Example of a Human Health Impacts Assessment Using the Plus Operator Object to Combine Output from Two Sources and Model a Secondary Contaminated Site as an Overland Flow Object (Example No. 8)

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May 2004

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Introduction

The U.S. Army Engineer Research and Development Center (ERDC) is developing the Army Risk Assessment Modeling System (ARAMS) to provide the Army with the capability to perform human and ecologically based risk/hazard assessments associated with past practice and current activities at military installations. The intent of the system is to provide a platform from which a variety of assessments can be performed. The system is envisioned to help a risk analyst visualize an assessment from source, through multiple environmental media (e.g., groundwater, surface water, air, and land), to sensitive receptors of concern (e.g., humans and ecological endpoints).

ARAMS uses the Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES) developed by the Pacific Northwest National Laboratory (PNNL) for linking disparate objects, such as environmental fate/transport models, databases, spreadsheets, etc. FRAMES is a Windows-based software platform that provides an interactive user interface and, more importantly, specifications to allow a variety of DOS and Windows-based environmental codes to be integrated within a single framework.

This document is intended to serve as a tutorial for helping new users with the application of ARAMS/FRAMES and the components within this system. This example does not include the steps for project planning and the use of associated tools under the "File" menu. These tools help the user plan the risk assessment including development of the conceptual site model and the RAGS Part D Table 1 for human health risk assessment. There are several Help files within ARAMS that explain these tools.

Example Description

This example (shown schematically in Figure 1) begins with two areas of contaminated soil (Site 1 and Site 2) and uses the Plus Operator Object to combine the contaminated storm water runoff from both sites that feed into another downstream site. Additionally, volatiles from Site 1 are deposited onto the downstream site. The downstream site is modeled with the Secondary Source in Soil Module within the Overland Flow Object using the combined runoff and deposited material from the Mepas 4.1 Air Module as inputs to calculate a contaminated runoff stream from the land area. The runoff from the Overland Flow object flows into a local water body and the Mepas 4.1 River Module is used to calculate the water concentration at a downstream extraction point. The water extracted is used for drinking, showering, and watering vegetables in a garden. The Exposure Pathways, Receptor Intake, and Health Impacts modules are used to determine exposure, uptake, and risk caused by contaminated water and vegetables from the garden.

Site 1, one of the originally contaminated sites, and the secondary site both use the Mepas 4.1 Source in Soil module to calculate the losses due to resuspension of particles, storm water runoff, and leaching. The leaching pathway is not considered for Site 1 due to the presence of a leachate collection system, rather leaching is treated as a known sink. The volatilization pathway is not considered for the secondary source site. Site 2, the other originally contaminated site, is a sediment trap and uses the WFF Overland Flow module to specify the known flux of water and constituents from the sediment trap. The constituents chosen for this example are PCB (General Classification) and STRONTIUM-90.

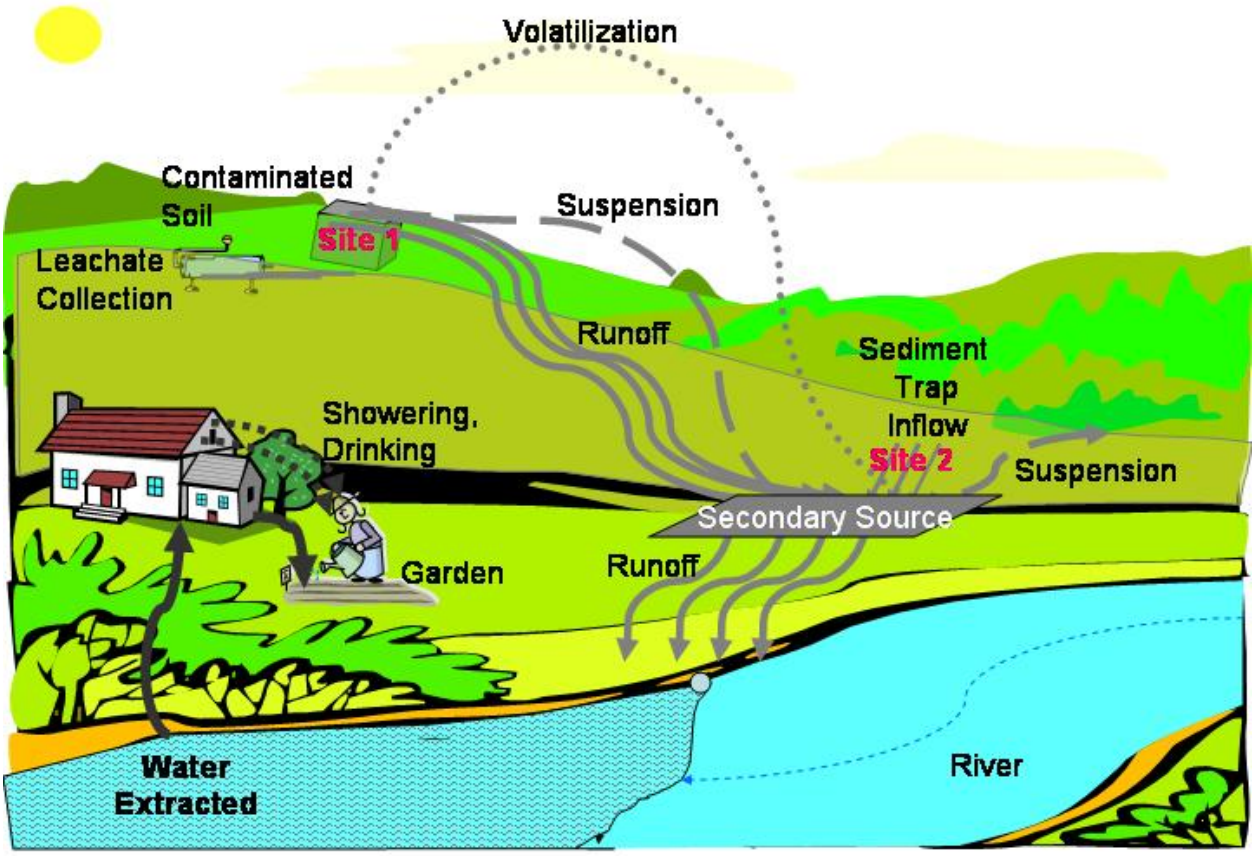


Figure 1. Illustration of the scenario being modeled in this example

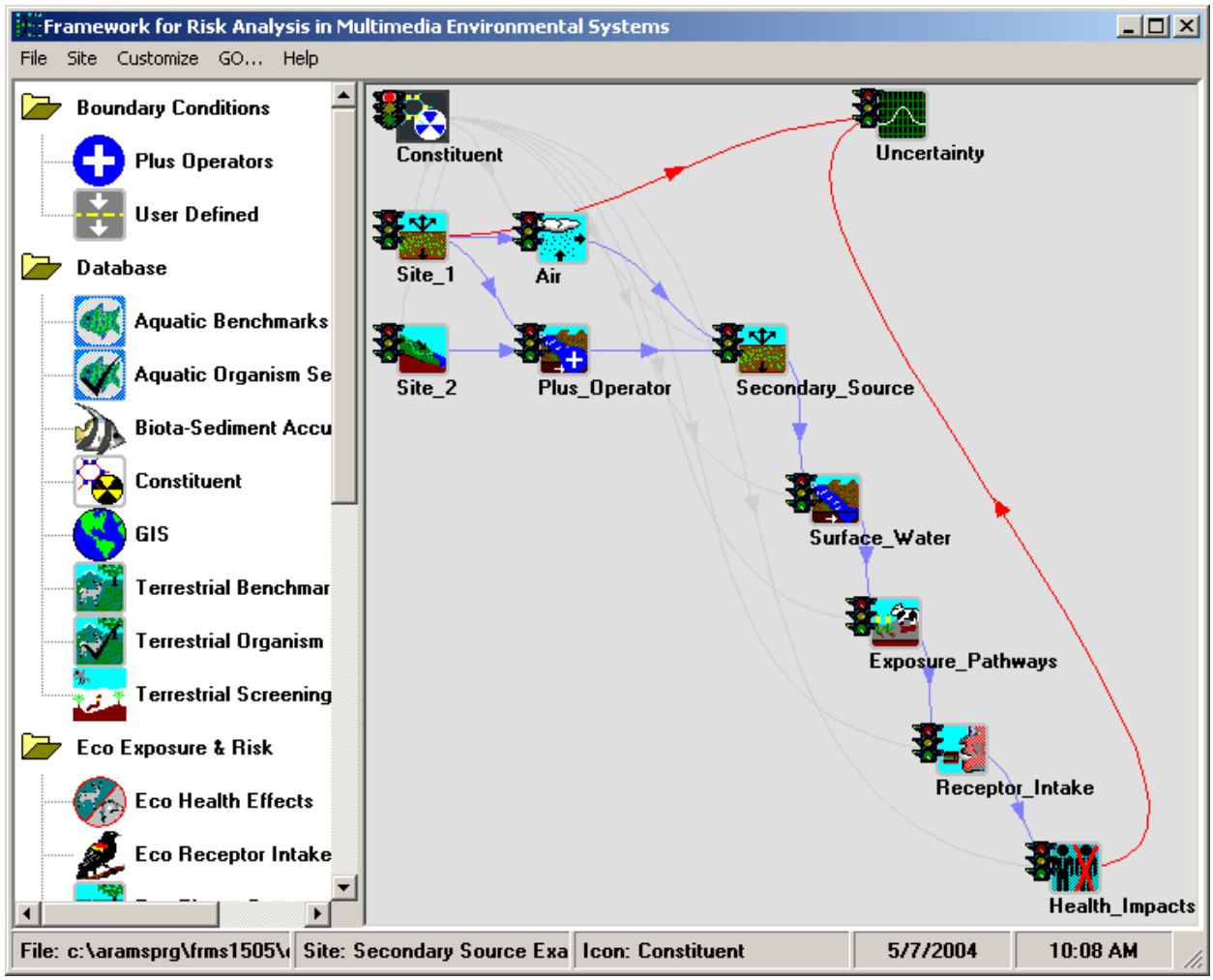


Figure 2. Object workspace for example application

Input Data

- Double-click on ARAMS icon to open "ARAMS info and Disclaimer" window and then select "Accept" to continue.

- Choose "FRAMES" in the ARAMS toolbar to launch FRAMES. (Note: If this is the first time you have used ARAMS, you will need to configure it for FRAMES by selecting "**File,**" then "*****Must Configure Path to FRAMES*****" and supplying the path to the "**fui.exe**" file).

- While ARAMS/FRAMES is running, click "File" from the FRAMES menu and choose "New." A window titled "Global Input Data Open New" will appear (see Figure 3). In the "File Name" box enter the project name (type: "Sample*1*," maximum of eight characters) and click "Open" (see Figure 4). **Do not name the new file "Example8" because it will write over the existing "Example8" file that was distributed with the tutorial.** A window titled "Create New Site" will appear. Next, type the project site name (type: Secondary Source Example) and click "OK" (see Figure 5).

The color of the workspace may change. Double-click on the Constituent icon so that the icon appears on the upper left corner of the main screen. Repeat this operation to place the following additional icons into the workspace:

"Source"
"Air"
"User-Defined" – for Overland Flow
"Plus Operators"
"Overland Flow"
"Surface Water"
"Exposure Pathways"
"Receptor Intake"
"Health Impacts"
"Sensitivity"

Click on and drag each icon to its respective position on the workspace. Connect the Constituent icon and Source icon by holding down SHIFT, clicking on the Constituent icon, dragging the cursor to the Source icon, and releasing the mouse button (Note: To remove this line, repeat the steps used to connect it. To remove an icon from the screen, right click and a menu will appear with various options. Click "Delete" and the icon will be taken out.).

In the same fashion, connect the following pairs of icons:

Constituent	→	*Source (*already done*)*
Constituent	→	*Air*
Constituent	→	*User-Defined (Overland Flow)*
Constituent	→	*Overland Flow*

Constituent	→	*Surface Water*
Constituent	→	*Exposure Pathways*
Constituent	→	*Receptor Intake*
Constituent	→	*Health Impacts*
Source	→	*Air*
Source	→	*Plus Operators*
User-Defined (Overland Flow)	→	*Plus Operators*
Plus Operators	→	*Overland Flow*
Air	→	*Overland Flow*
Overland Flow	→	*Surface Water*
Surface Water	→	*Exposure Pathways*
Exposure Pathways	→	*Receptor Intake*
Receptor Intake	→	*Health Impacts*
Source	→	*Sensitivity*
Health Impacts	→	*Sensitivity*

FRAMES should now look something like Figure 2.

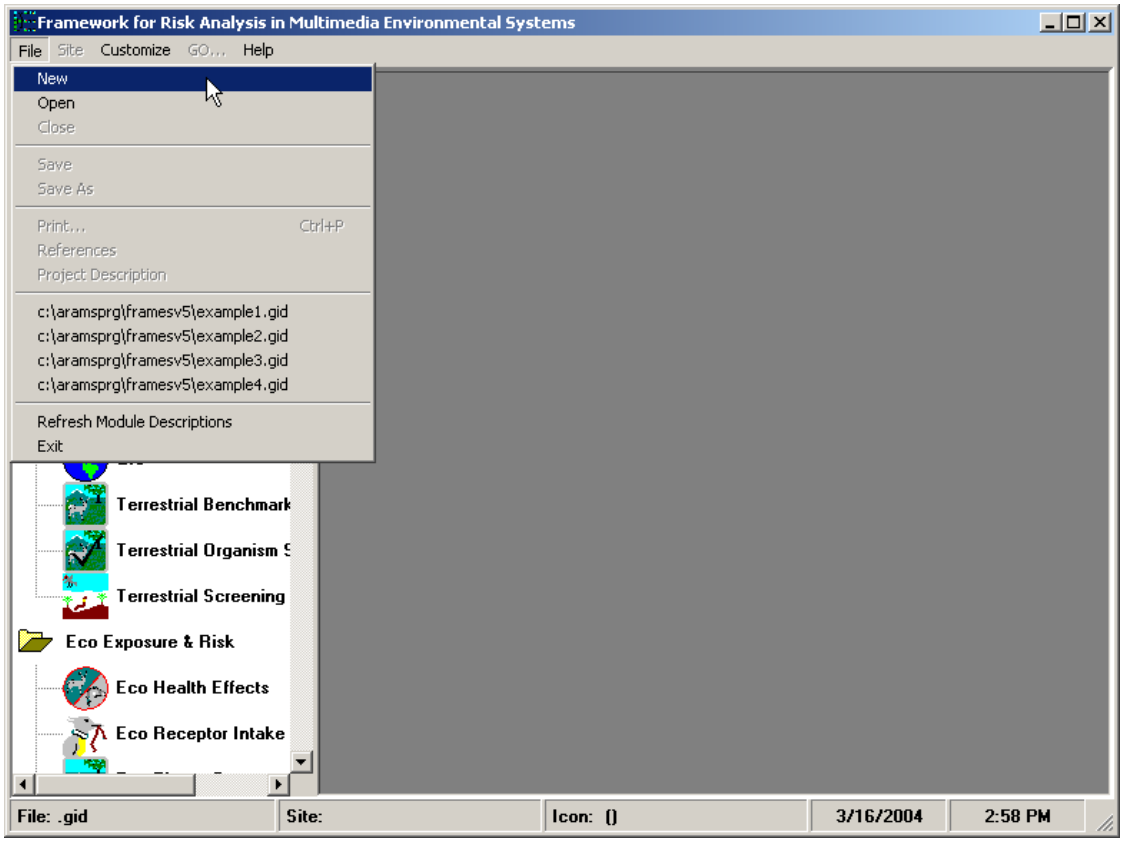


Figure 3. Opening a new file

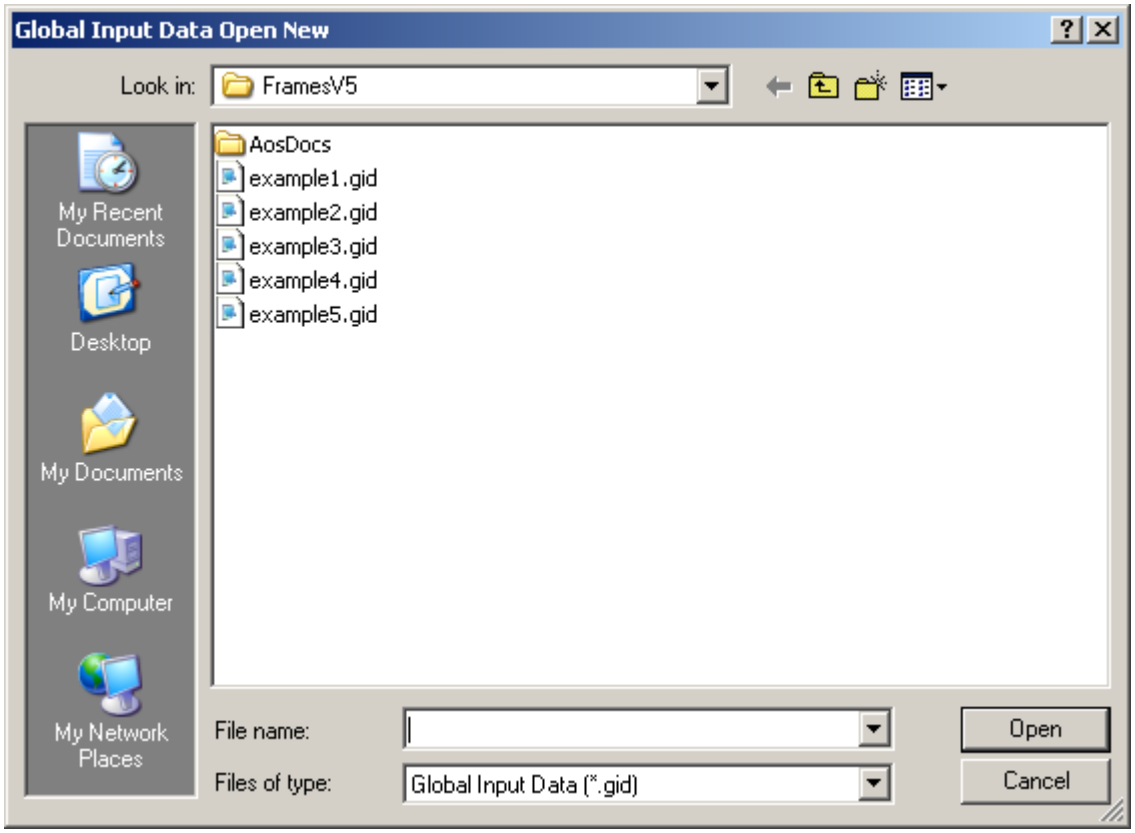


Figure 4. Global Input Data Open New screen (new file window)

