BEAM Version: BEAM*2022
User Guide Version: v2 September 20, 2022

Contents

1. Introduction

BEAM*2022 is a spreadsheet modeling tool that calculates net GHG emissions from various biosolids management processes and allows comparisons for planning purposes. BEAM *2022 is an updated version of BEAM, which was originally developed by the Canadian Council of Ministers of the Environment based on work by SYLVIS Environmental. The original BEAM has been used for the past decade by many municipal water resource recovery facilities (WRRFs) as part of their greenhouse gas (GHG) inventories. The ECAM model, created for estimating emissions from municipal water and wastewater services, relied on BEAM for many default values and calculations. In its current form, BEAM*2022 can be used to:

- estimate a program's GHG emissions, including establishing a baseline,
- compare emissions from different biosolids management scenarios,
- estimate the impacts on GHG emissions resulting from changes in biosolids management, and
- understand the factors that have the greatest impact on increasing or reducing GHG emissions.

2 Installation

Installation of the BEAM*2022 is as simple as downloading the spreadsheet model. The model can be downloaded from https://www.BiosolidsGHGs.org. Before downloading, you must agree to the following Terms of Use:

1) The original BEAM v1.1 model remains the property of CCME.

2) As with BEAM v1.1 , the BEAM*2022 is intended to be freely and publicly available for non-proprietary use.

3) By agreement with CCME, NEBRA and Northwest Biosolids have created BEAM*2022, which may be adapted to local needs, as long as BEAM*2022 is cited using the recommended citation below.

4) The authors, producers, and funders – including NEBRA and Northwest Biosolids – are not liable for any losses or harm caused by use of the spreadsheet model and other documents and information provided on the BiosolidsGHGs.org website. Use is at your own risk.

5) The BEAM*2022 model that you download is for your individual or team use and is not to be forwarded in spreadsheet form to anyone outside your team. You may share PDFs and images (screen shots) of your BEAM*2022 work, but not the spreadsheet itself. Anyone interested in obtaining the spreadsheet model should be referred to this website: https://www.BiosolidsGHGs.org.

6) We recommend that, when you use BEAM*2022 for your calculations, you create a copy of the spreadsheet and label it something different. We recommend this file-naming format: [author]-[utility/municipality]-BEAM*2022Calculations-v.[number.number]-[dateMONTHyear].xlsx. Keep a copy of your original unaltered download, so you have it for future use or as a backup. You will not be able to return to the website for another download without going through payment again.

Recommended citation:

North East Biosolids and Residuals Association (NEBRA), Northern Tilth LLC, and Northwest Biosolids, 2022. Estimating greenhouse gas emissions from biosolids management. BEAM*2022

spreadsheet model and supporting information, https://www.BiosolidsGHGs.org. Accessed 8/1/2022.

3. Changes to the Structure of the Original BEAM

Since the original BEAM v1.1 was created in 2011, the spreadsheet has undergone several updates. Several organizations that sponsored updates have donated their work, allowing substantial improvements incorporated by Northern Tilth LLC into BEAM*2022. Some of these improvements are:

- ability to accommodate up to 10 biosolids management scenarios at one time
- additional worksheets:
  - second copies of the Anaerobic Digestion, Composting, and Land Application worksheets to allow multiple processes within the same scenario
  - four Landfill Disposal pages, each reflecting one of the WARM gas capture scenarios
  - addition of worksheets for Pyrolysis and Biodrying as optional unit processes
  - an Amount and Destination worksheet to streamline data entry
  - an Analysis worksheet to tailor results to custom analytical data
  - Digestion-Process and Scenarios Data worksheets for further custom data entry
- a remake of the Transportation page that only shows outputs

The most recent update occurred in the Spring of 2022. Northwest Biosolids initiated a formal update effort, bringing together stakeholders and funding. NEBRA convened a Science Review Team (SRT) to conduct a formal review of literature and real-world data to recommend updates to key default values and assumptions embedded in the spreadsheet calculator model. Using those recommendations, Northern Tilth LLC completed the most recent overhaul of BEAM, resulting in BEAM*2022.

4. Overview

The following tabs/worksheets are found within the spreadsheet:

- Instructions
- WRRF Info & Results
- Scenarios Data
- Amount and Destination
- Digestion-Process
- Analyses
- Storage
- Conditioning Thickening
- Aerobic Digestion
- Anaerobic Digestion
- Anaerobic Digestion (2)
- De-watering
- Thermal Drying
- BioDrying
- Alkaline Stabilization
- Composting
- Composting (2)
- Landfill Disposal Typical
- Landfill Disposal Worst-case
- Landfill Disposal Aggressive
- Landfill Disposal CA Regulatory
- Combustion
- Pyrolysis
- Land Application
- Land Application (2)
- Miscellaneous Emissions
- Transportation
- References & Assumptions

The worksheets from Storage through Miscellaneous Emissions allow the user to input specific data for each Scenario to estimate the total GHG emission debits and credits from each process. Other worksheets, such as WRRF Info & Results, Amount and Destination, Scenarios Data, and Transportation are summary sheets requiring other inputs that organize and display data about all of the 10 Scenarios. The remaining sheets, Analyses, Digestion-Process, and References & Assumptions, include input data that feed into other calculations.

5. Inputting Data to BEAM*2022

The model is color-coded to facilitate proper and complete data entry. A color-coded key is located on all user-input sheets.

Key	
Input	0
Default from reference values	0
Data used to calculate default (for information only)	0
Process output	**0**
Input with possible cell reference	0
Calculated result	0

Understanding the Color-coding:

- Olive green input cells are for entry of known data. These are the cells the user will use mostly. Data should be entered in the correct unit. Common unit conversion factors are included on the References & Assumptions worksheet.
- If specific data are unknown, the default in the adjacent blue cell can be entered into the olive green cell instead. *Note that using real-world, local data will typically result in a more accurate estimation of emissions. Those scenario-specific data should be sought out before resorting to defaults.*
- Pink cells show values that are calculated based on inputs, which feed into blue cells. They contain information which may be useful or interesting to the user. However, these data are generally not used as inputs.
- Gray cells hold GHG emission results from different steps of the process, as well as summed totals.
- Orange cells are input cells as well, but they may be filled in with a formula that draws from another cell (i.e. the quantity of sludge going to composting may draw directly from the Amounts and Destinations sheet). Orange cells containing formulas may be overwritten by the user if better data are available.
- There are white cells throughout all of the worksheets. These cells are either text or are results from calculations based on input cells and are locked.

