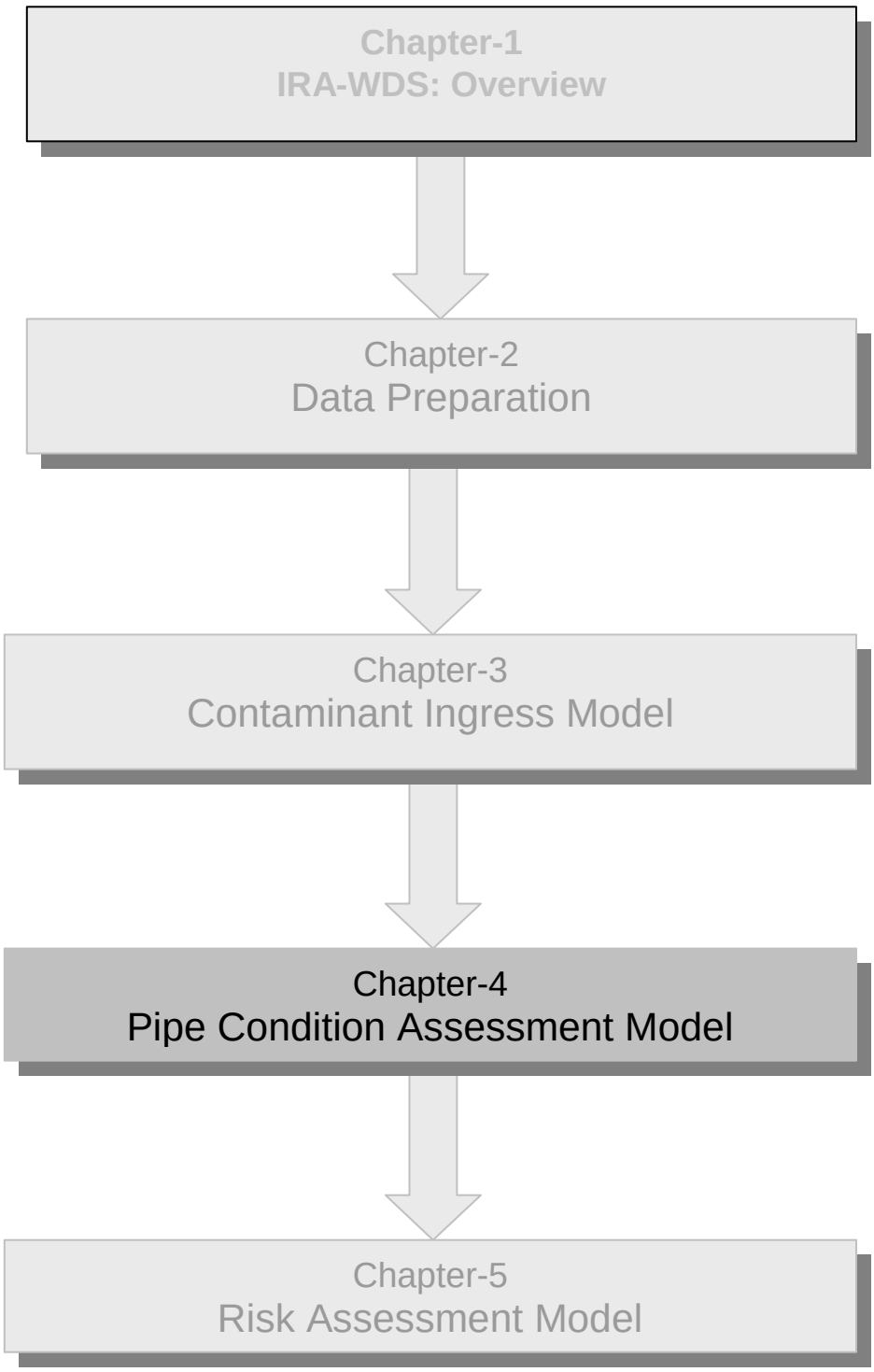
CHAPTER FOUR

Pipe Condition Assessment Model

Manual of Risk Assessment for Contaminant Intrusion into Water Distribution Systems



Chapter 4: Pipe Condition Assessment Model

4.1 Introduction

There are several submenus under the Pipe Condition Assessment menu. This chapter describes the use of these submenus and associated commands for running the Pipe Condition Assessment Model. Figure 4.1 shows the steps involved in executing this component of the software.

The example files given in Table 4.1 are used for illustration purposes to describe the Pipe Condition Assessment Model with the help of IRA-WDS.

Table 4.1. Example input files

Themes	Filenames
Water distribution	wdstesttheme.shp
	wdstestnode.shp
Groundwater	gwt.shp
Pressure zone	pressure.shp
Soil type	soilbound.shp

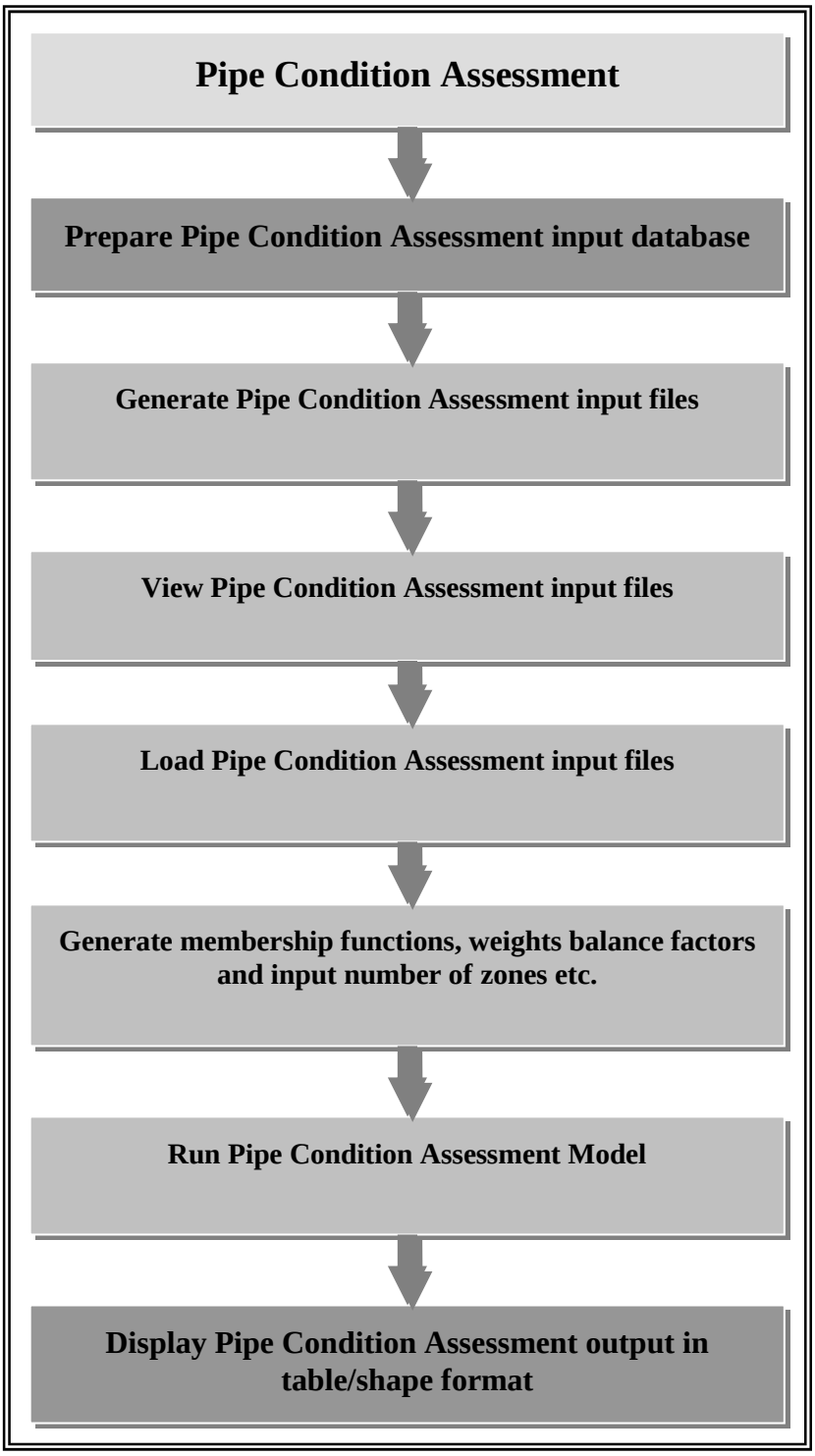


Figure 4.1. Overview of Pipe Condition Assessment Model of IRA-WDS

The following steps need to be performed for running the Pipe Condition Assessment (PCA). These are:

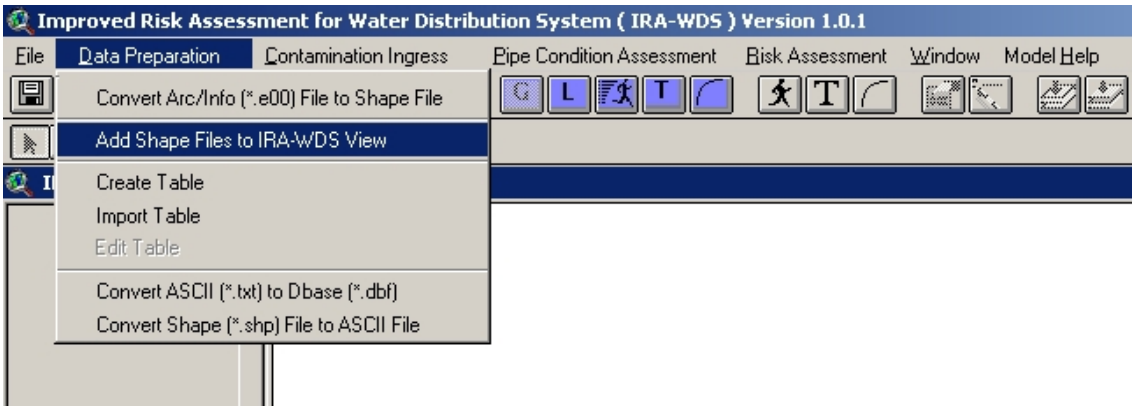
- Adding the data (if not already done so)
- Rearranging the data (optional)
- Generating an input file

- Viewing PCA input file (optional)
- Loading input file
- Running model
- Displaying output (optional)

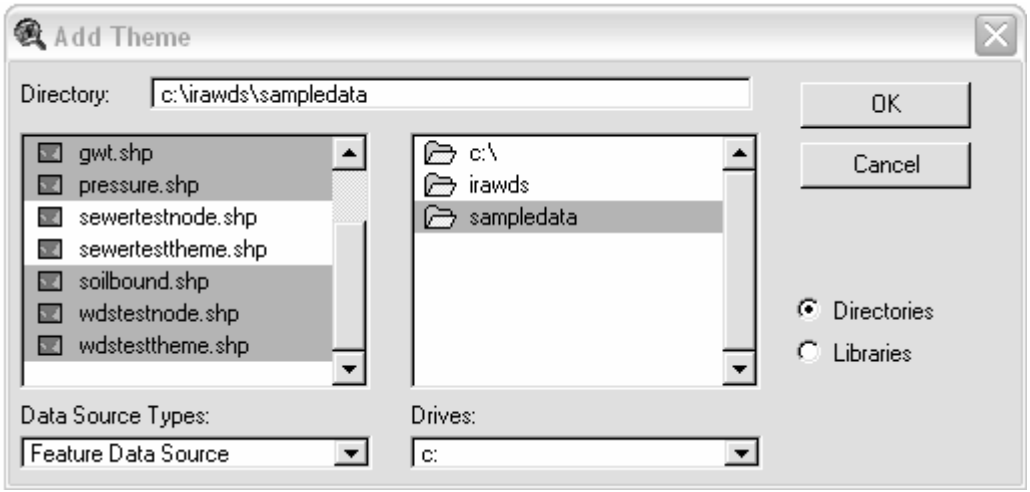
4.2 Shape files

4.2.1 Adding shape files

Adding shape files can be done by clicking on the Tool icon  which is just below the 'Data Preparation' menu or by clicking on the 'Data Preparation' menu and then clicking on the submenu 'Add Shape Files to IRA-WDS View', as shown in the screen below:

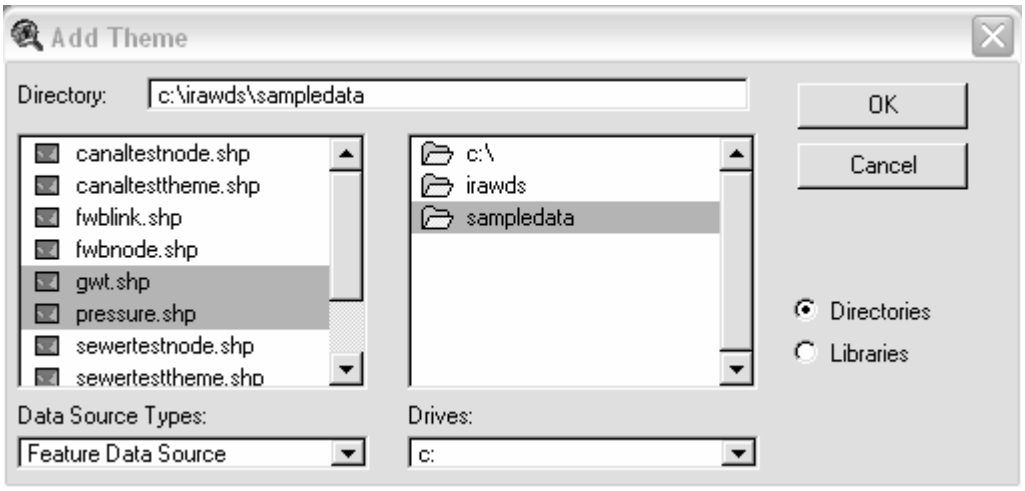


This opens the 'Add Theme' form, as shown below, and the user is then required to select the desired files. At this stage, these files are those relating to: water distribution link and node; soil polygon map; groundwater zone polygon map; and pressure zone polygon map.



If the user is continuing on from the Contaminant Ingress Model, then water distribution link and node data and the soil polygon map will have already been added. (Note that the sewer pipe, canal and foul water bodies link and node data, which are all needed for pipe condition assessment, will also have been added in this

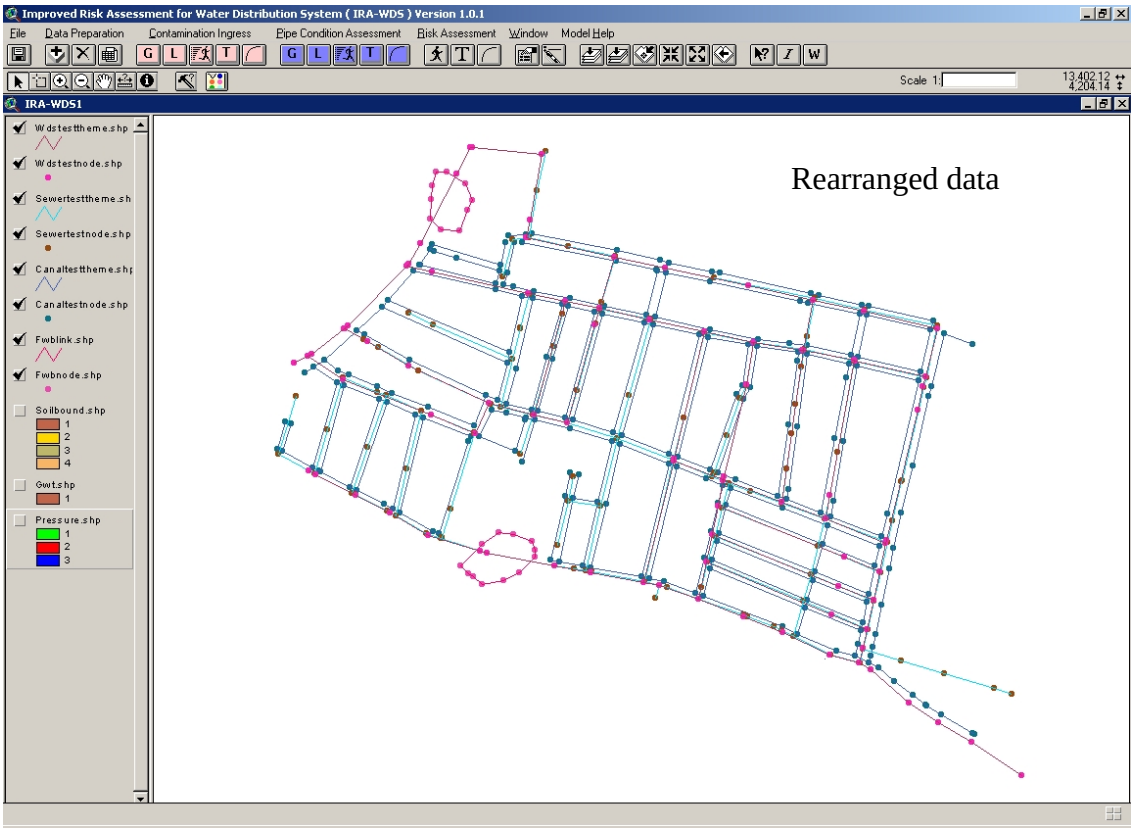
case). Only the groundwater zone polygon map and the pressure zone polygon map need to be added by the user as below.