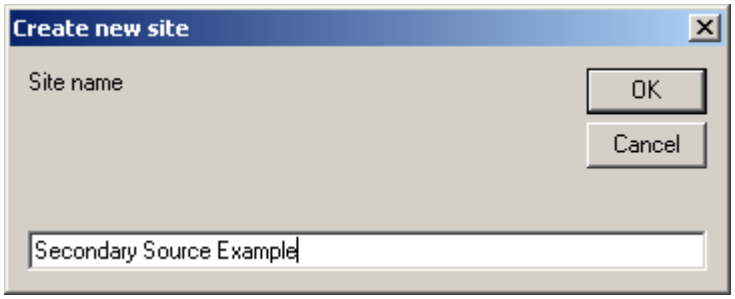


Figure 5. Create New Site screen (input "Site name" box)

CONSTITUENTS DATABASE MODULE

Right-click the Constituent icon and choose "General Info" (see Figure 6). When the General Info screen opens, enter "Constituent" in the "User Label" text box and select "FRAMES Default Constituent Database Selection" in the "Select from applicable models" text box (see Figure 7). Click OK at the bottom of the screen to return to the workspace area. The Constituent icon's status indicator will now display a red light. Right-click on the constituent icon in the main screen and choose "User Input." The Constituent Selection screen will open (see Figure 8). The constituents used in this case are PCB (General Classification) and STRONTIUM-90. Scroll to select the constituents from the constituents list or use the Find option to search for them. Click the "Add >>>" button to add each constituent to the

selected constituents list. Select “Save and Exit” from the File menu to return to the workspace screen. The Constituent icon’s status light will change from red to green.

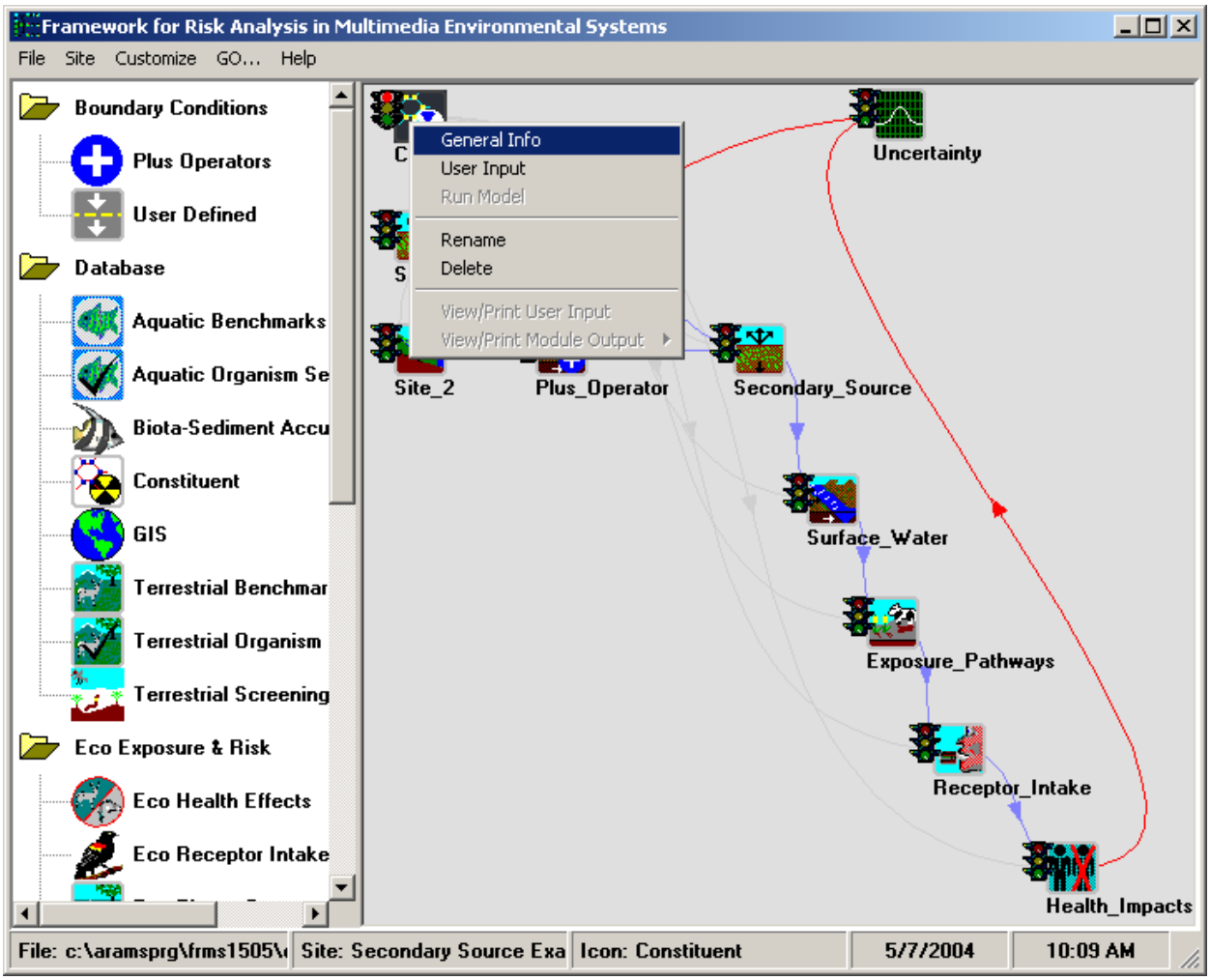


Figure 6. Workspace screen (right-click in the Constituent icon)

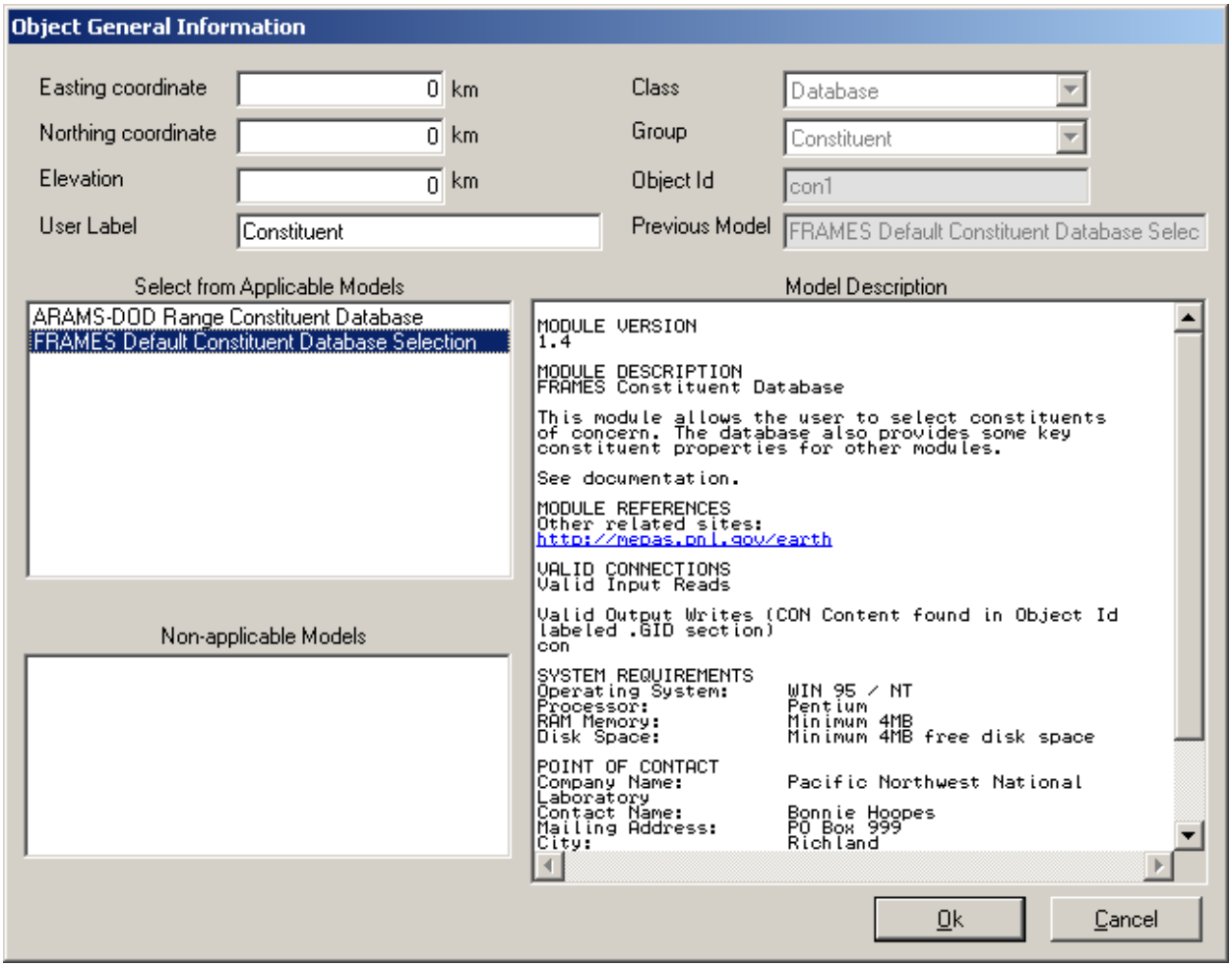


Figure 7. Object General Information screen

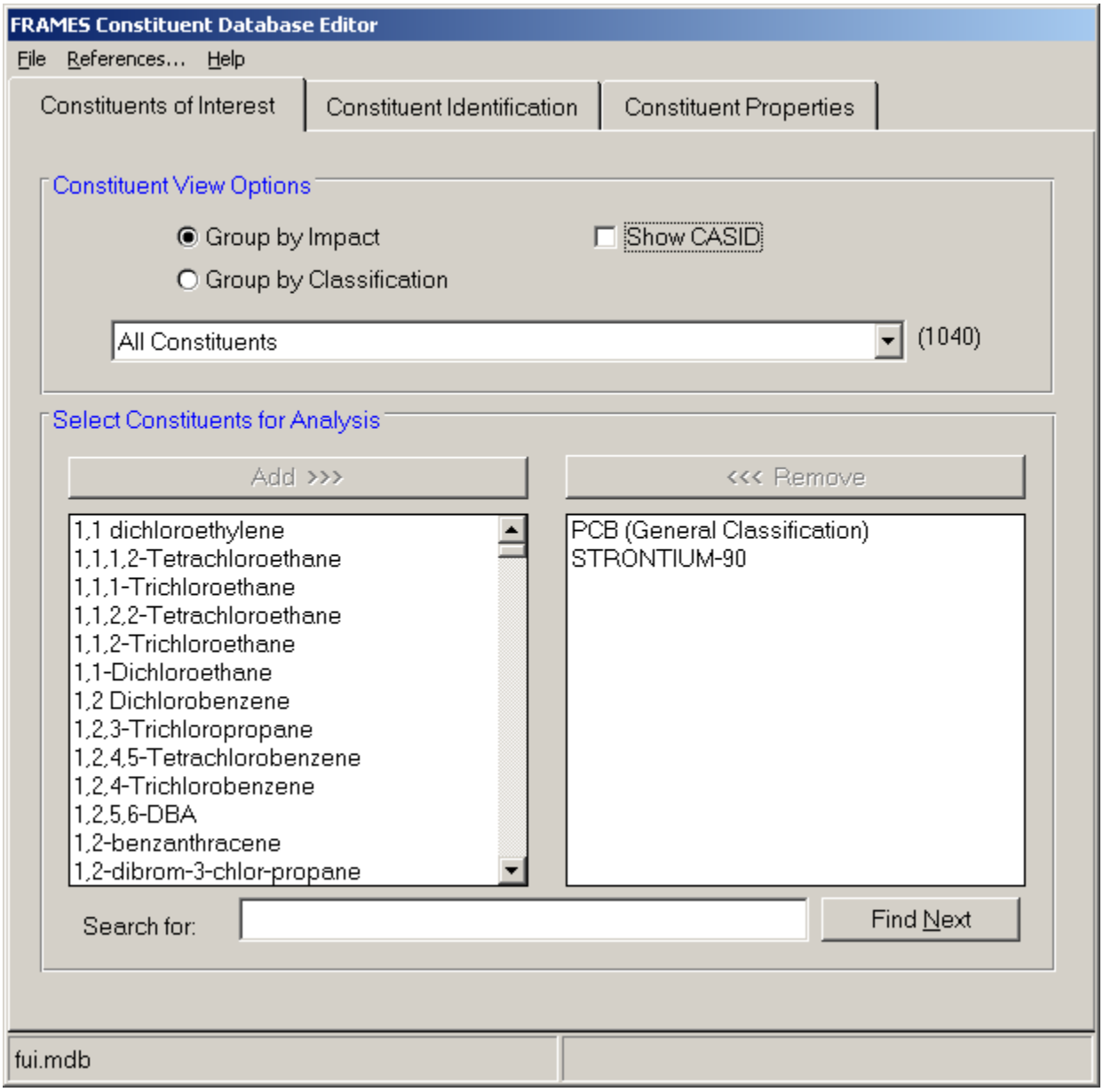


Figure 8. FRAMES Constituent Selection screen ("Constituents of Interest" tab)

The following is a listing of all data input required by the remaining modules used in this example. *Names of object icons* are in bold, italics, and underlined headings. *Menu items* (displayed by right-clicking on the icon) are shown below the module in bold and indented to the right of the icon names. *Explanations* of data required by each menu item are indented further to the right. To save information for your scenario, select "File" and then "Save" from the main FRAMES menu.

For ease of presentation, the instructions below proceed with selecting module, entering data, running the module, and viewing module output. However, the user should select all object modules prior to entering data for each module.

Source

General Info

A window titled "Object General Information" will appear. Input "Site 1" in the Label text box. Select "Mepas 4.1 Source in Soil" in the section labeled "Select from Applicable Models." Note the northing, easting, and elevation fields at the top left corner of the form. These are used to enter the coordinates in three-dimensional space relative to a user-defined origin. For this example, Site 1 is assumed to be the origin so these values will all be zero. Click the button labeled "OK" to return to the FRAMES workspace. The status light next to the Source icon should turn red.

User Input

In the window titled "Source Term Module Input," enter the information for each of the tabs as described below.