6. Basic Steps to Running the BEAM*2022

Detailed descriptions of each tab/worksheet in the Excel spreadsheet are provided in Appendix A, but these six steps outline the overall strategy. Pay careful attention to the units requested for each data entry. Tons of biosolids, etc. are to be entered as *short (U. S.)* tons, unless indicated otherwise.

1. On the "WRRF Info & Results" sheet, fill in the olive green input cells with overall project information.
2. On the "Scenarios Data" sheet, fill in the olive green input cells for as many scenarios as you want to test, and select which unit processes to include for each scenario by inserting an "x" in the appropriate cell.
3. On the "Amount and Destination" sheet, fill in the olive green input cells with information about specific scenarios.
4. On the "Analyses" sheet, fill in as much real-world data from your project as possible in the olive green input cells. Although default values are provided in the cells, overwriting the default values with measured data from your facility will produce results better tailored to your operation.
5. Fill in the olive green input cells on each unit process sheet for which you filled out an "x" in the Scenarios Data worksheet.
6. Evaluate your results on the "WRRF Info & Results" worksheet.

7. References & Assumptions

The last worksheet holds input data used in calculations throughout the workbook, as well as numbers used in conversions and calculations and words used in formulas and drop-down menus. Refer to this page to understand calculations and to learn more about the source of default values and assumptions. Many of the values come from named cells, which can be viewed through the Name Manager on the Formulas tab in the far left end of the Excel ribbon bar that appears just above the spreadsheet cells.

Most of the cells on the "References & Assumptions" sheet are locked, to prevent accidental changes. However, there are a few unlocked cells (colored olive green), which allow the user to define certain variables. Perhaps most important among these user-defined options are the cells for Global Warming Potential (GWP) of methane and nitrous oxide (cells E285:F286). These have been left unlocked to allow the use to tailor the model to any given greenhouse gas accounting protocol. The default values of the updated BEAM*2022 follow the IPCC's 4th Assessment Report (AR4), which is the same as what U. S. EPA uses, including in the EPA WARM model.

Global Warming Potentials (GWP) used in model		
	GWP Time Horizon (years)	
	20	100
	GWP (IPCC AR4)	
CH_4	72	25
N_2O	289	298

Additional color key for 'Reference' worksheet cells

Cell Color Key for References Worksheet	
number used in original BEAM calculations	
Input Cell	
Calculated Result	
Constant	

8. Interpreting Results

Model results are found on two worksheets: "WRRF Info & Results" and "Scenarios Data."

'WRRF Info & Results' worksheet

Greenhouse gas (GHG) emissions results for each scenario are summarized on the 'WRRF Info & Results' worksheet in units of CO_2 equivalents (CO_2eq). Results on this worksheet are provided by unit process and in total CO_2eq metric tonnes per year (Mg/yr). The results by scenario are also provided in CO_2eq per dry Mg of biosolids input, which aids in normalizing the data if the tonnage changes between scenarios. Finally, GHG emissions are broken down separately into CO_2, CH_4, N_2O, and biogenic CO_2 to help with reporting requirements.

'Scenarios Data' worksheet

The 'Scenarios Data' worksheet provides a slightly more detailed summary of the GHG emissions results, including providing the CO_2eq/dry Mg and the breakdown of GHG emissions by gas type on a unit process basis. Additionally, GHG emissions results on this worksheet are separated out by unit process and scope. Simple definitions for each scope are below:

- *Scope 1* describes direct emissions from owned and/or controlled facilities or operations.
- *Scope 2* describes indirect emissions from purchased electricity, heat, or steam.
- *Scope 3* describes indirect emissions from production of purchased (supply chain) goods and services and transportation of those items and downstream outputs.

9. Recommended Citation

North East Biosolids and Residuals Association (NEBRA), Northern Tilth LLC, and Northwest Biosolids, 2022. Estimating greenhouse gas emissions from biosolids management. BEAM*2022 spreadsheet model and supporting information, https://www.BiosolidsGHGs.org. Accessed_____ [insert date].

10. Additional Assistance & Contact

If you need additional assistance with using BEAM*2022, please see the webpage https://www.BiosolidsGHGs.org/beamexpert-community. There you will find a listing of experienced BEAM*2022 users who offer assistance. For other questions, email info@nebiosolids.org.

Appendix A: Sheet-by-Sheet Instructions for BEAM*2022

Best practice is to save a copy of the original, unaltered spreadsheet to serve as a template for all future projects. When beginning a new project, open and save a new copy of the template with a project-specific name. It may also be prudent to save a new copy any time major changes are made to a project's BEAM*2022 spreadsheet. All cells other than input cells are password protected to prevent accidentally changing formulas.
The following instructions are organized by worksheet, **listed in the order in which data should be added.**

Step 1: Instructions

Review the instructions prior to beginning work on the model.

Step 2: WRRF Info & Results

Fill in the olive green input cells with the project's basic information. Once all other worksheets are filled out, this worksheet displays emissions for each of 10 possible Scenarios in the gray output cells. The "Processor" refers to the entity managing the material that is being modeled. Emissions generated by each unit process are displayed in CO_2 equivalents per dry metric ton of material. Total emissions per scenario are also shown, broken down into CO_2, CH_4, N_20, and biogenic CO_2.

