new livestock species, click the "Add New Livestock Species…" button to the left of the screen. The following screen will appear:

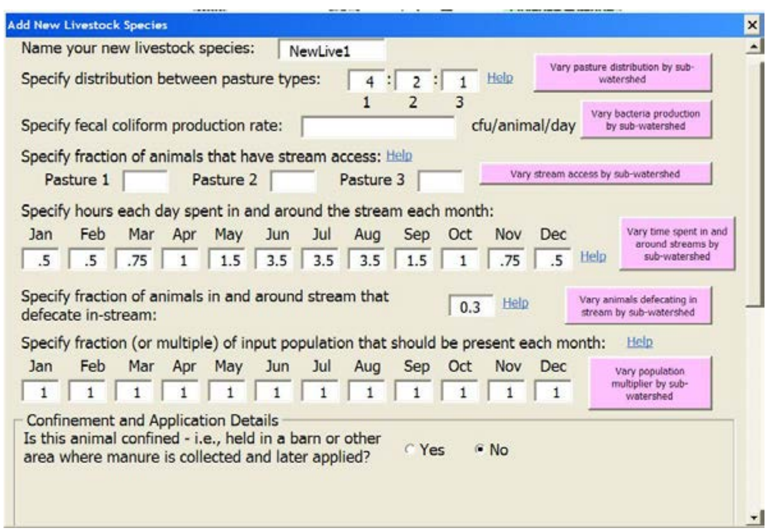


Figure 6. New Livestock Species Dialog

You must enter something in each box (even if the value is 0). The BSLC will prompt you to correct anything not filled in or filled in erroneously (text in number fields, for example). Clicking the "Help" links will pop up a short description about the values to be filled in. Where default values exist for a given parameter, they are filled in for you. Most of the parameters can be entered uniquely by subwatershed; click on the appropriate pink button if you would like to do this. The "Continue" button is located at the bottom of the form; you must scroll to see it.

If you want to consider manure collection and application for your new livestock species, choose "Yes" when asked if the animal is confined. This will pop up a new set of parameters you must supply. Again, where default values are available, they are filled in for you; however, you are cautioned that you should customize these values as much as possible.

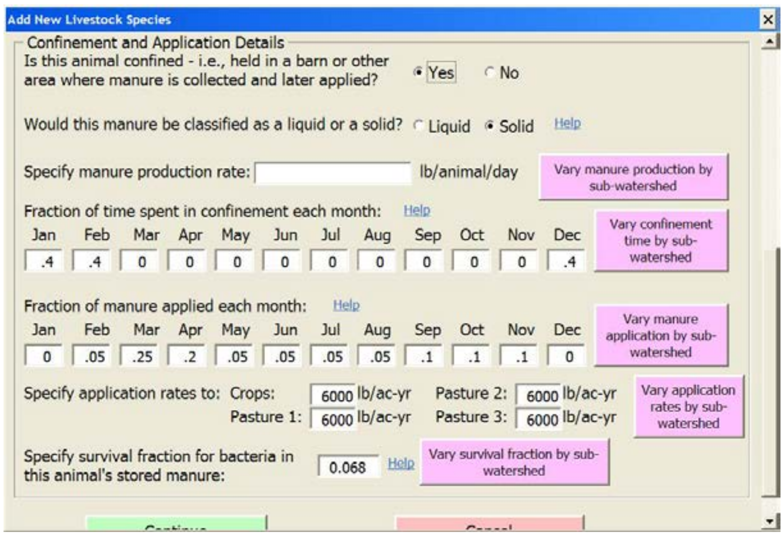
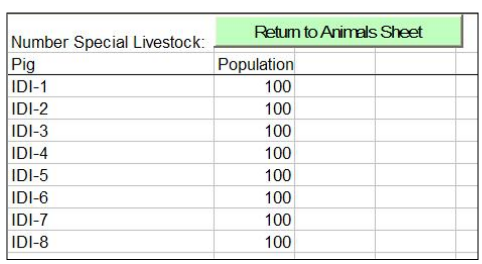


Figure 7. Confinement Information in New Livestock Species Dialog

When you are finished, click the "Continue" button at the bottom of the form. You will then be prompted to fill in populations for this new livestock species in the NewLivestock worksheet.



Number Special Livestock:	Return to Animals Sheet
Pig	Population
IDI-1	100
IDI-2	100
IDI-3	100
IDI-4	100
IDI-5	100
IDI-6	100
IDI-7	100
IDI-8	100

Figure 8. NewLivestock Worksheet

Make sure you locate the correct species name in the first column – if you have created multiple new livestock species, they will be stacked horizontally and you will need to scroll down to see the latest species. The parameters you just entered in the "Add New Livestock Species" form are in the hidden columns B-BM if you need to access them (this is not advised). Once you enter your populations, click "Return to Animals Sheet"; at that point you can then add another livestock species by clicking the "Add New Livestock Species…" again or proceed with the next step in the instructions.

Wildlife

Eight categories of wildlife are currently included in the BSLC. These species are typically found in large enough quantities and/or produce enough fecal matter to warrant being represented individually in the model in the mid-Atlantic region. You can also add additional species that may be of significance to your study area.

1. **Deer—Enter a population estimate for the number of individual deer in each subwatershed.**

2. **Raccoons—Enter a population estimate for the number of individual raccoons in each subwatershed.**

3. **Muskrats—Enter a population estimate for the number of individual muskrats in each subwatershed.**

4. **Beavers—Enter a population estimate for the number of individual beavers in each subwatershed.**

5. **Geese—Enter geese population estimates for the three subcategories—Peak, Season 2, and Season 3.**

   The BSLC default bacterial loading rate is based on the assumption that there are a number of resident geese living year-round in each subwatershed. During the peak season, migratory geese add to the population. You can change the months included in the peak season in the References worksheet. Refer to Appendix B, page 69 for detailed instructions. The remainder of the year is divided into two separate seasons to give the user more flexibility in inputs. Use red **reference corners** and the following definitions to guide your data entry.

   a. Peak: period when the most of the geese (resident and migratory) are in the subwatershed
   b. Season 2: period equal to one half of the remainder of the year
   c. Season 3: period equal to one half of the remainder of the year (typically has the same population as used for Season 2)

6. **Ducks—Enter duck population estimates for the three subcategories—Peak, Season 2, and Season 3.**

   The BSLC default bacterial loading rate is based on the assumption that there are a number of resident ducks living year-round in each subwatershed. During the peak season, migratory ducks add to the population. You can change the months included in the peak season in the References worksheet. Refer to Appendix B, page 69 for detailed instructions. The remainder of the year is divided into two separate seasons to give the user more flexibility in inputs. Use red **reference corners** and the following definitions to guide your data entry.

   a. Peak: period when the most of the ducks (resident and migratory) are in the subwatershed

   b. Season 2: period equal to one half of the remainder of the year

   c. Season 3: period equal to one half of the remainder of the year (typically has the same population as used for Season 2)

7. **Wild Turkeys—Enter a population estimate for the number of individual wild turkeys in each subwatershed.**

8. **Click "Details" buttons if you want the BSLC to estimate wildlife populations for you based on site-specific data for habitat acreage or population density; this button can also be used to specify which land uses should be used as defecation areas for each species, either along with the population estimates or independently of them (Figure 6).**

   Use of the Detailed Wildlife Information worksheet is not necessary to generate BSLC results, and should only be used if the information entered will increase the accuracy of the results for the particular subwatershed. You may choose to do the following combinations of steps listed below: only a, b, and d; only c and d; or a, b, c, and d.

   a) Enter the habitat area in acres for each of the animals listed.
   b) Enter the population density (number of animals per area of habitat listed in the first column) for each of the animals listed.
   c) Adjust the defecation areas for each animal by checking or unchecking the corresponding boxes.
   d) When you are finished, select one of the following options:
      i. Click "Update Animal Populations Only & Close" if you wish to use this worksheet only to estimate population.
      ii. Click "Update Defecation Areas Only & Close" if you wish to use this worksheet only to specify defecation areas.
      iii. Click "Update Both & Close" if you wish to update both types of information.
      iv. Click "Cancel" if you do not wish to use the Detailed Wildlife Information worksheet.

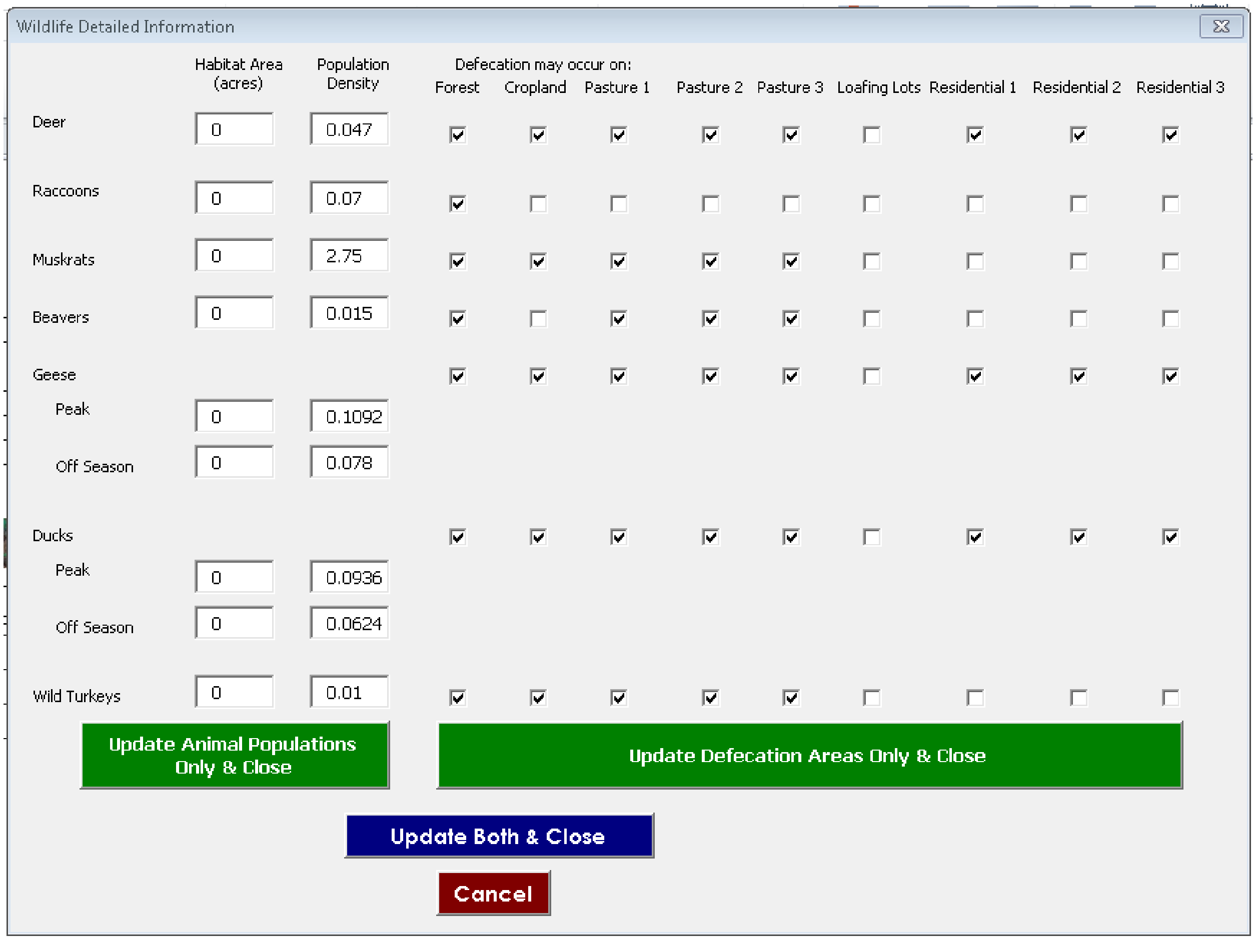


Figure 9. Detailed Wildlife Information

9. If you would like to include a wildlife species not in the basic options, click the "Add New Wildlife Species…" button.

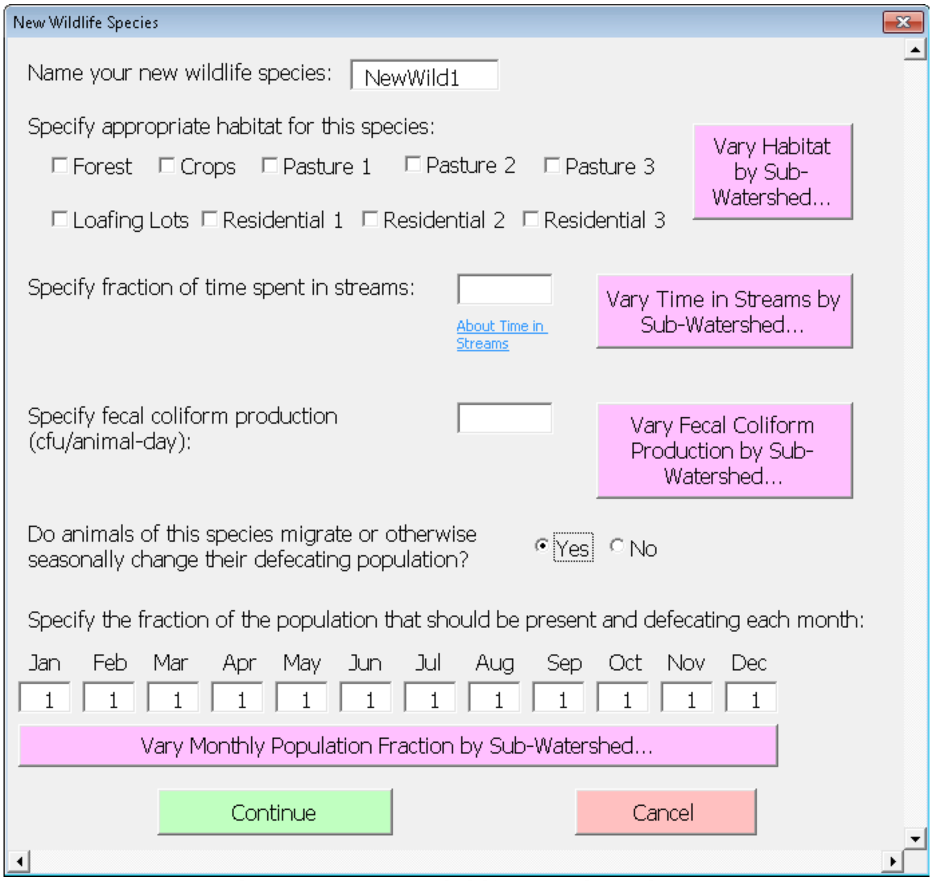


Figure 10. New Wildlife Species Dialog

Provide the BSLC with a name for your new wildlife species. Next, select to which areas fecal matter from this species should be applied. Give a fraction of time in a day spent in streams by this species (click "About Time in Streams" if you would like some more guidance on this topic). Provide a fecal coliform production rate in cfu per animal per day. Next, you have a choice as to whether the species' population should change throughout the year. If the population fluctuates throughout the year, then choose "Yes" and one more row of inputs will appear as shown in the figure above. Here you should enter a multiplier for the population in each subwatershed. For example, if you give the population in subwatershed 1 as 100 animals, but in February there are 120 animals, then in the box below "Feb" on the "New Wildlife Species" dialog you should enter 1.2 as the fraction.

If any of the information you provided should vary by subwatershed, click the appropriate pink button. Once you are finished specifying parameters, click the “Continue” button. The BSLC will take you to the NewWild worksheet and prompt you to enter the populations for the new species.

Number Special Wildlife:	Return to Animals Sheet
Squirrel	Population
IDI-1	26
IDI-2	9
IDI-3	24
IDI-4	89
IDI-5	38
IDI-6	97
IDI-7	94
IDI-8	41

Figure 11. NewWild Worksheet

Once you are done entering populations, click “Return to Animals Sheet” to return to the Animals worksheet. You can then create another new wildlife species by clicking “Add New Wildlife Species…” again or proceed with the next step in the instructions.

10. Click “Click Here When You Have Finished Entering Numbers” when you have completed data entry.

More detailed information

See Appendix B for further information regarding the Animals worksheet.