- *Options Tab (for pathway and simulation settings) – Figure 9*
  - Turn off leaching loss route since a leachate collection system is used
  - Set the overland runoff loss route as a known erosion rate
  - Set the volatilization and suspension loss routes as known constituent fluxes
  - Set the known source/sink option to a known constituent flux because the values from the leachate collection system will be entered
  - Time interval for the simulation is 1 year
  - Time period for the simulation is 60 years
  - Fraction of residual mass for the simulation is 0.01

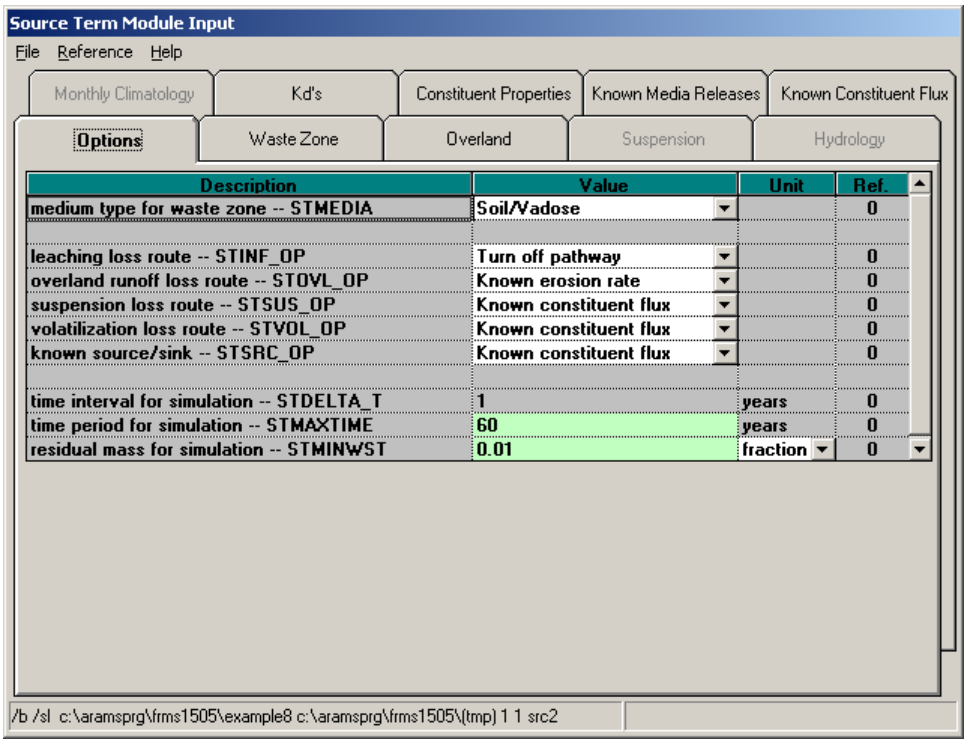


Figure 9. Source Term Module Input – Options tab

- *Waste Zone Tab (soil and other physical properties) – Figure 10*
  - Thickness of clean overburden = 0 cm
  - Thickness = 7 m
  - Length = 7 m
  - Width = 5 m
  - Bulk density = 1.855 g/cm^3
  - Total porosity = 0.3
  - Moisture content = 0.15
  - Volumetric air content = 0.15
  - Average air temperature = 25˚C
  - Height above ground of local wind measure = 10 m

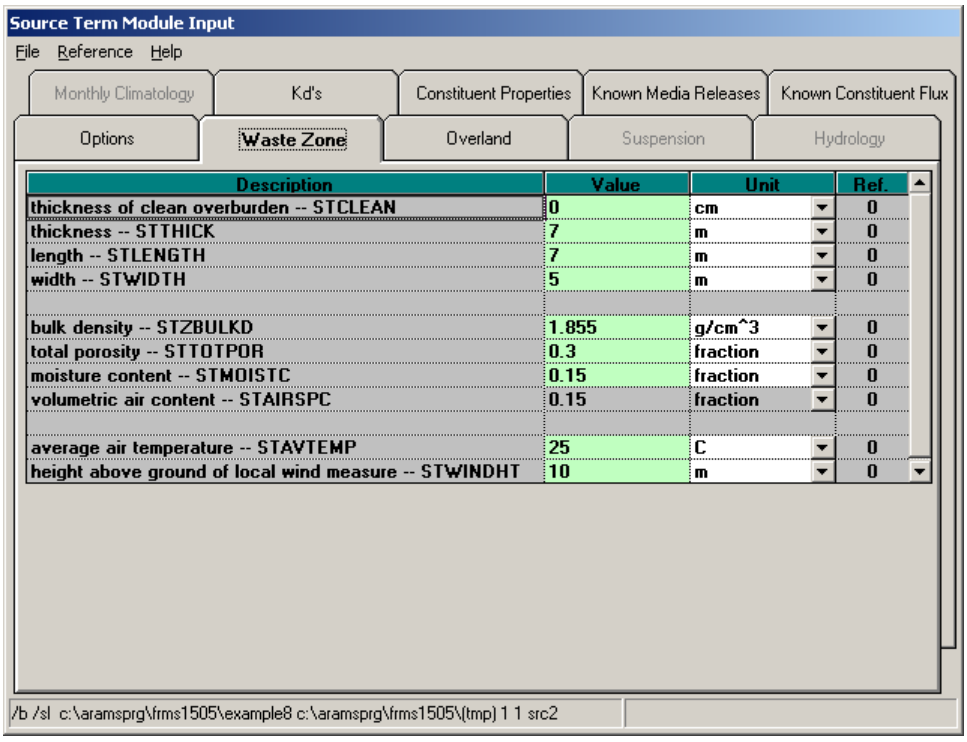


Figure 10. Source Term Module Input – Waste Zone tab

- *Overland Tab (overland flow data) – Figure 11*
  - Discharge of water to overland = 2 m^3/yr

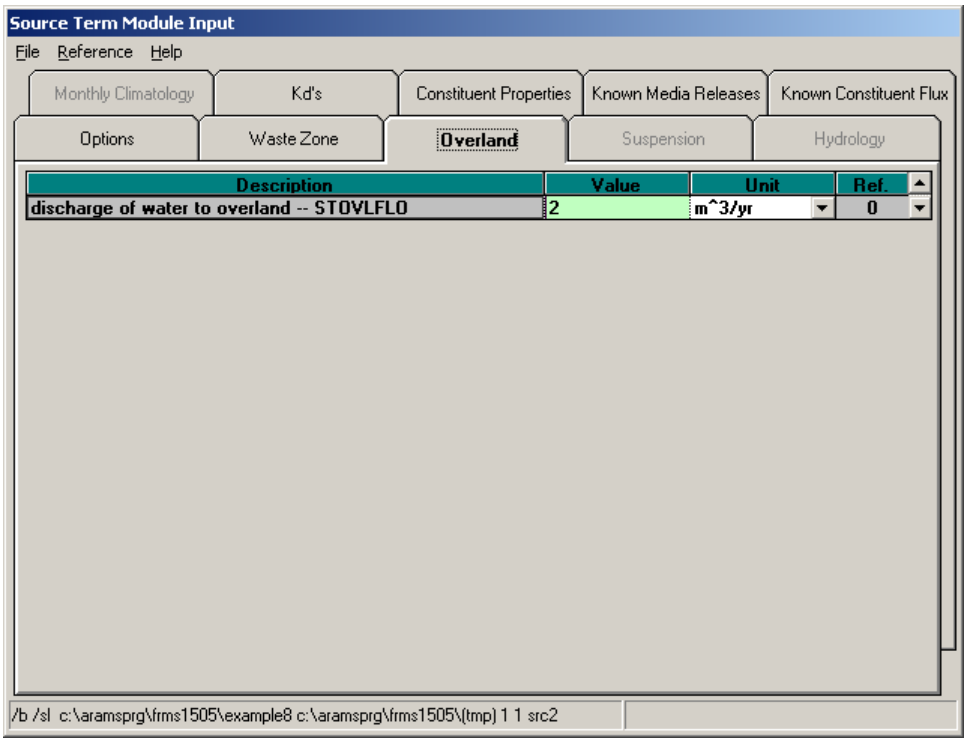


Figure 11. Source Term Module Input – Overland tab

- *Kd's Tab (Soil partitioning parameters) – Figure 12*
  - Set the type of equilibrium coefficient to "Select Adsorption Coeff." and the count to "2" for each constituent. This will allow the user to enter values for the equilibrium coefficient at two different time points. Other options are also available from the dropdown box as shown in Figure 12 (user specified values, the value from the constituent database, an estimated value based upon soil properties, and a value from a look up table for metals). The value is shown first followed by the source of the data such as 228 mL/g from the Lookup Table. Enter the following values for the partition coefficients (these values are for illustration only; as may be noted, the value for PCB is much lower than usual).
    - PCB (General Classification)
      - 1 ml/g at time = 0 years
      - 1 ml/g at time = 60 years
    - STRONTIUM-90
      - 2 ml/g at time = 0 years
      - 2 ml/g at time = 60 years
    - YTTRIUM-90
      - 2 ml/g at time = 0 years
      - 2 ml/g at time = 60 years

    If the Estimated Value option is used, then the user must click the "Soil Properties" button and the form shown in Figure 13 will appear. Values should be entered such that they add to 100%. Note that the type of soil could also be chosen from the list at the top right corner of the form. Making a selection from this list will automatically fill in the percentage of each component in the soil.

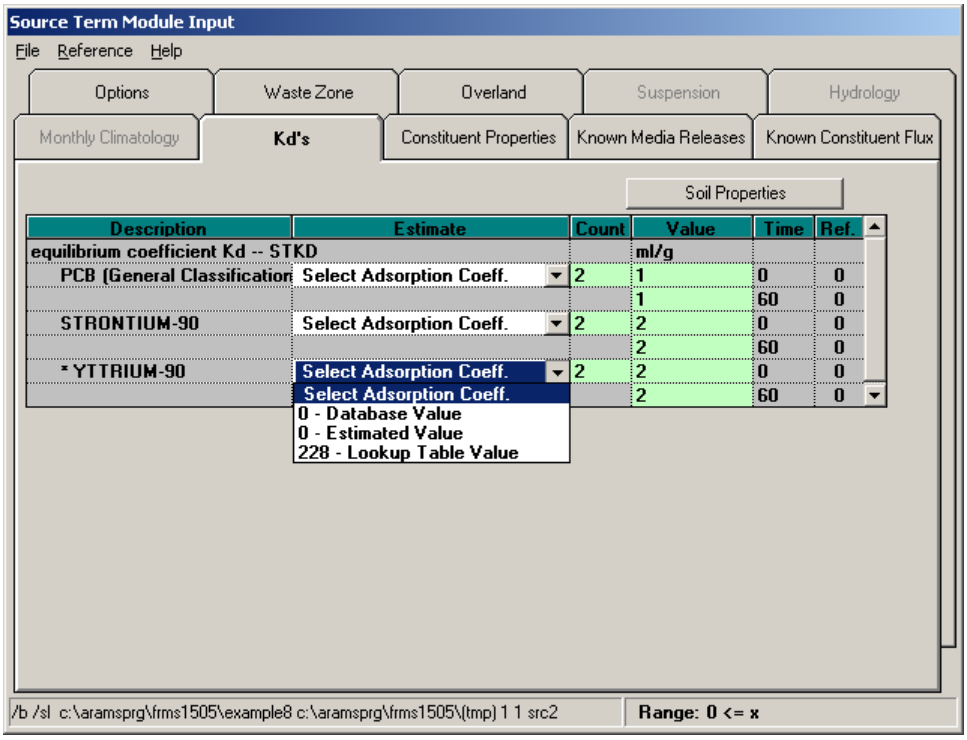


Figure 12. Source Term Module Input – Kd's tab

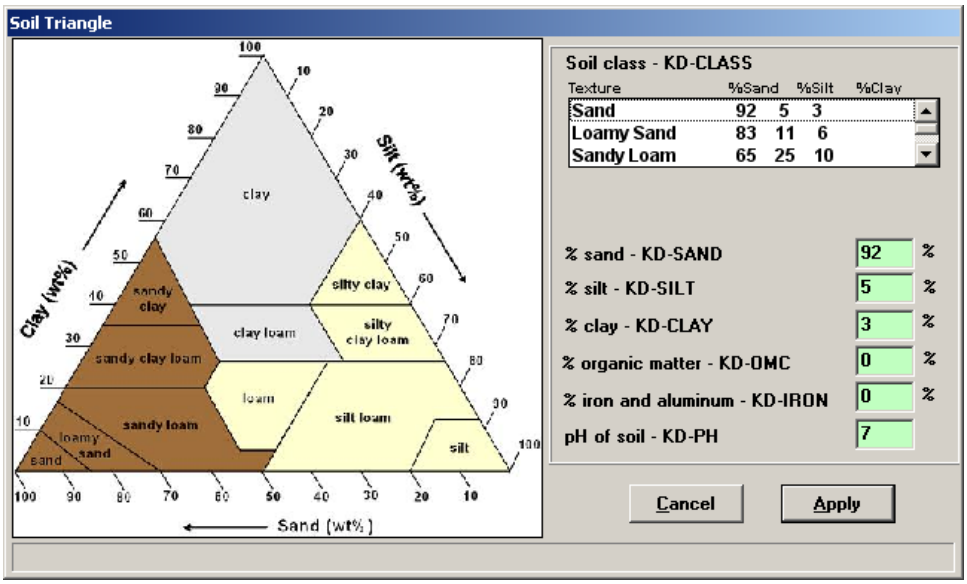


Figure 13. Soil Properties Dialog

- *Constituent Properties Tab (Chemical properties and inventory) – Figure 14*
  - Enter the following values for the water solubilities
    - PCB (General Classification) – 0.031 mg/L
    - STRONTIUM-90 – 1000000 mg/L
    - YTTRIUM-90 – 1000000 mg/L

Note that if a value exists for the water solubility for any of these chemicals in the FRAMES Constituent Database, as is the case for PCB, it will appear in the appropriate box on this form. The values entered here for STRONTIUM-90 and YTTRIUM-90 are fictitious and are set to a very large number to allow the transport of these constituents to the secondary source for illustration of how these radionuclides are handled by the modules used in this example.

- Use the "Worksheet" button for each constituent to enter the inventory as shown in Figure 15. This is the original amount of material present. The two input options available are "Inventory" and "Concentration." The inventory option allows the user to specify the exact mass of the constituent present while the concentration option allows the user to specify a concentration of the constituent present on a mass of dry soil, mass of wet soil, or volume of soil basis. Enter the values given below.
  - PCB (General Classification) – Inventory = 1500 g
  - STRONTIUM-90 – Inventory = 40 Ci
- Enter the following values for the decay/degradation half-life for each constituent. Note that these values will also be filled from the database if present.
  - PCB (General Classification) – 43800 days
  - STRONTIUM-90 – 10600 days
  - YTTRIUM-90 – 2.7 days
- The fraction of volatilization release is used to control volatilization rate at constituent level if the user determines that the model-estimated volatilization rate is too high. This value is generally set to 1 for most constituents and should only be changed if the user has monitoring data that can be used to estimate the adjustment required to define this value.

