APPENDIX I

USER'S GUIDE FOR THE CHEMICAL MASS BALANCE MODEL VERSION 1.0

(Adapted from Karri, 2004)

Overview of the Model

The Chemical Mass Balance Model (CMBM) estimates the most likely source components that contribute to outfall flows during dry weather. In order to use the model, the user must have a Library File in the form of an Excel file in a specified format. This library file describes the concentration characteristics of potential local contributing flows. In the CMBM, the user selects the sources to be evaluated for an outfall, enters the values of the concentrations of the tracers measured at the outfall, and obtains a plot of the most likely source component in tabular form, and in probability plots.

Installation of the Model

The user must first install the model by inserting the disk and then clicking the 'CMBM_setup.exe' icon and following the on-screen instructions.

Model Inputs

The user enters the following data:

1. The potential sources to be evaluated for a particular outfall. The number of sources is entered in the first form (Figure I.1) and the user must then select the same number of sources and tracers when the lists of the sources and tracers are loaded.
2. The source library file containing source flow characteristics (median, COV, and distribution type) for the Monte Carlo statistical simulations (Figure I.2).
3. The tracer parameters for these sources and outfall contained in the library file. The user selects the specific tracers to be used from the check boxes when they are loaded in the first form.
4. The number of Monte Carlo simulations that are to be used by the model, up to 10,000 runs.
5. The observed outfall concentrations of the selected tracer parameters measured for a particular outfall (in the second form of the model). Press the continue button when these concentrations are entered.

In the first form

- Navigation from one step to another can be done by using either the mouse or the 'tab' button.
- Changing the value entered for 'Number of contributing sources to be evaluated' after entering subsequent steps will likely result in an error message. If the user wishes to change this value after starting on later forms, the user must use the 'Start over again' button (third form) and re-enter the earlier forms.
- The model can run up to eight sources and tracers in a single trial.

In the third form

- The user must first save the output file to run the Monte Carlo simulation.
- The user must first save the graph to view or print it.
- The user must first save the table to print it.
- If the table cannot be viewed properly, it can be resized.

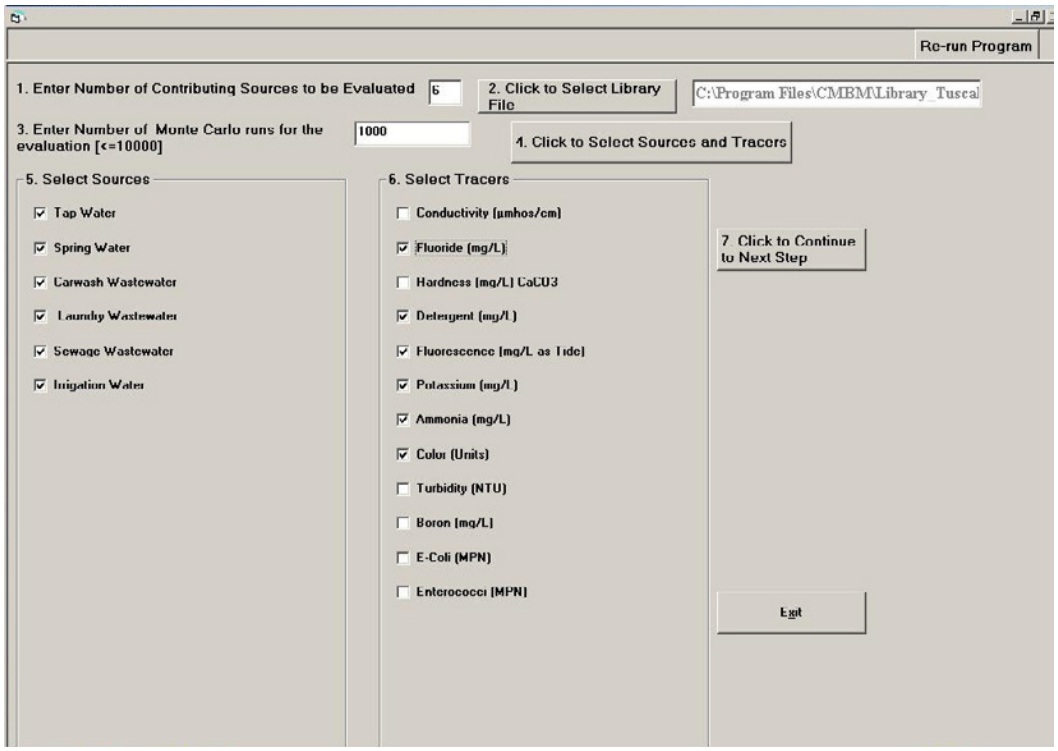

Figure I.1: Form-1 (Model inputs)

