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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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 Risk Assessment Guidelines for Superfund (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) is fairly complex and demonstrates the versatility of ARAMS for analyzing multiple fate/transport pathways within a watershed. The example 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 from Sites 1 and 2 and air deposition computed by the MEPAS Air Module as inputs to calculate a contaminated runoff stream from the land area of the downstream site. The runoff from the Overland Flow object flows into a stream and the MEPAS River Model is used to calculate the water concentration at a downstream extraction point. The extracted water 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. The object workspace for this example is shown in Figure 2.

Site 1, one of the originally contaminated sites, uses the MEPAS Source in Soil module, and the secondary overland site uses the MEPAS Secondary Source in Soil module to calculate the losses due to resuspension of particles, storm water runoff, degradation, and leaching. The leaching pathway is not considered for Site 1 due to the presence of a leachate collection system; rather, the leachate collection system 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 User Defined WFF

(Water Flux File) Surface Water module to specify the known flux of water and constituents from the sediment trap. The constituent chosen for this example is PCB (General Classification).

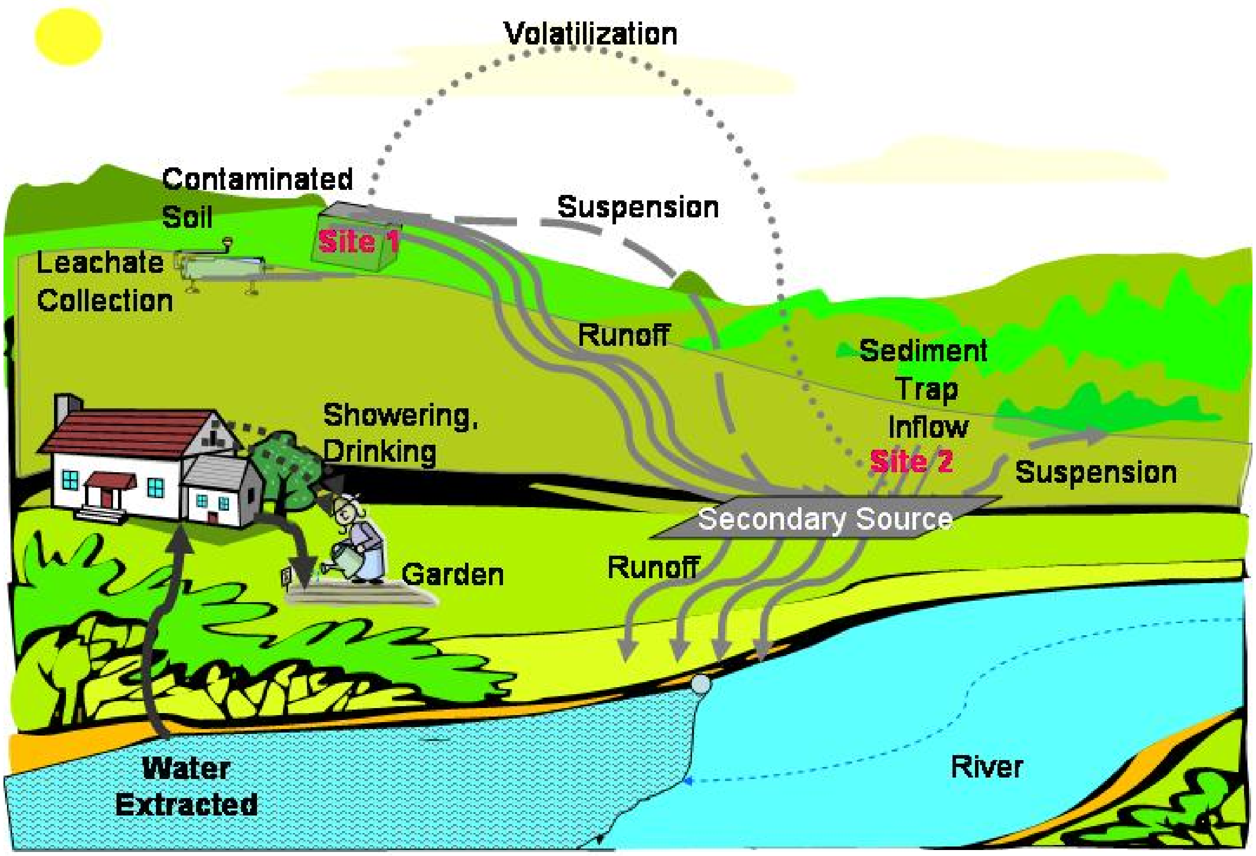


Figure 1. Illustration of the scenario being modeled in this example

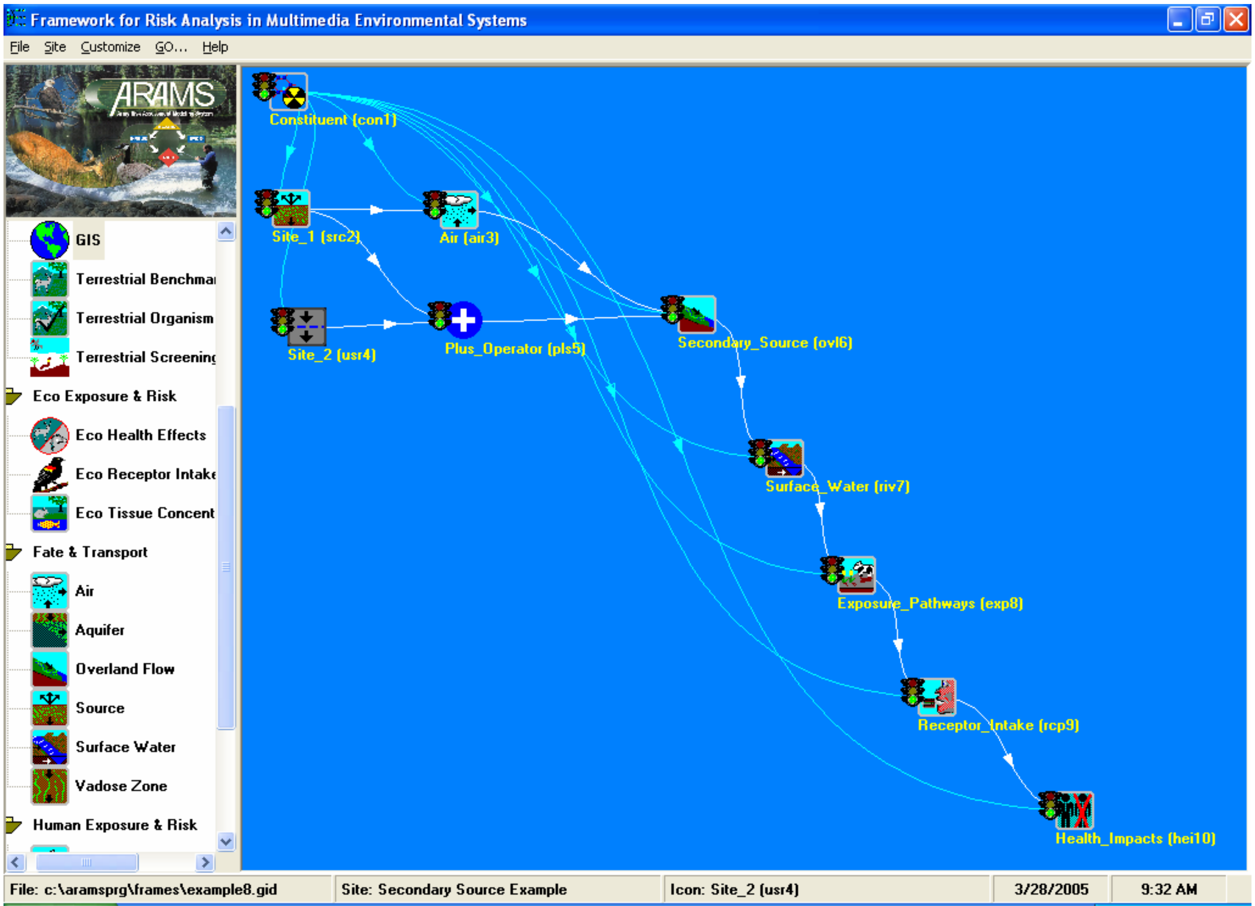


Figure 2. Object workspace for example application

Input Data

- Double-click on the ARAMS icon to open the “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 may 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” (see Figure 3). A window titled “Global Input Data Open New” will appear. 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”
“Plus Operator”
“Overland Flow”
“Surface Water”
“Exposure Pathways”
“Receptor Intake”
“Health Impacts”

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 removed.). Lines from the Constituent icon can be made transparent to make the object work space less cluttered by clicking *Customize* on the FRAMES menu bar, clicking *Colors*, making sure *Database Connections* is highlighted, then un-checking *Visible*.

Connect the following pairs of icons:

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

Constituent	→	*Overland Flow*
Constituent	→	*Surface Water*
Constituent	→	*Exposure Pathways*
Constituent	→	*Receptor Intake*
Constituent	→	*Health Impacts*
Source	→	*Air*
Source	→	*Plus Operator*
User-Defined	→	*Plus Operator*
Plus Operator	→	*Overland Flow*
Air	→	*Overland Flow*
Overland Flow	→	*Surface Water*
Surface Water	→	*Exposure Pathways*
Exposure Pathways	→	*Receptor Intake*
Receptor Intake	→	*Health Impacts*

FRAMES should now look something like Figure 2.

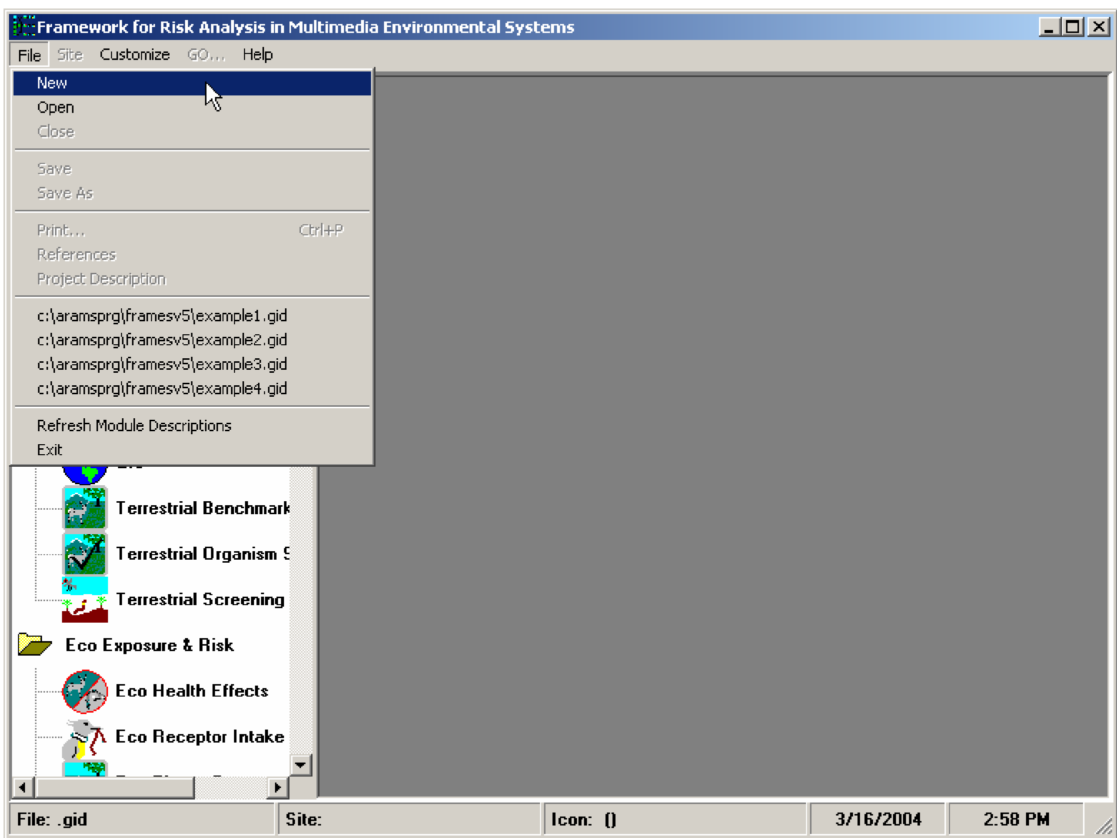


Figure 3. Opening a new file

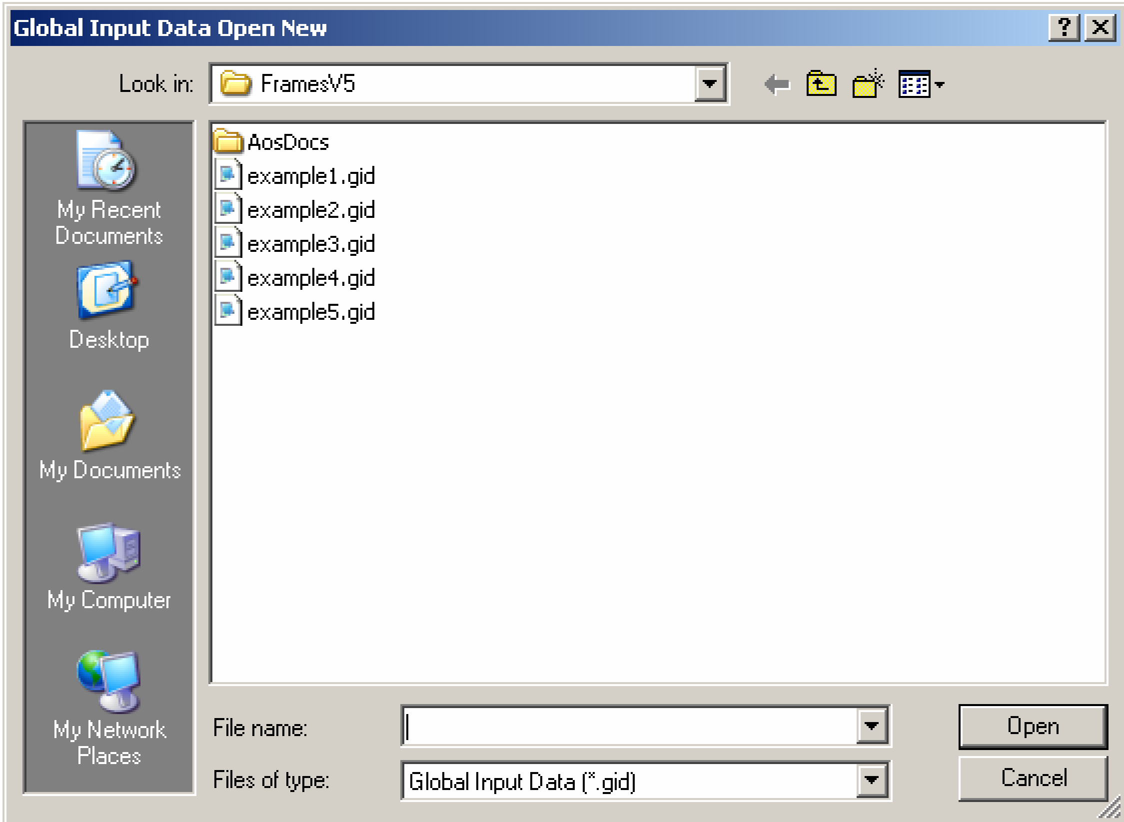


Figure 4. Global Input Data Open New screen (new file window)

