

MAGNET Pipe Network Analysis

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Quick Tutorial

MAGNET4WATER



Hydrosimulatics

Based on:
EPANET2 Quick Start Tutorial from
U.S. Environmental Protection Agency

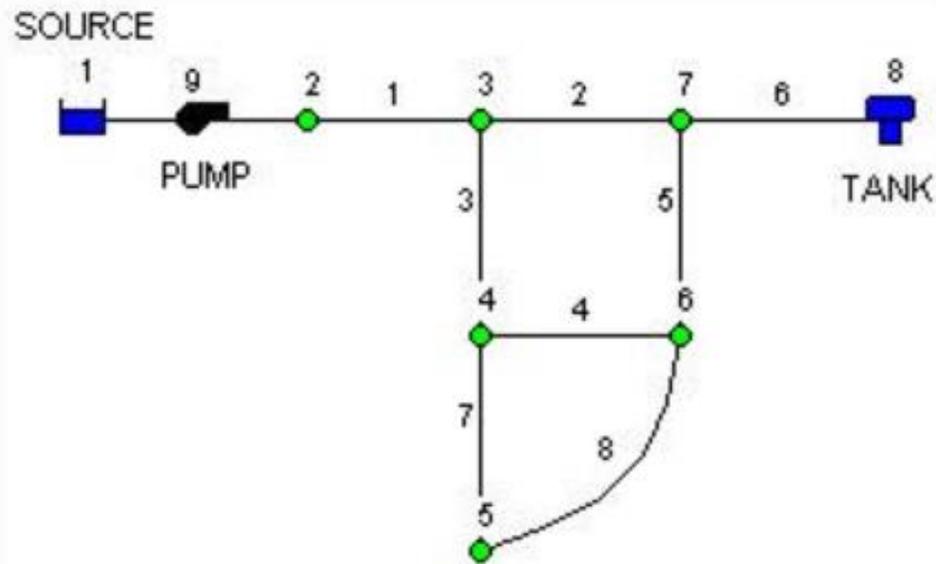
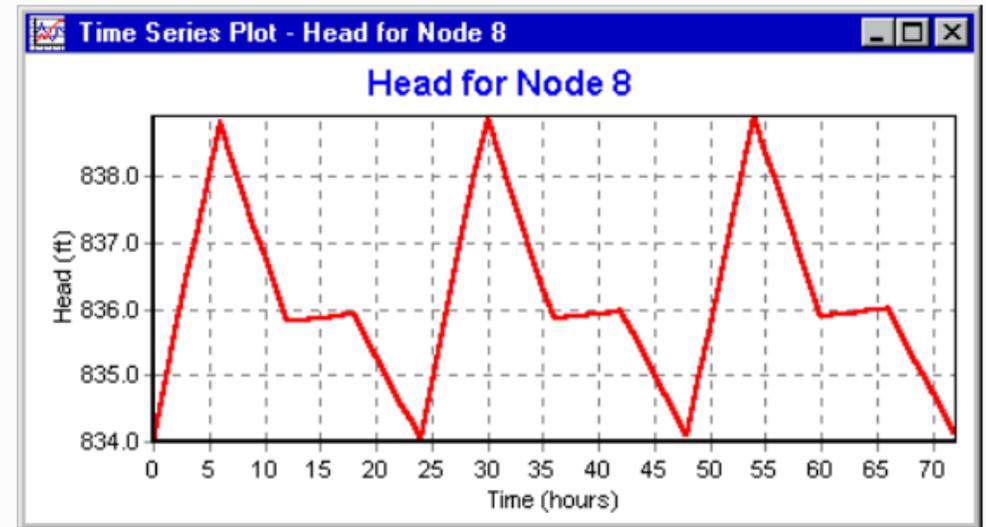


Fig. 2.1 Example Pipe Network.



Browse to:
<https://www.magnet4water.org/pipenet>

This site hosts the complete, integrated pipe network modeling, analysis, and visualization platform. The default interface environment is shown here.

[Object Edit Tools]

[Menu bar]

[Toggle Full Screen]

[Objects and Options]

[Background Maps Selector]

[Objects Attributes Viewer]

[Hover Map Status]

ATTRIBUTES	VALUES
baseDemand	200
coordinates	-85.04868513635256,44.199599
demandCategory	
demandPattern	1
description	
elevation	600
emitterCoeff	0.1
id	1
initialQuality	1
label	Junc 1
operation	Junctions
outputDemand	
outputHead	
outputPressure	
outputQuality	

[Map Display / Working Environment]



Create an account:

[Menu Bar] SIGN UP > Complete Form

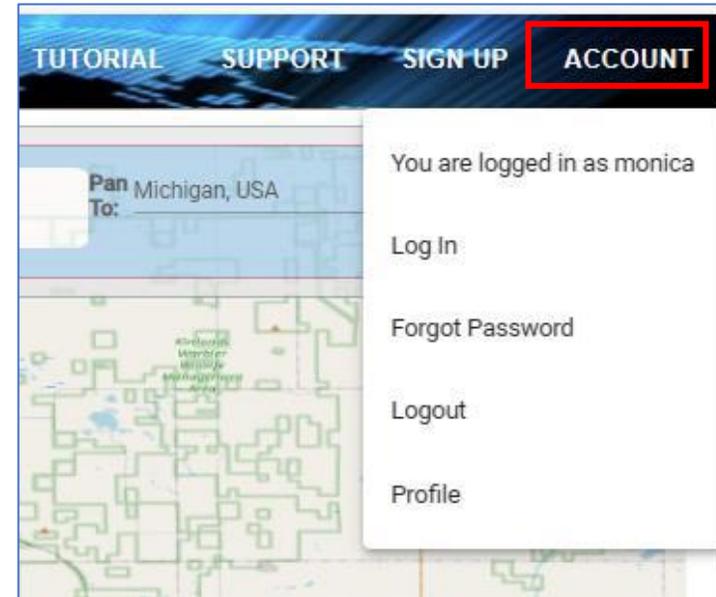
*The email you provide is used for resetting your password should you forget it.

A 'New User Sign Up Form' window with a light blue background and a title bar containing the text 'New User Sign Up Form' and a close button (X). The form contains several input fields, each with a 'Required *' label above it. The fields and their values are: First Name (Zachary), Last Name (Curtis), Position/Title (Water Resource Engineer), User Name (curtiswa), Password (*****), Email (zach@magnet4water.com), Organization (Hydrosimulatics), and Purpose of Use (Education). At the bottom of the form are two buttons: 'Sign Up' (blue) and 'Cancel' (white).

Account:

[Menu Bar] ACCOUNT > ...

Use this menu to request a password reset, update your email, user type, etc.



[Change email, User Type, Password, etc.]

Start a New Project:

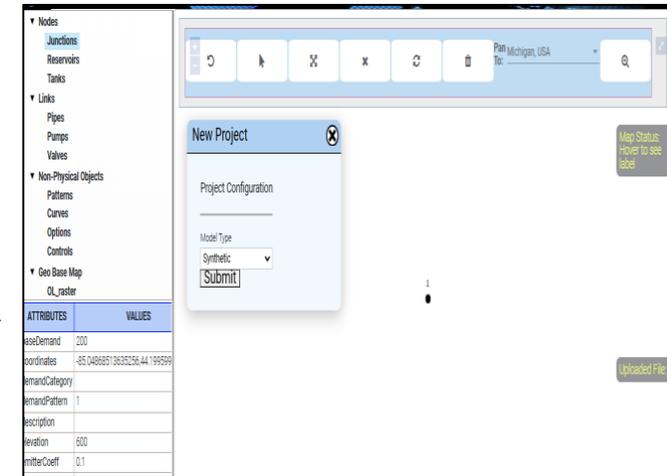
[Menu Bar] FILE > New Project

For this tutorial, choose the Synthetic Model Type and click Submit. This will remove the background map from the display / Working Environment so the user can work within a “numerical sandbox”.

Note: By default, Pipenet models are map-based (or geo-referenced to real-world locations). In these types of models, pipe lengths can be auto-calculated and pipe elevations can be based on a Digital Elevation Model (DEM). A Quick Tutorial for Geo-Referenced models is coming soon.



[Use this menu to start a new project, save the model file, upload an existing model, export the model map or model Geojson file, or view the model INP (input) file or simulation RPT (report) file.]

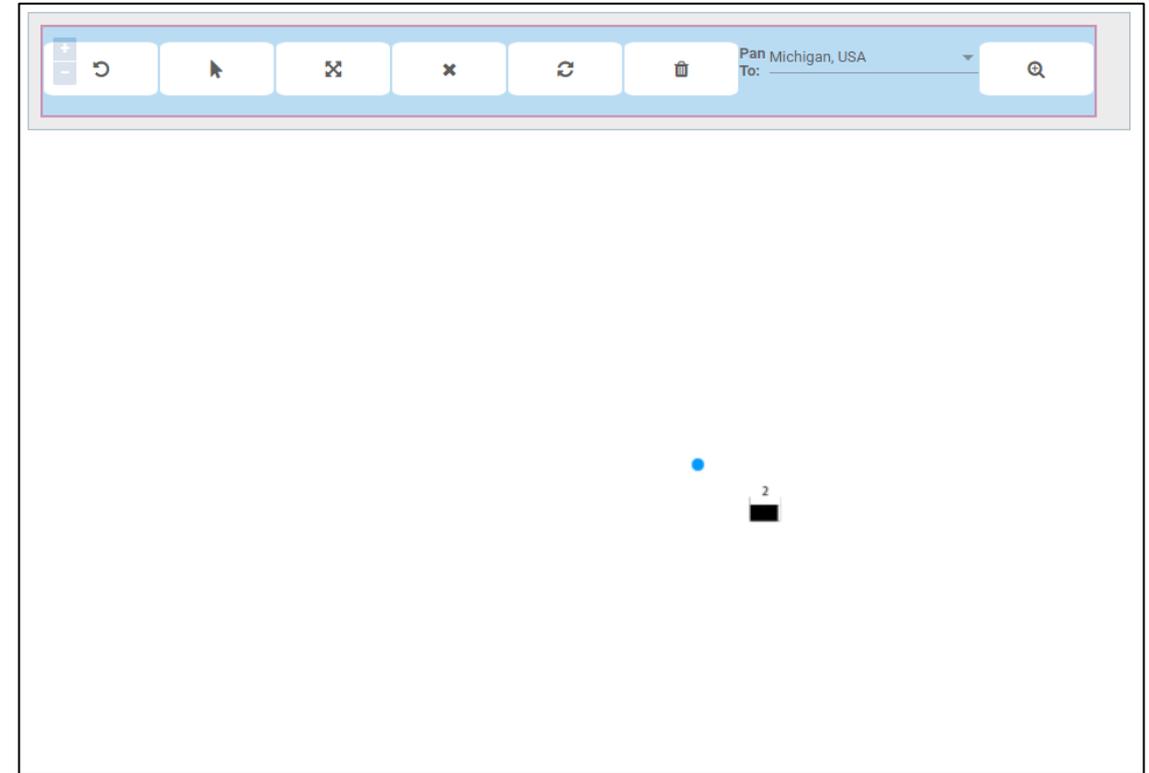
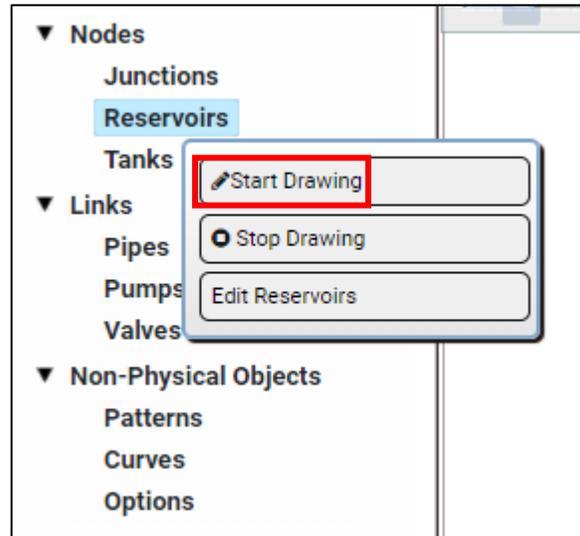


Add Reservoir:

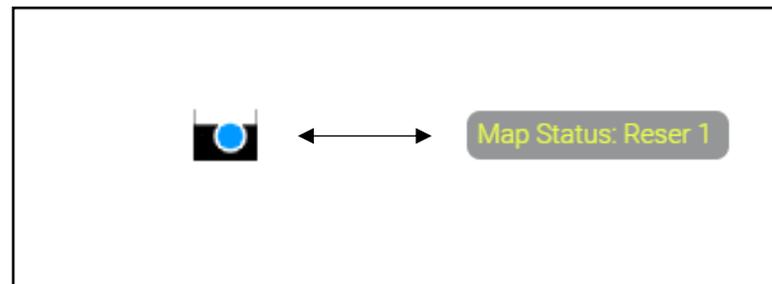
Nodes > Reservoirs > click,
right click > Start Drawing

The cursor turns into a blue circle,
indicating 'Drawing Mode' is active.