Input data for WRRF Info & Results sheet:

Site-Specific Data	Data Entry Notes
Annual Production of de-watered biosolids (wet tons)	*Entered for information purposes only; not used in model calculations*
Location (from e-Grid)	*Choose from drop-down list of e-Grid regions*
GWP time horizon (years)	*Choose from drop-down list: 20-year or 100-year time horizon for Global Warming Potentials. BEAM*2022 default CO_2-eq for CH_4 & N_2O follow the IPCC's 4th Assessment Report. Users have option to overwrite the CO_2-eq values in the References & Assumptions worksheet if needed; see notes under Section 7: References & Assumptions of this User Guide.*

Step 3: Scenarios Data

This worksheet is where Scenarios are given titles and descriptions. Scenario 1 appears at the top, followed by Scenario 2 below it, and so on; data for up to 10 different scenarios can be entered on this sheet.

In Column B, an 'x' is entered for each unit process that will be included for an individual Scenario. Unit processes with an 'x' are the only processes that will be summed and displayed in the final results on the 'WRRF Info & Results' worksheet. Each unit process matches up with a worksheet in the spreadsheet.

This worksheet is also used to display additional emissions data by scope for each unit process. Refer to it after all data is input in all applicable worksheets. Other useful data such as CO_2 equivalents per dry metric ton of material for each unit process allow the user to compare the emissions contributions of each process, such as the emissions per metric ton for landfilling vs. land application.

Input data for Scenarios Data sheet:

For each Scenario:	Data Entry Notes
Scenario Title	*Make up a short name for scenario*
Scenario Description	*Longer description of the scenario*
Select the unit processes to be included	*Enter an X in Column B for each unit process to be modeled for each scenario*

Step 4: Amount and Destination

On this worksheet, scenarios to be modeled (as entered in the previous step) will display with titles and descriptions at the top of the table for each scenario.
Fill in all olive green input cells for all scenarios to be modeled. After your inputs are complete, the table will automatically sum the amount of material to each process, and this information feeds into the 'Transportation' worksheet which calculates emissions produced during transportation.
For each location of end use, a management main category and management subcategory must be selected. Main category management options include: Landfill, Combustion, Composting, and Land Application. The management subcategory options change based on the main category management option selected, and are summarized in the table below:

Management Main Category Selection	Process or System Type	Management Sub-Category Selection Options
Landfill	Landfill Gas Capture Scenario	Typical
		Worst-case
		Aggressive
		CA Regulatory
Combustion	Combustion Process	Multiple Hearth Furnace
		Fluidized Bed
		Gasification*
		Pyrolysis-C
Composting	Compost System	Windrow
		ASP
		In-vessel
Land Application	Processing prior to land application	Thermal Drying
		Alk Stab
		Other**

**Parameters for gasification have not been developed for the BEAM*2022 at this time. DO NOT SELECT*

***"Other" simply means not alkaline stabilized or thermally dried (e.g. Class B anaerobically digested)*

Input data for Amount and Destination sheet:

For each Final Destination of Biosolids:	Data Entry Notes
Location of End Use	*Name of destination (e.g. name of farm or landfill)*
Management – Main Category	*Select from drop-down list (options listed in table above)*
Management – Subcategory	*Select from drop-down list (options listed in table above)*
Comments	*Other brief info*
Town	*Destination town*
State	*2-letter state abbreviation*
Annual wet tons to destination	*Can be entered for up to 6 different facilities that are the starting points of transport (e.g. de-watering facilities), as long as they are all going to the same destination. You have the option of replacing the numbers 1-6 in Row 3 with starting point facility names. Enter in wet short (U. S.) tons. This will be the amount delivered to compost, landfill, land application, combustion and/or pyrolysis, etc. For materials going to pyrolysis or combustion, the amounts coming out of those processes will be significantly reduced compared to the amounts delivered to these processes. These reductions in mass will need to be accounted for by the user in the transportation unit process*
One way or round trip?	*Choose from drop-down; one-way indicates vehicle is returning empty; round-trip indicates vehicle is back-hauling.*
Miles	*Enter one-way distance in miles (if round trip was chosen above, the one-way distance will automatically be doubled)*
Truck or Rail?	*Choose transport vehicle type from drop-down list*
Biodiesel as % fuel	*Enter % biodiesel in fuel mixture. A credit will then be factored into transportation emissions.*

Step 5: Analyses

This worksheet holds lab analyses of materials used in the model; data stored here are used in calculations throughout the spreadsheet. Units are important – the model only works if analysis data matches the units shown in the column heading for each test parameter. (Conversions can be found at row ~244 in the "References & Assumptions" worksheet.) Fill in the olive green input cells with actual data from your facility. If possible, use average values calculated from regular analyses gathered over time (for example, one or two years' worth of monthly data, averaged).

Input data for Analyses sheet:

For De-watered Biomass and/or Biochar	Data Entry Notes
WRRF	*Name of facility (or "mean" if using an average of several WRRFs' data))*
Date	*For information purposes only; not used in calculations*
Sample ID	*Name of sample. For information purposes only; not used in calculations*
Wet Density (g/ml)	*Enter from lab analysis (or average of analyses) of dewatered biomass and/or biochar*
% Solids	*Enter from lab analysis (or average of analyses) of dewatered biomass and/or biochar*
% Organic Matter	*Enter from lab analysis (or average of analyses) of dewatered biomass and/or biochar*
Organic C (%)	*Enter from lab analysis (or average of analyses) of dewatered biomass and/or biochar*
Total N (%)	*Enter from lab analysis (or average of analyses) of dewatered biomass and/or biochar*
Total P (%)	*Enter from lab analysis (or average of analyses) of dewatered biomass and/or biochar*
Percent solids after thermal drying	*Enter if thermal drying is a unit process being modeled*
Percent solids after biodrying	*Enter if biodrying is a unit process being modeled*
Percent solids after combustion	*Enter if combustion is a unit process being modeled*
Percent solids after pyrolysis	*Applies to biochar only*

Step 6: Digestion-Process

This worksheet contains process data related to digestion and dewatering; data stored here are used in calculations throughout the spreadsheet. Units are important – the model only works if digestion process data matches the units shown in the column heading for each test parameter. (Conversions can be found at row ~244 in the "References & Assumptions" worksheet.) Fill in the olive green input cells with actual data from your facility. If possible, use average values calculated from regular analyses gathered over time. Data in cells on this page are not necessary for further calculations in the model, but when these processes are used, data from this page can be used in the relevant unit processes.