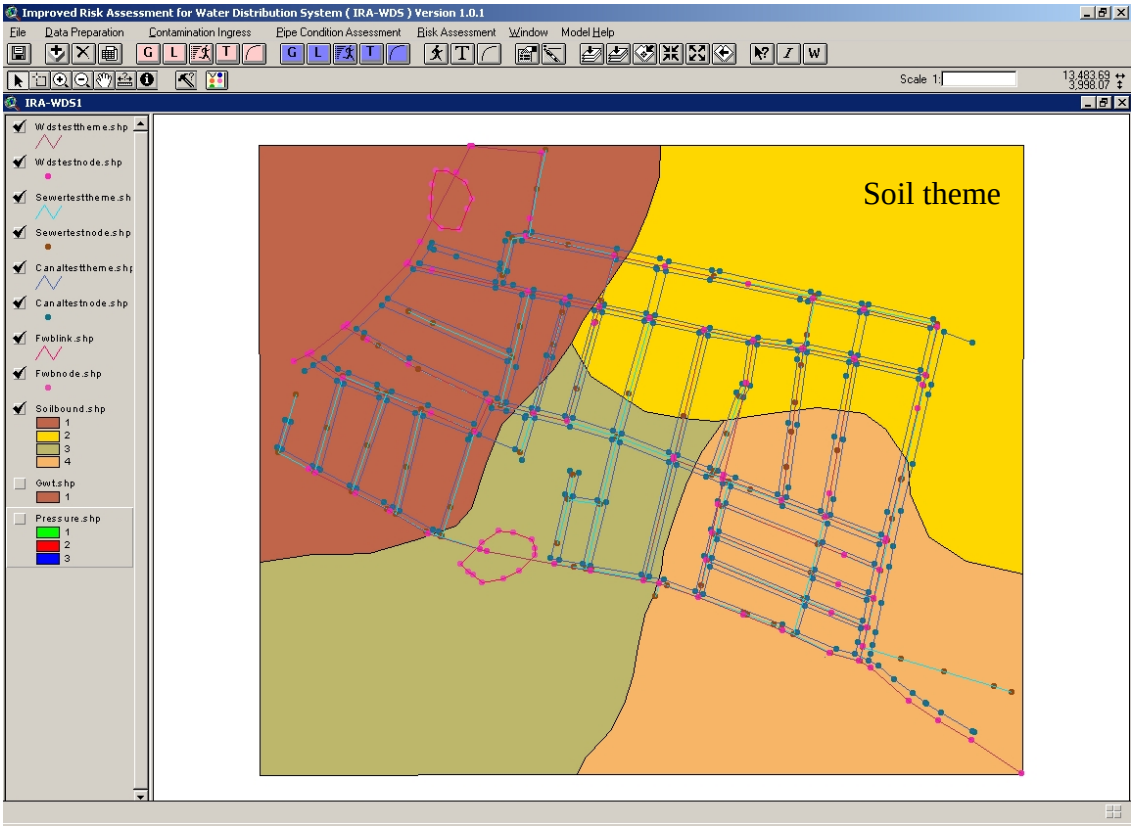


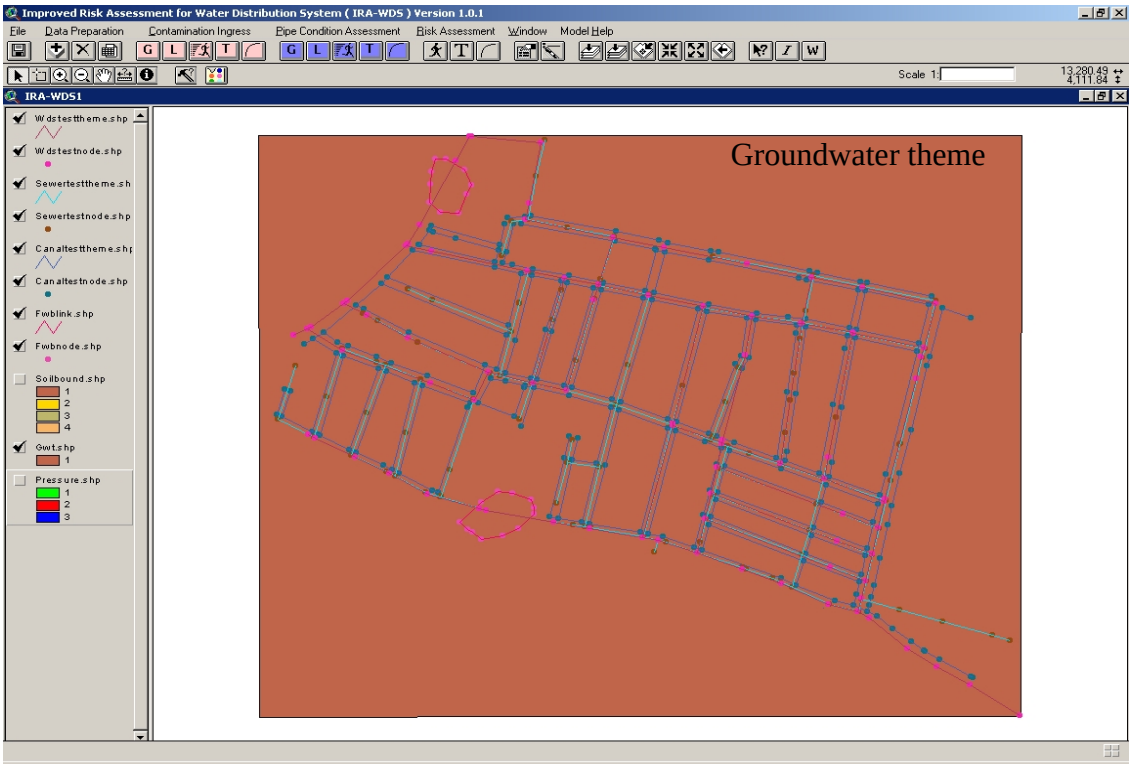
4.2.2 Rearranging shape files

If the user wishes to do so, he or she can rearrange the data to view and query different themes. The following snapshots show:

- Rearranged link and node data
- A soil theme map
- A groundwater theme map
- A pressure theme map




Improved Risk Assessment for Water Distribution System (IRA-WDS) Version 1.0.1
File
Data Preparation
Contamination Ingress
Pipe Condition Assessment
Risk Assessment
Window
Model Help
Scale 1:
IRA-WDS1
Wdstestttheme.shp
Wdstestnode.shp
Sewertesttheme.sh
Sewertestnode.shp
Canaltesttheme.shp
Canaltestnode.shp
Fwblink.shp
Fwbnode.shp
Soilbound.shp
1
2
3
4
Gwt.shp
1
Pressure.shp
1
2
3
Soil theme


Improved Risk Assessment for Water Distribution System (IRA-WDS) Version 1.0.1
File
Data Preparation
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Pipe Condition Assessment
Risk Assessment
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Model Help
Scale 1:
IRA-WDS1
Wdstestttheme.shp
Wdstestnode.shp
Sewertesttheme.sh
Sewertestnode.shp
Canaltesttheme.shp
Canaltestnode.shp
Fwblink.shp
Fwbnode.shp
Soilbound.shp
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Gwt.shp
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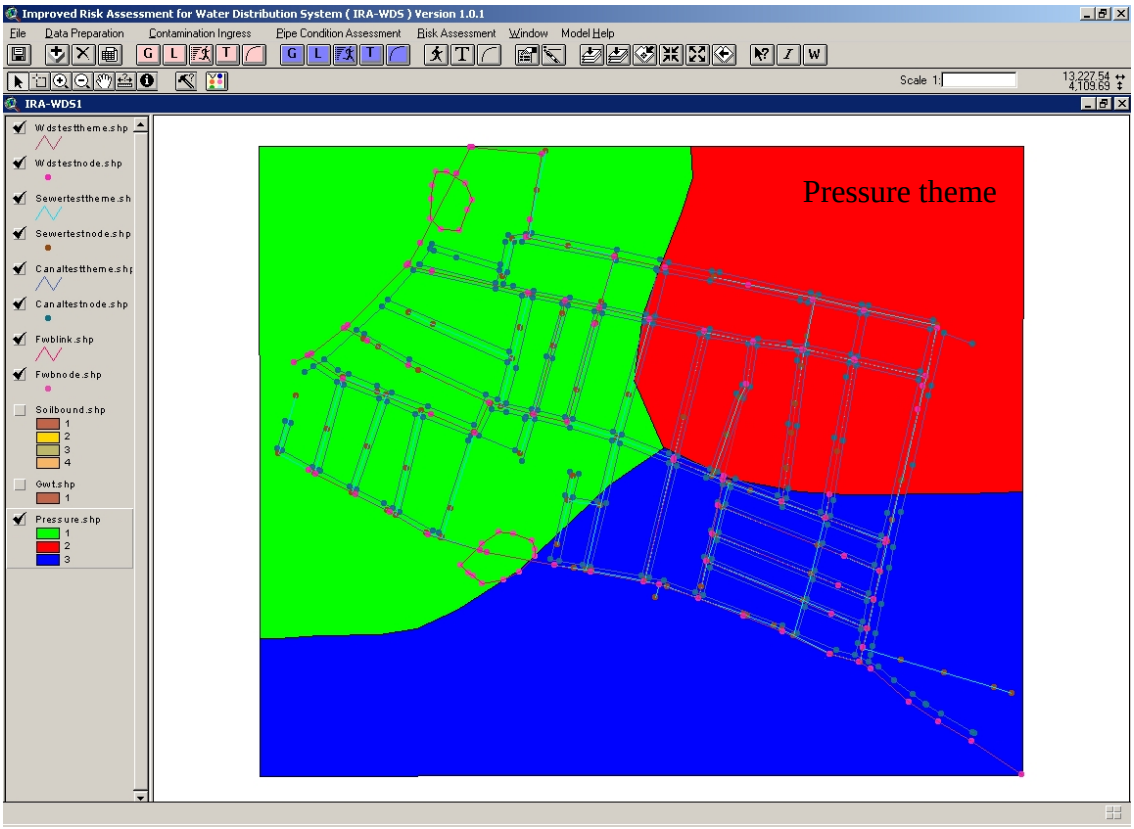
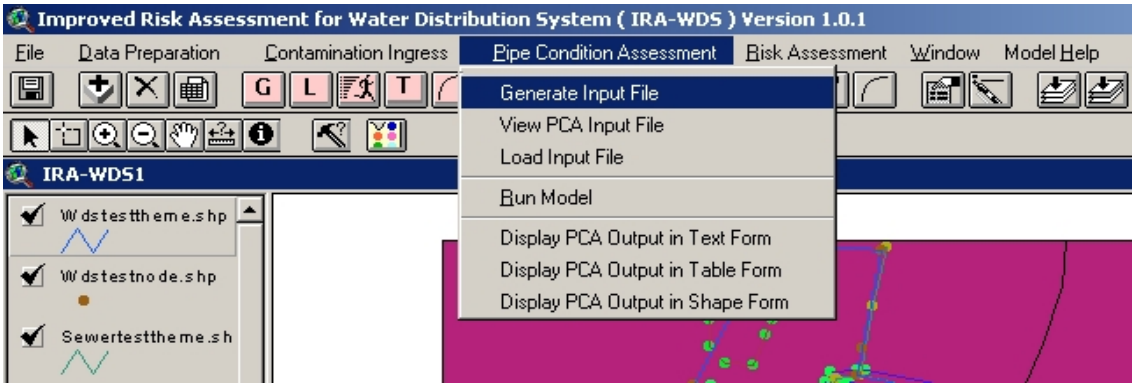
Pressure.shp
1
2
3
Groundwater theme



4.3 Generating an input file

4.3.1 Background to Pipe Condition Assessment Model input

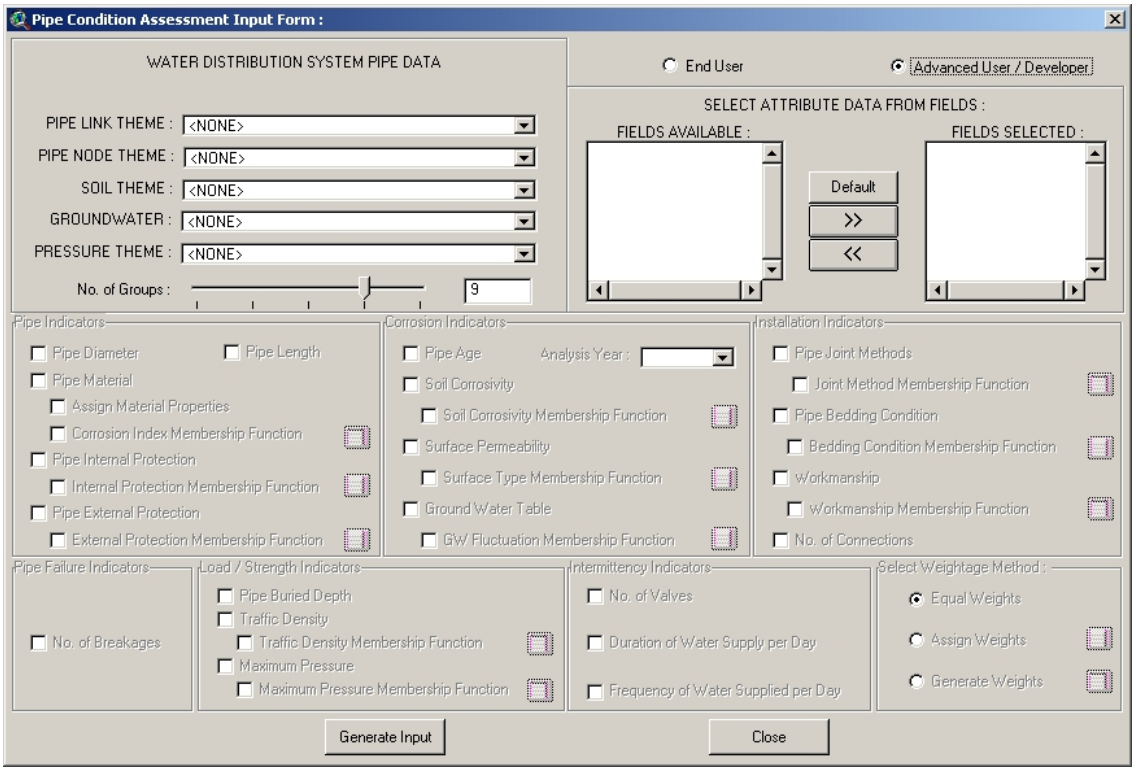
An input file can be generated by clicking on the Tool icon  which is just below the 'Pipe Condition Assessment' menu or by clicking on the 'Pipe Condition Assessment' menu and then clicking on the submenu 'Generate Input File', as shown on the screen below:



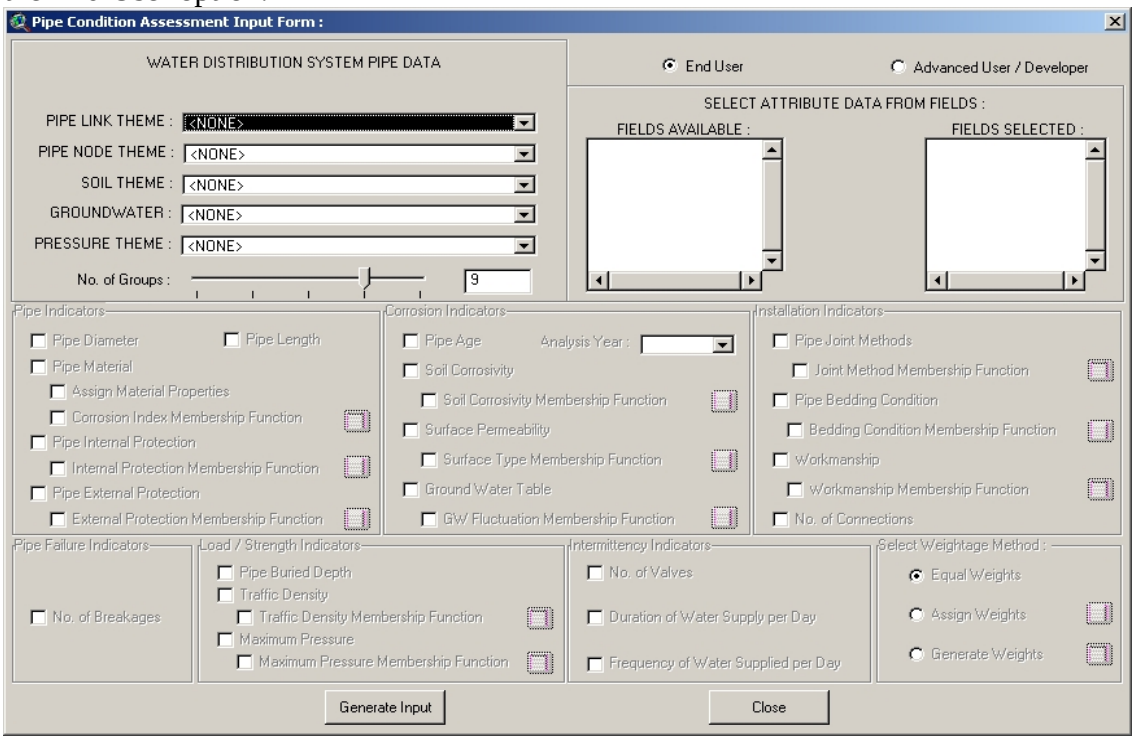
The 'Pipe Condition Assessment Input Form' has two radio button options: '**Advanced User'** and '**End User'**.

Advance Users can click on the radio button next to Advance User / Developer, which will allow the user to add or remove fields to or from the 'SELECTED FIELDS' list box. The user can click the  button to select the default field names. Advanced users can add fields to the 'SELECTED FIELDS' list box by selecting

those fields in the 'FIELDS AVAILABLE' list box and then clicking on the >> button. To remove fields from the 'SELECTED FIELDS' list box, the user can select those fields in the 'SELECTED FIELDS' list box and remove by clicking on the << button.

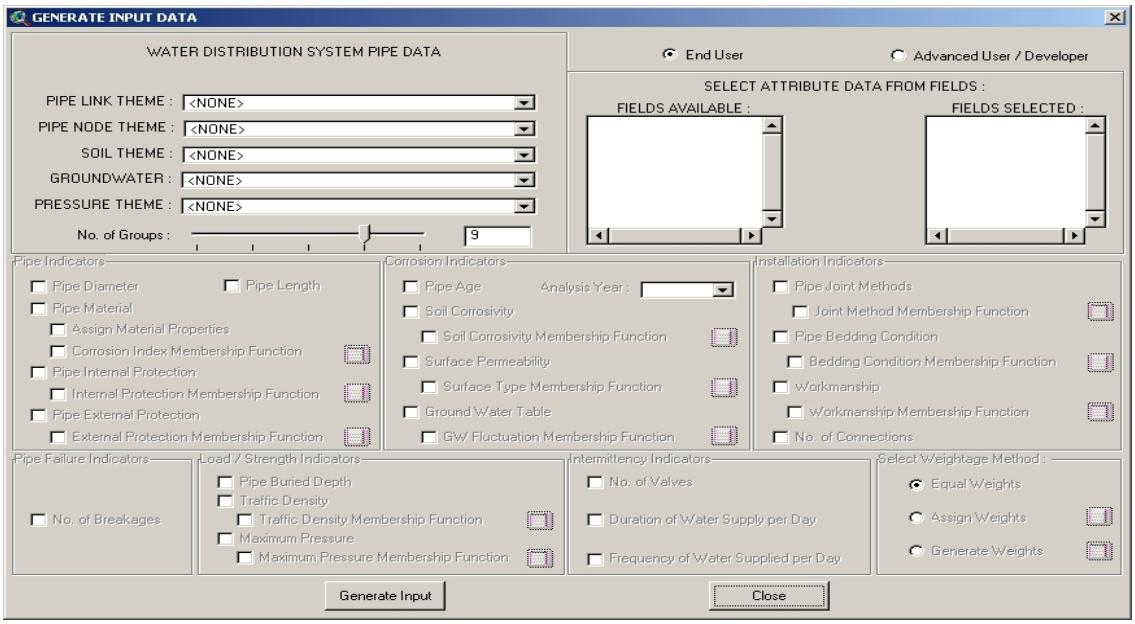


End Users are not provided with an option for adding or deleting fields to or from the 'SELECTED FIELDS' list box. In this case, the fields are automatically selected with the End User option.



4.3.2 Adding shape files

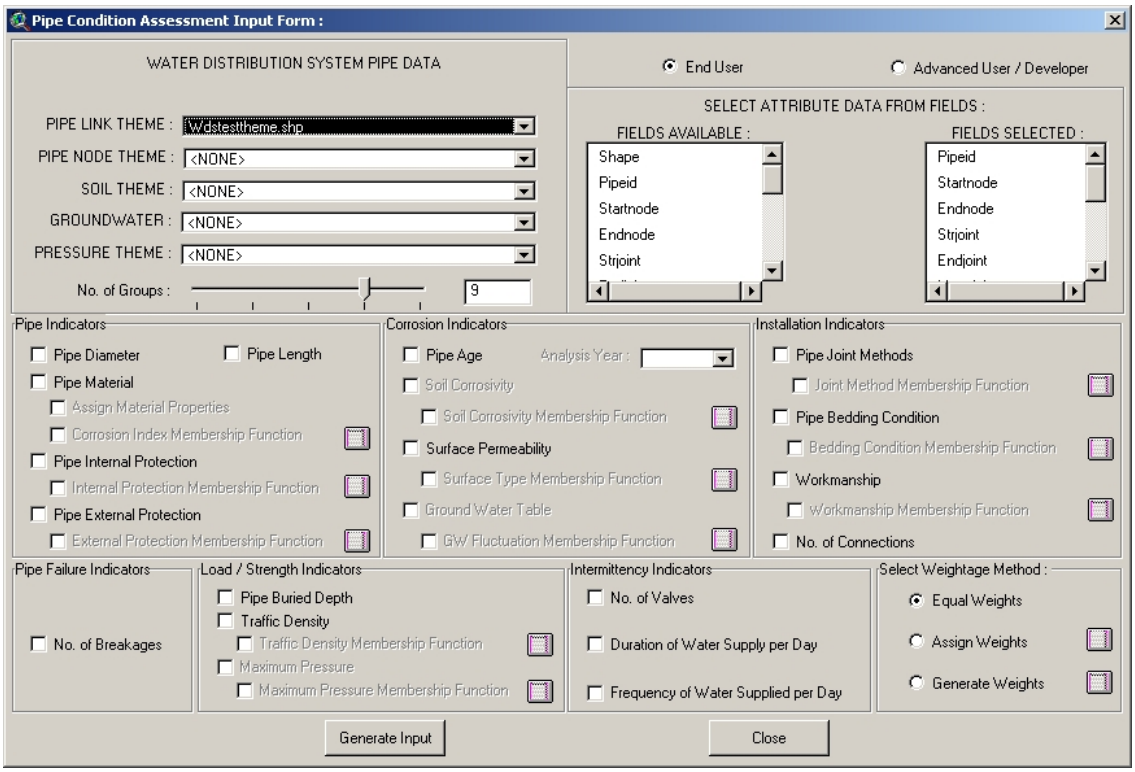
The user needs to define which theme in the IRA-WDS View represents the water distribution system pipe theme, the node theme, the soil theme, the groundwater theme and the pressure theme. All polyline / line themes added to the IRA-WDS viewer are added to the 'PIPE LINK THEME' combo box. All point / node themes added to the IRA-WDS viewer are added to the 'PIPE NODE THEME' combo box. All polygon themes added to the IRA-WDS viewer are added to the 'SOIL THEME', 'GROUNDWATER THEME' and 'PRESSURE THEME' boxes.