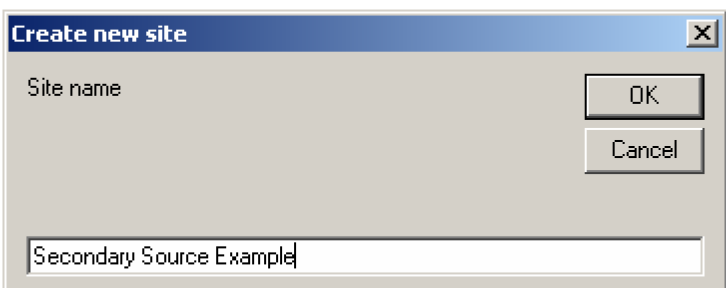


Figure 5. Create New Site screen (input "Site name" box)

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 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 constituent used in this case is PCB (General Classification). Scroll to select the constituent from the constituents list or use the Find option to search for it. Click the "Add >>>" button to add PCB 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.

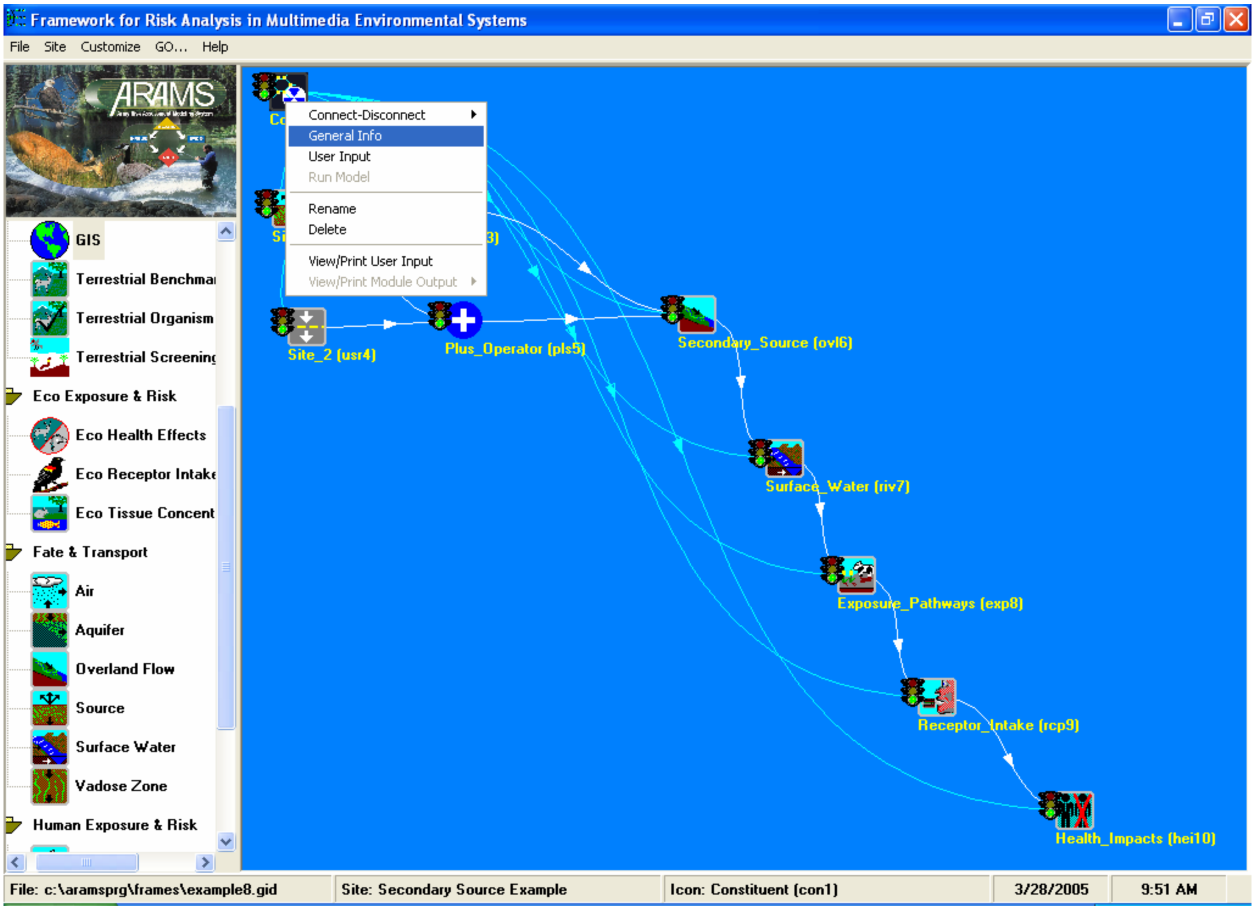


Figure 6. Workspace screen (right-click on the Constituent icon)

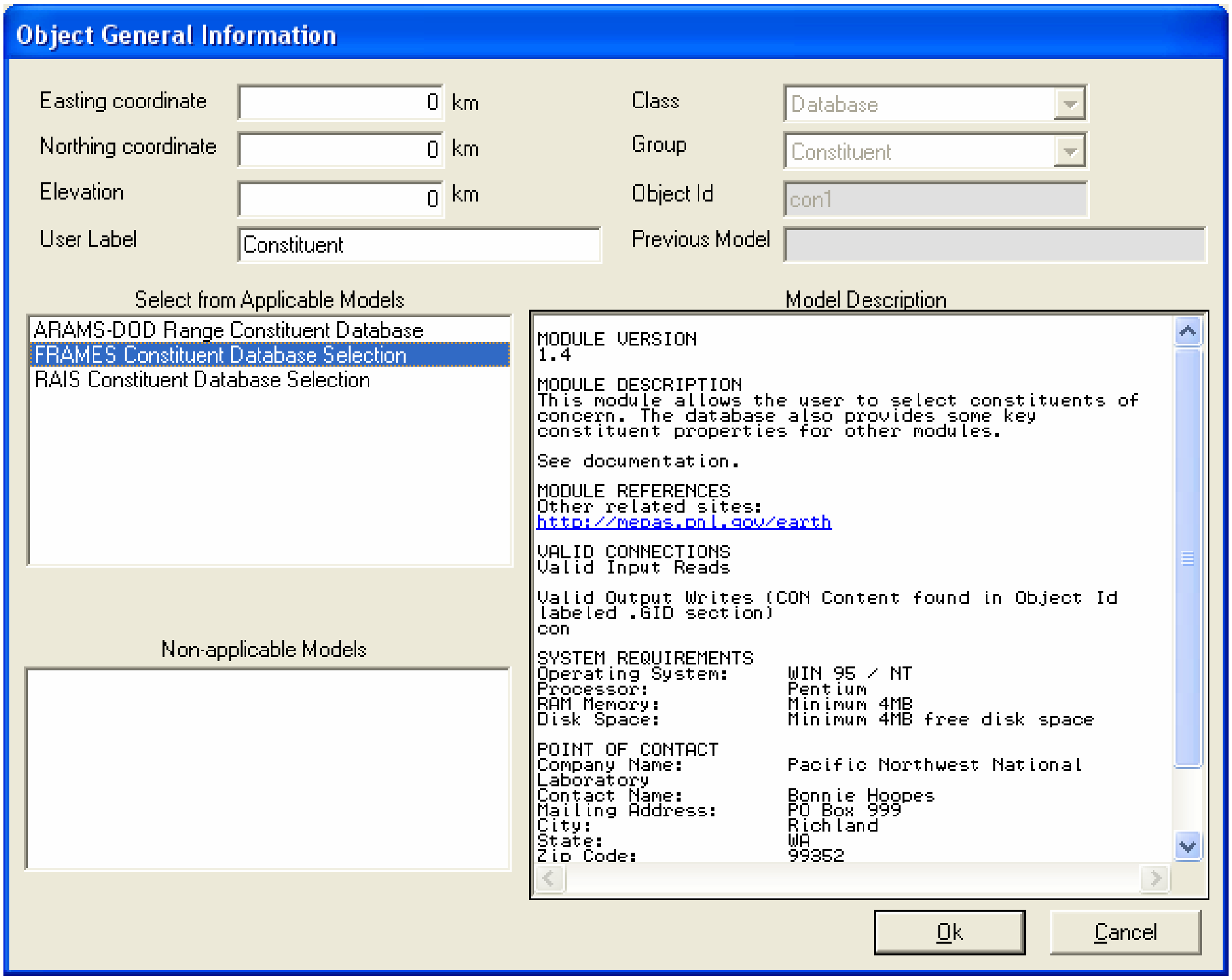


Figure 7. Object General Information screen

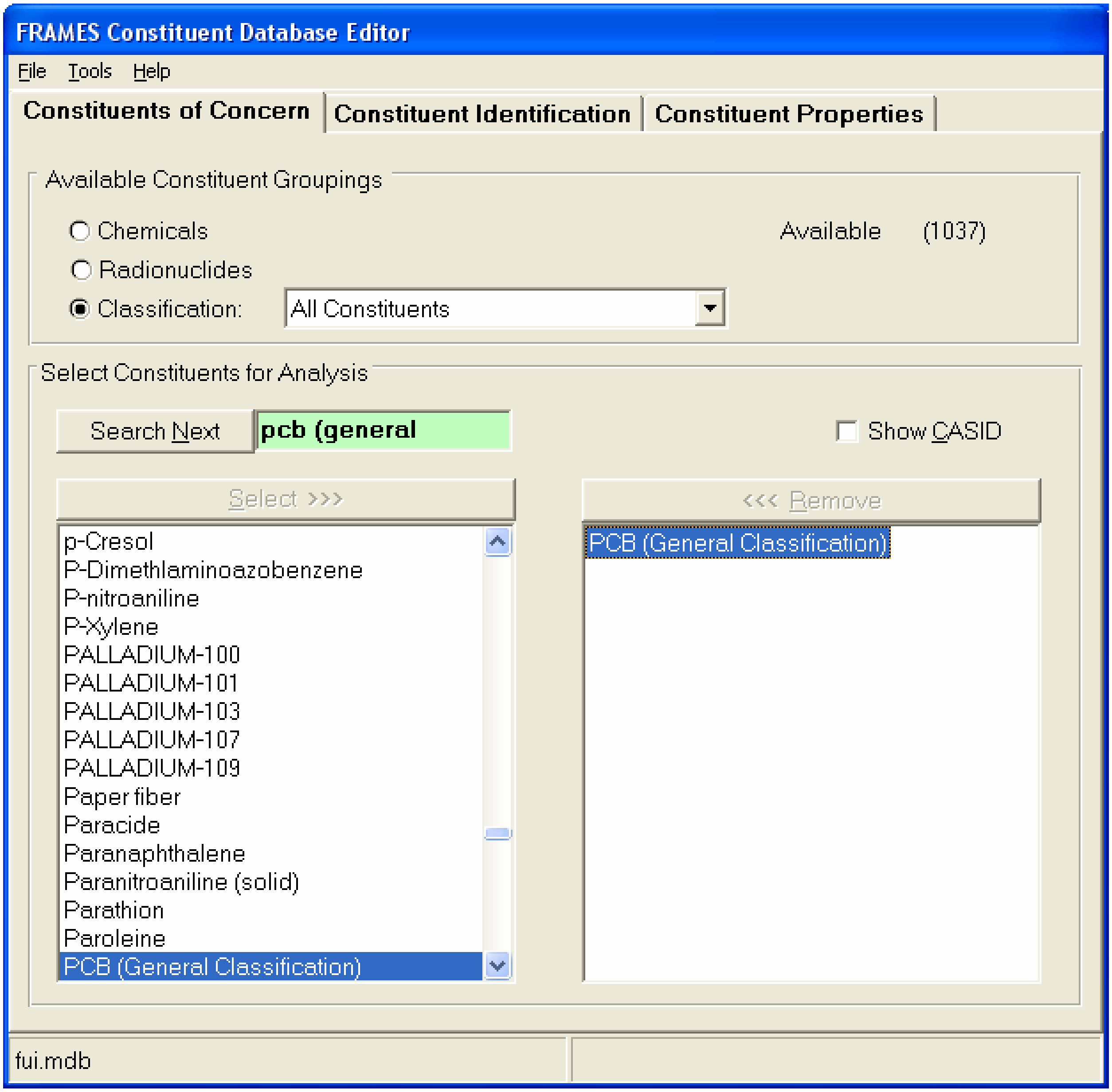


Figure 8. FRAMES Constituent Selection screen ("Constituents of Concern" tab)

