

EPA Bacterial Indicator Tool

User's Guide

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March 31, 2000**

INTRODUCTION

The Bacterial Indicator Tool is a spreadsheet that estimates the bacteria contribution from multiple sources. Currently, the tool is enabled for fecal coliform. However, the tool could be adapted for other bacterial indicators, such as *E. coli*, if the necessary bacteria production information is available. Output from the tool is used as input to WinHSPF and the Hydrological Simulation Program Fortran (HSPF) water quality model within BASINS. The tool estimates the monthly accumulation rate of fecal coliform bacteria on four land uses (cropland, forest, built-up, and pastureland), as well as the asymptotic limit for that accumulation should no washoff occur. The tool also estimates the direct input of fecal coliform bacteria to streams from grazing agricultural animals and failing septic systems. The Bacterial Indicator Tool was developed to provide starting values for model input, however a thorough calibration of the model is still recommended.

The Bacterial Indicator Tool is based on a modeling study of 10 subwatersheds, composed of four land uses (cropland, forest, built-up, and pastureland). BLUE text found throughout the spreadsheet presents valuable information and assumptions. RED text designates values that should be specified by the user. BLACK text usually presents information that is calculated by the spreadsheet or that should not be changed. The tool contains the following worksheets:

Worksheet Name	Purpose
Land Use	Lists the distributions of built-up land, forestland, cropland, and pastureland in up to 10 subwatersheds.
Animals	Lists the number of agricultural animals in each subwatershed (beef cattle, dairy cattle, swine, chickens, horses, sheep, and other [user-defined]), and the densities of wildlife by land use category (ducks, geese, deer, beaver, raccoons, and other [user-defined]).
Manure Application	Calculates the fraction of the annual manure produced that is available for washoff based on the amount applied to cropland and pastureland in each month and the fraction of manure incorporated into the soil (for hog, beef cattle, dairy cattle, horse, and poultry manure).
Grazing	Lists the days spent confined and grazing for beef cattle, horses, sheep, and other. Beef cattle are assumed to have access to streams while grazing.
References	Lists literature and assumed values for manure content, wildlife densities, and built-up fecal coliform accumulation rates. These values are used in calculations in the remaining worksheets.

Worksheet Name	Purpose
Wildlife	Calculates the fecal coliform bacteria produced by wildlife by land use category.
Cropland	Calculates the monthly rate of accumulation of fecal coliform bacteria on cropland from wildlife, hog, cattle, and poultry manure.
Forest	Calculates the rate of accumulation of fecal coliform bacteria on forestland from wildlife.
Built-up	Calculates the rate of accumulation of fecal coliform bacteria on built-up land using literature values.
Pastureland	Calculates the monthly rate of accumulation of fecal coliform bacteria on pastureland from wildlife, cattle, and horse manure, and cattle, horse, sheep, and other grazing.
Cattle in Streams	Calculates the monthly loading and flow rate of fecal coliform bacteria contributed directly to the stream by beef cattle.
Septics	Calculates the monthly loading and flow rate of fecal coliform bacteria from failing septic systems.
ACQOP&SQOLIM (for land uses)	Summarizes the monthly rate of accumulation of fecal coliform bacteria on the four land uses; calculates the build-up limit for each land use. Provides input parameters for HSPF (ACQOP/MON-ACCUM and SQOLIM/MON-SQOLIM).

The following information must be input by the user:

- Land use distribution for each subwatershed (built-up, forest, cropland, and pastureland, including, to the extent possible, the breakout of built-up land into commercial and services, mixed urban or built-up, residential, and transportation/communications/utilities).
- Agricultural animals in each subwatershed
- Wildlife densities for forest, cropland, and pastureland in the study area (built-up land is assumed not to have wildlife)
- Number of septic systems in the study area
- Number of people served by septic systems in the study area
- Failure rate of septic systems in the study area

Default values are supplied for the following inputs, but they should be modified to reflect patterns in the study watershed:

- Fraction of each manure type that is applied each month
- Fraction of each manure type that is incorporated into the soil
- Time spent grazing and confined by agricultural animals (and in stream for beef cattle only)

Literature values are supplied for the following inputs, but they may be replaced with user values if better information is available for the study watershed:

- Animal waste production rates and fecal coliform bacteria content
- Fecal coliform bacteria accumulation rates for built-up land uses
- Raw sewage fecal coliform bacteria content and per capita waste production

The remainder of this document describes the purpose and use of each worksheet within the Bacterial Indicator Tool, as well as the input required by the user (if any). The symbol “U” indicates that user input is required in the sheet being described; the symbol “ - ” indicates that no input is needed.

