Example of an Aquatic Ecological Assessment Using the Environmental Residue-Effects Database and the RECOVERY, TBP, and WEAP Models (Example No. 1)

M. S. Dortch, J. A. Gerald, and T. Toney
U.S. Army Engineer Research and Development Center, Vicksburg, MS

G. M. Gelston and J. L. Kirk
Pacific Northwest National Laboratory, Richland, WA

S. A. Fant
Analytical Services, Inc., Vicksburg, MS

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Environmental Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, Mississippi 39180

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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 uses the Wildlife Ecological Assessment Program (WEAP), the RECOVERY model, the Theoretical Bioaccumulation Potential (TBP) model, the Environmental Residue-Effects Database (ERED), the Aquatic Organism Selector (AOS), and the Biota-Sediment Accumulation Factors (BSAF) Database. RECOVERY is a surface water model that assesses fully mixed water bodies, including layered bed sediments, and computes time-varying sediment and water constituent concentrations/fluxes. TBP converts contaminated sediment concentrations to organism body burden (tissue concentration), based on a theoretical bioaccumulation potential. WEAP is a software package that summarizes ecological health impacts to various organisms from exposures to constituents. WEAP is a statistical package that 1) correlates duration of exposure to constituent levels to help determine the impacts of the exposure to organisms, and 2) bridges the gap between simulated chemical transport and fate modeling and ecological-risk assessment data that are available from laboratory studies. ERED is an aquatic ecological toxicity database, containing ecological benchmark data of effects as related to body burdens (or tissue residues) by chemical and organism species.

This example begins with contaminated water column and sediments and computes time-varying surface water and sediment concentrations with RECOVERY. Sediment concentrations are used by the TBP model to produce time-varying body burdens. WEAP uses the time-varying body burdens, couples these with Toxicity Reference Values (TRV) end points (e.g., No Observable Effects Dose, NOED) from the ERED toxicity benchmark database to compute Ecological Hazard Quotients (EHQs). Time-varying EHQs are reported. Probabilities of Exceedence (i.e., equal to or greater than), based upon time series results, are calculated for body-burden levels and EHQs. The constituent that will be evaluated is "Aroclor

1254," and "Oncorhynchus mykiss" will be the target species. Each of these components can be found within the objects in the FRAMES project object working space, as shown in Figure 1.

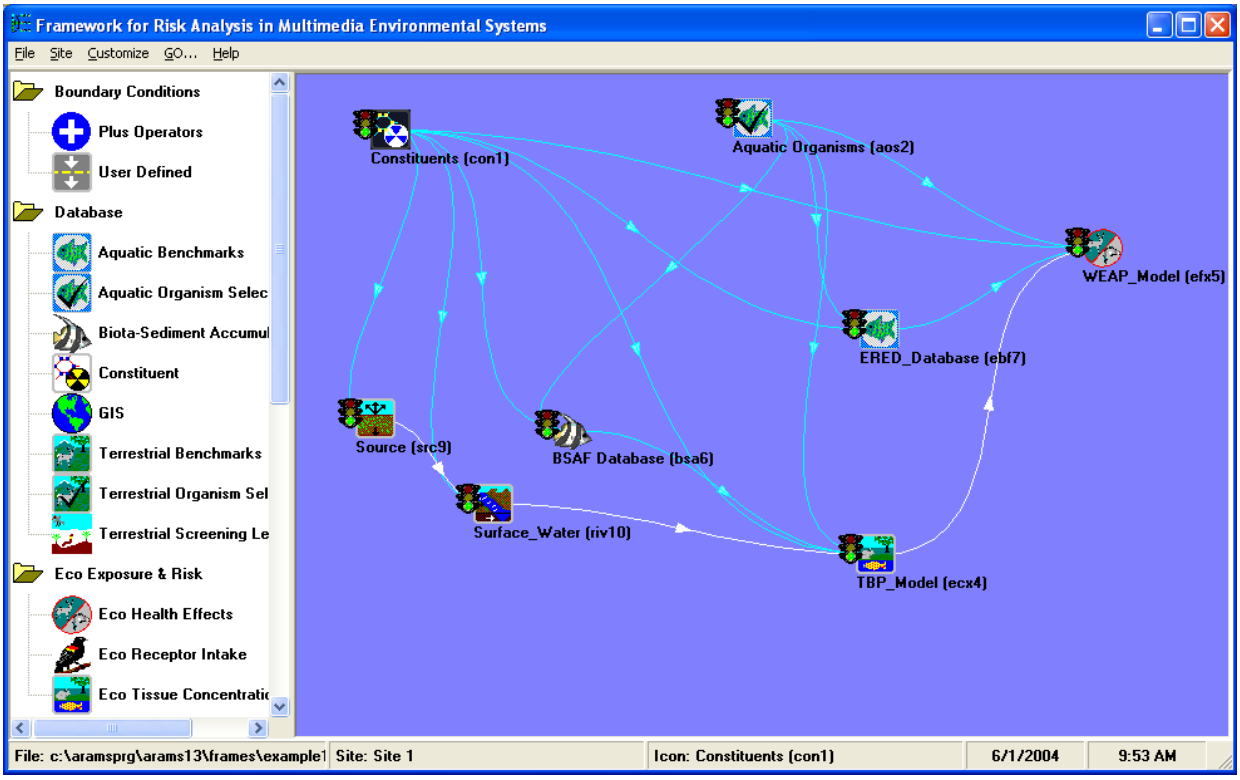


Figure 1. Object workspace for example application

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 2). In the "File Name" box enter the project name (type: "Sample*1*," maximum of eight characters) and click "Open" (see Figure 3). **Do not name the new file "Example1" because it will write over the existing "Example1" file that was distributed with the tutorial.** A window titled "Create New Site" will appear. Next, type the project site name (type: Site 1) and click "OK" (see Figure 4).

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"
"Surface Water"
"Eco Tissue Concentrations"
"Aquatic Benchmarks"
"Eco Health Effects"
"Biota-Sediment Accumulation Factor"
"Aquatic Organism Selector"

Click on and drag each icon to its respective position on the workspace. Connect the Constituent icon and Source icons 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 different 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	→	*Surface Water*
Constituent	→	*Eco Tissue Concentrations*
Constituent	→	*Eco Health Effects*
Constituent	→	*Aquatic Benchmarks*
Constituent	→	*Biota-Sediment Accumulation Factor*
Source	→	*Surface Water*
Surface Water	→	*Eco Tissue Concentrations*

Eco Tissue Concentrations	→	*Eco Health Effects*
Aquatic Organism Selector	→	*Eco Tissue Concentrations*
Aquatic Organism Selector	→	*Biota-Sediment Accumulation Factor*
Aquatic Organism Selector	→	*Aquatic Benchmarks*
Aquatic Organism Selector	→	*Eco Health Effects*
Biota-Sediment Accumulation Factor	→	*Eco Tissue Concentrations*
Biota-Sediment Accumulation Factor	→	*Aquatic Benchmarks*
Aquatic Benchmarks	→	*Eco Effects*

FRAMES should now look something like Figure 1.

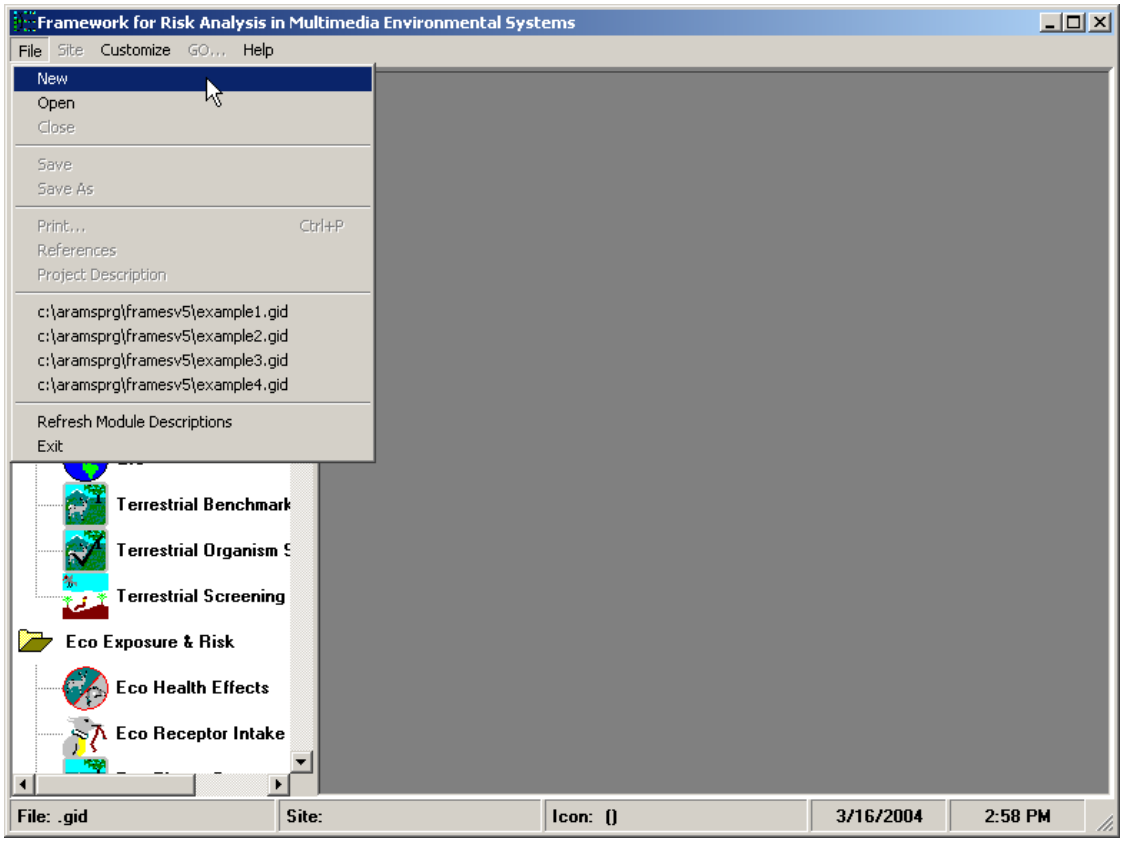


Figure 2. Opening a new file

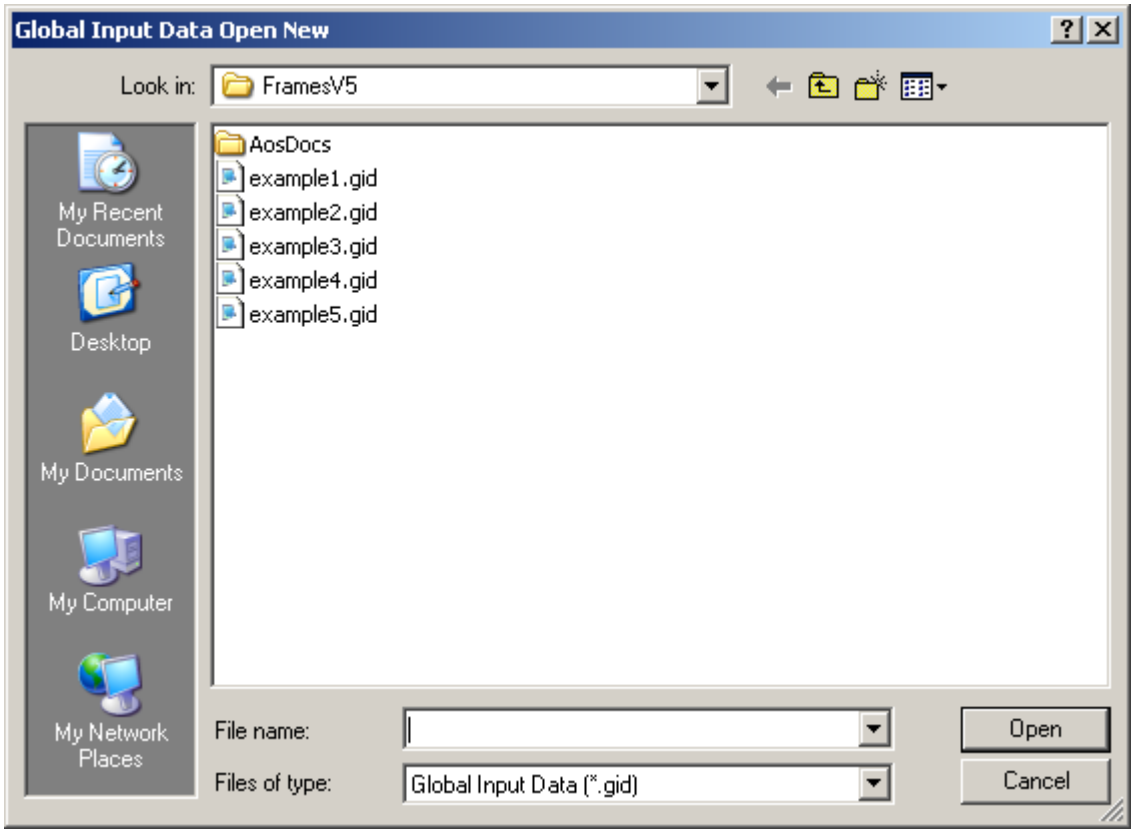


Figure 3. Global Input Data Open New screen (new file window)