The user is required to select the theme that represents the water distribution pipe theme, the node theme, the soil theme, the groundwater theme and the pressure theme from the combo box. Initially, before selection of the themes, all other menus are disabled. During the selection of themes, the list of fields available and fields that will be selected from that theme are listed in the 'FIELDS AVAILABLE' and 'FIELDS SELECTED' list boxes (just below 'SELECT ATTRUBUTE DATA FROM FIELDS').

4.3.2.1 Pipe (water distribution) link theme

Selecting the water distribution theme in the pipe link theme box lists the fields available and fields selected. It also goes through the first record of the theme and finds which data are available and then enables the further options for data definition accordingly. For example, if the Pipe Diameter has a numeric value in its database, then it enables the Pipe Diameter check box in the Input Form so that the user can choose this for assessing the pipe condition and so on, as shown below:

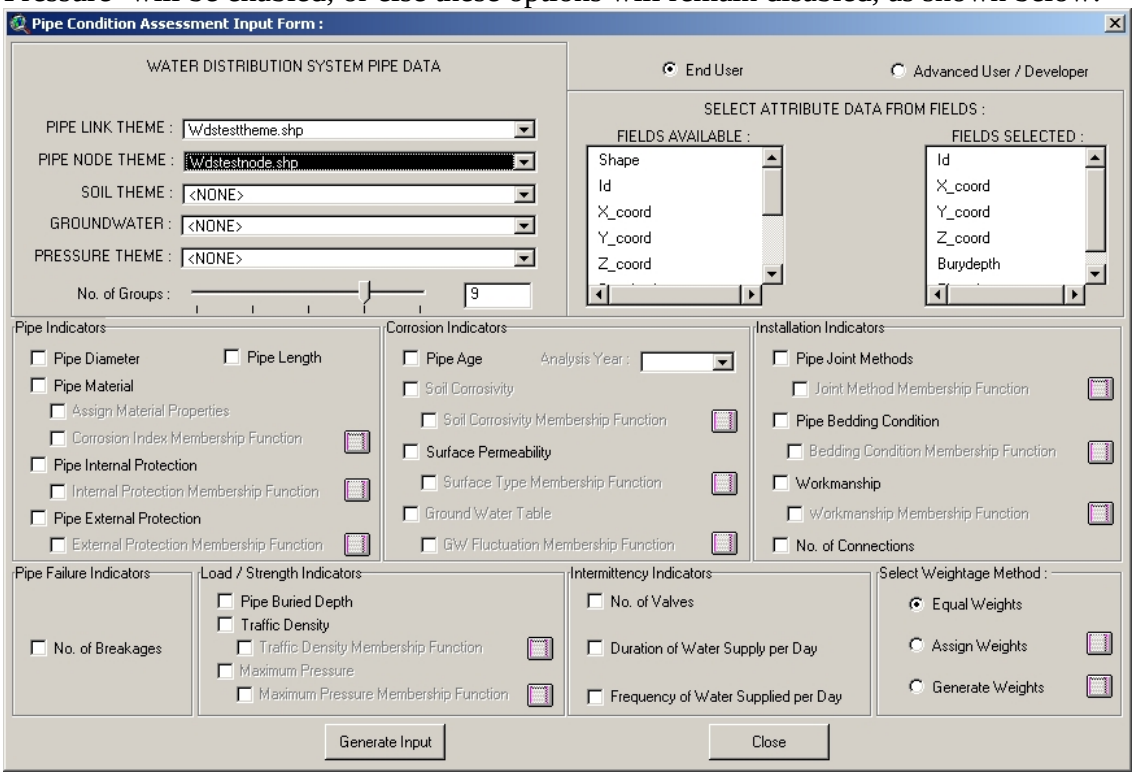


4.3.2.2 Pipe node (water distribution) theme

Selecting the water distribution theme in the pipe node theme box updates the list of fields available and selected.

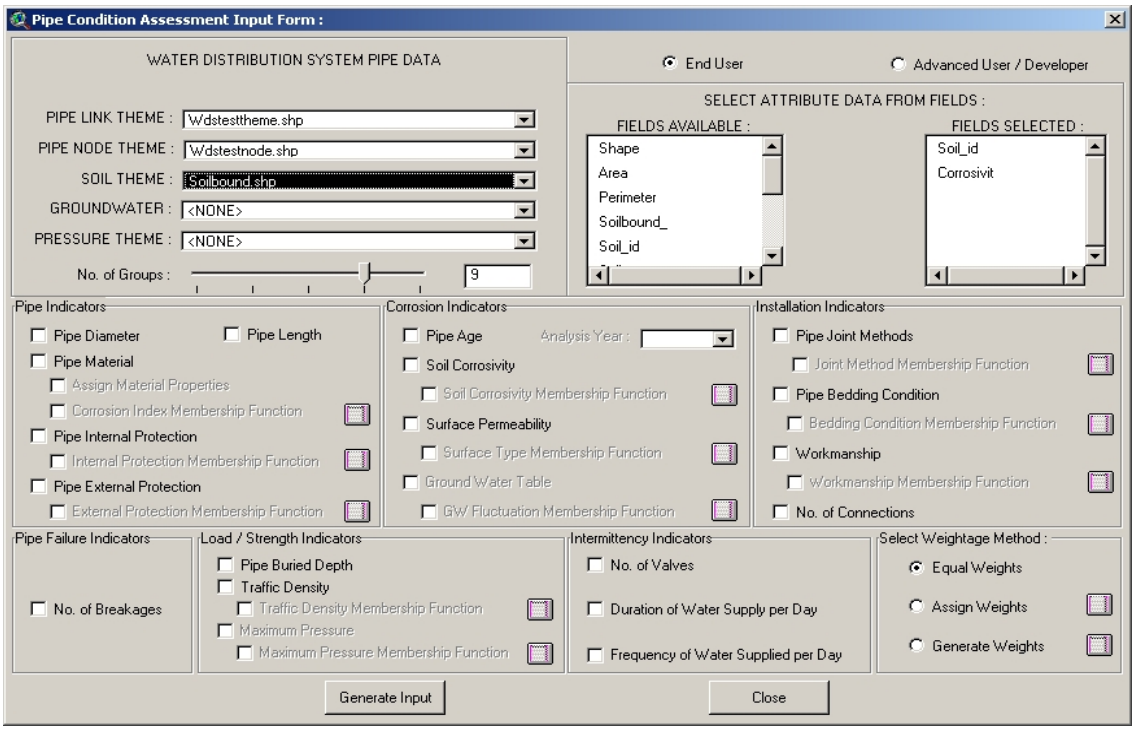
4.3.2.3 Soil, groundwater and pressure themes

If any of the soil, groundwater or /pressure themes is already selected, then the check box options corresponding to ‘Soil Corrosivity’, ‘Ground Water Table’ or ‘Maximum Pressure’ will be enabled, or else these options will remain disabled, as shown below:



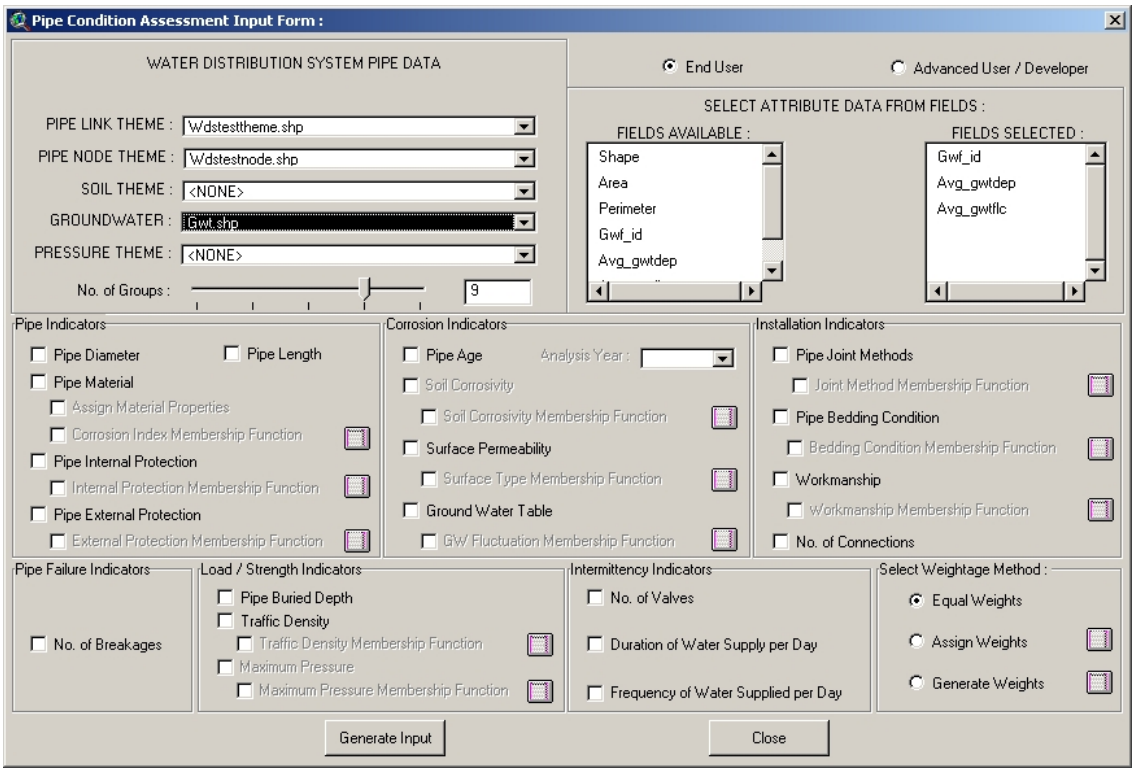
4.3.2.4 Soil theme

Selecting the soil theme updates the list of available and selected fields. This also enables check box options corresponding to 'Soil Corrosivity' (see screen below). If the water distribution (pipe) node theme is not already selected, then the check box options corresponding to 'Soil Corrosivity' will remain disabled.



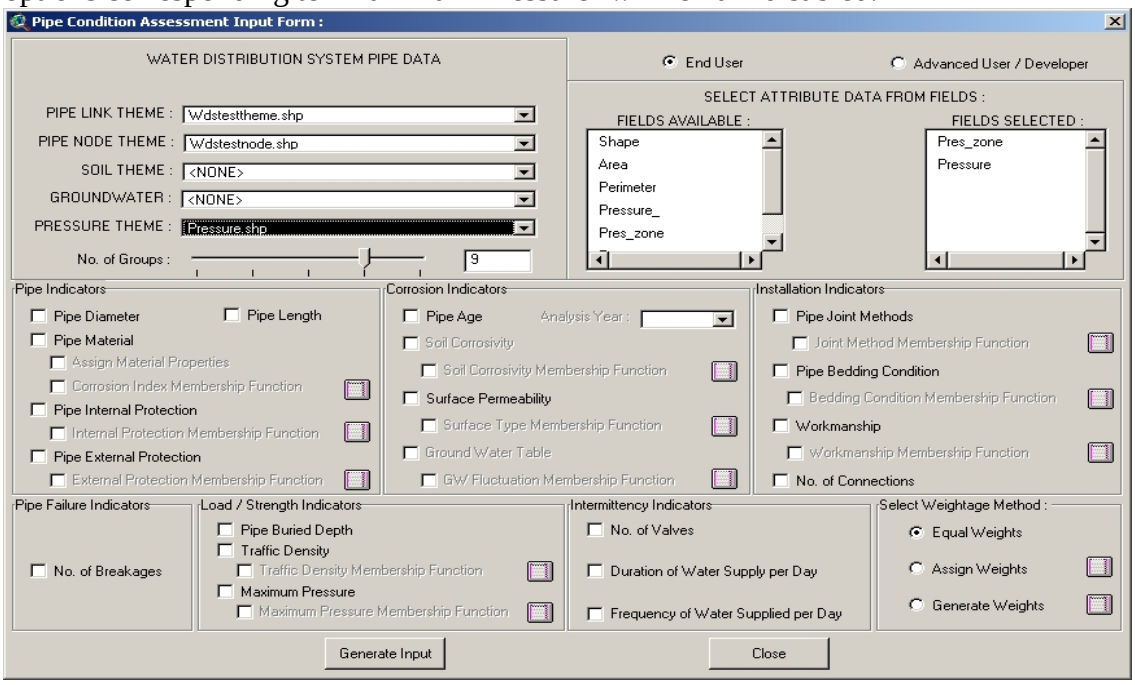
4.3.2.5 Groundwater theme

Selecting the groundwater theme updates the list of available and selected fields. This also enables check box options corresponding to 'Ground Water Table' (see screen below). If the water distribution node theme is not already selected, then the check box options corresponding to 'Ground Water Table' will remain disabled.



4.3.2.6 Pressure theme

Selecting the pressure theme updates the list of available and selected fields. This also enables check box options corresponding to ‘Maximum Pressure’ (see screen below). If the water distribution node theme is not already selected, then the check box options corresponding to ‘Maximum Pressure’ will remain disabled.



4.4 Indicator data

Depending on the data available on various themes, the options for entering data for the following different indicators will be enable or disenabled.

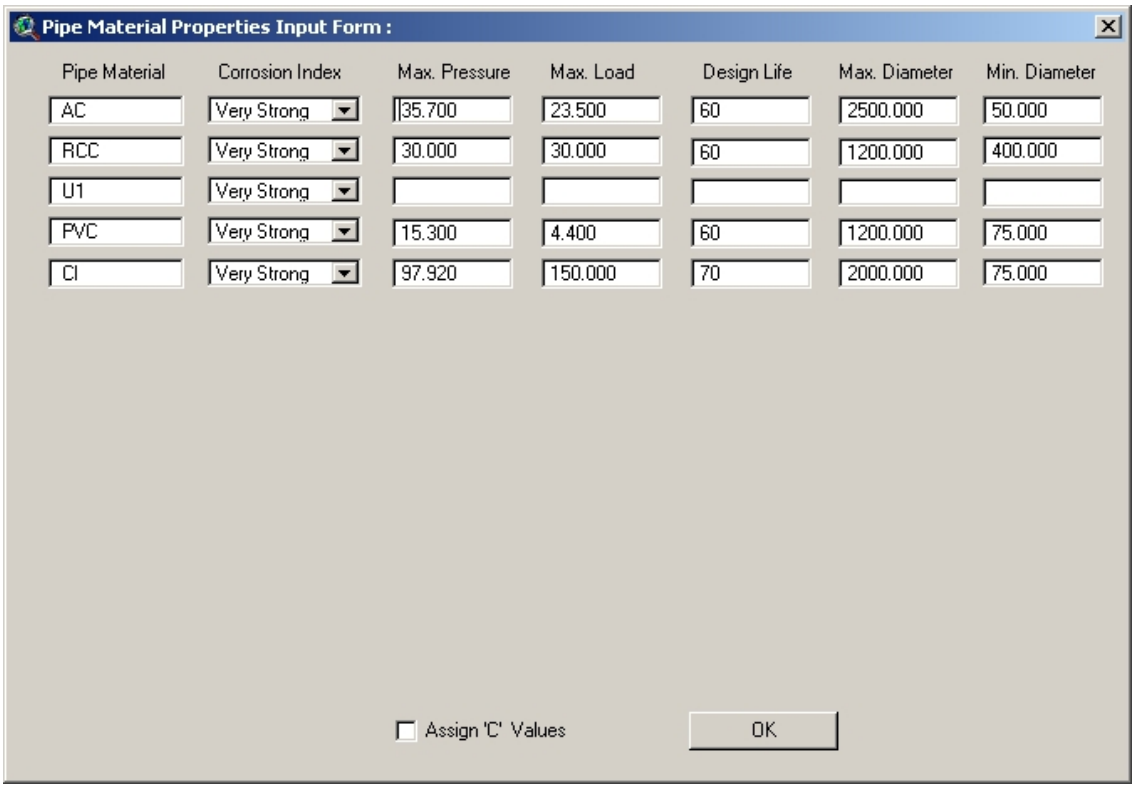
1. Pipe Indicators
2. Corrosion Indicators
3. Installation Indicators
4. Pipe Failure Indicators
5. Load/Strength Indicators
6. Intermittency Indicators

The user needs to select which parameters of these indicators he or she wants to use for pipe condition assessment. The data used for these parameters are not only quantitative (crisp value data) but also qualitative (fuzzy data). In case of fuzzy data, the user needs to define the membership functions for the fuzzy data sets.

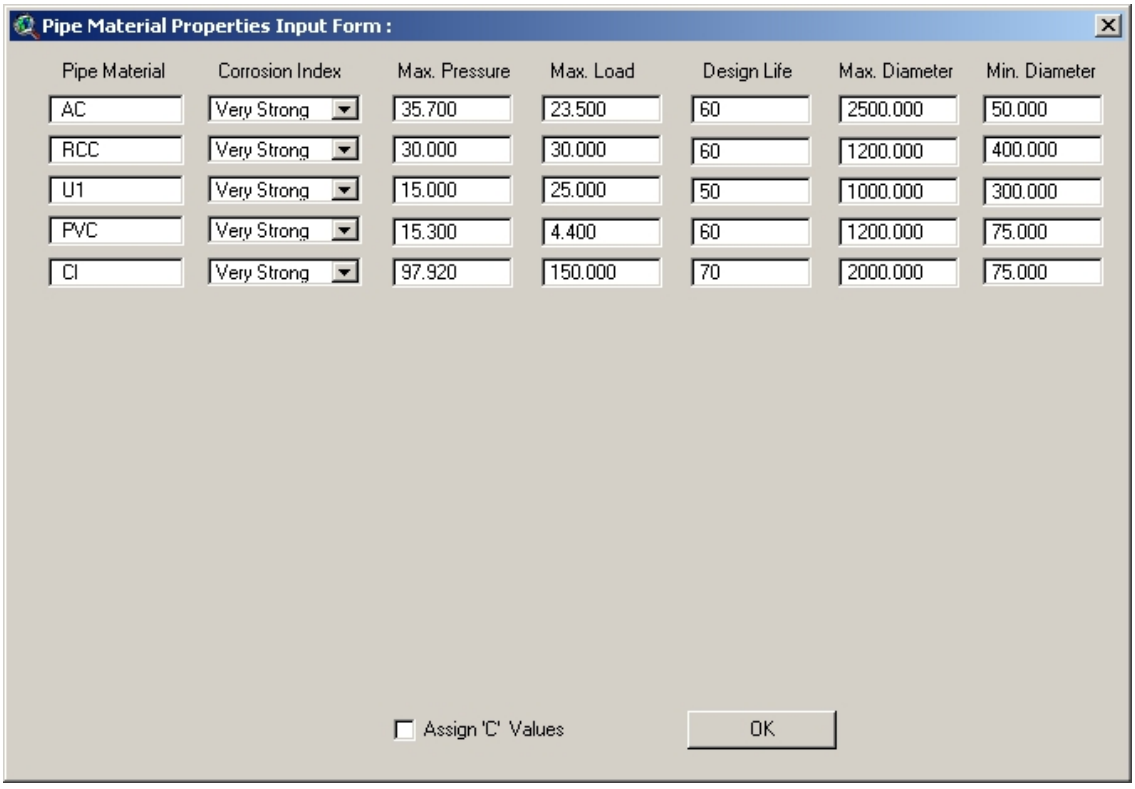
Pipe material
Various material properties are considered while deciding the condition of the pipe. These properties are:

1. Resistance to corrosion (a fuzzy parameter)
2. Maximum pressure it can sustain
3. Maximum impact load it can sustain
4. Minimum and maximum diameters in which pipes are made
5. Minimum and maximum lengths in which pipes are made
6. Maximum design life
7. Age-Hazen-William Roughness Coefficient (C) relationship

The input for pipe material properties is made in two different input forms. After opening the form ‘Pipe Material’, the user checks the “Assign Material Properties” box (see screen below). This form lists the available pipe materials in the water distribution pipe theme. If the default database for the pipe material in the IRA-WDS contains the pipe material listed in water distribution pipe theme, then it populates the respective fields for those pipe material properties for which data are available; otherwise nothing is written. For example, in the screen below the IRA-WDS database has all the necessary data for the pipe material ‘AC’ listed in the water distribution pipe theme, hence all the pipe material properties’ check boxes are filled. However, for the pipe material ‘U1’, the IRA-WDS database has no pipe material data and hence all the pipe material properties’ check boxes are empty. The user needs to fill in all the empty fields in the form appropriately. He or she can also modify the data if they do not agree with the IRA-WDS default database. An input form having some default data from the database and some material to be defined by the user is shown on next page.