LAND USE

U	User Input Required
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The modeled land uses are derived from the original land uses by reassigning the original categories to the corresponding model categories. Only four categories are considered in this tool: Cropland, Forest, Built-up, and Pastureland. Reassign the categories in your existing land use database, and calculate the acres of each of the four model land use categories within each subwatershed. Enter the values in the appropriate cells on the Land Use sheet. Total acres by subwatershed and land use category will be calculated automatically.

ANIMALS

U	User Input Required
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Fecal contributions from the animals listed in this worksheet are used to derive loading estimates for all land uses except for built-up. Only manure from cattle, swine, and poultry is assumed to be collected and applied to cropland. Cattle manure is also assumed to be applied to pastureland. Horse manure is assumed to be collected and applied to pastureland only. Manure from cattle, horses, sheep and "other" agricultural animals is assumed to be contributed to pastureland in proportion to time spent grazing. Wildlife densities are provided for all land uses except built-up and are assumed to be the same in all subwatersheds. An “other” category is provided for both agricultural animals and wildlife to allow the user to include animals that are not already available in the tool.

In the absence of site-specific data, the number of agricultural animals present in each subwatershed can be determined using county-level data from the Census of Agriculture (<http://www.nass.usda.gov/census/census97/highlights/ag-state.htm>). The total number of

agricultural animals can be estimated for each subwatershed based on a ratio of subwatershed-level pastureland to county-level pastureland area. For example, assume Subwatershed 1 is located entirely within County A and that County A contains 1000 acres of pastureland and 200 dairy cows. If Subwatershed 1 contains 100 acres of pastureland, this subwatershed is assigned $[(200/1000)*100] = 20$ dairy cows. Calculate the number of agricultural animals (dairy and beef cattle, swine, chickens, horses, sheep, and “other”) in each subwatershed and enter these values in the appropriate cells on the Animals sheet. Totals by subwatershed and animal type will be calculated automatically.

The densities of wildlife are estimated based on the best available information. It is assumed that no wildlife are present on built-up land and that the densities of wildlife on each of the remaining land use types (forest, cropland and pastureland) are the same across all subwatersheds. Enter the density for each form of wildlife (ducks, geese, deer, beaver, raccoons, and “other”) on each land use type in animals per square mile. The wildlife densities per acre will be calculated automatically.

MANURE APPLICATION

U	User Input Required
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This sheet contains information regarding the land application of waste produced by agricultural animals in the study area. Application of hog manure, cattle manure, horse manure, and poultry litter is considered. The information is presented based on the monthly variability of waste application. The annual production of manure is calculated and then applied each month using the information in this sheet. It is assumed that cattle manure is applied to both cropland and pastureland using the same method. Hog manure and poultry litter are assumed to be applied only to cropland. Horse manure is assumed to be applied only to pastureland.

For each of the four major manure sources (hogs, cattle, horses, and poultry), specify the fraction of the annual manure produced that is applied each month (January through December) and the fraction of the manure applied that is incorporated into the soil. The fraction of manure available for washoff each month for each type of manure will then be calculated automatically. Note that the equation used to calculate the fraction available for runoff can be updated if necessary.

GRAZING

U	User Input Required
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This sheet contains information relevant to cattle, horses, sheep, and “other” animals grazing in the study area. Dairy cattle are assumed to be kept only in feedlots. Therefore, all of their waste