Figure 4. Create New Site screen (Input "Site name" box)

CONSTITUENTS DATABASE MODULE

Right-click the Constituent icon and choose "General Info" (see Figure 5). When the General Info screen opens, enter "Constituents" in the "User Label" text box and select "FRAMES Default Constituent Database Selection" in the "Select from applicable models" text box (see Figure 6). 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 7). The constituent used in this case is Aroclor 1254. Scroll to select the constituent from the constituents list or use the "Find" option to search for it. Click the "Add >>>" button to add the constituent to the selected constituents list. Click "File" and choose

"Save and Exit" to return to the workspace screen. The Constituent icon's status light will change from red to green.

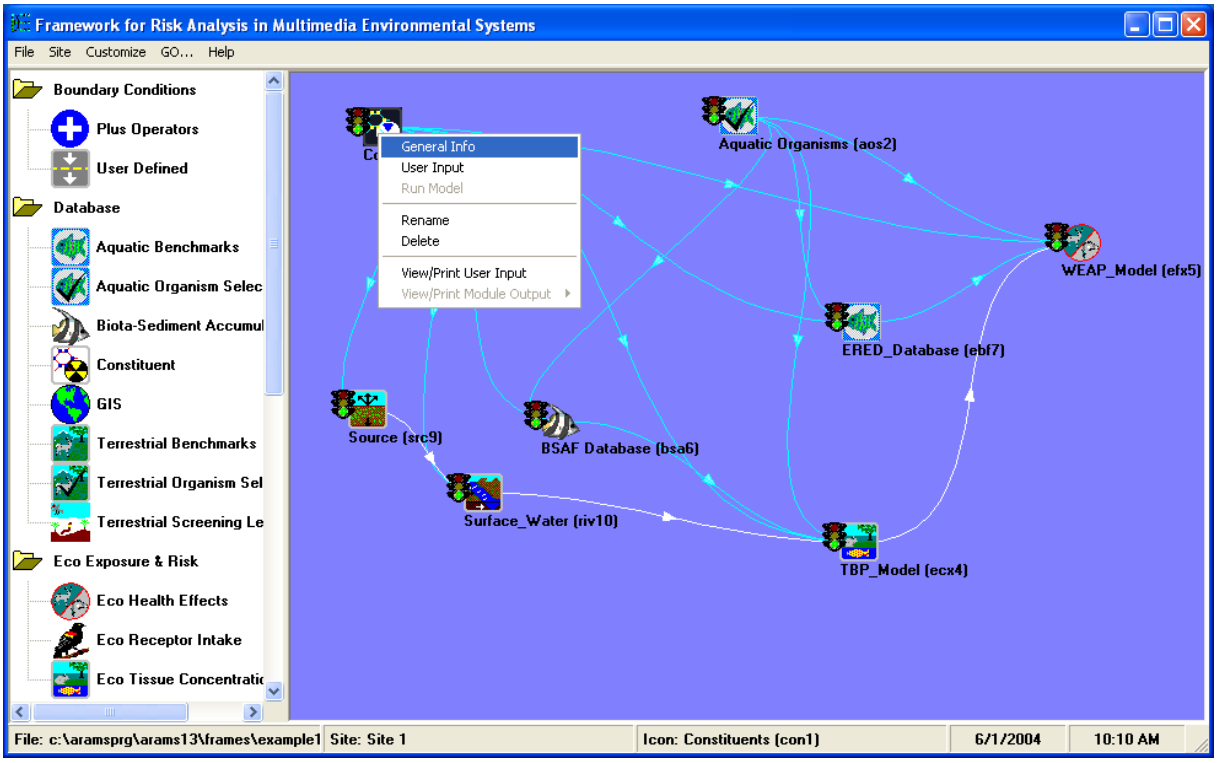


Figure 5. Workspace screen (right-click in the Constituent icon)

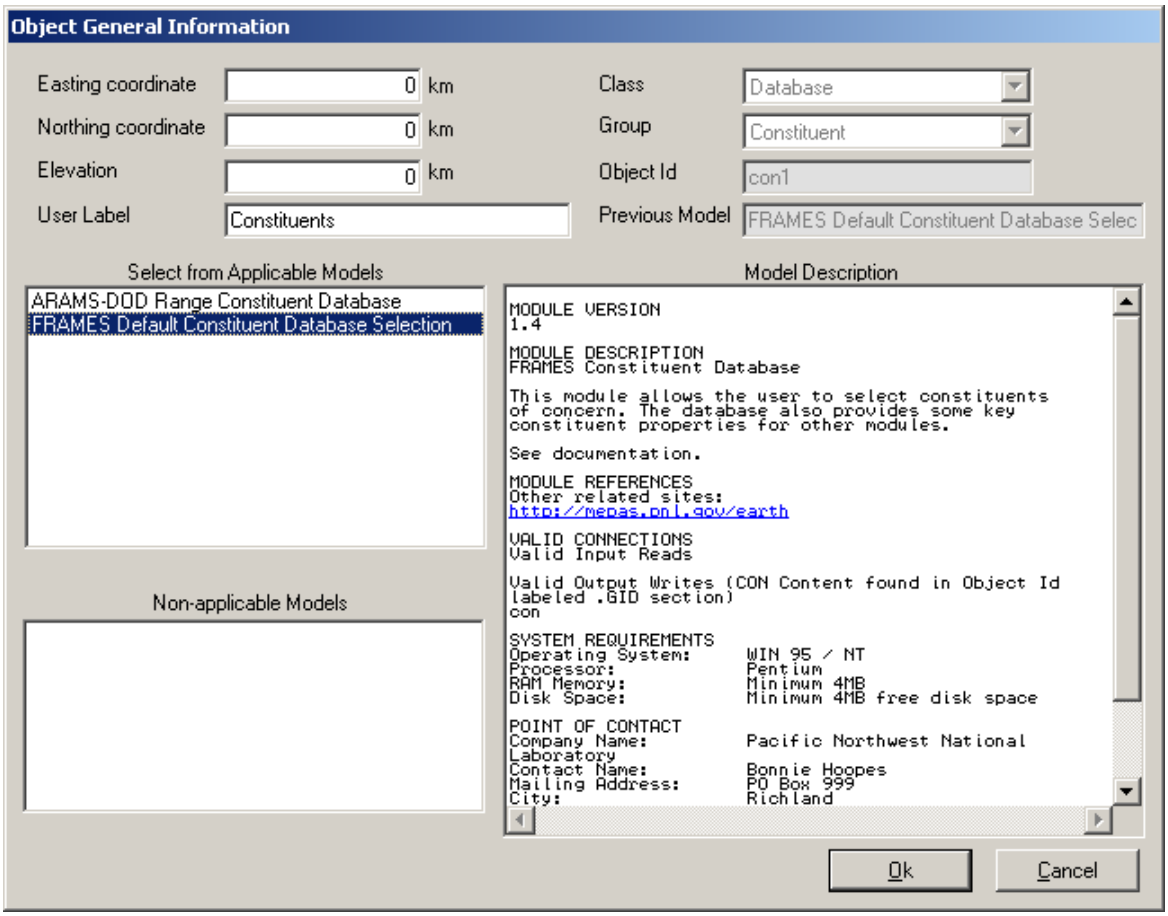


Figure 6. Object General Information screen

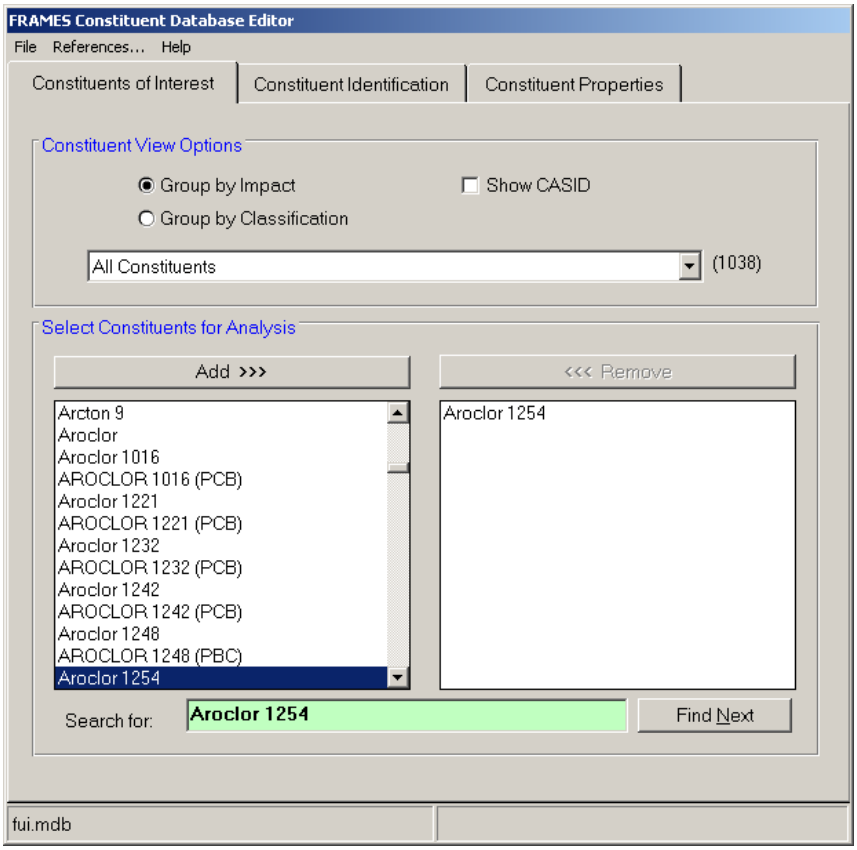


Figure 7. FRAMES Constituent Selection screen ("Constituents of Interest" tab)

The following is a listing of all data input required by the remaining modules used in this example. *Names of module 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.

AQUATIC ORGANISM SELECTOR

General Info

A window titled "Object General Information" will appear. Put in "Aquatic Organisms" in the Label text box. In "Select from Applicable Models," choose "Aquatic Organism Selector" and click "Ok." The status light next to the Aquatic Organism Selector icon should turn red.

The user should first choose each module for each object before entering any data; thus, enter the "General Info" on each remaining module and make a selection before selecting the "User Input." After selecting modules, User Input should be performed, and the modules run, starting with the modules at the upper end of the chain and working down the chain.

User Input

A window titled "ARAMS Aquatic Organism Selector" will appear. Select "Oncorhynchus mykiss" as shown in Figure 8. Choose "Save and Exit" from the File menu. The status light next to the Aquatic Organism Selector icon should turn green.

