Expert System Capabilities

The user is given continual guidance and assistance during data entry. For parameters that are difficult to estimate the user may be advised of literature to aid in selecting a value, or an explanation of a parameter and some proposed values may be shown on the screen. If there are other ways to pick the value, typically if the parameter is a function of other variables, the equation is shown to the user.

The user interface is intelligent and offers expert system capabilities based on the knowledge of the software developers and experienced users. For example, as various graphical elements are connected to form a network, XP filters the user's actions so that a network that is beyond the scope of the model is not created. The general philosophy is to trap any data problems at the highest possible level - at the point the data is created by the users.

In addition to the well-known and accepted benefits of input and output graphics, the xp environment provides the user with expert data checking facilities. The following sections outline the checks used by XPSWMM and XPStorm.

Network Manipulation

Knowledge based data filtering prevents the creation of an illegal network or modifications that would result in an illegal network. The network is checked to meet the following constraints:

- Number of links connected at a node not greater than 20.
- Double links not allowed - a multi-link must be used.

Data Type Checking

Data entered via text items is checked against the data type expected for that item. If a number is expected then the text string entered is interpreted to see it follows the rules for numerical strings. For example, if an integer (whole number) is expected, then invalid characters such as non-digits, decimal points etc, are trapped and the data is not accepted.

Pure text strings or comments are accepted as entered.

The syntax for numerical strings follows the usual rules. Larger-magnitude numbers can be entered via exponential notation.

xp indicates floating-point numerical items by adding a decimal point if this hasn't already been done.

Data Range Checking

As data is entered it is filtered on two levels:

- Data is checked to ensure it is within a "reasonable" range. eg. Mannings 'n' has a reasonable range of 0.005 to 0.5. If data outside the reasonable range is entered a warning message is issued, with the reasonable range indicated and the data is accepted.
- Data is checked to ensure it is within an absolute limit. eg. Mannings 'n' cannot be less than zero. If data is outside the absolute range an error message is issued, with the valid range indicated, and the data not accepted. Execution cannot continue unless a valid value is entered or "Cancel" is selected.

Relational Consistency Checking

After all the data has been entered and the user attempts to solve the networks the inter-relationship of all data is checked for consistency, again at two levels:

- Warning messages are generated for data outside reasonable constraints, or missing data for which default parameters have been provided, but the network can still be solved
- Error messages are generated for data outside the absolute range, or data that is illegal in its context with other parameters, and the network can not be solved until these errors are corrected.

ERRORS

Hydraulics Layer (EXTRAN) Errors

1. Elevation in pump, weir or orifice below node invert.
2. Missing input hydrograph data.
3. Storage data missing.
4. Node data missing.
5. Ground elevation below node invert.

6. User tide coefficients undefined.
7. Undefined outfall boundary condition.
8. Not enough points in input hydrographs.
9. Insufficient points in input hydrographs.
10. Node storage elevation above spill elevation.
11. Run control parameters missing.
12. Unconnected node present in network.
13. Unnamed node present in network.
14. Node storage elevation below highest crown elevation.