is used for manure application (divided between cropland and pastureland). Beef cattle are assumed to be kept in feedlots or allowed to graze (depending on the season). When they are grazing, a certain proportion is assumed to have direct access to streams. The grazing time spent in streams actually represents a combination of the number of animals with stream access and the percent of time these animals spend contributing waste directly to the streams. Beef cattle waste is therefore applied as manure to cropland and pastureland, contributed directly to pastureland, or contributed directly to streams (referred to by the tool as Cattle in Streams). Horses are assumed to be either kept in stables or allowed to graze. Horse waste is therefore either applied as manure to pastureland or contributed directly to pastureland; horse manure is not applied to cropland. Sheep are assumed to be allowed to graze year-round. Sheep waste is therefore contributed only directly to pastureland. The purpose of the “other” animal category is to allow you to define the grazing patterns of an agricultural animal not available in the default information. To use this category, you must be sure to enter the number of “other” animals in each subwatershed (on the Animals sheet) and to specify a fecal coliform bacteria production rate for this animal (on the References sheet). "Other" animal waste is contributed directly to pastureland only while grazing.

For cattle, horses, sheep, and “other,” enter the fraction of time spent confined each month (from 0, never confined, to 1, always confined). The fraction of time and the number of days per year spent grazing will be calculated automatically. For cattle, you should also specify the fraction of time grazing that is spent in streams. The fraction of time grazing spent in pasture will be calculated automatically.

REFERENCES

-	User Input Required
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The data from the References sheet are accessed in the remaining worksheets. Fecal coliform production rates for various animals are presented from several sources, and you may select the source you prefer or enter a value of your own in the “Best Professional Judgement” column. The spreadsheet is set up to use the ASAE values by default. If you prefer to use a different source, be sure to change the values in cells B9 through B23 on the References sheet. To use the “other” agricultural and wildlife animal categories, you must provide the number of “other” animals in each subwatershed (on the Animals sheet) and a fecal coliform bacteria production rate for this animal (on the References sheet). The References sheet also contains fecal coliform accumulation rates for five Built-up land use types. These numbers may also be changed if appropriate.

WILDLIFE

-	User Input Required
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This sheet calculates the total fecal coliform bacteria produced by wildlife each day per acre of cropland, pastureland, and forest. This calculation is performed by multiplying the density (animals per acre) of each type of wildlife on each land use by the rate of fecal coliform production for that wildlife type (count per animal per day). The number of fecal coliform bacteria produced is then summed across all wildlife types for each land use to obtain a total wildlife fecal coliform production rate (count per acre per day), which will be used in subsequent sheets.

To use the “other” wildlife category, you must be sure to enter the number of “other” animals in each subwatershed (on the Animals sheet) and to specify a fecal coliform bacteria production rate for this animal (on the References sheet). No user input is required on the Wildlife sheet.

CROPLAND

-	User Input Required
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This sheet calculates the total fecal coliform bacteria applied to each acre of cropland by month. The sources of fecal coliform bacteria for cropland are wildlife, hog manure application, cattle manure application, and poultry litter application. No user input is required on the cropland sheet. Chickens and hogs are assumed to be confined all of the time, and their manure is applied only to cropland. Dairy cattle are also assumed to be confined all of the time, and their manure is applied to both cropland and pastureland. Beef cattle are assumed to be either kept in feedlots or allowed to graze, depending on the season. When they are grazing, a certain proportion is assumed to have direct access to streams (as specified in the Grazing sheet.) Beef cattle manure is therefore either applied to cropland and pastureland, contributed directly to pastureland during grazing, or contributed directly to streams (referred to by the tool as Cattle in Streams.)

Wildlife

The fecal coliform bacteria produced by wildlife per acre of cropland is determined for each month as follows:

1. The total wildlife population of each subwatershed is calculated (acres of cropland from the Land Use sheet multiplied by the cropland wildlife density from the Wildlife sheet.)
2. The total daily fecal coliform bacteria load generated by that population is calculated (acres of cropland from the Land Use sheet multiplied by the fecal coliform generated per acre of cropland from the Wildlife sheet).

3. The daily per acre accumulation rate of fecal coliform bacteria from wildlife is calculated by dividing the total load generated by the number of acres of cropland in each subwatershed.