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 5.0 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 to compute pathway 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, which is presently fixed
    - Time period for the simulation is 130 years
    - Fraction of residual mass for the simulation is 0.01

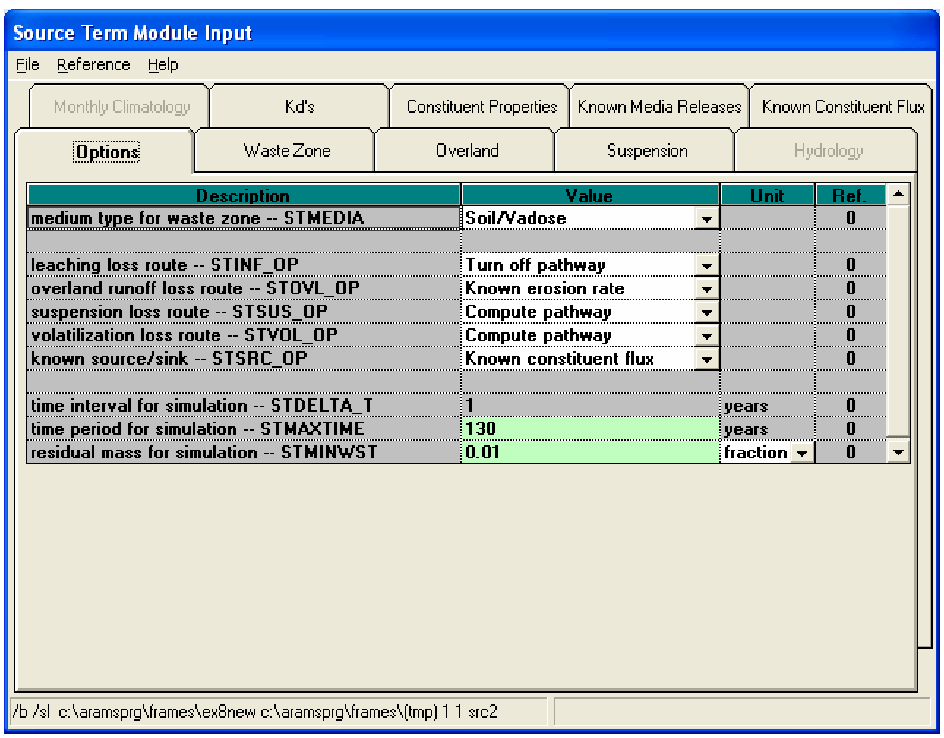


Figure 9. MEPAS Source in Soil Model – Options tab

- *Waste Zone Tab (soil and other physical properties) – Figure 10*
    - Thickness of clean overburden = 0 cm
    - Thickness = 3 m
    - Length = 100 m
    - Width = 100 m
    - Bulk density = 1.6 g/cm^3
    - Total porosity = 0.4
    - Moisture content = 0.15
    - Volumetric air content is computed
    - Average air temperature = 25˚C
    - Height above ground of local wind measure = 10 m
    - Mean annual wind speed = 5 m/sec

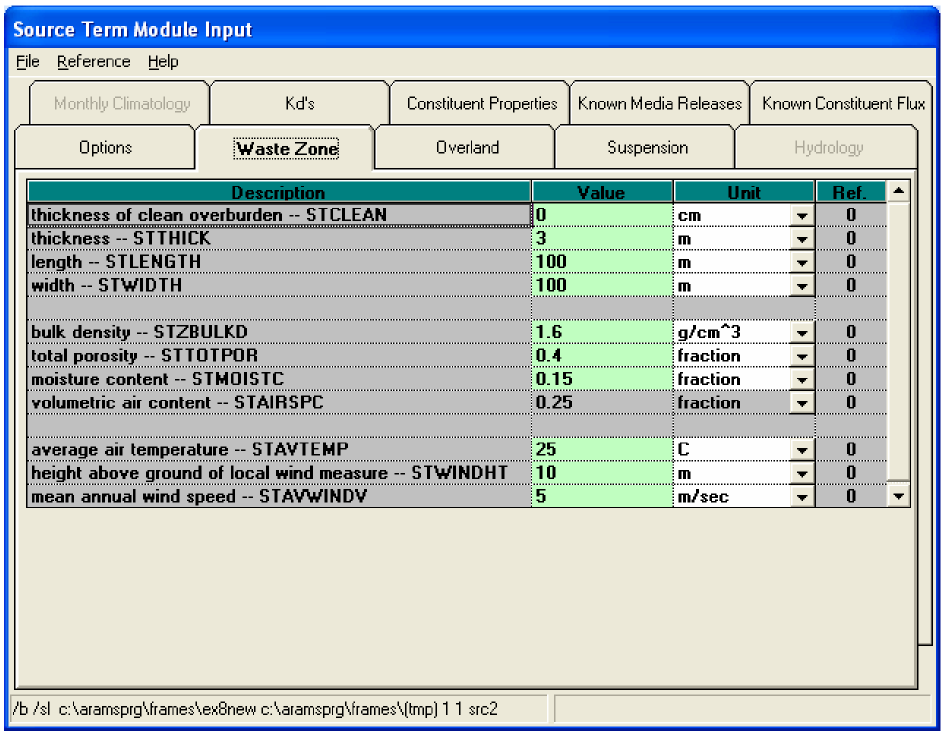


Figure 10. MEPAS Source in Soil Model – Waste Zone tab

- *Overland Tab (overland flow data) – Figure 11*
    - Discharge of water to overland = 5000 m^3/yr

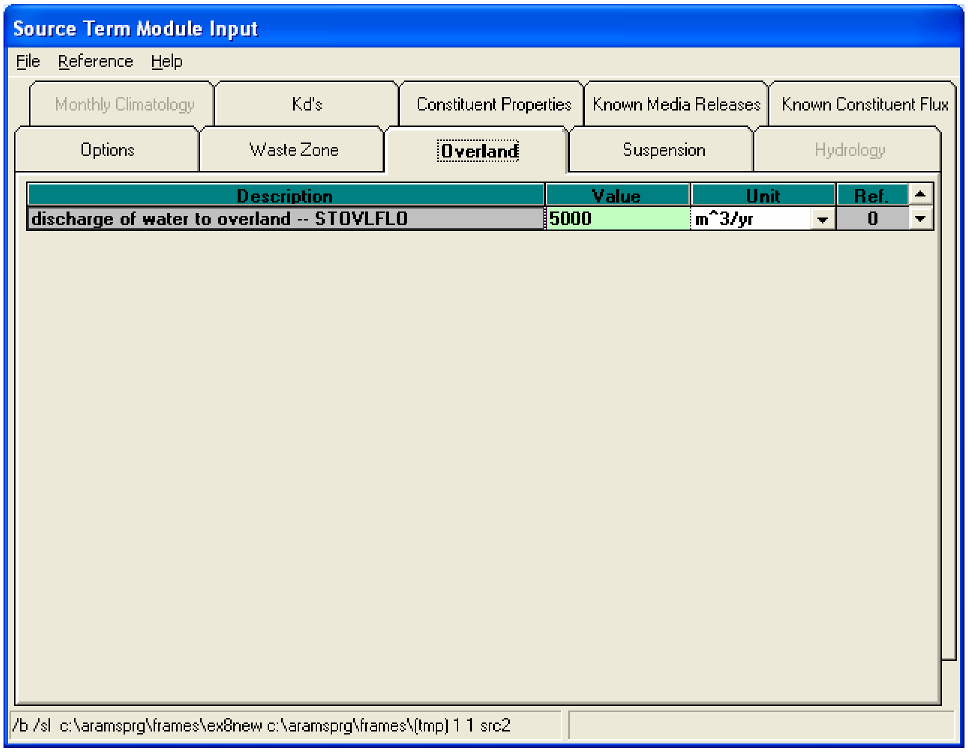


Figure 11. MEPAS Source in Soil Model – Overland tab

- *Suspension Tab – Figure 12*
  - Figure 12 shows the inputs for the soil suspension model. This suspension model is based on a 1985 report by Chatten Cowherd of the Midwest Research Institute prepared for the EPA Office of Health and Environmental Assessment. Set all parameters to those shown in Figure 12.

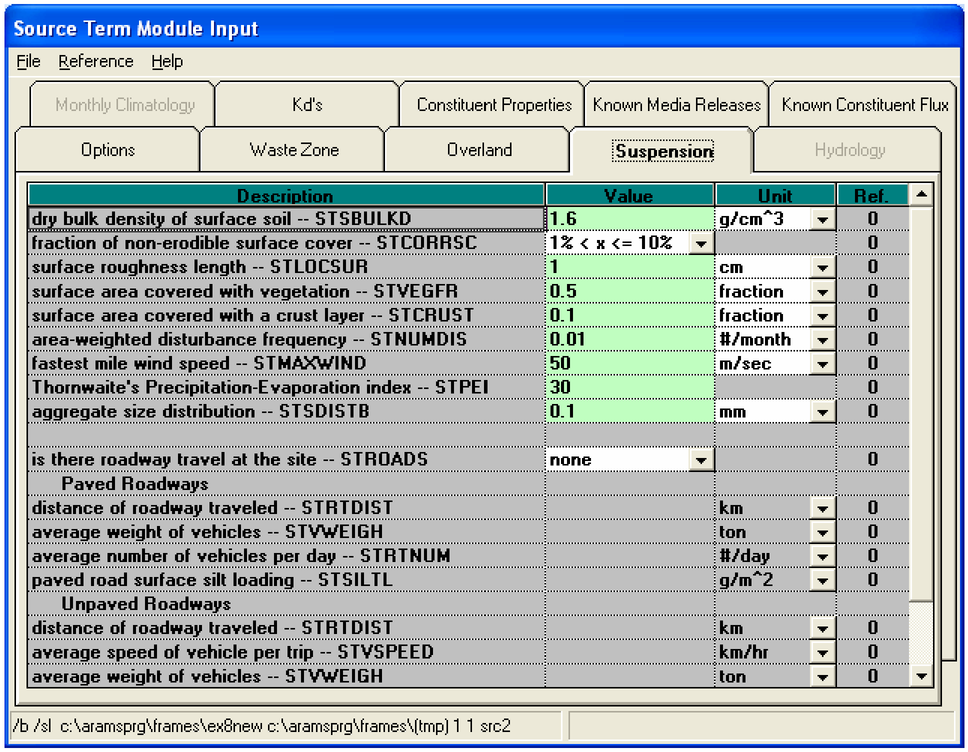


Figure 12. MEPAS Source in Soil Model – Suspension tab

- *Kd's Tab (Soil partitioning parameters) – Figure 13*
  - Set the *count* to "2". This will allow the user to enter values for the equilibrium coefficient at two different time points. Options are available from the dropdown box as shown in Figure 13 (the value from the constituent database, an estimated value based upon soil properties, and a value from a look-up table for metals), and the user can enter values directly in the *Value* field. The value is shown first followed by the source of the data. The estimated value will be used in this example. The user must click the "Soil Properties" button, and the form shown in Figure 14 will appear. Values should be entered such that they equal 100 percent. 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. Values shown in Figure 14 should be entered, "Apply" should be clicked, and the "estimated" values of 8892.7 ml/g should be used as shown in Figure 13.