Runoff Layer Errors

1. Unable to open the rainfall interface file.
2. Error reading the number of stations from the rainfall interface file.
3. More than the maximum number of user defined global rainfall records referenced.
4. Rainfall input interface file not specified.
5. Rainfall station name not found in the input interface file.
6. Time control data missing.
7. Invalid simulation start or end date.
8. Simulation end earlier than simulation start.
9. Invalid start date or start time entered in rainfall record.
10. The maximum number of inlets has been exceeded.
11. Invalid print period date encountered.
12. Node downstream of channel not specified as a runoff node.
13. The maximum number of subcatchments has been exceeded.
14. The maximum number of subcatchments with Groundwater compartments has been exceeded.
15. Rainfall data not selected for a subcatchment.
16. Infiltration data not selected for a subcatchment.
17. Groundwater data not selected for a subcatchment.
18. Groundwater drainage name, selected for a subcatchment, is not a valid runoff node or conduit.
19. Groundwater Field Capacity must be greater than the Wilting Point.
20. Snowmelt data has not been selected for a subcatchment.
21. At least one pollutant must be specified for water quality.
22. More than the maximum number of pollutants have been specified in water quality.
23. At least one landuse must be specified when simulating water quality.
24. More than the maximum number of landuses have been specified in water quality.
25. Buildup parameters not specified for pollutant.
26. Washoff calculation cannot be set to 'Exponential' when buildup calculation is set to 'None'.
27. Washoff calculation cannot be set to 'EMC' unless buildup calculation is set to 'None'.
28. Erosion details for a subcatchment not selected.
29. Street sweeping data for Water Quality missing.
30. Print control data missing.
31. Water quality data for a subcatchment missing.
32. Subcatchment data missing.
33. Job control snow melt data missing.
34. Job control snow melt single event data missing.
35. Job control continuous snow melt data missing.
36. Global pollutant data missing.
37. Global landuse data missing.
38. Global snowmelt snow covered area data missing.
39. Global snowmelt normally bare impervious area data missing.
40. Global snowmelt snow plowing data missing.
41. Global snowmelt areal depletion curve missing.
42. Global groundwater data missing.
43. Global groundwater outflow calculation data missing.
44. Global groundwater evapo-transpiration data missing.
45. Global groundwater infiltration/percolation data missing.
46. Global infiltration data missing.
47. Global infiltration Horton data missing.
48. Global infiltration Green-Ampt data missing.
49. Global rainfall data missing.
50. Global rainfall gauge input missing.
51. Global buildup/washoff data missing.
52. Global buildup/washoff time data missing.

53. Global buildup/washoff exponential data missing.
54. Global buildup/washoff rating curve data missing.
55. Global buildup/washoff EMC data missing.
56. Global erosion data missing.
57. Job control data missing.
58. Global snowmelt data missing.
59. Global snowmelt single event data missing.
60. Job control water quality erosion data missing.
61. Job control water quality data missing.

Sanitary Layer (Transport Mode) Errors

1. Dry Weather Flow reference missing in Job Control
2. Evaporation Data Missing.
3. Evaporation must be entered with storage units.
4. Invalid Treatment Plant print period start date or end date encountered.
5. Invalid simulation start date or end date.
6. Number of Input Hydrographs exceeds maximum allowed.
7. Number of Nodes in Network exceeds maximum allowed.
8. Number of Particle Sizes exceeds maximum allowed.
9. Number of Pollutants exceeds maximum allowed.
10. Number of Settling Velocities exceeds maximum allowed.
11. Number of Storage Elements exceeds maximum allowed
12. Number of Storage Treatment Plants exceeds maximum allowed
13. Number of Storage Treatment Units exceeds maximum allowed
14. Number of Transport Elements exceeds maximum allowed
15. Number of Transport Hydrograph Points exceeds maximum allowed
16. Number of Upstream Conduits exceeds maximum allowed
17. Bypass Flow Threshold data missing
18. Capital Cost variable missing
19. Dry Weather Flow dialog data missing
20. Constant Pumping dialog data missing
21. Depth Outflow Table data missing
22. Flow Divider dialog data missing
23. Job Control Evaporation dialog data missing
24. Job Control Print Control dialog data missing
25. Job Control Removal Equation Variables dialog data missing
26. Node data missing
27. Outflow Power Equation dialog data missing
28. Particle Size Distribution dialog data missing
29. Particle Size Ranges dialog data missing
30. Plug Flow dialog data missing
31. Pollutant Particle Size Distribution data missing
32. Pollutant Scour / Deposition data missing
33. Pollutant Study Area Process Flow data missing
34. Pollutant data missing
35. Pollutant; Critical Particle Size data missing
36. Pollutant; Critical Settling Velocity data missing
37. Pollutant; Removal Option data missing
38. Print Control dialog data missing
39. Removal Equation dialog data missing
40. Residential Sewer Area dialog data missing
41. Residual Power Equation dialog data missing
42. Screen Process Removals dialog data missing
43. Screen Process dialog data missing
44. Second Outflow Power Equation dialog data missing
45. Settling Velocities dialog data missing
46. Settling Velocity Range dialog data missing
47. Sewer Dry Weather Flow data missing
48. Sewer Input Time Series dialog data missing
49. Sewer Inputs dialog data missing
50. Storage Node Initial Concentrations dialog data missing