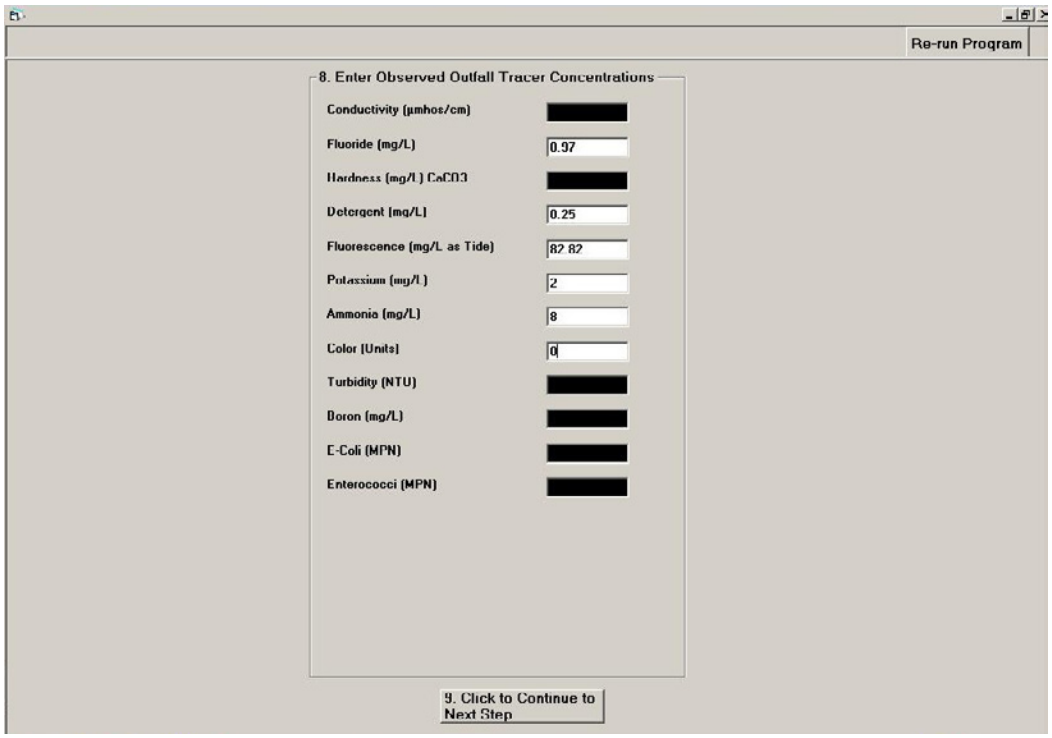

Figure I.2: Form-2 (Model inputs)

Model Outputs

The output of the model is in two forms:

- *A summary table lists the 95th percentile confidence interval (the 2.5th and the 97.5th percentile values) and the 50th percentile (median) values of the mass fraction for each source contributing to the outfall dry weather flow, as calculated by the CMBM and using the number of Monte Carlo simulations specified. This table also shows these values for an error term, μ (Mu):* This table can be saved and printed by selecting the options in the third form. In order to print the table (a small Excel spreadsheet), it must first be saved on the computer.

- *A probability plot of the calculated mass fractions for each selected source flow and also for the error term, μ (Mu)*: This plot (see Figure I.3) can be saved and printed by selecting the options in the third form. In order to print each figure, they must first be selected and saved on the computer.