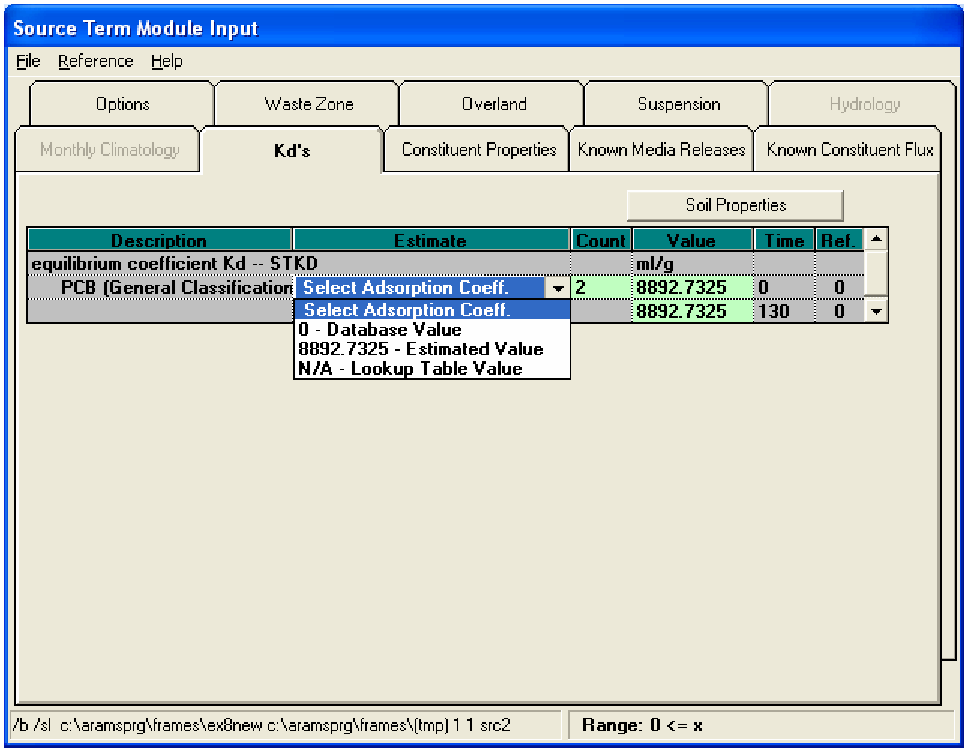


Figure 13. MEPAS Source in Soil Model – Kd's tab

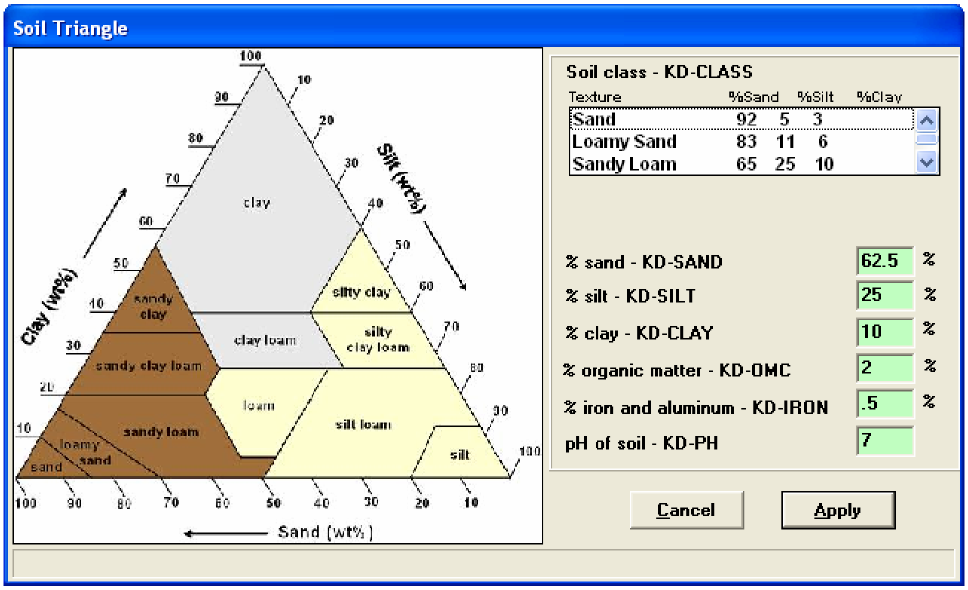


Figure 14. Soil Properties Dialog

- *Constituent Properties Tab (Chemical properties and inventory) – Figure 15*
    - o Ensure that a value for water solubility for PCB of 0.031 mg/L was passed from the Constituent Database to this screen as shown in Figure 15. Note that if a value exists for the water solubility for any of the chemicals in the

FRAMES Constituent Database, as is the case for PCB, it will appear in the appropriate box on this form.

- Use the “Worksheet” button to enter the inventory as shown in Figure 16. 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 mass of the constituent present initially, 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. Use the Inventory option and enter the value for PCB of 300 kg
- Enter a decay/degradation half-life for PCB of 43800 days. Note that this value will also be filled from the database if present.
- The fraction of volatilization release is used to control the volatilization rate at the 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.

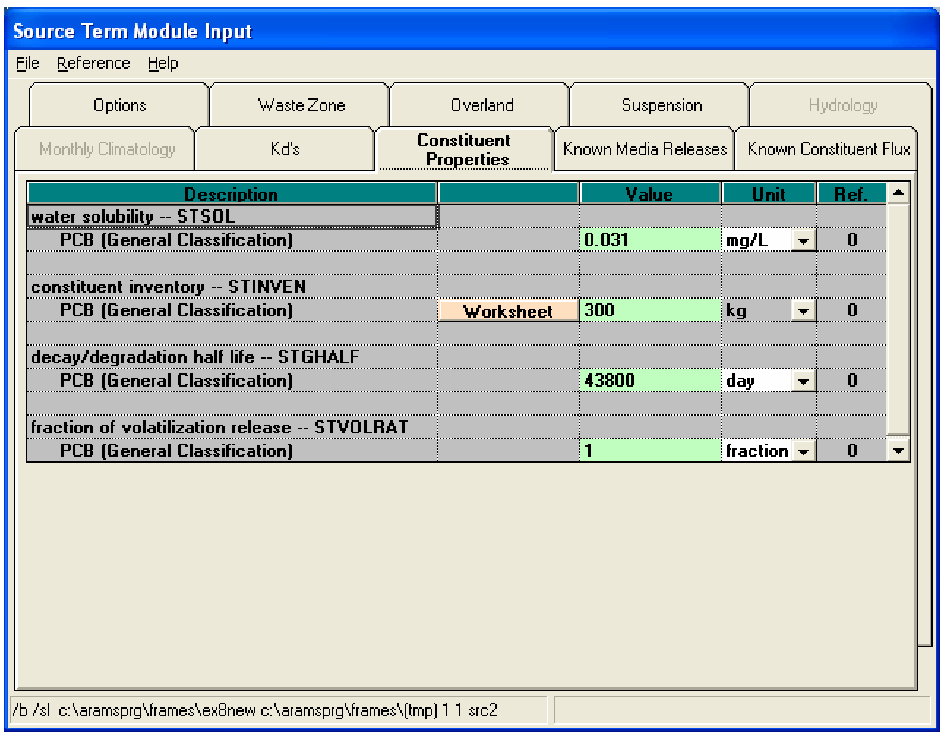


Figure 15. MEPAS Source in Soil Model – Constituent Properties tab

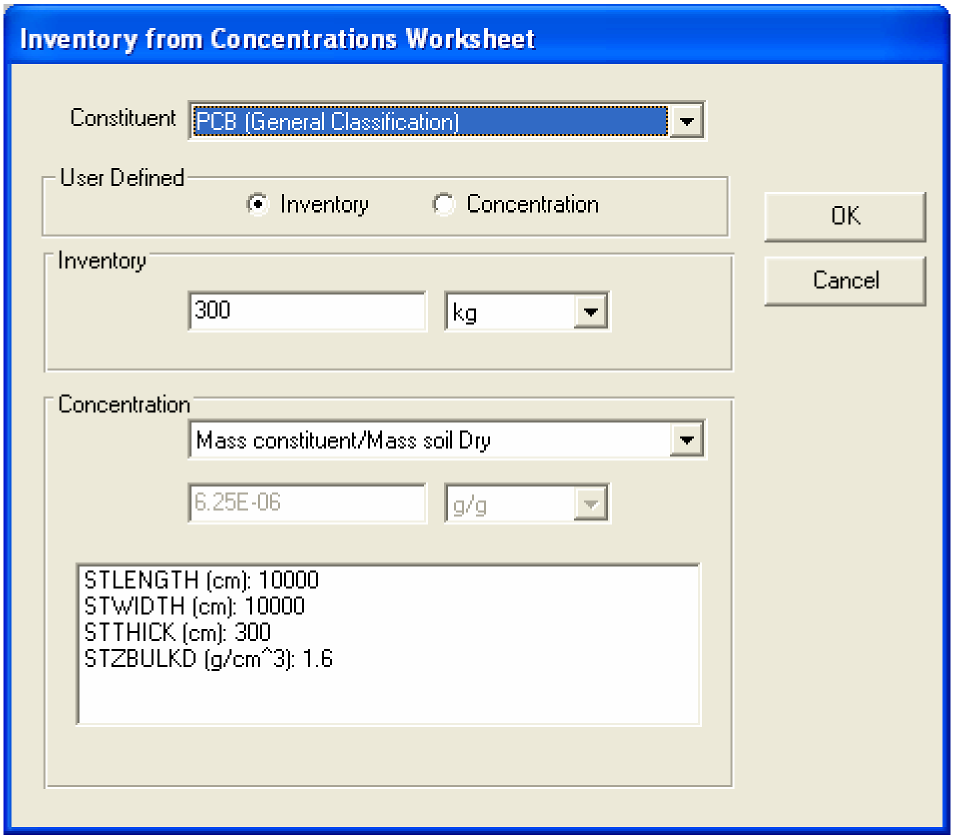


Figure 16. Constituent Inventory Worksheet

- *Known Media Releases Tab (Known Erosion Rates) – Figure 17*
  - Since the overland runoff loss route was set to a known erosion rate, the erosion rate must be defined on this tab. Enter a value for the soil depth lost to water erosion of 1 cm/year for 0 and 130 years; thus, a constant erosion loss rate is assumed for this example.

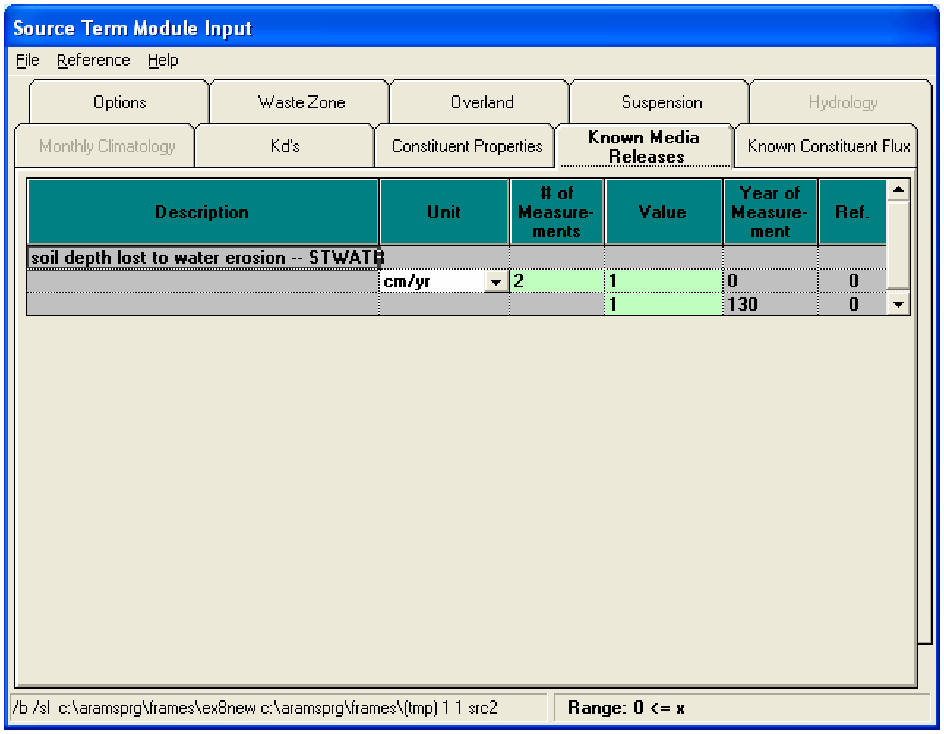


Figure 17. MEPAS Source in Soil Model – Known Media Releases tab

- *Known Constituent Flux Tab – Figure 18*
  - The known constituent fluxes are specified on this screen. For this example, the only known flux selected on the Options tab was for the "known source/sink," which is the leachate capture system. A constant value of -1000 g/yr should be set for two years, year 0 and year 130. The minus sign indicates that mass is taken out of the soil, thus a sink.

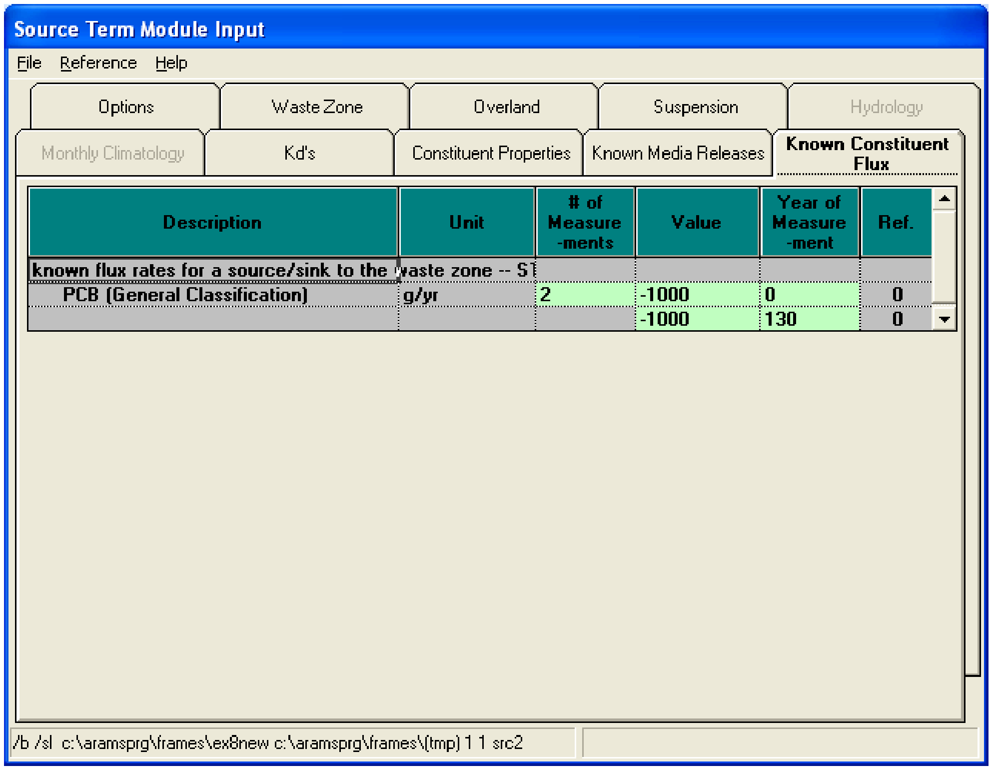


Figure 18. MEPAS Source in Soil Model – Known Constituent Flux tab

After 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 for soil concentrations in Excel format (see Figure 20). There are also similar viewers for air flux (AFF) and overland water flux (WFF).

