REENGINEERING SWMM/EPANET   
USER INTERFACE APPLICATION SOFTWARE ARCHITECTURES:   
APPLICATION FEATURES REQUIREMENTS DOCUMENT

**RSI-2577**

Revision 0

*prepared for*

U.S. Environmental Protection Agency

Office of Research and Development

26 West Martin Luther King Drive

Cincinnati, Ohio 45268

December 2015



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*by*

AQUA TERRA Consultants

2685 Marine Way, 1314

Mountain View, California 94043

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Cincinnati, Ohio 45268

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# 0 INTRODUCTION

From the Statement of Work, Task 1.2 – *The contractor shall provide a living document which details the specific requirements that must be embodied in each software deliverable. Software development shall follow an Iterative Rapid Development Cycle approach. Development and deployment of features shall occur using this iterative development cycle approach with each software deliverable representing a Minimum Testable Product (MTP). Multiple MTPs shall be developed and each evaluated by EPA in a serial, agile process. Based on the evaluations, plans for the next version of the MTP shall be determined by the project team in consultation with the EPA TOCOR. For both the SWMM and EPANET re-engineered user interfaces, the progression of MTPs shall culminate in the final deliverable product under the contract. The AFRD shall be written to include as many as 3 MTPs per year and specify the feature targets for each MTP. The AFRD shall also specify the requirements for the online help system supporting the final products of re-engineered user interfaces for SWMM and EPANET.*

The purpose of this project is to reengineer the User Interface (UI) architecture for the EPA’s collection system and water distribution system simulation products, the Storm Water Management Model (SWMM) and software that models water distribution-piping systems (EPANET). The project focuses on the design of a modular and extensible user interface application software architecture for SWMM and EPANET. The modular and extensible architecture will enable deployment of new application features created by the EPA, third-party developers, and end users employing scripts and application “plug-ins.”

Each software deliverable for this project is defined as a Minimum Testable Product (MTP). The first section of this document details the required application features for both the SWMM and EPANET UIs; the second section of this document places each of the features within one of the MTPs. Thus the section detailing the MTPs identifies particular application features to be included within each software deliverable. The assignment of features into MTPs is expected to be an iterative process, where the completion of one MTP leads to a reassessment of the contents of each subsequent MTP.

# 0 SWMM and EPANET User Interfaces: Required Features

Both the SWMM and EPANET user interfaces (UIs) will provide capabilities to perform the interactions detailed below:

* **Read Input File**

The UIs will provide the ability to read the SWMM .inp file and the EPANET .inp file.

* **Write Input File**

The UIs will provide the ability to write the SWMM .inp file and the EPANET .inp file.

* **New Project**

The UIs will provide the ability to create a new SWMM/EPANET project.

* **Scripting Support**

The UIs will provide the ability to run a Python script. This scripting feature will allow access to the internal data model for SWMM and EPANET.

* **Plug-in Manager**

Plug-in managers will provide a means for developers to write a tool to extend the functionality of the existing UIs. The UIs will provide an API such that a plug-in developed by a third party will add menus and/or toolbar buttons to the UI, and using these new UI features will provide additional functionality.

* **GIS Functionality**
* Geodatabase Import/Export: The UIs will allow the import of GIS data from a Geodatabase into the model data structure, and export from the model data structure into a Geodatabase. These features will require the GIS data be in a pre-determined data format.
* Map Rendering: The UIs will provide map displays with options for rendering features by color, line style, thickness, etc. for rendering model results on the map.
* Map Interaction: The UIs will provide map interaction functionality including the ability to pan, zoom in, zoom out, draw at full extent, and set reference coordinates and distance units.
* Print Map: The UIs will provide a means for the user to send the map display to a printer.
* Map Bounds Editing: The UIs will provide a means for editing the X and Y coordinates of the map’s bounding rectangle as well as distance units.
* Subcatchment Polygon Editing: The SWMM UI will provide a means for adding, removing and editing the X and Y coordinates for each vertex of the subcatchment polygons. (Applies to SWMM UI only as subcatchments are not applicable to EPANET).
* Node Coordinate Editing: The UIs will provide a means for editing the X and Y coordinates of the nodes.
* Link Vertex Editing: The UIs will provide a means for adding, removing and editing the X and Y coordinates of the interior vertices of the polyline links.
* Map Labeling: The UIs will provide a means for adding, removing and editing the *X* and *Y* coordinates and text of map labels.
* Map Backdrop Setting: The UIs will provide a means for adding, removing and editing the *X* and *Y* coordinates of the bounding rectangle and file name of the backdrop image for display in the map pane.
* With regard to map interactions, the UIs will provide the ability to undo/redo recent changes.
* Digitization Support: UI support for an end-user digitizing additional nodes, links, or subcatchments.
* Identification Support: UI support for an end-user interactively identifying map attributes at a given point, such as elevation values from a DEM layer.

In addition, the UIs will expose the full suite of QGIS libraries so that a plug-in or script developer can create additional tools for advanced GIS interaction.

* **General Settings Editing**

The UIs will provide a means for editing general settings for the model such as the title, options, report and file settings, etc. Complete details of these options are listed in Appendix A. With regard to editing tables, the UIs will provide the ability to undo/redo recent changes.

* **Specialized Property Editors**

The UIs will have a series of specialized property editors for advanced interaction with the internal data model. Complete details of these editors are provided in Appendix B. With regard to editing tables, the UIs will provide the ability to undo/redo recent changes.

* **Visual Object Adding, Removing, and Editing**

The UIs will provide means for adding, removing, and editing the visual objects of each model. Complete details of the required interactions with these visual objects are provided in Appendix C.

With regard to adding, removing, and editing visual objects, the UIs will provide the ability to undo/redo recent changes. The UIs will allow worksheet-style editing of data in grid format, with physical entities as rows and parameters/settings as columns.

* **Infographic Style Project Summary**

The UIs will provide an Infographic project summary.

* **Simulation Status**

The UIs will provide a simulation status message and progress bar while the SWMM/EPANET simulation is running.

* **Results Display**

The UIs will provide plots and list displays of simulation results.

* **Calibration Data Importing**

The UIs will contain a user interface for specifying calibration time series.

* **Internationalization Support**

The UIs will provide internationalization support.

* **Help System**

The UIs will provide context sensitive help through a Windows compiled HTML format help file.

# 0 Minimum Testable Products

As described in the introduction, each software deliverable for this project is defined as a Minimum Testable Product (MTP). This section proposes a series of MTPs, with a list of application features to be included in each MTP.

## MTP #1 — Reengineered SWMM and EPANET User Interface Shells

Within the first MTP, focus will be given to the three main features that these new UIs will provide, the modular software design, scripting, support, and plug-in support. To provide testable products, other features will be added such as reading and writing the input files. The following capabilities will be included in this MTP:

* Scripting Support
* Plug-in Manager
* Read Input File
* Write Input File
* New Project (blank/empty project)
* Simulation Status (run simulation)
* Install Package for Windows
* Editing SWMM project title and options
* Editing EPANET project title and options.

## MTP #2 — Functional Implementation of USER INTERFACE Controls

In this MTP, all specialized property editors and options/settings will be implemented based on the original UI source code and runtime behavior. The progressive focus will be given to the UI elements related to the following capabilities:

* All SWMM Specialized Property Editors
* SWMM Report Options and Files
* All EPANET Specialized Property Editors
* EPANET Report Options, Times, Reactions, and Energy Settings
* Results Display (graphing)
* Help System
* Suggested improvements from previous MTP.

## MTP #3 — Functional Implementation of Visual Objects

In this MTP, mapping and visual objects will be implemented, including tabular editing of the attributes of the visual objects. The progressive focus will be given to the UI elements related to the following capabilities:

* Required GIS Functionality (limited functionality including the following: loading visual objects/ attributes from a GIS layer, exporting visual objects/attributes to a GIS layer, constructing visual objects interactively/digitize, thematic mapping of results, and access to GIS objects through scripting/plugins)
* SWMM Visual Objects
* EPANET Visual Objects
* Internationalization Support
* Suggested improvements from previous MTP.

## MTP #4 — Beta Release

In this MTP, all remaining functionality will be implemented in preparation for a beta release, including:

* Install Package for Mac OS X
* Install Package for Linux
* Infographic Style Project Summary
* Calibration Data Importing
* Suggested improvements from previous MTP.