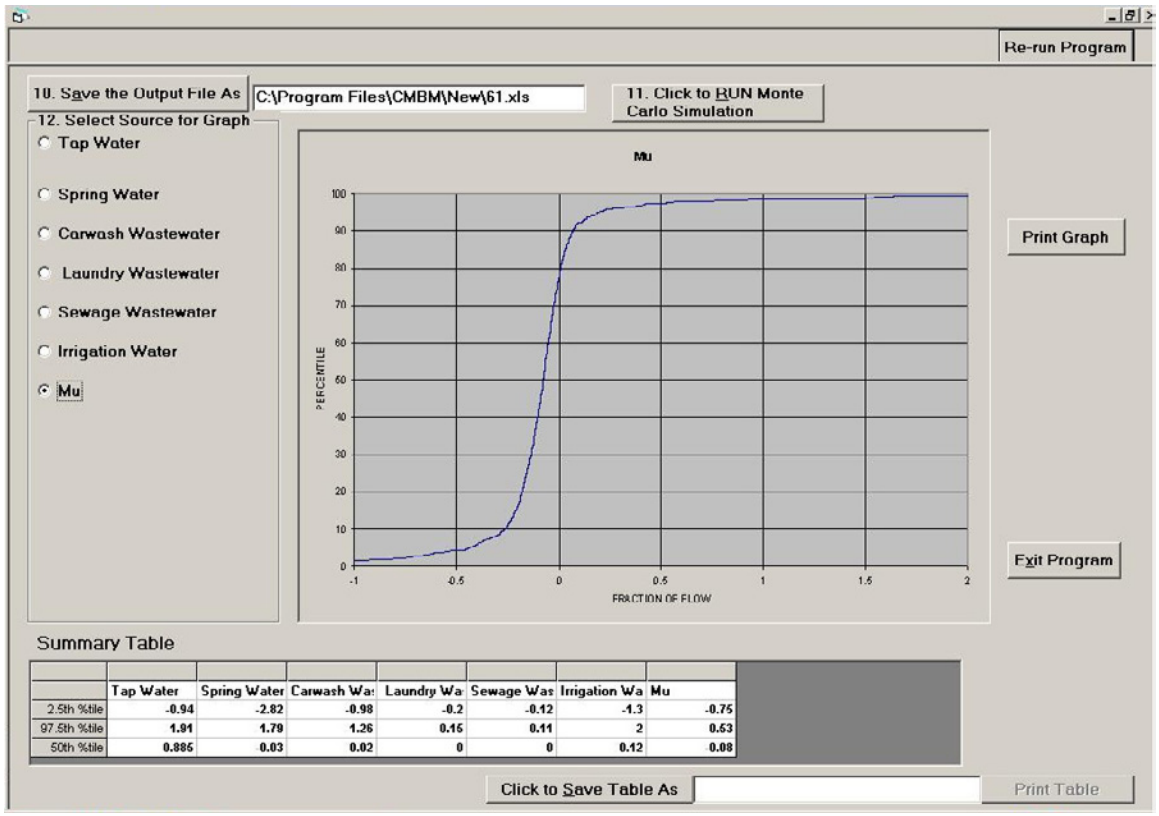

Figure I.3: Form-3 (Model output)

Library File Format

This model recognizes the source file for evaluation, only when it is in a specific format in an Excel spreadsheet.

- The data for each source is entered in an Excel file, with a separate worksheet being used for each individual source. Worksheets should be named according to the source (e.g., tap water, spring water, sewage, etc.)
- The first column of the Excel data sheet must contain the names of the tracers, starting with the second row, the second column must contain values of mean concentration, the third column, the coefficient of variation, and the fourth column the type of distribution. "N" is for "normal", or Gaussian, distributions, while "L" if for log-normal distributions. Figure I.4 is an example spreadsheet file for source area library flows.

Tracer	Mean Concentration	COV	Distribution
Conductivity (µmhos/cm)	274.67	0.46	N
Fluoride (mg/L)	1.23	1.57	L
Hardness (mg/L) $CaCO_3$	71.17	0.27	N
Detergent (mg/L)	140.91	0.21	N
Fluorescence (mg/L as Tide)	90.98	0.47	N
Potassium (mg/L)	3.58	0.67	L
Ammonia (mg/L)	0.90	1.42	L
Color (Units)	100.00	0.01	N
Turbidity (NTU)	156.81	0.78	N
Boron (mg/L)	0.65	0.74	L
E-Coli (MPN)	100.00	0.00	L
Enterococci (MPN)	10.00	0.00	L

Figure I.4: Excel Sheet in Library File

Example Problems

Example 1
This first example illustrates a verification procedure that is used to ensure the model is functioning as expected. It assumes the analysis of an undiluted flow.