Use a single-click to add the reservoir to
the map display.



*Note that if you hover the cursor over
a node or link object, the Map Status
hover field will indicate the node / link
ID of that object.



Edit Reservoir:

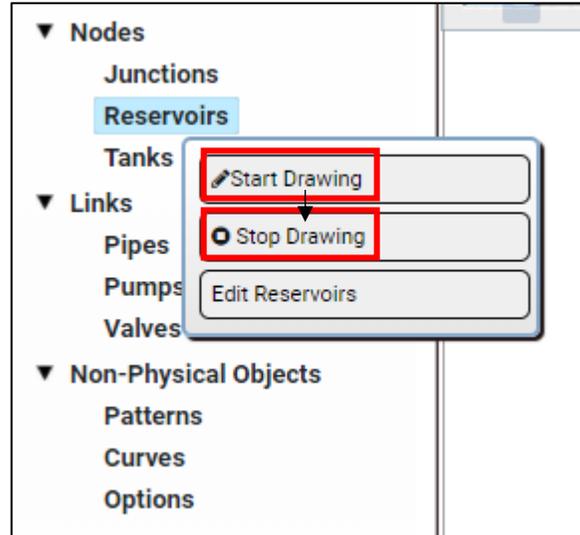
1. Nodes > Reservoirs > click, right click > Stop Drawing
2. Nodes > Reservoirs > click, right click > Edit Reservoirs*

*A single-click on any map object also launches its Editor menu.

Select the reservoir by its Reservoir ID (1 for this example).

The total head in Reservoir 1 should be set to 700ft.

Click 'Save' to finalize changes before exiting the Reservoir Data Editor ('X' button).



A screenshot of the 'Reservoir Data Editor' window. The title bar says 'Reservoir Data Editor' with a close button (X). The window contains a table with two columns: 'Property' and 'Value'. The first row is 'Reservoir Id: Select:' with a dropdown arrow. This row is highlighted with a red box. Below it are several other rows with labels and input fields: 'X-Coordinate: X-Coordinate', 'Y-Coordinate: Y-Coordinate', 'Description: Description', 'Tag: tag', '*Total Head:(ft) Total Head', 'Head Pattern: Head Pattern', 'Initial Quality Initial Quality', and 'Source Quality Source Quality'. At the bottom, there are two buttons: 'Save' (blue) and 'Remove' (red).

A screenshot of the 'Reservoir Data Editor' window, similar to the previous one. The 'Reservoir Id' dropdown now shows '1' and is highlighted with a red box. The '*Total Head:(ft) 700' field is also highlighted with a red box. The 'Save' button at the bottom is also highlighted with a red box. The 'Remove' button is red. The other fields and layout are the same as in the previous screenshot.

Add Junctions:

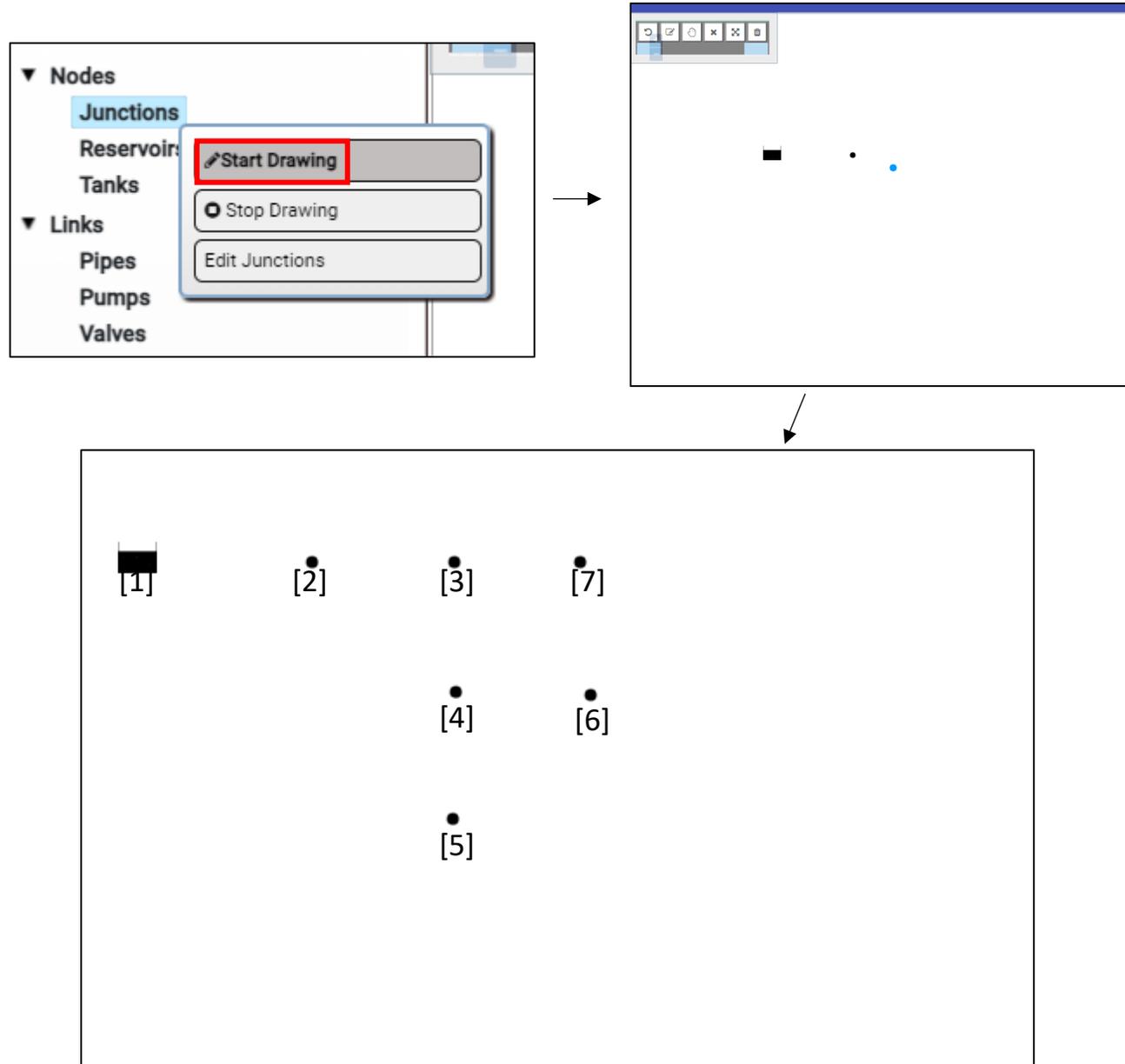
Nodes > Junctions > click,
right click > Start Drawing

Again, the cursor turns into a blue circle,
indicating 'Drawing Mode' is active.

Use a single-click to add the six junctions
to the map display.

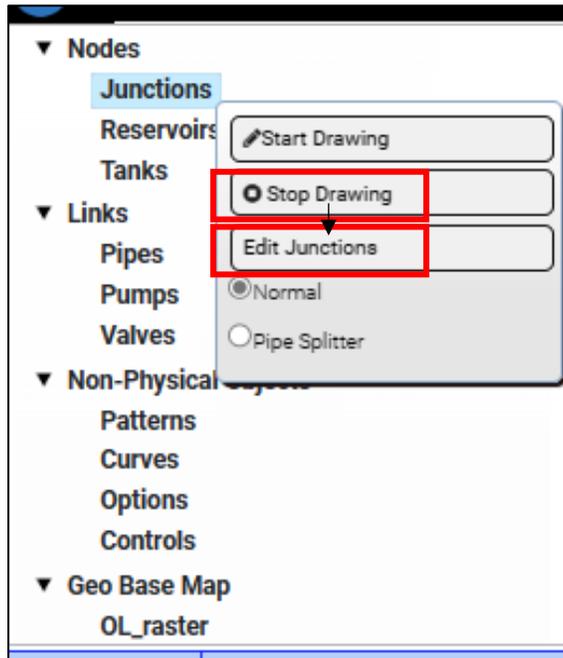
Add the notes in the approximate
locations indicated in the figure. Follow
the correct order so that the Junction ID
matches the network plan shown here
and in slide 2*.

*Note that, in principle, the IDs can be
different from those used in the network
plan, but it makes trickier to assign
junction-specific attributes from the
example.



Edit Junctions:

1. Nodes > Junctions > click, right click > Stop Drawing
2. Nodes > Junctions > click, right click > Edit Junctions



The 'Junction Data Editor' window displays the following properties and values:

Property	Value
Junction Id:	2
X-Coordinate:	-2124823.5331239677
Y-Coordinate:	1040279.316353072
Description:	Description
Tag:	tag
Elevation:(ft)	600
Base Demand:(GPM)	0
Demand Pattern:	1
Demand Category:	Demand Category
Emitter Coeff:	0.1

Buttons: Save, Remove, Pattern Editor, Edit

Edit Junctions (cont.):

Select the different junctions by their Junction ID (2-7 for this example) for attribute editing.

The total head in Junction 2 should be set to 700ft. The Base Demand should be set to zero.

Click 'Save' to finalize changes before selecting a new junction for editing: Junction 3, edit attributes, Save; Junction 4, edit, Save; and so on...

After updating and saving all of the junctions, close the Junction Data Editor window ('X' button).