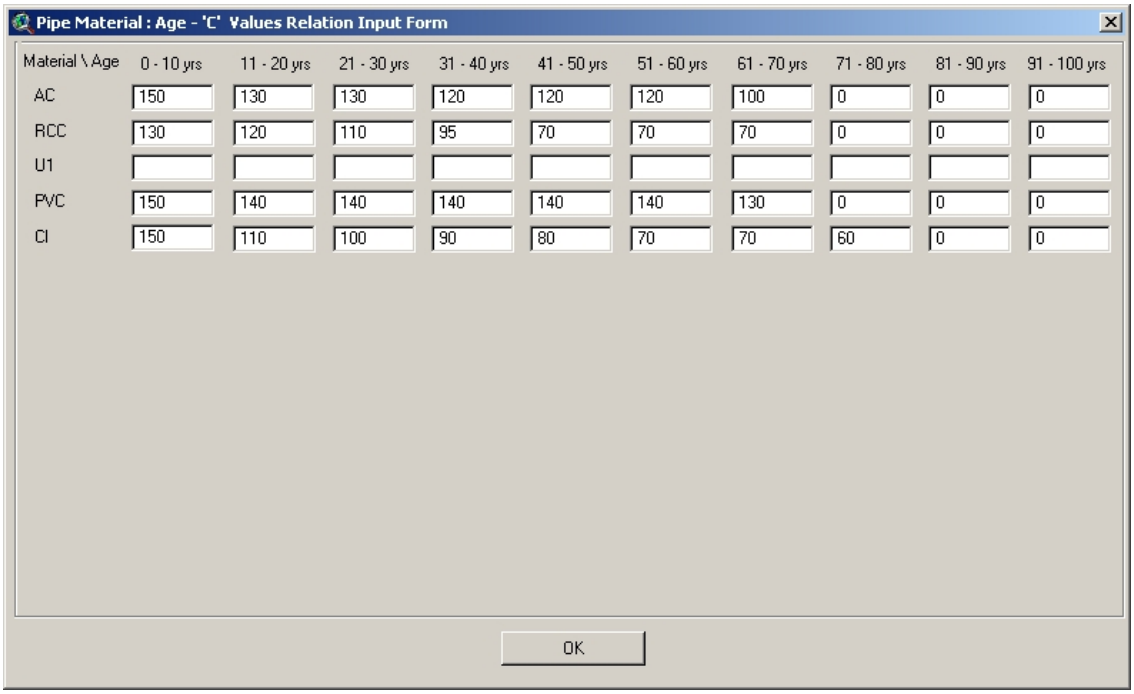


The completed data form is shown below:

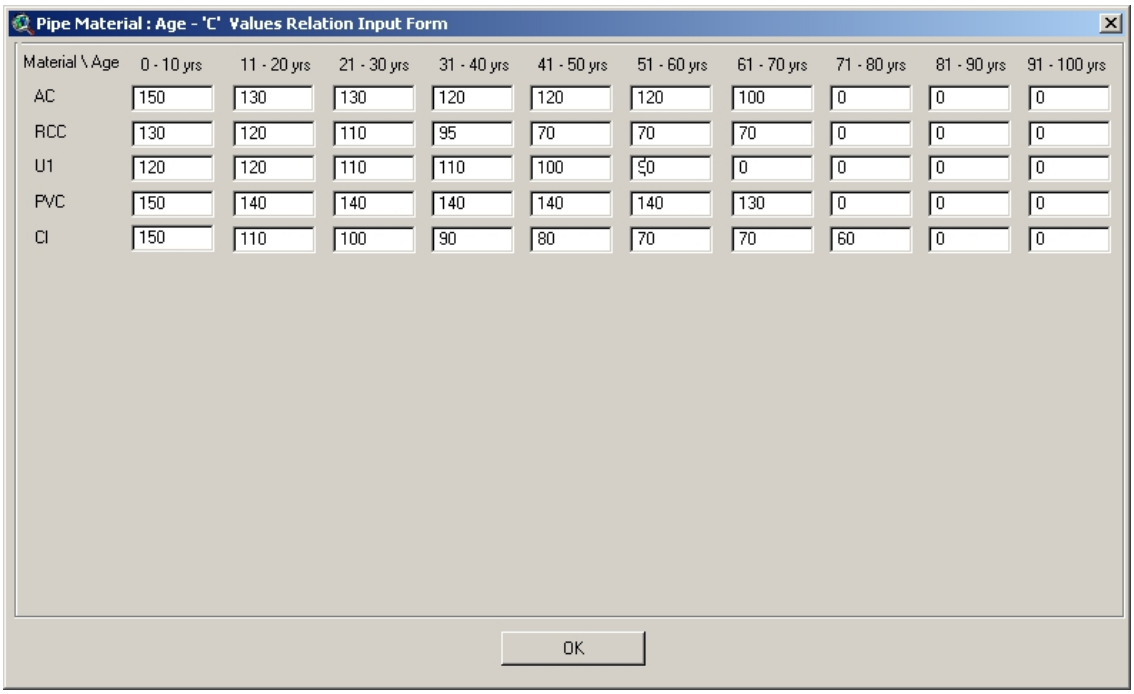


To define the ‘Pipe Material: Age-C’ relationship, the user should click on the check box ‘Assign ‘C’ Values’ on the ‘Pipe Material Properties Input Form’. This opens the ‘Pipe Material: Age-‘C’ Values Relation Input Form’. Again, if the default database for the pipe material in the IRA-WDS program contains the pipe material listed in

water distribution pipe theme, ‘C’ values appear in the check boxes; otherwise the check boxes remain empty. (Note that values are assigned up to the designed age of the pipe and ‘0’ ‘C’ values are assigned for any ages greater than the designed age of the pipe). An input form filled in with values from the database is shown below:



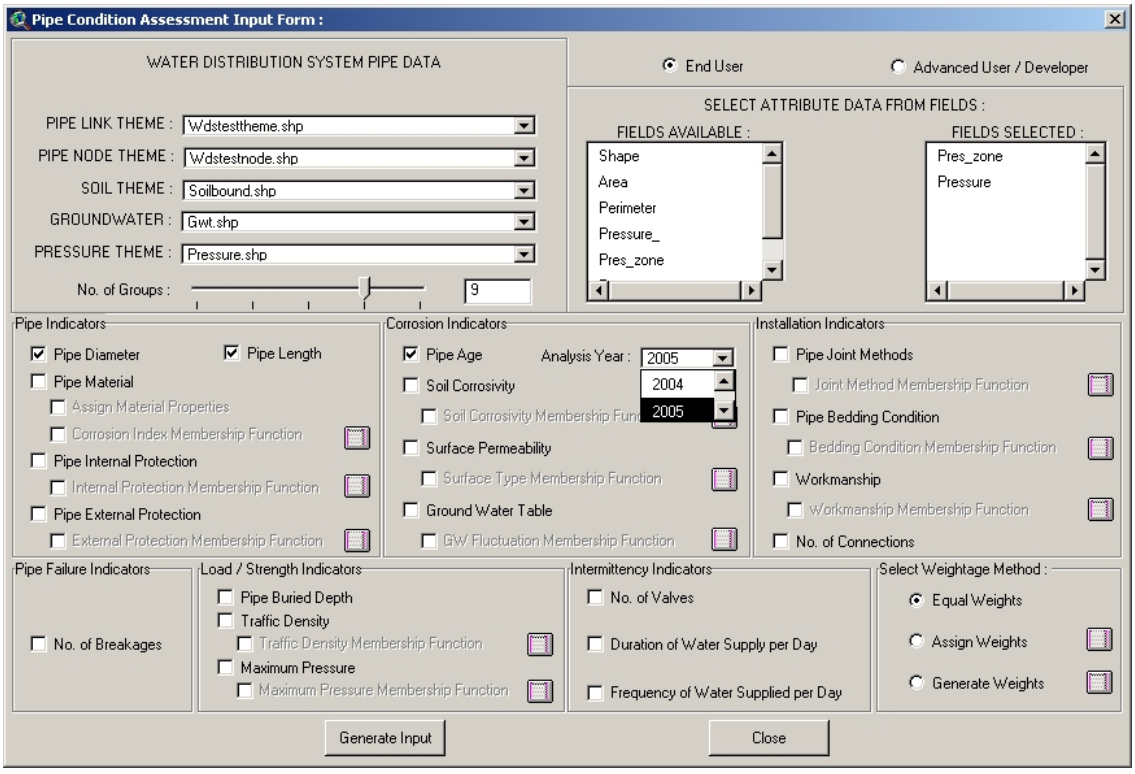
The user needs to complete the form appropriately by entering values in any blank fields. He or she can also modify the data if they do not agree with the default database. The completed data form is shown below:



4.5 Other data

The remaining data used is in quantitative (crisp data) and qualitative (fuzzy data) forms, which are described below.

Crisp data
The parameters that are quantitative in nature are: 'Pipe Diameter', 'Pipe Length', 'Pipe Material', 'Pipe Age', 'Number of Connections', 'Number of Breakages', 'Pipe Buried Depth', 'Number of Valves', 'Duration of Water Supply per Day' and 'Frequency of Water Supplied per Day'. Except for the 'Pipe Age', the remainder of the parameters do not require any more information. These parameters need to be selected if required. For 'Pipe Age', further information pertaining to the 'Analysis Year' is required, which can be selected from the combo box, as shown below:



Fuzzy data
The parameters that are qualitative in nature are: the 'Pipe Material Corrosion Index', 'Pipe Internal and External Protection', 'Soil Corrosivity', 'Surface Type/Permeability', 'Ground Water Table Fluctuation', 'Traffic Density', 'Maximum Pressure', 'Pipe Joint Methods', 'Pipe Bedding Condition' and 'Workmanship'. All of these require further information regarding their membership function.

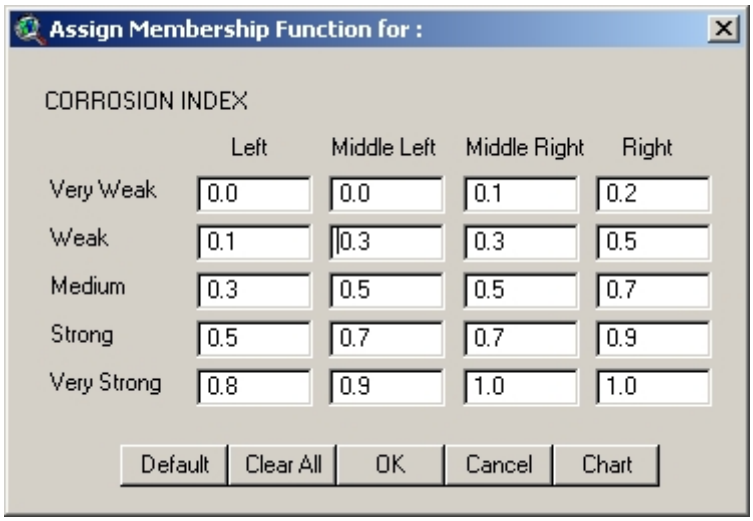
4.5.1 Membership functions

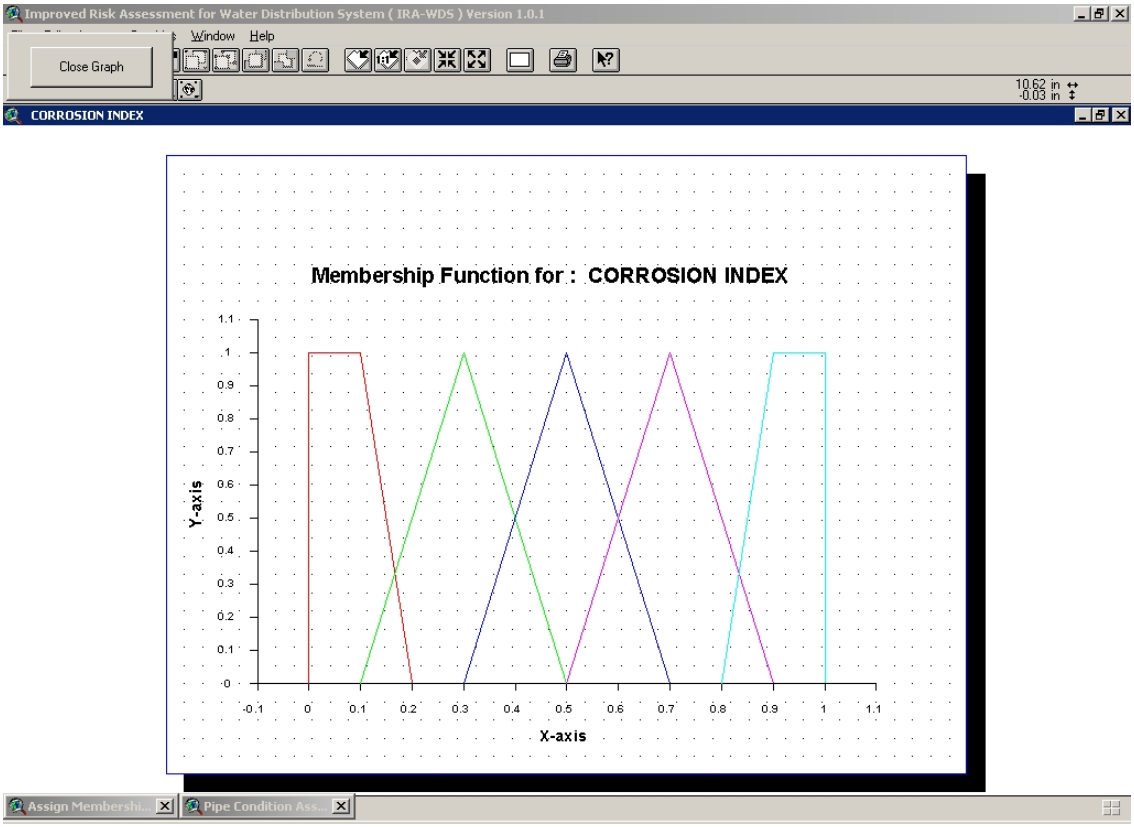
If any fuzzy parameter is clicked, its membership definition form appears. For example, if Pipe Material and then Corrosion Index Membership Function are clicked, its membership form appears (see screen below). The form is common for all the parameters except the title and group labels, which vary according to the indicator for which membership function is to be defined.

The form consists of five buttons and 20 text boxes for user input. The membership function is defined with the help of these text boxes. A trapezoidal or triangular membership function can be defined with this input form. If the 'Middle Left' and 'Middle Right' values of the membership form are the same, the membership function is triangular. The membership form that appears on the screen contains the default values membership function. However, the user can change the membership function. He or she is advised to refer to the Book-3 (Risk assessment of contaminant intrusion into water distribution systems) of this series for this purpose.

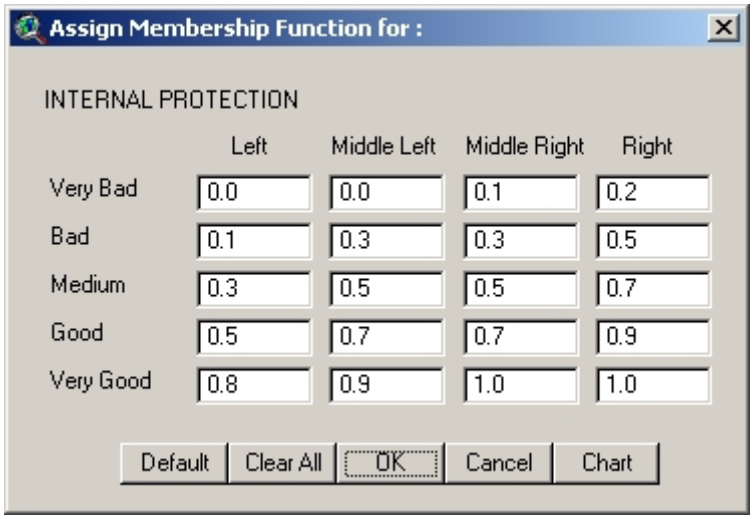
There are five buttons to facilitate defining membership functions. These are:
Default: Clicking this button loads the membership definition text boxes with default values defined for various indicators in the IRA-WDS database.
Clear All: Clicking this button clears all membership definition text boxes.
OK: By clicking this button, the membership definition is completed and the membership definition dialogue box is closed.
Cancel: By clicking this button the membership definition is cancelled and the dialogue box is closed.
Chart: By clicking this button, the membership definition and the 'Pipe Condition Assessment Input Form' are minimized and the layout dialogue box is opened within which the membership defined is shown graphically.

1. Pipe Material Corrosion Index

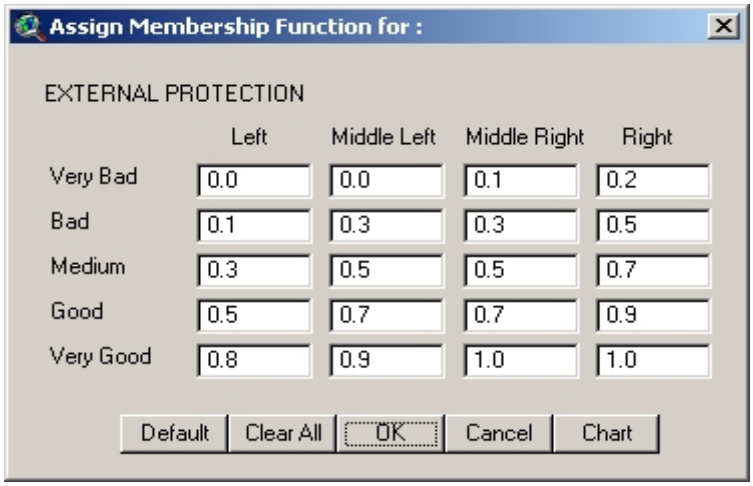




2. Pipe Internal Protection

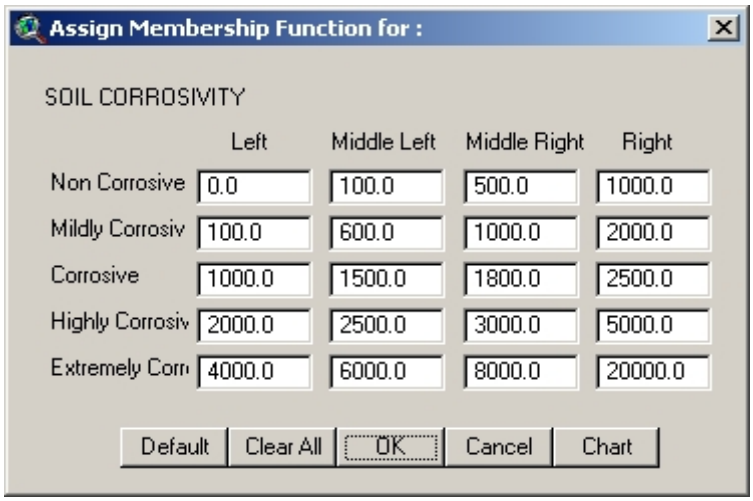


3. Pipe External Protection

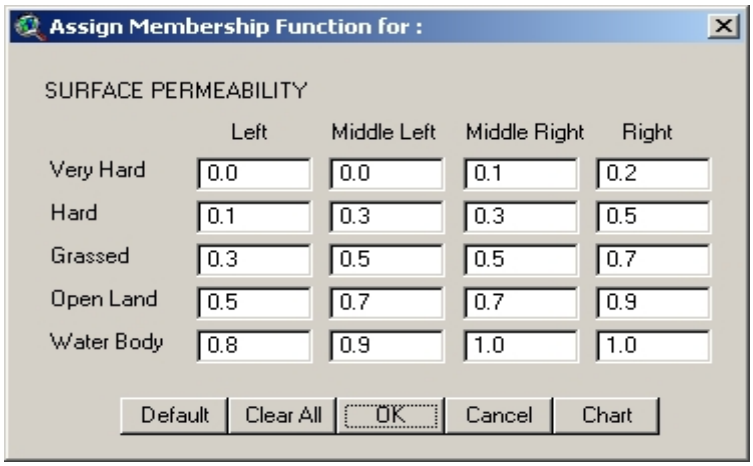


4. Soil Corrosivity

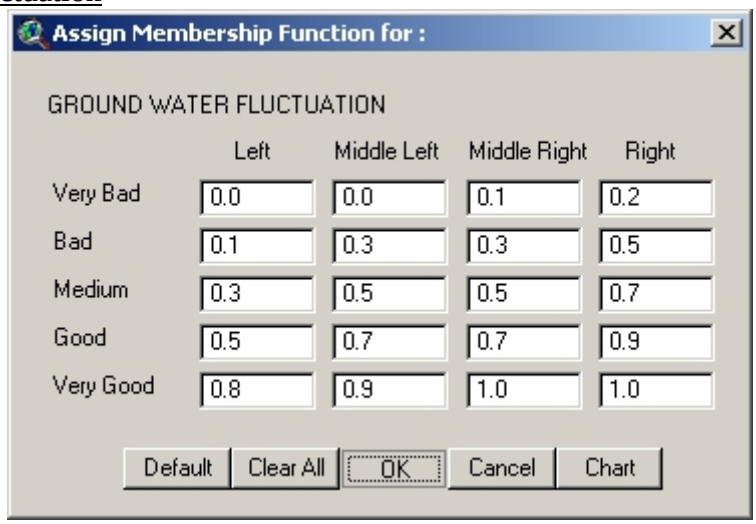
When defining the soil corrosivity membership function, the 'Soil Corrosivity' property is used.