Farm and Land Use Data Worksheet

Please Enter the Following Information About the Land Uses in Each SubWatershed:

Click Here When You Have Finished Entering Numbers

Subwatershed	Total Forest Acreage	Total Residential 1 Acreage	Total Residential 2 Acreage	Total Residential 3 Acreage	Total Cropland Acreage	Total Pasture Acreage	Total Loafing Lot Acreage	Loafing Lot Time Dairy	Loafing Lot Time Beef	Pasture 1 Fraction of Total	Pasture 2 Fraction of Total	Pasture 3 Fraction of Total	Stream Access Pasture 1	Stream Access Pasture 2	Stream Access Pasture 3	Straight Pipes
SLC-1	1000	25	10	0	200	100	0			0.6	0.15	0.25	0.5	0.3	0.2	0.5
SLC-2	750	50	15	0	100	150	0			0.7	0.25	0.05	0.2	0.4	0.5	0
SLC-3	800	75	20	0	300	200	0			0.2	0.8	0	0.1	0	0	0

Figure 12. Farm and Land Use Data Worksheet

Data entered in this worksheet provide the BSLC with basic land use information needed to compute monthly land loadings.

1. **Total Forest Acreage—Enter the total acres of forest present in each subwatershed.**

2. **Total Residential Acreage—Enter the total acres of residential land use present in each category in each subwatershed.**

   Historically, the three land use types were (1) farmstead, (2) low density residential, and (3) high density residential. However, with version 4, there is no restriction on what the residential land uses actually represent. All three have the potential to receive wildlife defecation (see step 8 in the Wildlife section), as well as fecal material from rural or urban pets and failing septic systems.

3. **Total Cropland Acreage—Enter the total acres of cropland present in each subwatershed.**

4. **Total Pasture Acreage—Enter the total acres of pasture present in each subwatershed.**

5. **Total Loafing Lot Acreage—Enter the total acres of loafing lots present in each subwatershed.**

6. **Loafing Lot Time—Enter loafing lot time fractions for both dairy and beef cattle.**

   Calculate the fraction (as a decimal percentage) of one day (24 hours) spent in the loafing lot. For instance, if beef cattle spend 12 hours per day in the loafing lot, the entry would be “0.5.” Use the red **reference corners** and the information below to guide your data entry.

   a. Dairy: Fraction of one day spent in the loafing lot by dairy cattle.
   b. Beef: Fraction of one day spent in the loafing lot by beef cattle.

7. **Pasture 1, 2 and 3 Fractions of Total—Use acreage subtotals for the three pasture types to calculate and enter what fraction each is of the total pasture acreage.**

   Pastures types are assumed to be either improved (1), unimproved (2), or overgrazed (3). Grazing livestock can be distributed to these three pasture types in different proportions (you can modify the proportion of livestock in each pasture category in the References worksheet). If you can't make a distinction between pasture types, or only have one pasture type, enter "1" (100 percent) in Pasture 1. If you have only two types of pasture, leave Pasture 3 blank. Enter fractions as decimal percentages. The sum of the three fraction of total columns should equal 1 for each subwatershed.

   Use the red **reference corners** and the information below to guide your data entry.

   a. Pasture 1 Fraction of Total: Improved pasture acreage in the subwatershed divided by the total pasture acreage in the subwatershed
   b. Pasture 2 Fraction of Total: Unimproved pasture acreage in the subwatershed divided by the total pasture acreage the subwatershed
   c. Pasture 3 Fraction of Total: Overgrazed pasture acreage in the subwatershed divided by the total pasture acreage in the subwatershed

8. **Stream Access Pasture 1, 2, and 3—Enter the fraction of pasture area that is bordered by a stream and allows livestock unencumbered access to the stream.**

   Do not include portions of pasture where fencing prevents livestock access to the stream, or where pastures do not border a stream. Enter fractions as decimal percentages. For example, if pasture 1 is 200 acres, borders a stream, and there is no fencing to keep livestock out, enter "1" (100 percent). If a similar size pasture has a 100-acre section that is fenced off, enter ".5" (50 percent) to represent the portion that has stream access. This assumes that there is a uniform density of cows across a given type of pasture in a given subwatershed. Consider the following as an example for addressing unequal densities. Assume there are 400 cows in Pasture 1 in subwatershed 1—300 on a farm with 100 acres and 100 on a farm with 100 acres. If the farm with a higher density of cattle does not fence the cows from the stream but the farm with a lower density of cattle does, this factor would be 0.75 (because ¾ of the cows have stream access), NOT 0.5.

   Use the red **reference corners** and the information below to further guide your data entry.

   a. Stream Access Pasture 1: Fraction of Pasture 1 acreage with stream access.
   b. Stream Access Pasture 2: Fraction of Pasture 2 acreage with stream access.
   c. Stream Access Pasture 3: Fraction of Pasture 3 acreage with stream access.

9. **Straight Pipes—Enter the fraction of dairies in the subwatershed that have straight pipes to carry untreated waste from dairy/milk parlors.**

   Enter fractions as decimal percentages. For example, if there are 10 dairies and 5 of them have straight pipes, enter ".5" (50 percent). Again, this assumes a uniform population of animals in dairies in the given subwatershed. If there are two dairies, one with 300 cows and one with 100 cows, and the one with 300 cows has a straight pipe from the milk parlor and the one with 100 cows does not, enter a 0.75 for this value, as ¾ of the cattle in the subwatershed are contributing to the milk parlor waste carried out through a straight pipe. Use the red **reference corners** to guide your data entry.

10. **Click "Click Here When You Have Finished Entering Numbers" when you have entered all land use data.**

More detailed information

See Appendix B, page 70 for further information regarding Farm and Land Use Data.

Human Activities Worksheet

Please Enter the Following Information About the Human Activities in Each SubWatershed:

Click Here When You Have Finished Entering Numbers

Subwatershed	Persons/ Unsewered House	Persons/ Sewered House	Number Unsewered Houses	Number Sewered Houses	Septic Systems			Straight Pipes		
					oldest	mid-age	newest	oldest	mid-age	newest
SLC-1	2.5	2.3	25	10	5	15	5	0	0	0
SLC-2	2.4	2.4	50	5	10	30	5	3	2	
SLC-3	2.2	2.1	30	0	15	5	10	0	0	0

Figure 13. Human Activities Worksheet

Two categories of homes, sewered and non-sewered, are considered when characterizing human and pet source loading.

1. **Persons per Unsewered House—Enter the average number of persons living in an unsewered house.**

   This information is used to calculate the number of people not connected to a sewer network and will also be used in conjunction with house ages to determine the amount of human-defecated bacteria coming from failing septic systems and straight pipes.

2. **Persons per Sewered House—Enter the average number of persons living in a sewered house.**

   This information is used to estimate total human population in the watershed. The BSLC does not estimate any loads from people in sewered houses, as their loads should be represented separately in contributions from a sewage treatment plant.

3. **Number of Unsewered Houses—Enter the total number of unsewered houses in each subwatershed.**

   This entry is used to determine the subwatershed's pet population. The BSLC computes the pet population based on an average number of pets per household. Default data for pets per household can be changed in the References worksheet.

4. **Number of Sewered Houses—Enter the total number of sewered houses.**

    This entry is used to determine the subwatershed's pet population. The BSLC computes the pet population based on an average number of pets per household. Default data for pets per household can be changed in the References worksheet.

5. **Septic Systems—Determine the approximate ages of all the septic systems in each subwatershed, and enter totals for each of the three age categories.**

    The number of failing septic systems is estimated as a percent of unsewered homes by age category. Old, Mid-Age and Newest Houses can be determined from revision dates on the USGS quadrangles and can typically be grouped into houses that were built before 1965, between 1965 and 1985, and after 1985, respectively. Use red **reference corners** and Appendix B, page 73 to guide your data entry. Failure rates are specified by age category in the References worksheet and can be customized to your watershed.

    Breakdown of unsewered houses
    Since unsewered houses will have either straight pipes or a septic system, be sure that the sum of the entries in the six Septic Systems and Straight Pipes columns equals the total number of unsewered houses.

6. **Straight Pipes—Determine the approximate ages of all the straight pipes in each subwatershed, and enter totals for each of the three age categories.**

    The age categories are used here to aid the user's organization of the data but do not have any bearing on the calculated bacteria loads. Use red **reference corners** and Appendix B, page 73 to guide your data entry.

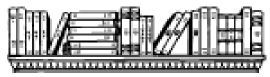
7. **Click "Click Here When You Have Finished Entering Numbers" when you have completed the worksheet.**

    More detailed information
    See Appendix B, beginning on page 72, for more detailed information regarding the Human Activities worksheet.

References Worksheet

These values are used in the loading calculations. You can change the results of the calculations by changing the values for these variables, or keep the defaults.

Reset Values | Use subshed-1 Values for Entire Watershed | Done



Parameter	Value subshed-1	Value subshed-2	Units	Source
Dairy Cow Parameters				
Weight of milk or dry cow	1400	1400	lbs	Livestock Waste Facilities Handbook, MWPS - 18
Weight of heifer	640	640	lbs	study
Manure production by heifers	40.7	40.7	lbs/day	Livestock Waste Facilities Handbook, MWPS - 18
Ratio of dairy cows on: Pasture 1	4	4	ratio	
to Pasture 2	2	2	ratio	
to Pasture 3	1	1	ratio	
Fraction of cows defecating in stream as compared to the cows that are in/around streams (dairy)	0.3	0.3	ratio	assumed
Fecal coliform production by milk or dry cow	2.50E+10	2.50E+10	total cfu/day-animal	
Manure excreted by milk or dry cow	115	115	lb/day-animal	Virginia Department of Conservation and Recreation
Liquid manure produced by confined milk cows	17	17	gal/day-animal	Virginia Department of Conservation and Recreation
Fraction of fecal coliform produced per milk cow lost in milk parlor wash-off	0.025	0.025	ratio	
Die-off coefficient for liquid manure	0.375	0.375	1/day	Kimberly Panhorst's research
Die-off coefficient for solid manure pile	0.05	0.05	1/day	Kimberly Panhorst's research
Survival factor for liquid manure	0.0345	0.0345	factor	
Survival factor for solid manure	0.068	0.068	factor	
Beef Cow Parameters				
Average weight of beef cow	1000	1000	lb	
Fecal coliform production by 1000-lb beef cow	3.30E+10	3.30E+10	total cfu/day-animal	
Ratio of beef cattle on: Pasture 1	4	4	ratio	Assumed to be 4:2:1 based on information gathered from
to Pasture 2	2	2	ratio	beef extension specialists at Virginia Tech.
to Pasture 3	1	1	ratio	

Figure 14. References Worksheet

This worksheet contains default values to calculate daily loading amounts for your subwatersheds. It is recommended that you customize these values to more accurately reflect specific conditions in your subwatersheds. For example, you may have specific manure application rates, detailed stream access acreage, and other local data such as the number of pets per household or failure rates for septic systems.

Default values were derived from a variety of sources, including research literature and professionals with subject-matter expertise. For many of the values, reference source information is available in the last column of the worksheet. Some also have additional details available through the red **reference corners**.

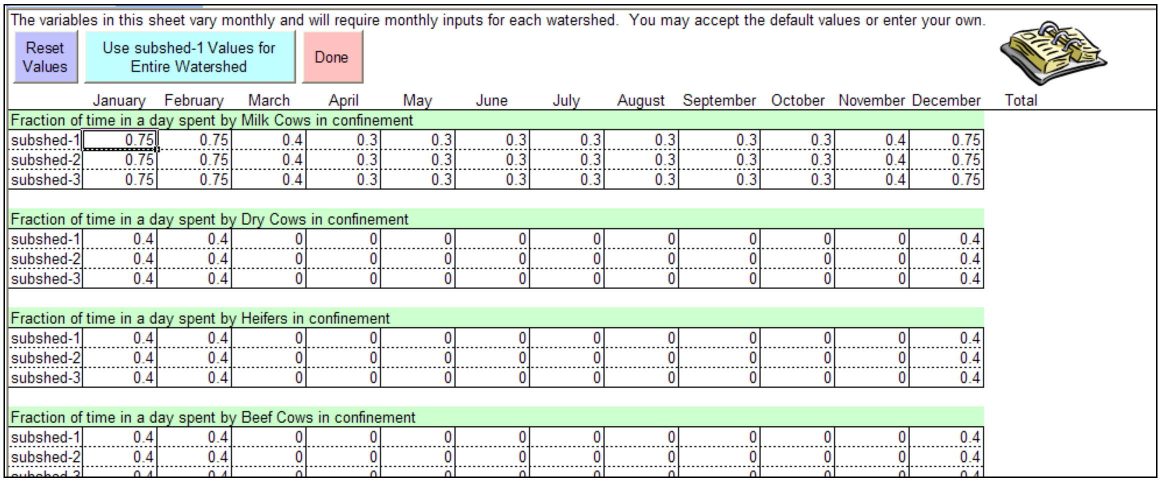
1. **Change or accept default values**
    a. Select the "Use <SubwatershedName>-1 Values for Entire Watershed" to condense the individual subwatershed columns into one so that new values entered are applied to the entire watershed. You should not click this button if you want to customize any of the listed values by subwatershed.

b. Briefly review the listed information and change any values that need to be changed for your watershed. Keep in mind that the earlier worksheets reference many values listed here in determining animal populations, such as number of lambs to be associated with each ewe and number of pets to be associated with each house.
c. To return altered values to their default entries, select "Reset Values."

2. **Click "Done" when finished making alterations, or if you simply wish to accept the default reference values.**

More detailed information
Use red **reference corners** within the References worksheet to guide changes to the BSLC default values.

Monthly Variables Worksheet


The variables in this sheet vary monthly and will require monthly inputs for each watershed. You may accept the default values or enter your own.

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Fraction of time in a day spent by Milk Cows in confinement													
subshed-1	0.75	0.75	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.75	
subshed-2	0.75	0.75	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.75	
subshed-3	0.75	0.75	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.75	
Fraction of time in a day spent by Dry Cows in confinement													
subshed-1	0.4	0.4	0	0	0	0	0	0	0	0	0	0.4	
subshed-2	0.4	0.4	0	0	0	0	0	0	0	0	0	0.4	
subshed-3	0.4	0.4	0	0	0	0	0	0	0	0	0	0.4	
Fraction of time in a day spent by Heifers in confinement													
subshed-1	0.4	0.4	0	0	0	0	0	0	0	0	0	0.4	
subshed-2	0.4	0.4	0	0	0	0	0	0	0	0	0	0.4	
subshed-3	0.4	0.4	0	0	0	0	0	0	0	0	0	0.4	
Fraction of time in a day spent by Beef Cows in confinement													
subshed-1	0.4	0.4	0	0	0	0	0	0	0	0	0	0.4	
subshed-2	0.4	0.4	0	0	0	0	0	0	0	0	0	0.4	

Figure 15. Monthly Variables Worksheet

Bacterial loading rates are not consistent throughout the year, so the BSLC provides monthly default values to calculate loading amounts for your subwatersheds. Again, it is recommended that you customize these values to more accurately reflect specific conditions in your subwatersheds.

As with the previous worksheet, default values were derived from a variety of sources, including research literature and professionals with subject-matter expertise. Read red **reference corners**, where available, for further details.

1. **Change or accept default values**
   a. Select the “Use <SubwatershedName>-1 Values for Entire Watershed” to condense the individual subwatershed rows into one so that new values entered are applied to the entire watershed. You should not click this button if you want to customize any of the listed values by subwatershed
   b. Briefly review the listed information and change any values that need to be changed for your watershed.
   c. To return altered values to their default entries, select “Reset Values.”

2. **Click “Done” when finished making alterations, or if you simply wish to accept the default monthly reference values.**

   Wait as the program computes your results. The screen will flash as your input is being processed.

Saving data

Clicking “Done” also copies your watershed data to the Excel worksheet you created when first opening the BSLC.

Errors

After clicking “Done” on the Monthly Variables worksheet, the screen will flash while the program is processing your data. At this point, your data are being stored in an Excel file that you should see on the task bar at the bottom of the computer screen. If a program error should occur after this point in the program, your data can be retrieved by saving this Excel file. To continue with the BSLC after saving these data, close any open windows, then reopen the BSLC. On the menu screen, select “Open Existing Watershed” and proceed using the instructions in the “Altering/Opening Previously Saved Worksheets” portion of this manual.