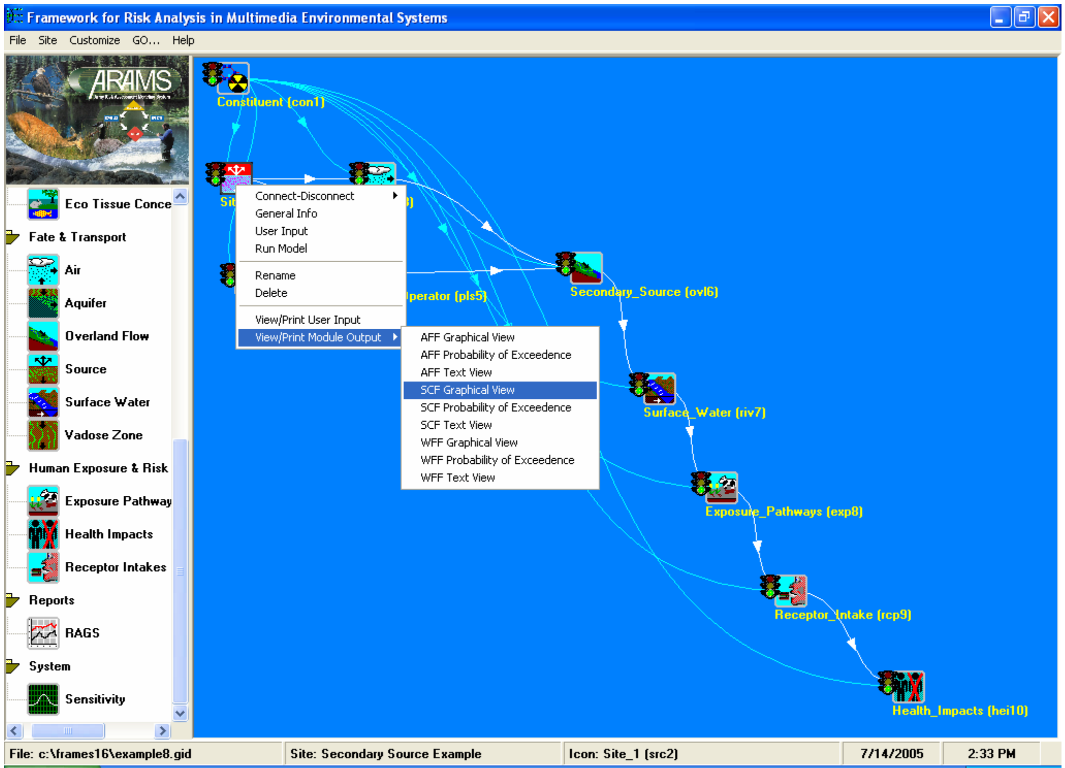


Figure 19. Output Menu for the MEPAS Source in Soil Module

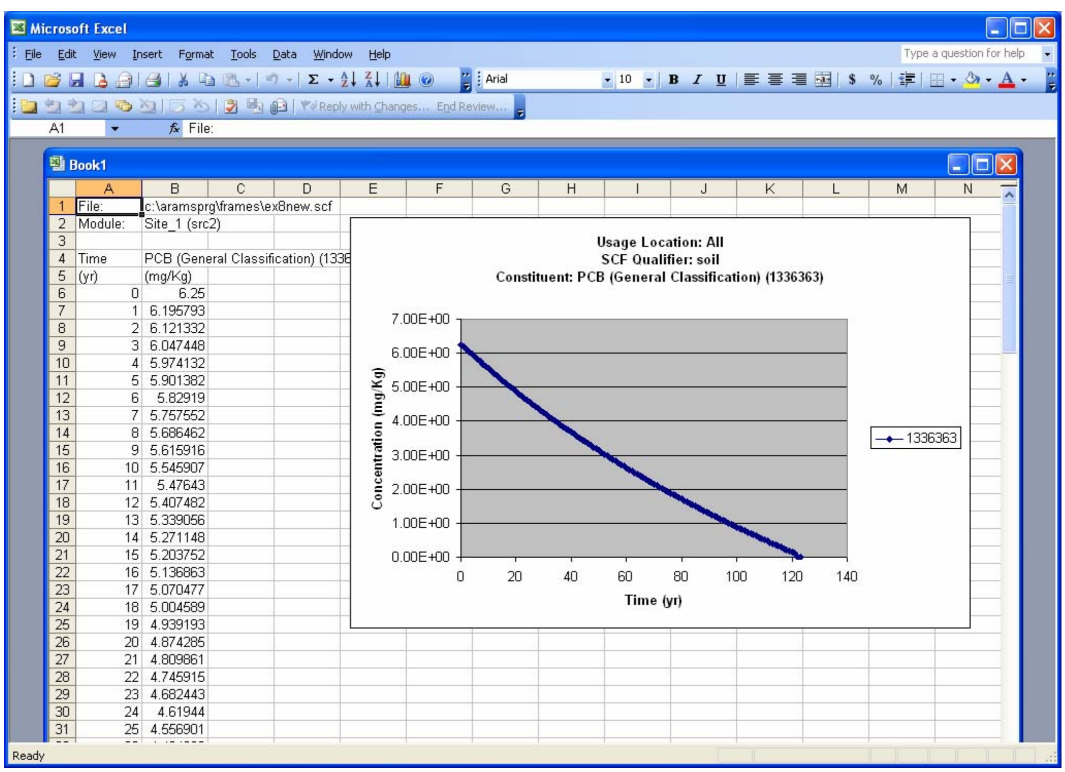


Figure 20. Graphical SCF Viewer Output

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 km to the north and east of Site 1 and is 5 m lower in elevation. In the Label text box, input "Site 2." In "Select from Applicable Models," choose "WFF Surface Water Module" and click "Ok." The status light next to the User Defined icon should turn red. It is important to recognize that the User Defined Surface Water module covers fluxes from a variety of surface water types, including lakes, streams, as well as sedimentation traps as for this example. It can also be used for overland flow fluxes, but there is also a User Defined WFF Overland Flow module that is identical to the WFF Surface Water module.

User Input

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

Width of Flux Plane = 500 m
Height of Flux Plane = 0.1 m

- Water Flux
  - 100,000 m^3/year at 0 years
  - 100,000 m^3/year at 130 years

- PCB (General Classification) Adsorbed Flux
  - 1000 g/year at 0 years
  - 1000 g/year at 50 years
  - 0 g/year at 51 years

- PCB (General Classification) Dissolved Flux
  - 0.0 g/year at 0 years
  - 0.0 g/year at 50 years
  - 0.0 g/year at 51 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.

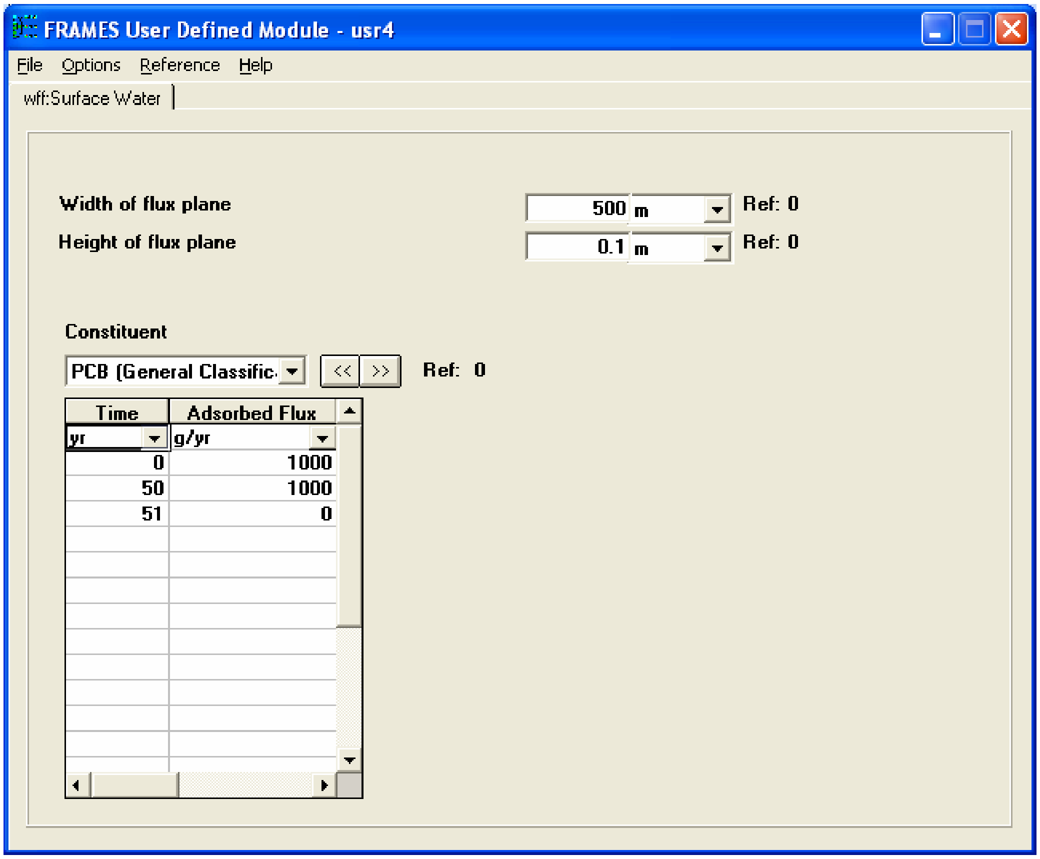


Figure 21. WFF Surface Water Module Input screen

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).

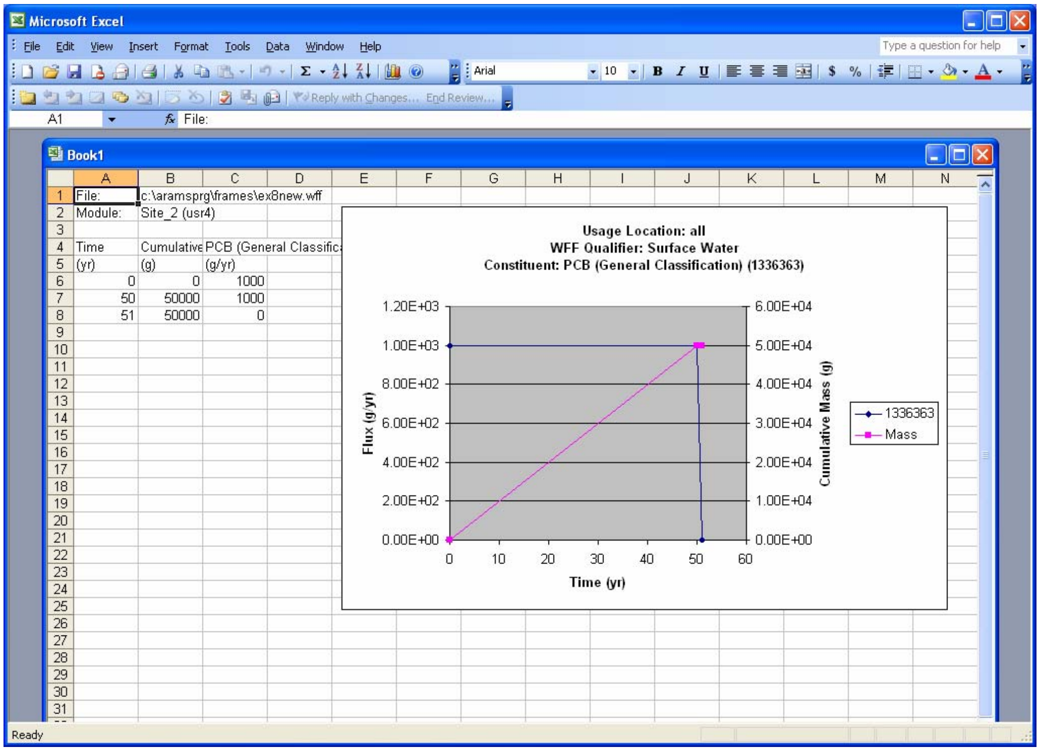


Figure 22. Graphical WFF Viewer Output

Plus Operator

General Info

The Plus Operator is used to combine mass fluxes or concentrations when two or more media export mass to a downstream medium. 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 runoff streams will combine to contaminate the Secondary Source land surface. 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 Surface Water Plus Operator" and click "Ok." The status light next to the Plus Operators icon should turn red. Note that the Surface Water Plus Operator is also applicable to overland flow, but an identical Overland Flow Plus Operator is available too.

User Input

The Plus Operator 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 Operator 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 23). The output from this module will be the sum of the outputs from the MEPAS Source in Soil (Site 1) and the WFF Surface Water (Site 2) modules. Notice how the combined fluxes drop at year 50 due to the cessation of Site 2 PCB fluxes at that time. The cumulative mass flux is also shown on the plot.

