

User manual for the Massachusetts Sustainable-Yield Estimator (MA SYE) tool

by Stacey A. Archfield and Gregory E. Granato

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Flow rate	
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)
cubic foot per second per square mile [(ft ³ /s)/mi ²]	0.01093	cubic meter per second per square kilometer [(m ³ /s)/km ²]

Abbreviations

MassDEP	Massachusetts Department of Environmental Protection
GIS	Geographic-information system
HUC	Hydrologic Unit Code
IHA	Indicators of Hydrologic Alteration
NAHAT	National Hydrologic Assessment Tool
PC	personal computer

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Using the Massachusetts Sustainable-Yield Estimator tool

The MA SYE tool begins with locating a stream and delineating the contributing basin area to the stream location you have selected in your ArcMap document. Once you have delineated a basin for the stream location of interest, a MA SYE spreadsheet template guides you through the remainder of the MA SYE tool and functions. All files related to the basin are stored in a project folder and related subfolders. Note that steps must be performed in the order they are presented or errors will result.

Using the ArcMap .mxd file

The ArcMap .mxd file has the following functionality:

- Delineates a basin and computes the basin characteristics needed to estimate the unregulated, daily streamflow;
- Creates a project directory, project name, and description for your study area;
- Writes files needed to compute the sustainable yield for your basin;
- Generates a shape file of your basin with the option to add the file to the MS SYE ArcMap document; and
- Exports a location map of your basin as an image file (optional).

Delineating a basin and computing basin characteristics

To delineate a basin, first turn the dendrite layer is on. You are able to delineate a basin for any stream location that is part of the dendrite layer (for ArcMap 9.2 users) or the NHDFlowline layer (ArcMap 9.3 users). To delineate a basin, zoom to the stream location to within a scale equal to or less than approximately 1:5,000. On the StreamStats Setup 9 toolbar, choose the point delineation tool (fig. 1). A dialog box will appear. Do not close this dialog box (although you can minimize it, if you would like to keep it out of sight). Place the pointer on the stream location and click. The program will delineate the basin and calculate the basin characteristics. When this process is complete, a scripting box titled “Parameters” will appear. Close this box. You can then continue to delineate basins or go to the next step of creating a project folder for your basin.



Figure 1. The StreamStats Toolbar, which is used to delineate contributing basins to an ungaged location in the Massachusetts Sustainable-Yield Estimator.

Creating a project folder and writing files

To create a project folder and related MA SYE files, select the basin of interest by highlighting it in the GlobalWatershed attribute table or by using the Select tool on the Tools toolbar. You can have only one basin selected at a time. You will receive an error message if no basin is selected or more than one basin is selected. Click “Export files” on the Sustainable-Yield Estimator toolbar (fig. 2).

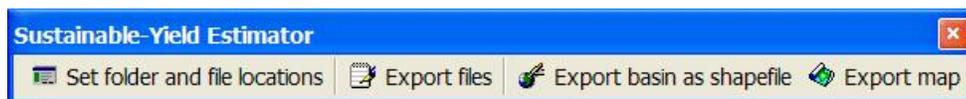


Figure 2. Sustainable-Yield Estimator toolbar, which is used to export the delineated basin and related information from the Massachusetts Sustainable-Yield Estimator tool.

This button will prompt you to choose a location to store the basin files. You will be asked to supply a project name, which should be short and without spaces. A subfolder will be created in the selected location that bears the project name you have specified. This subfolder will be used to store all files related to your basin. You are then asked to enter the location of the file SustainableYieldEstimator_v1.5.xls, the MA SYE spreadsheet template. You will then be prompted to enter a brief description of your project. This can be a sentence or two in length and will appear in the MA SYE spreadsheet template. Once you have finished entering information into the “Export files” dialog boxes, you will receive a message that the basin file has been successfully written to the basin subfolder. The “Export files” button copies the MA SYE spreadsheet template and renames the file as the project name. The newly renamed MA SYE spreadsheet template and related files are placed in the project directory, which will have the same name as the project name. Also note that the name of your basin in the attribute table of the GlobalWatershed layer will be changed to the project name.