Table ‑. MTP Delivery Schedule

|  |  |
| --- | --- |
| **MTP** | **Delivery Schedule** |
| Reengineered SWMM and EPANET User Interface Shells | 4 months from AFRD approval |
| Functional Implementation of UI Controls | 8 months from AFRD approval |
| Functional Implementation of Visual Objects | 12 months from AFRD approval |
| Beta Release | TBD in Year 2 |

Appendix A

Details of SWMM and EPANET General Settings

# Appendix A. Details of SWMM and EPANET General Settings

* 1. SWMM General Settings
     1. Title

The User Input (UI) will provide a means for setting the project title.

* + 1. Options

The UI will provide a means for setting the project options/settings as shown in Table A-1.

Table A-. Options (Page 1 of 2)

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Flow Units | Indicates choice of flow units |
| Infiltration | Selects a model for computing infiltration of rainfall into the upper soil zone of subcatchments |
| Flow Routing | Determines which method is used to route flows through the drainage system |
| Link Offsets | Determines the convention used to specify the position of a link offset above the invert of its connecting node |
| Force Main Equation | Establishes whether the Hazen-Williams (H-W) or the Darcy-Weisbach (D-W) equation will be used to compute friction losses for pressurized flow in conduits that have been assigned a Circular Force Main cross-section shape |
| Ignore Rainfall | Indicates if all rainfall data and runoff calculations should be ignored |
| Ignore Snowmelt | Indicates if snowmelt calculations should be ignored when a project file contains snow pack objects |
| Ignore Groundwater | Indicates if groundwater calculations should be ignored when a project file contains aquifer objects |
| Ignore Routing | Indicates if only runoff should be computed even if the project contains drainage system links and nodes |
| Ignore Quality | Indicates if pollutant washoff, routing, and treatment should be ignored in a project that has pollutants defined |
| Allow Ponding | Determines whether excess water is allowed to collect atop nodes and be re-introduced into the system as conditions permit |
| Skip Steady State | Indicates if flow routing computations should be skipped during steady state periods of a simulation during which the last set of computed flows will be used |
| Start Date | Date when the simulation begins |
| State Time | Time of day on the starting date when the simulation begins |
| End Date | Date when the simulation is to end |
| End Time | Time of day on the ending date when the simulation will end |
| Report Start Date | Date when reporting of results is to begin |
| Report Start Time | Time of day on the report starting date when reporting is to begin |

Table A-1. Options (Page 2 of 2)

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Sweep Start | Day of the year (month/day) when street sweeping operations begin |
| Sweep End | Day of the year (month/day) when street sweeping operations end |
| Dry Days | Number of days with no rainfall prior to the start of the simulation |
| Report Step | Time interval for reporting of computed results |
| Wet Step | Time step length used to compute runoff from subcatchments during periods of rainfall or when ponded water still remains on the surface |
| Dry Step | Time step length used for runoff computations (consisting essentially of pollutant buildup) during periods when there is no rainfall and no ponded water |
| Routing Step | Time step length in seconds used for routing flows and water quality constituents through the conveyance system |
| Lengthening Step | Time step, in seconds, used to lengthen conduits under dynamic wave routing, so that they meet the Courant stability criterion under full-flow conditions |
| Variable Step | Safety factor applied to a variable time step computed for each time period under dynamic wave flow routing |
| Inertial Damping | Indicates how the inertial terms in the Saint Venant momentum equation will be handled under dynamic wave flow routing |
| Normal Flow Limited | Specifies which condition is checked to determine if flow in a conduit is supercritical and should thus be limited to the normal flow |
| Min Surface Area | Minimum surface area used at nodes when computing changes in water depth under dynamic wave routing |
| Min Slope | Minimum value allowed for a conduit’s slope |
| Temp Dir | Name of a file directory (or folder) where SWMM writes its temporary files |

* + 1. Report

The UI will provide a means for setting the following report options/settings:

Table A- Report Settings

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Input | Specifies whether or not a summary of the input data should be provided in the output report |
| Continuity | Specifies whether continuity checks should be reported or not |
| Flow Stats | Specifies whether summary flow statistics should be reported or not |
| Controls | Specifies whether all control actions taken during a simulation should be listed or not |
| Subcatchments | Gives a list of subcatchments whose results are to be reported |
| Nodes | Gives a list of nodes whose results are to be reported |
| Links | Gives a list of links whose results are to be reported |

* + 1. Files

The UI will provide a means for setting the interface files as listed in Table A-3:

Table A-. File Settings

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Use/Save Rainfall | Specifies name of rainfall file |
| Use/Save Runoff | Specifies name of runoff file |
| Use/Save Hotstart | Specifies name of hotstart file |
| Use/Save RDII | Specifies name of RDII file |
| Use Inflows | Specifies name of inflow file |
| Save Outflows | Specifies name of outflow file |

* 1. EPANET General Settings
     1. Title

The UI will provide a means for setting the project title.

* + 1. Options

The UI will provide a means for setting the following project options/settings:

Table A-. Options

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Units | Indicates choice of flow units |
| Head Loss | Selects a formula to use for computing head loss for flow through a pipe |
| Hydraulics | Indicates whether to save the current hydraulics solution to a file or use a previously saved hydraulics solution |
| Quality | Selects the type of water quality analysis to perform |
| Viscosity | Kinematic viscosity of the fluid being modeled relative to that of water at 20 deg. C |
| Diffusivity | Molecular diffusivity of the chemical being analyzed relative to that of chlorine in water |
| Specific Gravity | Ratio of the density of the fluid being modeled to that of water at 4 deg. C |
| Trials | Maximum number of trials used to solve network hydraulics at each hydraulic time step of a simulation |
| Accuracy | Prescribes the convergence criterion that determines when a hydraulic solution has been reached |
| Unbalanced | Determines what happens if a hydraulic solution cannot be reached within the prescribed number of TRIALS at some hydraulic time step into the simulation |
| Pattern | Provides the ID label of a default demand pattern to be applied to all junctions where no demand pattern was specified |
| Demand Multiplier | Used to adjust the values of baseline demands for all junctions and all demand categories |
| Emitter Exponent | Specifies the power to which the pressure at a junction is raised when computing the flow issuing from an emitter |
| Tolerance | Difference in water quality level below which one can say that one parcel of water is essentially the same as another |
| Map | Used to supply the name of a file containing coordinates of the network's nodes so that a map of the network can be drawn |

* + 1. Report

The UI will provide a means for setting report options:

Table A-. Report Settings

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Pagesize | Sets the number of lines written per page of the output report |
| File | Supplies the name of a file to which the output report will be written |
| Status | Determines whether a hydraulic status report should be generated |
| Summary | Determines whether a summary table of number of network components and key analysis options is generated |
| Energy | Determines if a table reporting average energy usage and cost for each pump is provided |
| Nodes | Identifies which nodes will be reported on |
| Links | Identifies which links will be reported on |
| Parameters | Used to identify which quantities are reported on, how many decimal places are displayed, and what kind of filtering should be used to limit output reporting |

* + 1. Times

The UI will provide a means for setting times options:

Table A-. Times Settings

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Duration | Duration of the simulation |
| Hydraulic Timestep | Determines how often a new hydraulic state of the network is computed |
| Quality Timestep | Time step used to track changes in water quality throughout the network |
| Rule Timestep | Time step used to check for changes in system status due to activation of rule-based controls between hydraulic time steps |
| Pattern Timestep | Interval between time periods in all time patterns |
| Pattern Start | Time offset at which all patterns will start |
| Report Timestep | Sets the time interval between which output results are reported |
| Report Start | Length of time into the simulation at which output results begin to be reported |
| Start Clocktime | Time of day at which the simulation begins |
| Statistic | Determines what kind of statistical post-processing should be done on the time series of simulation results generated |

* + 1. Reactions

The UI will provide a means for setting parameters related to chemical reactions:

Table A-. Reactions Settings

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Order | Used to set the order of reactions occurring in the bulk fluid, at the pipe wall, or in tanks, respectively |
| Global | Used to set a global value for all bulk reaction coefficients (pipes and tanks) or for all pipe wall coefficients |
| Bulk, Wall, and Tank | Used to override the global reaction coefficients for specific pipes and tanks |
| Limiting Potential | Specifies that reaction rates are proportional to the difference between the current concentration and some limiting potential value |
| Roughness Correlation | Make all default pipe wall reaction coefficients be related to pipe roughness in a specified manner |