51. Storage Node Outflow Power Equation dialog data missing
52. Storage Node dialog data missing
53. Storage Treatment 'More' dialog data missing
54. Storage Treatment Plant data missing
55. Storage Unit data missing
56. Subarea Process Flow dialog data missing
57. Operational & Maintenance Cost variable missing
58. Plug Flow Sludge Pollutant data missing
59. Screen Unit Cost data missing
60. Sewer Dry Weather Flow Study Area data missing
61. Sewer Dry Weather Flow Temporal Variation data missing
62. Storage Unit Cost data missing
63. Storage Unit Hydraulic Properties data missing
64. Storage Unit Residual Flow data missing
65. Waste Stream Temperature reference missing
66. No Detailed Print Periods Entered
67. No Storage Treatment Units Entered
68. Pollutant %Greater values must decrease
69. Removal Equation Variable is duplicated
70. Removal Equation Variables must all be unique
71. Residential Landuse must be selected to Estimate Dry Weather Flow
72. Sewer Dry Weather Flow Land-use areas do not add up to total area
73. Sewer Infiltration reference missing in Job Control
74. Simulation Time Step must not be zero
75. Simulation end date earlier than simulation start date
76. Undefined Removal Equation Variable for pollutant
77. Storage Treatment Unit has a circular output reference
78. Storage Treatment Unit is duplicated
79. Storage Treatment Unit references an unknown output unit
80. Upstream node not in transport mode
81. Use of Removal requires Equation Variables flag in Job Control
82. Waste Stream Temperature Data Missing
83. You must select some Pollutants in Job Control to export Storage Treatment Plants

Conduit Errors (All layers)

1. Conduit invert below node invert.
2. Only one connecting conduit to outlet node.
3. Pump data missing.
4. Pump head-discharge data missing.
5. Inline lift pump data missing.
6. Offline wet-well pump data missing.
7. Weir data missing.
8. Flagged orifice time history missing.
9. Orifice data missing.
10. More than one conduit connected to an offline pump.
11. At least one conduit connected to an inline pump.
12. Must be a weir outfall only (no combination of conduits/weirs).
13. Channel data missing.
14. Unnamed Natural Channel cross section.
15. Conduit data missing.
16. Conduit obvert above ground surface elevation.
17. Unnamed conduit present in network.
18. The maximum number of channels and pipes has been exceeded.
19. Multiple conduit data missing.
20. Natural channel section coordinates not found.
21. The maximum number of natural channels has been exceeded.
22. Station position of the left bank not found in natural channel section coordinates.
23. Station position of the right bank not found in natural channel section coordinates.
24. User defined conduit data not found.
25. Maximum user defined conduit depth above ground surface level.
26. Circular conduit height cannot be zero.

27. Special conduit type data missing.
28. Special conduit height cannot be zero.
29. Special conduit width cannot be zero.
30. Conduit cross section data missing.
31. Conduit profile data missing.
32. Zero length conduit.
33. The maximum number user defined cross-sections exceeded.

Utilities

1. Hotstart Data undefined
2. Undefined Hot-Start file name
3. File does not exist
4. RAIN Input Interface file doesn't exist
5. RAIN Output Interface file isn't valid
6. Rainfall Synoptic Analysis Event Summary file isn't valid
7. Rainfall Output report file isn't valid
8. A standard format has not been selected for RAIN interface file
9. Invalid format string entered
10. Neither synoptic analysis nor interface file output selected. At least one output type must be selected.
11. Invalid start date or end date entered.
12. Year field not specified in user defined format.
13. Month field not specified in user defined format.
14. Day field not specified in user defined format.
15. Hour field not specified in user defined format.
16. Minute field not specified in user defined format.
17. Precipitation field not specified in user defined format.
18. User defined precipitation field must be specified in the first or last position.
19. Rain data not entered
20. User defined data not entered
21. User defined format fields not entered
22. Synoptic analysis options not entered
23. Additional rain data not entered
24. A valid input file must be entered
25. A valid output file must be entered
26. A report output file must be entered
27. An input station name must be entered
28. Statistics Input Interface file doesn't exist
29. Statistics Output file isn't valid
30. Statistics Start date/time is after End date/time
31. Statistics Node name undefined
32. TEMP Input Interface file doesn't exist
33. Temperature Output Interface file isn't valid
34. Temperature Output report file isn't valid
35. Temperature Invalid format string entered
36. Minimum Temperature field not specified in user defined format
37. Evaporation estimate field not specified in user defined format
38. Wind Speed field not specified in user defined format
39. Minimum Temperature field not specified in user defined format.