Land Receiving Manure

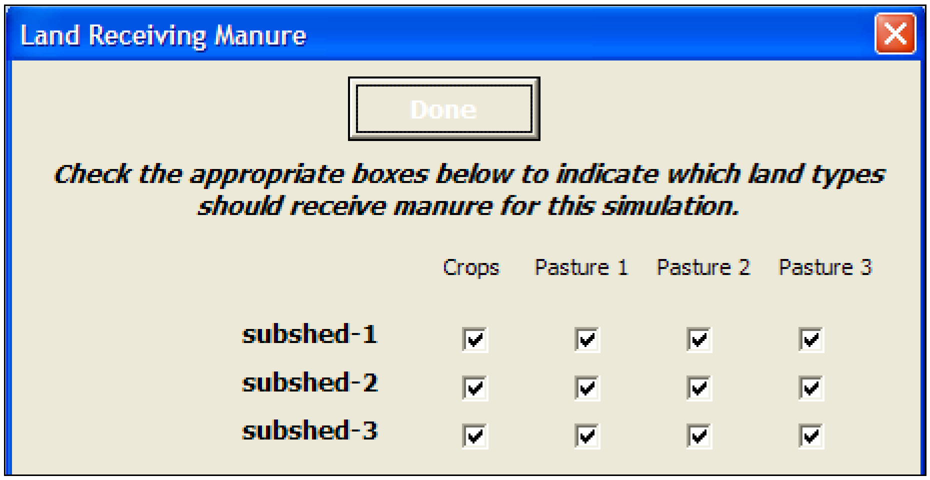


Figure 16. Land Receiving Manure

This pop-up window allows you to specify which land use areas should receive manure application. Crops and Pastures 1, 2 and 3 should already be checked for each subwatershed.

1. **Uncheck the boxes for any land use area that does not receive manure application in each subwatershed.**

   The BSLC assumes that manure will be applied to land in the following order:

   - 1st –liquid manure
   - 2nd –solid manure
   - 3rd –poultry litter

   It is also assumed that manure will be applied to cropland first, then pasture 1, pasture 2, and finally pasture 3.

2. **Click "Done" when you are finished.**

Saving data
Any changes made in the Land Receiving Manure pop-up window will not be saved. If you wish to run the BSLC again to update/change the same watershed data, make sure you have some record of which boxes are checked.

Section

3

Reports and Outputs

Generating Basic Reports and Modeling Outputs

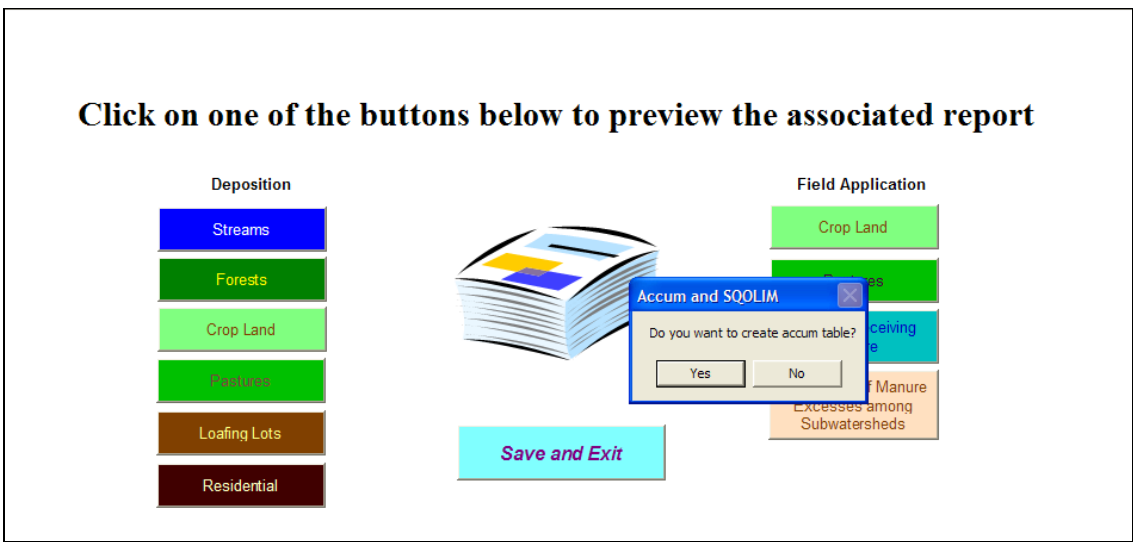


Figure 17. BSLC Results Worksheet

At this stage, the BSLC has completed computing the data entered in the previous worksheets. You can either save and exit the program or continue with the creation of a monthly bacteria accumulation (ACCUM) table and a monthly limit on surface storage (SQOLIM) table. Both are required inputs for HSPF. Reports generated so far contain loading results in per month units. When creating ACCUM and SQOLIM tables, the BSLC generates additional loading results in per acre units. This is required by HSPF.

If you choose not to create ACCUM and SQOLIM tables at this time, click "No" to indicate you do not wish to create an ACCUM table. You will then have immediate access to many different reports. Access to these reports, listed below, will be temporarily delayed if you proceed with ACCUM and SQOLIM table generation.

- Stream Loading Results
- Forest Loading Results
- Cropland Loading Results
- Pasture Loading Results
- Loafing Lot Loading Results
- Residential Loading Results
- Fecal Coliform Application to Crops
- Fecal Coliform Application to Pasture
- Area of Each Land Type Receiving Each Type of Manure
- Distribution of Manure Excesses to Surplus Land
- Report AniNum (animal numbers)—use Excel tabs at the bottom of the screen to access this report
- Report Summary—use Excel tabs at the bottom of the screen to access this report

Useful data can be extracted from these reports for a variety of purposes, including the identification of errors, such as typos and obvious over or under estimates.

Exiting and saving data
If you click "No" when asked about creating ACCUM and SQOLIM tables, you should then click "Save and Exit" to close the BSLC. This will save your data and results to the Excel worksheet you created at the start of the program. You will also be returned to the Introduction worksheet. You can create ACCUM/SQOLIM tables at a later time using this saved information and the "Open an Existing Watershed" button.

As previously mentioned, the BSLC can generate input parameters specifically formatted for use with HSPF. You can also write your own Visual Basic for Applications (VBA) programs to format this information for alternative watershed simulation models. You can alter the code of the BSLC to produce correctly formatted values while still accessing the allocation scenario development tools built into the program. Use of these tools is described in the following pages.

Input Parameters for HSPF

The BSLC produces three types of output for use with HSPF:

1. monthly accumulation (ACCUM) table
2. monthly limit on surface storage (SQOLIM) table
3. direct deposit tables, also known as multiple sequential input (MUTSIN) files

Creating ACCUM and SQOLIM Tables

The ACCUM table contains the monthly bacteria loadings represented in colony-forming units per acre per day (cfu/acre/day) (Figure C.1). The SQOLIM table contains the limit on accumulation of bacteria on the land surface (cfu/acre), which also varies monthly. Separate ACCUM and SQOLIM tables can also be generated for wildlife, livestock, septic, and pets if you wish to isolate contributions from individual sources of bacteria in HSPF. The contents of all these tables are correctly formatted for HSPF and can be cut and pasted into the appropriate position in a UCI file.

1. **Click "Yes" to create an ACCUM table. You will also begin the process of creating a SQOLIM table and MUTSIN files.**

2. **In the supplementary Land Use Table worksheet, review the land use areas (in acres) you previously entered to ensure they are correct.**

   Previously entered data from the Farm and Land Use Data worksheet will already appear in this worksheet. If you do not have any land use of a particular type in a sub-watershed, you can leave that cell blank (i.e., you do not need to enter '0' in cells where there is no area to enter).

   If you need to alter the default land use name to match what is in your GEN-INFO table, do this here by changing the TMDL Description in the first column of the Land Use Table worksheet.

	A	B	C	D	E
1	TMDL Description	TMDL LU	SLC-1	SLC-2	SLC-3
2	Cropland	1	200.00	100.00	300.00
3	Pasture 1	2	60.00	105.00	40.00
4	Pasture 2	3	15.00	37.50	160.00
5	Pasture 3	4	25.00	7.50	0.00
6	Res1	5	25.00	50.00	75.00
7	Res2	6	10.00	15.00	20.00
8	Res3	7	0.00	0.00	0.00
9	LL	8	0.00	0.00	0.00
10	Forest	9	1,000.00	750.00	800.00
11	Total	All	1,335.00	1,065.00	1,395.00

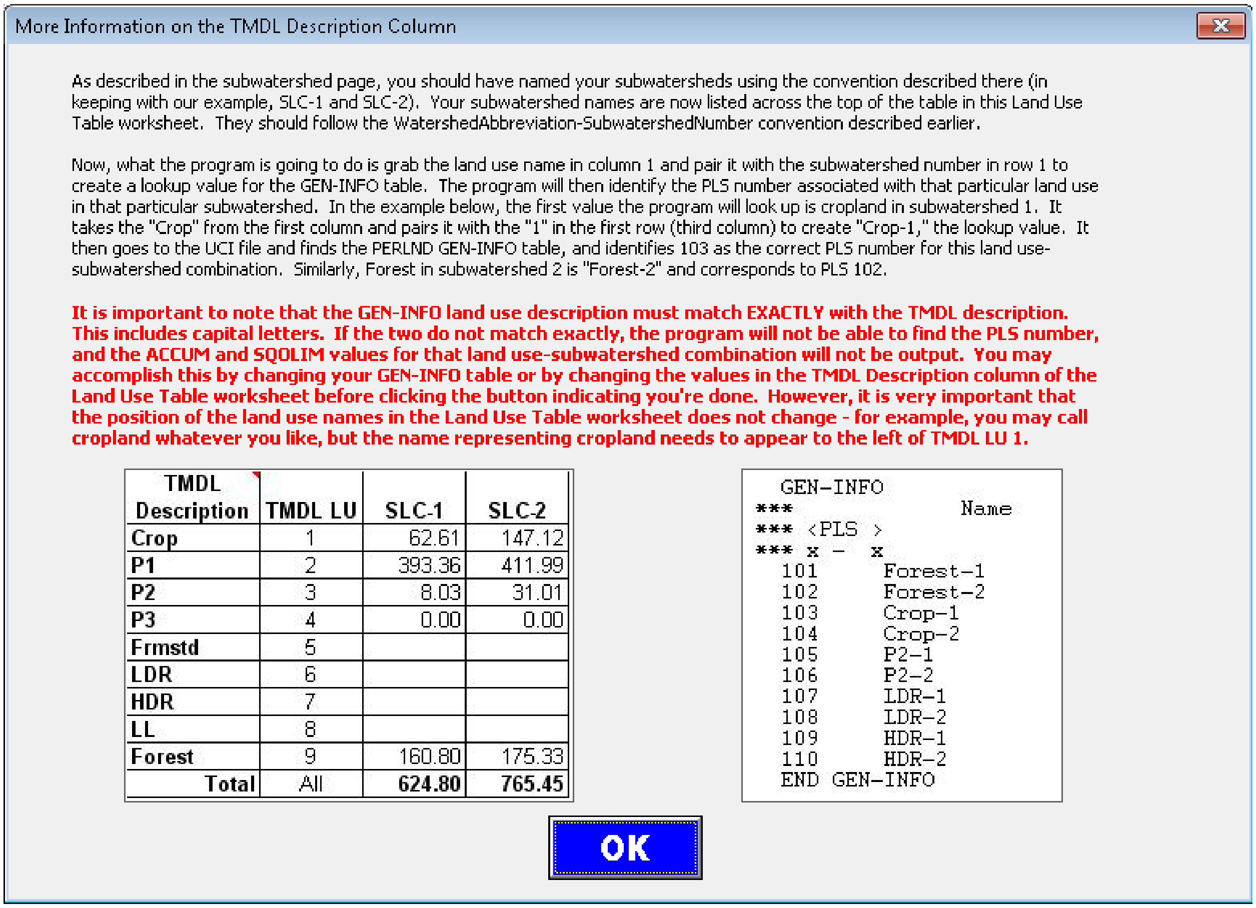
More...

Click me when you finish entering landuse areas.

Figure 18. Supplementary Land Use Table worksheet

3. **Click the "More" button if you want additional information about the abbreviations in the TMDL Description column, naming conventions, and matching abbreviations/names with the UCI file/GEN-INFO table. Click "OK" when finished reading.**

Land Use Abbreviations
It is very important to follow the naming convention directions. Additional information is available in Appendix A.



More Information on the TMDL Description Column

As described in the subwatershed page, you should have named your subwatersheds using the convention described there (in keeping with our example, SLC-1 and SLC-2). Your subwatershed names are now listed across the top of the table in this Land Use Table worksheet. They should follow the WatershedAbbreviation-SubwatershedNumber convention described earlier.

Now, what the program is going to do is grab the land use name in column 1 and pair it with the subwatershed number in row 1 to create a lookup value for the GEN-INFO table. The program will then identify the PLS number associated with that particular land use in that particular subwatershed. In the example below, the first value the program will look up is cropland in subwatershed 1. It takes the "Crop" from the first column and pairs it with the "1" in the first row (third column) to create "Crop-1," the lookup value. It then goes to the UCI file and finds the PERLND GEN-INFO table, and identifies 103 as the correct PLS number for this land use-subwatershed combination. Similarly, Forest in subwatershed 2 is "Forest-2" and corresponds to PLS 102.

It is important to note that the GEN-INFO land use description must match EXACTLY with the TMDL description. This includes capital letters. If the two do not match exactly, the program will not be able to find the PLS number, and the ACCUM and SQOLIM values for that land use-subwatershed combination will not be output. You may accomplish this by changing your GEN-INFO table or by changing the values in the TMDL Description column of the Land Use Table worksheet before clicking the button indicating you're done. However, it is very important that the position of the land use names in the Land Use Table worksheet does not change - for example, you may call cropland whatever you like, but the name representing cropland needs to appear to the left of TMDL LU 1.

TMDL Description	TMDL LU	SLC-1	SLC-2
Crop	1	62.61	147.12
P1	2	393.36	411.99
P2	3	8.03	31.01
P3	4	0.00	0.00
Frmstd	5		
LDR	6		
HDR	7		
LL	8		
Forest	9	160.80	175.33
Total	All	624.80	765.45

```
  GEN-INFO
***                Name
*** <PLS >
*** x -  x
  101       Forest-1
  102       Forest-2
  103       Crop-1
  104       Crop-2
  105       P2-1
  106       P2-2
  107       LDR-1
  108       LDR-2
  109       HDR-1
  110       HDR-2
  END GEN-INFO
```

OK

Figure 19. Information on Land Use Abbreviations

4. **Click "Click me when you finish entering land use areas" when you have entered your data.**

Errors

After clicking "Click me when you finish entering land use areas" on the Land Use Table worksheet, the screen will flash while the program is processing your data. At this point, your data are being stored in an Excel file that you should see on the task bar at the bottom of the computer screen. If a program error should occur after this point in the program, your data can be retrieved by saving this Excel file. To continue with the BSLC after saving this data, close any open windows, then reopen the BSLC. On the menu screen, select "Open Existing Watershed" and proceed using the instructions in the "Altering/Opening Previously Saved Worksheets" portion of this manual.

5. Decide where your unsewered and sewered areas are located.

The BSLC will prompt you to distribute your sewered and unsewered pets and houses to the three residential land use categories. Checking a sewered box for a particular land use category will allow the BSLC to distribute pet defecation associated with sewered houses to that land use category; checking an unsewered box for a particular land use category will allow the BSLC to distribute failing septic systems loads and pet defecation associated with unsewered houses to that land use category. One land use category may receive loads from both sewered and unsewered areas (both boxes checked), just one or the other (only one box checked), or neither sewered nor unsewered areas (neither box checked). Click the pink button if these associations should vary by subwatershed.

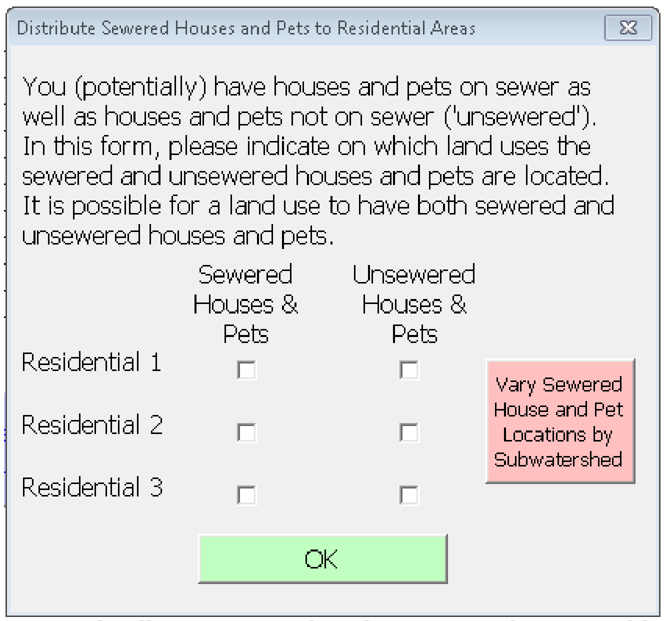


Figure 20. Distribute sewered and unsewered pets and houses

6. Answer the prompt asking if you would like to create source breakdown files for ACCUM and SQOLIM tables. If you wish to obtain source-specific tables in addition to the all-inclusive ACCUM and SQOLIM tables, click "Yes."