5. Surface Type/Permeability

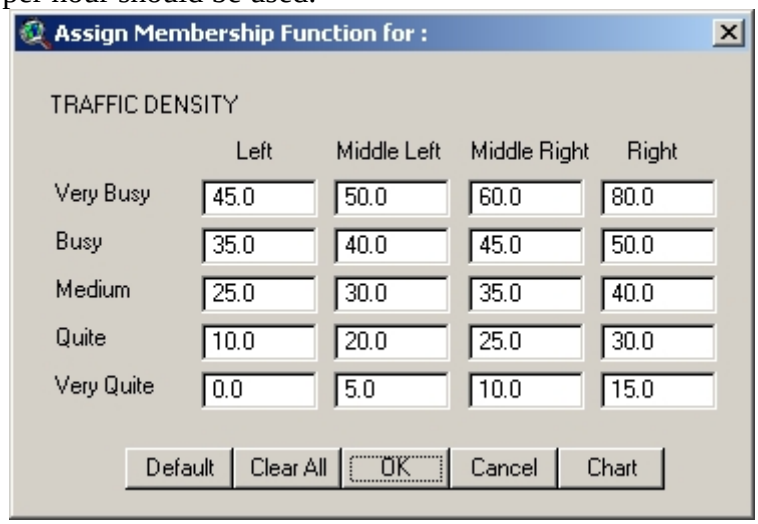


6. Ground Water Table Fluctuation



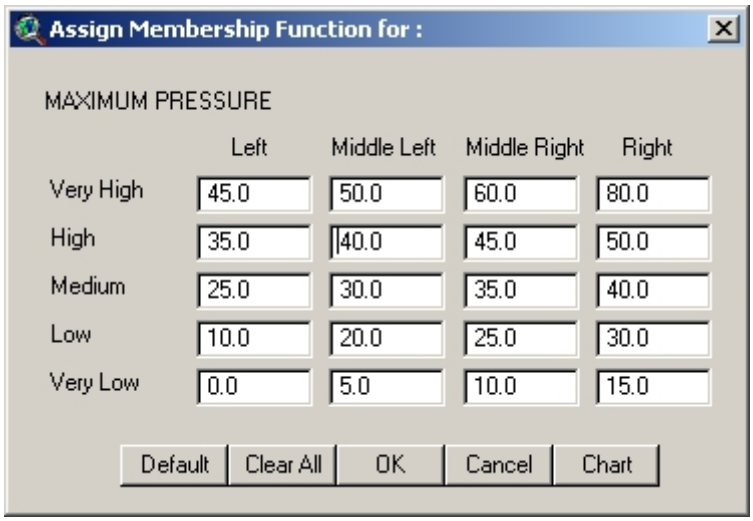
7. Traffic Density

When defining the traffic density membership function, the actual observed values of number of vehicles passing per hour should be used.

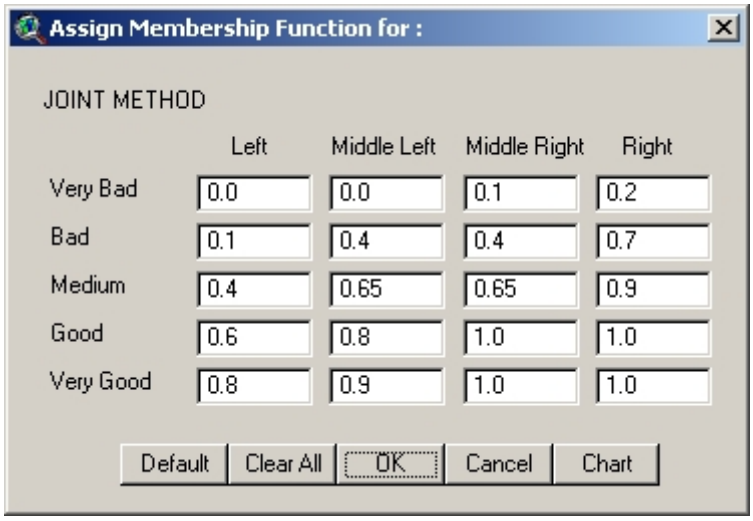


8. Maximum Pressure

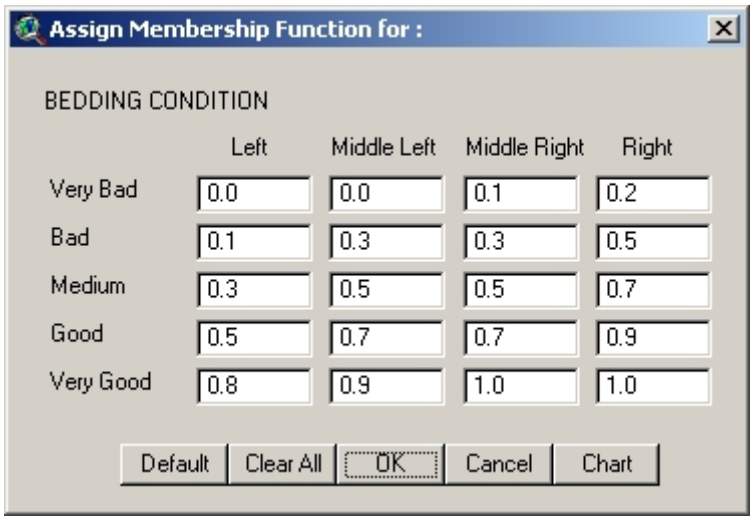
When defining the maximum pressure membership function, the values of pressure at the outlets should be used.



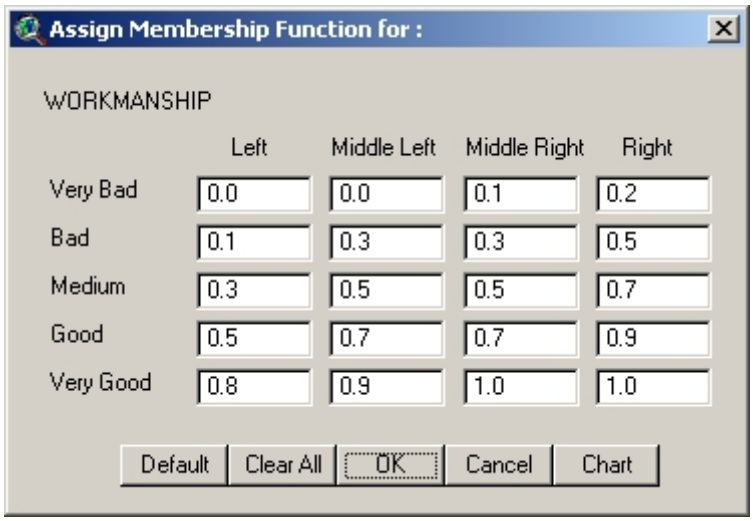
9. Joint Method



10. Bedding Condition



11. Workmanship

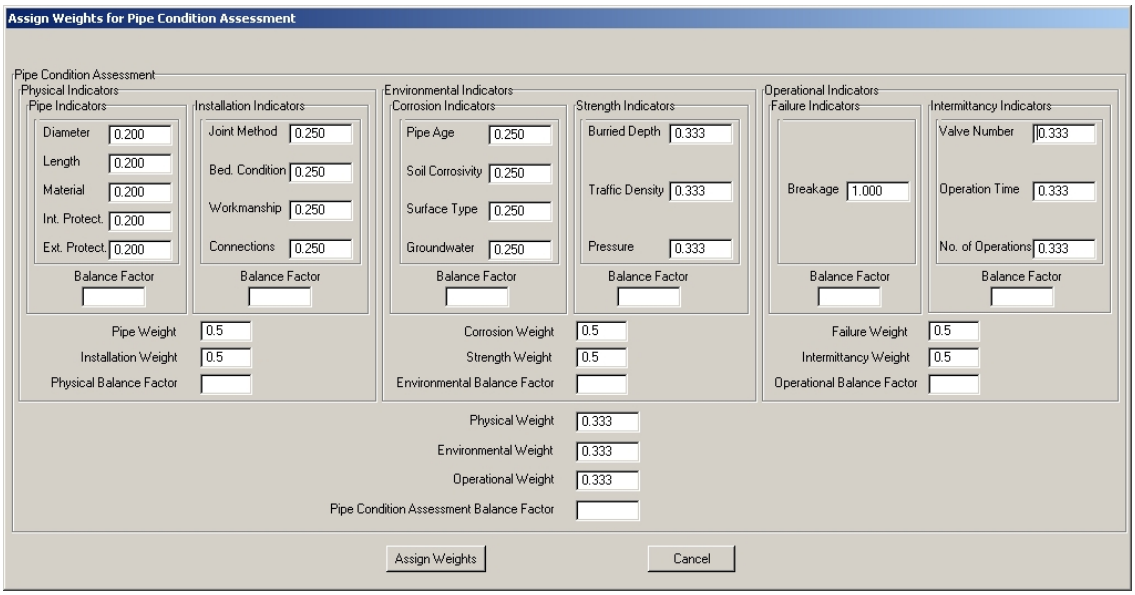


4.5.2 Weightage methods

The user also needs to assign weights for various indicators and balance factors for various groups. Weight allows importance to be given to different parameters/indicators within a group. Balance factors reflect the importance of the maximal deviations between indicators (criteria) in the same group, where 'maximal deviation' means the maximum difference between an indicator value and the best value for that indicator. The larger the balancing factor, the greater the concern with respect to the maximal deviation. Low balancing factors are used for a high level of allowable compromise between indicators of the same group. A balancing factor equal to 1 means that there is a perfect compromise between indicators of the group. If the level of compromise between indicators is moderate, a balancing factor of 2 will be sufficient. A balancing factor of 3 or more reflects a situation of minimal compromise between indicators. In the present (Pipe Condition Assessment) model, three weightage methods are included. These are:

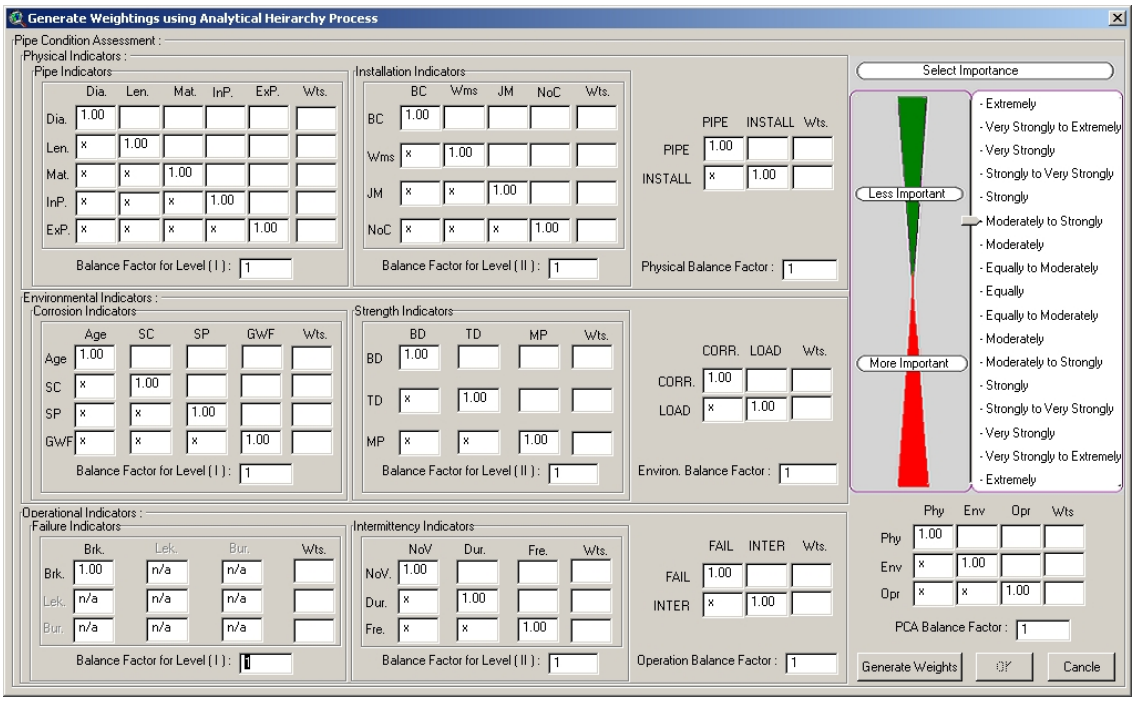
Equal Weights: With this method, equal weights are assigned to all the indicators of particular group. A balancing factor of 1 is assigned to all the groups.

Assign Weights: With this method, weights are assigned directly. The form in which they are assigned is shown below:

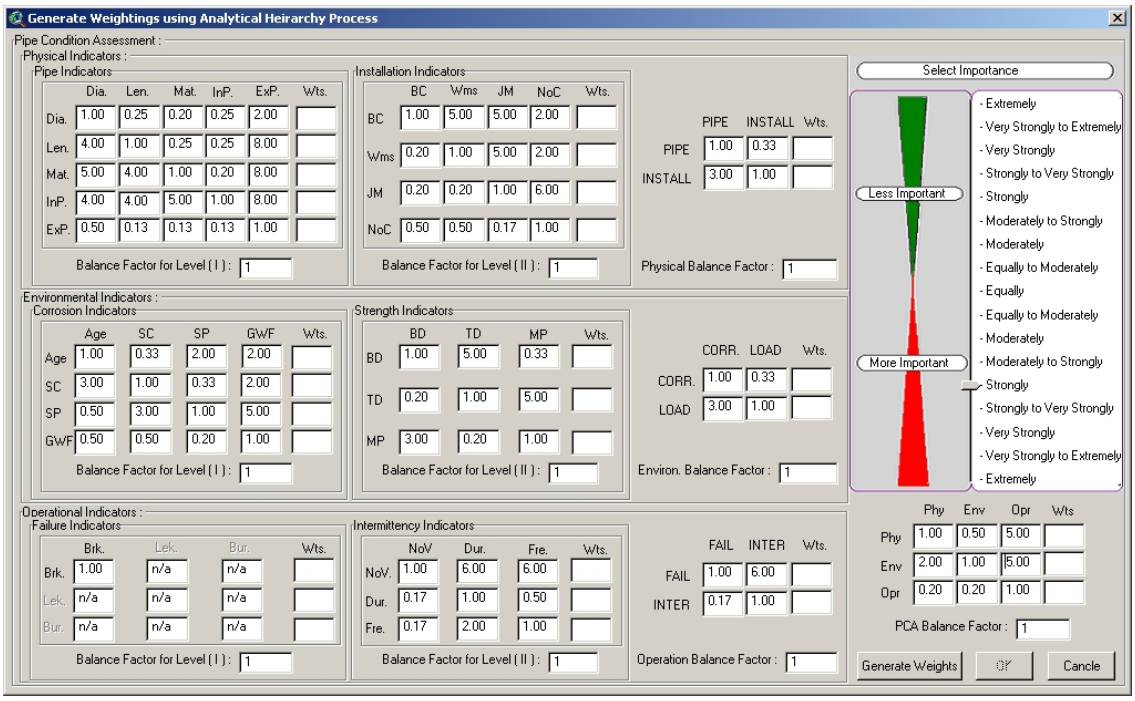


Depending on the number of indicators selected for the assessment, equal weights are assigned initially to all the indicators. The user can change the weights assigned to each indicator. However, it is necessary that the sum of the weights given in one group should be equal to 1 (see screen above). The user needs to input values for the balance factors of each group. After completing the form, the user can click on the 'Assign Weights' button to assign the weights and close the form. The program then displays the following Information message regarding weights assigned. Clicking on 'OK' closes this form.

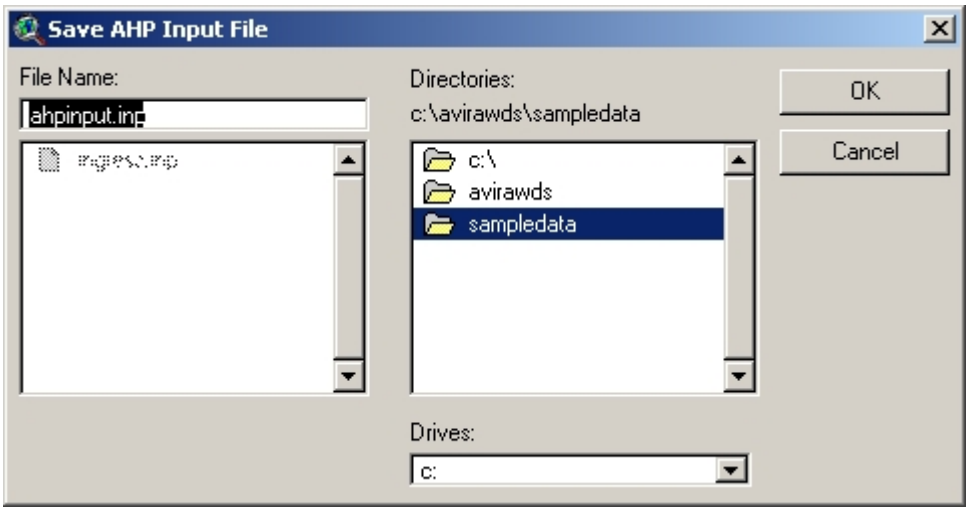
Generated by AHP: Weights can also be generated using the pair-wise comparison, that is, by Analytical Hierarchy Process (AHP). Clicking on 'Generate Weights' causes the following 'Generate Weights using Analytical Hierarchy Process' form to appear.



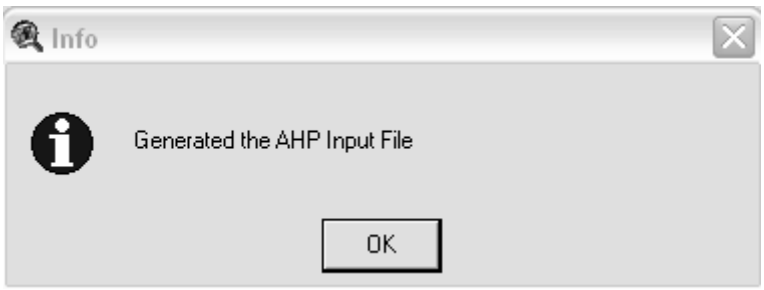
The matrix elements are enabled for those indicators that are selected in the 'Pipe Condition Assessment Input Form'. The slider on the right-hand side of the 'Generate Weightings using Analytical Hierarchy Process' form can be used to define the matrix element. The user needs to input values for the balance factors of each group. On completion of the matrix elements and inputting the balance factors, the form appears as shown in the example in next page.