* + 1. Energy

The UI will provide a means for setting parameters used to compute pumping energy and cost:

Table A-. Energy Settings

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Global | Used to set global default values of energy price, price pattern, and pumping efficiency for all pumps |
| Pump | Used to override global defaults for specific pumps |
| Demand Charge | Used to specify added cost per maximum kW usage during the simulation period |

Appendix B

Details of SWMM and EPANET SPECIALIZED PROPERTY EDITORS

# Appendix B. Details of SWMM and EPANET SPECIALIZED PROPERTY EDITORS

B.1 SWMM Specialized Property Editors

B.1.1 Aquifers Editor

The UI will provide a means for adding and removing unconfined aquifers in the simulation study area, as well as to supply parameters for each unconfined groundwater aquifer in the study area. Editable parameters include the following:

Table B-. Aquifers Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Name | Name of aquifer |
| Porosity | Soil porosity |
| Wilting Point | Soil wilting point |
| Field Capacity | Soil field capacity |
| Conductivity | Saturated hydraulic conductivity |
| Conduct. Slope | Slope of the logarithm of hydraulic conductivity versus moisture deficit curve |
| Tension Slope | Slope of soil tension versus moisture content curve |
| Upper Evap Fraction | Fraction of total evaporation available for evapotranspiration in the upper unsaturated zone |
| Lower Evap Depth | Maximum depth into the lower saturated zone over which evapotranspiration can occur |
| Lower GW Loss Rate | Rate of percolation from saturated zone to deep groundwater when water table is at ground surface |
| Bottom Elevation | Elevation of the bottom of the aquifer |
| Water Table Elevation | Water table elevation at start of simulation |
| Unsat Zone Moisture | Unsaturated zone moisture content at start of simulation |

B.1.2 Climatology Editor

B.1.2.1 Evaporation

The UI will provide a means for setting evaporation as a constant, monthly values, timseries, computed from temperature, or read from a file. In addition, the UI will provide an interface for specifying optional monthly recovery rates, and for determining if evaporation occurs only during periods of no precipitation.

Table B-. Evaporation Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Constant | Use constant evaporation rate |
| Monthly | Use monthly values for evaporation rates |
| Timeseries | Use timeseries from timeseries section |
| Temperature | Compute from daily air temperature |
| File | Use same file as in temperature section |
| Recovery | Specifies monthly time pattern |
| Dry only | Determines if evaporation only occurs during periods with no precipitation |

B.1.2.2 Temperature, Wind Speed, Snow Melt

The UI will provide a means for setting daily air temperatures, monthly wind speed, and various snowmelt parameters for the study area.

Table B-. Temperature, Wind Speed, Snow Melt Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Timeseries | Name of timeseries in timeseries section |
| File | Name of external climate file |
| Windspeed | Average monthly windspeed or external climate file |
| Snowmelt |  |
| Stemp | Air temperature at which precipitation falls as snow |
| ATIwt | Antecedent temperature index weight |
| RNM | Negative melt ratio |
| Elev | Average elevation of study area above mean sea level |
| Lat | Latitude of the study area in degrees North |
| DTLong | Correction, in minutes of time, between true solar time and the standard clock time |
| ADC Impervious | Areal Depletion Curve for impervious land uses |
| ADC Pervious | Areal Depletion Curve for pervious land uses |

B.1.3 Control Rules Editor

The UI will provide a means for adding, deleting, and editing control rules.

B.1.4 Cross-Section Editor

The UI will provide a Cross-Section Editor for specifying the shape and dimensions of each conduit cross-section.

B.1.5 Curves Editor

The UI will provide a means for adding, deleting, and editing curve objects. The editor will adapt itself to the category of curve being edited (Storage, Tidal, Diversion, Pump, or Rating).

B.1.6 Groundwater Flow Editor

The UI will provide a Groundwater Flow Editor for editing the groundwater property of each subcatchment. The parameters include the following:

Table B-. Groundwater Flow Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Aquifer Name | Name of aquifer object that supplies groundwater |
| Receiving Node | Name of node that receives groundwater from the aquifer |
| Surface Elevation | Elevation of ground surface for the subcatchment that lies above the aquifer |
| Groundwater Flow Coefficient | Value of A1 in the groundwater flow formula |
| Groundwater Flow Exponent | Value of B1 in the groundwater flow formula |
| Surface Water Flow Coefficient | Value of A2 in the groundwater flow formula |
| Surface Water Flow Exponent | Value of B2 in the groundwater flow formula |
| Surface-GW Interaction Coefficient | Value of A3 in the groundwater flow formula |
| Fixed Surface Water Depth | Fixed depth of surface water at the receiving node |
| Threshold Groundwater Elevation | Groundwater elevation that must be reached before any flow occurs |

B.1.7 Infiltration Editor

The UI will provide an Infiltration Editor for specifying values for the parameters that describe the rate at which rainfall infiltrates into the upper soil zone in a subcatchment's pervious area. The infiltration parameters depend on which infiltration model was selected for the project: Horton, Green-Ampt, or Curve Number.

Table B-. Infiltration Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Horton Max Infilt Rate | Maximum infiltration rate on the Horton curve |
| Horton Min Infilt Rate | Minimum infiltration rate on the Horton curve |
| Horton Decay Const | Infiltration rate decay constant for the Horton curve |
| Horton Drying Time | Time in days for a fully saturated soil to dry completely |
| Horton Max Infilt Volume | Maximum infiltration volume possible |
| Green-Ampt Suction Head | Average value of soil capillary suction along the wetting front |
| Green-Ampt Conductivity | Soil saturated hydraulic conductivity |
| Green-Ampt  Initial Deficit | Fraction of soil volume that is initially dry |
| Curve Number | SCS curve number |
| Curve Number Conductivity | Deprecated and is no longer used |
| Curve Number Drying Time | Number of days it takes a fully saturated soil to dry. |

B.1.8 Inflows Editor

The UI will provide an Inflows Editor for assigning Direct, Dry Weather, and RDII inflow into a node of the drainage system. For direct inflows, editable parameters include the following:

Table B-. Direct Inflows, Editable Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Constituent | Name of constituent |
| Baseline | Value of the constant baseline component of the constituent's inflow |
| Baseline Pattern | Optional Time Pattern whose factors adjust the baseline inflow on either an hourly, daily, or monthly basis |
| Time Series | Name of the time series that contains inflow data for the selected constituent |
| Scale Factor | Multiplier used to adjust the values of the constituent's inflow time series |
| Inflow Type | Selects the type of inflow data contained in the time series as being either a concentration (mass/volume) or mass flow rate (mass/time) |
| Conversion Factor | Numerical factor used to convert the units of pollutant mass flow rate in the time series data into concentration mass units per second |

For dry weather inflows, editable parameters include the following:

Table B-. Dry Weather Inflows, Editable Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Constituent | Name of constituent |
| Average Value | Average (or baseline) value of the dry weather inflow of the constituent in the relevant units |
| Time Patterns | Names of the time patterns to be used to allow the dry weather flow to vary in a periodic fashion by month of the year, by day of the week, and by time of day |

For rainfall-dependent infiltration/inflow (RDII), editable parameters include the following:

Table B-. Rainfall-Dependent Infiltration/Inflow Editable Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Unit Hydrograph Group | Name of the Unit Hydrograph group that applies to the node in question |
| Sewershed Area | Area (in acres or hectares) of the sewershed that contributes RDII to the node in question |

B.1.9 Initial Buildup Editor

The UI will provide an Initial Buildup Editor for specifying for each pollutant the amount of pollutant buildup existing over the subcatchment at the start of the simulation.

B.1.10 Land Uses Editor

The UI will provide a Land Uses Editor dialog for defining each category of land use for the study area and to define each land use’s pollutant buildup and washoff characteristics. General editable parameters are listed in Table B-9.

Table B-. General Editable Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Land Use Name | Name assigned to the land use |
| Description | Optional comment or description of the land use |
| Street Sweeping Interval | Days between street sweeping within the land use |
| Street Sweeping Availability | Fraction of the buildup of all pollutants that is available for removal by sweeping |
| Last Swept | Number of days since last swept at the start of the simulation |

Editable Buildup parameters are listed in Table B-10.