If you answer "yes" to this prompt, the BSLC will isolate source contributions from wildlife, livestock, septic systems, and pets, generating ACCUM and SQOLIM tables for each source. This information is intended to be used to allow HSPF to generate model outputs that can be compared to observed bacterial source tracking data.

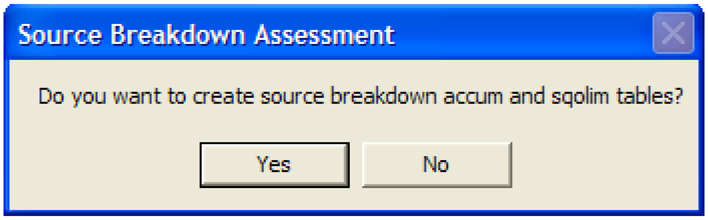


Figure 21. Source Breakdown Assessment

7. **Enter ACCUM reduction factors and SQOLIM multiplication factors into the window that appears.**

ACCUM reduction factors are used to reduce bacteria loads predicted for a given land use type. SQOLIM multiplication factors are related to HSPF's ability to represent die-off of bacteria in the model. If you would like to use the same factor for ACCUM and/or SQOLIM for all land uses, enter the factor into the bottom of the window and check the appropriate box. Typically, these factors should not be adjusted during the initial BSLC run for a watershed. SQOLIM multiplication factors are often adjusted later during calibration. ACCUM reduction factors are adjusted during allocation. Values entered in the ACCUM reduction factor column should be entered as decimal percentages (i.e., a 96 percent reduction would be entered as 0.96). A record of the factors you enter here is kept in the RunParameters.txt file stored in the same directory as your UCI file.

Clicking "More about SQOLIM/Calculate SQOLIM factors based on die-off" will allow you to determine the appropriate SQOLIM multiplication factor for a known bacterial die-off rate.

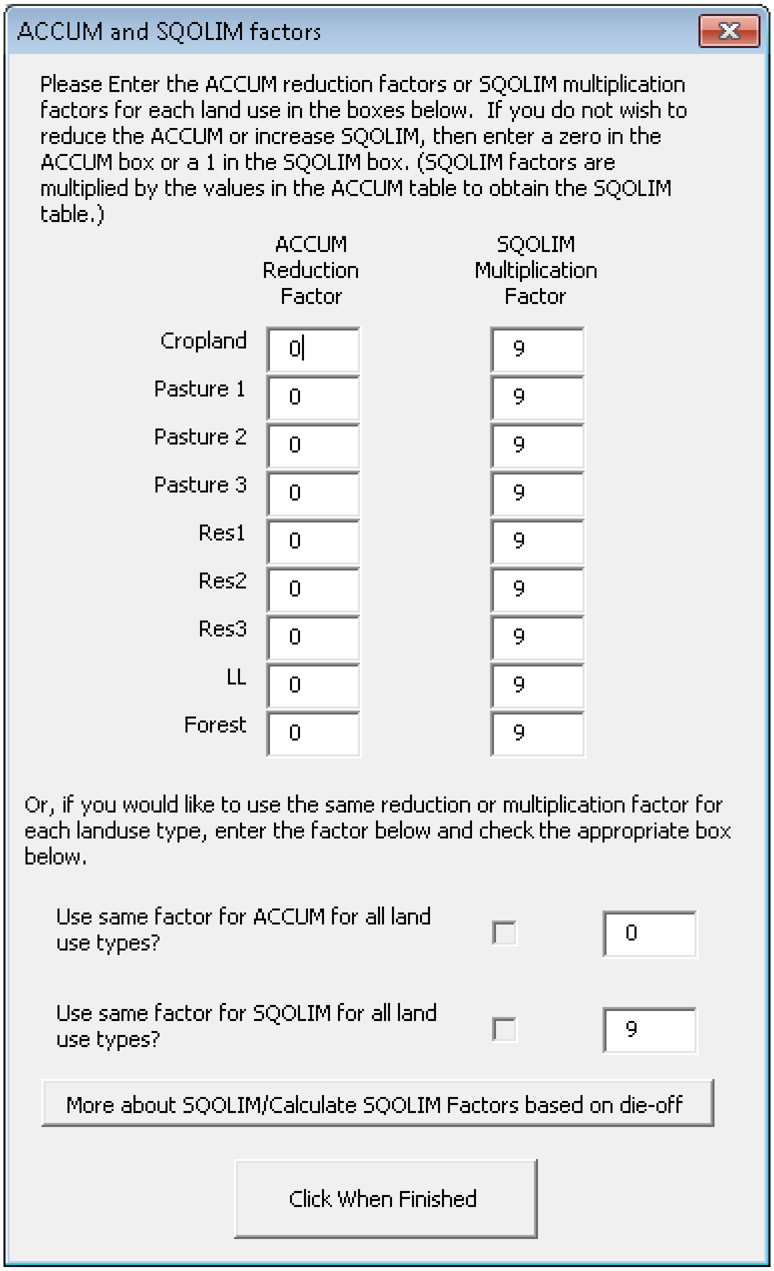


Figure 22. ACCUM and SQOLIM Factors

More detailed information

See Appendix C for more information about ACCUM reduction factors and SQOLIM multiplication factors.

8. Specify groupings of land uses for your report appendix tables.

The BSLC will produce nicely formatted tables for your TMDL report containing monthly bacteria loads by land use, reductions for each land use and direct deposit load, and final allocated loads for each land use (all segregated by subwatershed). In this screen you can tell the program how you would like your land uses grouped for these tables – for example, you may wish to group all your pasture or residential land uses together. You may also wish to give a more descriptive name to a land use you have previously abbreviated for the GEN-INFO table (e.g., LL). Finally, if you wish to create a new grouping name, you may do that by selecting ‘Create New Grouping…’ from the drop down box. Selecting ‘Do Not Aggregate’ will tell the BSLC to put the data for that land use into the appendix tables using the name displayed in the Land Use Name column. In general, 7 land use groupings can be nicely displayed in one output table.

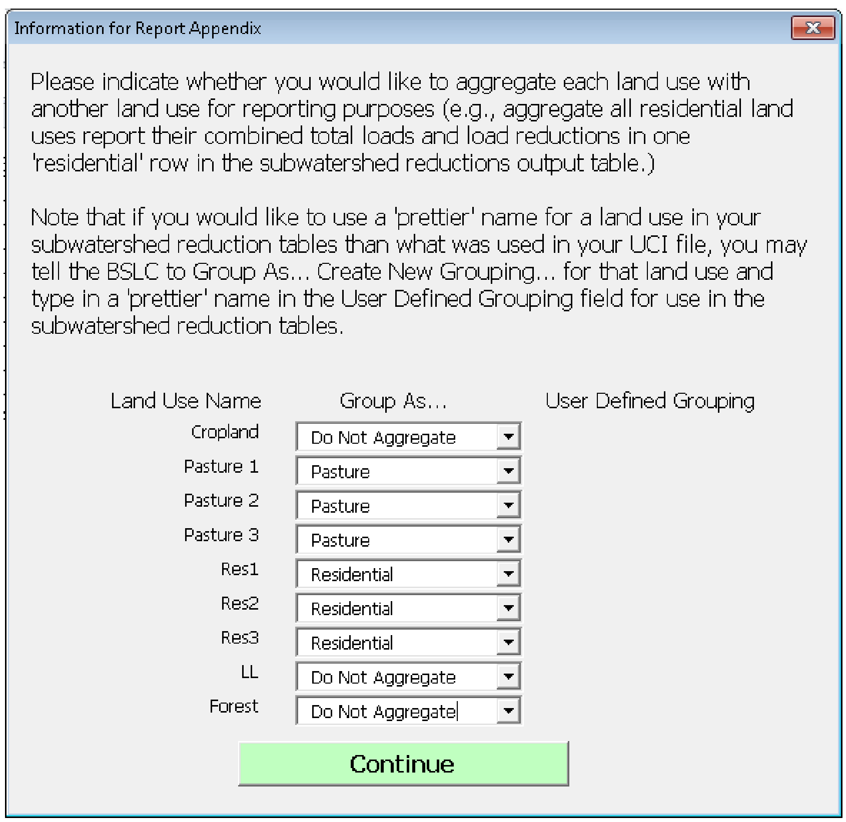


Figure 23. Land Use Groupings for Report Appendices

9. Enter the path and file name for your UCI file for the particular watershed.

You can use the browse button to select a saved file from your computer. The BSLC reads the UCI's GEN-INFO table, matching land use information and generating input parameters for HSPF.

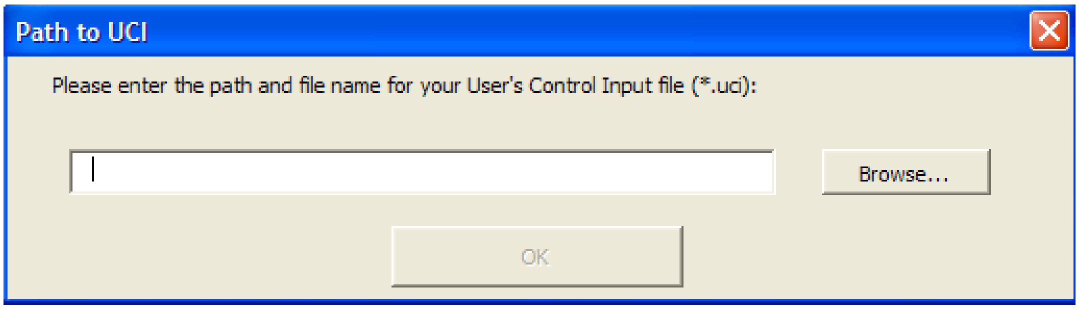


Figure 24. Path to UCI File

10. Click "OK" when you have entered the file name.

11. Enter the percent of pervious land for each land use category.

The impervious fraction automatically adjusts itself to the remaining percent. Example values are provided. However, you are strongly encouraged to customize these values for your particular subwatershed. These values need to match the breakdown between pervious and impervious land areas entered in the SCHEMATIC block of your UCI file.

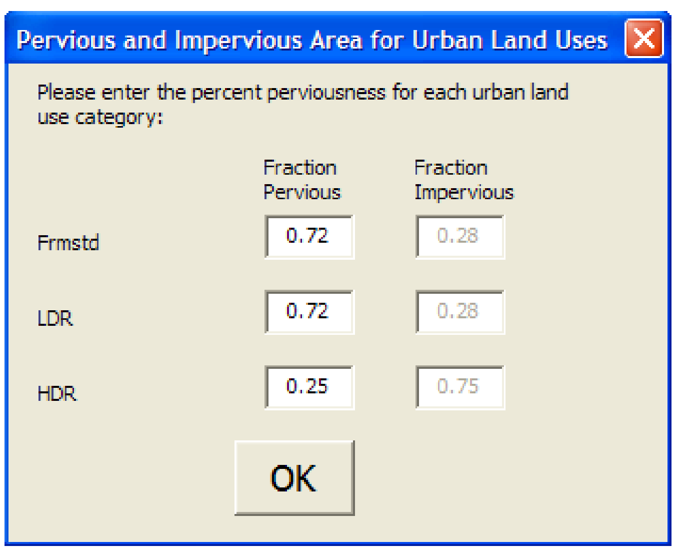


Figure 25. Pervious and Impervious Area for Urban Land Uses

Saving data
The values entered in the Pervious and Impervious Area for Urban Land Uses pop-up window will not be saved in your output file from the BSLC. A record of the entered values is kept in the RunParameters.txt file stored in the same directory as your UCI file.

12. **Click "OK" when finished.**

13. **Click "OK" when the program notifies you that your files have been created successfully.**

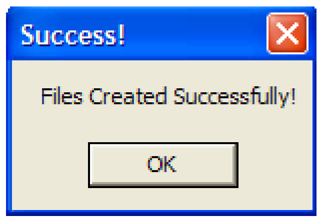


Figure 26. ACCUM and SQOLIM Tables Successfully Created

More detailed information
See Appendix C for more information regarding ACCUM/SQOLIM tables.

Creating MUTSIN Files

The BSLC generates stream direct deposit time series data consisting of hour-by-hour bacteria loads deposited directly in the stream by livestock, wildlife, and straight pipes.

1. Click “Yes” if you want to create Direct Deposit Tables.

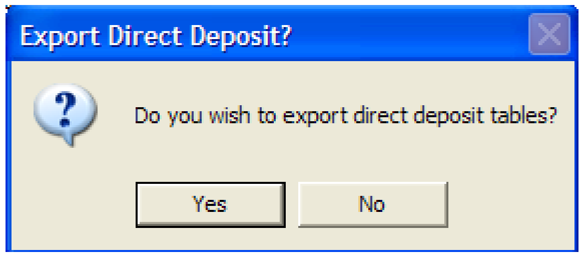


Figure 27. Exporting Direct Deposit Tables

2. Enter the date on which you would like the Direct Deposit Tables to begin.

First choose the year, then the month, then the day from the drop-down boxes. The date you select will be displayed in the <start> field. The year field automatically populates with 40 years before and 20 years after the current system date; if you need a year that does not fall in this range, click the ‘Add Years…’ button to add the required number of years to the Year drop-down box.

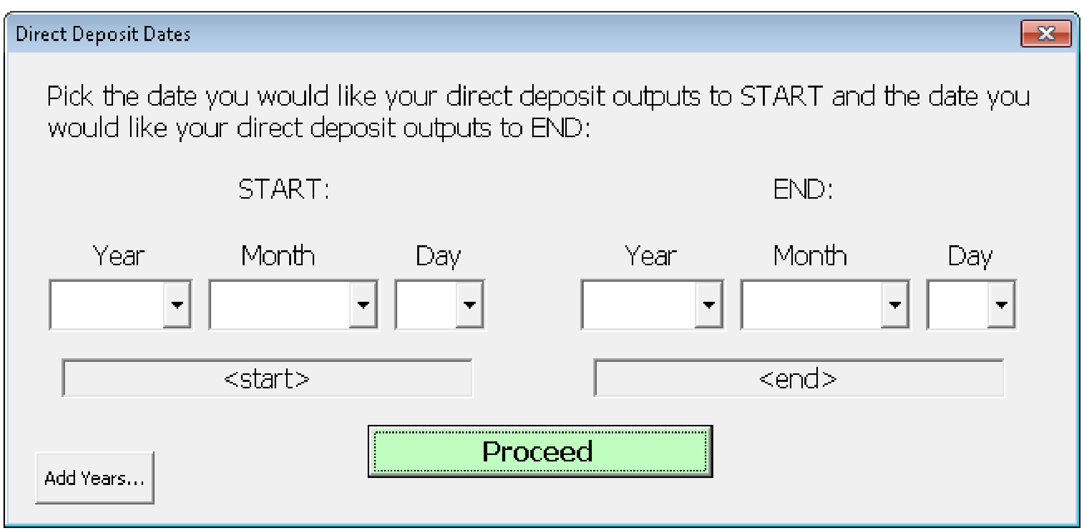


Figure 28. Entering Direct Deposit Dates

3. Enter the date on which you would like the Direct Deposit Tables to end.

First choose the year, then the month, then the day from the drop-down boxes. The date you select will be displayed in the <end> field. The year field automatically populates with 40 years before and 20 years after the current system date; if you need a year that does not fall in this range, click the ‘Add Years…’ button to add the required number of years to the Year drop-down box.

4. Click “Proceed.”

5. Read the information window regarding MUTSIN Output Format.

a. Select “Individual Files” if you plan to manually input the files to the Watershed Data Management Utility (WDMUtil). This selection will generate one MUTSIN file for every animal type/subwatershed combination.

b. Select “Files grouped by animal type” if you plan to use HSPF to input the files to a Watershed Data Management (WDM) file (recommended). This selection will generate one MUTSIN file for each animal type, with a column for each subwatershed.