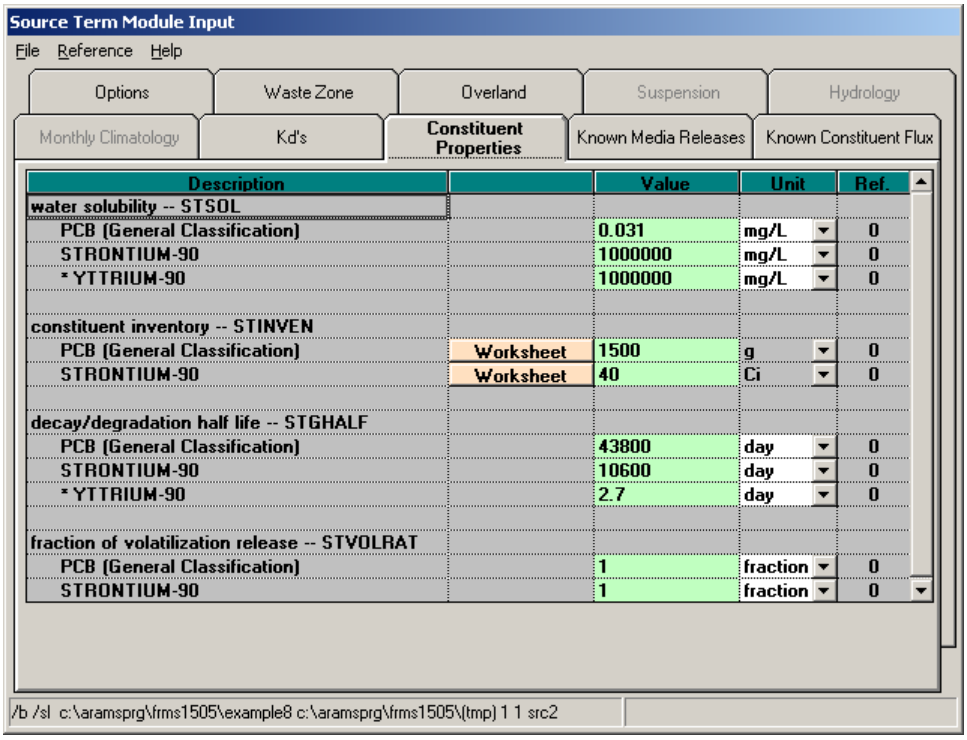


Figure 14. Source Term Module Input – Constituent Properties tab

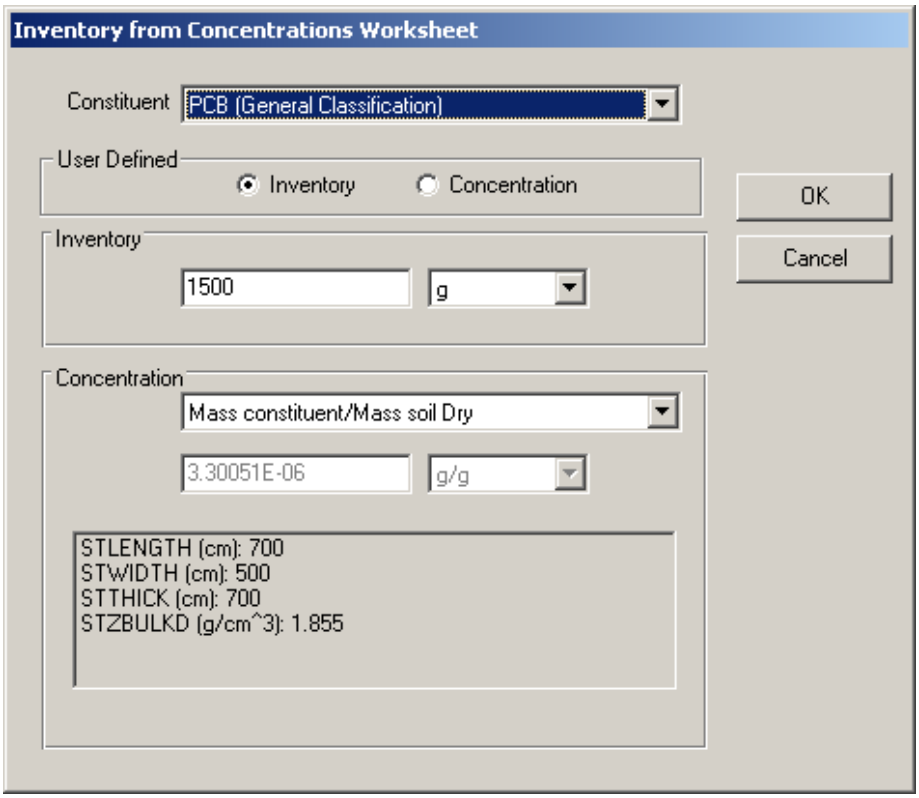


Figure 15. Constituent Inventory Worksheet

- *Known Media Releases Tab (Known Erosion Rates) – Figure 16*
  - Since the overland runoff loss route was set to a known erosion rate, the erosion rate must be defined on this tab. Although the constituent flux to suspension will be specified, the erosion rate from suspension must also be defined to determine the amount of soil material that is lost through suspension. Enter the following values as specified. Once again, values at two points in time are specified for each variable.
    - Soil depth lost to water erosion = 2 cm/yr at 0 years
    - Soil depth lost to water erosion = 2 cm/yr at 60 years
    - Wind erosion rate = 1 cm/yr at 0 years
    - Wind erosion rate = 1 cm/yr at 60 years

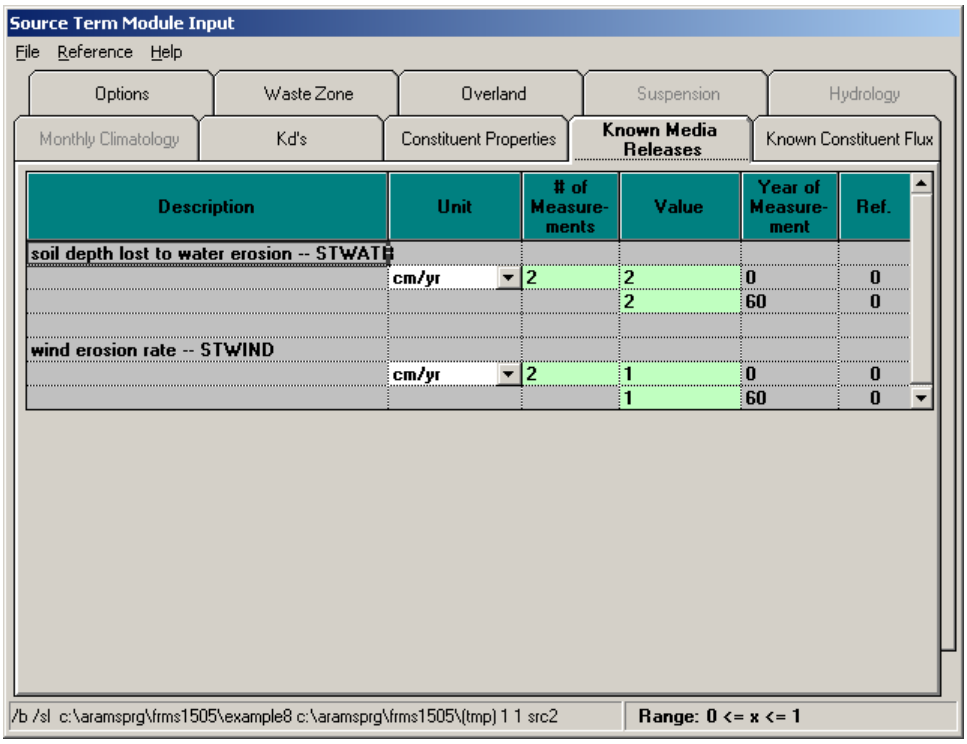


Figure 16. Source Term Module Input – Known Media Releases tab

- *Known Constituent Flux Tab – Figure 17*
  - Since the losses to wind suspension and volatilization were indicated as known fluxes on the Options tab they must be entered here. For this example, all values are entered using 4 points in time except for the STRONTIUM-90 volatilization flux rate. This rate is zero at all time points so only two entries are needed to accurately define this rate with regard to time. Enter the following values as shown in Figure 17.
    - Known wind suspension flux rates
      - PCB (General Classification)
        - 0 g/yr at 0 years
        - 1.5 g/yr at 10 years
        - 2.5 g/yr at 40 years

        - 0 g/yr at 60 years
    - STRONTIUM-90
        - 0 Ci/yr at 0 years
        - 3 Ci/yr at 10 years
        - 5 Ci/yr at 40 years
        - 0 Ci/yr at 60 years
- Known constituent volatilization flux rates
    - PCB (General Classification)
        - 0 g/yr at 0 years
        - 10 g/yr at 10 years
        - 20 g/yr at 40 years
        - 0 g/yr at 60 years
    - STRONTIUM-90
        - 0 Ci/yr at 0 years
        - 0 Ci/yr at 60 years

- Because there is a leachate collection system, the leaching loss pathway was turned off and the known source/sink pathway was set to be a known constituent flux. The loss to the leachate collection system will be entered as a sink term at the bottom of the "Known Constituent Flux" tab. The values entered will be negative to indicate that this is a sink instead of a source. Enter the leachate loss values given below and shown in Figure 18.
    - PCB (General Classification)
        - –0.1 g/yr at 0 years
        - –0.1 g/yr at 60 years
    - STRONTIUM-90
        - –0.05 Ci/yr at 0 years
        - –0.05 Ci/yr at 60 years

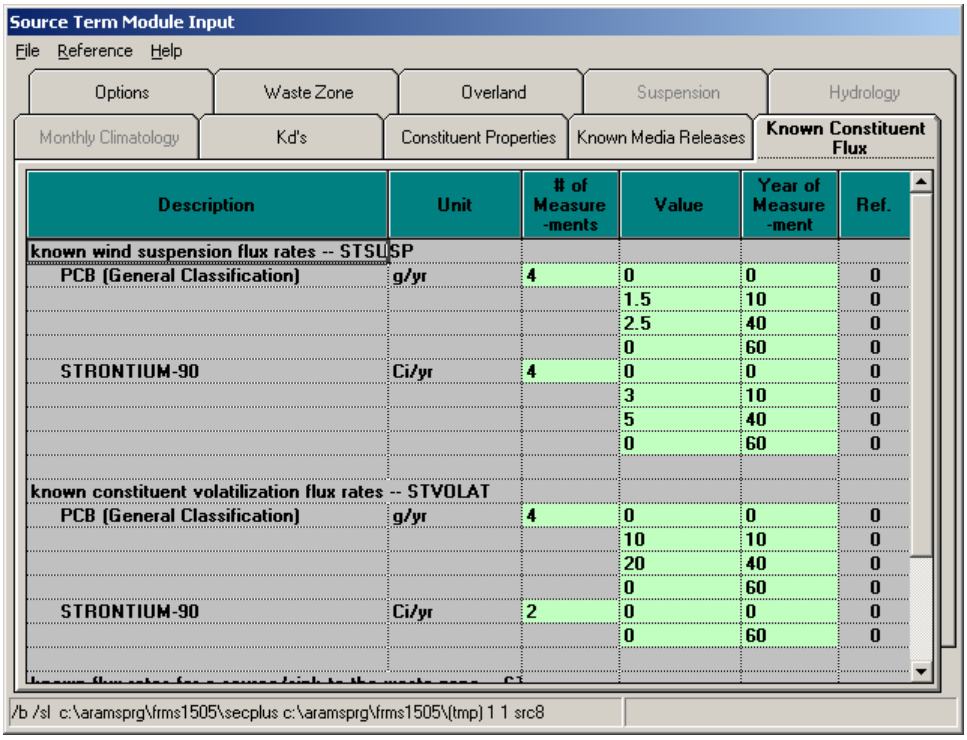


Figure 17. Source Term Module Input – Known Constituent Flux tab

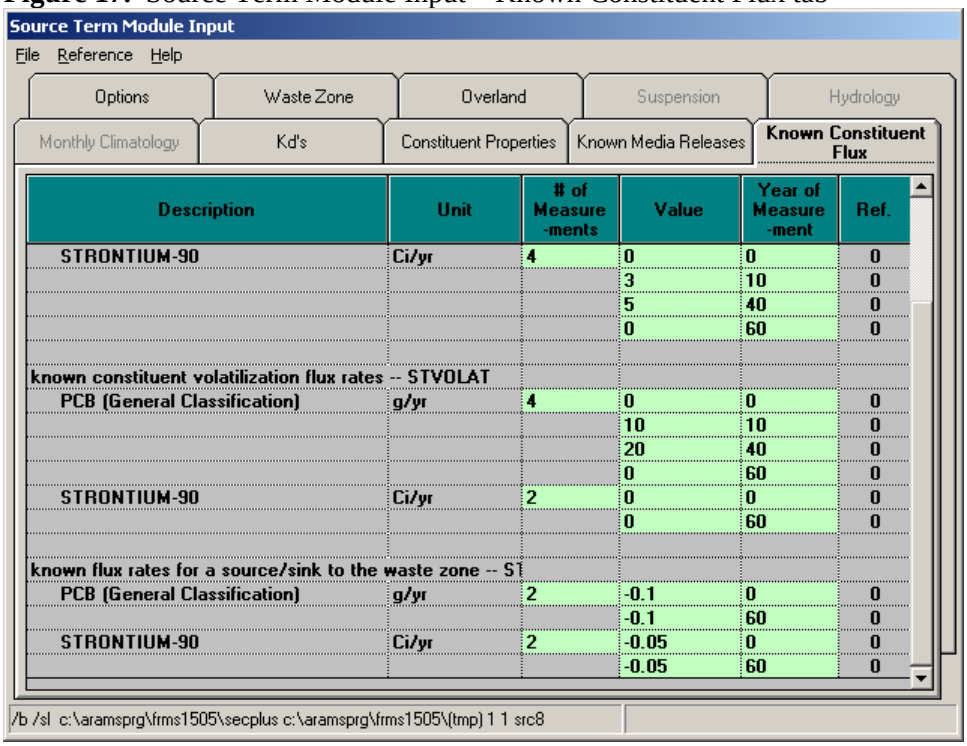


Figure 18. Source Term Module Input – Known Constituent Flux tab cont.

When all of the information on each tab has been entered, select “Save and Exit” from the File menu to return to the FRAMES workspace. The status indicator next to the Source icon will change to yellow to indicate that the inputs have been entered.

Run Model

The model runs in the background. The status light next to the Source icon should turn green.

View/Print Module output

A second menu will appear (see Figure 19). Choose “SCF Graphical View” to view a screen output in Excel format (see Figure 20). There are also similar viewers for air flux (AFF) and overland water flux (WFF).

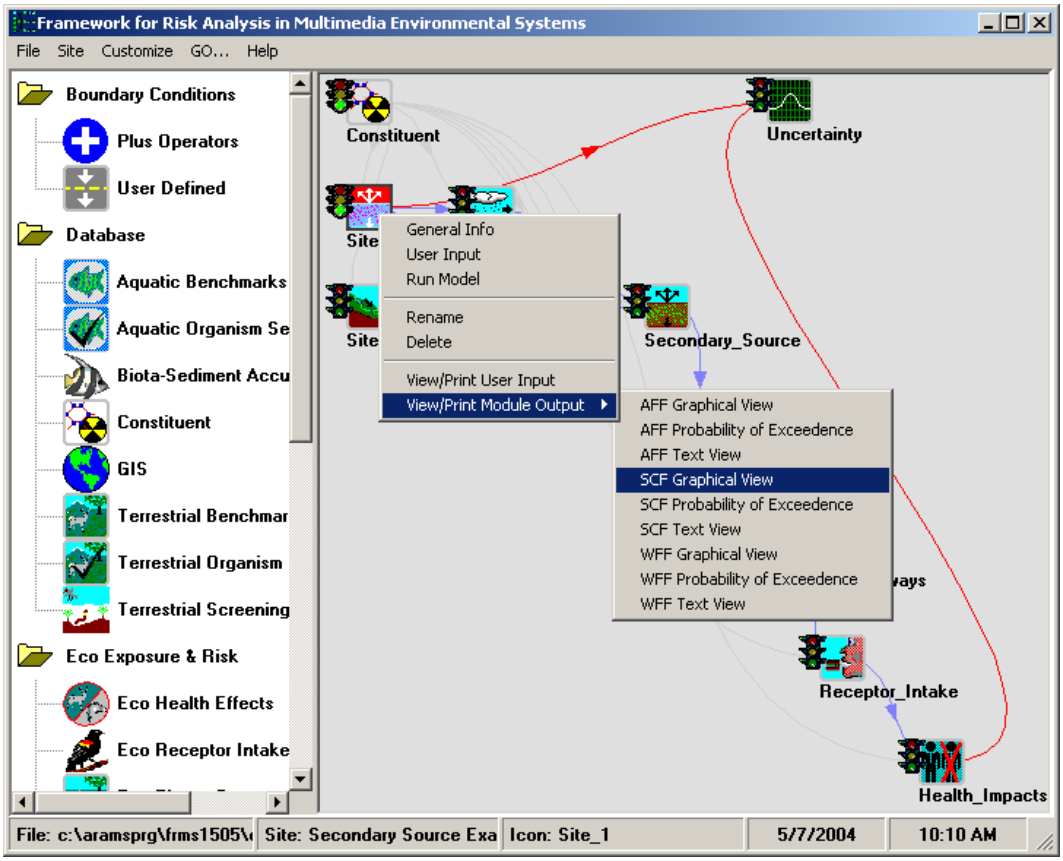


Figure 19. Output Menu for the Mepas 4.1 Source in Soil Module

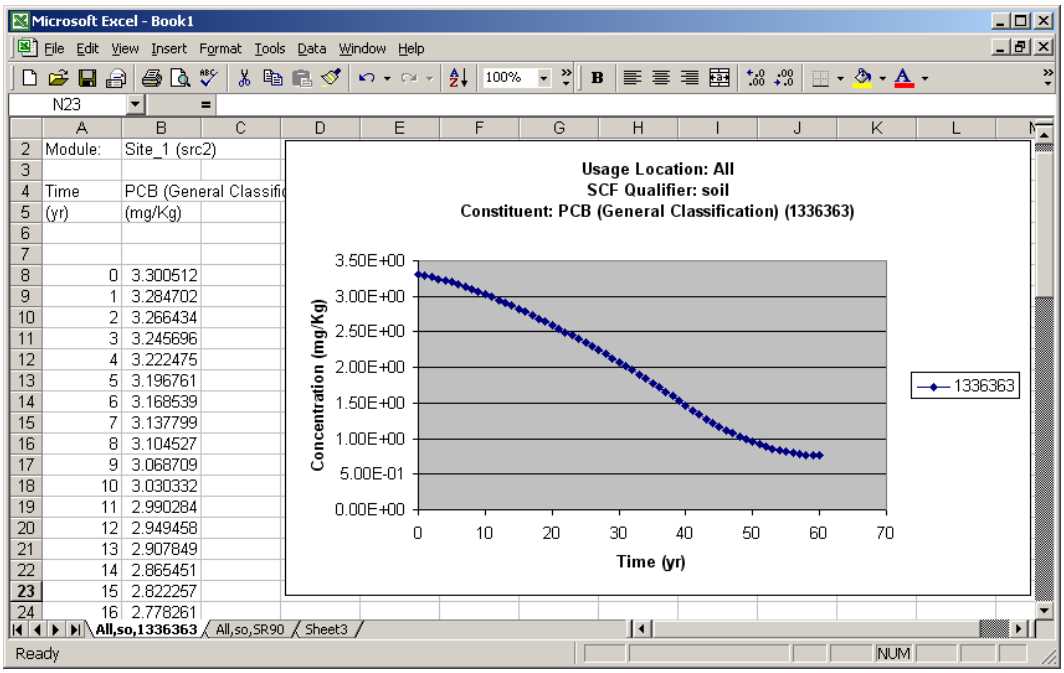


Figure 20. Graphical SCF Viewer Output

User Defined

General Info

A window titled "Object General Information" will appear. Enter 0.5 for both the northing and easting coordinates and –0.005 for the elevation. This indicates that Site 2 is 0.5 kilometers to the north and east of Site 1 and is 5 meters lower in elevation. In the Label text box, input "Site 2." In "Select from Applicable Models," choose "WFF Overland Flow Module" and click "Ok." The status light next to the User Defined icon should turn red. Note that the User Defined icon will now also change to that of an Overland Flow object to reflect the type of module that was chosen.