You can bypass the prompts asking for locations of directories by pre-populating these values in the “Select folder and file locations” toolbar (fig. 3). If this toolbar is not visible in the MA SYE ArcMap document, open the toolbar from the Sustainable-Yield Estimator toolbar (fig. 2). If you do not pre-populate these values, the paths specified in the “Write basin files” process will be populated in the “Select folder and file locations” toolbar.



Figure 3. Toolbar to specify the working directory and location of the master Excel file in the Massachusetts Sustainable-Yield Estimator tool.

Exporting a shape file and location map

A location map or shapefile can be exported to be stored with the project data. The shapefile will allow you to bring the basin boundary into another GIS application to create a publication-quality map of the study area. These functions can be accessed from the Sustainable-Yield Estimator toolbar (fig. 2). The “Export map” button on the Sustainable-Yield Estimator toolbar will allow you to export an image file in the .jpg file format for use in presentations or as part of a final report on the basin. The file will contain an image of the layers and data is currently displayed the MA SYE ArcMap document. You will be asked if you want to save this map to the same project folder and with the same project name as the last-selected basin. If you want to save the map to another project folder or with another project name, a series of dialog boxes will allow you to select a new path and file name. If there is no project folder or project name stored in the ArcMap document, a series of dialog boxes will allow you to select a new path and file name. If you are exporting a shapefile, you will be asked if you would like to add the shapefile to the table of contents in the MA SYE ArcMap document. If you add the shapefile, it will appear in the table of contents with the project name you have specified. Unless another location or name is chosen, these files are stored in a subfolder within the main project folder and with the suffix “_gisfiles.”

Finishing up with ArcMap

You can continue to use the MA SYE ArcMap document to delineate basins and create project folders and files. Each new basin will show up in the GlobalWatershed table. Once you have finished, close the MA SYE ArcMap document before proceeding to open the project Excel files. If you do not

choose to save the MA SYE ArcMap document, your delineated basins will not be saved in the Global Basin layer; however, if you have exported any project files, they will have already been saved in their respective project folders and will not be lost.

Using the project Microsoft Excel .xls file

After you have delineated a basin and created the project directory for your basin, open the project folder. You will see an Excel file with the project name in the main project folder. Open this file. This file will navigate you through the remaining steps of the MA SYE process and stores all of the data relating to your basin.

When you first open the project MA SYE spreadsheet, the project name, path to the ArcMap basin files, and project description lines should automatically populate. Before you begin working with the any of the MA SYE functionality, first you need to specify the location of the files SYE_ReferenceGageInformation.xls (the reference-streamflow-gage spreadsheet) and syewateruse_v1pt5.mdb (the MA SYE water-use database) by typing the path or by using the set path button, located in cells N5 and N6 on the Master worksheet. Once you have specified these paths, you can begin using the MA SYE spreadsheet. If you forget to enter these paths, you will receive a warning message and be prevented from continuing..

The MainMenu worksheet

When the MA SYE spreadsheet is first opened, only one worksheet is visible – the MainMenu worksheet. This worksheet contains the buttons that compute unregulated streamflow, allow for the user to review data for the water-use points located within the basin, compute streamflow adjusted for groundwater and surface-water withdrawals and discharges, and compute sustainable yield. Buttons on

the MainMenu worksheet are activated when the actions upon which they depend are completed. The functionality, dependency and results of the buttons are explained below.

Compute Unregulated Streamflow button

This step must be completed before proceeding to any other part of the MA SYE process. This button activates the Review Water Use Data and Compute Sustainable Yield buttons and computes the unregulated streamflow and reports the results in the following worksheets: BasinCharacteristics, ReferenceGageSelection, ContinuousFlowDuration, and ContinuousDailyFlow. The BasinCharacteristics worksheet contains the basin characteristics needed to compute the unregulated streamflow. This worksheet also contains a column for warning messages, if any of the basin characteristics are outside of the range under which the regression equations were developed.

The ReferenceGageSelection worksheet contains information on the reference streamgage chosen to transform the flow-duration curve to a continuous daily hydrograph. The worksheet contains the name and station number for the reference streamgage, the estimated correlation between the unregulated sites and the reference streamgage, the basin characteristics for the reference streamgage, the distance between the reference streamgage and the basin, and the relative percent difference between the basin characteristics at the reference streamgage and the characteristics of the selected basin. Users can also view the top five most correlated streamgages. A user can recompute the daily streamflow values and flow duration curve using a different reference streamgage by selecting a new streamgage from the pull-down list and pressing the Update button.

The ContinuousFlowDuration worksheet contains the continuous flow-duration curve, in cubic feet per second and cubic feet per second per mile, for the unregulated site and the reference streamgage. The ContinuousDailyFlow worksheet contains the continuous daily streamflow from October 1, 1960,

through September 31, 2004, in cubic feet per second and cubic feet per second per mile, for the ungaged site and the reference streamgage.

The user can proceed to review the water-use points located with the basin by pressing the Review Water Use Data button or can compute the sustainable yield of the basin by pressing the Compute Sustainable Yield button.

Review Water-Use Data button

This button will open the water-use database to a form that allows the user to view and edit information for the water-use points located in the basin. The commands contained within this button cannot be carried out until the unregulated streamflow is calculated. The water-use database contains the raw data that were electronically available from the MassDEP. To preserve the water-use data, direct changes to the water-use data are recommended only if the user is able to obtain detailed water-use data from the MassDEP Annual Statistical Reports, if an inaccuracy exists in the database, or the user is able to obtain aquifer properties for a groundwater withdrawal or discharge location. For all other changes to the water-use location or data, the user is referred to the WaterUsePoints worksheet.

When you have completed your review of the information in the water-use database, click the “Data Review Complete” button located directly on the database form. This will export the available data for each water-use point, disaggregate the water use to a monthly time step (if only annual data is available), convert all water-use data to a common unit of measure, and write any messages about the water-use data. A subfolder with the suffix waterusefiles will also be created in the project folder, which contains individual text files of the water-use data for all water-use points included in the analysis. This button also closes the water-use database and returns the user to the Master worksheet, where the user can then compute adjusted streamflows. PLEASE NOTE: Do not exit the database in any other manner or the MA SYE process will not work properly.

Compute Adjusted Streamflows button

The user must have reviewed the water-use data before accessing this portion of the MA SYE. When the Compute Adjusted Streamflows is pressed, the user is presented with the option to edit the water-use data from the MA DEP water-use database or the program will use the default water-use values and the user will be directed to the ComputeSustainableYield worksheet.

The WaterUsePoints worksheet contains a pull-down list of water-use points located in the basin. Users can choose to edit aquifer properties for the water-use point, choose to include or leave out the water-use point from the analysis, view and edit water-use data, and view all warnings associated with the water-use point and related data. It is important to note that changes made to the water-use point or data are saved in the related water-use files in the project folder; however, changes are not written to the water-use database.

To edit data for one of the water-use points, select the point from the pull-down list and press the Edit button. A form pops up that has been populated with information about the water-use point that was selected. To edit data, first select the year from the pull-down menu in the Water-Use Data tab. Values will populate for each month. To change the value for a particular month, move to cursor to that month and edit the data value. When finished editing, press the Update Data button. To edit other values, such as STRMDEPL parameters or to include or exclude the water-use point from the analysis, click on the Additional Information tab and edit this information. When you are finished updating data for this point, press the Save Changes button. Note that the old values are not saved and you will not be able to revert to the old values once you press the Save Changes button.