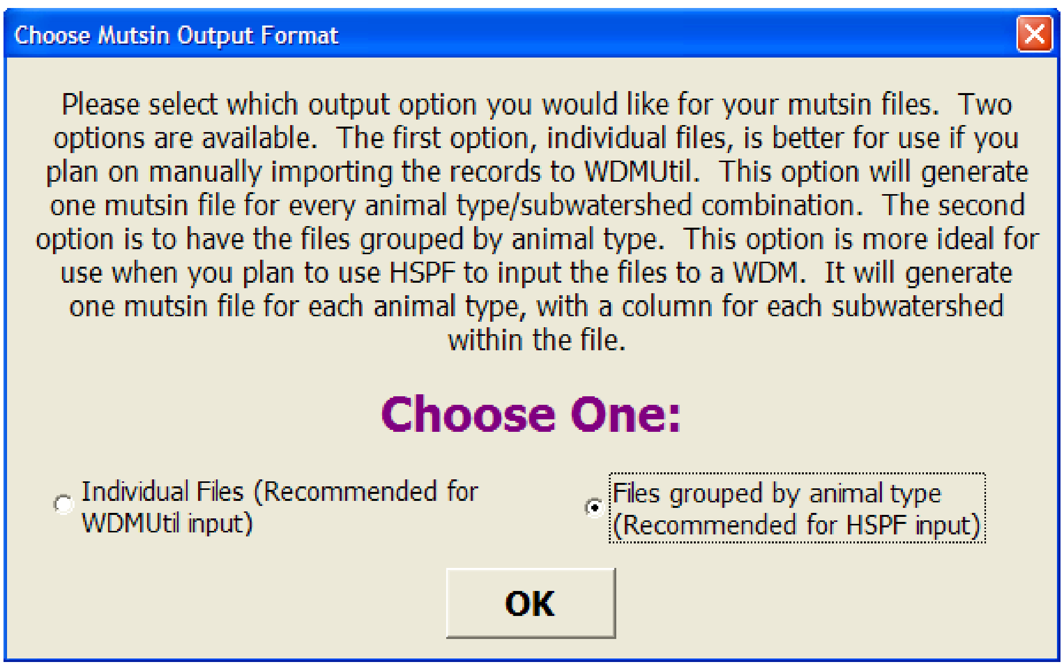


Figure 29. Choose MUTSIN Output Format

Creating a utility file
A utility file to aid in the import of the MUTSIN files to your WDM file will be generated regardless of the option you choose. See Appendix D to learn more about this file and its use.

Saving time
Manually inputting MUTSIN files into WDMUtil can be very time-consuming.

6. **In the MUTSIN Output pop-up window, click "Browse" to select an appropriate location on your computer where you would like MUTSIN files saved, and click "Open."**

   It is recommended that you choose a directory on your local hard drive (as opposed to a mapped network drive), because processing data through a network takes much longer to complete.

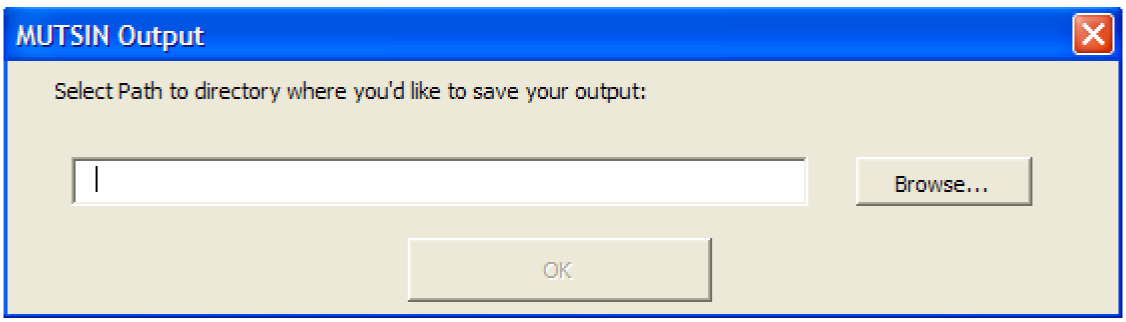


Figure 30. Directing MUTSIN Output

Make sure that the folder in which you would like to save your MUTSIN files is displayed in the "Folder name" field before clicking OK. If you are too quick in your clicking you may have inadvertently moved one folder too deep.

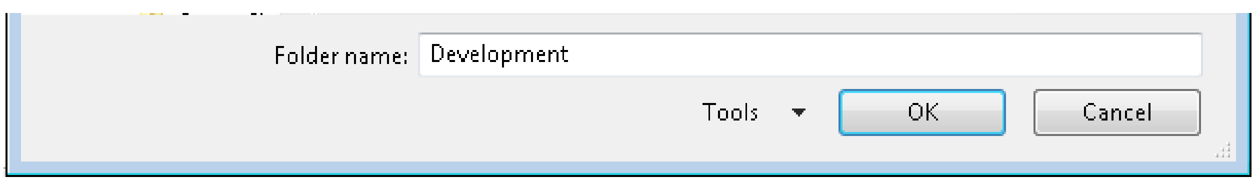


Figure 31. Saving MUTSIN Files

Processing time
Depending on the number of subwatersheds you've specified and the total time to be represented, the direct deposit export will take anywhere from 30 seconds to 30 minutes. Text in the bottom left corner of the window specifies the progress; if this text stops changing, do not be concerned, as the computer has begun processing too intensely to bother changing the message. It is likely that your files are still being exported.

7. **In the pop-up window, select appropriate categories of direct deposit output that should be generated and click "Proceed."**

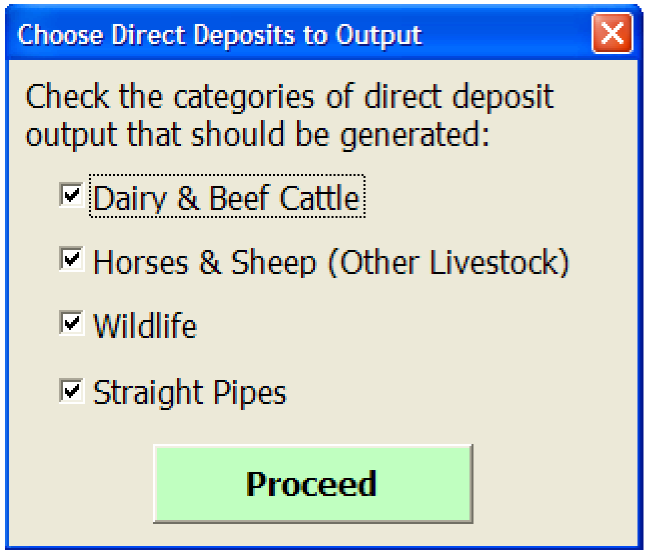


Figure 32. Choose Direct Deposit Tables to Output

8. **Click "OK" when the program notifies you that your files have been exported successfully.**

Figure 33. Successfully Exporting Direct Deposit Tables
(F: is only used for demonstration purposes.)

9. **Enter the name of the WDM file that will contain your direct deposit inputs.**

The "WshedDD.wdm" (see Figure 25) name is only a surrogate. You can change the name to an existing WDM file or, if none exists, use the program-generated surrogate name.

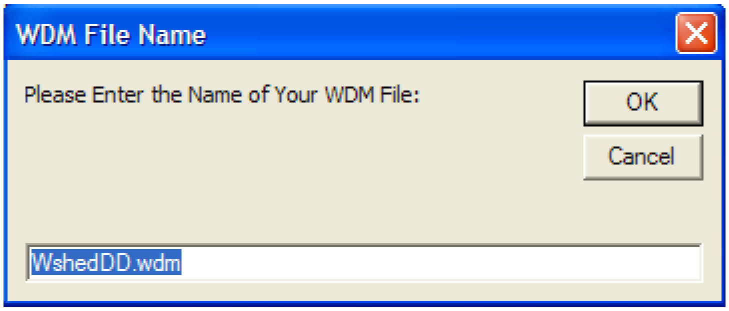


Figure 34. Naming WDM File

More detailed information
See Appendix D for more information regarding MUTSIN tables and related output from the BSLC.

Creating TMDL Loading Tables in Microsoft Word

Once you are back at the Results worksheet, you may generate Loading Tables in Microsoft Word—text that is already formatted and can be pasted as appendices into a TMDL study.

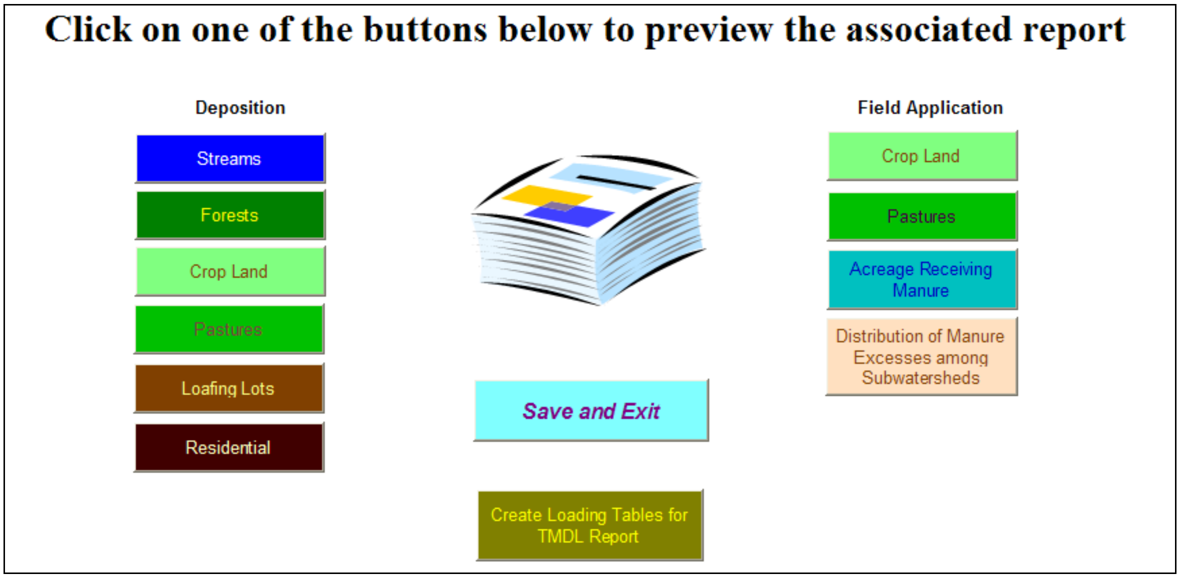


Figure 35. Creating Loading Tables for TMDL Report
(Olive green button at bottom center)

1. **Select "Create Loading Tables for TMDL Report" if you wish to create these tables.**

   This option will allow you to generate loading and reduction tables in Word that can be included in an appendix table in the TMDL report.

2. **Enter the required information into the purple box at the top of the screen.**

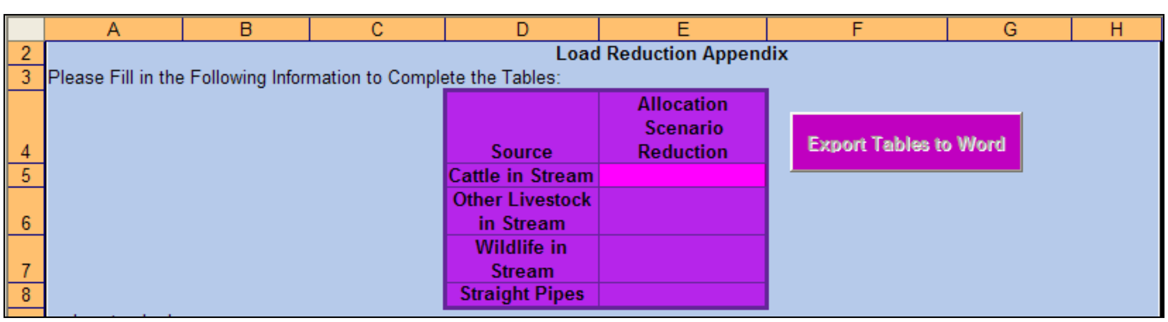


Figure 36. Load Reduction Appendix

3. Click “Export Tables to Word.”

Sometimes, after you click “Export Tables to Word”, the prompt to save the Word file will be hidden behind the BSLC and the program will appear to have frozen. You may even get a pop-up message like the one below. If an inordinate amount of time (more than 10 seconds) passes before you receive a prompt to save your data, try typing Alt+Tab and then continue pressing Tab while holding down Alt until the Microsoft Word icon is highlighted.

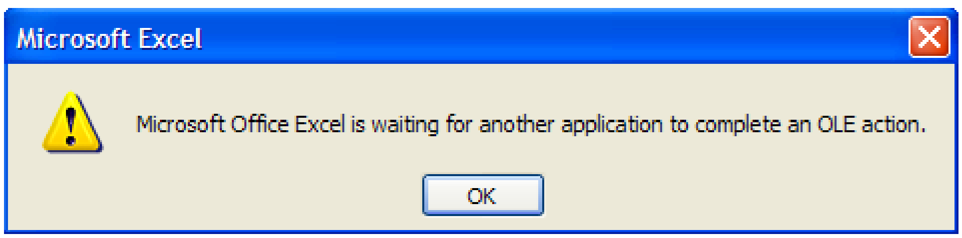


Figure 37. Possible Popup when Exporting Word Files

4. Save the Word file wherever you like.

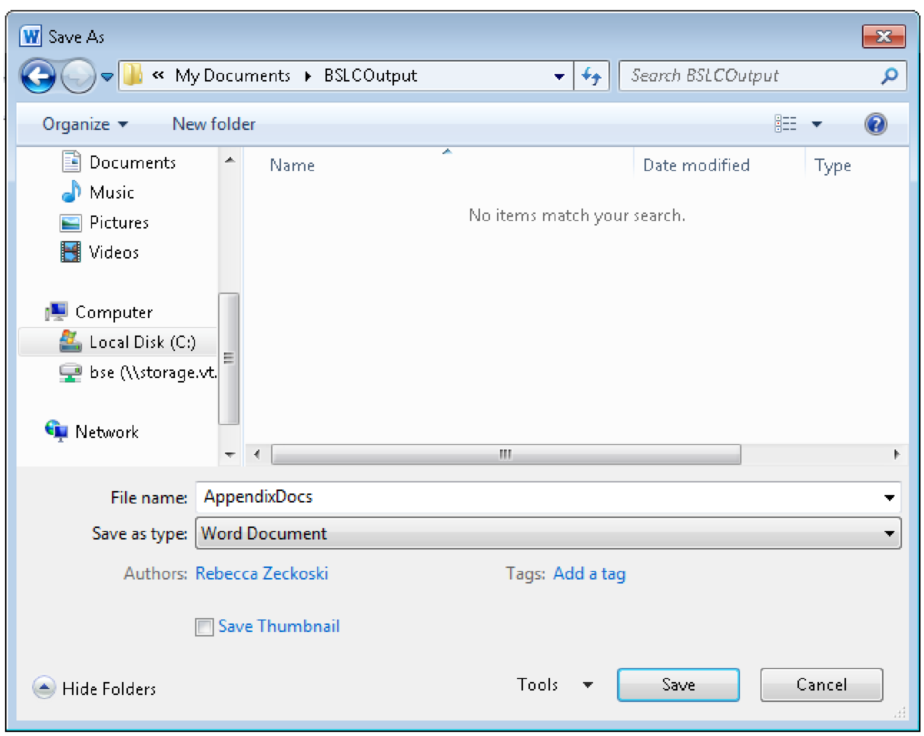


Figure 38. Saving Appendices in Word

Figure 39 displays a sample of the data exported to Word.

Table G-1a. Required annual reductions in nonpoint sources in sub-watershed LCC-1.

Land Use	Current conditions load (x 10^8 cfu/year)	Percent of total load from nonpoint sources	TMDL nonpoint source allocation load (x 10^8 cfu/year)	Percent Reduction
Cropland	8	0%	8	0%
Pasture	6,235,385	98%	6,235,385	0%
Loafing Lots	0	0%	0	0%
Forest	6,320	0.1%	6,320	0%
Residential	106,836	2%	106,836	0%
Total	6,348,548	100%	6,348,548	0%

Table G-1b. Required annual reductions in direct nonpoint sources in sub-watershed LCC-1.

Source	Current Conditions load (x 10^8 cfu/year)	Percent of total load to stream from direct nonpoint sources	TMDL direct nonpoint source allocation load (x 10^8 cfu/year)	Percent Reduction
Cattle in Streams	119,411	70%	0	100%

Figure 39. Sample Loading Tables in Microsoft Word

Reviewing Input Parameters Generated for HSPF

When the BSLC has finished all computations, including generation of input parameters for HSPF, you should have the following computer documents saved in a convenient location.