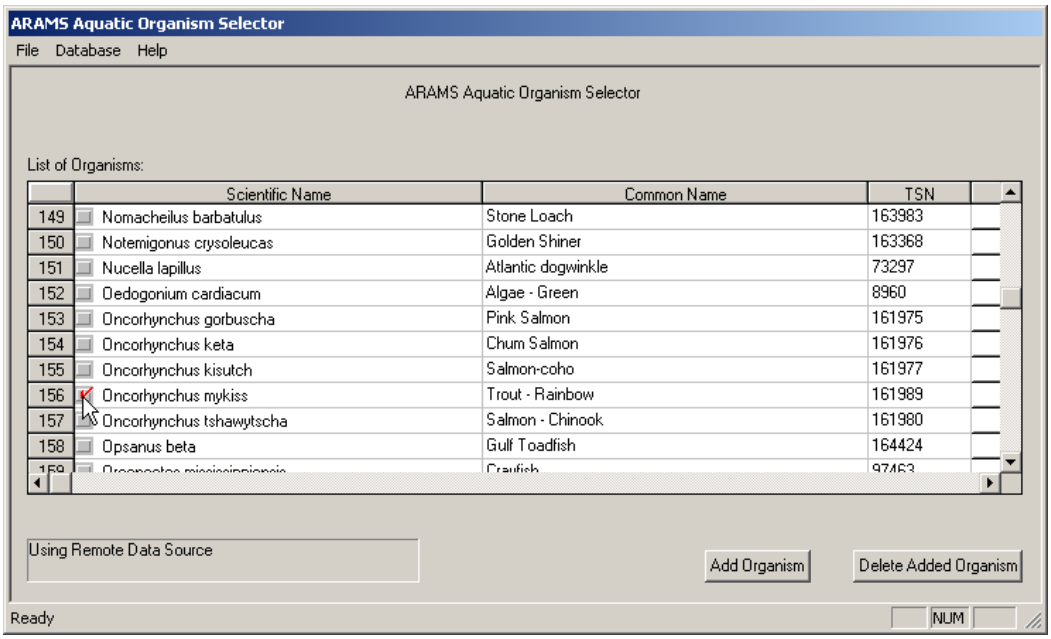


Figure 8. Aquatic Organism Selector main screen

BIOTA-SEDIMENT ACCUMULATION FACTOR

General Info

A window titled "Object General Information" will appear. Put in "BSAF Database" in the Label text box. In "Select from Applicable Models," choose "BSAF Database" and click "Ok." The status light next to the BSAF icon should turn red.

User Input

A window titled "BSAFClient" will appear. There were no data in the BSAF database for the constituent of concern and target organism, so the organism is aliased to Dover Sole (Microstomus Pacificus). While under the *Select Alias* tab, click the target organism in the far left box, then scroll the organism aliases until Microstomus Pacificus is found and click it. Next click the *Lipid and BSAF Values* tab, then click the *Retrieve Lipid/BSAF Values* button. The BSAF database did not compute a grand mean from the values in the database for lipid and BSAF, so the user must examine the available values under *Details* and estimate or select a representative value from the available list. Enter values of 11.33 and 1.36 as representative values for lipid and BSAF grand means in the appropriate spaces shown in Figure 10. Choose "Save and Exit" from the File menu. The status light next to the BSAF icon should turn green.

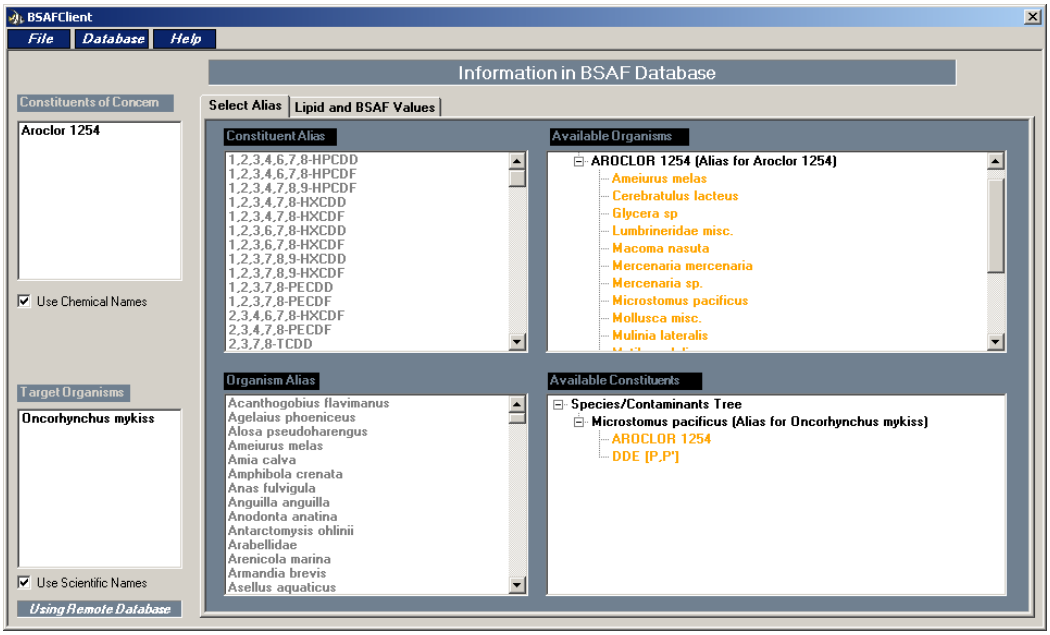


Figure 9. BSAF Database Alias Selection screen

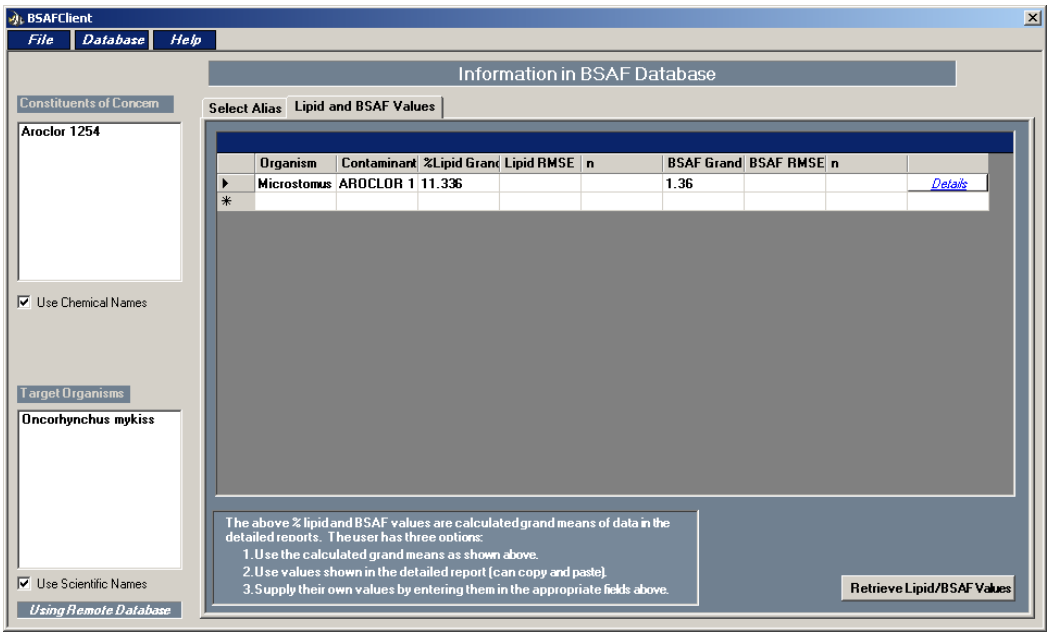


Figure 10. BSAF Database Lipid and BSAF Values screen

AQUATIC BENCHMARKS

General Info

A window titled "Object General Information" will appear. In the Label text box, input "ERED Database." In "Select from Applicable Models," choose "ERED Database" and click "Ok." The status light next to the Aquatic Benchmarks icon should turn red.

User Input

ERED data will proceed to be loaded from the database.

A window titled "EREDClient" will appear.
Note: Should you receive an error message "Unable to Retrieve Organism Data," you may need to verify that you installed the security certificate for accessing the ERED database server. To install the certificate, providing you haven't already done so, run "InstallCert.exe" located in the "Frames" subdirectory of your ARAMS installation directory.

Click the tab labelled "Constituent/Organism Aliasing" at the top of the screen (see Figure 11). Lists containing the selected constituents and organisms will appear at the left side of the screen. Click the check boxes labelled "Use Constituent Name" and "Use Common Names" to work with constituent and organism names instead of constituent CAS Ids and scientific organism names. If the selected organisms and constituents of concern are found in the ERED database, the aliases will automatically be chosen as they are in this case. If they were not automatically selected, the alias would need to be chosen by clicking on either the constituent name or the organism name and then choosing the alias from the appropriate box labelled "Constituent Alias" or "Organism Alias." See Figure 11 to verify that the selections are correct.

Select the tab labelled "View and Edit Data" at the top of the screen and then click the button labelled "Retrieve Data" in the top right corner of the screen.

The database will be queried and a progress bar will display in the lower right corner of the Data Editor Screen. After the database has been queried, the left tree menu will populate with descriptions of the retrieved data under the "View and Edit Data" tab. Verify that the information is the same as shown in Figure 12.

Click "Save and Exit" under the File menu. The Aquatic Benchmarks icon's status light will change from red to green.