Table B-. Editable Buildup Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Pollutant | Pollutant whose buildup properties are being edited |
| Function | Type of buildup function to use for the pollutant |
| Max Buildup | Maximum buildup that can occur |
| Rate Constant | Time constant that governs the rate of pollutant buildup |
| Power/Sat. Constant | Exponent C3 used in the Power buildup formula, or the half-saturation constant C2 used in the Saturation buildup formula |
| Scaling Factor | Multiplier used to adjust the buildup rates listed in the time series |
| Time Series | Name of the Time Series that contains buildup rates |
| Normalizer | Variable to which buildup is normalized on a per unit basis |

Editable Washoff parameters are listed in Table B-11.

Table B-. Editable Washoff Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Pollutant | Pollutant whose washoff properties are being edited |
| Function | Choice of washoff function to use for the pollutant |
| Coefficient | Value of C1 in the exponential and rating curve formulas |
| Exponent | Exponent used in the exponential and rating curve washoff formulas |
| Cleaning Efficiency | Street cleaning removal efficiency (percent) for the pollutant |
| BMP Efficiency | Removal efficiency (percent) associated with any Best Management Practice that might have been implemented |

B.1.11 Land Use Assignment Editor

The UI will provide a Land Use Assignment Editor for assigning land uses to the subcatchment for water quality simulations. The percent of land area in the subcatchment covered by each land use is entered.

B.1.12 LID Controls Editor

The UI will provide an LID Controls Editor for defining each low impact development control that can be deployed throughout a study area to store, infiltrate, and evaporate subcatchment runoff. The editor contains the following data entry fields:

Table B-. LID Controls Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Control Name | Name used to identify the particular LID control |
| LID Type | Generic type of LID being defined |
| Process Layers | Surface Layer, Pavement Layer, Soil Layer, Storage Layer, and Underdrain System |
| Surface Layer Storage Depth | Maximum depth to which water can pond above the surface of the unit before overflow occurs |
| Surface Layer Vegetative Cover Fraction | Fraction of the storage area above the surface that is filled with vegetation |
| Surface Layer Surface Roughness | Manning's n for overland flow over the surface of porous pavement or a vegetative swale |
| Surface Layer Surface Slope | Slope of porous pavement surface or vegetative swale |
| Surface Layer Swale Side Slope | Slope (run over rise) of the side walls of a vegetative swale's cross section |
| Pavement Layer Thickness | Thickness of the pavement layer |
| Pavement Layer Void Ratio | Volume of void space relative to the volume of solids in the pavement |
| Pavement Layer Impervious Surface Fraction | Ratio of impervious paver material to total area for modular systems |
| Pavement Layer Permeability | Permeability of the concrete or asphalt used in continuous systems or hydraulic conductivity of the fill material (gravel or sand) used in modular systems |
| Pavement Layer Clogging Factor | Number of pavement layer void volumes of runoff treated it takes to completely clog the pavement |
| Soil Layer Thickness | Thickness of the soil layer |
| Soil Layer Porosity | Volume of pore space relative to total volume of soil |
| Soil Layer Field Capacity | Volume of pore water relative to total volume after the soil has been allowed to drain fully |
| Soil Layer Wilting Point | Volume of pore water relative to total volume for a well dried soil where only bound water remains |
| Soil Layer Conductivity | Hydraulic conductivity for the fully saturated soil |
| Soil Layer Conductivity Slope | Slope of the curve of log(conductivity) versus soil moisture content |
| Soil Layer Suction Head | Average value of soil capillary suction along the wetting front |
| Storage Layer Height | Height of a rain barrel or thickness of a gravel layer |
| Storage Layer Void Ratio | Volume of void space relative to the volume of solids in the layer |
| Storage Layer Filtration Rate | Maximum rate at which water can flow out the bottom of the layer after it is first constructed |
| Storage Layer Clogging Factor | Total volume of treated runoff it takes to completely clog the bottom of the layer divided by the void volume of the layer |
| Storage Layer Drain Coefficient and Drain Exponent | Coefficient C and exponent n that determines the rate of flow through the underdrain as a function of height of stored water above the drain height |
| Storage Layer Drain Offset Height | Height of any underdrain piping above the bottom of a storage layer or rain barrel |
| Storage Layer Drain Delay | Number of dry weather hours that must elapse before the drain line in a rain barrel is opened |

B.1.13 LID Group Editor

The UI will provide an LID Group Editor for identifying a group of previously defined LID controls that will be placed within the subcatchment, the sizing of each control, and what percent of runoff from the non-LID portion of the subcatchment each should treat.

B.1.14 LID Usage Editor

The UI will provide an LID Usage Editor to specify how a particular LID control will be deployed within the subcatchment. The parameters include the following:

Table B-. LID Usage Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Control Name | Name of a previously defined LID control to be used in the subcatchment |
| Number of Replicate Units | Number of equal size units of the LID practice deployed within the subcatchment |
| Area of Each Unit | Surface area devoted to each replicate LID unit |
| Top Width of Overland Flow Surface | Width of the outflow face of each identical LID unit |
| Percent Initially Saturated | Degree to which storage zone is initially filled with water |
| Percent of Impervious Area Treated | Percent of the impervious portion of the subcatchment's non-LID area whose runoff is treated by the LID practice |
| Send Outflow to Pervious Area | If the outflow from the LID is returned onto the subcatchment's pervious area rather than going to the subcatchment's outlet |
| Detailed Report File | Name of an optional file where detailed time series results for the LID will be written |

B.1.15 Pollutants Editor

The UI will provide a Pollutants Editor for defining each pollutant used in the simulation, including the pollutant name, units, concentrations, and decay terms. The parameters include the following:

Table B-. Pollutants Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Name | Name assigned to the pollutant |
| Units | Concentration units in which the pollutant concentration is expressed |
| Rain Concentration | Concentration of the pollutant in rain water |
| GW Concentration | Concentration of the pollutant in ground water |
| I&I Concentration | Concentration of the pollutant in any Infiltration/Inflow |
| DWF Concentration | Concentration of the pollutant in any dry weather sanitary flow |
| Decay Coefficient | First-order decay coefficient of the pollutant |
| Snow Only | YES if pollutant buildup occurs only when there is snow cover, NO otherwise |
| Co-Pollutant | Name of another pollutant whose runoff concentration contributes to the runoff concentration of the current pollutant |
| Co-Fraction | Fraction of the co-pollutant's runoff concentration that contributes to the runoff concentration of the current pollutant |

B.1.16 Snow Packs Editor

The UI will provide a Snow Packs Editor for creating and/or editing snow pack parameters.

The parameters include the following:

Table B-. Snow Packs Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Minimum Melt Coefficient | Degree-day snow melt coefficient that occurs on December 21 |
| Maximum Melt Coefficient | Degree-day snow melt coefficient that occurs on June 21 |
| Base Temperature | Temperature at which snow begins to melt |
| Fraction Free Water Capacity | Volume of a snow pack's pore space which must fill with melted snow before liquid runoff from the pack begins, expressed as a fraction of snow pack depth |
| Initial Snow Depth | Depth of snow at the start of the simulation |
| Initial Free Water | Depth of melted water held within the pack at the start of the simulation |
| Depth at 100% Cover | Depth of snow beyond which the entire area remains completely covered and is not subject to any areal depletion effect |
| Fraction of Impervious Area That is Plowable | Fraction of impervious area that is plowable and therefore is not subject to areal depletion |
| Depth at which snow removal begins | Depth which must be reached before any snow removal begins |
| Fraction transferred out of the watershed | Fraction of snow depth that is removed from the system |
| Fraction transferred to the impervious area | Fraction of snow depth that is added to snow accumulation on the pack's impervious area |
| Fraction transferred to the pervious area | Fraction of snow depth that is added to snow accumulation on the pack's pervious area |
| Fraction converted to immediate melt | Fraction of snow depth that becomes liquid water which runs onto any subcatchment associated with the snow pack |
| Fraction moved to another subcatchment | Fraction of snow depth which is added to the snow accumulation on some other subcatchment |

B.1.17 Time Patterns Editor

The UI will provide a Time Patterns Editor for creating and/or editing time pattern objects.