Table 2.1 Example Network Node Properties

Node	Elevation (ft)	Demand (gpm)
1	700	0
2	700	0
3	710	150
4	700	150
5	650	200
6	700	150
7	700	0
8	830	0

Reservoir → Node 1

Junctions → Nodes 2-7

Tank → Node 8

Junction Data Editor

Property	Value
Junction Id:	2
X-Coordinate:	-2124823.5331239677
Y-Coordinate:	1040279.316353072
Description:	Description
Tag:	tag
Elevation:(ft)	700
Base Demand:(GPM)	0
Demand Pattern:	1
Demand Category:	Demand Category
Emitter Coeff:	0.1

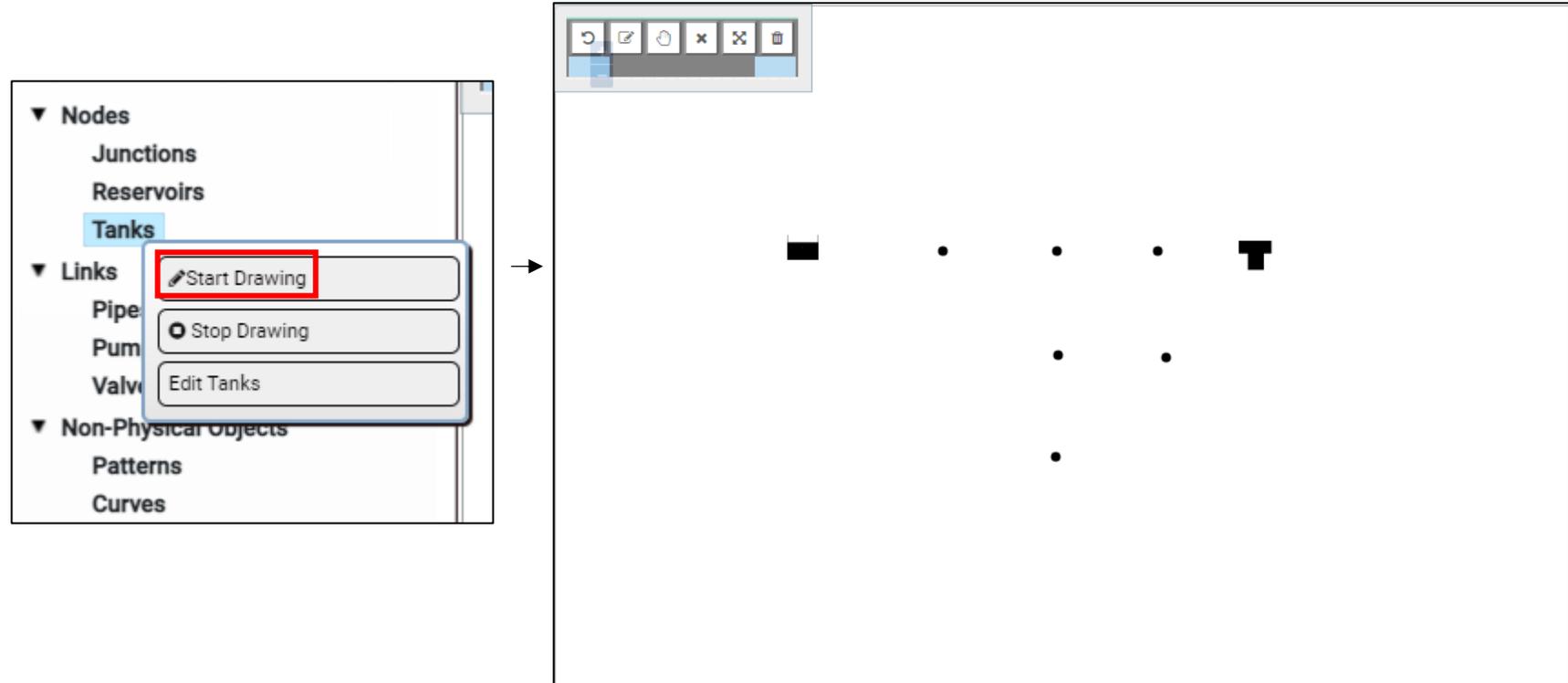
Buttons: Save, Remove, Pattern Editor, Edit

Add Tank:

Nodes > Tanks > click, right click
> Start Drawing

The cursor turns into a blue circle, indicating
'Drawing Mode' is active.

Use a single-click to add the tank to the map
display.



Edit Tank:

1. Nodes > Tanks > click, right click > Stop Drawing
2. Nodes > Tanks > click, right click > Edit Tanks

Select the tank using the Tank ID (8 for this example).

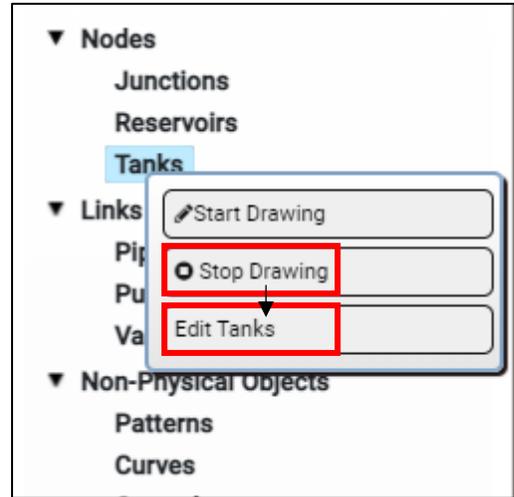
Assign a elevation of 830ft.

Assign an initial water level of 3.5ft.

Assign a minimum level of 0ft.
Assign a maximum level of 20ft.

Assign a diameter of 60ft.

Click 'Save' to finalize the changes before closing the Tank Data Editor.



The image shows a 'Tank Data Editor' dialog box. The dialog has a title bar 'Tank Data Editor' and a close button. It contains a table with 'Property' and 'Value' columns. The 'Tank Id' is set to 8. The 'Elevation:(ft)' is 830, 'Initial Level' is 3.5, 'Minimum Level' is 0, 'Maximum Level' is 20, and 'Diameter:(ft)' is 60. These values are highlighted with red boxes.

Property	Value
Tank Id:	8
X-Coordinate:	-36049.61346499626
Y-Coordinate:	47773.14267823516
Description:	Description
Tag:	tag
Elevation:(ft)	830
Initial Level:	3.5
Minimum Level:	0
Maximum Level:	20
Diameter:(ft)	60
Minimum Volume:(ft^3)	0

Add Pipes:

Links > Pipes > click, right click > Start Drawing

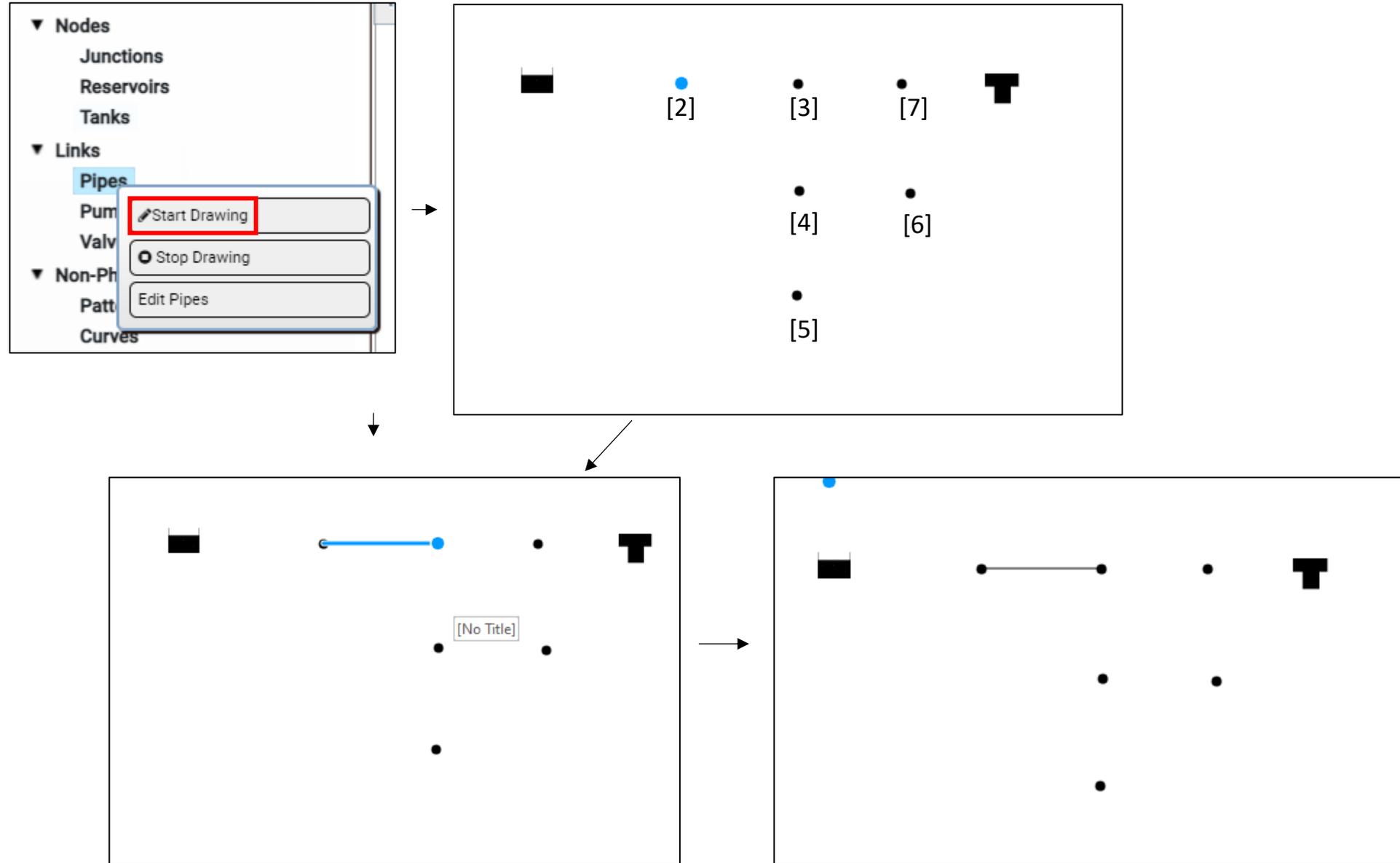
Again, the cursor turns into a blue circle, indicating 'Drawing Mode' is active.

Click once on Junction 2 to snap the pipe's starting position to it. A blue line will extend from the node as you move the cursor.

Double click on Junction 3 to snap the pipe's ending position to it.

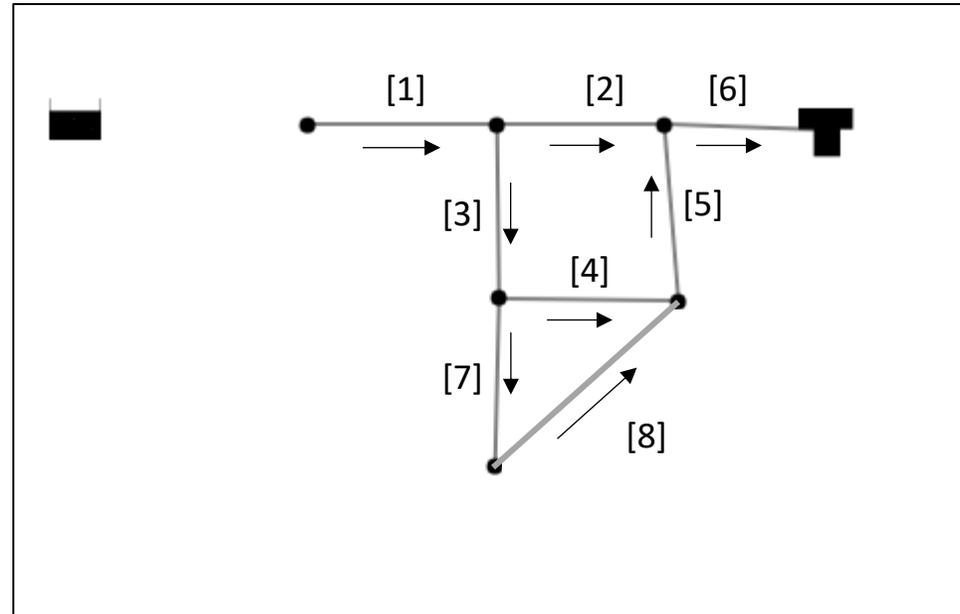
*At this time polylines are not supported.

**A pipe must have a starting and ending node. "Bad" pipes are deleted from the map display. If you get a thin blue line this indicates the link was unsuccessful. When this happens click "Undo" on the map toolbar, or "Stop Drawing" and "Start Drawing" on the Link menu.



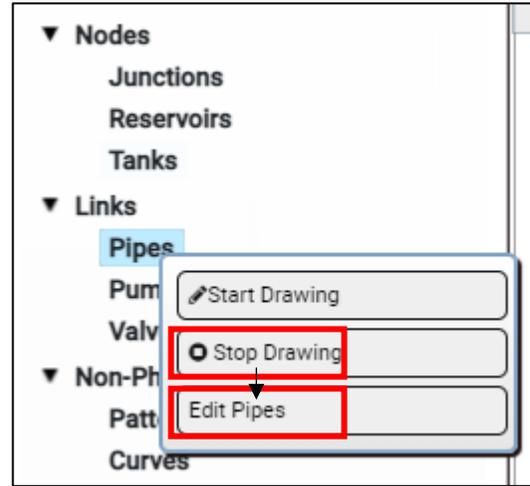
Continue adding pipes to the network in the order indicated here and on slide 2.