1. In the directory you specified at the beginning of the BSLC, you should have your output Excel file identified by the name you chose at that time. This file can be read back into the BSLC at a later time using the "Open Existing Watershed" button.
2. In the same directory as your UCI file:
   a. Accum Table.txt
   b. SQLIM Table.txt
   c. RunParameters.txt
   d. SQOSettings.txt
   e. Additionally, if you asked for source breakdown tables:
      i. Accum Livestock.txt
      ii. SQLIM Livestock.txt
      iii. Accum Wildlife.txt
      iv. SQLIM Wildlife.txt

v. Accum Septic.txt
vi. SQLIM Septic.txt
vii. Accum Pets.txt
viii. SQLIM Pets.txt

3. In the directory you specified to save your MUTSIN files:
   a. Either: Wildlife.mut, Cattle.mut, Livestock.mut, and StraightPipes.mut
   b. Or: Wildlife_1.mut, etc – a series of files with a prefix specified in (a) and a suffix representing the subwatershed number
   c. MutImp.uci
4. Additionally, if you asked to generate tables for Word, you should have your output Word file saved with the name and location you specified at the end of the program.

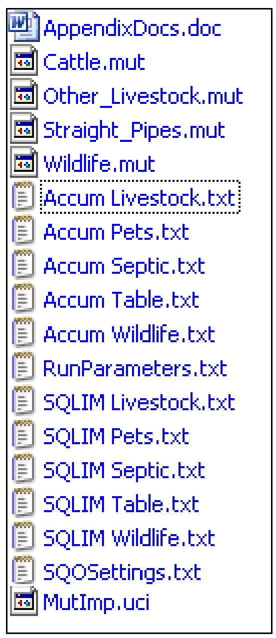


Figure 40. Typical Documents Generated by BSLC

More detailed information

See Appendices D and E for more information on BSLC outputs.

Section

4

Previously Saved Worksheets

Altering/Opening Previously Saved Worksheets

The BSLC allows you to continue work on a previously saved watershed worksheet. You can add, delete, or change any values within three watershed-specific data input sheets, the reference worksheets, or the pop-up windows.

1. **Click "Open Existing Watershed" on the main menu screen.**

2. **Select your saved Excel file and click "Open."**

3. **Answer the questions in the window that appears.**

   <u>If you wish to alter some parameters of the existing watershed and save these results in addition to your previous results, select "New File.</u>" In this current version of the BSLC, the "Overwrite" feature is not functional. You can not use the program to make changes and replace your previous results in the same saved worksheet.

   If you want to add more subwatersheds, select "Yes". You will be directed to type the number of extra subwatersheds to be evaluated. Next you will be able to enter new data for these subwatersheds into the three watershed-specific data input sheets: an animal sheet (Figure 5), a farm and land use sheet (Figure 7), and a human activity sheet (Figure 8).

Figure 41. Opening Existing Watershed Options

4. **Select an appropriate folder and name for your new file.**

5. **Click "Confirm Options" to proceed.**

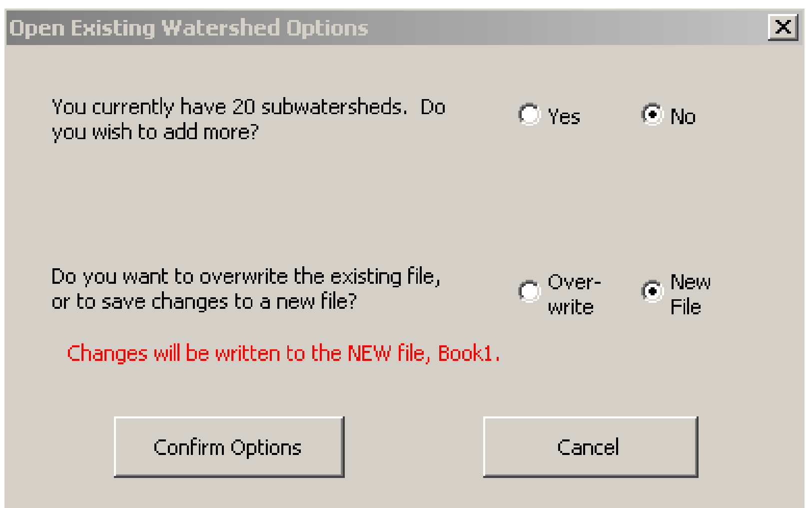


Figure 42. Confirming Method for Opening Existing Watershed

6. **Read the text in the window that pops up and click "OK".**

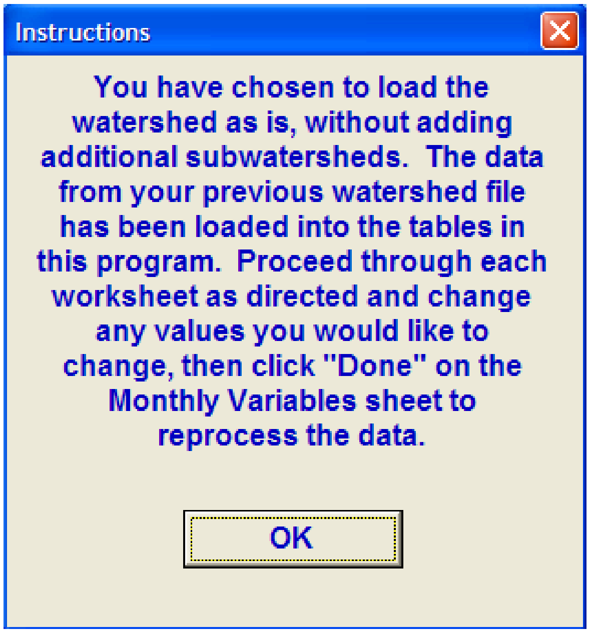


Figure 43. Instructions for Opening an Existing Watershed

Wait as the program processes your requests. The screen will flash, and you will see the Animals worksheet. The previously entered data regarding this watershed are already entered into the worksheet. Change any values you wish.

7. **Proceed throughout the program, changing any values you wish in the remaining worksheets, and following the steps outlined in the Data Entry Worksheets section beginning with the Animals worksheet on page 16.**

Section

5

Skip to ACCUM/SQOLIM Table Creation

Creating ACCUM/SQOLIM Tables from an Existing File

In the last stage of TMDL development, various scenarios are evaluated to determine compliance with water quality standards. At this point, it may be useful to take existing loadings and reduce them by various amounts to represent the effect of best management practice installation in the watershed. This is the intended use of the final button on the introduction sheet – "Skip to ACCUM/SQOLIM Table Creation." It allows you to apply reductions to loads previously calculated by the BSLC and stored in the BSLC output file in order to create new ACCUM and SQOLIM tables without having to recalculate the baseline loads.

1. **Click "Skip to ACCUM/SQOLIM Table Creation" on the main menu screen.**

2. **Select "Yes" if you have a saved file that has already been fully processed by the program. This means that you have previously created ACCUM and SQOLIM tables with the file of interest.**

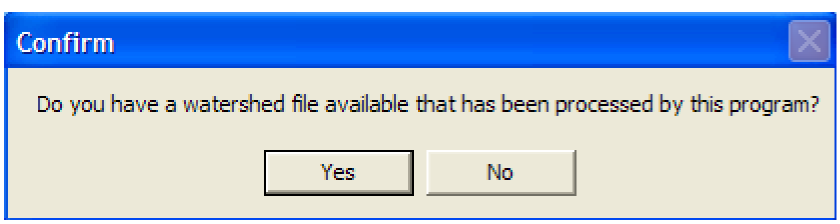


Figure 44. Confirming Existence of Previously Saved Watershed File

3. **Select the Excel file and click "Open."**

4. **Make any necessary adjustments to the values in the ACCUM reduction factors and SQOLIM multiplication factors pop-up window.**

Skip to ACCUM/SQOLIM Tables

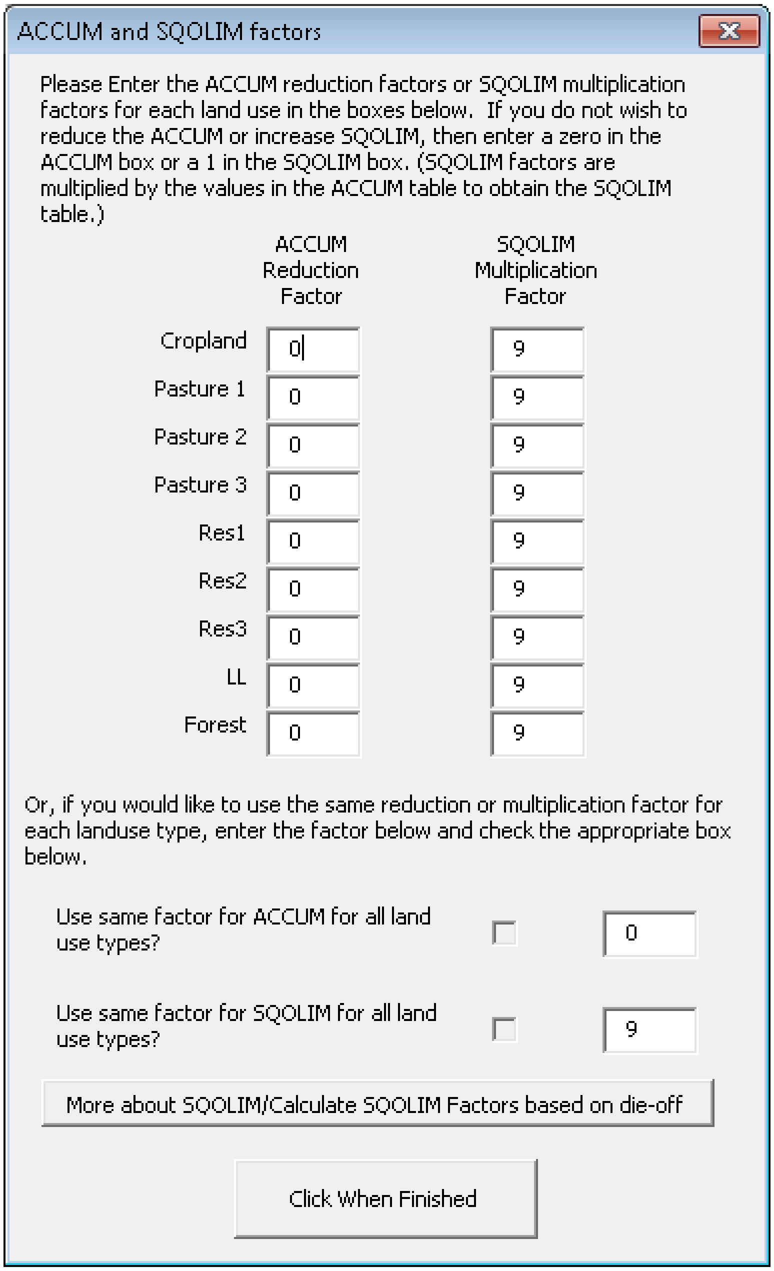


Figure 45. ACCUM and SQOLIM Factors

5. **Continue with instructions for "Creating ACCUM and SQOLIM Tables" and "Creating MUTSIN Files" starting on page 43, beginning with Step 8.**

Ensuring data consistency
Any values previously entered in the percent pervious land pop-up window will not have been saved by the BSLC. You must re-enter or paste watershed-specific values.

6. **After proceeding through the ACCUM, SQOLIM, and MUTSIN generation steps, you will be presented with the option to export appendix tables in Word format. If you answer yes to this question, proceed as in "Creating TMDL Loading Tables in Microsoft Word" on page 51.**

Section

6

Appendices

Appendix A: Naming Subwatersheds

If you plan to create ACCUM and SQOLIM Tables, you must use specific naming conventions for land uses within the UCI file and each subwatershed in the BSLC.

In the GEN-INFO table in the UCI file, each land segment must correspond with a Pervious Land Segment (PLS) number, as shown in Figure A.1. PLS numbers are set according to a modeler's preference and function in HSPF as reference numbers for a specific set of pervious land segment parameters. They are limited to three characters each. In order to be compatible with the BSLC, the land segment name must consist of the land use name, followed by a dash, and then the subwatershed number. Thus, it is also necessary that the PLS numbers be unique for each land use and subwatershed combination. For example, numbers 101-110 in Figure A.1 are the subwatershed's PLS numbers, while "Forest-1" is a land segment name. Within the land segment name, "Forest" specifies the land use, while "1" specifies the subwatershed in which that segment exists. Therefore, PLS number 101 represents forest area in subwatershed 1.

Land Use Abbreviations
The GEN-INFO land use descriptions must match exactly with the TMDL Descriptions entered in the BSLC Supplementary Land Use Table worksheet. This includes capital letters. If the two do not match exactly, the program will not be able to find the PLS number, and the ACCUM and SQOLIM values for that land use-subwatershed combination will not be output. Accomplish this by either changing the GEN-INFO table or the TMDL Description value.

In the BSLC subwatershed input sheet, subwatershed names must consist of a watershed abbreviation followed by the subwatershed number. The abbreviation can be any length, but the subwatershed number must correspond to the subwatershed numbers used as the suffix of the land segment names in the GEN-INFO table. For example, if the subwatershed name is Slow Creek and the abbreviation chosen is SLC, subwatershed 1 would be named SLC-1, as shown in Figure A.1. All land segments within subwatershed 1 would then be followed by a 1 in the UCI file, as mentioned previously and illustrated in Figure A.1.

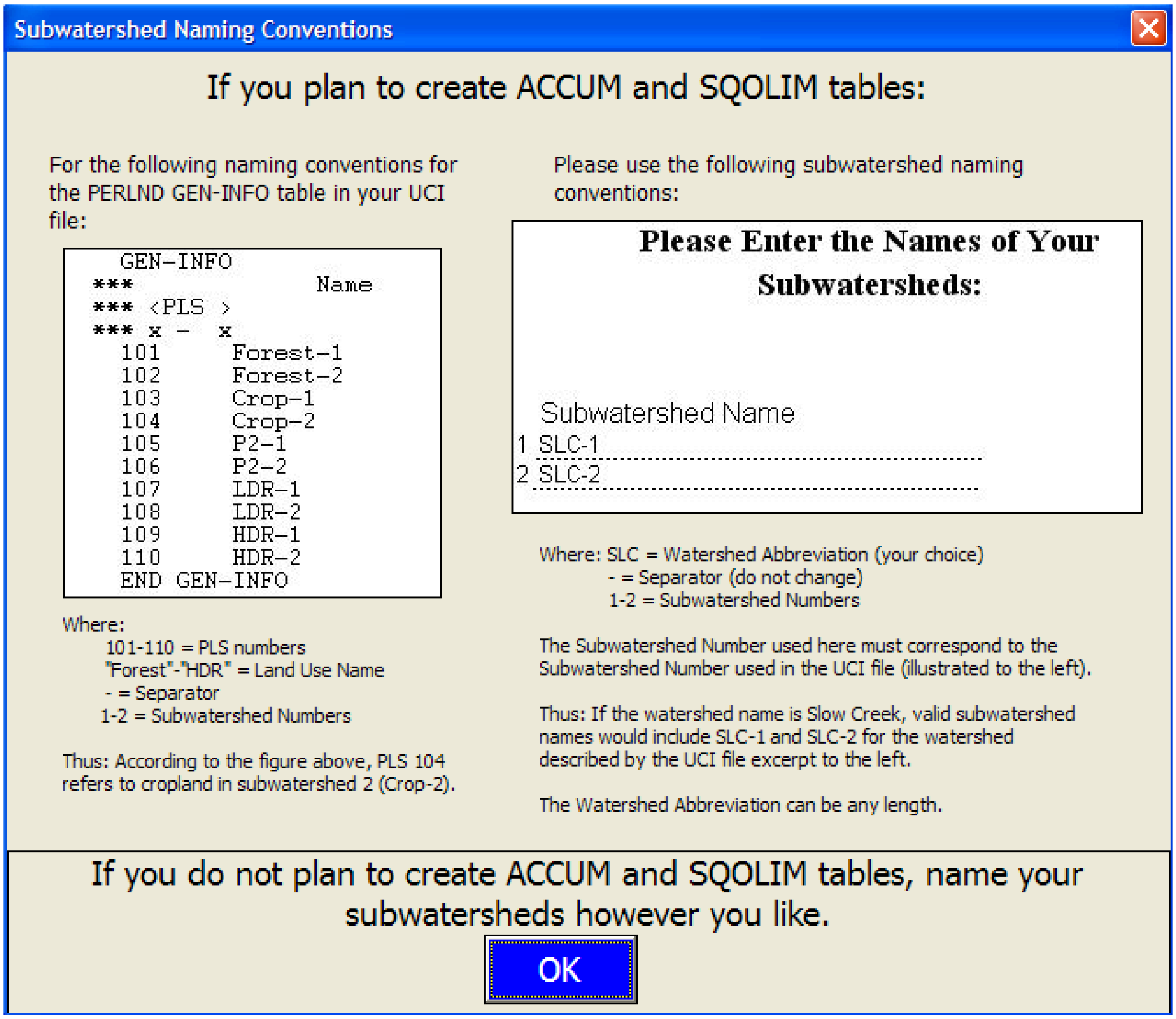


Figure A. 1 Subwatershed Naming Conventions

Appendix B: Data Resources

The following sections describe possible methods for source characterization and load estimation for the typical source categories considered when developing a bacterial TMDL—livestock, wildlife, humans, and pets. Each section explains how to determine numbers of animals, as well as other factors that are specific to that source. As previously mentioned, the BSLC is not capable of remedying errors caused by incorrect determination of input parameters; therefore, great care should be exercised in settling on final animal and land use inputs to the BSLC.