The following fields are available for editing:

Table B-. Time Patterns Settings

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Name | Name assigned to the time pattern |
| Type | Type of time pattern being specified |
| Description | Optional comment or description for the time pattern |
| Multipliers | Value for each multiplier |

B.1.18 Time-Series Editor

The UI will provide a Time-Series Editor for creating and/or editing time series objects. Time series may be entered as external files or entered directly through a data entry grid.

B.1.19 Transects Editor

The UI will provide a Transects Editor for creating and/or editing transects. It will contain the following data entry fields:

Table B-. Transects Fields

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Name | Name assigned to the transect |
| Description | Optional comment or description of the transect |
| Station/Elevation Data Grid | Values of distance from the left side of the channel along with the corresponding elevation of the channel bottom as one moves across the channel from left to right, looking in the downstream direction |
| Roughness | Values of Manning's roughness for the left overbank, right overbank, and main channel portion of the transect |
| Bank Stations | Distance values appearing in the Station/Elevation grid that mark the end of the left overbank and the start of the right overbank |
| Stations Modifier | Factor by which the distance between each station will be multiplied when the transect data is processed |
| Elevations Modifier | Constant value that will be added to each elevation value |
| Meander Modifier | Ratio of the length of a meandering main channel to the length of the overbank area that surrounds it. |

B.1.20 Treatment Editor

The UI will provide a Treatment Editor for specifying the treatment property of a node using a treatment expression.

B.1.21 Unit Hydrographs Editor

The UI will provide a Unit Hydrographs Editor for creating and/or editing a unit hydrograph. It will contain the following data entry fields:

Table B-. Unit Hydrographs Fields

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Name of UH Group | Name assigned to the UH Group |
| Rain Gage Used | Name of the rain gage that supplies rainfall data to the unit hydrographs in the group |
| Hydrograph Months | Month for which hydrograph parameters will be defined |
| Unit Hydrographs | R-T-K shape parameters for each set of unit hydrographs in selected months of the year |
| Initial Abstraction Depth | Maximum depth of initial abstraction available |
| Initial Abstraction Rate | Rate at which any utilized initial abstraction is made available again |
| Initial Abstraction Amount | Amount of initial abstraction that has already been utilized at the start of the simulation |

B.2 EPANET Specialized Property Editors

B.2.1 Time Patterns

The UI will provide a means for adding, removing and editing time patterns. Editable parameters include the following:

Table B-. Time Patterns Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Pattern ID | ID label of the pattern |
| Description | Optional description of what the pattern represents |
| Multipliers | Multiplier value for each time period of the pattern |

The editor will also provide the ability to add additional time periods and multipliers to the pattern, as well as a graphical display of the pattern. Patterns can be saved to a file and loaded from a file.

B.2.2. Curves

The UI will provide a means for adding, removing and editing curves, as well as to supply parameters for each curve. Editable parameters include the following:

Table B-. Curves Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Curve ID | ID label of the curve |
| Description | Optional description of what the curve represents |
| Type | Type of curve |
| X-Y Data | X-Y data points for the curve |

The equation and plot of the curve are also displayed in the curve editor.

B.2.3 Controls

The UI will provide a means for adding, deleting, and editing control rules.

B.2.4 Demands

The UI will provide a means to assign base demands and time patterns when there is more than one category of water user at a junction.

B.2.5 Sources Quality

The UI will provide a means for editing the quality of the source flow entering the network at each specific node. Editable parameters include the following:

Table B-. Sources Parameters

|  |  |
| --- | --- |
| **Option/Setting Name** | **Description** |
| Source Type | Select either:   * Concentration * Mass Booster * Flow Paced Booster * Setpoint Booster |
| Source Quality | Baseline or average concentration (or mass flow rate per minute) of source |
| Quality Pattern | ID label of time pattern used to make source quality vary with time |

Appendix C

Details of SWMM and EPANET VISUAL OBJECTS

# Appendix C. Details of SWMM and EPANET VISUAL OBJECTS

C.1 SWMM Visual Objects

C.1.1 Rain Gages

Edit Rain Gage Properties -- The UI will provide the capability to edit the following rain gage properties:

Table C-. Rain Gage Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned rain gage name | [**RAINGAGES**] |
| X-Coordinate | Horizontal location of the rain gage on the Study Area Map | [**SYMBOLS**] |
| Y-Coordinate | Vertical location of the rain gage on the Study Area Map | [**SYMBOLS**] |
| Description | Optional description of the rain gage | [**RAINGAGES**] |
| Tag | Optional label used to categorize or classify the rain gage | [**TAGS**] |
| Rain Format | Format in which the rain data are supplied: INTENSITY: each rainfall value is an average rate in inches/hour (or mm/hour) over the recording interval, VOLUME: each rainfall value is the volume of rain that fell in the recording interval (in inches or millimeters), CUMULATIVE: each rainfall value represents the cumulative rainfall that has occurred since the start of the last series of non-zero values (in inches or millimeters) | [**RAINGAGES**] |
| Rain Interval | Recording time interval between gage readings in either decimal hours or hours:minutes format | [**RAINGAGES**] |
| Snow Catch Factor | Factor that corrects gage readings for snowfall | [**RAINGAGES**] |
| Data Source | Source of rainfall data; either TIMESERIES for user-supplied time series data or FILE for an external data file | [**RAINGAGES**] |
| TIME SERIES |  |  |
| - Series Name | Name of time series with rainfall data if Data Source selection was TIMESERIES | [**RAINGAGES**] |
| DATA FILE |  |  |
| - File Name | Name of external file containing rainfall data | [**RAINGAGES**] |
| - Station No. | Recording gage station number | [**RAINGAGES**] |
| - Rain Units | Depth units (IN or MM) for rainfall values in the file | [**RAINGAGES**] |

Add Rain Gage – The UI will provide the capability to add rain gages by clicking on the ‘Add’ button and then placing the rain gage on the map.

Remove Rain Gage – The UI will provide the capability to remove a rain gage by selecting one and then clicking a ‘Remove’ button.

C.1.2 Subcatchments

Edit Subcatchment Properties -- The UI will provide the capability to edit the following subcatchment properties:

Table C-. Subcatchment Properties (Page 1 of 2)

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned subcatchment name | [**SUBCATCHMENTS**] |
| X-Coordinate | Horizontal location of the subcatchment's centroid on the Study Area Map | [**POLYGONS**] |
| Y-Coordinate | Vertical location of the subcatchment's centroid on the Study Area Map | [**POLYGONS**] |
| Description | Optional description of the subcatchment | [**SUBCATCHMENTS**] |
| Tag | Optional label used to categorize or classify the subcatchment | [**TAGS**] |
| Rain Gage | Name of the rain gage associated with the subcatchment | [**SUBCATCHMENTS**] |
| Outlet | Name of the node or subcatchment which receives the subcatchment's runoff | [**SUBCATCHMENTS**] |
| Area | Area of the subcatchment (acres or hectares) | [**SUBCATCHMENTS**] |
| Width | Characteristic width of the overland flow path for sheet flow runoff (feet or meters) | [**SUBCATCHMENTS**] |
| % Slope | Average percent slope of the subcatchment | [**SUBCATCHMENTS**] |
| % Imperv | Percent of land area which is impervious | [**SUBCATCHMENTS**] |
| N-Imperv | Manning's n for overland flow over the impervious portion of the subcatchment | [**SUBAREAS**] |
| N-Perv | Manning's n for overland flow over the pervious portion of the subcatchment | [**SUBAREAS**] |
| Dstore-Imperv | Depth of depression storage on the impervious portion of the subcatchment (inches or millimeters) | [**SUBAREAS**] |
| Dstore-Perv | Depth of depression storage on the pervious portion of the subcatchment (inches or millimeters) | [**SUBAREAS**] |
| % Zero-Imperv | Percent of the impervious area with no depression storage. | [**SUBAREAS**] |
| Subarea Routing | Choice of internal routing of runoff between pervious and impervious areas: IMPERV: runoff from pervious area flows to impervious area, PERV: runoff from impervious area flows to pervious area, OUTLET: runoff from both areas flows directly to outlet. | [**SUBAREAS**] |
| Percent Routed | Percent of runoff routed between subareas | [**SUBAREAS**] |
| Infiltration | Infiltration parameters for the subcatchment | [**INFILTRATION**] |
| LID Controls | Use of low impact development controls in the subcatchment | **[LID\_CONTROLS]** |
| Groundwater | Groundwater flow parameters for the subcatchment | [**GROUNDWATER**] |

Table C-2. Subcatchment Properties (Page 2 of 2)

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Snow Pack | Name of snow pack parameter set (if any) assigned to the subcatchment | [**SNOWPACKS**] |
| Land Uses | Assign land uses to the subcatchment | [**LANDUSES**] |
| Initial Buildup | initial quantities of pollutant buildup over the subcatchment | [**LOADINGS**] |
| Curb Length | Total length of curbs in the subcatchment (any length units). Used only when pollutant buildup is normalized to curb length | [**SUBCATCHMENTS**] |

Add Subcatchment – The UI will provide the capability to add subcatchments by clicking on the ‘Add’ button and then drawing the subcatchment on the map.