User Input

A window titled "FRAMES User Defined Module" will appear. Enter the data as given below and shown in Figure 21 for each constituent.

Width of Flux Plane = 7 m
Height of Flux Plane = 0.5 m

- Water Flux
  - 5 m^3/yr at 0 years
  - 5 m^3/yr at 50 years

- PCB (General Classification) Adsorbed Flux
  - 1 g/yr at 0 years
  - 2 g/yr at 10 years
  - 3 g/yr at 20 years
  - 2 g/yr at 30 years

    - 1 g/yr at 40 years
    - 0 g/yr at 50 years

- PCB (General Classification) Dissolved Flux
    - 0.1 g/yr at 0 years
    - 0.2 g/yr at 10 years
    - 0.3 g/yr at 20 years
    - 0.2 g/yr at 30 years
    - 0.1 g/yr at 40 years
    - 0 g/yr at 50 years

- STRONTIUM-90 Adsorbed Flux
    - 0.05 Ci/yr at 0 years
    - 1 Ci/yr at 10 years
    - 0.5 Ci/yr at 20 years
    - 0.1 Ci/yr at 30 years
    - 0.05 Ci/yr at 40 years
    - 0 Ci/yr at 50 years

- STRONTIUM-90 Dissolved Flux
    - 0.002 Ci/yr at 0 years
    - 0.04 Ci/yr at 10 years
    - 0.02 Ci/yr at 20 years
    - 0.004 Ci/yr at 30 years
    - 0.002 Ci/yr at 40 years
    - 0 Ci/yr at 50 years

Choose "Save and Exit" from the File menu to return to the FRAMES work space. The status light next to the User Defined icon should turn yellow.

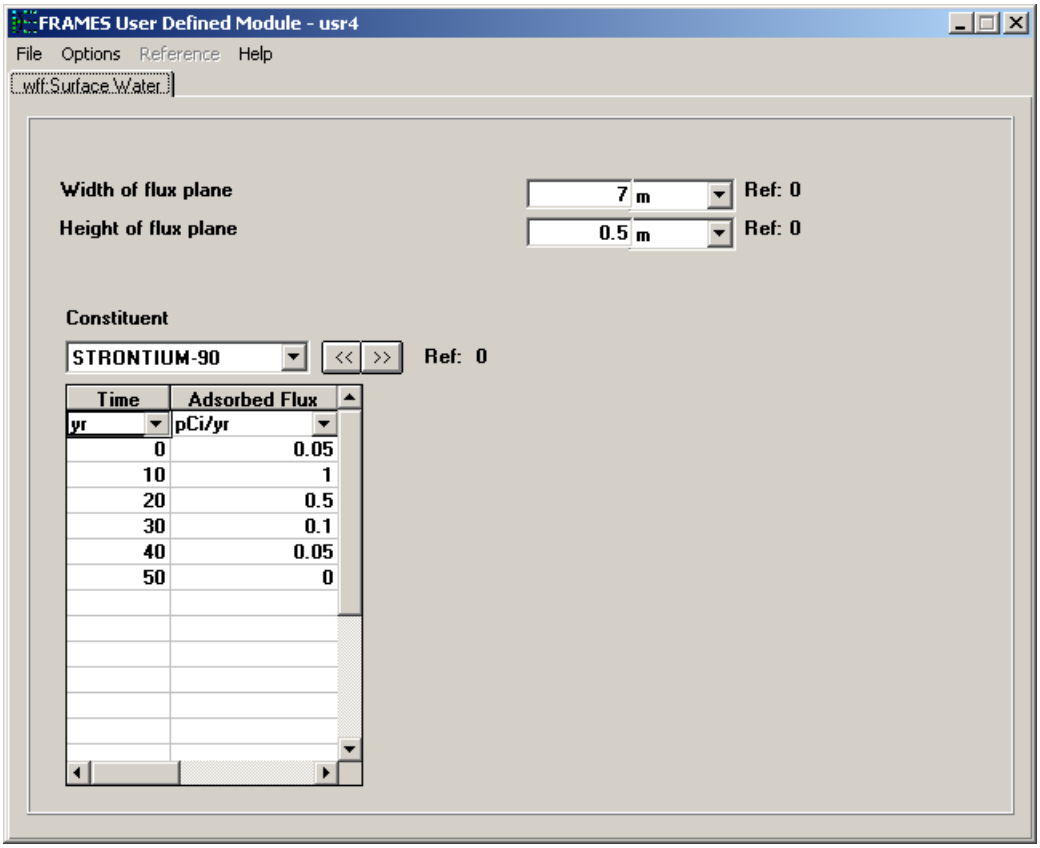


Figure 21. WFF Overland Flow Module Input screen

Run Model

The model runs in the background. The status light next to the User Defined icon should turn green.

View/Print Module output

A second menu will appear. Choose “WFF Graphical View” to view a screen output in Excel format (see Figure 22).

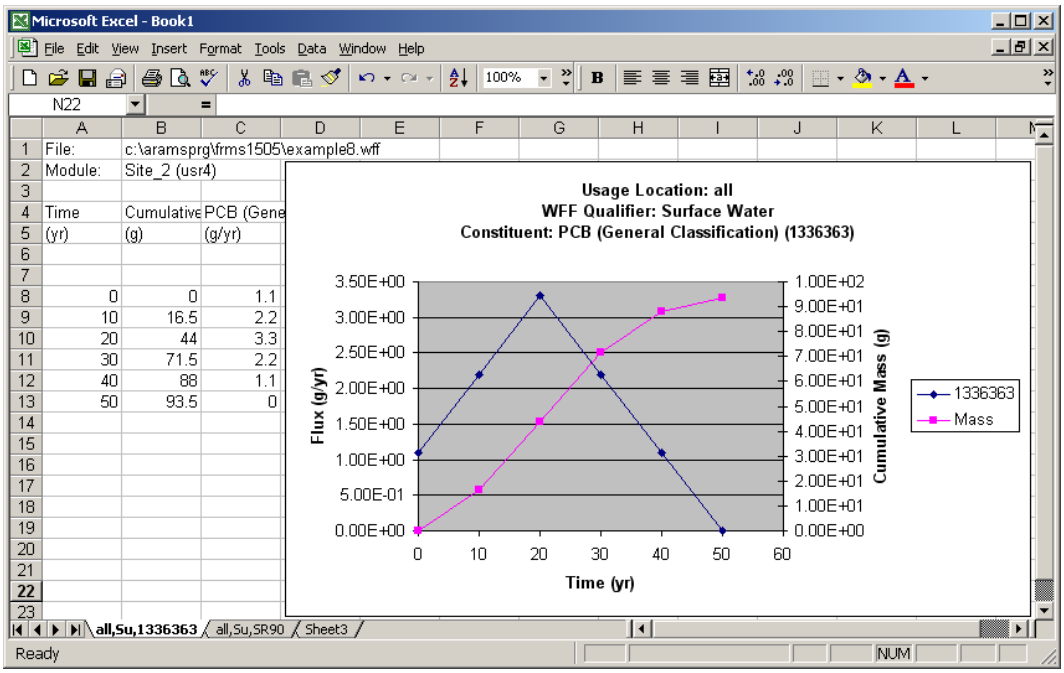


Figure 22. Graphical WFF Viewer Output

Plus Operators

General Info

A window titled “Object General Information” will appear. The Plus Operator is assumed to be at the same location as the Secondary Source since this is where the two overland runoff streams will combine to contaminate the Secondary Source. Enter 0.5 for the easting coordinate, 0 for the northing coordinate, and –0.01 for the elevation. In the Label text box, input “Plus Operator.” In “Select from Applicable Models,” choose “WFF Overland Plus Operator” and click “Ok.” The status light next to the Plus Operators icon should turn red.

User Input

The Plus Operators object does not require any user input since it is simply taking the output from two upstream modules and combining them to produce a single output file. In this case a Water Flux File (WFF) will be produced, which is the sum of runoff from Site 1 and Site 2.

Run Model

The model runs in the background. The status light next to the Plus Operators icon should turn green.

View/Print Module output

A second menu will appear. Choose "WFF Graphical View" to view a screen output in Excel format (see Figure 22). The output from this module will be the sum of the outputs from the Mepas 4.1 Source in Soil (Site 1) and the WFF Overland Flow (Site 2) modules.

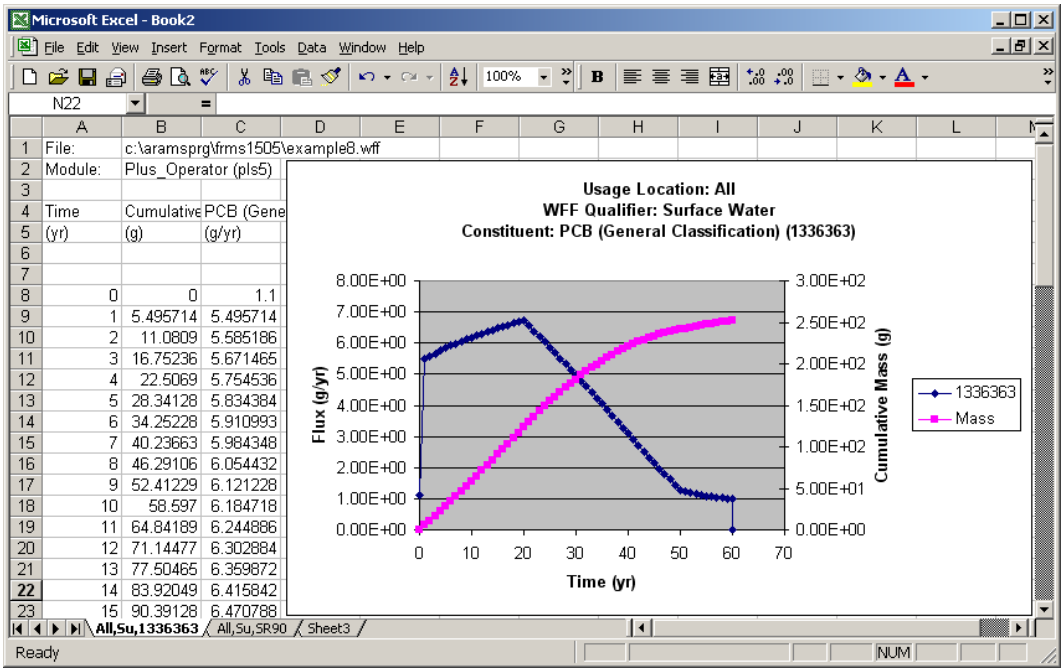


Figure 22. Graphical WFF Viewer Output

Air

General Info

The Air module will simulate the transport of material from Site 1 to other locations, including the secondary source site. A window titled "Object General Information" will appear. The origin of the air model is assumed to be coincident with the origin of this scenario and Site 1, so it will have the same coordinates and elevation as Site 1, which is the origin. In the Label text box, input "Air." In "Select from Applicable Models," choose "Mepas 4.1 Air Module" and click "Ok." The status light next to the Air icon should turn red.

User Input

A screen titled "Mepas Atmospheric Module" will appear. There are three main tabs containing fields that must be filled by the user. Enter the information for each tab as given below. For further information on any of these fields, select "How to …" from the Help menu or press the F1 key to go directly to the information for the current field.

- The first tab labeled “Climatology” is shown in Figure 23 and contains general climatological data.

    - Reference Weather Station – identifier of the weather station where the data was obtained (this field is not required and may be left blank)
    - Morning mixing height = 400 m
    - Afternoon mixing height = 900 m
    - Annual precipitation = 10 in
    - Precipitation days per year = 70
    - Thunderstorms per year = 25

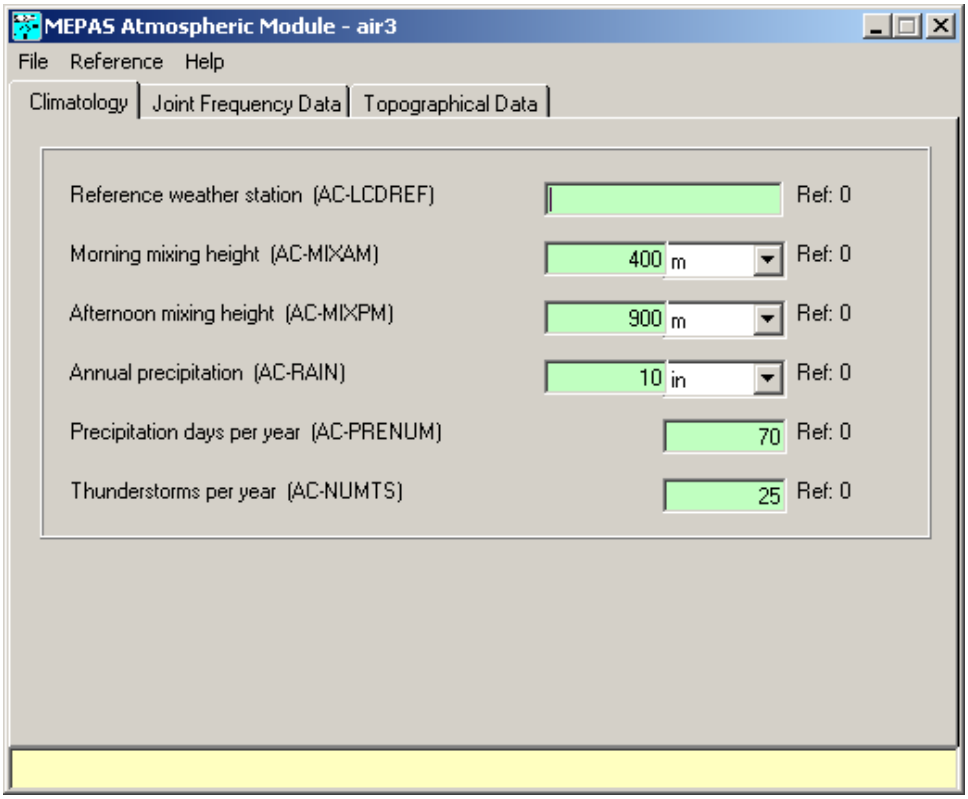


Figure 23. Mepas Atmospheric Module – Climatology tab

- The second tab is the “Joint Frequency Data” tab shown in Figure 24. This tab will be used to input data pertaining to the relative frequencies of various wind conditions for the area surrounding the current site. There are eight tabs under the Joint Frequency Data section. The tab labeled “General” is used to enter general information pertaining to the frequency data. The other seven tabs labeled “Class A” through “Class G” contain tables for entering information about each of these wind stability classes. Wind frequency data can be obtained through the STAR PROGRAM summaries from the National Climatic Data Center (NCDC) in Asheville, North Carolina, which is operated by the National Oceanic and Atmospheric Administration (NOAA's) Environmental Data Service. A file containing frequency data will be imported and used to fill the tables in this example. Click the button labeled “Import Joint Frequency Data” at the bottom of the “General” tab. Select the file titled

"JFData.jfd" from the FRAMES directory as shown in Figure 25 and select "OK." The data for the "Wind joint frequency calms" section on the "General" tab will be filled in along with the tables for the wind stability classes on the remaining tabs. Enter the additional data given below on the "General" tab as shown in Figure 24.