Consider an outfall, which has the same data for the tracer parameters as were observed at the sewage treatment plant (which is the same as the library data for sewage wastewater). This means that the model must predict the most likely source component to be sewage and with a predicted fraction of flow for sewage close to one.

The library file used here is the Birmingham library file 'Library_BHM.xls' (which is included with the program). Let the number of Monte Carlo simulations considered be 1000, and the number of sources selected for evaluation be 4 (sewage wastewater, tap water, spring water, and landscape irrigation runoff). The tracers selected are conductivity, fluoride, potassium and ammonia. Figure I.5 shows these corresponding entries, while Figure I.6 shows the Excel spreadsheet for the library file used.

Figure I.7 shows the entries made in the second form. It should be noted that the values for the tracers entered are the same as those in the library file for sewage.

Figure I.8 shows the output form. The 50th percentile value for Sewage Wastewater flow in the summary table is 1.06, while the 95 percent confidence interval is 0.54 to 2.2. This table shows that the most likely source at the outfall is Sewage Wastewater, which is the same as the initial assumption. Also, the fraction of flow that is sewage is 1.06, very close to 1.0. Also, the sum of all 50th percentile flow contributions is 0.98, also very close to 1.0, indicating good agreement. The potential mass contributions for the other source flows are also close to zero.

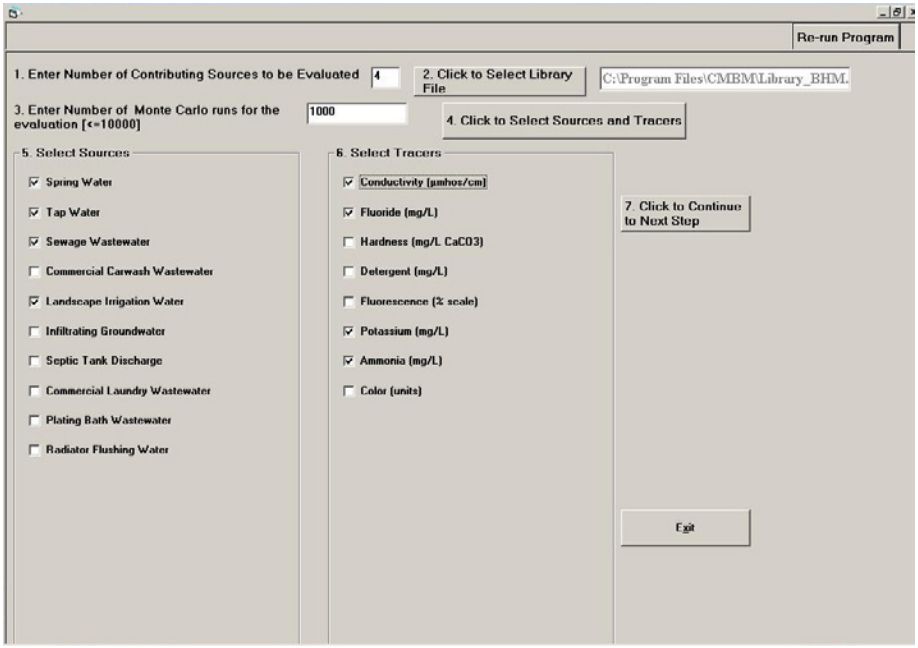

Figure I.5: Form 1 (Input for Example 1)

Tracer	Median Concentration	COV	Distribution
Conductivity (µmhos/cm)	419.86	0.13	N
Fluoride (mg/L)	0.76	0.23	N
Hardness (mg/L $CaCO_3$)	142.92	0.11	N
Detergent (mg/L)	1.5	0.82	N
Fluorescence (mg/L)	250.89	0.2	N
Potassium (mg/L)	5.97	0.23	N
Ammonia (mg/L)	9.92	0.34	L
Color (mg/L)	37.89	0.55	N

Figure I.6: Library File Excel Sheet (Sewage Wastewater)