Remove Subcatchment – The UI will provide the capability to remove a subcatchment by selecting one and then clicking a ‘Remove’ button.

C.1.3 Junction Nodes

Edit Junction Node Properties -- The UI will provide the capability to edit the following junction node properties:

Table C-. Junction Node Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned name of junction | [**JUNCTIONS**] |
| X-Coordinate | X coordinate of junction on study area map | **[COORDINATES]** |
| Y-Coordinate | Y coordinate of junction on study area map | **[COORDINATES]** |
| Description | Optional comment or description | [**JUNCTIONS**] |
| Tag | Optional category or classification | [**TAGS**] |
| Inflows | External inflows received at the junction | [**INFLOWS**] |
| Treatment | Pollutant removal at the junction | [**TREATMENT**] |
| Invert Elev | Elevation of junction invert | [**JUNCTIONS**] |
| Max Depth | Depth from ground to invert elevation | [**JUNCTIONS**] |
| Initial Depth | Water depth at start of simulation | [**JUNCTIONS**] |
| Surcharge Depth | Maximum additional head above ground elevation that manhole junction can sustain under surcharge conditions | [**JUNCTIONS**] |
| Ponded Area | Area subjected to surface ponding once water depth exceeds Ymax | [**JUNCTIONS**] |

Add Junction Node – The UI will provide the capability to add junction nodes by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Junction Node – The UI will provide the capability to remove a junction node by clicking on the schematic diagram or junction node table and then clicking a ‘Remove’ button.

C.1.4 Outfall Nodes

Edit Outfall Node Properties: The UI will provide the capability to edit the following outfall node properties:

Table C-. Outfall Node Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned name of outfall | [**OUTFALLS**] |
| X-Coordinate | X coordinate of outfall on study area map | **[COORDINATES]** |
| Y-Coordinate | Y coordinate of outfall on study area map | **[COORDINATES]** |
| Description | Optional comment or description | [**OUTFALLS**] |
| Tag | Optional category or classification | [**TAGS**] |
| Inflows | External inflows received at the outfall | [**INFLOWS**] |
| Treatment | Pollutant removal at the outfall | [**TREATMENT**] |
| Invert Elev | Elevation of outfall invert | [**OUTFALLS**] |
| Tide Gate | Outfall contains a tide gate to prevent backflow | [**OUTFALLS**] |
| Route To | Subcatchment outflow is routed onto | [**OUTFALLS**] |
| Type | Type of outfall boundary condition | [**OUTFALLS**] |
| Fixed Stage | Water elevation for a fixed boundary condition | [**OUTFALLS**] |
| Curve Name | Name of tidal curve for a tidal boundary condition | [**OUTFALLS**] |
| Series Name | Name of timeseries for a timeseries boundary condition | [**OUTFALLS**] |

Add Outfall Node – The UI will provide the capability to add outfall nodes by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Outfall Node – The UI will provide the capability to remove an outfall node by clicking on the schematic diagram or outfall node table and then clicking a ‘Remove’ button.

C.1.5 Flow Divider Nodes

Edit Divider Node Properties -- The UI will provide the capability to edit the following divider node properties:

Table C-. Flow Divider Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned name of divider | [**DIVIDERS**] |
| X-Coordinate | X coordinate of divider on study area map | **[COORDINATES]** |
| Y-Coordinate | Y coordinate of divider on study area map | **[COORDINATES]** |
| Description | Optional comment or description | [**DIVIDERS**] |
| Tag | Optional category or classification | [**TAGS**] |
| Inflows | External inflows received at the divider | [**INFLOWS**] |
| Treatment | Pollutant removal at the divider | [**TREATMENT**] |
| Invert Elev | Elevation of divider invert | [**DIVIDERS**] |
| Max Depth | Maximum water depth | [**DIVIDERS**] |
| Initial Depth | Water depth at start of simulation | [**DIVIDERS**] |
| Surcharge Depth | Depth in excess of maximum depth before flooding occurs | [**DIVIDERS**] |
| Ponded Area | Area of ponded water when flooded | [**DIVIDERS**] |
| Diverted Link | Name of link which receives diverted flow | [**DIVIDERS**] |
| Type | Type of flow divider | [**DIVIDERS**] |
| Cutoff Flow | Cutoff flow value used for a cutoff divider | [**DIVIDERS**] |
| Curve Name | Name of diversion curve used with a tabular divider | [**DIVIDERS**] |
| Min Flow | Minimum flow at which diversion begins for a weir divider | [**DIVIDERS**] |
| Max Depth | Depth at maximum flow for a weir divider | [**DIVIDERS**] |
| Coefficient | Discharge coefficient for a weir divider | [**DIVIDERS**] |

Add Divider Node – The UI will provide the capability to add divider nodes by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Divider Node – The UI will provide the capability to remove a divider node by clicking on the schematic diagram or divider node table and then clicking a ‘Remove’ button.

C.1.6 Storage Units

Edit Storage Unit Properties -- The UI will provide the capability to edit the following storage unit properties:

Table C-. Storage Unit Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned name of storage unit | [**STORAGE**] |
| X-Coordinate | X coordinate of storage unit on study area map | **[COORDINATES]** |
| Y-Coordinate | Y coordinate of storage unit on study area map | **[COORDINATES]** |
| Description | Optional comment or description | [**STORAGE**] |
| Tag | Optional category or classification | [**TAGS**] |
| Inflows | External inflows received at the storage unit | [**INFLOWS**] |
| Treatment | Pollutant removal at the storage unit | [**TREATMENT**] |
| Invert Elev | Elevation at the bottom of the storage unit | [**STORAGE**] |
| Max Depth | Maximum depth of the storage unit | [**STORAGE**] |
| Initial Depth | Initial depth of water in the storage unit | [**STORAGE**] |
| Ponded Area | Area of ponded water when flooded | [**STORAGE**] |
| Evap Factor | Fraction of evaporation rate realized | [**STORAGE**] |
| Seepage Loss | Soil properties that determine seepage loss | [**STORAGE**] |
| Storage Curve | Method of describing the geometric shape of the storage unit | [**STORAGE**] |
| Coefficient | Coefficient in functional area curve | [**STORAGE**] |
| Exponent | Exponent in functional area curve | [**STORAGE**] |
| Constant | Constant in functional area curve | [**STORAGE**] |
| Curve Name | Name of storage curve to use | [**STORAGE**] |

Add Storage Unit – The UI will provide the capability to add storage units by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Storage Unit – The UI will provide the capability to remove a storage unit by clicking on the schematic diagram or storage unit table and then clicking a ‘Remove’ button.