WARNINGS

Hydraulics Layer (EXTRAN) Warnings

1. Hydrograph shorter than simulation period - constant extrapolation for hydrograph.
2. Number of input hydrographs greater than maximum number of inputs allowed.
3. Number of nodes for detail printing greater than maximum number of print nodes allowed.
4. Number of nodes for flow-history plotting greater than maximum number of print nodes allowed.
5. Number user input hydrographs greater than maximum number of inputs allowed.
6. Defaulting to imperial units.
7. Hotstart option flagged but undefined.

Runoff Layer Warnings

1. Rain interface file not in the format expected.
2. Number of Stations specified in the Rainfall interface file exceeds the maximum allowed.
3. Groundwater Field Capacity is greater than 0.9 x POROSITY.
4. Subcatchment water quality initial loading reference missing. Using default initial loadings of zero.
5. Units missing, defaulting to METRIC.
6. Catchbasin data missing.
7. Evaporation data not entered. Using defaults.
8. Global landuse Street sweeping data missing.
9. Node data has not been entered.
10. Groundwater Porosity should be greater than Initial Upper Zone Moisture to give a positive initial available volume.

Sanitary Layer Warnings

1. Job Control Options data not entered. Using defaults.
2. Sum of Sub-areas does not equal Total Catchment Area.

Conduit Warnings (All layers)

1. Pump on level less than off level.
2. Number of conduits for head plotting greater than maximum number of print nodes allowed.
3. Conduit flows can only run uphill using Extran. Uphill only flag ignored.
4. Conduit slope inconsistent with length and invert levels. Invert levels ignored.

Utilities

1. Mode data not entered. Exporting runoff mode data by default.
2. Runoff, Transport or Extran interface files not specified.

IMPORT ERRORS

Runoff Mode

1. Subcatchment name referenced on I1 card not found or not in the same order as subcatchment names on the H1 cards.
2. Attempt to import more than the maximum number of pollutants.
3. Attempt to import more than the maximum number of landuses.
4. Invalid pollutant number reading J4 lines.
5. Non-existent subcatchment name on K1 line. Erosion data not imported.
6. Non-existent subcatchment name on L1 line. Surface quality data not imported.
7. M3 line contained the unknown object.
8. M4 line contained the unknown object.
9. ROPT = 1 and a rainfall interface file has not been specified.
10. Rain interface file not in the format expected.
11. Number of Stations specified in the Rainfall interface file exceeds the maximum.
12. Invalid hyetograph number on H1 card.
13. Attempted to import more than the maximum number of subcatchments into a node.

Sanitary (Transport) Mode

1. Backwater type 25 will use manhole element
2. Conduit element has multiple upstream non-conduit elements: subsequent connections ignored
3. Conduit element has upstream conduit and non-conduit elements - non-conduits ignored
4. Element has undefined upstream element
5. Element in process flow data is not defined
6. Element in subarea is not defined
7. Element not found (I2 cards)
8. Element not imported
9. Error encountered reading E4 lines
10. Error encountered reading GR lines
11. Errors in input file - import abandoned

12. Flow divider type 24 not yet supported - will use flow divider type 21
13. Import Equation in error
14. Lift Stations not yet supported - will use manhole element
15. No Nodes to import into - import abandoned
16. Non-conduit element has an upstream non-conduit element - connection ignored
17. Number of pollutants must be 3 or 4 if Dry Weather Sewage Inflow is to be estimated
18. Pollutant with selector has been given new name
19. Undiverted flow destination conduit not defined
20. Storage Treatment Unit number not recognised

Utilities

1. Attempting to import a node. A link with this name already exists.
2. Attempting to import a link. A node with this name already exists.

IMPORT WARNNGS

Runoff Mode

1. G1 line with empty name string ignored.
2. Subcatchment name on H2 line does not match the preceding H1 line.

Sanitary (Transport) Mode

1. Dummy Node created
2. Hydraulic design disable flag ignored
3. Storage Treatment should have at least one pollutant
4. Cannot extract pollutants from interface file.

Utilities

1. No Nodes selected for Statistics
2. Invalid number of blocks specified on the SW card
3. Invalid number of scratch files specified on the MM card
4. Interface file on the SW line given a file name
5. Quote option not implemented
6. Graph module not implemented. Use Review Results