Input data for Digestion-Process sheet:

For Conditioning/Thickening (if applicable)	**Data Entry Notes**
Amount of solids to be thickened (m^3/day)	*Enter volume of material being conditioned/thickened*
Solids content of biomass (e.g. sludge/solids) prior to thickening (%)	*Enter solids content prior to conditioning/thickening*
Solids content of biomass after thickening (%)	*Enter solids content after conditioning/thickening*
Aerobic Digestion (if applicable)	**Data Entry Notes**
Amount of solids to be digested (m^3/day)	*Automatically input from Conditioning/Thickening data, but can be overwritten if better number is available.*
Average retention time (SRT) in digesters (days)	*Enter average solids retention time during digestion*
Solids content of biomass fed to digesters (%)	*Automatically input from Conditioning/Thickening data, but can be overwritten if better number is available.*
Volatile solids content of biomass prior to digestion (%-dry wt)	*Enter volatile solids content prior to digestion on a dry weight basis*
% Volatile solids reduction during digestion	*Enter the % of initial volatile solids destroyed during digestion*
Solids content of biomass out of digesters (%)	*Enter volatile solids content after digestion on a dry weight basis*
Volume Reduction During Aerobic Digestion	*If there is any evidence of volume reduction during digestion, enter that here, otherwise leave at 0%*
Anaerobic Digestion (if applicable)	**Data Entry Notes**
Amount of solids to be digested (m^3/day)	*Automatically input from Conditioning/Thickening data, but can be overwritten if better number is available.*
Average retention time (SRT) in digesters	*Enter average solids retention time during digestion*

Solids content of solids fed to digesters (%)	*Automatically input from Conditioning/Thickening data, but can be overwritten if better number is available.*
Volatile solids content of solids prior to digestion (%-dry wt)	*Enter volatile solids content prior to digestion on a dry weight basis*
Volatile solids reduction (VSR) - during digestion (%-dry wt)	*Enter the % of initial volatile solids destroyed during digestion*
Solids content of solids out of digesters (%)	*Enter volatile solids content after digestion on a dry weight basis*
Volume Reduction During Anaerobic Digestion	*If there is any evidence of volume reduction during digestion, enter that here, otherwise leave at 0%*
Dewatering	**Data Entry Notes**
Amount of solids to be dewatered (m^3/day)	*Automatically input from Anaerobic Digestion data, but can be overwritten if not digested, for example, it could be the amount of solids coming out of conditioning/thickening.*
Solids content of solids prior to dewatering (%)	*Enter solids content after dewatering*
Solids content of solids after dewatering (%)	*Automatically input from Analyses sheet, but can be overwritten if better number is available.*

Step 7: Unit Processes ('Storage' through 'Miscellaneous Emissions')

Each unit process has been given its own worksheet within the spreadsheet. Some unit processes have two worksheets to allow for multiple phases of the same process. The following pages provide detailed lists of all of the data inputs required for each unit process. For each of the unit processes that are included in the scenario(s) to be modeled, fill in data according to the color-coded key.

Key	
Input	0
Default from reference values	0
Data used to calculate default (for info only)	0
Process output	**0**
Input with possible cell reference	0
Calculated result	0

On each unit process sheet, leave blank any scenario(s) that does not include that unit process. For example, if "Scenario 2" in your project does not include anaerobic digestion, make sure that the input cells on the anaerobic digestion sheet are left blank in the "Scenario 2" column.

Fill each Scenario out completely and make sure to convert inputs to the correct unit. If an input is not known, use the default value instead. It is important to note that many of the "default" values are more accurately described as "dynamic defaults," in that they are calculated using a combination of both "book values" and user inputs added to the BEAM*2022. Despite this attempt to make the default values as tailored as possible, ***using actual data from the WRRF for which the model is being run will usually increase the precision of the model results.*** The Data Entry Notes in the tables below will indicate when a default value is informed by user inputs.

7.a Storage

Estimates emissions attributed to the storage of wastewater solids (such as lagoons or tanks) prior to undergoing one of the other processes.

Input data for Storage sheet:

Storage Input	**Data Entry Notes**
Volume of biomass (e.g. sludge/solids) to unit process (m^3/day)	*Enter the volume of biomass directed to storage*
MGD (million gallons/day) treated	*Enter the volume per day of wastewater influent that is represented by the volume of biomass directed to storage. For example, if 50% of the sludge generated at a 40 MGD plant ends up going to a storage lagoon, enter 20 MGD.*
MLD (million liters/day) treated	*Automatically calculated based on input above*
BOD in influent (mg/L)	*Enter the biochemical oxygen demand of the influent to the WRRF*
Mass of BOD to storage (kg/day)	*Enter the mass of BOD to storage. The adjacent blue cell has a default value that can be used as a default; it is calculated based on BOD in influent, volume to storage, and typical BOD removal.*
Process Options	**Data Entry Notes**
Is the storage lagoon or tank aerated with aerators?	*Yes/No drop-down. Default option displayed in blue cell next to input cell.*
Is the depth of the lagoon **less than** 2 meters (on average)?	*Yes/No drop-down. Default option displayed in blue cell next to input cell.*
Electricity Use	**Data Entry Notes**
Electricity use (kWh / day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

7.b Conditioning/Thickening

This worksheet estimates emissions attributed to the use of polymers for conditioning/thickening of wastewater solids. Enter data for wastewater solids thickening, and conditioning for thickening (using polymers; ignore other conditioners such as ferric chloride or alum). Do not use this page for dewatering (see separate Dewatering worksheet).