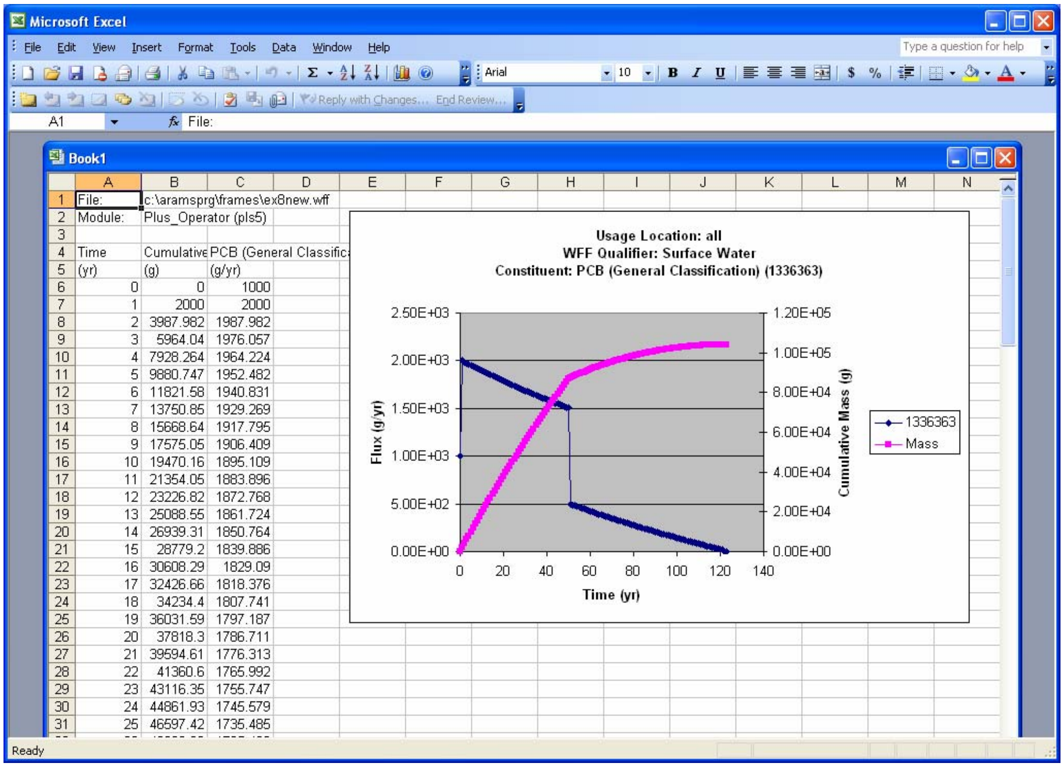


Figure 23. Plus Operator Graphical WFF Viewer Output

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 5.0 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 24 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

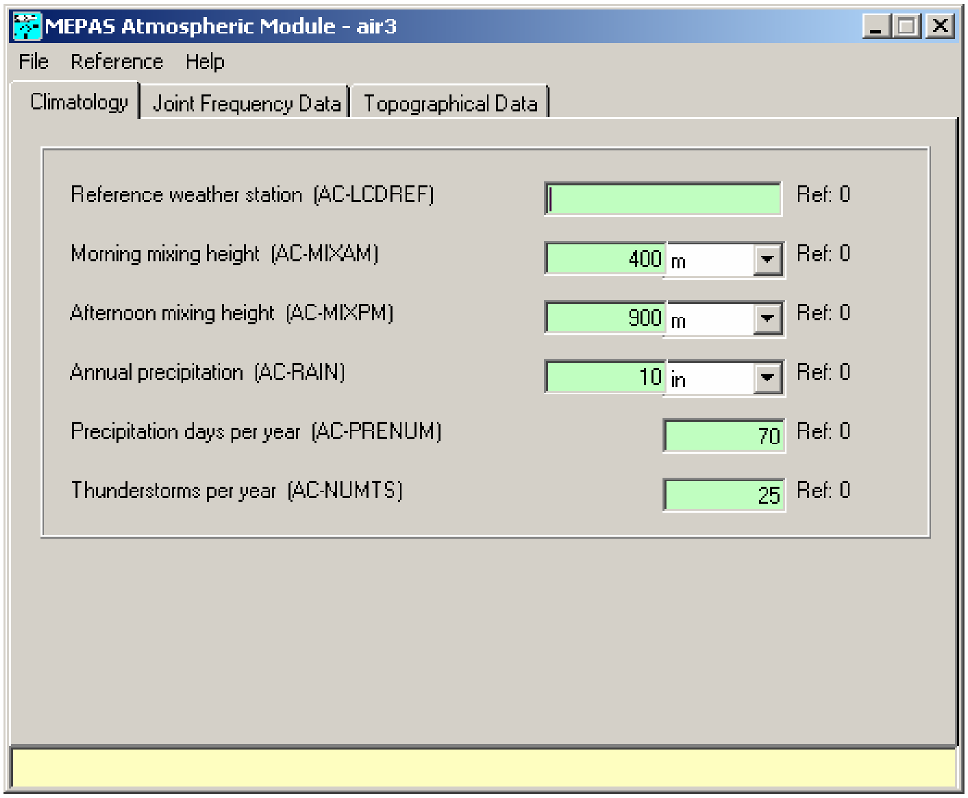


Figure 24. MEPAS Atmospheric Module – Climatology tab

- The second tab is the “Joint Frequency Data” tab shown in Figure 25. 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 joint frequency data (JFD) will be imported and used to fill the tables in this example. There are plans to have an ARAMS utility that will take NOAA data and develop the JFD file. 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 26 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 25.

- Anemometer 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

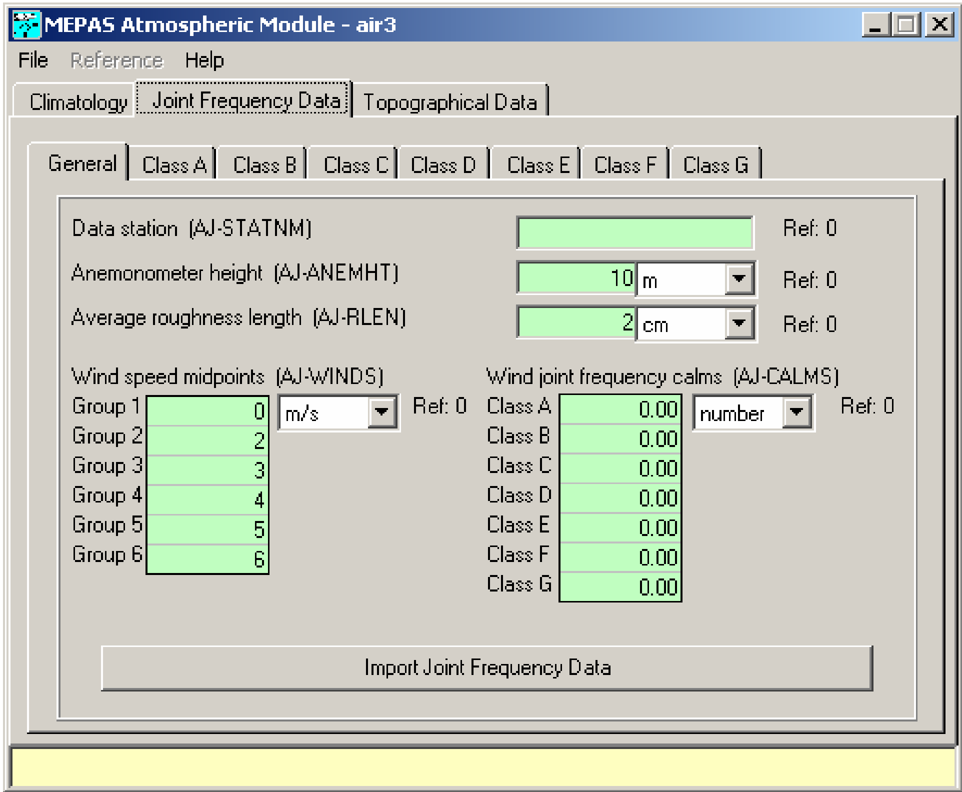


Figure 25. MEPAS Atmospheric Module – Joint Frequency Data tab

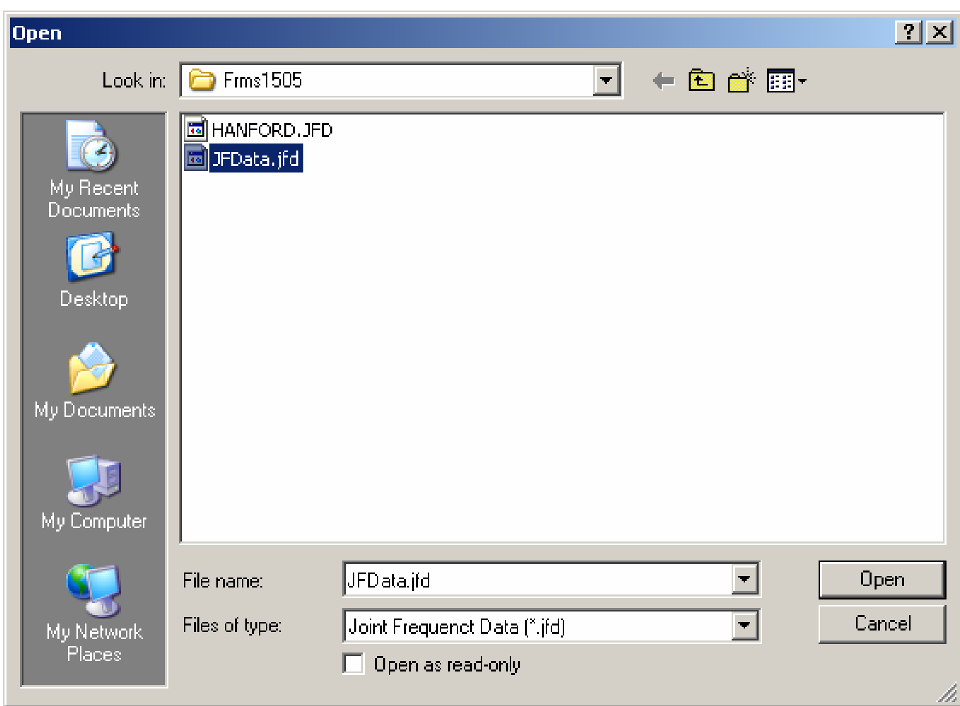


Figure 26. Selection of a Joint Frequency Data File for Importing

- 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 27 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.

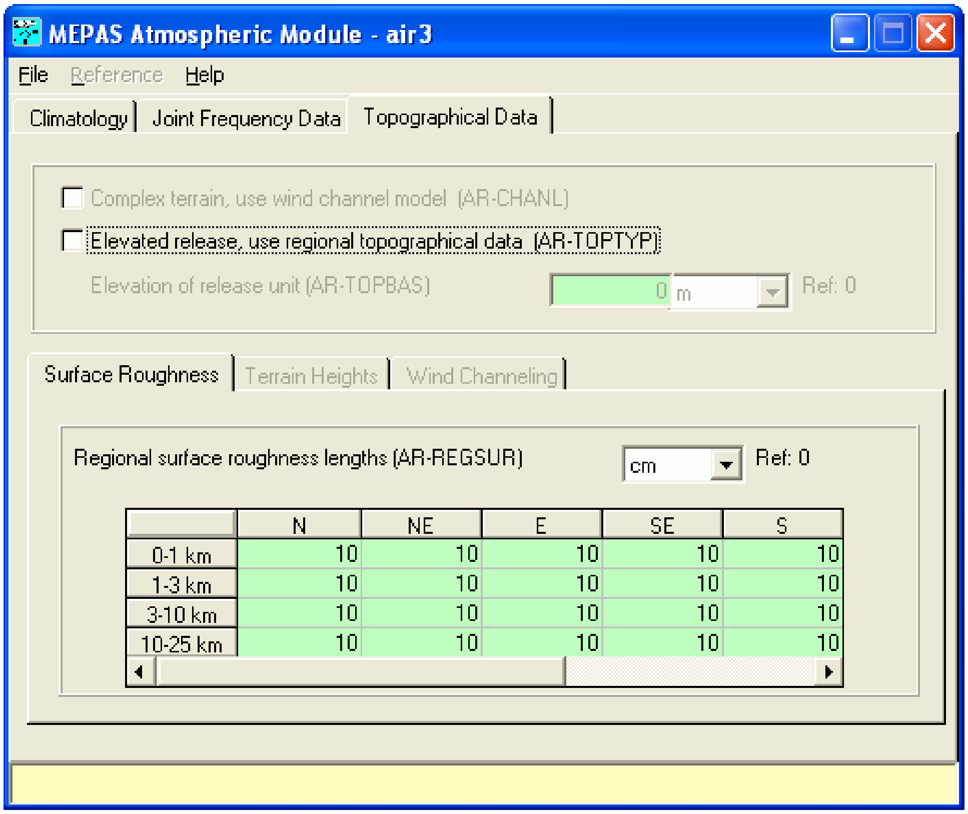


Figure 27. MEPAS Atmospheric Module – Topographical Data tab

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 28). Accept the default values and click the "Convert" button to load the first graph. This viewer will produce plots at different time intervals of the constituent concentrations in air as well as deposition rates (Figure 29).