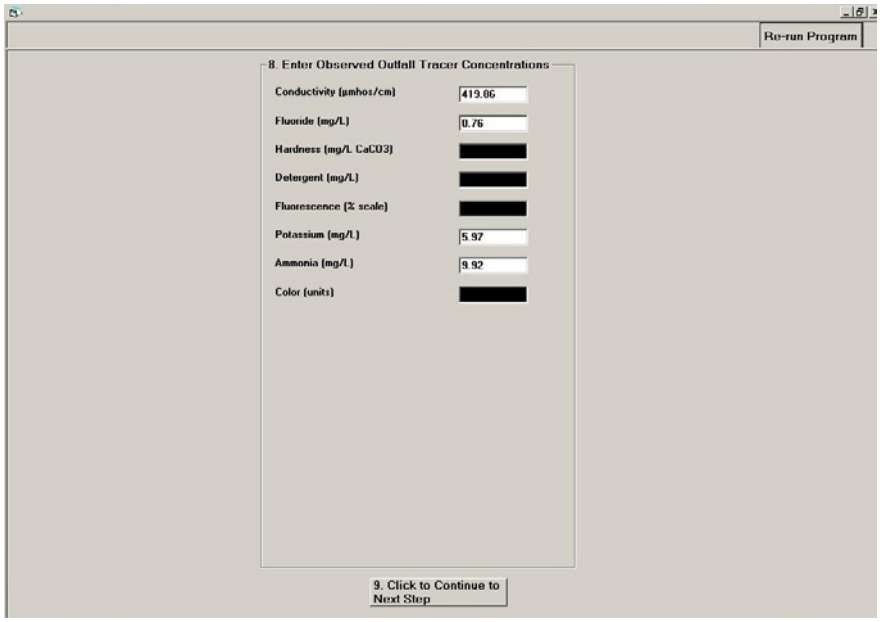

Figure I.7: Form 2 (Input)

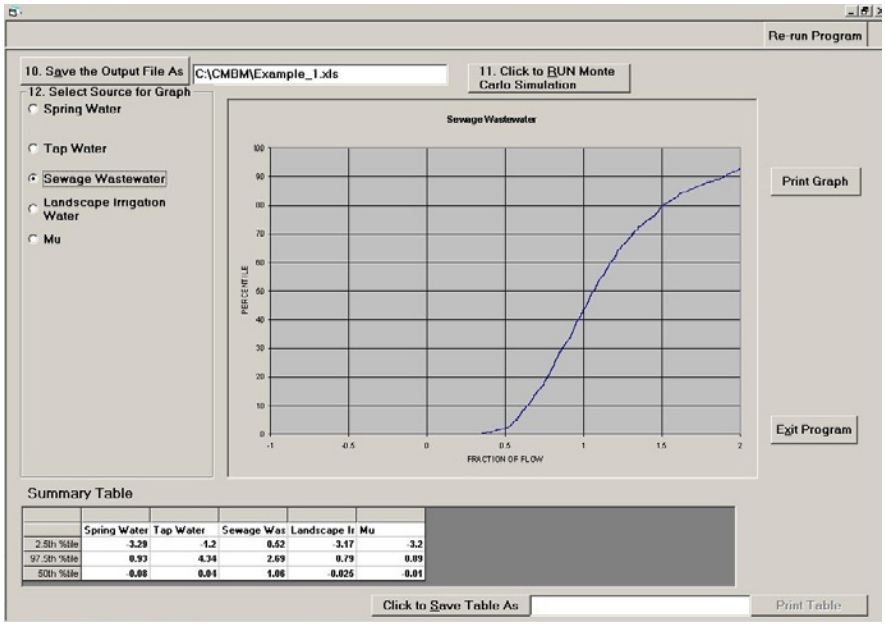

Figure I.8: Form 3 (Output for Example 1)

Example 2
In this example, eight possible source types and eight tracer parameters are selected, based on sample data from outfall # 20 in Birmingham, AL, collected on March 3, 1993.

The library file used in this example is also the Birmingham library file: 'Library_BHM.xls'. Let the number of Monte Carlo simulations be 1000, the number of sources selected for evaluation be 7 (spring water, tap water, sewage wastewater, commercial carwash wastewater, landscape irrigation water, infiltrating groundwater, and septic tank discharge. The seven tracers selected are conductivity, fluoride, hardness, detergents, fluorescence, potassium, and ammonia.