*Do not use a pipe to link the reservoir to Junction 2.
A pump will be used as a link between the reservoir and Junction 2.



Edit Pipes:

1. Links > Pipes > click, right click > Stop Drawing
2. Links > Pipes > click, right click > Edit Pipes



Select the different pipes by their Pipe ID (1-8 for this example) for attribute editing.

The length of Pipe 1 should be set to 3000ft*. The diameter should be set to 14. The C-Factor (Roughness) should be set to 100.

*Note that the pipe length is automatically calculated from the map, but this can always be overwritten with user-inputs.

Click 'Save' to finalize changes before selecting a new pipe for editing: Pipe 2, edit attributes, Save; Pipe 3, edit, Save; and so on...

Pipe	Length (ft)	Diameter (inches)	C-Factor
1	3000	14	100
2	5000	12	100
3	5000	8	100
4	5000	8	100
5	5000	8	100
6	7000	10	100
7	5000	6	100
8	7000	6	100

Pipe Data Editor

Property	Value
Pipe Id:	1 <small>Select</small>
Start Node:	2
End Node:	3
Description:	Description
Tag:	tag
Length:(ft)	3000
Diameter:(in)	14
Roughness:	100
Loss Coeff.:	0.1
Initial Status:	Open <small>Initial Status</small>
Bulk Coeff.:	1

Edit/Define Pump Curve:

Non-Physical Objects > Curves > click, right click > Edit Curves

Select the **Pump Curve** tab from the Curve Editor Window

A pump curve (Curve Id '1') is automatically predefined.*

Update Flow to 600 GPM and the Head to 150. The software will create a curve through this (pumping rate, head) data point to define the relationship between pumping rate and head in the pump object.**.

Click "Save Curve" to finalize the changes.

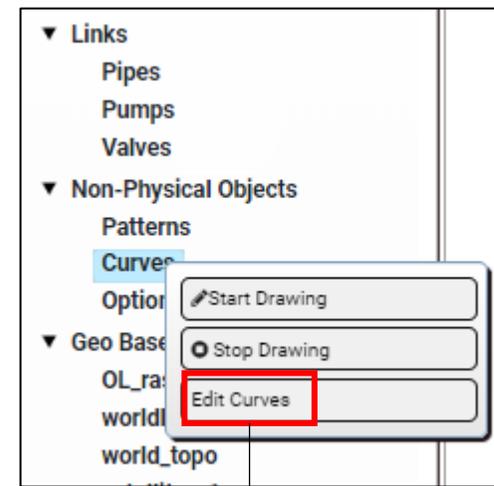
For one point curves the equation used by the software is of the form:

$$h = b - aQ^2$$

Where h is the Head, Q is the Flow, and b and a are constants determined from the input point(s).

*When additional pump curves are needed, click "Add New Curve" button, a new Curve Id (e.g. '2') will appear in the "Curve Id" dropdown box.

**Generally speaking, as flow increases, head decreases.



The screenshot shows the 'Curve Editor' window. At the top, there are three tabs: 'Pump Curve' (selected and highlighted with a red box), 'Efficiency Curve', and 'Volume Curve'. Below the tabs, there is a 'Select Curve Id:' dropdown menu with '1' selected (highlighted with a red box). To the right of the dropdown are 'Add New Curve' and 'Delete Curve' buttons. Below these are 'Add New Row', 'Delete', and 'Clear Table' buttons. A table with the following data is shown:

Id	Flow	Head
1	600	150
2		
3		
4		
5		

At the bottom of the window, there is a 'Save Curve' button (highlighted with a red box) and a note: '* Click to save data in the grid'. To the right of the window, there is a graph titled 'Single-Point Curve'. The graph shows a curve on a coordinate system with Flow on the x-axis (0 to 1000) and Head on the y-axis (0 to 200). A red dot is plotted at (600, 150), labeled 'Single Point'. A legend indicates that the red dot represents a 'Single Point' and the curve represents 'Calculated Points'.

Add Pump

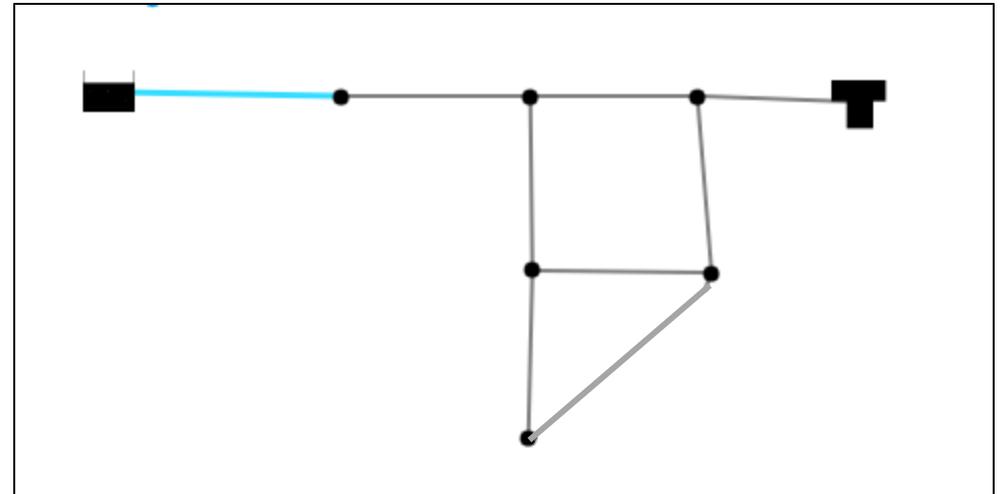
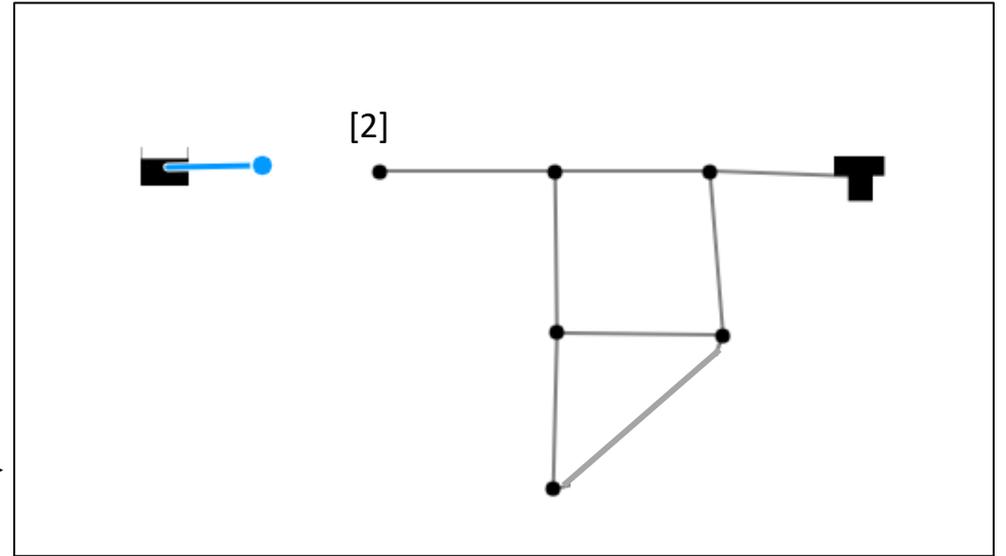
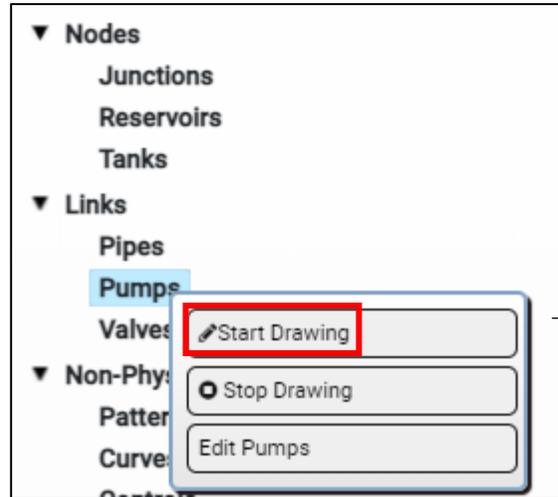
Links > Pumps > click, right click > Start Drawing

Again, the cursor turns into a blue circle, indicating 'Drawing Mode' is active.

Click once on Reservoir 1 to snap the pump's starting position to it. A blue line will extend from the reservoir as you move the cursor.

Double click on Junction 2 to snap the pipe's ending position to it.

*A pump must have a starting and ending node. "Bad" pumps are deleted from the map display. If you get a thin blue line this indicates the link was unsuccessful. When this happens click "Undo" on the map toolbar, or "Stop Drawing" and "Start Drawing" on the Link menu.



Edit Pump:

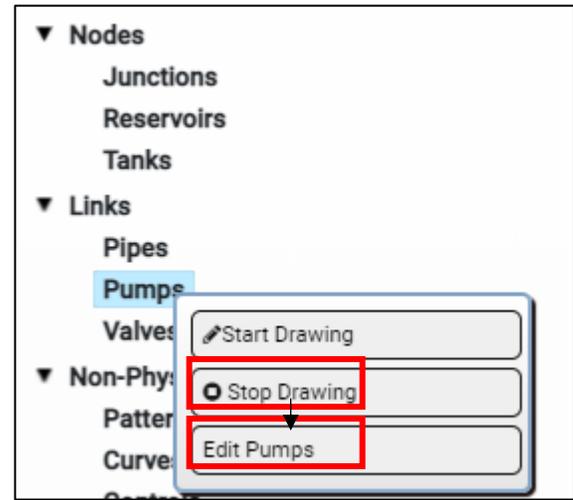
1. Links > Pumps > click, right click > Stop Drawing
2. Links > Pumps > click, right click > Edit Pumps

Select the pump using the Pump ID (9 for this example).

Assign a 'Pump Curve' of 1 (see previous slide).

Make sure the 'Speed' field is null/empty.

Click 'Save' to finalize the changes before closing the Pump Data Editor.



Pump Data Editor

Pump Properties | Pump Energy Properties

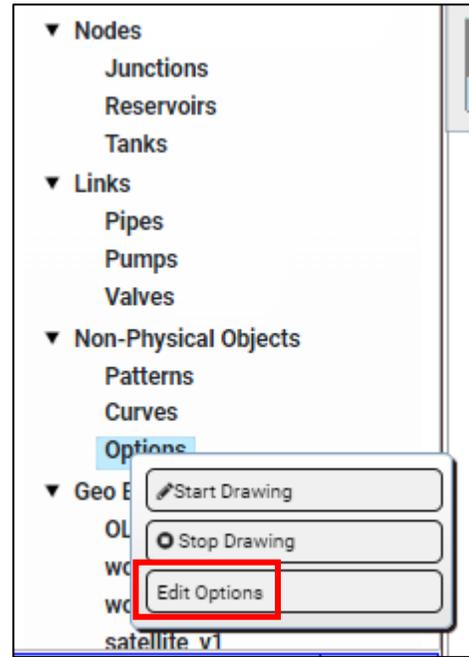
Property	Value
Pump Id:	9
Start Node :	1
End Node :	2
Description:	Description
Tag:	tag
Pump Curve:	1
Power:(horsepower)	Power
Speed:(ft/s)	Speed
Pattern:	
Initial Status:	Open

Buttons: Curve Editor, Pattern Editor, Save, Remove

Edit Time Settings:

Non-Physical Objects >
Options > click, right
click > Edit Options

Click the “Save” button
on each Tab if changes
are made to the data in
that Tab



Options

**Note: FOR CHANGES TO BE SAVED GLOBALLY, CLICK SAVE BUTTON ON EACH TAB IF CHANGES ARE MADE TO THE DATA IN THE TAB.

Hydraulics Quality Reactions Times Energy

Property	Value	Property	Value
Flow Units:	GPM	Max. Head Error:	0
Head Loss Formula:	H-W	Max. Flow Change:	0
Specific Gravity:	1.0	Demand Model:	DDA
Relative Viscosity:	1.0	Minimum Pressure:	0
Maximum Trials:	40	Required Pressure:	0.1
Accuracy:	0.001	Pressure Exponent:	0.5
if Unbalanced:	Continue 10	CHECKFREQ:	2
Default Pattern:	1	MAXCHECK:	10
Demand Multiplier:	1.0	DAMPLIMIT:	0
Emitter Exponent:	0.5	DIFFUSIVITY:	1.0
StatusReport:	Yes	TOLERANCE:	0.01
		QUALITY:	Chlorine,mg/L

Save Hydraulics Data

Navigate to the 'Times' tab.