C.1.7 Conduits

Edit Conduit Properties -- The UI will provide the capability to edit the following conduit properties:

Table C-. Conduit Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned conduit name | [**CONDUITS**] |
| Inlet Node | Name of node on the inlet end of the conduit (which is normally the end at higher elevation) | [**CONDUITS**] |
| Outlet Node | Name of node on the outlet end of the conduit (which is normally the end at lower elevation) | [**CONDUITS**] |
| Description | Optional description of the conduit | [**CONDUITS**] |
| Tag | Optional label used to categorize or classify the conduit | [**TAGS**] |
| Shape | Geometric properties of the conduit's cross section | [**XSECTIONS**] |
| Max. Depth | Maximum depth of the conduit's cross section (feet or meters) | [**XSECTIONS**] |
| Length | Conduit length (feet or meters) | [**CONDUITS**] |
| Roughness | Manning's roughness coefficient | [**CONDUITS**] |
| Inlet Offset | Depth or elevation of the conduit invert above the node invert at the upstream end of the conduit (feet or meters) | [**CONDUITS**] |
| Outlet Offset | Depth or elevation of the conduit invert above the node invert at the downstream end of the conduit (feet or meters) | [**CONDUITS**] |
| Initial Flow | Initial flow in the conduit (flow units) | [**CONDUITS**] |
| Maximum Flow | Maximum flow allowed in the conduit (flow units) – use 0 or leave blank if not applicable | [**CONDUITS**] |
| Entry Loss Coeff. | Head loss coefficient associated with energy losses at the entrance of the conduit | [**LOSSES**] |
| Exit Loss Coeff. | Head loss coefficient associated with energy losses at the exit of the conduit. For culverts, use a value of 1.0 Avg. | [**LOSSES**] |
| Loss Coeff. | Head loss coefficient associated with energy losses along the length of the conduit | [**LOSSES**] |
| Flap Gate | YES if a flap gate exists that prevents backflow through the conduit, or NO if no flap gate exists | [**LOSSES**] |
| Culvert Code | Code number of inlet geometry if conduit is a culvert – leave blank otherwise | [**XSECTIONS**] |

Add Conduit – The UI will provide the capability to add conduits by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Conduit – The UI will provide the capability to remove a conduit by clicking on the schematic diagram or conduit table and then clicking a ‘Remove’ button.

C.1.8 Pumps

Edit Pump Properties -- The UI will provide the capability to edit the following pump link properties:

Table C-. Pump Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned name of pump | [**PUMPS**] |
| Inlet Node | Name of node on the inlet end of pump | [**PUMPS**] |
| Outlet Node | Name of node on the outlet end of pump | [**PUMPS**] |
| Description | Optional comment or description | [**PUMPS**] |
| Tag | Optional category or classification | [**TAGS**] |
| Pump Curve | Name of pump curve | [**PUMPS**] |
| Initial Status | Initial status of the pump | [**PUMPS**] |
| Startup Depth | Depth at inlet node when the pump turns on | [**PUMPS**] |
| Shutoff Depth | Depth at inlet node when the pump turns off | [**PUMPS**] |

Add Pump – The UI will provide the capability to add pump links by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Pump – The UI will provide the capability to remove a pump link by clicking on the schematic diagram or pump link table and then clicking a ‘Remove’ button.

C.1.9 Flow Regulators

Edit Orifice Properties -- The UI will provide the capability to edit the following orifice link properties:

Table C-. Flow Regulator Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned name of orifice | [**ORIFICES**] |
| Inlet Node | Name of node on the inlet end of orifice | [**ORIFICES**] |
| Outlet Node | Name of node on the outlet end of orifice | [**ORIFICES**] |
| Description | Optional comment or description | [**ORIFICES**] |
| Tag | Optional category or classification | [**TAGS**] |
| Type | Type of orifice | [**ORIFICES**] |
| Shape | Initial status of the pump | [**ORIFICES**] |
| Height | Depth at inlet node when the pump turns on | [**ORIFICES**] |
| Width | Depth at inlet node when the pump turns off | [**ORIFICES**] |
| Inlet Offset | Depth of bottom of orifice opening from inlet node invert | [**ORIFICES**] |
| Discharge Coeff. | Discharge coefficient | [**ORIFICES**] |
| Flap Gate | If orifice contains a flap gate to prevent backflow | [**ORIFICES**] |
| Time to Open/Close | Time to open/close a gated orifice | [**ORIFICES**] |

Add Orifice – The UI will provide the capability to add orifice links by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Orifice – The UI will provide the capability to remove an orifice link by clicking on the schematic diagram or orifice link table and then clicking a ‘Remove’ button.

Edit Weir Properties -- The UI will provide the capability to edit the following weir link properties:

Table C-. Weir Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned name of weir link | [**WEIRS**] |
| Inlet Node | Name of node on the inlet side of weir | [**WEIRS**] |
| Outlet Node | Name of node on the outlet side of weir | [**WEIRS**] |
| Description | Optional comment or description | [**WEIRS**] |
| Tag | Optional category or classification | [**TAGS**] |
| Type | Type of weir | [**WEIRS**] |
| Height | Vertical height of weir opening | [**WEIRS**] |
| Length | Horizontal length of weir crest | [**WEIRS**] |
| Side Slope | Slope of trapezoidal weir side walls | [**WEIRS**] |
| Inlet Offset | Depth of bottom of weir opening from inlet node invert | [**WEIRS**] |
| Discharge Coeff. | Discharge coefficient for central portion of weir | [**WEIRS**] |
| Flap Gate | If weir contains a flap gate to prevent backflow | [**WEIRS**] |
| End Contractions | Number of end contractions | [**WEIRS**] |
| End Coeff. | Discharge coefficient for flow through the triangular ends of a trapezoidal weir | [**WEIRS**] |
| Can Surcharge | If weir can surcharge | [**WEIRS**] |
| Road Width | Width of road lanes and shoulders | [**WEIRS**] |
| Road Surface | Type of road surface | [**WEIRS**] |

Add Weir – The UI will provide the capability to add weir links by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Weir – The UI will provide the capability to remove a weir link by clicking on the schematic diagram or weir link table and then clicking a ‘Remove’ button.

Edit Outlet Properties -- The UI will provide the capability to edit the following outlet link properties:

Table C-. Outlet Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Name | User-assigned name of outlet | [**OUTLETS**] |
| Inlet Node | Name of node on the inlet end of outlet | [**OUTLETS**] |
| Outlet Node | Name of node on the outlet end of outlet | [**OUTLETS**] |
| Description | Optional comment or description | [**OUTLETS**] |
| Tag | Optional category or classification | [**TAGS**] |
| Inlet Offset | Depth of outlet above inlet node invert | [**OUTLETS**] |
| Flap Gate | If weir contains a flap gate to prevent backflow | [**OUTLETS**] |
| Rating Curve | Method of defining flow as a function of either freeboard depth or head across the outlet | [**OUTLETS**] |
| Coefficient | Coefficient in outflow expression | [**OUTLETS**] |
| Exponent | Exponent in outflow expression | [**OUTLETS**] |
| Curve Name | Name of rating curve that relates outflow to either depth or head | [**OUTLETS**] |

Add Outlet – The UI will provide the capability to add outlet links by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Outlet – The UI will provide the capability to remove an outlet link by clicking on the schematic diagram or outlet link table and then clicking a ‘Remove’ button.

C.2 EPANET Visual Objects

C.2.1 Junction Nodes

Edit Junction Properties -- The UI will provide the capability to edit the following junction properties:

Table C-. Junction Node Properties (Page 1 of 2)

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **EPANET Section** |
| Junction ID | A unique label used to identify the junction | **[JUNCTIONS]** |
| X-Coordinate | The horizontal location of the junction on the map, measured in the map's distance units | **[COORDINATES]** |
| Y-Coordinate | The vertical location of the junction on the map, measured in the map'sdistance units | **[COORDINATES]** |
| Description | An optional text string that describes other significant information about the junction | **[JUNCTIONS]** |
| Tag | An optional text string (with no spaces) used to assign the junction to a category, such as a pressure zone | **[TAGS]** |
| Elevation | The elevation in feet (meters) above some common reference of the junction | **[JUNCTIONS]** |

Table C-12. Junction Node Properties (Page 2 of 2)

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **EPANET Section** |
| Base Demand | The average or nominal demand for water by the main category of consumer at the junction, as measured in the current flow units | **[JUNCTIONS]** |
| Demand Pattern | The ID label of the time pattern used to characterize time variation in demand for the main category of consumer at the junction | **[JUNCTIONS]** |
| Demand Categories | Number of different categories of water users defined for the junction | **[DEMANDS]** |
| Emitter Coefficient | Discharge coefficient for emitter (sprinkler or nozzle) placed at junction | **[EMITTERS]** |
| Initial Quality | Water quality level at the junction at the start of the simulation period | **[QUALITY]** |
| Source Quality | Quality of any water entering the network at this location | **[SOURCES]** |

Add Junction – The UI will provide the capability to add junctions by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Junction – The UI will provide the capability to remove a junction by clicking on the schematic diagram or junction table and then clicking a ‘Remove’ button.