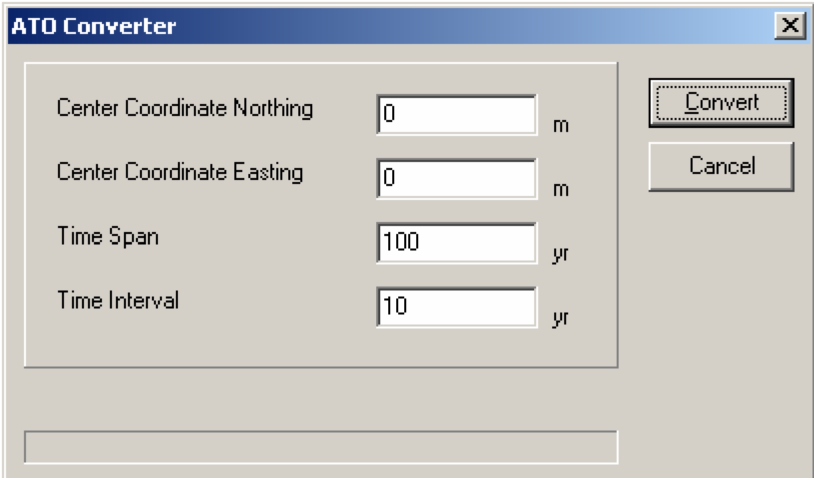


Figure 28. GNUPLOT ATO Converter Dialog

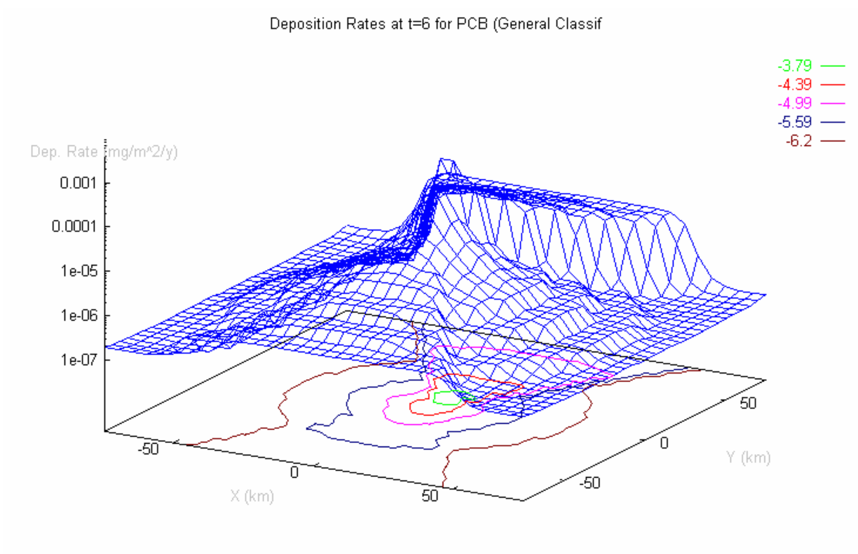


Figure 29. Plot of PCB deposition rates at Site 1 after 6 years

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 5.0 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 5.0 Source in Soil, the module and the inputs are similar to those explained for the MEPAS 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 source fluxes from the Plus Operator and MEPAS Air Module. Note that the known source/sink option is preset to “Use Secondary Sources” 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
  - Turn off the suspension and volatilization loss routes
  - Time period for the simulation is 130 years
  - Fraction of residual mass for the simulation is 0.01

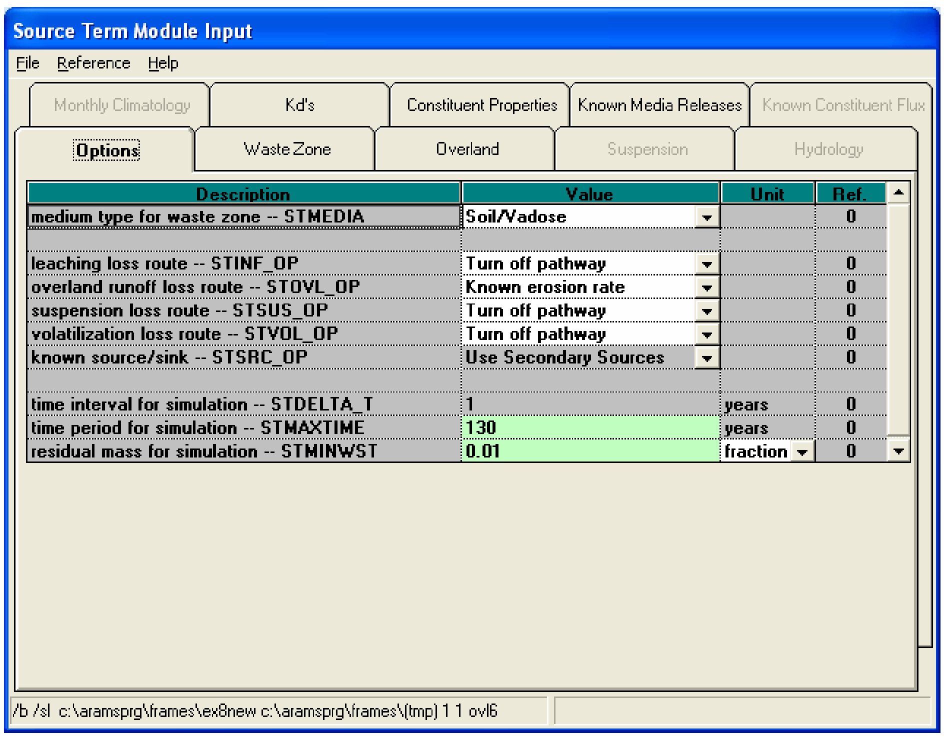


Figure 30. Secondary Source Term Module Input – Options tab

- *Waste Zone Tab (soil and other physical properties) – Figure 31*
  - Thickness of clean overburden = 0 cm
  - Thickness = 0.2 m
  - Length = 2 km
  - Width = 2 km
  - Bulk density = 1.1 g/cm^3
  - Total porosity = 0.6
  - Moisture content = 0.2
  - Average air temperature = 25˚C

- Height above ground of local wind measure = 10 m

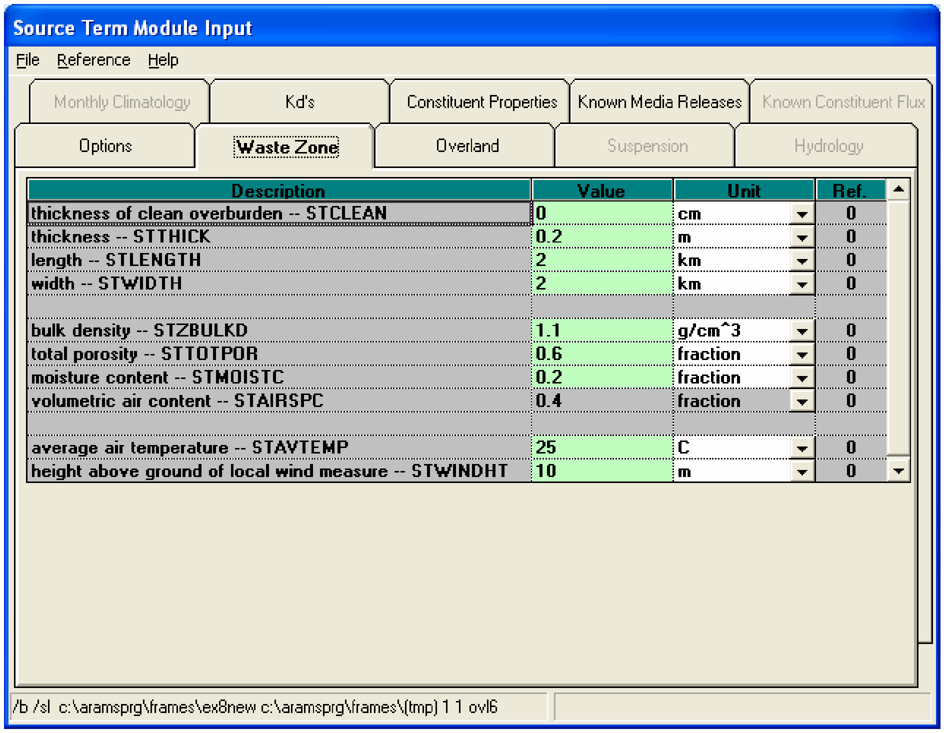


Figure 31. Source Term Module Input – Waste Zone tab

- *Overland Tab (overland flow data)*
  - Discharge of water to overland = 2.0 E6 m^3/year

- *Kd's Tab (Soil partitioning parameters)*
  - Estimate the value as before for Site 1 using the same soil properties to get a value of 8892.7 ml/g.

- *Constituent Properties Tab (Chemical properties and inventory)*
  - Ensure the value from the database of 0.031 mg/L is passed to this screen.
  - Use the "Worksheet" button to enter the inventory of negligible mass on the site initially. A zero value is not allowed, so a very small value of 1.0 E-20 is entered instead.
  - Enter a decay/degradation half-life of 43800 days, but this value should be passed from the database.
  - 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 = 0.1 cm/year at 0 years
    - Soil depth lost to water erosion = 0.1 cm/year at 130 years

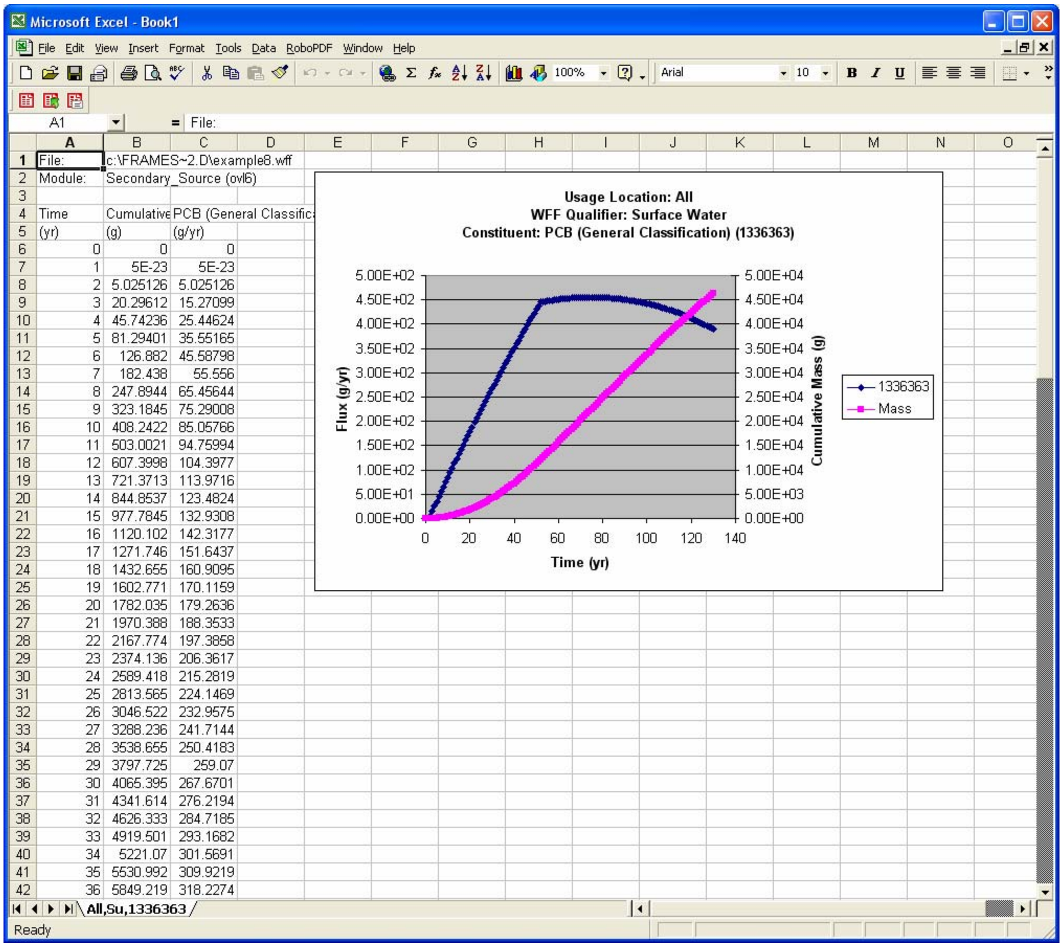
When all of the information on each tab has been entered, select "Save and Exit" from the File menu to return to the FRAMES workspace. The status indicator next to the Overland Flow icon will change to yellow to indicate that the inputs have been entered.

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 fluxes from this site in a screen output in Excel format (see Figure 32).



File:	c:\FRAMES~2.D\example8.wff	
Module:	Secondary_Source (ovl6)	
Time	Cumulative	PCB (General Classific
(yr)	(g)	(g/yr)
0	0	0
1	5E-23	5E-23
2	5.025126	5.025126
3	20.29612	15.27099
4	45.74236	25.44624
5	81.29401	35.55165
6	126.882	45.58798
7	182.438	55.556
8	247.8944	65.45644
9	323.1845	75.29008
10	408.2422	85.05766
11	503.0021	94.75994
12	607.3998	104.3977
13	721.3713	113.9716
14	844.8537	123.4824
15	977.7845	132.9308
16	1120.102	142.3177
17	1271.746	151.6437
18	1432.655	160.9095
19	1602.771	170.1159
20	1782.035	179.2636
21	1970.388	188.3533
22	2167.774	197.3858
23	2374.136	206.3617
24	2589.418	215.2819
25	2813.565	224.1469
26	3046.522	232.9575
27	3288.236	241.7144
28	3538.655	250.4183
29	3797.725	259.07
30	4065.395	267.6701
31	4341.614	276.2194
32	4626.333	284.7185
33	4919.501	293.1682
34	5221.07	301.5691
35	5530.992	309.9219
36	5849.219	318.2274

Figure 32. 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 River Module does not accept air deposition. In the Label text box, input "Surface Water." In "Select from Applicable Models," choose "MEPAS 5.0 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 33). Enter the data as given below for each tab.

- *Dimensions Tab (physical properties of the river) – Figure 33*
  - Flow velocity at constituent entry point = 0.5 m/sec
  - Depth at constituent entry point = 2 m
  - Width at constituent entry point = 20 m
  - 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 = 5 km
    - Average annual discharge at location = 20 m^3/sec

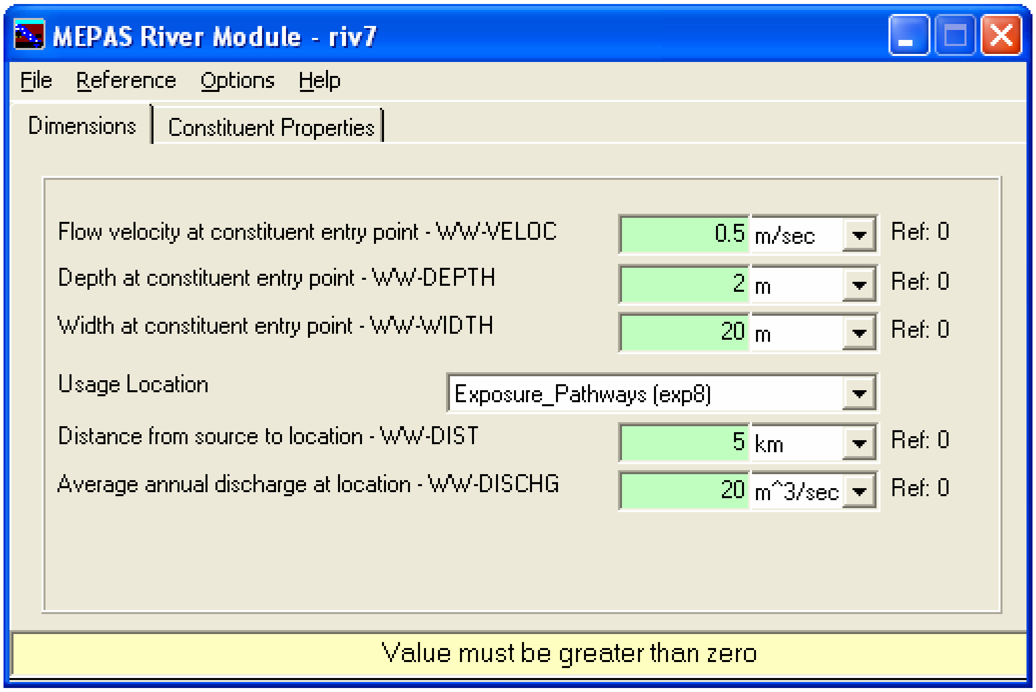


Figure 33. MEPAS River Module – Dimensions tab

- *Constituent Properties Tab (chemical properties for each constituent) – Figure 34*
    - PCB (General Classification)
        - Water solubility = 0.031 mg/L
        - Half-life in surface water = 20 yr

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.