Assign a Total Duration of 72 hours (72:00). (This means the analysis will be for a 3-day time period)

Assign a Pattern Time Step 6 hours (6:00). (This means demand will be specified in 6-hr increments).

Click 'Save Time Data' before closing the Options interface.

Property	Value
Total Duration:	72:00
Hydraulic Time Step:	1:00
Quality Time Step:	0:05
Pattern Time Step:	6:00
Pattern Start Time:	0:00
Reporting Time Step:	1:00
Report Start Time:	0:00
Clock Start Time:	12 am
Statics:	Statics NONE

Save Time Data

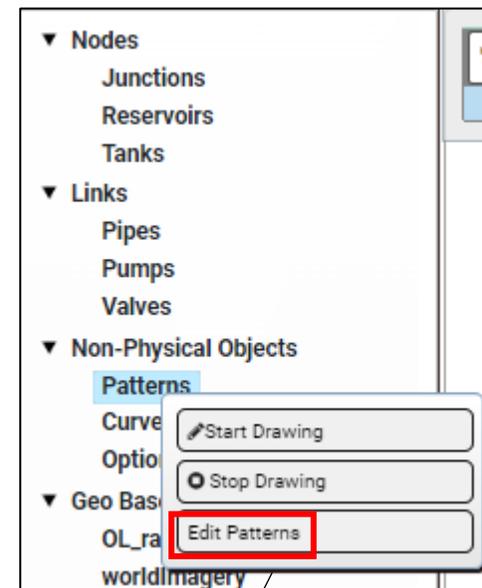
Define Demand Pattern:

Non-Physical Objects > Patterns > click, right click > Edit Patterns

Select Pattern 1 from 'Pattern Id:'.

A default demand pattern is automatically provided.

*Note that actual demand is product of Base Demand and the Multiplier, where Base Demand is defined in the Junction Data Editor.



The 'Pattern Editor' window displays a table with 12 rows. The columns are 'Id', 'Time Period', and 'Multiplier'. The 'Multiplier' column is set to 1 for all rows. A graph on the right shows a bar chart of the multiplier over 12 time periods, with a legend indicating 'Demand Pattern' (red bars) and 'Average = 1' (blue line). The x-axis is labeled 'Time(Time Period = 2hrs)' and the y-axis is labeled 'Multiplier'.

Id	Time Period	Multiplier
1	1	1
2	2	1
3	3	1
4	4	1
5	5	1
6	6	1
7	7	1
8	8	1
9	9	1
10	10	1
11	11	1
12	12	1

* Click Save if changes are made in the data table

Use the “Delete” button to modify the default pattern (remove all but 4 rows)*.

* The “Add New Row” button can be used to add rows if more too many rows are deleted.

The screenshot displays the 'Pattern Editor' window. At the top, it shows 'Pattern Id: 1' with 'Add Pattern' and 'Delete Pattern' buttons. Below this is a table with columns 'Id Time Period' and 'Multiplier'. The table contains four rows, each with a multiplier of 1. A red box highlights the 'Delete' button above the table. To the right of the table is a bar chart with 'Multiplier' on the y-axis (0 to 1) and 'Time(Time Period = 2hrs)' on the x-axis (1 to 4). The chart shows four pink bars, each with a height of 1. A blue line with dots at the top of each bar represents the 'Average = 1'. A legend on the right identifies the pink bars as 'Demand Pattern' and the blue line as 'Average = 1'. At the bottom left of the editor is a 'Save Pattern' button. A note at the bottom center states: '* Click Save if changes are made in the data table'.

Id Time Period	Multiplier
1	1
2	1
3	1
4	1

Multiplier

Time(Time Period = 2hrs)

Demand Pattern

Average = 1

Save Pattern

* Click Save if changes are made in the data table

Assign a Multiplier of 0.5 for Time Period 1, 1.3 for Time Period 2, 1.0 for Time Period 3, and 1.2 for Time Period 4.

Click 'Save Pattern' to save changes.

Pattern Editor

Pattern Id: 1 **Add Pattern** **Delete Pattern**

Add New Row **Delete**

Id	Time Period	Multiplier
1	1	.5
2	2	1.3
3	3	1
4	4	1.2

Save Pattern

* Click Save if changes are made in the data table

Multiplier

Time(Time Period = 2hrs)

Legend: Demand Pattern (pink bar), Average = 1 (blue line)

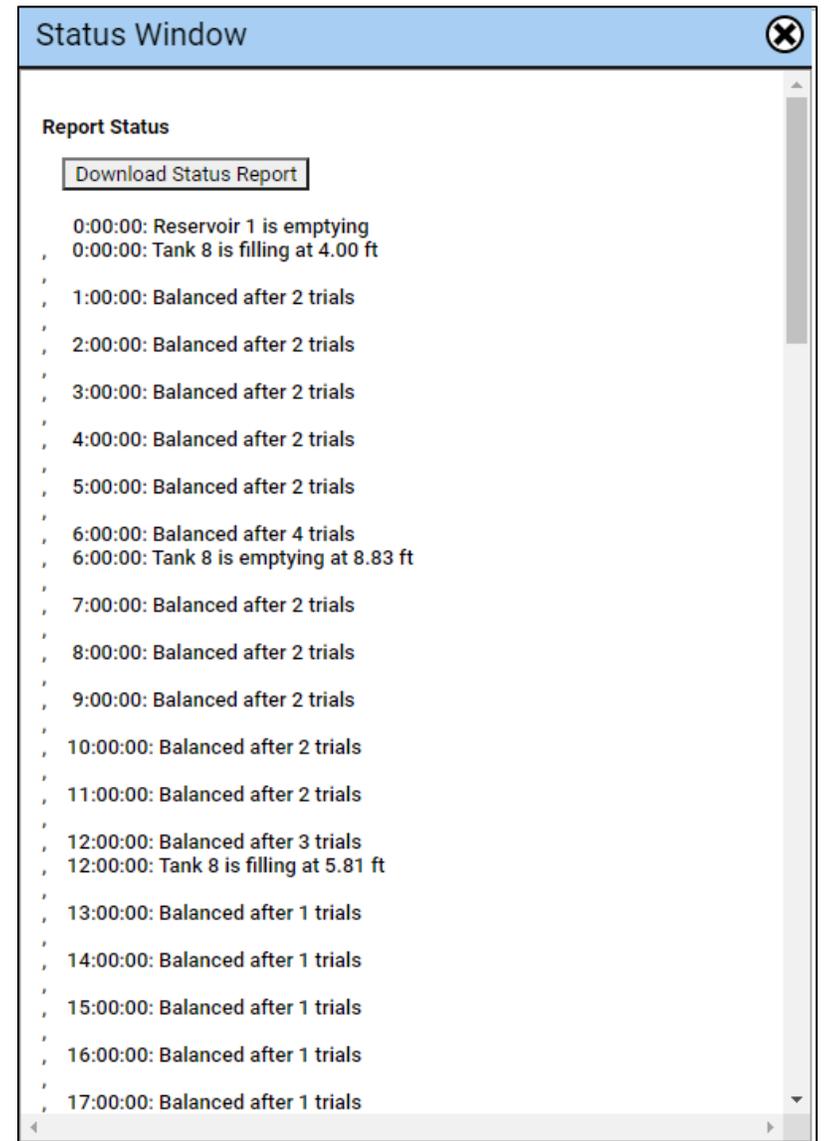
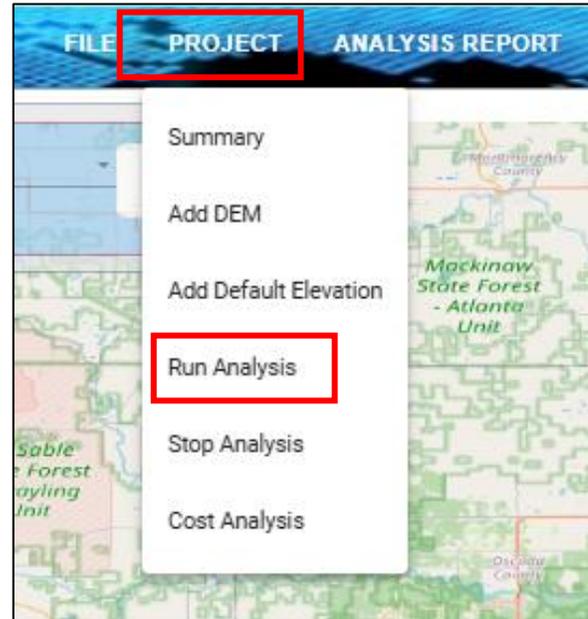
Time Period	Multiplier
1	0.5
2	1.3
3	1.0
4	1.2

Run Model:

[Menu Bar] PROJECT > Run Analysis

After the model is executed, the Status Window will appear.

This window indicates if there were any errors found in the model, and if the model is balanced (water coming in equals water going out), among other information, at different times.



Visualize Results for the Tank:

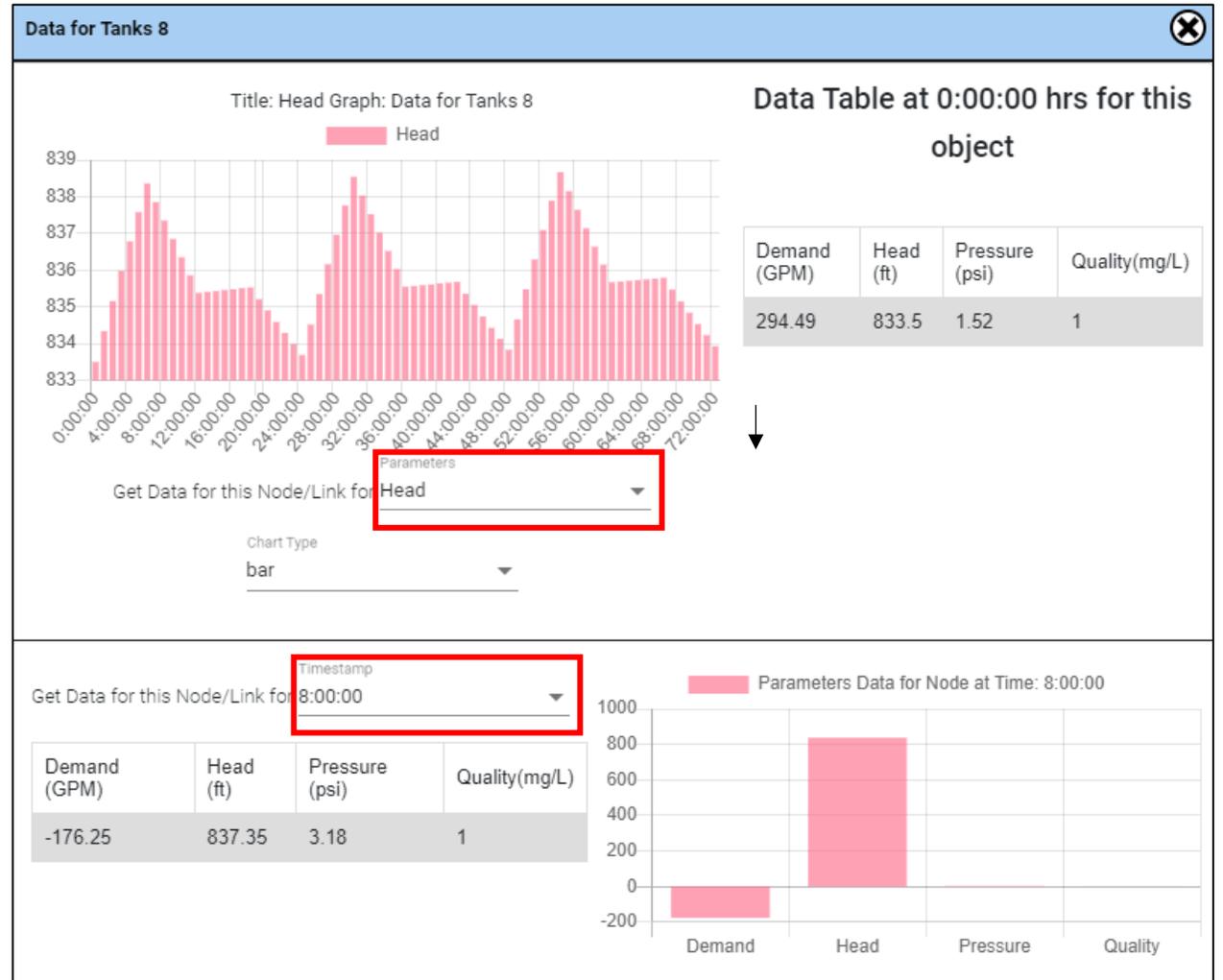
Double-click on the Tank map symbol

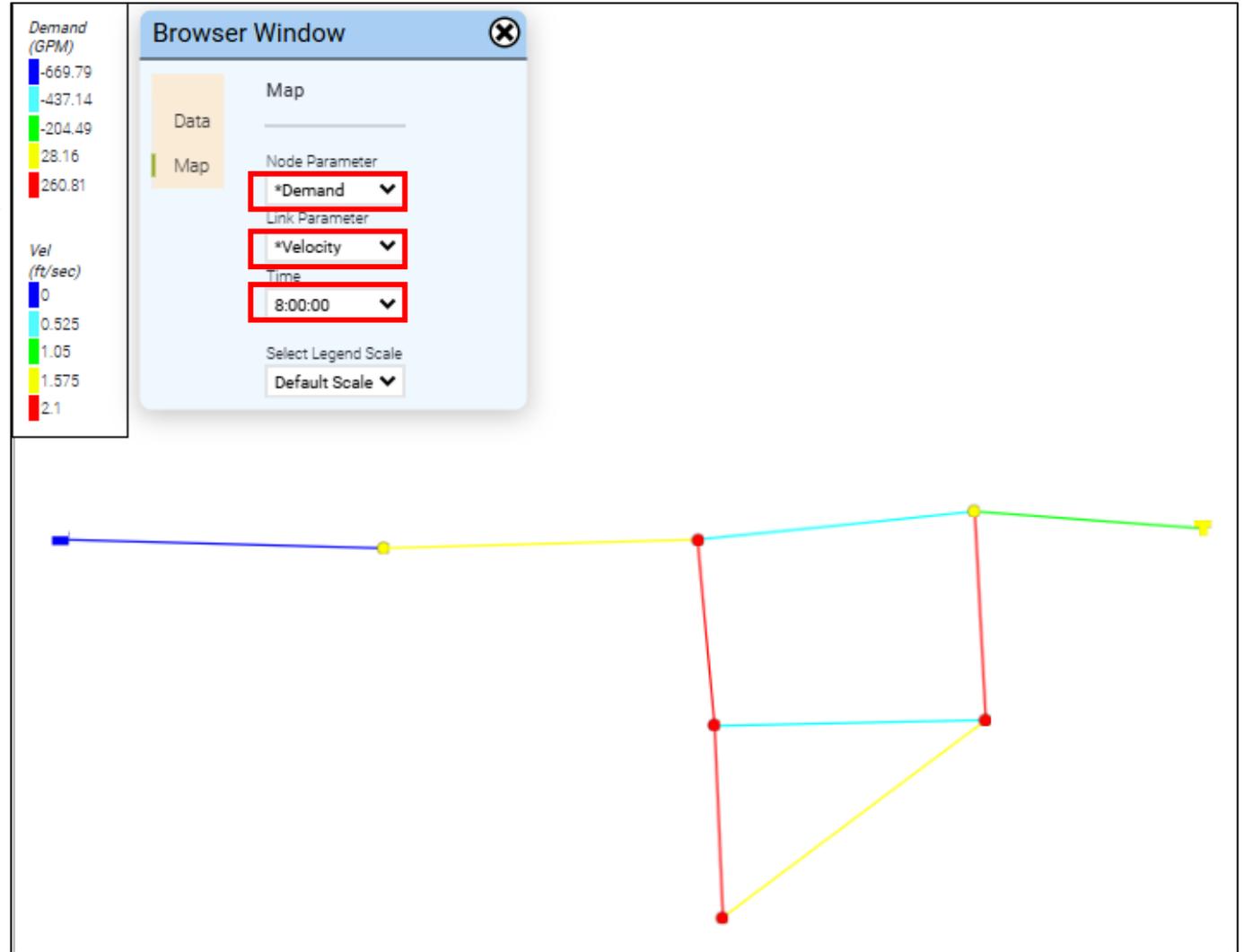
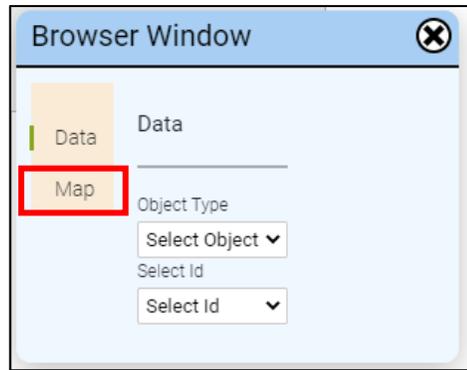
This launches the Data for Tanks interface for the tank (Tank ID 8).

Select 'Head' from the 'Parameter' drop-down menu. This creates a time-series of the head (water level) in the tank as a function of time (0 to 72 hours).

Select '8:00:00' from the 'Timestamp' drop-down menu. This generates a bar chart of the results for four key model parameters (demand, head, pressure, and water quality) at 8 hours of simulation*.

*Note that the demand is negative at this time-stamp because the tank is losing water as it provides supply to the pipe system.





Visualize Results Across the Network:

Go to Browser Window (automatically generated after Run Analysis)

*You may need to close/move the Status Window to see it. Or browse so:
View > Map Browser

Click on the 'Map' tab.

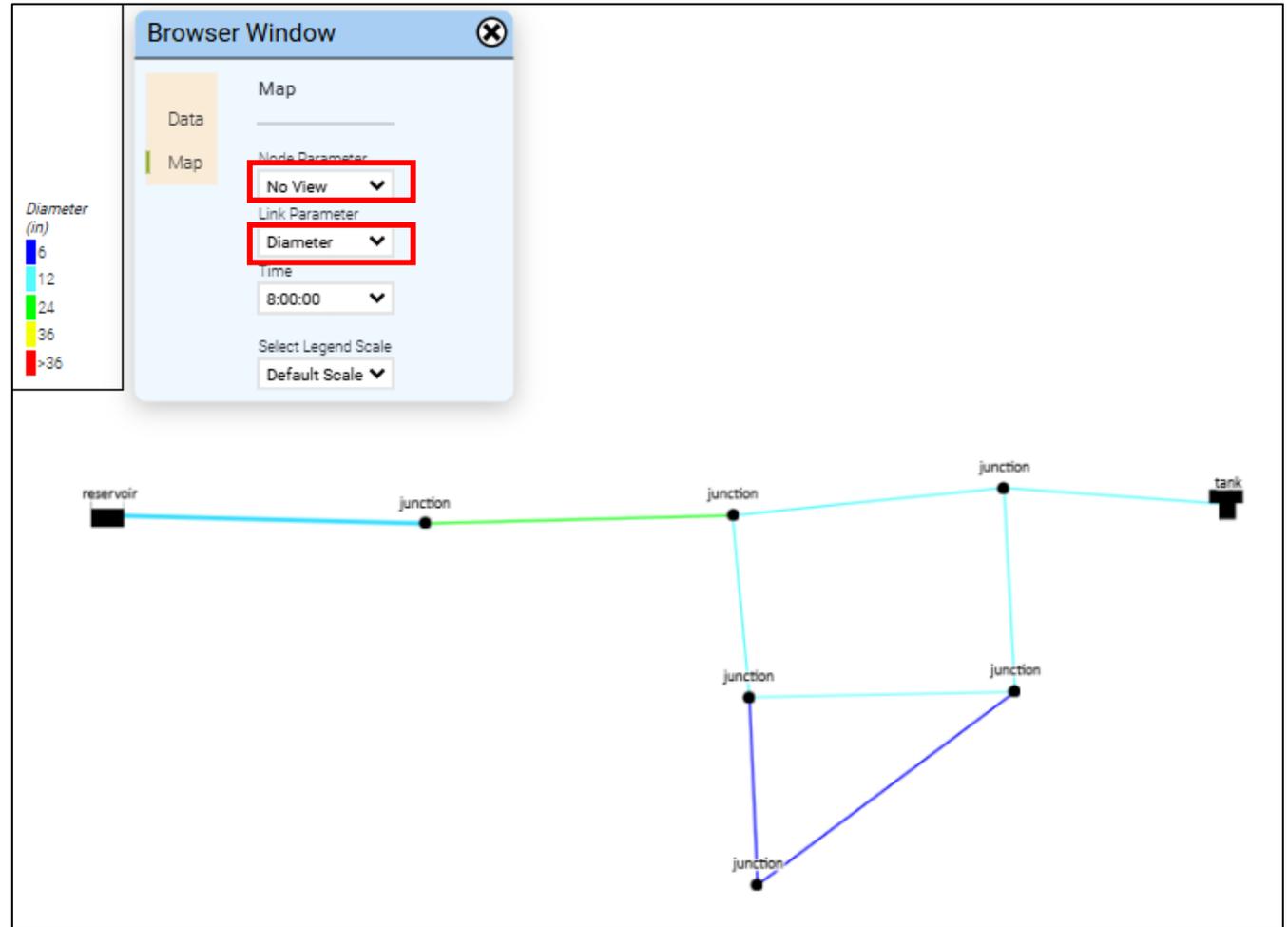
Select '*Demand' as the Node Parameter.

Select '*Velocity' as the Link Parameter.

Select '8:00:00' as the Time.

The map objects will then be color-coded based on the parameter values at 8 hours of simulation. Note the legend that automatically appears.

You can also view some of the model inputs, e.g., the diameters of the pipes.