Hog Manure

The fecal coliform bacteria from hog manure applied per acre of cropland is determined for each month as follows:

1. The number of hogs in each subwatershed (from the Animals sheet) is multiplied by the daily fecal coliform production rate per hog (from the References sheet) to obtain the daily hog fecal coliform production rate.
2. The daily rate is then multiplied by 365 to obtain the amount of fecal coliform produced by hogs per year.
3. The fecal coliform bacteria available for washoff is then calculated by multiplying the annual fecal coliform produced by the amount applied and available for washoff in each subwatershed in each month (from the hog manure section of the Manure Application sheet).
4. The monthly total is then divided by the number of days in each month to obtain the daily accumulation rate.
5. Finally, the daily accumulation rate is divided by the number of acres of cropland in each subwatershed to obtain the daily per acre load of fecal coliform bacteria from hog manure.

Cattle Manure

The fecal coliform bacteria from cattle manure applied per acre of cropland is determined for each month as follows:

1. The number of dairy and beef cattle in each subwatershed (from the Animals sheet) is multiplied by the daily fecal coliform production rate per dairy and beef cow (from the References sheet) to obtain the daily dairy and beef cattle fecal coliform production rates.
2. The daily dairy fecal coliform production rate is then multiplied by 365 to obtain the amount of fecal coliform produced by dairy cattle and available for application as manure per year. The daily beef fecal coliform production rate is multiplied by 365 minus the days spent grazing (from the cattle section of the Grazing sheet) to obtain the amount of fecal coliform produced by beef cattle and available for application as manure per year. (The fecal coliform bacteria produced by beef cattle while grazing is assumed to be delivered directly to pastureland.) The total fecal coliform load from cattle manure application is the sum of the dairy and beef loads.
3. The fecal coliform bacteria available for washoff is then calculated by multiplying the annual fecal coliform produced by the amount applied and available for washoff in each subwatershed in each month (from the cattle manure section of the Manure Application sheet).
4. The monthly total is then divided by the number of days in each month to obtain the daily accumulation rate.

5. Finally, the daily accumulation rate is divided between cropland and pastureland and the portion applied to cropland is divided by the number of acres of cropland in each subwatershed to obtain the daily per acre load of fecal coliform bacteria from cattle manure.

Poultry Litter

The fecal content of the litter is considered here, despite the fact that litter is the combination of manure and bedding. As such, the fecal coliform bacteria produced by chickens and applied to cropland is estimated from the rate of manure production per chicken and the bacteria content of that manure, rather than from the bacteria content of the combined manure and bedding.

The fecal coliform bacteria from poultry litter applied per acre of cropland is determined for each month as follows:

1. The number of chickens in each subwatershed (from the Animals sheet) is multiplied by the daily fecal coliform production rate per chicken (from the References sheet) to obtain the daily poultry fecal coliform production rate.
2. The daily rate is then multiplied by 365 to obtain the amount of fecal coliform produced by chickens per year.
3. The fecal coliform bacteria available for washoff is then calculated by multiplying the annual fecal coliform produced by the amount applied and available for washoff in each subwatershed in each month (from the poultry litter section of the Manure Application sheet).
4. The monthly total is then divided by the number of days in each month to obtain the daily accumulation rate.
5. Finally, the daily accumulation rate is divided by the number of acres of cropland in each subwatershed to obtain the daily per acre load of fecal coliform bacteria from poultry litter.

The total accumulation rate of fecal coliform bacteria from cropland is calculated as the sum of the accumulation rates from wildlife and hog, cattle, and poultry manure applications.

FOREST

-	User Input Required
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The wildlife population is the only fecal coliform contributor to forest considered. No user input is required on the Forest sheet. The fecal coliform bacteria produced by wildlife per acre of forest is determined for each month as follows:

1. The total wildlife population of each subwatershed is calculated (acres of forest from the Land Use sheet multiplied by the forest wildlife density from the Wildlife sheet).

2. The total daily fecal coliform bacteria load generated by that population is calculated (acres of forest from the Land Use sheet multiplied by the fecal coliform generated per acre of forest from the Wildlife sheet).
3. The daily per acre accumulation of fecal coliform bacteria from wildlife is calculated by dividing the total load generated by the number of acres of forest in each subwatershed.