Livestock

The first step in bacterial source characterization is to estimate the number of livestock in the impaired watershed. There are four commonly available methods/resources for characterizing livestock populations.

1. The most recent countywide Agricultural Census published by the USDA (USDA, 2002) can be used to estimate and distribute livestock among subwatersheds based on farm locations, average herd size, and relative size of the subwatershed agricultural area as compared to the overall county agricultural area. Values derived in this way should be verified according to method 4.
2. Beef cattle populations can be estimated as a function of pasture area in each subwatershed. In Virginia, Center for TMDL and Watershed Studies personnel frequently use 0.71, 0.36, and 0.18 head/acre to calculate beef populations on improved, unimproved, and overgrazed pastures, respectively. These estimates are based on observed stocking rates in Virginia and carrying capacities suggested by beef extension specialists at Virginia Tech. This is a more refined estimate than method 1, but should also be checked according to method 4.
3. To the extent possible, producers (particularly permitted dairies and poultry operations) should be contacted directly to obtain estimates of livestock numbers on their farms.
4. After initial estimates are created, producers, county extension agents, and other experts should be consulted and site-checks should be conducted to refine the livestock numbers.

Fecal coliform loads from livestock sources are allocated to different land areas according to factors given in Table B.1. The allocation to fertilized land, or cropland and pasture receiving applications of manures from confined livestock, depends on livestock confinement schedules, as well as other factors. In practice, livestock confinement times vary throughout the year, ranging from zero to 100 percent. Default values for a dairy herd confinement schedule (Figure B.1) are representative of confinement schedules in watersheds studied by the Center for Watershed Studies. Whenever possible, you should estimate appropriate confinement schedules for your watersheds through communication with local producers and agency personnel. The allocation of fecal coliform loads to streams from livestock sources depends on the time that livestock spend in and around streams. The BSLC default values (Figure B.1) for dairy cattle are based on communication with producers in Virginia. Little research has been published regarding time spent in and around streams by cattle. Therefore, as research is conducted, or if you have better knowledge of time spent in and around streams in a specific watershed, these values should be customized for individual watersheds.

Table B. 1. Factors considered in allocating fecal coliform

Management Area	Determining Factors
Crop and pasture land receiving applied manure	• Number of livestock (can vary monthly for beef) • Percent of time livestock are confined – varies monthly • Die-off rates for bacteria in stored manure • Manure application rates to different land uses (crops and pasture) (the BSLC default rates are those recommended for nutrient management planning) • Availability of crop and pasture land for manure application • Fraction of manure that is incorporated
Loafing lots	• Number of cattle (can vary monthly for beef) • Percent of time cattle spend in loafing lots
Streams	• Number of livestock on each type of pasture (can vary monthly for beef) • Stream access of each pasture • Time spent in and around streams (varies monthly) • Percent of livestock in and around streams that are defecating in the stream
Pasture	• Number of livestock on each type of pasture (can vary monthly for beef) • Fraction of time remaining after livestock have been allocated to confinement, loafing lots, or streams

Factors Used in BSLC Dairy Herd Distribution Calculations

Cow confinement schedule and time spend in and around stream throughout the year (default assumptions).

	Time spent in confinement (%)		
Month	Lactating Cows	Dry cows, heifers, beef cattle	Time spent in stream (hrs/day)
January	75	40	0.50
February	75	40	0.50
March	40	0	0.75
April	30	0	1.00
May	30	0	1.50
June	30	0	3.50
July	30	0	3.50
August	30	0	3.50
September	30	0	1.50
October	30	0	1.00
November	40	0	0.75
December	75	40	0.50

In the example calculations shown in this figure (b)

- Twenty-seven percent of the pasture in the subwatershed has unrestricted stream access (typically determined from stakeholder input and GIS analysis).
- Thirty percent of cows in and around a stream defecate in that stream (default assumption)

Sample Calculation: Distribution of Dairy Herd
(Typical subwatershed during January)
Note: Due to rounding numbers may not add up

Breakdown of dairy herd: 96 lactating cows, 20 dry cows, 95 heifers

1. During January, lactating cows are confined 75% of the time (see table in fig 4a). Dry cows and heifers are confined 40% of the time.
   Lactating cows in confinement = 96 x .75 = 72
   Dry cows in confinement = 20 x .40 = 8
   Heifers in confinement = 95 x .40 = 38
2. When not confined, dairy cows are on pasture or in the stream:
   Lactating cows on pasture and in the stream = 96-72 = 24
   Dry cows on pasture and in the stream = 20-8 = 12
   Heifers on pasture and in the stream = 95-38 = 57
3. As indicated in Figure 4a, 27% of the pasture acreage has stream access. Hence dairy cows with stream access are calculated as:
   Lactating cows on pasture with stream access = 24 x .27 = 6.5
   Dry cows with stream access = 12 x .27 = 3.2
   Heifers with stream access = 57 x .27= 15.4
4. Dairy cows in and around the stream are calculated using the number of cows calculated in Step 3 and the number of hours cattle spend in the stream in January (Figure 4a):
   Lactating cows in and around streams = 6.5 x (0.5/24) = 0.14
   Dry cows in and around streams = 3.2 x (0.5/24) = 0.07
   Heifers in and around streams = 15.4 x (0.5/24) = 0.32
5. Number of cows defecating in the stream is calculated by multiplying the number of cows in and around the stream by 30% (Figure 4a):
   Lactating cows defecating in streams = 0.14 x 0.30 = 0.04
   Dry cows defecating in streams = 0.07 x 0.30 = 0.02
   Heifers defecating in streams = 0.32 x 0.30 = 0.10
6. After calculating the number of cows defecating in the stream, the number of cows defecating on the pasture is calculated by subtracting the number of cows defecating in the stream (Step 5) from the number of cows in the pasture and in the stream (Step 2):
   Lactating cows defecating on pasture = 24 – 0.04 = 23.96
   Dry cows defecating on pasture = 12 – 0.02 = 11.98
   Heifers defecating on pasture = 57 – 0.10 = 56.90

Figure B. 1. Example of dairy cattle distribution calculations performed by subwatershed in the BSLC

Based on program defaults and additional user-defined information described in Table B.1, the BSLC calculates the number of animals present in each land use or management area and apportions their bacterial production appropriately, according to the bacteria produced per day per animal (Table B.2). Some animals (cattle) can be present in each of the four management areas. Others are restricted to one area (e.g., poultry are restricted to confinement; sheep are restricted to pasture).

Table B. 2. Select manure and fecal coliform production rate reference values used in the BSLC

Animal	Animal Weight (kg)[a]	Manure Production Rate (kg/animal/day)[b]	Fecal Coliform Production Rate (cfu/day-animal)
Dairy cow	635[c]	52[d]	2.50×10^{10}[e]
Beef cattle	450[f]	27[g]	3.30×10^{10}[h]
Sheep	27[c]	1.08[i]	1.2×10^{10}[i]
Chicken layers	1.8[c]	0.115[i]	1.4×10^{8}[i]
Chicken broilers	0.9[c]	0.0765[i]	8.9×10^{7}[j]
Turkeys	6.8[c]	0.320[i]	9.3×10^{7}[i]
Goat	64[c]	—	2.8×10^{10}[k]
Horse	450[c]	—	4.2×10^{10}[i]
Deer	—	—	3.5×10^{8}[l]
Raccoon	—	—	5.0×10^{7}[m]
Muskrat	—	—	2.5×10^{7}[n]
Goose		—	8.0×10^{8}[o]
Duck	1.4[c]	—	2.4×10^{9}[i]
Beaver	—	—	2.0×10^{5}[p]

[a]Animal weight only given where it was used to calculate manure or fecal coliform production rates.
[b]Manure production rates only needed for animals whose manure is applied.
[c]*ASAE Standards* (1998).
[d]Calculated from Barth (1992) for given animal weight in second column.
[e]Based on estimates ranging from 1.7×10^4 to >8.0×10^6 cfu/g manure as given by Yagow (2001), Geldreich (1978), and *ASAE Standards* (1998); and on mass of feces from *ASAE Standards* (1998).
[f]VADCR (1993).
[g]MWPS (1993).
[h]Based on estimates ranging from 6.5×10^1 to >8.0×10^6 cfu/g manure as given by Yagow (2001), Geldreich (1978), and *ASAE Standards* (1998); and on mass of feces from *ASAE Standards* (1998).
[i]Calculated from *ASAE Standards* (1998).
[j]Assume fecal coliform density is the same as in layer manure; calculate based on manure production rates in *ASAE Standards* (1998).
[k]Calculated from sheep fecal coliform and ratio of sheep and goat weights.
[l]Calculated from Yagow (2001) fecal coliform densities and Harlow (1984) forage intake and dry matter digestibility analyses.
[m]Assumed twice the contribution from muskrats.
[n]Calculated from Yagow (2001) fecal coliform densities and Kator and Rhodes (1996) mass of feces.
[o]Calculated from Moyer and Hyer (2003).
[p]Calculated from Maptech, Inc. (2000).

Cattle

Cattle are assumed in the BSLC calculations to occupy confined areas, pastures, loafing lots, and streams according to the breakdown of time spent in each area given in the Farm and Land Use Data, References, and Monthly Variables worksheets. Manure (and thus bacteria) produced by cattle is allocated to each of these areas according to the time the cattle spend in each area.

Poultry

Six categories of poultry are considered by the BSLC. This detailed breakdown allows different management practices, which may be in place within the watershed, to be appropriately represented in the program. When possible, information from producers and local agency personnel is used to estimate the number of poultry in each subwatershed based on house locations and flock management. Concentrated Animal Feeding Operation (CAFO) permits may also provide detailed poultry population information. When these sources are not available, the number of poultry houses in each subwatershed is estimated using USDA Farm Service Agency (FSA) aerial photographs, U.S. Geological Survey (USGS) 7½-min topographic maps, and local building footprint data. The number of poultry is then based on estimates of house dimensions, space requirements/bird, and flock management. Poultry populations used in the BSLC are based on the number of birds produced per cycle (as opposed to an annual production total) in order to get an accurate count of the actual poultry population in a watershed at any given time, and thus the total amount of bacteria that have been produced in the watershed. Using the poultry population estimates (Animals worksheet) and manure production characteristics (References worksheet) (Table B.2), the BSLC calculates poultry litter production in each subwatershed. Poultry are assumed to be confined at all times.

Horses, Sheep, and Goats

Horses, sheep, and goats are assumed in the BSLC calculations to occupy pasture areas with no confinement. The default assumption is that these other livestock will not spend time in streams; however, this can be changed in the References worksheet. All manure and, thus, bacteria produced by these animals is allocated by the BSLC to pasture land surfaces and streams according to the fraction of animals in each pasture and the stream specified in the Farm and Land Use Data, References, and Monthly Variables worksheets. In the future, the BSLC will incorporate new routines to allow simulation of other types of livestock, e.g., pigs and exotics. In the current version of the software, these additional animal inputs can be approximated by adding to other animals. For instance, a significant population of free-range pigs could be scaled by the ratio of pig bacteria production to sheep bacteria production, and the new population number added to the total number of sheep for each subwatershed.

Manure Application

Livestock manure from all CAFOs is assumed to be initially stored and subsequently applied to pervious land surfaces, either cropland or pasture. Bacterial die-off during storage is accounted for by the BSLC because the HSPF model does not have this capability. The BSLC calculates bacterial loads in stored manure immediately prior to application based on the inputs shown in Table B.3. The BSLC calculates the amount of bacteria applied to each land use based upon the estimated bacterial load in stored manure immediately prior to application and the required inputs shown in Table B.3. Relevant factors affecting the inputs shown in Table B.3 are found in the References worksheet.

Table B. 3. Required inputs to the BSLC to calculate bacteria loads from land-applied manure

Bacterial load in stored manure immediately prior to application	
Required Inputs	*Input Source*
Amount of each type of manure (liquid dairy, solid/semisolid cattle, poultry litter)	Previously calculated by BSLC based on user-input animal numbers and user-input or default values of manure production characteristics
Die-off rate of manure in storage	Default values supplied by BSLC, or user can enter custom value
Amount of storage time available for each type of manure/application schedule for each type of manure	Default values supplied by BSLC based on application timing recommended by nutrient management plans, or user can enter custom value
Amount of bacteria applied to each land use	
Required Inputs	*Input Source*
Allowable application rates of each type of manure to each land use category	Supplied by BSLC based upon typical Virginia nutrient management plan guidelines (Yagow, 2001), or user can enter custom value
Monthly application schedule to each land use category	Supplied by BSLC based upon typical Virginia nutrient management plan guidelines (Yagow, 2001), or user can enter custom value
Land use category receiving the waste	Based on available land use in each subwatershed entered by the user

Wildlife

When estimating wildlife populations as inputs for the BSLC, a direct inventory of wildlife populations is neither practical nor feasible; therefore, an indirect approach based on the available suitable habitat for each candidate species is used. First, suitable habitat areas are defined for individual wildlife species, typically within a certain buffer of water bodies and within a given type of land use (Table B.4). A geographic information system (GIS) is used to create spatial buffers and to calculate the suitable habitat area available in each subwatershed. Populations are calculated as the product of the suitable habitat area for each species within each subwatershed and literature values of typical species densities. These initial estimates are adjusted as necessary, based on watershed reconnaissance and consultation with local stakeholders and wildlife agency personnel. It is not feasible to determine a habitat area and population density that would be applicable to the array of conditions found throughout the country; thus, it is highly recommended that you consult local wildlife experts when developing wildlife estimates. Wildlife populations from the Animals worksheet are coupled with their bacteria production rates and time spent in streams given in the References worksheet to calculate loads to the land and the stream.

Table B. 4. Wildlife habitat areas and population estimates

Wildlife Type	Habitat	Population Density (animal/ha-habitat)	Source of Information
Deer	Entire watershed	0.12	MapTech (2000)
Raccoons	Low density on forests not in high density area; high density on forest within 183 m of a permanent water source or 0.8 km of cropland	Low density: 0.040 High density: 0.12	Virginia Department of Game and Inland Fisheries (personal communication, 2004)
Muskrats	26/km of ditch or medium sized stream[a] intersecting cropland; 13/km of ditch or medium sized stream intersecting pasture; 16/km of pond or lake edge; 81/km of slow-moving river edge	-see habitat column-	Virginia Department of Game and Inland Fisheries (personal communication, 2004)
Beavers	91-m buffer around streams and impoundments in forest and pasture	0.037	Density calculated from colony size estimates from MDC (1997) and colony density estimates by Stromayer (1999); habitat modified from estimates by MapTech (2000)
Geese	91-m buffer around main streams and impoundments	0.19 – off season 0.27 – peak season	Moyer and Hyer (2003)
Ducks	91-m buffer around main streams and impoundments	0.15 – off season 0.23 – peak season	Habitat area from Moyer and Hyer (2003)
Wild Turkey	Entire Watershed except urban and farmstead	0.025	Brannan et al. (2002)

[a]For practical purposes at the Center for Watershed Studies, we assume a ditch or medium-sized stream is a perennial stream or canal/ditch that would show up as a line (not an area) on a USGS quad sheet; generally this corresponds to NHD (USGS, 2005) FCODEs 46004, 46005, 46006, and 33602 or TIGER (U.S. Census Bureau, 2002) CFFC codes H11, H13, and H21. These classifications should be field-checked prior to use.

Geese and Ducks

The BSLC default bacterial loading rates are based on the assumption that there are a number of resident geese and ducks living year-round in each subwatershed. During the peak season, migratory geese and ducks add to the population. You can change the months included in the peak season in the References worksheet. Look for the following parameters:

- First Month of Goose Peak Season (mm format, e.g., Dec=12);
- Last Month of Goose Peak Season (mm format, e.g., Dec=12);
- First Month of Duck Peak Season (mm format (e.g., Dec = 12)); and
- Last Month of Duck Peak Season (mm format (e.g., Dec = 12)).