- Anemonometer height = 10 m
- Average roughness length = 2 cm
- Wind speed midpoints
  - Group 1 = 0 m/s
  - Group 2 = 2 m/s
  - Group 3 = 3 m/s
  - Group 4 = 4 m/s
  - Group 5 = 5 m/s
  - Group 6 = 6 m/s

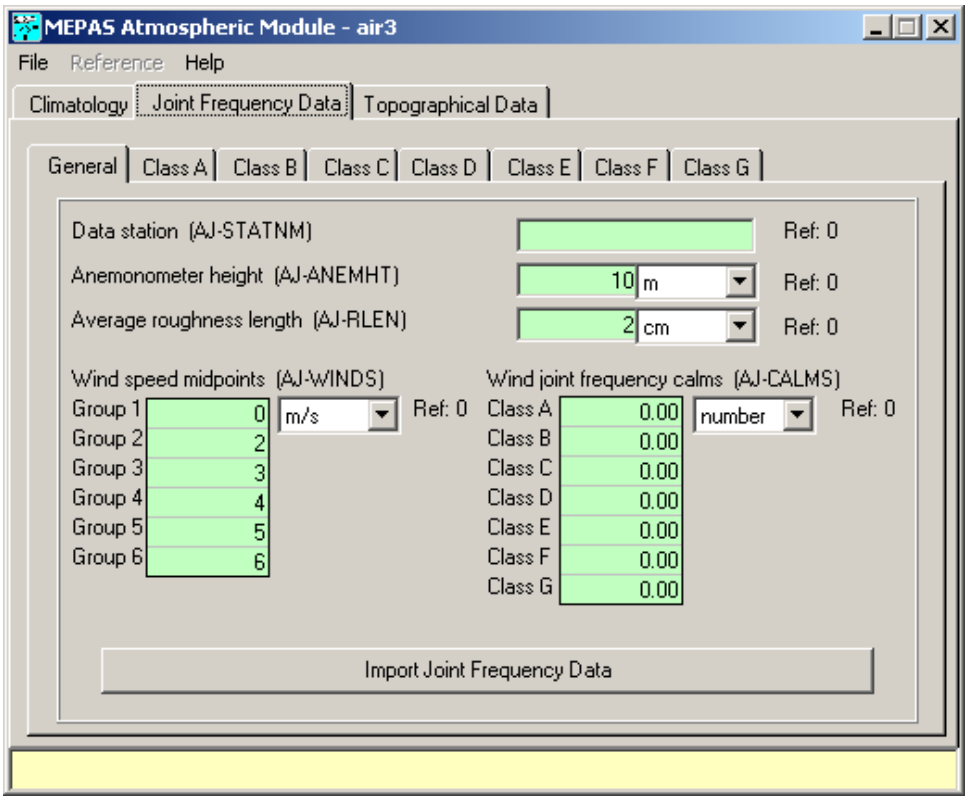


Figure 24. Mepas Atmospheric Module – Joint Frequency Data tab

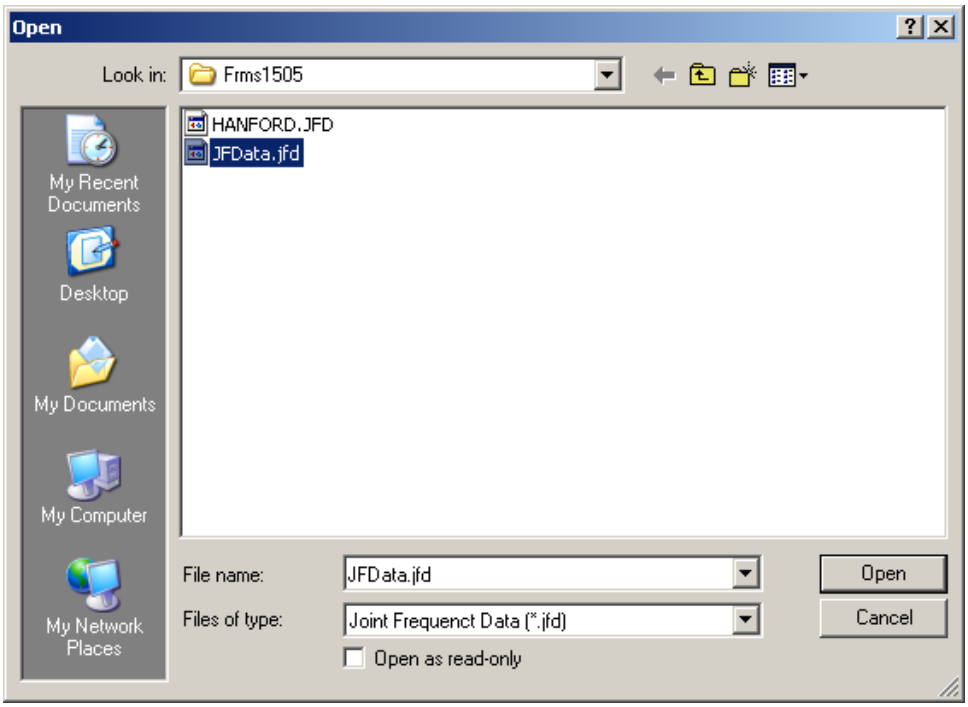


Figure 25. Selection of a Joint Frequency Data File for Importing

- The last tab is labeled “Topographical Data” and is used to enter information for elevated releases or information about the topography of the site if the terrain will be assumed to influence the atmospheric movements. For this example the default values will be used as shown in Figure 26 so no further input is required. Select “Save and Exit” from the File menu to return to the FRAMES work space. The status light next to the Air icon should turn yellow.

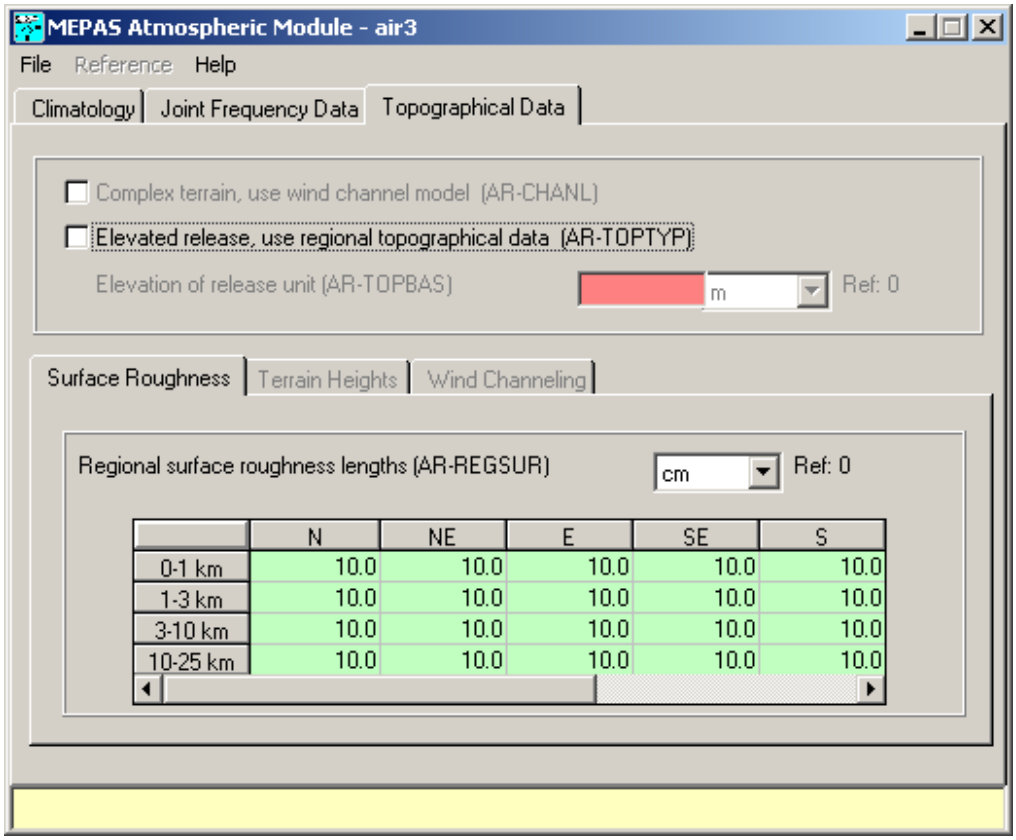


Figure 26. Mepas Atmospheric Module – Topographical Data tab

Run Model

The model runs in the background. The status light next to the Air icon should turn green.

View/Print Module output

A second menu will appear. Choose “GNUPLOT ATO Concentrations” to view a three-dimensional plot of the constituent concentrations and deposition rates in the atmosphere around the current site. A dialog will appear prompting the user for the center coordinate for both northing and easting as well as the time span and time interval for the graphs that will be created (see Figure 27). Accept the default values and click the “Convert” button to load the first graph. This viewer will produce plots of the constituent concentrations in air as well as deposition rates as shown in Figures 28 and 29, respectively.

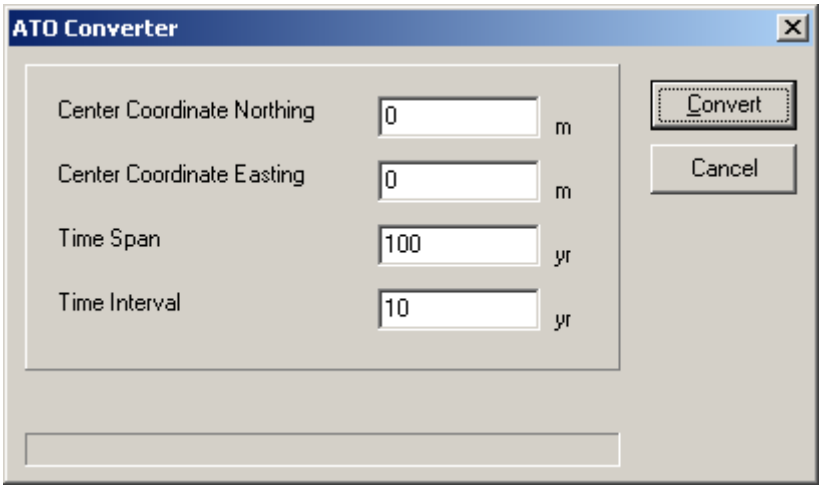


Figure 27. GNUPLOT ATO Converter Dialog

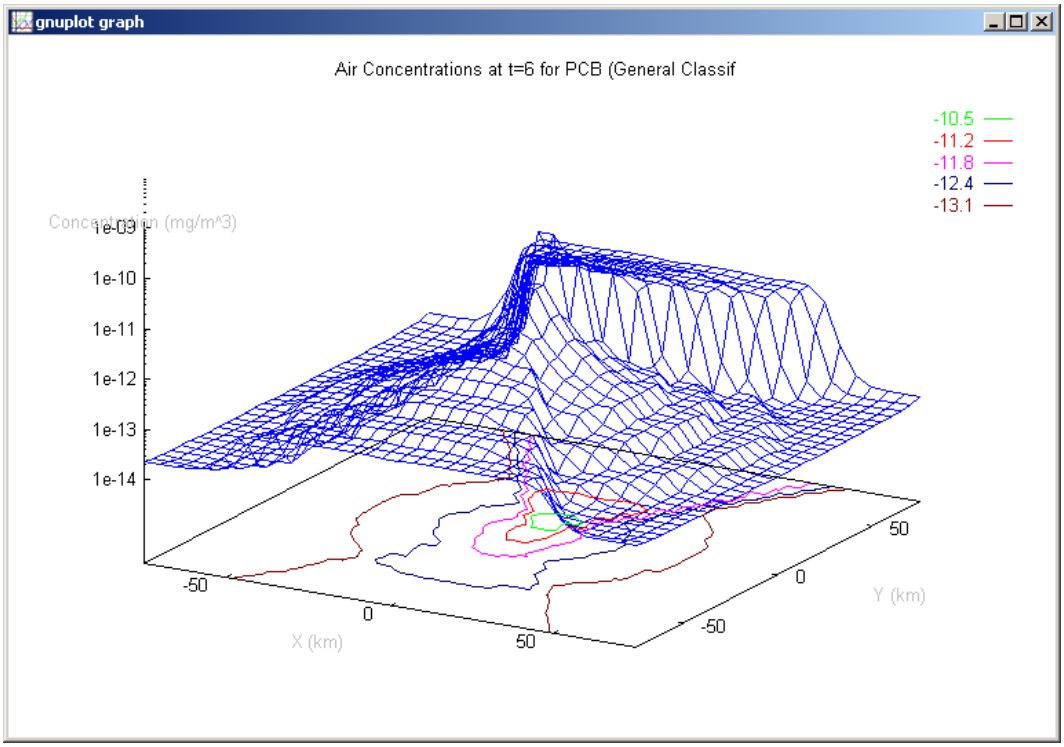


Figure 28. Plot of PCB concentrations in the air at Site 1 after 6 years

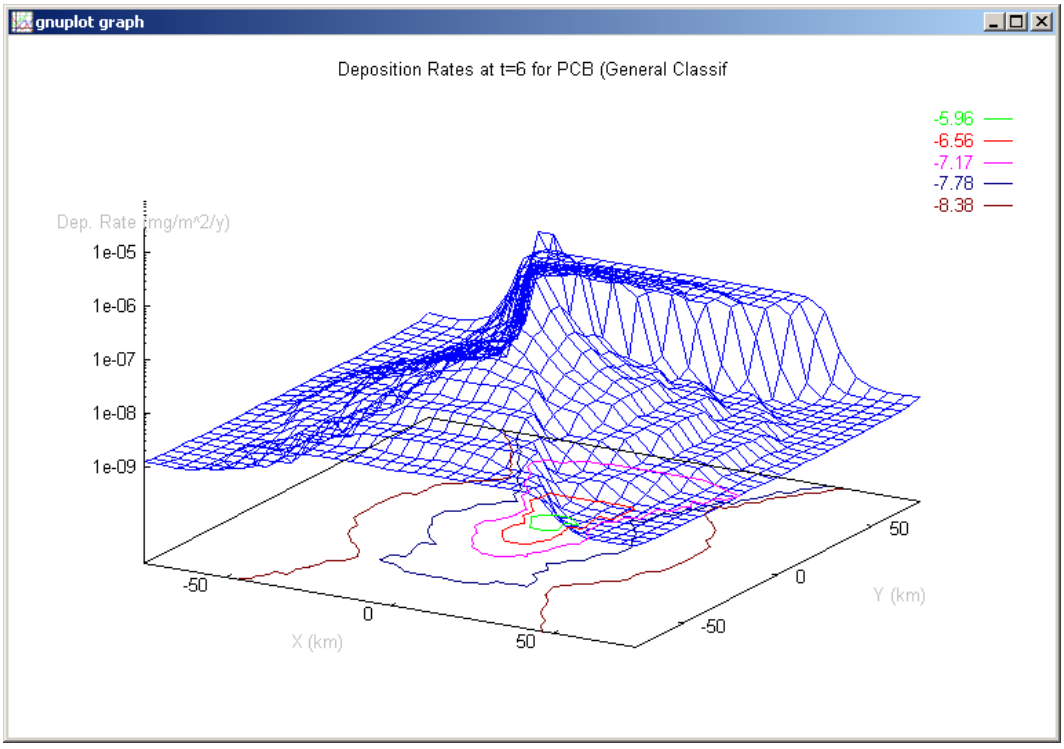


Figure 29. Plot of PCB deposition rates at Site 1 after 6 years

Overland Flow

General Info

A window titled "Object General Information" will appear. Enter 0.5 for the easting coordinate, 0 for the northing coordinate, and –0.01 for the elevation. The location can affect how much deposition from air is received from the air model. In the Label text box, input "Secondary Source." In "Select from Applicable Models," choose "Copy of Mepas 4.1 Secondary Source in Soil" and click "Ok." The status light next to the Overland Flow icon should turn red.

User Input

Since this module is a copy of the Mepas 4.1 Secondary Source in Soil, the module and the inputs are similar to those explained for the Mepas 4.1 Source in Soil module that was used to model Site 1. The main difference in the Secondary Source module is that the source/sink terms are automatically set to use the Secondary Sources from the Plus Operator and Mepas 4.1 Air Module as shown in Figure 30. Enter the data for each tab as given below.

- *Options Tab (for pathway and simulation settings) – Figure 30*
  - Turn off the leaching loss route
  - Set the overland runoff loss route as a known erosion rate
  - Set the suspension loss route to be computed
  - Turn off the volatilization loss route

- Time period for the simulation is 210 years
- Fraction of residual mass for the simulation is 0.01

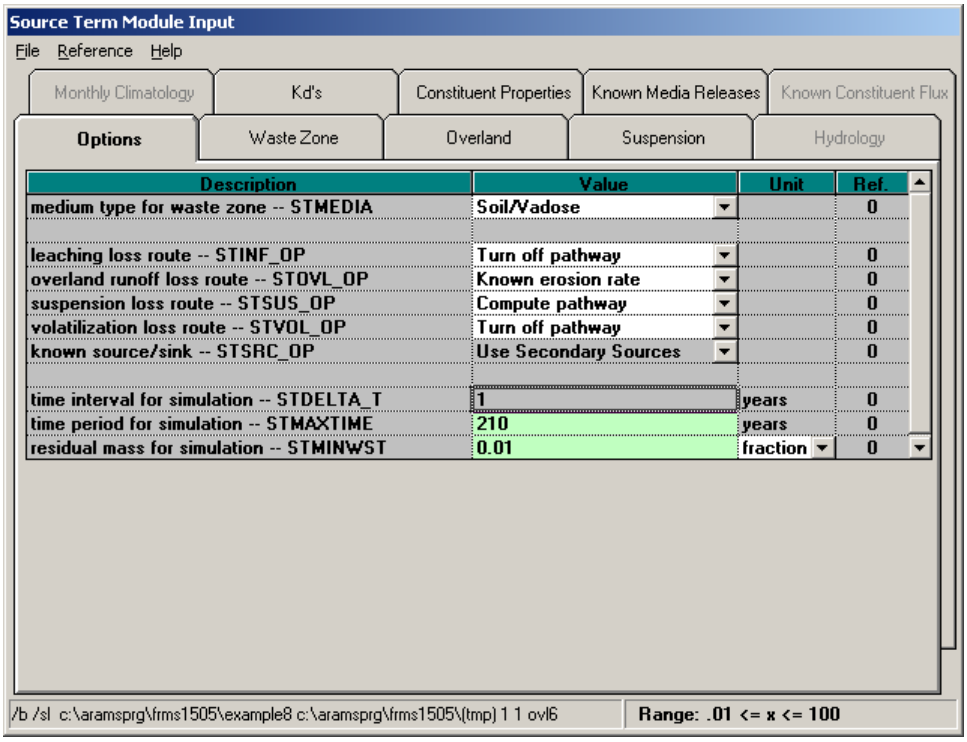


Figure 30. Source Term Module Input – Options tab

- *Waste Zone Tab (soil and other physical properties) – Figure 31*
  - Thickness of clean overburden = 0 cm
  - Thickness = 5 m
  - Length = 200 m
  - Width = 100 m
  - Bulk density = 1.4 g/cm^3
  - Total porosity = 0.4
  - Moisture content = 0.2
  - Average air temperature = 25˚C
  - Height above ground of local wind measure = 10 m
  - Since the “Compute pathway” option was selected for the suspension pathway, the mean annual wind speed is required. Set this value to 10 mi/hr.

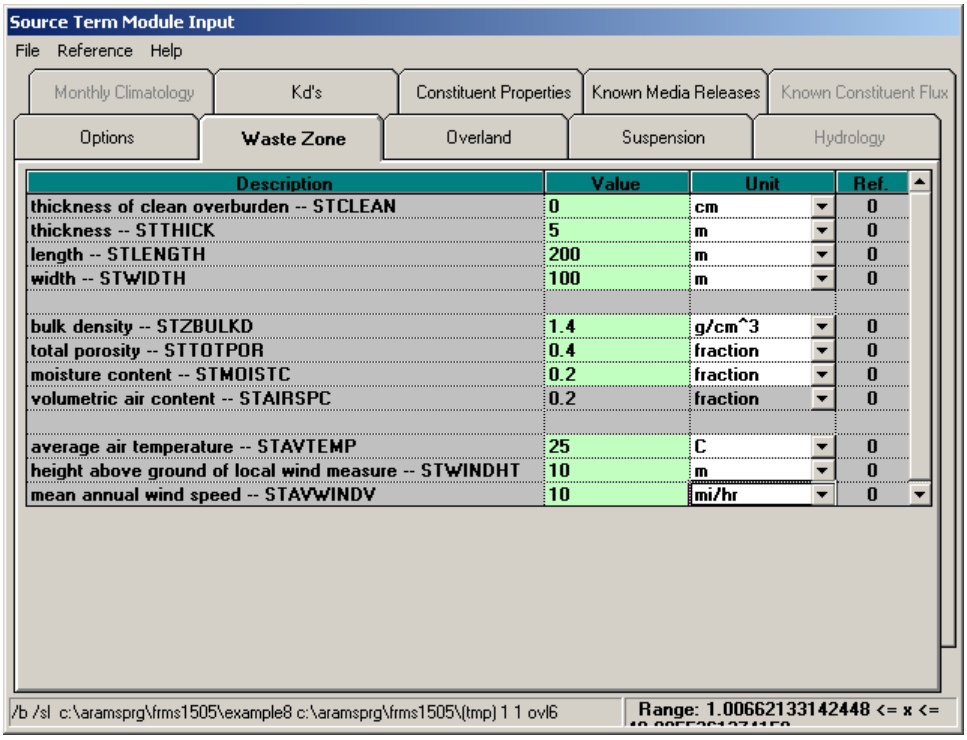


Figure 31. Source Term Module Input – Waste Zone tab

- *Overland Tab (overland flow data)*
  - Discharge of water to overland = 5 m^3/yr

- *Suspension Tab (data for calculating particle suspension) – Figure 32*
  - The suspension model used in the Mepas 4.1 Secondary Source in Soil module is based on a 1985 report by Chatten Cowherd of the Midwest Research Institute prepared for the EPA Office of Health and Environmental Assessment. Enter the following data on the suspension tab.
    - Dry bulk density of surface soil = 1.65 g/cm3
    - Fraction of non-erodable surface cover is between 0 and 1%
    - Surface roughness length = 0.6 cm
    - Surface area covered with vegetation = 0.7 (fraction)
    - Surface area covered with a crust layer = 0.2 (fraction)
    - Area-weighted disturbance frequency = 1 per month
    - Fastest mile wind speed = 60 mi/hr
    - Thornwaite's precipitation-evaporation index = 100
    - Aggregate size distribution = 0.6 mm
    - No roadway travel at the site

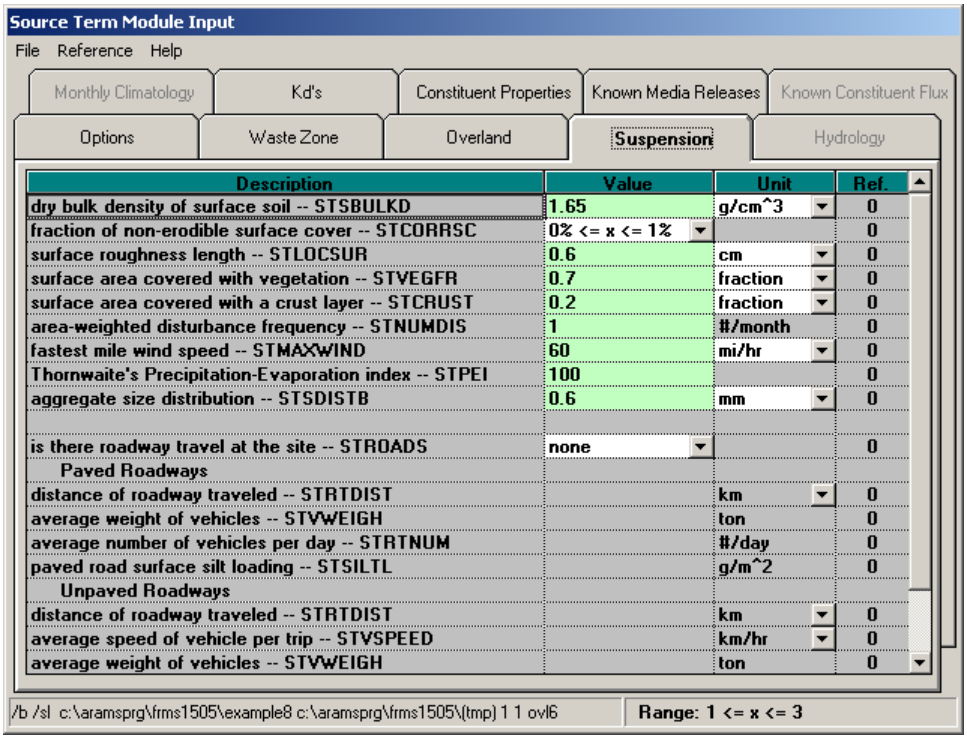


Figure 32. Source Term Module Input – Suspension tab

- *Kd's Tab (Soil partitioning parameters)*
  - Accept the default settings of "Select Adsorption Coeff." and a count of "2" for each constituent. Enter the following values for the partition coefficients.
    - PCB (General Classification)
      - 0 ml/g at time = 0 years
      - 0 ml/g at time = 210 years
    - STRONTIUM-90
      - 0.1 ml/g at time = 0 years
      - 0.1 ml/g at time = 210 years
    - YTTRIUM-90
      - 0.1 ml/g at time = 0 years
      - 0.1 ml/g at time = 210 years

- *Constituent Properties Tab (Chemical properties and inventory)*
  - Enter the following values for the water solubilities. These are the same values as seen in the Source object description above.
    - PCB (General Classification) – 0.031 mg/L
    - STRONTIUM-90 – 1000000 mg/L
    - YTTRIUM-90 – 1000000 mg/L

  - Use the "Worksheet" button for each constituent to enter the inventory as given below. The inventory cannot be set to zero so it is set to a small number in this example to show that the loading is coming from the other sources.
    - PCB (General Classification) – Inventory = 0.1 g

        - STRONTIUM-90 – Inventory = 0.1 Ci

    - Enter the following values for the decay/degradation half-life for each constituent. Note that these values will also be filled from the database if present. These are the same values from the Source object description above.
        - PCB (General Classification) – 43800 days
        - STRONTIUM-90 – 10600 days
        - YTTRIUM-90 – 2.7 days

    - The fraction of volatilization release is not enabled because this pathway was turned off on the Options tab.

- *Known Media Releases Tab (Known Erosion Rates)*
    - Enter the following values as specified.
        - Soil depth lost to water erosion = 5 cm/yr at 0 years
        - Soil depth lost to water erosion = 5 cm/yr at 210 years

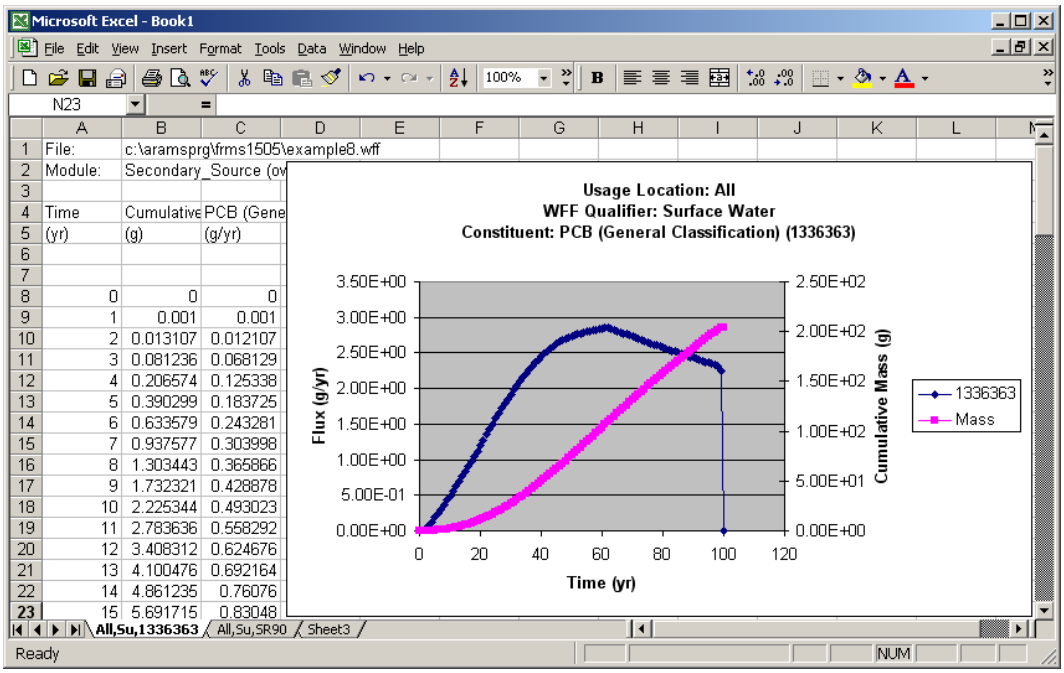
When all of the information on each tab has been entered, select "Save and Exit" from the File menu to return to the FRAMES work space. The status indicator next to the Overland Flow icon will change to yellow to indicate that the inputs have been entered.

Run Model

The model runs in the background. The status light next to the Overland Flow icon should turn green.

View/Print Module output

A second menu will appear. Choose "WFF Graphical View" to view a screen output in Excel format (see Figure 33).



	A	B	C
1	File:	c:\aramsprg\frms1505\example8.wff	
2	Module:	Secondary_Source (ov	
3			
4	Time	Cumulative	PCB (Gene
5	(yr)	(g)	(g/yr)
6			
7			
8	0	0	0
9	1	0.001	0.001
10	2	0.013107	0.012107
11	3	0.081236	0.068129
12	4	0.206574	0.125338
13	5	0.390299	0.183725
14	6	0.633579	0.243281
15	7	0.937577	0.303998
16	8	1.303443	0.365866
17	9	1.732321	0.428878
18	10	2.225344	0.493023
19	11	2.783636	0.558292
20	12	3.408312	0.624676
21	13	4.100476	0.692164
22	14	4.861235	0.76076
23	15	5.691715	0.83048

Figure 33. Graphical WFF Viewer Output

Surface Water

General Info

A window titled “Object General Information” will appear. Enter 0.5 for the easting coordinate, –0.5 for the northing coordinate, and –0.015 for the elevation. However, the location of the surface water object does not matter for this example since the MEPAS 4.1 River Module does not accept air deposition. In the Label text box, input “Surface Water.” In “Select from Applicable Models,” choose “Mepas 4.1 River Module” and click “Ok.” The status light next to the Surface Water icon should turn red.

User Input

A window titled “Mepas River Module” will appear (Figure 34). Enter the data as given below for each tab.

- *Dimensions Tab (physical properties of the river) – Figure 34*
  - Flow velocity at constituent entry point = 2.5 ft/s
  - Depth at constituent entry point = 2 ft
  - Width at constituent entry point = 20 ft

  - There is only one Exposure Pathways object so the usage location is automatically set to this object. Enter the properties given for the river at the usage location.

    - Distance from source (entry point) to (exposure) location = 500 m

- Average annual discharge at location = 100 ft^3/s

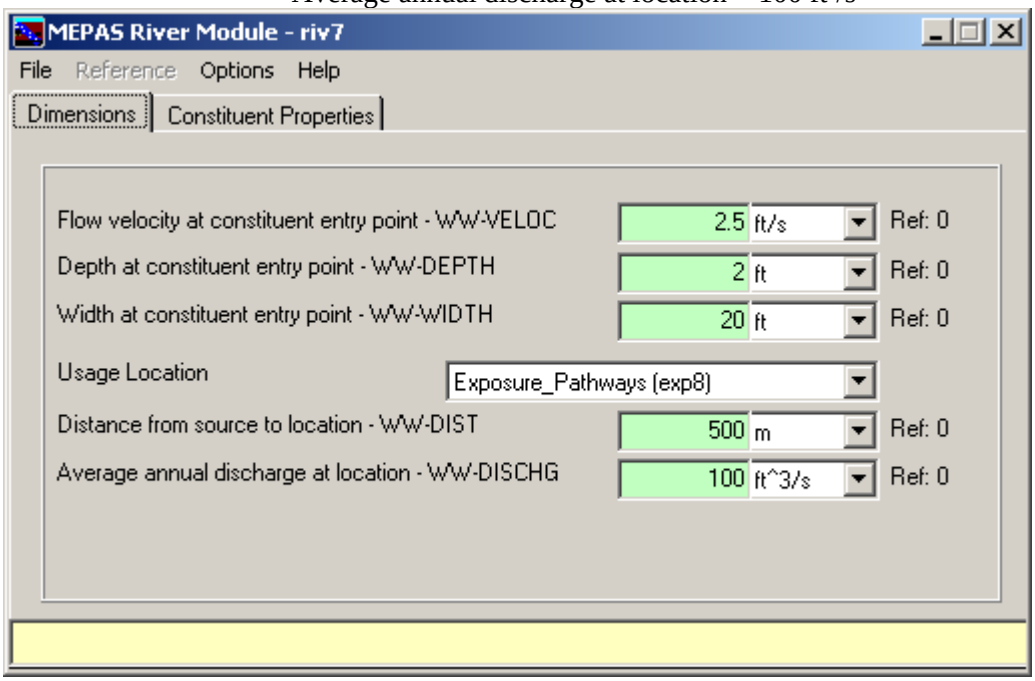


Figure 34. Mepas River Module – Dimensions tab

- *Constituent Properties Tab (chemical properties for each constituent) – Figure 35*
    - PCB (General Classification)
        - Water solubility = 0.031 mg/L
        - Half-life in surface water = 20 yr
    - STRONTIUM-90
        - Water solubility = 1000000 mg/L
        - Half-life in surface water = 10600 days
    - YTTRIUM-90
        - Water solubility = 1000000 mg/L
        - Half-life in surface water = 2.7 days

When all of the information on each tab has been entered, select “Save and Exit” from the File menu to return to the FRAMES work space. The status indicator next to the Surface Water icon will change to yellow to indicate that the inputs have been entered.