BUILT-UP

U	User Input Required
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Because of the lack of animal counts and other specific source information for built-up land, literature values are used. Built-up land is broken out into four categories:

- Commercial and Services
 - Mixed Urban or Built-Up
 - Residential
 - Transportation, Communications and Utilities
1. The percentage breakout of these categories is specified by the user in the Built-up sheet. The acres of each built-up category in each subwatershed are calculated by multiplying the total built-up acres (from the Land Use sheet) by the percentage breakouts specified by the user.
 2. A daily per acre fecal coliform bacteria loading rate is calculated for each built-up category using literature values. The loading rates provided in Horner (1992) and presented in the References sheet are applied as follows:

Built-up category	Fecal coliform loading rate (count per acre per day)
Commercial and Services	Commercial
Mixed Urban or Built-Up	Average of road, commercial, single-family low-density, single-family high-density, and multifamily residential
Residential	Average of single-family low-density, single-family high-density, and multifamily residential
Transportation, Communications and Utilities	Road

3. A weighted average built-up fecal coliform bacteria accumulation rate is calculated for each subwatershed based on the individual built-up land use categories present and their corresponding accumulation rates.

PASTURELAND

-	User Input Required
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This sheet calculates the total fecal coliform bacteria applied to each acre of pastureland by month. The sources of fecal coliform bacteria for pastureland are wildlife, cattle and horse manure application, and beef cattle, horse, sheep, and other grazing. No user input is required on the Pastureland sheet. It is assumed that dairy cattle are confined all of the time and their manure is applied to both cropland and pastureland. Beef cattle are assumed to be kept in feedlots or allowed to graze, depending on the season. When they are grazing, a certain proportion of the cattle is assumed to have direct access to streams (as specified on the Grazing sheet.) Beef cattle manure is therefore applied to cropland and pastureland, contributed directly to pastureland during grazing, or contributed directly to streams (referred to by the tool as Cattle in Streams.) Horse manure that is not deposited in pastureland during grazing is assumed to be collected and applied to pastureland. Sheep and "other" animal manure that is not deposited in pastureland during grazing is assumed to be collected and treated or transported out of the watershed and is tabulated in the last column of the Pastureland sheet (FC collected).

Wildlife

The fecal coliform bacteria produced by wildlife per acre of pastureland is determined for each month as follows:

1. The total wildlife population of each subwatershed is calculated (acres of pastureland from the Land Use sheet multiplied by the pastureland wildlife density from the Wildlife sheet).
2. The total daily fecal coliform bacteria load generated by that population is calculated (acres of pastureland from the Land Use sheet multiplied by the fecal coliform generated per acre of pastureland from the Wildlife sheet).
3. The daily per acre accumulation rate of fecal coliform bacteria from wildlife is calculated by dividing the total load generated by the number of acres of pastureland in each subwatershed.

Cattle Manure

The fecal coliform bacteria from cattle manure applied per acre of pastureland is determined for each month as follows:

1. The number of dairy and beef cattle in each subwatershed (from the Animals sheet) is multiplied by the daily fecal coliform production rate per dairy and beef cow (from the References sheet) to obtain the daily dairy and beef cattle fecal coliform production rates.
2. The daily dairy fecal coliform production rate is then multiplied by 365 days to obtain the annual amount of fecal coliform produced by dairy cattle and available for application as manure. The daily beef fecal coliform production rate is multiplied by 365 days minus the days spent grazing (from the cattle section of the Grazing sheet) to obtain the annual amount of fecal coliform produced by beef cattle and available for application as manure.

(The fecal coliform bacteria produced by beef cattle while grazing is assumed to be delivered directly to pastureland; see below.) The total fecal coliform load from cattle manure application is the sum of the dairy and beef loads.

3. The fecal coliform bacteria available for washoff is then calculated by multiplying the annual fecal coliform produced by the amount applied and available for washoff in each subwatershed in each month (from the cattle manure section of the Manure Application sheet).
4. The monthly total is then divided by the number of days in each month to obtain the daily accumulation rate.
5. Finally, the daily accumulation rate is divided between Cropland and Pastureland and the portion applied to Pastureland is divided by the number of acres of pastureland in each subwatershed to obtain the daily per acre accumulation of fecal coliform bacteria from cattle manure.