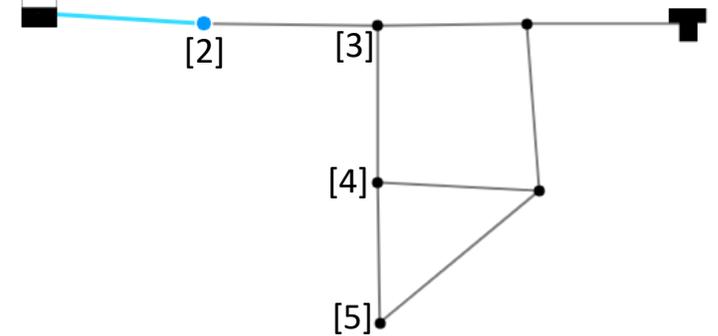
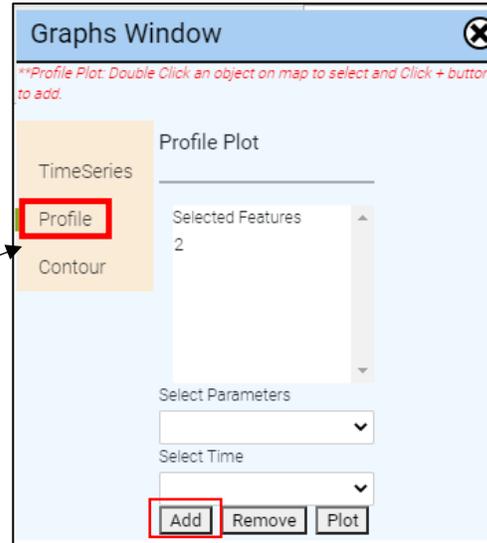
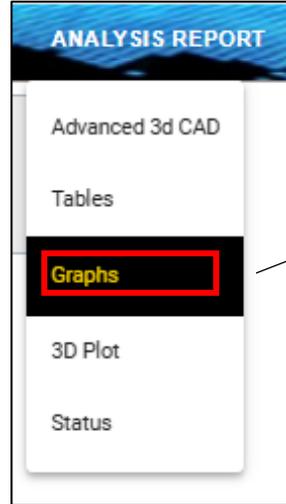
Visualize Results Along a Profile:

[Menu Bar] ANALYSIS REPORT >
Graphs

This launches the 'Graphs Window'.

Select the 'Profile' tab.

Double-click on the Junction 2 and then click
'Add'. This will be the first object along the profile.
(Note the '2' add under 'Selected Features').

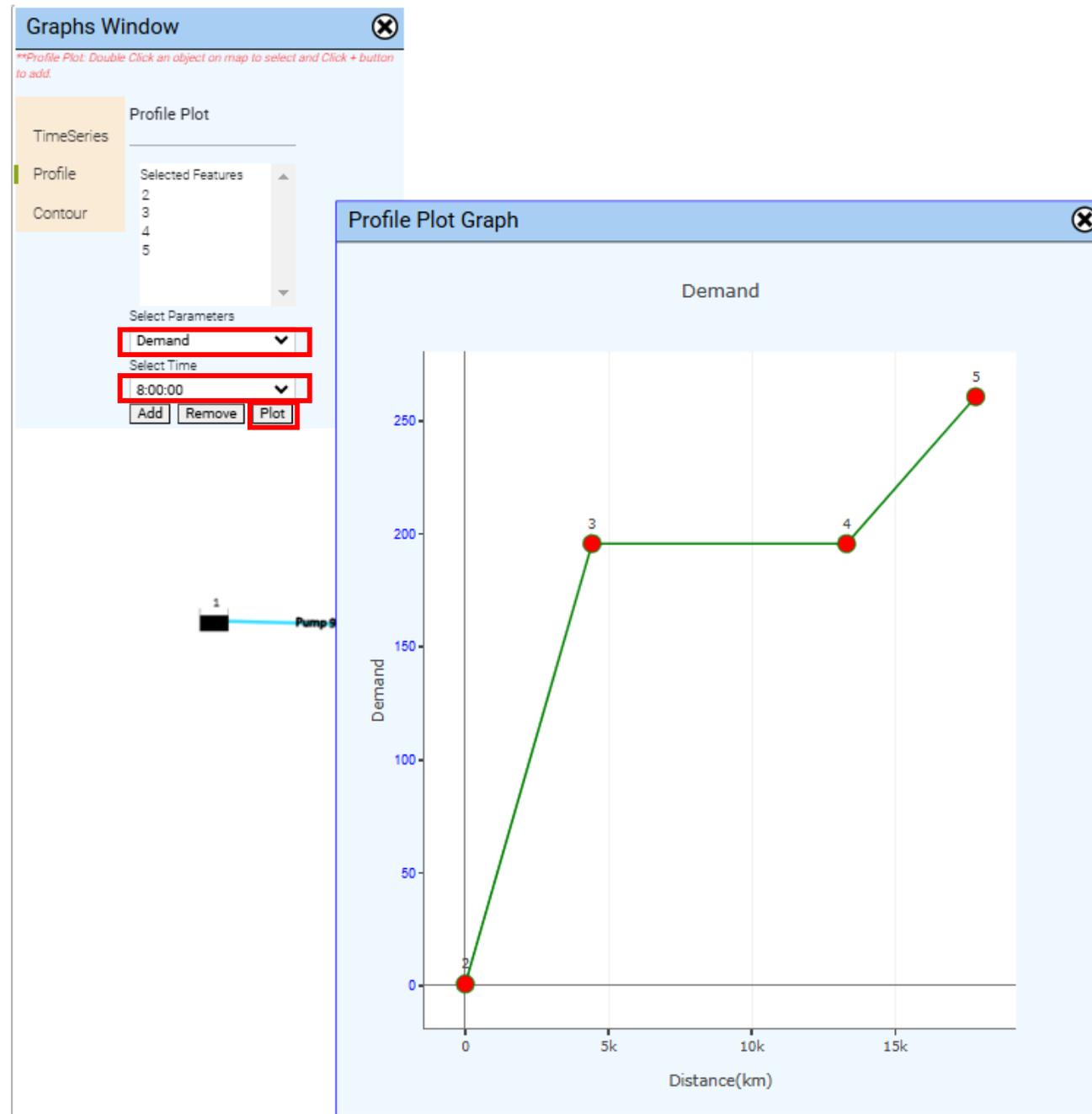


Continue adding Junctions 3, 4 and 5 in the same manner Junction 2 was added.

Choose 'Demand' from the 'Select Parameters' drop-down menu.

Choose '8:00:00' from the 'Select Time' drop-down menu.

Click 'Plot'. This generates a profile graph of the demand at each Junction (2-5).



Visualize the Network in 3D

Report > 3D Plot

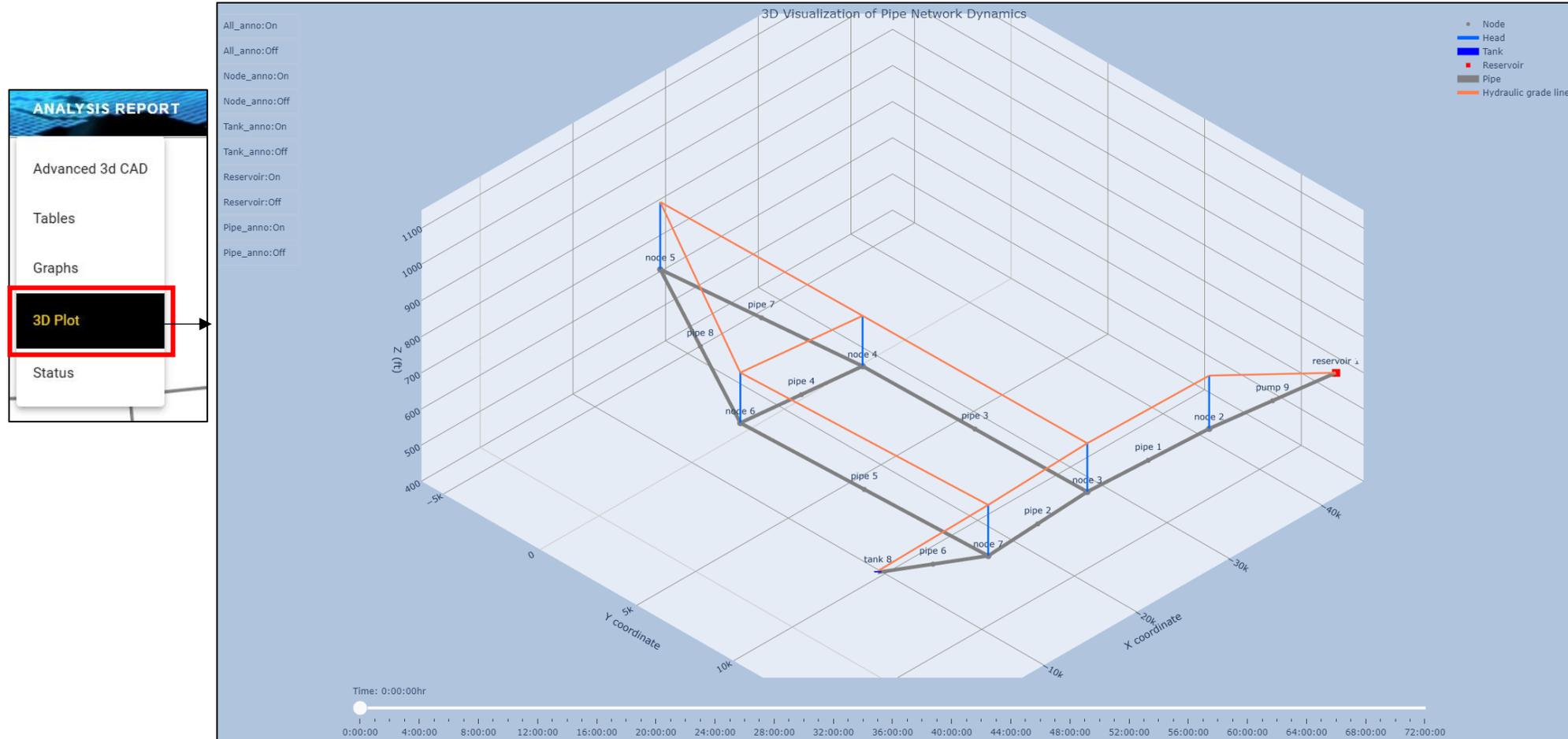
This opens the '3D Visualization of Pipe Network Dynamics' – a 3D rendering of the physical network (pipes and nodes) as well as the simulated parameters (head and hydraulic grade line).

*Users can turn on or off any of the 3D plot features using the button palette along the left side of the plot display.

**

Use the glider at the bottom of the interface to control the time-stamp for which results are displayed.