Input data for Conditioning/Thickening sheet:

Conditioning/Thickening Input	**Data Entry Notes**
Amount of sludge to be thickened (m^3/day)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
Solids content of sludge (%)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available. Default option displayed in blue cell next to input cell.*
Type of thickener	*Drop-down choices of either "centrifuge" or "other". Default option displayed in blue cell next to input cell.*
Polymer use (kg/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Electricity Use	**Data Entry Notes**
Electricity Use (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

7.c Aerobic Digestion

This worksheet estimates emissions associated with the aerobic digestion of biosolids. Enter combined data from all aerobic digesters. If the digesters are heated (not common), enter the amount of natural gas used.

Input data for Aerobic Digestion sheet:

Digester Input	**Data Entry Notes**
Sludge quantity fed to digesters (m^3/day)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
Average retention time (SRT) in digesters	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available. Default option displayed in blue cell next to input cell.*
Solids content fed to digesters (%)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
VS prior to digestion (% - dry wt.)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
Digester Output	**Data Entry Notes**
Sludge quantity (m^3/day)	*Automatically calculated from Digestion-Process sheet, but can be overwritten if better number is available. Default option displayed in blue cell next to input cell.*
% VS destruction	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
Energy Balance	**Data Entry Notes**
Heating requirements of the digesters, if any (m^3-natural gas/day)	*Enter the amount of natural gas used to heat the digesters*
Electricity requirements of the digesters (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

7.d Anaerobic Digestion

This worksheet estimates emissions associated with the anaerobic digestion of biosolids. Data for digester input, output, electricity consumption, and biogas/electricity production are needed. Note: There are **two** Anaerobic Digestion sheets; the second anaerobic digestion worksheet is the same as the first, but allows for a separate, second anaerobic digestion process to be considered within the same Scenario. In other words, each of the 10 possible scenarios can have 2 separate anaerobic digestion options.

Input data for Anaerobic Digestion sheet:

Digester Input	**Data Entry Notes**
Biomass (e.g. sludge/solids) to digesters (m^3/day-wet)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
Biomass to digesters (Mg/day-wet)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.* ***NOTE: the automatic input is based on the assumption that the solids have the same bulk density as water (1.00 g/ml).***
Biomass to digesters (Mg/day-dry)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
VS prior to digestion (% - dry wt.)	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
VS (Mg/day) - dry wt.	*Automatically input from Digestion-Process sheet, but can be overwritten if better number is available.*
Solids retention time (SRT) (days)	*Automatically calculated Digestion-Process sheet, but can be overwritten if better number is available. Default option displayed in blue cell next to input cell.*
Digester Output	**Data Entry Notes**
Biomass quantity (m^3/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs. If volume reduction on Digestion-Process sheet is kept at 0%, this will be the same as the volume of digester input*
% VS destruction	*Automatically calculated Digestion-Process sheet, but can be overwritten if better number is available.*
Energy Balance	**Data Entry Notes**
Biogas Yield (m^3/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Methane Yield (m^3/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Combined Heat and Power (CHP) Engines used	*Yes/No drop-down*

Biogas combusted for energy recovery (boilers, CHP, etc.); do not include RNG to pipeline (that is covered below) (%)	*Enter % of total biogas combusted in any process other than a flare or via RNG to pipeline.*
Efficiency of combustion for energy recovery relative to methane emissions	*Choose from drop-down list: Normal, Inefficient, or User-defined. If user-defined is selected, input the data on the References & Assumptions worksheet in the Anaerobic Digestion section (row~70).*
% Combusted biogas generating heat (%)	*Default option displayed in blue cell next to input cell. This default option is 0% unless CHP engines are used, in which case a default value is calculated based on the percentage of biogas directed to the CHP engines.*
% Combusted biogas generating electricity generated at 100% efficiency (%)	*Default option displayed in blue cell next to input cell. This default option is 0% unless CHP engines are used, in which case a default value is calculated based on the percentage of biogas directed to the CHP engines.*
Renewable natural gas (RNG) to pipeline	*Yes/No drop-down.*
Renewable natural gas (RNG) to pipeline (% of biogas generated)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Type of flare	*Choose from drop-down list: Default, Enclosed, Candlestick, User-defined.*
% Biogas Flared	*Enter the % of biogas generated that is flared*
Total percent of biogas combusted (%)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs. Note: If the value in the blue cell is greater than 100%, check row 24 and 32; the sum of these two should not be greater than 100%.*
% Un-combusted Biogas Fugitive Emissions	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs. The sum of this value and rows 24 and 32 should equal 100%. NOTE: Scientific Review Team recommends using 1% of methane in biogas as being fugitive, uncombusted emissions*
Natural gas equivalent generated (m^3/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Electricity generated (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

Heating requirements of the digesters (m^3-natural gas/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Electricity requirements of the digesters (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Net natural Gas used (m^3/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Net electricity used (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

7.e De-watering

This worksheet estimates combined emissions from all dewatering units used to dewater biosolids. If a passive drying system with no polymers is used (e.g. drying beds), either estimate the energy use (in kWh equivalents/day) or assume zero emissions.

Input data for De-watering sheet:

De-watering Input	**Data Entry Notes**
Amount of biomass to be de-watered (m^3/day)	*Automatically calculated from Anaerobic Digestion sheet, but can be overwritten if better number is available, or if the material is not coming out of digestion (e.g. from conditioning/thickening without going through a digestion step.*
Solids content of biomass prior to de-watering (%)	*Automatically calculated from Digestion Process sheet, but can be overwritten if better number is available. Default option displayed in blue cell next to input cell.*
Type of de-watering equipment	*Drop-down choices of either "centrifuge" or "other". Default option displayed in blue cell next to input cell.*
Polymer use (kg/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Electricity Use	**Data Entry Notes**
Energy use (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

7.f Thermal Drying

This worksheet estimates emissions generated by thermal drying of biosolids. Enter data for thermal drying processes (e.g. rotary drum dryers), whether indirectly or directly heated. Enter actual natural gas and electricity use per day, if available. In the Fuel Use and Electricity Use sections, enter natural gas use and electricity requirements in rows 15 and 19, respectively. The model is currently set up to use default values for these parameters, but actual natural gas and electricity usage are better to use if available.

Input data for Thermal Drying sheet:

Thermal Drying Input	**Data Entry Notes**
Quantity of biomass (e.g. solids/sludge) (Mg/day-wet)	*Automatically calculated from Amount & Destination sheet, but can be overwritten if better number is available.*
Solids content going in to dryer (%)	*Automatically calculated from Analyses sheet, but can be overwritten if better number is available.*
Solids content coming out of dryer (%)	*Automatically calculated from Analyses sheet, but can be overwritten if better number is available.*
Fuel Use	**Data Entry Notes**
Natural gas use (m^3/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Electricity Use	**Data Entry Notes**
Electricity requirements of dryer (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

7.g BioDrying

This worksheet estimates emissions generated by pyrolysis of biosolids. Select whether or not the BioDrying is fueled by heat from a pyrolysis unit (row 10). In the Fuel Use section, enter the volume of natural gas used in cubic meters per day. In the Electricity Use section, the values will populate based on information in the BioDrying Input section, but the user can overwrite the formulas in the orange cells if better local data are available.

Note: this unit process is based on BioForceTech's biodrying technology; default values for this technology-specific process have been provided by BioForceTech.

Input data for BioDrying sheet:

BioDrying Input	**Data Entry Notes**
Quantity (Mg/day-wet)	*Automatically calculated from Amount & Destination sheet, but can be overwritten if better number is available.*
Solids content going in to dryer (%)	*Automatically calculated from Analyses sheet, but can be overwritten if better number is available.*
Solids content coming out of dryer (%)	*Automatically calculated from Analyses sheet, but can be overwritten if better number is available.*
Is the BioDrying fueled by heat from pryolysis unit	*Yes/No drop-down*
Fuel Use	**Data Entry Notes**
Natural gas use (m^3/day)	*Enter the amount of natural gas used to run the biodrying process, if applicable*
Electricity Use	**Data Entry Notes**
Electricity requirements of BioDryer for heat (kWh/day)	*Automatically calculated from default data and user inputs, but can be overwritten if better number is available.*
Electricity requirements of BioDryer for ancillary equipment (kWh/day)	*Automatically calculated default data and user inputs, but can be overwritten if better number is available.*

7.h Alkaline Stabilization

This worksheet estimates emissions generated by the use of alkaline materials to stabilize biosolids. Enter data from alkaline stabilization processes, regardless of whether this happens before or after dewatering. Some advanced alkaline stabilization systems may use supplemental heat from natural gas combustion to achieve Class A; if so, enter amount of natural gas used. If electricity is used for supplemental heat for achieving Class A, this is included in the Class A calculation. Default values for the amount of alkaline product used and natural gas and electricity used for the alkaline stabilization process are automatically calculated, but, again, actual data are better, if available.

Input data for Alkaline Stabilization sheet:

Alkaline Stabilization Input	**Data Entry Notes**
Mass of sludge to be stabilized-wet (Mg/day)	*Automatically calculated from Amount & Destination sheet, but can be overwritten if better number is available.*
Solids content of sludge to be stabilized (%)	*Automatically calculated from Analyses sheet, but can be overwritten if better number is available.*
Degree of stabilization	*Choose from drop-down: Class A or Class B.*
Is the lime in biosolids derived from a waste product (e.g. cement kiln dust)?	*Yes/No drop-down. Default option displayed in blue cell next to input cell.*
Amount of alkaline product added (Mg lime or lime equivalent/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Fuel Use	**Data Entry Notes**
Fuel use (kg CO_2-eq/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Electricity Use	**Data Entry Notes**
Electricity requirements of alkaline stabilization (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

7.i Composting

This worksheet estimates the emissions generated by composting biosolids, based on compost system, feedstock characteristics, energy use, and fertilizer off-sets. Default values are available for most of the inputs if the actual values are not known.

*NOTE: The composting unit process **assumes** land application and no data entry is required in the Land Application unit process worksheet.*

Note: There are **two** Composting sheets; the second composting worksheet is the same as the first, but allows for a separate, second compost process to be considered within the same Scenario. In other words, each of the 10 possible scenarios can have 2 separate composting options.

Input data for Composting sheet:

Feedstock Input	Data Entry Notes
Type of composting operation	*Choose from drop-down list: Windrow, ASP, or In-vessel*
Quantity of biomass (e.g. sludge/solids) going to composting (Mg/day-wet)	*Automatically calculated based on type of compost operation and data from Amount & Destination sheet, but can be overwritten if better number is available.*
Solids content (%)	*Automatically calculated from Analyses sheet, but can be overwritten if better number is available.*
Biomass density (kg/m^3)	*Default option displayed in blue cell next to input cell.*
Has the biomass been digested prior to composting?	*Yes/No drop-down. Default option displayed in blue cell next to input cell. This answer informs the default values calculated for total nitrogen, total phosphorus, total volatile solids, and organic carbon below.*
Total nitrogen (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Total phosphorus (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Total volatile solids - TVS (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Organic carbon (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

Volumetric ratio of amendment to biomass (m^3 amendment:m^3 biomass, as is)	*Default option displayed in blue cell next to input cell.*
Amendment grinding on-site?	*Yes/No drop-down. Default option displayed in blue cell next to input cell.*
Density of amendment (kg/m^3)	*Default option displayed in blue cell next to input cell. Default amendment density is the density of sawdust.*
Blended Feedstock Characteristics	**Data Entry Notes**
C:N (ratio)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Solids content (%)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Are active composting piles covered and is the air from them treated through a biofilter?	*Yes/No drop-down. Default option displayed in blue cell next to input cell.*
Fuel Use	**Data Entry Notes**
Total fuel use for composting equipment (L-diesel fuel/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Applying compost to land (L-diesel fuel/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Electricity Use	**Data Entry Notes**
Electricity requirements of composting system (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Carbon Sequestration	**Data Entry Notes**
Carbon sequestered as result of land application (Mg CO_2/dry Mg biosolids)	*Choose from drop-down list: Current Default, Old Default, WARM FW, or User Defined. If user defined is selected, must input the carbon sequestration value (in the correct units) in Cell B150 of the References & Assumptions worksheet. See references pages for origin of default values.*

7.j Landfill Disposal

This worksheet estimates emissions generated by the disposal of biosolids in landfills. There are four 'Landfill Disposal' worksheets, each representing a different biogas (methane) capture scheme, listed here in order from *least efficient* gas capture to *most efficient* gas capture:

a) Worst-case
b) Typical
c) Aggressive
d) California Regulatory

Each worksheet has the same input options, but calculates emissions differently based on the four gas capture scenarios, which are based on the scenarios from the EPA WARM model (https://www.epa.gov/warm). Only fill out the worksheet(s) that apply to the gas capture scheme that best fits conditions at the landfill(s) being modelled in your scenario(s).

Input data for the Landfill Disposal sheets:

Sludge Characteristics Input	Data Entry Notes
Quantity going to landfill (Mg/day-wet)	*Automatically calculated from Amount & Destination sheet, but can be overwritten if better number is available.*
Solids content (%)	*Automatically calculated from Analyses sheet, but can be overwritten if better number is available.*
Has the sludge/solids been digested prior to disposal?	*Yes/No drop-down. Default option displayed in blue cell next to input cell. This answer informs the default values calculated for total nitrogen, total volatile solids, and organic carbon below.*
Total nitrogen (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Total volatile solids (TVS) of solids going to landfill (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Organic carbon in solids going to landfill (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Methane correction factor for landfill (DOC_f that will decompose in landfill)	*Default option displayed in blue cell next to input cell.*
Quality of soil cover at landfill (high = good organic matter content, supports vegetation well)	*Default option displayed in blue cell next to input cell.*
Percent of captured methane used to generate electricity	*Default option displayed in blue cell next to input cell.*

Level of Digestion/Processing	*Choose from drop-down options: Complete digestion, Partial digestion, Undigested/Raw, or user defined. If user defined is selected, must input a percentage to indicate the fraction of degradable organic carbon that is available to further decompose within a landfill (DOC_f) in Cell B168 of the References & Assumptions worksheet (45% is the current default in that cell).*
Landfill climate zone (see Reference sheet cells A141 - A 147 for climate criteria)	*Choose from drop-down options: cool dry, cool wet, warm dry, warm wet, user defined. "Cool" is defined as mean annual temperature (MAT) less than 20°C; "warm" is therefore MAT > 20°C. "Dry" is defined as mean annual precipitation (MAP) less than 1 meter; "wet" is therefore MAP > 1 meter. If user defined is selected, must input a K-decay rate constant for DOC in biosolids in Cell B175 of the References & Assumptions worksheet (0.6 is the current default in that cell).*

7.k Combustion

This worksheet estimates emissions from the incineration of biosolids. Default values are available for many of these inputs.

Input data for Combustion sheet:

Solids Input (to incinerator)	Data Entry Notes
Quantity of solids/sludge going into incinerator(s) (Mg/day-wet)	*Automatically calculated based on type of incinerator and data from Amount & Destination sheet, but can be overwritten if better number is available.*
Solids content of solids/sludge going into incinerators (%)	*Automatically calculated from Analyses sheet, but can be overwritten if better number is available.*
Is solids/sludge digested prior to incineration?	*Yes/No drop-down. Default option displayed in blue cell next to input cell. This answer informs the default values calculated for total nitrogen, total phosphorus, and total volatile solids below.*
Total nitrogen (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Total phosphorus (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Total volatile solids (TVS) (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Type of incinerator	*Choose from drop-down list: Multiple Hearth Furnace, Fluidized Bed,Gasification. Default option displayed in blue cell next to input cell. Note: The gasification option is not available in BEAM*2022.*
Recovered energy to electricity (%)	*Enter the percentage of energy given off by oxidation of biomass (solids/sludge) that is captured and converted to electricity*
Recovered energy as heat (%)	*Enter the percentage of energy given off by oxidation of biomass that is captured and converted to heat that is used in a process*
Disposition of ash - Is it used to replace phosphorus fertilizer or in cement or brick?	*Choose from drop-down list: P fertilizer, Cement, None. Default option displayed in blue cell next to input cell. Select "Cement" if ash is recycled to either cement or brick.*
Is a urea-based selective noncatalytic reduction emissions system being used?	*Default option displayed in blue cell next to input cell.*
Average high temperature in the combustion zone and freeboard area (°C)	*Default option displayed in blue cell next to input cell.*
Fuel Use	**Data Entry Notes**
Net natural gas used (m^3/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Electricity Use	**Data Entry Notes**

Net Electricity used (kWh/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Nitrous Oxide Emissions	**Data Entry Notes**
N_2O emitted during incineration (Mg/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

7.1 Pyrolysis

This worksheet estimates emissions from pyrolysis of biosolids. The type of pyrolysis unit selected in row 14 influences the percent mass loss. The percent mass loss associated with each of the four pyrolysis unit types, shown in the table below, can also be viewed on the 'References Assumptions' sheet in cells A215:B218.

BFT	50%
User-defined 1	45%
User-defined 2	55%
User-defined 3	65%

Note: The "BFT" mass loss default was provided by BioForceTech and, is, consequently, potentially unique to BioForceTech's pyrolysis technology.