Horse Manure

The fecal coliform bacteria from horse manure applied per acre of pastureland is determined for each month as follows:

1. The number of horses in each subwatershed (from the Animals sheet) is multiplied by the daily fecal coliform production rate per horse (from the References sheet) to obtain the daily horse fecal coliform production rate.
2. The daily rate is then multiplied by 365 days minus the days spent grazing (from the horse section of the Grazing sheet) to obtain the amount of fecal coliform produced by horses and available for application as manure per year. (The fecal coliform bacteria produced by horses while grazing is assumed to be delivered directly to pastureland; see below.)
3. The fecal coliform bacteria available for washoff is then calculated by multiplying the annual fecal coliform produced by the amount applied and available for washoff in each subwatershed in each month (from the horse manure section of the Manure Application sheet).
4. The monthly total is then divided by the number of days in each month to obtain the daily accumulation rate.
5. Finally, the daily accumulation rate is divided by the number of acres of pastureland in each subwatershed to obtain the daily per acre accumulation of fecal coliform bacteria from the application of horse manure.

Beef Cattle Grazing

The fecal coliform bacteria from beef cattle manure deposited during grazing per acre of pastureland is determined for each month as follows:

1. The number of beef cattle grazing is calculated by multiplying the number of beef cattle per subwatershed (from the Animals sheet) by the fraction of time spent grazing (from the Grazing sheet).
2. The fecal coliform load delivered directly to pastureland is calculated by multiplying the number of cattle grazing by the fraction of time spent in pasture (as opposed to in

streams, from the Grazing sheet) and by the rate of fecal coliform bacteria production per beef cow (from the References sheet).

3. Finally, the daily grazing beef cattle fecal coliform production is divided by the number of acres of pastureland in each subwatershed to obtain the daily per acre accumulation rate of fecal coliform bacteria from beef cattle grazing.

Horse Grazing

The fecal coliform bacteria from horse manure deposited during grazing per acre of pastureland is determined for each month as follows:

1. The number of horses grazing is calculated by multiplying the number of horses per subwatershed (from the Animals sheet) by the fraction of time spent grazing (from the Grazing sheet).
2. The fecal coliform load delivered directly to Pastureland is calculated by multiplying the number of horses grazing by the rate of fecal coliform bacteria production per horse (from the References sheet).
3. The fecal coliform load in manure collected for application is calculated by subtracting the number of horses grazing from the total number of horses and multiplying by the rate of fecal coliform bacteria production per horse (from the References sheet).
4. Finally, the daily grazing horse fecal coliform production is divided by the number of acres of pastureland in each subwatershed to obtain the daily per acre accumulation rate of fecal coliform bacteria from horse grazing.

Sheep Grazing

The fecal coliform bacteria from sheep manure deposited during grazing per acre of pastureland is determined for each month as follows:

1. The number of sheep grazing is calculated by multiplying the number of sheep per subwatershed (from the Animals sheet) by the fraction of time spent grazing (from the Grazing sheet).
2. The fecal coliform load delivered directly to Pastureland is calculated by multiplying the number of sheep grazing by the rate of fecal coliform bacteria production per sheep (from the References sheet).
3. The fecal coliform load in manure collected for disposal is calculated by subtracting the number of sheep grazing from the total number of sheep and multiplying by the rate of fecal coliform bacteria production per sheep (from the References sheet).
4. Finally, the daily grazing sheep fecal coliform production is divided by the number of acres of pastureland in each subwatershed to obtain the daily per acre accumulation rate of fecal coliform bacteria from sheep grazing.

Other Animal Grazing

The purpose of the “other” animal category is to allow you to define an agricultural animal not available in the default information. To use this category, you must be sure to enter the number of “other” agricultural animals in each subwatershed (on the Animals sheet), to enter the time spent grazing (on the Grazing sheet), and to specify a fecal coliform bacteria production rate (on

the References sheet). The fecal coliform bacteria from “other” animal manure deposited during grazing per acre of pastureland is determined for each month as follows:

1. The number of “other” animals grazing is calculated by multiplying the number of “other” animals per subwatershed (from the Animals sheet) by the fraction of time spent grazing (from the Grazing sheet).
2. The fecal coliform load delivered directly to pastureland is calculated by multiplying the number of “other” animals grazing by the rate of fecal coliform bacteria production per “other” animal (from the References sheet).
3. The fecal coliform load in manure collected for disposal is calculated by subtracting the number of “other” animals grazing from the total number of “other” animals and multiplying by the rate of fecal coliform bacteria production per “other” animal (from the References sheet).
4. Finally, the daily grazing “other” animal fecal coliform production is divided by the number of acres of pastureland in each subwatershed to obtain the daily per acre accumulation rate of fecal coliform bacteria from “other” animal grazing.

The total accumulation rate of fecal coliform bacteria from pastureland is calculated as the sum of the accumulation rates from wildlife, cattle and horse manure applications, and beef cattle, horse, sheep and “other” grazing.

CATTLE IN STREAMS

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This sheet contains information related to the direct contribution of beef cattle fecal coliform bacteria to streams. This contribution can be represented as a point source in HSPF, which requires input of a flow rate (cubic feet per second, or cfs) and a fecal coliform bacteria loading rate (count per hour). No user input is required on this sheet. It is assumed that only beef cattle have access to streams when grazing. The fraction of grazing time spent in streams is specified on the Grazing sheet.

1. The number of beef cattle in streams is calculated by multiplying the total number of beef cattle (from the Animals sheet) by the fraction of time spent grazing and the fraction of grazing time spent in streams (from the Grazing sheet).
2. The fecal coliform bacteria loading rate (count/hr) is calculated by multiplying the number of beef cattle in streams by the fecal coliform production rate per beef cow (from the References sheet.)
3. The beef cattle waste flow rate is calculated by multiplying the number of cattle in streams by the waste production rate per beef cow (from the References sheet) and an assumed beef cattle waste density of 62.4 pounds per cubic foot.

SEPTICS

U	User Input Required
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This sheet contains information related to the contribution of failing septic systems to streams. The direct contribution of fecal coliform from septic systems to a stream can be represented as a point source in the model, which requires input of a flow rate (cfs) and a fecal coliform bacteria loading rate (count/hr).

To estimate the contribution of fecal coliform bacteria from failing septic systems, the number of septic systems, the number of people served by septic systems, and the estimated rate of septic system failure in the study area must be entered. Population and septic tank data can be retrieved from the U.S. Census Bureau web site (<http://venus.census.gov/cdrom/lookup>). For example, county level populations and septic tank information can be retrieved from this web site as follows:

- Under “Choose a Database to Browse” select STF3A
- On the next screen, click on “Go to level State--County” and choose a State from the list below, and then click on “Submit.”
- On the next screen, choose “Retrieve the areas you've selected below” and select a county on the list, and submit.
- Select “Choose TABLES to retrieve” and submit.
- From the list of tables, select “P1” and “H24” and submit
- Select the format for the retrieval (e.g., HTML)
- The information displayed will include a county level summary of population and of housing units with public sewer, septic tank or cesspool, or other.

The estimated rate of septic system failure in the area of interest should be estimated based on local knowledge. From the preceding information, the average number of people served by each septic system, number of failing septic systems, and density of failing septic systems in the study area are calculated.

1. The number of failing septic systems in each subwatershed is calculated by multiplying the total area of each subwatershed (from the Land Use sheet) by the density of failing septic systems.
2. The number of people served by failing septic systems in each subwatershed is calculated by multiplying the number of failing septic systems by the average number of people served by each septic system.
3. The failing septic system flow rate is calculated by multiplying the number of people served by failing septic systems by an assumed daily waste flow of 70 gallons per person.
4. The fecal coliform bacteria loading rate from failing septic systems is calculated by multiplying the failing septic system flow rate by an assumed fecal coliform bacteria

concentration of 10,000 counts per 100 mL of waste flow. Note that any of the assumed values can be updated to represent more appropriate site-specific information.

ACQOP&SQOLIM (FOR LAND USES)

-	User Input Required
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This sheet summarizes HSPF input parameter values calculated based on designations made throughout the spreadsheet. It contains values for model inputs ACQOP (or MON-ACCUM if monthly) and SQOLIM (or MON-SQOLIM if monthly). These parameters represent the rate of fecal coliform accumulation and the maximum storage of fecal coliform bacteria on land uses.