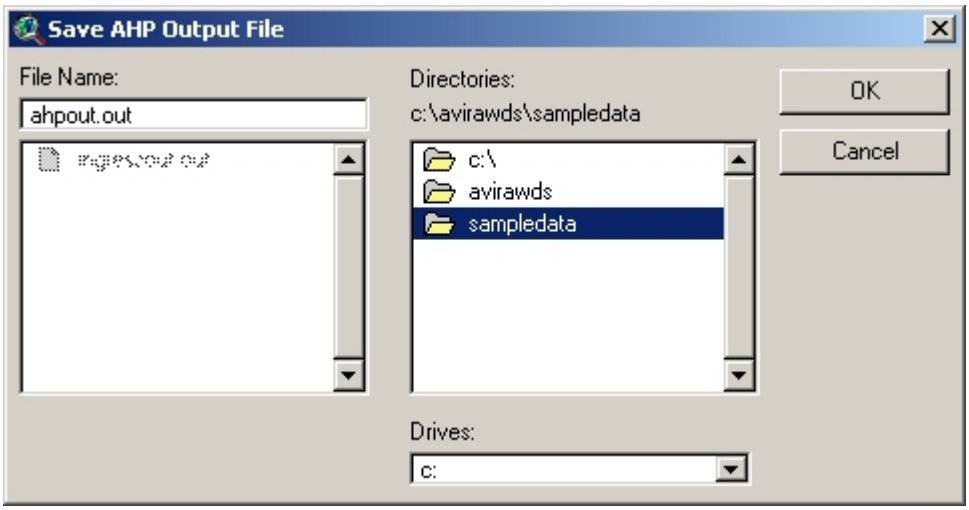
The user then clicks the 'Generate Weights' button, which opens the 'Save AHP Input File' dialogue box to save the AHP input matrix, as shown below:



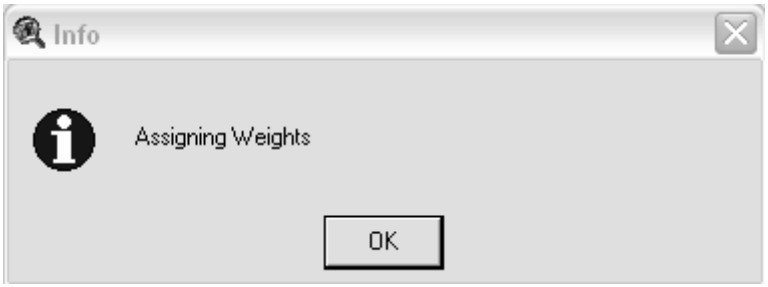
After selecting the input filename to save AHP input, the following dialogue box appears:



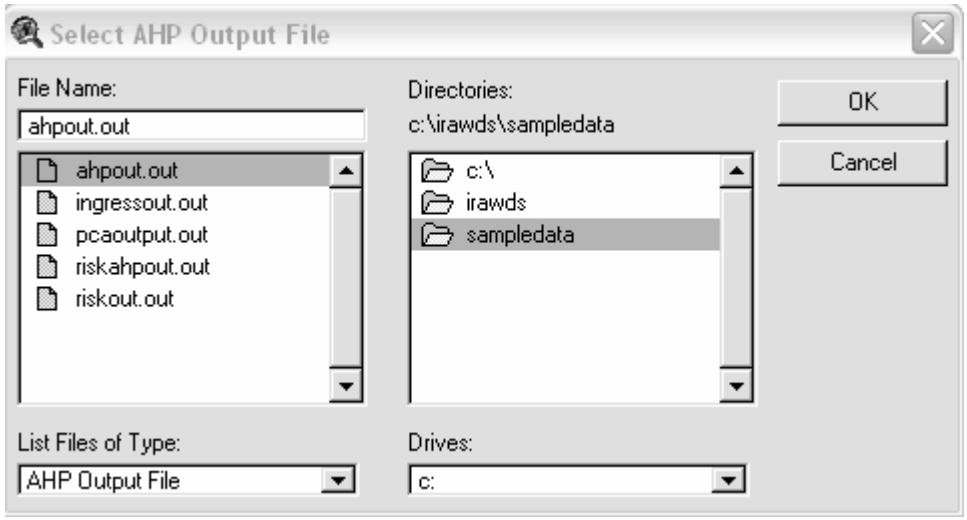
Confirming ‘OK’ on the ‘Generated the AHP Input File’ Info message box opens the ‘Save AHP Output File’ dialogue box and prompts the user about the filename to save the AHP output under, as shown below:



After selecting the output filename to save AHP output under, the following dialogue box appears:

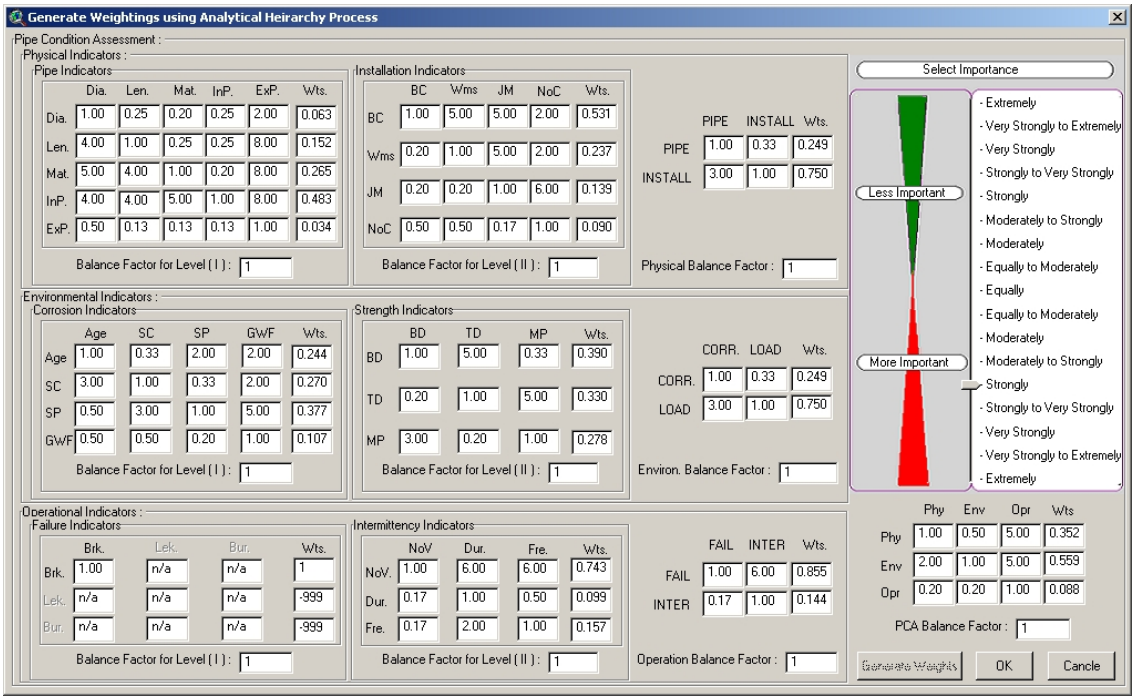


Clicking ‘OK’ executes the AHP model, which generates the weight for each parameter considered in the ‘Pipe Condition Assessment Input Form’ and then asks the name of AHP output file for viewing, as shown below:

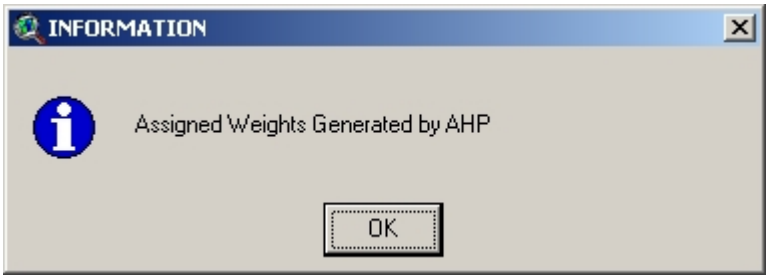


After the user gives the name of AHP output file, the following message appears:

After the user confirms 'OK', the weights can be seen (see screen below). If the weights generated using AHP are consistent, then those values are presented in the respective text boxes; otherwise '–99' appears in those boxes. If any particular indicator is not considered in the analysis, then '–999' appears in the text box as shown below:



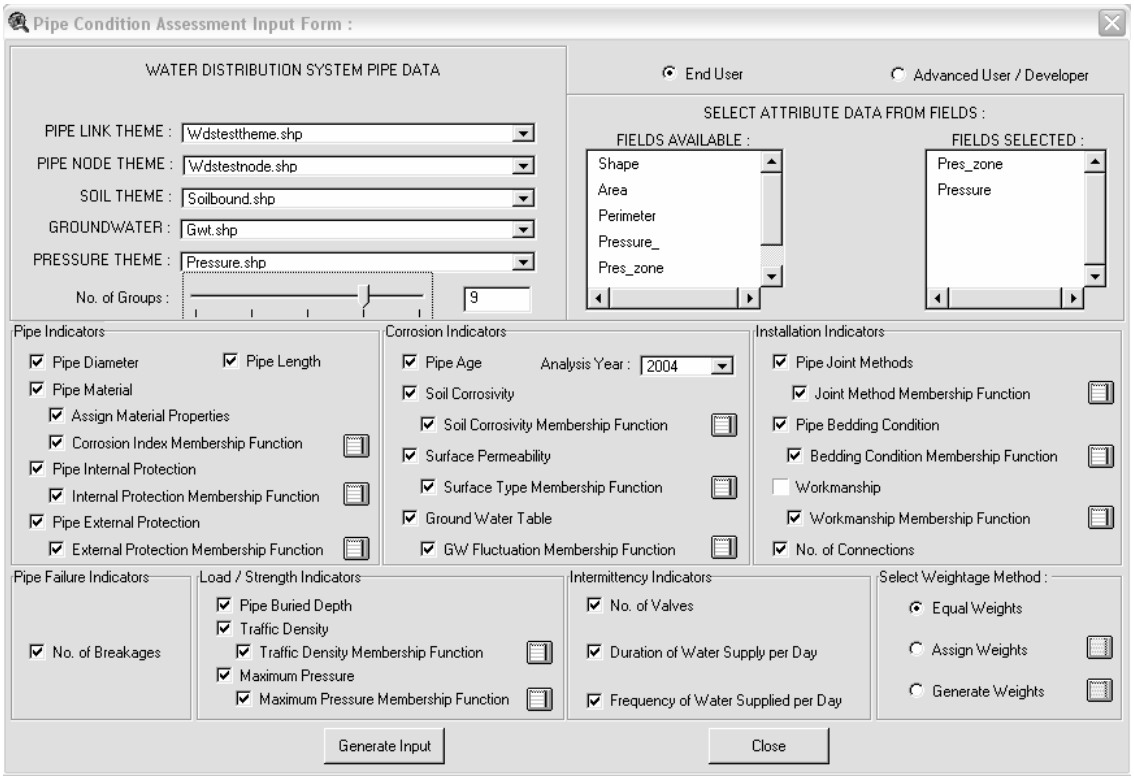
During this step the 'Generate Weights' button is disabled and 'OK' button is enabled. If the user clicks the 'OK' button, then the weights generated by AHP are assigned and a message is displayed as shown below:



If the 'Cancel' button is clicked, then the 'Equal Weights' option will be selected and 'Weights by AHP' will not be selected.

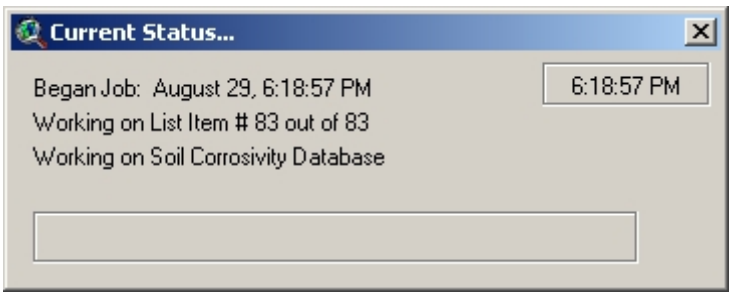
4.6 Number of groups

The output of the PCA model is a ranking of different pipes depending on their respective conditions. These pipes can be placed in different groups on the basis of their conditions. The number of groups can be entered by sliding the bar in front of 'No. of Groups' on the 'PCA Input Form' or by entering a value for the number of groups in the box provided, as shown below:



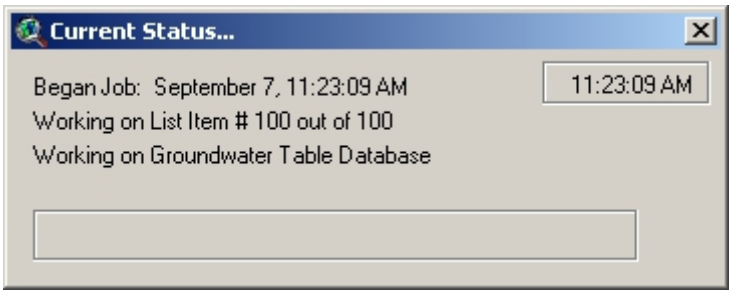
4.7 Generating the input file (PCA)

To generate the pipe condition assessment input file, the user should click on the 'Generate Input' button on the 'Pipe Condition Assessment Input Form'. If 'Soil Corrosivity' is selected, the model finds which pipe falls in which soil type and then appends the water distribution system pipe theme with soil corrosion category data accordingly.

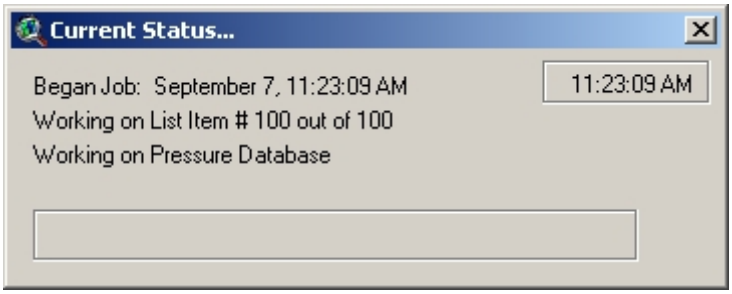


If the 'Ground Water Table' is selected, the interface finds the average groundwater table depth and groundwater fluctuation depth for each pipe. Then using the pipe

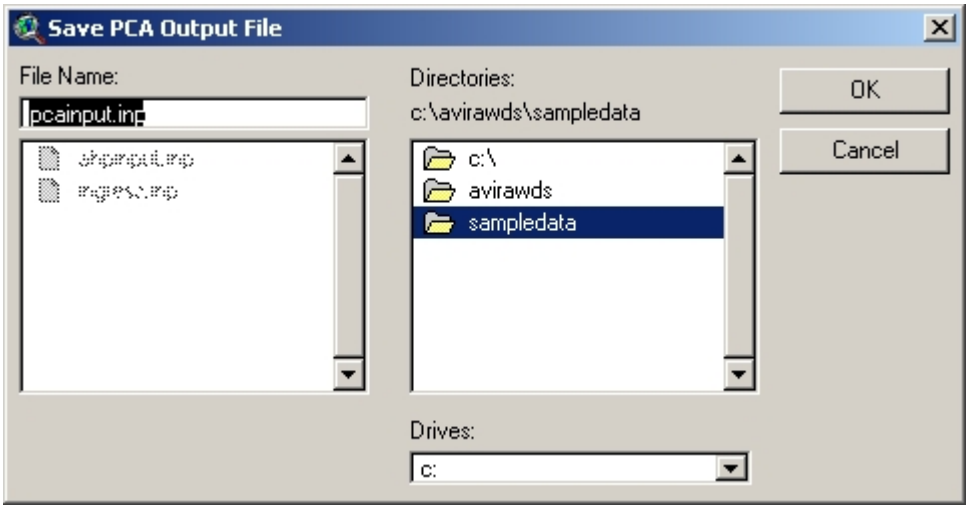
buried depth and the groundwater table data, it computes the groundwater category for each pipe and appends the water distribution pipe theme accordingly.



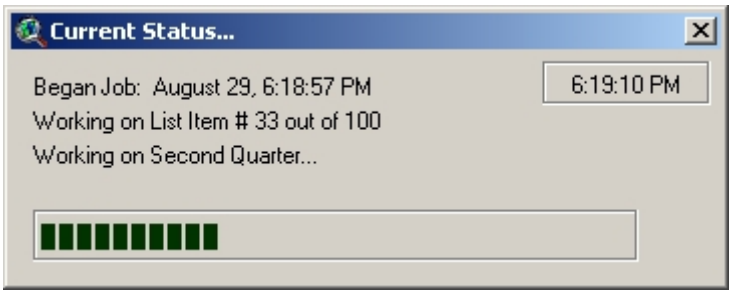
If the 'Maximum Pressure' is selected, the interface finds the pressure for each pipe and then appends the water distribution pipe theme according to the pressure category.



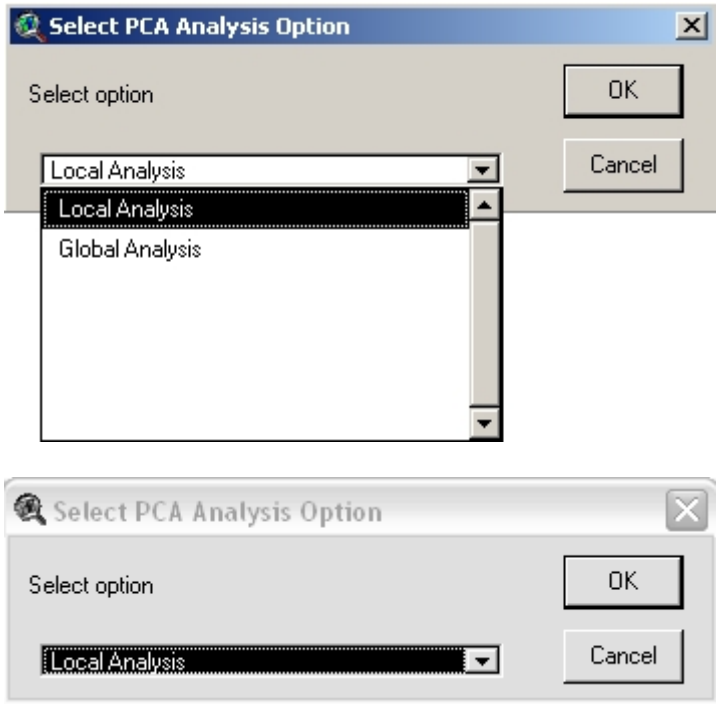
It then opens the 'File Save' dialogue box to save the file with the user-defined name.



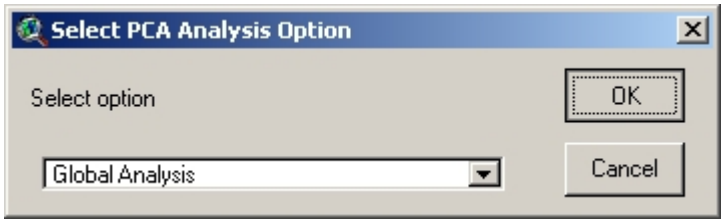
After the user writes/selects the input filename, the interface starts writing the input file. The data generation and writing progress is shown in the 'Current Status…' bar, as shown below:



Before completion of data writing, the model prompts an 'Input Choice' box asking the user for a 'Local Analysis' or 'Global Analysis' of pipe condition.

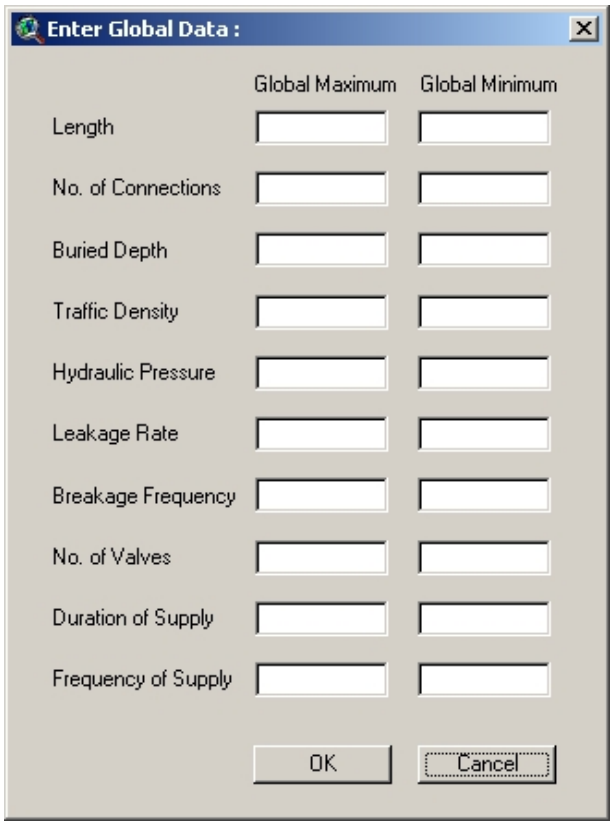


If user selects the 'Local Analysis' option, no more data input is required and the interface scans through the data input and finds the local maximum and minimum for the particular parameter required.