You can also choose to enter a volume or percent of total withdrawals that is returned to the basin by way of septic-system discharge. This information can be entered directly to the WaterUsePoints worksheet. Choose percent or volume in the data type drop-down list, and enter the

value. If you specify a zero value or leave this cell blank, this information will not be included in the calculation of the sustainable yield.

When the user is finished editing the water-use data, press the Compute Adjusted Streamflows button. The user is then directed to the ComputeSustainableYield worksheet. The user can edit additional water-use information at any time by selecting the WaterUsePoints worksheet. If the user chooses to start over and use the original data contained in the water-use database, the user can go to the MainMenu worksheet and repress the Review Water Use Data button. This will hide the WaterUsePoints worksheet until the water-use data is again reviewed and the Compute Adjusted Streamflows button is pressed on the MainMenu worksheet.

Compute Sustainable Yield button and worksheet

To activate the Compute Sustainable Yield button on the MainMenu worksheet, the unregulated streamflows must be computed first. The ComputeSustainableYield worksheet appears when the unregulated streamflows have been computed. Users are directed to this worksheet in one of four ways: 1 – the Compute Sustainable Yield button on the MainMenu worksheet is pressed, 2 – the user selects the ComputeSustainableYield worksheet, 3 – the user chooses to use the default water-use data when the Compute Adjusted Streamflows button on the MainMenu worksheet is pressed, or 4 – the user is directed to the ComputeSustainableYield worksheet after they have finished editing water-use data. where the user can select the inputs used in the computation of the sustainable yield for the basin.

The ComputeSustainableYield worksheet

Users are able to select the time period of unregulated streamflows for use in the sustainable yield analysis. Users can also select an instream-flow target from the pull-down box. A data entry form will appear the first time a particular instream-flow regime is chosen or an instream-flow regime different from the currently-selected one is chosen. The grey area below the pull-down box will update

based on the user-selected instream-flow regime. Once the user selects a particular target, they can directly update the values shown in the grey area can be directly updated using the data-entry form for that particular instream-flow regime.

Users can then choose to have the water-use data for a particular year or an average year applied to every year of unregulated streamflow or the user can choose to apply any year of water-use data with a year of unregulated streamflow. The regulated flow is computed by subtracting and adding the effects of all water withdrawals and discharges, respectively, resulting in regulated flow that is the streamflow from a particular year of unregulated streamflow with the effects of the withdrawals and discharges from that year imposed on the selected year unregulated streamflow. When data entry is completed, the user presses the Compute Sustainable Yield button. Results of the computed and the user is directed to the Report worksheet. The time series of daily unregulated and adjusted streamflows along with the daily instream-flow values are stored in the FlowsForSustainableYieldCalcs worksheet. When any value in the ComputeSustainableYield worksheet is changed, the Report and FlowsForSustainableYieldCalcs worksheets are hidden until the user presses the Compute Sustainable Yield button again and results are recomputed with the new parameters.

The Report worksheet

This worksheet provides a printer friendly, two-page report that summarizes the results of the water-management scenario. Graphs of the unregulated streamflow, regulated streamflow, and instream-flow targets for the selected period are shown, as well as selected flow statistics. Graphs and flow statistics are shown in both cubic feet per second and cubic feet per second per mile.

The FlowsForSustainableYieldCalcs worksheet

This worksheet contains the unregulated and regulated flow-duration curve and time series of daily streamflow along with the daily instream-flow regime for the period specified in the

ComputeSustainableYield worksheet. Users can easily cut and paste or save this data for use in other applications.

Stream locations in southeastern Massachusetts

Two Excel spreadsheets are located in the subfolder southeastern_ma. These files contain worksheets with fixed average monthly streamflows for the stream locations described in the text and shown in Figure 15 of the main report (<http://pubs.usgs.gov/sir/2009/5227/>). The worksheet format follows the Report worksheet format in the MA SYE master spreadsheet. Users can select the worksheet named for the stream of interest, add monthly instream-flow targets and view results and graphs of the unregulated and adjusted monthly streamflows along with the instream-flow targets.