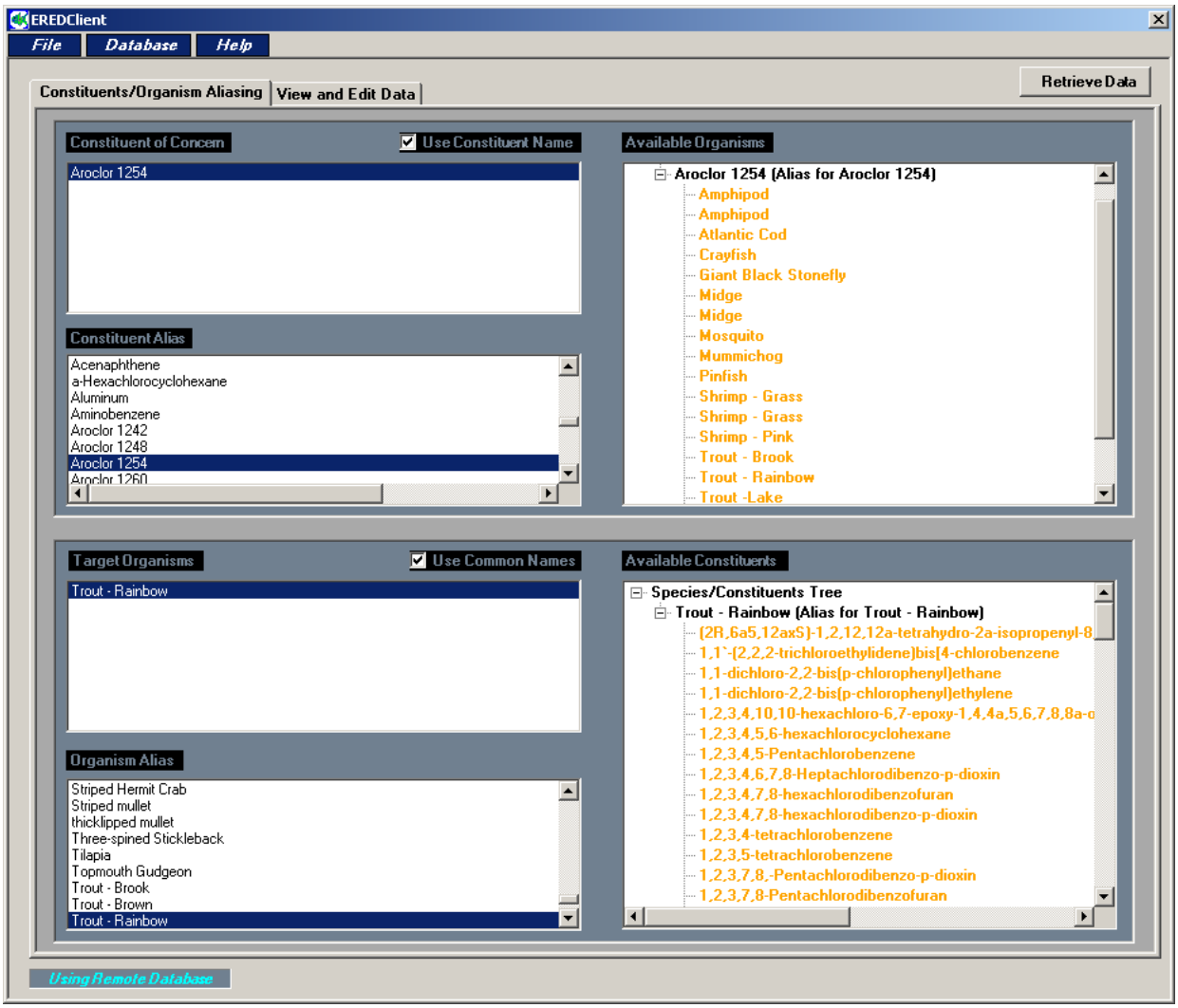


Figure 11. Constituent and Organism Aliasing in the ERED database client

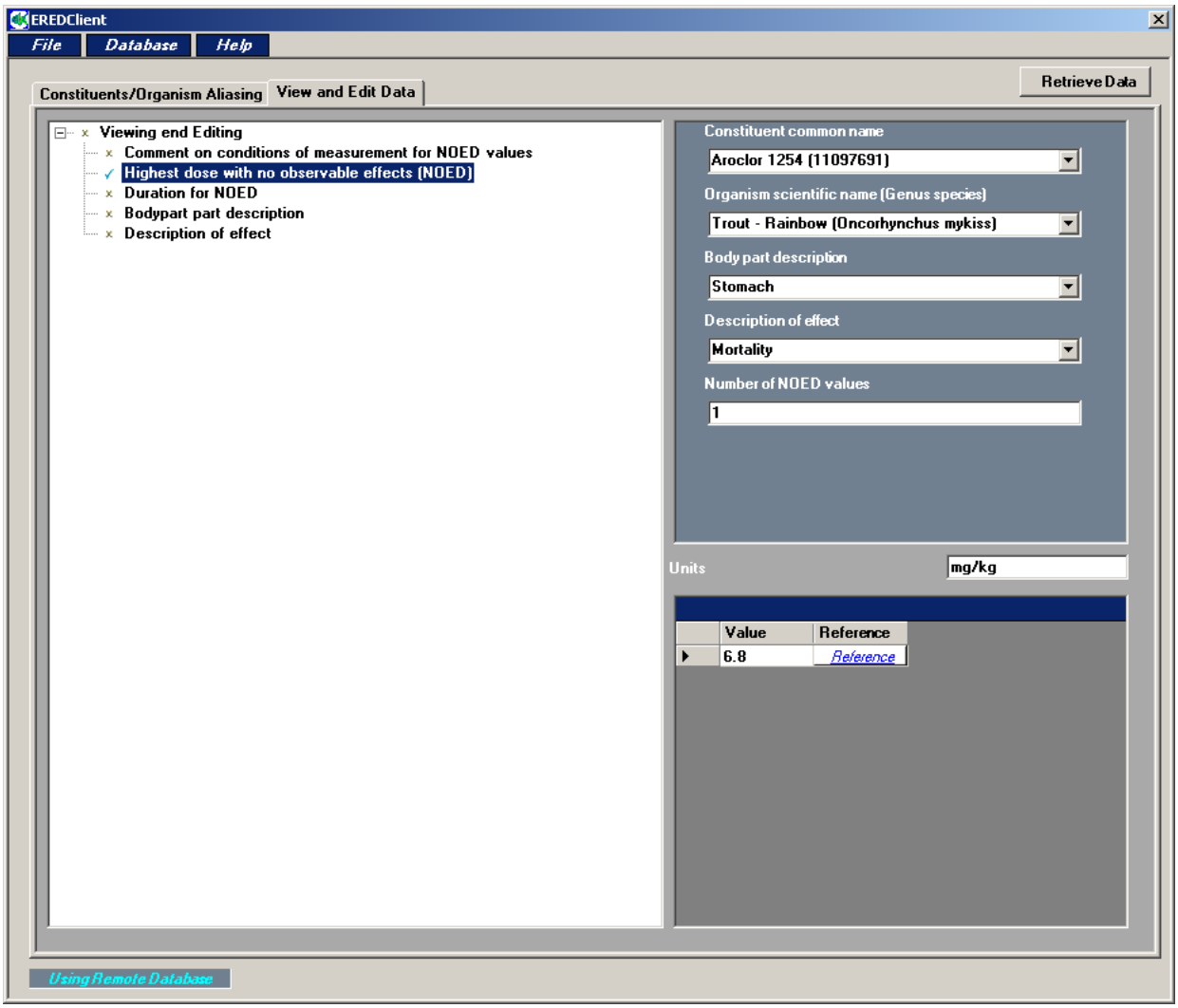


Figure 12. "View and Edit Data" tab in the ERED ERDC DCE

SOURCE TERM

General Info

A window titled "Object General Information" will appear. Put in "Source" in the Label text box. In "Select from Applicable Models," choose "RECOVERY 3.0 Source - Known Loads and Inflow Concentrations" and click "Ok." The status light next to the Source Term icon should turn red.

User Input

A window titled "RECOVERY 3.0 Source Term" will appear. Fill it out according to the data shown in Figure 13. Click "Save and Exit" to return to the work screen. The status light next to the Source Term icon should turn yellow.

Run Model

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

View/Print Module output

A second menu will appear (see Figure 14). Select the "WCF Text View" to view a screen output like Figure 15. Choose "WCF Graphical View" to view a screen output in Excel format (see Figure 16).