C.2.2 Reservoir Nodes

Edit Reservoir Properties -- The UI will provide the capability to edit the following reservoir properties:

Table C-. Reservoir Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **EPANET Section** |
| Reservoir ID | A unique label used to identify the reservoir | **[RESERVOIRS]** |
| X-Coordinate | The horizontal location of the reservoir on the map, measured in the map's distance units | **[COORDINATES]** |
| Y-Coordinate | The vertical location of the reservoir on the map, measured in the map's distance units | **[COORDINATES]** |
| Description | An optional text string that describes other significant information about the reservoir | **[RESERVOIRS]** |
| Tag | An optional text string (with no spaces) used to assign the reservoir to a category, such as a pressure zone | **[TAGS]** |
| Total Head | The hydraulic head (elevation + pressure head) of water in the reservoir | **[RESERVOIRS]** |
| Head Pattern | The ID label of a time pattern used to model time variation in the reservoir's head | **[RESERVOIRS]** |
| Initial Quality | Water quality level at the reservoir at the start of the simulation period | **[QUALITY]** |
| Source Quality | Quality of any water entering the network at this location | **[SOURCES]** |

Add Reservoir – The UI will provide the capability to add reservoirs by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Reservoir – The UI will provide the capability to remove a reservoir by clicking on the schematic diagram or junction table and then clicking a ‘Remove’ button.

C.2.3 Tank Nodes

Edit Tank Properties -- The UI will provide the capability to edit the following tank properties:

Table C-. Tank Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **EPANET Section** |
| Tank ID | A unique label used to identify the tank | **[TANKS]** |
| X-Coordinate | The horizontal location of the tank on the map, measured in the map's scaling units | **[COORDINATES]** |
| Y-Coordinate | The vertical location of the tank on the map, measured in the map's scaling units | **[COORDINATES]** |
| Description | An optional text string that describes other significant information about the tank | **[TANKS]** |
| Tag | An optional text string (with no spaces) used to assign the tank to a category, such as a pressure zone | **[TAGS]** |
| Elevation | Elevation above a common datum of the bottom shell of the tank | **[TANKS]** |
| Initial Level | Height of the water surface above the bottom elevation of the tank at the start of the simulation | **[TANKS]** |
| Minimum Level | Minimum height in feet (meters) of the water surface above the bottom elevation that will be maintained | **[TANKS]** |
| Maximum Level | Maximum height in feet (meters) of the water surface above the bottom elevation that will be maintained | **[TANKS]** |
| Diameter | The diameter of the tank | **[TANKS]** |
| Minimum Volume | The volume of water in the tank when it is at its minimum level | **[TANKS]** |
| Volume Curve | The ID label of a curve used to describe the relation between tank volume and water level | **[TANKS]** |
| Mixing Model | The type of water quality mixing that occurs within the tank | **[MIXING]** |
| Mixing Fraction | The fraction of the tank's total volume that comprises the inlet-outlet compartment of the two-compartment (2COMP) mixing model | **[MIXING]** |
| Reaction Coefficient | The bulk reaction coefficient for chemical reactions in the tank | **[REACTIONS]** |
| Initial Quality | Water quality level in the tank at the start of the simulation | **[QUALITY]** |
| Source Quality | Quality of any water entering the network at this location | **[SOURCES]** |

Add Tank – The UI will provide the capability to add tanks by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Tank – The UI will provide the capability to remove a tank by clicking on the schematic diagram or tank table and then clicking a ‘Remove’ button.

C.2.4 Pipes

Edit Pipe Properties -- The UI will provide the capability to edit the following pipe properties:

Table C-. Pipe Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **EPANET Section** |
| Pipe ID | A unique label used to identify the pipe | **[PIPES]** |
| Start Node | The ID of the node where the pipe begins | **[PIPES]** |
| End Node | The ID of the node where the pipe ends | **[PIPES]** |
| Description | An optional text string that describes other significant information about the pipe | **[PIPES]** |
| Tag | An optional text string (with no spaces) used to assign the pipe to a category, perhaps one based on age or material | **[TAGS]** |
| Length | The actual length of the pipe in feet (meters) | **[PIPES]** |
| Diameter | The pipe diameter in inches (mm) | **[PIPES]** |
| Roughness | The roughness coefficient of the pipe. It is unitless for Hazen-Williams or Chezy-Manning roughness and has units of millifeet (mm) for Darcy-Weisbach roughness | **[PIPES]** |
| Loss Coefficient | Unitless minor loss coefficient associated with bends, fittings, etc. Assumed 0 if left blank | **[PIPES]** |
| Initial Status | Determines whether the pipe is initially open, closed, or contains a check valve. If a check valve is specified then any flow in the pipe must be from the Start node to the End node | **[PIPES]** |
| Bulk Coefficient | The bulk reaction coefficient for the pipe. Use a positive value for growth and a negative value for decay | **[REACTIONS]** |
| Wall Coefficient | The wall reaction coefficient for the pipe. Use a positive value for growth and a negative value for decay | **[REACTIONS]** |

Add Pipe – The UI will provide the capability to add pipes by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Pipe – The UI will provide the capability to remove a pipe by clicking on the schematic diagram or pipe table and then clicking a ‘Remove’ button.

C.2.5 Pumps

Edit Pump Properties -- The UI will provide the capability to edit the following pump properties:

Table C-. Pump Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| Pump ID | A unique label used to identify the pump | [**PUMPS**] |
| Start Node | The ID of the node on the suction side of the pump | [**PUMPS**] |
| End Node | The ID of the node on the discharge side of the pump | [**PUMPS**] |
| Description | An optional text string that describes other significant information about the  pump | [**PUMPS**] |
| Tag | An optional text string (with no spaces) used to assign the pump to a category,  perhaps based on age, size or location | [**TAGS**] |
| Pump Curve | The ID label of the pump curve used to describe the relationship between the  head delivered by the pump and the flow through the pump | [**PUMPS**] |
| Power | The power supplied by the pump in horsepower | [**PUMPS**] |
| Speed | The relative speed setting of the pump | [**PUMPS**] |
| Pattern | The ID label of a time pattern used to control the pump's operation | [**PUMPS**] |
| Initial Status | State of the pump (open or closed) at the start of the simulation period | [**STATUS**] |
| Efficiency Curve | The ID label of the curve that represents the pump's wire-to-water efficiency as a function of flow rate | [**ENERGY**] |
| Energy Price | The average or nominal price of energy in monetary units per kw-hr | [**ENERGY**] |
| Price Pattern | The ID label of the time pattern used to describe the variation in energy price  throughout the day | [**ENERGY**] |

Add Pump – The UI will provide the capability to add pumps by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Pump – The UI will provide the capability to remove a pump by clicking on the schematic diagram or pump table and then clicking a ‘Remove’ button.

C.2.6 Valves

Edit Valve Properties -- The UI will provide the capability to edit the following valve properties:

Table C-. Valve Properties

|  |  |  |
| --- | --- | --- |
| **Property Name** | **Description** | **SWMM Section** |
| ID Label | A unique label used to identify the valve | [**VALVE**] |
| Start Node | The ID of the node on the nominal upstream or inflow side of the valve | [**VALVE**] |
| End Node | The ID of the node on the nominal downstream or discharge side of the valve | [**VALVE**] |
| Description | An optional text string that describes other significant information about the valve | [**VALVE**] |
| Tag | An optional text string (with no spaces) used to assign the valve to a category, perhaps based on type or location | [**TAGS**] |
| Diameter | Valve diameter | [**VALVE**] |
| Type | Valve type | [**VALVE**] |
| Setting | A required parameter that describes the valve's operational setting | [**VALVE**] |
| Loss Coefficient | Unitless minor loss coefficient that applies when the valve is completely opened | [**VALVE**] |
| Fixed Status | Valve status at the start of the simulation | [**STATUS**] |

Add Valve – The UI will provide the capability to add valves by clicking on the schematic diagram or by clicking an ‘Add’ button.

Remove Valve – The UI will provide the capability to remove a valve by clicking on the schematic diagram or valve table and then clicking a ‘Remove’ button.