Figure I.9 shows all the corresponding entries using this information. Figure I.10 shows the entries made in the second form. Figure I.11 shows the output form. The fraction of flow as indicated for the 50th percentile value for tap water on the summary table is the highest value (0.72) compared to the other potential source flows. This indicates that the most likely source at the outfall is tap water, as verified through field observations. The spring water mass fraction is also relatively high (0.42), indicating that this source water may also be present.

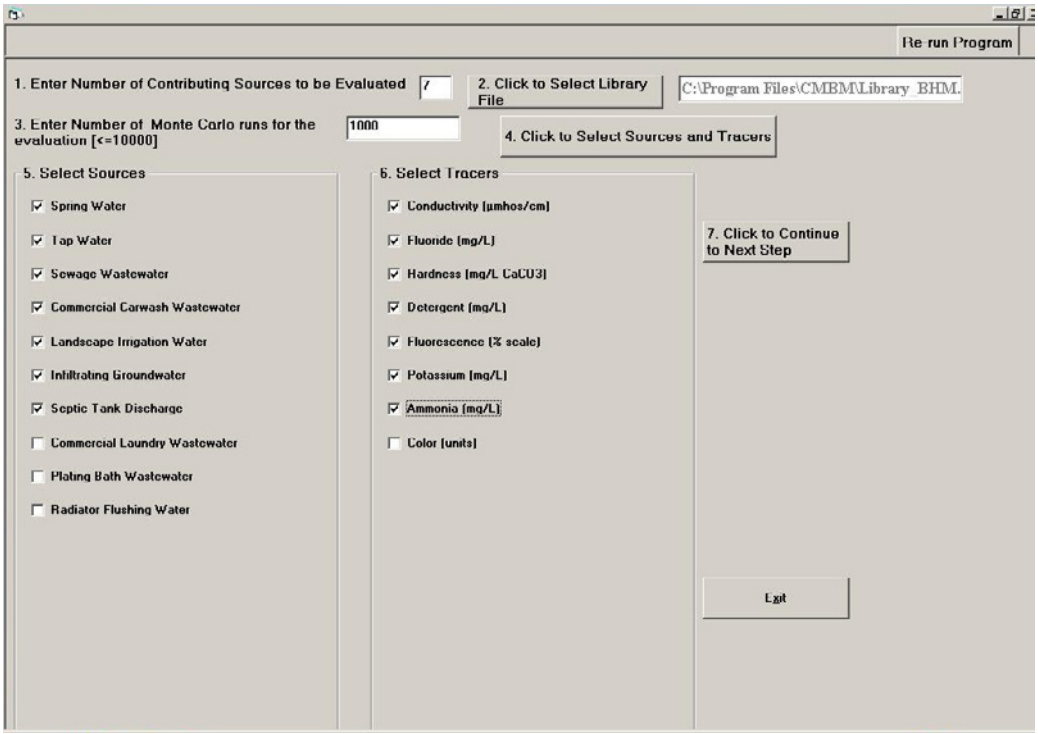

Figure I.9: Form 1 (Input for Example 2)

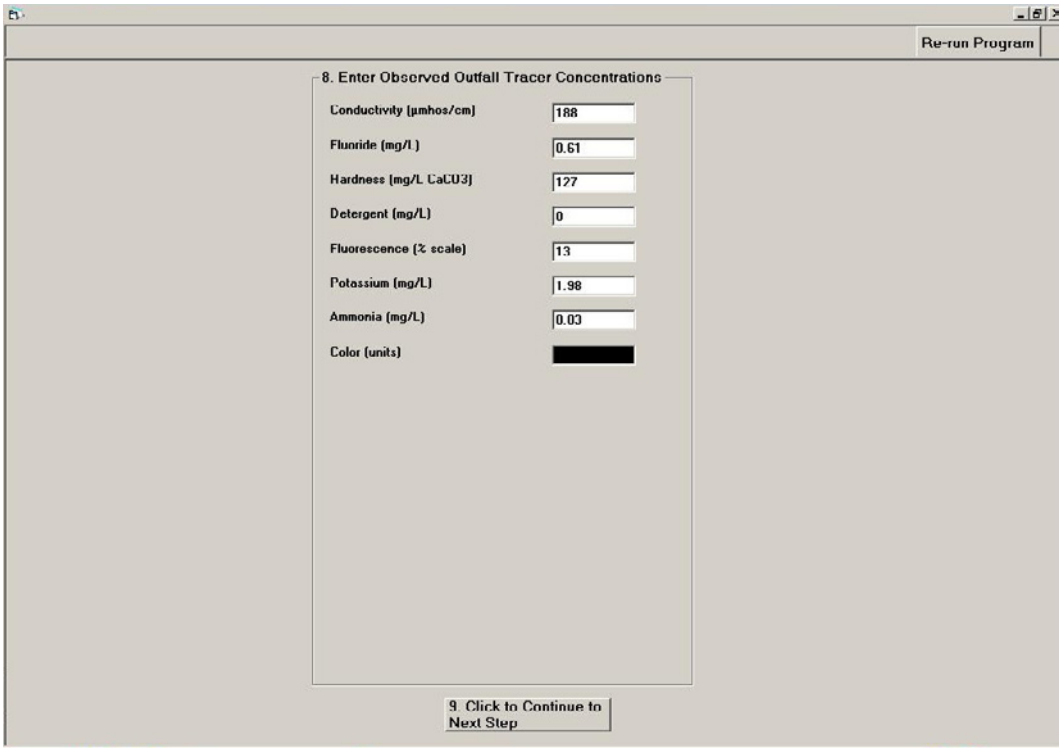

Figure I.10: Form 2 (Input for Example 2)

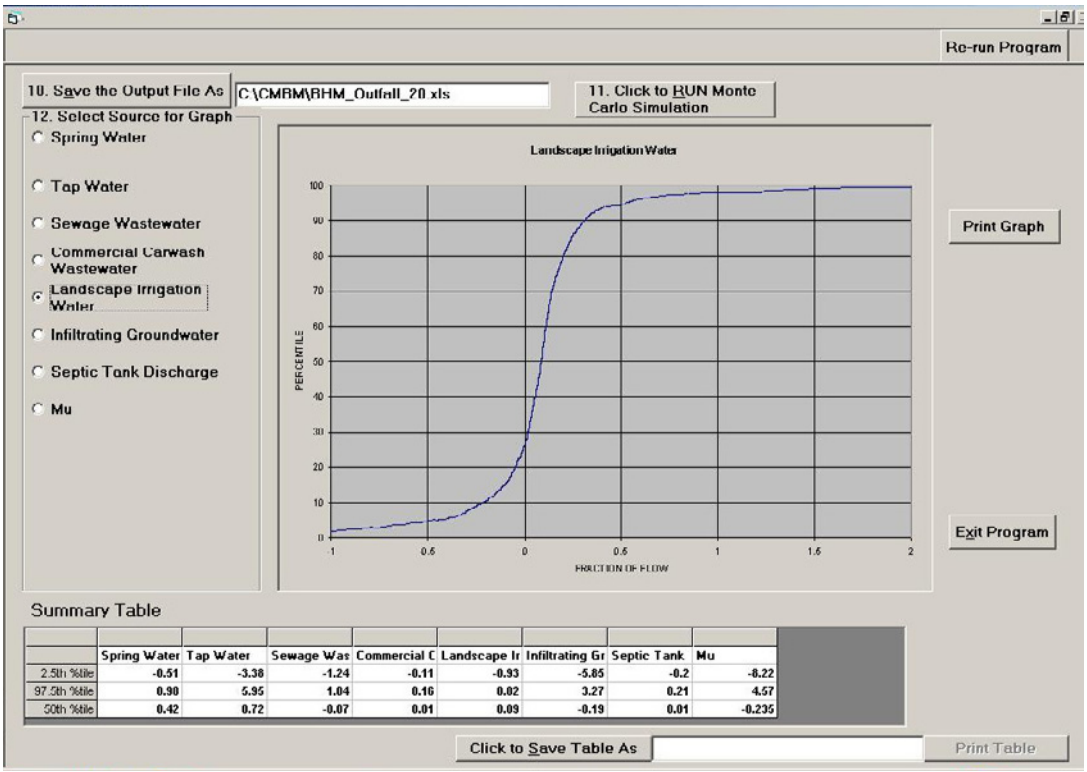

Figure I.11: Form 3 (Output for Example 2)