Input data for Pyrolysis sheet:

Solids Input (to pyrolysis unit)	**Data Entry Notes**
Is the material coming from a biodryer?	*Yes/No drop-down*
Quantity of solids/sludge going to pyrolysis (Mg/day-wet)	*Automatically calculated based on data from Amount & Destination sheet, but can be overwritten if better number is available.*
Solids content of solids/sludge going to pyrolysis (%)	*Automatically calculated ONLY if material is coming from a biodryer. If not coming from a biodryer, must manually input solids content.*
Is material digested prior to pyrolysis?	*Yes/No drop-down. Default option displayed in blue cell next to input cell. This answer informs the default values calculated for total nitrogen, total phosphorus, and total volatile solids below.*
Total nitrogen (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Total phosphorus (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Total volatile solids (TVS) (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Type of pyrolysis unit (mass reduction as a %)	*Choose from drop-down list: BFT, User-defined 1, User-defined 2,User-defined 3. If a user-defined option is selected, must input mass reduction as a percentage in either Cell B216, B217 or B218 on the References & Assumptions sheet.*
Mass loss during pyrolysis (%-dry weight)	*Automatically calculated based on user input above.*
Solids content after pyrolysis (%)	*Automatically calculated.*
Fuel Use	**Data Entry Notes**

Natural gas used (m^3/day)	*Amount of natural gas used, if any, for drying biomass prior to pyrolysis*_____
Electricity Use	**Data Entry Notes**
Electricity generated during pyrolysis used for ancillary equipment (kWh/day)	*Amount of electricity generated if excess energy from the pyrolysis process is used to generated electricity*

7.m Land Application

This worksheet estimates emissions from the land application of biosolids.

NOTE: If biosolids were composted, the composting unit process accounts for land application and no data entry is required in the Land Application unit process worksheet.

The quantity (row 7) is already set to draw from the total amount to land application, according to prior processing and from data entered in the Amounts and Destinations page. Next, enter the density of the biosolids and select the type to be land-applied. Enter the $CaCO_3$ equivalence and average number of days the biosolids are stored prior to land application. Select the climate at the application sites, whether the lime in the biosolids is derived from a waste product, and whether the lime in the biosolids is replacing purchased lime where it is applied. In the Soil Texture section, enter the percent of the land application area with fine-textured soil. In the Fuel Use section, enter the fuel use per day from land application.
Note: There are **two** Land Application sheets; if there is a second land application management scheme for a given Scenario that is different than the first, also fill out the 'Land Application (2)' worksheet.

Input data for Land Application sheet:

Biomass characteristics	Data Entry Notes
Processing prior to land application	*Choose from drop-down list: Thermal drying, Alk Stab (Alkaline Stabilization), Other, Pyrolysis-LA (for biochar from pyrolysis that will be land applied).*
Quantity of treated biosolids going to land application (Mg/day-wet)	*Automatically calculated based on data from Amount & Destination sheet, but can be overwritten if better number is available.*
Solids content of treated biosolids going to land application (%)	*Automatically calculated based on previous user input, but can be overwritten if better number is available.*
Density of treated biosolids (kg/m^3)	*Default option displayed in blue cell next to input cell.*
Type of biosolids to be land applied	*Choose from drop-down list: unprocessed, digested, limed, or pyrolyzed. This answer informs the default values calculated for total nitrogen, total phosphorus, total volatile solids, organic carbon, and calcium carbonate equivalence below.* ***NOTE: If biosolids were composted, the composting unit process accounts for land application and no data entry is required on the land application unit process.***
Total nitrogen (%-dry weight)	*Automatically calculated from Digestion-Process sheet, but can be overwritten if better number is available. An additional, default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*

Total phosphorus (%-dry weight)	*Automatically calculated from Digestion-Process sheet, but can be overwritten if better number is available. An additional, default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Total volatile solids (TVS) (%-dry weight)	*Automatically calculated from Digestion-Process sheet, but can be overwritten if better number is available. An additional, default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Organic carbon (%-dry weight)	*Automatically calculated from Digestion-Process sheet, but can be overwritten if better number is available. An additional, default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
$CaCO_3$ equivalence (%-dry weight)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Average number of days biosolids are stored prior to land application	*Enter the average number of days that the biosolids are stockpiled out of doors prior to being land applied*
Climate at land application sites	*Choose from drop-down list: humid or arid.*
Is lime in biosolids derived from a waste product? (e.g. cement kiln dust)	*Yes/No drop-down. Default option displayed in blue cell next to input cell.*
Will the lime in biosolids replace purchased lime where it is applied?	*Yes/No drop-down. Default option displayed in blue cell next to input cell.*
Soil Texture at land application sites (total)	**Data Entry Notes**
Fine-textured (% of land application area)	*Enter % of area of fine-textured soil at land application site. Default option displayed in blue cell next to input cell.*
Fuel Use	**Data Entry Notes**
Applying biomass to land (L-diesel fuel/day)	*Default option displayed in blue cell next to input cell. Calculation of default value informed by previous user inputs.*
Carbon Sequestration	**Data Entry Notes**
From biosolids applied to soil (Mg CO_2/day)	*Choose from drop-down list: Current Default, Old Default, WARM FW, or User Defined. If user defined is selected, must input the carbon sequestration value (in the correct units) in Cell B150 of the References & Assumptions worksheet. See references pages for origin of default values.*

7.n Miscellaneous Emissions

This worksheet is included as a "catch all" to account for any additional emissions not accounted for on other unit process sheets. Input here any additional use of electricity, diesel, propane, or natural gas which is not accounted for elsewhere in the spreadsheet.

Step 8: Transportation

This worksheet displays data; there are no input cells. It is fed from data on the 'Amounts and Destinations' worksheet, which should be filled out completely for each destination. This worksheet calculates emissions due to transportation. For greatest precision and if Scope 1 emissions is a focus of modeling, be sure to include all transportation of wastewater solids and biosolids, including within the wastewater treatment plant, to processing and storage facilities, and to final end use and disposal sites. Do not include diesel fuel used for applying biosolids to land or managing it in a landfill (those are accounted for in the Land Application and Landfill Disposal worksheets, respectively). If biodiesel or other non-fossil fuel is used, enter the percentage used in the appropriate row.

Step 9: Inspect Results

At this point, having followed the previous 8 steps, all inputs to the model should be complete.

Model results are found on two worksheets: "WRRF Info & Results" and "Scenarios Data." The former worksheet displays side-by-side results for all scenarios to allow easy comparison between scenarios. The latter worksheet provides detailed results for each scenario, including a breakdown of CO2-eq by scope.