The remainder of the year is divided into two separate seasons to give the user more flexibility in inputs.

Farm and Land Use Data

Distribution of land use and stream access within each subwatershed can be determined largely from GIS analysis of land use characteristics and stream locations. Sources of GIS data on land use and stream locations include on-line information from USGS National Land Cover and Hydrography Datasets (NLCD and NHD) (USGS, 2004, 2005), satellite imagery from USDA (2005), the U.S. Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) data (U.S. Census Bureau, 2002), and local maps.

Stream Access

Only one stream access value can be used for each subwatershed. Generally, you should not include portions of pasture where fencing prevents livestock access to the stream. Enter fractions as decimal percentages. For example, if pasture 1 is 200 acres and borders a stream, and there is no fencing to keep livestock out, enter "1" (100 percent). If a similar size pasture has a 100-acre section that is fenced off, enter ".5" (50 percent) to represent the portion that has stream access. This assumes that there is a uniform density of cows across a given type of pasture in a given subwatershed. However, if, for example, there are 400 cows in Pasture 1 in subwatershed 1, and 300 are on a farm with 100 acres and 100 are on a farm with 100 acres, and the farm with a higher density of cattle does not fence the cows from the stream but the farm with a lower density of cattle does, this factor would be 0.75 (because ¾ of the cows have stream access), not 0.5.

Modifying default values for varying stream access
The stream access percentages listed in the Farm and Land Use Data worksheet apply to all grazing animals on the relevant pasture type. If the grazing livestock (dairy cattle, beef cattle, horses, sheep, and goats) do not all have the same fraction of stream access, it is necessary to alter other parameters in the BSLC to appropriately represent the actual stream access for each livestock type.

If different livestock grazing on the same pasture types in the same subwatershed have different levels of stream access, you will need to change a default in the References worksheet that estimates the fraction of livestock in and around the stream actually defecating in the stream.

The following (equation 1) describes how the BSLC calculates in-stream bacterial loading for each animal type (see also Figure B.1):

$$BACT = POP * FRSTR * FRTIME * FRDEF * PROD \qquad [1]$$

Where:

BACT	= bacteria deposited in the stream (cfu)
POP	= total number of livestock (animals)
FRSTR	= fraction of livestock with stream access (unitless)
FRTIME	= fraction of time in a day spent in and around the stream (unitless)
FRDEF	= fraction of livestock in and around the stream actually defecating in the stream (unitless)
PROD	= bacteria production per livestock (cfu/animal)

POP is given in the Animals worksheet; FRSTR in the Farm and Land Use Data worksheet; FRTIME in the Monthly Variables worksheet; and FRDEF and PROD in the References worksheet. POP, FRDEF, and PROD are unique by livestock type. FRSTR and FRTIME are common for all livestock.

Keeping in mind that multiplication is commutative and associative, if we want to reduce the fraction of livestock with stream access for a given species, it would not matter whether we reduced the actual FRSTR variable or reduced another variable in its place. Keep in mind also that POP and PROD directly influence the amount of bacteria deposited on the land surface, and thus it is preferable not to alter them from actual values. Thus, it makes sense to alter FRDEF for each type of livestock in order to represent their actual access to streams relative to the baseline FRSTR provided in the Farm and Land Use Data worksheet. As an example, consider a case where 40 percent of beef cattle and 100 percent of horses have stream access from the same pasture types in the same subwatershed. Say FRSTR has been set to 0.4 (the correct number for beef cattle). In this case, FRDEF for beef cattle would be held at 0.3 (the default). However, FRDEF for horses would be recalculated as 0.3 * (1.0/0.4) = 0.75. This is derived on the following page.

Because FRSTR has been set to 0.4 (the correct values for beef cattle), FRDEF for beef cattle remains at 0.3:

BACT = POP * 0.4 * FRTIME * 0.3 * PROD

Now it is necessary to determine how FRDEF must change for horses. Here is the derivation for horses:

1. **We want to have this relationship, where FRSTR = 1.0:**
   BACT = POP * 1.0 * FRTIME * 0.3 * PROD

2. **But FRSTR is fixed at 0.4; rewrite the equation this way:**
   BACT = POP * (0.4 * 1.0/0.4) * FRTIME * 0.3 * PROD

3. **Because multiplication is commutative, we can move the 1.0/0.4 factor around:**
   BACT = POP * 0.4 * FRTIME * 0.3 * (1.0/0.4) * PROD

4. **Thus, FRDEF becomes 0.3 * (1.0/0.4) = 0.75 and FRSTR is held at 0.4.**

Human Activities

The BSLC calculates an hourly direct loading time series for input to HSPF using a Watershed Data Management (WDM) file based on the number of houses with straight pipe discharges, the bacterial production rate per person, and the average number of people living in each house. It also calculates surface loadings from failing septic systems based on house age, an age-specific failure rate, the bacterial production rate per person, and the average number of people living in each house. The bacterial production rate per person in both cases is defined by the value given in the References worksheet. Additionally, pet populations are estimated based on the total number of houses and a pet per household estimate found in the References worksheet.

Unsewered and Sewered Houses—Persons per and Total Number

Two categories of homes, sewered and non-sewered, should be considered when developing human and pet source inputs for the BSLC (Figure 8). People living in houses on a sewer network do not contribute bacteria to the stream via a nonpoint source pollution route. Rather, sewage from sewered homes is routed to a sewage treatment plant, which can be accounted for separately in the watershed model through a point source discharge. Properly installed and maintained septic systems are designed to treat waste and are not considered a source of bacteria. However, improperly installed or poorly maintained systems represent potential sources of human bacteria within a watershed. Effluent from a failing septic system that rises to the surface can be carried away with runoff during storm events. The total number of houses is used to compute a pet population for the watershed. The people per household are used to determine a total bacteria load in the unsewered houses, as described earlier. The number of people per household can be obtained on a block or sub-block group level from the U.S. Census. Persons per house and the total number of houses are entered in the Human Activities worksheet.

Septic Systems and Straight Pipes

The first task in calculating the number of houses with septic systems and straight pipes is to identify the locations and ages of houses in each subwatershed that are not on the sewer network. Some localities have electronic data on house locations and ages, and this source of information should be used where available. If this information is not locally available, it is possible to use house locations on USGS 7½-min quadrangles. As a last resort, it is also possible to use housing information from block or sub-block groups in the U.S. Census to try to approximate house locations.

Photorevisions of the USGS 7½-min quadrangles allow the modeler to approximate general house ages, grouping houses into categories of old, mid-age, and new. Houses that were present on the original quadrangles published in the 1960s appear in black on the quadrangles. Houses that were added between the original publication and the revision in the 1980s appear in maroon on the quadrangles. Newer houses will not appear on the quadrangles, so comparison with existing building locations typically available from the local government GIS office will show which houses must have been added since the 1980s. Specific dates will depend on the publication and revision dates of the individual quadrangles, which can be found in the title bar at the bottom of each USGS quadrangle. If local electronic data are not available, it may be possible to estimate houses in the new age category as the difference between total houses in the U.S. Census data and the total houses that have been enumerated from the USGS quadrangles.

The age breakdown in the Human Activities worksheet will determine how many septic systems should be "failing" according to the corresponding age-specific failure rates in the References worksheet. The BSLC calculates the amount of bacteria deposited on residential land surfaces based on these data, the bacteria production per person, and the average number of people per house.

Older homes, particularly in rural areas, might have straight pipes discharging sewage directly to the stream. In order to discharge sewage directly to the stream, a house must be located within a reasonable distance from the stream. Benham et al. (2004) estimated that homes within 50 meters of streams might have straight pipe discharges as a function of the age of the home (Table B.5), and that 10 percent of older houses and 2 percent of mid-age houses located in this buffer could be estimated to have straight pipes. Bacteria produced in these homes are input into the HSPF model as a direct load to receiving waters. You must input the number of houses with straight pipes in the Human Activities worksheet (Figure 8).

Table B. 5. Estimated septic system failure rates and existence of straight pipes as function of home age and proximity to stream in Virginia (Benham et al., 2004)

Age Category	Estimated Septic System Failures (%)	Estimated Straight Pipe Sewage Discharges for Homes within 50 m of Stream (%)
Pre-1966	40	10
1966-1985	20	2
Post-1985	3	0

Appendix C: ACCUM and SQOLIM Tables

The generation of ACCUM and SQOLIM tables is a major benefit of using the BSLC. The bacterial loading rates and accumulation limits contained in these tables are automatically and correctly formatted for HSPF.

The ACCUM table (Figure C.1) contains monthly bacterial loadings (cfu/acre/day). The first column contains a reference to a particular land surface as described in the HSPF User's Control Input (UCI) file, and the 12 following columns (format ##E##) indicate the loading rate for each month of the year. The subwatersheds are broken out and labeled with the '***' comment line symbol for HSPF. The contents of the ACCUM text file can be cut and pasted into the appropriate position in an HSPF UCI file.

```
*** BVR-1
101 11E0711E0846E0838E0898E0773E0673E0673E0611E0715E0815E0811E07
131 16E0919E0935E0935E0933E0934E0934E0935E0936E0923E0925E0915E09
112 11E0711E0775E0675E0675E0675E0675E0675E0611E0711E0711E0711E07
*** BVR-2
102 40E0616E0872E0860E0815E0833E0633E0633E0640E0618E0823E0840E06
132 16E0918E0937E0939E0935E0936E0936E0936E0938E0931E0930E0915E09
125 75E0875E0875E0875E0875E0875E0875E0875E0875E0875E0875E0875E08
113 42E0642E0635E0635E0635E0635E0635E0635E0642E0642E0642E0642E06
*** BVR-3
103 18E0612E0854E0844E0811E0818E0618E0618E0618E0615E0817E0818E06
144 21E0688E0739E0832E0880E0783E0780E0780E0716E0816E0816E0821E06
133 16E0918E0934E0936E0934E0935E0935E0935E0936E0928E0928E0915E09
126 41E0841E0841E0841E0841E0841E0841E0841E0841E0841E0841E0841E08
114 20E0620E0620E0620E0620E0620E0620E0620E0620E0620E0620E0620E06
```

Figure C. 1. Sample ACCUM table output from the BSLC

The BSLC itself does not simulate die-off once bacteria reach the land surface; however, the BSLC does calculate the values needed by the SQOLIM table, a required input to HSPF.

The SQOLIM table contains the limit on accumulation of bacteria on the land surface (cfu/acre), which varies monthly. This limit is HSPF's method of representing die-off of bacteria on the land surface. If a population follows Chick's Law for first order decay of bacteria (Equation 2), and a constant load is applied to the land surface every day, the total population on the surface will approach an asymptotic limit.

$$\frac{N}{N_0} = 10^{-kt} \qquad [2]$$

Where: N = population size (cfu)
N_0 = initial population size (cfu)
k = base 10 die-off rate (day^{-1})
t = time (day)

Given a constant daily loading rate L, the accumulation of bacteria at the beginning of any given day becomes a sum of a geometric progression with the first term L and common ratio 10^{-k}. Thus, the population size increases every day according to Equation 3. As t grows large, 10^{-kt} in Equation 3 approaches zero (Equation 4).

$$N_t = \frac{L * \left(1 - 10^{-kt}\right)}{1 - 10^{-k}} \quad [3]$$

Where: N_t = population size at the beginning of the current day (cfu)

$$N_{t \to \infty} = \frac{L}{1 - 10^{-k}} \quad [4]$$

Equation 4 can be used to calculate the asymptotic limit of surface accumulation (SQOLIM) for any value of k. More specifically, the daily load can be multiplied by a constant value $[(1\text{-}10^{-k})^{-1}]$ to obtain SQOLIM. This constant value is what is required for use in the BSLC. The SQOLIM multiplication factor is multiplied by the ACCUM value (aka daily load) to obtain the asymptotic limit of surface accumulation of bacteria.

Appendix D: MUTSIN Input and Associated Files

The BSLC outputs several MUTSIN files for use with HSPF. Depending on the form of output you choose within the BSLC, you will have either one MUTSIN file for each of the four animal types or four MUTSIN files for each subwatershed. The MUTSIN files themselves are fairly simple, containing hourly time series of inputs for HSPF. These files can be read directly by HSPF using the MUTSIN block. However, the more typical method of bringing hourly direct deposit time series into the HSPF model now is through use of Watershed Data Management (WDM) files. These WDM files store multiple time series that are read into HSPF using the EXT SOURCES block.

Preparing for Input from MUTSIN Files

In addition to the MUTSIN outputs (*.mut), the BSLC will output one UCI file called MutImp.uci. This file allows you to use the MUTSIN and EXT TARGETS blocks of HSPF to read the individual MUTSIN files output by the BSLC. Before using MutImp.uci for the first time in a watershed, follow steps 1 and 2. After you have created the WDM file and tell the BSLC its name, you will just need to repeat steps 3-5 for future runs of the BSLC. The files are set up to work correctly if you follow these steps:

1. Create ‘blank’ time series in your WDM file to receive the input from the MUTSIN files; if you are unsure of how to do this, refer to WDMUtil’s documentation. To work properly, you need one time series for each subwatershed for each type of direct deposit you chose to output from the BSLC. The TSTYP for each of the ‘blank’ time series needs to be FC. Use the following numbering conventions when creating the time series in your WDM file:
    a. For cattle direct deposit: start numbering at 101 for subwatershed 1, then add one for each subwatershed (103 = cattle direct deposit in subwatershed 3);
    b. For wildlife direct deposit: start numbering at 201 for subwatershed 1, then add one for each subwatershed (203 = wildlife direct deposit in subwatershed 3);
    c. For straight pipe direct deposit: start numbering at 301 for subwatershed 1, then add one for each subwatershed (303 = wildlife direct deposit in subwatershed 3); and
    d. For other livestock (horses, sheep) direct deposit: start numbering at 401 for subwatershed 1, then add one for each subwatershed (403 = other livestock direct deposit in subwatershed 3).
2. If you did not know the name of your WDM file when you executed the BSLC, open MutImp.uci in a text editor and replace the WshedDD.wdm entry in the FILES block at the top of the file with the name of your WDM file. Save and close MutImp.uci, making sure that the text editor does not attempt to save it with a *.txt extension.
3. Place the WDM file with the blank time series, all of the MUTSIN files, and MutImp.uci in the same directory.

4. Run WinHSPFLt and choose MutImp.uci file as the file to run. The program should execute quickly (1-5 seconds).
5. You should spot check one or more of the resulting time series in the WDM file to ensure that the data were imported correctly.
6. You can now copy the WDM file containing your direct deposit information to whatever folder is appropriate to execute HSPF for your watershed.

Appendix E: Calibrating Data and Allocating Loads

Calibration is a modeler's term for the process used to adjust model parameters until a model's output matches observed data. This is critical if the modeler's goal is to assess, for example, a watershed's compliance with water quality standards. In choosing model parameters to adjust, the modeler starts changing the most uncertain model parameters, balancing his or her choices with the impact of the model parameters on model output. It is up to the modeler to decide what parameters are most appropriate to adjust.

The BSLC can help this process by isolating the many different aspects of bacteria load estimates. Thus, rather than directly adjusting the ACCUM load in HSPF, which disconnects the modeler from the practical implications of adjustments, actual parameters can be adjusted in the BSLC. For example, the modeler can adjust the ACCUM load indirectly by adjusting the bacteria production rate by a particular animal within a range of values reported in the literature. Thus, there is a very clear tie between the adjustments in the ACCUM load and the real-world parameters affected by those adjustments.

Allocation is a watershed modeler's term used primarily in the context of TMDLs (see Appendix F) to describe the process of running the model repeated times, each time altering the pollutant load in the model to represent reductions due to the presence of best management practices. Allocation runs typically continue until the model output demonstrates compliance with water quality standards. The BSLC can assist with these calculations through the "Skip to ACCUM/SQOLIM Table Creation" feature. Users can specify ACCUM reduction factors that represent the placement of best management practices on particular land uses and regenerate new ACCUM and SQOLIM tables for use in HSPF.

Appendix F: Developing TMDL Studies

The Total Maximum Daily Load (TMDL) program, mandated by the Clean Water Act, is a watershed management process that integrates watershed planning with water quality assessment and protection. Water bodies in violation of state water quality standards are referred to as "impaired," and pollutant-specific TMDL plans are required for them. The TMDL development process includes three steps. First, identify the sources of the pollutants causing water quality impairments. Second, quantify the pollutant contribution from each source (or source category in the case of non-point source pollution). Third, determine the pollutant reduction from each source required to meet applicable state water quality standards. As described in Appendix E, the BSLC is a valuable tool that can be used during the second and third steps of the TMDL development process.

Section

7

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