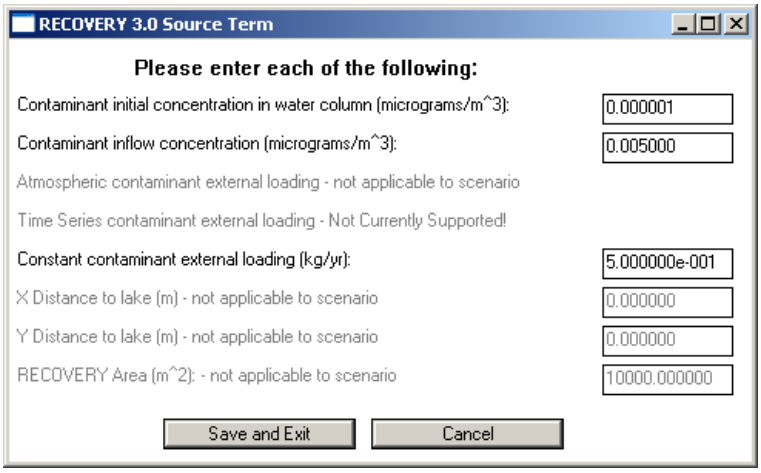


Figure 13. RECOVERY 3.0 Source Term input screen

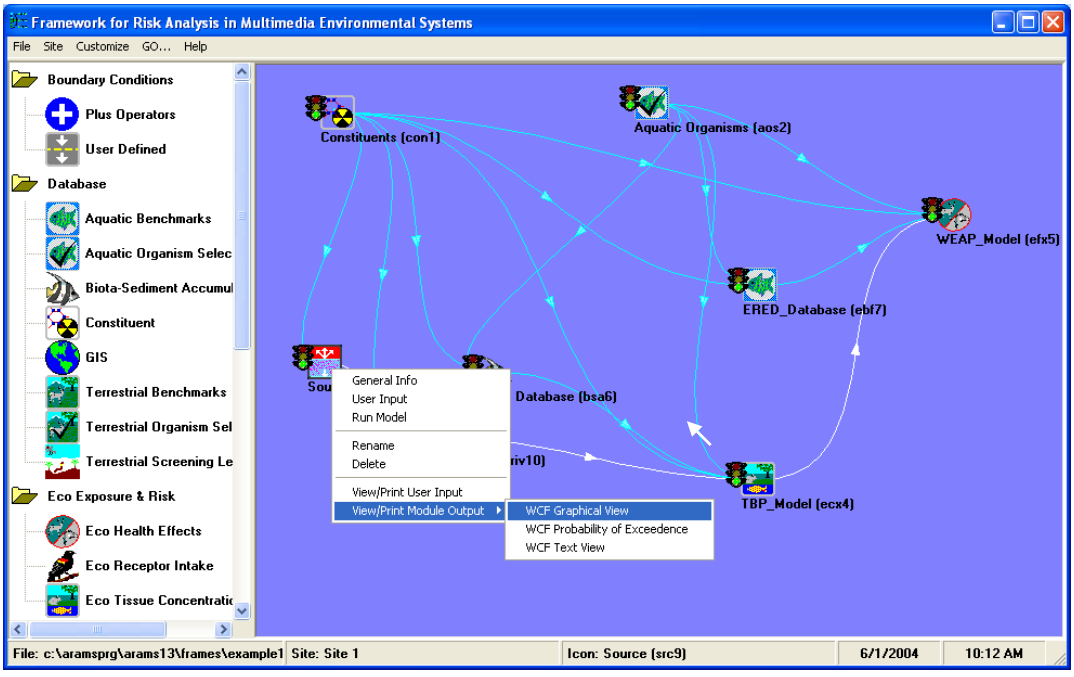


Figure 14. Selecting the output display format

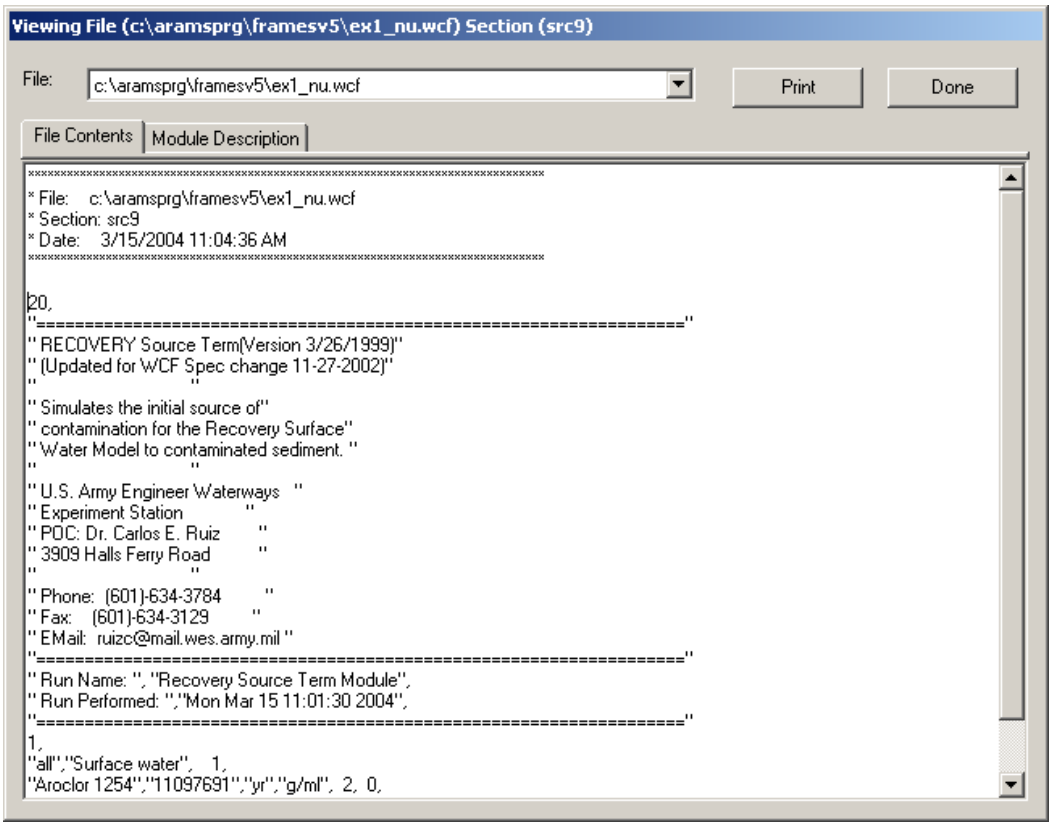


Figure 15. WCF text view

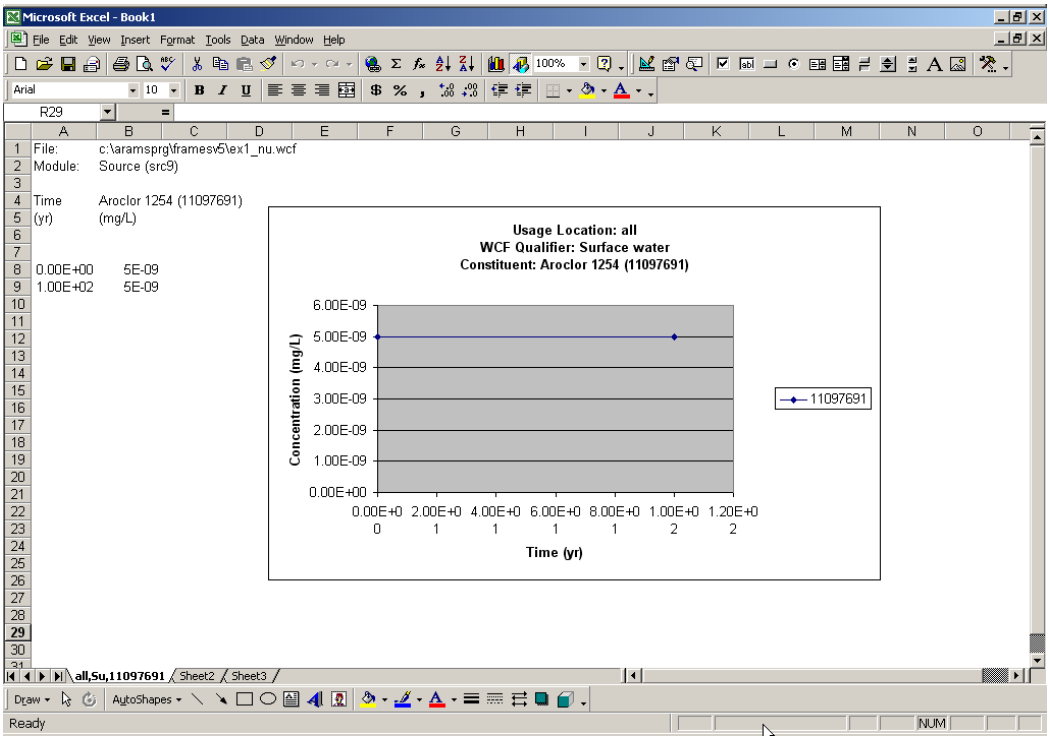


Figure 16. Source Term icon output (Excel format view)

SURFACE WATER

General Info

A window titled “Object General Information” will appear. In the Label text box, put in “Surface Water.” In “Select from Applicable Models,” choose “RECOVERY 3.0 Surface Water Module” and click “Ok.” The status light next to the Surface Water icon should turn red.

User Input

A window titled “ADDAMS Applications” will appear; this window displays the disclaimer of the RECOVERY software. Click on “Next” to continue. A screen displaying a brief description about the program and the names of its developers will appear; click “Next” to continue. A window titled “ADDAMS Applications RECOVERY Version 1.0” will come into view; this screen displays five options. Click in the radio button left of “Edit/Modify Existing File” to select that option. Click “Next” to continue. Another window will appear; select from the existing recovery input files list (by clicking in the right box of the window) FRAMES.REC and click “Next.” NOTE: The FRAMES.REC file is in the FRAMES subdirectory of the ARAMSPRG directory on the hard disk of the computer.

(NOTE: In the followings windows that are referenced, enter the values in logical order. Do not pass to the next tab until the previous values have been entered.)

A window like Figure 17 will appear (water and watershed properties). Fill it out according to the data shown in the figure. Click on “Recalculate,” choose “Save” and select “Next.”

A screen like Figure 18 will appear (mixed sediments layer properties). Fill it out according to the data shown, click “Save,” and select “Next.”

Another window like Figure 19 will appear (deep contaminated sediments layer properties). Fill it out according to the data shown, click “Save,” and select “Next.”

A window like Figure 20 will appear, make sure that the system properties shown in the figure coincide with your screen values. Click on “Recalculate,” choose “Save,” and select “Next.”

A screen like Figure 21 will appear, ensure that the Aroclor 1254 properties and decay coefficients shown coincide with your screen values, click “Save,” and “Next.”

A window like Figure 22 will appear (system parameters). Fill it out according to the data shown, click “Save,” and “Next.”

A window like Figure 23 will appear. Click on “Save Input” and a window asking “Overwrite Existing File?” will appear, select “Yes” and the window will close. Now click “Exit.” The status light next to the Surface Water icon should turn yellow.

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. Select the "SCF Text View – Sediments Concentrations" to view a screen output like Figure 24. Choose "SCF Graphical View – Sediment Concentration" to view a screen output in Excel format (see Figure 25).

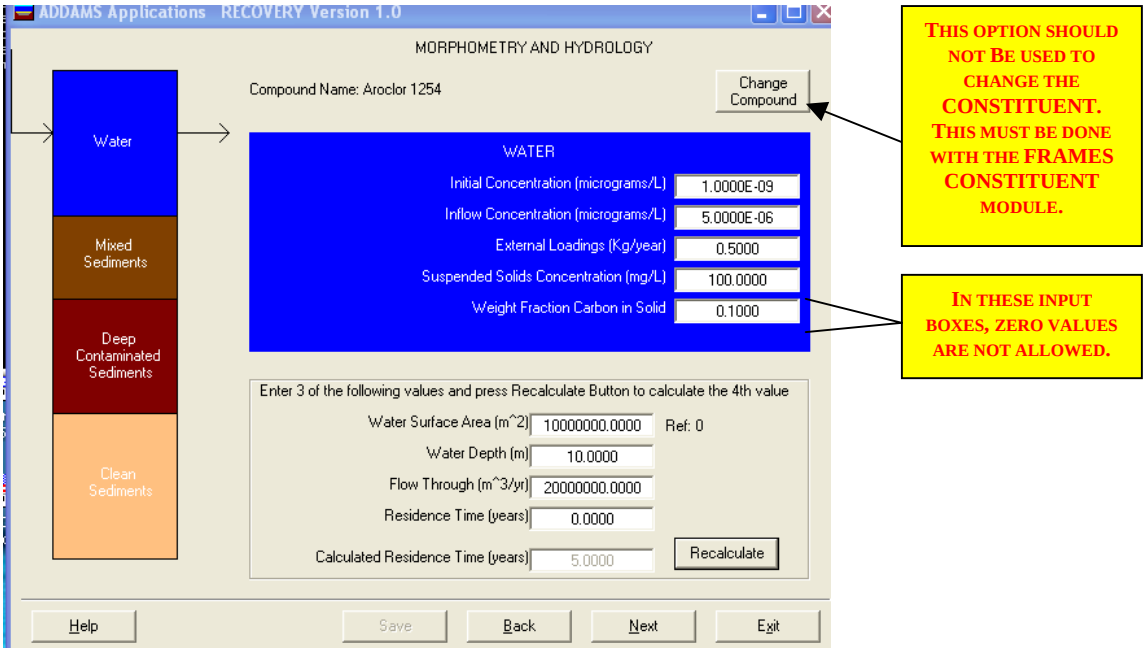


Figure 17. Screen for modifying existing recovery file (water and watershed properties)

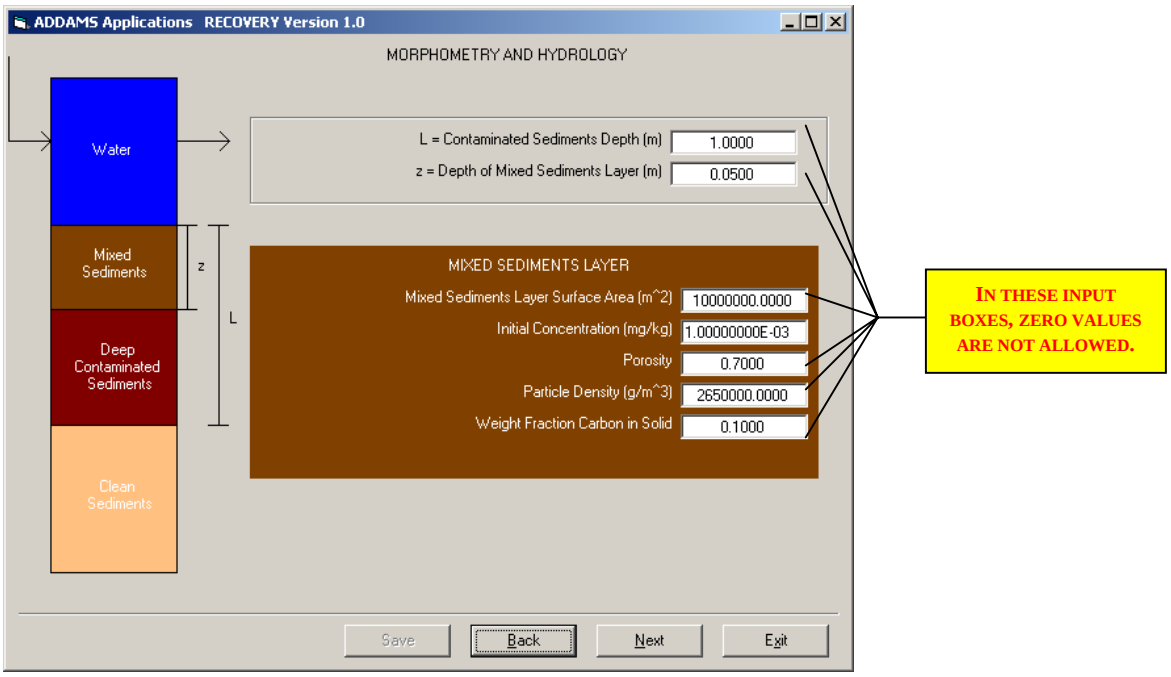


Figure 18. Screen for modifying existing recovery file (mixed sediments layer properties)

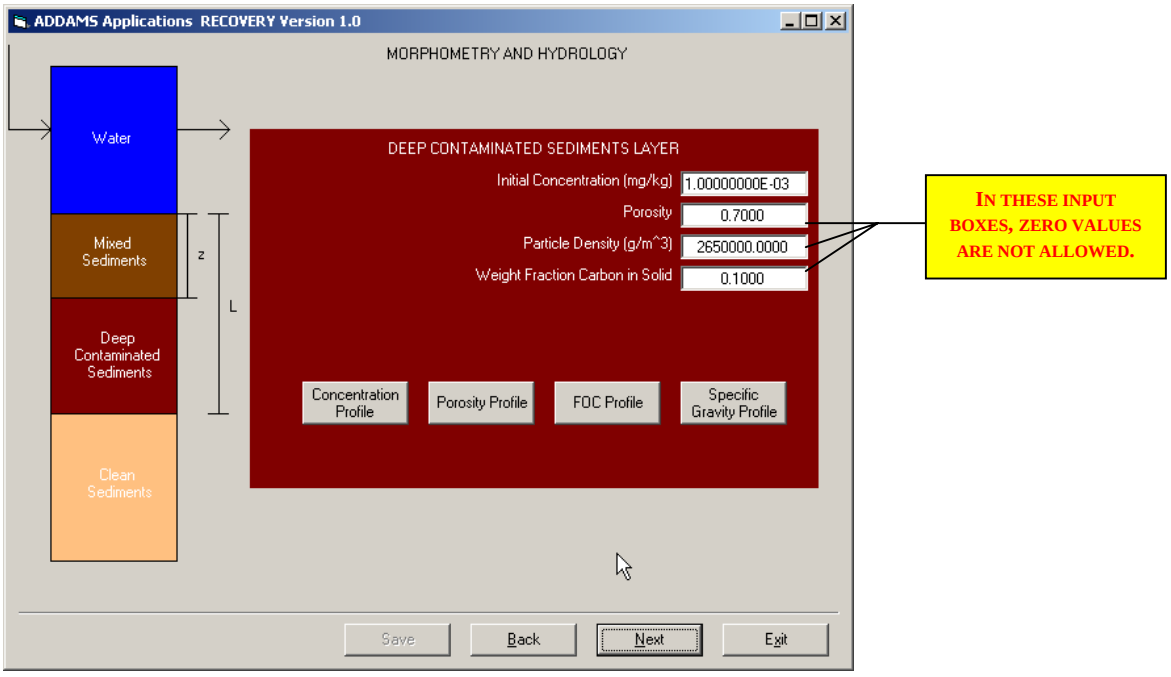


Figure 19. Screen for modifying existing recovery file (deep sediments layer properties)

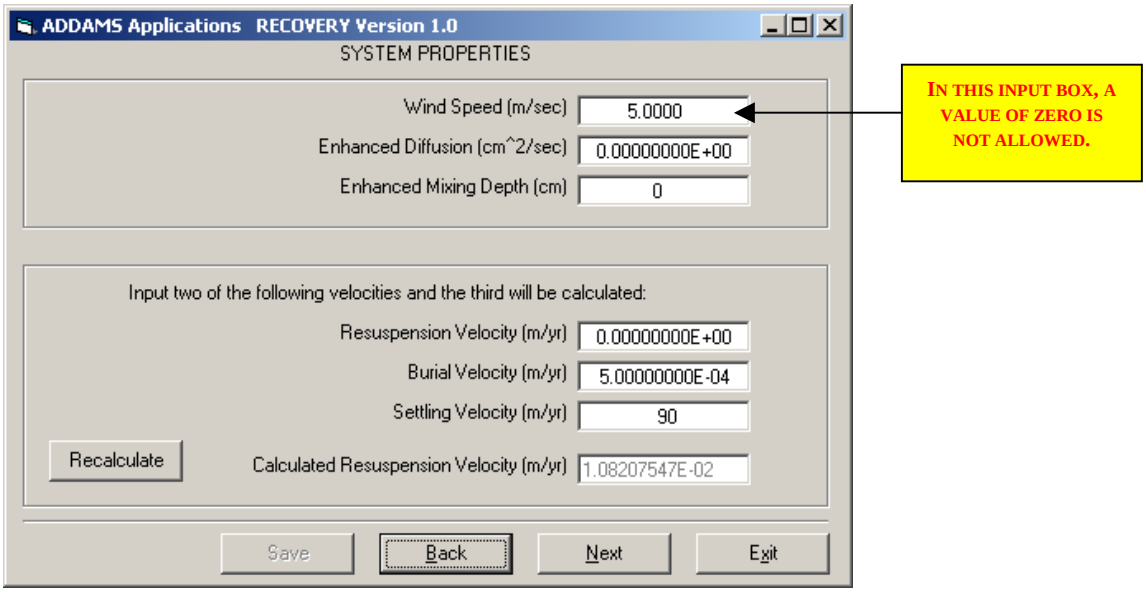


Figure 20. Screen for modifying existing recovery file (system properties)

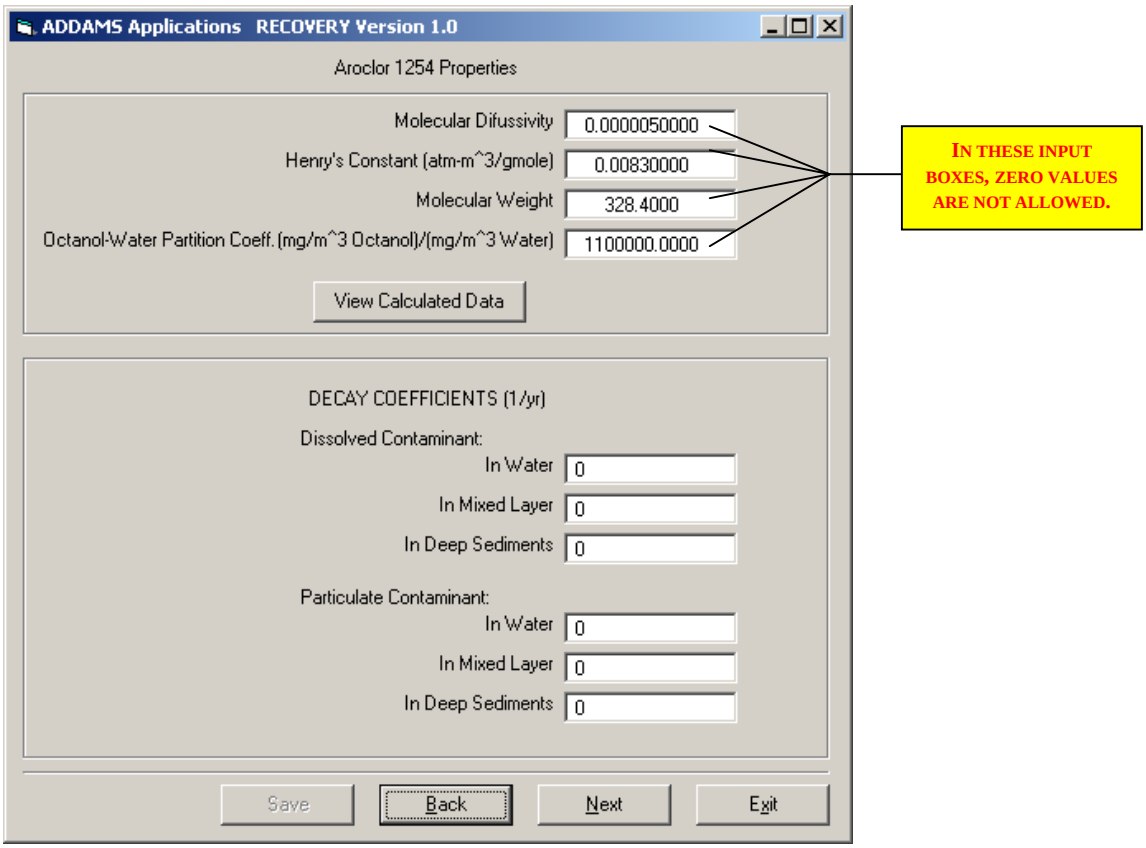


Figure 21. Screen for modifying existing recovery file (Aroclor 1254 properties and decay coefficients)

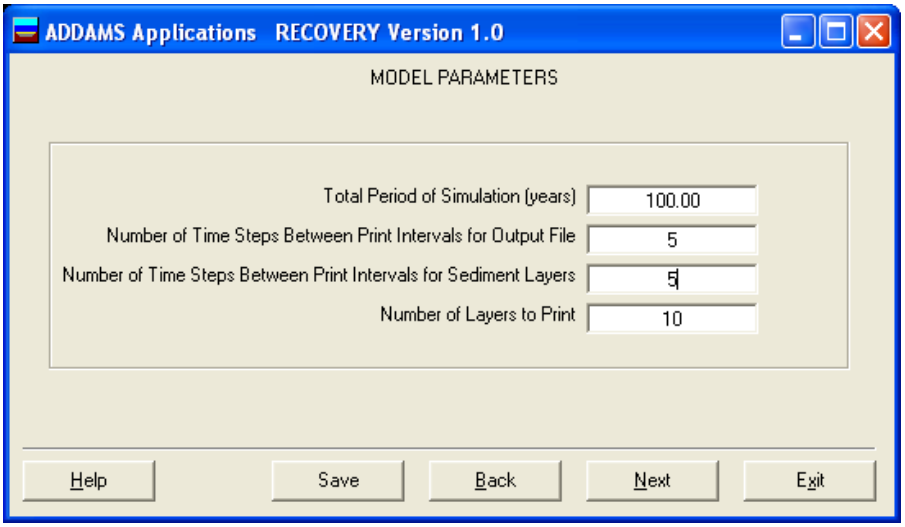


Figure 22. Screen for modifying existing recovery file (model parameters)

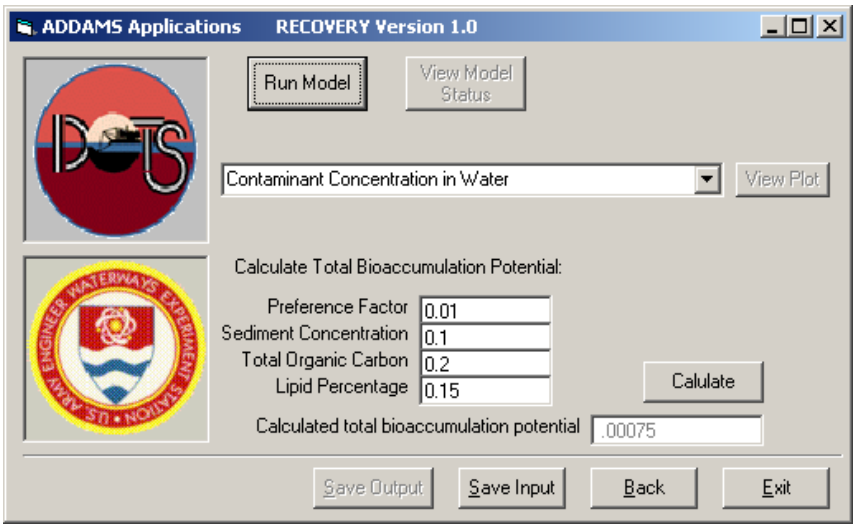


Figure 23. Screen for modifying existing recovery file (model output/exit)

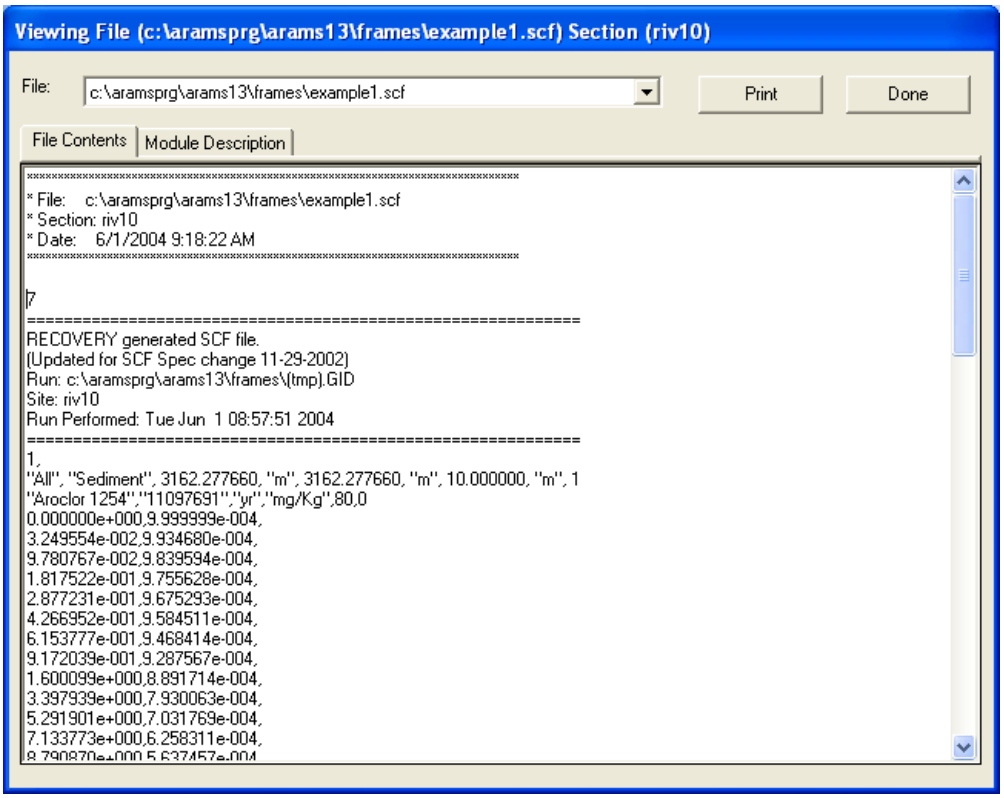


Figure 24. SCF text view – sediments concentrations

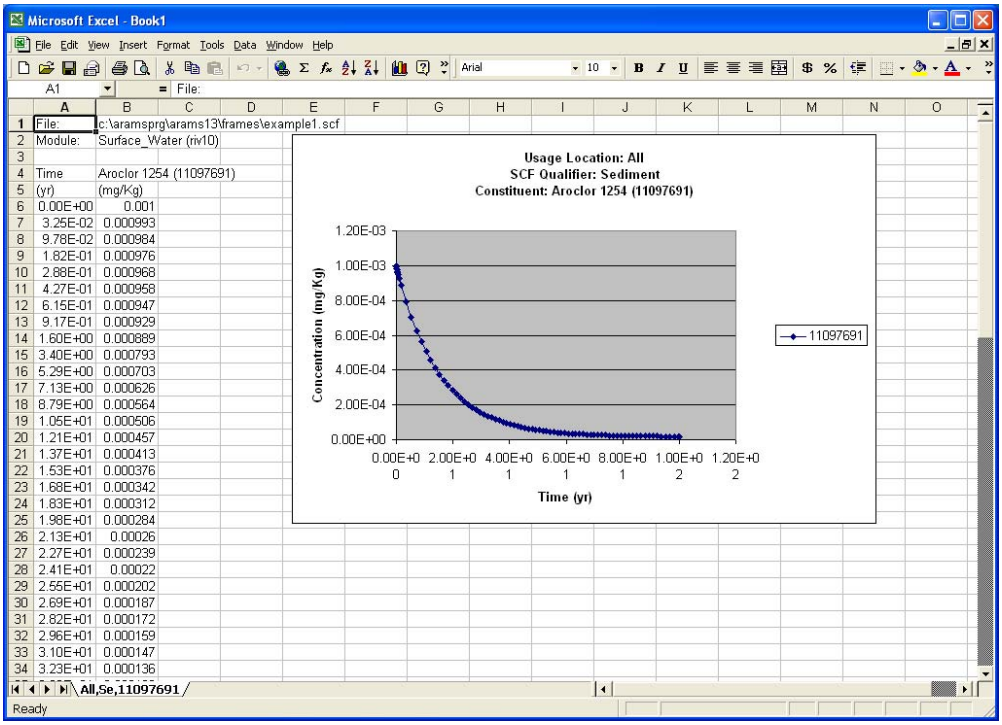


Figure 25. SCF graphical view – sediment concentration

ECO TISSUE CONCENTRATIONS

General Info

A window titled "Object General Information" will appear. In the Label text box, input "TBP Model." In "Select from Applicable Models," choose "Theoretical Bioaccumulation Potential (TBP) DCE" and click "Ok." The status light next to the Eco Tissue Concentrations icon should turn red.

User Input

The main TBP screen will appear (see Figure 21) and is pre-populated with the constituent(s) and organism(s) selected from the Constituent Database and the Aquatic Organism Selector objects, respectively. Lipid and BSAF values are retrieved from the Biota-Sediment Accumulation Factor object. The only additional information required for this module is the Total Organic Carbon (TOC) fraction in the sediment. Enter the value for TOC as shown in Figure 26.

Click "File" and choose "Save and Exit." The Eco Tissue Concentrations icon's status light will change from red to yellow.

Run Model

The model runs in the background. The status light next to the Eco Tissue Concentrations icon should turn green.

View/Print Module Output

A second menu will appear; select the "BBF Text View" to view a screen output like Figure 27. Choose "BBF Graphical View" to view a screen output like Figure 28 (Excel format).

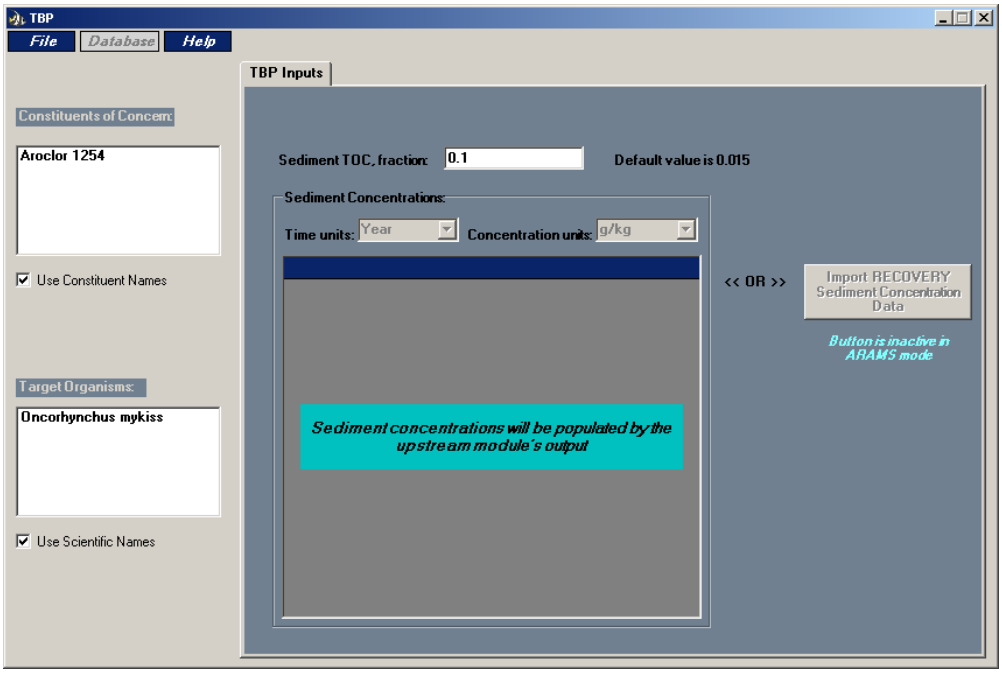


Figure 26. TBP input screen

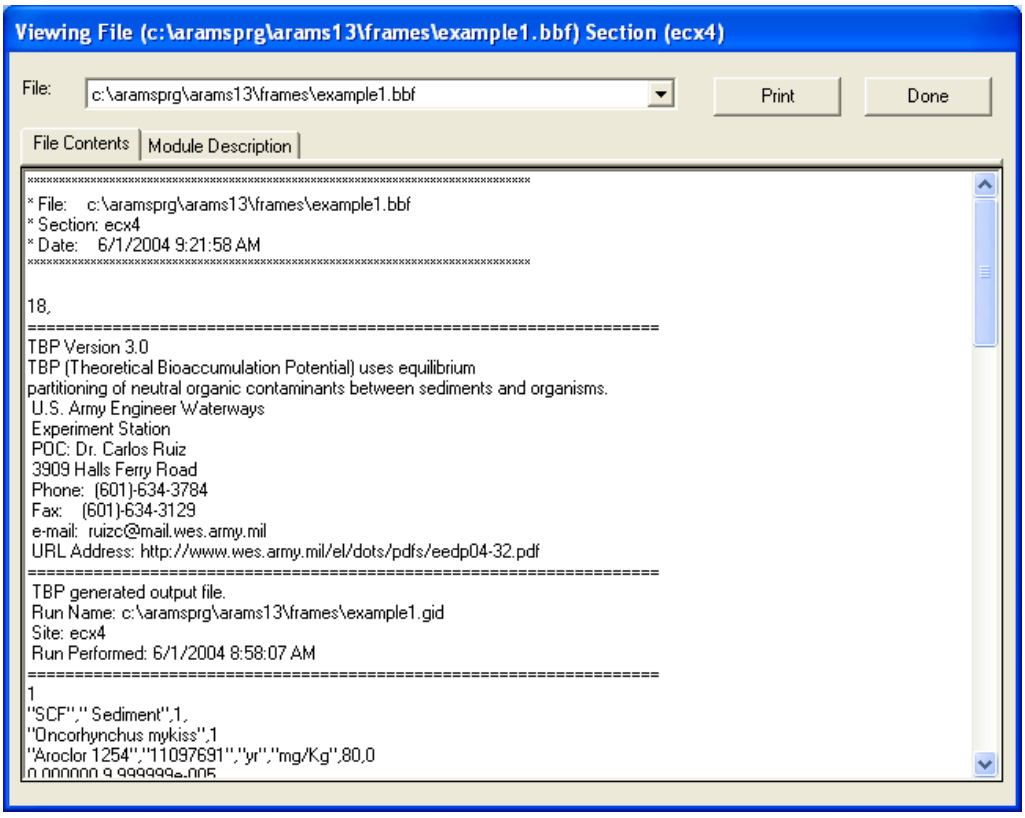


Figure 27. Eco Tissue Concentrations Output (text view)

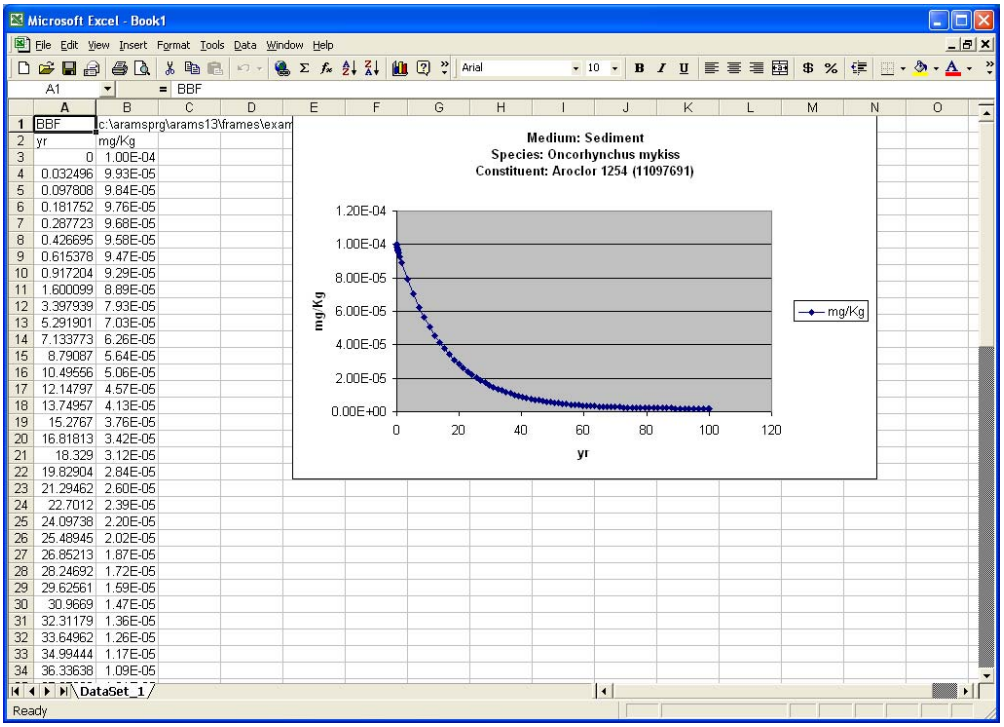


Figure 28. Eco Tissue Concentrations Output (Excel format)

ECO HEALTH EFFECTS

General Info

A window titled "Object General Information" will appear. In the Label text box, input "WEAP Model." In "Select from Applicable Models," choose "Wildlife Ecological Assessment Program" and click "Ok." The status light next to the Eco Effects icon should turn red.

User Input

A window titled "Wildlife Ecological Assessment Program" will appear. In the right panel labeled "Aquatic Body Burden Dose Assessment," click in the check box to the left of "No observable effects dose." In the data tree at left, click on "Body part of concern" and a list labeled "Body part of concern" will appear at right. From this list choose (by clicking on) "Visceral Fat" and "Whole Body" (see Figure 29). Click on "Type of effect" in the data tree at left. Choose "Mortality" and "Physiological" from the "Type of effect" list in the right panel of the window (see Figure 30).

Click "File" and choose "Save and Exit" to return to the workspace screen. The Eco Health Effects icon's status light will change from red to yellow.

Run Model

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

View/Print Module Output

A second menu will appear. Select the "EXF Text View" to view a screen output like Figure 31. Choose "EXF Graphical View" to view a screen output like Figure 32 (Excel format).

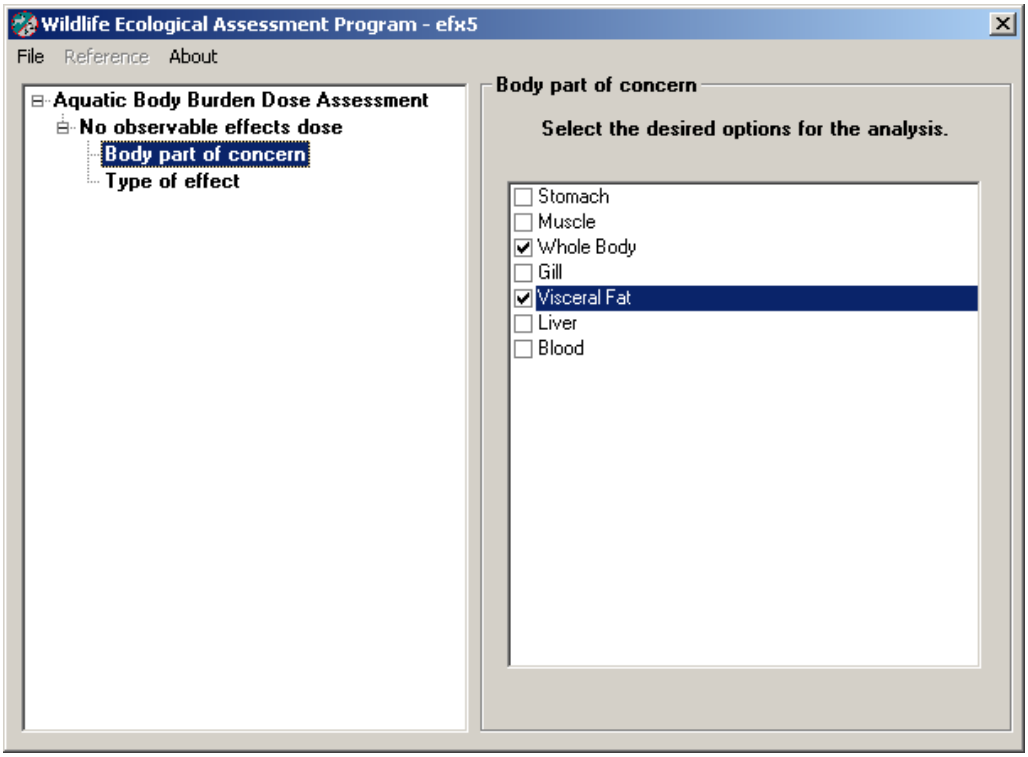


Figure 29. Wildlife Ecological Assessment Program (body part of concern)

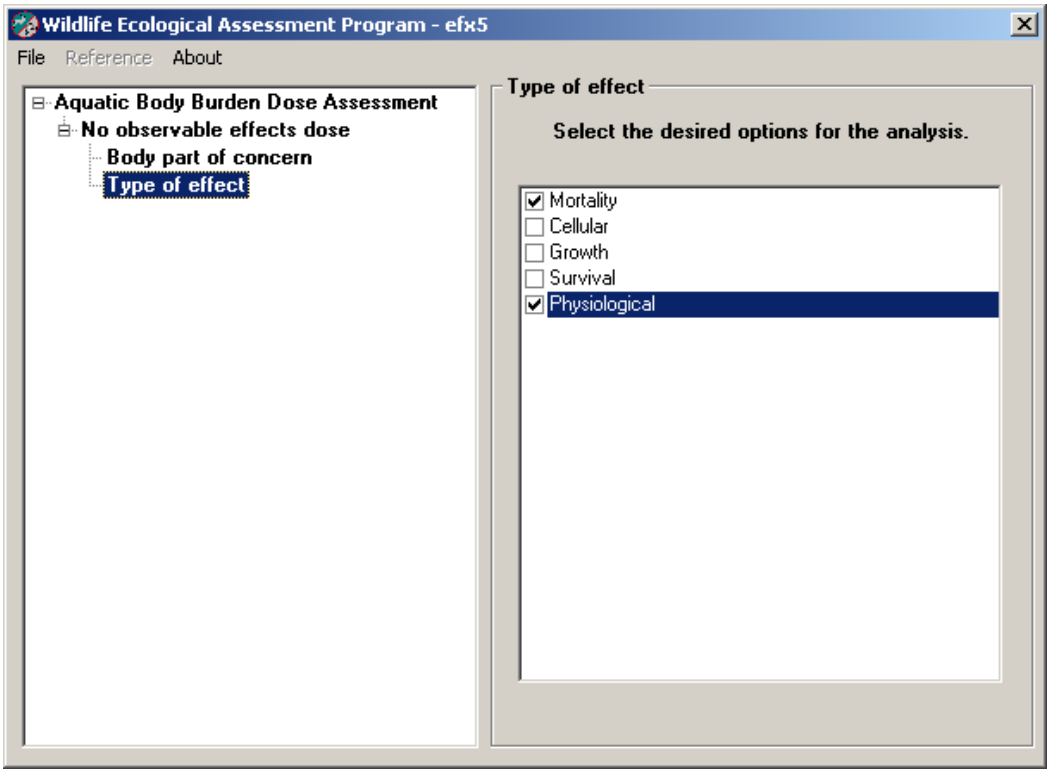


Figure 30. Wildlife Ecological Assessment Program (type of effect)

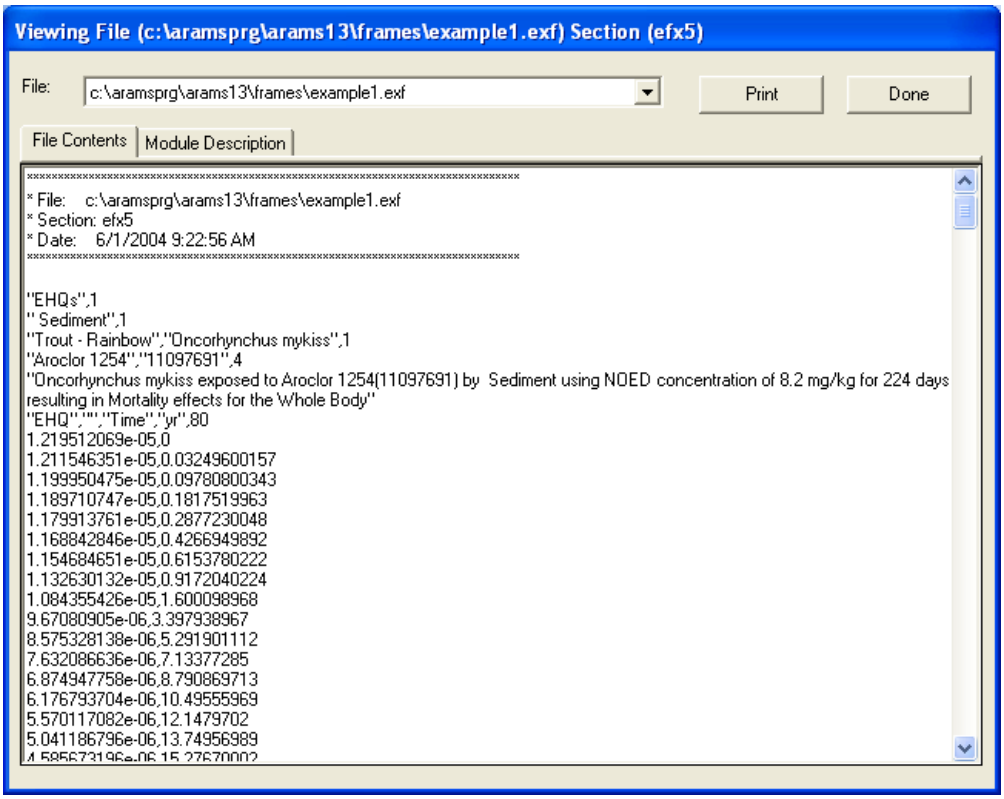
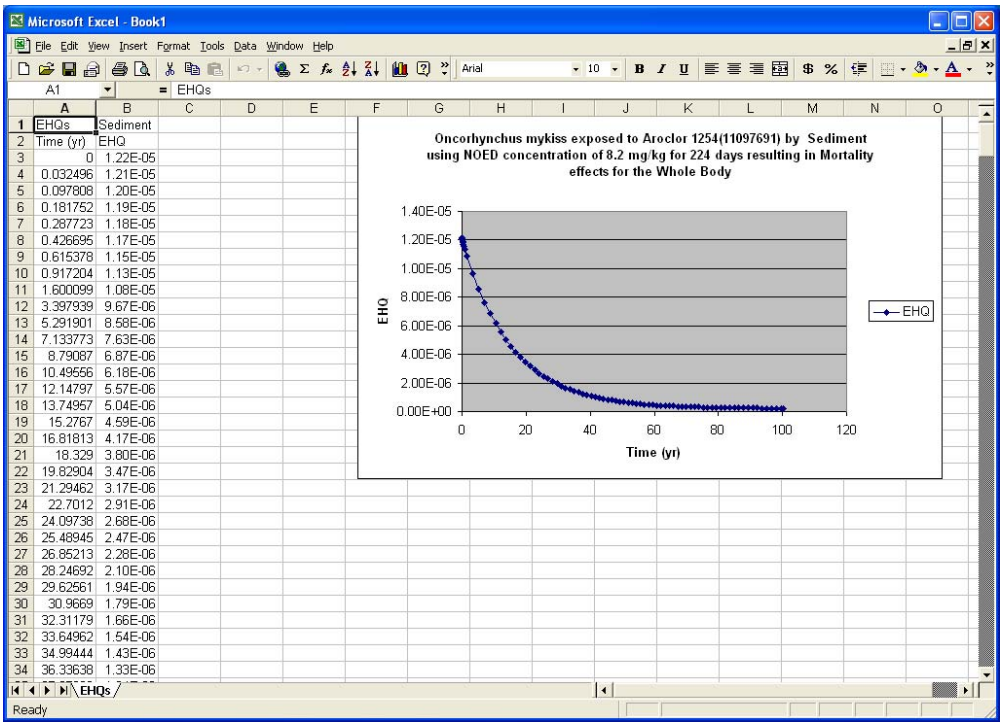


Figure 31. Eco Health Effects output (text view)



	A	B
1	EHQs	Sediment
2	Time (yr)	EHQ
3	0	1.22E-05
4	0.032496	1.21E-05
5	0.097808	1.20E-05
6	0.181752	1.19E-05
7	0.287723	1.18E-05
8	0.426695	1.17E-05
9	0.615378	1.15E-05
10	0.917204	1.13E-05
11	1.600099	1.08E-05
12	3.397939	9.67E-06
13	5.291901	8.58E-06
14	7.133773	7.63E-06
15	8.79087	6.87E-06
16	10.49556	6.18E-06
17	12.14797	5.57E-06
18	13.74957	5.04E-06
19	15.2767	4.59E-06
20	16.81813	4.17E-06
21	18.329	3.80E-06
22	19.82904	3.47E-06
23	21.29462	3.17E-06
24	22.7012	2.91E-06
25	24.09738	2.68E-06
26	25.48945	2.47E-06
27	26.85213	2.28E-06
28	28.24692	2.10E-06
29	29.62561	1.94E-06
30	30.9669	1.79E-06
31	32.31179	1.66E-06
32	33.64962	1.54E-06
33	34.99444	1.43E-06
34	36.33638	1.33E-06

Figure 32. Eco Health Effects Output (Excel format)