***Hover the mouse over any of the pipe features to show parameter values / results.

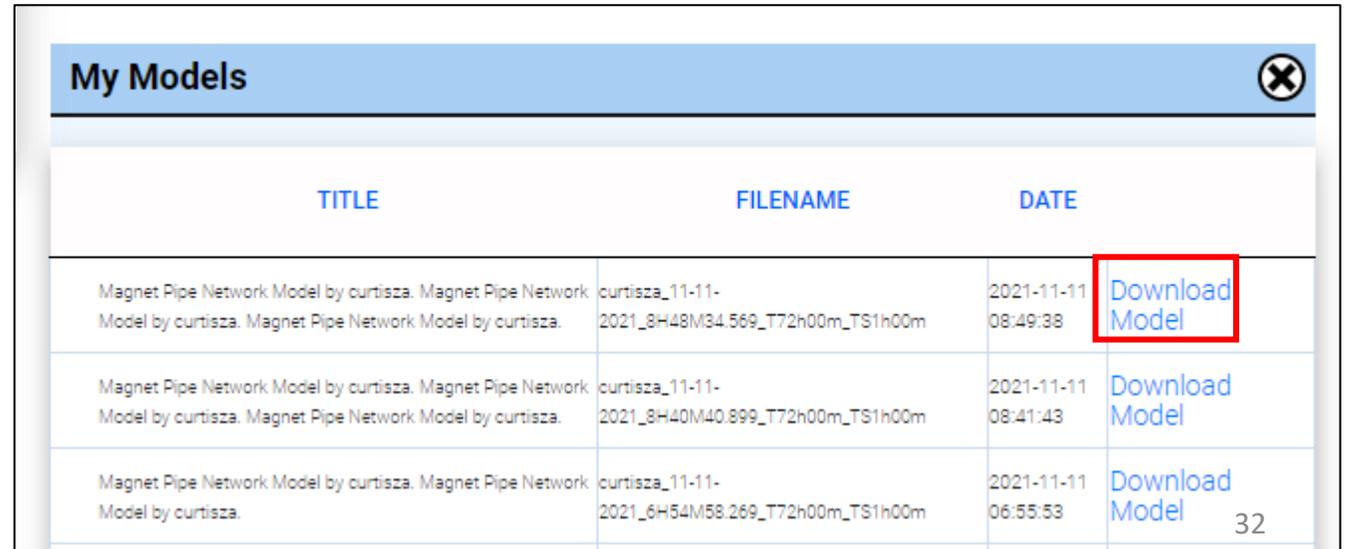
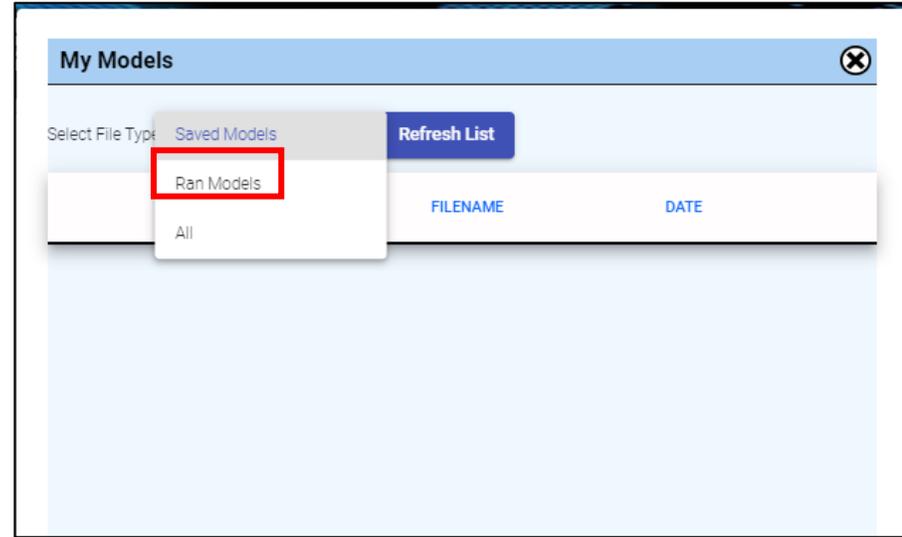
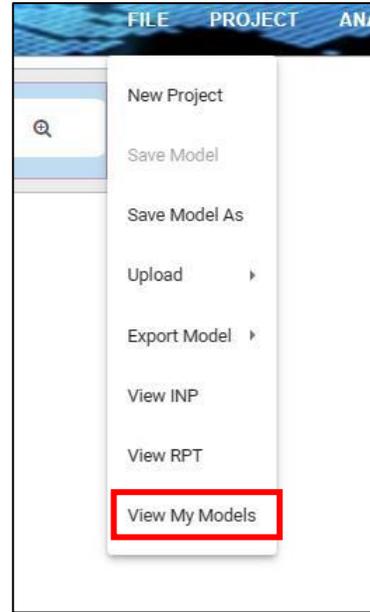


View/Download the Model File:

[Menu Bar] FILE > View My Models

This opens a My Models interface. You can select from Saved Models (i.e., those created from File > Save Model ...) or Ran Models (previously executed models linked to your user account). Select Ran Models and click Refresh List.

In the list that appears Click 'Download Model' to download your latest .inp (model input) file to your local machine's Downloads folder.

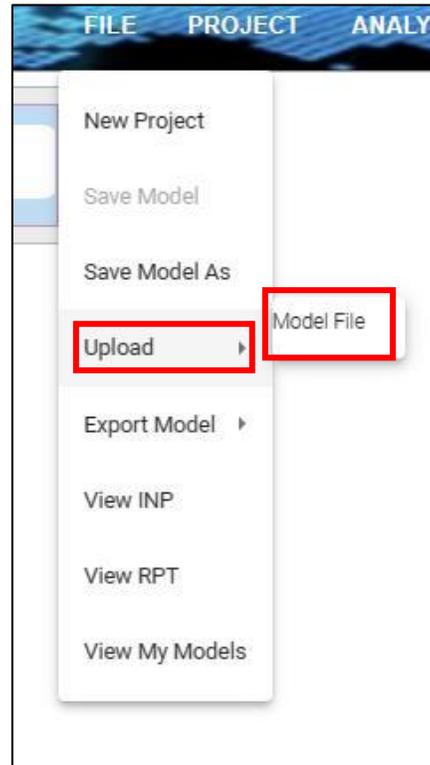


A screenshot of the 'My Models' interface showing a table of models. The table has columns for TITLE, FILENAME, DATE, and a 'Download Model' button. The 'Download Model' button in the first row is highlighted with a red box.

TITLE	FILENAME	DATE	
Magnet Pipe Network Model by curtisza. Magnet Pipe Network Model by curtisza. Magnet Pipe Network Model by curtisza.	curtisza_11-11-2021_8H48M34.569_T72h00m_TS1h00m	2021-11-11 08:49:38	Download Model
Magnet Pipe Network Model by curtisza. Magnet Pipe Network Model by curtisza. Magnet Pipe Network Model by curtisza.	curtisza_11-11-2021_8H40M40.899_T72h00m_TS1h00m	2021-11-11 08:41:43	Download Model
Magnet Pipe Network Model by curtisza. Magnet Pipe Network Model by curtisza.	curtisza_11-11-2021_6H54M58.269_T72h00m_TS1h00m	2021-11-11 06:55:53	Download Model

The .inp file can be uploaded back into
MAGNET PipeNET with:

[Menu Bar] FILE > Upload > Model File



Saving the Model File:

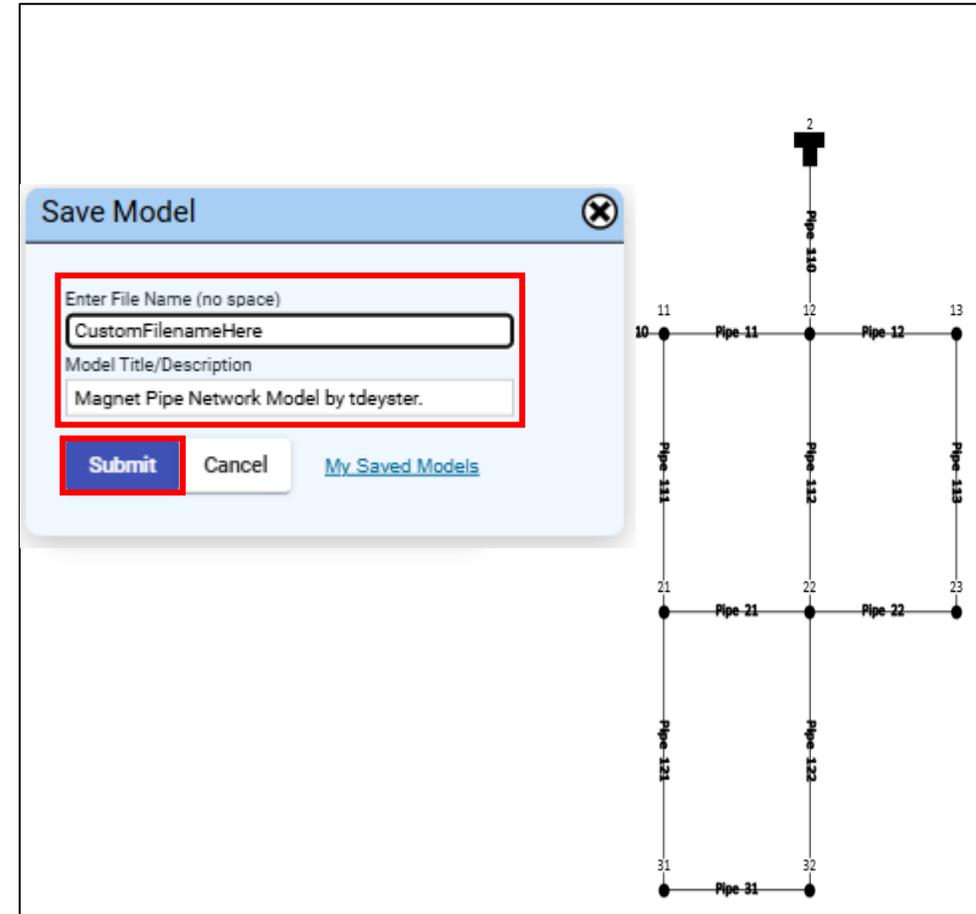
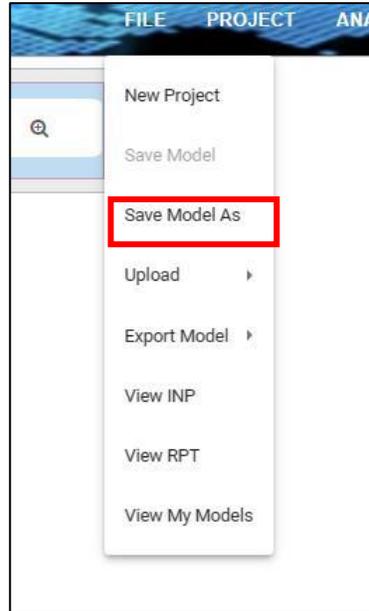
[Menu Bar] FILE > Save Model As

The model can be saved with a custom name (no space)*, and uploaded back into MAGNET PipeNET with:

FILE > Upload > Model File

For uploaded models, the 'Save Model' option is enabled and can be used to quickly save the model with its current name.*

*Model file names must be unique to preserve old versions. If a model is saved with a name already existing on the server it will overwrite the previous version.

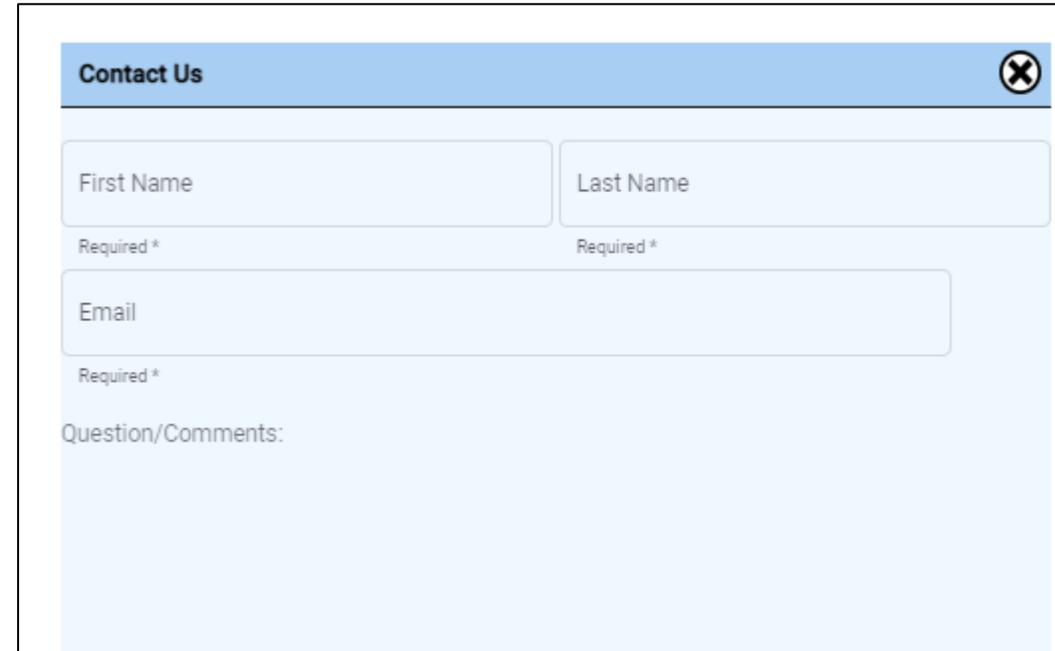


Questions / Comments / Issues?

Use: [Menu Bar] > SUPPORT > Contact Us

Or directly email:

support@magnet4water.com



The image shows a screenshot of a web form titled "Contact Us". The form has a blue header bar with the title "Contact Us" and a close button (X) in the top right corner. Below the header, there are four input fields: "First Name" and "Last Name" are side-by-side, both with "Required *" labels below them. Below these is a single "Email" field with a "Required *" label. At the bottom is a large text area labeled "Question/Comments:". The form is styled with light blue borders and a clean, modern look.