1. The values for ACQOP are simply the total fecal coliform bacteria accumulation rates from each land use sheet (Cropland, Pastureland, Forest, and Built-up).
2. The value for SQOLIM is derived using the following die-off equation from Horsley & Whitten (1986):

$$N_t = N_0(10^{(-kt)})$$

where: N_t = number of fecal coliforms present at time t
 N_0 = number of fecal coliforms present at time 0
 t = time in days
 k = first order die-off rate constant. Typical values for warm months = 0.51/day and for cold months = 0.36/day

In the above equation, N_0 is the count of fecal coliforms applied per acre per day (MON-ACCUM). N_t is the count of fecal coliforms applied on a given day that survive for some number t of days. The maximum buildup of fecal coliform (MON-SQOLIM) is equal to the sum of the fecal coliforms applied on a given day and of the fecal coliforms that were applied on previous days and have survived until that day. When this calculation is done, the maximum buildup is estimated to be approximately 1.5 times the daily buildup rate during warm months (die-off rate of 0.51/day) and 1.8 times the daily buildup rate for colder months (die-off rate of 0.36/day). Warmer months are assumed to be April through September; colder months are October through March. A buildup limit of 1.8 times the daily buildup rate is assumed for nonmonthly varying SQOLIM (Forest and Built-up).

TRANSFERRING DATA FROM THE BACTERIAL INDICATOR TOOL TO WINHSPF

Information contained in three sheets of the Bacterial Indicator Tool can be transferred to WinHSPF. These sheets are Cattle in Streams, Septics, and ACQOP&SQOLIM (for land uses). The information in the Cattle in Streams and Septics sheets are input into the model as point

sources. Each sheet contains the fecal coliform loading rate (in count/hr) and flow rate (in cfs) for each subwatershed. The Cattle in Streams loading and flow rates vary monthly, while the septic rates are constant. See “Detailed Functions - Points Sources” of the *WinHSPF Version 2.0 Manual* (USEPA, March 2001) found in the “\basins\docs” folder for detailed instructions on how to incorporate point sources into WinHSPF.

The information contained in the ACQOP&SQOLIM (for land uses) sheet should be input into WinHSPF using the Input Data Editor. See “Detailed Functions - Input Data Editor” of the *WinHSPF Version 2.0 Manual* (USEPA, March 2001) for detailed instructions on using WinHSPF’s Input Data Editor. The constant values for forest and built-up land should be input using the *ACQOP* and *SQOLIM* columns in the PERLND\PQUAL\QUAL-INPUT and the IMPLND\IQUAL\QUAL-INPUT tables.

The monthly varying values for cropland and pastureland should be input using the *MON-ACCUM* and *MON-SQOLIM* tables under PERLND\PQUAL\ and IMPLND\IQUAL\.

REFERENCES

- American Society of Agricultural Engineers (ASAE). 1998. *ASAE Standards, 45th edition: Standards, Engineering Practices, Data*. St. Joseph, MI.
- North Carolina Cooperative Extension Service. 1994. *Agri-Waste Management: Livestock Manure Production and Characterization in North Carolina*. Raleigh, NC.
- Metcalf & Eddy. 1991. *Wastewater Engineering: Treatment, Disposal and Reuse*. Third edition. George Tchobanoglous and Franklin L. Burton, Eds.
- Long Island Regional Planning Board. 1978. *Long Island Comprehensive Waste Treatment Management Plan. Volume II: Summary Documentation*. Nassau-Suffolk Regional Planning Board. Hauppauge, NY.
- Horner, R.R. 1992. Water quality criteria/pollutant loading estimation/treatment effectiveness estimation. In R.W. Beck and Associates. *Covington Master Drainage Plan*. King County Surface Water Management Division. Seattle, WA.
- Horsley & Whitten. 1996. *Identification and Evaluation of Nutrient and Bacteriological Loadings to Maquoit Bay, Brunswick, and Freeport, Maine. Final Report*. Casco Bay Estuary Project, Portland, ME.
- USEPA. 2001. *WinHSPF Version 2.0, User's Manual*. Aqua Terra Consultants under contract number 68-C-98-010 to U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Standards and Health Protection Division, Health Protection and Modeling Branch, Washington, DC.
- USEPA. 2001. *Better Assessment Science Integrating point and Nonpoint Sources, BASINS Version 3.0 User's Manual*. EPA-823-B-01-001. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Standards and Health Protection Division, Health Protection and Modeling Branch, Washington, DC.