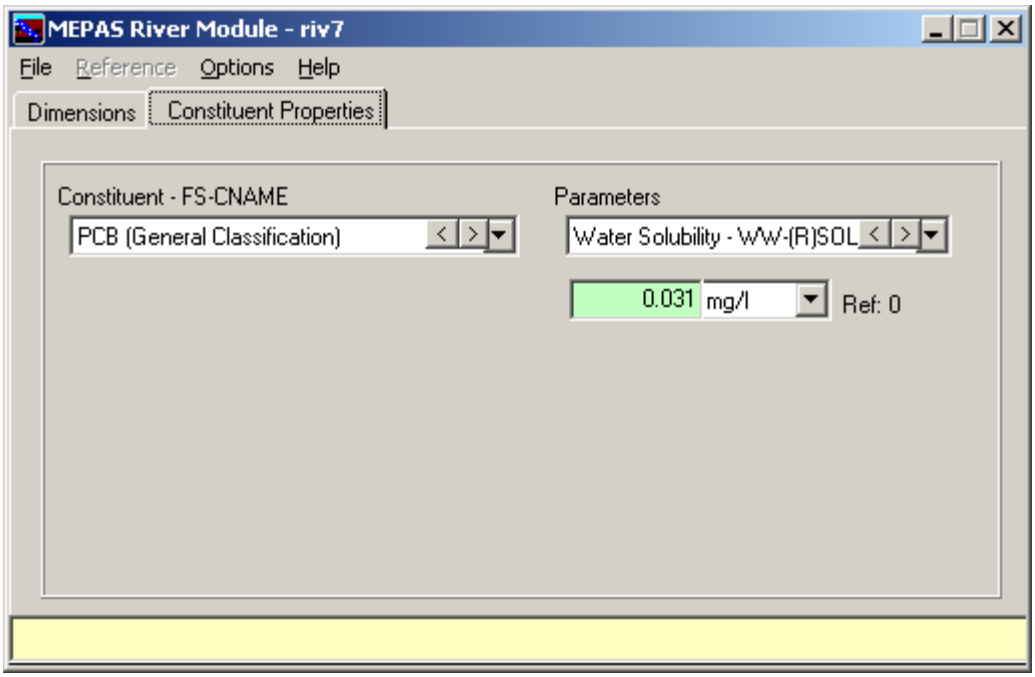


Figure 35. Mepas River Module – Constituent Properties tab

Run Model

The model runs in the background. The status light next to the Overland Flow icon should turn green.

View/Print Module Output

A second menu will appear. Choose “WCF Graphical View” to view a screen output in Excel format (see Figure 36).

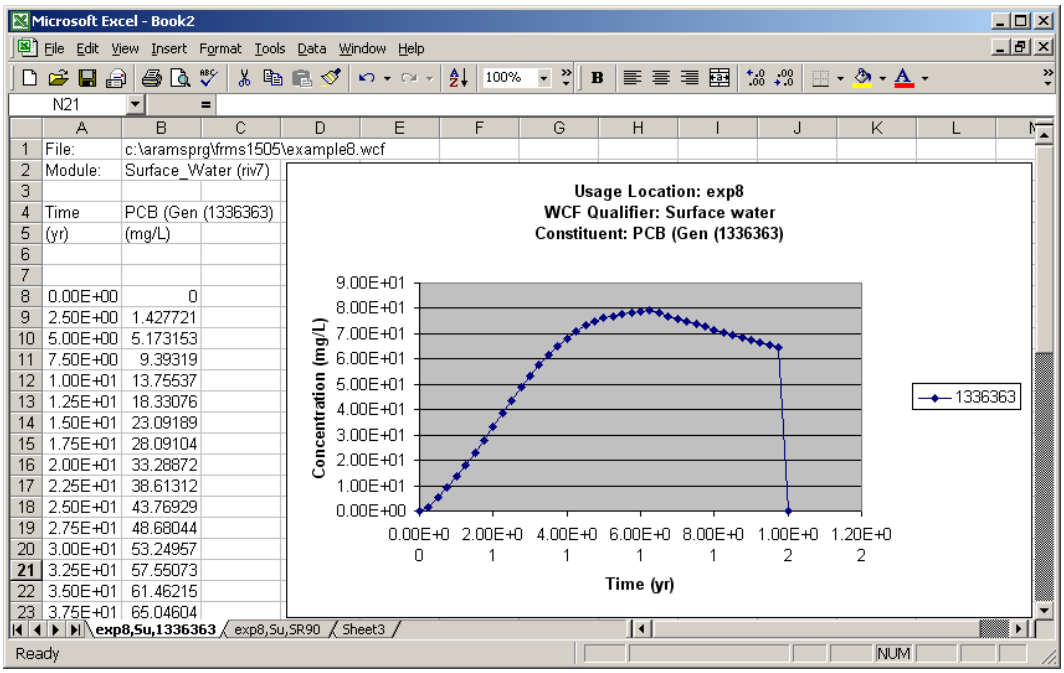


Figure 36. WCF graphical viewer output

Exposure Pathways

General Info

The Exposure Pathways object has been discussed in other tutorials and will be mentioned only briefly here. Enter 0.5 for the easting coordinate, -1 for the northing coordinate, and –0.02 for the elevation. However, the locations don't matter for this example since the exposure location was set in the river module. In the Label text box, input "Exposure Pathway." In "Select from Applicable Models," choose "Mepas 4.1 Chronic Exposure Module" and click "Ok." The status light next to the Exposure Pathways icon should turn red.

User Input

Enter the data given for each of the tabs on the Mepas Chronic Exposure Module screen.

- Surface Water Tab
  - Pathways Tab
    - Exposure duration = 30 yr
    - Select "Leafy vegetables," "Drinking water," and "Shower water" as the pathways to be considered
  - Water Usage Tab (default values are used)
    - Fraction of year that surface water is used for irrigation = 1
    - Irrigation rate = 100 L/m^2/month
    - Domestic water distribution time = 0.5 days
    - Domestic water is not treated

    - Recreational tab (no pathways are considered that would affect data on this tab)
- Exposure Controls Tab
    - Time to start exposure computation = 0 yr
    - Maximum time for reporting = 210 yr
    - Number of time points for evaluation = 20
- Leach Rates Tab (leach rates are set to low values to simulate a worst case scenario where leaching losses are minimal)
    - Leachate selection option = "User provided leach rate constants"
    - Surface soil leach rate constant
        - PCB (General Classification) = 0.05/yr
        - STRONTIUM-90 = 0.05/yr
        - YTTRIUM-90 = 0.05/yr
- Constituent Parameters Tab
    - Half-life in surface water
        - PCB (General Classification) = 20 yr
        - STRONTIUM-90 = 10600 days
        - YTTRIUM-90 = 2.7 days

Changes can also be made to other parameters such as Animal Intake Rates, Feed and Water Contamination, etc. by selecting "Customize" from the menu. Default values were used for this example. Choose "Save and Exit" from the File menu. The status indicator next to the Exposure Pathways icon should turn yellow.

Run Model

The model runs in the background. The status light next to the Exposure Pathways icon should turn green.

View/Print Module Output

Refer to Example 4 for a sample of output data from the Exposure Pathways object.

Receptor Intake

General Info

The Receptor Intake object has been discussed in other tutorials and will be mentioned only briefly here. In the Label text box, input "Receptor Intake." In "Select from Applicable Models," choose "Mepas 4.1 Intake Module" and click "Ok." The status light next to the Receptor Intake icon should turn red.

User Input

Enter the data given below. All default values are used for this example.

- Body weight of individual = 70 kg
- Exposure duration = 30 yr
- Water dermal absorption model = "EPA model"

- Ground water ingestion rate = 2 L/day
- Surface water ingestion rate = 2 L/day
- Age of receptor at start of exposure = 0 yr
- Age of receptor at end of exposure = 70 yr
- Method for inhalation impact analysis = "Air concentration"

Additional parameters may be modified by selecting "Customize" from the menu. However, all default values for this module were used for this example as stated earlier. Choose "Save and Exit" from the File menu. The status indicator next to the Receptor Intake icon should turn yellow.

Run Model

The model runs in the background. The status light next to the Receptor Intake icon should turn green.

View/Print Module Output

Refer to Example 4 for a sample of output data from the Receptor Intake object.

Health Impacts

General Info

The Health Impacts object has been discussed in other tutorials and will be mentioned only briefly here. In the Label text box, input "Health Impacts." In "Select from Applicable Models," choose "Mepas 4.1 Human Health Impact Module" and click "Ok." The status light next to the Health Impacts icon should turn red.

User Input

Enter the data given below. All default values are used for this example.

- Chemical Tab
  - Calculate lifetime cancer incidence = True
  - Calculate hazard index = True
    - Hazard quotient threshold limit = 0
  - Method for inhalation impact analysis = "Air concentration"

- Radionuclide Tab
  - Calculate lifetime cancer incidence = True
    - Conversion factor = 0.06
  - Cancer risk evaluation method = "ICRP dose and risk factors"
  - Thickness of contaminated soil/sediment layer = 0.04 m
  - Density of contaminated soil/sediment layer = 1.5 g/cm^3

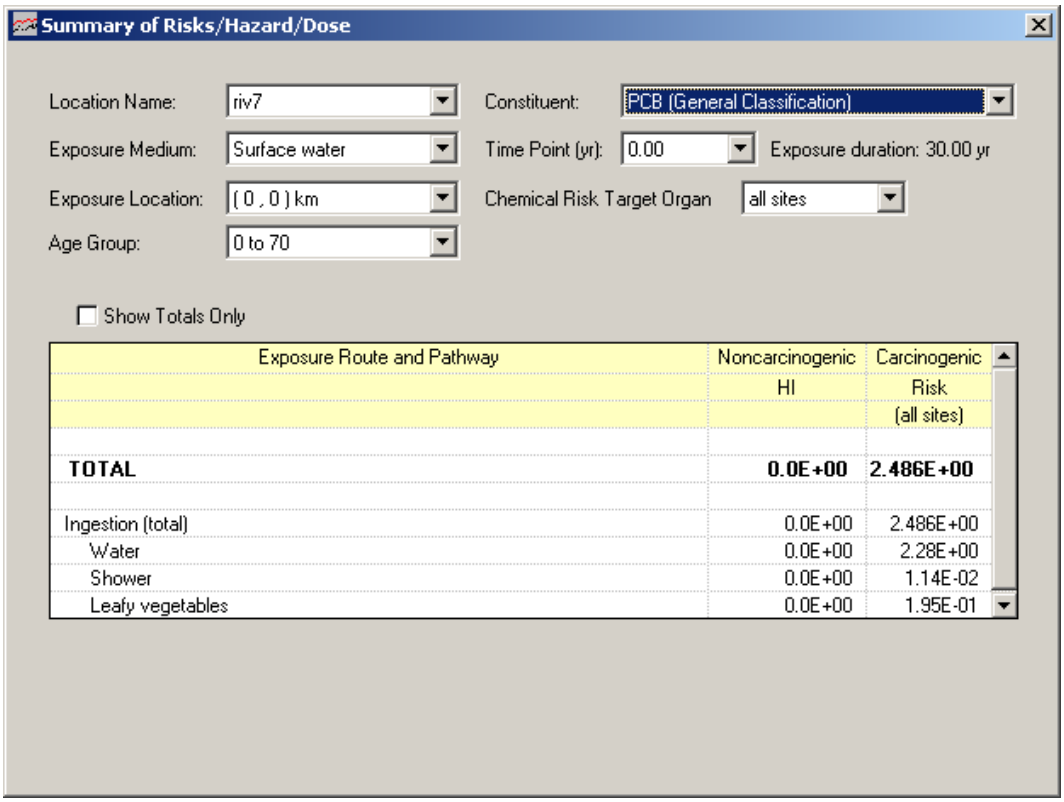
Choose "Save and Exit" from the File menu. The status indicator next to the Health Impacts icon should turn yellow.

Run Model

The model runs in the background. The status light next to the Health Impacts icon should turn green.

View/Print Module Output

A second menu will appear. Choose "Summary Views of Risk, Hazard and Dose" to view the screen shown in Figure 37. This viewer shows summary data and totals for the exposure pathways that were chosen. The user can select options such as the location, exposure medium, constituent and time point to determine the data that are shown.



Exposure Route and Pathway	Noncarcinogenic HI	Carcinogenic Risk (all sites)
TOTAL	**0.0E+00**	**2.486E+00**
Ingestion (total)	0.0E+00	2.486E+00
Water	0.0E+00	2.28E+00
Shower	0.0E+00	1.14E-02
Leafy vegetables	0.0E+00	1.95E-01

Figure 37. Summary Viewer for Health Impacts Module

Sensitivity

General Info

The Health Impacts object has been discussed in other tutorials and will be mentioned only briefly here. In the Label text box, input "Uncertainty." In "Select from Applicable Models," choose "Mepas Sensitivity/Uncertainty" and click "Ok." The status light next to the Sensitivity icon should turn red.

User Input

The variables and outputs that were considered uncertain in this example are listed below. For more information on the Sensitivity object refer to Example 4.

- Variables
  - Wind suspension flux rates at Site 1
    - PCB (General Classification) at times 0, 10, 40 and 60 years
    - STRONTIUM-90 at times 0, 10, 40 and 60 years
  - Water erosion rates at Site 1 at times 0 and 60 years

- Output Parameters
  - Total constituent flux peak for PCB (General Classification) at Site 1
  - Carcinogenic risk peak for PCB (General Classification)

Run Model

The model runs in the background. The status light next to the Health Impacts icon should turn green.

View/Print Module Output

An example of output from the Sensitivity/Uncertainty Module is shown in Figure 38 for PCB peak carcinogenic risk probability of exceedence.

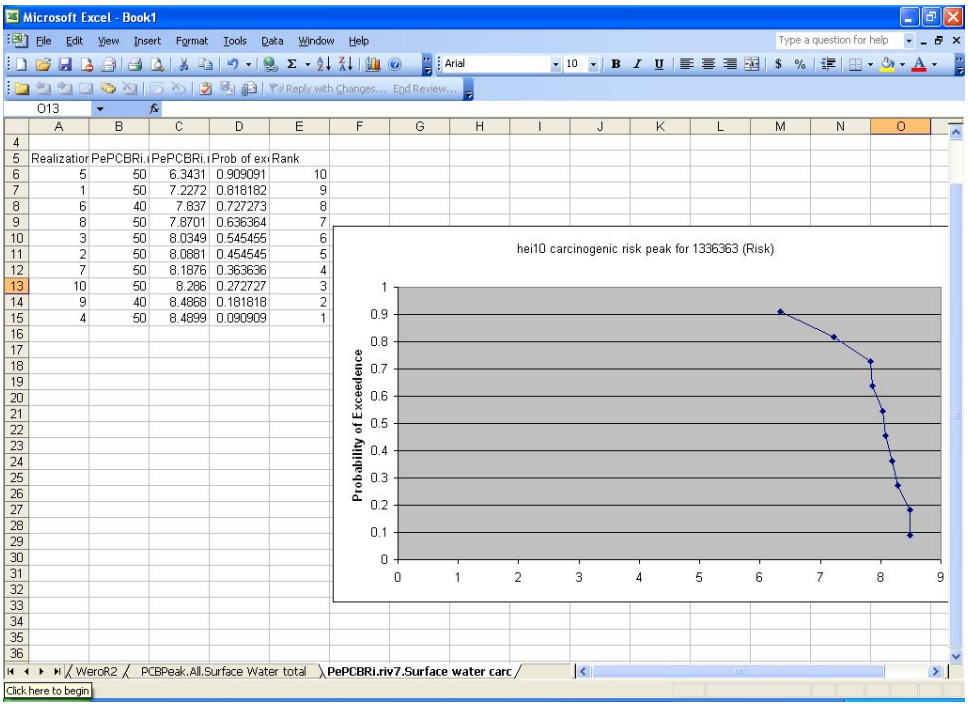


Figure 38. Output from Sensitivity/Uncertainty Module viewer for PCB peak carcinogenic risk