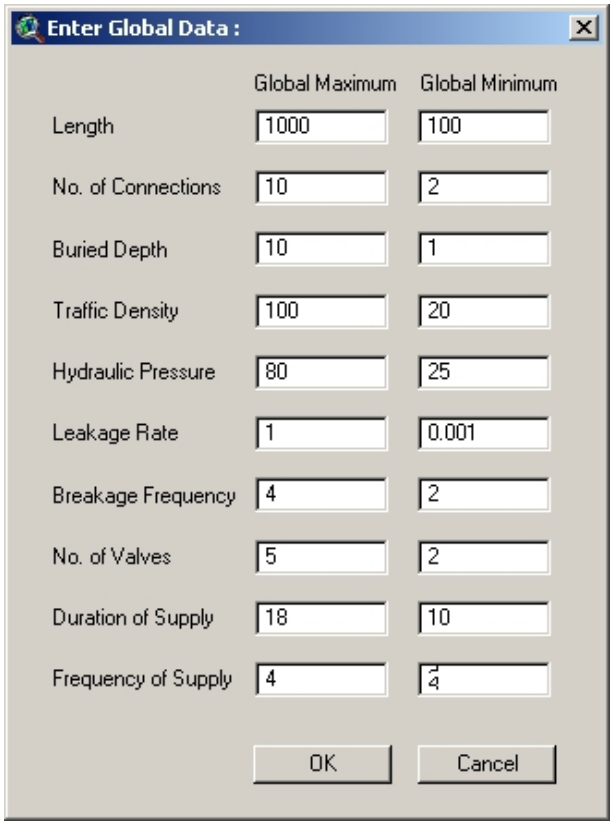


If the 'Global Analysis' option is selected, then one more input form is opened asking the user to fill in the maximum and minimum for certain parameters; these can then be

used to study and compare different networks in different conditions. The ‘Global Data’ input form is shown below:



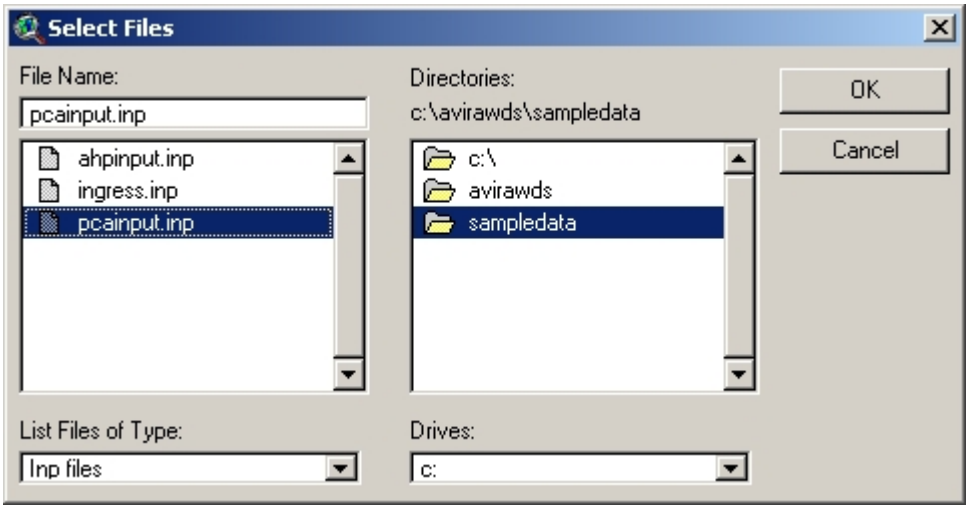
After the user has completed the data, the ‘Global Data’ input form looks as shown below:



After completing the data, the user can click on the 'OK' button. After generating the input file successfully, an 'Info' message box indicating 'Input File Generation completion' is displayed as shown below:

4.8 Viewing the PCA input files

The user can view the input file in the notepad by clicking on the  button or alternatively by selecting the 'View PCA Input Files' submenu from the 'Pipe Condition Assessment' menu and browsing the appropriate file to view.



pcainput - Notepad

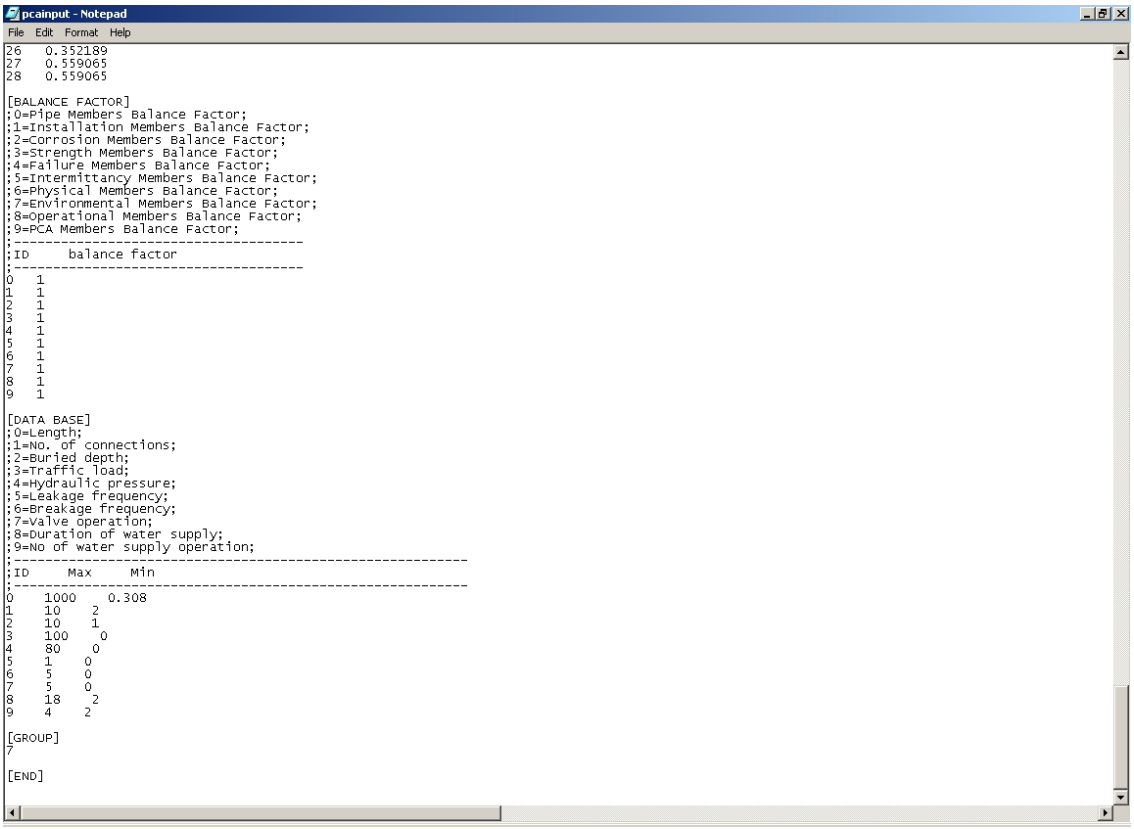
File Edit Format Help

```
;====================================================================;
;       WATER PIPELINE Vulnerability Assessment Input
;====================================================================;

[WATER PIPE]
;--------------------------------------------------------------------------------------------------------------------------------------------
;ID     StNode  EndNode StJoint EndJoint        Material        Traffic SurfPerm        InProtect       ExProtect       BedCond Workship
;--------------------------------------------------------------------------------------------------------------------------------------------

689     631     632     4       4       0       2       0       2       1       0       4       0       1       2       500     50 120  1.312
703     632     643     1       1       0       2       2       2       4       4       1       0       1       2       500     50 120  51.20
722     660     631     1       1       1       2       2       2       4       3       1       0       1       2       500     50 70   21.79
762     643     696     2       2       0       2       2       2       4       3       2       0       1       2       400     50 120  48.79
781     696     713     2       2       0       2       2       2       4       3       2       0       1       2       400     50 120  13.70
786     719     660     2       2       1       2       2       2       4       1       2       0       1       2       500     50 70   57.72
796     713     728     2       2       0       2       2       2       4       3       2       0       1       2       400     50 120  65.78
800     732     719     2       2       1       3       2       2       4       1       2       0       1       2       500     50 70   17.32
803     734     732     2       2       1       3       2       2       4       1       2       0       1       2       500     50 70   1.848
808     728     739     2       2       0       2       0       2       1       3       3       1       1       1       400     35 120  37.87
809     740     734     2       2       1       3       2       2       4       1       2       0       1       2       500     50 70   18.99
818     739     747     2       2       0       2       0       2       1       3       3       1       1       1       400     35 120  62.12
824     753     740     2       2       1       3       2       2       4       1       2       0       1       2       200     50 70   72.37
830     747     758     2       2       0       2       0       2       1       3       4       1       4       1       400     35 120  48.64
831     760     753     2       2       1       3       0       2       1       1       2       0       1       2       200     50 70   27.62
836     765     728     2       2       0       2       0       2       1       3       2       1       1       2       400     20 130  38.94
837     765     760     2       2       1       3       0       2       1       1       2       1       1       2       200     20 120  25.67
842     758     769     2       2       0       2       0       2       1       3       4       1       4       1       400     35 120  38.08
852     777     765     2       2       1       3       0       2       1       1       2       1       1       1       200     35 95   37.53
855     780     765     2       2       0       3       0       2       1       1       2       1       1       2       200     20 130  12.74
856     781     734     2       2       2       4       2       1       4       1       2       0       1       2       500     50 100  61.00
861     785     781     2       2       2       4       2       1       4       1       2       0       1       2       200     20 120  3.559
862     786     785     2       2       2       4       2       1       4       1       2       0       1       2       200     20 120  0.308
865     769     788     1       1       0       3       0       2       1       3       4       1       4       1       400     35 120  54.68
866     789     777     2       2       1       3       0       2       1       1       3       1       1       1       200     35 95   40.72
879     800     786     1       1       2       4       2       1       4       1       2       0       1       2       200     20 120  19.12
880     789     801     2       2       1       3       0       2       1       1       3       1       1       1       200     35 95   36.71
883     801     806     2       2       1       3       0       2       1       1       4       1       4       1       200     35 95   36.38
884     807     758     2       2       1       2       0       2       1       3       4       1       4       1       400     35 95   37.14
885     806     807     2       2       1       3       0       2       1       1       4       1       4       1       200     35 95   0.517
892     814     785     1       1       2       4       2       1       4       1       2       0       1       2       200     20 120  30.13
893     815     814     1       1       2       4       2       1       4       1       2       0       1       2       200     20 120  3.216
898     807     821     2       2       1       3       0       2       1       1       4       1       4       1       200     35 95   37.69
899     821     822     2       2       1       3       0       2       1       1       4       1       4       1       200     35 95   1.133
900     823     815     1       1       2       4       2       1       4       1       2       0       1       2       200     20 120  11.45
905     827     800     1       1       2       4       2       1       4       1       2       0       1       2       200     20 120  35.15
914     834     788     1       1       0       3       0       2       1       3       4       1       4       1       400     35 120  35.88
915     822     834     1       1       1       3       0       2       1       1       4       1       4       1       200     35 95   52.62
917     815     836     1       1       2       4       2       1       4       1       2       0       1       2       200     20 120  30.48
918     801     837     2       2       0       1       0       2       1       1       3       1       4       1       200     35 120  31.21
920     839     834     1       1       0       3       0       2       1       1       4       1       4       1       200     35 120  7.589
936     852     827     1       1       2       1       0       1       1       1       2       0       1       2       200     20 120  64.84
942     858     839     1       1       0       3       0       2       1       1       4       1       4       1       200     35 120  17.21
944     760     860     2       2       0       1       0       2       1       1       2       1       1       2       200     20 130  85.53
945     852     860     2       2       0       1       0       2       1       1       2       1       1       2       200     20 130  33.33
949     836     863     1       1       2       4       2       1       4       1       2       0       1       2       200     20 120  69.51
950     865     780     2       2       0       1       0       2       1       1       2       1       1       2       200     20 130  74.34
951     860     865     2       2       0       1       0       2       1       1       2       2       1       2       200     20 130  25.65
956     869     852     1       1       2       1       0       1       1       1       2       0       1       2       200     20 120  24.21
957     863     869     1       1       2       3       0       1       1       1       2       0       1       2       200     20 120  35.20
```

pcainput - Notepad

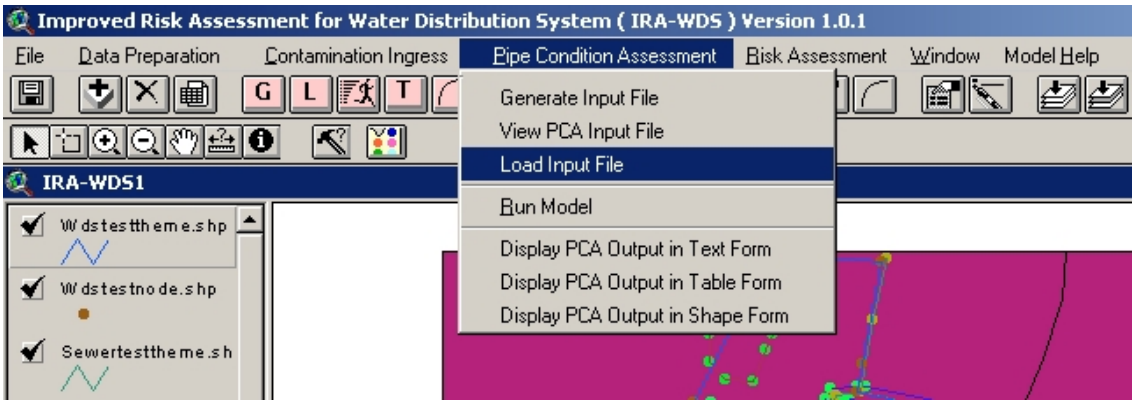
File Edit Format Help

```
1196    1039    1075    4       4       4       4       3       3       3       2       3       3       4       3       300     20 110  36.67
1220    1075    1095    4       4       4       4       3       3       3       2       3       3       4       3       300     20 110  26.47
1235    1095    1109    4       4       4       4       3       3       3       2       3       3       4       3       300     20 110  27.57
1269    1137    1109    4       4       4       4       3       3       3       2       3       3       4       3       300     20 110  44.32

[PIPE MATERIAL]
;0= AC
;1= RCC
;2= U1
;3= PVC
;4= CI
;-------------------------------------------------------------------------------------------
;ID      CorrResis       MaxPres         MaxLoad         MaxDia          MinDia          MaxLife
;ID      Corros  Max P   Max L   Design Life     Max CFactor     Min Cfactor     Max D   Min D
;-------------------------------------------------------------------------------------------
0       4       35.700      23.500      60      150     100     2500.000        50.000
1       4       30.000      30.000      60      130     70      1200.000        400.000
2       4       15.000      25.000      50      120     90      1000.000        300.000
3       4       15.300      4.400       60      150     130     1200.000        75.000
4       4       97.920      150.000     70      150     60      2000.000        75.000

[CORROSION RESISTANCE]
;0=Very Weak
;1=Weak
;2=Medium
;3=Strong
;4=Very Strong
;-----------------------------------------------------------------------
;ID      Left    MidLeft     MidRight    Right
;-----------------------------------------------------------------------
0       0.0     0.0     0.1     0.2
1       0.1     0.3     0.3     0.5
2       0.3     0.5     0.5     0.7
3       0.5     0.7     0.7     0.9
4       0.8     0.9     1.0     1.0

[INTER PROTECTION]
;0=Very Bad
;1=Bad
;2=Medium
;3=Good
;4=Very Good
;-----------------------------------------------------------------------
;ID      Left    MidLeft     MidRight    Right
;-----------------------------------------------------------------------
0       0.0     0.0     0.1     0.2
1       0.1     0.3     0.3     0.5
2       0.3     0.5     0.5     0.7
3       0.5     0.7     0.7     0.9
4       0.8     0.9     1.0     1.0

[EXTER PROTECTION]
;0=Very Bad
;1=Bad
;2=Medium
;3=Good
;4=Very Good
;-----------------------------------------------------------------------
;ID      Left    MidLeft     MidRight    Right
```

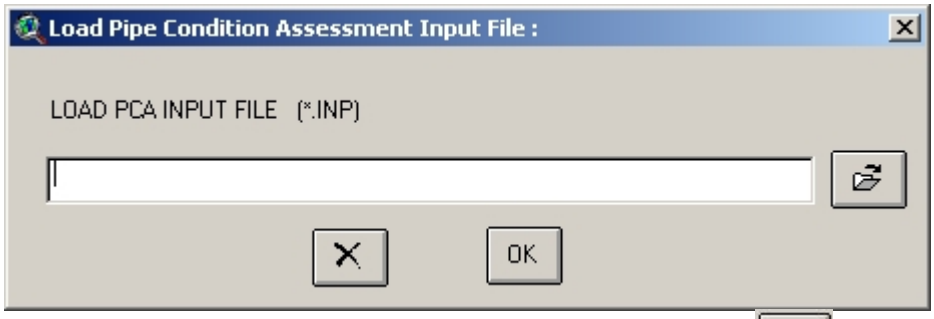


4.9 Loading the input file

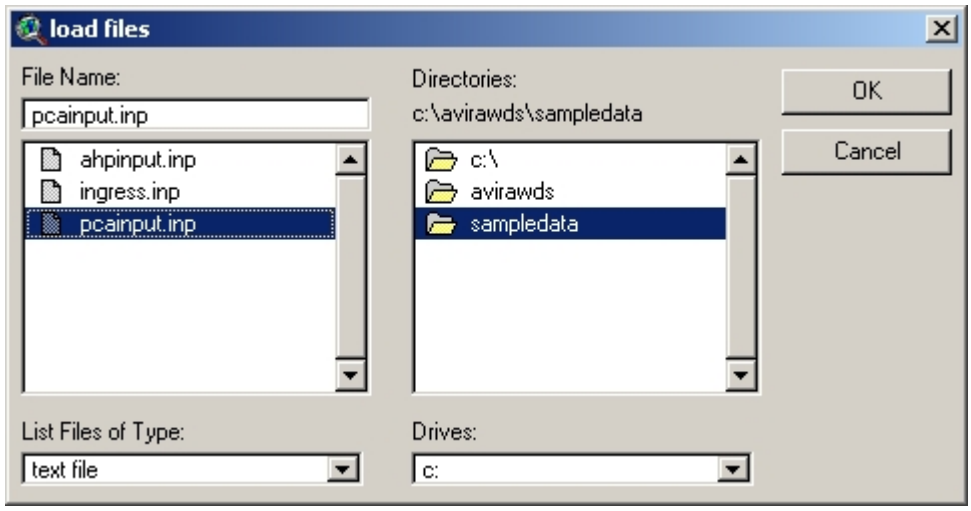
The input file to be used for running the Pipe Condition Assessment Model is loaded using the tool  , which is just below the 'Pipe Condition Assessment' menu or by clicking on the 'Pipe Condition Assessment' menu and then clicking on the submenu 'Load Input File', as shown in the screen below:



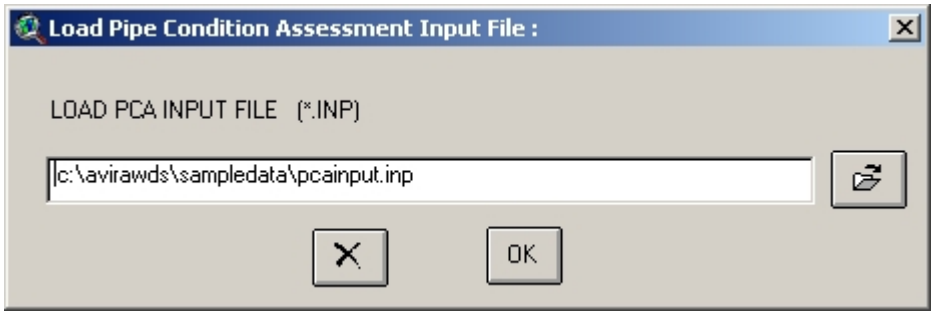
The ‘Load Pipe Condition Assessment Input File’ is shown below:



The user can browse through the computer by clicking on the  button on the ‘Load Pipe Condition Assessment Input File’ dialogue box. This opens the ‘ load files’ dialogue box, as shown below:



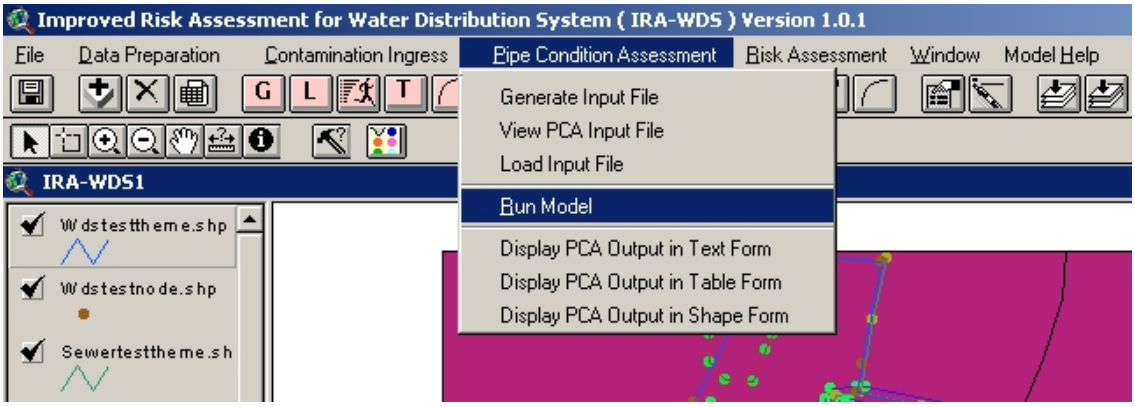
After the appropriate file has been selected and the user has pressed the ‘OK’ button on the filename, the filename appears in the ‘Load Pipe Condition Assessment Input File’ dialogue box.