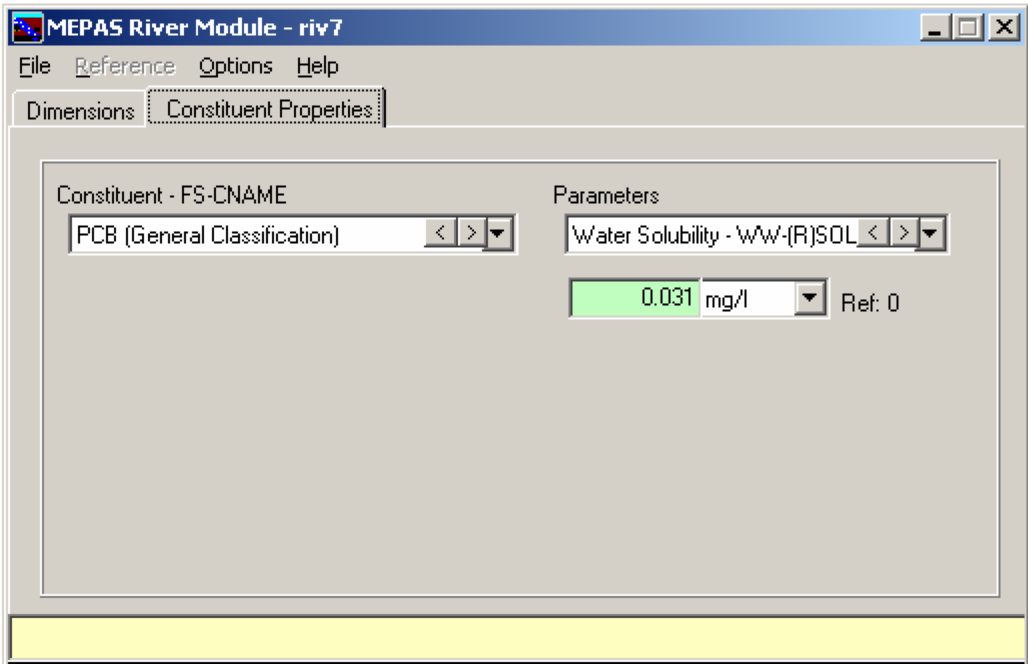


Figure 34. MEPAS River Module – Constituent Properties tab

Run Model

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

View/Print Module Output

A second menu will appear. Choose "WCF Graphical View" to view water concentrations in a screen output in Excel format (see Figure 35).

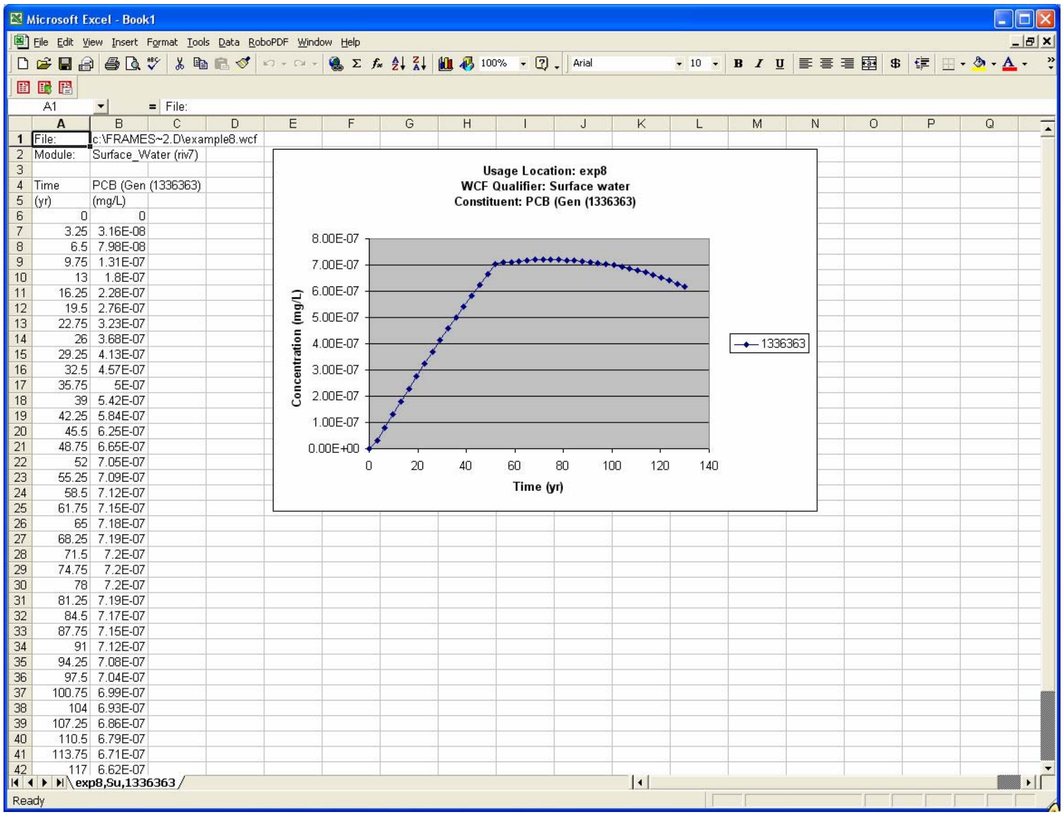


Figure 35. WCF graphical viewer output for MEPAS River Module

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, relative to the river (i.e., distance downstream). In the Label text box, input "Exposure Pathway." In "Select from Applicable Models," choose "MEPAS 5.0 Exposure Pathways 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
  - Exposure duration = 30 years
  - Pathways Tab
    -
    - Select "Leafy vegetables," "Drinking water," and "Shower water" for ingestion pathways; "Air volatiles from water" with

“Shower – Air” as the suboption for the inhalation pathway, and “Shower water” for dermal pathway 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 day
        - 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 years
    - Maximum time for reporting = 100 years
    - Number of time points for evaluation = 50
- 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 for PCB = 0.0 /year
- Constituent Parameters Tab
    - Half-life in soil = 10 years
    - Half-life in surface water and groundwater = 20 years
    - Half-life in air = 1.0 E20 day

Changes can also be made to other parameters such as on the “Soil and Crop,” “Growing Period,” and other screens 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. Enter 0.5 for the easting coordinate, -1 for the northing coordinate, and –0.02 for the elevation. In the Label text box, input “Receptor Intake.” In “Select from Applicable Models,” choose “MEPAS 5.0 Receptor Intakes 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 years
- 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 years
- Age of receptor at end of exposure = 70 years
- 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. Enter 0.5 for the easting coordinate, -1 for the northing coordinate, and –0.02 for the elevation. In the Label text box, input “Health Impacts.” In “Select from Applicable Models,” choose “MEPAS 5.0 Health Impacts 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”

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 “HIF Graphical View,” select “Risk” for unit of “Measure,” and click “Chart” to generate the cancer risk versus time graph shown in Figure 36. Note how the risk peaks around year 50. Next choose “Summary Views of Risk, Hazard and Dose,” and then select the 50-year time point 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. This viewer gives a clear indication of the risk contributions of each pathway and route. For this example, the shower dermal and shower air inhalation pathway-routes are the greatest risk contributors.

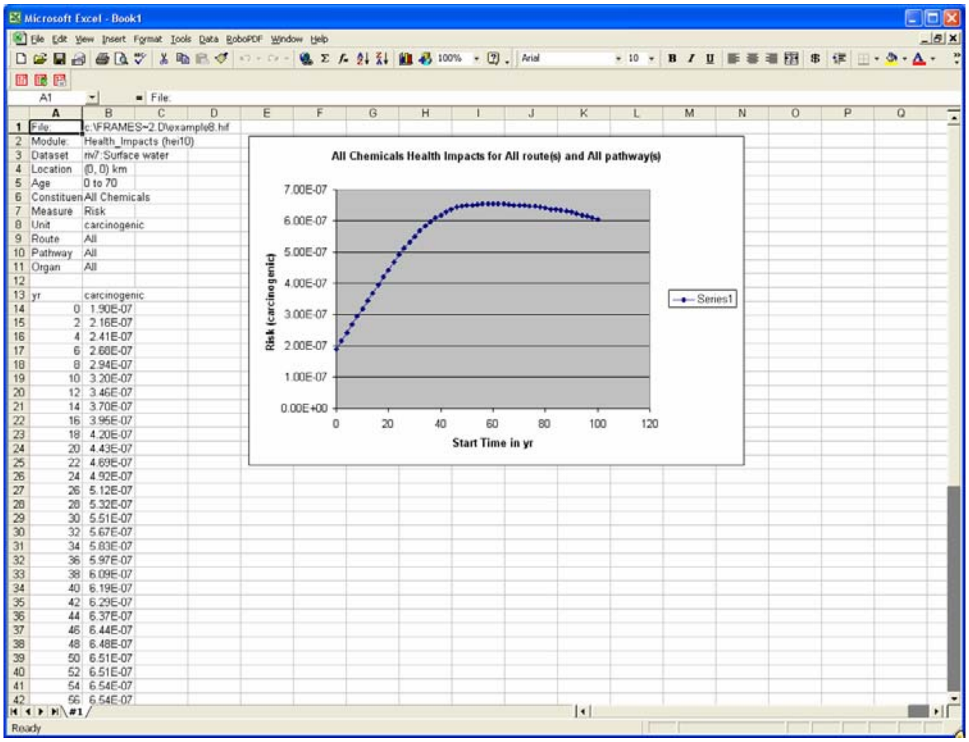


Figure 36. Health Impacts viewer – HIF Graphical View

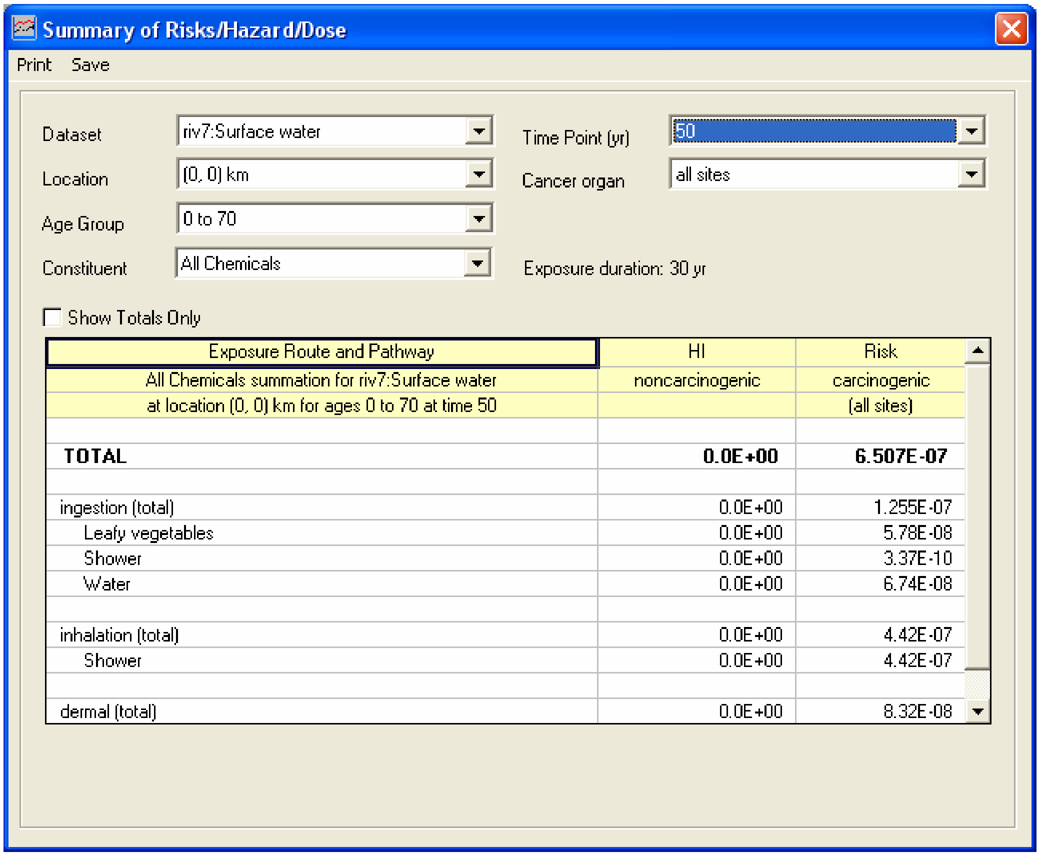


Figure 37. Summary Viewer for Health Impacts Module