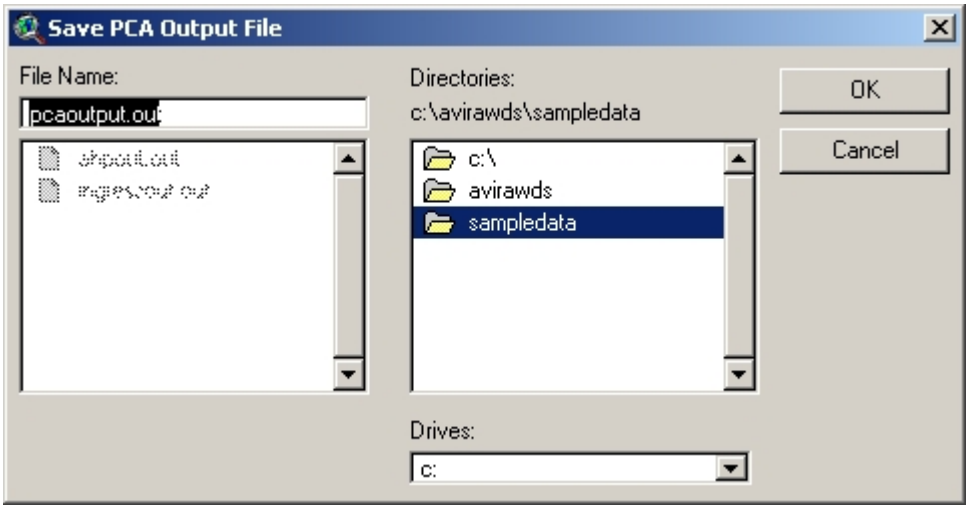
If the user wants to change the filename, he or she can do so by clicking the button  , which clears the filename from the ‘Load Pipe Condition Assessment Input File’ dialogue box. If user is sure of the input file selected, he or she can load it by clicking on the  button. This also closes ‘Load Pipe Condition Assessment Input File’ dialogue box.

4.10 Running the Model (PCA)

To run the model, the user should click on the  button, which is just below the 'Pipe Condition Assessment' menu or he or she should click on the 'Pipe Condition Assessment' menu and then click on the submenu 'Run Model', as shown on the screen below:



This opens the 'File Save' dialogue box for saving the Pipe Condition Assessment output file as *.out. Once the user has typed the appropriate name and clicked on 'OK', this generates the output selected by the user.



The interface then displays the 'Task Completed' Result message box, as shown below:

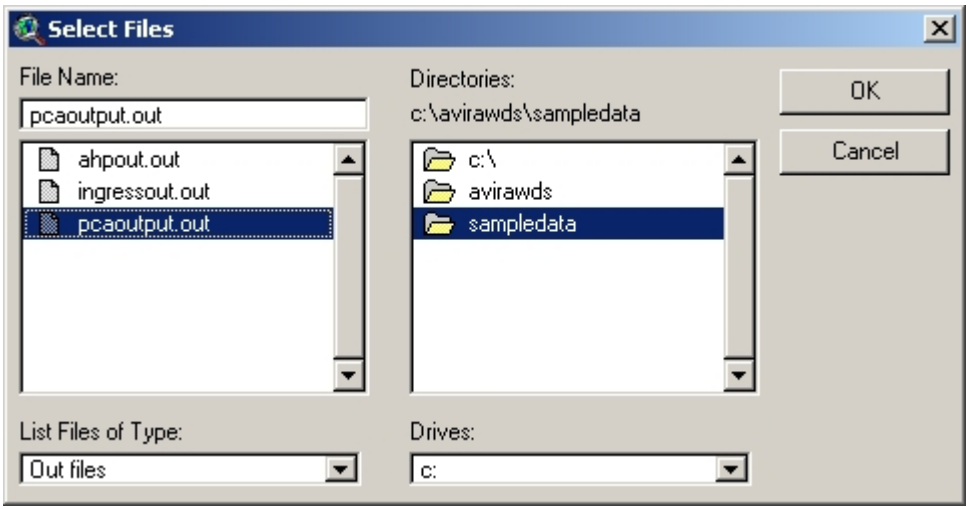
4.11 Displaying the output

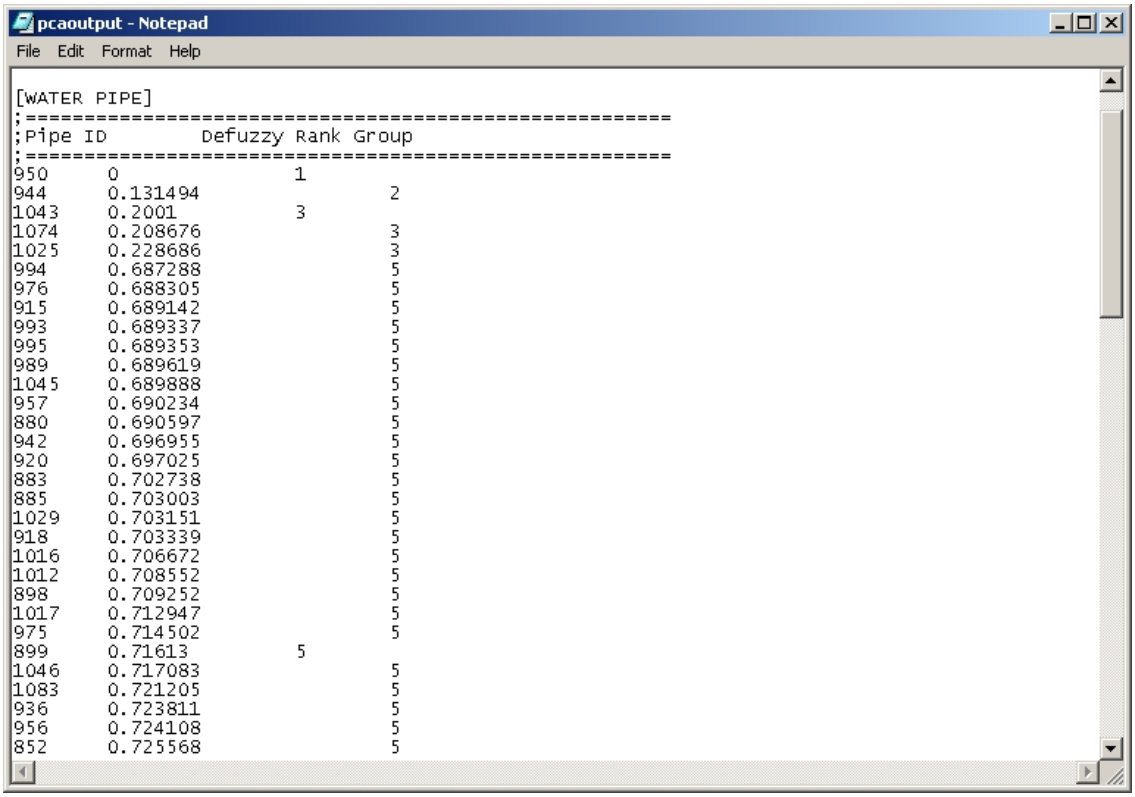
Output can be displayed in the following three forms:

1. Display PCA Output in Text form
2. Display PCA Output in Table form
3. Display PCA Output in Shape form

4.11.1 Displaying PCA output in text form

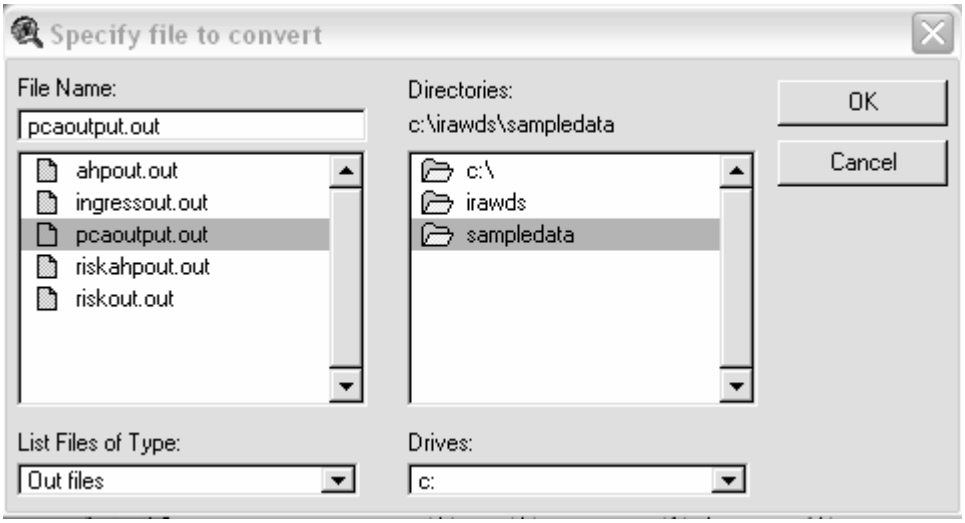
The user can view the output file in the text form in notepad by clicking on the  button or by selecting the 'Display PCA Output in Text Form' submenu from the 'Pipe Condition Assessment' menu and browsing the appropriate output file to view.





4.11.2 Displaying PCA output in table form

The user can view the output file in table form by selecting the 'Display PCA Output in Table Form' submenu from the 'Pipe Condition Assessment' menu and specifying the appropriate output file to view by browsing, as shown below:

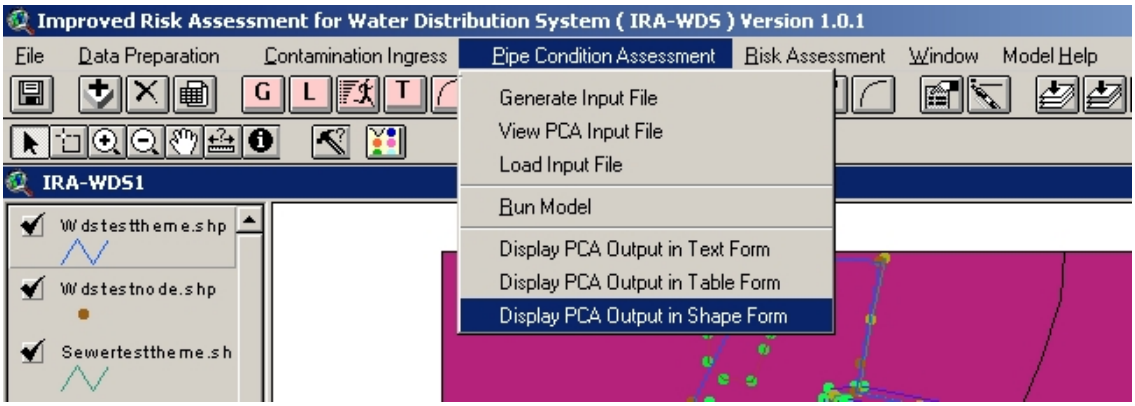


c:\irawds\sampledata\pcaoutput.dbf

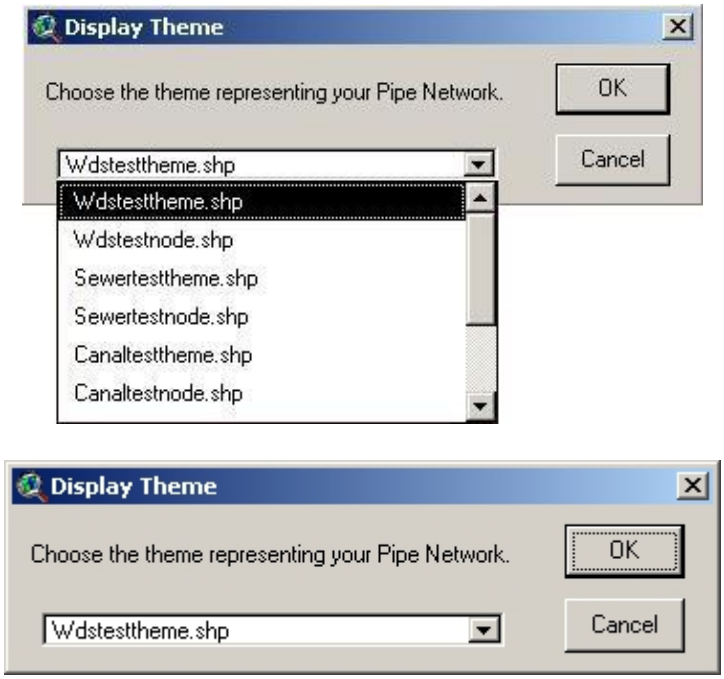
PipeID	DeFuzzy	Rank
950	0.000	1
944	0.283	3
1043	0.430	4
1074	0.448	4
1025	0.491	5
831	0.776	7
975	0.777	7
824	0.778	7
880	0.781	7
852	0.793	7
866	0.797	7
837	0.797	7
951	0.797	7
936	0.799	7
1083	0.799	7
957	0.800	8
809	0.802	8
989	0.804	8
883	0.805	8
994	0.805	8
945	0.806	8
956	0.806	8
915	0.808	8
786	0.809	8
885	0.811	8
1017	0.814	8
949	0.814	8
855	0.815	8
976	0.817	8
856	0.817	8
993	0.817	8

4.11.3 Displaying Pipe Condition Assessment output in shape form

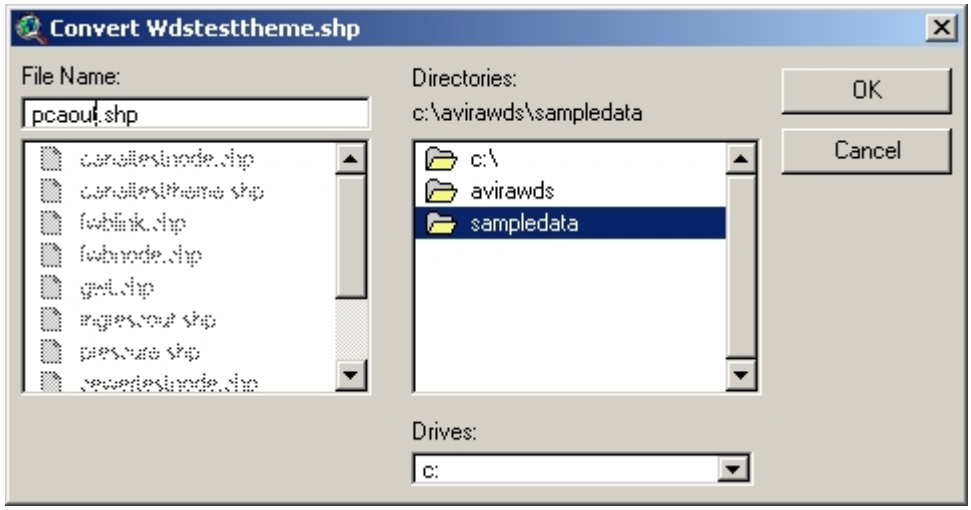
To view the Pipe Condition Assessment output in shape file form, the user should click on the  button, which is just below the 'Pipe Condition Assessment' menu or he or she can click on the 'Pipe Condition Assessment' menu and then click on the submenu 'Display Ingress Output in Shape Form', as shown on the screen below:



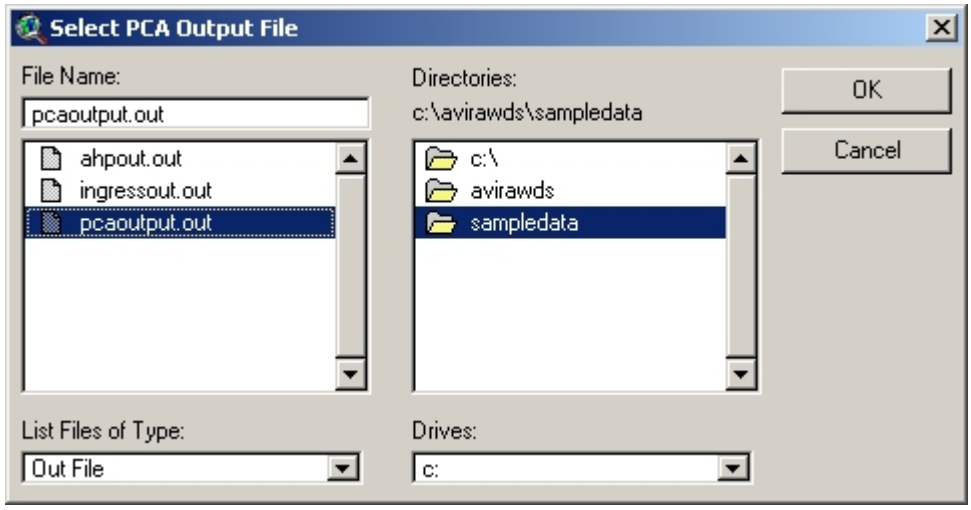
This opens the 'Display Theme' message box asking the user to specify which theme represents the water distribution system pipe theme, as shown below:



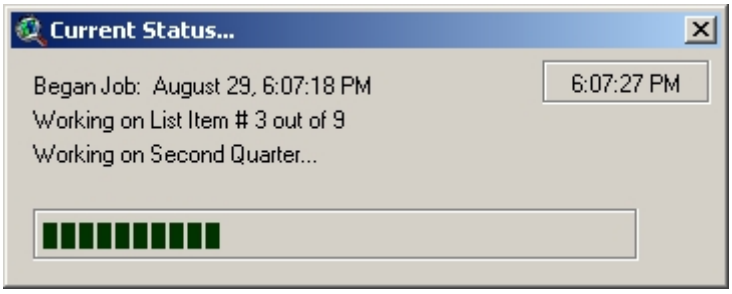
Once the user selects the appropriate theme representing the water distribution system pipe network and clicks on the 'OK' button, the 'Convert Theme' dialogue box appears on the screen and asks the user to give the name with which he or she wants to store/convert the selected theme, as shown on next page.



The interface then opens the 'File Select' dialogue box for selecting the Pipe Condition Assessment output file as *.out, from which attributes for pipe condition (PCAValue and PCARank) are to be added to the output theme, as shown below:



Once the user has selected the appropriate filename and clicked 'OK', the program shows the progress meter, as below:



On completion of theme generation and attribute addition, it displays the 'Completed' Info message box, as shown on next page.

After clicking the ‘OK’ button on this message box, the new shape-file is added to the IRA-WDS data viewer. The ‘PCAOut’ theme legend needs to be changed by the user and instead of viewing the theme in a single colour, it can be viewed by unique values of ‘PCARank’, as shown below: